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Research Institute for Sustainable Humanosphere (RISH) Kyoto University
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THE 3rd INTERNATIONAL SYMPOSIUM FOR SUSTAINABLE HUMANOSPHERE (ISSH) - a Forum of The Humanosphere Science School (HSS) 2013, Bengkulu Indonesia, September 17-18, 2013

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"THE DYNAMIC INTERACTION BETWEEN PEOPLE AND ECOSYSTEMS FOR THE FUTURE OF HUMAN SUSTAINABILITY"

Gedung Rektorat,
University of Bengkulu,
Bengkulu-Indonesia.

September 17-18, 2013

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The Dynamic Interaction between People and Ecosystems for the Future of Human Sustainability

September, 2013
Gedung Rektorat, University of Bengkulu - Bengkulu
INDONESIA

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PREFACE

The 3rd International Symposium for Sustainable Humanosphere 2013 attracted the interest of scientists from Indonesia and Japan. The symposium covered the disciplines of community-based development and social economic science (climate change and society; ecosystem and community; the economical of natural resources; the role of traditional knowledge and values in managing ecosystems; women and natural resources), atmospheric science (airpollution; equatorial atmosphere; global climate change models; land-ocean weather systems; radar observations; solar activities; space environment; weather patterns), biosphere science (agricultural in changing world; animal ecology and animal husbandry; anthropological approach; bio-indicator; ethnobotany; food security; human development index), geosphere science (earth geological dynamics and natural disasters; earth carbon cycle dynamics; heat, water and CO; hydrology and water management system; land resource management), wood science and technology (biomass conversion; carbonized wood based composites; cellulose; chemical, physical and mechanical properties of wood; timber structure; wood for energy; wood cell formation; wood biochemistry; wood anatomy and plant physiology; wood deteriorating organisms; wood preservation; wooden construction; wood-based material; wood adhesive), wood and urban pest management (insect pest management, ecology and biology of urban pests, control of urban pest including biological, cultural, mechanical, physical and chemical controls), and forest science (biodiversity and society; biodiversity in tropical plantation forests; climate change and biodiversity; forest biomass dynamics; forest carbon accounting and monitoring; forest fire; invasive species; intensive silviculture; structure, growth and function; tree biotechnology). The technical program consisted of 38 oral presentations under 11 sessions and 19 poster presentations.

This publication is a compilation of presented papers. Every effort has been carried out to retain the original meaning and views of authors during the editing processes. All claims on trade products and processes and views expressed do not necessarily imply endorsement by the editors.

We believe that this publication will be a useful source of information and achieved its primary objective of disseminating new experiences and information to researchers, academics, policy makers and students.

The organization of this international gathering and compilation of the proceedings could not have been achieved without the combined effort of all members of the organizing committee and the supports of Research Institute for Sustainable Humanosphere (RISH), Center for South East Asian Studies (CSEAS) Kyoto University, International Center for Interdisciplinary and Advanced Research (ICIAR) – LIPI, University of Bengkulu (UNIB). The editors hereby wish to acknowledge the contributions of all parties.

Editors

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BIODIVERSITY FOR SUSTAINABLE DEVELOPMENT

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Abstract

As an archipelagic state , with its thousands of islands scattered between two continents (Asia and Australia) and between the Pacific and Indian oceans, Indonesia endowed with a rich and unique biodiversity. Biodiversity is the foundation of life on earth and one of the pillars of sustainable development. Human survival and wellbeing depend upon biodiversity and healthy ecosystems, and the goods and services they provide. Biodiversity is life insurance for sustainable development in Indonesia. Therefore, efforts to conserve biodiversity in Indonesia are very important since many places are centres of origin, centres of diversity and centres of endemism. Conserving and promoting sustainable use of biodiversity creates opportunity for reducing poverty and for improving human well-being, and it is one of the challenges that Indonesia has committed itself to addressing. So many conservation areas have been established or designated on all major habitat types, including 8 Biosphere reserves as models of land management and of approaches to sustainable management. Experience shows that Biosphere reserve considered as the most suitable approach. Biosphere Reserve is based on holistic landscape approach by considering real problems on field and involves stakeholders to understand and solve the problem together. For sustainable use and conservation of biodiversity, require creativity and new advances in scientific knowledge. We must take efforts in research activities, because biodiversity sciences are an integrated field of science requiring a wide scope of knowledge.

Keywords: Biodiversity, sustainable development, biosphere reserve, Indonesia.

INDONESIA GREEN BUSINESS STRATEGY

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Abstract

We recognize that green business plays a vital role on conservation and sustainable development. The green business developments present both opportunities and challenges for socioeconomic development and environment and have a number of potential impact on natural resources and the rural poor who depend on natural resources for their livelihoods. The green business defined as: bio-energy, climate change, job creation & poverty eradication, enhancing food security, bioactive compound for medicine, biodiversity, water-quality, quantity & regimes, and forest health & sustainability as agreed during United Nation Conference, Rio + 20. At more strategic vision, Indonesia has also committed to achieve United Nation Conference on Sustainable development at Rio 1992 and Rio 2012(Rio + 20). The tropical rain forest of Indonesia is a treasure house of potentially useful species. Consequently, in this global era, we have to work hard, keep creating and innovating a new technology to utilize our resources. Among other positive results, the author has developed an innovative planting model and silvicultural system for commercial plantations and the rehabilitation of logged over areas and other degraded forests. The system was referred as Intensive Silvicultural Technique (SILIN). SILIN improve forest productivity from (20 – 40)m^3/ha/35 yrs to 280 m^3/ha/30 yrs. SILIN has showed to be economically profitable and environmentally compatible and has been selected in Year 2008 as one of hundred prospective Indonesia best innovations by Business Innovation Centre & Kantor MenRistek & BPPT. In Year 2013 the GOI established Tem Task Force SILIN to guide and speed up the progress of SILIN to facilitate green business program.

Keyword: Green Business, Strategy, Sustainability, Productivity.

Introduction

According to Rio + 20, **g**reen business in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development and that could provide options for policymaking but should not be rigid set of rules. Green business will promote economic growth, foster innovation and provide opportunities, and benefit for all and respect of all human rights.

In the context of forest resources, green business will contribute to provide source of energy, reducing CO_2 emission, job creation & poverty eradication, enhancing food security, providing bioactive compound for medicine, sustaining biodiversity, ensuring water in term of quality, quantity & regimes, and improving forest health and sustainability. Therefore, green business hopefully will improve economic growth.

However, Indonesia has been facing dramatic challenges to protect, manage and improving its forest resources. The country is well known for its high rates of deforestation and degraded forests, due to illegal logging, natural fire, and over exploitations, as seen in Figure 1. The GOI was, and still is, concerned that if the continuing forest degradation was not addressed successfully, it could result in the potential loss of forest resources, with serious biological, ecological and economic consequences for the country. In this regards, Indonesia has developed new technique was referred by the innovator as ***intensive silvicultural technique*** (eventually renamed ***SILIN*****)** Shown in Figure 2**.**

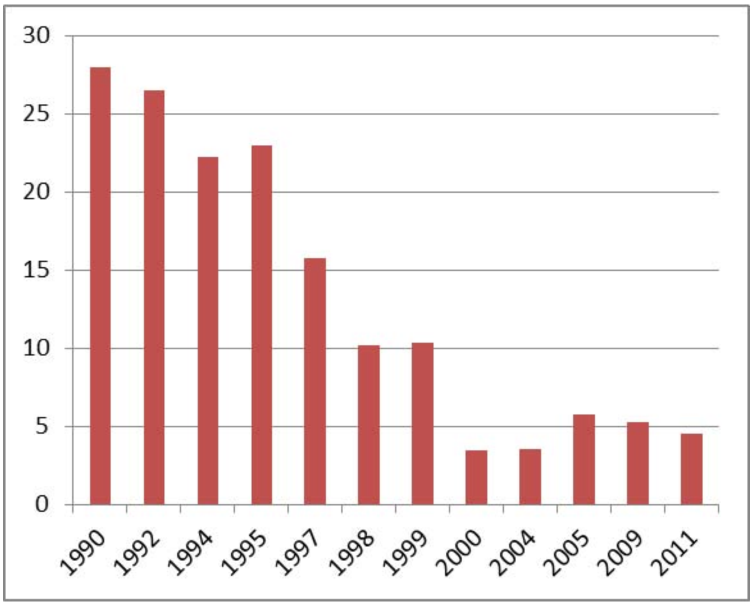


Figure 1. Trend in reducing wood production

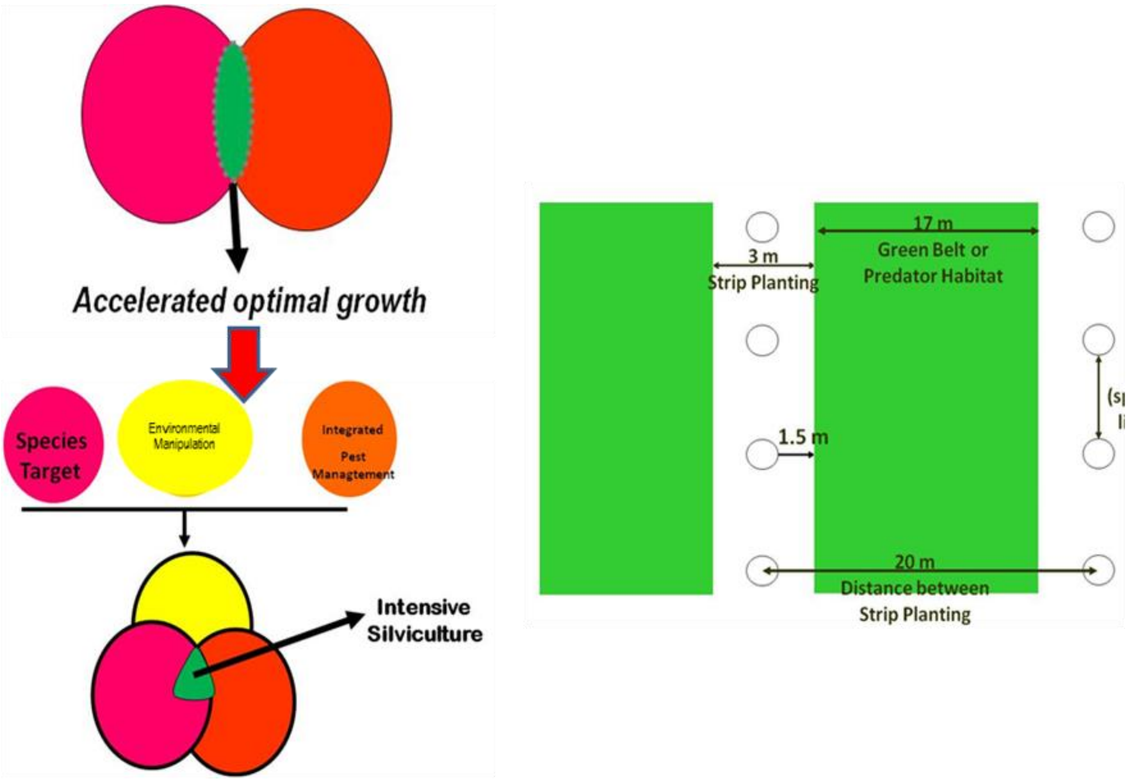


Figure 2. SILIN technique

SILIN technique consists of three elements (Figure 1 left) that are (1) selected species, (2) environment manipulation and (3) integrated pest management [1]. Selected species was the results from species trials, in this regards we screened group of commercial species in several locations and replicated. Environment manipulation is by providing optimal light and enough nutrition by digging planting hole (40 cm x 40 cm x 30 cm) for new planted young trees. Planting hole be put mixture of compos and mineral soils (1 : 1 by volume), see Figure 1 right. Integrated pest management is by providing habitat of predator in un-disturb area (85%).

The un-disturb areas (Figure 1 right) are intended to serve the following purpose :

1. As habitat for predator, native flora, and fauna, and therefore to maintain biodiversity
2. To maintain the semi -natural nature of the forest for conservation purposes.

The advantages of SILIN technique over the existing silvicultural systems are :

a. Management control by both the concession holders and independent auditors can be conducted easily and efficiently
b. Forest productivities is increasing (5 – 9) times compares to existing systems
c. High productivity and product quality harvested continually would increase company activities, which would lead to increase of job positions available, increasing company capital and investment and intensification of funds for business and activities. All of these would eventually lead to increase company reputation.

Attempt to increase productivity of logged over forests could be achieved by using SILIN technique. However, before applying the SILIN technique at a large scale, we had to test SILIN technique in pilot test called ***concession pilot test model*** **(HPH/concessions model).** There were six HPH model as shown in Figure 3.

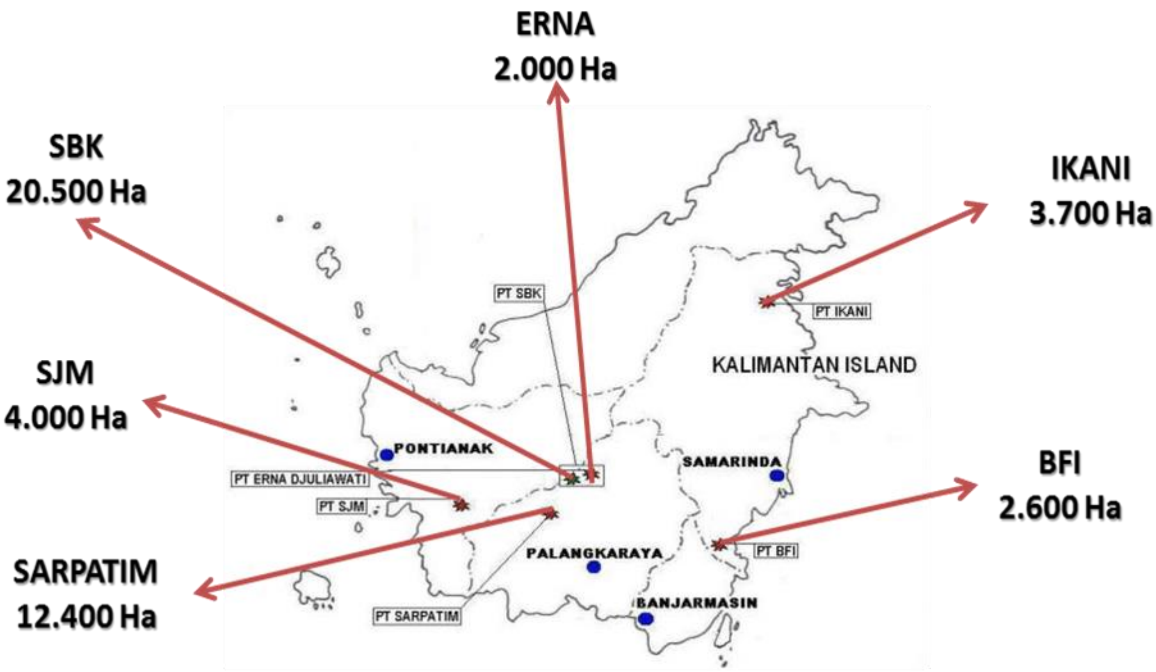


Figure 3. SILIN technique practiced in six HPH model

The condition of plantations at five years old be illustrated in Figure : 4, 5, and 6.

5 years old of *S.leprosula* plantation
Mean annual increment 2.5 cm/year (SBK)

5 years old of *S. leprosula* plantation
Mean annual increment 2.17 cm/year (Erna)

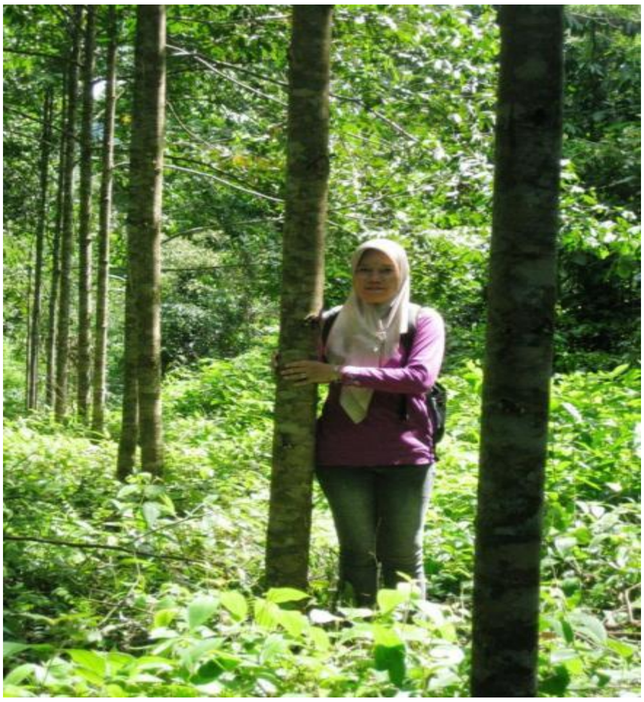
Figure 4. Left Sari Bumi Kusuma concession, right Erna Djuliawati concession, both located in Center of Kalimantan Province

5 years old of *S.leprosula* plantation
Mean annual increment of DBH= 2.19 cm/year (Sarpatim)

5 years old of *S.leprosula* plantation
Mean annual increment of DBH= 2.2cm/year (SJM)

Figure 5. Left Sarpatim Concession, Centre of Kalimantan Province

Right Satya Jaya Makmur Concession, West of Kalimantan Province



Shorea leprosula 5 years old diameter 10 cm

Figure 6. Balikpapan Forest Industry, East of Kalimantan Province

Based on the above information presented in Figures 4, 5, and 6 the predicted productivity is more than 335 m^3/ha/30 yrs, this productivity is much higher than targeted productivity in SILIN technique concepts (280 m^3/ha/30 yrs). Whether the plantation be managed by the private sector or the government, timber from this technique will play an important role in relieving the pressure on natural forests by supplementing wood supply in the future.

The objectives of developed of Pilot Test Plantation at six HPH model were :

1. To improve productivity and quality product of the existing logged over forests
2. To develop effective and efficient of logged over forests management
3. To improve competitive value and dynamically sustainable of logged over forests
4. To encourage private sector participation in forest establishment and development .
5. To strengthen and intensify current research on the production of high quality planting materials
6. To formulate more effective silvicultural regimes for plantation based on research and development finding
7. To continue supporting the of resources needed by business of green economy, these are bio-energy (***Bio-methanol*)**, reducing CO_2 emission, job creation & poverty eradication, ***bio-active compounds*** for medicine, enhancing food security, and sustaining biodiversity.

Green Business

Green business in the context of sustainable development should contribute eradicating poverty as well as sustained economic growth, improving human welfare and creating opportunities for employment, while maintaining the healthy function of the Earth's ecosystem. In this regard **green business** covers **: bio-energy, reducing CO_2 emission, job creation & poverty eradication, bioactive compounds for medicine, enhancing food security, sustaining biodiversity, and others.**

Rehabilitation of logged over forests using SILIN technique is generally more efficient in producing commercial timber than natural forests. In a view of rapid degradation of logged over forests, SILIN technique has been promoted as a better alternative to enhance timber production. SILIN technique for Indonesia is an option that needs to be carefully considered and given greater emphasis in preparing business of green economy and activities for various compelling reasons:

- There are vast areas of devastated forests may be converted into productive forests and will contribute to restore ecological health of our planet
- Tropical countries in a view of their superior growth rate

Bio-energy

Bio-energy is, in turn, defined as fuel derived from biomass. Bio-energy can be further sub divided by type (solid, liquid or gas) and by origin (forest, agriculture or municipal waste). Bio-energy from forest and agriculture (wood-fuel and agro-fuel) can come from a wide range of sources (forests, farms, specially grown energy crops and waste after harvesting or processing of wood or food crops).

The last ten or fifteen years have seen a strong resurgence of interest in bio-energy along with the gradual development of more modern and efficient bio-energy production systems. This has been driven by several factors including oil producing regions, extreme weather events, and others. High oil prices were directly related to the establishment of bio-energy mandate. Other drivers for bio-energy production may include demand for self-supply of energy commodities, mitigation of climate change, and the belief that such bio-energy is cheaper in response to these various factors, many countries have begun to explore bio-energy alternatives.

The development of bio-energy is likely to have significant impacts on the forest sector directly. It is expected that wood liquid or bio-energy (***bio-methanol***) will contribute lower carbon emission than fossil fuels, and consequently will benefit to climate. Fossil fuel combustion represents the return to atmosphere of carbon that was originally trapped by the biosphere and then transferred to geological reservoirs, effectively being removed from the fast carbon cycle. In 1998 fossil fuel and gas combustion have risen prominence, partition of emissions is coal 35,7 %, oil 42 %, gas 18,5 % and cement production 3,1 % [2].

The SILIN technique provide enough timber waste for producing ***bio-energy*** or ***bio- methanol.*** Each m^3 of timber waste equivalent to 0,24 ton of ***bio-methanol.*** At present condition, during land preparation of 1 000 hectare /year, at logged over forest with the potential production of 40 m^3/ha of commercial timber be estimated will produce 14.000 m^3 timber waste/ year or 46 m^3 of waste/ day. This waste will produce 3,360 ton of ***bio****-energy*/year or 12,2 ton/day. After 30 years, timber product will increase up to 280.000 m^3 logs/year and waste of 112.000 m^3/year or equivalent with 26.880 ton of bio-methanol/year.

There are two types of ***bio-methanol factories*** **:** mobile factory and stationer factory. For mobile factory needs the minimum of waste is amount of 10 m^3 per day, and for stationer factory require minimum of waste of wood amount of 100.000 m^3/day. This information, therefore, the concession with area of 50.000 ha forest logged over area and potential wood product of 40 m^3 logs is suitable to run one mobile factory during preparing plantation of 1.000 ha/year. Thirty years after planting the concession will run two type of bio-methanol factories that are mobile and stationer factories.

Reducing CO_2 emission

The global CO_2 question was started be observed regular, detailed sampling of atmospheric chemistry, in 1958 by the scientists at the Mauna Loa Observatory on the Island of Hawaii. The site was chosen partly because of its distance from human influences which reduces the effects of local sources such as factory, car, or home furnace exhausts on air chemistry. The measurements taken are assume to represent the average or well mixed condition of troposphere in the northern hemisphere.

Those measurements clearly show two patterns : (1) natural origin and (2) human origin. The natural origin is an annual cycle in concentration of CO_2 tied mainly to the seasonality of photosynthesis in northern hemisphere. CO_2 concentrations to decline in spring and summer, as photosynthesis outpaces decomposition, and to rise again in the fall and winter. The long term increase in CO_2 concentration at human origin, was suspected due to human intervention.

From those basic information in forested ecosystems, carbon accumulate through the absorption of atmospheric CO_2 and its assimilation into biomass. Carbon is stored in various pools in a forest ecosystem : above and below ground living biomass, including standing timber, branches, foliage, and roots; and necro-mass, including litter, woody debris, soil organic matter and forest products. Approximately 50 % of the dry biomass of trees is carbon. Any activity that affects the amount of biomass in vegetation and soil has the potential to sequester carbon from, or release carbon into, the atmosphere.

In the pre-agricultural state, forests are estimated to have covered 57 million km^2 and contained 500 Pg C (1 Pg C = Gt C = 10^{15} g of carbon) in living biomass and further 700 Pg C in soil organic matter, and circulating 10 % of atmospheric CO_2 back and forth into the biosphere every year through gross photosynthesis [3]. The intensity and human alteration of biosphere has accelerated since the industrial revolution, and by 1990 (20-30) % original forest area had been lost. This loss of forest cover has contribute 45 % of the increase in atmospherric CO_2 observed since 1850 [2]. Recent estimates, the tropical land use, mainly in a few countries (including Indonesia) contributes about 20 % of the global emission.

Figure 7. CO_2 sequestered in strip line and non strip

SILIN has been designed to continuously provide atmospheric CO_2 absorption as shown in Figure 7. In this picture CO_2 sequestered in the strip line plantation (Fig. 7 left) and the remaining areas (non strip planting). The results of CO_2 sequestered rate with SILIN in the strip line is much higher than in the area non disturb or logged over forest that design for the habitat of predator and for conserving natural biota.

The results of plantation using SILIN technique from Year 1999 to Year 2011 using 3D SAR approach [4]. The result is presented in Figure 8. Figure 8 indicated that :

- 3D SAR approach is successfully to monitor technique SILIN
- Plantation using technique SILIN after 10 years is close to the virgin of natural forest
- SILIN technique can be monitor both by radar as practiced by Solberg or by ordinary monitor (Figure 9)

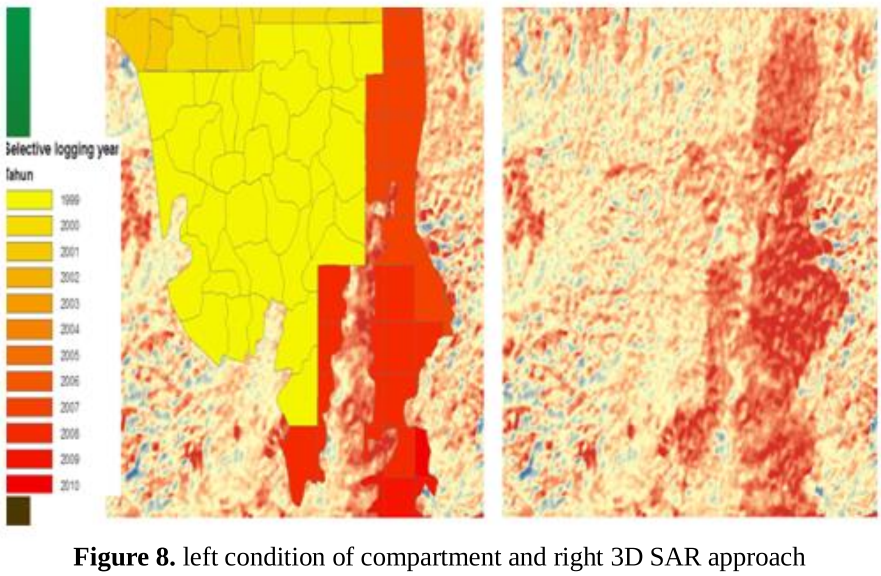


Figure 8. left condition of compartment and right 3D SAR approach

Figure 9. left ground picture of 10 yrs old, right air photo of 5 yrs old

Some conclusions on CO_2 sequestration discussion may be drawn :

- SILIN Technique will lead to enhanced environmental resilience and alleviation of rural poverty, although the lessons learned are limited.
- Some emerging issues need further elaboration
- Links between mitigation and adaptation strategies are urgently needed.

Job creation & poverty eradication

The opportunity for job creation can be generated through SILIN technique, where the technique has to develop commercial plantation of dipterocarps. The products of plantation are needed by wood factories and wood markets. Therefore, job opportunities may be required for planting and improving productivity of logged over forests, wood factories and wood markets. The personnel consists of many labors untrained and trained, technicians, professionals (foresters and non forester) and scientists.

We recognize that a significant portion of poor people live in rural area close to forests. Given an opportunities that rural communities to work to rehabilitate logged over forest, they will play an important role in economic development, especially to assist green business economy. The job for establishing of commercial plantation consist of :

1. Site preparation by making liberation line of 3 m wide (1.5 m from left side and 1.5 m from right side of line, about 15 % of the total area (Figure 2), so that allow light enters planting line optimally.
2. Space of planted seedling 2.5 m
3. Space between line 20 m
4. Remaining un-disturb vegetation 17m, for habitat of predators, maintain native dipterocarps.
5. Preparing planting materials in a nurseries 220.000 good quality seedlings for 1.000 ha plantations

The job to manage forests consist of :

1. Forest inventory
2. Planning on working area
3. Selecting harvesting systems
4. Planning and designing forest road networks
5. The social function of managed forests

The job for wood factory, such as wood factories including bio-methanol factory Certainly require many workers . For plywood factory, with intake of (250.000 to 300.000) m^3 log would require 3.000 workers. Many of un-skill people live in urban area, where, wood factories are located, therefore, planned prospective forest and good forest management are needed.

Bio-active compounds

Tropical Rain Forests typify, to the most people, the ultimate source of biological diversity on this planet. Indeed, of the more than 50.000 species of trees, worldwide, greater than 70 % of them are tropical endemics. Moreover, the typical species mixtures of tropical rain forests are remarkably diverse, often more than 250 tree species may be found growing on a single hectare. The tropical rain forest of Indonesia is a treasure house of potentially useful species.

Biodiversity provides the basis for life on earth. The variability among living organisms and among the ecological complexes of which they are part of many commercial products for human life, but also providing essential of ecosystem services such as the purification of water, prevention of soil erosion and floods and regulation of the climate.

Recently, in addition of pharmaceutical industry, rapid growth of the botanical medicine industry. Botanical medicine, as distinct from pharmaceuticals, are produced directly from whole plant meaterial. As a result, they contain a large number of constituents and active ingredients working in conjunction with each other.

Example of potentially useful species as illustrated in Figure 10, ***Calophyllum laningerum*** , that found in Batam, and other Rio Isle Province, and West Kalimantan

Figure 10. left plant, right chemical structure & function

Figure 11 ***Eurycoma longifolia,*** found under story or ground flora of Kalimantan and Sumatera, and hundred other sample of potentially useful species.

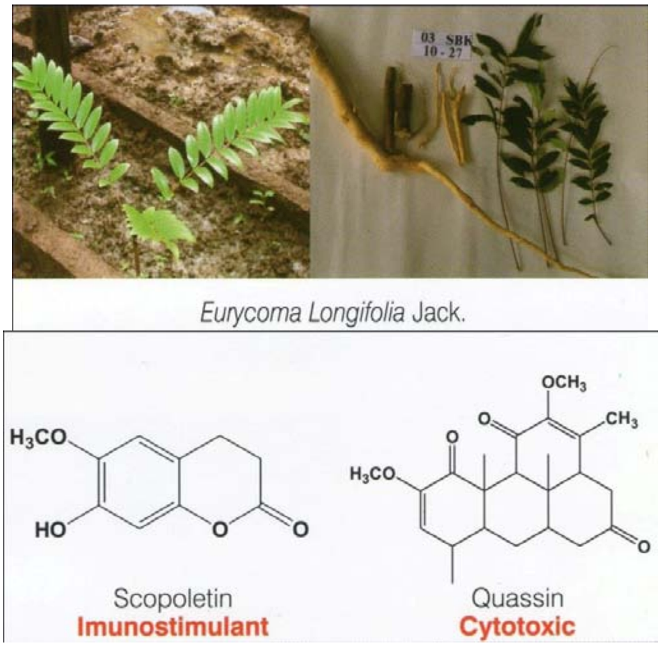


Figure 11. ***Eurycoma longifolia,*** left plant, right chemical structure & function

Enhancing food security

Food security and nutrition have become a pressing global challenge. We recognize the importance of taking the necessary actions to better address the need of rural community, usually community around forest area, enhancing access to credit and financial services, markets, social services, education, training of affordable technologies are required.

One way of improving sustainability of food, in forest area, ***tumpangsari*** technique plays an importance role to secure food. Tumpangsari technique refers to land-use-systems and technologies where trees are deliberately used on the same land management unit as food crops either in some form of spatial arrangement or temporal sequence. Tumpangsari uses tree as a major component of multi-crop production system that echoes more natural multilayered ecosystem.

Effort Fakultas Kehutanan Gadjah Mada University to take action in improving productivity and quality of product of tumpangsari plantations through research as shown in Figure 12. The research has been conducted at three locations, Ngawi, Randublatung and Cepu since Year 2010. The research is a cooperative program with Perum PEHUTANI.

Figure 12. Left 3- month-old plantation, right food crop 3-month-old and teak one year old

The results are significantly improve for supporting food stock and support more sustainable food security and is economically viable as illustrated in Figure 13.

Varieties	Randublatung		Ngawi		Cepu	
	Jajar Legowo (ton/ha)	Konven Sional (ton/ha)	Jajar Legowo (ton/ha)	Konven Sional (ton/ha)	Jajar Legowo (ton/ha)	Konven Sional (ton/ha)
Inpago 4	10,97-13,03	8,74-11,04	7,59-10,35	-	9,37-11,15	7,47-9,44
Inpago 5	10,12-12,88	8,40-11,96	7,82-10,75	-	8,65-11,01	7,18-10,22
Inpari 6 Jete	9,66-13,95	10,27-12,19	8,05-11,27	6,67-7,74	8,26-11,93	8,79-10,42
Inpago 6	7,82-10,23	-	8,56-11,73	7,94-10,47	6,69-8,75	-
Situ Patenggang	7,13-11,12	-	9,05-12,19	7,98-11,67	6,10-9,50	-

Figure 13. Productivity of rice at 3 locations of trial

Resource sustainability to support green business

To call the resource sustainable mean that it can be continued for the foreseeable future. Sustainability has thus become one of the core concepts. In forestry a sustained yield may be defined as regular and continuing supply of desired goods and services to full capacity of the forest and without impairing the capability of the land.

The cncept of sustained yield is central to all organized forestry but the interpretation of it varies with circumstances. There are two major developments which have induced a fundamental shift in attitude towards coupling sustained yield closely to normal growing stock. The first of these is the formation of new forest resources based on pure, regular stands, often exotic species; the second is the use of research and development to devise ways of increasing the yield of forest.

The second development can be seen in SILIN technique as the results of research into forest genetic and environmental manipulation to improve the productive capacity of plantation as illustrated in Figure 9 and 12. To monitor sustainability is a long term program based on status, changes and trends in condition (indicator, such as growth, fertility of soil,) of plantation/forest. The change of condition of plantation at 10 years-old minus 5 years-old in Figure 9 is clearly positive. When monitoring is conducted every year, the results will be a trend of growth.

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SUPER SWEET Sorghum (Sorghum bicolor (L.) Moench) POTENTIAL AS A RAW MATERIAL INDUSTRY IN INDONESIA

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[3]Sorghum Japan Foundation; [4]Syswave Holdings

Abstract

Opportunities to develop sweet sorghum in Indonesia are very high as a source of raw materials of food, feed and bioethanol for energy. Besides that bagasse can used as a raw material substitute wood particles or fibers as a raw material particle board, cement bonded board and fiberboards. The last few years have developed planting of local sorghum of Indonesia as a substitute for grain and forage source for cattle farming and bio-ethanol. But local production of both grain sorghum and biomass still low at 30-35 tones / ha / year of wet weight biomass (Wardani, 1996). Since 2012 in Indonesia has performed tests planting new varieties of super sweet sorghum from Japan. This new variety trial plantation conducted at several locations such as Cibinong, Yogyakarta, Lampung, Riau and Pasuruan. The production of biomass each location can be seen in Figure below. From the figure seen that super sweet sorghum production from Japan is showing very high compared with the production of local sorghum of Indonesia.

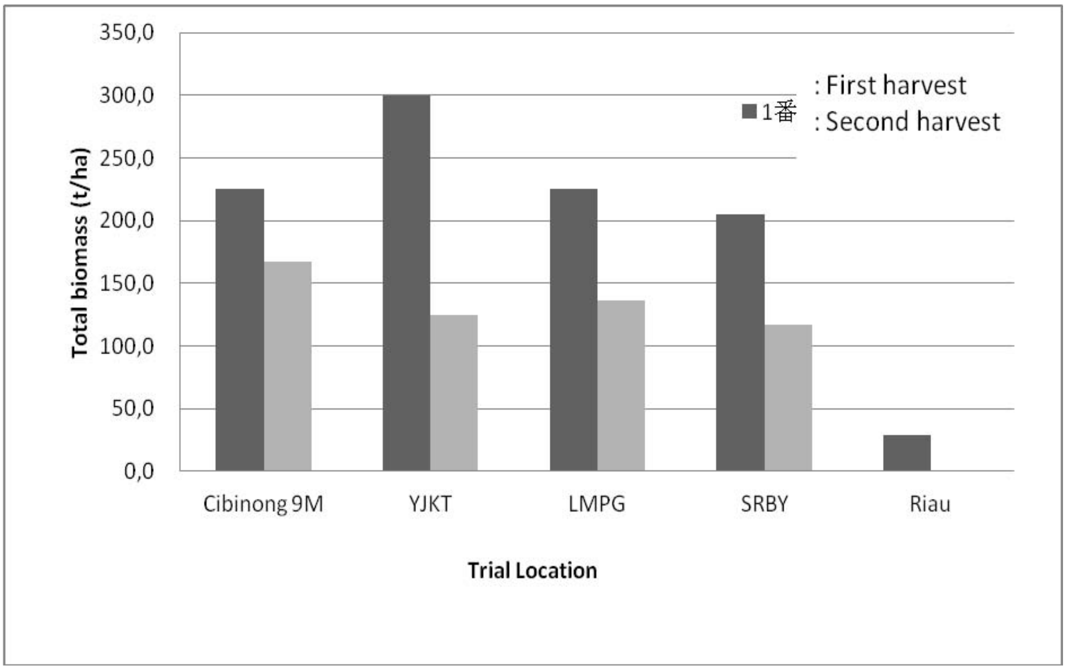

Figure 1. Production of biomass in wet weight in several locations on the first and second harvest
Note: Cibinong 9M = Cibinong; YJKT = Yogyakarta; LMPG = Lampung; Srby = Pasuruan, and Riau = Pekanbaru

LEARNING FROM COMMUNITIES, BRIDGING GENERATIONS: INDONESIA-JAPAN COLLABORATIVE PROJECT FOR DOCUMENTING COMMUNITY'S ECOLOGICAL KNOWLEDGE

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Abstract

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Keywords: Central Sulawesi; forest policy and community; Indonesia-Japan collaboration; tenure systems; the role of traditional knowledge and values in managing ecosystems

COMMUNITY DEVELOPMENT MODELS IN HANDLING CONFLICTS IN FORESTED LANDSCAPE: TOWARDS HORIZONTAL AND VERTICAL EQUITY

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Abstract

Many communities in forested landscape in Indonesia have expressed their dissatisfaction for unjust landscape governance. Landscape is a mosaic of forest core used mostly for ecological purposes, forest edge for economical purposes, and mix agriculture that work as an ecosystem. Value added or money generated and obtained by local communities in forest core was less than they obtained in forest edge, while value added in agriculture was the largest. This horizontal imbalance created pressure to forest areas due to agricultural expansion. In the other side, value chains of forest and agricultural products such as wood, rubber or coffee were buyer driven. Those who close to buyers or marketing side enjoyed the greatest value added. This vertical imbalance made local communities in forest core, forest edge, and agricultural mosaic land relatively less prosper compared to those who participated in trading. Local communities located in forest core, East Kalimantan felt that forest concessionaires took most value added from their customary land. Local communities in forest edge, South Sumatra thought they obtained unfair value added from a community-company partnership on acacia plantation. Small-scale teak furniture producers in Central Java enjoyed the least value added compared to large furniture business actors. These evidences emerged as conflicts at various levels. This paper describes community development models to reduce horizontal and vertical conflicts by reviewing and prospecting three community development cases in Kalimantan, Sumatra and Java. The cases were sites of participatory action research, which built under communicative action and complexity theories. The model provides learning that words or talks or even commitment is necessary but is not sufficient. Only institutionalized action that is well communicated creates reciprocal action for social and political transformation towards better governance, livelihoods and landscape sustainability.

Keywords: *conflict, governance, landscape, sustainability, value added,*

Introduction

Landscape degradation is continuing to occur globally. Land conversion and grabbing is happening. Managing natural resources means managing an ecosystem with various stakeholders who have interests on that ecosystem. Landscape is not empty [19]. The stakeholders can act and behave with conflicting interests. Synergy of stakeholders is highly expected, but trade-off of interests among stakeholders repeatedly occurs. Resource users frequently behave individually to maximize their interests and may change their strategies and actions to respond other users.

Landscape is a mosaic of different land cover and land use patches, which work as an ecosystem. Three zone types of a landscape are identified i.e. forest core, forest edge and agriculture mosaic land mosaic-lands [4]. Forests are located in the forest core and edge zones, while agriculture is located in the mosaic land. The expansion or extension of agriculture both small- and large scale have threatened forested land. Evidently agriculture e.g. rice field, oil palm and cacao plantations produce value added higher than forestry e.g. logging concession, national park and protected forest. Pressure on forest by agricultural extension occurred in Java, Sumatra and Kalimantan. This horizontal inequality needs to be managed, otherwise horizontal conflict will emerge.

Actors in different landscape zone produced commodities that link to market forming commodity value chains. Agriculture and forest products and services mostly are buyer driven. It means that buyers who are located outside or 'above' the landscape have more power than the producers who are located in landscape. In other words, landscape actors enjoy less value added compared those who do trading or marketing commodities.

There is no single definition on conflict. However, most definition involves the following factors: there are at least two independent groups, the groups perceive some incompatibility between themselves. Conflict is an expressed struggle between at least two interdependent parties who perceive incompatible goals, scare resources, and interference from others in achieving their goals. There are several causes of conflict. Conflict may occur when among others (a) A party is required to engage in an activity that is incongruent with his or her needs or interests; and (b) A party wants some mutually desirable resource that is in short supply, such that the wants of all parties involved may not be satisfied fully [27]. Conflict was managed in many ways among other by compromising and integration.

This paper reviews community development cases in Sumatra, Kalimantan and Java to take lessons learnt how to deal with conflicts. The sources of review were journal articles published by the authors and related researchers. This was an early stage for more robust review.

Methods

This paper was developed using systematic review method involving the following steps: (a) planning the review: question formulation and protocol development; (b) Conducting the review: literature search and selection, methodological assessment, literature extraction and synthesis; and (c) reporting and disseminating the review [10]. While [1] and [24] stated that systematic review was a study with the following steps: (a) formulating research questions; (b) intensive literature search; (c) formulating inclusion and exclusion criteria; (d) assessing literature; (e) synthesis and meta-analysis; (f) interpreting the overall result.

Since this paper was the early stage, then we were not able to complete these steps in comprehensive manner. We selected cases in Sumatra, Kalimantan and Java that the authors personally involved in that Participatory Action Research (PAR). The cases can be framed as a part of conflict resolution. From the definition of conflict, a case can be categorized as conflict if there are two or more interdependent groups who perceive incompatible in achieving their goals.

Participatory Action research (PAR) is a process through which members of a community identify a problem, collect and analyze information, and act upon the problem to find solutions and to promote social and political transformation with support from an external facilitator [23]. We, as researchers and facilitators, collaborated with community members or stakeholders and perceived them as co-researchers in PAR, which uses a cycle of reflection, planning, action and monitoring (see **Figure 1**).

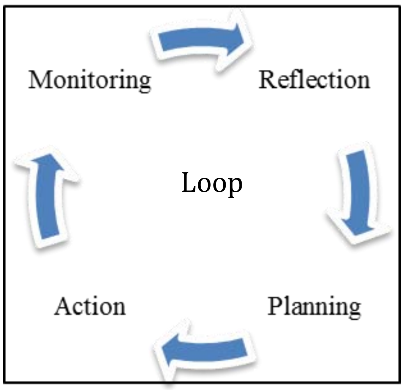

Figure 1. The reflection-planning-action-monitoring loop used for upgrading

Results

Formulated Research Questions

There were three research questions we would like to answer (a) How did conflict emerge in selected areas? (b) What efforts have been done to resolve the conflicts? (c) What is the lesson learnt from the conflict resolution?

Literature used

We found rich body of literature regarding conflict theory and conflict in natural resource management. Many international centers including CIFOR, ICRAF, United Nations Interagency Framework Team for Preventive Action provided publications in this topic. Three cases were extracted from the articles published by [11] [20] [21]. Other articles as listed in the references support the cases.

Review Result

Landscape is a mosaic of different land cover and land use patches, which work as an ecosystem. For the landscape we took thoughts of three zone types i.e. forest core, forest edge and mosaic-lands as proposed by [4]. The features and challenges for each zone is described in **Table 1**.

Table 1. Landscape elements, features and challenges [4]

Type of area	Features	Poverty and development challenge	Environmental challenge	Governance challenge
Forest core	Most of forests, minority of forest inhabitants but many indigenous people	Providing services for dispersed populations	Maintaining large-scale environmental processes	Protecting indigenous people's rights; adverting disorderly frontier expansion
Forest edge	Agricultural expansion, rapidly increasing land values; conflicts over forest use	Fostering more intensive rural development and access to off-farm employment	Avoiding irreversible degradation; mitigating CO_2 emissions, avoiding forest fragmentation	Restraining resource grabs by large actors; averting races for property rights by smallholders
Mosaic-land	High land value, many inhabitants, small fraction of the forest	Managing landscapes for production and environmental services; preventing extinctions of threatened species; fostering carbon sequestration		Enforcing property rights over land and environmental services

In general, forest core tends to have less people and less economical value compared to forest edge and mosaic land. This economical imbalance creates horizontal pressures from mosaic land to forest core (**Figure 2**). In the other side, the buyer-driven value chain of forest and agricultural products make actors located outside the landscape e.g. brokers, traders and retailers have more power and enjoy more value added compared the raw material producers.

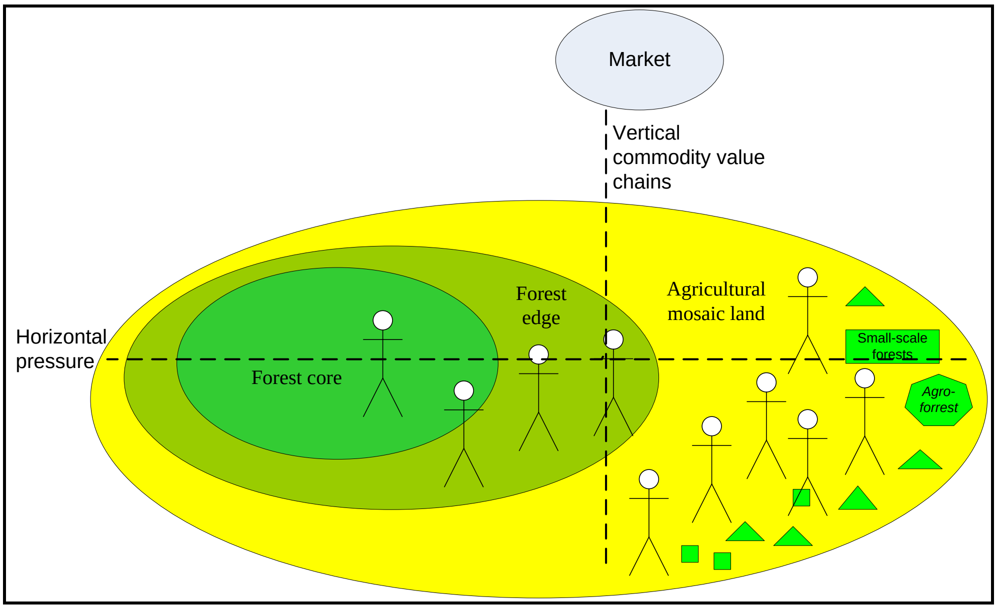

Figure 2. Landscape and its horizontal and vertical links

Sumatra case

The plantation is located in South Sumatra, Indonesia (**Figure 3**). it is a well-planned acacia plantation. The company obtained an industrial forest concession and began to transform rubber and reforestation lands in South Sumatra Province in 1991. Among 296,400 ha included in its concession, about 10% were disputed. The local government recommended that development should be suspended on disputed lands until a solution could be mediated. However, the proposed resolutions had not yet met the aspirations of the local communities.

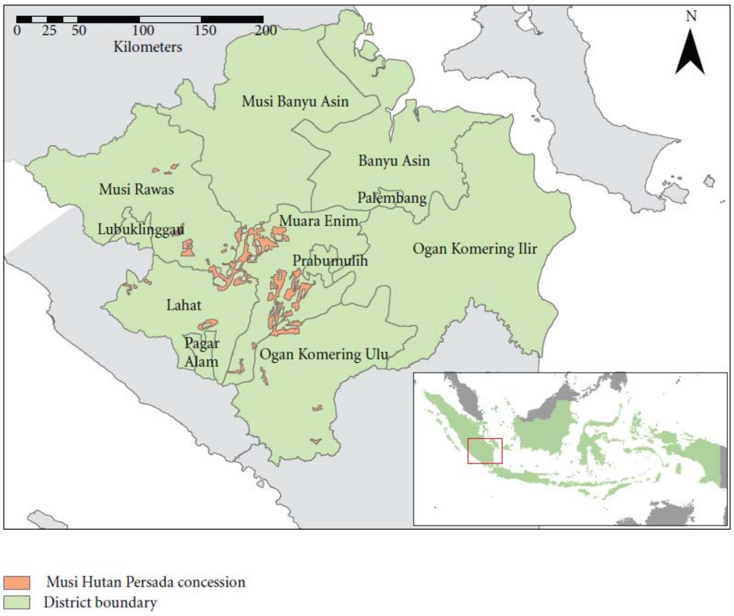

Figure 3. The forest plantation concession in Sumatra [15]

The company, which has been operational since 1990, developed two partnerships with local communities in 1998 to resolve land-use issues and secure the company concession. These partnerships were *Mengelola Hutan Bersama Masyarakat* (MHBM), collaborative management on concession land through a partnership agreement, and *Mengelola Hutan Rakyat* (MHR), collaborative management of communities' traditional lands through a benefit-sharing agreement. Nevertheless, communities did not consider MHBM fair when it was implemented. Therefore, horizontal conflict between the company and local communities, and among local communities emerged in this area.

The European funded project titled *Levelling the Playing Field* http://www.cifor.org/lpf (2004-2008) had been undertaken action research to mediate conflcit and facilitate the development of local institution which named SEBAHU SEJALAN, which is an acronym for *serasan membangun hutan sekundang sejahtera berkelanjutan* ('together we establish the forest for sustainable well-being'). This forum had become a place to discuss possible solutions on the conflicts among the community members and between the community and the company. These stakeholders with different rationalities i.e. market, industrial, civic, fame and inspiration were mediated in the forum. They communicated each other and transformed into collection action framed by the forum with clear vision, planning and action (**Figure 4**).

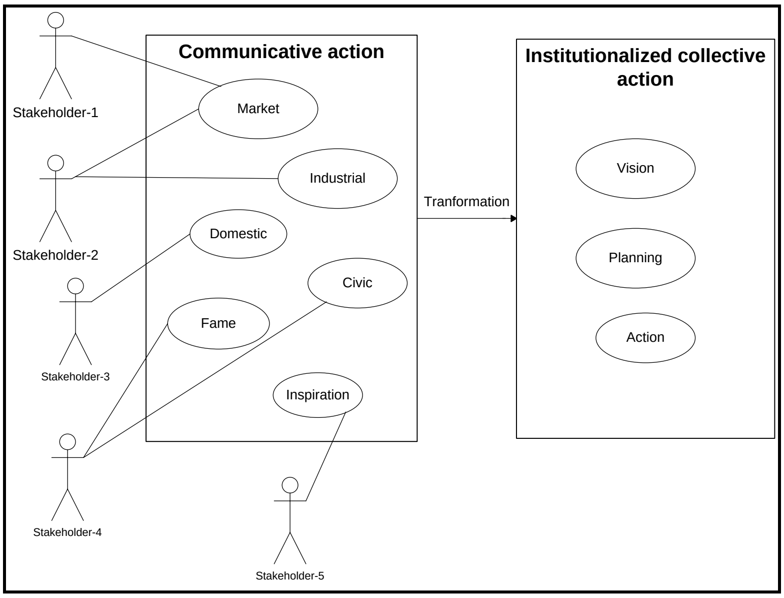

Figure 4. Stakeholders, communicative actions and collective actions

Kalimantan case

The case included a nature reserve (Lumut Mountain Forest), two villages (Rantau Layung and Rantau Buta) and a forest concession located in District of Pasir, East Kalimantan (**Figure 5**). Lumut mountain had been declared a protected area through Ministerial Decree No. 24/Kpts/Um/1993. It involved 35,350 ha of steep country, and was decreed to conserve soil and water resources. Timber cutting was prohibited. The main tree species found in the area are *Aglaia tomentosa*, *Artocarpus elasticus*, *Madhuca sericea* and *Shorea leprosula*. During 1970-93, the timber concession company PT Telaga Mas had harvested timber from the area. Telaga Mas retained rights to 130,000 ha outside the protected area. The central government had allocated the area to Telaga Mas in 1970 without deeply considering the concerns of local communities, as was the practice in Indonesia in the past. Therefore, horizontal conflict between the concession and local communities emerged.

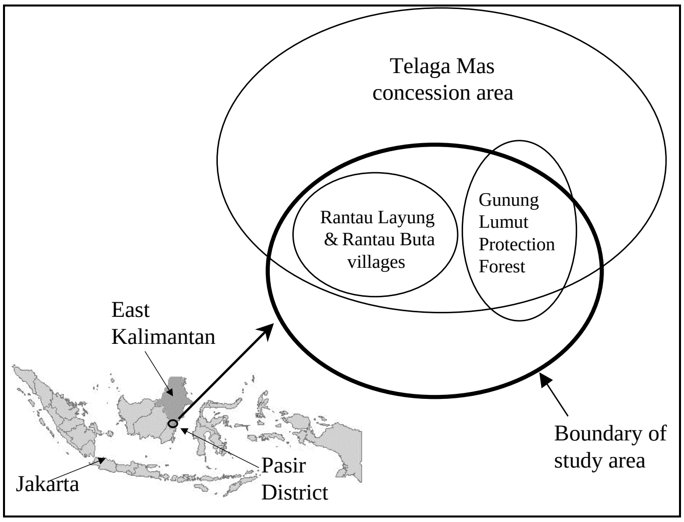

Figure 5. Location of the study area in East Kalimantan, Indonesia [11]

In 1970, government was highly centralized. However, Indonesian government had issued several important pieces of legislation aimed at transferring authority to the provincial and district governments, and at allowing resource-rich regions to retain a larger share of revenues generated within their jurisdictions. This case explored the common vision among Lumut Mountain Forest stakeholders to improve the sustainability and productivity of the area through participatory or collaborative modeling. The ultimate goal of this collaborative modelling approach was not to produce a rigorous model, but to propose an approach to integrate different stakeholder perceptions for forest management. The quality of built model and scenarios depend on the ability of the approach to faithfully represent the views articulated by stakeholders. The collaborative modelling process combined simulation [6], soft systems methodology [3], participatory research [23] and process agreements among the stakeholders.

It was assumed that village and customary leaders would represent the interests of local communities in the area. Similarly, it was assumed that the parliament member represented the district of Pasir. The Telaga Mas representative had a formal mandate to articulate his company’s interests. It was also assumed that NGO representatives could articulate the interests of local villages or organizations they represented. The Government and timber company could articulate their interests easily, but local communities were less able to do so without help of trusted local NGOs. These stakeholders, in a workshop, talked and discussed a common vision to understand the problems and came up with scenarios to solve them. As a result, a multi-stakeholders’ model was produced as shown in **Figure 6**.

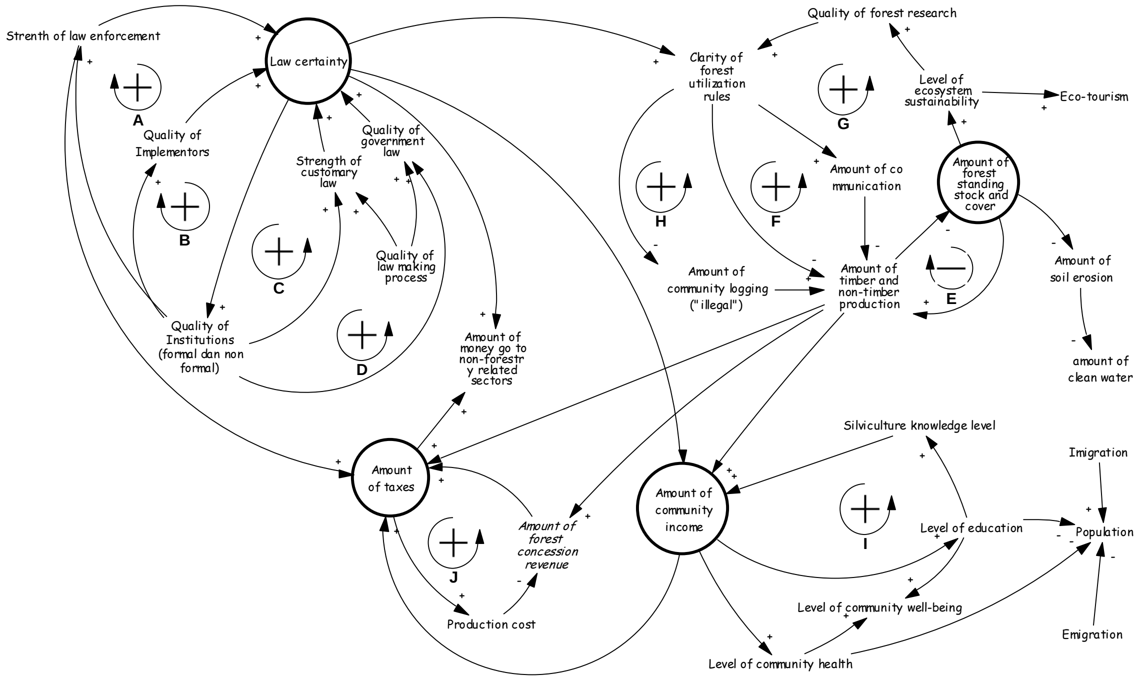

Figure 6. The complete causal loop diagram developed by the stakeholders [11]

The stakeholders perceived that 'Law certainty' was the key indicator in relationships involving forest laws and rules. 'Law certainty' is the level of transparency, persistence and enforcement of law perceived by stakeholders. 'Law certainty' influences quality of forest utilization rules, community income, and re-investment of forest taxes in other sectors. The 'Amount of forest standing stock and cover' and 'Amount of community income' were also selected by the participants as key factors within feedback loops. They identified a negative loop (E) between 'Amount of timber and non-timber production' and 'Amount of forest standing stock and cover'. The stakeholders also noted that 'community logging' influenced the 'amount of timber and non timber production' and increased the 'Amount of community income'. 'Amount of community income' and 'Amount of taxes' were also identified as key indicators. The feedback loop (I) highlights the role of education in increasing community income. **Figure 6** also reveals the expectation that better education will foster small planned families rather than unplanned families, as a result of the government's family planning campaign in schools.

As a result of the participatory modelling exercise, the following outcomes were realized:

- Public consultation. The District Government Regulation on Utilization Permission of Timber Forest Products (*Ijin Usaha Pemanfaatan Hasil Hutan Kayu, IUPHHK*) was opened for public comment.
- Collaborative forest management. Part of the concession would be allocated to the communities under existing regulations such as Permission of Timber Collection and Utilization (*Ijin Pemungutan dan Pemanfaatan Kayu*, IPPK).
- Infrastructure for the community to access the forest. In time, the local communities repay the forest concessionaire. Clear benefits for the community, for Telaga Mas and for the district government need to be identified to sustain the collaboration.
- Public hearings. District Parliament Members initiated a series of public hearings on the future of forest management in Pasir.

A collaboration between local communities and private company was also recommended in East Kalimantan in a case of forest concession [13].

Java case

Ninety five percent of furniture industry in Indonesia is composed of small and medium enterprises (SMEs). In Jepara District, Central Java, the furniture industry contributes about 27% of the district's economy. Exports were valued at about USD 120 million in 2009. The government, however, has categorized the furniture sector as an industry in decline. The SMEs have a lower market position than the bigger players. Still, the livelihoods of millions of people along the value chain depend on the sustainability of the furniture industry [5]. A survey conducted in 2005 estimated that 15,271 furniture enterprises existed in Jepara [22]. In five years, the furniture market has changed substantially. A survey in 2010 found only 11,597 enterprises. The distribution of furniture enterprises in Jepara is shown in **Figure 7**.

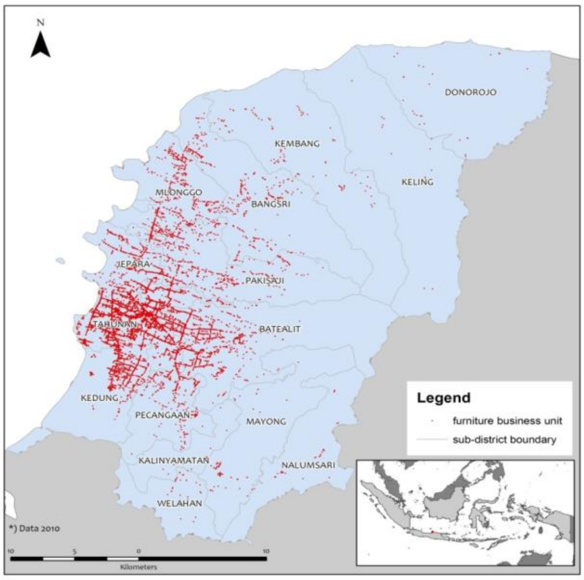

Figure 7. Furniture business unit distribution in Jepara (inset Indonesia)

Business relations between furniture producers and their buyers are usually imbalanced: Buyers set prices and producers cannot negotiate better deals. These unfair relations are part of the legacy from Javanese court practices. These patron–client relationships are still present in modern day relations between buyers and Indonesian furniture producers [16]. The compatible case existed in Sabah, Malaysia, in which local communities had low value added of small-scale acacia plantations [14]

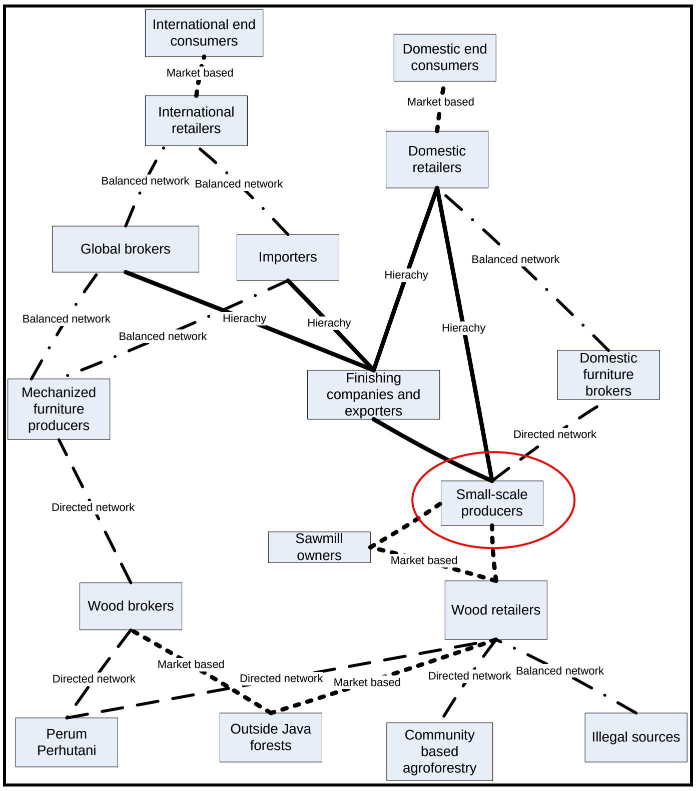

Figure 8. Value chains governance of Jepara furniture industry (Purnomo *et al.* 2011)

Small-scale producers, circled in **Figure 8**, were the focus of the study. They were involved in a directed network relationship with domestic brokers. The brokers were the main customers of the small-scale producers taking more than 50% of their product. However, the brokers could easily shift from one producer to another, ending the directed-network type of governance between exporters and small-scale producers. The relations between small-scale producers and sawmill owners and wood retailers were of a market-based type of governance. Transactions or prices were not controlled. Small-scale producers could freely buy wood from retailers. However, if they did not have sufficient funds, they would take loans from closer wood retailers. They were also free to choose which sawmill sawed their logs. The relationship between wood retailers and tree growers was a directed network. The structure of the value chain is buyer-driven. This governance structure influences the distribution of value added among actors in the chains. Buyers define standards and rules for the producers. This buyer-driven, which power lies on buyers rather than producers, occurs in most forest and agriculture commodities.

Overseas teak actors obtained 61.1% of the value added, while local teak growers, log traders, furniture producers and exporters together received only 38.9% of value added [17]. This smaller value added supported mostly furniture producers and community teak growers, while the poor actors get the smallest part of value added. There was vertical inequity among the actors that can emerge into vertical conflict e.g. tree growers vs. wood traders, furniture producers vs. furniture brokers.

Synthesis

Conflict anatomy

We can synthesize the cases into **Table 2**. Sumatra and Kalimantan cases are categorized as horizontal conflicts, while Java case is categorized a vertical conflict. The key causing factor of conflicts were imbalance of power among those actors, lack of mechanism to resolve conflicts and income gap. The governments in three cases were passive to resolve any conflicts. However, they welcomed if others could mediate the conflicts.

Table 2. Synthesis of cases in Sumatra, Kalimantan and Java

Conflict attributes	Sumatra case	Kalimantan case	Java case
Nature	Forest plantation (2004-2007)	Forest concession (2000-2002)	Furniture industry (2008-2013)
Conflict type in landscape perspective	Horizontal, between actors in forest core vs. mosaic land	Horizontal, between actors in forest core vs. forest edge	Vertical; between actors in furniture industry located in mosaic land vs. traders
Actor	Forest dependent communities vs. acacia plantation company	Forest dependent communities vs. forest concessionaire	Small-scale furniture producers vs. furniture exporter and retailers
Substance	Land acquisition; Imbalance power of partnership	Land acquisition, imbalance power of collaboration	Imbalance power and value added
Effort to solve the conflict	Mediated the conflict and established a forum named '*Sebahu Sejalan*'	Developed common vision, planning and action to reduce the conflict	Developed small-scale furniture producer association (APKJ) to obtain more value added
Government's role	Encouraged collaboration to make all parties have better income	Participated in conflict resolution effort	Supported all institutions including APKJ
Outcome	Better communication between the company and local community; better partnership	Better law making process to reduce conflict	Better income for small-scale furniture producers; better institution to resolve conflict

These cases demonstrated how conflict taken place as disagreement over what should be determinants (criteria, bases, priorities) of a policy decision and relationship. Land use policy has been one of the key reason why community struggle over their right in these two cases of Sumatra and Kalimantan. Before 1998, the government was highly centralized and forest was managed centrally allowing forest revenue transferred to central government. In contrast, after 1998 the Indonesian government has issued several important legislations aimed at transferring authority from central to the Provincial and District governments, and at allowing resource-rich regions to retain a larger share of revenues generated within their jurisdictions. Furthermore, the central government controlled and designated land use for production as well as conservation purposes. It allowed private concessionaire used the land without having local community consent. As a result the designated concession land often challenged by local community by asking to return their communal land.

The Java case has different conflict anatomy. The small-scale furniture producers have to deal with various actors along the value chains who have vertical relationship. The struggle is purely economic to improve their profit. Small producers have imbalance relationship with the brokers, the retailers as well as tree growers and wood traders. This becomes more complex as it also involved trans-boundary actors from national to global market.

Conflict resolution mechanism

Conflict in classical perspective is seen as negative goods therefore needs to be resolved by using several strategies namely negotiation, mediation, arbitration, adjudication, coercion and avoidance [26]. Each strategies requires stakeholder capacities to effectively deliver resolution.

Negotiation involving voluntary bargaining process to find compromise among disputants, while mediation requires third party intervention to bridge communication and seek compromise thus neutrality and participatory skilled are needed. Moreover, arbitration is similar to mediation both in requiring competency and the use of third party except arbitrator who mediate arbitration makes a decision for the conflicting parties; where mediator does not decide. Adjudication refers a process through formal procedures in court. The most extreme strategy is coercion by using power to resolve a conflict: often destructive and sometimes violent. In avoidance strategy, both parties deny the existence of conflict and assume it will go away by itself [26].

In three cases, negotiation and mediation were the preferred strategy for conflict resolution. However, the situation was dynamic over time so that there was impossible to use single mechanism to resolve conflict. For instance in Sumatra case, the acacia plantation had developed partnerships that is *Mengelola Hutan Bersama Masyarakat* (MHBM), collaborative management on concession land through a partnership agreement, and *Mengelola Hutan Rakyat* (MHR), collaborative management of communities' traditional lands through a benefit-sharing agreement. Nevertheless, communities did not consider MHBM fair when it was implemented and exercised coercion strategy. As a result, a violent outbreak occurred between residents of villages inside and outside of the plantation concession boundaries.

Efforts to resolve the conflicts were facilitated for better and true communication among those actors to find common ground to narrow their conflicting interests. Actions on the ground that favor other stakeholders were encouraged and communicated. These actions could be in the forms of more communication, donation, contribution to establish secretariat for forum or invited each other. Local institutions were established to institutionalize communication and conflict resolution. For instance, in Java case, small producers formed an association of furniture producers to level the playing field with the bigger actors such as large furniture companies and brokers in terms of negotiation and price setting mechanism. The efforts had produced positive outcomes in terms of better communication, improved law making process and better income.

Discussion

Discussion on Results

We argue that forest community are the one who are the worse off affected by the conflict over the forest and the landscape. In Sumatra and Kalimantan cases, forest communities were experiencing landscape pressure by plantation and concession expansion. They lost their livelihood as they lost access to their land. In this type of conflict, zero sum game is likely to occur. Such pressure also reflected on the way the community exercised their power to influence a solution, e.g., Sumatra case. Violent and non-compromise strategy were taken to improve bargaining position of the community over the acacia plantation.

Further the problem of imbalance power of one disputant over the others has also reflected in actors along the commodity value chains. Teak furniture in Java case indicated the low bargaining power of the small producers to brokers and retailers as well as to wood traders and tree growers. Having power imbalance and conflict among actors along the value chains, the small producers were worse off. Instead of using coercion strategy to influence the resolution which probably effective in a short run but not in the long run period, the small producers chose to adapt, manage the conflict and resolved it gradually. With the collaboration with Australian Centre for International Agricultural Research (ACIAR) FVC (Furniture Value Chains) project aimed to improve the structure of furniture industry has contributed to reduce the likelihood of conflict escalation. In addition, the basis for conflict in Java case was economy thus the small producers still be able to manage their business either by sourcing cheap materials or increasing the price.

Resolving a conflict is not an easy task and requires capacity to deal with social dynamic. The Sumatra' action research has succeeded to bring stakeholders communicating their interest and shared common goals. The values of transparency and fair negotiation emerged and established common ground among the stakeholders. The problems of land boundaries and tenure, elite capture and institutional weaknesses challenged the action research process. The forum could be useful for discussing the issues of REDD+ and bio-energy.

Partnership will emerge naturally if there is a certain degree of commonality. The partnership in Sumatra case emerged because (1) the company could not repress local community requests in the period of decentralization reforms; (2) the company could not secure the area without collaboration with local communities; and (3) the local government had to reduce the conflict. Collaboration then emerged because they were interdependent and wanted to achieve their goals in harmony with others.

The collaborative modelling process is a positive way for stakeholders to express their views and interests in managing forest, and encourages collaborative learning through participation in defining the model. The scenarios and roles defined in the modelling effort, as well as the development of a mutual understanding of stakeholder perceptions, influenced stakeholder plans for collaborative action. Such a shared perspective on forests management should precede any collaborative action planning. The modelling process can contribute to a collaborative action plan by helping to integrate stakeholder perspectives in a systematic way.

In Java case, VCA helped to explain the position of furniture SMEs, and improve the valued added obtained. PAR was implemented in Jepara following requests for intervention and supported by local government. PAR allowed the use of action to reach mutual understanding, increase knowledge and skills and change behavior amongst small-scale producers to improve their profit. These communicative actions catalyzed understanding among stakeholders as defined by Habermas (1987). This communicative action has transformed distrust into more a cooperative perception of others. Action that is well communicated will orient stakeholders towards a mutual agreement and collective action. The facilitators ensured that these actions and rationalities behind the actions were well communicated to all stakeholders.

These cases have demonstrated that the key success of conflict resolution is by leveling the playing field. It is measured in five ways: (1) the clear existence of local demand for intervention; (2) support from all stakeholders throughout the process; (3) institutionalization of the multi-stakeholder forum; (4) improved communications and interactions among stakeholders; and (5) ongoing discussion on the betterment of the partnership for future vision

We also argue that the final result of social dynamics is unpredictable, as underlined by complexity theory. Complexity theory engages the tempting idea that understanding the link between a transformed ‘whole’ and its original constituent parts is difficult to make [12]. There is emerging evidence that supports complexity theory, for instance for Java case, was the emergence of mandatory certification (SVLK), which has improved APKJ’s situation.

Conflict cycle and intervention

Conflict is dynamic. We took guidance from [25] to depict five important stages in the conflict cycle, starting from grievance to insecurity, conflict, negotiation and peace-making, and then post-conflict (**Figure 9**). Grievance is the existence of pain or protest by one part of society against another. Insecurity is under threat situation. Conflict is the transformation of grievance into violent conflict and its evolution. Conflict is defined as a dispute or incompatibility caused by the actual or perceived opposition of needs, values and interests. In **Figure 9** the term ‘conflict is understood to mean violent conflict. Negotiation and Peace-making is attempts to transform the conflict from one characterized by violence to a non-violent path and resolution. Post-conflict generally refers to the period after which major fighting have ended and assistance can begin to flow. This post-conflict can transform into true peace or return to conflict. Depends on ability to manage localized violence and address conflict drivers [25].

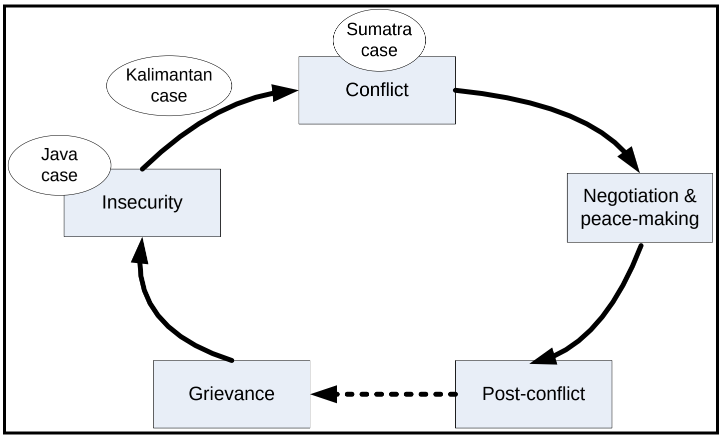

Figure 9. Conflict cycle and the cases

Java case lies in the stage of insecurity, Sumatra case lies in the stage of conflict, while Kalimantan case is in between. In Java case, small-scale furniture producers felt they were unsecured with the least value added they obtained compared those who were located on the higher position in the value chains (**Figure 8**). In Kalimantan, the insecurity of local community had been emerging to conflict. While in Sumatra case, there was a violent conflict among them.

The actions for reducing conflict can be illustrated in **Figure 10** [25]. For Java case, the effort can be perceived as 'conflict prevention', which promoted dialogue and mediation between small-scale furniture producers, large furniture producers, exporting companies and Jepara government to level the power among them. For Kalimantan case, dialogue and mediation were undertaken by having collaborative modeling that produced common vision, agenda and actions. For Sumatra case, the effort to reduce conflict can perceived as 'conflict management', by promoting non-violent approaches and minimizing conflict impacts.

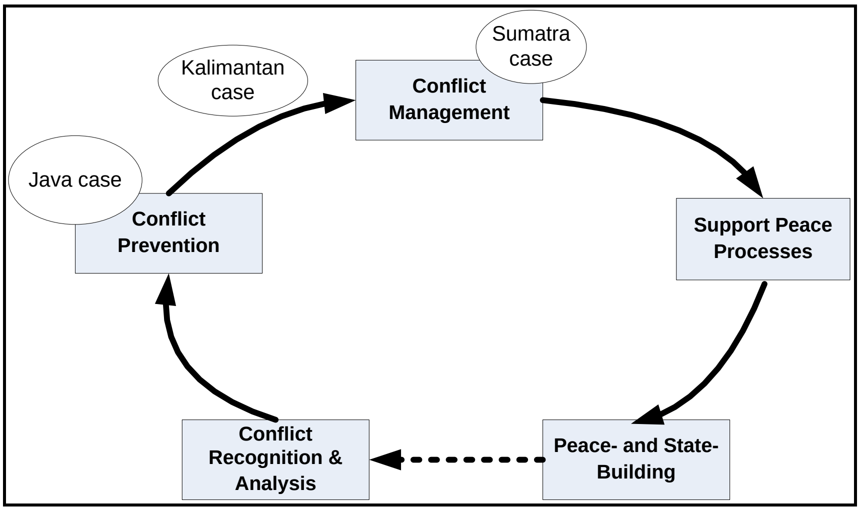

Figure 10. Conflict resolution cycle

Conflict, power relation and good governance

Natural resource governance comprises three sectors of society, situated among citizens at large: government, private sectors, the institutions of civil society (including the voluntary or not-for-profit sector). Civil society is defined as organized interests with a significant degree of autonomy from the state [8]. **Figure 11** shows a Venn diagram of three actors. Good natural resource governance is achieved by clarifying the relationships, rights, responsibilities and incentives among these key actors.

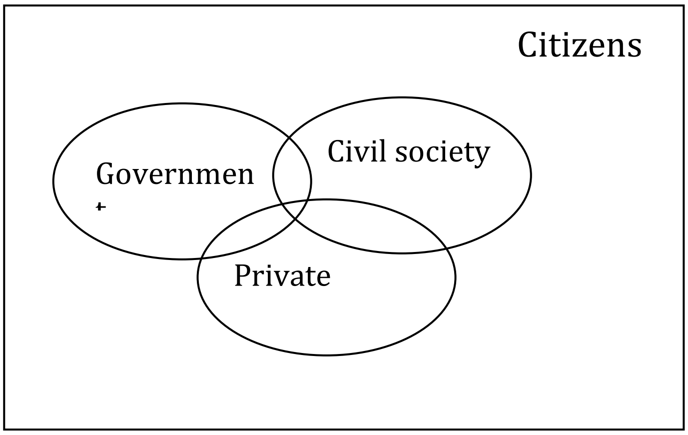

Figure 11. A Venn diagram of general governance structure [9]

International calls for sustainable natural resource management is increasingly concerned with questions of natural resource and environmental governance, i.e. with the rules under which power is exercise in the management of natural resources and environment, and the relationships between the *state* and its citizens, civil society and the private sectors [2]. Governance is about how governments and other social organizations interact, how they relate to citizens, and how decisions get taken in an increasingly complex world [9]. Governance involves the interactions among structures, processes and traditions that determine how power is exercised, how decisions are taken, and how citizens or other stakeholders have their say. Fundamentally, it is about power, relationships and accountability: who has influence, who decides, and how decision makers are held accountable.

We ensure the conflicts would be reduced by empowering civil society vis-à-vis private sectors and government. We believe a balance of power among civil society, government, and private sectors will effectively deliver conflict resolution. That was why we developed and made functions of Forum *Sebahu Sejalan* for Sumatra case and APKJ for Java case. This civic association improved power of local communities in both cases. As result, in Java case for example, government regulation that favor small-scale furniture producers is being drafted. This in line with peace and state building action (**Figure 10**) to prevent another cycle of conflict. Therefore, balancing power in horizontal and vertical dimensions will improve the sustainability of landscape.

Conclusion

This review paper describes a landscape with horizontal and vertical inequality that could produce conflicts. Conflict solving mechanism in Java, Sumatra and Kalimantan cases can be lesson learnt for other areas. The paper concludes the followings: (a) Empowering local communities is a key; (b) Facilitation and mediation is essential for conflict management; (c) Participatory tools such as collaborative modeling and action research can be implemented in understanding disputed problems; (d) Institutionalizing conflict resolution platform through having e.g. small-scale producer association or multi-stakeholder forum is essential to not have another cycle of conflict.

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THE USE OF MODIFIED MERCALLI INTENSITY (MMI) SCALE FOR THE GUIDANCE OF PREPAREDNESS IN EARTHQUAKE ANTICIPATING

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Abstract

Geologically, the Indonesian archipelago was built by the convergence of three major plates, the Eurasian, the Pacific and the Indo-Australian Plates. The implications of the collision of these plates is the emergence of earthquake epicenters along the convergent zone. Indonesia is known as one of the most active earthquake areas Since 9.3-magnitude the Aceh earthquake of 2004, there has occurred at least 23 earthquakes that caused damage, panic and killed many lives. The loss of many lives in general because of lack of knowledge about the nature of earthquakes and earthquake preparedness. This paper discusses the potential of knowledge of earthquake shocks as a preparedness guide to reduce disaster risk. Indonesia implements the Modified Mercalli Intensity scale (MMI scale) in measuring the level of earthquake shocks. In practice, the MMI scale has not been widely understood and frequently misunderstood as the magnitude scale. To facilitate the understanding and using of the MMI scale, simplification and scalability which is based on the socio-economic and cultural circumstances is proposed here. To support it, teaching aid of earthquake shocks has been made in conjunction to discriminate the earthquake magnitude and intensity. The government (through BMKG, BNPB, Kemkominfo) intervention is needed to disseminate the knowledge of earthquake intensity in order to keep the sustainability of community preparedness in anticipating earthquakes.

Keywords: *earthquake, MMI, preparedness, government intervention.*

OCCURRENCE OF SILENCE DEAD, WHITE ROOT DISEASE (*Rigidoporus microporus*) ON PARA RUBBER (*Hevea brasiliensis*) AT SOUTHERN PART OF THAILAND

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Abstracts

White root disease causes severe damage to Para rubber in this time and possible increase to be the major damage in the short period. This research objected to study the occurrence of white root caused by *Rigidoporus microporus*. The occurrence and symptom were observed in 4 provinces included Nakhon Si Thammarat, Trang, Phatthalung and Surat Thani. Soil sample and basidiocarp were collected from Para rubber orchard to isolate *R. microporus*. All disease appeared orchards, 50 orchards (66.67%) were re-growing to replace old Para rubber plant and 25 orchards (33.33%) were new growing area. Disease symptom was observed on 1-year plant to 25-year plant. The symptom began from yellowing of young leaves at the top of canopy, rubber plant decline, leaves curl, new small leaves, flowering and more fruit setting. Later, the leaves turned to yellow and brown, then falling. The infected root covered with rhizomoph and brownish orange bracket basidiocarp developed at the crown upper soil surface. Wood of plant at crown and main root was loose. The latest symptom, plants died and fell down. Causing fungal, *R. mcroporus* isolated from collected sample growing on PDA was white and flat colony, hyaline, septate, and no clam connection hypha. Spore was round hyaline with 10 micrometer diameter. Basidiocarp was leathery semi circular flat yellowish to brownish orange bracket. It attached directly to the bark of Para rubber crown or substrate with the broad base without stalk. From this survey research convinced that white root disease caused severe damage and the most destructive silence dead and it will be the major problem of natural rubber production in erelong.

Keywords: antagonistic bacteria, white Root Disease, Para rubber

Introduction

Para rubber tree was introduce to Thailand by prefect of Trang City (Phraya Ratsadanupradit Mahitsaraphakdi ,born Khaw Sim Bee,Trang provincial administrator) since 1899. In recently, Thailand is the first ranking of world rubber latex produce[1]. In 2012, rubber latex produce was 3,778,010 metric tons from growing area 2,953,797 hectares [2]. One threat of natural rubber production in Thailand was disease include *Phytophthora* leaf fall, powdery mildew, and new severe damage, white root disease. White root disease caused by *Rigidoporus microporus* and occurred in all growing area of Para rubber throughout the world. These disease occurrences were reported in Africa and Asia at growing area in Gabon, Cameroon, Ivory Coast, Nigeria, India, Sri Lanka, Indonesia, Philippines, Malaysia and Thailand [3].

This pathogen infected the rubber tree since the first year growing. It has been reported of infection on several hosts, such as neem (*Azadirachta spp.)*, jack fruit (*Artocarpus heterophyllus)*, cacao (*Theobroma cacao)* , coffee (*Coffea sp.*), djenkol tree (*Archidendron jiringa*), stink bean (*Parkia speciosa*), longkong (*Lansium domesticum*), durian (*Durio spp.*), palm, mangium (*Acacia mangium*) , teak (*Tectona grandis*) [4] [1] [5]. This pathogenic fungus produced laccase [6] [7] to degrade lignocellulose of wood became the soft, loose and white texture wood. The root system and crown of rubber tree infected were vunerable and plant finally fell dawn. This fungus produced brownish orange basidiocarp and spores also spread as air-bome [8] [9] [10]. This research objected to study the occurrence of white root caused by

Rigidoporus mcroporus in 4 provinces included Nakhon Si Thammarat, Trang, Phatthalung and Surat Thani.

Materials and Methods

Occurrence of white root disease

Survey of white root disease caused by *Rigidoporus microporus* to observe symptom and incidence assessment were done in 4 provinces included Nakhon Si Thammarat, Trang, Phatthalung and Surat Thani. Leaf symptom, flowering fruit setting, crown/foot, root were observed. Soil condition, PH, moisture, and soil texture were recorded. Basidiocarp and rhizosphere siol were collected to isolate pathogen.

Isolation of pathogen

Basidiocarp and rhizosphere soil collected from orchard were brought to isolate the causing fungal *R. microporus*. Basidiocarp was used to isolate by tissue transplanting and washing technique for spore dilution plate technique. Sample soil was isolated by soil surface and soil dilution plate technique. Potato dextrose agar (PDA) adding streptomycin (100 μg/ml) and metalaxyl (500 μg/ml) was isolation medium. Pure cultures were stored for biological characterization study.

Morphological characters study and pathogenic test of R. microporus

Morphological characters including hypha, mycelium and colony growing on PDA, Basidiocarp, hymenophore, and basidiospore were observed under microscope and recorded. Basidiocarp produced in sawdust medium and pathogenicity was observed to confirm. Basidiocarp development was conducted by culture *R. microporus* on sorghum grain (14-day) and transferred to sawdust medium. Pathogenic *R. microporus* cultured on sorghum grain was inoculated on rubber sawdust medium (sawdust: rice bran: sucrose: water: at ratio100: 3:2:50) and incubated at room temperature until fungus growing cover medium (30- day) [4]. Pathogenic fungus on sawdust medium was implanted in1year Para rubber tree pot. Infected symptom and basidiocarp was observed every 30-day for 120 days.

Result

Occurrence of white root disease

Survey of white root disease in 4 provinces, Nakhon Si Thammarat, Trang, Phatthalung and Surat Thani, the occurrence of this disease in infectious orchard appeared in replanting of old rubber orchard was 66.67 % while in area which have been never grow rubber tree was 33.33% (Table 1). Most growing area which this disease more severe was rubber tree growing in sandy loam clay with high humidity. RRIM 600 was the most variety of rubber tree growing in this area and also was mostly severe infection of 81.13 of all disease occurrence orchards (data not show).

Table 1. Para rubber tree orchards which white root disease caused by *R. microporus* were observed.

Province	Replanting in old orchard Orchard (%)	New area Orchard (%)	Total Orchard
Nakhon Si Thammarat	20 (80.00)	5 (20.00)	25
Trang	10 (55.67)	8 (44.44)	18
Phatthalung	10 (58.82)	7 (41.18)	17
Surat Thani	10 (66.67)	5 (33.33)	15
Total orchard (%)	50 (66.67)	25 (33.33)	75 (100)

Disease symptom

Early stage of infection. Root of healthy plant contacted to infected root (Fig. 1 a) and rhizomoph of *R. microporus* grow throughout healthy root (Fig. 1 b) or some healthy roots were infected by new colonized mycelia in rhizosphere. Later rhizomoph infected to healthy root and caused root necrosis and developed root dead symptom. In condition of high moisture content in soil and high relative humidity, main root and crown colonized with white mycelia. (Fig. 1 c)

Early stage symptom. The appearance symptom began from yellowing of young leaves at the top of canopy, leaves pale and turned to yellow (Fig. 1 d). Some of leaves changed to brown or red (Fig. 1e).

Severe stage symptom/decline stage symptom. Some of plant, after leaf fell, new leaves grow in small size pale or yellow and few leaves developed on canopy (Fig. 1 f). Flowers and fruits were always setting. Several leaves curled down. Most of leaves will turn to yellow (Fig. 2 a) and red or brown (Fig. 2 b). Leaves fell and finally plant died down (Fig. 2 c). If moisture content in soil and high relative humidity, basidiocarp began setting or appear at the crown upper soil surface level (2-5cm) (Fig. 2 g, h, i). Sometime, this pathogen did not infect the main root or severe damage, the basidiocarp developed at infectious wood without symptom appearing on canopy.

Fallen dawn. The crown and root of plant infected by *R. microporus* were loose and soft white texture. The completely infected plant fell down in finally (Fig. 2 e, f). However, if pathogen infected and destroyed the main root, the plant fell at the early stage of the appearance symptom or fell in the case of win was strong (Fig. 2 d).

Morphological characteristic study and pathogenic test of *R. microporus*

Morphological characteristics of *R. microporus* were studied. Causing fungal *R. microporus* isolated from collected sample growing on PDA was white cottony flat colony (Fig. 3 e), hyaline, septate, and no clam connection hypha (Fig. 3 f). Basidiocarp was leathery semi circular flat yellowish to brownish orange bracket, soft and smooth touching. It attached directly to the bark of Para rubber crown or substrate with the broad base without stalk (Fig. 3a, b). Basidiocarp obsereved at orchards varied size from 5-50 centimeters. While in artificial culture on sawdust medium, basidiocarps were small as 3-10 centimeters. hymenophores (tube) were round and ovoid, straight and regular (Fig. 3 c). Spore was round hyaline with 10 micrometer diameter (Fig. 2 d). When inoculate on 1-year rubber plant growing on pot, symptom appeared 60 days after inoculation with low rating of infected plants.

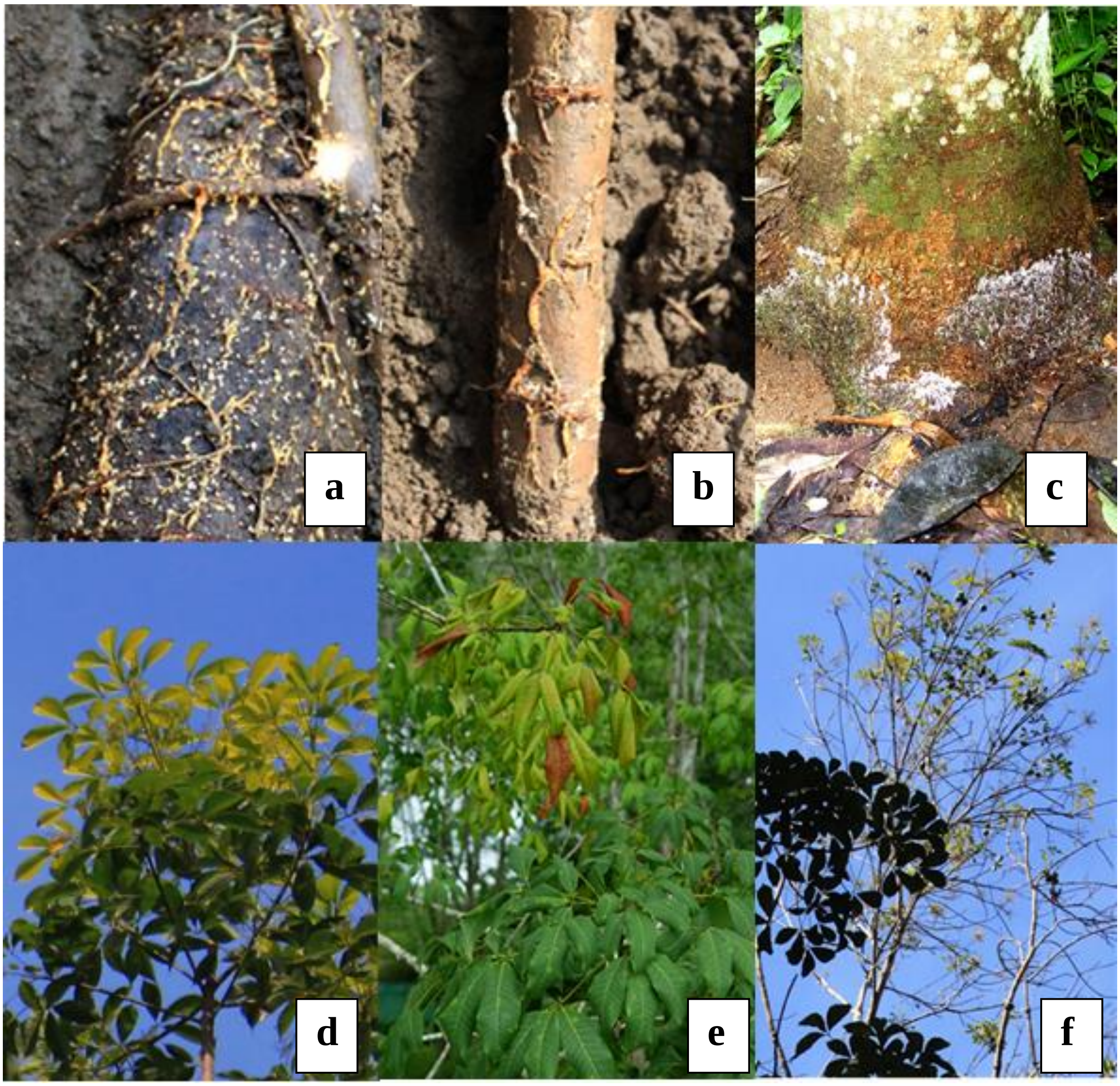

Figure 1. Early stage of infection, root of healthy plant contacted to infected root (a) and rhizomoph of *R. microporus* grow throughout healthy root (b). In high moisture content in soil and high relative humidity, main root and crown colonized with white mycelia (1c). At the early stage symptom, the appearance symptom began from yellowing of young leaves at the top of canopy, leaves pale and turned to yellow (d). Some of leaves changed to brown or red and curl down (e). Some of plant, after leaf fell, new leaves grow in small size pale or yellow and few leave developed on canopy (f).

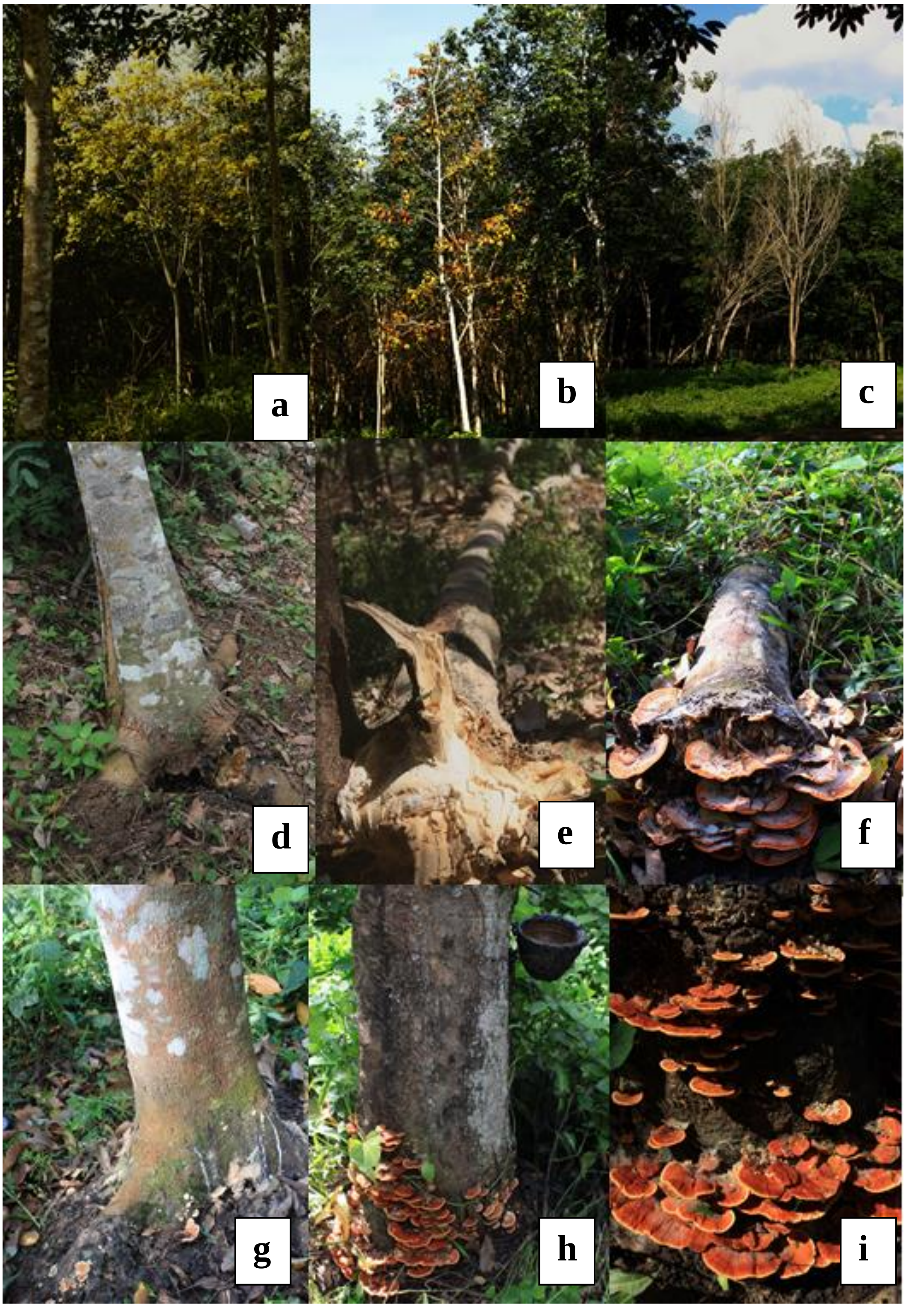

Figure 2. Severe stage symptom, Most of leaves turned to yellow (a) and red or brown (b). Leaves fell and finally plant died down (c). The completely infected plant fell down (d, e, f). High moisture content in soil and relative humidity, basidiocarp began setting or appear at the crown upper soil surface level (2-5cm) (g, h, i).

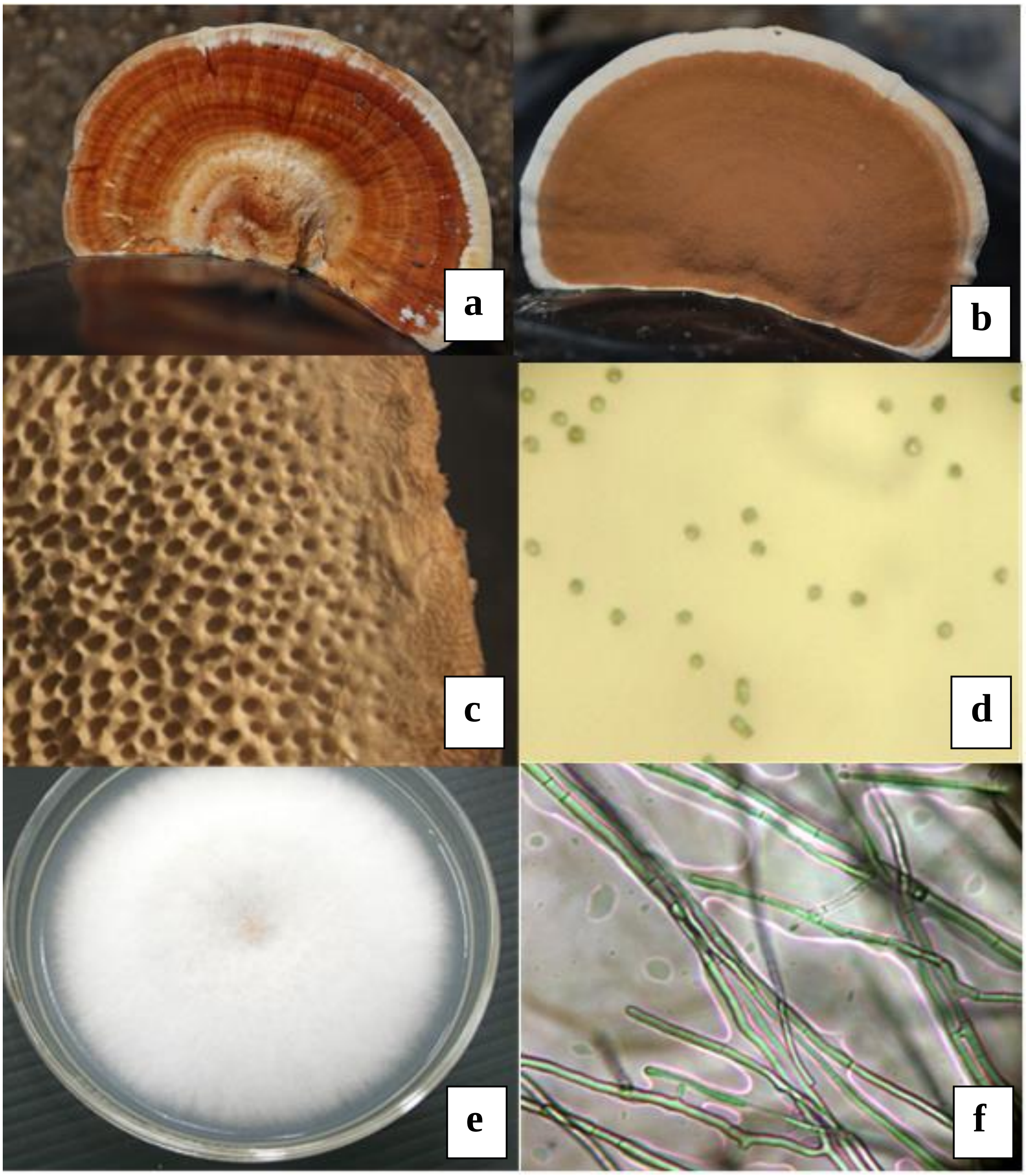

Figure 3. Basidiocarp of *Rigidoporus microporus* was leathery semicircular flat yellowish orange to brownish orange bracket, attached directly to the bark of Para rubber crown with the broad base or substrate without stalk (a). Hymenophores (tube) were round and ovoid, straight and regular (b, c). Spore was round hyaline with 10 micrometer diameter (d). Colony growing on PDA was white cottony flat colony (e), hyaline, septate, and no clam connection hypha (f).

Discussion

In this survey and observation occurrence of white root disease, symptom of this disease on rubber tree was difficult to monitor. The early symptom was only chlorosis of the young leaves on the top of canopy and it was similar to nutrient deficiency. Sometime, this symptom did not progress in the short period. It took time for 90 -120 days or may be over the year. When root more severe damage, then severe symptom on canopy appeared clearly to monitor and confirm. It was too late to control. It was seemly silence of dead. However, if chorosis symptom was monitored at the plant next to dead infected plant, it could be confirmed the sign of white root in early symptom. White root pathogen, *R. microporus* produced lacase enzyme. [6] [7] to degrade lignocellulose of wood became the soft, loose and white texture wood due to topple of the tree in finally. Several plant fell at the early stage of the appearance symptom or fell in the case of win was strong consequent from the pathogen infected and destroyed the main root. For control approach, it was difficult to control this pathogen. This study and several report convinced that rhizomoph was developed on root plant beneath the soil. It was difficult to treat with fungicide to contact and inhibit mycelium or rhizomorp. Basidiocarp produced on crown which produced spores spreading by air born was ignored by farmers. This disease occurred 33.33 % in area which have been never grow rubber tree in this survey. *R. microporus* was root-infecting thorough rhizomophs growing as epiphyte on rubber or alternate host root or in rhizosphere. Although in new growing area the occurrence was seemly low but it indicated that the soil born pathogen *R. microporus* survived in several areas possible in both of saprophyte and in infecting some alternate host [4], [1] [5]. However, this fungus produced spores on brownish orange basidiocarp and also spread as air-borne but less important than root-infection [8] [9] [10].

Summary

Disease symptom of white root disease caused by *Rigidoporus microporus* was observed on 1-year plant to 25-year plant. All disease infected orchards, fifty orchards (66.67%) were re-growing to replace old Para rubber plant and 25 orchards (33.33%) were new growing area. The symptom began from yellowing of young leaves at the top of canopy, rubber plant decline, leaves curl, new small leaves, flowering and more fruit setting. Leaves turned to yellow and brown and fell. Plants died and fell down. Causing fungal, *R. microporus* isolated from collected sample growing on PDA was white and flat colony, hyaline, septate, and no clam connection hypha. Spore was round hyaline with 10 micrometer diameter. Basidiocarp was leathery semicircular flat yellowish to brownish orange bracket. It attached directly to the bark of Para rubber crown or substrate with the broad base without stalk.

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THE CHALLENGES FOR SUSTAINABLE FOREST MANAGEMENT IN BENGKULU PROVINCE: A BROAD REVIEW

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Abstract

The total forest area constitutes 46% of land area of Bengkulu Province. Of the forest area, 77% is conservation and protection forests where tree cutting is not allowed, so these forests are perceived by local people and local government as hindrance to economic development. Currently forestry sector contributes little to the economy of Bengkulu. In the past, several forest concession companies operated in production forest. But their practices were not sustainable so their permits were not renewed by the Ministry of Forestry. A new concession company is now operating in Bengkulu's production forest. Much of production forest area has been neglected for many years, so some of which has been occupied illegally by local people as well as plantation companies. Much of the protection forest has been cleared for plantation too. Even the most guarded forest, the conservation forest, also suffers encroachment. Deforestation and degradation of forest will continue unless fundamental measures are taken to develop sustainable forest management. Managing forest in a developing country is essentially managing people. So, we must work to tackle the social aspects of forest management. First, we must hold continuous dialog among stake holders to have common understanding on the need for sustainable forest management. Second, we must improve the implementation of social forestry and forest rehabilitation programs which have been conducted. Third we must enforce the laws strictly for those illegally cut trees or occupy forest areas. Finally we should accelerate the creation of forest management units and empower the existing one. To achieve sustainable forest management in Bengkulu is a very challenging task, requiring concerted efforts of all stakeholders.

Keywords: Sustainable forest management, Bengkulu

Introduction

The concept of sustainable forest management

As a renewable resource, forest can be harvested on a sustainable basis. Although the term sustainable forest management is relatively new, actually foresters have known the concept of sustainable since the 18th century [1]. For two centuries forest exploitation has been based on the maximum sustained yield principle. Originally the purpose of this principle is to ensure the sustainability of timber production from the forest. This principle can be achieved by determining the volume of timber that can be harvested based on the stand increment or trees' growth. Several methods have been developed to determine the annual allowable cut in order to get maximum yield without reducing the forest potential to produce timber in the following harvest cycle.

In the 20th century, forest was seen not merely as timber producer but as an ecosystem with many functions. The sustainable principle was, therefore, expanded to include non timber forest products and other forest ecosystem functions such as water protection, recreation and wildlife conservation. In the US the principle was implemented in the Multiple-Use Sustained Yield Act of 1960. In Indonesia multiple use of forest was also recognized in the Forestry Act of 1967 which designated forest into several four categories: production, protection, nature reserve and nature recreation. In the new Forestry Act of 1999 Indonesian forest is classified into production, protection and conservation forests.

Although foresters have known the sustainable principle for two centuries, the utilization of forest around the world has not been sustainable, and neither have those of other natural resources. In response to the depletion of natural resources and environmental degradation, in 1987 the United

Nation World Commission on Environmental and Development introduced the concept of sustainable development defined as development that meets the needs of the present generation without compromising the ability of future generation to meet their own need. The Earth Summit in 1992 in Rio de Janeiro, the United Nation Conference on Environment and Development adopted Forest Principle which captured the concept of sustainable development in forestry sector. Sustainable Forest Management aims to ensure that the products and social, cultural, and environmental services provided by forests meet the needs of the current generation, while at the same time maintaining their availability for the development needs of future generations [2]. Sustainable forest management encompasses three aspects: ecology, economy and social. The Forest Stewardship Council [3] put it appropriately that forest management must be environmentally appropriate, socially beneficial and economically viable. Ecologically, the biodiversity, productivity and ecological process of forest must be maintained. Economically, forest must be structured and managed to be sufficiently profitable without generating financial profit at the expense of forest resources, the ecosystem and the affected communities. Socially, forest management must helps local people and society at large to enjoy long term benefits and provides strong incentives to local people to sustain the forest resources and adhere to long term management plan [3].

Challenges in implementing sustainable forest management

Ideal it may sound, the concept of sustainable forest management is not easy to implement [1]. The concept of SFM is very complex and different parties may have different ideas on the sustainability. To standardize the implementation of SFM, several institutions and working groups (such as, International Tropical Timber Organization, Montreal Process, Forest Europe, Forest Stewardship Council) have developed principle, criteria and indicators for SFM. These criteria and indicators have been used to measure whether a given forest management unit has been managed according to sustainable principle. Some countries have modified these criteria and indicators to suit their particular needs. There are, however, some criticisms on the criteria and indicators for SFM. Howard [4] found several self contradictions within the criteria and indicators that foresters must apply at the forest management unit level. The criteria for three components (ecology, economy and social) of SFM are commonly regarded as competing, or even mutually exclusive, so it is impossible to meet the three aspects of SFM at stand level, but it is possible at broader spatial scales, such as regional and national scale [5].

In Bengkulu and many provinces in Indonesia, the challenge for SFM implementation is not at conceptual levels but at the practical level, namely: how to solve land conflict and to protect the forest from illegal activities. There is no guarantee that the existing forest stand will continue to exist next year because of illegal logging and encroachment. No SFM can be implemented unless illegal activities and land conflict are resolved. Forestry conflicts escalated drastically when the New Regime collapsed in 1998. Local communities who used to be suppressed by the government committed illegal logging and cleared the forest area for plantation. The conflict decreased in 2001 but was still twice than that in 1997 [6]. Data from the Ministry of forestry showed that between 1990-1997 deforestation rate in Indonesia was 1.8 million hectares per year [7]. It increased to 2.83 when the new order collapsed. Since 2000 the deforestation rate declined to 1.08 million hectares per year.

Conflicts in forestry sector result from different ideas and interests among stakeholders. Implementing SFM will require minimizing the conflicting ideas and interests. Even among the government institutions there are conflicting interests. Often, local governments have different interest from the central government. Although local governments have been given authority to manage production and protection forest since the collapse of New Order, all forestry regulations are made by central government. Local governments, therefore, have no freedom in managing forest areas. As a result, many governors and regents have submitted their request to the Ministry of Forestry for the conversion of forest areas into other land uses. Only few requests have been granted.

In the past, the interest of the Ministry of Forestry was represented by local forestry offices. But, since the autonomy era began, the local forestry offices have been loyal to governors and regents because the head of forestry offices are appointed by governors or regents. Now, at the provincial level, the Ministry of Forestry is represented by the Agency of Natural Resource Conservation and the Agency of National Park which manages conservation forest, and by the Agency of Watershed management which deals with land rehabilitation and social forestry program.

Local people have another interest. They want to get a greater access to forest resources and get the economic benefit from them. Some communities do have legitimate claim over forest area, because their ancestor had utilized the land. Their claim is further reinforced by the decision of constitutional court that tribal forest can no longer be classified a state forest. To achieve SFM in Bengkulu, land conflict and illegal activities must be minimized first, then best practice of forest management should follow.

Bengkulu Forest

Area and categories

Bengkulu Province consists of 2,007,223 hectares of terrestrial area. About 46%, i.e. 924,631 ha, of this terrestrial area are legally defined as forest areas. Forests in Bengkulu are divided into several categories: protection forest, production forest and conservation forest (Table 1).

Table 1. The detail of forest areas in Bengkulu based on Minister of Forestry Decree No. 784/Menhut-II/2012

No.	Forest classification	Area (ha)
1.	Conservation area	438,095
2	Protection forest	250,750
3	Production forest	210,916
	TOTAL	**924.631**

It can be seen that most of forest areas (77%) in this province are categorized into protection and conservation forests. Therefore, challenges in managing the situation differ from other provinces where production forests are more dominant. The existence of protection and conservation forest is more perceived as burden in regional development rather than a window of opportunity for innovation. However, in the middle of the growing issues on climate change, forestry programs aiming to conserve and to improve forest cover are increasingly important.

Problems

Forestry sector in Bengkulu faces many serious problems. Deforestation has been happening for years. One cause of this problem is illegal occupation of forest areas by local people.

This illegal occupation has increased after reformation era. Illegal occupation means that people cut forest without permits and some turn it into farming fields. This activity creates a conflict between those people and the government.

Based on land satellite imagery analysis, significant areas of plantations and agricultures (about 130,000 ha) occupy forest areas [8]. The vegetation cover of national parks remains in an appropriate condition, consisting of 76% of primary and 16% secondary forests. On the other hand, only 42% of protection forests remain primary forests and 33% are secondary forests, which mean that 25% of protection forest areas are not forest vegetation. The production forest is in much worse condition where it has lost about 50% of its forest coverage [8].

On the other hand, population continues to grow. Bengkulu Statistical Bureau [9] reported that the total population in Bengkulu is about 1,742,080 people, about half of whom are workforce and the majority are farmers. A fast population growth and limited natural resources are potential sources of tenure conflicts. Natural resources conflicts, in this case the conflict in using forest areas, are the result of some problems. According to Wulan *et al*. [6], based on media and field report, the causes can be divided into 5 categories; border, illegal logging, illegal occupation, environmental damage and the change of forest function.

As more than 2/3 of Bengkulu forests are protection and conservation forests areas, land availability for productive activities, such as farming, are limited. In contrast, more than half of Bengkulu’s people are farmer, especially perennial plants (coffee, pepper etc.). It is obvious that their life depend on the land availability. In addition, their farming techniques are mainly traditional, which is not very effective, so that they need more agricultural lands in order to increase their production. Thus, some of them occupy protection forest that should not be exploited. Indeed, soils of this area are very fertile and very suitable for annual plants.

In terms of population mobility, there is lack of administrative control. Many people moved to village around protected areas and could not be detected. These people come from other districts or even other provinces, such as South Sumatra. Then, they cut forest and turn it into farming fields.

These people are not recorded because of the lack of citizenship administrative system; thus their mobility cannot be monitored, including their agriculture activities.

Another problem is unclearness forest boundaries. In several cases, settlements, in which they have legal structure (village leader etc.), are actually in protection forest areas. One example is Tanjung Alam village. Total areas of this village are 1,500 ha with 1,164 number of population. In fact, after the government remapped the forest area, 1,400 ha of the village area are protected areas [10]. They have settled there for several decades and there have been no actions taken by the government, so they considered that there is nothing wrong with that. Another case, agricultural fields are very near with protected forest areas. It makes those farmers easily to broaden their fields by cutting down the forest. They argue that they do not know if those lands are protected areas. This is not only because there are no clear signs of the borders but also there is no socialization from the government about the borders. The other reason that illegal occupation of forest areas keeps happening is that there are no legal actions in order to punish the laws breakers. Therefore, they are not afraid to occupy the areas. The lack of law enforcement in fact has encouraged other people to do the same thing.

Some communities, however, have legitimate claim over forest areas because they ancestors had occupied the land before the designation of forest areas by the government. In 2012 forest area boundary was revised because to accommodate the claims of communities. Many other claims have not been settled yet.

If these problems are only tackled by the government, it evidently will not generate a fruitful result. Community participation is important part to ensure the success of programs in forestry sector. We know that it is not only the government will suffer from the effects of damaged forest and ecosystems, but also the people. By collaborative management, the community actively participates in decision making on how forest will be managed. Forest management should also consider the community welfare itself, which in return, the society will also responsible in forest conservation.

Social forestry is one type of the involvement of the community on management of forest area. Through this program, the community can utilize the forest area with little negative impacts on the forest function. It is not only reducing the pressure on the forests, but also resolving some social related problems around the forest area. However, the forest areas in Bengkulu that have been intervened by the program are still so narrow, which only cover about 2,667 ha till 2011 [11]. Therefore, this type of program has to be prioritized by the authority.

Although the need on the forest product, i.e. timber, keeps increasing, the production of timber from production forests is still small. Based on the survey during 1996 – 2009, forest stands on one hectare of forests in Bengkulu are potentially to content about 130 m^3/ha of timber [11]. It can be estimated that 200,000 ha of production forests would results a huge amount of timber, although it is only about 50% production forests areas which are still covered by tree vegetation. However, the timber production in Bengkulu is significantly low (Table 2). To fulfill the timber demand, the government should optimize the legitimate utilization of production forests through forest consessions, which could be granted to private companies or community organization such as "koperasi". Otherwise, protection and conservation forests are potentially to be illegaly logged to provide the market need.

Table 2. The recapitulation of timber log production per regency for the last 5 (five) years (Source: Forestry Beureau of Bengkulu [12])

No.	Regency	Timber log production per year (m^3)				
		2008	2009	2010	2011	2012
1	North Bengkulu	0	0	1,953	124	3,997
2	South Bengkulu	181	29	0	2,922	4,823
3	Rejang Lebong	409	260	0	0	669
4	Bengkulu City	0	0	0	0	0
5	Mukomuko	848	1,036	1,047	4,645	0
6	Seluma	0	0	1,436	0	0
7	Kaur	1,154	0	0	0	0
8	Lebong	0	0	0	0	0
9	Kepahiang	208	198	0	0	751
10	Central Bengkulu	0	0	223	428	197
	TOTAL	2,800	1,523	4,659	8,119	10,437

Fundamental Measures for Sustainable Development

Dialog among stakeholders

Sustainable forest management can only be achieved if conflicting interests among stakeholders can be reduced to a minimum level. In the past, local forestry offices were representative of the MOF, so they had no conflict of interest with the MOF. Since the autonomy era began, local forestry offices and MOF had different interest and priorities regarding the forest resources, so there must be dialog between local government and MOF. Suhirman *et al*. [13] from their study on the implementation of community based forest management recommended that the MOF and local governments had to make agreement to do collaborative works. Dialog between local government and the MOF should also result in better regulations and financial arrangement in forestry sector.

In the past conflicts between local people and forestry office or forest companies were suppressed by forces. This method is no longer acceptable. So, dialog between government and local communities must be conducted too. It will take long time lime before all parties come to an agreement, but it is impossible to eliminate all differences.

Different opinion regarding forest may not all result from different interest but some may be due to different knowledge of the function of forest. The ministry of forestry must explain the different categories of forest and their functions. In reality, however, the biophysical conditions of forest do not always meet the criteria for the designated categories. For example, some nature reserve strict areas do have highly specific natural features to protect. Or, some relatively flat forest areas are categorized as protection forest. The ministry of forestry should be willing to negotiate on the category of forest when the actual conditions do not meet the criteria stipulated by the government regulations.

Many local governments perceive protection forest and, especially, conservation forest as hindrances to economic development because no logging can be done in these forest categories. Environmental education must be given to government officials on the role of these forests to protect watersheds which supply water for multiple purposes, to absorb carbon from the atmosphere, and to protect biodiversity which provide various benefits to human. With the help of NGOs the local communities must be educated too.

In the last ten years the role of forest in sequestering carbon has been emphasized. Carbon trading as mechanism to protect forest from degradation has been popularized. The Ministry of Forestry has issued decree on the procedures to get payment from REDD. In practice, however, local government and local people have not benefitted from carbon trading. Simpler procedures to get compensation need to be developed.

Social forestry and forest rehabilitation

Currently in Indonesia there are more than 19 thousand villages located near and within forest areas with a total population of 48.8 million. Bengkulu forests are also located near human settlements. Those people have fulfilled some of their daily need from forest areas. After the large scale exploitation of forest outside of Java began at the late 1960s, many rural people have been deprived access to forest areas. To achieve SFM, rural people must be involved in the management of forest. This concept is called social forestry.

The term social forestry has been used with various meanings. It can be used to describe a relatively narrow range of activities that produce fire wood from small woodlots in order to reduce deforestation, or, it refers to forestry activities conducted mainly to improve the welfare of the poor, as opposed to purely commercial activities [2]. The Ministry of forestry defines the term social forestry as a system of forest resource management in state forest or private forest involving local communities as the actors or partners in order to improve their welfare and to conserve the forest [13]. Another term having similar meaning is community forestry. RECOFTC defines it as a practice that “includes all aspects, initiatives, sciences, policies, institutions, and processes that are intended to increase the role of local people in governing and managing forest resources [14].

The Ministry of Forestry has conducted social forestry programs since 1970s using different names and schemes. In the 1970s, the state-owned forest company in Java introduced the prosperity approach program referring to forestry programs to improve the welfare of local communities. Other programs or terms include forest village development, forest village community development, community forestry, community-based forest management, forest management together with the community, forest management by the communities [15].

In Bengkulu, the Ministry of Forestry started establishing community forestry in the mid 1990s. However, the social forestry programs have not been successful in Bengkulu province as well as at national level due to the complexity of the problems. The ministry of forestry itself has not settled with the concept of social forestry. This is reflected in the rapid changes of regulations regarding community forest. In 1995 the Minister of Forestry issued a decree no 622 regarding community forestry. This decree has been replaced or amended several times with the following decrees: no 677 (in the year of 1998), no 865 (1999), no 31 (2001), no 37 (2007), no 18 (2009) and no 13 (2010).

The MOF has not enthusiastically implemented social forestry. The decision makers in the MOF are forestry graduates trained in forestry faculty, who studied forest mostly from silvicultural and management aspects. They are not sufficiently trained in resolving social problems. Forest is viewed more as natural resource, and the people living in the forest are not seen as the integral part of the ecosystem, but as illegal encroachers. Land tenure is the main cause of conflicts between communities and forestry authorities [16]. Awang [14] believes that social forestry programs have failed because agrarian law has not been reformed.

Limberg *et al.* [17] found several constraints in the implementation of community forestry in Malinau, East Kalimantan. The constraints in the village were: the weak institutional capacity, the unfair profit sharing, the lack of effective conflict resolution, the lack of market information, the lack of equipments, the high transportation cost and the unclear forest boundary. At the district government level, the constraints were: the limited experience and knowledge regarding community forestry, the high number of facilitators needed, the difficulty in implementing community at large scale, and the lack of legal certainty of property right and tax and its consequence on the access and control of forest areas. the constraints at the central government level were: the difficulty in developing regulations ensuring sustainability and at the same time adjustable to local conditions, the difficulty in developing tax and profit sharing mechanisms for community forestry, and the difficulty in monitoring and controlling the regulations. The NGOs had difficulties in providing enough number of facilitators, bridging the interest of government and communities, implementing lesson-learned from experience in other places and preventing communities' dependence on NGOs. The many constraints in the implementation of community forestry have prevented the MOF meeting its target. Community forestry and village forest can be developed only in villages which have intensive facilitation from NGOs and other social forestry supports.

Suhirman *et al*. [13] in their studies on the implementation of community based forest management (CBFM) in four provinces found three fundamental problems and another additional one. First, the MOF, provincial government and district government had different priorities in implementing CBFM. For the MOF the implementation of is CBFM is important so they had higher target, meanwhile for provincial and district governments forestry sector may not be important, so they had no target for CBFM implementation. Second, the relation among parties, namely the MOF, provincial government, district government and NGOs were not solid because they were only bound in a forum, whose activities were mostly socialization and not making decisions. Third, there were differences in financial capability. The MOF had sufficient fund to implement CBFM, but since the autonomy era began the role of central government to finance local program has been limited. Meanwhile, the local governments, which should have played a greater role, did not have sufficient fund and human resources to implement CBFM. In addition to the three fundamental problems above, another problem arose from the view of local government that implementation of CBFM was merely a forestry sector, whereas actually the implementation CBFM would require a concerted efforts among local government offices.

Although there are many constraints, social forestry must be continued because the MOF as well as local forestry office won't be able to control all forest areas. People have already occupied forest areas. Social forestry program will regulate the involvement of people in forest management. Without social forestry, many forest areas will be accessible to everybody who will race to loot them as much as he can. The social forestry programs which have been conducted since the 1990s must be continuously improved by strengthening the institutions in villages and communities which will manage the forest, improving the quality and increasing the number of facilitators, simplifying the procedures in the government, adjusting regulations which facilitate the selling of forest products, enforcing the law for illegal activities.

The communities must continue to be involved in forest rehabilitation. For several decades, forest rehabilitation program in general has not been successful. The rate of rehabilitation is less than the rate of forest degradation [18]. In the 1970s, forest rehabilitation was conducted with top down approach, but since 1990s communities have been actively involved. During the Megawati's presidency era, the reforestation program was revived or renamed into a Movement for Land and Forest Rehabilitation. During the SBY's presidency era, the government commitment for land and forest rehabilitation is even greater because the President has pledged to the world that Indonesia would reduce carbon emission up to 26% by 2020. Planting trees is the solution for absorbing carbon from the atmosphere. The MOF during MS Kaban's ministerial era created a slogan: Plant Today, Harvest in the Future. Subsequently the MOF created another slogan: One Man One Tree. In 2012 the MOF had a movement to plant one billion trees and created a new slogan More Trees More Bounties.

The MOF must always evaluate and improve the policy and implementation of forest rehabilitation. Local communities should be involved not only in the planting phase, but since the planning phases. The selection of species, number plants and areas of planting should match with the need of local communities. For several decades, fast-growing, exotic species have been planted nation-wide. Those species may be good if the objectives of reforestation are to increase forest coverage and to prevent erosion, but those species may not what the local people needs. The financial arrangement should ensure the maintenance of the plants. The sustainability of the program would depend on the benefit people get from the program. The government should, therefore, help the marketing products of the plants. To improve the capacity of local communities, the government should finance NGOs to provide facilitation to the local communities. In short, the forest rehabilitation program should be integrated with other development programs of the local communities and it should address the causes of deforestation [18].

Law enforcement

Illegal logging and other forestry crimes are the constraints for achieving SFM and therefore must be combated. They also cause large economic loss to the nation. Illegal logging, corruption and mismanagement in forestry sector in Indonesia was estimated to cause US$2 billion loss in 2006 [3]. This amount included forest taxes and royalties not collected on illegally harvested timber; shortfalls due to unacknowledged subsidies to the forestry industry (including basing taxes on artificially low market prices and exchange rates); and losses from tax evasion by exporters practicing 'transfer pricing'. It was estimated by EIA/Telapak that in 2001, approximately 73% of logging in Indonesia was illegal. This figure might be too high. A consensus among sources estimated that illegal logging account for more than 40% of Indonesia's total wood supply [3].

Crimes in forestry are the result of failure of rule of law which can be divided into two types, namely the failure of law and the failure of implementations [19]. Failures of law include: (a) Clashes of norms, when "the rights to the resources as set out in law are not the same as the rights that people or communities believe that they are entitled to have", (b) Undetectable violations, when the law is written in such a way that makes it difficult to enforce, (c) Weak penalties, resulting in insufficient punishment to deter criminal behavior and (d) Conflicting legislation. Failures of implementation include: (a) Poor dispute resolution, which can lead to solutions outside the law, (b) Unfair application of the law (for example, bias, patronage, corruption, and so on), (c) Failure on the part of forest agencies to follow the law, (d) Lack of capacity to enforce the law, (e) Lack of capacity to administer the law, (f) Lack of coordination among government agencies, (g) Lack of enforcement of laws outside the forest sector (for example, in banking or immigration law), (h) Lack of government oversight. Most of the above points are found in Indonesia.

Several international and national efforts have been done by the Indonesian government to combat illegal logging and other illegal activities, such as engaging in the Forest Law Enforcement, Governance and Trade (FLEGT) process, bilateral agreements between Indonesia and major importers of timber, as timber certification and conducting joint security sweeps [3]. To improve law enforcement in forestry sector we also need to improve the governance because weak law enforcement in forestry sector is associated with poor quality governance not only forestry sector but also in other sectors [19]. Indonesian government has poor record on corruption, and since the autonomy era began, the corruption has spread to provincial and district levels. Many governors, mayors, regents and parliament members have been indicted for corruption. The high cost of election has caused pervasive corruption among politicians.

The implementation of social forestry can improve law enforcement because the communities who have the license for managing the forest will have willingness to protect the forest. So far, many communities living near the forest border have not had the courage and willingness to prevent illegal logging committed by other people because they would not have advantage for doing so.

Creation and empowerment of forest management units

In Java, most forest areas are managed by Perhutani, a state-owned forest company. The forest areas in Java are divided into many management units, each managed by the head of forest management unit and his or he staff. Each forest management unit is large enough to be managed on a sustainable basis. The government regulations mandate that all forest areas in Indonesia must be divided into management units too. In reality, however, only recently has the ministry of forestry established forest management unit models outside Java. In Bengkulu there is only one forest management unit.

Forest area licensed to a forest concession company is essentially a management unit. Within a concession area sustained yield principle can be implemented, especially for timber production. However, many forest concession companies have not implemented sustained yield principle. They cut more than the allowable cut. As a result, before the first harvest cycle ended most concession areas had been logged. The MOF did not renew their licenses. In Bengkulu there used to be 5 concession companies operating in production forest, but all of them didn't get their license renewed. A great part of the forest areas left by the concession companies have been taken by communities as well as plantation companies. The forestry offices at district and provincial level do not have enough resource to manage the forest directly. Their roles are mostly administrative. Technical aspects of management are out of reach.

To have a better control of forest areas, the government must create more forest management units, each managed by a complete organization capable of implementing SFM. Currently the only one forest management unit in Bengkulu has so incomplete organization structure that it is impossible to do the job. To function effectively the organization must be empowered by appointing complete competent staff so it can conduct all aspects of forest management. Since recruiting new staff will add financial burden to the District of Mukomuko, the completion of the organization can be done by relocating of government officials from the office of forestry to the forest management unit.

Subsequently, other forest management units must be established in other districts. As mandated by the government regulation, finally all forest areas in Bengkulu must be divided into forest management units.

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MESOCARP, OIL PALM RESIDUES AND TORREFACTION FOR IMPROVING ITS ENERGY CONTENT

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Abstract

As climate change is globally high lightened, the demand for substituting fossil resources to renewable energy resources is also increasing to reduce GHG emission. Among many ways to achieve this goal, co-firing in the power plant with coal and biomass is seemed to be one of promising options. A mesocarp fiber is generated as one of biomass residues during crude palm oil (CPO) process. It is obtained at the nut and fiber separator. In terms of sustainability, this resource is highly being considered because of its amount and productivity. Even though significant amount of mesocarp is burned as biomass fuel in CPO mills, the potential to be exportable or transportable as biomass fuel is still large. Recently torrefaction technology is focused by many scientists and engineers due to its practical applicability and transportability.

In this study, the optimal condition for the torrefaction of oil palm mesocarp fiber was investigated by response surface methodology. Pelletizing properties of torrefied biomass were analyzed depending on torrefaction conditions. The elemental composition of torrefied biomass was influenced by the Severity Factor (SF) of torrefaction. The carbon content in the torrefied biomass increased from 49.90 to 57.64%, while the hydrogen and oxygen contents decreased with the SF. The calorific value of torrefied biomass ranged from 20.77 to 23.05 MJ/kg. This implied that the energy contained in the torrefied biomass increased by 5 to 19%, when compared with untreated biomass. The calorific value and weight loss in the biomass increased as the SF increased. The energy yield was high at a low SF, allowing for weight loss and calorific value. At a high SF, no pellets were made by torrefied biomass, or many defects were shown in the torrefied pellet, while the pellets were produced with good formation at a low SF.

Keywords: *Torrefaction, Response surface methodology, Severity factor, Energy yield, Calorific value*

Introduction

Lignocellulosic biomass residues plays a major role in the production of sustainable energy, because it is abundant, relatively inexpensive, and often locally available. In recent years, growing attention worldwide has focused on the use of lignocellulosic biomass residues as a feedback to produce biofuel pellet, as an alternative to fossil fuel. Malaysia is one of largest exporters of palm oil in the international market. In the process of extraction of palm oil from palm fruit, a mesocarp fiber is generated as a residue, which is obtained at the nut and fiber separator [1]. In practice, this mesocarp fiber is burned in incinerators by palm oil mills, which not only creates environmental pollution in nearby localities, but also offers limited value to the industry. The annual amount of mesocarp fiber generated by the oil palm industry is 10.3 million tonne [2]. Therefore, availability of mesocarp fiber is considered to be the best among biomass residues.

The torrefaction process has been used for high energy density of lignocellulosic biomass. Torrefaction is a thermal pretreatment process where raw material is heated in an inert or nitrogen atmosphere, at a temperature of 200 – 300°C. This provides a hydrophobic condition for the biomass, due to the removal of the hydroxyl group during thermal treatment. Therefore, the torrefied biomass provides suitable chemical and physical characteristics for long-distance transportation and long-term storage in order to overcome the drawbacks of biomass as renewable energy resource. Additionally, the advantages of torrefaction include a higher calorific value or energy density, lower moisture content, and better grinding. Through the torrefaction process of biomass, most of the volatile compounds are removed from the biomass as vapors, and consequently results in a higher energy density. Researchers have reported that torrefaction temperatures for lignocellulosic biomass range from 250 to 300℃. Additionally, the advantages of torrefaction include a higher calorific value or energy density, lower moisture content, and better grinding. However, torrefaction of biomass accompanies significant weight loss, depending on the torrefaction condition. A high calorific value of the torrefied biomass is indicative of such weight loss during torrefaction. Therefore, torrefied biomass should be evaluated in terms of energy yield. Some studies have reported torrefied pellets lead to poor quality. It is implied that it is difficult to form torrefied pellet from torrefied biomass, under the same procedures as making regular pellets from untreated biomass.

In this study, based on the paper about torrefaction of mesocarp, we further investigated the effects of torrefaction on weight loss and calorific value of mesocarp by response surface methodology, and then made torrefied biomass into pellets in order to verify the characteristics of torrefied biomass on pelletizing [13].

Materials and Methods

Materials

Mesocarp fiber of the oil palm was purchased from New Star Inc. located in South Korea. The biomass was collected at an oil palm plantation in Kelantan, Malaysia in 2011. They were dried to below 10% moisture content for safe outside storage, and were used in this study without grinding.

Torrefaction process

The torrefaction conditions were based on a 2^2 factional design augmented with star design (four axial point) and three replicates in the central point. The mesocarp fiber was dried at 105℃ for 24h before torrefaction in order to remove the water remaining in the biomass. The dried mesocarp fiber was placed in a batch reactor (designed by Drying Engineering Inc., Korea), which has a temperature controller, and which was sealed to increase the temperature. The mesocarp fiber was torrefied under nine different conditions, with stirring. Torrefaction was performed under anaerobic condition to avoid oxidation and ignition. A nitrogen flow of 2 L/min was used as the inert carrier gas. After torrefaction, the heater was turned off, and the reactor was left to cool down to room temperature. Torrefied biomass was passed through five different sieves (0.425 mm, 1 mm, 2.8 mm, 4 mm, 6.35 mm), resulting in the accumulation of six differently-sized particle collections. A schematic diagram of the torrefaction reactor is shown in Fig. 1.

For the torrefaction of biomass, a severity factor (SF) was used to integrate the effects of reaction times and temperature into a single variable [3]. The SF used in this study is defined as

$$\mathrm{SF} = \mathrm{Log}\left[t \cdot \exp\left(\frac{Th - Tr}{14.75}\right)\right] \tag{1}$$

Where t is the reaction time of the torrefaction in minutes, Th the reaction temperature in ℃, and Tr the reference temperature, most often 100°C.

Elemental analysis and calorific value of biomass

The moisture content of torrefied biomass was performed using the oven-dry method. The gross calorific value based on dry weight at constant volume was determined by the bomb calorimeter (Parr 6400, USA). The oxygen content was determined by an elemental analyzer (EA-1110, Thermo Quest, Italy). The contents of carbon, hydrogen and nitrogen were calculated by an elemental analyzer (EA-112A, Thermo, USA) according to Korea wood pellet standard [4]. All experiments were performed according to the quality standard of the wood pellet, in triplicate, and a mean value was reported.

Surface response analysis

A 2^2 factorial design was used for optimizing the torrefaction of mesocarp fiber to improve its energy density for pellet production. Time (20 – 80 min) and reaction temperature (220 – 280℃) were chosen as the independent variables. Calorific value, weight loss of biomass, and energy yield were used as the dependent output variables. Second-degree polynomials were calculated using statistical software R to estimate the response of the dependent variables.

Pelletizing

The torrefied pellets were pelletized using a single pelletizer (designed by Drying Engineering Inc. Korea). The press consisted of a cylindrical die of 8 mm in diameter and 40 mm in length. The die was heated to 100 ℃ for pellet production. The compression rod speed was 127 mm/min. The end of the die was opened. Torrefied biomass was loaded stepwise in amount less than 0.25 g into the unit, and then pressed. The pressure was released after 5s, the piston removed, and more torrefied biomass loaded and pressed until pellet formation occurred. The moisture contents of torrefied biomass were maintained at 10% before pelletizing.

Results and Discussion

Changes of C, H, O by torrefaction

The elemental component of untreated and torrefied biomass is shown in Table 2. The moisture content of torrefied biomass decreased from 7.84 to 0.98%, as the torrefaction severity increased. The behavior may be due to the torrefaction process. However, there is no trend for the ash content, depending on torrefaction severity. This result is very similar to that stated in the report by Uemura et al [5]. The major ash compositions of oil palm wastes are K(1.6%), Ca(0.18%) and Mg(0.16%). Some of the potassium moves from the solid phase to the gas phase, depending on the torrefaction condition. Therefore, the torrefaction of mesocarp fiber provided unhomogeneity of ash content in the torrefied biomass. In larger scale of torrefaction process, appropriate feedstock handling before torrefaction process could be assumed to be important stage due to be able to have an impact on the quality of torrefied products. Table 2 Carbon content

As shown in Fig. 2, Van Krevelen diagram was reveiwed in order to clearly show the changes of torrefaction by torrefaction. Torrefaction of the mesocarp fiber resulted in a higher carbon, low oxygen and hydrogen contents as the SF increased, resulting in the decrease of H/C(from 1.17 to 0.84) and O/C(from 0.41 to 0.25) ratios. This is due to the release of volatile compounds rich in hydrogen and oxygen, such as water and carbon dioxide [6]. Torrefied biomass is believed to have a higher calorific value. However, the nitrogen content remained almost constant. This result implies that energy densification was performed through torrefaction process within the range 220 to 280℃.

Weight loss and calorific value on the torrefaction temperature

In thermal decomposition of biomass, increase of calorific value and weight loss of biomass have closed positive correlation. Torrefaction temperature has significant effect on the increase of calorific value of biomass. According to Fig. 3, the significant increase of calorific value was observed between 250 and 270℃ when compared to the range from 230 to 250℃. The R square values were different between SF (R^2 0.8830) and temperature only (R^2 0.9768). It could be exploited that temperature has more critical effect on the torrefaction when compared to the mixed variables. Among experiment conditions, if experimental time is considered as a variable in same temperature, the variations of result in same temperature could be elucidated in this 2^2 experimental design. This result showed that there is critical torrefaction conditions could be existed for optimization. On the while, the difference of calorific value in 270℃ was not much higher than that in 230 and 250℃. This implies that isothermal decomposition of biomass at 230 and 250 ℃ was not completed, however, almost completed at 270℃.

$$\text{Weight loss (\%)} = \left(\frac{mass\ of\ untreated\ biomass - mass\ of\ torrefied\ biomass}{mass\ of\ untreated\ biomass}\right) \times 100 \qquad (2)$$

The result of weight loss indicates that the regression line showed more close to linear type. This implies that the optimized condition could exist in oder to decrease the weight loss and increase the calorific value of feedstock. Based on the graph in Fig. 5, the rate of increase of calorific value is more higher than that of decrease of mass yield when severity factor is higher 6.32. This difference shows the clue for solving the optimal condition in large scale facility. This energy density result is very similar to that of other researches using wood chips and other biomass resources [5,6,7].

In this study, the concept of energy density was introduced in order to clarify the effect of torrefaction. This concept was defined as

$$\text{Energy densification} = \frac{Etorr}{Mtorr} \tag{3}$$

Where, $E_{torrified}$ is the percentage of calorific value increased through various torrefaction conditions. $M_{torriefied}$ is the mass yield of torrefied biomass. Similar concept which is called as energy densification was discussed by Luo [7]. The correlation of energy densification and severity factor showed that there is critical changes of the energy densification between 250 and 270°C.

Energy yield also represents the efficiency of torrefaction process. The results of energy yield in Table 3 range from 72.20 to 94.11%, depending on the torrefaction condition. They were calculated from the mass yield and calorific value using equation and expressed as a percentage of the energy content of untreated dry biomass: $M_{torrefied}$ denotes dry mass of torrefied biomass $M_{initial}$, dry mass of untreated biomass; specific energy content of biomass after torrefaction; and $E_{initial}$, specific energy content of biomass before torrefaction.

$$\text{Energy yield (\%)} = \left(\frac{Mtorrefied}{Minitial}\right) \times \left(\frac{Etorrefied}{Einitial}\right) \times 100 \tag{4}$$

The correlation of energy yield with energy densification could be explained by Fig. 6. As the energy densification increased, mass yield was decreased. The degree of energy densification increased from 1.02 to 1.67 with the increase of SF or temperature. When the energy densification is up to approx. 1.4, the steep decreasing rate of energy yield is observed. Then, the rate of regression is slightly changed. To explain the correlation between energy yield and energy density more mathmatically, further studies need to be performed.

Response surface analysis of energy yield

Calorific value and weight loss in the biomass over a range of SF values are shown in Table 1. The experimental calorific value and weight loss increased with SF. These factors are major determinants in the energy density of biomass. In particular, the calorific value dramatically increased as the SF increased from 6.32 to 7.0 and when slowly increased until 6.32. This was due to removal of the moisture and volatile compounds remaining in the biomass, rather than to degradation of the major compounds of biomass, such as cellulose and lignin. This is similar to the change in carbon content in biomass during torrefaction. The calorific value ranged from 20.8 to 23.0 MJ/kg, depending on the torrefaction conditions. This implies that the energy content in the torrefied biomass increased by 5-19%, as compared to the untreated biomass. The calorific value was affected more by the temperature than by the reaction time. In particular, the calorific value significantly increased with a torrefaction temperature over 250°C, regardless of time. The highest calorific value was 23.0 MJ/kg for the torrefied biomass at 280°C for 50 min, corresponding to a weight loss of 33.69%. Based on the calorific value, the response surface determined the optimal torrefaction condition to yield the highest calorific value. The results of the analysis of variance (ANOVA) in equation are presented in Table 4, where x1 and x2 denote reaction time and temperature. This model was significant at the 99% confidence level, and the p-values for temperature and reaction time were close to 0.

The weight loss of the biomass during torrefaction is plotted in Fig. 4. Reaction temperature has an impact on biomass weight loss during torrefaction. This might be due to the removal of water and volatile compounds present in the biomass as an initial reaction of the thermo-degradation of biomass.

According to Chin et al., hemicellulose of biomass is more easily decomposed compared to cellulose under mild torrefaction condition (below 250°C) [8]. The temperature ranged from 220 to 280°C in this study. In this range, most of the hemicellulose, and some of the cellulose and lignin content in the biomass could be degraded during torrefaction. Weight loss highly depended on reaction temperature, rather than time, during torrefaction. Table 4 shows the ANOVA of the quadratic model adjustment, where the total error was classified into lack-of fit and pure error. The F value estimated using the experimental data corresponded to the total residual and lack-of-fit values, respectively, and was lower than the tabular F value. This indicates that the models were significant in the region studied. For both models, the p-value was 0.0001, which shows that the models were strongly significant at 99% confidence level.

The energy yield per untreated biomass indicates the total energy preserved in the torrefied biomass. It was highest when the difference between the weight loss and calorific value was high. Reaction temperature had the highest impact on the energy yield of torrefied biomass, while the effect of time was considerably lower. Below a SF of 5.72, the energy yield was maintained over 90%. However, the energy yield was very low at a high SF. This difference is mainly due to the poor mass yield of mesocarp fiber, while the calorific value increased to a similar extent by torrefaction. The energy yield was fitted to the response surface model provided in equation, in order to analyze the effect of the torrefaction factors on energy yield.

The present study using the technique of response surface methodology (RSM) enables accurate values of the torrefaction condition to be found for the maximum energy yield. When considered the goal of this study, the optimal condition for the torrefaction of mesocarp fiber was not confirmed yet.

Pellet production & pressure tolerance

According to the preliminary results, torrefied biomass was found to be difficult to form into pellets, under the same conditions as making control pellets [3]. Therefore, a single pellet was produced by a die of 8 mm diameter and 40 mm length in this study. The die condition was appropriate to produce a single pellet over the range of the torrefaction conditions used in this study. Typical pressure change curve for compaction and extrusion of torrefied biomass in the single pelleter are shown in Fig. 6. The pressure increased, when comparing raw material and torrefied biomass. This implies lack of water and low hemicelluloses play the parts of a binder and platicizer. The hydroxyl group in water and hemicelluloses strengthen the bonds between individual particles in the pellets. In addition, they provide flexibility in the biomass [9,12].

The pellets were very different in quality. No pellets could be made from torrefied biomass at a SF of 7.0, and even at a SF of 6.85 the pellet exhibits many defects. The pellet length increased with decreasing SF. At a high SF, the torrefied pellet has a short length and poor adhesion between the particles, while the torrefied pellet was producted with good formation at a low SF.

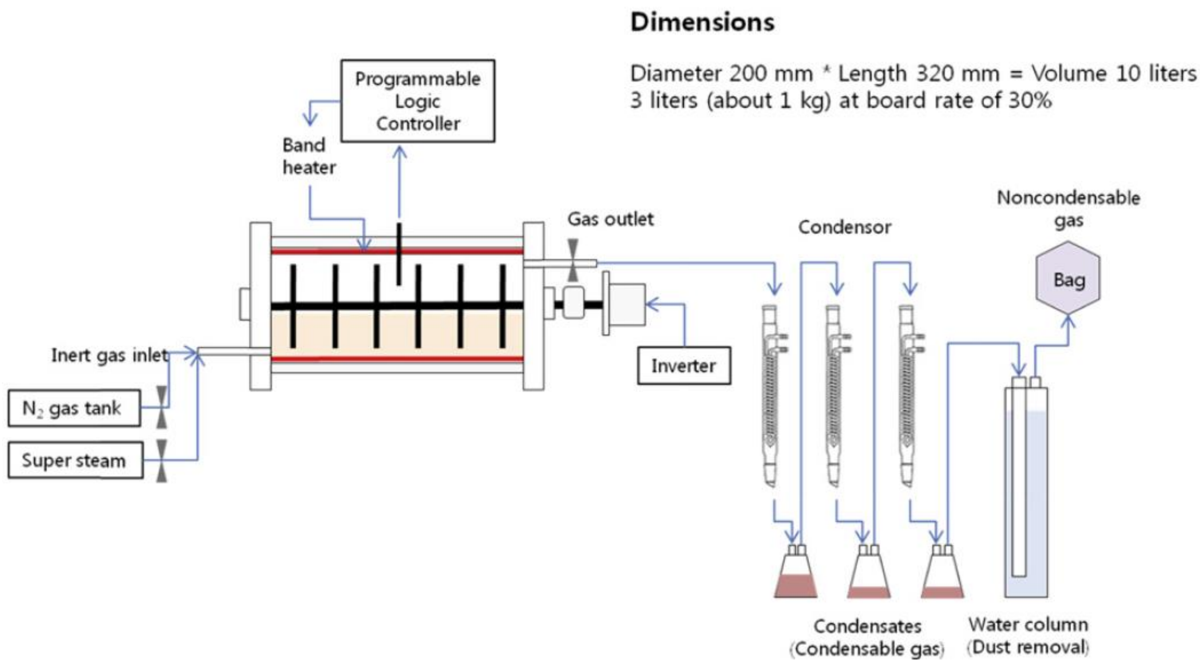

Figure 1. The design of the torrefaction reactor

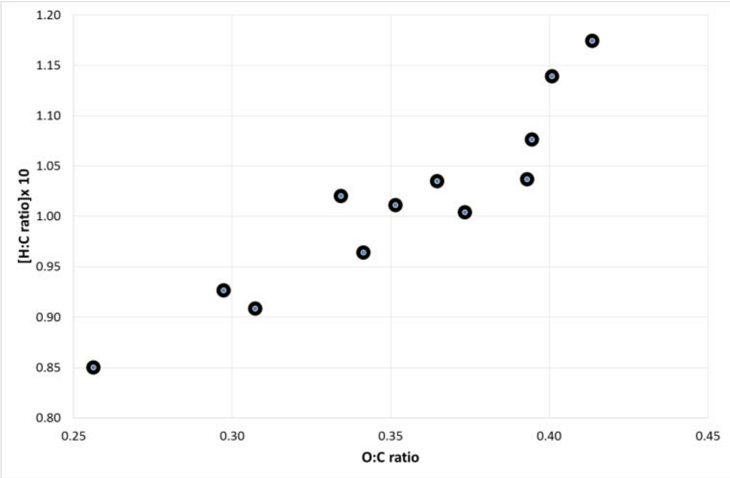

Figure 2. The Van Krevelren diagram of torrefied biomass

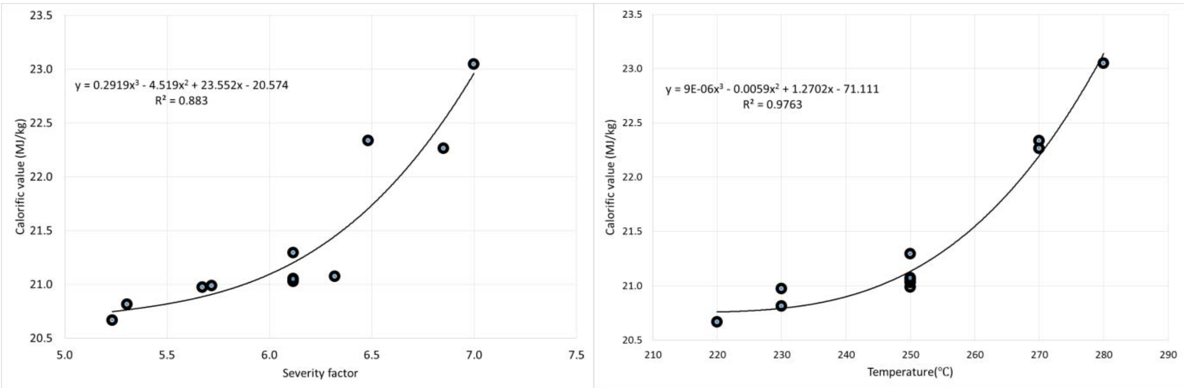

Figure 3. Calorific value depending on SF(right) or torrefaction temperature (left)

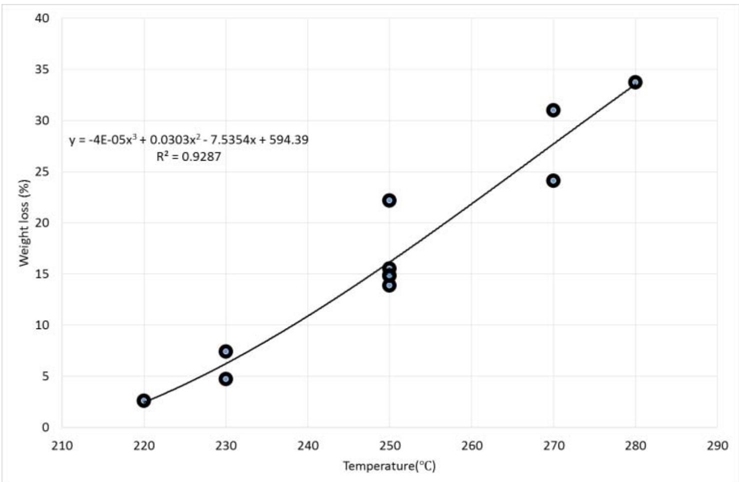

Figure 4. Weight loss depending on torrefaction temperature

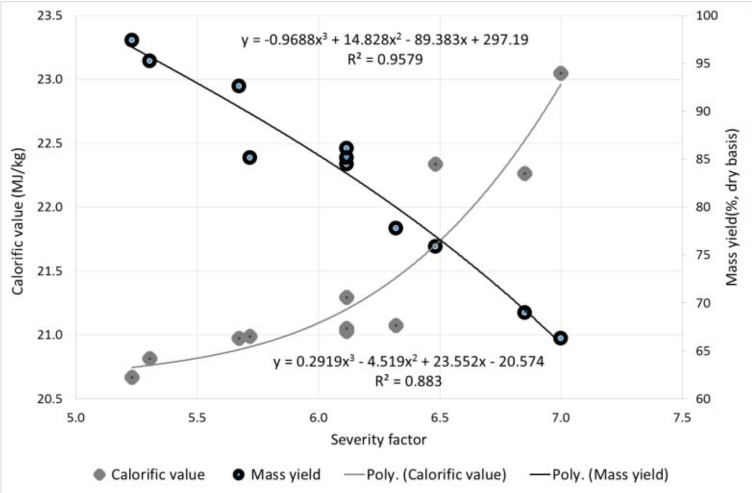

Figure 5. Correlation of calorific value and mass yield depending on severity factor

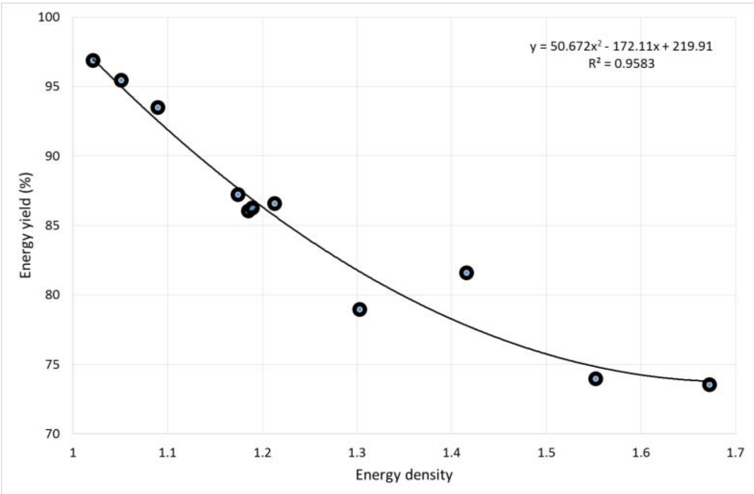

Figure 6. Correlation between energy yield and energy density

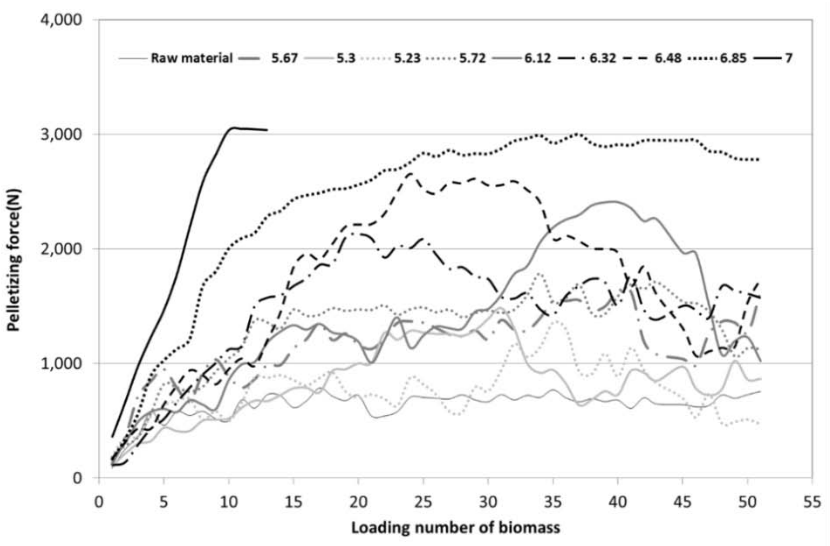

Figure 7. Pressure change curves during pelletization of raw material and torrefied biomass

Table 1. The 2^2 factorial design with four axial points and three replicates in the central point matrix employed for two independent variables

Sample No.	Temp	Time	Temp., x2	Time, x1	SF
1	250	50	0	0	6.12
2	250	50	0	0	6.12
3	250	50	0	0	6.12
4	270	70	1	1	6.85
5	230	70	-1	1	5.67
6	270	30	1	-1	6.48
7	230	30	-1	-1	5.30
8	250	80	0	1.4	6.32
9	280	50	1.4	0	7.00
10	250	20	0	-1.4	5.72
11	220	50	-1.4	0	5.23

Table 2. Elemental analysis of torrefied biomass

SF	MC (%)	Ash (%)	Elements (%)			
			C	H	O*	N
5.23	2.68	8.39	49.90	5.86	20.64	2.25
5.30	2.64	10.08	50.36	5.37	19.69	2.29
5.67	4.54	10.00	50.46	5.22	19.80	2.20
5.72	2.33	9.52	50.56	5.44	19.17	2.27
6.12	1.66	9.35	51.73	5.23	18.19	2.36
6.12	2.70	9.53	51.95	5.20	18.37	2.22
6.12	2.49	9.44	51.41	5.03	18.71	2.40
6.32	1.76	11.75	52.40	5.05	17.90	2.19
6.48	2.19	10.67	54.83	5.08	16.31	2.40
6.85	1.31	9.96	54.51	4.95	16.75	2.20
7.00	0.98	10.26	57.08	4.85	14.63	2.37
Feedstock	7.84	10.79	48.02	5.83	22.54	2.41

Table 3. Calorific value and weight loss of biomass by torrefaction

SF	Weight loss (%)	Calorific value (MJ/kg)	Energy yield (%)
5.23	2.61	20.67	96.86
5.30	4.73	20.81	95.43
5.67	7.40	20.97	93.46
5.72	14.82	20.99	86.03
6.12	13.84	21.03	87.19
6.12	15.53	21.30	86.57
6.12	14.86	21.05	86.25
6.32	22.18	21.07	78.92
6.48	24.10	22.34	81.58
6.85	30.98	22.26	73.95
7.00	33.70	23.05	73.54
Feedstock	0.00	20.78	100.00

Table 4. Analysis of variance (ANOVA) for the adjusted model for the calorific value, weight loss and energy yield of biomass during torrefaction

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
		Energy yield			
Model	358.10	2	179.05	15.50	0.0018
Temperature (coded levels)	356.85	1	356.85	30.88	0.0005
Reaction time (coded levels)	1.25	1	1.25	0.11	0.7510
Residual	92.43	8	11.55		
Lack of Fit	84.07	6	14.01	3.35	0.2477
Pure Error	8.37	2	4.18		
Cor Total	450.54	10			
		Weight loss			
Model	856.54	2	428.27	87.17	< 0.0001
Temperature (coded levels)	838.34	1	838.34	170.63	< 0.0001
Reaction time (coded levels)	18.20	1	18.20	3.70	0.0905
Residual	39.31	8	4.91		
Lack of Fit	34.37	6	5.73	2.32	0.3316
Pure Error	4.94	2	2.47		
Cor Total	895.85	10			
		Calorific value			
Model	7.27	5	1.45	70.93	0.0001
Residual	0.10	5	0.02		
Lack of Fit	0.07	3	0.02	1.34	0.4545
Pure Error	0.03	2	0.02		
Cor Total	7.37	10			
Temperature (coded levels)	6.04	1	6.04	294.77	< 0.0001
Reaction time (coded levels)	0.00	1	0.00	0.02	0.8880
AB	0.02	1	0.02	1.10	0.3428
A^2	1.18	1	1.18	57.72	0.0006
B^2	0.03	1	0.03	1.56	0.2672

Conclusion

The optimal condition for the torrefaction of mesocarp fiber was investigated with respect to the reaction temperature and time. While the reaction temperature had a strong impact on the energy yield of torrefied biomass, the effect of reaction time was considerably lesser, under the torrefaction conditions used in this study. When the weight loss of biomass by torrefaction is considered, introducing low SF values for mesocarp fiber is appropriate for the torrefaction of biomass for the production of high energy density fuels. The torrefaction condition has a strong effect on the pelletization properties of the biomass. Overall, optimal torrefaction condition for pellet production was below SF of 6.37, which can be used to produce high energy yield and pellet with good formation.

In this study, we showed that the torrefaction is typically done for overcoming the drawbacks of biomass as renewable energy resource. Characteristics like bulk, low calorific value and hydrophobicity could be dramatically improved [7,8,9]. However, for industrial utilization of oil palm related biomass, more insightful studies need to be continued in future[13].

Acknowledgment

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SUSTAINABLE URBAN PEST MANAGEMENT IN SOUTHEAST ASIA -- CHALLENGES AND FEASIBILITIES

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Abstract

We live in a millennium where more than half of the human populations live in the urban area. Out of this portion, a large percentage concentrates in Asia. In fact, out of the 10 most populated countries in the world, six of them will come from Asia. Today, Asia has some 550 million people living in slums, followed by Africa with 187 million, and Latin America and the Caribbean with 128 million. The highest percentage of slum dwellers is in Africa with 72% of the urban population, followed by South Central Asia (59%), eastern Asia (36%), western Asia (33%), and Latin America and the Caribbean (32%). Although the highest percentage of slum dwellers is in African cities, in numbers alone, Asia accounts for some 60% of the world's urban slum residents.

Poor air and water quality in many of these cities affect the health of the urbanites. In high densely populated cities, the people have limited access to the health services. In addition, the slums also host a variety of infectious diseases (eg. dengue, malaria, tuberculosis, etc) where a number of them are transmitted by insect vectors. These diseases spread even faster in highly populated areas.

Pest control in the urban environment has always relied heavily on the use of pesticides. Injudicious use of pesticides against urban insect pests have led to four major problems, namely (1) accumulation of toxic residues in the urban environment, (2) pest resistance, (3) occurrence of secondary pests, and (4) pest resurgence. Besides the ecological and biotic issues, irresponsible use of pesticides may also lead to other economic and social consequences.

Integrated pest management (IPM) is a pest management system that is designed to provide long-term management of pests, and not as a short-term measure. The concept of IPM emerged from the agro-ecosystem. Direct adoption of the concept of IPM into the urban ecosystem is not possible as it is uniquely different and consisted of multiple interacting factors (such as human behavior, cost, aesthetics, etc) and these are not present in the agro-ecosystem. The implementation of IPM in the urban ecosystem is far more challenging and in most situation, more costly as well.

Sustainable urban pest management is a feasible, affordable and long lasting ecologically acceptable pest management approaches with no or limited economic, social and environmental consequences. Pest management professionals should regulate their activities on monitoring, maximizing their efforts on prevention, rather than cure. They should emphasize on protecting the buildings and structures, and the landscapes, instead of killing the pests. Pesticides should only be used as the last resort, as and when it is absolutely required. The key principle in sustainable urban pest management is to reduce the pest population up to an acceptable aesthetic level with as little ecological disruption as possible.

Having said this, there are numerous challenges and feasibility issues in ensuring the success practice of sustainable urban pest management. These include (1) Lack of pest management measures that are truly long lasting and sustainable, (2) Human behavior, (3) cost, (4) Limited awareness and lack of cooperation among the stakeholders. In this paper, I will discuss how the above challenges will hamper the implementation of sustainable urban pest management and propose a feasible framework to overcome the numerous challenges.

OVERVIEW OF RADAR STUDIES OF EQUATORIAL ATMOSPHERE AND IONOSPHERE IN INDONESIA

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Abstract

We are interested in the equatorial atmosphere. The Earth's atmosphere is vertically coupled with atmospheric waves. Momentum transfer from lower to upper atmosphere through wave propagation plays a big role of determining the dynamics of the whole atmosphere. The equatorial region is important as energy input from the sun is the maximum that leads to the intense wave generation. We have been studying the atmosphere and ionosphere in the equatorial region for long time collaborating with Indonesian scientists from various institutions. Especially, we installed the Equatorial Atmosphere Radar (EAR) at Kototabang, West Sumatra in 2001. This radar continued long-term continuous observations under close collaboration with LAPAN (National Institute of Aeronautics and Space (LAPAN). In this presentation we would like to show basic of the radar for atmospheric measurement, overview of study results from the EAR, and future expansion plan of the system.

Keywords: Dynamics of Earth's atmosphere and ionosphere, Radar observation, atmospheric waves, vertical coupling, Equatorial Atmosphere Radar

APPROPRIATE TECHNOLOGY DIFFUSION IN SUPPORT FOR SUSTAINABLE DEVELOPMENT IN BORDER LINE EAST NUSA TENGGARA

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Abstract

One problems of national development is growth disparity due to geographical conditions especially in borderline areas. East Nusa Tenggara (NTT), which is located in borderline of Indonesia and Democratic Republic of Timor – Leste, is one of poor province because of growth disparity between central and remote areas. This unique position needs special strategy in the development program. One strategy is community development through appropriate technology diffusion. Program was focusing on community capacity building in managing local resources for the benefit of their life. Appropriate technology diffusion was applied through training and implementation program toward community groups (farmer and small enterprises). Training and continued with assisstancy was applied to guarantee the sustainability of the program. An evaluation was conducted in collaboration with local government, with the intention of understanding how technology was diffused and accepted by people. The research showed that training of trainer (ToT), training for community/trainee (TFT) and technical assistances were the best practices of technology diffusion strategy in NTT. Those strategies were satisfactory factor in increasing local economy.

Keywords: *Appropriate Technology, Technology Diffusion, Community Development*

Introduction

East Nusa Tenggara (NTT) is one of district in East Region of Indonesia and is located in borderline of Indonesia and Democratic Republic of Timor – Leste (DRTL). NTT has potential natural resources, especially in agricultural sector. According 2006 data published by the Bureau for Statistics (BPS) [1], land areas for crop cultivation in NTT was 3.2 million hectares. Maize, cassava, sweet potatoes were food crops production in NTT while type crops of smallholder estate were dominated by candlenut and cashew nut.

Although a lot of natural resources produced, unfortunately, NTT was still one of poor provinces in Indonesia. BPS [2] reported that the percentage of people living below the national poverty line was still 26% in 2008, and its Human Development Index (HDI) was rank of 31st out of 33 provinces in Indonesia [3]. In education sector, NTT had one of the lowest junior secondary and primary enrolment rates, the highest repetition rate in the country (13%), and one of the lowest literacy rates (84%). In terms of health indicators, 46% of the population still had no access to clean water, while 32% did not have access to health facilities [4].

Even as NTT had large land areas, only 50% (1.6 million hectares) was utilized for plantation and food crops, 50% rest was meadows and temporarily fallow land. Yet, agricultural sector was predicted could not give more added value to economics of NTT society.

Many causes happened for those conditions. One of the problems was growth disparity due to geographical conditions as well as historical development of the country. Growth disparity noticed between western part of Indonesia (Java, Sumatera, Bali) and eastern Indonesia (Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua). More specifically, the disparity considered between Java and outside Java.

LIPI as a research institute has 3 responsibilities, those are: responsibility to science and technology development; to stake-holder; and to society. In carrying out the responsibility to society, LIPI handled a community development program. NTT was one district was being selected as a target program due to its conditions. Economics development in NTT was left behind compared to economics of others districts in Indonesia. Furthermore, as a borderline, NTT is an important district for politic stabilities in the country.

On the basis of geography location, economics situation and human resources conditions, appropriate technology was identified as a tool to help society in utilizing natural resources therefore they could get many advantages of using technology. Technology could process raw material to be a finish good that has high added values.

Appropriate technology in NTT had been diffused by LIPI since 1986 in order to improve the level of life of society. Appropriate technology diffusion was one of LIPI's strategies in community development program. This activity was a contribution of LIPI to National Development. The aim of the research was to understand how technology was diffused and accepted by people.

Methods

Rogers [5] described technology diffusion as "the process through which an individual or other decision maker unit passes from first knowledge of an innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation. According to Rogers [6], technology diffusion which was resulted from an innovation, was a theory of how, why, and at what rate new ideas and technology spread through cultures. Term of diffusion was defined by Rogers as a process by which an innovation was communicated through certain channels over time among the members of a social system.

Appropriate technology diffusion was chosen by LIPI, as a tool to perform a community development program. This program was one of LIPI's contributions to National Development. A selection of appropriate technology as a tool of community development was based on Blackman's finding [7]. Blackman confirmed that only appropriate technology that would guarantee to be utilized by developing country.

The primary outcome of community development as indicated by Frank and Smith [8] was to improve quality of life of community. Frank and Smith explained that community development was the planned evolution of all aspects of community well-being (economic, social, environmental and cultural). It was a process whereby community members came together to take collective action and generate solutions to common problems. Furthermore, Frank and Smith described that community development required and helped to build community capacity to address issues and to take advantage of opportunities, to find common ground and to balance competing interests. Community development required both a conscious and a conscientious effort to do something (or many things) to improve the community.

Community development program was carried out in NTT, a district that economics of community was still left behind because of growth disparity. Community development program was performed through appropriate technology diffusion. ESCAP [9] explained that community development was a basic need strategy to get an opportunity in having the benefit of national development.

To obtain required information, data collecting had been done to target's community using survey methods. Interview had been done to community that received program, to researcher of LIPI who delivered the program, and to resource person from Local Government. Research sample was LIPI's target group and all LIPI's researcher who involved in community development program in NTT. The groups was observed and recognized since the beginning until the end of the program. As comparator, survey was done to others group who received relevant program from other institution outside LIPI. To distinguish the impact of activity, apart from interview, information was collected on relevant report and publications.

Interview had been done to 21 researchers on May-July 2007 and to 33 people as targets group in July-August 2007. Community as target group was farmer; breeder; micro enterprises of agro-based industry. Interview was carried out to resource people from Local Government and key person. There were 22 resource people and key persons. Interview to resource people from Local Government who were not receive LIPI's program was done to three persons, for comparators of LIPI's program.

To understand the pattern of community development in NTT, firstly, a number of variables were determined. Selection criteria of variable was based on some theories relating to community development such as APO [10]; Arief [11]; Chambers [12]; ESCAP [13] Weber [14]; World Bank [15], and also LIPI's experience in carrying out of community development in Papua, NTT and NTB [16], [17], [18]; Darmajana [19]; Hidajat *et al*. [20]; Patton [21], Policy of Government (PP No 32 year 1998) concerning Small Industry, and also Quality Procedure of LIPI's Monitoring and Evaluation.

All set of variables were compiled in questionnaire. Before used, Questionnaire was tested on April 2007 to researchers in LIPI who had community development in outside region of NTT. Questionnaire was tested to communities in Garut which have guidance from Local Government of Garut. 12 questionnaire (out of 30) from researchers and 8 (out of 20) from communities were tested. The results show that most of proposed variables that were tested, were valid. Unacceptable variables were eliminated. Quantitative data were explored using principal component analysis; whereas qualitative data was explored with content analyses. Content analysis was carried out to draw abstraction of information.

Results and Discussion

There were 18 women and 15 male as respondents from community in NTT; 42 years old in average with educational level were senior high school. 24 respondents were handing food industry, 2 respondents were ox breeder, and others were carpenters.

To know people's opinion about dominant factor of technology diffusion, collected quantitative data were analyzed using principal component analysis. The result showed that improvement of earning money, the ability to become trainer, better understanding of production technology, quality and product standard, design product, were the first dominant factor of technology diffusion in NTT, with 33.3% weight. Whereas product improvement, marketing skill and managerial technique, labor management were the second dominant factor of technology diffusion, with 29.4% weight. Improvement of capital and the ability to manage it, accessing to financial institution were the third dominant factor of technology diffusion with 21.4% weight. The rest (16%) was other factor outside of the research.

To know how technology was diffused to and accepted by people, information had been explored to community who received technology diffusion program in 1986-1990s. in 1986, LIPI diffused economical stove in Kupang NTT. The program was stopped in 1990s when subsidies kerosene was spread out to country wide.

Appropriate technology diffusion project was starting again from 2003 (until at this moment), by seven Research Centers under LIPI's Organization. The project was executed with different strategies. Center for Appropriate Technology Development (CATD) was providing TOT (Training of Trainer) to Local Government Officer (NTT), and technical training in processing of post harvest technology to a certain (target) group. The training was the first effort in growing household economic activity (micro enterprise). Some equipment for micro business was offered as an initial capital. Technical education during 1-3 months as well as supervision for 2-3 years was provided to the target group. Business strengthening was performed to the enterprises which have a further prospect. Those activities were run along with Local Government as counterpart.

Research Center for Biotechnology was running the activity through technical training as well. Intentional insemination and ox fatness program was arranged in NTT. Technical training was carried out to group of ox breeder. Similar to CATD, Research Center for Biotechnology leads Local Government to run those activities.

Research Center for Electronics and Telecommunication carried out the activity via equipment installation for television relay station and telecommunication kiosk. Technical tutorial for operating of telecommunication equipment and transmitter of TV was done starting from installation, until transmitter function well. Supervision was provided to target group. The activity was associated with Local Government.

Research Center for Electricity Power built an ice plant in fisherman port area. Technical training how to make ice was carried out to Local Government. Unfortunately diffusion of technology did not run smoothly. When some equipments damage, no technician could repair it, so the plant was idle since the first year of project.

Land conservation around big pond (small lake) was prepared by Research Center for Biology. The head of Countryside of Leosama reported that the activity involved Leosama community in three regions. Local Government in Agricultural Field was counterpart of this project. Since no technical requirement for this activity, Research Center for Biology did not train local community to plan trees.

In addition of land conservation, Research Center for Biology executed ‘Cendana’ Agro-forestry project. Regrettably, this activity did not collaborate with Forestry Local Institution (Local Government for Forestry). Technology diffusion likely executed to certain local community but not to Local Government, so when the project finished, the activity stop.

The result indicated that contribution of Local Government were varied, some Institution involved in tutorial, some of them were providing capital, equipments for small business, and some of them gave facilities to the target group.

In carrying out the project, LIPI recommended researcher to link up Local Government of NTT, since many facilitates offered them, such as problems identification, current policies, existing Government effort, and other relevant information for based-line data.

In general, LIPI carried out community development program through diffusing appropriate technology to community. Some activities created micro business as household activity with utilizing natural resources as local potency. Others built infra structure to facilitate communications and distribute information of Local Government.

Technical training was part of technology diffusion strategy. Technical training was carried out to community in order to increase community’s skill in utilizing local potency through processing it to be a finish good. Selling finish product could earn more money rather than marketing of raw materials. Technical training was done to Staff of Local Government as well. Training of trainer was implemented to staffs who would continue tutoring the activity when the project came to an end. The target of training was to create technical instruction in processing of natural resources and skilled up of other relevant field that was needed to support local economics growth.

Technical tutorial was completed for about 2-3 years until we convinced that the target group (community) ready to empower himself. Technical tutorial was part of technology diffusion strategy in building and developing capacity of community.

Equipments were provided to the target group. The aims of equipping facilities were triggering local economics activities through productivity growth. Economics growth was expected could stabilize politics and economics of borderline country.

It is clear enough that one of challenge in community development is reducing of poor people. Appropriate technology was one of LIPI’s strategies to utilize local potency in NTT which was located in borderline Indonesia – RDTL, the area that many conflicts frequently occurred. The study showed that appropriate technology diffusion improved the economics of target group.

Conclusion

Training of trainer (TOT), training for community/trainee (TFT) and technical assistances were the best practices of technology diffusion strategy in NTT. Those strategies were satisfactory factor in increasing local economy.

From the study, we identified that involvement of Local Government determined the usefulness of the project. How far of Local Government concerned to the project depended on how close of researchers worked together with them.

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FROM FISHERIES CONSERVATION TO COMMUNITY SUSTAINABILITY (STUDY ON BENGKULU GOVERNMENT'S POLICY ON FISHERIES)

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Abstract

Bengkulu, which is located in the western coast of Sumatra and is adjoining Indian Ocean with an area of 12335.20 km2 sea, has high levels of biodiversity thus it included in one of Mega Biodiversity. However, some species are endangered and fishing economic level in general is still low. This is due to the rampant of illegal fishing, lack of disciplines from fishery community in conducting their activities (such as docking and selling not on the designated places, unregistered fleets). This writing began from field surveys in the coastal town of Bengkulu, but problem raised is how local government policies in manage these issues. This paper used normative juridical method with literature searches and statute approaches. Interview with officials from the Ministry of Marine and Fisheries is conducted as a complement. Results of the writing shows the government's policies on fisheries can be found in Act on ratification of UNCLOS in 1982; Act on Waters, Act on Biodiversity; Act on Fisheries; Regulation of the Minister of Marine Affairs and Fisheries No. PER.05/MEN/2008 on Fisheries Capture Business. These acts have lead to the sustainable use of fisheries. Unfortunately, policy on obligation to anchor in PPI and on registry for small fishing fleets, for which fisheries act mandated, are still not found in Bengkulu. Suggestion; despite the absence of policy, the Government of Bengkulu as an inherent part of Indonesia should be fully aware that Indonesia is bound to UNCLOS 1982 and UNIA 1995, also Code of Conduct for Responsible Fisheries, so the measures taken can lead to responsible management, thus sustainable fisheries management can be achieved.

Keywords: community, fisheries, government policy, sustainability.

Introduction

Bengkulu, which is located in the western coast of Sumatra and is adjoining Indian Ocean with an area of 12335.20 km2 sea, has high levels of biodiversity thus it included in one of Mega Biodiversity. It is not surprised if people tend to choose fishing as a living [ ]. They are varied from traditional to modern.

Even though Bengkulu is very rich of fishery recourses the fishermen economy are still in low level. In 2012 Bengkulu Marine and Fishery Department (DKP Bengkulu) noted a decrease in the number of fishermen [ ], and Ulayat [ ] recorded that no less than 500 fishermen and farmers turned to coal waste collection along Bengkulu River even to the edge of sea. Even today there are nearly 50 coal gatherer communities along the Watershed Bengkulu organized by fences. They sell it not only in Bengkulu [ ]. While doing the survey it is found many fishing fleets under 10 gross tonnage (GT) landed outside the fish landing port (PPI); many people sell fish along the seashore in buildings (some of the buildings are permanent and others are not where the roof made of only tarpaulin or iron sheeting). From interviewed with a fisherman it is known that Indo-pacific sailfish, Yellowfin Tuna, Senangin Fish, Terong fish, Gebur fish, Karang fish are now difficult to find. These are issues regarding not only fish but also fisherman, marine environment, and society around it which should be addresses by Bengkulu Government immediately.

Indonesia has ratified United Nation Convention on The Law of The Sea 1982 by enacted it through Act No. 17 year 1985 on the ratification of UNCLOS 1982 which then implemented in Act No. 6 Year 1996 on Indonesia Water and ratified Agreement for the Implementation of the provision of the UNCLOS 1982 relating to the conservation and management of straddling fish Stock and Highly Migratory Fish Stock (UNIA 1995) through Act No. 21 year 2009 and also adopted Code of Conduct for Responsible Fisheries (CCRF). It means Indonesia has to commit what have been agreed by those regulations, especially CCRF in relation to sustainable fishery management [ ] This paper tries to analyze Bengkulu Government policy in realizing community sustainability in fisheries. What efforts have been done in enhancing fisheries community in Bengkulu.

Materials and Methods

This research is a juridical normative research (Soerjono Soekanto and Sri Mamudji: 1983)[6], in particular the inventory of policy of Bengkulu Government in forming community sustainability in fisheries. Primary legal materials include regulations, both international and national which become references to Bengkulu Government in making such policy. Secondary legal materials that complement the primary legal materials include literatures relating to the topic of the paper. The legal materials collected by the laws of search methods both written and unwritten law of primary and secondary legal materials. Search the written law and unwritten literature studies done both on line and off line.

Results and Discussion

Sustainable Development and the Chancing Paradigm on Fisheries

The general principle that States should ensure the development and use of their natural resources in a manner which is sustainable has emerged only recently. It appeared firstly in treaties in 1980. The term is generally consider to have been coined by 1987 Brundant Report, which is defined it as 'development that meets the needs of the present without compromising the ability of the future generations to meet their own needs'[ ].

Fisheries are a common property natural resource; anyone can, in principle, fish in the sea. Anyone can enter a particular fishery. If the quantity of fish being caught together with fish lost through natural mortality exceeds the amount of fish being added to the stock through reproduction, then the size of the stock will start to decrease. This phenomenon is known as over-fishing. To prevent it is usually necessary to regulate the amount of fish to be caught [ ].

Fisheries sustainability began with conservation paradigm by biology scientists. In this paradigm fisheries sustainability is defined as long term conservation. It means that fisheries activity will be "sustain" if it is able to protect fishery resource from extinction. This concept gave a little attention to human purpose in conducting fishery activity.

Then in 1950s, there appeared a new paradigm, rationalism paradigm which focused on fishery sustainability that rational from economic point of view and based the argumentation on a concept the achievement of maximum profitability for resource owner.

This concept was challenged by Charles who proposed community paradigm in 2001. He argued that fishery sustainability will be achieved through community approach, which means main concern should be addressed to fishery community sustainability as a community system. Traditional fisheries concepts which proved to be of self control against the catch, appropriate use of technology, high levels of collectivity among fishing communities and traditional knowledge which reflects the resilience of fisheries. Thus, fishery sustainability not solely for the sake of the preservation of the fish itself or for economic benefit (as rents) but more than that to the sustainability of fisheries communities (sustainable community) which is supported by institutional sustainability including the quality of sustainability of regulation devices, policies and organization promoting the achievement of ecology, economic and fishery community sustain.

International Regulations on Fisheries

UNCLOS 1982

The core of the fisheries provisions of UNLOC 1982 is to be found in the articles dealing with the EEZ [ ] As regards conservation, article 56 (1), article 61(1) and (3), article 62(1), of UNCLOS

1982 provide the coastal state's rights and duties on the fisheries regime of the EEZ. These articles show that the coastal state's management are very important in preserving fish. Under article 192 States have the obligation to protect and preserve the marine environment. Article 193 provides States have the sovereign rights to exploit their natural resources pursuant to their environmental policies and in accordance with their duty to protect and preserve the marine environment. Article 194 provides measurement that States should take to prevent, reduce and control pollution of the marine environment. It is seen that UNCLOS 1982 tries to prevent the failure of conservation by marine pollution of a State. That is why these regulation are related one each other.

Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating of the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks **(United Nations Implementing Agreement/UNIA) 1995.**

In essence, the UNIA 1995 contains provisions, standards, management and conservation of fish species and migratory species straddling fish, which has been ratified by 75 countries. UNIA 1995 effective from December 11, 2001.

Ratifying this strengthening Indonesia commitment to prevent infringement and uncontrolled illegal fishing by foreign vessels in our EEZ zone, which cause increasing high commercial value of fish stock that has been rife in Indonesian. It will then easier for Indonesia to get data and information related to fisheries, by changing the information and data among contracting States. Indonesia has rights and duties to implement conservation and manage fish stock.

Code of Conduct for Responsible Fisheries (CCRF) **[9]**

FAO is a UN Body which one of its mandates is responsible for global fisheries management. To achieve this FAO published CCRF. The Code is global in scope, and is directed toward members and non-members of FAO, fishing entities, sub regional, regional and global organizations, whether governmental or non-governmental, and all persons concerned with the conservation of fishery resources and management and development of fisheries, such as fishers, those engaged in processing and marketing of fish and fishery products and other users of the aquatic environment in relation to fisheries. The Code provides principles and standards applicable to the conservation, management and development of all fisheries. It also covers the capture, processing and trade of fish and fishery products, fishing operations, aquaculture, fisheries research and the integration of fisheries into coastal area management.

Some of general principles of CCRF are [10]:

(1) States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources.
(2) Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development. Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species.
(3) States should prevent overfishing and excess fishing capacity and should implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilization. States should take measures to rehabilitate populations as far as possible and when appropriate.

Indonesia Policy on Fisheries

In Indonesia, contribution of marine resources to the national economic is in the second level after services. Moreover, there is a tendency that industry competency has moved to marine industry based. Marine development in future needs support from politics and all stakeholders. In achieving this goal Indonesia government develops an integrated maritime economy by optimizing the utilization of marine resources sustainably [ ].

Act No. 31 Year 2004 and Act No. 45 Year 2009 on Fisheries

Two important points from those which are governed in the acts are about compulsories to register the fleet and to land the fleet on fish landing port (PPI)

Fishing fleet is defined as a vessel, boat, or other floating device used to catch fish, to support fishing operations, fish farming, fish processing, fisheries training and research/exploratory fishery. The act obliges all fleets to be registered. To follow up this act, ministry of marine and fishery published Ministry Regulation No. 5 Year 2008 on Fish Captured Business. In chapter 7, article 19 to 21 provides authority in licensing for fleets with certain weights. Article 21 requires Regents / Mayors to manage registration of fishing boats weighing less than 5 GT domiciled in its jurisdiction.

Article 41 provides all fleets to land and unload the fish captured on fish landing port (PPI). It is understood that in a PPI there is Governmental functions that setting, coaching, controlling, monitoring, and security and operational safety of fishing boats in the fishing port. On the other hand, the operation function is a function to carry out the operation in the form of the provision and / or related services in the fishing port. The importance of government function in the port is as a control in avoiding over fishing and illegal fishing.

The compulsory to land the fish catch on pointed port has a coercion meaning as there is an administrative sanction if it isn't obeyed. The sanctions include warning, liquidation or revocation of licenses. Coercion is one of legal element in order to achieve its goal, order and justice [ ].

Bengkulu Government Policy

Policy of Bengkulu Government which constitute [ ] follow up action of national long term development plan [ ] should in accordance with regulation both national and international which referred by Indonesia government.

Bengkulu government realizes that natural resource management is still not sustainable and ignore aspects of environmental preservation. It makes environmental carrying capacity decreases and the availability of natural resources depleted. Mining business contributes to land and water pollution which causes an imbalance in the overall system environment supporting human life. Coral reef are now in poor condition as impacts of fishing by fishermen that use explosive material and coral reef mining for building materials and street paving.

In achieving the sustainable utilization of natural resources and environment Bengkulu Government makes programs as follows:

a. Utilization of farm and marine natural resources sustainably
b. Forestry development and conservation of water resources
c. Utilization of mineral and mining
d. Control of natural resource and environment appropriately
e. Law enforcement law enforcement for natural resources and environmental safety.
f. Fishermen with modern fishing gear shall not enter traditional fishermen capture zone.
g. Coaching and counseling should be done continuously so that fishermen will notice the aspect of environmental sustainability in particular the preservation of coral reefs.
h. Coastal area and fisheries development can be directed to the beach and sea tourism related sectors. But should be based on environmentally sound development concept and also should involve surrounding communities so there will be symbiosis between government and the community. It is hoped to increase community welfare and district revenue.

Marine Affairs and Fishery Department of Bengkulu Policy as a Partner of Bengkulu Government

To attain the goals Bengkulu Government incorporates with Bengkulu Marine Affairs and Fishery Department (DKP). The function of DKP Bengkulu in promoting Bengkulu government program in fisheries is to formulate technical activities, capture technology coaching, other means and methods of good catching. One of drifts of policy and strategy of DKP is increasing utilization and management of fish resources through coaching and supervision and increase community empowerment activities in order to achieve responsible and sustainable fisheries.

There are several important issues which become focus of DKP Bengkulu [ ], some of them are over fishing, illegal fishing, environmental damage and fishermen poverty. These issues affect sustainable of community. To overcome these issues DKP Bengkulu has arranged programs which set out in strategic plan 2010-2015. Programs and activities of DKP Bengkulu are below:

1. On Capture Fishery Field:
   a. Fish resources breeding program
      a. Procurement of supervisory board
      b. Fish captured business allocation based on fish stock and worth ship of fleets
      c. Licenses control, by not adding new licenses, except substitute the expired licenses.
      d. Rerecord of active fleets
      e. Arrangement of fishing gear
   b. Restructurization program for fleets
   c. Diversion and Diversification Fishermen Business
   d. Production improvement program
      a. Repair /maximize record of fish captured on fish auction place (TPI)
      b. Reduce the number of boats without motors into motor boats
      c. Enrichment of local fish biomass which is still low.
      d. Coaching and handling fish captured post-harvest on board
      e. Limitation of new licenses to make economic value of company competitive
   e. Improvement of fish captured export
      a. Implementation of CCRF
      b. Improve capture fish handling to keep quality
      c. Coaching and handling fish captured post-harvest on board
      d. Increase of fleets that meet seaworthy and save worthy.
   f. Non fishermen employment program. One of them is to make fish landing port (PPI) become the center of Minneapolitan zone of fish capture activity.
   g. Fishery port development program, its activities:
      a. Improve facilities and services of PPI
      b. Improve Fishery Port Information Center
      c. Improve fishing port as a center of economic zone based on marine and fishery activities.
2. On Coastal And Small Islands Fields:
   a. Marine Partner Program in developing District Marine Conservation Zone (KKLD). Bengkulu has three water conservation zone; Turtle conservation in Muko Muko, Linau, Merpas, and reservation zone in Enggano (in process)
   b. Workshop on status of fish species protection. Result of the workshop is that the species below are under protection

Table 1. OTTV value in typical Indonesian buildings

No.	**Species**	**District**									
		City	**Kaur**	**M-M**	**B-U**	**B-S**	**Seluma**	**B-T**	**Kpyng**	**Curup**	**Lebong**
1	Terubuk		√					√			
2	Banggai Cardinal Fish										
3	sea cucumbers	√									
4	Shark						√	√			
5	Turtle		√	√	√	√	√	√			
6	Dugong	√			√						
7	Super Red Arowana										
8	arowana jardini										
9	Whale	√			√			√			
10	Kima	√	√		√						
11	Lola	√	√		√						
12	Napoleon		√		√						
13	Sea horse	√	√		√						

14	Ornamental corals	√	√		√	√	√	√
15	Labi-Labi		√	√	√		√	√

3. On Supervision Field

   a. DKP Bengkulu has improved operation and maintenance of surveillance vessels. This has been available for speed boat used for controlling activity.
   b. Programs on Settlement of marine and fisheries offenses are coordinating forum in handling fishery crime, technical meetings of provincial fisheries surveillance, data building control based, potential and utilization of marine resources monitoring, coordination/supervision/verification of fish resource case.
   c. Surveillance operation of fisheries resource improvement field the programs are to build and monitor, identification and verification district fisheries licenses.

The policy of Bengkulu Government together with DKP Bengkulu and its programs are obviously seen that there is a strong will to create a sustainable fishery community, but it is law enforcement which is difficult to implement.

Regulations on registration of fleet imply regularity, order and discipline. The fleets under 5 GT are also need to be registered, even though small in scale but they also capture fish. The fish captured, the way they capture and the fishing gear they use need to be monitored. How will data regarding amount and species fish captured be gotten if they even not registered? Then it is impossible to get accurate data on whether over fishing has been occurred or not in Bengkulu.

Furthermore, fish landing ports (PPI) in Bengkulu city (Pulau Baai, Pondok Besi and Malabero) are still from fish landing activity. The fleets back to their own dock while the rule says they are to land the fish captured on fish landing port (PPI). Some fishermen told different reason of why they do not land on the port; one said the facilities on the port is not adequate and make fish easily damage; other said that they have to pay expensive if they want to land there. But both of them do not know they have to land there by rules. Another reason from DKP officer was that PPI were build too far from the sea. It is noted that PPI building haven't been coordinated well. It should have been planned well as it is hoped to become a center of economic zone based on marine and fishery activities. By not landing on the port, it is difficult to get data over amount of fish and kind of species captured accurately.

From the policy, the programs tend to be directed more on coaching the harvest on the board. There should also be a program that makes a group of fishermen that environmentally sound. These groups will grow into a bigger group and later will become a community that environmentally sound.

Other problem that needs to be addressed is the pollution of Bengkulu river caused by coal waste from coal mining. Coal mining caused damaged over Bengkulu river basin and the waste up to coastal area. Revenues derived from mineral and mining resources directed to accelerate economic growth by investing in other sectors with high productivity. In addition, a part of the revenue has to be saved for reclamation and conservation activities, especially for environmental damage as a result of the utilization of both resources.

After inventorying the rules, there are no rules regarding registration of fleets under 5 GT or rules over coal waste collecting along the coastal area and Bengkulu river basin, there is no rules over that matter in Bengkulu. Some fishermen on Pantai Zakat said that they haven't registered or have been registered by DKP or district government because the compulsory is only for big fleets.

For Bengkulu river pollution case, district revenue from coal mining which waste pollutes the river has to be allocated to recover river basin and coastal area.

Conclusion

Most of policy of Bengkulu Government in creating a sustainable fishery community has already been in accordance with national policy drift. However, not everything goes right easily. The facts that fish landing port that are not going as they were hoped, no regulation on registration of fishing fleets under 5GT, coastal environment damaged as a result of coal waste collecting by people. This, of course needs a further research, but anyhow as Churchill stated in his book that various explanations can be given for the lack of success of management, such as non-compliance by fisherman with such measures as are adopted, such non compliance being facilitated by a lack of rigors in enforcement. The root cause, however, which lies behind these explanations, is over capacity of many fishing fleets, i.e., there are far more vessels then are economically justified or necessary to catch the fish available. This leads fisherman to disregard conservation measures because of the competition to catch any available fish. Unless the problem of registration of fleets under 5 GT, compulsory land to fish landing port, coal waste collecting are seriously addressed, it seems unlikely that fisheries management in Bengkulu will improve, thus community sustainability won't be achieved.

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COMPARISON OF MONTHLY PRECIPITATION FROM RAIN-GAUGE AND TRMM SATELLITE OVER PALEMBANG DURING 1998-2008

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Abstract

This study has compared monthly precipitations from in-situ observation in the Palembang city and those derived from Tropical Rainfall Measuring Mission (TRMM) for a period of January 1998 - December 2008. This study used two rain gauges, in the Sultan Mahmud Badaruddin II (SMB) and Kenten station. A statistical analysis, includes a correlation analysis, a Mean Bias Error (MBE) and a regression analysis, was employed in this study. The result shows that the TRMM data significantly correlates with rain gauges data. The coefficient correlation between TRMM data and SMB data and also Kenten data were 0.7366 and 0.6556, respectively. However, the TRMM data underestimate the rain gauges data. The monthly correlation between TRMM data and the rain gauges data also indicates significant correlation ($r > 0.5$ significant at 95%), except during February when the correlation fall down the significant level ($r = 0.1097$). In general, the TRMM data can be used to replace the rain gauges data after taking into account the errors.

Keywords: *Correlation Coefficient, Kenten Precipitation, Sultan Mahmud Badaruddin II Precipitation, and TRMM Precipitation.*

Introduction

Precipitation is one of the major components of the global hydrological cycle that maintains the terrestrial, atmospheric and oceanic water balance. Variations in precipitation may have serious effects on global water cycle, climate changes and societal activities [1]. In Indonesia, rainfall variations have a major impact on the local agriculture and fresh water supply for human consumption. Excess rainfall causes severe flooding, property and lives loss.

A better understanding of the spatial and temporal rainfall distributions would be essential in estimating crop water uses, the water available for direct human consumption and water resource management, assessing efficient irrigation and understanding the ecosystem. Also, accurate monitoring and prediction of rainfall would help reduce property damages and lives loss that may occur from flooding.

The basic rain measuring instruments have been the rain gauges. However, Rain gauges provide only point measurements in limited areas. Remote sensing techniques, such as those using radar or satellites are great complements for monitoring rainfall over large areas.

Accurate temporal knowledge of global precipitation is essential for understanding the multi-scale interactions among weather, climate and ecological systems, as well as for improving our ability to manage freshwater resources and predict high-impact weather events including hurricanes, floods, droughts and landslides [2].

Especially for the tropics area, now available a remote sensing device that performs missions in the region measuring tropical rainfall using satellite TRMM (Tropical Rainfall Measurement Mission). Tropical Rainfall Measuring Mission (TRMM) is a joint project two national space agency of the United States (NASA: National Aeronautics and Space Administration) and Japan (NASDA: National Space Development Agency of Japan, now changed to JAXA: Japan Aerospace Exploration Agency).

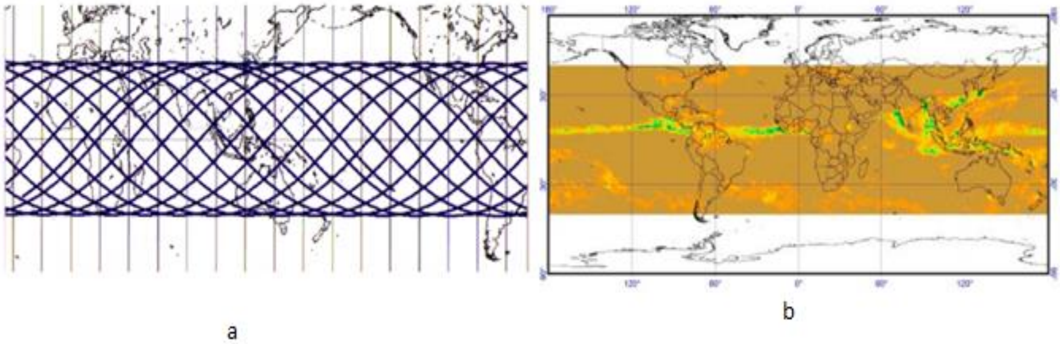


Figure 1. (a) Orbit and (b) TRMM-satellite coverage
(*Source:http://trmm.gsfc.nasa.gov*)

TRMM is designed to measure rainfall (precipitation) in the tropics and its variations from a low inclination orbit, combined with a set of high-tech sensors to overcome the limitations of the use of the previous sensor. Inclination is the angle between the reference planes to the field measured slope. Inclination is commonly used in astronomy to describe the shape and orientation of the orbits of celestial bodies. Natural and artificial satellites inclination measured by the surrounds of celestial bodies. TRMM satellite was launched on 27 November 1997 at 6:27 am and was taken by the Japanese H-II rocket in the center of the rocket launch station owned by JAXA (Japan Aerospace Exploration Agency) in Taneghasima, Japan. TRMM carries five sensor that are PR, TMI, VIRS, CERES (Clouds and the Earth's Radiant Energy System), and LIS (Lightning Imaging Sensor), but that is often used to take only two types of rainfall data are PR and TMI sensors [3].

TRMM is a program for long-term research that is designed for the study of land, sea, air, ice, and a total system of life on earth [4]. TRMM is able to observe the structure of the rain, the amount and distribution in the tropics and sub-tropics area who an important role to determine the mechanisms of global climate change and monitoring the environmental variation.

Precipitation data generated by the TRMM had type and quite diverse shapes starting from level 1 to level 3 [5]. Level 1 is the data that is still in raw form and has been calibrated and geometrically corrected, Level 2 is an overview of the data that has had rain geophysical parameter sat the same spatial resolution but still in original condition when the satellite is the rain pass through the area were recorded, while level 3 is the data that has values of rainfall, monthly rainfall conditions in particular is an amalgamation of rain from a rain to get the data in the form of a millimeter (mm) should use level 3with a spatial resolution of 0.25°x0.25°. Temporal resolution is every three hours.

Materials and Methods / Experimental

The monthly precipitation data were obtained by Tropical Rainfall Measuring Mission (TRMM) and Other satellite monthly 0.25° x 0.25° rainfall data product (3B43 Version 7) and The monthly rain gauges data were obtained from the Indonesian Meteorology, Climatology and Geophysics Agency (BMKG) office for the Palembang region, in the Sultan Mahmud Badaruddin II (SMB) airport and Kenten station cover the period from 1998 to 2008.

Rain gauges data were compared with monthly TRMM data using statistical scores such as RMSE, MBE, MAE, regression, correlation coefficient, and significant values. Monthly rain gauges data and TRMM data were sorted then compared to obtain correlation coefficient.

Linear Correlation

Correlation analysis is an analysis of the relationship between the independent variable, for example x with a variable that is not free, for example y. Strength of the relationship will be indicated by a number called the correlation coefficient. Thus, the linear correlation is a measure of the linear relationship between two variables x and y is denoted by and defined as follows:

$$r = \frac{1}{N-1}\sum_{i=1}^{N}\frac{(x_i - \bar{x})(y_i - \bar{y})}{s_x s_y} \qquad \textbf{(1)}$$

When s_x and s_y are the standard deviations for the two data. The value of r ranges between -1 ≤ r ≤ 1.Perfect linear relationship between two variables would be if the value of r = +1 or r = -1. For r = ± 1, the data points (x_i, y_i) cluster along a straight line and the samples are said to have a perfect correlation (plus (+)for 'in-phase') fluctuations and minus (-) for 180^0 'out-of-phase) fluctuations). For r $\approx$ 0, the points are scattered randomly on the graph and there is little or no relationship between the variables.

Linear Regression

Regression equation is a mathematical equation that can be used to interpret the values of a dependent variable from the independent variable. To find the regression line equation can be used a variety of approaches (formulas), so the value of the constant (a) and regression coefficient (b) can be searched using the following method:

$$a = \frac{\left[\left(\sum y.\sum x^2\right) - \left(\sum x.\sum xy\right)\right]}{\left[\left(N.\left(\sum x^2\right)\left(\sum x\right)^2\right)\right]}$$
$$atau \qquad \textbf{(2)}$$
$$a = \left(\frac{\sum y}{N}\right) - b\left(\frac{\sum x}{N}\right)$$

$$b = \frac{\left[N\left(\sum xy\right) - \left(\sum x.\sum y\right)\right]}{\left[\left(N.\sum x^2 - \left(\sum x\right)^2\right)\right]} \qquad \textbf{(3)}$$

Standard Error

The accuracy of the regression line can be seen if all the distribution points close to the regression line. Development and the deviation of points from the regression line is called the error. There are three standard error, the Mean Bias Error (MBE), The Root Mean Square Error (RMSE) and the Mean Absolute Error (MAE), which were defined as follows [6].

The Mean Bias Error (MBE) is obtained from the total existing errors. Where the positive value means the estimated data end to be lower than the actual data. The mean bias error can be expressed by the following equation:

$$MBE = \frac{1}{n}\sum_{i=1}^{n}(x_i - y_i) \qquad \textbf{(4)}$$

The Root Mean Square Error (RMSE) is an alternative method for evaluating a forecasting technique, where each squared residual errors or mistakes which usually results in a smaller but sometimes produces very big error. The root mean square error can be expressed by the following equation:

$$RMSE = \sqrt{\left(\frac{1}{n}\sum_{i=1}^{n}\{x_i - y_i\}^2\right)} \qquad \textbf{(5)}$$

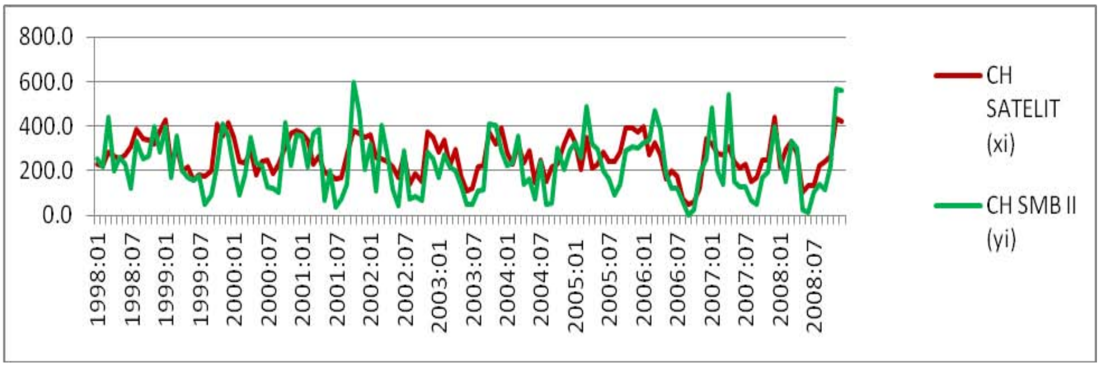
The Mean Absolute Error (MAE) is used to measure the forecasting accuracy by averaging the forecast error (in absolute value) in units of the same size as the original. In general, the smaller the MAE value then the value the more accurate forecasting. The mean absolute error can be expressed by the following equation:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|x_i - y_i| \qquad \textbf{(6)}$$

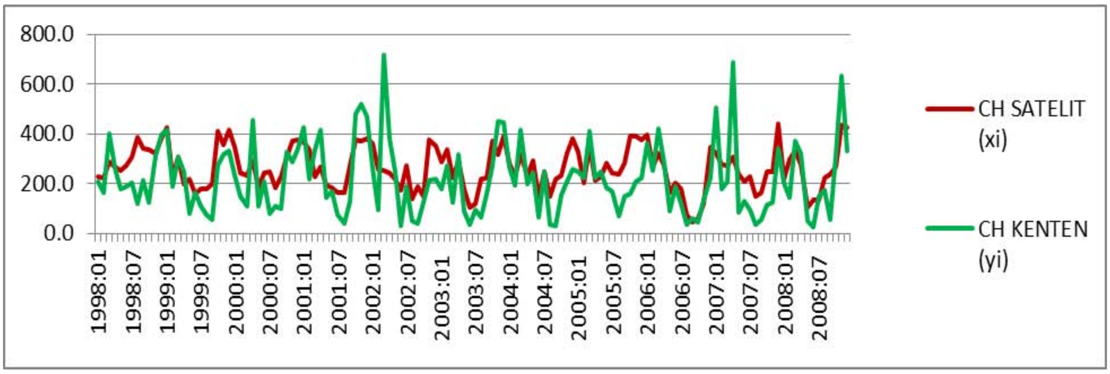
where x_i are the estimated values, y_i are the reference gauge values, and n is the number of data pairs. In contrast, the MAE and RMSE are used to ascertain the random component of the error in the satellite estimates. The RMSE involves the square of the departures from reality and, therefore, is sensitive to extreme values [7]. If the RMSE is used, then anomalous values could significantly change the evaluation of a TRMM when comparing it with rain gauge data. The MAE uses the absolute difference, thus reducing the sensitivity to extreme differences. In our analysis, the MBE and RMSE were used to ascertain the systematic and random components of the error, respectively, in our product estimates [8].

Results and Discussion

This study has compared monthly precipitations from in-situ observation in the Palembang city and those derived from Tropical Rainfall Measuring Mission (TRMM) for a period of January 1998 - December 2008. Comparison of monthly precipitation from rain-gauge and TRMM satellite are presented in **Figure 2.**



a



b

Figure 2. Graphs of monthly rainfall measured by 3B43 and gauges, in the a. SMB II and b. Kenten, Palembang.

Comparison of monthly precipitation from SMB II station and TRMM satellite showed by **Figure 1**.a, where rainfall pattern of SMB II station seen relatively higher than rainfall of TRMM satellite. The higher rainfall has recorded by SMB II station on November in 2001 with the rainfall value is 602 mm/hour. Whereas, The higher rainfall of TRMM satellite occured on December in 2007, it is 425 mm/hour. Meanwhile, the lower rainfall has occured on August in 2007 and 2008, it is 0 mm/hour, whereas the lower rainfall has recorded by TRMM satellite on August 2007, it is 50 mm/hour.

Figure 1.b, shows comparison of monthly precipitation from Kenten station and TRMM satellite, where its rainfall pattern have been same pattern with rainfall pattern of SMB II station and TRMM satellite. The higher rainfall from Kenten station has occured on February in 2002, and TRMM satellite on December in 2007, where rain-gauge recorded rainfall is 715 mm/hour and TRMM satellite is 425 mm/hour. Meanwhile, the lower rainfall from Kenten satellite occured on July in 2001, 2002, 2004 and 2008, it is 0 mm/hour, whereas, the lower rainfall from TRMM satellite is 50 mm/hour. Its occured on August 2007.

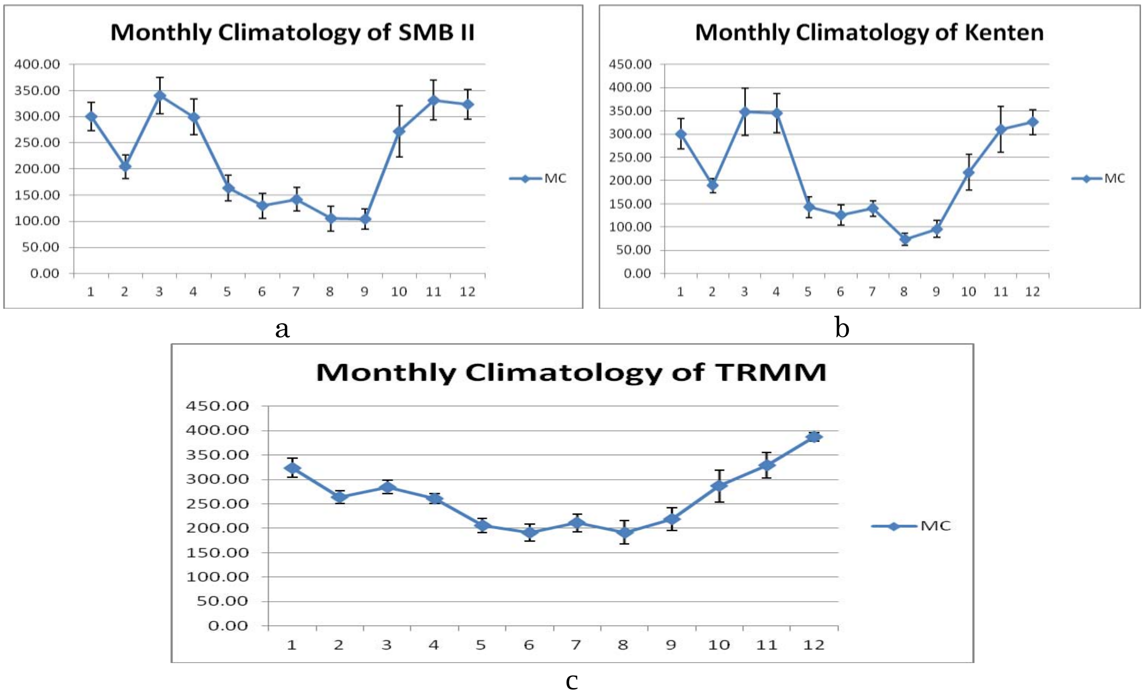


Figure 3 Monthly climatology: a. SMB II station, b. Kenten station, and c. TRMM satellite.

Calculation of monthly climatology from monthly precipitation of SMB II station data, and Kenten station data have been relatively showed same rainfall patterns. Meanwhile, monthly climatology of monthly precipitation from TRMM satellite have different pettern. Monthly climatology graph of SMB II have two peak of rainfall, i.e. on March (*MC*= 340 mm/hour) and November (*MC* = 342 mm/hour) (**Figure 3**.a). The lower rainfall has occured on September (*MC* = 99 mm/hour), meanwhile rainfall decraesing has recorded om February too (*MC* = 200 mm/hour). Monthly climatology graph Kenten station (**Figure 3**.b) has relatively similar pattern with SMB II satation. Where, the higher precipitation on March (*MC* = 350 mm/hour) and December (*MC* = 325 mm/hour). Meanwhile, rainfall decreasing on February (*MC* = 195 mm/hour) has relatively lower value than on August (*MC* = 80 mm/hour). Monthly climatology graph of TRMM satellite (**Figure 3**.c) relatively different, where one of the higher rainfall has recorded on December (*MC* = 397 mm/hour). The lower rainfall has occured on August (186 mm/hour).

To determine the correlation of monthly precipitation measurement result of rain-gauge and TRMM satellite, so that the linear correlation calculation using **Equation 1**. whereas to determine the value of deviation of TRMM satellite data to rain-gauge data, then MBE, RMSE, and MAE calculation (**Equation 4, 5,** and **6**). From the calculation results derived correlation data like presented in **Table 1**.

Table 1. Correlation Coefficient and Error

	parameter	**Stasiun**	
		SMB II	**Kenten**
Satelit	r (mm/hour)	0.7366	0.6556
	MBE (mm/hour)	36.34	44.93
	RMSE (mm/hour)	47.54	56.24
	MAE (mm/hour)	83.58	92.41

*The correlation coefficient is significant in 95% level, is r = ± 0.5.

The table above can be concluded that the TRMM satellite data has significant correlation (95%)

with precipitation data from rain-gauge. The higher correlation coefficient has showed by comparison of monthly precipitation from rain-gauge (SMB II) and TRMM satellite, i.e. r = 0,7366 mm/hour, whereas correlation coefficient from comparison of monthly precipitation from Kenten station and TRMM satellite, i.e. r = 0.6556 mm/hour.

The larger systematic error in the comparison of monthly precipitation from rain-gauge and TRMM sattelite is comparison of Kenten station data and TRMM satellite data (MBE = 44.93 mm/hour). Whereas, comparison of montlhy precipitation from SMB II station and TRMM satellite have MBE value as many as 36.34 mm/hour. The RMSE value have same pattern with MBE pattern. Kenten station have the higher value (56.24 mm/hour) and RMSE SMB II station have value as many as 47.54 mm/hour. Comparison of montlhy precipitation Kenten station and TRMM satellite have the higher MAE value, i.e. 92.41 mm/hour, meanwhile SMB II station have the lower MAE value (83.58 mm/hour).

To determine correlation of monthly precipitation from rain-gauge and TRMM satellite, so correlation coeficient calculation was done in every month of observation. The calculation value is presented in **Figure 4**.

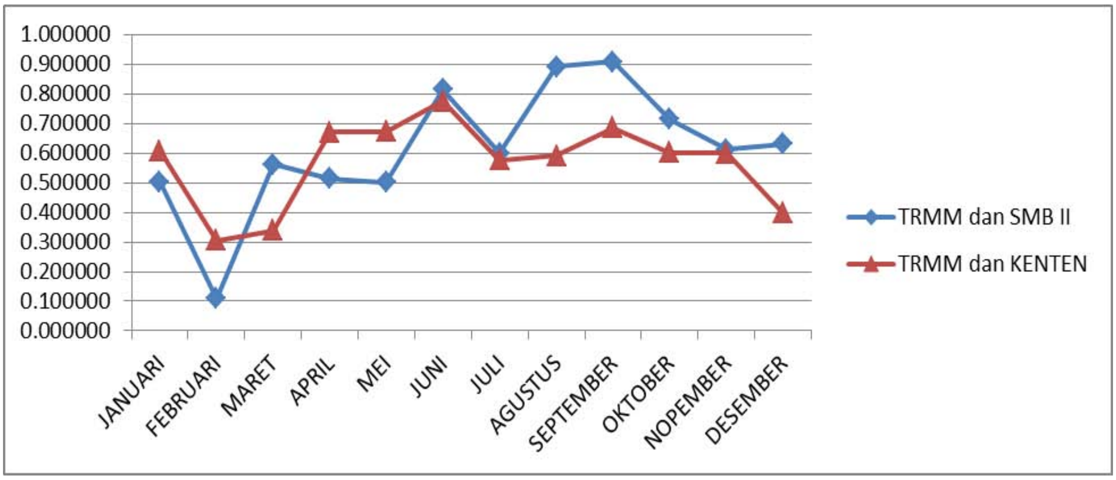
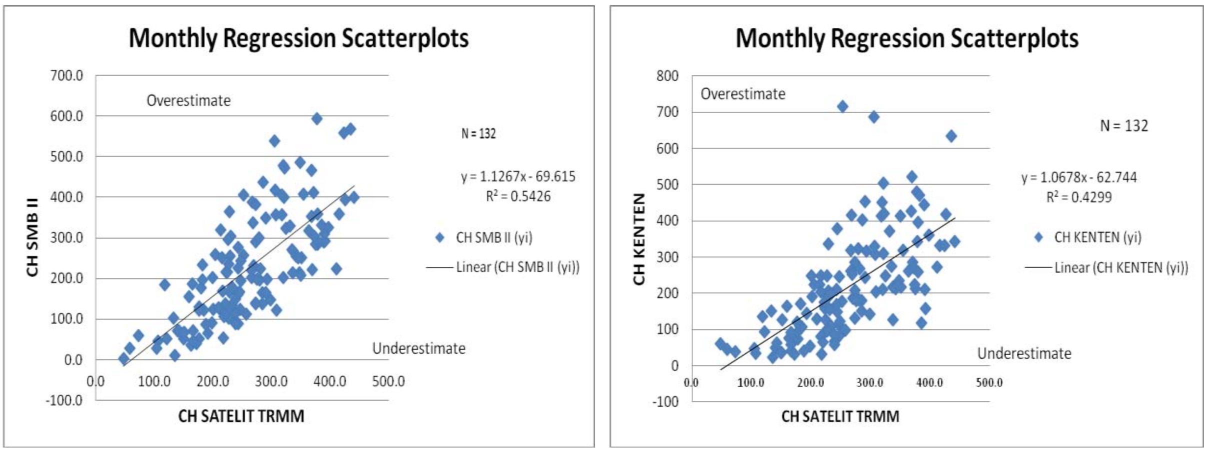


Figure 4 comparison average monthly values of correlation coeficient in every month of observation.

Comparison of monthly precipitation data from SMB II station , Kenten station and TRMM satellite is above of significant level (95%), except in some month.

Calculation results of correlation coeficient and error has supported by linear regression analysis. Analysis results is presented in **Figure 5**.



a b

Figure 5. Scatterplots of monthly 3B43 TRMM product vs monthly rain gauge data in the a. SMB II, and b. Kenten.

Figure 5 shows regression graph of monthly precipitation from SMB II station and TRMM satellite. Data points of monthly precipitation from SM II station and TRMM sattelite closed to regression line. It is showed that both of data have strong relationship, where y = 1.1267x-69.675 and determination coefficient $R^2 = 0.5426$.

The regression graph of precipitation Kenten station and TRMM satellite is presented in **Figure 5.**b, where data points Kenten station and TRMM satellite has good pattern. The relationship both of data has showed by regression equation, y = 1.0678x – 62.744 and determination coefficient, R^2 = 0.4299. In general, rainfall from the rain gauge data was lower than the rainfall from TRMM satellite data: the average rainfall from the rain gauge in the SMB II and Kenten were 226.3 mm h^{-1} and 217.9 mm h^{-1}. Whereas the average rainfall from 3B42 was 262.6 mm h^{-1}.

Monthly values of the error statistics showed instability during the dry season. However, the instability did not affect the MBE error, the absolute error or the random error. The TRMM sattelite showed slight improvements when compared with the rain gauges data in terms of its ability to reduce both the random error and the scatter of the estimates.

Conclusion

The compared monthly and average monthly of TRMM data and rain gauges data has good correlation. However, the error values are large. The correlation and monthly climatology was relative stable. In general, the TRMM data can be used to replace the rain gauges data after taking into account the errors.

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ANALYSES ON SPATIAL DISTRIBUTION OF ATMOSPHERIC WATER VAPOR OVER EAST JAVA REGION, INDONESIA USING CONTINUOUS GPS

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Abstract

Water vapor plays a critical role for global/regional scale of weather and climate changes. Observation of water vapor in the atmosphere are still a through job that has been difficult for researchers atmosphere. It causes the movement of the water vapor content of both temporal and spatial quickly in the atmosphere. The utilization of the estimated count of delay and bending signals in the troposphere, GPS has been offered a new method for water vapor content in the atmosphere accurately. This study used eight (8) GPS CORS stations Geospatial Information Agency (BIG) to estimate the water vapor in the surrounding area of the study site, among others: Tuban, Lamongan, Mojokerto, Surabaya, Nganjuk, Malang, Pasuruan, and Sampang. The results of the data validation ZTD GPS obtained from GPS observation data by Zenith Path Delay (ZPD) that acquired from the International GNSS Service (IGS) showed a good correlation with the values of the correlation of 99.1% and mean bias 2.080 mm. Precipitable water vapor data obtained from GPS observations in Surabaya also has a good agreement with a bias value is 0.761 and a 98.3% correlation from the result of conventional meteorological observation, radiosonde balloon. The results from spatial distribution showed that the movement of PWV in 2012 moving from the south towards the north-west, and vice versa. This is possible due to the influence of Monsoon Asian-Australian cycles that affect weather and climate in Indonesia.

Keywords: *Asian-Australian Monsoon; GPS CORS; PWV; Water Vapor; ZTD*

Introduction

Global Positioning System (GPS) was originally designed for navigation and positioning. Amongst other possible applications it can also be used to derive information about the state of the atmosphere, what is now recognized as ground permanent stations meteorology observation [1]. Continuous observations from GPS receivers provide an excellent tool for monitoring water vapor in the Earth's atmosphere. One of these is the capability to provide continues data at similar quality under all weather conditions [2].

Estimating Atmospheric Water Vapor from GPS Observations

GPS observations mainly comprise pseudo-range (or code range) and carrier phase measurement. Phase measurement has a noise level of a few millimeters and is very precise in comparison to code ranges that are only accurate to a few meters or some decimeters. For this reason carrier phases are the primary and most important type of observation for high precision GPS positioning and GPS meteorology, while the pseudo-ranges are treated as ancillary observations and primarily used for synchronizing receiver clocks, resolving ambiguities and repairing cycle slips during the pre-processing stages of advanced GPS analysis. [3].

Let L_A^1 and L_A^2 be observation of satellites 1 and 2 by receiver A, and L_B^1 **and** L_B^2 be observations by receiver B. These observations can then be combined into double-difference as:

$$\nabla\Delta L_{AB}^{12} = \nabla\Delta S_{AB}^{12} + \nabla\Delta dS_{AB}^{12} + \nabla\Delta STD_{AB}^{12} - \nabla\Delta dion_{AB}^{12} + \nabla\Delta MC_{AB}^{12} + \nabla\Delta\lambda.N_{AB}^{12} + \nabla\Delta\vartheta c_{AB}^{12} \quad (1)$$

where $\nabla\Delta S_{AB}^{12}$ is difference geometric phase distance in station A and B from satellite 1 and 2, $\nabla\Delta dS_{AB}^{12}$ is error distance from satellite orbit, $\nabla\Delta STD_{AB}^{12}$ is difference slant tropospheric delay station A and B from satellite 1 and 2, $\nabla\Delta dion_{AB}^{12}$ is delay from ionosphere, $\nabla\Delta MC_{AB}^{12}$ is effect from multipath, $\nabla\Delta\lambda.N_{AB}^{12}$ is phase ambiguity parameters, and $\nabla\Delta\vartheta c_{AB}^{12}$ is receiver noise.

By assuming the errors except tropospheric delay can be eliminated, this equation can be written, i.e.:

$$\nabla\Delta L_{AB}^{12} = \nabla\Delta S_{AB}^{12} + \nabla\Delta STD_{AB}^{12} \quad \textbf{(2)}$$

Therefore, ZTD in station A and B can be estimated with this question:

$$\nabla\Delta STD_{AB}^{12} = ZTD_A\left[mf\left(el_A^1\right) - mf\left(el_A^2\right)\right] - ZTD_B\left[mf\left(el_B^1\right) - mf\left(el_B^2\right)\right] \quad \textbf{(3)}$$

After this ZTD can be estimated, ZNHD can be calculated by total delay minus ZTD.
To obtain water vapor moisture, the amount recovered by PWV (Precipitable Water Vapor) this is the amount of water vapor in the zenith direction receivers [4]. PWV values in millimeters obtained from the following equation, [5].

$$PWV = \Pi.ZNHD \quad \textbf{(4)}$$

where Π is function from mean weight temperature and, density of water, and molar ratio of water vapor and air mass.

$$\Pi = \frac{10^6}{\rho R_v\left[\left(\frac{k_3}{T_m}\right) + k'_2\right]} \quad \textbf{(5)}$$

T_m constants generally used for the determination of PWV is a constant of Bevis. [5].

$$T_m = 70.2 + 0.72T_s \quad \textbf{(6)}$$

where T_s is surface temperature.

Materials and Methods / Experimental

We analyzed eight station continuous GPS in Eastern Java region, Indonesia.

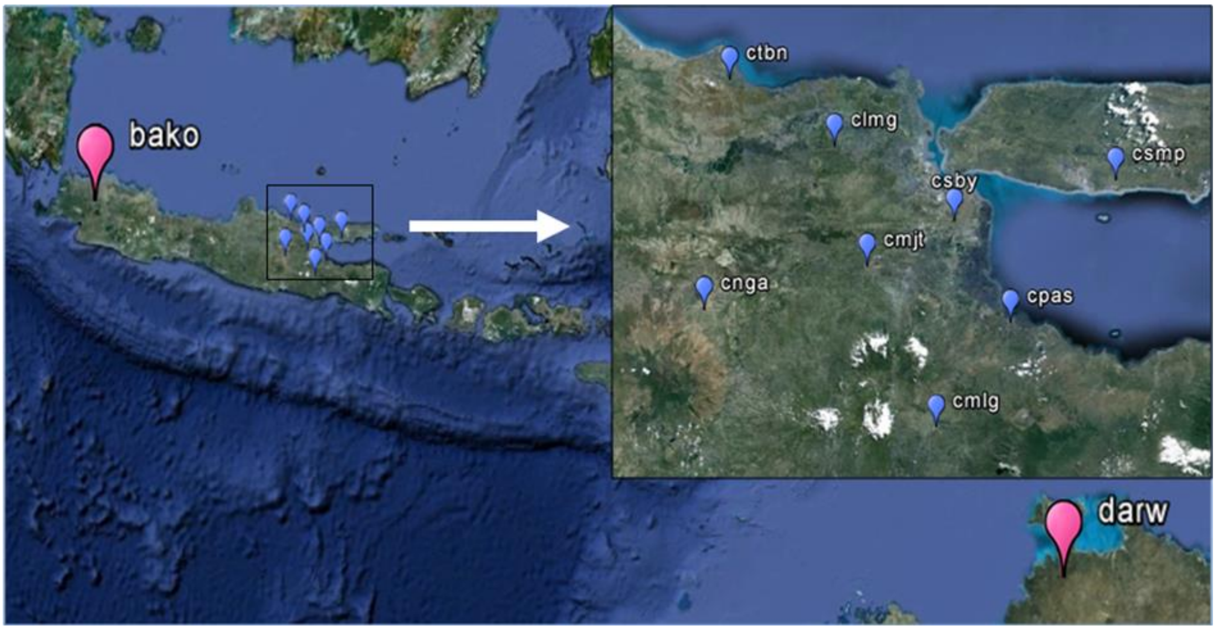


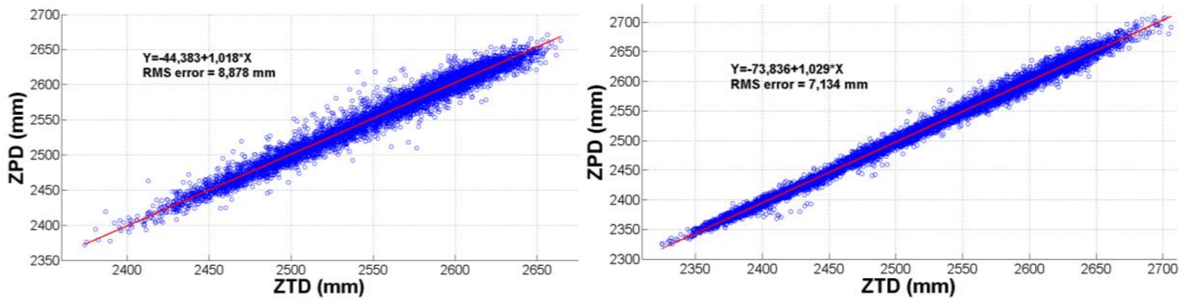
Figure 1. Regional network continuous GPS BIG in Eastern Java Region (Google Earth)

In GPS Processing, we used the GPS processing software GAMIT 10.4 to calculate daily coordinates with the ionosphere-free L3 combination in double difference mode. The coordinates from Geospatial Information Agency were kept fixed to ITRF2008 (International Terrestrial Reference Frame 2008). The elevation cut-off angle was 10º. And we included two IGS station in GPS processing (darw and bako). Station IGS darw has been included due to obtain the absolute ZTD value is required distance between the GPS stations more than 1000 km. [6].

Results and Discussion

Zenith Tropospheric Delay Validation

To validate ZTD values obtained from GPS observation processing data, we compared ZTD value from GAMIT processing software with zenith path delay (ZPD) value which calculated the Working Group of the International GNSS Service (IGS) Troposphere.



(a) (b)

Figure 2. Scatter Plot comparison between ZPD and ZTD value;
(a) bako; (b) darw

From figure above it, we can see that the mean value of the bias between ZTD and ZPD is 2.080 mm, with the mean rms e (root mean square error) of 8.006 mm, and the correlation of 0.991. With these values, it can be concluded that the ZTD generated from this study have a good agreement with the values of the IGS ZPD.

Precipitable Water Vapor Validation

Before conducting a spatial analysis of the PWV value. We compare PWV was obtained from GPS observation with the result of conventional meteorological observation, radiosonde balloon.

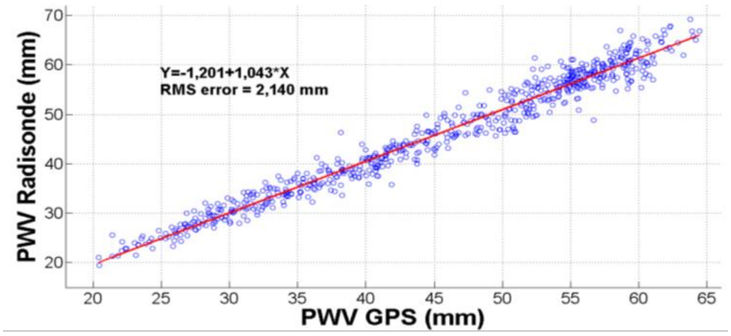


Figure 3. Scatter Plot comparison between PWV GPS and PWV Radiosonde

From figure above it, we can see that the mean value of the bias between PWV GPS and PWV Radiosonde is 0.761 mm, with the mean rms e of 2.14 mm, and the correlation of 0.983. With these values, it can be concluded that Precipitable water vapor data obtained from GPS observations in Surabaya also has a good agreement with the result of radiosonde balloon.

Spatial Distribution of PWV

Depiction the process of spatial variation in this study using ordinary kriging interpolation. The advantage of the model is able to account error variance in the interpolation process. In this analysis of spatial variation is assumed that the effect of PWV interpolation for the distribution of GPS stations is considered less influence.

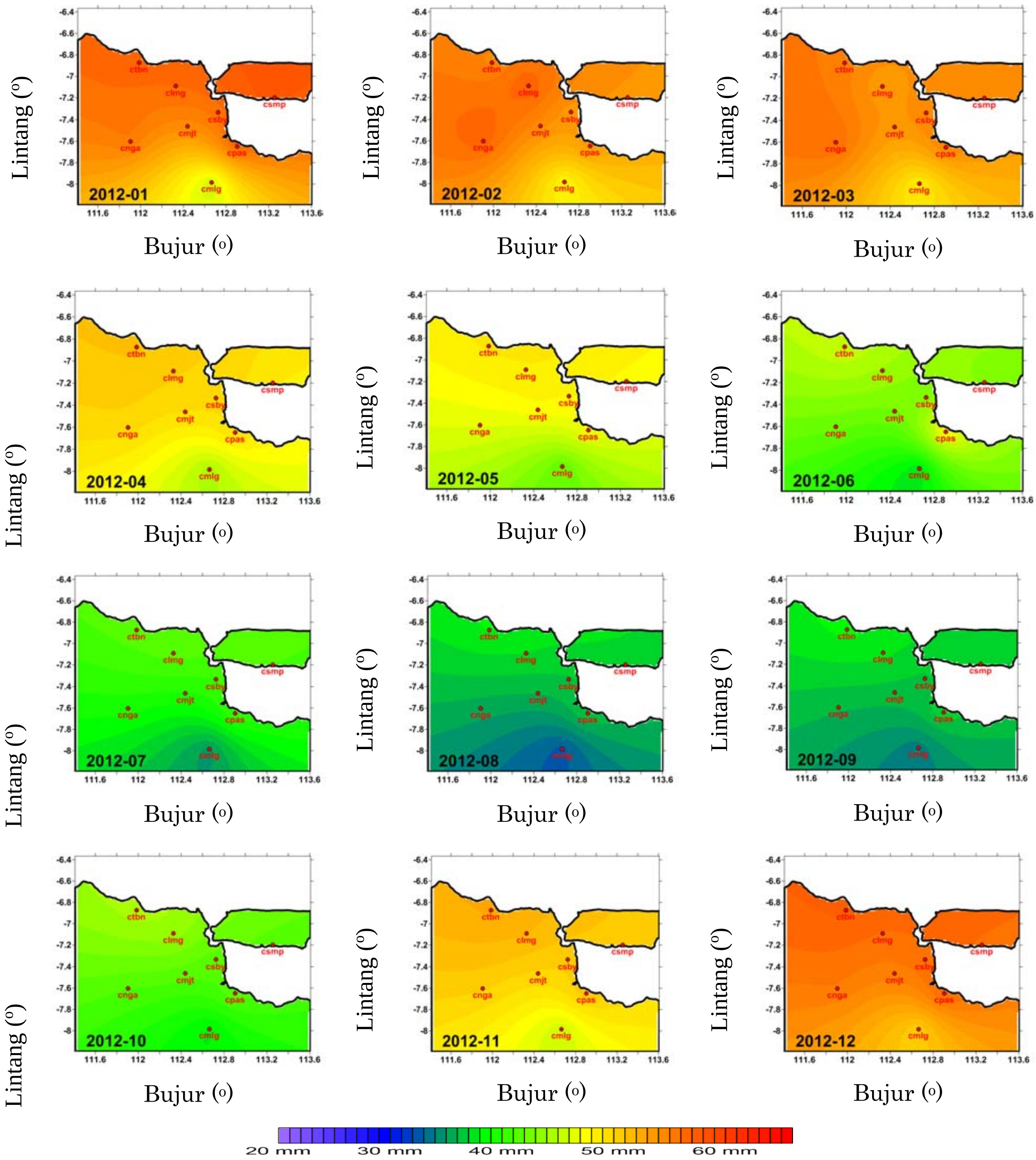


Figure 4. Spatial Distribution of Monthly PWV

From the result of spatial variation plotting, we can get information that the results of mean monthly PWV from May to October 2012 has the monthly distribution PWV pattern that is quite low, and in November - April 2012 has a distribution PWV pattern that is relative high. Spatial movement of PWV is clearly evident from the south to the northwest, and vice versa. And CMLG station has a different value PWV other stations. This is possible because of differences in topography between CMLG station in Malang is relatively higher than the other stations.

Conclusion

- In general at 2012, the wettest month in the study site was in January, while the driest month is

August.

- Depiction of the result of the spatial distribution pattern obtained in PWV monthly from May to October 2012, the distribution pattern is quietly low, and in November - April 2012 has a pattern of relatively high PWV distribution.

- Spatially, PWV in study site in 2012 has a cycle of the movement from south to the northwest, and vice versa.

Acknowledgment

We would like to thank to [2]The Centre for Geodesy and Geodynamic, Geospatial Information Agency (BIG), Indonesia, which has provided support in the form of data and infrastructure that are very useful in supporting this research.

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ANALYSIS OF SEA SURFACE HEIGHT USING WAVEFORMS RETRACKING IN THE COASTAL AREA (CASE STUDY: JAVA SEA)

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Abstract

A lot of Indonesian regions are located at coastal area or waterfront such as Jakarta, Surabaya, Semarang, Medan, Makasar, and Balikpapan. One of the current issues has been familiar regarding the phenomena of global warming, which is the level of sea has been increasing time by time. Therefore this condition will be impact to the activities on the mainland. In this study, the indicator used for determine sea level rise is the sea surface high (SSH). The quality of SSH measurements from satellite radar altimetry in coastal area is not only lots of errors but also noiser. These errors are caused by the complexity of coastal areas such as coastal morphology, vegetation and human activities. In order to get the better result of SSH in the coastal areas, some researcher used waveforms re-tracking. The method of waveforms re-tracking used in this study consists of retracking offset center of gravity (OCOG) and threshold method. In this case, threshold method is better and smoother than OCOG. Therefore the threshold method can be used to minimize noise at nearly all location. The comparison between Geoid Model EGM 1996 and threshold method is generally showed the result of SSH value has minimum discrepancies, particularly of threshold in 75%.

Keywords: *Altimetry; OCOG; Retracking Waveform; SSH; Threshold*

Introduction

Indonesia is the largest archipelago in the world. It covers almost 3 million km^2 of water. Therefore, lots of Indonesia regions are located in the coastal area or waterfront such as Jakarta, Surabaya, Semarang, Medan, Makassar, and Balikpapan. Indirectly, this condition will be impact to the many activities in that city like ocean tides, current, waves, sea breeze and etc. The other side, a phenomenon of rise and fall (tidal) sea water is one of the factors that effect in the land. Now, the issue about the phenomenon of global warming has been familiar, which is the level of sea has been increasing time by time. One of indicator can be used to determine sea level rise is sea surface height (SSH). The measurement of SSH is based on ellipsoid World Geodetic System 1984 (WGS'84).

Actually, there is several methods can be used to analyze sea surface height. However, they need much time and high cost to conduct observations directly or in situ measurement for example tidal observations. One of the fastest methods to perform effective observations of SSH changes over time is using satellite altimetry. Altimetry system has been developed since 1975, it was started from the GEOS-3 satellite to satellite Jason-2. The purpose of the satellite altimetry development is to analyze the phenomenon of ocean dynamics accurately and precisely. Basically, the result of SSH from altimetry observations has high degree accuracy in the offshore region, but the accuracy is slightly reduced due to errors or high noises in coastal areas [1]. These errors are caused by the complexity of coastal areas such as coastal morphology, dense vegetation (mangrove forest) and human activities. The research on SSH method and its impact to reduce errors thus get better result in the coastal areas is needed. One method which can be used to obtain a better result of SSH is waveforms retracking [2].

In this paper, we applied two methods to perform of waveforms re-tracking Jason-2 altimetry satellite data at Java Sea. They are Offset Center Of Gravity (OCOG) and threshold which will be compared between them. Finally, the comparison of the methods can be obtained an appropriate method to process of waveforms retracking. It is used to get the best SSH value for coastal area especially in the coastal of Java Sea.

Materials and Methods

Ocean Surface Topographic Mission (OSTM) Jason-2 Satellite Altimetry

Satellite altimetry is equipped with radar pulse transmitter and receiver sensitive radar pulses, which is as well as high accuracy clock. In this system, a radar altimeter is carried by the satellite which emitted pulses of electromagnetic waves to the sea surface. The pulses are reflected back by the sea surface and return to the satellite, it can be illustrated in **Figure 1**[3][4].

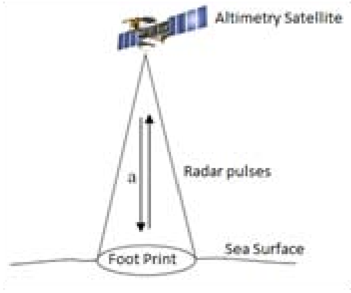

Figure 1. Principle of altimetry satellite

The radar altimeter measurement refers to [3] which measures the height of the satellite above the sea surface (a) by using the travel time (Δt) of the transmitted radar pulses to the ocean surface and reflected back to the satellite as follows equation:

$$a = c\frac{\Delta t}{2} \tag{1}$$

where :
a = altitude of the satellite (m)
c = velocity signal (m / s)
Δt = time (s)

In addition, the data of altimetry can be extracted into much information which can be applied in geodesy, general ocean circulation, coastal, ocean variability, ice topography, hydrology and other applications [5].

OSTM Jason-2 altimetry is generated by the cooperation project between the Centre National d'Etudes Spatiales (CNES) of France and the National Aeronautics and Space Administration's (NASA) United States. The satellite was launched from Vandenberg Air Force Base on December 7, 2001 in California, USA [6]. The OSTM/Jason-2 contains three type of data products, there are Operational Geophysical Data Record (OGDR), Interim Geophysical Data Record (IGDR), and Geophysical Data Record (GDR). The characteristic of (O)(I)GDR is identical products **(Table 1)**, the discrepancies except for the auxiliary data used in the processing.

Table 1. Discrepancies of The Auxiliary Data for O/I/GDR Products [6]

Auxiliary Data	Impacted Parameter	OGDR	IGDR	GDR
Orbit	Satellite altitude, Doppler correction	DORIS Navigator	Preliminary (DORIS MOE)	Precise (DORIS+Laser+GPS POE)
Meteo Fields	Dry/wet tropospheric corrections, U/V wind vector, surface pressure, inverted barometer correction	Predicted	Restituted	Restituted
Pole Location	Pole tide height	Predicted	Predicted	Restituted
Mog2D	HF ocean dealising correction	Not available	Preliminary	Precise
GIM	Ionospheric correction	Not Available	Available	Available
Radiometer antenna temperature coeff	Wet tropospheric correction, Sigma0 rain attenuation	Preliminary	Preliminary	Precise (accounting for radiometer)

The Level-2 products in this mission contain a family of nine different types of geophysical data records (GDRs), where in the each of three families has up to three types of files in NetCDF format, with increasing size and complexity. For example, The 1 Hz subset of the full dataset is reduced in NetCDF format (O/I/GDR-SSHA); the native NetCDF is formatted in datasets (O/I/GDRs) which contain the records of 1Hz is as well as 20 Hz high-rate values; and an expert sensor product contain the full radar-echo waveforms in NetCDF format (S-IGDR/S-GDR, not applicable to the OGDR).

In this paper, we used the SGDR data emanating from OSTM Jason-2 satellite which passed over the Java Sea in 2012 **(Figure 2)**.

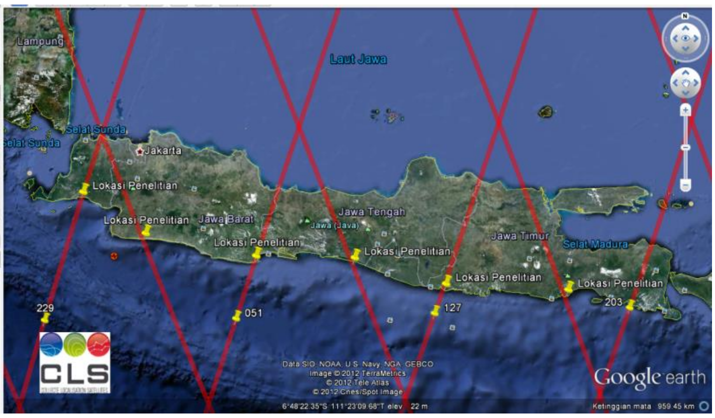

Figure 2. Area study: Java Sea, Indonesia

Waveforms Retracking Method

Waveforms retracking are remodeling of waveform which is delivered by altimetry satellite to the mainland. It aims to get the better results than other method. Basically, altimetry has good accuracy in the open sea for gate 1 to 44 (**Figure 3**), while it is not good enough for coastal area, waves crash vegetation, sea wave, beach and other objects, because it interfered for gate 44 to 128 [7].

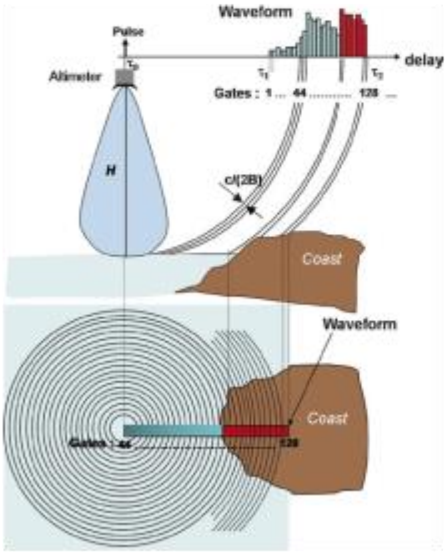

Figure 3. Comparison between altimetry waveform at coastal and open sea

The processing of altimetry retracking waveform classification used interpretation method that has been described by [2], show in **Figure 4**.

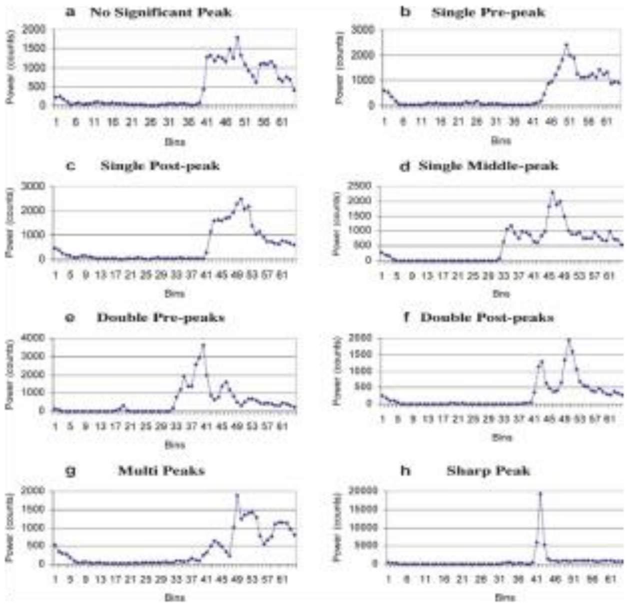

Figure 4. Waveforms classification [2]

Offset Center of Gravity (OCOG) Method

Offset Centre of Gravity (OCOG) is a retracking algorithm which has been developed by Wingham, et al (1986) in [7]. This algorithm (see Equation 2 and 3 below) aims to determine the center of gravity of each waveform based on the power levels of the waveforms.

$$A = \sqrt{\sum_{i=1+n_1}^{N-n_2} P_i^4(t) / \sum_{i=1+n_1}^{N-n_2} P_i^2(t)} \tag{2}$$

$$W = \left(\sum_{i=1+n_1}^{N-n_2} P_i^2(t)\right)^2 / \sum_{i=1+n_1}^{N-n_2} P_i^2(t) \tag{3}$$

The Equation 2 was used to determine the value of the amplitude in altimetry waveform, whereas the Equation 3 was used to determine wavelength. On altimetry, wavelength is same as the gate of altimetry waveforms.

Threshold Method

Threshold method is a method which has been invented by Davis in 1997[7]. This method is based on the calculation of OCOG. In addition, the threshold values based on the value of the amplitude in OCOG or the value of the waveforms amplitude, such as 25%, 50% and 75%. Refers to [8] the calculation of threshold is used as below.

Calculation of thermal noise is

$$P_N = \frac{1}{5}\sum_1^5 p^i \tag{4}$$

and threshold calculation is

$$T_h = (A - P_N).q + P_N \tag{5}$$

$$G_r = G_{k-1} + \frac{T_h + P_{k-1}}{P_k + P_{k-1}} \tag{6}$$

A method for calculating the value is equal to the OCOG method, P_N is the average value of the strength in the first gate, q is the threshold value, G_k is the power of the gate, where k is a location based T_h value.

Sea Surface Height

In Altimetry, Sea Surface Height (SSH) is defined as sea surface height above the reference ellipsoid World Geodetic System 1984 [4]. The result of SSH is determined by subtracting the corrected range from the altitude of altimetry satellite (see Equation 7) as follows [6]:

$$SSH = s - (a + W_{trop} + D_{trop} + I_{ono} + EMB) \qquad (7)$$

where:

SSH	= sea surface height above the reference ellipsoid WGS'84 (m)
s	= satellite altimetry height above the reference ellipsoid WGS'84 (m)
a	= distance from the antenna to the satellite altimeter sea surface moment (m)
W_{trop}	= wet tropospheric correction (m)
D_{trop}	= dry tropospheric correction (m)
I_{ono}	= ionospheric correction (m)
EMB	= electromagnetic bias (m)

Results and Discussion

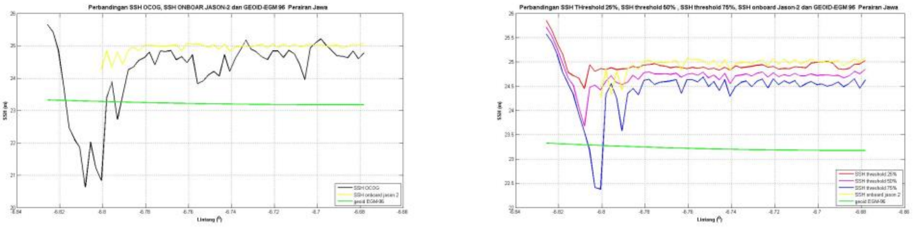

Figure 5. SSH Comparation between OCOG (black) and Threshold (other colors) method with SSH onboard (yellow) and Geoid EGM 1996 (green) at Pass 64

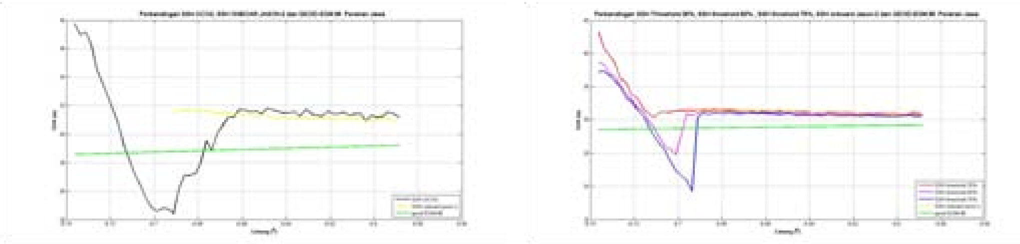

Figure 6. SSH Comparation between OCOG (black) and Threshold (other colors) method with SSH onboard (yellow) and Geoid EGM 1996 (green) at Pass 127

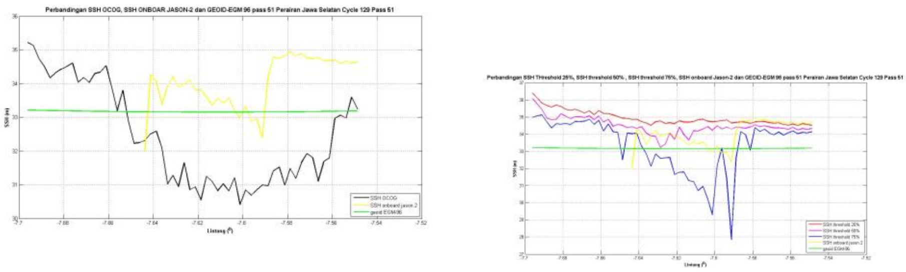

Figure 7. SSH Comparation between OCOG (black) and Threshold (other colors) method with SSH onboard (yellow) and Geoid EGM 1996 (green) at Pass 203

Based on the results of retracking waveform data Jason-2 altimetry satellite at coastal of Java sea show that SSH onboard (original waveform without retracking (yellow)) has no value on the coastal area or approximately 3 – 5 km from the beach. It means that the original waveform of Jason-2 can not be used directly to get SSH on the coastal area because of lots of noises and biases such as dense vegetation (mangrove forest), building, settlement and other objects. This condition caused by the policy of Aviso which cut the pulse of information until approximately 5.5 km from coastline. But after retracking data with OCOG and threshold method, the contrast result have been found, those is

SSH can be determined at coastal area. Due to SSH waveforms re-tracking is constructed from satellite altimetry which is still reflected pulse in the land.

The comparison of result between the threshold methods and the OCOG methods at coastal area show that SSH value of threshold methods is better and smoother than OCOG methods. Those discrepancies due to fundamentally threshold method used amplitude of OCOG method; moreover the result is recalculated to get SSH value. In addition, the result of threshold methods of SSH in threshold 75% is closer with the geoid EGM1996 than other thresholds (50% and 25%).

Conclusion

1. SSH onboard (original waveform) has no value at coastal area of Java Sea but waveforms retracking with OCOG and threshold method has SSH value at coastal area of Java Sea.
2. SSH with retracking threshold has smoother and closer to geoid than SSH with retracking OCOG method at the coastal area of Java Sea.
3. SSH value in threshold waveform retracking generally has minimum discrepancies, particularly of threshold in 75%. It was compared with Geoid Model EGM 1996.

Acknowledgment

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ASSESSING WATER DISCHARGE IN MANJUNTO WATERSHED-INDONESIA USING GIS AND SWAT MODEL

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Abstract

This study applied GIS and the Soil and Water Assessment Tool (SWAT) model to assess discharge in the Manjunto watershed, Indonesia. Discharge is an important hydrological parameter in watershed management. It useful for flood forecasting and predicting sediment loads. This study aim to quantifying the impact of topographic, land use, soil and climatic conditions on water discharge in the Manjunto watershed, Indonesia using GIS that integration with SWAT. In this integration, a GIS provides a graphical user interface and supplies required SWAT input data including elevation, soil properties, land use and weather data. SWAT is used to simulate the hydrology of the watershed, as a function of the input data, delineated watershed (subdivided into sub watersheds), accounting of different physical processes, and finally display of discharge and sediment output data. The simulation results for the period 2006 to 2010 represent fluctuation of discharge relatively well, as indicated by the computed R^2 and NSE values which were both above 0.75. The conclusion of this research is SWAT can be used for predicting the water discharge using GIS and SWAT model in support of watershed management and flood control

Keywords: *Discharge, GIS, watershed, physical processes, SWAT*

Introduction

Discharge data is needed in the management of water resources [1] [2]. One of the variables that make up the formula discharge is the runoff coefficient (C). Runoff occurs when the amount of rainfall that falls on a catchment area exceeds the infiltration capacity of the watershed area [2] [3]. Its variable is influenced by the type of vegetation, land cover, topography and soil type [4] [6]. Therefore, the value of runoff coefficient (C) of a watershed can not equal to another watershed.

The method for estimating the runoff coefficient has developed [6]. It is a function of the slope, land cover, infiltration and surface water accumulation. However, the application of rational methods for estimating discharge will have a lot of trouble if done on a watershed which is extremely broad and does not have complete data and has a topography and land cover variation [7]. The capability of GIS to provide spatial information efficiently and effectively is very helpful in finding the data on the characteristics of the watershed [6] [7]. This study aims to develop a model estimation algorithm on the discharge at watershed scale by integrating the rational method with GIS.

Materials and Methods

Study Site

Location of the study, as shown in **Figure 1**, located in Mukomuko residence, Bengkulu province, Indonesia. Geographically located between $2^0 23'14''$ LS and $101^0 20'24$ EL.

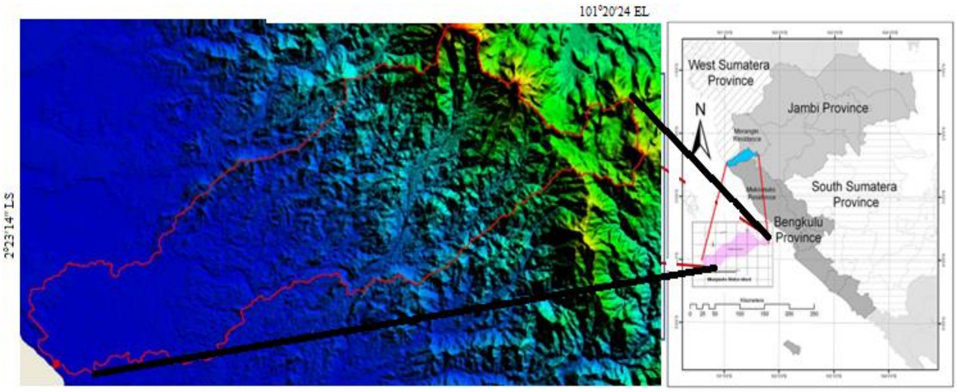
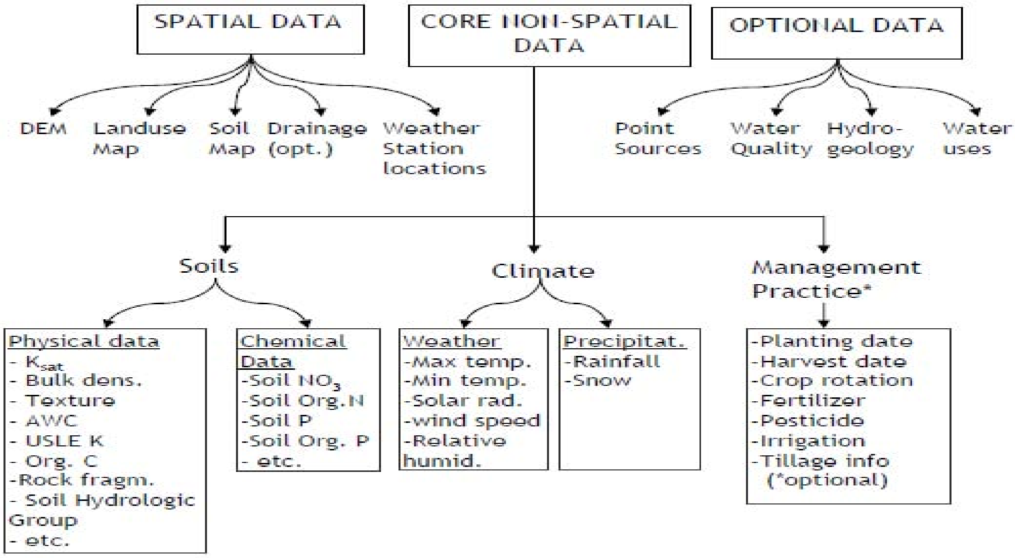


Figure 1. Study Site

Data

The data required in this study are as follows:



(Source : Gokmen, 2006[9])

Figure 2. Input Data for SWAT Model

Land use map obtained from digital data acquisition Spot 4 dated July 17, 2012 path 271/row 355. Data Digital Elevation Model (DEM) take from Shuttle Radar Topography Mission (SRTM) with a spatial resolution of 90 m obtained from the Institute of Aeronautics and Space (LAPAN). Rainfall data from TRMM (tropical rainfall measurement mission) with a spatial resolution of 3 km for the recording of 2005-2012, and soils data take from Balai Besar Sumber Daya Lahan (BBSDL)-Bogor, Indonesia. Drainage data and weather station locations obtained from the Office of Public Works (DPU-Bengkulu Province).

Identification of Land Cover

The land cover map obtained through a process of image processing recordings Spot 4 in 2009. Rectification process carried out between the geometric correction of image data recorded in 2009 with Spot 4 image data that has been corrected (RBI) by taking the point of GCPs (ground control points) by 18 points until the error of RMA is less than 1. From this process of digital image data obtained by DAS Manjunto corrected. Further field surveys for sampling land cover as much as 35 points and recorded the coordinates and land cover analysis using the object-based classification techniques to produce land cover maps in 2009.

Slope

Principles calculations based on the slope of the transformation results in the form of the difference in value of elevation from west to east through the process of decline partially on the x-axis (map dx) and the difference in elevation values from north to south, which is a partial decrease in the y-axis (map dy). Value of the difference is a reference for the calculation of slope. In this study, the slope derived from DEM SRTM is processed with GIS and grouped into several classes' slopes.

Estimate of Discharge

The method to estimate of discharge using SWAT presented by Figure bellow:

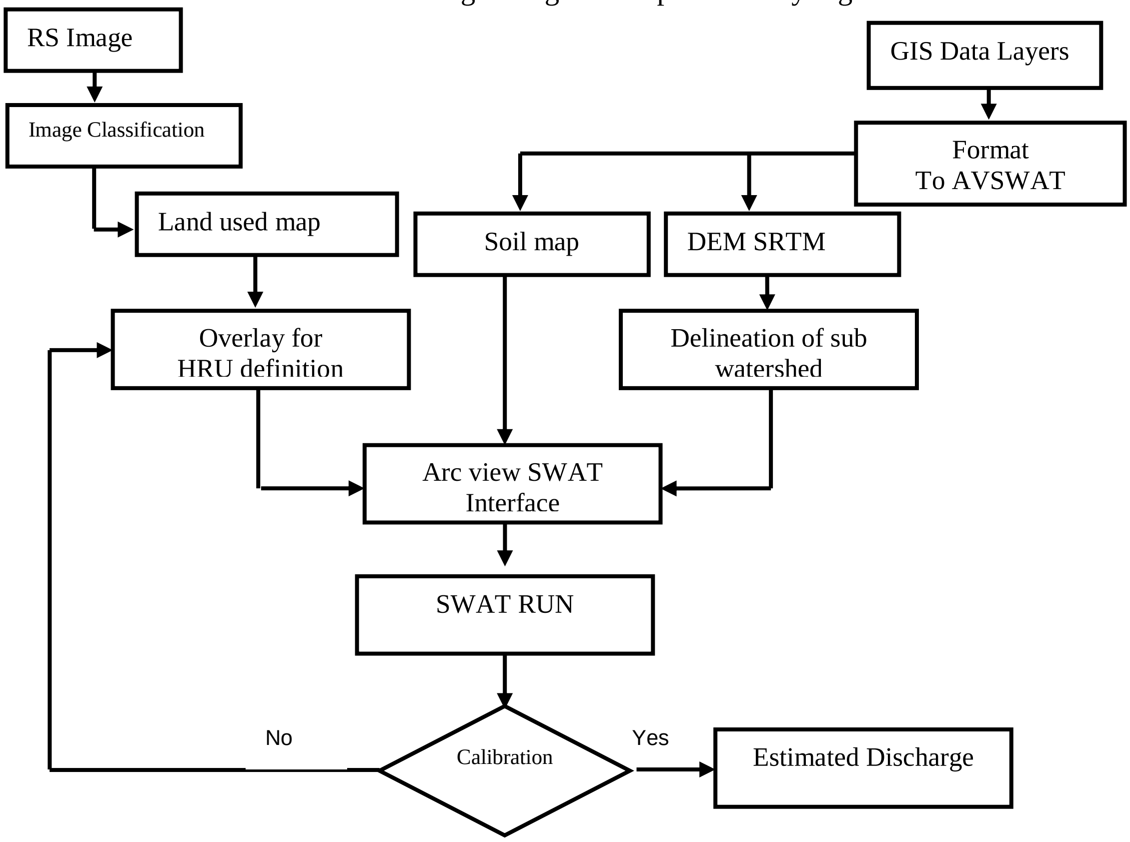


Figure 3. Input Data for SWAT Model

Model Validation

In this validation study conducted partial validation by calculating the deviation based on the following equation.

Deviation = (C actual Value - The value of C estimated) / actual value C x 100% **(1)**

The model is considered valid if the value of deviation is less than 10%.

Results and Discussion

Land Cover

Forest consists of primary forest area of 45,165 ha (56.75%) and 6,548 hectares of secondary forest (8.23%), mixed farms 7,035 ha (8.84%), field/moor 3,143 ha (3.95%), plantation 9,731 ha (12.23%), 1,639 shrubs ha (2.06%), rice 2,687 ha (3.38%), open of land 1961 hectares (2.46%), and the settlment area of 849.13 ha (1, 07%) and the remainder for other uses. The results of identification of Land Cover area presented in the **Table 1**.

Table 1. Land Cover of Manjuto in 2009.

No.	Land Cover Class	Area (hectare)	Percentage (%)
1	Open land	1,961	2.46
2	Bush	1,639	2.06
3	Paddy Field	2,687	3.38
4	Plantation	9,731	12.23
5	Settlement	849	1.07
6	Field/Moor	3,143	3.95
7	Mix farm	7,035	8.84
8	Secondary Forest	6,548	8.23
9	Primary Forest	45,165	56.75

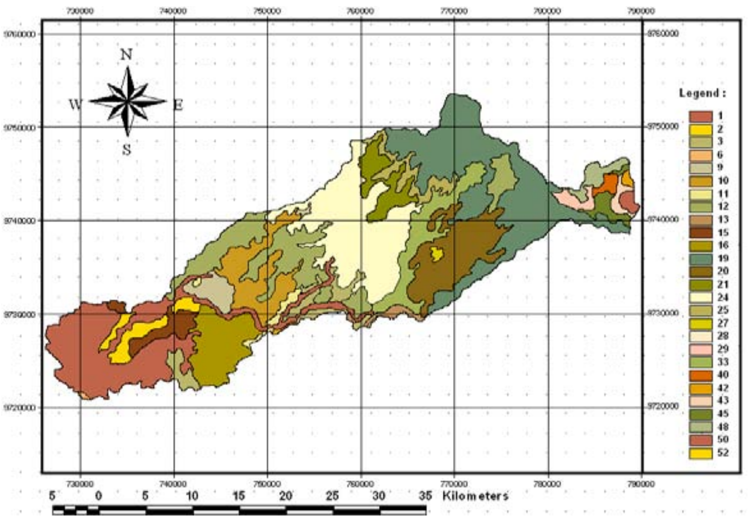
Slope

Based on the slope, the study area has a variety of slopes are quite diverse. Area of each slope class is presented in **Table 2**.

Table 2. Slope of Manjuto Watershed

No.	Slope Class	Area (Ha)	Percentage (%)
1	0 - 8	20.923,88	26,29
2	8 - 15	31.949,35	40,14
3	15 - 25	15.155,84	19,04
4	25 - 45	5.667,82	7,12
5	> 45	5.883,76	7,39
		79.580,678	**100,000**

From the **Table 2** above known that Manjuto watershed has slopes that vary from flat (0-8%) covering 26.29%; ramps (8-15%) covering 40.14%; rather steep (15-25%) covering an area of 19.04 (%), steep (25-45%) covering an area of 7.12%, and very steep (> 45%) covering an area of 7.39%.



Source: Gunawan, et al. 2013 [10]

Figure 3. Soil Mapping Unit of Manjunto Watershed

Soil Mapping Unit

The results of class identification of each SMU by the spreading of the dominant soil types are presented quantitatively in **Figure 3**.

Discharge Estimation Results

The value of the discharge of surface flow (qi) for Manjuto Watershed presented in **Table 3**. The results estimate the average discharge of surface flow rate for each land cover shows that the lowest occurred in the primary forest and the highest in open land. The visualization of distribution of discharge of surface flow is presented in **Figure 4**.

Table 3. Surface Flow Discharge in Manjuto Watershed

MON	RAIN	WATER				SED	
		SURFQ	LATQ	YIELD	ET	YIELD	PET
	(MM)	(MM)	(MM)	(MM)	(MM)	(T/HA)	(MM)
1	64.28	1.92	16.75	44.51	20.88	0.37	25.62
2	67.54	1.71	19.48	41.85	23.46	0.31	28.55
3	69.8	3.29	17.38	41.76	32.7	0.18	41.4
4	65.34	1.58	15.4	35.92	33.21	0.08	42.59
5	51.7	0.44	8.45	24.64	36.93	0.02	55.08
6	67.12	1.54	14.33	28.6	36.68	0.08	55.57
7	62.42	0.9	12.66	26.07	37.05	0.06	55.9
8	51.34	0.5	9.15	20.43	35.95	0.03	55.74
9	72.72	1.18	16.01	27.34	31.32	0.06	41.84
10	91.04	5.01	25.78	45.41	28.99	0.46	38.51
11	72.48	1.57	20.17	41.89	24.07	0.13	31.8
12	85.4	3.55	28.44	56.88	17.24	0.41	21.48

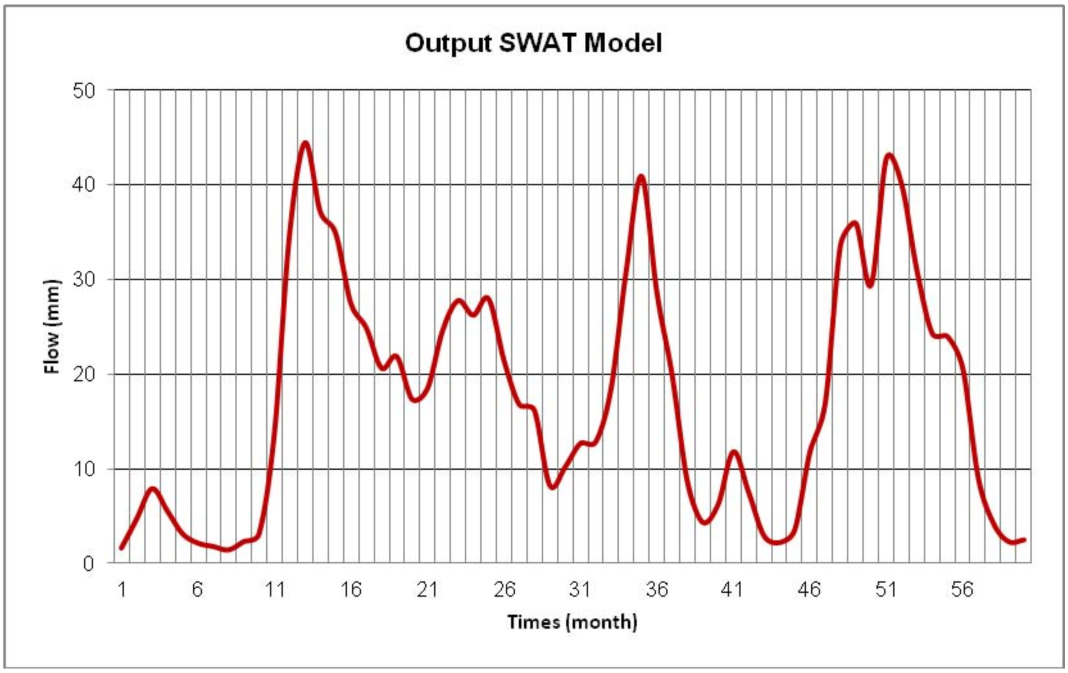


Figure 4. Flow in Manjuto Watershed

Model Validation

Model validation is done by comparing the output SWAT discharge flow data measurements or actual discharge. Model validation results are presented in **Figure 5** below.

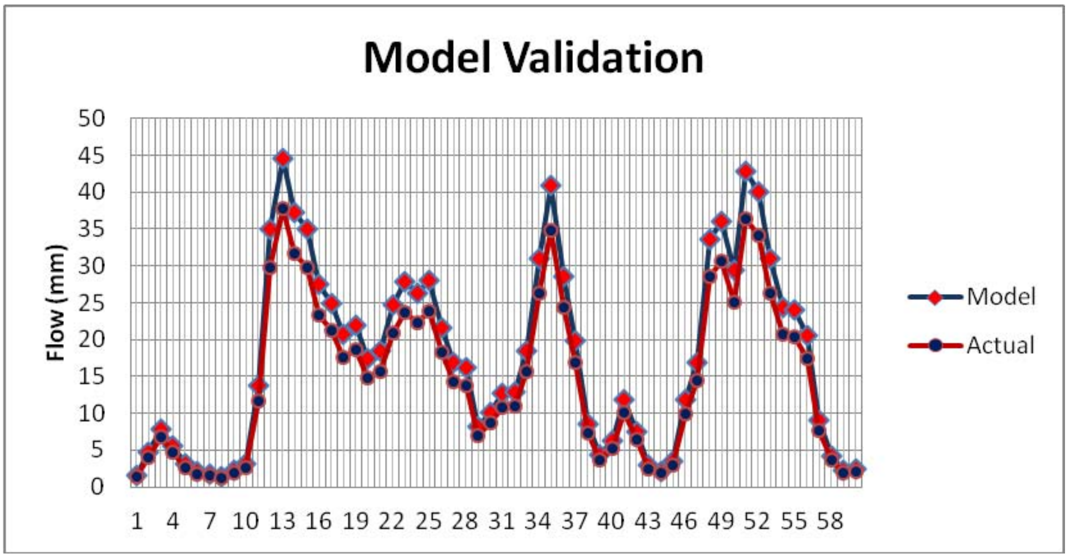


Figure 5. Map of Discharge Distribution on Surface Land

Calculation results of Deterministic Coefficient Index (R^2) are as follows:

$$R^2 = \frac{\sum(713{,}479) \;\; -\sum(1329{,}208)}{\sum(713{,}479)}$$

Value of R^2 obtained was - 0.70 or close to 1. This indicates that the model development enough accurate. This is in accordance with the opinion of Nash and Sutclife (1970) in Hangtuah (2006). He stated that "If the model is perfect, so the value of (Qo-Qm) ^{2} is close to zero, then the value of R^2 close to 1".

Conclusion

This study demonstrated a model to estimate the discharge of surface flow integrates rational methods with geographic information systems. The conclusions that can be derived from the results of this study are geographic information systems can be used to determine the value of the discharge on the surface of each type of land cover. The results validate the stream flow output models with actual stream flow has deviation small than 10%. Some low accuration of the model that development needs to be refined in further research.

Acknowledgment

In preparing this paper, we gratefully acknowledge the assistance from the colleagues from Indonesian National Institute of Aeronautics and Space and with their generosity in encouraging the usage of Digital Elevation Model (DEM) and Geographic Information System (GIS).

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PALEOSEISMOLOGY STUDY AT KALIGARANG FAULT ZONE RESULT EARTHQUAKE IN THE PAST, SEMARANG, INDONESIA

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Abstract

Earthquake in the past can study with paleoseismology. Kaligarang Fault Zone will record the event of earthquake and result the sediment. The methode of research is detail field mapping and field excavation. Evidence of paleoseismology in the field, we find the sand boil and carbon materials. We find two location of sand boil near with reverse faults. Sand boil to precipitate at unit B Kalibeng Formation. Phase tectonic to cause earthquake occure at late Miocene – Early Pliocene.

Keyword: *Kaligarang fault zone, paleoseismology, sand boil.*

Introduction

Research on seismicity in Semarang conducted by Lumbanbatu (2004) in Lumbunbatu and Hidayat [1]. He mentioned that earthquakes in the area, there were 3,002 times. Furthermore, it was mentioned that this area should be observed as areas that are vulnerable to earthquake. Studies of active faults Kaligarang were done by Helmy [2], Poedjoprajitno et al. [3] and Fahrudin et al. [4].

Paleoseismology is the study of past earthquakes (paleoearthquake) especially regarding location, time, and magnitude. Paleoseismology focus is simultaneously researching deformation of landforms and sediments during past earthquakes.

Seismic evidence that there are two primary and secondary evidences. Primary evidence generated from tectonic deformation that produce movement along the fault plane includes escarpment fault, fissure, layers to faulting and other. Whereas, evidence of secondary paleoseismic is a phenomenon resulting from earthquake shocks include mass movement, sand blows, sand dikes and trees were damaged (**Figure 1**). Paleoseismic record evidence will further distinguished whether the fault lies in the field (on-fault or near field feature) or remotely located and fault traces (off-fault).

Seismicity that occurred in Semarang can be studied from the rock or stratigraphic sequence. Earthquakes will record sediment. Earthquake will keep the flow of sediment deposition in the form of soil organic (peaty), sandy, and marsh sediments. Thus it is necessary to know the process paleoseismic study earthquakes of the past. Records of past earthquakes would be useful to know that an earthquake is coming.

This study aims to find evidence that seismicity occurred and reconstruct the earthquake in the past.

Materials and Methods

Research sites located in the vicinity of the River Kaligarang Tinjomoyo located in Semarang, Central Java (**Figure 2**).

Detailed geological mapping around Tinjomoyo. Identify secondary evidence of the paleoseismology. There are two locations in the encounter paleoseismology evidence in the form of sand boil. The location of the discovery of sand boil, then performed trenching of length x width x height is 6 x 1.5 x 4 m. Microfossil observations to determine the age of rocks and filling fractures.

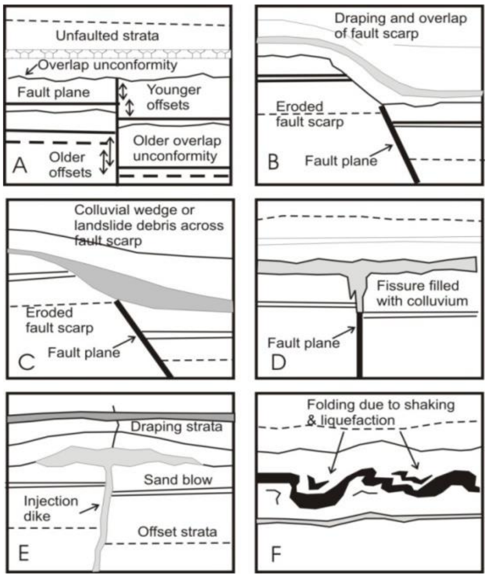

Figure 1. Filler material at the crack zone and field discontinuities.

Figure 2. Research area in surrounding Kaligarang River.

Results and Discussion

Geological Map

Geological conditions Tinjomoyo area is divided into 5 units: A Marl of Kalibeng Formation (Tmpk (Na)), B Marl of Kalibeng Formation (Tmpk (Nb)), Sandstones of Kalibeng Formation (Tmpk (Bps)), Bedding of claystone and siltstone predominantly mudstone from Kerek Formation (Tmk (Bpl)), and Bedding of claystone and sandstone predominantly sandstone from Kerek Formation (Tmk (Bps)). (**Figure 3**).

A Marl of Kalibeng Formation composed of yellowish marl, limestone granules are dull white in color, size and hard gravel. The marl has a grain size <1/256 mm, sorting good and closed fabric. Granular limestone found in abundant quantities in the outcrop (**Figure 4**). Microfossil analysis of fossils obtained *Globorotalia menardii, Globigerina riveroae, Globorotalia tumida, Orbulina universa, Globorotalia pseudomiocenica, Sphaeroidinella dehiscens.* Based on the analysis of the fossil, can be determined relative that this rock unit formed at Late Miocene **-** Pliocene (N17 – N19). B Marl of Kalibeng Formation composed of marl colored black. The marl has a grain size <1/256 mm, sorting good and sealed fabric (**Figure 5**). Sandstones of Kalibeng Formation composed of fine sandstone colored yellowish gray, is calcareous, has a grain size of 1/8 **-** 1/4 mm, better sorting and closed fabric. At this sandstone, contained shell fragments and coarse sandstone gray (**Figure 6**).

Bedding of claystone and siltstone predominantly mudstone from Kerek Formation composed of mudstone and siltstone. Claystone bluish gray, calcareous cements. While siltstone has bluish gray color, there are fossil shells of molluscs, gastropods, black mineral (biotite and hornblende), there are fragments of claystone (Figure 7). Microfossil analysis of fossils obtained *Globigerinoides immaturus, Globorotalia archomenardii, Globigerina venezuelana, Orbulina universa, Globorotalia obesa, Globorotalia siakensis, Globigerinoides primordius, Globorotalia menardii.* Based on the chart biozonasi conducted, known lithological unit's relative age is Middle Miocene (N12 – N14**).** Bedding of claystone and sandstone predominantly sandstone from Kerek Formation composed of mudstone and sandstone. Claystone bluish gray, calcareous cements. While subtle yellowish sandstone, is calcareous, having grain size of 1/8 **-** 1/4 mm, sorting good and sealed fabric (**Figure 8**).

Fissure Filling

Microfossils contained on fractures is composed foraminifera is *Globigerinoides immaturus, Globigerina venezuelana, Orbulina universa, Orbulina bilobata, Globorotalia pseudomiocenica* (**Figure 9A**), *Sphaeroidinella subdehiscens* (**Figure 9B**), *and Globorotalia siakensis*. Biozonation results (Table 1) shows the age of N13 **-** N14 (Middle Miocene) or the rest of the Kerek Formation.

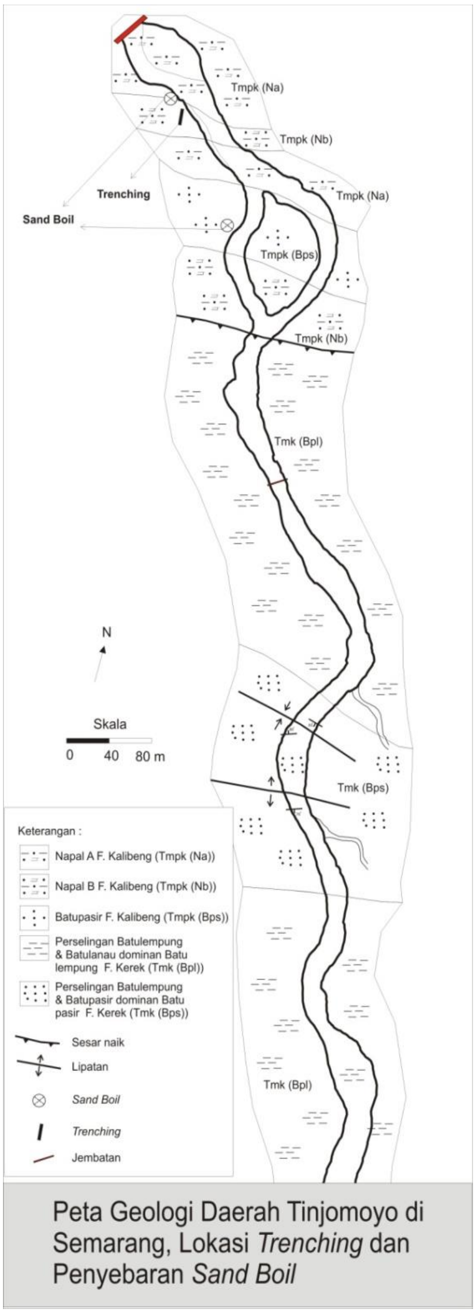

Figure 3. Geological map of Tinjomoyo area.

Figure 4. A Marl of Kalibeng Formation.

Figure 5. B Marl of Kalibeng Formation

Figure 6. Sandstones of Kalibeng Formation

Figure 7. Bedding of claystone and siltstone predominantly mudstone from Kerek Formation.

Figure 8. Bedding of claystone and sandstone predominantly sandstone from Kerek Formation.

Table 1. Biozonation results.

Spesies Foraminifera	Oligosen						Miosen														Pliosen				Plistosen	
	Awal			Akhir			Awal					Tengah						Akhir			Awal			Akhir		
	P18	P19	P20	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20	N21	N22	N23
Globigerinoides immaturus								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Globorotalia archeomenardii							■	■	■	■	■	■	■	■	■	■	■									
Globigerina venezuelana	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Orbulina universa												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Orbulina bilobata												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Globorotalia pseudomiocenica												■	■	■	■	■	■	■	■	■						
Sphaeroidinella Subdehiscens																■	■	■	■	■	■	■				
Globorotalia siakensis					■	■	■	■	■	■	■	■	■	■	■	■	■									

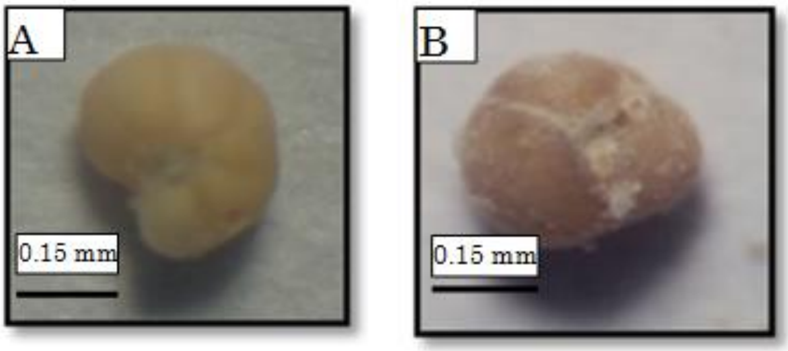

Figure 9. foraminifera A. *Globorotalia pseudomiocenica*, B. *Sphaeroidinella subdehiscens*.

Geological structure

Geological structures encountered in the form of bedding, joint, and fault. Bedding of Kalibeng Formation contained in have dip between 42° - 58°, being in Kerek Formation has a dip between 35° - 86°. Fracture at Kalibeng Formation in the form of shear fracture and extension fractures, and the following **Table 2**, stereonet and histogram (**Figure 10** and **11**). Fracture at Kerek Formation in the form of shear fracture and fracture extension, the following **Table 3**, stereonet and histogram (**Figure 12**). Reverse fault to be found in the Persen village, fault plane is N110°E/65°. Right strike slip to be found in the Pentul village, fault plane is N303°E/8°. Boundary between Kerek and Kalibeng Formation is interpreted as a reverse fault.

Table 2. Fracture at Kalibeng Formation.

Fractures	
Shear fracture	**extension fracture**
N 180º E/75º	N 285º E/60º
N 311º E/70º	N 200º E/67º
N 161º E/65º	N 139º E/74º
N 254º E/80º	N 120º E/75º
N 155º E/72º	N 134º E/64º
N 275º E/64º	N 110º E/71º
N 285º E/64º	N 323º E/76º
N 44º E/74º	N 260º E/80º
N 145º E/84º	N 341º E/84º
N 65º E/82º	
N 338º E/66º	
N 264º E/75º	
N 300º E/79º	
N 299º E/78º	
N 127º E/80º	
N 12º E/67º	

Table 3. Fracture at Kerek Formaton.

Fracture	
N 320º E/40º	N 267º E/65º
N 230º E/81º	N 186º E/85º
N 45º E/63º	N 334º E/15º
N 140º E/25º	N 180º E/81º
N 55º E/70º	N 210º E/55º
N 56º E/54º	N 270º E/88º
N 70º E/66º	N 110º E/75º
N 200º E/48º	N 210º E/60º
N 183º E/89º	N 150º E/90º
N 255º E/72º	N 350º E/70º

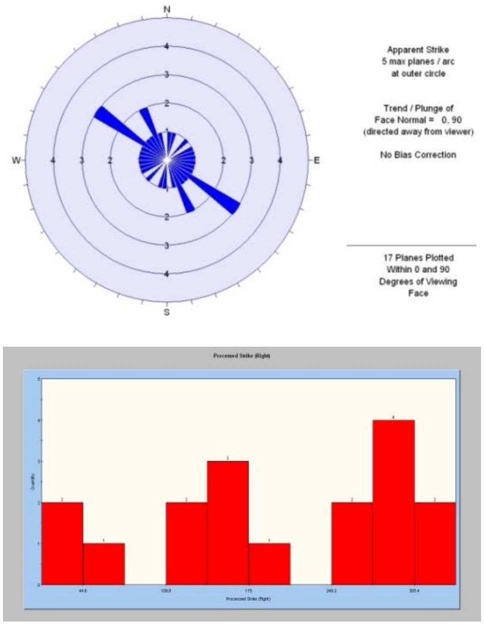

Figure 10. Stereonet and histogram of shear fracture at Kalibeng Formation.

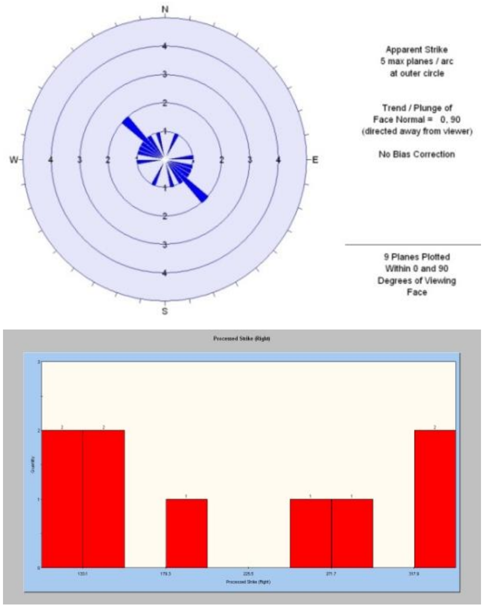

Figure 11. Stereonet and histogram of extension fracture at Kalibeng Formation.

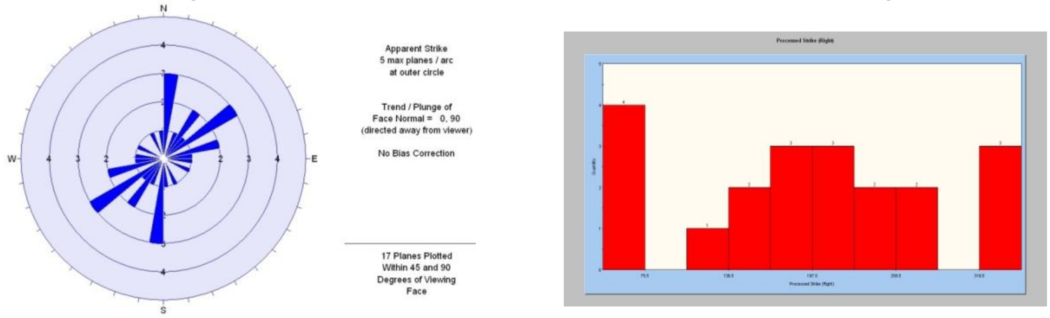

Figure 12. Stereonet and histogram of fracture at Kerek Formation

Trenching and Sand boil

Sand boil encountered in unit B Marl of Kalibeng Formation and sandstone Kalibeng Formation (**Figure 3**). Trenching carried out around the discovery of sand boil. Form of trench is cubes, so there are four side walls. Description of four sides walls includes the west side (**Figure 13**), east (**Figure 14**), the north and south (**Figure 15**). Rock unit is divided into 5 units namely:

1. Unit A: black mudstone, there are fragments of gravel, black color, non calcareous, limestone fragment colored dull white.
2. Unit B: siltstone, cracks filled with coarse sands material, carbon fragments, gravel sized fragments of igneous rocks and black mudstone, matrix of calcareous sandstone, calcareous siltstone.
3. Unit C: Sandstone, laminated structure, calcareous, sandstone medium-sized.
4. Unit D: Sandstone has the material of medium size grain, massif, there are bedding mudstone, sandstone lens, laminate structure.
5. Unit E. alluvial deposits, sand size - boulders, unconsolidated, river sediment.

Fracture, carbon fragments and sand boil found in layers of rock unit B. Fractures in this unit is irregular and sand boil deposited on siltstone layer Kalibeng Formation. Contact between unit A and unit B shows conformity contact. Units A, B, C, and D into the Kalibeng Formation. In addition to that there is a sand boil on the horizon unit B as evidence of past seismic mass, also found that carbon fragments sized gravel. This carbon is also evidence of seismicity

Synthesis of Structure Geology, Stratigraphy and Paleoseismology

Secondary evidence of the seismic activity in the Late Miocene - Early Pliocene in form is sand boil, that fills a fracture in Kalibeng Formation siltstone. This fracture is part of the fault off. Tectonic activity study area is divided into 5 phases as follows (**Figure 16**):

1. Phase 1: Establishment of fold and a pre-existing fractures of reverse fault with fault plane is N110°E/65° on Kerek Formation. This activity occurs in the Middle Miocene.
2. Phase 2: By unconformity precipitated Kalibeng Formation and unit A rock formations until this unit folded with dip between 42° - 58°.
3. Phase 3: reverse fault reactivation, in conformity deposited units B, C, and D Kalibeng Formation and occurs seismicity (coseismic) around the reverse fault resulting in a sand boil on the horizon unit B. This process occurs in the Late Miocene - Early Pliocene.
4. Phase 4: Uplift Process Kerek Formation continues to occur until the fault ride through the fields. This process occurs in the Plio - Pleistocene.
5. Phase 5: In Holocene, River activities cover Kalibeng and Kerek Formation.

Direction of shear fractures and extension fractures in the Kalibeng Formation showed the same relative direction is NW-SE, it shows that fracture formation is different time. Means at least Kalibeng Formation occurs tectonic twice. Phase 3 is the second tectonic on Kalibeng Formation that caused to create the sand boil and form a unit horizon B.

Discussion

Paleoseismology identified relative to the encountered sand boil and carbon contained in the B horizon Kalibeng Formation unit. This tectonic causes unit members B, C, D are deposited conformity on above the Kalibeng Formation unit A. At the time forming of the Kalibeng Formation happened twice tectonic and this last tectonic seismicity resulting evidence (coseismic). This earthquake occurred in the Late Miocene - Early Pliocene.

Seismic evidence found in rock Kalibeng Formations Late Miocene - Early Pliocene, whereas the Holocene seismicity yet to find proof. Stream sediment were found as evidence of activity in the Holocene, found no evidence of seismicity.

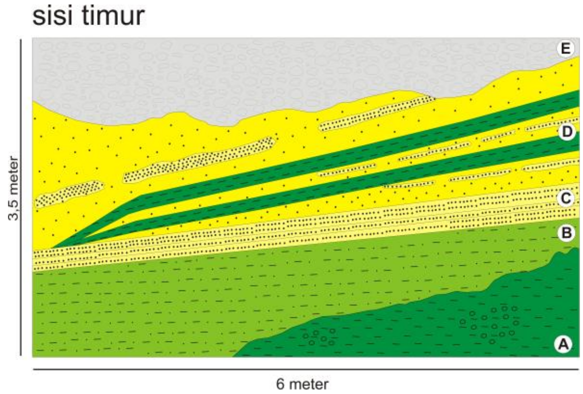

Figure 14. Sequence stratigraphy units on the east side.

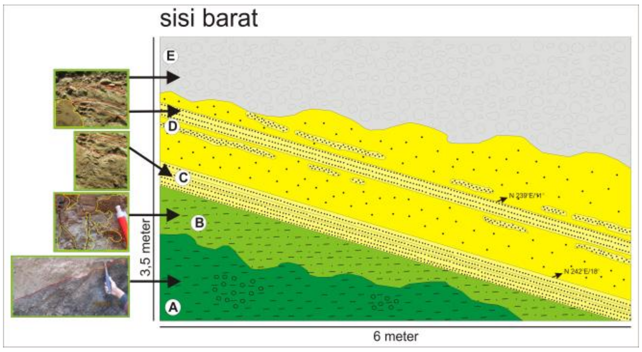

Figure 13. Sequence stratigraphy units on the west side.

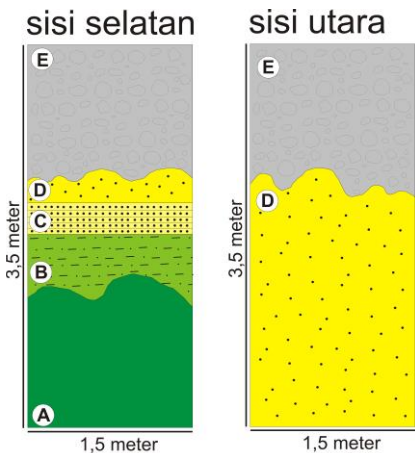

Figure 15. Sequence stratigraphy units on the south side and the north.

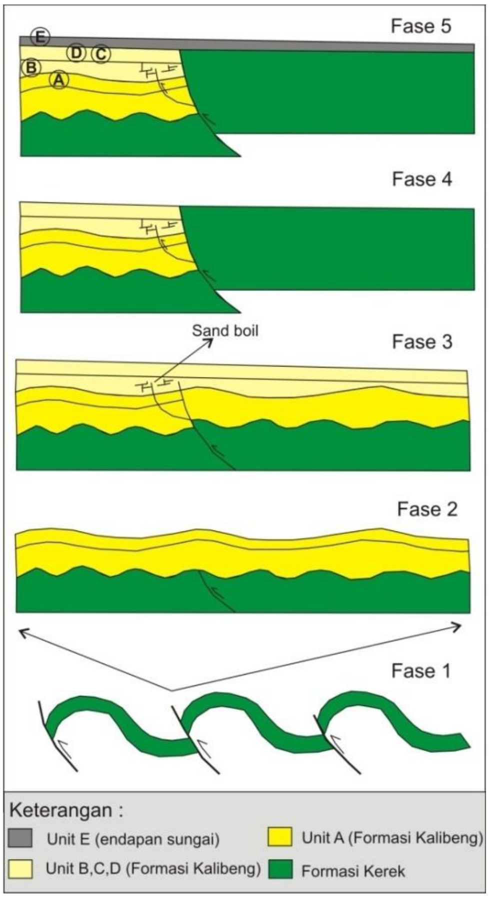

Figure 16. Past tectonic activity

Conclusion

1. Past seismicity occurred in Late Miocene - Early Pliocene marked by the sand boil and carbon around the reverse fault and fracture zones in unit B Kalibeng Formation.
2. Tectonic occurrence in the study area consists of 5 phases, seismicity occurs with marked by reverse fault reactivation in phase 3 and 4.

Acknowledgment

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CALCULATION OF DISASTER RISK VALUE IN THE PROSPECT MINING AREA, BLITAR DISTRICT, EAST JAVA USING MICROTREMOR ANALYSIS

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Abstract

Indonesia has a wealth of natural resources is so large to be managed and utilized, both by the government and local communities themselves, particularly in the mining sector. However, mining exploitation can change the state of the surface layer of the earth that have a high disaster risk. This could threaten the safety and disrupt human life, environmental damage, loss of property, and the psychological impact, as referring to the law No. 24 of 2007 on disaster management. In this study, we propose a way to manage and minimize the risk of bentonite mine disasters in the region, by using the calculation method of Amplification Factor (AF) based on microtremor analysis of Kanai and Nakamura interpretation . Based on the amplification factor obtained, some area in blitar district showed instability in the surface layer of a mining area include the site of the TP-7, TP-8, TP-9, TP-10, (Birowo 2 Area). If we analys it in terms of structure, the location of this indicated unstable, because it has a sloping surface layer, resulting in the occurrence of landslides and high seismic risk . In the meantime, other areas (Birowo 1 and Ringinrejo Area)of the mine site can be said to be a stable area.

Keywords: *Risk Reduction, Microtremor Analysis, Interpretation of surface layer Referring to the value of the Disaster Risk by Amplification Factor*

Introduction

Bentonite mining acvities will alter Earth's surface layer becomes unstable. If this is allowed, then it will lead to a high risk of disasters, especially landslides. According to the head of departement of energy and mineral mineral resources, the province of East Java, Ir. Dewi J. Putriani MSc (2010)[5], “if mining exploitation management is done wihout seeing the seriously impact, then our children and grand children would be bear later” (The information and communication services of East Java Province, 2010). So, In this study, we propose a way to manage and reduce disaster risk in the mining prospects using the Amplification Factor (AF) of microtremor analysis.

The study area is a bentonite mining, located in Blitar district, East Java Province, within the coordinates of $112^0$18'20"E to 112^o 22' 26” E and $8^0$12'09"S to $8^0$05'15"S. This region is a mountainous area with steep valleys in the southern part of East Java. It stretches from Pacitan, Ponorogo, Trenggalek, Tulungagung, Blitar, Malang southand Jember. Access to the area is difficult due to itsrough morphology and the possibility of natural disasters. These problems include landslides, earthquakes, and tsunamis on the beach ramps. There is also potential to develop mining projects for natural resources such as metals and minerals (gold, copper, zeolite, bentonite) and in certain locations limestone and andesite. Tourism can also benefit in the area with activities such as whitewater rafting and tours in limestone caves (Van Bemmelen, 2005)[6].

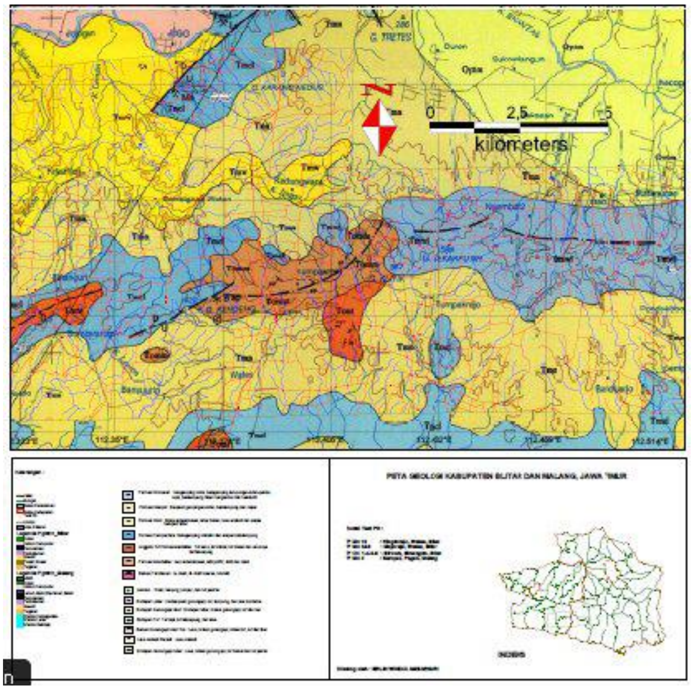

Figure 1. Geological map of East Java

Amplification factor is the main factor to detect the risk of an earthquake on the surface layer of sediment. The technique of measurement and calculation is obtained from the microtremor analys of surface waves. From this method, it can be informed which areas are prone to disasters or not, so the handling and control of mining areas in the region could be followed up.

A microtremor is a low amplitude ambient noise produced by subsurface movements; these movements are caused by artificial disturbances such as traffic, machine factories, and other human activity on the earth's surface. They can also be caused by natural forces such as wind or ocean waves that have a short period of about 0.1 to 1 or 1.6 microns and a long period of 1.6 to 2 seconds or more. (Parwatiningtyas Diyan, 2009)[4].

The nature of the wave of the microtremor is variable. It depends on the conditions of different regions. The basic principle of implementation is to research the effects of the microtremor under the surface.The microtremor as a wave is moving beneath the surface and is amplified in periods that are synced to the natural periods in sub soil, along with the selection of resonance, and increase in frequency components. When the periods reflect the formation of the microtremor under surface, the period length is associated with the formation depth. Microtremor was first investigated by Omori in 1908 in his attempt to resolve issues including: Resources vibration, wave transmission mechanism, and someinterests in engineering applications. The microtremor observation survey is conducted to determine the dynamic characteristics of the surface layer, such as resonant frequency and seismic vulnerability (Nakamura, 2000)[2].

Correlation between the levels of earthquake damage and the Microtremor Spectrum

There is a correlation between the characteristics of the micro-tremor spectrum and the level of damage in earthquakes. The research of Daryono (2011)[1], indicates that the micro-tremor spectral rises to a peak on sedimentary formations and fine sediment materials. The spectrum of research conducted by Singh et al. (2003) in the former swamp in Mexico City also had similar results indicating that micro-tremor spectral peaks are increased in areas composed of fine sediments material in the former swamp. Mucciarelli et al. (1996) and Moisidi et al. (2004) stated that the HVSR analysis method is able to estimate the area that suffered from earthquake damage in the past.

The intensity of the damage and the amplification factor of high seismicity in the earthquake usually occur in a location with a pattern of micro-tremor spectrum where the resonant frequency (f_{dom}) is high with low spectral peaks (dominant period (T_{dom})). In contrast, the intensity of the damage and the amplification factor of low seismicity occur in a location with a pattern of micro-tremor spectrum where the resonant frequency (f_{dom}) is low with high spectral peaks (dominant period(T_{dom})).

Distribution Period in Microtremor

By running a systematic measurement of micro-tremor in some regions in Japan, Dr. Kanai and Omote – Nakajima (2001)[3], found that there was particular classification to each kind of sub-soil, in terms of the distribution of the micro-tremor period, among which are:

Table 1. Soil formation based on the Period of Microtremor

Soil Formation	Period Distribution	Specification
Simplicity of the composition	0.1 - 0.6 seconds.	
Complex Formation	0.2 (short period) – 1 second(length of period)	>Two peaks.
Fixed Diluvial soil	0.2 – 0.4 seconds.	
Soft alluvial soil.	0.5 – 0.8 seconds.	Flat curve
The thickness of the soft soil	0.05 ; 0.1 – 1.2 seconds	

In other cases, the distribution of the period is influenced by the nature of the first layer of soil. When the curve of the fresh rock and the horizontal curve of bedrock have a period that ranges between 0.1 seconds and 1 second or more; the amplitude of the micro-tremor on the surface of the soil becomes enlarged. As a result, the period is synced with the natural period of the soil's sub virtue selective resonance.

The following table shows the soil classification based on an analysis on the distribution of the period of microtremor proposed by Kanai and Omote-Nakajima:

Table 2. Soil Classification based on the Analysis Microtremor

No	Soil classification		T (sec)	Specification
	Kanai	Omote Nakajima		
1.	Type-1	Type A	0.05 – 0.15	Tertiary or older rocks composed of hard sand-gravel.
2.	Type-2	Type A	0.10-0.25	Diluvium rock, with a thickness of 5 m, consists of sand-gravel, sand hard clay, loam.
3.	Type-3	Type B	0.26-0.40	Alluvial rock that isnearly similar to type 2
4.	Type-4	Type C	>0.40	Consisting of alluvial sediment delta, top soil, mud, with a thickness of 30 m or more.

Materials and Methods / Experimental

The research method consist of two parts:

1. Data processing.
2. Looking for value and calculation resonant frequency of the dominant period to get the value of the amplification factor from microtremor analysis. This method refers to the observation of existing geological maps.

Instrumentation and Measurement Systems

Instrumentasion used in this study is a set of microtremor equipment form a single short period seismometers (velocity sensitive sensor) type TDS – 303 (3 parts) is vertical direction (V), the North-South (NS) and East – West (EW) with a sampling frequency of 100 Hz. This appliance is equipped with a data cable, digitizer, solar cell panel, GPS, UPS, and compute data acquisition (Figure 1). To facilitate measurement in field, othertools also prerared a geological compass and personal computer or note book to download data.

Figure 2. Instrument of Microtremor

Method of Data Analysis Microtremor

There are three techniques that have been developed to analyze the data to obtain values microtremor amplification factors, including:

- ***Direct interpretation of the curve Fourier Spectrum or Spectrum Power (Kanai & Tanaka, 2001)[3].***

In general, the frequency analysis method for the irregular variation of the data according to time as microtremor, applied the power spectrum method. If the data is randomvariation as afunction of time is f(t), then the fourier transform is defined as follow :

$$F(\omega) = \sqrt{An^2} + Bn^2 \tag{1}$$

Which :

$$An(\omega) = (2/T)\int_0^T f(t)Cos\,\omega t dt$$

$$Bn(\omega) = (2/T)\int^T f(t)Sin\,\omega t dt$$

And the Power Spectrum $\mathrm{Pn}(\varpi)$ is shown by the following equation :

$$P(\varpi) = An(\varpi) + Bn(\varpi) \tag{2}$$

Microtremor amplitude spectrum can be obtained directly by fourier transformation is defined as follows :

$$f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f*(p)e^{ipt}dt \tag{3}$$

Invers from $\boldsymbol{f^*(t)}$ is

$$f(p) = \frac{1}{2\pi}\int_{-\infty}^{\infty} f*(T)e^{ipt}dt \tag{4}$$

- ***Period predominant interpretation to determine the amplification factor of the surface sediment layer (Kanai & Omote Nakajima 2001)[3].***

Kanai and Omote Nakajima describes the layers of sedimentary soil amplification factors obtained from the calculation of the predominant period of the surface sediment layer.

Amplification factor formula described by Kanai :

$$1+\sqrt{\frac{T_o}{3}} \tag{5}$$

Where *To* is the soil predominant.

- ***Nakamura (2000)[2] proposed a hypothesis that vibration microtremor at a location can be determined by calculating the spectral ratio between the horizontal component to the vertical component observed in the same location.***

Spectral ratio equation are defined:

$$Se(\varpi) = Hs(\varpi) / Hb(\varpi) \tag{6}$$

And the effect of the vertical component of the spectra is :

$$As(\varpi) = Vs(\varpi) / Vb(\varpi) \tag{7}$$

Then modified spectral ratio is defined as :

$$\begin{aligned} Sm &= Se(\varpi) / As(\varpi) \\ &= (Hs/Hb)/(Vs/Vb) \\ &= (Hs/Vs)/(Hb/Vb) \end{aligned} \tag{8}$$

Based on experiments using the drill data, if the microtremor rayleigh wave form, it can be assumed that:

$$Hb(\varpi) = Hb(\varpi) / Vb(\varpi) \approx 1$$

In a wide frequency, interfal modified spectral ratio be :

$$Sm(\varpi) = Hs(\varpi) / Vs(\varpi) \tag{9}$$

Results and Discussion

The data used in the processing microtremor obtained from measurements in the field for 6 days in May 2012. The total point locations measured were 15 (fifteen) points, which conducted at night and during the day, in order to avoid the ambient noise caused by vibrations associated with human activities and other vibrations. Each point of data recording was performed for approximately 15 minutes.
The equipments used during the processing of the data were 1 set of Microtremor Equipment, GPS and Compass, software Dimas 2008, GEOPSY, and SURFER *8*. Data processing results shown in the tables and figures below:

Figure 3. Sample of Bentonite

Figure 4. Birowo 1 Area (TP-1 until TP- 6 points)

Figure 5. Birowo 2 Area (TP-7 until TP- 10 points)

Figure 6. Ringinrejo Area (TP-11 until TP-15 points)

No	Site	Predominan Period (T) sec
1	TP-1	0.775
2	TP-2	0.730
3	TP-3	0.681
4	TP-4	0.671
5	TP-5	0.766
6	TP-6	0.627
7	TP-7	0.283
8	TP-8	0.268
9	TP-9	0.541
10	TP-10	0.790
11	TP-11	0.127
12	TP-12	0.102
13	TP-13	0.134
14	TP-14	0.102
15	TP-15	1.232

Figure 7. Results of Calculation Period predominant at each site (Kanai and Omote Nakajima)

Number	Site Location	Amplification Factor (SR) Nakamura	Amplification Factor Kanai
1	TP-1	0.808	1.293
2	TP-2	0.716	1.285
3	TP-3	0.851	1.275
4	TP-4	0.540	1.273
5	TP-5	0.834	1.292
6	TP-6	0.859	1.264
7	TP-7	0.843	1.177
8	TP-8	0.862	1.173
9	TP-9	0.773	1.245
10	TP-10	0.869	1.296
11	TP-11	0.829	1.119
12	TP-12	0.780	1.107
13	TP-13	0.915	1.122
14	TP-14	0.812	1.107
15	TP-15	0.629	1.370

Figure 8. Amplification factor table based interpretation Kanai and Nakamura

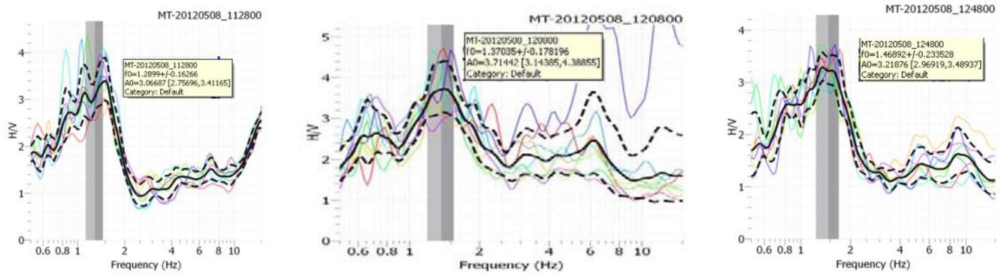

Figure 9. Spectrum Curve Microtremor (TP-1 until TP-3 Sites)

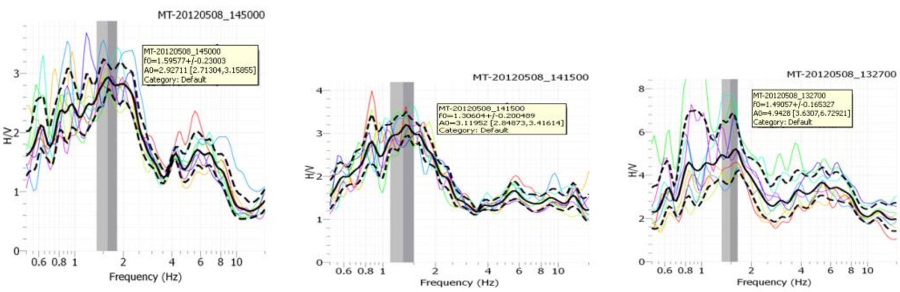

Figure 10. Spectrum Curve Microtremor (TP-4 until TP-6 Sites)

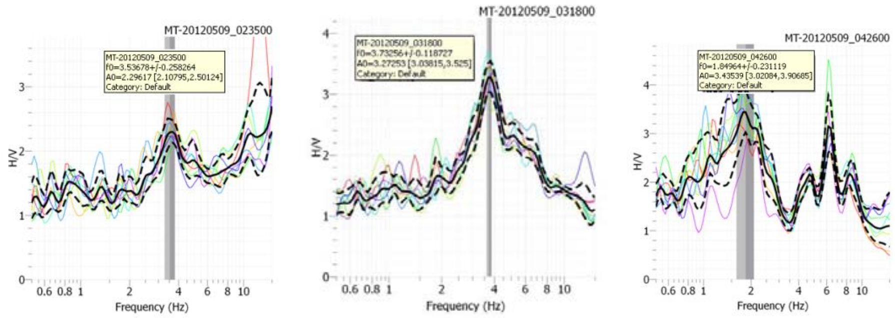

Figure 11. Spectrum Curve Microtremor (TP-7 until TP – 9 Sites)

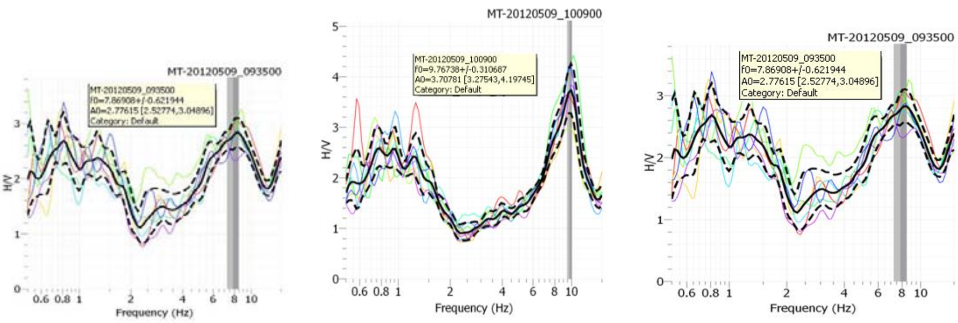

Figure 12. Spectrum Curve Microtremor (TP-10 until TP – 12 Sites)

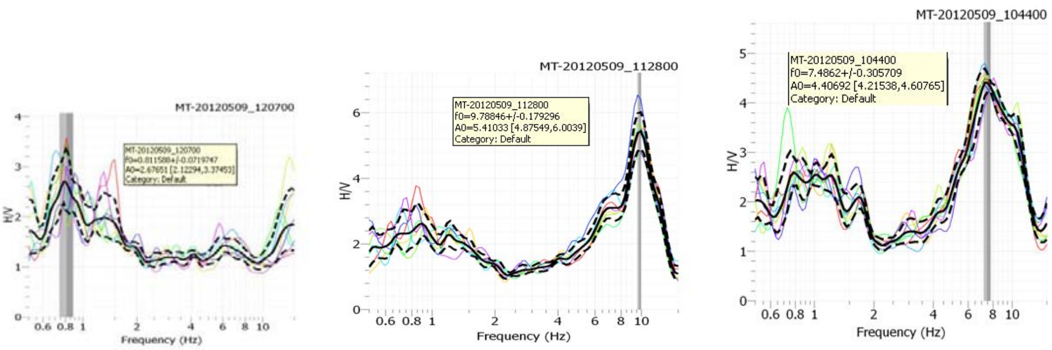

Figure 13. Spectrum Curve Microtremor (TP-13 until TP – 15 Sites)

Conclusion

Based on the calculation of the amplification factor of microtremor analysis showed that in some mine sites there were stable in the surface layer, such as (TP-1, TP-2, TP-5, TP-6) in the Birowo 1 Area (Figure 7 and 8 in spectrum curve)), and in the Ringinrejo Area (TP-13 until TP-15 which is showed on figure 11 from spectrum curve). The most instability location is the Birowo 2 Area (TP-7, TP-8, -9 TP, TP-10. TP – 11, TP-12, Figure 9 and 10 from Spectrum Curve). Beside that, if we seeing it from the dominant period of analysis, (Tdom) by Kanai and Omote-Nakajima, based on the type of soil classification, the location of Birowo 2 needed a caution in the implementation of mining ekspolitation, specially in the TP-7, TP-8, TP-9, TP-10 until TP-12, because due to bentonite at this location has a type of soft alluvial soil, and in the complex formation. It causing landslide and high earthquake risk.

Acknowledgment

We express our thanks to God Almighty. We also thank the committee of ISSH 2013 who have given us the opportunity to participate in this symposium. Likewise, we thank to the bentonite mining companies in the Birowo area, Blitar that provided accessibility in this research activit. May God bless you all.

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GEOMORPHIC FEATURES ALONG THE MANNA FAULT SEGMENT OF SUMATRAN FAULT ZONE BASED ON REMOTE SENSING INTERPRETATION

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Abstract

The tectonic history of the Sumatran Fault Zone has a complex character. Previous tectonic and kinematic investigations and research of the fault have revealed that Sumatran Fault Zone is a right-lateral strike-slip fault regime. The Manna Fault Segment is one of the segmentation of the Sumatran Fault Zone that located at the southeast part of the Bengkulu Province. The Manna Segment is one of the most active fault that produce many earthquakes at the land of Sumatra. Landsat 7ETM+ imagery and also ASTER-DEM imagery are used for detail geomorphic remote sensing along the fault. From the remote sensing interpretation, could determine the characteristic of the fault by detailed mapping of the geomorphic markers and geomorphic expressions along the fault. Based on interpretations of Landsat 7ETM+ imagery and ASTER-GDEM imagery, the geomorphic markers of The Manna Fault Segment could be determined from the offset of the river, grabenlike valley which probably as the thinning part of the crust in the pull-apart mechanism of the fault and the locations of the active volcanoes, calderas. The movement of the fault based on the geomorphic features that had been interpreted is right-lateral strike-slip movement. This study could be used for the preliminary study for active tectonic and express the potential geological hazard area.

Keywords: *active tectonic, geomorphic, manna fault segment*

Introduction

The tectonic history of Sumatran Fault Zone has a very complex character but the 1900-km length of the Sumatran Fault Zone has a kinematic role that simple: It accommodates a significant amount of the strike-slip component of the oblique convergence between Australian/Indian and Eurasian plates [1].

Sumatran Fault Zone was divided into 19 segments which bears the name of a major river or bay along the segments. Manna Fault Segment (103.42^0 E and 4.35^0 S to 102.88^0 E and 3.8^0 S) deviates only a kilometer or two from being rectilinear but has rather obscure terminations on both ends. The Manna segment appears discontinuous because the trace is obscure locally on the aerial photographs and topographic maps [1]. A destructive earthquake occurred in the vicinity of this segment on June 12, 1893. The area of greatest damage coincided with the central part of The Manna Fault Segment [2].

In preliminary active tectonic study, interpretation of remote sensing plays an important role in determining the faults. Remote sensing interpretation showed commonly by lineaments extraction. The lineaments showed the behavior of the strike-line and commonly as a faults-line. Another geomorphic features were also derived by manual extraction of imageries and we can obtain every single unique shapes from the morphological and geological features along the fault.

The geomorphic features from The Manna Fault Segment showed that there are mountainous range on east side of the fault, associated with possible folds and thrust valley or depression [1].

The Sumatran Fault Zone as the source of many destructive earthquakes and a long-time ago historical earthquake occurred at The Manna Fault Segment has motivated authors to map out the surface deformation that build geomorphic features along The Manna Fault Segment.

Materials and Methods / Experimental

The obvious features of the Sumatran fault have long been known from analysis of small-scale topographic and geologic maps. More detailed small-scale maps of the fault, based upon analysis of satellite imagery, have been produced recently [1]. A significant research for Sumatran Fault Zone and the segmentation have been conducted by some researcher.

Imagery Processing

This study focused at Manna Fault Segment. We used Landsat 7ETM+ Imagery and ASTER-Digital Elevation Model as the base map and those two kind imageries were extracted manually. The main advantage on manual extraction is to facilitate the detection the non-geological lineaments such as roads, fences, field boundaries - with human eyes; although this kind of extraction take longer time to do and should be done carefully.

For manual lineament extraction, color composite at band 4, band 5 and band 7 has been combined for satellite imagery. These color composite combination commonly used for geological interpretation. In lineaments interpretation, greyscale combination has been used instead of combination of band 4, band 5 and band 7. The greyscale imagery also used on the ASTER-GDEM imagery.

The ASTER-GDEM has been used for extracting the topography profile along the map. The extracting processes has been proceed by ArcGIS software. The software also useful for digitizing lineaments, plotting the location of the fault, and digitizing every single geomorphic features on the map.

Simple Model of The Fault

In order to show the behavior of the fault related to surface deformation, the image of extension and contraction along an irregular strike-slip fault, and the cartoon of geomorphology of strike slip fault zones, will be showed as the comparator for The Manna Fault Segment modelling (**Figure 5**)

Results and Discussion

The Manna Fault Segment laid along the west side of Bukit Barisan Range which coordinates are 103.42^0 E and 4.35^0 S to 102.88^0 E and 3.8^0 S. The lineaments derived from the imagery are clearly seen by human eyes, although it seems discontinuous but the direction and trend of the faults are clearly observed (**Figure 1**). The discontinuity of the fault is caused of probably the faults were in this case buried by younger volcanic deposit at some place.

From the Landsat imagery interpretation, the lineaments are commonly NW-SE orientation. The lineaments could be the faults, the strike of the bedding, the axes of folding and scarps. The lineaments are clearly seen from the Landsat imagery with combination of band 4, band 5 and band 7 (**Figure 2**). Some features maybe not clearly seen from the Landsat imagery because of the limit of its resolution and cloud covered. So the ASTER-GDEM imagery could be helpful for interpretation of the lineaments

The geomorphic features from The Manna Fault Segment showed there are mountainous range on east side of the fault, associated with possible folds and thrust valley or depression [1]. As it was mentioned by other researcher, the interpretation determined that the location of the volcano, Gunung Dempo laid on the east side of the main fault, where along the east side there were mountainous range that seen by height differentiation determined from the Landsat 7ETM+ and ASTER-GDEM imagery. Scarps, traces of the bedding planes and geomorphic offsets of the channels also determined by the interpretation.

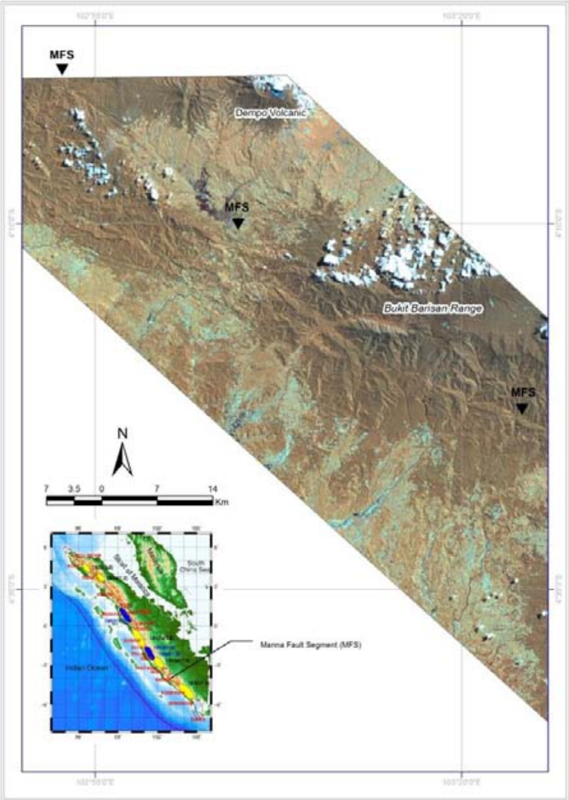

Figure 1. Landsat 7ETM+ imagery of Manna Fault Segment

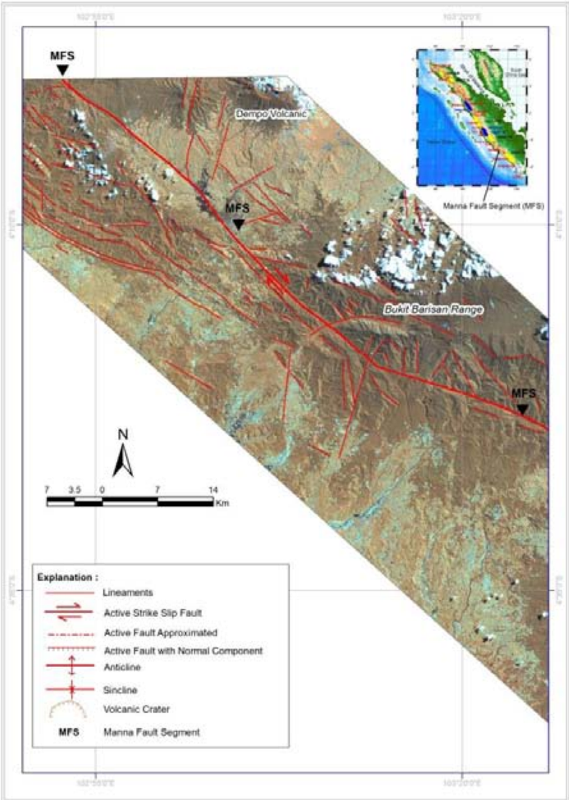

Figure 2. Map of lineaments and main fault of Manna Fault Segment

As the limitation resolution of the imageries, either Landsat or ASTER, the computerized analysis such as hillshading, extracting the river channels and flow direction were really helpful interpreting the datas. The offset channels derived from the computerized analysis by overlayering the Landsat imagery and the river-flow direction maps extracted from the hydrological analysis by ArcGIS software. There were five probabilities of the offset channels distance derived from the analysis. Dextral strike-slip movement determined by the direction of the offsets (**Figure 3).** The offset consecutively from northwest to southeast are : 1.28 km~~.~~, 4.05 km, 1.6 km, 1.15 km and 2.07 km. Both topographic and geomorphic features are seen clearer after the processing. The scarps are commonly seen at the west side of The Manna Fault Segment, either the folds such anticlines or sinclines (**Figure 4).**

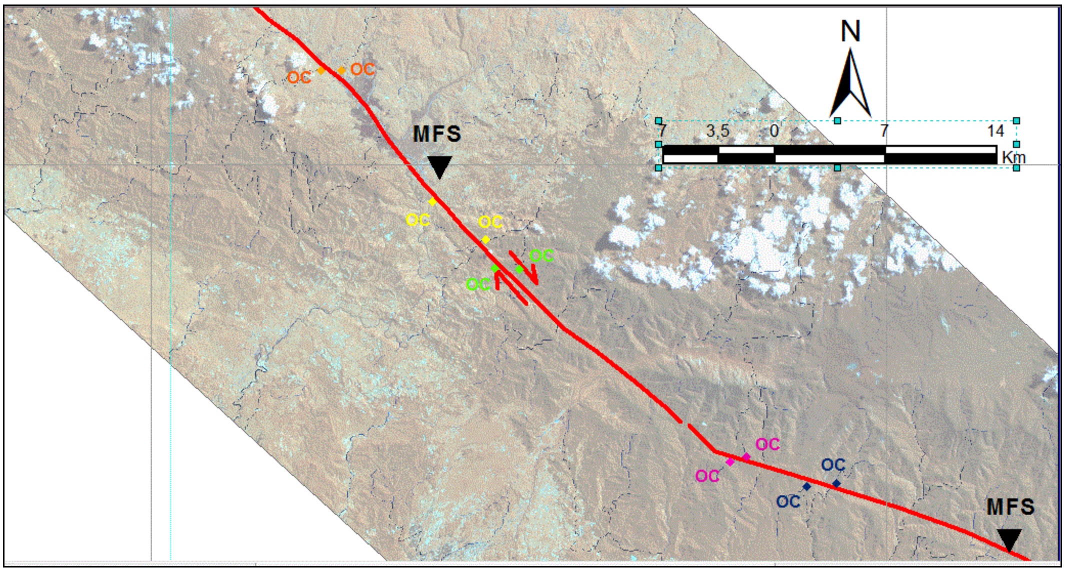

Figure 3. Overlayering map between transparent Landsat 7ETM+ with hydrological analysis of the hill-shaded Landsat 7ETM+ relief

The Manna Fault Segment produced by tectonic activity which accommodates a significant amount of the strike-slip component of the oblique convergence between Australian/Indian and Eurasian plates [1]. As observed in laboratory experiments and field studies, a predictable geometry of structures may formed in shallow crustal rocks and alluvium in response to horizontally maximum compressive stress (**Figure 5A)** [3]**.** In this case the strike-slip movement is the maximum compressive stress. So the product of this deformation can include restraining bends associated with thrusts and mountain building; releasing bends associated with basin development and rapid subsidence; horsetail splays of either normal or reverse fault and the right-stepping step-overs in a dextral zone create pull-apart basins as the fault tips curve toward the continuing fault trace and generate normal slip (**Figure 5B)** [3]; or in other word, it was mentioned as grabenlike valley.

The geomorphic features along the main fault was produced by deformation of the dextral component of the strike-slip fault. The offset channels were the products of the horizontal movements, as seen on the map where the offsets determined the dextral movement of the faults. The higher topographic as mentioned as mountainous range which laid on the east side of the Manna Fault Segment determined both of horizontally and vertical movement, where the right-stepping has higher relief than that of left-stepping (**Figure 5).** The scarps were the product of vertical movement along the fault. As a consequences that most of the faults in detail not wholly has one component such strike-slip only, or the fault is not simple vertical plane.

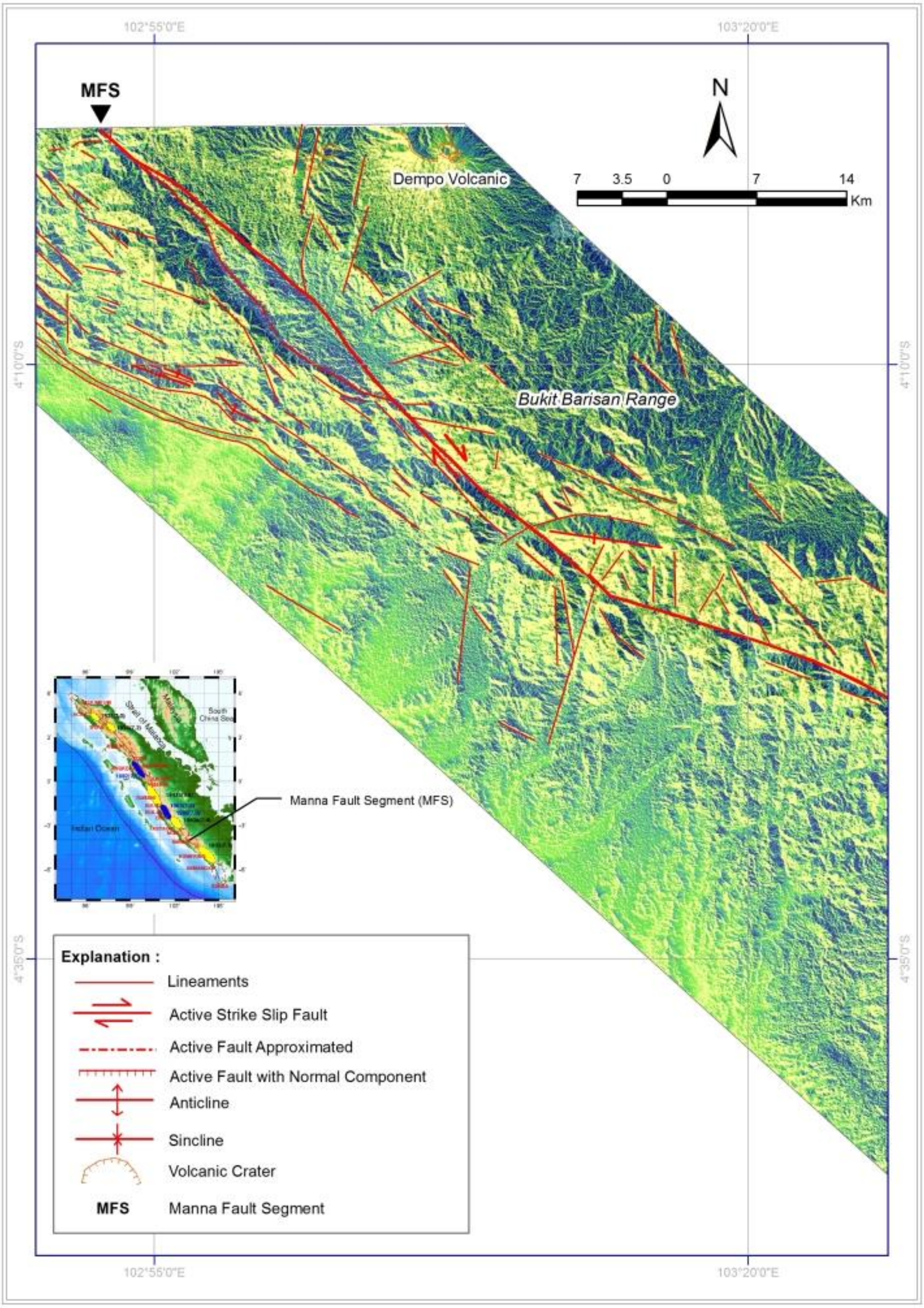

Figure 4. Hill-shaded relief map of The Manna Fault Segment, hill-shaded from the ASTER-GDEM imagery

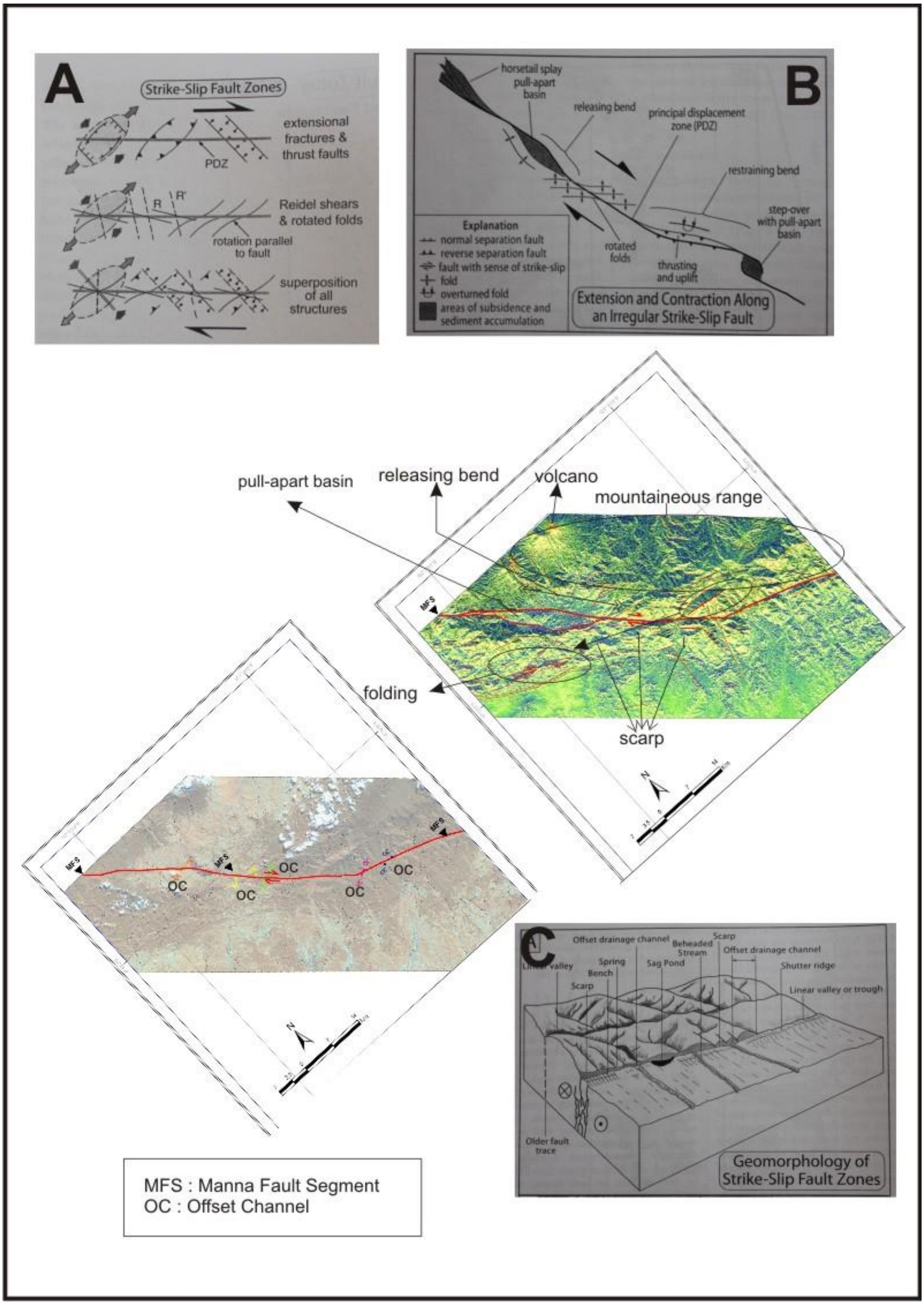

Figure 5. Simple Manna Fault Segment modeling. **A.** Orientation of structural features formed in response to strike-slip shear couple. **B**. Regional scale structures along a strike-slip fault. **C.** Geomorphic features of strike-slip fault zones

Conclusion

The Manna Fault Segment laid along the west side of Bukit Barisan Range which coordinates are 4.35^0 S to 3.8^0 S. From the Landsat 7ETM+ imagery interpretation, the lineaments are commonly NW-SE orientation. The lineaments could be the faults, the strike of the bedding, the axes of folding and scraps. The interpretation determined that the location of the volcano, Gunung Dempo laid on the east side of the main fault, where along the east side there were mountainous range that seen by height differentiation determined from the Landsat 7ETM+ and ASTER-GDEM imagery. Scarps, traces of the bedding planes and geomorphic offsets of the channels were also determined by the interpretation.

The geomorphic features along the main fault was produced by deformation of the dextral component of the strike-slip fault. The offset channels were the products of the horizontal movements, as seen on the map where the offsets determined the dextral movement of the faults. The higher topographic as mentioned as mountainous range which laid on the east side of the Manna Fault Segment determined both of horizontally and vertical movement, where the right-stepping has higher relief than that of left-stepping. The scarps were the product of vertical movement along the fault. As a consequences that most of the faults in detail not wholly has one component such strike-slip only, or the fault is not simple vertical plane. So the detail mapping by higher resolution imagery interpretation or field work along the fault trace should be conducted to get more information about characteristic and kinematic of The Manna Fault Segment.

Acknowledgment

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CHARACTERISTICS OF TEMPERATURE AND PRESSURE ON GAS HYDRATE STABILITY ZONE USING SEISMIC 2D-MULTI CHANNEL IN SIMELUE FORE ARC BASIN, SUMATRA

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Abstract

Gas hydrate is very potential unconventional energy resources in the future. Simelue *fore arc basin* is one of the estimation zone in Indonesia which has gas hydrate. The existence of gas hydrate explorated with seismic reflection method, because it has ability describe the sediment layer laterally. BSR (*Bottom Simulating Reflector*) in seismic section is first identification of gas hydrate. On the other side, BSR does not always show the existence gas hydrate so temperature and pressure at the gas hydrate stability zone should be calculated. The processing data seismic was done from raw data until Post stack depth migration. The result of data processing, located of BSR showed at depth of 1250 up to 1650 m with temperature range around 279.38 – 280.079 ˚K and pressure 20.796 - 26.6368 MPa. This condition match with curve of gas hydrate stability zone.

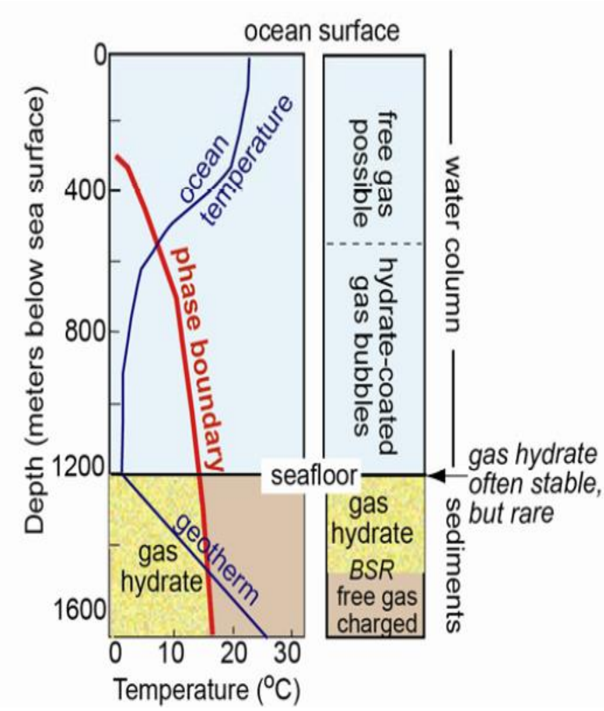
Keywords: *gas hydrates, temperature and pressure, 2D seismic multichannel*

Introduction

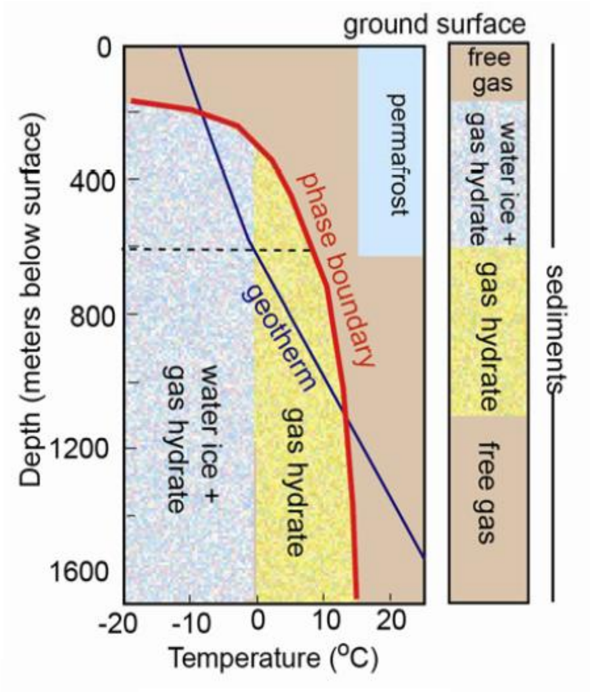
The main reason of gas hydrate prediction as potential energy source is an extensive geographical distribution all over the world. Naturally occurring gas hydrates are expected to be a potential resource in the near future. Hydrate exist in many locations, stricly permafrost and oceanic regions. They can be formed and are stable at high pressure and relatively low temperature in the presence of gases such as methane and other hydrocarbons. The equilibrium conditions for gas hydrates depend on the hydrate forming gas compositions. Many experimental data on the conditions for equilibrium formation of gas hydrates have been reported. In last decade, many data have been accumulated from geophysical surveys, the Ocean Drilling Program (ODP), direct seafloor observation and samplings devoloped to gas hydrate. One of geophysical surveys is seismic reflection method which know existence of gas hydrate in subsurface. The presence of gas hydrates in seismic profile has been inferred mainly from anomalous seismic reflectors that coincide with the predicted phase boundary at the base of the gas-hydrate stability zone. This reflector is commonly called a bottom simulating reflector or BSR. BSRs have been mapped at depths below the sea floor ranging from about 1100 to 1,500 m [1]. In this paper we present , calculation of the temperature and pressure from the depths of BSR in seismic profile used for prediction characteristic of gas hydrate in the area offshore of Simelue fore arc basin, Sumatera.

Gas hydrate

Gas hydrate is an ice-like crystalline mineral distributed on continental slopes worldwide where temperature and pressure are suitable for hydrate stability and being easy to burn [1]. Hydrogen bonded water molecules, usually referred as “hosts” encage “guest” gas molecules and gas hydrates are formed at suitable temperature and pressure values. High pressure and low temperature values favor hydrate formation. Gas hydrates, mostly the methane hydrates at the conditions of 1-2 to 50 MPa pressure and at 264-300 °K temperature values are considered as significant hydrate resources of interest [2]. Diffusion gas hydrate is defined as gas hydrate that occurs in an area where BSR was identified in seismic record profile. Within the GHSZ, there are hydrate and water with dissolved methane rather than free gas. Dissolved methane in pore water migrates by the diffusion process. Therefore, this type of gas hydrate was named as diffusion gas hydrate [3].



(a). Deepwater marine



(b). Permafrost

Figure 1. The stability of an idealized methane hydrate in nature (area to the left of the red phase boundary) in nominal marine (A) and permafrost (B) cases [3].

Figure 1 show only where gas hydrate is stable in ocean water and/or sediments, not where it actually occurs in nature. **Fig 1**.(a). For the marine case at an arbitrary water depth of 1200 m, gas hydrate is in theory stable in the lower part of the water column (where the ocean water temperature curve dips below the stability curve) and in the uppermost ~200 m of the seafloor sediments (where the blue geotherm overlaps the yellow stability zone). The possible configuration of gas hydrate bearing sediments over free gas is shown in the column at the right. Depending on the sediment geotherm and the ocean temperature structure, the gas hydrate stability zone thins to vanishing at ~300 to 500 m water depth on the continental margins and can thicken to include more than 1000 meters of seafloor sediments at great water depths. **Fig 1**.(b) For a nominal permafrost thermal gradient (geotherm), gas hydrate is theoretically stable starting within the bottom part of permafrost-bound sediments and extending to several hundred meters below the base of permafrost, as indicated by the depths over which the geotherm (blue) is cooler than the temperature of the phase transition (red).

Locations of known and inferred gas hydrates exist all over the world in polar and oceanic outer continental margins, as indicated in **Figure 2** [4]. The solid circles show gas hydrates in oceanic sediments; while the solid squares indicate the gas hydrates in permafrost regions. Gas hydrates in polar regions are encountered in permafrost regions both onshore in continental sediments and offshore in sediment of the polar continental shelves. On the other hand, in oceanic outer continental margins, gas hydrates are encountered in sediment with cold bottom water, specifically, in the sediments of the continental slope and rise [5].

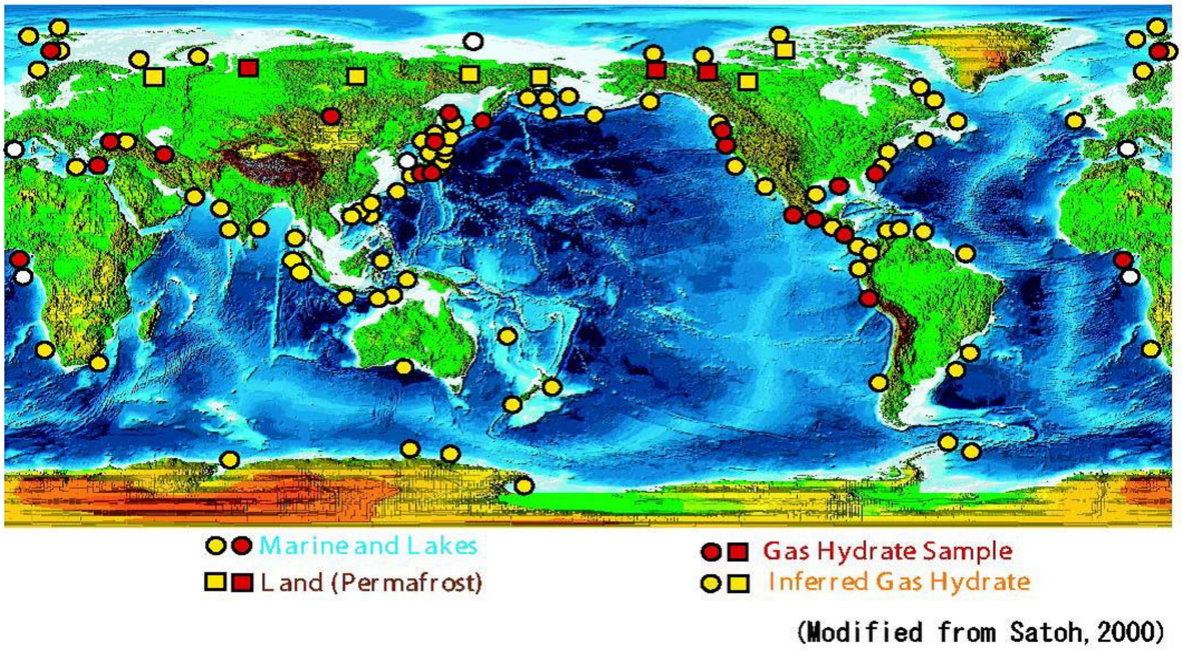


Figure 2. Locations of known and Inferred Gas Hydrates in marine sediments (solid circles) and in Permafrost Regions (solid squares) [4]

Some of the gas hydrate locations can be listed as offshore from Panama, Peru, Costa Rica, Guatemala, Japan, western and eastern United States, New Zealand, Russia, Argentina, Brazil, Norway, Oregon, California Gulf of Mexico, Black Sea, Caspian Sea, Sea of Okhotsk and Lake Baikal, indonesia etc.

Seismic Imaging and Identification gas hydrate

The key seismic techniques for identification of gas hydrate include 2-D seismic imaging, impedance inversion and a variety of cluster analysis, of which seismic imaging is the basis. On the one hand, accurate seismic imaging can highlight the unique seismic reflecting characteristics of possible gas hydrate and velocity anomalies can be used to infer the existence of gas hydrates preliminarily. The association between BSRs and gas hydrate accumulations is illustrated in **Figure 3**. Briefly, gas hydrates form within the uppermost part of the sedimentary column within the "gas hydrate stability zone", which is the zone within which the physical conditions within the sediments (eg. pressure, temperature, interstitial water salinity, etc.) allow for the formation of gas hydrates. Below this zone the physical conditions do not permit hydrate formation, consequently, the gas is in a free state and collects within the pore spaces of the sediments. Since the gas hydrates form a seal, the upward migrating free gas is trapped at the base of the gas hydrate stability zone. This free gas lowers the acoustic impedance of the gas charged sediments below the base of the hydrates, which normally results in a negative acoustic impedance contrast as well as an increase in the absolute value of the acoustic impedance contrast. Thus, the seismic reflections (BSRs) from the base of the gas hydrate stability zone are expected to be of high amplitude and to have a polarity that is the reverse of the down-going seismic pulse. As the name implies, a BSR in general mimics the shape of the seafloor reflector [6]. The depth of the base the gas-hydrate stability zone is controlled by temperature, pressure, gas chemistry and salinity of the interstitial fluids; therefore if these parameters do not vary drastically within a given area, then the depth of the base of the hydrate layer below the seafloor should remain fairly constant and hence the BSR should mimic the seafloor reflector.

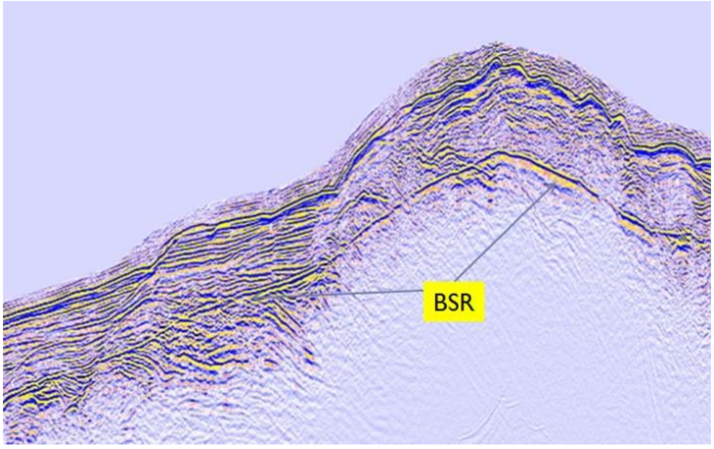


Figure 3. Drawing illustrating the BSR can cut across the sediment layers[4].

Calculation of temperature and pressure in Gas Hydrate Stability Zone (GHSZ)

Two major issues to determine the gas hydrate stability zone in marine areas are temperature and pressure. Hence in this paper, calculation of temperature and pressure is used to know gas hydrate stability in research zone. The BSR sub-bottom depth in general correlates positively with the seafloor depth. Assuming that the BSR marks the bottom of the gas hydrate stability zone, we can calculate the gas hydrate stability curves as a function of the BSR sub-bottom depth versus water depth for hydrostatic or lithostatic pressure conditions. For a given water depth y, the pressure at the BSR sub-bottom depth x is given by

$$P = \rho_w g\, y + \rho\, g\, x \qquad (1)$$

ρ_w is the density of water and ρ the density sediments (for lithostatic conditions) above the BSR. The temperature at the BSR is

$$\Delta T = \frac{Q}{c} \qquad (2)$$

and,

$$T = T_0 + \Delta T \qquad (3)$$

where, temperature at the seafloor T_0 = 279.69 °K, and conductivity c = 1.3 W m°K-1 within the sediments above the BSR, for heat flow values Q= 77.5 mW m^{-2}.

Seismic Investigation

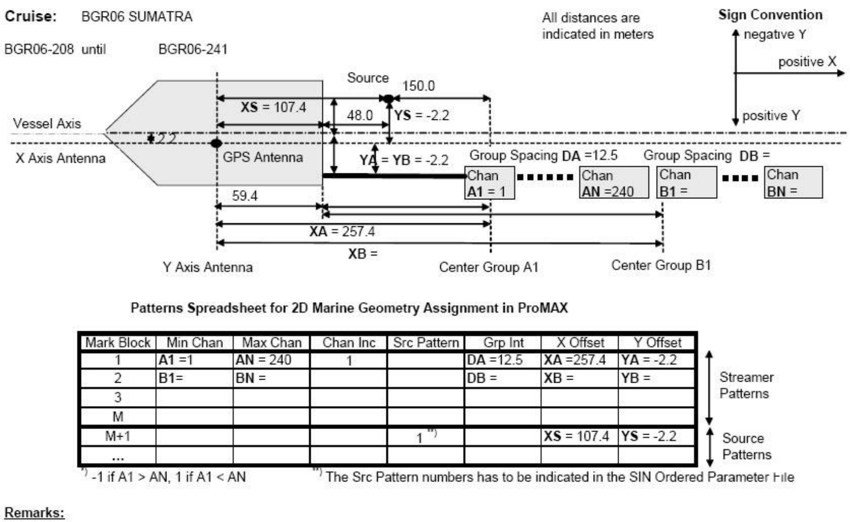


Figure 4. Geometry, airgun, and streamer position [7].

Seismic reconnaissance surveys for gas hydrate investigation have been carried out since 2006 using a high-resolution multichannel seismic (MCS) reflection which 240 channel solid streamer with 12.5 m channel interval was used to receive seismic signals. Seismic surveys were designed to collect parallel lines that run across the structural trend with line spacing of about 3.175 km . All the MCS data used in this study were processed at The Agency for The Assessment and Application Of Technology (BPPT), Jakarta, Indonesia using the ProMAX seismic data processing systems. The typical seismic data processing sequence used comprises geometry set up, trace editing, water column mute, True Amplitude Recovery, velocity analysis, and then imaging until get depth section.

Results and Discussion

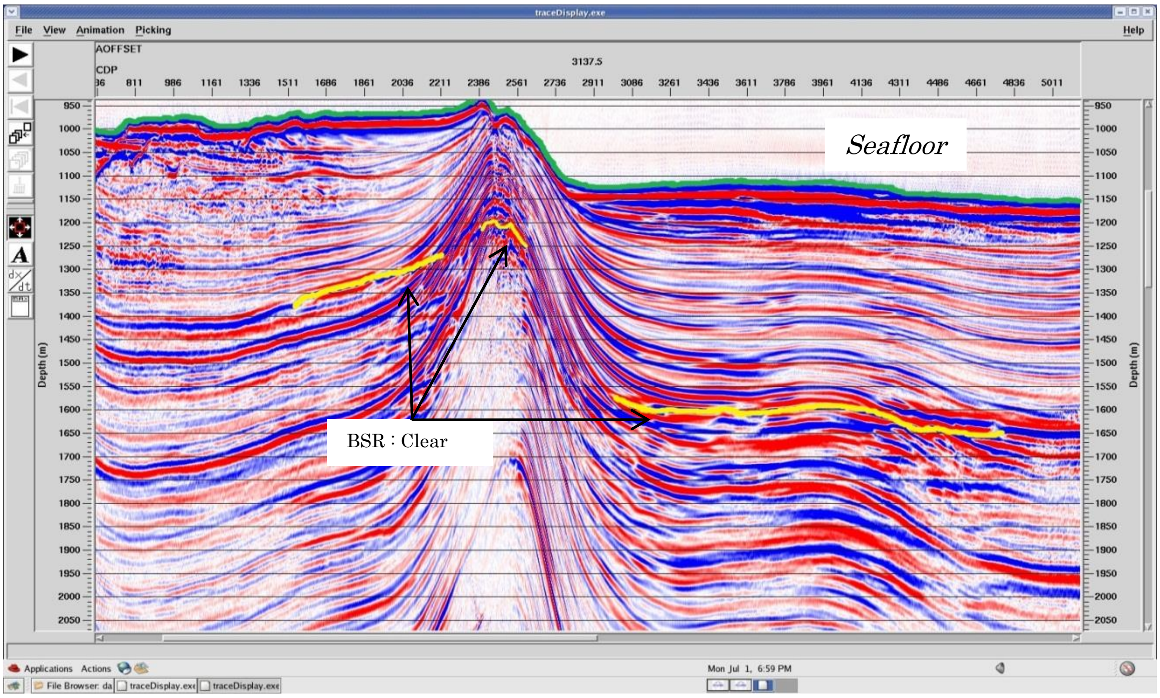


Figure 5. BSRs in depth seismic profile.

Result processing data seismic at **fig. 5** show depth of BSR. Generally, hydrate is formed where some processes (such as tectonic uplift, a change in bottom-water temperature or ongoing rapid sedimentation) have disturbed the thermal structure and caused the phase boundary to move upward relative to the sediments. . Because of its occurrence in shallow marine sediments at temperatures less than 293°K, the natural gas in marine gas hydrates is most likely derived from biological processes rather than thermochemical processes. Hydrates might, be present at places where no BSR (prime indicator of gas-hydrates) is observed on 'seismic section. High-resolution seismic reflection data is well suited for mapping BSR. With the reconnaissance surveys conducted using a high-resolution MCS system. With detailed mapping of BSRs and their sub-bottom depths, we have estimated the temperature and pressure values in the investigation area. The calculation of temperature use heatflow data (**table 1**). Result of the regional temperature and pressure value estimated from water depth until BSR sub-bottom depth is 279.38 – 280.079 ˚K and 20.796 – 26.6368 MPa. BSR appears to be a zero-phase reflection in shot gathers and CDP gathers, and its polarity is reversed compared to the seabed reflection. Better images of the sub-bottom shallow structure and the BSR were obtained by seismic image processing. BSR is recognized clearly in migrated depth sections. These results prove that the proposed the calculation of temperature and pressure can be used successfully for the prediction of the presence gas hydrate in Simelue fore arc basin.

Table 1. *Heatflow* Survey [7].

Station	Lattitude	Longitude	Thermal Conductivity λW ($m^{-1}K^{-1}$)	Stand. Deviasi	Heat flow (mWm^{-2})
07 HF	-4.689	101.958	0.86	± 0.067	34.7
08 HF	-4.161	101.64	0.85	± 0.089	29.8
13 HF	-3.729	101.229	1.09	± 0.13	64.9
23 HFhg	-3.411	100.983	0.76	± 0.026	69.2
37 HF	-0.875	99.795	0.99	± 0.072	78.3
43 HF	0.341	98.127	1.03	± 0.132	55.1
49 HFhg	0.953	98.133	1.31	± 0.125	112.9
57 HFhg	1.442	98.049	1.18	± 0.0	93.7
67 HFhg	1.68	97.716	1.25	± 0.119	71.3
71 HFhg	2.561	96.757	1.36	± 0.118	107.4
74 HFhg	2.83	96.385	1.09	± 0.146	77.4
81 HFhg	2.951	96.5	1.3	± 0.136	77.5
107 HFhg	3.195	96.7778	1.53	± 0.258	47.4
117 HF	3.192	95.331	1.03	± 0.258	60.6
123 HFhg	3.275	96.154	1.38	± 0.131	78.7
141 HFhg	1.763	96.774	1.14	± 135	93

Table 2. Calculation of temperature and pressure at BSRs

CDP	Depth (m)		Sediment thickness	Heat flow	C	Gradient	Temperature	Temperature	Temperatur	Pressure
	Seafloor Depth	BSR Depth	Seafloor ke BSR(Km)	mWm^2	(W/m˚K)	Termal(˚K/m)	Seafloor (˚K)	BSR (˚K)	BSR(˚C)	BSR
1511	970	1380	0.41	77.5	1.3	0.05962	279.69	279.835	6.84	22.6776
1686	970	1340	0.37			0.05962	279.69	279.851	6.85	22.3248
1861	970	1320	0.35			0.05962	279.69	279.860	6.86	22.1484
2036	970	1310	0.34			0.05962	279.69	279.865	6.87	22.0602
2211	960	1270	0.31			0.05962	279.85	280.042	7.04	21.6094
2386	940	1200	0.26			0.05962	279.85	280.079	7.08	20.796
2561	1010	1250	0.24			0.05962	279.48	279.728	6.73	21.923
2911	1130	1570	0.44			0.05962	279.48	279.615	6.62	25.9214
3086	1130	1590	0.46			0.05962	279.48	279.610	6.61	26.0978
3261	1130	1610	0.48			0.05962	279.48	279.604	6.60	26.2742
3300	1130	1610	0.48			0.05962	279.48	279.604	6.60	26.2742
3611	1130	1610	0.48			0.05962	279.48	279.604	6.60	26.2742
3786	1120	1600	0.48			0.05962	279.48	279.604	6.60	26.088
3961	1120	1600	0.48			0.05962	279.48	279.604	6.60	26.088
4136	1120	1590	0.47			0.05962	279.48	279.607	6.61	25.9998
4486	1140	1640	0.5			0.05962	279.27	279.389	6.39	26.6368
4661	1140	1640	0.5			0.05962	279.27	279.389	6.39	26.6368

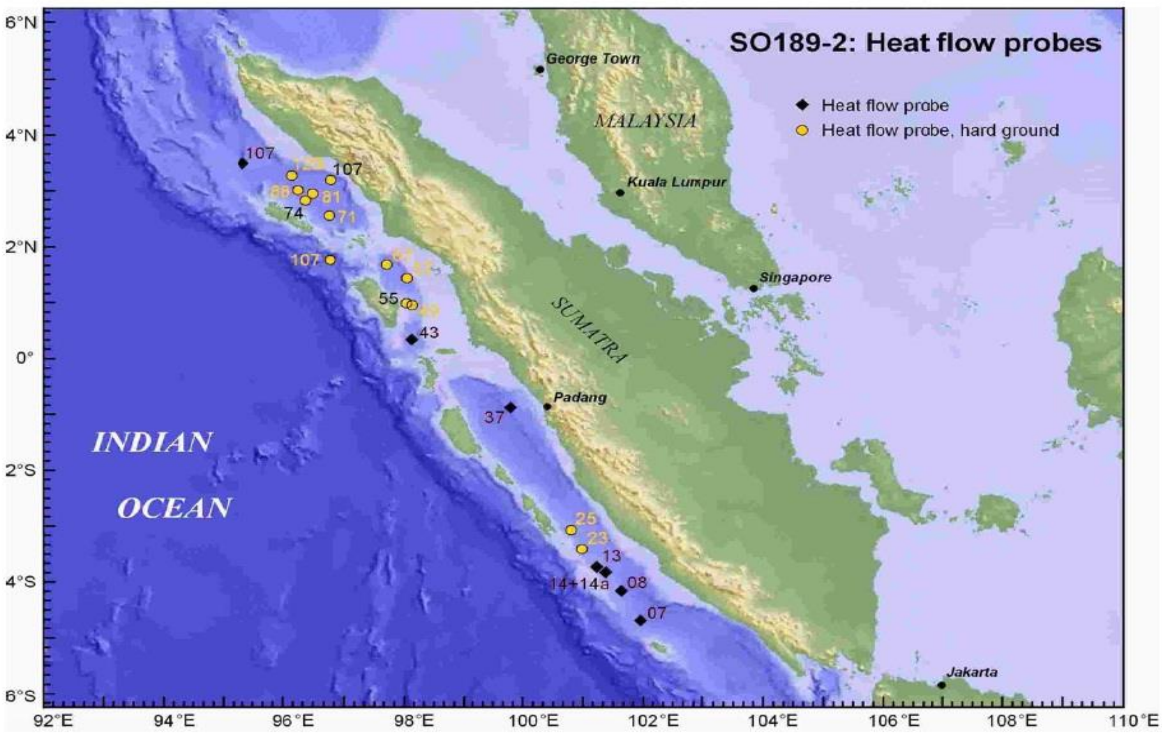


Figure 6. location of survey *Heatflow* [7].

Conclusion

In this work, seismic multichannel have been developed for the first prediction of gas hydrate. Seismic data showing “enhanced reflections”, anomalous strong reflection events, and that may result from reflections from strong acoustic impedance contrasts generated at gas pockets. Result of calculation temperature and pressure is 279.38 – 280.079 ˚K and 20.796 – 26.6368 MPa. This condition matching with gas hydrate stability zona.

Acknowledgment

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ETHNOBOTANICAL STUDY OF MEDICINAL PLANTS FOR LEMBAK DELAPAN ETHNIC IN TANJUNG TERANDA, BENGKULU

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Abstract

The puposes of this research was to document the medicinal plants and their use for traditional medicine of Etnic Lembak Delapan in Tanjung Teranda, Bengkulu, Indonesia. The research has been conducted from September 2011 to January 2012, using observation and purposive interview methods. Herbarium specimens have been collected and determined. The study documented that 106 plant species from 48 familes were used as medicines. There are 67 diseases were tradisionally cured using medicinal plants. Among those medicinal plants, kunyit (*Curcuma domestica*) is one of those medical plants cured the most. Kunyit is capable of curing 6 common diseases found in Tanjung Terdana, namely stomachace, short-winded, vomit, defecate trouble, ulcerous, stomachace on baby. The study also found that fever and malaria are diseases can be curred by some medicinal plants. Among the plant parts leaf is the plant part used the most for curing.

Keywords: *Ethnobotanical, Tradisional medicine, Medicinal Plant, Lembak Delapan Ethnic Bengkulu*

Introduction

Diverse Ethnic (tribe) are in Indonesia, which is spread from Sabang to Merouke, there were 550 species [1]. Tribe - the tribe is scattered in diverse ecosystems and have local knowledge of the resource utilization of existing plant around it. One of the utilization of these resources is the use of plants as medicine. Utilization of plants as medicine has actually been carried out, visible from their everyday life, which is when one member of the family/community hospital, the majority of the plant was used to treat it. But most use of plants has not been recorded/documented properly or even not recorded at all, so the use of plants as medicine is not growing as it should.

End - the end of the development of the concept of "back to Nature " / Nature -based medicine , or the development of treatment "ala herbl" where the Medical also been many who looked at this treatment, we must make programmatic document with knowledge of local treatment which has been derived this generation and allegedly has tremendous benefits as well. From the first Indonesian famous plants wealth, which accounted for 70 % (30,000 species) of the plant world (40,000 species). 1260 species of plants used as medicine (90 % of total Asian medicinal plants). Indonesian people know and use medicinal plants as part of efforts to control the disease long before the formal health services with synthetic drugs [2].

Diverse tribes (ethnic), culture, plants, and ecosystems that exist in Indonesia, is the capital that needs to be developed to improve the health, income of Indonesian society. It is necessary to continue to develop a study scope Ethnobotany which include local residents gain knowledge (Indigenous knowledge) of its natural resources, to later become one of modern knowledge is medicinal plant resources. As it was revealed by Zuhud [3] in his "Revitalization Ethnobotany Knowledge for Development of Small Society (Ethnic) Towards Independent Nation And Dignity In The Global Era" who wrote ethnobotany with various aspects of the policy include ethnobotany and health policy.

If we try to look into the province of Bengkulu, in fact many tribes who inhabit this province either tribal, or ethnic immigrants and have local knowledge and also the knowledge of the medicinal plants. Indigenous tribes are Bengkulu Kaur, Pekal, Pasemah, Rejang, Serawai, Enggano, Lembak, Muko - Muko [4], various medicinal plants research has been conducted on these tribes, eg assessing medicinal plants that are utilized to support fertility by the city of Bengkulu [5], there are 99 species found. of inter- ethnic research turned out to have a diverse knowledge of the plants he uses , and how to use it. of research in the ancient tribal KagaNga Serawai [6], found 63 species of medicinal plants. Further research carried out by the text in the Manna South Bengkulu, it turns out that the results obtained there are people who are not familiar with these plants at all, but there are also new knowledge is obtained, in which they wear in addition to the existing plants in the draft. So in conclusion need more extensive excavation, documentation well in a different ecosystem and different tribes. This is also supported by expert advice Plant Medicine Univ. Andalas Paandg Prof Manjang, every seminar that followed (last 2010 in the Department of Pharmacy Unand Paandg stated that the excavation of the medicinal plant knowledge of the Sumatran not finished, need more extensive research. At the Rejang in Taba Penanjung Mountain Region has conducted a survey in 2007, there were more of 100 plant species used by the community, the benefits and the medicine plant diversity there are differences and similarities with the location and other tribes.

Lembak eight tribes, spread in the city of Bengkulu and Bengkulu Central, but the most dominant is the area of Pondok Tanjung Kubang Teranda District, 90 % of the people are indigenous Lembak, another tribe of immigrants / migrants). This area is located region Rajolelo Forest Park, the majority of the population are farmers. Regional or tribal community is untouched by ethnobotany study. The majority of people use herbs as medicine to cure the disease. They still believe in the shaman as an expert in healing disease. Although it has been utilizing medicinal plants of the ancients but the documentation and research on plants and treatable disease that this region is not yet there. This study aims to determine the types of plants used traditionally to cure diseases, part used as medicine.

Materials and Methods /Experimental

The content of this paper based on the exploration held in September 2011 to January 2012 in Lembak Delapan Ethnic, Tanjung Teranda Village Pondok Kubang District, Bengkulu. Ethnobotanical information gained from interview with four (4) key-informants in Tanjung Teranda village. Herbarium specimens has collected and determined

Results and discussion

The results were obtained 106 species and 48 families of medicinal plants used in the treatment of various diseases by tribal Lembak Eight, which is dominated by family Zingiberaceae (9 species), Asteraceae (8 types), Lamiaceae (6 types), Cucurbitaceae, Euphorbiaceae , Fabaceae , Malvaceae , Myrtaceae , Poaceae , Rubiaceae , and Solanaceae (4 types). Diseases - diseases treated there are 68 diseases (**Table 1**).

Disease - a disease treatable by the tribe is Lembak eight tonsils, ashma, gout, muscle pains, urinary stones, darak low/high, fever, dengue fever, ambaien, delicate creatures disorders, black spots on the face, can bite (scorpion, centipedes and wasps, snakes) , boils, pox, acne, cancer, cataracts, skin fungus, ringworm ringworm, itchy rash, sores nock, bruises, burns, anddruff, warts, wounds (burns, ulcers, bruises, notch, malaria, nosebleeds, postpartum, tinea versicolor, ringworm, scabies, hair growth, and others. Disease is classified as an external disease and internal medicine. Treatment is carried out with boiled and drunk, smeared, bathed, in a poultice, made sequins, dripped, and jam it. Society still believes that illness is caused by spirits disorders in young children.

Used plant habitus habitus dominated by herbceous, respectively - also is herbs (54 species) , tree (24 species) , shrubs (22 JEMIS), and shrubs (9 species). Plant parts used are the leaves (54.13 %) , fruit (17 %) , rhizome (9.17 %) , all parts (8.26 %) , roots (64.2 %) , trunk (5 , 5 %) , bark (4.58 %) , beans (2.75 %) , flowers (2.75 %) , umbut rods (1.83 %) , and sap (1,83) . Report - the report that other studies have also found a lot of the leaves is used in the treatment , because it leaves the most part easy to find , easy to take , not much damage plant growth if taken , and also the leaves contain compounds that secondary metabolite contains a toxic compound that is widely used in medicine .

Plants that utilized existing plants that are cultivated and wild plants there. Zyngiberacea is one of the cultivated plants. In the previous studies, in the region and other tribes , Zingiberaceae , has a fairly high level of usage , as well as the Eight Lembak tribe . Family Zingiberaceae plant species have a wider utilization levels , as well as medicinal plants , these plants also serve as a spice , seasoning , and views of the cultivation of this group is very easily cultivated , produces fast and does not require treatment difficult [7]. In addition to the diseases that can be treated with plant species of this family is a mild disease that often affects the public interest Lembak Eight in the village of Tanjung Teranda this example colds , cough , muscle pains , body weakness and fatigue , rheumatism , sores , pain stomach , cure postpartum , and skin diseases , as well as used also for appetite enhancer drug in children .

This Zingiberaceae generally contain volatile oil, starch , tannin , and resin . The content of these essential oils can stabilize the nervous system, causing feelings of pleasure and calm , increased appetite , and cure disease . The health benefits because the content of the compound in the essential oil is used to improve blood circulation , as a sedative (sedative) , antiseptic , antipyretic (fever) , karmintif (laxative fart) , stimulating appetite, improve digestion , and so forth [8], so it can be used to treat a variety of health problems ranging complaints or mild to severe , such as colds, the body weak and tired after work , rheumatism , and shortness of breath . In addition, secondary metabolites produced plants of the family Zingiberaceae generally can inhibit the growth of pathogenic microorganisms that harm human life.

One of the common diseases that attack the Bengkulu people is infected with malaria. Malaria, which is endemic diseases Bengkulu. The survey results turned out to have 10 people Lembak eight herbl medicines for combating it are: plant Sungkai, Sambiloto, Papaya, Mahogany, Weeds, horse whip, Brotowali, Fruit Makasar, sugar apple and Kepayang. 10 plant species are used as medicine malaria because villagers have been tried and believed for generations that this plant as a medicine is malaria , and these plants are found in this area . Sungkai plant is a plant that is widely available in the Forest of Bengkulu, which grows wild.

In addition to malaria, a disease that often strikes people is fever. The types of plants that have been used by the public interest to treat fever Lembak Eight bandotan ie, cotton, gourd, leaf scoop, cocor duck, red hibiscus, aloe vera, brotowali, horse whip, reeds, and ciplukan . Bandotan contain important compounds such as amino acids, alkaloids, essential oils. Bandotan also contains organacid, pectic substance, essential oils coumarin, ageratochomene, friedelin, sitosterol, stigmasterol, tannins, sulfur and potassium chloride, so efficacious to treat fever, malaria, sore throat, sores, and other health problems. Also based on the literature review has been conducted, cotton, gourd, leaf scoop, hibiscus, aloe vera, brotowali, horse whip, reeds, and ciplukan also contains alkaloid compounds and essential oils are efficacious as an antipyretic, so that everything can function as fever reliever.

Information of medicinal plants, there are 8 species of plants typical use rate / area are: Beans Gude (*Cajanus cajan*), this plant is used as medicine for women can be a difficult descent, mempelam (*Mangefera laurina*) used as a smallpox drug, Grass balungan (*Panicum repens*) acne medication, root Tarum (asthma), luwingan (fever), locust wood (arthritis drug), Vernonia (asthma and abdominal pain), ki lemongrass (upset stomach).

Table 1. Types of Plants Used as Medicine by Lembak Eight Tribal Tanjung Teranda Village Pondok Kubang District of Central Bengkulu

No	Plant names	Part used	Disease	Habitus
1.	**Acanthaceae**			
	1. *Andrographis paniculata* /Sambiloto	Leaf	Malaria	Herb
	2. *Graptophyllum pictum* /Puding itam	Leaf	Launched / late come menstruation	Shrubs
2.	**Achariaceae**			
	3. *Pangium edule* / Kayu kepayang	Bark	Malaria	Tree
3.	Acoraceae			
	4. *Acorus calamus* / Jeghangau	rhizome	Anti conceded	Herb
4.	Amaranthaceae			
	5. *Celosia cristata* / Jawer kotok	Leaf	Cancer	Herb
5.	Anacardiaceae			
	6. *Mangifera laurina* / Memplam	Leaf	Smallpox	Tree

6.	Annonaceae			
	7. *Annona squamosa* / Sghahkayo	Leaf	Malaria	Shrubs
	8. *Annona muricata* / Sirsak	Leaf	Cancer, wound infections, diarrhea	Shrubs
7.	Apiaceae			
	9. *Centella asiatica* / Antanan	All	Typhus, Maag	Herb
8.	**Apocynaceae**			
	10. *Catharanthus roseus/* Pecah pighing	Leaf	(Diabetes)	Bush
	11. *Alstonia schlolaris* / Kayu pulai	Bark	Ulcer	Tree
9.	**ecaceae**			
	12. *Arenga pinnata* / Aren	Root	rheumatism,Uric acid, stiff	Tree
	13. *Cocos nucifera* / Kelapo	Root, fruit	Urinary stones, Urinating blood, rheumatism, Uric acid, Stiff, rheumatism.	Tree
	14. *Areca catechu /*Pinang	Root, fruit	worms, Heartache foul (liver), rheumatism, Uric acid, stiff	Tree
10.	**clepiadaceae**			
	15. *Marsdenia tinctoria /* Taghum root	Leaf	Asthma	Herb
11.	**teraceae**			
	16. *Ageratum conyzoides* /Radada	Root and Leaf	Ulcers, fever	Herb
	17. *Pluchea indica* / Bluntas	Leaf	Smooth milk , prevent body odor	Bush
	18. *Blumea balsamifera/* Capo	Leaf	cold	Herb
	19. *Gynura procumbens* / Daun dewa	Leaf, rhizome	tonsils, wound	Herb
	20. *Chromolaena odorata* / Rumput Malaysia	Leaf	Hack wounds , ulcers (wounds that had become raw)	Bush
	21. *Gynura crepidioides/* Sentrong	Leaf	High blood pressure (Hypertension)	Herb
	22. *Artemisia vulgaris* / Kenikir	All	Limp body after childbirth , Senggugut	Herb
	23. *Vernonia arborea* / Ketepung besi	Leaf and flower	Shortness of breath, abdominal pain	Shrubs
12.	**lsaminaceae**			
	24. *Impatient balsamina /* Inai aek	Leaf	Hot bodies in children (fever night)	Herb
13.	**sellaceae**			
	25. *Anredera cordifolia /* Binahong	Leaf	High blood pressure (Hypertension)	Herb
14.	**mbacaceae**			
	26. *Durio zibethinus /* Duren	Leaf	Heat in	Tree
	27. *Ceiba petandra /* Kapok	Leaf	fever	Tree
15.	mpanulaceae			
	28. *Isotoma longiflora* / Rumput katarak	Latex	Cataract	Herb
16.	**nnaceae**			
	29. *Canna edulis* Ker. Ganyong	Rhizome	Urinary tract inflammation Heat in	Herb
17.	ricaceae			
	30. *Carica papaya /* Geandg/ Kates	Leaf, fruit	Smooth milk, Malaria	Tree
18.	ısiaceae			
	31. *Garcinia mangostama* / Manggis	Leaf	Diarrhea	Tree
19.	**nvolvulaceae**			
	32. *Ipomea batatas* / Ubi jalar	Leaf	Burn	Herb
20.	**assulaceae**			
	33. *Kalanchoe integre /* Sedingin	Leaf	Burn	Herb
	34. *Kalanchoe pinnata /* Sergayu	Leaf	Fever	Herb
21.	**curbitaceae**			
	35. *Benincasa hispida /* Kundo	Leaf	Fever	Herb
	36. *Cucurbita moschata /* Peghenggi	Leaf	Diarrhea / vomiting	Herb
	37. *Momordica charantia /* Peghio	Fruit	Typhus	Herb
	38. *Cucumis sativus* / Timun	Fruit	Cough	Herb

22.	**phorbiaceae**			
	39. *Jatropha curcas* / Jaghak	Petiole latex	earache	Shrubs
	40. Jatropha podagrica / Jaghak bungo/ jaghak hias	Leaf	Can bite scorpions, centipedes, wasps, snakes, etc.	Shrubs
	41. *Sauropus androgynus* /Katu	Leaf and young stems	Postpartum drug (increase stamina and make her milk)	Shrubs
	42. *Euphorbia tirucalli /*Patah tulang	Latex	Toothache, warts	Shrubs
23.	**baceae**			
	43. *Cajanus cajan* / Kacang kayu	Leaf	Difficult to have children	Shrubs
	44. *Cassia alata / K*etepeng	Leaf	Tinea versicolor, ringworm, and other skin diseases	Shrubs
	45. *Parkia speciosa /* Petai	Rind and bark	Smooth milk, postpartum Drugs	Tree
	46. *Leucaena leucocephala/* Petai cino	Fruit	Wormy	Tree
24.	**liconiaceae**			
	47. *Heliconia colinsiana /* Pisang licin	Umbut rod	Heat in	Herb
25.	**miaceae**			
	48. *Coleus amboinicus /* Jitan	Leaf	Abdominal pain / Flatulence	Herb
	49. *Orthosiphon stamineus/* Kumis kucing	All	Inflammation of the kidneys, kidney stones. Gonorrhea / urinating blood, Diabetes	Herb
	50. *Pogostemon cablin* / Manila kayu	Leaf	Tinea versicolor, ringworm, rashes and other skin diseases.	Herb
	51. *Ocimum tenuiflorum /* Ruku-ruku hitam	Leaf	Senggugut (painful menstruation)	Herb
	52. Ocimum basilicum / Selasih	Seed	Thrush	Herb
	53. *Coleus atropurpureus /* Siati-ati meghah	Leaf	Hemorrhoid	Herb
26.	**uraceae**			
	54. *Cinnamomum porrectum* /Kayu gadis	Leaf	Stomach ache	Tree
	55. Persea americana / Jambu pokat	Seed	Ulcer	Tree
27.	iaceae			
	56. *Crinum asiaticum* / Bakung	Leaf	Lumbago	Herb
	57. *Aloe vera* / Lidah buayo	Leaf	Fever, hair Fertilising	Herb
	58. *Cordyline fruticosa /* Salanyuang meghah	Leaf	Scabies, Smallpox	Shrubs
28.	**ranthaceae**			
	59. *Dendrophthoe pentandra/* Kayu singgah di rod kopi	All	Cancer	Herb
29.	**alvaceae**			
	60. Hibiscus rosa-sinensis L. var 1 Bungo rayo merah *Hibiscus rosa-sinensis* L var 2 / Bungo rayo putih	Leaf Leaf	Fever, Dysentery cholesterol	Shrubs Shrubs
	61. *Hibiscus sabdariffa* / Rosella	Flower	High blood pressure (Hypertension)	Bush
	62. Sida rhombifolia / Sidaguni	All	Rheumatism, Gout.	Bush
30.	**lastomataceae**			
	63. Melastoma malabathricum Dedughuk (*)	Leaf	Lack of appetite in children.	Bush
31.	liaceae			
	64. *Dysoxylum arborescens /* Kayu belalang	Leaf	rheumatism	Tree
	65. *Swietenia mahagoni* / Mahoni	Seed	Malaria	Tree
32.	**nispermaceae**			
	66. *Tinospora tuberculata/* Brotowali	Rod	Fever, Malaria, rashes	Shrubs
33.	**mosaceae**			
	67. *Mimosa pudica /* Sekejut	All	Tonsils, Heat in	Bush
34.	**raceae**			
	68. *Ficus benjamina /* Beghingin	Root	Tonsil	Tree
	69. Ficus hispida / Nuing	Umbut rod	Headache, Heartburn	Tree

35.	**ısaceae**			
	70. *Musa acuminata* /Pisang kepok	flower	Ulcer	Herb
	71. *Musa rhumpiana* / Pisang mas	Leaf	Ulcer, appetite enhancer	Herb
	72. *Musa paradisiacal* / Pisang tembatu	Flower	smooth milk	Herb
36.	**ɪrtaceae**			
	73. *Psidium guajava* L. var 1 Jambu biji hijau (*) *Psidium guajava* L. var 2 Jambu biji meghah (*)	Leaf, bark, and fruit Fruit	diarrhea scarlet fever	Tree Tree
	74. *Syzygium polyanthum* / Salam	Leaf	High blood pressure (Hypertension)	Shrubs
37.	**ctaginaceae**			
	75. *Mirabilis jalapa* / Kembang petang putih	Leaf	stomach ache	Herb
38.	**alidaceae**			
	76. *Averrhoa bilimbi* / Belimbing tunjuk	Fruit and Leaf	mumps	Tree
39.	**ɔeraceae**			
	77. *Piper betle* / Ilim	Leaf	Bleeding, vaginal discharge, rashes, eye Cleansing	Herb
	78. *Peperomia pellucida* / Rumput bisul	All	Ulcer	Herb
40.	ntaginaceae			
	79. *Plantago mayor* / Sapno	Leaf	Fever	Herb
41.	**aceae**			
	80. *Bambusa vulgaris* / Bambu kuning	Water in a small branch	Cough	Tree
	81. *Imperata cylindrica* / Lalang	Root	Ulcer, Fever, Malaria, Stiff	Herb
	82. *Panicum repens/*rumput dat	Fruit	Acne	Herb
	83. *Sacharum officinarum* / Tebu hitam	Rod	Stiff, tired Agency (restoring force)	Herb
42.	**biaceae**			
	84. *Musaenda frondosa* / Bungo nusa indah	Leaf and bark	breast cancer	Shrubs
	85. *Morinda citrifolia* / Mengkudu	Fruit and Leaf	High blood pressure, Dandruff, Nausea cold	Shrubs
	86. *Hedyotis corymbosa* /Rumput siku-siku	All	contusion	Herb
	87. *Ixora paludosa* / Siantan	Flower	Senggugut	Shrubs
43.	**taceae**			
	88. *Citrus aurantifolia* / Jeruk nipis	Fruit	Colds / Snivel	Shrubs
44.	**naroubaceae**			
	89. *Brucea Javanica* .\/ Empedu beruang	Fruit	Malaria	Tree
	90. *Eurycoma longifolia* / Pasak bumi	Rod	Rheumatism, sore pains, Baand weakness, lethargy and lack of energy	Shrubs
45.	**lanaceae**			
	91. *Solanum nigrum* / Lumai	Leaf and fruit	Enhancer of appetite, low blood	Bush
	92. *Solanum torvum* / Rimbang/ takokak	Fruit	high blood	Shrubs
	93. *Physalis peruviana* / Seletup root	Leaf	Hot bodies in infants (fever night)	Herb
	94. *Physalis angulata* / Seletup rod	All	Fever, cough	Herb
46.	ymelaeaceae			
	95. *Phaleria macrocarpa* /Mahkota dewa	Fruit	High blood pressure, cancer	Shrubs
47.	**rbenaceae**			
	96. Stachytarpheta jamaicensis / Jarong	Leaf	Fever, Malaria, Headache.	Herb
	97. *Peronema canescens* / Sukai	Leaf	Malaria	Tree
48.	**Zingiberaceae**			
	98. *Zingiber cassumunar /* Bangle	Rhizome	Anti conceded	Herb

	99. *Zingiber officinale/* Jahe *Zingiber officinale* Var Rubrum Jahe merah	Rhizome Rhizome	catch a cold weakness, lethargy, fatigue, rheumatism	Herb Herb
	100. *Kaempferia galanga* / Kencur	Rhizome	Bruises from falls, Cough	Herb
	101. *Curcuma domestica* / Kunyit	Rhizome	Shortness of breath, stomach pain, vomiting, vomiting, difficult defecation, ulcers, abdominal pain in infants	Herb
	102. *Alpinia galanga* Linn.,/ Lengkuas	Leaf	Acute shortness of breath, Panu, ringworm, scabies, drug postpartum (so as not to smell), Rheumatism	Herb
	103. *Boesenbergia pandurata* /Te kunci	Rhizome	Postpartum cleanser	Herb
	104. *Curcuma zedoaria* / Temu putih	Rhizome	Acne and black spots, Cough	Herb
	105. *Curcuma xanthorriza* / Temulawak	Leaf	Back pain, shortness of breath	Herb
49.	106. *Sp. 1 /* Sipit (*)	Root	Drugs that fat	Bush

Conclusion

There are 106 species of medicinal plants, which consist of trees, shrubs, bushes, and herbs are utilized by the tribe in the village of Tanjung Lembak Eight Teranda, to treat 68 kinds of diseases. Plant parts used are the leaves, fruits, roots, all parts, roots, stems, bark, seeds, flowers, stems umbut, and sap, there are 8 new plant species known to use.

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THE IMPORTANCE ROLE OF ANIMAL ECOLOGY DEEPLY TO CONSERVATION POPULATION OF PANGOLIN IN SECONDARY FOREST OF SUMATRA ISLAND

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Abstract

The Pangolins or scaly anteaters also known in Indonesian languae as Trenggiling and scientific name into genus of *Manis*. In Indonesia area, this animal can be into endangered species and protected into nations laws. In Indonesia, the pangolins as known as one species, namely *Manis javanicus* Desmarest, 1822. The distribution of pangolins in Indonesia include regions: Nias, Pagai islands, Sumatra, Riau islands, Lingga islands, Bangka, Belitung, Natuna islands, Karimata islands, Borneo, Java and Bali. Pangolins or known as scaly-ant-eater or anteaters are include into Ordo of Pholidota in the Class of Mammalian have some importance's characteristic as their unique covering of horny body scales, which overlap like shingles on a roof with raring hair among scales, no tooth, tongue slender and use to capture insects. A lot of factors to effect depletion of pangolin population naturally but very importance factors are behavior to feeding and how to make the foodstuff naturally enough for their living. This the problems why the pangolins very difficult to conservation in situ.

Keywords: *behavior, conservation, depletion, feeding, population*

Introduction

The Pangolins or scaly anteaters also known in Indonesian language as Trenggiling and scientific name into genus of *Manis*. The pangolins in Indonesia are rare animals and finding protection in law of Indonesian Government. . In Indonesia, the pangolins as known as one species, namely *Manis javanicus* Desmarest, 1822. As the rae animals, pangolins have protection according to (1) Rules of Wildlife Protection 1931; (2) The Government Rule No. 7 1999 give confirmation that *Manis javanica* Desmarest, 1822 distributed on regions: Nias, Pagai islands, Sumatera, Riau islands, Lingga islands, Bangka, Belitung, Natuna islands, Karimata islands, Borneo, Java and Bali [1].

The Pangolin or known as scaly-ant-eater or anteaters include to the little ordo whose name as Pholidota in the class of Mammalia and zoo geographically distributed to Africa and South-East Asia Continents [2]. Another researchers also confirm that the genus of Manis known as pangolins or scaly anteater distributed in Afrika and Asia Tenggara can describe as animal whose body entirely covered by scales. The body covered by large overlapping horny plates with sparse hair between; no teeth, tongue slender and use to capture insects.

The rare of pangolins because depletion of their population naturally by so much human hunters locally. In Indonesia there are in Sumatra, Java, Kalimantan (Borneo) Bali and some other islands in Indonesia Archipelago. Beside that the pangolins also found in Burma, Thailand, Indochina, Malaysia and Philipina. Pangolins distribution do not only in South-East Asia, but also in Africa. The habitats of pangolin or trenggiling (Indonesian) are mountain forests, shrubs, open forest, savana, and sometimes in agriculture fields.

The naturally population of pangolins as long as depletion probably because much of naturally population hunter by men for using it's meat. It's scaly use medicine and decoration and also believes in as charm.

Base to information of BKSDA, Badan Konservasi Sumberdaya Alam (Agency of Coordination Natural Resources) of South Sumatra Government at 2008 had confiscated and destroyed about eleven ton pangolins fresh meat when knowed will to export abroad through the river harbor of

Palembang. This condition point out that depletion and destroyed of pangolins survival by men do not responsible. The hunting of pangolin in South Sumatra actually in environment of pangolin habitat have been long time by men who not responsible. Responsible by government to prevent and protecting this pangolins as wildly can not doing optimally. Also to watch the welfare of pangolin habitats as rare animal and giving conservation cannot be done wisdomly.

The information about pangolin habitats for survival of pangolin and natural foodstuff supply still less and difficult to find. The tropical level of pangolins as insectivore can interpret that this animal eat much insects lake the ants and termites. The pangolins eat the specific ants and termites with amounts that very much. This condition of pangolins contributed by the long tongue and producing much mucous to invite many insects when are there around of habitat.

The main factors to determinate about presence and absence species naturally, namely (1) dispersal pertaining of the area do not arrive by some species; (2) behavior pertain to habitat selection; (3) other species (predation, parasitism, competition and disease); and (4) Physical and Chemical Factors consist of temperature, light, soil structure, fire, current and water, oxygen, salinity, pH, soil nutrients etc. Existence of pangolins in Sumatra Island recently had been dangerous because that populations continuously depletion every time moreover every day.

Materials and Methods / Experimental

The Materials that need for field and laboratory research are formalin and alcohol, samples of soil, insects, termites, pangolins. The tools may be used for this research are camera digital, telescope, binoculars, jacket, motor car, etc.

The method which used in this research are survey and investigation in the fields (secondary forests (Ogan Komering Ilir Region and Muara Enim Region) and in the laboratory. In the survey methods, something importance for knowing are niche, behavior of pangolins and then the type of niches or specific habitat for their nests and resources of foodstuff by pangolins. The another method in this research was questionnaire to village peoples who live near secondary forest or traditional rubber plantation. With questionnaire method, can be knowed what respond of peoples to existence of pangolins near their activity everyday when they go to work in their field.

Results and Discussion

The Sumatra Pangolins or Sunda Pangolin or Malayan Pangolins (*Manis javanicus* Desmarest, 1822.) are true nocturnal and arboreal animals which use their well-developed sense of smell to find insects. The Sumatra Pangolins less active by day. Other species of pangolins spend most of the daytime sleeping curled up into a ball. Arboreal pangolins live in hollow trees, whereas the ground dwelling species dig tunnels underground, to a dept of 2 up to 4 meters (6 up to 13 ft). pangolins are also good swimmers [3]. Sometime the Sumatra pangolin can be found in the hole of big stems in the secondary forest and traditional rubber plantation.

The secondary forest consist of trees, shrubs and grasslands cause much species of flora tobe resources of nutrition by much kinds of ants and termites which mightbe become foodstuff by pangolins. They go down from their nests to look for foods at nearly afternoon everyday. Some Genera of big trees which frequently become the place of nests by pangolins of Sumatra are *Ficus*, *Vitex*, *Dillenia*, *Campnosperma*, *Artocarpus* and *Fagraea*. In the traditional rubber plantation some genera of plants which tobe nests by Sumatra pangolins are *Vitex*, *Pithecellobium*, *Hevea*, *Dillenia*, *Melastoma*, *Camnosperma*, *Eugenia*, *Peronema*, *Mallotus*, *Melaleuca* and *Tristania*. In the big trees at the secondary forests or in the traditional rubber plantation the pangolins frequently found in the ground holes of big trees or in the high density vegetations or the groups of vegetation. Some time the pangolins can be found swim across the river at afternoon from their nest over jungle trees to look for foods like ants and termites around of their niche.

According to Harrison (1962) in Whitten *at al.* [4], report that every individual of Malayan pangolin can spent about 200,000 ant workers and pupae a night with a stomach capacity about of 2 liter. The conditions of environment currently for Sumatra pangolins probably difficult to find the foodstuff enough everyday because the habitat niche for ants and termites continuously destroyed by farmers. Land clearing of much secondary forest everyday in Sumatra Island include South Sumatra because million ants ant termites be die. The conversion of forest lands to fields and plantations since long ago even now had effected the lost of nest and habitat niche for Sumatra pangolins. The hunting of peoples who live near the secondary forest also effected as soon as possible depletion of Sumatra pangolins. Several peoples of village always catch pangolins for their foods. But others village peoples catch pangolins to sell off another man because they afraid to general police or to police of Agency of Coordination Natural Resources because their attitude or their doing illegal to sell pangolins. According to the rule of Indonesian Government 1977 No. 7 that the pangolins had found protection because include to Endangered or Restricted Animals. Something to be opinion that very anxious up to now do not yet to map out pangolins diversity actually in Sumatra Island. The map of pangolins will help to conserve pangolins because able to explain in detail distribution and their niche.

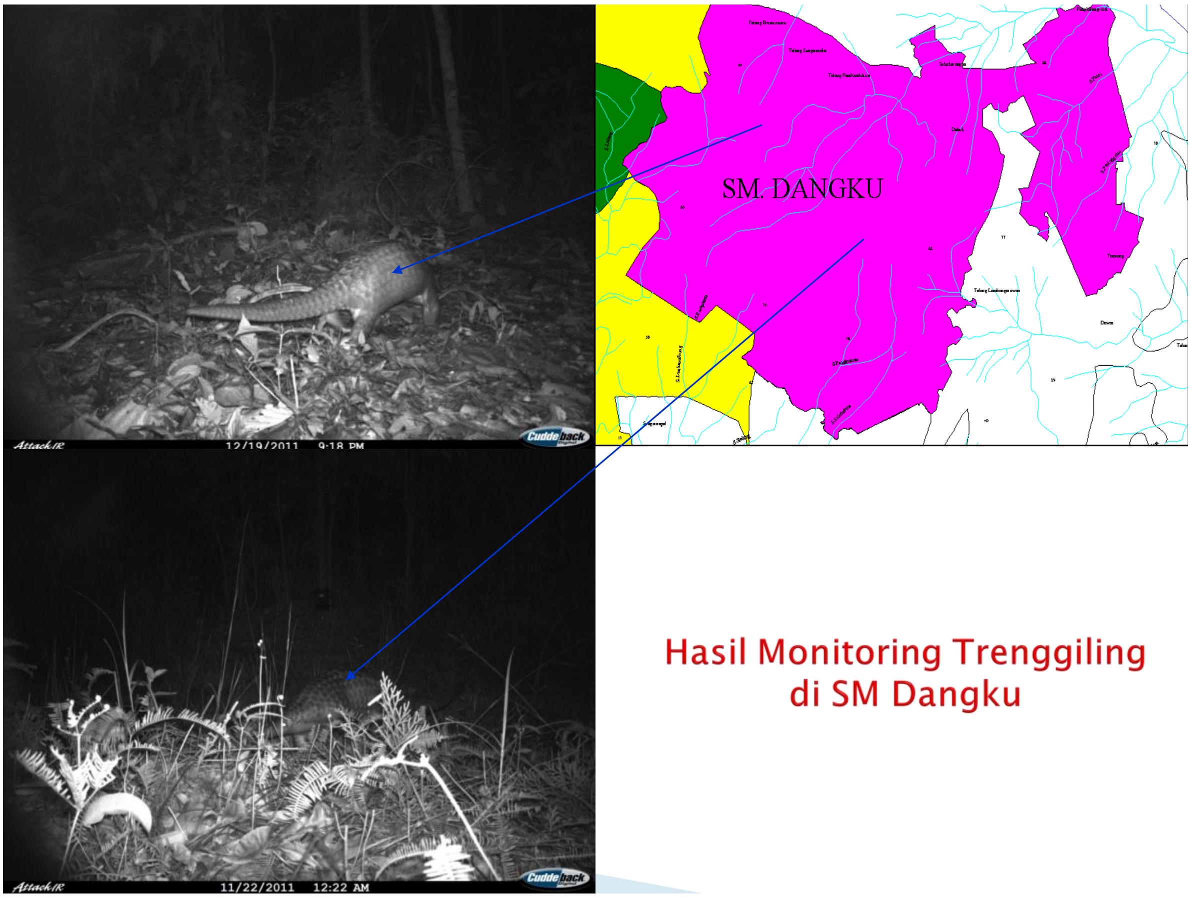

Figure 1. Monitoring result of pangolins in South Sumatra in the area of Wildlife Protection in the secondary forest. From: BKSDA, South Sumatra, 2013.

Figure 2. *Manis javanica* Desmarest, 1822. Colecction from Palembang, 1988.

Several efforts to conserve the Sumatra pangolins:

1. Study of plants community or which was contributed a lot of nutrition or foodstuff to kinds of ants and termites. Existence of vegetations in ecosystem also give nutrition like detritus to

termites.

2. Study of animals ecology about termites and ants very importance be done for knowing the potentials of ecosystem in contributing foodstuff enough to survival of pangolins. How many species termites and ants which be come foodstuff by pangolins.
3. Study of animal ecology about pangolins : distribution, population, behavior, environmental carrying capacity to contribute survival of pangolins.
4. Study of social environment for contributing the program to conserve of pangolins. In this ways the village peoples shall be conscious so that do not hunt or hunting up the pangolins around when they live there.
5. Mapping the distributions and existence of pangolins in Sumatra Island and archipelago near Sumatra.
6. Making the culture of pangolins in artificial habitat which compatible to survive for pangolins.
7. To identify the pangolins of Sumatra Island at every regions or every sub habitat what are there the differences into subspecies of *Manis javanica* Desmarest, 1822.

Conclusion

The animals ecology completely or deeply need to conserve the pangolin populations in forest secondary of Sumatra Island. Some steps very importance in this study consist of study of plants, termites and ants ecology, pangolins ecology (distribution and abundance of populations), study of social environment. The other studies also so importance are mapping distribution and existence of pangolins in Sumatra Island and archipelago near Sumatra, making culture of pangolins in artificial habitat which compatible to survive for pangolins. Furthermore, need to describe and identifying the pangolins of Sumatra Island at every regions or every sub habitat what are there the differences into subspesies of *Manis javanica* Desmarest, 1822.

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INITIAL STUDY ON INVENTORY OF VEGETATION IN SUMATRAN ELEPHANT HABITAT IN PADANG SUGIHAN RESERVE, SOUTH SUMATRA PROVINCE

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Abstract

Padang Sugihan Reserve is one of sanctuary areas in South Sumatra Province becoming the natural habitat of Sumatran elephants. Nowadays, this areal reserve is going through destruction threat because of local society activities staying in surrounding sanctuary area. Illegal logging *Maleleuca cajuputi* and annual fire of vegetation in dry season have changed the vegetation structure in preserve area. Deforestation has affected on micro climate, decreased the supply of elephant food plants and reduced elephant home range. The vegetation destruction can minimize the elephant reproduction hatchability so that it can threat elephant conservation. This study aims to inventory the vegetation species involving species of elephant food plants in five community types growing in reserve area that is mixed swamp forest in along the edge of Padang river, community of secondary forest growing along several primary channels, *Malaleuca cajuputi* community, land grass community and swamp grass community along Sugihan river. The vegetation analysis had been conducted by using line transect method in square plots sizing 20 x 20 m (trees), 10 x 10 (stands), 5 x 5 m, 2 x 2 m (seeds), 1 x 1 (herbs and grasses). The results showed that there were 48 species of plants in mixed swamp forest and secondary forest that are 27 species as seeds till trees and 17 species as herb vegetation and 4 species as small plant. Mentaru (*Schima walichii*), Putat (*Barringtonia spicata*), Pelangas (*Antidesma tetrandum*), Leban (*Vitex repens*) as trees and stands, and Lempuar (*Achasma megalocheilas*), pakis (*Nephrolepis exalata*) as herb vegetation were the general species found in both communities. Plant species as elephant foods consisted of 14 species (seeds till trees) and 17 species as herbs. *Malaleuca cajuputi* was the dominant trees in this community type and almost there were none of another tree species. Herb vegetations were dominated by Belidang (*Fimbristylis annua*) and Ilalang (*Imperata cylindrica*). In the type of land grass and swamp grass communities, it was found 10 species that is almost all of them as elephant food plants, in which Belidang, Ilalang and Pakis Resam (*Gleichenia linearis*) dominated land grass communities and Kumpai Minyak (*Paspalumconjugatum*), *Paspalum virgatum*, kumpai tembaga (*Paspalum fasciculatum)* dominate the communities of swamp grasses.

Keywords: *Vegetation inventory, elephant habitat, Padang Sugihan Reserve, Line Transects*.

Introduction

Padang Sugihan Area was legalized as reserve area by Indonesian government especially authorized by the decision letters of the Ministry of Forestry, number 004/Kpts-II/1983, 19 April 1983 with area wide 71.807 ha [1]. This protected site locates in the administrative area of local government of Banyuasin and Ogan Ilir Regency, while forestry administration is managed by the Conservation Board of Natural Resources, division of South Sumatra.

This reserve area is mainly as a wetland ecosystem of lowland type and has an urgent function both for wildlife and for people staying in surrounded reserve site. For local people, the existence of preserved area contributes in supporting the daily their family life, while for a wildlife especially Sumatran elephants, Padang Sugihan reserve is natural habitat for their protection site, socialization, reproduction and nurture of their babies and juveniles. In fact, the utilization of reserve natural resources by local people is the form of physical stress affecting on the quality reduction of elephant habitat. Illegal logging on *Malaleuca cajuputi* stands and annual fire of reserve vegetation impact to the change of the micro climate to be extreme and decrease the composition of vegetation species involved the supply of elephant's food plants species. Degradation of food plant supply will push the elephant population to go out of habitat area so population raid and destruct local people crops locating outside of preserve area and will appear the conflict among elephant population and local people [2].

The supply of elephant's food plant species in enough quantity will affect on the elephant's hospitality level so they will produce good generations that have the high reproduction capacity and immune for many diseases. Food plant supply will also affect on their fertility and fecundity [3]. The demand of mature elephant on fresh food plants varies enough with range 200-300 kg daily or about 5-10 % of their body weight. In Padang Sugihan reserve, elephants are predicted that they need 130-150 kg of fresh biomass of food plants daily [4] while in NAD province, they need about 300 kg and in Riau, about 396 kg of fresh biomass [5]. The elephant demand for food plant quantities can be estimated based on biomass weight. By estimation the food biomass number in habitat, it can be known that how many individuals of elephants can be supported by their habitat. In natural situation, elephants do daily activities about 16-18 hours and most their activities (70-90 %) are allocated for food [6].

The previous studies in mountain rain forest ecosystems showed that species of elephant's food plant varied between one habitat to another habitat. In NAD province, there were found 51 species of elephant's food plants consisting of 17 crop species, 8 grasses, 5 species of pterydophytes, 4 species of bamboo and sapling plants of *Ficus sp* and *Litsea sp* [7]. While study conducted in out side of protected forest of Kerinci Seblat National Park showed that dominant species of elephant's food plants were *Shorea spp, Macaranga pruinosa, Pterospermum javanicum, Tarrietia javanica, Shorea leprosula* and *Terminalia catapa* and also rattans. While below vegetation being favorite as elephant foods were *Curcuma xanthorrhiza, Achasma megalocheilas, Cyperus unicetus, C. ferax and Pandanus terestris* [8]. Observing on the elephant's food plants in forest park of Cut Nyak Dhien, Seulawah, NAD Province found 69 species in secondary forest and 51 species in primary forest. *Oplimenus burmanii, Imperata cylindrica, Crassocephalum crepidiodes, Mimosa pudica* and *Zingiber aquosum* were dominant in secondary forest and being favourite elephant's food plants [9].

The recent studies focusing on kinds of elephant's food plant species in tropical wetland ecosystems especially in lowland type are still rare so in searching those scientific publication are difficult. To fill the literature empty about them, this study aims to inventory the vegetation of wetland ecosystems involved species of elephant's food plants locating in elephant habitat of Padang Sugihan reserve.

Materials and Methods / Experimental

This study had been conducted in Padang Sugihan Reserve having wetland ecosystem of lowland type. This area locates in East of Palembang City, South Sumatra Province with coordinate points 105^{o} 00' – 105^{o} 20' East, and 2^{o} 30' – 3^{o} 00' South and also has width about 71.807 hectares [1]. Observation located in five typologies of vegetation that is (1) mixed swamp forest with 2-7 km length along with the edge of Padang river in the west of Padang Sugihan area with 50-150 m width (2) secondary forest from the edge of Padang River to terminate of all primary channels with 5 – 50 m width (3) swamp grasses along with the edge of Sugihan river with 500 m – 2 km vegetation width (4) land grasses in open areas which are always filled by water from primary channels and rivers in rainy season with 1-4 km width (5) *Malaleuca cajuputi* stands dominating in the East and Southern of sanctuary area along with 1-7 km of primary channels [10].

Vegetation analysis was used to inventory and to study the vegetation structure involving kinds of food plant species in five vegetation types. Line transect method with square plots was used to this analysis. 20 plots with size 20 x 20 m, 10 x 10 m, 5 x 5 m, 2 x 2 m and 1 x 1 m were made vertically from the edge of rivers or primary channels to deep land. Besides inventory plant species, individual densities and relative density of species were calculated [11]. Coordinate points of plots were recorded by using GPS. Food plant species in field can be known from broken trees and rests of food plants [2; 8] and gotten from some local informants who have experiences knowing the local name of species.

Results and Discussion

Composition of vegetation and elephant's food plant species in Padang Sugihan Reserve

The numbers of plant species in five vegetation types of Padang Sugihan Reserve were 48 species consisting of 27 species as wood species (from seedling to stands), 17 species as herbs and lianas, 4 species as small plants. In stand strata (as data illustration), the highest density was found in mixed swamp forest (18 ind/plot), next, 12 ind/plot in secondary forest and 10 ind/plot in Gelam (*Malaleuca cajuputi*) stands. Mentaru (*Schima walichii*) and Putat (*Barringtonia spicata*) have the highest density in mixed swamp forest along with the edge of Padang river because these plant species are the characteristic of species of coastal swamp forest affected by tidal waves. Pelangas (*Antidesma tetrandum*), Leban (*Vitex repens*) and Balik Angin (*Mallotus paniculatus*) are the general species growing almost in all the edges of primary channels. This vegetation grow in high land especially in soil deposits produced from the digs of primary channels so that vegetation in these areas are not flooded by water from rivers or channels in rainy season.

Table 1. Species and wood plant densities in Sumatran elephant habitat of Padang Sugihan Reserve

No	Species	Mixed Swamp Forest		Secondary Forest		Gelam Forest	
		Density (/plot)	Relative Density(%)	Density (/plot)	Relative Density(%)	Density (/plot)	Relative Density(%)
1	Mentaru *(Schima walichii)*	**2.3**	**12.5**	1.0	8.3	0.0	0.0
2	Putat *(Barringtonia spicata)*	**4.8**	**26.4**	0.0	0.0	0.0	0.0
3	Tejo *(Cinnamomum verum*)*	0.3	1.4	0.0	0.0	0.0	0.0
4	Siasam *(Syzigium cumini *)*	0.8	4.2	0.0	0.0	0.0	0.0
5	Simpur (*Dillenia excelsa*)	0.3	1.4	0.0	0.0	0.0	0.0
6	Kelat Jambu *(Syzigium paniculatum*)*	0.5	2.8	0.0	0.0	0.0	0.0
7	Mesiro *(Baccaurea pendula)*	0.3	1.4	0.2	1.4	0.0	0.0
8	Jejawi *(Ficus microcarpa)*	1.3	6.9	0.0	0.0	0.0	0.0
9	Gelugur *(Garcinia atroviridis)*	0.0	0.0	0.3	2.8	0.0	0.0
10	Pelangas *(Antidesma tetrandum)*	**2.3**	**12.5**	**1.7**	**13.9**	0.0	0.0
11	Medang Pelam *(Litsea spp*)*	1.5	8.3	1.8	15.3	0.0	0.0
12	Rambai Ayam *(Calophyllum wallichianum*)*	0.3	1.4	0.3	2.8	0.0	0.0
13	Perupuk *(Coccoceras sumatrana*)*	0.3	1.4	0.5	4.2	0.0	0.0
14	Terentang *(Compnosperma auriculatum*)*	1.3	6.9	0.0	0.0	0.0	0.0
15	Mampat *(Cratoxylum arborescens)*	0.0	0.0	0.3	2.8	0.0	0.0
16	Bebelingan *(Eusideroxylon zwageri)*	0.5	2.8	0.0	0.0	0.0	0.0
17	Gelam putih *(Malaleuca cajuputi)*	0.3	1.4	1.3	11.1	**10.0**	**100.0**
18	Leban *(Vitex repens*)*	0.8	4.2	**2.8**	**23.6**	0.0	0.0
19	Balik angin *(Malotus paniculatus*)*	0.0	0.0	**1.5**	**12.5**	0.0	0.0
20	Mahang *(Macaranga triloba*)*	0.0	0.0	0.2	1.4	0.0	0.0
21	Rejasa (*Eleaocarpus grandiflorus*)	0.5	2.8	0.0	0.0	0.0	0.0
22	Kenidai (*Bridelia pustulata**)	0.3	1.4	0.0	0.0	0.0	0.0
	Numbers	18.0		12.0		10.0	
	Other wood species						

23	Kayu nasi (*Chrysophyllum roxburghii**)
24	Tembesu laut (*Fragraea sororia*)
25	Kandis (*Garcinia parvifolia**)
26	Rukam (*Flacourtia rukam**)
27	Rengas (*Gluta Renghas*)

Note: *species of elephant's food

From 27 wood plant species, 17 species as herbs and 4 species as small plants composing vegetation of lowland ecosystem, it just only 10-30 % of those species having similarity with species of secondary forest vegetation in mount-land [5; 7; 8]. The numbers of below vegetation in three typologies of communities were about 13 species in which the highest density (99,8 ind/plot) were found in Gelam forest (*Malaleuca cajuputi*) and then, 29,3 ind/plot were in secondary forest and 14,3 ind/plot in the mixed swamp forest. Lempuar (*Achasma megalocheilas*), rumput senayan (*Eleusine indica*) and rumput pait (*Axonophus compressus*) were the characteristics species growing in below vegetation of mixed swamp forest. The existence of these species in below canopy of wide leaf plants may relate to protect their self from the extreme light and temperature. In Gelam forest, Belidang (*Fimbristylis annua*) are more general found than others and Seripit (*Alternanthera sessils*) including *Achasma megalocheilas* was more common found in below vegetation of secondary forest.

Table 2. Species of below vegetation in elephant habitat of Padang Sugihan Reserve

No	Species	Mixed Swamp Forest		Secondary Forest		Gelam Stands	
		Density (/plot)	RD (%)	Density (/plot)	RD (%)	Density (/plot)	RD (%)
1	Lempuar *(Achasma megalocheilas*)*	**1.8**	**12.3**	**8.7**	**29.5**	2.40	2.4
2	Pakis *(Nephrolepis exaltata*)*	1.5	10.5	1.8	6.3	0.00	0.0
3	Rumput pait *(Axonophus compressus*)*	**6.3**	**43.9**	0.7	2.3	0.00	0.0
4	Kalamento *(Leersia hexandra*)*	0.5	3.5	0.0	0.0	0.00	0.0
5	Rumput senayan *(Eleusine indica*)*	**3.0**	**21.1**	0.0	0.0	0.00	0.0
6	Gadung (*Dioscorea hispida**)	0.3	1.8	0.0	0.0	0.00	0.0
7	Rotan (*Calamus spp**)	1.0	7.0	0.2	0.6	0.00	0.0
8	Seripit *(Alternanthera sessilis)*	0.0	0.0	**4.7**	**15.9**	0.00	0.0
9	Belidang *(Fimbristylis annua*)*	0.0	0.0	**3.3**	**11.4**	**87.40**	**87.6**
10	Seduduk *(Melastoma malabatrichum)*	0.0	0.0	1.3	4.5	0.40	0.4
11	Resam *(Gleichenia linearis)*	0.0	0.0	0.7	2.3	2.60	2.6
12	Kumpai Padi *(Paspalum virgatum*)*	0.0	0.0	6.0	20.5	0.00	0.0
13	Ilalang *(Imperata cylindrica*)*	0.0	0.0	2.0	6.8	7.00	7.0
	Numbers	14.3		29.3		99.80	

Note: RD = Relative Density

The supply of elephant's food plants in Padang Sugihan Reserve more varied in level of below vegetation in secondary forest (90 %) and mixed swamp forest (86 %) than in below Gelam stands (60 %) but in quantity, Gelam stands much more food supply such as Belidang (*Fimbristylis annua*) than two other vegetation (Table 3). In higher strata of vegetation, the supply of food species variation tended to be lower ranging between 25-69 %. Food supply of below vegetation in enough quantities and the existence of stand canopy will invite elephant population to search food plants in this site and take a rest in order to avoid from extreme light and temperature because elephants just have a little of wet glands. The high transpiration of their body skin may cause the death of individual [12; 13; 14; 15; 6]

Table 3. Ratio between elephant's food plant species with total of species numbers composing to vegetation in Padang Sugihan Reserve

Vegetation Strata	Mixed Swamp Forest	Secondary Forest	Gelam Stands
	(%)	%	%
Tree Level	43.0	50.0	0
Stand Level	56.0	33.0	0
Sapling Level	46.0	45.0	0
Seedling Level	25.0	69.0	50
Below vegetation level	86.0	90.0	60

Based on the differences between land grass and swamp grass communities dominant living in Padang Sugihan Reserve, Belidang (*Fimbristylis annua*), iIalang (*Imperata cylindrica*) and Kumpai Padi (*Paspalum virgatum*) were plant species dominating land grass vegetation. Kumpai Padi was much more found along with the edge of primary channels while Belidang and Ilalang much growed in open land and far away from primary channels and two surrounding rivers. Areas in which this community grows were arid in dried season and flooded in rainy season with 1-1.5 m depth. Fire to Belidang and Ilalang biomasses in dried season is routinely accident in every year in land grass vegetation. The other side, swamp grass communities are always live in flooded areas and are much found along with the edge of Sugihan river especially from mouth of primary channel 21 until channel 7 and dominant species in this vegetation type were Kumpai Minyak (*Paspalum conjugatum*) and Bakung (*Crinum asiaticum*); Table 4.

Table 4. Species and Relative Density of Land and Swamp Grass Vegetation in Padang Sugihan Reserve

No	**Species**	**Land Grasses**	**Swamp Grasses**
1	Belidang *(Fimbristylis annua*)*	**51.0**	5.0
2	Ilalang *(Imperata Cylindrica*)*	**22.8**	0.0
3	Leban *(Vitex repens*)*	0.2	0.0
4	Seripit *(Alternanthera sessilis)*	0.1	0.0
5	Kenidai *(Bridelia pustulata)*	0.1	0.0
6	Kayu Nasi *(Chrysophyllum roxburghii)*	0.1	0.0
7	Rumput gajah *(Penisetum purpureum*)*	1.0	6.0
8	Kumpai padi *(Paspalum virgatum*)*	**13.8**	7.5
9	Ritang *(Passiflora foetida)*	1.7	0.0
10	Resam *(Gleichenia linearis)*	3.3	0.0
11	Kalemento *(Leersia hexandra*)*	3.5	0.0
12	Perumpung *(Malachra alceifolia*)*	0.1	0.0
13	Seduduk *(Melastoma malabatrichum)*	0.2	0.0
14	Bengkirai *(Dryobalanops aromatic)*	0.3	0.0
15	Kumpai tembaga *(Paspalum fasciculatum*)*	1.8	3.5
16	Kumpai minyak *(Paspalum conjugatum*)*	0.0	**52.5**
17	kumpai padi *(Paspalum virgatum*)*	0.0	7.0
18	Kumpai kerbau (*Hymeneche amplexicaulis**)	0.0	6.5
19	Bakung *(Crinum asiaticum)*	0.0	**12.0**

Note: *species of elephant foods

Although relative density of grass species in swamp grass community (87 %) were higher than in land grass community (67), species structure in land grass community more varied and were more in quantity. Elephants tend to prefer land grass community in order to search their food plants than in swamp grass community because of the reasons for the dangerous level and the ease of finding food. Searching food plants in swamp grass vegetation are much more difficult for elephants because they have to swim for a long time and probability to meet human in the edge of Sugihan River is bigger.

Conclusion

Based on results of this study, it could be concluded that there were 48 species of plants in mixed swamp forest and secondary forest that are 27 species as seeds till trees and 17 species as herb vegetation and 4 species as small plant. Mentaru (*Schima walichii*), Putat (*Barringtonia spicata*), Pelangas (*Antidesma tetrandum*), Leban (*Vitex repens*) as trees and stands, and Lempuar (*Achasma megalocheilas*), pakis (*Nephrolepis exaltata*) as herb vegetation are the general species found in both communities. Plant species as elephant foods consist of 14 species (seeds till trees) and 17 species as herbs. *Malaleuca cajuputi* is the dominant trees in this community type and almost there is none of another tree species. Herb vegetation are dominated by Belidang (*Fimbristylis annua*) and Ilalang (*Imperata cylindrica*). In the type of land grass and swamp grass communities, it is found 10 species that is almost all of them as elephant food plants, in which Belidang, Ilalang and Pakis Resam (*Gleichenia linearis*) dominate land grass communities and Kumpai Minyak (*Paspalum conjugatum*), *Paspalum virgatum*, kumpai tembaga (*Paspalum fasciculatum)* dominate communities of swamp grasses.

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GREEN HOUSE EFFECT SOLAR DRYERS : AN APPROPRIATE TECHNOLOGY FOR FOOD SECURITY

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Abstract

Drying is determinant process in post-harvest handling and processing for food products. Open air sun drying has been widely used to dry so many varieties of foods by small scale farmer and fishery in developing countries. Although the technique is simple, this drying faces some problems, such as space intensive, risk of product damage, contamination and losses, and time consuming, especially when practiced during rainy season. To overcome these problems several models of green house effect solar dryers have been developed and explored to dry several agricultural products, such as fish (Model I) banana chips (Model II), fish crackers and salted mustard green (Model III). This paper presents the designs and results of performance testing of these three models of solar dryers. Using threshold of 20% moisture content to define dry fish, Model I was able to finish drying process in 11.87 hours while Model II completed drying process in 17 hours on the other hand sun drying needed 44 hours to produce dry fish. Performance testing of Model II also demonstrated that banana cracker drying needed only 1-3 days depending on weather condition. If dry product for fish cracker was characterized utilizing the same threshold of moisture content as fish, Model III only needed about 5 hours to result dry fish cracker. Based on **Figure 10** and adopting moisture content threshold of 10% for mustard green, this last model was also able to complete drying process in about 33 hours. Seeing the results of performance testing, the dryers might be adopted by the farmers and fisheries wishing to contribute in food security efforts.

Keywords: *solar dryer, design, performance, food product, food security.*

Introduction

Drying is one way of adding value to agricultural products. With good knowledge and sufficient equipment it can be done properly so that dried products can be locally marketed or even for export with good price. Knowledge plays important role in finding out the best method of drying in order to effectively conserve nutritive values of the products. Equipments with any level of technological contents are available in market to speed up drying performance. But lack of knowledge and investment drags small scale farmers and fisheries who in fact are the poor to find out the simplest way of drying which is open air sun drying. This drying is intensively practiced for wide variety of agricultural products such as grain, fruit , vegetables, fish, herbs and spices, recycled foods. After harvest grain is sun dried in common by spreading it on floor which may be in the forms of compacted ground, cement, asphalt country road or plaited bamboo. Nut and beans are sun dried on compacted ground. Placing picked fresh coffee fruit on the ground for sun drying is often practiced by some farmers in Bengkulu as part of obtaining coffee grain. Small scale farmer in Java Island usually spread paddy grain for drying on the plaited bamboo. In accordance to the development of infra structure in the country sides, asphalt country road is benefited as sun drying facility for almost all grains. Groups of small scale farmers provide cemented floor for paddy drying in some central paddy areas. Fruit and vegetables are usually sliced and placed on rounded woven bamboo, plastic tray or plastic canvas tent before sun dried on the ground, asphalt country road or even on the roof of country houses. The same manner is also done for herbs and spices. Fish is widely sun dried on the plastic net laid on bamboo or wooden platform placed in open areas. In Indonesia only less commercial for fresh market or having small size fishes which are usually processed by drying. Fish is cut at the abdomen to take out it's feces. The fishes are dried with or without salting. To speed up drying process, fishes are split, especially for fishes with quite bigger sizes. Recycles foods are usually resulted from unfinished consuming for the product such as boiled rice, cassava etc. These stuffs are needed to be preserved by drying in order to be re-utilized for human or animal. Because their quantity are usually small, they can be dried by placing on the round woven bamboo container or plastic tray exposing to the sun.

Although sun drying is simple and cheap but it faces some problems. It shell be conducted with limited thickness or layer to assure that produce to be dried can receive as much as possible direct light from the sun. Since agricultural products are naturally bulky, sun drying is spacious. Due to produce is exposed to open space, it is risk of produce contamination, damage and losses. Sun drying is labor intensive since the produce in needed to be removed, turned over and covered when drying is interrupted by rain or has to be done overnight. For the products which are attractive to the insects, such as fish and processed food, sun drying may be in risk of contamination which endangers human health. Insects like flies may lay their eggs, bacteria or virus on the fish or food which may cause some diseases. All of these will endanger food safety and security.

Overcoming these problems various models of solar dryer have been proposed [1]. By manipulating energy coming from solar radiation and then applying for agricultural products solar dryers may be categorized into hot-box type in which product is dried by the energy taking directly from the sun, indirect type conventional dryers that heat product with solar energy heater, and mixed type dryers in which product is dried by solar energy directly received from the sun and heat collected by solar collectors [2][3]. In indirect mode type dryers, drying rate depends on design, size of collector and thickness of the product being dried. The design and size of collector will determine rate and number of energy supply on the other hand the thickness will be influenced by rate of drying air [4], properties, shape and porosity of product [5], size of individual product [6] and product moisture content [7].

Since 1999 Agricultural Technology Department, University Bengkulu has developed several models of green house effect solar dryer for agricultural products. This article presents the performance of some of them, hoping that they may be adopted by the poor to solve the problems usually encountered when they dry agricultural products and food by sun drying.

Materials and Methods / Experimental

Activities of experiment consisted of constructing dryers, installing them in the places of experiment, testing their performances and evaluating the results. The dryers were constructed in Laboratory of Agricultural Technology, Department of Agricultural Technology, Faculty of Agriculture, University of Bengkulu. To adapt different products and condition of space for installation in the field six models were introduced and among them were distinguished by with and without heat collectors, and with and without chimney. Main materials for construction were wood for main structure and frame of trays, UV plastic for cover (roof, wall, collector, chimney) except for Model I (roof and cover of collectors), and aluminum sheets for heat collectors. Model I (**Figure 1**) consisted of drying room with trays inside, collector made of aluminum sheet painted in black and equipped with air inlets at the lower ends, and chimney situated in the center of the roof and equipped with air outlet at the side of its the upper end. This dryer operated as soon as the structure received heat from the sun. The fresh ambient air entered into the inlets, and was heated by solar energy captured by the collectors. This air passed through trays in the drying chamber and was then further heated by solar energy collected directly by the structure. The passing dry air removed the moisture content of the product to be dried which was placed in the trays. The humid air entered to and then escaped from the chimney through the outlet. Model IV (**Figure 4**) made of drying chamber equipped with perforated floor functioned as air inlets connected to outside air. This chamber was covered with inclined roofs met at difference heights one and other at the upper their upper ends. Air ventilation was constructed along the clearance of the two roofs. Drying trays were placed inside the drying chamber. When the structure received solar energy from the sun, this energy heated air inside the drying chamber. Heated air experienced its density decrease and tried to escape from the chamber through the ventilation. Flowing dry air removed water from the product to be dried placing in the trays and humid air escaped from the drying chamber through the ventilation. Model III (**Figure 3**) was similar to Model IV except chimney was constructed along the center of roof. The chimney had two air outlets along its side of upper end. This model operated with the same manner as Model IV and humid air came out from the dryer through the outlets of the chimney. Model II (**Figure 2**) had a similar design as Model III but was equipped with collectors. The collectors were embedded to the floor of drying chamber. Mode of operation of this model was similar to model I. Model V (**Figure 5**) was very similar to Model II except the trays were inclined and separated in two parties by a space's clearance. This model operated in the same manner as Model II. Model VI (**Figure 6**) had design similar to Model I but its chimney was fixed at the one of the wide sides of the dryer and was equipped with exhausted fan inside. This model worked in the same manner as Model I but air circulation within the drying chamber and collectors was accelerated with the fan. For all models, frames of the trays were made of wood while for their platforms three different materials were introduced i.e. non-corrosive wire, nylon and perforated woven bamboo. Inlets and outlets of the dryers were covered by nylon screens to protect the products being dried from insects invasion.

During experiments, samples of products were prepared and placed in the trays. For each product experiment was repeated three times. During operation of drying, temperature and relative humidity of ambient and drying chamber air together with product moisture content were observed. Thermo-hygrometer and high sensitivity balance were used for measurement. Data of moisture content of the products being tested were presented in function of time. Mathematical model was employed to characterized drying rate of each commodity and each model of dryer.

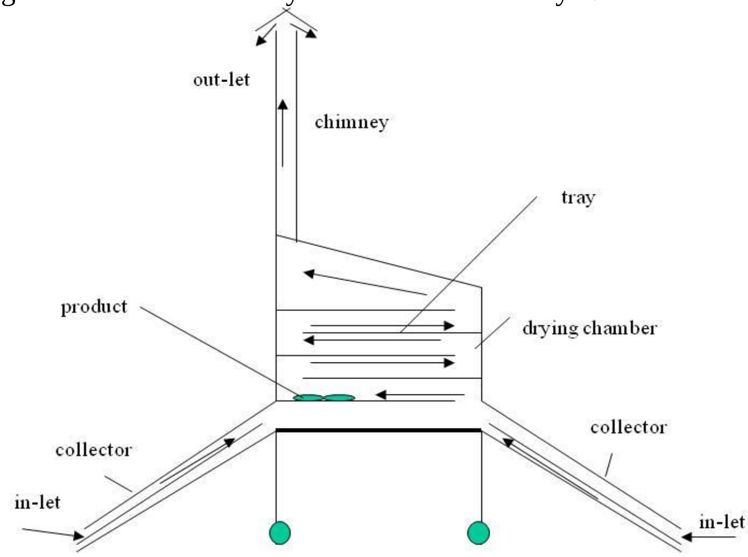

Figure 1. Solar dryer Model I

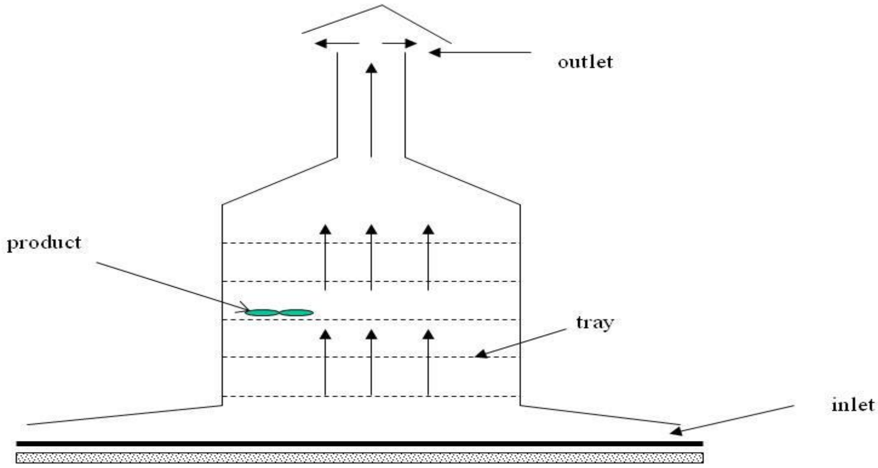

Figure 2. Solar dryer Model II

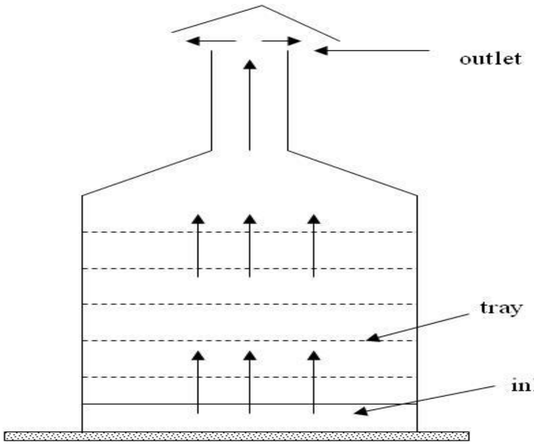

Figure 3. Solar dryer Model III

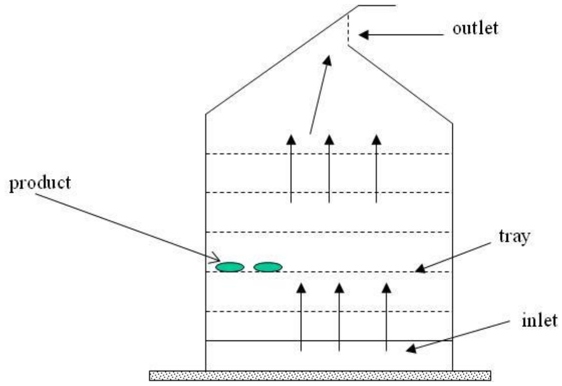

Figure 4. Solar dryer Model IV

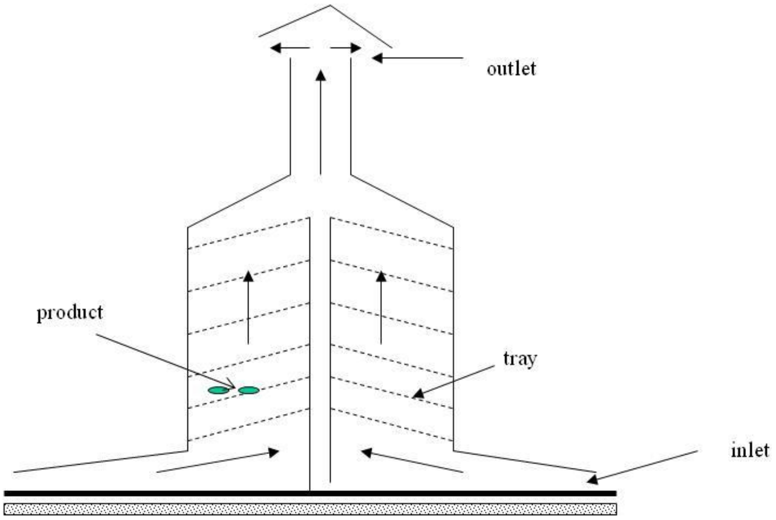

Figure 5. Solar dryer Model V

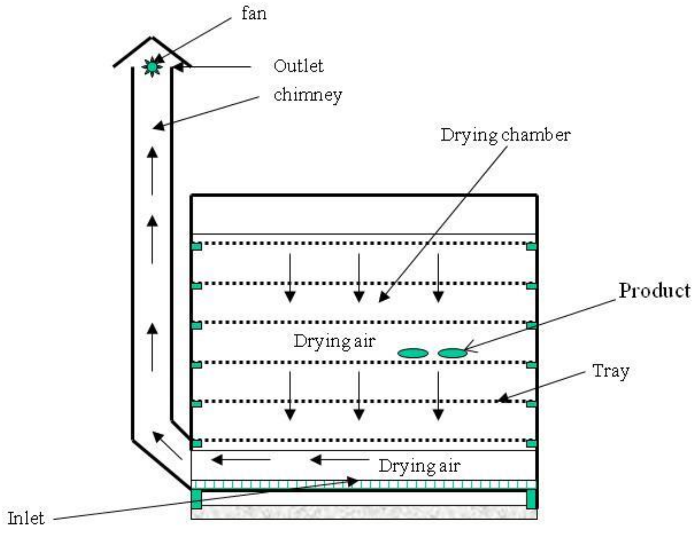

Figure 6. Solar dryer Model VI

Results and Discussion

Due to limited space results of the experiment would not be presented in detail here. Changes in temperature and relative humidity were illustrated together with drying rate. Relationships between moisture content and drying time in the form of figure were presented only for three products. **Figure 7** and **8** illustrated the relationships between moisture content and drying time for fish.

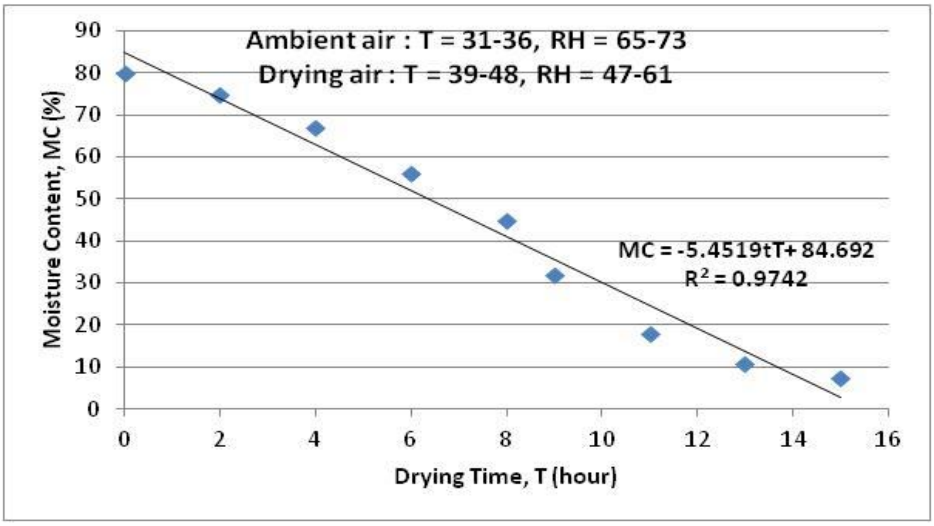

Figure 7. Relationship between moisture content of fish and drying time for Model I [8]

Using threshold of 20% moisture content to define dry fish, Model I was able to finish drying process in 11.87 hours while Model VI completed drying process in 17 hours and sun drying needed 44 hours to produce dry fish. Although Model I had faster drying rate, it was not favorable to be recommended because the dryer used glass as roof and cover of collector which was material front to damage.

Figure 9 showed the relationship between moisture content of fish cracker and drying time for Model III while **Figure 10** indicated the same relationship resulted by the same model of dryer when utilized for mustard green. If dry product for fish cracker was characterized utilizing the same threshold of moisture content as fish and then the dryer only needed about 5 hours to result dry fish cracker. Based on **Figure 10** and adopting moisture content threshold of 10% for mustard green, Model III was also able to complete drying process in about 33 hours.

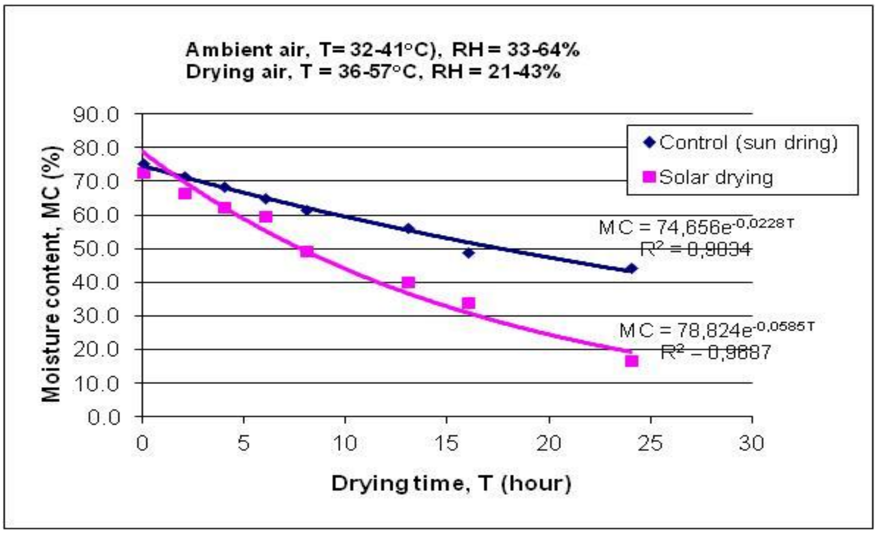

Figure 8. Relationship between moisture content of fish and drying time for Model II [9]

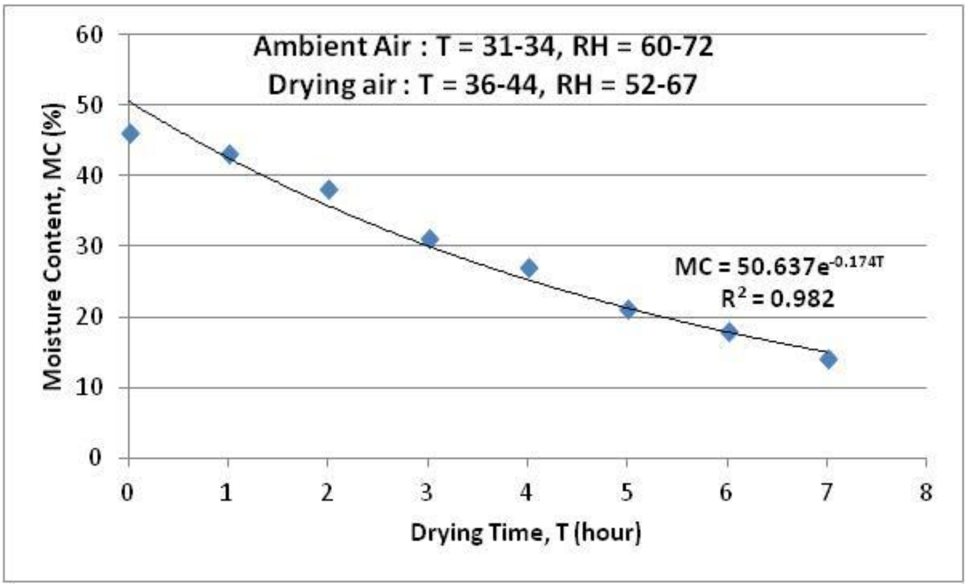

Figure 9. Relationship between moisture content of fish cracker and drying time for Model III [10]

Result of experiments also indicated that employing Model IV, drying of banana and rice cracker could be completed in 2-3 days [11]. In term of drying banana, Model V performed twice faster comparing to drying time utilized by sun drying [12]. Performance testing of Model II demonstrated that banana cracker drying needed only 1-3 days depending on weather condition [13].

Seeing advantages from exploration of utilization green house effect model solar dryers presented above in term of drying performance, drying time and labor efficiencies, minimization of product damage and losses, availability material for construction, simple in design and affordable in budget for user, it comes to suggest that this appropriate technology may be adopted for the poor, especially farmers and fisheries to solve the problems rising from sun drying which is usually practiced. Since these advantages promises an economic added value this appropriate technology will contribute in eradicating poverty.

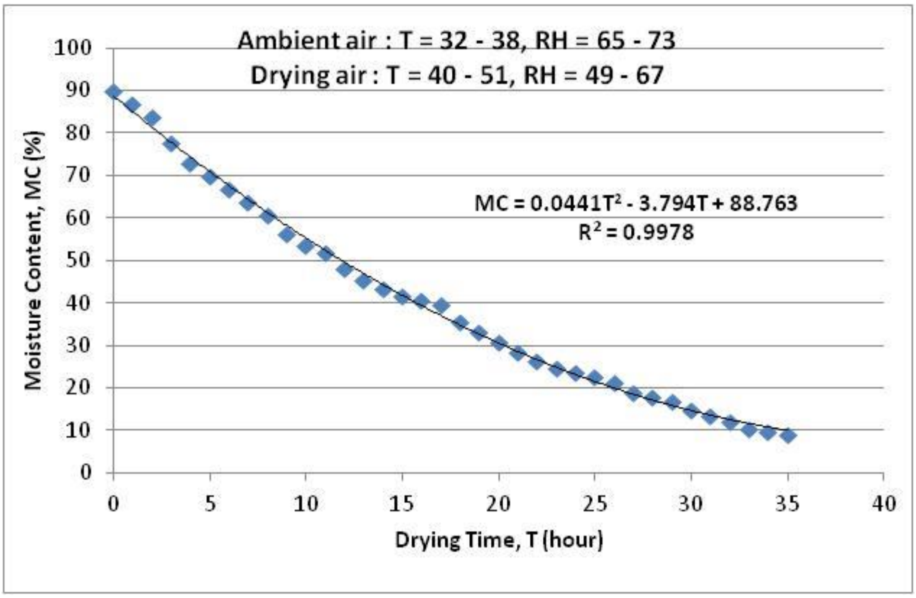

Figure 10. Relationship between moisture content of salted mustard green and drying time for Model III [14]

Conclusion

Green house effect model solar dryers presented above were promising good performances in which Model I, II, III, IV, V and VI were able to respectively finish fish drying in 11.87 hours, banana cracker drying in 1-3 days, fish cracker and mustard green drying in 5 hours and 33 hours, banana and rice cracker drying in 2-3 days, and fish drying in 17 hours. These models might be adopted by the farmer and fisheries in the effort of contributing to the food safety and security.

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DEVELOPING SUBJECTIVE ECOLOGY FOR SUSTAINABLE AND THE FITNESS OF HUMANOSPHERE

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Abstracts

For a hundred centuries human being has been developing his culture and civilization as an attempt for temporary and spatially artificial adaptation. In the beginning, hominoid civilization was integrated with the biosphere, but at their later stage of biological as well as cultural evolution, Homo sapiens sapiens have been developing their own environment - that is humanosphere - that barely separated with the biosphere. With the principle of territorialism, human beings have been marked, and worked on environmental wild nature with exploration, extraction, manufacture, production, distribution, material consumption and eventually dump the wastes. The activity has been changing from natural participation, to strong domination, and to strong defeat the nature, and eventually yielding excessive natural destruction into irreversible and unfavourable changes for life. Due to the strong anthropocentrism, unfriendly humanosphere has been a threat for biosphere. Here, this paper attempted to overview environmental ethics to change the human attitude from opponent to the state of being kind and generous attitude as a human responsibility for the sustainable humanosphere. With the proper perceptual ecology, we attempted to unravel human adaptive actual ecology. Most of the expert has come to the pragmatism programme with an approach of weak anthropocentrism, but we also extended to the other philosophical basis for an environmental ethics.

Key words: *subjective ecology, perceptual ecology, adaptive actual ecology, sustainable humanosphere, pragmatism, weak anthropocentrism.*

Introduction

In terms of biology, human being is only a biological organism belongs to a species of Homo sapiens sapiens survived in the modern world [1. Human beings belongs to a group of animal that has a dorsal chord (Chordate), filled with a spinal backbone (Vertebrate), a pair of glands of mammae that is used for nurturing the baby with milk during lactation (Mammalian), and his body is fulfilled with fur and hair, arm is used for grasping (Primates). The biological characteristic anatomy of human being lies on the ability to walk upright biped ally, whereas his free hand is fully design for manipulative work [2]. Most of human biologist emphasized on both bipedalism and cerebralization as supportive evolutionary explanation bearing the most distinctive value that eventually distinguishing human being from other animals.

Both biology and biological philosophy interprets the biological data on human being as the following [3]: he has very limited biological ability, he was born at a premature stage that every single human babies is not being prepared for his own life unless after some years under both biological and cultural nurture and conditions.

As results, the development of human culture and civilizations is a direct product of biological nature and nurture in which the advancement of millions brain cells obtain accumulative socio cultural learning from their environment. The civilizations wave that is a form of an accumulation of learning ability is enhanced by the human artificial and symbolical vehicle, e.g. evolution of oral language to written language. The language has become importance for a vehicle of social experiences, mostly and specifically scientific experience [4].

Although human life has more sophisticated quality in term of the human capacities to develop his culture and civilization that is very different from animal life, the biological manifestation on behaviour has no significant different. His biological behaviour concerns to the individual and species fitness against the pressure of Darwinian selection. The main fitness focuses on biological fitness, e.g. health or life fitness that includes effort to fulfil biological needs, food, clothing and housing; efforts to defeat against infectious disease, metabolic decay, and eventually reproductive fitness which ensure the sustainability of new offspring in the next generation.It is therefore, the development of culture and civilization of human beings and their meaning can be seen as for the human species fitness.When human evolution is to take into account, the birth of Homo sapiens fossilis (and also Homo sapiens neanderthalensis were start sometime at 100.000 years ago [3]. The modern human being (Homo sapiens sapiens) was presumably come into account after the period of 60.000 years ago [5]. The development of culture and civilization can be seen as a human effort to solve their temporary and spatially artificial adaptation, and in turns the solving were inherited via oral and then written languages of extra cellular mechanism

Biosphere and humanosphere

Biosphere is the widest and the most complex living organization on the surface of earth. It is a dynamic result of fragile steady state that is supported by dynamic composition of its sub level organisation. The most prominent factor influencing the steady state is a balance between oxygen – carbon dioxide production. The biosphere is therefore responsible for the existence living organism on earth.

Humanosphere, on the other hand, is a partial part of biosphere that has been affected by human beings during his history. The human influent on biosphere was ranging from hunter and gather the natural resource (mostly food, and other life support for clothing and housing), to the landscape conversion from naturally existence to the form of garden, agricultural field, mining, housing, cities, office, and factory.

The relation between biosphere and humanosphere has multifacet meanings. One is a relation between nature and human. The relationship is reciprocal one, in the sense that the nature create man and vice versa. [6]. Biosphere had been created human beings species, whereas human beings in turns have been created humanosphere. But in the case of the condition(s) bearing the relationship, it is more likely that the inter-relationship is moving in one direction. The biosphere is independent nature, whereas the humanosphere depends on the biosphere. Therefore one can not reject or neglect the existence of the biosphere in order to the survival of humanosphere. In other word, the biosphere is very importance for the whole life that support the humanosphere. The dependable of humanosphere relies on the fact that the humanosphere nurtures the biosphere in terms of natural recources, water, energy support, and most of the important needs.

The level of human culture and its effect on biosphere

According to Toffler [7], human being in his history has passed three stages of civilization (he called as three times cultural waves). Before the wave of cultural leap, pre human being live in the stage of animal society, i.e. they develop common human organization and tools for hunting the prey, and collecting the plant for their biological support and consumption.

The First wave of cultural leap was appeared at the period when human beings developed the agricultural ability to cultivate the needed plant, and domesticated wild animal for its husbandry. It was begun at about a hundred centuries ago. At this stage they replaced the habit of hunter-gatherer to the habit of plant cultivation and animal domestication in order to minimize time consumption, and to reduce exhausted energy they spent on one hand and to increase number of agricultural yield on the other hand. The impact of this wave was time leisure that could be contributed to the learning processes, and therefore increase the number of literacy and knowledge.

The Second wave begun at the seventeenth century when human beings introduced ability to develop industry in order to produce massively human facilities, and machine. This application gave rise the impact on externalization of body task, from muscle task, to muscle tool and machine tool. All these externalization was made life to be easier, increase more efficient in term of time and energy consumption, but gaining massive production, distribution, consumption, education, media information, entertainment, weapon and massive destruction. The further implication was on standardization, centralization, concentration, and synchronization on technically mass industrial process and life in general; and eventually it resulted on efficient management, organization and bureaucracy [7].

The Third wave started at the beginning of 1940th when human being has ability to create computer, and it begun the era of information and communication technology. This era also called as post-second wave of Cultural Revolution. The wave implied what so called super-industrial society, and introduced the era of globalization that the whole of human life was united into the idea of global village, in which all events occurred in different place was put into one concern and consciousness on spatial unity (globalization) and temporal unity (cyberspace). The other results were arising the mass production, distribution, and consumption tend to be personalized, cheap, and instant or "just in time" production. During the second wave revolution there were a gap between producers and consumers, whereas during the third wave the gap was mediated by prosumers orientation, at where the people might have information from open source.

There were some additional wave that cited by other futurolog, i.e. the fourth wave of Cultural Revolution. The wave was only switched on recently, since 1980th, when we are able to precede the biological manipulation for biotechnology purpose. Again, as we can see, the more progresses the human capacity to handle the technology, the more impact on the biosphere occurs.

The history incident notes stated that, in the beginning, hominoid (pre-human) civilization was integrated with the biosphere. Hunting and gathering behaviour limits the effect results on the biosphere layer. The ability of the biosphere to maintain the balance was still being kept on. One might hypothesize that at the later stage of biological as well as cultural evolution, Homo sapiens sapiens have been developing their own environment - that is humanosphere - that barely separated with the biosphere. The problem is the more the civilization stage developed, the devastative effects has been the results.

The way of human beings attempts to win the nature

In the basic biological term, human being is only a member of animal life that now is being away separated from animal way of life –not because human being is very special animal but - because of the ability to perform the super leap quantum civilization as compare to animal life. It is therefore, from the basic biological term view, human being is only a member of food chain network that cannot be separated from their biosphere environment. As a result the humanosphere relies on the facilities provided by the biosphere. Humanosphere is an incomplete organization of ecosystem, due to the support of biosphere to the fragile humanosphere in terms of energy and natural resources.

The development of humanosphere.

The human being expands and widens the humanosphere on the biosphere during its own cultural evolution scale, from limited influences in hunting and gathering strategy, to massive influence in agriculture and industrial strategy. With the principle of territorialism, human being have been enforces his domination against another animal life. They marked the environment via the development of perceptual experience and increase their own extrinsic and instrumental value on the environment.

The increase number of rational as well as empirical science was strengthening the power of the domination to the biosphere. Human being marked, and worked on environmental wild nature with exploration on natural resources in order to fulfil the need for industrial input. Human being execute the extraction on the explored natural resources, manufacture the specific natural product in order to gain production of industrial support, distribute the products to the consumers via market by using a massive transportation to mobilize the allocations, consume material product, and eventually dump the wastes. As a result, the activity of human being in humanosphere has been shifting the pattern of human influence on biosphere ranging from mild to hard, and hazardous effect, form natural participation, to strong domination, and to strong defeat the nature, and eventually yielding excessive natural destruction into irreversible and unfavourable changes for life.

The series of change is to be explained as in the following narration:

Natural participation had been appeared when pre human had only limited relationship with nature, i.e. only collecting the food needed for the actual day of hunting and gathering. The domination begun to occur in the first wave of cultural leap, because at that period human beings was able to develop the agricultural technology for the cultivation of the plant desired for fulfilling the need for food, and domestication of wild animal for its husbandry in order to accomplish the basic need for food, cloth and housing. The human impact on environment in this period was the reduction of natural diversity of life, loss of top soil. The domination became stronger because of the more human powerful occupation on biosphere, and because of the fact that human desire for being the winner of the competition amongst the predators. For all the efforts human introduce chemically toxic of herbicides and pesticides to the agricultural field.

The natural defeat by human has been begun in the second wave of cultural leap at the seventeenth century when human beings introduced ability to produce his machine to serve massive production of human facilities via industrial activities. These activities include natural resources exploration, extraction and upstream to downstream industrial processes, mass production, mass mobilization, transportation and consumption. These were all introducing a massive natural destruction and irreversible alteration.

Our choices, and the fight against strong anthropocentrism

Nowadays we are facing all of the consequence of devastative impact on our biosphere, including massive pollution, climate change, and global warming. For many hundred years, humanosphere were occupied by human egocentrism and strong anthropocentrism (under the name of different orientation, i.e. nationalism, nationwide interests, and other primordial destinations). All have been yielded unfriendly devastative on humanosphere that eventually have been a threat for biosphere. Ideally, - we all dream - humanosphere, as an artificial environment influenced by human being, will have no more result worst and irreversible destruction on the biosphere.

It is clear that all the culprits for the irreversible destruction on earth are our greedyness driven by strong anthropocenrism on economic motive in order to fullfil our unlimited needs. Careless on environment impact had been defined in the actual decision at almost politic, economic, and social concerns. Therefore, it is suggested that the way to shifting paradigm is rooting on fight against our self, against our egocentrism and collective egocentrism. In order to shift the paradigm, first we are seeking a proper choice of whether we are on the way to survive, or to the dead end and committed suicide. (UNESCO [8] had published a book about the two choices in a title: Survival or suicide, the challenges of the year 2000. Part one on this book was on a title “Man, puppet or master of own his achievement”. While the humanosphere is might be one of the leap achievements of man, one might ask of whether man is puppet or master of his own humanosphere. If we still believe that man is the master of the humanosphere, then we still have an expectation on man’s own ability to overcome the devastation).

The demolition is not good, in the sense that it will damage humanosphere itself, and deteriorate human beings as a species, and even for all living things in the biosphere. The devastation is the subject of concern for environmental ethics both on the basis of anthropocentrism point of view and biocentrism point of view.

The needs for subjective ecology that give arise to environmental ethics.

As consequences of that, we need for a subjective human environmental ethics. Here, this paper attempted to overview environmental ethics to shift the human paradigm, perception, attitude, and behaviour; from egocentrism and strong anthropocentrism based behavioural ethics, to weak anthropocentrism and biocentrism based ethics, from opponent against nature to the state of being kind and generous attitude and behaviour as a human responsibility for the sustainable humanosphere.

For the purpose, we put a subjective ecology as a centre of attention. Subjective Ecology is an ecology that subjectively and intentionally being constructed for adaptive and sustainable humanosphere. It has a must that the assembly of the subjectivity has to elaborate our well knowledge on objective ecology as developed in the discipline of ecology as a science of biology. Here, the subjective ecology relies on the works developed by Jakob von Uexkuell (1864-1944). Uexkuell stated that every single individual species is not being able to be separated from his “umwelt”. The umwelt itself means as an entity of organism subjective world that he/they interact(s) with [9]. Uexkull [9] explained that the interaction between an organism with his umwelt relies on the subjectivity of the organism. The organism limits the interaction only according to the mind map that he has been constructed in his perceptual needs. For example a mosquito is only interested with the surface of human skin, where it sucks the fresh blood for it needs. In the same room a human being is more interested with the television he watches the news or entertainment, or some other human being in the room is dealing with his smart phone. In other words, although a number of individual organism living in or occupying the same room or space, every single individual organism has their own umwelt that they have been committed to interact with. The typical action of interaction is due to their own different perception. It is therefore Uexkuell further divided the umwelt (subjective environment) into markwelt (marked or perceptual world of organism) and wirkwelt (actual world of organism)

Why we need such proper subjective ecology. Animal does not need ethics, while man does need it. Perceptual ethics - whether animal should not be greedy, egoist, harsh, and ruthless - is not be necessarily relevant to animal life. Animal does not need to have a good deed. In the humanosphere, animal does not have to allow a man made regulation and manmade ethics. The only wisdom for animal is to win and to survive against selection pressure, competition and fight against unfavourable environment. Human beings are different. The biological fitness for man does not depend only on the individual fitness, as in the case of animal world, but collectively social fitness is very important value. It is because, at earlier committed steps of human being, organization is one of the fitness indicators. Wilson [10] stated that human being has been under multilevel selection pressure that basically operates on two distinct behaviour, i.e. social as well as individual behaviour. Both are seemingly beneath genetic multilevel factors. Social behaviour increases the competitive ability of individuals within groups and among groups of men. In order to survive, human being promotes adaptive social behaviour, beside of individual behaviour. As a result, good and honourable characters must be maintained in the human society. Honesty, generous, compassion, kind, work hard, integrity, is some of the good deeds, as oppose to delude and cheat, miserly, laziness, bad purpose etcs.

Human umwelt

In the history of human civilization, the humanosphere is then being seen as the evolution of the human umwelt itself, in the sense that the development of humanosphere (in terms of its intensity as well as it's enlarge of impact scale) is the entity of human subjectivity of his environment. The different between animal umwelt and human being umwelt relies on the perceptual and actual subjectivity. The animal subjectivity is merely (or relatively) due to innate behaviour, and somehow it has low relation with learned behaviour. The human umwelt, on the contrary, is more complicated, and is a result of his learned subjectivity, or (in other words) it depends on the stage of his civilization.For the peasant, for example, the environment he interact intensively is limited only with his garden or his agricultural plant field, but for the real estate developer, he deeply concern with how to establish his business to transform the paddy field into housing facilities.

The perceptual world of the humanosphere was then different for each of the person effecting the environment. Their different was because of personal job occupation, and proffession. But it is also due to temporal mood or spatial mood. The need for adrenalin work or endorphin mood is the examples of temporal moods. Whereas a particular activity will differ according to the site of place, whether it is at mall (for shopping), at recreational location, at workplace, etc.

As stated earlier, it is obvious that the main problem of increasing vulnerability of humanosphere is due to egoism and strong anthropocentrism, that drive human to several following reasons. The strong anthropocentrism school instruct short term satisfaction to be fulfilled, rather than long term and sustainable life support. Human pragmatism is being distorted into a naive goals. The strong anthropocentrism at the upstream activity has put the humanosphere and biosphere as resource for all and unlimited human needs. The greediness has been the product of the needs. The strong anthropocentrism promises all and instant human satisfaction. It calls for more egocentrism, and stronger anthropocentrism. Life is more being an egoist lust rather than responsibility. As a result, human careless, and irresponsible is getting more dominant in human decisions. At the downstream activity, strong anthropocentrism has been viewed humanosphere and biosphere as a place for wide disposal of all the human wastes. Careless has been established for the fulfillment. Unlimited need, unlimited consumerism is the basic humanosphere willingness.

It has no doubt that all vulnerability has rather ambigious meaning at practical level. For instance at one hand human beings nowadays has been facing worsen impact at all sectors of life. At economics sectors it raise stagnant grows due to the principle of law diminishing returns. At environment level it results land, water, and air pollutions. At social life it yield worsen social quality of life. At psychological level, it bears mental disorder, misbehavior, and psychological schock due to immediate change of social life. At political view, it gives arise wider crisis at the global scope.

Basically, collective human instinct has sniffed the obvious damage via scientific data, and has executed the overcome by collective consensus. It has raising more human concerns and the need to more ethical actions. As a result, we now – at both micro and macro ethics - have stronger eagerness for establishing the proper action, and established a better environment wide world concensus, convention on environment, public polecy, rule of law, and its enforcement dealing with a better quality of environment, humanosphere and sustainable biosphere. But at the opposite of view, human being is still anesthetized by the strong improper need to be filled up. When one refer a standard of prosperity showed by developed country such as USA, and the standard is being seen an idealistic value to be replicated globally, then humanosphere needs three times biosphere to support the prosperity [11]. In order to measure the human impact on earth in a clear manner, recently experts have developed ecological footprint for sustainable development [12].

It is therefore one has to raise a global conciousness that humanosphere is only existed on the limited one global planet with a vulnarable biosphere. It could have gone awry when a small group of people to occupy and dominate the global humanosphere for their satisfaction, while at the same time majority of poor people struggle for their existence [13]. Despite of different back ground on moral philosophical issues, environmental ethics now have concensus on the following common enemy at practical issues that might rise to worsen the earth quality [14].

Pollution or industrial crisis is a pathology for industrial civilitation. High pollution on humanisphere is a kind of high kolesterol and other exessive unnecessary compound in our body that would give arise to hypertension, heart attack and eventually irreversible stroke that lead to the death of life. Pollution is caused by modern industrial civilization and its principle values. Therefore to reduce the number of pollution, we have to transform the value of life underlying the civilization and perform a friendly environmental industry (post industrial civilization)

Unequal prosperity on earth will drive unbalanced exploration. Excessive prosperity life style will drive high consumption that lead to increase pollution, waste, and dissipation. The indigence on the other hand will cause the low and marginal quality of life. It is therefore a proper policy must be implied on both side in order to reach a life in humanosphere as a global prosperity for all human kind. In the developing countries a concern must focus on the balance between economic growth and environment protection, while in the developed countries the focus is more on how to reduce energy consumption and any kind that create worsen environment quality.

Poverty is a kind of pollution that must be reduced and wiped out. Poverty will drive into environmental crisis due to the fact that it will limit economic access to fulfill the daily needs, and will result many crime action to their vicinities/communities, including biotic and abiotic environment. It is because the poverty will attempt to solve the problem of economic limit access illegally, i.e. illegally life on marginal environment, illegally lodge the forest trees, that decrease the number of forest and eventually raise the environmental crisis via un-absorbed gas emissions, and lead to global warming.

Militarism is one kind of serious threat for all life on earth. It is because the excessive military will intimidate the public life and even will unreasonably destroy the whole life on earth. Using strong and most developed military arms, the massive destruction is created in order to defeat the enemy. Militarism and environmentalism therefore are ideologically exclusive each other.

Environmentaly un-equal justice is unfavourable issue for environmental ethics. Human history had been experimenting a bitter experience of unequal human justice through out their life in civilization that had created human tortures and slavery. Since the declaration of human right at 1948, human civilization does recognize mutual and equal respect among human kinds. In doing so, now the environmental ethics extending human right into enviromental right. The idea is similar, i.e. any kind that support the whole life in biosphere must be mutually as well as equally respected in order to assertain that life on earth is not being distorted. Anyone and/or group of people, including any state/countries have to support the efforts.

Any process of decision making on environmental issues that does not involve environmental ethic considerations is dismissed and harmfull for whole life. The role of environmetal ethics is to assure sustainable humanosphere, human life and whole life in the biosphere. Humanosphere quality relies on the public polecies that prevent the rise of environmental crisis, and to support the proper and considerable preservation, environmental protection, restoration. As a result, humanosphere does not only deal with the increase number of economic growth, stable politics on human resources management, but also environmental ethics as well.

Re-evaluation on Human (proposed) markwelt and wirkwelt

To put the discussion into short, in dealing with the sustainable humanosphere, and the fitness, it is important to consider a deliberate proper subjective ecology to our consideration and decission making process. Human markwelt or human perceptual ecology has to established into common ground of the following our prudences We live only on one earth. While the earth has been established at least three billion years to prepare a steady state biosphere that very suitable place for humanosphere. Humanosphere must work on the basis of biosphere capacity, its rules and self maintaining its steady state. Any distortion on its capacity, environmental rule misconduct will destroy the ability of biosphere to support the humanosphere. Any attempt human violation on the rules will end up of dead end biosphere that lost its capacity to support humanosphere

Only the prudences that certainly lead to the adaptive sustainable humanosphere. It is therefore in order to implement the adaptation, humanosphere must undergo into six the following principles :

1. Avoid, limit or decrease the number of environmental crisis that lead to the humanosphere crisis.
2. Establish the most favourable humanosphere on earth as a place of wealth for all - both all human kinds, and all organisms.
3. Avoid, limit, and decrase the number of poverty experiencing by all - both all human kinds, and all organisms.
4. Develop mutual understanding amongst human kind, that anykind of militarism is threatening for all - both all human kinds, and all organisms.
5. Arise an environmental justice for all - both all human kinds, and all organisms
6. Increase the role of environmental ethic consideration in the active participation for ethics and legal environmental polecies.

The development of subjective ecology to increase sustainable and the fitness of humanosphere.

Despite on the different basis of moral philosophy alternatives, weak anthropocentrism and pragmatism have been proven to be a good and suitable ground for the development of subjective ecology founded by Uexkull [6]. At least this stated by some experts, such as Sharov [15], and Afeissa [13]. I want to state here that humanosphere is a kind of human subjective ecology, in the sense that humanosphere is a product of subjective interaction between human being with his umwelt (his subjective environment). The interaction has been established along with the existence of the human culture throughout its evolution. In the sence of pragmatism, humanosphere is not an ultimate and irreversible human environment. Instead, it is a subsequential interaction of human umwelt driven by both human self interest and usefulness subjective perception on his environment at one hand, and human creation or action on it as a result of his ability increase the usefulness by using his developed technology on the other hand.

According to Sharov [15], self interest and usefulness are essential part of subjective meaning of an organism, and therefore usefulness is important for biological adaptation and help the organism to survive. It must be stated that self interest and usefulness for human has to be fitted with the Darwinian selection pressure, that is in order to achieve the fitness of humanosphere. As a result, human usefulness and human self interest must not be distorted into short term achievement (as in the term of economic and development value) but it includes long term achievement and sustainable prosperity in the long run – spatially extend to the usefulness of other organism that is not merely human being side of view, and temporally usefulness that includes the prosperity for next generation. In order to do that, individual egoism and human egoism - as it is deeply insighted by the strong anthropocentrism – have to be transformed into colateral concern of empathy and intimacy (as it is recognized by weak anthroposentrism and even by biocentrism). Strong anthropocentrism has been proved to be reductionistic side view of human life, whereas the weak anthropocentrism has more on being holistic value.

The transformation of the point of view then will drive the change of human perception about his subjective ecology, that is his most valuable onest humanosphere in one biosphere, and in turns the perceptual changing will drive the action enforcement into more friendly humanosphere on earth.

Summary

In the view of pragmatism, human and his humanosphere are then becoming a process of functional circle (active interaction between perception and action at the same time) of active human functional space that must be always reevaluated, renewed, and recreated for most adaptative, suitable and most fitness of humanosphere.For the instruments of the fitness, we have to develop the indicators of Humanosphere fitness and indicators of sustainable humanosphere as well.

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FOLIAR FERTILIZER APLICATION FOR INDUCING RAPID AND UNIFORM FLOWERING ON *Spahoglottis plicata* Blume. var. ALBA ORCHID

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Abstract

Fertilizing orchids will be more effective when applied on leaves in addition the flower can be induced by proper type of fertilizer at optimum concentration. This study was aimed at determining the best combination of type and concentration of foliar fertilizer in inducing rapid and uniform flower. A completely randomized design with five replications was used to allocate factorial arrangement of the treatments. The first factor was type of foliar fertilizer, consisted of Growmore, Gaviota, Gandasil B, and Hyponex. The second factor was concentration of application and consisted of 0, 1, 2, 3, and 4 g L-1. The results showed that Growmore and Hyponex with concentration between 2 to 3 g L-1 were able to accelerate flowering of S. plicata var. Alba orchids and to induce uniform flowering, as indicated by uniformity in cormus diameter, flower stalk length, diameter and number, number of flowers, flower diameter and vase life.

Key words: *Spathoglottis plicata, orchid, foliar fertilizer, flowering*

Introduction

Orchid takes place as the Indonesian most important export commodity for ornamental crops [1]. As the demand for exotic orchid is becoming increased, however, genetic resources for this plant are declined due to excessive exploitations. This phenomenon can be eased if the wild orchid is used only as the parental materials for the development of new varieties [2,3].

Currently, a domestication program for a number of wild orchid species in Bengkulu Province had been initiated in University of Bengkulu. However, the difficulty in providing suitable micro climate and growing media that similar to their natural habitat has hindered progress of the program. Attempts have been made to develop a suitable growing media for those orchids, including the utilization of organic and inorganic fertilizers for promoting the plant growth. Unfortunately, no single media is suitable for all species, as each of them requires a specific type of fertilizer and dose of application [4].

Foliar-applied fertilizers for orchid are more effective than soil-applied fertilizers in that the nutrients absorption is maximized. Orchid absorbs 70% nutrient though leaf stomata and only absorbs 30% through root system, as root serves mainly as the organ for water absorption and attachment to other plant. Flower induction on Phalaenopsis, Dendrobium, Vanda, Cattleya (epiphyte orchids) can be trigerred made by application of foliar fertilizer containing NPK in proportional concentrations or higher phosphor concentration depending on the plant growth stages. It has been recommended that during juvenile to maturity stage, the proportion of NPK is 20 : 20 : 20, while during maturity to flowering stage is 10: 40 : 15 [5]. Additional micro nutrients, including B, Fe, Zn, Ca, Co, Cu, Mg, Mn, Mo, S would be required to NPK fertilizer in order to produce better growth [6].

Study on growth improvement in a terrestrial orchid, including *S. plicata* is limited and, consequently, no specific recommendation on type and concentration of fertilizer to acquire the optimum growth for such orchid. The objective of the present study was to determine the best combination of type and concentration of foliar fertilizer in inducing rapid and uniform flower in *Spathoglottis plicata* Blume. var. Alba orchid.

Materials and Methods

The orchid used in this study was Spathoglottis plicata var. Alba. The 4-old-month acclimated plants with four fully developed leaves, 65 to 70 cm leaf length, and 2 cm cormus were grown in a screen house with 45% shading. The growing media was mixture of soil, cow manure, and fern root with proportion 2: 1: 1. A randomized complete block design with factorial arrangement of the treatments and five replications was used in this study. The first factor was foliar fertilizer consisted of Growmore (20-20-20), Gaviota (12-24-24), Gandasil B (6-20-30), and Hyponex (20-20-20). The second factor was concentration of application onsisted of 0, 1, 2, 3, and 4 g L-1.

Fertilizer was sprayed thoroughly to the plant surface using a hand sprayer at rate of 100 ml plant-1 week-1. Each plant was bordered with plastic sheet to isolate the fertilizer application.

Observations were on days to flower stalk appearance after fertilzer application and number of flower stalk, length of flower stalk, flower number per stalk, number of simultaneously blooming flower, flower diameter, and vase life at 12 weeks after fertilzer application. The collected data were subjected to analysis of variance with F test at 5% level. Duncan's Multiple Range Tets (DMRT) at 5% level was employed as mean comparison procedure.

Result and Discussion

No significant interaction effect was detected on all observed characters. All fertilizer resulted in a relatively simultaneous flower stalk appearance and comparable flower diameter (**Table 1**). This finding indicated that the appearance of flower stalk in S. plicata var. Alba orchid is determined by genetic factor and physical performances of young plant when the fertilizer was applied. A flowering induction was set as the plant had 4 leaves with minimum leaf length 64 cm, leaf width 4 cm, and cormus diameter 2 cm. Application of fertilizer before this stage would not be effective in inducing flower formation. Similarly, flower diameter was genotypic dependent.

Number of flower stalk, length of flower stalk, flower number per stalk, number of simultaneously blooming flower, and vase life were significantly affected by type of fertilizer. Most of these characters influence the consumer preference. The highest number of flower stalk (3.12) was exhibited by Growmore application, which was 1.6 times higher than Gandasil or Hypones or 1.47 time higher than Gaviota. Growmore and Hyponex produced longer flower stalk, flower number per stalk, and number of simultaneous blooming flower than the other fertilizers.

Table 1. Mean performances of *S. plicata* var. Alba orchid with different types of fertilizers application

Fertilizer	Flower stalk appearance (daf)	Number of flower stalk	Length of flower stalk (cm)	Flower number per stalk	Number simultaneusly blooming flower	Vase life (day)	Flower diameter (cm)
Growmore	18.87	3.12 a	73.37 a	23.28 a	4.02 a	4.58 a	4.84
Gaviota	19.97	2.12 b	68.28 b	18.28 b	3.23 b	4.04 b	4.48
Gandasil B	19.84	1.96 b	68.67 b	17.08 b	3.13 b	4.30 ab	4.26
Hyponex	20.05	1.96 b	71.78 ab	23.28 a	4.22 a	4.06 b	4.62

Mean in the same column followed the same notation indicate non significant difference on DMRT at 5% level; waf = weeks after fertilizer application

A higher number of flower stalks indicated that plant was intensive in flower production. Length of flower stalk is important for performance of S. plicata orchid, as it determine the visibility of flower amongst long and dense foliage. Number of flower determine the duration of flower to catch sight, whereas number of simultaneously blooming flower determine the consumer preference. Normally, the more flowers bloom simultaneously the more attractive their appearance.

In general, S. plicata orchid in this study performed better than its appearance in the natural habitat. The plant is commonly set flowers after 18 month old with plant height 168 cm, cormus diameter + 4 cm, and leaf number 7. Number of flower stalk is usually only 2 at a time with 2 or 3 blooming flower. Also, flower diameter is + 3 cm with vase life about 2 to 3 days [7, 8].

Some flower characteristics were affected by concentration of foliar fertilizer application. At an optimum concentration, fertilizer can promote flower stalk appearance and increase number flower stalk, number of flower, number of simultaneously blooming flower, and flower diameter. Compared to control treatment (0 g L-1), application of foliar fertilizer at 3 to 4 g L-1 produced earlier flower stalk appearance, more flower stalk, more flower blooming simultaneously, and larger flower diameter by12.23 days, 280%, 227.02%, and 152.25%, respectively (**Table 2**)

Table 2. Mean performances of *S. plicata* var. Alba as applied with different concentrations of fertilizer

Fertilizer concentration	Flower stalk appearance (waf)	Number of flower stalk	Length of flower stalk (cm)	Flower number per stalk	Number simultaneusly blooming flower	Vase life (day)	Flower diameter (cm)
0 g L^{-1}	30.87 c	1.05 b	70.18	10.55 b	2.89 c	3.05 b	3.24 b
1 g L	24.07 bc	2.05 ab	68.25	17.55 ab	3.12 c	3.20 b	4.06 b
2 g L	19.97 a	2.95 a	68.55	23.95 a	4.40 a	4.45 a	4.96 a
3 g L	18.64 a	2.15 ab	72.44	22.90 a	3.92 ab	4.25 ab	4.82 a
4 g L^{-1}	20.05 ab	2.05 ab	73.20	22.98 a	3.49 bc	3.25 b	3.97 b

Mean in the same column followed the same notation indicate non significant difference on DMRT at 5% level; waf = weeks after fertilizer application

Application of compound fertilizer enriched with micro nutrients B, Fe, Zn, Ca, Co, Cu, Mg, Mn, Mo, and S at concentration 2-3 g L-1 was best for the generative growth of S. plicata var. Alba orchid. The present study showed that Growmore (20:20:20) or Hyponex (20:20:20) conferred more vigorous growth as well as earlier and uniform flowering than Gaviota (12-24-24) or Gandasil B (6-20-30) (Figure 1). For Dendrobium orchid, foliar fertilizer concentration 1 to 2 g L-1 was the best for increasing plant height, leaf width, and bud [9, 10, 11].

A balanced NPK application will have better effect on plant growth. Nitrogen plays an important role in chlorophyll formation for promoting better plant metabolism and, in turn, for improving carbohydrate accumulation as source of energy for flower initiation. Phosphor is important in synthesis of ATP, whereas potassium is in stomata opening and plant resistance to environmental stresses. Therefore, plant will have the capability of accelerating the vegetative growth and producing earlier blooming with uniform flower [6]. Additional Ca, Mg, and S contained in Growmore dan Hyponex can improve the enzyme activities in plant metabolism [6].

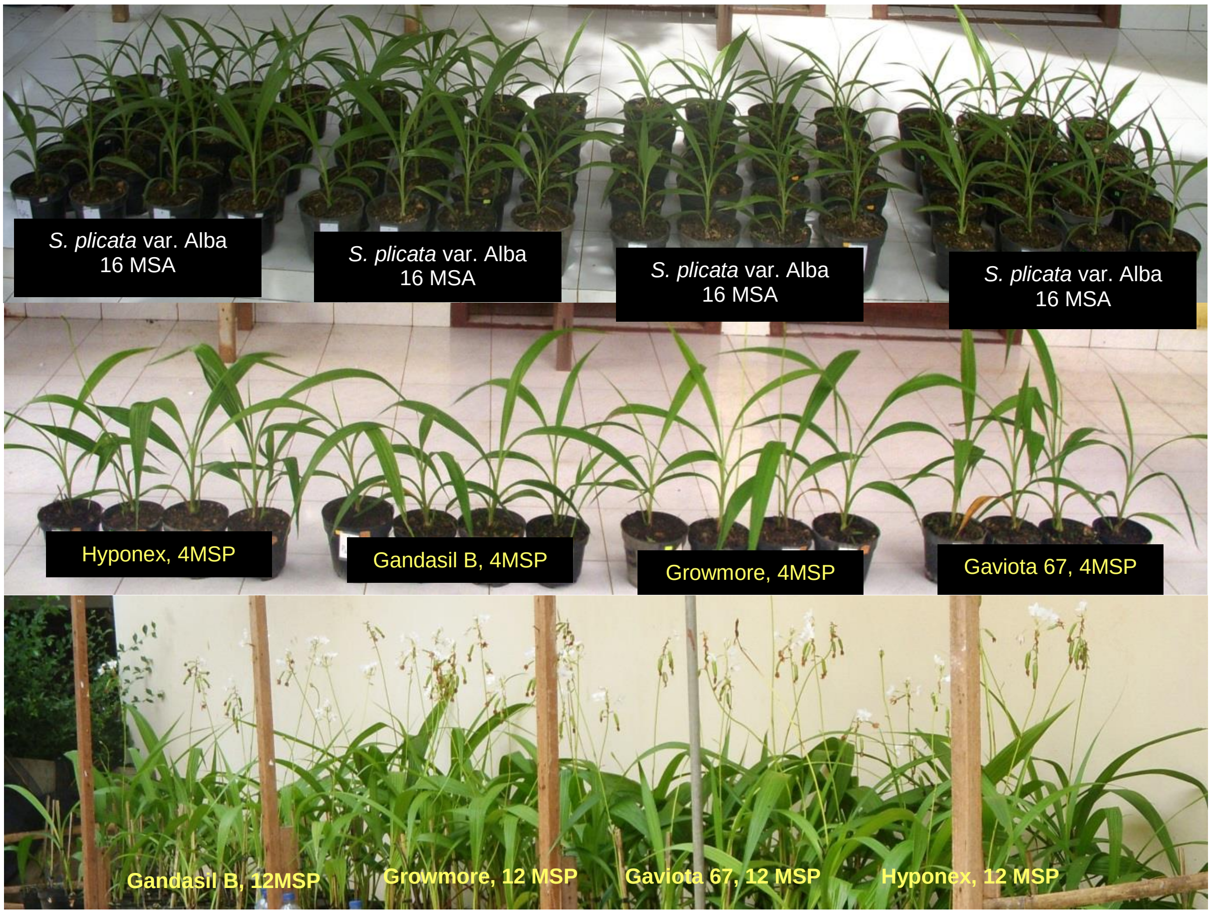

Figure 1. Performances of S. plicata orchid at 16 week after acclimatization (first row), at 4 weeks after fertilizer application (second row), and at 12 weeks after fertilizer application

Conclusion

Growmore and Hyponex concentrations from 2 to 3 g L^{-1} wer able to accelerate flowering in *S. plicata* var. Alba orchids and to induce uniform flowering, as indicated by uniformity in cormus diameter, flower stalk length, diameter and number, number of flowers, flower diameter and vase life.

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DIALLEL ANALYSIS OF BEGOMOVIRUS RESISTANCE AND AGRONOMIC PERFORMANCES IN CHILI PEPPER

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Abstract

Diallel analysis provides estimation of genetic parameters which is important in plant breeding program. This analysis can estimate gene action, combining ability and heterosis of a crossing combination. Objective of this study was to estimate the genetic paramaters of Begomovirus resistance and other agronomic characters in chili pepper using diallel analysis. As much as 42 hybrids and 7 selfed families generated from a full diallel cross of seven parental lines varying in Begomovirus resistance and yield potential were allotted in a randomized complete block design with three replications. Virus infection was made by inoculating 'Segunung' isolate from infected plant using *Bemisia tabaci* as the vector. Based on general combining ability (GCA) value, IPBC12 and IPBC10 showed as good combiners for the resistance, whereas IPBC14 was a good combiner for fruit yield per plant. Considering the value of specific combining ability (SCA), crosses of IPBC18xIPBC26, IPBC10xIPBC15 showed good crossing combinations for Begomovirus resistance and fruit yield, IPBC14x35C2 was a good combination for Begomovirus resistance, whereas IPBC14xIPBC18 was a good combination for fruit yield.

Keywords: Genetic parameters, Begomovirus, *Bemisia tabaci,* diallel analysis

Introduction

Genetic study plays an important role in developing on disease resistant crop variety. It helps elucidate the genetic mechanisms controlling the resistance to permit determining selection strategy during the breeding process [1]. Amongst the methods, diallel analysis is most commonly used to estimate the genetic parameters. This method was developed to explore the genetic behavior of quantitative traits in early generations [2] and to determine superior parents for developing hybrids with desirable performances [3].

Different approaches of diallel analysis have been devised for different purposes of genetic parameter estimation, notably those developed by [4] and [5]. Griffing's diallel is mainly developed through partition of genotypic variance components into general combining ability (GCA) and specific combining ability (SCA) components which, in turn, can be translated into genetic components, including variance to additive genetic variance, dominance variance, and heritability [6]. Knowledge of GCA and SCA estimates from a diallel cross would help the breeder in determining potential parents for creating the best hybrid combinations [7].

Yellow leaf curl caused Begomovirus is a devastative disease in a wide range of important crops causing significant yield losses [8]. In chili pepper, developing resistant varieties would be a reasonable option in easing the risk of failure in the fruit production. However, breeding for disease resistant is a complex process [9]. Several issues may decelerate the breeding process, including the genetic background controlling the resistance and determination of parental materials which generate recombinants having sufficient resistance and high yielding capacities. The objectives of present study were to estimate GCA effect and SCA effect on Begomovirus resistance and chili pepper yield relating traits for determination of potential parents in the development of new high yielding and Begomovirus resistant chili pepper varieties.

Material and Method

Study was conducted during Juli 2008 and April 2009 at screenhouse of Agriculture Production Department, University of Bengkulu and Cikabayan greenhouse and breeding orchard of Bogor Agricultural University. The parental materials used to generate F1, reciprocal, and selfed progenies through a full diallel cross were IPBC10, IPBC12, IPBC14, IPBC15, IPBC18, IPBC26 and 35C2. These parental lines were chosen on the basis of their Begomovirus resistance and agronomic performances.

Seedlings for each genotype was prepared by germinating the seeds on plastic tray containing media consisted of mixture of 1/2 soil, 1/4 compost, and 1/4 rice hull and maintained for 14 days. The resulted seedlings were, then, transplanted on 35 cm x 40 cm polybag containing mixture of 6 kg soil and 0,5 cow manure. The standard recommendations for chili pepper production were adopted in the study.

At 16 days after transplanting, each plant was individually covered with insect-proof cage. About 10 adult whitefly (*Bemisia tabaci*) which had had acquisition access period for 24 h on plants inoculated with Begomovirus carrying isolate ‘Segunung’ were placed in each caged plant for an additional 48 h. The infected plants were then sprayed with detergent solution and grown in a greenhouse in a randomized complete block design arrangement with three replications. Ten infected plants from each genotype were treated as the experimental plot.

Observations were made on disease intensity (%, measured at first harvest using equation as described by [10 and 11], where disease intesity 0 - 1 %= highly resistant, 1 – 5 % = resistant, 5 – 10 % = moderately resistant, 10 – 20 % = moderately susceptible, 20 – 40 % = susceptible, >40 % = highly susceptible); incubation period (number of days from infection to symptom appearance); plant height and first branch height (cm, measured at first harvest); days to first flowering (number of days from transplanting to first flowering); fruit diameter (mm, mean diameter of 10 fruits per plant); fruit length (cm, mean length of 10 fruits per plant); fruit number (number of fruits per plant from all harvest); and fruit yield per plant (g, total fruit weight per plant).

Analysis of variance was conducted on mean value of cross observed in each block. Diallel analysis was performed according to Grifing’s approach considering method I with random model as described by [12]. All analyses were carried out by using statistical software SAS 9.1.

Results and Discusion

Analysis of variance (ANOVA)

ANOVA for Begomovirus resistance and agronomic traits (not shown) indicated significant variations among the genotypes studied. Similarly, ANOVA for combining ability showed that variations due to GCA, SCA, and reciprocal effects were significant on all Begomovirus resistance traits and most of agronomic traits (**Table 1**). These findings suggested that additive and non-additive gene actions [13;14] and maternal effect [15;16] had important influences on the expression of observed traits. Non- significant GCA and reciprocal effects on plant height indicated that this trait was solely controlled by additive gen action. On the other hand, non-significant SCA effect on fruit number and fruit weight indicated that additive gene action was not involved in controlling these traits.

Table 1. Mean square of GCA, SCA, and reciprocal components for Begomovirus resistance and agronomic traits

Source of variation	GCA	SCA	Reciprocal
Disease intensity	803.66 **	89.91 **	125.51 **
Incubation period	183.82 **	114.62 **	102.09 **
Plant height	362.92 ns	347.34 *	210.16 ns
First branch height	390.70 **	30.64 **	32.95 **
Days to first flowering	126.50 **	46.66 *	66.32 **
Fruit diameter	621.04 **	1.04 **	0.84 **
Fruit length	0.27 **	0.01**	0.005 **
Fruit number	1908.13 **	118.39 ns	437.33 **

Fruit yield per plant	1788.04 **	907.24 ns	4920.84 **

* P<0.05, ** P<0.01 respectively

General combining ability (GCA) effect

The significant GCA components shown in **Table 1** also indicated the existence of parental line(s) that, on average, combined well with the other parental lines for the corresponding traits [17]. The evaluation of GCA effects for each pair of cross in **Table 2** suggested that there was no single parental line representing as a good general combiner for all observed traits. The negative sign of a GCA effect on disease intensity and days to first flowering indicated Begomovirus resistant and early flowering, respectively. IPBC12 exhibited a good general combiner for improving Begomovirus resistance, but not for improving fruit number and fruit weight. IPBC10 was the next good general combiner for improving the disease resistance and also served as a good general combiner for improving fruit number, but with small fruit size IPBC10 was not a good general combiner for improving fruit weight. IPBC26 was a good general combiner for minimizing disease resistance, but not good for improving fruit number and fruit weight. IPBC14 was not the best general combiner for disease resistance, but it showed as a maximum GCA effects on improving fruit number and fruit weight, indicating the best general combiner for yield improvement.

Table 2. GCA effects of six chili lines for Begomovirus resistance and agronomic traits

Traits	IPBC10	IPBC12	IPBC14	IPBC15	IPBC18	IPBC26	35C2
Disease intensity	-4.93	-9.93	-4.72	1.93	-0.86	-6.72	7.51
Incubation period	0.09	-2.87	2.70	-3.44	0.62	-2.53	-1.65
Plant height	5.11	-5.44	0.27	-1.23	-3.49	-4.33	3.06
First branch height	4.39	7.19	-0.49	-2.78	0.88	-0.23	2.55
Days to first flowering	5.13	0.55	6.47	2.39	-0.01	1.77	2.92
Fruit length	-1.87	-1.44	-0.06	-0.53	-0.09	-1.11	-0.76
Fruit diameter	-0.23	-0.18	-0.04	-0.03	-0.06	-0.05	-0.17
Fruit number	13.05	-6.67	18.22	-4.22	-5.68	-5.16	-3.61
Fruit yield per plant	-11.67	-40.91	61.68	-19.32	-17.89	-24.87	-26.96

Specific combining ability (SCA) effect

SCA effects of the crosses are presented in **Table 3**. It shows that there were a number good crosses with desirable magnitude and direction for Begomovirus resistant and agronomic performances. IPBC18 x IPBC26 exhibited a maximum negative SCA effects on disease intensity and incubation period, implying the most resistant hybrid to Begomovirus. Furthermore, this hybrid had considerable SCA effects on fruit number and fruit yield per plant. IPBC10 x IPBC15 conferred a relatively resistant hybrid to the virus and produced early flowering plant and high yield due to high negative SCA effect on days to flowering and high SCA effect on fruit yield per plant. IPBC14 x 35C2 was less resistant hybrid to Begomovirus, but it had a considerable positive SCA effect on fruit number and fruit yield per plant. Although IPBC10 x 35C2 was the second best Begomovirus resistant hybrid, it less desirable due to large negative effects on fruit number and fruit yield per plant. Similarly, IPBC14 x IPBC18 showed the maximum SCA effect on fruit yield per plant but it was relatively susceptible to Begomovirus. As [4] has pointed out that selecting for the hybrids with high specific SCA effect from at least one parent with high or average GCA effects for a desired trait is a sensible strategy for plant breeding. Considering the situation, IPBC18 x IPBC26 and IPBC10 x IPBC15 were considered the best combinations for Begomovirus resistance, days to first flowering, and fruit yield per plant, although GCA effects of the corresponding parental lines were trivial on fruit yield per plant.

Conclusion

1. IPBC12 and IPBC10 were good combiners for the resistance, whereas IPBC14 was a good combiner for fruit yield per plant.
2. Hybrid IPBC18xIPBC26, IPBC10xIPBC15 conferred good crossing combinations for Begomovirus resistance and fruit yield,
3. HybridIPBC14x35C2 was a good combination for Begomovirus resistance.
4. IPBC14xIPBC18 was a good combination for fruit yield

Tabel 3 SCA effects of crosses for Begomovirus resistance and agronomic traits

Crosses	Disease intensity	Incubation period	Plant height	First branch height	Days to first flowering	Fruit length	Fruit diameter	Fruit number	Fruit yield per plant
IPBC10 x IPBC12	0.36	-1.95	7.00	3.04	-2.54	0.61	0.02	0.57	**8.72**
IPBC10 x IPBC14	-0.07	4.04	8.48	8.97	0.36	-0.51	-0.01	20.99	-1.56
IPBC10 x IPBC15	-6.00	-1.94	14.90	0.30	-12.51	1.08	0.03	-1.51	**16.79**
IPBC10 x IPBC18	4.43	-0.65	-8.66	0.98	-0.27	-0.34	-0.03	-8.38	-4.20
IPBC10 x IPBC26	7.93	3.23	-0.97	-6.30	1.01	-0.01	0.02	2.13	17.90
IPBC10 x 35C2	-8.86	-5.77	-1.59	-5.43	4.89	-0.55	-0.02	-2.73	-11.01
IPBC12 x IPBC14	-1.42	-2.18	-10.63	-1.29	2.58	-0.63	-0.04	3.82	**2.42**
IPBC12 x IPBC15	-0.84	-4.20	-4.26	-2.35	3.15	0.21	-0.05	-0.85	0.62
IPBC12 x IPBC18	2.58	-2.41	-7.60	-4.17	-5.05	0.11	0.01	2.08	**7.50**
IPBC12 x IPBC26	-3.42	-8.42	15.71	-0.75	0.60	-0.31	-0.08	-6.76	-13.53
IPBC12 x 35C2	-2.78	21.00	-11.79	-2.07	-0.80	-0.06	0.03	7.89	**1.80**
IPBC14 x IPBC15	-5.27	-0.74	-10.63	-1.73	7.27	-0.22	0.03	-7.21	-31.11
IPBC14 x IPBC18	3.16	-1.29	9.92	2.38	2.42	0.56	0.04	-2.66	**44.81**
IPBC14 x IPBC26	6.66	10.53	3.08	0.35	-4.70	1.54	0.01	-9.53	-29.40
IPBC14 x 35C2	-0.71	-8.17	8.47	1.50	3.77	1.01	0.03	5.89	40.54
IPBC15 x IPBC18	11.73	-0.92	-6.29	-2.09	3.55	-0.31	-0.04	0.33	-20.95
IPBC15 x IPBC26	2.73	0.63	-29.12	2.94	0.12	-0.85	-0.11	4.72	13.70
IPBC15 x 35C2	0.86	-1.97	5.68	-0.67	-3.51	0.47	0.05	-2.59	-6.50
IPBC18 x IPBC26	-15.84	-11.68	18.91	2.62	0.34	0.79	0.13	8.25	**12.63**
IPBC18 x 35C2	2.29	-2.85	-1.98	0.12	-0.35	-0.01	-0.01	-2.93	-16.01
IPBC26 x 35C2	11.29	-0.11	-14.11	2.27	2.48	-0.13	-0.13	4.15	13.13

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CORRELATION AND PATH ANALYSES FOR DETERMINATION OF SELECTION CRITERIA IN CHILI PEPPER BREEDING FOR FRUIT YIELD IMPROVEMENT

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Abstract

Knowledge on trait association provides basic criteria for an efficient selection program. This study was undertaken to elucidate the most reliable fruit yield contributing traits in chili pepper. Measurements were made on 15 agronomic traits of 49 chili pepper families generated from a complete diallel cross of 7 parental lines. Analysis correlation revealed that fruit yield per plant had highly significant positive correlations with canopy diameter, fruit number, marketable yield, average fruit weight, and fruit length. Path coefficient analysis based on fruit yield per plant as the dependent variable indicated that positive direct effects of fruit number, marketable yield, average fruit weight, and fruit length were the main contributing traits to fruit yield per plant with the maximum effect was exhibited by fruit length. The significant correlation of canopy diameter with fruit yield per plant was mainly due to indirect effect over marketable yield. Both analyses suggested that chili pepper selection program for higher fruit yield could be based on these traits as selection criteria.

Key words: *chili pepper, fruit yield, correlation, path analysis, selection criteria*

Introduction

Chili pepper (*Capsicum annuum* sp.) almost always presents in Indonesian dishes making the crop as one of the most important vegetables in term of harvest area and production. The area under cultivation of chili pepper in Indonesia during 2011 was 237,253 ha with total production 1.4 million tones, whereas the annual consumption was 1.12 million tones [1]. This figure should indicate self sufficiency for national demand on chili pepper. Nevertheless, shortage is often occurred due to the use of low yielding genotypes and fluctuation in production patterns. Current average yield 6.07 tones ha^{-1} was comparatively lower than 21.5 and 14.2 ton ha^{-1} achieved by China and Thailand, respectively [2]. Development of high yielding cultivars, therefore, is the ultimate objective in chili pepper breeding program.

Fruit yield is the most important and complex trait for the genetic improvement of chili pepper [3]. It depends directly or indirectly dependent on a number of traits known as yield components. The knowledge of traits association will be helpful in determining the selection criteria for yield improvement for which direct selection is not effective. Correlation analysis generally reveals the degree of association among traits and degree of linear relation between these traits. It is not sufficient to describe causal relationship among traits and, hence, is not sufficient determine reliable selection criteria. Path analysis provides an effective means of partitioning the correlation coefficients into direct and indirect effects of the component characters on yield by which the selection criteria in crop breeding program for yield improvement can be logically devised [4]. Considering these stand points, the present study was undertaken to elucidate the most reliable fruit yield contributing traits in chili pepper as selection criteria in chili pepper breeding program.

Materials and Methods

This study was carried out on ultisol at Experiment Station of Agricultural Production Department orchard, University of Bengkulu during July 2011 and November 2011. Genetic materials consisted of 49 families of chili pepper generated from a complete diallel cross of 7 chili pepper lines, i.e. IPBC110, IPBC19, IPBC120, IPBC12, UNIBC GTS1, IPBC10, and IPBC 1. A randomized complete block design with 3 replications was used to allocate the genetic materials in 1.2 m x 3.6 m plots with 12 plants per plot. Seedlings were prepared by growing the seeds on plastic trays filled with a mixture of 1/2 soil, 1/4 compost, and 1/4 rice hull ash and maintained for 4 weeks. Seedlings from each family were transplanted on the experimental plots in a double row with spacing of 60 cm between rows and plants. All recommended cultural practices, including fertilizer application, weeding, pest and disease controls, and irrigation, were followed to rise healthy chili pepper plants.

Eight harvests at one week interval were made by hand picking the ripe fruits. Six randomly selected plants in each plot were observed for the following traits: plant height and first branch height (cm, measured at the first harvest); canopy diameter (cm, measured at the first harvest); leaf width and length (cm, mean width and length of 10 leaves per plant at the first harvest); days to first harvest (number of days from transplanting to first harvest); fruit number (number of fruits per plant from all harvest); marketable yield (number of non-defective fruits per plant from all harvest); average fruit weight (g, ratio between total weight of fruit per plant and number of fruits per plant); fruit length (cm, mean length of 10 fruits per plant); fruit diameter (mm, mean diameter of 10 fruits per plant); pericarp thickness (mm, mean pericarp thickness of 10 fruits per plant); seed number (number of seed per fruit considering 10 fruits per plant); pedicel length (cm, mean pedicel length of 10 fruits per plant); and fruit yield per plant (g, total fruit weight obtained in eight harvests).

Simple correlation analysis was performed to estimate the coefficient of correlation for every pair of the traits using IBM SPSS Statistics v19. Path analysis to estimate the direct and indirect effect to the fruit yield per plant was performed following procedure given by [5].

Result and Discussion

Estimations of correlation coefficients among the observed agronomic traits were presented in **Table 1**. Traits showing highly significant positive correlation with fruit yield per plant were canopy diameter, fruit number, marketable yield, average fruit weight, and fruit length. These findings were in accordance with [6,7,8,9]. Therefore, these five traits can be regarded as the yield components. In addition, degree and direction of these traits with the other traits were varied. Canopy diameter showed positive and highly significant correlation only with marketable yield. Fruit number had highly significant positive correlations with plant height, first branch height, and marketable yield, but it had highly significant negative correlations with average fruit weight, fruit diameter, and pericarp thickness. Average fruit weight was observed to have highly significant positive correlation with fruit length, fruit diameter, pericarp thickness, and pedicel length, but it had highly significant negative correlation with plant height, first branch height, and days to first harvest, beside with fruit number. Furthermore, fruit length conferred highly significant positive correlation with leaf length, seed number, and pedicel length alongside with average fruit weight, and highly significant negative correlation with leaf width and seed number.

Partition of coefficient correlations between fruit yield per plant and yield components by path analysis were shown in **Table 2**. The maximum positive direct effect to fruit yield per plant was exhibited by fruit length (0.575), followed by marketable yield (0.477), average fruit weight (0.426), fruit number (0.358). The importance of fruit length, average fruit length and fruit number in determining fruit yield has been reported by [10]. Highly significant positive correlation between canopy diameter and fruit yield per plant was mainly due to indirect effect over marketable yield. Similarly, Pedicel length had a comparable negative direct effect to fruit yield per plant but its total effect was relatively low. These results suggested that longer fruit, less defective fruit, heavier individual fruit, and more fruit per plant should be used as reliable criteria in the selection program for chili pepper yield improvement.

Table 1. Correlation coefficients among different pairs of agronomic traits of chili pepper

Trait	First branch height	Canopy diameter	Leaf width	Leaf length	Days to first harvest	Fruit Number	Marketable yield	Average fruit weight	Fruit length	Fr dian
Plant height	0.486**	0.074	-0.006	-0.488**	0.431**	0.555**	0.071	-0.578**	-0.273	-0.2
First branch height		0.482**	0.175	-0.092	0.371**	0.458**	0.203	-0.426**	-0.206	-0.3
Canopy diameter			0.082	0.363*	-0.123	0.350*	0.444**	-0.026	0.095	-0.
Leaf width				-0.049	0.066	0.068	-0.086	-0.303*	-0.621**	0.3
Leaf length					-0.364*	-0.231	0.049	0.384**	0.439**	-0.
Days to first harvest						0.340*	0.067	-0.471**	0.007	-0.4
Fruit Number							0.588**	-0.550**	-0.293*	-0.5
Marketable yield								0.102	0.158	-0.
Average fruit weight									0.598**	0.3
Fruit length										-0.
Fruit diameter										
Pericarp thickness										
Seed number										
Pedicel length										

Table 2. Path coefficients showing direct and indirect effects of different traits on fruit yield per plant

Trait	Direct effect	Indirect effect									
		Plant height	First branch height	Canopy diameter	Leaf width	Leaf length	Days to first harvest	Fruit Number	Marketable yield	Average fruit weight	Fruit length
Plant height	0.065	-	-0.017	0.004	0.000	0.010	-0.007	0.199	0.034	-0.246	-0.157
First branch height	-0.035	0.032	-	0.024	0.004	0.002	-0.006	0.164	0.097	-0.181	-0.118
Canopy diameter	0.050	0.005	-0.017	-	0.002	-0.007	0.002	0.125	0.212	-0.011	0.055
Leaf width	0.024	0.000	-0.006	0.004	-	0.001	-0.001	0.024	-0.041	-0.129	-0.357
Leaf length	-0.020	-0.032	0.003	0.018	-0.001	-	0.006	-0.083	0.023	0.163	0.252
Days to first harvest	-0.016	0.028	-0.013	-0.006	0.002	0.007	-	0.122	0.032	-0.200	0.004
Fruit Number	0.358	0.036	-0.016	0.018	0.002	0.005	-0.005	-	0.281	-0.234	-0.168
Marketable yield	0.477	0.005	-0.007	0.022	-0.002	-0.001	-0.001	0.210	-	0.043	0.091
Average fruit weight	0.426	-0.038	0.015	-0.001	-0.007	-0.008	0.007	-0.197	0.049	-	0.344
Fruit length	0.575	-0.018	0.007	0.005	-0.015	-0.009	0.000	-0.105	0.075	0.255	-
Fruit diameter	-0.044	-0.019	0.011	-0.004	0.008	0.001	0.008	-0.180	-0.098	0.164	-0.140
Pericarp thickness	0.024	-0.022	0.013	-0.003	-0.002	-0.001	0.007	-0.160	-0.013	0.218	0.072
Seed number	-0.006	0.020	0.005	-0.011	0.006	0.008	0.001	0.052	-0.022	-0.111	-0.336
Pedicel length	-0.346	-0.009	0.003	0.008	-0.014	-0.009	0.000	-0.108	0.063	0.221	0.508

Conclusion

Fruit yield per plant had highly significant positive correlations with canopy diameter, fruit number, marketable yield, average fruit weight, and fruit length. Path coefficient analysis based on fruit yield per plant as the dependent variable indicated that positive direct effects of fruit number, marketable yield, average fruit weight, and fruit length were the main contributing traits to fruit yield per plant with the maximum effect was exhibited by fruit length. The significant correlation of canopy diameter with fruit yield per plant was mainly due to indirect effect over marketable yield. Both analyses suggested that chili pepper selection program for higher fruit yield could be based on these traits as selection criteria.

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PROMOTING EFFECT OF ETHANOLIC EXTRACT OF ROOT TUBER OF *Gloriosa superba* L. ON MELON GROWTH AND FRUIT QUALITY

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ABSTRACT

An increase in the demand of colchicine extracted from *Colchicum autumnale* for plant mutagenic and medicinal activities makes the search of locally plant based product for its substitution critically important and *Gloriosa superba* is considerred one of them since this plant contains colchicine. For this purpose, a field experiment was done to determine the effective concentration of root tuber extract of *G.superba* L. on promoting melon growth and fruit quality. Hybrid melon seeds of Action 434 were soaked in water as a control, in 0.04 gL^{-1} colchicine, and in 10%, 20%, and 30% (wv^{-1}) root tuber extract of *G.superba*. The soaked seeds were then planted in October 2012 at Agriculture Faculty Bengkulu University research plot in a CRD arrangement. Results showed that the 20% and 30% root tuber extract of *G.superba* were highly effective in promoting melon growth as indicated by larger leaf size, taller plant, and larger flower size and fruit quality as indicated by heigher fruit weight, larger fruit diameter, thicker edible fruit with and without rind, and higher dissolved sugar content. The promoting effect of these two concentrations on growth and fruit quality was as effective as 0.04 $gL^{-}1$ pure colchicine. Overall, from these three treatments 20% root tuber extract of *G.superba* was considered the most promising treatment because at this concentration fruit weight and fruit diameter was almost 1.5 times higher and fruit was approximately 2 *Brix* sweeter.

Keywords: *alkaloid, growth analysis, fruit quality, mutagenic substance, biological active substance*

Introduction

In recent years there has been increased interest in screening higher plants for biologically active products [16] and *Gloriosa superba* L. (Family Liliaceae) is considerred one of them. *G. superba* L. also called “kembang sungsang” (Java, Indonesia) or Glory Lily (English) is a native of tropical Africa and is found growing naturally in many countries of tropical Asia including Indonesia. The plant is found in the wild on natural fences a decade back but now it has been domesticated for an economic gain. All its part contains valuable alkaloids viz., colchicine and colchicoside as the major constituents [12], gloriosin and colchicocides, which are very costly, being highly demanded by pharma industries [10]. Due to excessive use of this plant for diverse medicinal purposes and poor seed germination the species has become endangered [3].

Medicinal importance of *G. superba* is due to the presence of colchicine. Colchicine is an alkaloid drug, chemically known as N-[(7*S*)-1, 2, 3,10-tetramethoxy-9-oxo-5,6,7,9 -tetrahydrobenzo[*a*]heptalen-7-yl] acetamide, originally extracted from *Colchicum autumnale* (autumn crocus, meadow saffron) medicinal plants and widely used for the treatment of gout disease [6]. Colchicine has the high market value and consistent demand in the field of medicine [5]. The alkoloid is the drug of choice to relieve acute attack of gout and familial Mediterranean fever [1]. At present there is renewed interest in the use of colchicine as a possible cure for cancer related diseases due to the action of colchicoside on spindle fibre formation during cell division [9]. Since the detection of colchicine in *G.superba* [7], a number of researchers have suggested that this spesies could serve as a commercial source of colchicine and be recommended as substitute plants for *C. autumnale* for the alkaloid colchicine because the colchicine content in the genera Colchicum has been reported to be lower than in Gloriosa [4].

In addition for the treatment of various diseases, colchicine is also used for induction of plant polyploidy, multiplication of the chromosome in cell nucleus, due to its potent affinity for tubulin. The main action of the colchicine for the induction is to prevent the formation of a spindle so the anaphase movement of the chromosomes does not take place and the cell fails to divide. When the daughter chromosomes finally divide, they are all included in one cell and the chromosome number is doubled [9].

Polyploid plants can be of much economic importance by increasing plant vegetative growth and fruit yield. Even some flower qualities are improved by polyploidization. For example, polyploids induced by mitotic chromosome doubling showed larger and deeper-colored flowers than diploids in carnation and cyclamen [22, 20]. In lily, the large flower and sturdy stem in the tetraploids were useful as compared with those in the diploids [21]. In potato, colchicine treatment enhanced plant height, fresh weight, and number of leaves, which consequently increase the number of tuber and finally increase total fresh weight of tubers [11]. In melon, from the literature cited very few works on the effect of colchicine extracted from *G. superba* tuber on its growth and fruit quality has been reported. Thus, the present study was undertaken to determine the ffective concentration of ethanolic extract of root tuber of *G.superba* L. on promoting melon growth and fruit quality.

Materials and Methods

The research was conducted in October 2012 - December 2012 at Agriculture Faculty Research Plot Bengkulu University. The experimental design used was a completely randomized design (CRD) with the concentration of ethanolic extract of *G. superba* tuber as a treatment. The concentration of the treatments were control, 0.04% colchicine (0.04 g 100 ml of water^{-1}), 10% root tuber extract of *G. superba* (10 g 100 ml of water^{-1}), 20% root tuber extract of *G. superba* (20 g 100 ml of water^{-1}), and 30% root tuber extract of *G. superba* (30 g 100 ml of water^{-1}).

G.superba tubers collected from the Tanjung Jaya villagers Bengkulu were used as a plant material for colchicine extraction. The powdered tuber was subjected to extraction by maceration method [13]. The dry extract was then dissolved in distilled water to prepare 10%, 20%, and 30% (w v^{-1}) concentrations. For 0.04% colchicine solution, 0.04 g colchicine (Sigma) was dissolved in 100 ml distilled water. These solutions were then tested for their agronomic effects by soaking F1 hybrid (Action 434) melon seed in each solution in a petridish for 24 haours. As a control, the seed was only soaked in distilled water. The soaked seeds were then planted in a ploybag containing 10 kg media, one seed per polybag. The growing media was a mixture of soil, manure, and paddy bract. Plants were fertilized with 8.3 g urea, 7.1 g SP-36, 7.1 g KCl, and 2.4 g NPK (15-15-15) each polybag. The growing plants were kept upward by lining stem on wool string and tide it in upright position. Cutting apical meristems was undertaken on the 22nd node of stem, fruits were thinned and one selected fruit was left until harvest. Fruits were harvested at 65 – 70 days after planting when fruit maturity was attained.

Data from the observations were statistically analyzed by analysis of variance (F test level of 5%) [17] and significant differences among the treatments were ther analyzed with Duncan's multiple range test (DMRT).

Results and Discussion

Results of analysis of variance showed that a significant increase in leaf area, stem length, and flower diameter due to root tuber extract of *G. superba* was observed, but not in root fresh weight, stem fresh weight, leaf fresh weight, stem diameter, number of nodes, root length, and leaf greeness level (data not shown). Further statistical analysis with DMRT showed that 20% and 30% root tuber extract of *G. superba* caused leaf area almost three times larger than control (**Table 1**) and considered the most effective concentration for promoting leaf area. A similar result was also reported by Ernawati *et al*. [8] on chilli. According to Suryo [19], an increase in leaf area occurred because colchicine transformed a diploid plant with a characteristic of larger size of polyploid cells. For plant stem length 30% root tuber extract of *G. superba* was considered the most efective treatment for promoting plant stem length, while 10% root tuber extract of *G. superba* was the worst. Plant stem at

30% root tuber extract of *G. superba* was about one third longer than that at 10% root tuber extract of *G. superba*. For flower diameter 0.04% pure colchicine was considered the most effective treatment but as effective as 20% root tuber extract of *G. superba*. At 0.04% colchicine flower diameter was approximately 1.50 times the width of flower diameter at control. An increase in flower diameter due to root tuber extract of *G. superba* was also reporetd by Sulistianingsih [18] on orchid.

Table 1. Mean of leaf area, stem length, and diameter of flower of melon treated with pure colchicine and root tuber extract of *G. superba*

Treatment	Leaf Area [cm^2)]	Stem Length [cm]	Diameter of Flower [cm]
Control	1481.00 c	131.25 ab	2.73 c
0.04% pure colchicine	2650.75 b	146.75 a	4.25 a
10% root tuber extract	1882.00 bc	114.25 b	2.95 bc
20% root tuber extract	4205.75 a	139.00 a	3.90 ab
30% root tuber extract	5064.50 a	153.50 a	3.63 abc

Values within the same coloumn that are not sharing the same letter differ significantly at $P \leq 0.05$ (DMRT)

Analysis of variance showed that a significant increase in fruit weight, fruit diameter, fruit flesh thickness, and the sweetness of the fruit due to root tuber extract of *G. superba* was obserbed, but not in the number of seeds (data not shown). Further statistical analysis with DMRT showed that 20% root tuber extract of *G. superba* was the most effective treatment in promoting fruit weight followed by 30% root tuber extract of *G. superba* (**Table 2**). The fruit weight at these two concentrations was approximately 1.5 to 2 times the fruit weight at 10% concentration and control and was as heavy as the fruit weight at 0.04% pure colchicine. Therefore, colchicinoid substances from tuber extract of *G. superba* was as effective as pure colchicine in promoting fruit weight. This result was in agreement with the one reported by Anggraito [2]. He stated that colchicine increased the size of the fruit. For fruit diameter 20% root tuber extract of *G. superba* was considered the most effective treatment (**Table 2**). At this concentration its fruit diameter was about 1.5 times the fruit diameter at control, about 1.2 times the fruit diameter at 20% root tuber extract of *G. superba* and 0.04% pure colchicine. This result was in accordance with the one reported by Anggraito [2]. He stated that colchicine increased the thickness of fruit mesocarp. For thickness of edible part 20% and 30% root tuber extract of *G. superba* and 0.04% pure colchicine were considered the most effective treatment and 20% and 30% root tuber extract of *G. superba* were as effective as 0.04% pure colchicine (**Table 2**). At these three concentrations the thickness of fruit edible part was about 1.25 times the thickness of fruit edible part at control. According to Ramachandran [14], an increase in these fruit quality indicators were probably due to the fact that colchicine made the treated plant experienced an increasing cell size and the metabolic activity of this cell also increased. This was ultimately able to improve fruit quality. However, the same treatment was not able to increase the number of seeds. This occurred because colchicine only affected the size of the cell, but not to the acceleration of cell division, including seed cells. Therefore, for the next study it was suggested that measuring the weight of 1000 seeds is more emphasized than measurement of the number of seeds.

Table 2. Mean of fruit characteristics as affected by pure colchicine and root tuber extract of *G. superba*

Treatment	Fruit weight [g]	Fruit diameter [cm]	Fruit thickness [cm]	Thickness of edible part [cm]	Fruit sweetness [Brix]
Control	1187.50 bc	11.30 c	3.30 b	3.20 b	7.63 c
0.04% pure colchicine	1552.00 ab	14.50 b	4.65 a	4.55 a	9.13 ab
10% root tuber extract	1050.00 c	11.53 c	3.28 b	3.18 b	8.00 bc
20% root tuber extract	1925.00 a	16.20 a	4.50 a	4.40 a	9.38 a
30% root tuber extract	1587.50 a	13.78 b	4.50 a	4.40 a	9.65 a

Values within the same coloumn that are not sharing the same letter differ significantly at $P \leq 0.05$ (DMRT).

In addition to fruit weight, fruit diameter, and thickness of fruit, an increase in fruit sweetness due to root tuber extract of *G. superba* was observed. Further statistical analysis with DMRT showed that 30% root tuber extract of *G. superba* was the most effective treatment for promoting fruit sweetness (**Table 2**). In addition, this treatment was as effective as 20 % root tuber extract of *G. superba* and 0.04% pure colchicine in promoting fruit sweetness. With these three treatment fruit with 9.65 Brix of dissolved sugar content was produced. Based on melon fruit quality developed by Rubatzky and Yamaguchi [15], melon fruit with 9.65 Brix of dissolved sugar content was categorized as high quality melon because sugar content was in the range of 9 – 11 Brix. According to Rubatzky and Yamaguchi [15], an increase in fuit sweetness occurred as the impact of enlargement of stomata due to colchicine application. The increase in the stomata size subsequently improved the process of photosynthesis due to increased CO_2 that enterred through it.

Conclusion

Application of 20% root tuber extract of *G.superba* effectively promoted melon growth as indicated by larger leaf size, taller plant, and larger flower size and melon fruit quality as indicated by heigher fruit weight, larger fruit diameter, thicker edible fruit part with and without rind, and higher dissolved sugar content.

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GROWTH OF ARTEMISIA ANNUA, ARTEMISININ SYNTHESIS, AND ARBUSCULAR MYCORRHIZAL FUNGUS COLONIZATION AS AFFECTED BY ACCESSION AND FERTILIZATION

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Abstract

Limited availability of artemisinin as a medicinal compound to overcome malaria disease is a serious problem that should be solved immediately. This research was designed to obtain combination of accession and fertilization to increase *Artemisia annua* L. biomass, artemisinin content, and arbuscular mycorrhizal fungus (AMF) colonization. Experiment was conducted using Split Plot design with three replications. The main plot was the accession of *A. annua* L. which was green and purple stem. Subplot was inorganic/control and organic fertilizer (0, 0.5, 1, 1.5, and 2 ton ha^{-1} of compost). The experimental results showed accession and fertilization significantly interacted to increase plant height, biomass, and AMF colonization. However, the levels of artemisinin and essential oils were affected by either accession or fertilization only. Inorganic fertilizer significantly increased plant height of *A. annua* at 4-8 weeks after planting. Conversely, the increase of plant biomass and AMF colonization was not affected by fertilization. Green and purple stem accession had the same plant height and biomass production. However, purple stem accession resulted in higher artemisinin contents and green stem accession had higher AMF colonization. *A. annua* L. purple stem accession cultivated with spacing 75 cm x 75 cm and compost at 0.5 t ha^{-1} was predicted to produce about 10 kg of artemisinin per hectare.

Keywords: *Arbuscular mycorrhizal fungus, Artemisia annua, artemisinin, organic fertilizer*

Introduction

It has been decades that human being had to struggle coping with malaria caused by *Plasmodium vivax*, *P. falciparum*, or *P. malariae*. Every year, about 500 million people are infected by *Plasmodium* and about one million of them died [1]. In Indonesia, malaria has infected more than half million people and caused death of 900 people annually [2]. A long term use of drug from quinine derivates has resulted in a number of *P. falciparum* strains more resistant to the drug.

World Health Organization (WHO) has recommended the use of artemisinin (sesquiterpene lactone) extracted from *Artemisia annua* L. as the substitute for quinine. The plant has been known by Chinese in 4th century as anti fever medicine [3,4]. However, coping malaria with artemisinin was hampered by limited supply of artemisinin in the world market [5]. In 2005, WHO predicted that drug for anti malaria containing artemisinin only 120 – 200 million dosage [2]. Similarly, artemisinin synthesis by chemical process or biotechnology is still low [6, 7]. Therefore, new strategy is required to improve artemisinin availability.

The improvement of *A. annua* L productivity in biomass and artemisinin by expanding growing area and intensification is short term strategy to improve artemisinin availability. Area expansion implies that *A. annua* is grown on area outside its natural habitat, but knowledge on the characteristics of habitat suitable for *A. annua* is limited [8]. Previous studies, [9] indicated that interaction between cytokinin application and dosage of N determined the biomass and artemisinin productions, whereas [10] reported otherwise. On nutrient deficiencies of Ultisol, biomass and artemisinin productivities were not affected by K application [11].

Intensification means improving biomass and artemisinin productivities per unit of land area. By improving plant biomass, higher availability of artemisinin can be expected, even the artemisinin content on each plant is not high. Arbuscular mycorrhizal fungus (AMF) colonization has been reported to improve secondary metabolite content, including artemisinin and aestheric oil contents in *A. annua* L. [12]. However, there was no sufficient information on AMF isolates compatible for *A. annua* L. under organic farming on acid mineral soil as in Bengkulu, Indonesia. For this reason, this study was undertaken to determine the best combination of *A. annua* L. accession and fertilizer application for biomass, artemisinin productions, and AMF root colonization of *A. annua* L.

Materials and Methods / Experimental

A field experiment has been conducted from April to September 2012 at Pematang Donok, Kepahyang, Bengkulu (about 1000 m above sea level). Seeds of green and purple stem accessions of *A. annua* procured from The Medicinal Plants and Traditional Medicine Research and Development Institute (Balai Besar Penelitian dan Pengembangan Tanaman Obat dan Obat Tradisional, B2P2TO2T) Tawang Mangu, Central Java were germinated and maintained in nursery for two month. Transplanting of ten-leave plants was carried out on 3 m x 3 m plot according to split plot arrangement of the treatments laid on a randomized complete block design with three replications. *A. annua* accessions were allotted as the main plot and fertilizer applications, consisted of control, 0.5, 1, 1.5, and 2 ton compost ha^{-1} were allotted as the sub plot. The Control fertilizer was mixture of 100 kg N, 50 kg P_2O_5, and 50 kg K_2O ha^{-1}. Common cultural practices for raising healthy plant were applied during experiment.

Observations were made on plant biomass (g, weight of oven dried plant at the end of vegetative stage); N, P and K nutrient content of leaves (% dry weight) using general methods at Indonesian Soil Research Institute [13]; artemisinin and aestheric oil content of leaves (% dry weight, measured using Thin Layer Chromatography as developed by B2P2TO2OT); and AMF colonization on plant root measured using modified Phillip and Hayman's [14].

Collected data were subjected to analysis of variance on sample means. Means comparison was made using Duncan Multiple Range Test at 5% significant level. Correlation and regression analyses were performed to evaluate associations among observed variables.

Results and Discussion

The present study showed that there were no significant different between the accession of *A. annua* on leave N, P, and aestheric oil contents (**Table 1**). However, they were different on plant biomass, AMF colonization, and artemisinin content. Fertilizer had positive effects on plant height, plant biomass, AMF colonization, and artemisinin content. Each accession showed a different response to fertilizer, indicating the existence of interaction effect between accession and fertilizer application on plant height, plant biomass, and AMF colonization.

Table 1. Effects of accession and fertilizer application on Artemisia annua growth at eighth week after planting.

Variable	Accession (A)	Fertilizer application (P)	A x P interaction
Plant biomass	*	**	**
Percentage of AMF colonization	*	**	**
N-content of leaves	ns	ns	ns
P-content of leaves	ns	ns	ns
Arhtemicyne content	*	*	ns
Aestheric oil content	ns	ns	ns

Note: ns = not significantly different ($p > 0.05$), * = significantly differeny ($p \leq 0.05$), ** = highly significant different ($p \leq 0.01$)

Plant biomass was significantly affected by interaction between accession and fertilizer application (**Table 1**). This indicated that effect of fertilizer was determined by accession of *A annua*. Organic fertilizer showed better effect on plant biomass than inorganic fertilizer. On average, organic fertilizer produced 75.66 g per plant biomass which was higher than inorganic fertilizer (61.13 g) (**Table 2**). The highest plant biomass (121.62 g) was produced by purple-stem accession with compost application at 0.5 ton ha^{-1}. Although the plants received this treatment was not as tall as thosed received inorganic fertilizer, they had more branches and leaves. In addition, the plants performed more vigorous compared to the other treatments.

Table 2. Mean plant height at 4 to 8 week after planting, plant biomass, and AMF colonization of *Artemisia annua* with different rate of fertilizer applications.

Accession	Fertilizer	Plant height (cm) at 4 to 8 after planting					Biomass (g/ plant)	AMF colonization (%)
		4	5	6	7	8		
Green	Inorganic	73.00 b	82.67 ab	105.67 b	123.33 b	136.67 bcd	51.48 d	67 a
Green	Compost 0.5t ha^{-1}	73.33 b	82.00 ab	103.67 b	117.67 b	131.33 de	63.71 bcd	70 a
Green	Compost 1.0t ha^{-1}	74.00 b	85.00 ab	107.67 b	125.67 b	146.33 b	56.51 cd	50 a
Green	Compost 1.5t ha^{-1}	77.67 ab	88.67 ab	112.67 b	125.67 b	140.67 bcd	73.17 bc	47 a
Green	Compost 2.0t ha^{-1}	74.00 b	82.33 ab	104.00 b	118.00 b	137.67 bcd	75.00 bc	47 a
Purple	Inorganic	87.67 a	96.33 a	129.00 a	143.00 a	176.33 a	70.79 bc	37 ab
Purple	Compost 0.5t ha^{-1}	71.33 b	81.00 ab	103.67 b	115.33 b	134.00 cd	121.62 a	43 a
Purple	Compost 1.0t ha^{-1}	59.00 c	65.00 c	82.67 c	98.67 c	121.00 e	63.88 bcd	33 ab
Purple	Compost 1.5t ha^{-1}	66.33 bc	75.33 bc	102.00 b	116.33 b	144.33 bc	69.77 bcd	0 b
Purple	Compost 2.0t ha^{-1}	76.67 ab	85.67 ab	110.00 b	126.33 b	148.33 b	81.60 b	30 ab
Inorganic vs Organic								
	Inorganic	80.33 a	89.50 a	117.33 a	133.17 a	156.50 a	61.13 b	52 a
	Organic	71.54 a	80.63 b	103.29 b	117.96 b	137.96 b	75.66 a	40 a

Mean in the same column followed by the same alphabet indicated non-significant on Duncan test at 5% level.
Inorganic fertilizer = 100 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1}

AMF colonization on both accessions was determined by fertilizer application (**Table 1**). Inorganic fertilizer produced 52 % colonization, which was comparable to average of organic fertilizer (40%) (**Table 2**). AMF colonization on purple-stem accession (56%) was higher than that of green-stem accession (29%). Compost at 0.5% resulted in the highest AMF colonization, although it was statistically not significantly different with other treatments.

Artemisinin content was affected by accession and fertilizer application (**Table 1**). Purple-stem accession had artemisinin content of 0.47% which was significantly higher than that of the green-stem accession (0.43%) (**Fig. 1**). Organic fertilizer produced higher artemisinin content than did the inorganic fertilizer. Among compost applications, the 1.0 t ha^{-1} treatment produced the highest artemisinin content. However, applications of 0.5 to 2.0 t ha^{-1} tended to produce artemisinin a slight increment from 0.48 % to 0.59%.

Besides producing the highest plant biomass, compost application of 0.5 t ha^{-1} on purple-stem accession also produced relatively high artemisinin content (0.48%) (**Fig 1**), which was higher compared to previous study [15]. Laboratory analysis showed that the soil used in this study was lack of N and K. The compost containing 0.91% total N could contribute N-content of soil, mainly NO_3^- that is required in plant tissues and artemisinin formations. However, dosage of application was apparently relatively high resulting a non-significant effect on N-content of plant tissue (**Table 3**).

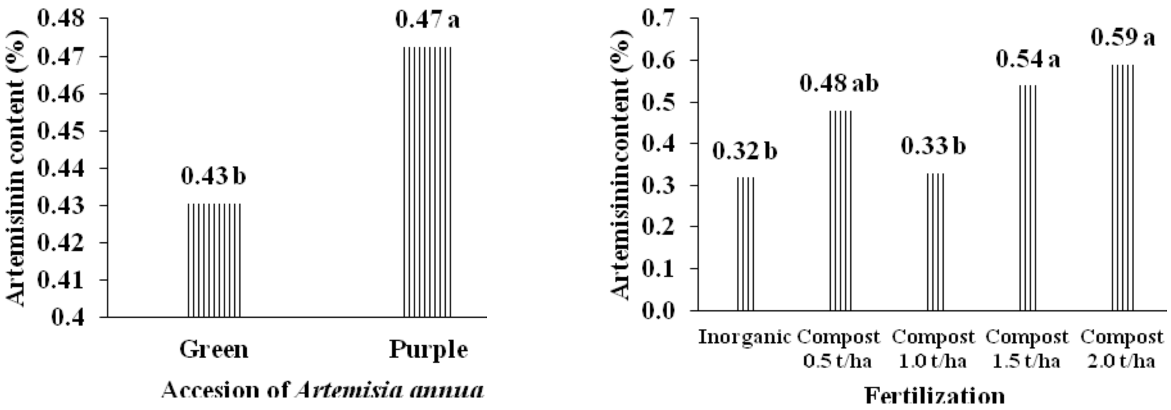

Figure. 1. Effect of accession (left) and fertilizer application (right) on artemisinin content of *Artemisia annua* L. at 8 week after planting.

Table 3. Mean N, P, aestheric oil contents of leaves tissue of *Artemisia annua* at 8 week after planting.

Accession	Fertilizer	N-content (%)	P-content (%)	Aestheric oil content (%)
Green	Inorganic	3.28	1.30	0.43
Green	Compost 0.5t ha^{-1}	3.82	1.36	0.43
Green	Compost 1.0t ha^{-1}	3.35	1.34	0.40
Green	Compost 1.5t ha^{-1}	3.98	1.81	0.43
Green	Compost 2.0t ha^{-1}	4.56	1.37	0.55
Purple	Inorganic	3.28	1.27	0.43
Purple	Compost 0.5t ha^{-1}	2.74	1.22	0.50
Purple	Compost 1.0t ha^{-1}	3.21	1.40	0.38
Purple	Compost 1.5t ha^{-1}	6.17	1.34	0.48
Purple	Compost 2.0t ha^{-1}	3.10	1.51	0.58

No significant different between accession and among fertilizer applications on N, P, and aestheric oil content. Inorganic fertilizer = 100 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1}

Compost application improves not only on N-content of soil but also on carbon compound that positively affect artemisinin production [16]. However, the improvement of compost dosage had not significantly improve plant growth and artemisinin production. Dosage 0.5 t ha^{-1} or equivalent to 5 kg N ha^{-1} was sufficiently improve biomass production and artemisinin content in green-stem *A. annua* grown at Pematang Donok, Kepahyang, Bengkulu. Furthermore, increasing K resulted from improvement of compost dosage can reduce artemisinin content [11]. Compost used in this study had K-content that meet the national standard SNI 19-7030-2004. However due to lack of K-content in the soil, improvement in the dosage of compost application had no negative effect on artemisinin content.

Significant interaction effects between accession and fertilizer application on plant height, plant biomass, and AMF colonization indicated that both genetic factor (accession) and environment (fertilizer application) played important role in these variables. Similarly, artemisinin production in the present study was affected by accession (genetics) or fertilizer application (environment). This indicated that the effects of genetic and environmental factors were comparable but they unnecessarily produced significant interaction effect on plant growth and artemisinin production. In earlier research, some workers concluded that effect of genetic factor was stronger than that of environmental factor on plant growth and artemisinin production [17, 8]. Such hypothesis was argued by other workers that environmental factor, such as planting density [18], N and cytokinin applications [9], day length and N application [15], nitrate content, phosphate, carbon compound (sucrose or glucose) [16] and micro nutrients sufficiency [19] also had positive effects on plant growth and artemisinin production in *A. annua*.

The previous study showed that at three plants m^{-2} density and application 97 kg N ha^{-1} had improved plant biomass but reduced artemisinin production [20] but at 11 plant m^{-2} had reduced plant biomass [18]. In the present study, the planting space was 75 cm x 75 cm or equivalent to 17,778 plant ha^{-1}. With this density, application of 0.5 t compost ha^{-1} had resulted in 2,162 kg biomass of *A. annua* or equivalent to 10 kg artemisinin. The improvement of artemisinin content, therefore, was not only dependent on genetic factor (accession), but also on environmental factor (fertilizer application and planting space).

Secondary metabolite production is basically determined by it primary metabolite production. Artemisinin is produced from farsenyl pyrophosphate aided by preniltransferase farnesyl diphosphate enzyme [16]. Farsenil pyrophosphate is a precursor for artemisinin synthesis [21]. The formation of this precursor requires soil phosphates [22]. All factors involved in the phosphates movement and absorption therefore had major effect on artemisinin production. The soil used in this study had high available P_2O_5 content (18.03 mg kg^{-1}). On the other hand, compost studied containing 0.30% P and categorized as low according to SNI 19-7030-2004. This made soil factor affected P supply more than compost.

High soil P-content was suspected as the cause of non-significant effect of fertilizer application on AMF colonization (**Table 2**) and P-content of plant tissue (**Table 3**). P-content of soil was recoqnized as an inhibitor for formation and development of MA symbiosis [23]. Both accession of *A. annua* seemed to have different preference on AMF. AMF colonisation on green-stem accession (56%) was significantly higher than than that on purple-stem accession (29%). However, it was reversed on artemisinin content where green-stem contained 0.43% artemisinin and purple-stem accession contained 0.56% artemisinin. This finding was inaccordance with previous studies that AMF inoculation could improve plant growth and artemisinin content [24, 25], however they did not mention the type of inoculants and AMF used in their study. Compatibility issue in AMF-plant symbiosis is commonly known [23]. Therefore, compatibility test should carried out to determine type of AMF that effective in improving biomass production and artemisinin content. The direct or indirect role of AMF on primary and secondary metabolite production was previously reported by other researcher [26]. AMF colonization also has been reported to have capability of improving salicylic acid [27] and jasmonic acid [28] which, in turn, improve artemisinin content in *A. annua* L.

Conclusion

Inorganic fertilizer of 100 kg N + 50 kg P_2O_5 + 50 kg K_2O ha^{-1} had positive effect in improving plant height of *A. annua*, whereas compost application of 0.5 t ha^{-1} produced the highest plant biomass (121.62 g) and artemisinin content (0.47%) on purple-stem accession. The artemisinin content produced by compost application of 0.5 t ha was as high as that produced by compost application of 2.0 t ha^{-1}. Colonization of AMF was more influenced by soil characteristics that rich in available P_2O_5 than did compost application. Green-stem accession was more colonized by AMF than did green-stem accession. Artemisinin content was determined by accession or fertilizer application. Purple-stem accession had artemisinin content higher than the green-stem accession did. Identification and production of AMF inoculants need futher study to determine the most effective AMF.

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VARIABILITY OF SEVEN ISOLAT OF *Colletotrichummusae* THE PATOGEN OF ANTHRACNOSE DISEASE ON BANANA FRUIT

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Abstract

In order to extend shelf life of banana fruit, controlling anthracnose disease must be done. Knowledge of *Colletotrichum musae*, the pathogen causing anthracnose disease, is needed to be studied in order to get better understanding about the patogen. The characteristics and virulence of the patogenare very important as a basic knowledge on controlling anthracnose disease.The objectives of this research were to characterize seven isolates of *C. musae* and to study the virulence of all isolates on banana fruit cvambonCurup. Methods of experiment were (1) isolation of *C. musae* from seven cultivars of banana (Kepok, Jantan, Srindit, Mas, Moli, ambon Hijau, and ambon Curup) using three kind of media (Potato Dextrose Agar, Banana Peel, and Banana Peel Dextrose Agar), (2) characterization of isolates, and (3) virulence study of isolates on banana fruit cvambonCurup. The variables that was observed were the diameter of colony, number of conidia, development of colony, incubation periode, diameter of lesion, and time for lesion to be united.The result indicated that on Potato Dextrose Agar media, all isolates of *C. musae* had white colony and become grey with the age which the centre of colony was black-very black. On Banana Peel and Banana Peel Dextrose Agar, the colour of all isolates colony were darker. Aerial mycelia grew with different thickness. All isolates had septate hypha, conidia were oval, nonspetate, hyaline with the size 8.12 – 11.5 x 3.04 - 3.89 µm, and had no setae. Isolate from banana cultivar Kepok had the highest number of conidia.Isolate from banana cultivar Jantan was the most virulen isolate because it had the shortest incubation periode (3.77 days), the biggest diameter of lession (21.28 mm), and the shortest time for lession to be united (7.90 days).

Key words: *Colletotrichummusae,* anthracnose disease, banana

Introduction

Ambon Curup banana fruit is very famous in RejangLebong District, the Province of Bengkulu, due to its high sugar content, delicious taste, good flesh color, and excellence texture. As a result, Ambon Curup banana fruits have good prices and people love to have them as a table fruits [1]. However, because of its high sugar content, low tannin contents, and thin wax layer, the fruits are very susceptible to anthracnose disease, caused by *Colletotricum musae*. Therefore, a very effective and efficient method to control the disease needs to be established to prolong the fruit shelf life so we can market the banana overseas.

The first step to control the disease is by understanding the characteristic of the pathogen and its virulence. The objective of this research was to study the characteristics of *Colletotricummusae*and its virulence on Ambon Curup banana fruits.

Materials and Methods

The experiment was carried out at the Plant Protection Laboratory, Faculty of Agriculture, Bengkulu University and at the Micology Laboratory, Faculty of Agriculture, GadjahMada University.

The experiment was conducted in three steps as the following: isolation, characterization, and testing the virulence of *C.musae*.

Isolation of Colletotrichum musae

The fungi of *C.musae*were isolated by moist chamber method from seven different banana varieties ("*Kepok*", "*Jantan*", "*Srindit"," Mas", "Moli", "Ambon Curup"*, and "*Ambon Hijau"*) having been infected by anthracnose disease. The banana fruits were washed under running water to eliminate the debris and were followed by blotch drying with clean clothes. Afterward, the fruits were disinfected with sodium hypochloride of 1% for 3 minutes, washed with sterile water, and air dried.

The fruits showing anthracnose disease symptoms were peeled. The inside part of the peel were cut in a size of 1 cm x 1 cm. The cuts were incubated in the petri dishes containing Potato Dextrose Agar (PDA) under room temperature condition. The hypha growing from the spot of anthracnose were sub-cultured to a new PDA medium and the colony of the fungi was identified to get a pure culture of the anthracnose fungi.

To get a stabile isolate of *C. musae,* suspension of conidia was stricken in an S shape onto a new solid PDA medium by following the method developed by Boisson and Lahlou having been modified by Hadisutrisno [2]. After six hours of incubation under room temperature, a single germinating spore was isolated in a new PDA medium and incubated for 4 x 24 hours to get a single spore isolate.

Characterization of C.musae fungi

The pure culture of the seven isolates of *C.musae* were multiplied in five replication by growing a dish of culture 6 mm in diameter produced by using a cork borer in the center of the PDA medium. The variable measured to characterize the colony include: (1) Colony diameter, observed from the day one to the day when the colony fully occupied the dish; (2) Conidia density, measured by haemositometer on day seven after incubation. A ten milliliter of sterile water was poured onto the culture, followed by conidia harvest by sweeping the conidia suspension with sterile L glass three times. The culture was diluted to a certain concentration and then the conidia density was measured with hemositometer under 100x magnifying microscope; (3) Colony growth was measured by the change of the colony color, evaluated since day one until no more color change took place. The color of the colony was compare to that of Metheun Handbook of Colour [3]. Colony thickness was also observed visually every day since day one to day seven of the incubation. To promote seta growth, *C.musae* isolate was grown under Banana Peel Dextrose Agar (BPDA) and Banana Peel (BP). Observation was done when the culture had been isolated for at least seven days in culture.

Virulence Test of C. musae Fungi

Mature Ambon Curup banana fruits were inoculated with *C.musae* isolate by following the method described by Martoredjo [4]. The fruits were washed under running water, air dried, disinfected with 1% of sodium hypochloride solution for 3 minutes, and rewashed with sterile water. The fruits then were punctured for 2 mm in depth in three different spot (petiole end, middle, stem end), by using sterile needles. A disc of *C. musae* isolate, 6 mm in diameter, was taken from 7 days old culture and put on top of the hole on the fruits. The fruits were incubated under room temperature (27 ^{o}C) for further observation.

The variables observed included: (1) Incubation period, observed daily from the day of incubation to the day of infection, indicated by the appearance of brown spots on the inoculation spot; (2) Brown spot diameter, observed daily by measuring diameter of the spot appeared on the banana peel; (3) Period of brown spot union, observed daily by counting the day when all brown spot get in touch together. The shortest period of union, the fastest time to show infection symptom, and the largest diameter of the colony were used to determine which isolate was the most virulence one.

Results and Discussion

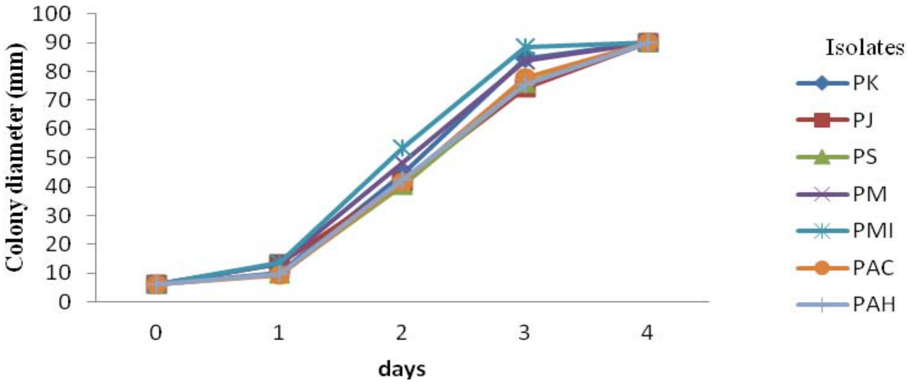
Characteristics of Colletotrichum musae Fungi

All *C.musae* isolates incubated under 27 ^{o}C and 90% of relative humidity had fully covered the surface of the petri dish on the 4th day, with the highest rate of diameter growth on the day 2. Among the isolates, Moli isolate (PMI) showed the largerst colony diameter growth on the day 1 and day 2, but slowed down on the day 3. (**Table 1**, **Figure 1**).

Table 1.Characteristics of *Colletotrichum musae* isolate.

Isolate	Colony diameter (mm) based on the incubation period					Conidia density (x 10^6/ml)	Colony growth
	0	1	2	3	4		
Pisang kepok (PK)	6.0 a	10.0 c	44.5b	84.5a	90 a	7.21 d	1A1-1D1-1E1-1F1, thick, dark black at the center
Pisang jantan (PJ)	6.0 a	13.2ab	41.5b	4.2ac	90 a	1.70 ab	1A1-1D1-!E1-1F1, thin, grey at the center
Pisang srindit (PS)	6.0 a	9.9c	40.5b	75.7a	90 a	0.71 a	1A1-1D1-1E1-1F1, thick, dark black at the center
Pisang mas (PM)	6.0 a	13.3 ab	48,.ab	83.8a	90 a	1.48 ab	1A1-1D1-1E1-1F1, between thin and thick, black at the center
Pisang moli (PMI)	6.0 a	13.6a	53.5a	88.4a	90 a	.,69 bc	1A1-1D1-1E1-1F1, between thin and thick, black at the center
Pisang ambon Curup (PAC)	6.0 a	9.3c	41.5b	77.7a	90 a	2.47 bc	1A1-1D1-1E1-1F1, thick, black at the center
Pisang ambon hijau (PAH)	6.0 a	9..7c	42.5b	75.3a	90 a	3.25 c	1A1-1D1-1E1-1F1, thick, black at the center

Note: two or more numbers followed by the same letter at the same column were non significant based on Duncan's Multiple Range Test on 5%
1A1: white, 1D1: light grey, 1E1: grey, and 1F1: dark grey

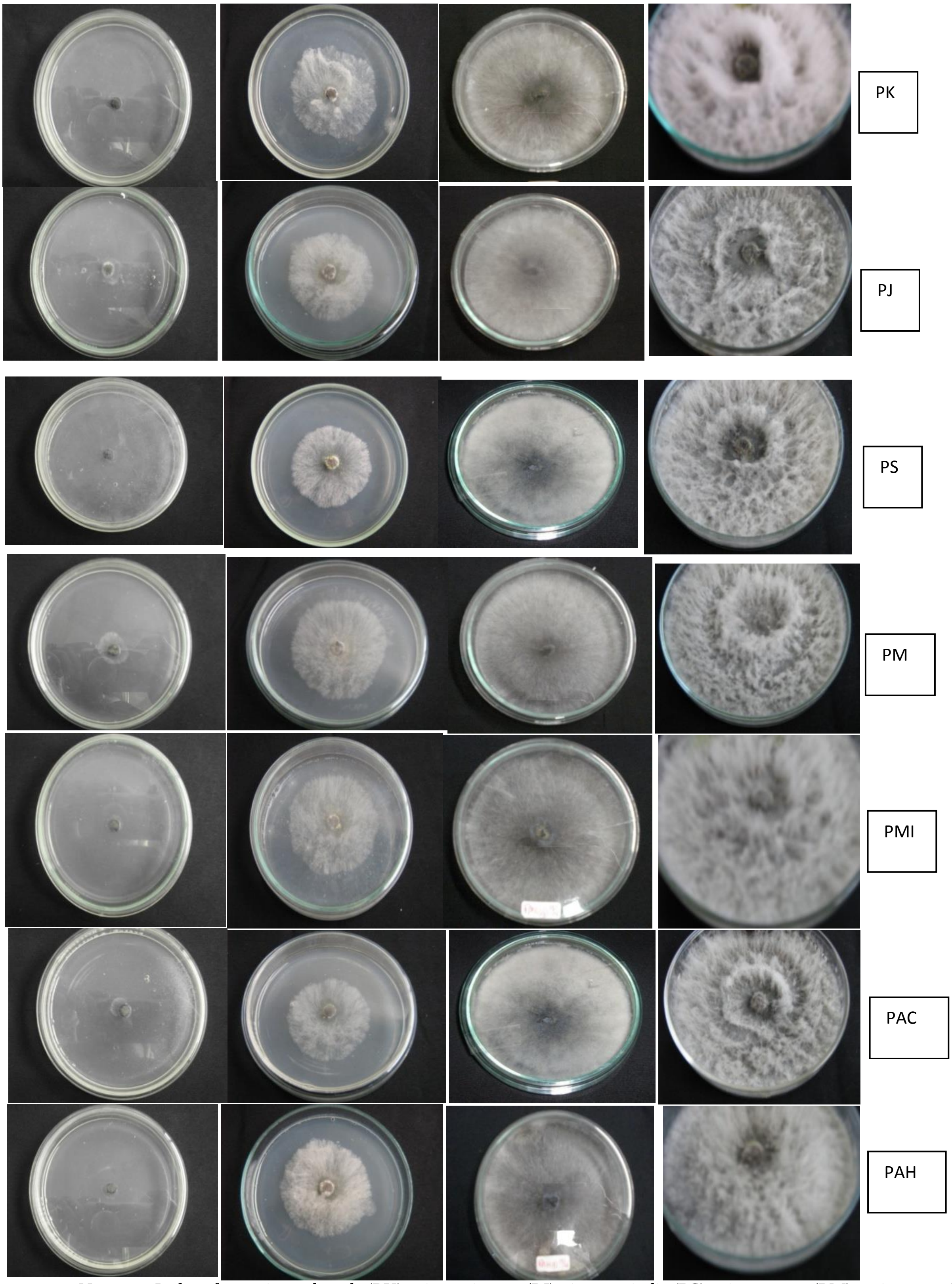


Note: Isolat pisang kepok (PK), pisang jantan (PJ), pisang srindit (PS), pisang mas (PM), pisang moli (PMI), pisang ambon Curup (PAC), and pisang ambon hijau (PAH).

Figure 1.Diameter growth of the seven isolates of isolate *Colletotrichum musae*

All isolates of *C.musae* demonsrated uniform color when grown on PDA media. The colonies were initialy looked white and finally turned to grey and dark grey in the end of the incubation period. These findings were conformed with the previous report by Kornerup and Wanscher [3] reporting that based on the Meutheun Handbook of Colour, the growth of *C musae* isolate showed the change in color pattern as follow: Code 1A1 (*white*) – 1D1 (*light grey*) – 1E1 (*medium grey*) – and 1F1 (*dark grey*). The center of the colony, from which the air miselia grew in different rate, looked blackish to black (**Figure 2**).

When grown on the Banana Peel Dextrose Agar (BPDA), the isolates showed the same colony growth rate as those grown on the PDA media. However, the colony grown on the BPDA showed darker colony color than those grown on PDA meda.



Note: Isolate from pisang kepok (PK), pisang jantan (PJ),pisang srindit (PS), pisang mas (PM), pisang moli (PMI), pisang ambon Curup (PAC), danigur ?

Figure 2. The growth of *Colletotrichummusae*colony at different period of incubation (1, 2, 3 and 5 hari, from left to right) on PDA media.

Different from the rest, pisang jantan (PJ) isolate showed blackish color at the center of the colony with thin air miselia while the others showed black to dark black color at the center of the colony with thick air miselia (**Table 1**). Moreover, pisang kapok (PK) isolate demonstrated the highest number of conidia among them.

Microscopic observation demonstrated that all isolates of *C.musae* had segmented hypha and non-segmented oval conidia with colored hialin, whose size was 8.12 – 11.5 μm x 3.04 – 3.89 μm (**Figure 3**). Furthermore, the results showed that all isolated produced no seta when grown in PDA, BP, and BPDA media.

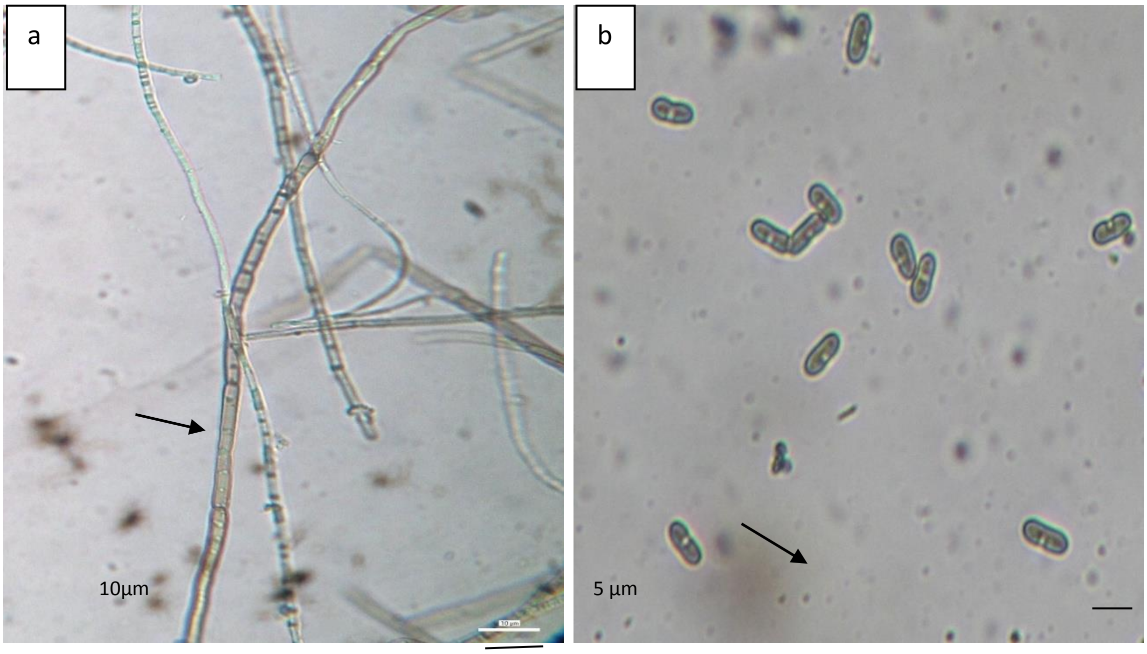


Figure 3. Hypha (a) and condia(b) of *Colletotrichum musae*

These findings confirmed the previous works of Ploets s or z *et al*. [5], [6], and [7] demonstrating that the color of *C.musae* colony grown on PDA media grew from white to grey, with no seta and sclerotium. Moreover, the isolates produced oval conidia and colored hialin with 11-17 x 4-6 μm [7] or 12-17 x 4.5-5.5 μm [6], and no segment [5]. Furthermore, Abdul-Elsalam *et al*. [8] reported that 11 isolates isolated from imported banana in Saudi Arabia produced non-segmented oval conidia and no seta. The results of genetic analysis of the 11 isolates with *Microsatellite-Primed PCR (MP-PCR)*showed that the genetic variability of the isolates was very narrow with 83-100% degree of similarity.

***Colletotrichummusae* Virulence**

The results of virulence test of seven isolates on Ambon Curup banana fruits demonstrated that the isoaltes incubation periods were 3.77 – 6.60 days, with 2.78 – 21.28 mm in diameter brownspot and 7.90 – 9.90 days of period to the spot to unite (**Table 2**). Further analysis showed that *C. musae* isolated from pisang jantan (PJ) had the shortest period of incubation (3.77 days), largest brown spot diameter (21.28 mm), and shortest period of brownspot union (7.90 days). These results suggested that the PJ isolates was the most virulence isolate among the seven isolates tested on the Ambon Curup banana fruit. Furthermore, the severity of anthracnose disease of the seven isolates of *C. musae* was presented on **Figure 3**.

Table 2. The virulenceof seven isolates of *Colletotrichum musae* on Ambon Curup banana fruits

Isolates	**Incubation Period (days)**	**Spot Diameter (mm) on the 6th day**	**Period of brown spot union (days)**
Pisangkepok (PK)	4.13 de	10.20 bc	8.50 cd
Pisangjantan (PJ)	3.77 de	21.28 a	7.90 d
Pisangsrindit (PS)	6.00 ab	7.28 bc	9.80 ab

Pisang mas (PM)	4.30 cde	12.58 b	8.00 d
Pisangmoli (PMI)	5.20 bc	11.20 bc	8.30 cd
PisangambonCurup (PAC)	4.87 cd	10.05 bc	9.20 abc
Pisangambonhijau (PAH)	6.60 a	2.78 c	9.90 a

Note: Data followed by the same letter at the same column were not significant based on DMRT at 5%

It appeared that the degree of virulence of *C. musae* isolated from pisang jantan (PJ) was related to its ability to produce enzyme that degrades the host pathogen cell wall (*cell-wall degrading enzymes*) and phytotoxin. Albaersheim and Anne [9] and Lara-Marquez *et al.* [10] reported that *Colletotrichum* sp. produced compound of enzymes to degrade the host cell wall. The first enzymes produced were polygalacturose and pectin liase, enzymes which degraded polymer pectin. The groups of enzymes were α and β-galactopiranosidaseas well as α-arabinofuranosidase to degrade polymer of araban neutral and galactan. The first set of enzymes play important role in degrading the host cell wall so that the *Colletotrichum* fungi could penetrate the host very easily while the seconf groups play important role in the nutrition uptake from the host to the fungus. Albersheim and Anne [9] reported that *C.lindemuthianum* produced polygalacturonase for hydrolyzing polygalacturonan and pectin liase to depolymerasize pectin of green bean. Based on its enzyme and phytotoxin production, the highest pathogenity (virulence) was founf in *C.musae* isolated from pisangjantan (PJ), as suggested by Bailey *et al.* [11] having identified three types of fitotoksin, *colletotrichin*, *colletopyrone*, and *aspergillo-marasmin*from culture fitrat of *Colletotrichum*.

Note: Isolate of pisangkepok (PK), pisangjantan (PJ), pisangsrindit (PS), pisang mas (PM), pisangmoli (PMI), pisangambonCurup (PAC), and pisangambonhijau (PAH)

Figure 4. Anthracnose disease severity of sevenisolates of*Colletotrichummusae*on ambonCurup banana fruits after 7 days of incubation

It was likely that the morphological characteristic of air miselia of *C musae* colony isolated from pisangjantan (PJ) contributed to the degree of virulence of the fungi. As reported by Hadisutrisno [2] finding that a fungus having very thin air miselia demonstrated very high degree of virulence. As a matter of fact, PJ isolate had very thin air miselia.

Our preliminary study showed that when the inoculum of *C musae* was inoculated to the banana fruits without making any puncture, the infection had not yet taken place when the banana fruit riped. So, we had to make a small hole, with sterile needle, and cover the whole with a mass of inoculum to make sure that the inoculum penetrated well into the banana peel or flesh. Bailey *et al* [11] found that even though direct penetration of the pathogen is the common way of *Colletotrichum* to penetrate its target, the best infection of *Colletotrichum* on heart of banana flower took place when there was a puncture present. Because of this, avoding bruise during banana harvest is very imperative to prevent anthracnose infection.

Conclussions

1. All colony of *C.musae*isolates were initially white then turned to grey when aging, grey to dark black in the center, with thin to thick air miselia, oval conidia, hialian and aseptat.
2. *C musae* isolate of pisangjantan was the most virulence isolate for Ambon Curup banana fruits.

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THE PROMOTION OF RURAL COMMUNITIES PARTICIPATION TO CONSERVE BIOMASS AND CARBON FUNCTIONS OF PEATLAND ECOSYSTEM IN RIAU BIOSPHERE RESERVE

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Abstract

Riau Biosphere Reserve covers a total area of 698,663 ha used to promote sustainable development of tropical peatland in the landscape scale. Unfortunately, most of the area has been deforested and converted to agro-silvocultural lands. Many peatlands are wasted out as shrublands after deforestation, since drying peat is very prone of fire, especially in long dry season. On the other hand, biosphere reserve still stored huge amount of biomass and carbon functions. The average of above-ground biomass is 115.25 Mg ha^{-1} storing below-ground carbon of around 5092.5 Mg ha^{-1}. Therefore conservation activities are important to be done continuously due to multiple functions of peatland. We have been collaborating with State Agency for the Conservation of Natural Resources (BBKSDA) Riau and Indonesian Institute of Sciences (LIPI) in Temiang since 2010. BBKSDA Riau is working on creating a model of "Conservation Village" and LIPI is working for the implementation of "Biovillage Concept". The project covers three activities which are enhancing the awareness of the importance of peatland ecosystem among local communities, designing the participation of local communities in peatland conservation and restoration through ecotourism, and generating local community incentives through purchasing seedlings from their nursery to extend experiment plots of local community-based restoration of degraded peatland in Tanjung Leban Village. We selected two degradation levels of peatland as follows: moderately degraded due to illegal logging activities in conservation areas of Bukit Batu Wildlife Reserve, and severely degraded of peatland due to fire. Restoration experiments started since 2010. Typical native species of peatland ecosystem were used such as *Callophylum lowii*, *Palaquium sumatranum*, *Shorea uliginosa*, *Mezettia parfivolia*, *Cratoxylon arborescens*, *Dyera lowii*, *Palaquium burckii*. Those species have both high conservation and economic values.

Keywords: *biomass, Biosphere Reserve, Biovillage, carbon, peatland ecosystem*

Introduction

A healthy natural environment such as natural peat swamp forest provides people not just with various goods (food, land, water, medicine) but also with a wide range of ecosystem services. These ecosystem services are often not apparent but assessing them involves the understanding of ecological complexity (ecosystem structures and processes) into a more limited number of ecosystem functions that are valued by humans [1].

Forest ecosystems are important in the terrestrial C cycle, as they store large amounts of C in vegetation, detritus and soil. C sequestration in sustainably managed forest can contribute to the drawdown of atmospheric CO_2. Optimum carbon storage in tropical peat requires a combination of high vegetation biomass (carbon sequestration potential), a water table that is near to or above the peat surface for most of the year, and a much-reduced rate of organic matter decomposition. Drainage and other disturbances lead to increased surface peat aeration decomposition, and carbon losses [2].

Furthermore, large degraded peatlands that are burned annually affect the world's climate by releasing globally significant amounts of carbon that are stored in forest vegetation and soils. Conversion of peatland for agriculture and plantations requires radical changes in the vegetation cover and permanent drainage. These changes reduce or, in most cases, remove the carbon sink capacity of the peatland system by lowering the peat water table which ensures continuous aerobic decomposition of organic matter, increases peat temperature, and hence enhances aerobic heterotrophic respiration and higher peat surface CO_2 emissions for most, if not all of the year [3],[4].

Although peat swamp forests are among the most rapidly disappearing forest types in the world, the importance of these forests for carbon sequestration and other ecosystem functions are widely recognized [5]. In a natural state, peat swamp forests are characterized by dense forest vegetation, thick (up to 20 m) peat deposits, and a groundwater table that is above or close to the peat surface throughout the year [6],[7],[8]. Peat has low bulk density (approximately 0.1 g cm^{-3}), being composed of approximately 10% tree remains and 90% water [9], and is 50-60% carbon by dry weight [2], [10]. Peat swamp forest stores large amounts of carbon in plant biomass, with typical values ranging 100-250 t C ha^{-1} [2].

Meanwhile, peatland of 2772 t C ha^{-1} is based on an average peat thickness of 5.50 m [2]. Peatlands' carbon (C) reserve is very high, ranging from 30 to 70 kg C m^{-3} [11] or equivalent to 300 to 700 Mg C ha^{-1} per meter of soil depth. Initial estimate shows that on average, peat in Sumatera is thicker and has C content of approximately 3000 Mg ha^{-1} [12]. Nevertheless, data availability on biomass and carbon storage in the remaining peat swamp forests is scarce [13].

One of the serious problems in sustainably managing peat swamp forests is their current state of severe degradation. In the Biosphere Reserve, land conversion and poor management had caused the loss of around 300,000 ha of natural peat swamp forest within the past 17 years. In addition to companies, local villagers also converted lands along Bukit Batu river basin for rubber jungle garden. The villagers used to only plant jungle rubber as marking for their own land but nowadays, younger villagers extend and convert more natural forest to establish wider land of rubber jungle cultivation. As a result of these land conversions and loss of drainage, forest fires occur annually, especially during dry season further worsening land degradation. Meanwhile, the remaining peat swamp forest in the core area of the Biosphere Reserve is subject to illegal logging activities. Local people used to gather timber and non timber forest products such as seeds of *Palaquium sumatranum* to produce oil for cooking, white latex from *Dyera lowii* and *Payena lerii*, and bark of *Alseodaphne ceratoxylon* used as mosquito repellant. Other trees provide medicine and fruits.

There is now a dilemma in sustainably managing tropical peatlands. They need to be conserved as they provide important ecosystem services but it is also a local reality that peatlands provide a quicker and more accessible solution to the problems of population growth and the lack of farm land and livelihoods sources.

This paper highlighted estimation of the amount of remaining carbon resources in various land use cover of the biosphere reserve and designing local community participation to involve efforts of peatland ecosystem conservation.

Materials and Methods

Site descriptions

In 2009, the peatland in Giam Siak Kecil-Bukit Batu area, altogether with its surrounding areas, have been embraced as a Biosphere Reserve by UNESCO. The core area of this reserve consists of Giam Siak Kecil Wildlife Reserve, Bukit Batu Wildlife Reserve and former Production Forest that connects them.

Research was carried out within the core, transition area and buffer zone of Giam Siak Kecil-Bukit Batu Biosphere Reserve following different land use covers: natural forest areas, developed peatland areas, and degraded forest areas. We classified three distinct peatland land uses. Firstly, peatlands with forest vegetation cover - represented in natural forest, logged over forest, and wind disturbed forest. Secondly, peatlands planted with either acacia or oil palm plantation.

To promote local participation in order to conserve important biomass and carbon functions, we carried out restoration experiments, initiated to establish an organization in village level, and invited wider stakeholders such as Natural Resources and Conservation Agency of Riau (BBKSDA) established village conservation model (MDK), and Indonesian Institute of Sciences (LIPI) in Biovillage Project. The program was implemented mainly in Temiang Village, then Tanjung Leban Village of Bengkalis District.

We have selected Temiang as the main target of our activities for several considerations:

1. This village is situated in the most immediate vicinities to Bukit Batu Wildlife Reserve.
2. The people of Temiang have been interacting with the peat swamp forest and river in the reserve for generations. The biological resources in the reserve serve as supplements to their livelihoods.
3. We have been collaborating with State Agency for the Conservation of Natural Resources (BBKSDA) Riau and Indonesian Institutes of Sciences (LIPI) in Temiang since 2010. BBKSDA Riau is working on creating a model of "Conservation Village" and LIPI is working for the implementation of "Biovillage Concept". "Conservation Village" refers to the socio-economic empowerment of human communities inhabiting the vicinities of protected areas through the provision of alternative livelihoods in order to prevent encroachments into the protected areas. "Biovillage Concept" refers to the application of low-cost but innovative technology to optimize the utilization of local biological resources, such as for the production of food and generation of energy that sustain the basic needs of local people.

We also selected Tanjung Leban as a target location for restoration, since it has the largest area of degraded peatland in Bukit Batu Subdistrict. It is also because Temiang has limited area to accomodate a restoration trial. We have been interacting and collaborating with the locals at this village since 2009.

Data collection

a. Aboveground carbon storage

Aboveground biomass and carbon storage was observed in 0.5 ha from 25 x 25 m plot for each type of the following forests: natural forest, logged over forest and wind disturbed forest in total are of 3 ha. The measurement of trees with DBH>3 cm was based on allometric equation calculation.

b. Belowground carbon storage

For the parameters of percentage C content and bulk density, peat samples were taken from soil with depths of 0-20 cm, 20-40 cm and 40-60 cm. Drilling was used to determine peat depth. The C content analysis was done in the Soil Laboratory of Bogor Agriculture University, Indonesia. Meanwhile, bulk density was analyzed in the Ecology Laboratory of Riau University.

Analysis

a. Carbon storage

Total aboveground biomass in each plot was estimated also using an allometric equation [14]. The allometric equation is:

$$Y = \exp(-2.134+2.53*\ln(D)) \qquad \text{(Eq.1)}$$

where Y is total aboveground biomass in kg/tree and D=diameter at breast height (DBH in cm).

For comparison, we used the allometric equation used in the following studies previous study below:

$$Y = \exp(-2.289+2.694 \ln(DBH)-0.021 (\ln (DBH)) \qquad \text{(Eq.2)}$$

The aboveground carbon storage was calculated by assuming that the carbon storage is 0.5 of the total aboveground biomass [15].

We used other secondary data sources to assume the amount of aboveground carbon storage of acacia, rubber, and oil palm plantation. These data were used to determine the total amount of above and belowground carbon storage in all the different land uses in the biosphere reserve.

b. Belowground carbon storage

The estimation of belowground carbon storage (Mg C/ha) involves determining bulk density of the soil organic matter content. We estimated bulk density by using tube core or clod method with the following formula: Bulk density (g/cm^3) = (weight of soil with tin-weight of empty tin)/volume of the tin [16].

The below carbon storage was estimated using the equation below:

$$C \text{ (ton)} = \sum [A \text{ (each depth category)} \times D \text{ (in each category)}] \times BD \times CC \quad \text{(Eq.3)}$$

where:

C : total carbon (ton/Mg)
A : area (ha)
D : average depth (meter)
BD : bulk density (g/cm^3)
CC : carbon content in peat sample (%)[12],[17],[18].

Results and Discussion

Aboveground biomass was estimated for the different forest types in order to indicate the proportion of carbon storage and carbon sequestration as presented in **Figure 1**. Mean carbon storage per ha varies from 10.6 Mg C ha^{-1} to 60.8 Mg C ha^{-1}. Comparison using calculation through other equations shows that carbon storage is higher in all of the sampling plots (**Figure 2**). A similar trend is observed, however, with the highest carbon storage is from natural forest (plots 1, 2, 3), followed by logged over forest (plot 4) and wind disturbed forest (plots 5 and 6). The highest amount of stored carbon ranges from 89.6 Mg C ha^{-1} to 98.2 Mg C ha^{-1} in natural forest (plots 1, 2, 3), followed by logged-over forest (plot 4) with 71.5 Mg C ha^{-1}, and decreasing in wind-disturbed forest (plot 5 and 6) ranging from 15.7 Mg C ha^{-1} to 37.8 C Mg ha^{-1}.

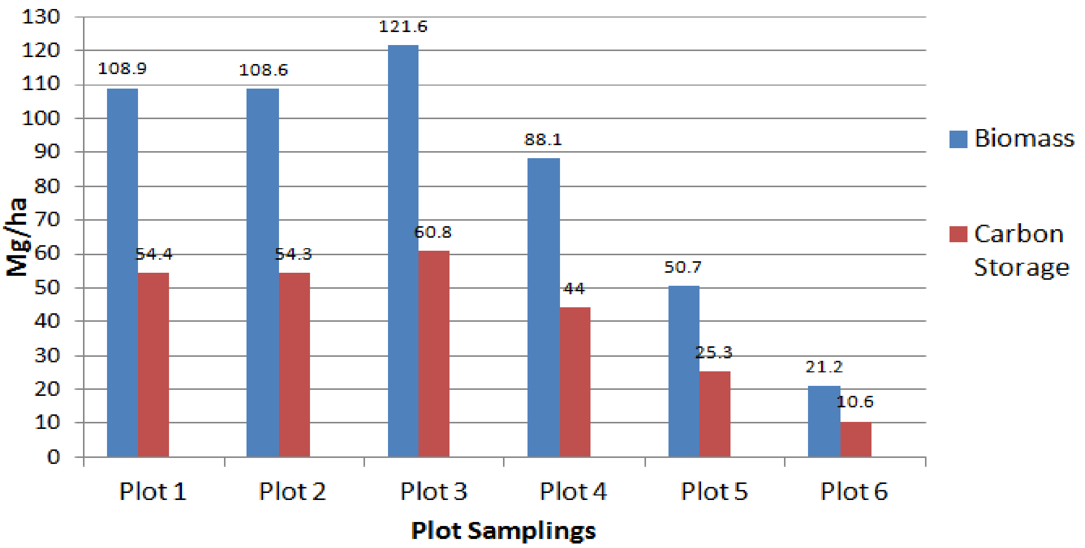

Figure 1. Aboveground biomass and carbon storage.

The aboveground biomass in natural forest ranged between 108.9 to 121.6 Mg ha^{-1}. The aboveground biomass of logged-over forest was lower with 88.1 Mg ha^{-1}; and 22.1 Mg ha^{-1} for wind-disturbed forest. A sharp drop of biomass occurred on disturbed forests, especially those that were affected by wind and fire. This shows that natural disturbances put negative pressure on protecting biomass and the carbon storage of remaining peat swamp forest in biosphere reserve. However, the change of land cover use from natural vegetation to industrial forest plantation put higher pressure. Wind-disturbed forest is one of remaining natural forests in the buffer zone of the Biosphere reserve. They are unique forest types having different environmental characteristics.

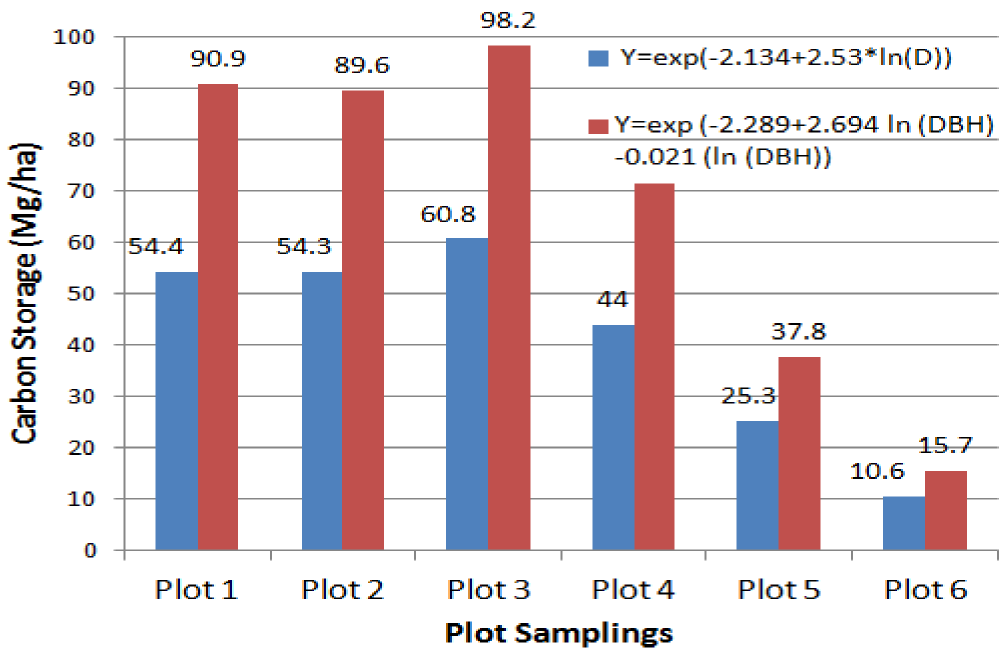

Figure 2. The amount of carbon storage using other allometric equations.

Based on belowground carbon stock of peat lands in biosphere reserve, when ranked from highest, shows first Logged Over Forest (5981 Mg C ha^{-1}), followed by Acacia Plantation (5460 Mg C ha^{-1}) (**Figure 3**). Differences in the below carbon stock of each land uses were determined by bulk density and depth/thickness of peat.

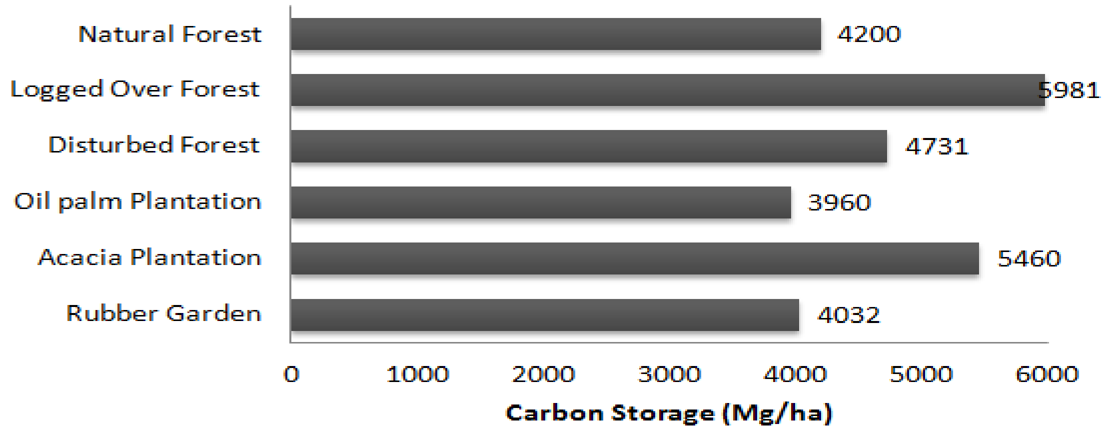

Figure 3. Belowground carbon storage in various land uses.

Our results show quite higher of belowground peatland carbon storage in both forested and developed peatland areas compared to research done by [11],[12]. Our study also reveals that belowground peatland stored carbon (C) is very high, ranging from 39 to 66 kg C m^{-3} or equivalent to 390 to 660 Mg C $ha\text{-}^{1}$ per meter of soil depth. Initial estimate shows that on average, peat in Sumatera is thicker and has C content of approximately 3000 Mg C ha^{-1} while the peat in Kalimantan is thinner and contains C average of about 2000 Mg C ha^{-1} In comparison, C content of mineral soil usually concentrates in the several cm of the surface layer and rarely exceeds 250 Mg C ha^{-1} [12].

Aboveground biomass in tropical forests may vary considerably in response to differences in climate and soil parameters. A study in Rondonia, Western Brazil for example, found that aboveground biomass in primary forest was 290-495 Mg ha^{-1} and about 40-60% less in young secondary forest in the same area. Another study in Sumatera showed that dipterocarp hill forest had an aboveground biomass ranging from 271-478 Mg ha^{-1} , whereas aboveground biomass of other lowland dipterocarp forest was 509 Mg ha^{-1} . According to values published in various sources, the aboveground biomass carbon stored in undisturbed peat swamp forest ranges between 73-323 Mg C ha^{-1}, and that of logged-over and secondary peat swamp forest between 65-167 Mg C ha^{-1} [13]. Estimated amount of aboveground biomass in Riau natural peat swamp forest was to be 252 Mg ha^{-1}, logged over forest to be 111.4 Mg ha^{-1}, and secondary forest to be 65 Mg ha^{-1}. In comparison with other types of forest, logging forest in Jambi, Sumatera, resulted in a biomass decrease of 158.8 Mg ha^{-1}. The difference in total aboveground biomass could be influenced by soil fertility. Page [18] revealed that the occurrence of different forest types depends on the hydrology, chemistry and organic matter content of the peat. Tropical peat swamp forests are characterized by its high acidity (pH usually <4), low nutrient quality and low rate of litter input [10].

The total amount of aboveground carbon storage in lowland peat swamp forest in Indonesia was around 230 Mg C ha^{-1} with belowground carbon storage of 2425 Mg ha^{-1}. Peat swamp forest stores large amounts of carbon in plant biomass, with typical values ranging from 100 to 250 Mg C ha^{-1} [18]. Belowground carbon storage on peatland of 2772 Mg C ha^{-1} is based on an average peat thickness of 5.50 m [2]. Peat in Sumatera is thicker and has carbon storage of approximately 3000 Mg ha^{-1} [12].

Local community participation

Given the unique ecological as well as socio-economic context of the different islands of Indonesia, area- or village-specific conservation could also be implemented in Temiang Village itself. This kind of initiative got the approval from the Forestry Department of Central Government and is being carried out under a project called the Village Conservation Model being carried out by Riau Natural Conservation Agency (BBKSDA) since 2011. This model is claimed to let village communities have access and rights to use resources within the forest conservation areas and in turn they will participate in managing and protecting them. Their current activities include public awareness campaigns, institutional capacity building, facilitation and provision of alternative income generating activities including training for the dissemination of appropriate agricultural-aquaculture technologies. Various conservation measures are needed especially to protect the standing natural forests, but these also need restoration and rehabilitation activities especially in areas already degraded and occupied by villagers. Forest restoration usually succeeds when it benefits the people be it in terms of their economic or cultural life. There are already examples of these kinds of activities.

During restoration experiments, villagers could be involved by collecting seeds-wildings-cuttings, seedlings-nurseries maintenance, land preparation, transplanting tree seedlings and maintenance. Even rubber farmers could earn income by getting involved in planting and enriching peat swamp forest species around or between their rubber jungle garden. With income from rehabilitation, further clearing of natural forests will be minimized. furthermore, the villagers should also be assisted in increasing their income from current jungle rubber garden such as from tapped rubber, white latex of Jelutung trees (*Dyera lowii*), seeds of Balam trees (*Palaquium sumatranum*), and other non timber forest products.

We considered a role of the villagers and the importance of addressing their livelihoods. We planted tree species which have both economic values (i.e. timber and non-timber forest products) and conservation values such as *Dyera lowii*, *Tetramerista glabra*, *Palaquium sumatranum*, *Palaquium burckii*, and *Cratoxylon arborescens*. Moreover, various non-timber forest products are provided by these different species such as seeds of *Palaquium sumatranum* to produce oil for cooking, and white latex from *Dyera lowii*.

Conclusion

Biosphere reserve still stores huge amount of biomass and carbon functions. Therefore, conservation activities are important to be done continuously due to multiple functions provided by peatland. To make Biosphere Reserve, as the location for the promoting local participation in order to conserve important biomass and carbon functions, support from various parties is still needed. Therefore, it is necessary to increase the role of stakeholders in the empowerment programs that have been done.

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THE PROVING OF POWERLESS MYSTIC OF AKAR NYILUM (*Millettia pachycarpa*) IN KEMELAK FOREST AREA, BATURAJA, SOUTH SUMATERA

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Abstract

An adventure study about proving of 'akar nyilum' ability to make the lost of people consciousness who step over its tree/trunk had been done during the end of 2012 until July 2013. Methods of study were collecting information about river layo bank forest from civilian peoples, planning a trip to akar nyilum area, preparing a local guide and coming to 'akar nyilum' plant for stepping its trees/liana trunk. The research was done in order to prove whether if trunk was stepped it could affect the lost of our consciousness then we could not come back to home base. Trunk and foliage were taken for herbarium needs and identification process. Identification was done at the Plant Taxonomy Laboratory, Biology Department, Faculty of Science, The University of Sriwijaya. The study proved that there was no loss of consciousness process of someone who steps over the plant trunk, and identification study found that the plant species was *Millettia pachycarpa*.

Keywords: *Millettia, powerless mystic, species identification*

Introduction

The World Agroforestry Centre (ICRAF) is a CGIAR Consortium Research Centre. ICRAF's headquarters is in Nairobi, Kenya, with five regional offices located at Cameroon, India, Indonesia, Kenya and Peru. Through these institutions, Garrity [1] published that there are important examples of farmer rehabilitation on Imperata grassland. Some transmigrants of small scale farming communities have evolved successful food crop farming system with modest fertilization on red-yellow podzolic soil (ultisol/exisol) in Lampung province, Sumatera and Baturaja, in South Sumatera Province. The above phenomena shows us, that problem of peoples increasing number, attach to alteration of the forest to become agriculture land and then initiated Imperata grassland problem. Baturaja in South Sumatera is an example of those story.

On the other hand, every part of the world has a myth about sacred tree or plant. From the oak at the central Europe, ash in Scandinavia, and Shorea in India trees were revered. Many early peoples thought that spirits of their ancestors lived in the trees. They cultivated and protected holy trees and would beg forgiveness from a tree if it was cut. Some believed that souls of unborn babies lived in trees until birth. In Korea, spirits of women who died in childbirth were believed to live in trees. Furthermore, Acacia is one of four trees of the Gods in China, and sacred to Baddish and Hindus [2].

In Kemelak Forest Area, local peoples believed that Akar Nyilum or Akar Melingkar, a kind of vein in forest area, has a myth power. Whoever come to Kemelak Forest Area then crossing over or passing below the vein tree or trunk, should loss their consciousness, and could not come back home. In order to prove those believes it is necessary to do an experiment by passing over or below the vein.. Then, for science development, it is needed to identify the species.

Materials and Methods

Information of akar nyilum or akar melingkar mystic power was obtained from local peoples around Kemelak forest, Baturaja. The preparation for proving this statement was made by preparing a journey to akar nyilum location with Plant Taxonomy students and Lecturer of Biology Department of Faculty of Science, Sriwijaya University. Two local peoples as guide were requested to join the journey on 8-9 March, 2013. All of research members try to pass over/ below of Akar Nyilum/ Akar Melingkar at destination forest. Sampling of herbarium was made by cutting of Akar Nyilum by local guide. Identification process was done at Plant Taxonomy Laboratory of Biology Department, Faculty of Science, Sriwijaya University.

Results and Discussion

After 30 minutes walks from the camp/dormitory, the researcher and guides found the area. The guides lead the researcher to Akar Nyilum or Akar Melingkar growth location. All of researchers and ten students passed below the vein, and made a deep breath to mind, whether the consciousness loss or not. The result showed that there was no one of researchers and students loss their consciousness. **Figure 1a** shows the guide cut the vein trees of *M. pachycarpa* , and **Figure 1b** shows the trunk and leaflets.

Figure 1 (a) The guide cut the vein of Akar Nyilum / Akar melingkar, (b) Leaves and tree of Akar Nyilum

Figure 2 Tree vein and some students try to pass below

The Guide (Mbah Rejo) has been asked to cut the vein of Akar Nyilum for herbarium need. Even the cutting of vein, and leaves never made the loss of consciousness. The proving of the powerless myth of Akar Melingkar/Nyilum was made. Figure 2 shows the researchers cross over and below the vein.

Identification of sample herbarium was done and it was concluded that the species is *Millettia pachycarpa.* This is a member of Fabaceae family, with lot of leaflets. **Figure 3**(a) and 3(b) shows the identification- picture as comparing tools.

Figure 3 (a) Herbarium [3],   (b) Leaves of *M pachycarpa* [4]

Jainul et al. [5] wrote that *M. pachycarpa* is a climbing shrub. It's pod contains 1 – 5 seeds. The flowers are lilac-colored and the leaves have 13 – 17 papery leaflets. It is endemic to south-east asian region including Bangladesh, Bhutan, China, India, Myanmar, Nepal, Taiwan, Thailand and Vietnam. It is one of the most well known species of *Millettia*, as it is widely used in traditional practices, such as fish-poisoning (so as it is called 'fish poison climber'). Peoples also use it as blood tonic, agricultural pesticide, treatments of cancer and infertility. Furthermore, Jainul et al. [5] experiment, showed that leaves extract of *M. pachycarpa* could kill 100 percent of brine shrimp at 500 µg/ml dose. Lalchandama [6] reported that *M. pachycarpa* root bark extract exhibited significantly as mosquitocidal activity for *Aedes aegypti*.

Some of *Millettia* sp have been known as numerous therapeutic; as antitumoral, antiimflamatory, antiviral, bactericidal, insecticidal and pest destroying in Africa [7]. As ichthyotoxic, local peoples used *M. pachycarpa* in Assam, India, for catching the fish [8]. Furthermore, Okamoto et al. [9] reported the anti-estrogenic-activity from *Millettia pachycarpa*.

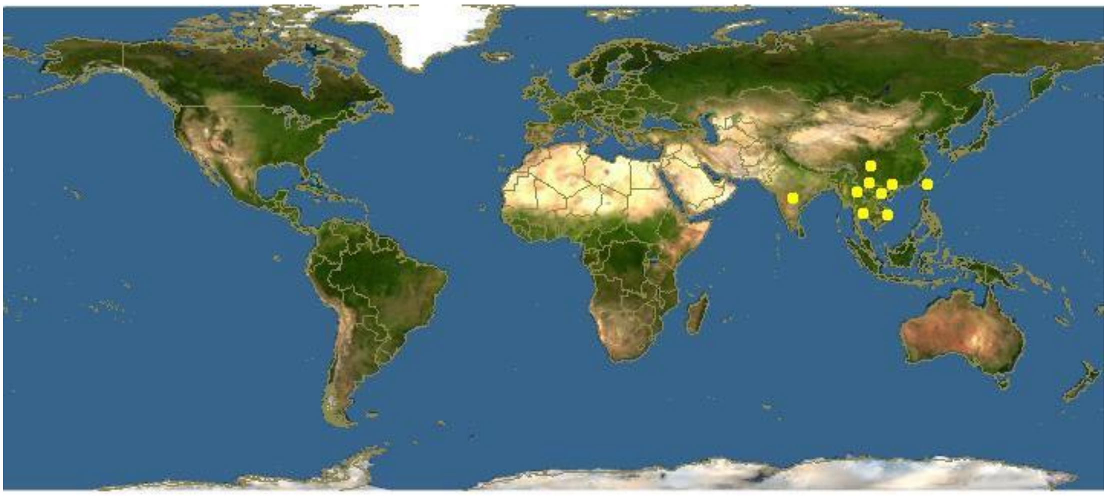

Figure 4. Distribution of *M. pachycarpa* [10]

Note that Indonesia has not recorded as the habitat of *M. pachycarpa* before this research (yellow spots in **Figure 4**). So, these journey research proved that *M. pachycarpa* grows in Sumatera/Indonesia for taxonomy and diversity advance information.

Conclusion

This research found two main conclusions as below:

1. There is no mystic power of akar nyilum (*M. pachycarpa*) in Baturaja, South Sumatera. This myth may be come as forest protection strategy by local peoples.
2. Akar Nyilum or Akar Melingkar is a species of Fabaceae with scientific name *Millettia pachycarpa* (Benth), family Fabaceae. Our identification also shows that these species exist in Indonesia (Sumatera); not only in Taiwan, China, Nepal, Vietnam, Thailand, Buthan, India, and Myanmar.

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POTENTIAL OF BIOMASS AND SPATIAL DISTRIBUTION OF FOREST PLANTATION OF HYBRID EUCALYPTUS

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Abstract

The purpose of this research was to estimate and determine the distribution of biomass in the Hybrid Eucalyptus forest. The allometric equation was developed based on the growth dimension, i.e. the diameter. The research was conducted at 0.3 up to 7 and 14 year of Hybrid Eucalyptus stands in industrial plantation forest of PT. Toba Pulp Lestari (PT. TPL) in Aek Nauli District, North Sumatera. The potential of biomass was estimated from direct measurement using destructive technique. The spatial distribution of biomass was determined using geospatial technology. Results showed that Hybrid Eucalyptus had an average above-ground biomass of 24,304 t/ha. The criteria for low, medium and high biomass in each compartment were 0 - 8 t/ha; 9 - 17 t/ha and 18 - 26 t/ha, respectively. The low biomass criteria had the largest percentage of 84.5% and also the largest area of 1,874.3 ha. While the medium and the high biomass criteria had a percentage of 12.69% and 2.76% with an area of 281.3 ha and 61.2 ha, respectively.

Keywords: *Hybrid Eucalyptus, biomass, forest, plantation, spatial distribution*

Introduction

Greenhouse gases may lead to an increased warming of the Earth or human-initiated global climate change. Vegetation acts as a sink—a natural storage area—for carbon dioxide by storing it over time through the process of photosynthesis. As forest fire continuously occurs, it releases vast amount of carbon dioxide into the atmosphere through biomass combustion in a matter of hours. This causes solar energy being trapped within earth atmosphere [1]. This change in global climate would affect forestry and agricultural sector [2].

In relation with forest ability to absorb carbon, emission trade or carbon trade constitutes a new paradigm in forestry sector and could become opportunity for Indonesia which is a developing country, to obtain foreign exchange from this sector. Forests store carbon and play role of carbon dioxide sinks. Tropical reforestation can mitigate global warming until all available land is covered with mature forests.

One of the efforts to minimize impacts on climate change is to stabilize the CO concentration in atmosphere. This is related with forest ability to absorb CO from atmosphere, and then store it in forest stand in the form of organic matter or plant biomass. Therefore, the potentiality of forest in terms of carbon absorption could be estimated through calculation of plant biomass, because half weight of the biomass usually comprises carbon [3].

Eucalyptus is one of plant species which has potency in development of industrial plantation forest [4], and has opportunity to produce carbon within rotation period (cutting cycle) which is considerably short (7-10 years) from growth process of the planted trees .

Research on biomass and plant carbon of hybrid eucalyptus is important enough to be conducted because this will be useful for plantation forest management plan, and constitutes one of the keys to support the success of industrial plantation forest development in Indonesia in sustainable manner in the future. Sustainable forest would have potential of environmental service to sequester carbon in increasing amount and duration in accordance with the determined rotation time

Materials and Methods

The study was conducted in Aek Nauli sector of the Industrial Timber Estate (*Hutan Tanaman Industri* - HTI) namely, PT. Toba Pulp Lestari(PT. TPL), and Laboratory of Forest Inventory, Forestry Study Program, Faculty of Agriculture, University of North Sumatra from May to August 2012. PT. TPL owns the 189,975 ha of plantation forest in this region. Research activities were focused on obtaining reliable model to estimate above ground biomass in hybrid eucalyptus stand at 0.3 up to 7 and 14 years of age.

Equipments used in this research were measurement tape, hypsometer, and chainsaw. Materials for measuring carbon contents were stems, branches, leaves, and shoots of Eucalyptus. Measurement plot (sample plot) had the size of 30 × 20 m (6 sample plot for each of age class) and distance between sample plot was 10 × 10 m. Selecting sample trees in sample plot was conducted by *systematic sampling with random start*. The collected data comprise diameter at breast height (dbh), branch free height, area size of crown section, and total tree height. Measurement of undergrowth vegetation was conducted at sub plots, measuring 2 × 2 m, within the sample plots.

Harvesting of biomass carbon stock is generally derived from the quantity of above ground biomass by assuming that 45% of the biomass value is composed of carbon [5]. The most accurate method is normally known as the destructive approach by cutting down trees and weighing all parts of the tree. Such destructive approach is frequently used to validate other method, which tend to be less disturbing and requires low cost, such as carbon stock estimation by in situ nondestructive and remote sensing measurement [6], [7]. Selected sample trees (3 trees for each age class) were cut down and their diameter measured at points of 0, 0.3, 1.3, 3.3, 5.3, 7.3, and 9.3 m above ground surface, and afterwards they were separated into stems, branches, and leaves. Weighing was conducted for all tree parts. In stem part, there were data collections on length and fresh weight per section, whereas in branches, leaves, and shoots there were data collection on fresh weight. Litters and undergrowth vegetation were collected and classified into particular parts, and their fresh weight were measured

Characteristics of sample trees.

All wood test samples were weighed for determining their fresh weight, and were subsequently dried in oven at temperature of 103 ºC ± 2 ºC for determining their dry weight. Percentage of water content (WC) was calculated with the following formula:

$$\% WC = ((FW - ODW)/ ODW) \times 100\% \quad (1)$$

Note
% WC = percentage of water content
ODW = oven dry weight of test sample (g)
FW = fresh weight of test sample (g)

Density of wood test samples needs to be known to calculate biomass of stem parts through approach of wood density with the following formula [8]:

$$D = M/V \quad (2)$$

note:
D = density of wood test sample (kg m^{-3})
M = oven dry mass of wood test sample (kg)
V = air dry volume of wood test sample (m^3)

Biomass of stem and undergrowth vegetation.

Biomass calculation of stem segments on the basis of water content data [8] is as follows:

$$\mathrm{ODW} = \mathrm{FW} \times [1 + \frac{(\% WC)}{100}] \quad (3)$$

where :
ODW = oven dry weight of test sample (g)
FW = fresh weight of segment of eucalypt tree (g)
% *WC* = percentage of water content

Biomass of undergrowth vegetation and litter was calculated with the following formula:

$$DW_{tot} = [\ (FW_{tot}/DW_{ts})/\ (FW_{ts}/S_{area})\ ] \quad (4)$$

where:
Dw_{tot} = total dry weight (kg m^{-2})
FW_{tot} = total fresh weight (kg)
DW_{ts} = dry weight of test sample (g)
FW_{ts} = fresh weight of test sample (g)
S_{area} = area size of sample (m^2)

Forest biomass could be used to estimate carbon content within forest vegetation because 45% of the biomass is composed of carbon. So, the amount of carbon stock is equal 0.45 of the biomass [5]. Carbon sequestration (Co) could be estimated with the following formula [9]:

$$\textit{Sequestration of } CO_2 = (\text{Mr } CO_2/\text{Ar C}) = 3.67 \times \textit{carbon content} \quad (5)$$

where :
Mr = molecule relative
Ar = atom relative

Reliability test of biomass model

Reliability test of a model is conducted by utilizing criteria to determine the best model in allometric model estimation. All equations were tested to determine which one is the best predictor of biomass for *Hybrid Eucalyptus*. The best model is the one which gives the largest coefficients of determination (R^2) and coefficients of correlation (r), aggregative deviation percentage (*AgD*) < 1%, and average deviation percentage (*AvD*) > -1% and < 10%. Selection of model also considers the simplicity of model and their practicability to be used in the field [10].

Biomass potential mapping

Spatial distribution of biomass and carbon storage potential is done by mapping potential stand biomass and carbon storage of *Hybrid Eucalyptus*. Prediction models were based on carbon storage. With allometric models of the Eucalyptus biomass will be obtained based on the data distribution of the potential biomass compartments. Then the value of the biomass can be calculated as potential carbon storage in each of the Eucalyptus species. Data values of biomass and carbon storage potential are then included in the map area of industrial forest plantations, so the final result is obtained in the form of a map of potential biomass stands of *Hybrid Eucalyptus* .

Results and Discussion

Models of biomass estimator

Live tree biomass estimates are essential for carbon accounting, bioenergy feasibility studies, and other analyses. Several models are currently used for estimating tree biomass on the basis of measurement of sample tree, there was construction of model which described the relationship between biomass and several variables. Several allometric models of biomass estimator were tried to obtain the best model for biomass estimation. Each tree species is associated with a set of local volume and biomass equations. Although the particular form of the equations may differ, the biomass calculation of major aboveground biomass components is similar to that for Eucalyptus species. Regional equations produce biomass estimates specific to each species and separated into major above ground components.

In terms of model application, allometric equation is specific for a particular species and location, so that allometric equations could not be compared across different species and locations. However, in terms of composition of variables and forms of equation, various allometric equation could be compared to obtain the best model [11]. Basically a good model is that which is simple enough, easy to be analyzed and easy to be applied. Apart from those, models should have considerably high accuracy of estimation [12]. In general, the selected model for each variable being tested, had good performance. On the basis of statistical analysis, it was obtained that allometric model $Y = 1{,}351.09x^{0.876}.\ e^{(0.094x)}$ had the best performance. This allometric model possessed R^2 value as large as 98.29%, r as large as 0.9849, AgD as large as 0,08%, and AvD as large as -0.28%. Therefore, this model fulfilled the requirement as a reliable model. Catahan [10] stated that a model is categorized as reliable if the aggregative deviation percentage (AgD) < 1% and -1 % < AvD < 10%. Besides statistical consideration, according to Catahan [10], the choice of best equation model should also consider the factor of practicability, efficiency, and ease in the collection of independent variable data in the equation.

Average deviation and aggregate deviation were used to measure the accuracy of a model. The smaller the values of AgD and AvD the more accurate would be the model. The value of AgD as large as 0.08% showed that the percentage of difference between value of estimation result and value of biomass measurement result of hybrid eucalypt was 0.08. On the other hand, value of AvD as large as -0.28% showed that average value of biomass estimation of hybrid eucalypt deviated as large as 0.28 from average value of their measurement result. Allometric model $Y = 1{,}351.09x^{0.876}.\ e^{(0.094x)}$ had possessed good value, while its AgD and AvD were in conformity with the determined criteria.

Potential of biomass Hybrid Eucalyptus

Forests are a significant part of the global carbon cycle. Forests sequester carbon by conducting photosynthesis, which is the process of converting light energy to chemical energy and storing it in the chemical bonds of sugar. Carbon sequestration through forestry has the potential to play a significant role in ameliorating global environmental problems such as atmospheric accumulation of GHG's and climate change. In relation with forest ability to absorb carbon, emission trade or carbon trade constitutes a new paradigm in forestry sector and could become opportunity for Indonesia which is a developing country, to obtain foreign exchange from this sector. Therefore, potency of forest in carbon absorption could be estimated through calculation of plant biomass, because half of the biomass comprise carbon [3].

Eucalyptus spp have been selected by PT. TPL as species at their forest plantations because it is one of the species, which produces quality sample pulpwood for paper and newsprint making. The biology of *Eucalyptus* is well known, seed of well-documented origin is available, nursery practices and silviculture are well defined and result is fairly predictable. Even the mention of the results of analysis of wood sample plot material that best comes from the eucalyptus because of high levels of cellulose were conceived and pretty good tear resistance. *Hybrid Eucalyptus* constitutes the species which are developed as sample pulp industry raw materials, in large scale in PT. Toba Pulp Lestari with cutting cycle (rotation) of 7-8 years. The results showed that. hybrids produced the highest increment of 289 m^3/ha , while the lowest increment generated by *E. pellita* of 116 m^3/ha [13] . Total potential of biomass of *Hybrid Eucalyptus* are shown in **Table 1**.

Industrial Plantation Forest (HTI) PT . Toba Lestari Tbk . in Aek Nauli sector have four types of *Eucalyptu*s spp and has a diversity of age classes are very diverse . In different types and age classes of stands of *Eucalyptus* spp are able to influence the content of the biomass on each stand *Eucalyptus* spp . **Table 1** indicated that the variability in average above ground biomass, carbon storage and carbon sequestration of hybrid eucalyptus with increasing age of the plant. It can be explained that the total biomass is by summing biomass existing trees within compartment. The total potential of Hybrid Eucalyptus was estimated to be about 1102.7389 tons and average per unit ha was 24.3 t/ha. The difference in the biomass of forest stands was caused by differences in site quality and the types of cloned eucalyptus. Site quality, in the context of timber management, can be defined as “the timber production potential of a site for a particular species or forest type.” The words “good” and “poor” are frequently used modifiers of site quality and simply imply a high productive potential as opposed to low potential. Genes are the basis for all biodiversity. A major reason for the differences between ecosystems is the differences in their species composition. Similarly, differences among species are due to differences in their genes. Among individuals of a species there is also variability in genes. Besides environment, heredity also affects tree growth. In a forest plantation, however, if the seeds used in forest planting are collected from stands considered significant in genetic variation, this factor is also considered as not constant. In addition, due to different total land area of compartment, and also differences in the number of trees in each compartment. This factor also affects the difference in carbon storage and carbon sequestration.

Types of Hybrid Eucalyptus has the most age classes ie 9 age classes include age 0.3 years , 1 year , 2 years , 3 years , 4 years , 5 years , 6 years old 7 years and 14 years . Hybrid eucalyptus with 1 year age class has the most extensive land area compared to other age classes is 877.3 ha of the total study area, and the lowest area is 14 year age class with area of 0.6 ha.

Table 1. Potential of biomass, carbon storage and carbon sequestration in various ages of hybrid eucalyptus

Age (year)	Average of biomass (t/ha)	Total of Biomass (ton)	Carbon Storage (t/Ha)	Carbon sequestration (t CO_2/Ha)	Area (Ha)
14	18,19	7,0312	3,2344	11,8701	0,60
7	54,26	20,9410	9,6328	35,3525	2,20
6	39,23	90,8785	41,8041	153,4211	11,50
5	28,57	121,3204	55,8074	204,8131	24,80
4	34,71	93,8525	43,1722	158,4418	80,20
3	26,53	349,6894	160,8571	590,3457	405,80
2	5,91	149,4270	68,7364	252,2626	797,90
1	8,72	249,9418	114,9732	421,9518	877,30
0.3	2,6	19,6571	9,0423	33,1851	16,50
Total	**24,3**	**1102,7389**	**507,2599**	**1861,6438**	**2216,80**

Hybrid eucalyptus 3 year age class had the greatest total biomass is 349.7 tons. This suggests that hybrid eucalyptus 3 year age class have large biomass and carbon storage than other young age, namely 0.3, 1 and 2 years. However, at the age classes 1 and 2 years of Hybrid eucalyptus has a high value of total biomass is 249.9 tons and 1249.4 tons. This is due to eucalyptus is a kind of hybrid clones were cultivated into producing seeds in Industrial Plantation Forest. Hybrid eucalyptus has a high total biomass so much more in carbon sequestration.

Spatial distribution of biomass of Hybrid Eucalyptus

Industrial Plantation Forest (HTI) PT. Toba Pulp Lestari Tbk. in Sector Aek have 4 types of eucalyptus, namely *Eucalyptus grandis, Hybrid Eucalyptus, Eucalyptus pellita* and *Eucalyptus urophylla*. Besides eucalyptus species, pine species are also found in several compartments. However, in this study, we focused on eucalyptus.

In this study, Hybrid Eucalyptus has the highest total biomass due to the dominate species in the area. Eucalyptus dominates the sector compartments in Aek Nauli is about 270 compartments. As shown in Table 2, the biomass distribution was classified with 3 types, i.e. Low, Medium and High, according to the biomass amount of ArcView program. Low, Medium and High of biomass represent 0 - 8 t/ha; 9 up to 7 t/ha and 18 up to 26 t/ha, respectively. The majority of the areas has biomass class 0 up to 8 t/ha with 1.874 ha or 84,55 % of total study site, followed by the biomass class 9 – 17 t/ha with 281,3 ha or 12,69 % of total study site, biomass class 18- 26 t/ha with 61, 2 ha or 2,76 % of total study site. Biomass distribution of Hybrid eucalyptus in Aek Nauli sector is depicted in **Table 2**

Table 2. Biomass distribution in each compartment of Hybrid Eucalyptus

Biomass (t/ ha)	Area (Ha)	Percentage	Criteria
0 s/d 8	1.874,30	84,55%	Low
9 s/d 17	281,30	12,69%	Medium
18 s/d 26	61,20	2,76%	High
Total	2.216,80		

Each compartment has a type of eucalyptus, thus the biomass depends on type of eucalyptus. The distribution map of biomass potential can be seen in **Figure 1**. The majority of the estate compartment has a low and medium biomass. Differences in biomass per compartment can be caused by differences in land area of each compartment, ranged from 0.1 ha to 43.30 ha. In addition, differences in biomass each compartment is also caused by differences in the number of trees in the compartment, also caused by differences in the average diameter of trees in each compartment. The average diameter of the tree at each compartment ranged from 0.1 cm to 16.2 cm.

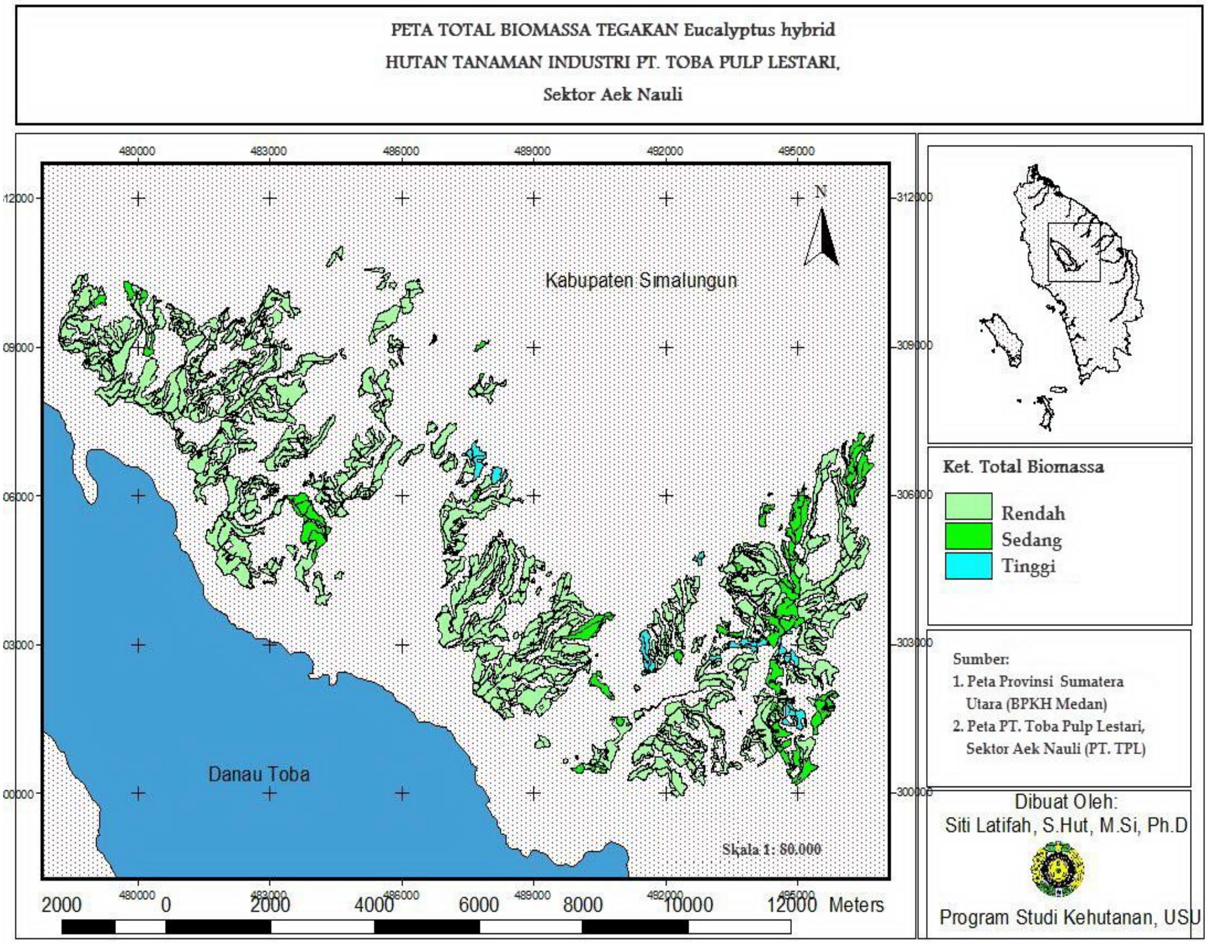

Figure 1. Map of *Hybrid Eucalyptus* biomass in Aek Nauli Sector, North Sumatera, Indonesia

Conclusion

The allometric model $Y = 1{,}351.09x^{0.876}.\ e^{(0.094x)}$ is selected as the best models to estimate biomass of hybrid eucalyptus. The total potential of biomass Hybrid Eucalyptus in study site is about 1102.7389 tons with average of biomass is 24.3 t/ha. The difference in the biomass of forest stands was caused by differences in site quality, the types of clone eucalyptus, land area in each compartment, number of trees, and the average diameter of trees in each compartment.

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TREES CHARACTERIZATION POTENTIALLY TO REHABILITATION OF WATER CATCHMENT AREAS AFTER 2010th MOUNT MERAPI ERUPTION

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Abstract

This paper is part of research which seeks to get proper trees species for the rehabilitation of catchment areas surrounding Mount Merapi after eruption in 2010. The study was conducted in March to November 2012, in five villages on the slope of Mt. Merapi, which are close to the area affected by the eruption of 2010th Mount Merapi. Characterization of trees in each area performed on four zones based on elevation and different land uses (yard, upland, and forests). Sampling were conducted in transect area of 5 x 40 m^2. Tree characterizations were selected only on five dominant tree species in transect and aged over 5 years. Observed variables include tree species, tree density, frequency, canopy shape, height and width, and number of branches, the stem diameter at breast height (1.3 m), horizontal and vertical of proximal roots, and important value index. There are 23 species with different characteristic were found in the yard, upland, and forest, at different altitude. The five important species among vairous forest tree species on the slopes of Merapi from highest to lowest is as follows: *Calliandra calothyrsus* (82.96%), *Acacia decurens* (42.09%), *Schina noronhae reinw* (18.96%), *Acacia mangium* (18.96%), and *Paraserianthes falcataria* (18.74 %). *P. falcataria* is the favorite species because it was found in all land uses with higher of important value, especially in upland (76.55%) and yard (34.41%). Further studies is needed to select proper tree species for rehabilitation of water catchment areas based on the combined estimates of canopy density index, index of root anchoring and root binding.

Keywords: *catchment area, characterization, Mt. Merapi, rehabilitation, tree species*

Introduction

Mount Merapi is one of Indonesia's active volcanoes, located in the 3 regions i.e. Magelang and Klaten districts in Central Java Province, and Sleman district in Yogyakarta. The position coordinates of Mt. Merapi is 7°32'30" S and 110°26'30" E. In the 20th century it has experienced five times the eruption, and the last eruption occurred in November 2010, which is the biggest eruption in the beginning of this century. Hot clouds and materials eruption resulted in the death of livestock, trees and other vegetation, especially in the eastern, south and west slopes of Merapi.

The area on the slopes of Mt. Merapi has an important function as rainwater catchment, and is supporting the availability of water for the surrounding areas. The death of the trees on the slopes of Mt. Merapi is a threat to the reserves and the availability of water, either for domestic or other purposes. Rehabilitation and conservation of land on the slopes of Mt. Merapi by planting different types of trees to be done urgently to prevent run-off and erosion, and increase of infiltration.

The tree is vital to the functioning of hydrological and soil conservation. The role of individual trees in the hydrological system performance is determined by the architecture of the canopy, the character stems, and roots architecture. The shape and density of the tree canopy will affect rainfall interception, while stem roughness will determine the amount of water passing the trunk to the ground [1]. Horizontal distribution of tree roots will determine the level of grip on the ground while the vertical root distribution will affect the ability of the tree to the ground anchors, and plays an important role as an entry way into the ground water [2,3].

Some previous researches indicate that the characteristic of the individual tree that have been proven to significantly influence the conservation of soil hydrological function, includes: canopy shape, Index of Canopy Density (ICD) [1], Index of Root Anchoring (IRA), and the Index of Root Binding (IRB) [3,4]. Columnar canopy shape such as Resin (*Agathis dammara* (Lamb.) Rich) have a very high pass rainwater, while the pyramidal canopy shape as Pinus tree (*Pinus elliottii*) has a moderate value, and rounded canopy shape tree as Teak (*Tectona grandis*) has the lowest value [5]. ICD is a function of the number of branches, the canopy height and width [1]. ICD values range from 0 to 1, and the closer to 1, the tree has the better hydrological functions. ICD value of Pine > Resin> Teak, was 1 ± 0.19, 0.59 ± 0.1, and 0.27 ± 0.1, respectively, which implies that the pine tree canopy is three times more dense than the Teak, and so forth [5].

This paper presents the types of trees are still found in some land uses on the slopes of Merapi, after the eruption of 2010. Characterization of canopy architects conducted as a preliminary stage to choose the right tree for the rehabilitation of water catchment areas on the slopes of Merapi.

Methods

Site description

The study was conducted in March-November 2012, in five villages on the slope of Mt. Merapi, which are close to the area affected by the eruption of Mount Merapi in 2010. The five villages include: Sidorejo and Balerante villages (Klaten district), and Ngablak village (Magelang distric) in Central Java Province, and also in Kepuharjo and Umbulharjo villages (Sleman district) in Yogyakarta. Areas of research in Klaten is at 7° 34'15.12 "- 7°37'08" S and 110°27'39.6"- 110° 29'31.7" E, whereas the boundary area in Magelang is 7°34'51.6 "- 7°35'12.6" S and 110°21'49.5" - 110°22'43.7" E, and in Sleman is at 7°35'53.6" - 7°37'29.8" S and 110° 25'56.2" - 110°29'31.7 E, at altitude between 724-1334 m above sea level.

Inventory and tree characterization

Inventory and characterization of trees in each area performed on four zones based on elevation, namely: Zone I (500 - 750 m), zone II (750-1000 m), zone III (1000-1250 m), and zone IV (> 1250 m). Sampling were conducted in transect area of 5 x 40 m^2 that determined from land use (upland, yards, and forest) and tree diversity. Tree characterizations were selected only on five dominant tree species in the transect and aged over 5 years. Observed variables include tree species, tree density, frequency, shape, height and width of canopy, and number of branches. The number of branches, canopy height and width is used to calculate the index of canopy density (ICD) [1].

Important Value Index (IVI)

Index of important value (IVI) is used to determine the importance of tree species in an area. The value is based on the relative density and relative frequency of a tree found in sampling points.

$$\mathrm{IIV = RD + RF} \qquad (1)$$

where IVI: Index of Important Value is between 0-200%. RD: relative density of a tree species (0-100%), based on the ratio of a species density by all species density in every land use. RF: relative frequency of a tree species (0-100%), which is determined by comparison of a species frequency by the frequency of all tree species in every land use. The greater value of IVI means the more important role of a species in a community.

Index of Canopy Density (ICD)

ICD is determined based on the following functional equation [1]:

$$ICD = -\left(k\,\frac{3\xi}{\pi h^2 w^2}\right) \qquad (2)$$ for elliptical canopy shape and

$$ICD = -\left(k\,\frac{12\xi}{\pi h w^2}\right) \qquad (3)$$ for a triangular canopy shape

Wherein: k = constant, ξ = number of branches (units/tree), π= 3.14, h = canopy height (m), and w =

canopy width (m).

ICD values range from 0 to 1, and the index value close to 1 means the dense canopy of which contribution to soil hydrological function is better.

Results and Discussion

Trees species in the slopes of Mt. Merapi

The selection of tree species for rehabilitation and conservation of recharge area performed on trees that are found in a various land uses and different altitude on the slopes of Mt. Merapi. The trees have adaptability in the area and remain alive after the eruption of Merapi 2010.

There are 23 species (14 woody species and 9 species of fruit and commercially trees) were found in the yard, upland, and forests at different altitude (**Table 1**). Type of woody trees include: *Swietenia mahagoni*, *Melia azedarach* L., *Hibiscus tiliaceus*, *Dysoxylum densiflorum*, *Azadirachta indica*, *Leucaena leucocephala*, *Dysoxylum gaudichaudianum*, *Senna siamea*, *Acacia mangium*, *Paraserianthes falcataria*, *Calliandra calothyrsus*, *Acacia decurrens*, *Pinus merkusii*, and *Schima noronhae reinw*, while the commercially trees species include: *Eugenia aromatic*, *Artocarpus heterophyllus*, *Persea americana*, *Coffea Arabica*, *Gnetum gnemon* L, *Durio zibethinus*, *Mangifera indica*, *Lansium domesticum*, and *Dimocarpus longan.* 15 trees species found at yard and 13 species found in upland, where the 9 species of which are found in both type of land uses. 6 trees species found in forests, and one of them was found in the three land uses is *Paraserianthes falcataria*. Characterization of canopy system only performed on selected trees, based on the Index of Importance Value (Table 2).

Table 1 Trees species found at various of land use and altitude zones

Scientific name	Local name	Yard				Upland				Forest			
		Z1	Z2	Z3	Z4	Z1	Z2	Z3	Z4	Z1	Z2	Z3	Z4
Eugenia aromatica	Cengkeh	√	√	√		√	√	√					
Artocarpus heterophyllus	Nangka	√	√	√		√		√					
Swietenia mahagoni	Mahoni	√	√	√		√		√					
Melia azedarach L.	Mindi	√	√	√		√		√					
Persea americana	Alpukad	√		√			√						
Coffea arabica	Kopi	√		√			√						
Gnetum gnemon L	Melinjo	√	√			√							
Durio zibethinus	Durian	√											
Hibiscus tiliaceus	Waru	√											
Dysoxylum densiflorum	Cepogo	√											
Mangifera indica	Mangga	√											
Lansium domesticum	Langsep	√											
Azadirachta indica	Minden		√										
Leucaena leucocephala	Lamtoro		√			√							
Dysoxylum gaudichaudianum	Bawangan					√							
Dimocarpus longan	Kelengkeng					√							
Senna siamea	Johar					√							
Acacia mangium	Akasia									√			
Paraserianthes falcataria	Sengon	√	√	√		√	√	√		√		√	
Calliandra calothyrsus	Kaliandra									√			√
Acacia decurrens	Kortus							√				√	√
Pinus merkusii	Pinus												√
Schima noronhae reinw	Puspa							√					√

Note: Z1 = zone 1 (500-750 m), Z2 = zone 2 (>750-1000 m), Z3 = zone 3 (>1000-1250m), Zone 4 = zone 4 (>1250m)

The Index of Important Value

Tree inventories can help to select suitable and adaptable tree species for rehabilitation of recharge area on Mt. Merapi slopes. Species of trees found in the yard and upland that has an important value index (IVI) more than 10 (8 trees), and all trees species found in forest, further characterized for estimating their role on soil hydrological function. The index is calculated based on the level of frequency a species found and the density per unit area [6]. There are 14 potential species for rehabilitation of catchment area on Merapi slopes and will be more detailed characterized of the canopy and roots (**Table 2**).

The importance of forest tree species on the slopes of Merapi from highest to lowest is as follows (**Table 2**): *Calliandra calothyrsus* (82.96%), *Acacia decurens* (42.09%), *Schina noronhae reinw* (18.96%), *Acacia mangium* (18.96%), *Paraserianthes falcataria* (18.74 %), and *Pinus merkusii (18.28%). Calliandra* and *Acacia* are two most important species in forest because both of them has the highest relative density i.e. 61.91% and 26.30%, respectively, while woody tree *Paraserianthes falcataria* is the favorite species because it was found in all three land uses with higher of important value, especially in upland (76.55%) and yard (34.41%). *Melia azedarach* L. and *Swietenia mahagoni* are two other common woody trees were cultivated by the people in the yard or in upland, while commercial species are clove (*Eugenia aromatic*), jackfruit (*Artocarpus heterophyllus*), *Gnetum gnemon* L and avocado (*Persea Americana*).

Table 2. Important value index of trees (IVI) for slopes of Mt. Merapi (%)

Trees Species	Yard			Upland			Forest		
	RD	RF	IVI	RD	RF	IVI	RD	RF	IVI
Calliandra calothyrsus	0.00	0.00	0.00	0.00	0.00	0.00	61.90	21.05	82.96
Acacia decurrens	0.00	0.00	0.00	2.27	6.00	8.27	26.30	15.79	42.09
Schima noronhae reinw	0.00	0.00	0.00	0.38	2.00	2.38	3.17	15.79	18.96
Acacia mangium	0.00	0.00	0.00	0.00	0.00	0.00	3.17	15.79	18.96
Pinus merkusii	0.00	0.00	0.00	0.00	0.00	0.00	2.49	15.79	18.28
Paraserianthes falcataria	17.74	16.67	34.41	54.55	22.00	76.55	2.95	15.79	18.74
Eugenia aromatica	17.38	9.72	27.10	2.27	4.00	6.27	0.00	0.00	0.00
Melia azedarach L.	12.42	13.89	26.31	7.58	10.00	17.58	0.00	0.00	0.00
Swietenia mahagoni	10.33	12.50	22.83	3.41	10.00	13.41	0.00	0.00	0.00
Artocarpus heterophyllus	9.32	12.50	21.82	7.58	16.00	23.58	0.00	0.00	0.00
Gnetum gnemon L	7.54	9.72	17.26	1.14	2.00	3.14	0.00	0.00	0.00
Azadirachta indica	7.54	4.17	11.71	0.00	0.00	0.00	0.00	0.00	0.00
Persea americana	4.45	5.56	10.01	2.27	6.00	8.27	0.00	0.00	0.00
Dysoxylum densiflorum	3.99	5.56	9.55	0.38	2.00	2.38	0.00	0.00	0.00
Lansium domesticum	3.99	4.00	7.99	0.00	0.00	0.00	0.00	0.00	0.00
Coffea arabica	1.76	2.78	4.53	7.57	1.11	8.68	0.00	0.00	0.00
Hibiscus tiliaceus	0.89	2.78	3.66	2.27	6.00	8.27	0.00	0.00	0.00
Leucaena leucocephala	1.33	1.39	2.72	0.38	2.00	2.38	0.00	0.00	0.00
Durio zibethinus	0.89	1.39	2.28	0.00	0.00	0.00	0.00	0.00	0.00
Mangifera indica	0.44	1.39	1.83	0.00	0.00	0.00	0.00	0.00	0.00
Dysoxylum gaudichaudianum	0.00	0.00	0.00	6.82	6.00	12.82	0.00	0.00	0.00
Dimocarpus longan	0.00	0.00	0.00	0.38	2.00	2.38	0.00	0.00	0.00
Senna siamea	0.00	0.00	0.00	0.76	2.00	2.76	0.00	0.00	0.00

Note: RD = relative tree density. RF = relative frequency. IVI = important value index

Tree canopy system

Shape and density of the tree canopy affects the role of the hydrological function. Canopy density affected by the number of branches, canopy width and height. Dense canopy has an important role in passing water into the ground. There are seven common of canopy shape i.e. : fastigiate tree (slim and tapered), columnar (oval), spreading (wide), rounded (rounded), pryramidal (pyramid), weeping (ducked) and picturesque (like painting) [7].

Canopy shape of fourteenth potential tree species for rehabilitation of water catchment areas on the slopes of Merapi ranged between rounded and columnar shape (**Table 3**). Number of branches, canopy height and width of the trees also varied (**Figure 2**). This will affect the density of the tree canopy (**Tabel 3**).

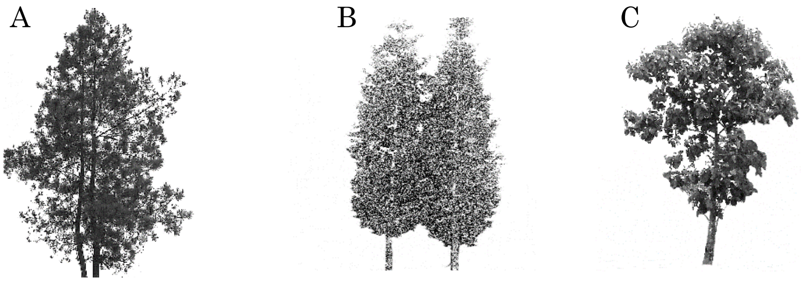

Figure 1. The pyramidal (A), columnar (B), and rounded/globular (C) canopy shape [4]

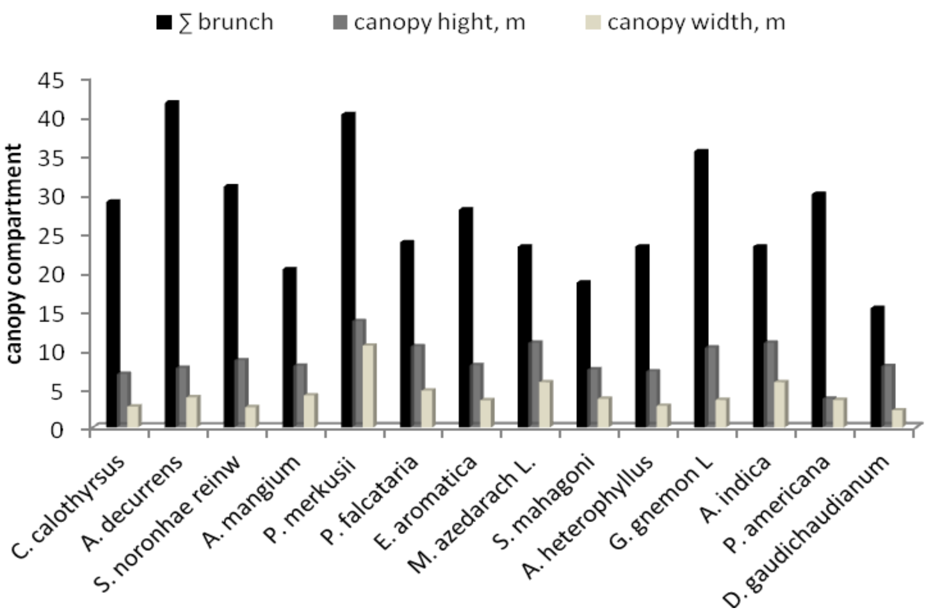

Figure 2. The number of branches, and canopy width and hight of several trees on the slopes of Merapi

Index of Canopy Density (ICD)

Canopy density index is closely related to the performance of the tree in the soil hydrologic function, because it affects the interception of rain water, throughfall, and stem flow. Index of canopy density of trees on the slopes of Merapi variety ranged between 0.31-0.90 (**Table 3**). ICD value closer to 1, the better the role of the tree to the hydrological function. There are 6 types of tree canopy that has a density index of more than 0.75, respectively, are as follows: *Gnetum gnemon* L (0.90), *Dysoxylum gaudichaudianum* (0.89), *Pinus merkusii* (0.87), *Eugenia aromatica* (0.84), *Persea americana* (0.84), and *Schima noronhae reinw* (0.76).

However, to choose the proper tree for the rehabilitation of hydrological functions of individual trees, need to consider other factors, such as the distribution of horizontal and vertical roots, root strength, and others.

Table 3. Shape and index of canopy density (ICD)

No.	Trees Species	Canopy shape	ICD
1.	*Calliandra calothyrsus*	rounded	0.43
2.	*Acacia decurrens*	rounded	0.46
3.	*Schima noronhae reinw*	columnar	0.76
4.	*Acacia mangium*	rounded	0.52
5.	*Pinus merkusii*	rounded	0.87
6.	*Paraserianthes falcataria*	rounded	0.31
7.	*Eugenia aromatica*	columnar	0.84
8.	*Melia azedarach* L.	rounded	0.54
9.	*Swietenia mahagoni*	rounded	0.57
10.	*Artocarpus heterophyllus*	rounded	0.51
11.	*Gnetum gnemon* L	rounded	0.90
12.	*Azadirachta indica*	rounded	0.60
13.	*Persea americana*	rounded	0.84
14.	*Dysoxylum gaudichaudianum*	columnar	0.89

Note: ICD = index of canopy density

Conclusion

Based on the IVI, there are 14 species of trees that potential for rehabilitation slopes of Merapi, and 5 of them are trees found in the forest, include: *Calliandra calothyrsus* (82.96%), *Acacia decurens* (42.09%), *Schina noronhae reinw* (18.96%), *Acacia mangium* (18.96%), *Paraserianthes falcataria* (18.74 %), and *Pinus merkusii (18.28%).*

Based on ICD, there are 6 types of tree canopy that has a density index of more than 0.75, respectively, are as follows: *Gnetum gnemon* L (0.90), *Dysoxylum gaudichaudianum* (0.89), *Pinus merkusii* (0.87), *Eugenia aromatica* (0.84), *Persea americana* (0.84), and *Schima noronhae reinw* (0.76).

The role of individual trees on hydrological function based on the estimated index of canopy density, need to be validated on actual conditions, to determine the ability of rainwater interception, throughfall, stem flow, reducing run-off and increasing infiltration. In addition, to choose the proper tree for the rehabilitation of hydrological functions of individual trees, need to consider other factors, such as the distribution of horizontal and vertical roots, root strength, and others.

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POPULATION PRESSURE ON THE VILLAGES AROUND KERINCI SEBLAT NATIONAL PARK (TNKS) OF LEBONG DISTRICT, PROVINCE OF BENGKULU, INDONESIA

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Abstract

The sustainability of Kerinci Seblat National Park (TNKS), especially the forest located in the Lebon District, is largely determined by the carrying capacity of surrounding villages. The carrying capacity can be described by the index of population pressure. According to this calculation of the sample villages shows that the population pressures of villages around TNKS were already happening (the average population pressure index is 3.5). This was means that there had been an over population in the majority of the sample villages because of the numbers above 1.00. Population pressure occurs more due to underdeveloped non-farm activities, while the productivity of the farm activities were still relatively low. Based on these facts, the carrying capacity could be increased by improving the application of technology and the creation of the attraction to the area in order to increase the population dynamics.

Keywords: *Kerinci Seblat National Park, carrying capacity, population pressure, population dynamic*

Introduction

Sustainable development was better understood as a form of natural resources use with respect to the availability and the ability to support any particular livelihood [1,2]. A simple depiction of sustainable development could be supposed to the drivers. They must consider the availability of fuel in the tank. How fast is the speed of oncoming vehicles depending on the vehicle capabilities. The ability of the resources that available in the nature can be described as the carrying capacity of land either physically or their biocapasity.

Starting from these understandings, sustainable development requires a natural resources management tools. The depiction described above indicate the importance of management tools that can reveal how much the capacity has been used by humans to support their life in achieving a certain level of prosperity. There was an old approach to analyze the human relationship with the environment proposed by Duncan by namely POET models [3]. POET models reveal any factors that determines the dynamics of the relationship between humans and the environment namely Population, Organization, Environment, and Technology. This model deals with the concept of carrying capacity where the ability of land to support a particular level of life was seen as direct and indirect impact of the four factors.

The carrying capacity can be determined by calculating the population pressure. Population pressure is a symptom of over population in the region, which are linked to the availability of resources, according to the desired standard of living in the area concerned. Population pressure occured when the population in the region has exceeded the carrying capacity [4].

The population pressure in the agrarian dominant areas were heavily influenced by farming system used. For example the wetland farming systems and the shifting cultivation systems will indicate population pressure levels different. If the pressure of population has occurred then it will most likely happen deterioration in the quality of wealth and the natural resources, population pressure to the villages around the forest could lead to forest clearing activities to the deepest location.

At the global level, the environmental degradation (i.e deforestation) are generated by the interaction of economic, demographic, cultural, and political causes [5]. There were two aspects, namely deforestation and the elements that are often cited as a cause, such as agricultural expansion as the tautological explanation [6]. An efforts to explain the destruction of forests by linking human activity as an independent variable will not find a comprehensive conclusion because it turns out their correlation are mutually influencing relationship. Environmental sustainability (forest) also determines the level of living of the population, vice versa [1]. The dynamic interaction of human and forest described as a reciprocal relationship between the demographic system, social system, and ecosystem [7].

For example, shifting cultivation activities. In general, the actors were small farmers who embrace the culture shifting cultivation in the forest areas. Sedentary activity was an agrarian culture reflection in order to sustain their life that contributed to the degradation of forests [8]. The destruction of forest on the other side also threaten the sustainability of the population livelihood because generally they also utilized either the forest timber and non-timber for various purposes of their life.

The phenomenon of deforestation and forest degradation in Indonesia, could be caused by the people's activities that settled around the forest. Forest Watch Indonesia suggested that the destruction of forests caused by several things such as timber extraction both by forest concession holders (HPH) and the activities of illegal logging, industrial timber opening (HTI), large-scale plantations of oil palm plantations, and small-scale agriculture [9].

Forest areas in Bengkulu Province were the threatened location sustainability due to people's activities. The rate of destruction of Kerinci Sebelat National Park (TNKS) in Bengkulu Province was very high, ie at the beginning of 2004 as much as 36.27% (123,534.58 ha) has been severely damaged (the condition of non-forest) area of 340 575 ha that are included in the administrative area of the Province of Bengkulu [10]. TNKS located in the Province of Bengkulu stretched in position 2 ° 16'36 .59 "S to 3 ° 27'2 .50" S and 101 ° 17'7 .76 "E to 102 ° 42'8 .52" E. Geaographically TNKS are in the District of Mukomuko, North Bengkulu, Rejang Lebong, and Lebong.

Kerinci Sebelat National Park (TNKS) established by the Decree of the Minister of Agriculture No. 736/Mentan/X/1982 then amplified by Decree of the Minister of Forestry and Plantations No. 901/kpts-II/1999 as conservation areas. The other areas were also confirmed as a Rimbo Pengadang Conservation Forest Areas Registers 42 and conservation areas Boven Lais that the first was designated as conservation forest by the Dutch Colonial Administration about 1927 known as the forest boundary Boszwezen [11].

The population and population density factors have to be recognition so we can know the demographic aspect contributing to the destruction of TNKS in Lebong district. Furthermore, it can be estimated also the impact on the sustainability of the livelihood system of people living around TNKS. So this study aimed to estimate the index of population pressure in the villages around TNKS.

Materials and Methods

The research was conducted in the district of Lebong, Province of Bengkulu. The early stage was identifying the villages that are directly contiguous to the forest. Data obtained from the sub-district office, there are 41 villages contiguous to the forest. Furthermore, the villages were randomly selected 20 of 41 villages directly contiguous to the TNKS.

The data collected consisted of the number of population, the annual rate of population growth, land use, land productivity, various of employment, and household income. Data collected by documenting the data available at the village office. If not available, conducted interviews with village heads and then loaded on the checklist provided. Especially revenue data was conducted by a survey of 15 households in each village randomly.

Population pressure index was calculated using the formula [12], namely:

$$PP_t = (1 - \alpha_t)\frac{F_t\, P_0(1+r)^t}{L_t}$$

where:

PP_t	= Population indexat year t
t	= Year
L_t	= Agricultural land area at year t
Z_t	= Average of agricultural land area required by each people at a needed standard of living
P_0	= Population at starting year
r	= Annual rate of population growth at year t
F_t	= Proportion of farmer population
α_t	= Proportion of non-farm to the farmer income

Population pressure indexes were calculated for each sample villages in 2012 and 2017. Here selected 2010 as a base year for determining population estimates for the year. In addition to productivity and agricultural land, use extrapolation techniques. The proportion of non-farm income was determined based on household surveys. While the standard of living used the World Bank poverty line of U.S. $ 2.00 (IDR 18,500) per capita per day; conversion of paddy into rice by 0.6, and rice productivity comparisons, dryland, and the estate was 10:5:6.

Results and Discussion

Population and its growth

Villages around TNKS have a different population (Table 1). Population minimum was the village of Talang Baru Sub-District of Rimbo Pengadang (370) and the maximum one was the village of Talang Leak 1 Sub-District of Lebong Selatan (1,833).

The annual population growth rate ranged from 0.67% to 6.73%. In general, these villages has had a population growth rate was quite high (more than 1:00%), except for the villages in the sub-district of Pinang Belapis (0.67%) and the Village Tambang Sawah and Air Kopras Sub-District of Lebong Tengah (0,67). There was a village with the highest growth in the village of Kota Baru Sub-District of Embong Uram.

The annual growth rate of population in these villages might be come from natural increases, the population growth was caused by the birth and death. There was no migration data making it difficult to quantitatively estimate the contribution of population movement to the total population. However, qualitatively it can be stated that the District of Lebong was a place that did not pass the road across the province so that the development of the region was relatively slow. Evens more not grown yet the industry that attracts people to come in and look for a job.

Tabel 1. Population and annual growth rate of villages around TNKS

No.	Villages	Year	Population	Growth Rate 2000-2010 (%)
	Sub-District of Rimbo Pengadang			
1.	Talang Ratu	2010	1,086	1.19
2.	Air Dingin	2010	1,323	1.19
	Sub-District of Topos			
3.	Talang Donok	2010	442	1.53
4.	Talang Baru	2010	370	1.53
	Sub-District of Bingin Kuning			
5.	Talang Leak 1	2010	1,833	1.62
6.	Kr. Dapo Atas	2010	1,039	1.62
7.	Kr. Dapo Bawah	2010	1,282	1.62
8.	Pl. Talang Leak	2009	1,015	1.62
	Sub-District of Lebong Atas			
9.	Desa Baru	2007	500	2.5
10.	Pelabi	2007	740	2.5
11.	Atas Tebing	2010	767	1.89
12.	Danau	2007	938	1.89

	Sub-District of Pinang Belapis			
13.	Ketenong 1	2009	568	0.67
14.	Ketenong 2	2009	478	0.67
15.	Sebelat Ulu	2009	310	0.67
	Sub-District of Embong Uram			
16.	Kota Baru	2010	672	6.73
17.	Talang Sakti	2009	1,388	1.73
18.	Tambang Sawah	2009	663	0.67
19.	Ujung Tanjung	2009	1,800	1.73
20.	Air Kopras	2010	666	0.67

Source: Villages Prophile and Monograph of Sub-District in District of Lebong 2007, 2009, 2010.

Land use and agrarian density

Land use was categorized based on the format issued by the Ministry of Home Affairs which was provided as a data base of every village, which consists of wetland, dryland, garden, swamp, yard, community forests, and state forests. Under the category then we classified in to two types of land namely arable land and non-arable land [4].

The villages around TNKS were generally more dominant arable land (Table 2). For example, the villages in the sub-district of Rimbo Pengadang, about 80% were arable land. In fact there were also villages where the amount of arable land close to 100%. There are two villages namely Talang Sakti and Tambang Sawah Sub-District of Embong Uram where 100% were arable land. The villages of this type means to the potential for agricultural development although not optimal cultivated, depending on the technology used and their capabilities.

The villages in the Sub-district of Lebong Atas were generally more dominant non-arable land (Table 2). Even the village of Atas Tebing nearly 100% was non-arable land, especially forests. The villages with a dominant type of non arable land indicates many lands that difficult to cultivate. Most of the non-arable land consists of swamps, community forests and state forests.

Real condition of arable lands in sustaining population was showed by agrarian density. According to the Table 2, generally were low agrarian density (below 3 people/ha). However, in some villages, especially in Sub-District of Embong Uram agrarian density was very high (above 6 people/ha). One even was reaching 11 people/ha, the Village Tambang Sawah.

Table 2. Land use and agrarian density of villages around TNKS

No.	Villages	Year	Arable Land (hectare)	Non Arable Land (hectare)	Agrarian Density (people/ha)
	Sub-District of Rimbo Pengadang				
1.	Talang Ratu	2010	678 (84.2)	127 (15.8)	1,49
2.	Air Dingin	2010	611 (83.2)	123 (16.8)	2,01
	Sub-District of Topos				
3.	Talang Donok	2010	137 (48.2)	147 (51.8)	3,00
4.	Talang Baru	2010	192 (60.6)	125 (39.4)	1,79
	Sub-District of Bingin Kuning				
5.	Talang Leak 1	2010	812 (95.9)	35 (4.1)	2,10
6.	Kr. Dapo Atas	2010	740 (98.0)	15 (2.0)	1,31
7.	Kr. Dapo Bawah	2010	106 (79.1)	28 (20.9)	11,25
8.	Pl. Talang Leak	2009	835 (78.8)	225 (21.2)	1,13
	Sub-District of Lebong Atas				
9.	Desa Baru	2007	100 (32.8)	205 (67.2)	3,85
10.	Pelabi	2007	300 (31.6)	650 (68.4)	2,20
11.	Atas Tebing	2010	145 (1.4)	10,004 (98.6)	4,50
12.	Danau	2007	1,089 (67.1)	535 (32.9)	0,80

	Sub-District of Pinang Belapis				
13.	Ketenong 1	2009	155 (31.0)	345 (69.0)	2,38
14.	Ketenong 2	2009	280 (73.7)	100 (26.3)	1,45
15.	Sebelat Ulu	2009	380 (77.9)	108 (22.1)	0,73
	Sub-District of Embong Uram				
16.	Kota Baru	2010	78 (79.6)	20 (20.4)	8,01
17.	Talang Sakti	2009	127 (100.0)	0 (0.0)	10,16
18.	Tambang Sawah	2009	24 (100.0)	0 (0.0)	11,05
19.	Ujung Tanjung	2009	260 (95.4)	12.5(4.6)	6,23
20.	Air Kopras	2010	165 (39.3)	255 (60.7)	3,23

Source: Villages Prophile and Monograph of Sub-District in District of Lebong 2007, 2009, 2010. (Data processed)

Notes:

a. Arable land consists of wetland, dryland, and estate.
b. Non arable land consists of swamp, yard, community forest, and state forest.
c. Agrarian density is number of people who depend on agriculture per hectare of arable land.
d. Numbers in the parentheses indicate percentage.

Population Pressure Index

The result of calculation of sample villages showed that the villages around TNKS, population pressure were already happened in 2012 (average of the population pressure index 3.21). This figure means that it has occurred over population in the sample villages (indexes above 1.00). Even there were some indexes very high, the Village Kr. Dapo Bawah, Kota Baru, Talang Sakti and Tambang Sawah. Contrary there were only 4 villages that have not experienced population pressure (population pressure indexes below 1.00), namely Talang Baru, Pelabi, Atas Tebing, and Danau. Population pressure will increase in 2017 (the average population pressure index 3.54). Completed results of the calculations are presented in Table 3.

Table 3. Population Pressure Index of Villages around TNKS, 2012 and 2017

No.	Village	2012	2017
	Sub-District of Rimbo Pengadang		
1.	Talang Ratu	1.28	1.36
2.	Air Dingin	2.76	2.93
	Sub-District of Topos		
3.	Talang Donok	1.83	1.97
4.	Talang Baru	0.26*	0.28*
	Sub-District of Bingin Kuning		
5.	Talang Leak 1	2.00	2.16
6.	Kr. Dapo Atas	1.01	1.10
7.	Kr. Dapo Bawah	8.96	9.71
8.	Pl. Talang Leak	1.32	1.43
	Sub-District of Lebong Atas		
9.	Desa Baru	1.41	1.59
10.	Pelabi	0.59*	0.67*
11.	Atas Tebing	0.89*	0.98*
12.	Danau	0.22*	0.24*
	Sub-District of Pinang Belapis		
13.	Ketenong 1	2.75	2.84
14.	Ketenong 2	1.29	1.33
15.	Sebelat Ulu	4.73	4.89
	Sub-District of Embong Uram		
16.	Kota Baru	7.81	10.81
17.	Talang Sakti	7.41	8.07

18.	Tambang Sawah	10.68	11.04
19.	Ujung Tanjung	2.7	2.98
20.	Air Kopras	4.3	4.48
	Average	3.21	3.54

Notes: * In these villages population pressure have not occured.

Population pressure index was formed by several important components, especially population growth rate, land productivity, and the proportion of non-farm income. The population growth rate above 1:00%, even there was reaching 6:00% (Kota Baru) what meaning?, causing rapid increase in population. The population was generally accommodated in the agricultural sector, which indicated the large proportion of the farmer population in these villages. The farmer population was the peoples who identifies the main occupation as a farmer. In those conditions, have not been available employment outside agriculture. Consequently, the proportion of non-farm income becomes smaller, which is equal to 0.32.

In some villages, there are some villages that have non-farm income proportion was quite large (around 0.5), the village of Danau (0.59), Ketenong 1 (0.47), Ketenong 2 (0.49), and Ujung Tanjung 2 (0.49). However, non-farm income sources have not yet contributed to the improvement of living standards. At the level of agricultural technology that was used by the villagers, where rice productivity is still low (around 2 tonnes / ha) have not produced the desired welfare (standard World Bank spending 2 dollars per capita a day). The villages that have not occured population pressures, the agricultural productivity apparently was large around 5 tonnes/ha. Consequently, although the agrarian density was still low, agricultural land was not able to sustain its population lives.

The standar of living that considered in this study population was equivalent to 2:00 expenditure US dollars per capita a day (roughly IDR 18,500). This has led to be good income either the agricultural sector and outside the agricultural sector. The implication was we need more intensive in using of technology or the expansion of agricultural land. Up here, it can be concluded that in the villages around TNKS has been a decreasing of the carrying capacity as big as population pressure above 1.00. It means that the available natural resources, especially the agricultural sector was not able to support the entire population at the level of properity.

Livelihood strategies of villagers would run to diversify sources of income called multiple livelihood. In the setting of mountains forest ecology and shifting cultivation cultural setting [8], then the chances of forest degradation around settlements the population will increase. In the calculation of the index population pressure here, the income from the utilization of forest products were removed. Thus, the figures obtained could explain the symptoms of deforestation were increased caused by agricultural activities.

The estimated of the island of Sumatra population pressure has not happened (in 2006 amounted to 0.80, and 0.86 in 2010) [7]. With an average productivity of land 4.17 tonnes / ha, the ecology of Sumatra Island was able to sustain the population lives on the same level of prosperity with this research. Specifically in the Province of Bengkulu, the population pressure nearly occurred in 2010, which amounted to 0.99 [7]. If the condition of the people and the land did not change the population pressure was estimated would have occurred in the following year. Worse situation occurred in North Sumatra (1.06), West Sumatra (1.18), and Lampung (1.53). Java situation as the worst, ie the population pressure in 2006 amounted to 1.80 and 2010 amounted to 1.83 [13].

Conclusion

Based on this study concluded that in 2012 the villages around TNKS has occurred population pressure (pressure index of 3.21 residents). Although agrarian density still quite low, but because of high population growth rate, of low agricultural productivity, and of proportion of non-farm income were also low, the population pressure has occurred. These conditions indicated the occurrence of overpopulation or the decreasing of carrying capacity of the environment.

To improve the environmental carrying capacity and sustainability of the population livelihood around TNKS required number of strategies. Multiple livelihood strategies by diversify the source of income was one of the solutions [1]. It's just that we need to take into account the population. The relatively small number of people have not been sufficient for the development of the secondary sector (trade) and tertiary (services). Demographically, the factors that can be considered to be better for the population growth was in-migration. The factors of birth and death can be ruled out because of these two factors still require long periods of time as well as development of human resources. Therefore, the development of trade and services sector needs to be supported by the government program such as agro tourism, agroforestry, and industry (e.g. mining). These option would improve the proportion of non-farm income to increase the internal carrying capacity.

Another option was the intensification of agriculture. The intensification was done by apllying the modern agricultural technology. The goal was to improve the productivity of agricultural land. Rice fields and plantations were conserved and replanted. If the productivity of land improved sucessfully, it could reduce the population pressure. It means that the carrying capacity of the environment would increase.

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THE ESTABLISHMENT OF *Alstonia muelleriana*, A RAINFOREST SPECIES IN WET SCLEROPHYLL FOREST IN NORTH QUEENSLAND FAVOURED BY FIRE: IMPLICATIONS FOR ITS MANAGEMENT

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Abstract

This study aims to evaluate the establishment of *Alstonia muelleriana*, a rainforest species, in wet sclerophyll forest in relation to fire occurrence by comparing population structure of the species in recently burnt (2003) and long unburnt (since early 1990s) areas in the Wallaman section of Girringun National Park. The population structures of unburnt and burnt areas were found to be significantly different, even though both areas were dominated by small individuals (size class 1, 0– 2 cm diameter). The abundance of *A. muelleriana* in each area also differed significantly. In the absence of fire, *A. muelleriana* might rely on seeds for regeneration. However, in general, *A. muelleriana* is favoured by fire, resprouts very quickly and forms dense clumps in the community. Resprouting seems to be the main strategy enabling this species to occupy and dominate the area after fire. The invasion of *A. muelleriana* is deleterious to the maintenance of wet sclerophyll forest. Therefore, appropriate management practices are needed to address this problem give example what specific management will be implemented based on study results

Keywords: *Alstonia muelleriana Fire, plant invasion, population structure, resprouting ability*

Introduction

Fire is widely recognized as one of the major ecological factors which impacts on the population dynamics of organisms in many ecosystems [1]. On the one hand, it adversely affects plants and animals in the immediate term [2]; however, it is an important tool for habitat manipulation and population enhancement [3]. In fire-prone communities, fire is often used as a management tool in order to reduce fuel loads. The aim is to reduce the risk and the extent of unplanned fires. However, in Australia, this practice often results in the high frequency of fire occurrence [4], which permits invasion by unwanted species. Therefore, the use of fire as a management tool in natural ecosystems has to be applied carefully. Liu *et al*. [5] suggested that, in conserving the ecosystem of fire-dependent species, it is essential to consider the historical fire regimes of the species. This is because species have been evolving over long periods of time in response to the prevailing environmental conditions, including fire. These fire regimes have favoured particular life history strategies of species.

Since there is evidence that the invasion of rainforest species into wet sclerophyll (tall-open) forest in the wet tropic region has been happening for thousands of years [6], historical fire regimes in this area have also had an influence for a long time. The interaction between this community and fire has resulted in a unique ecosystem. Therefore, the management strategy for this area, which consists of plant populations adapted to a fire-prone habitat, should take into account the fire regimes in which the plants have been evolving [7] [8]. Rainforest pioneers invade the wet sclerophyll forest, and the thickening canopy prevents regeneration of the wet sclerophyll species. In order to conserve representative areas of wet sclerophyll forest, land managers use prescribed fire to open up the invading rainforest.

Pioneer species rely very much on seeds rather than vegetative regeneration for recruitment [9]. *A. muelleriana* is a typical rainforest pioneer species, which is shade-intolerant and vigorous in open conditions. It produces large numbers of seeds, which are able to germinate in full light and are easily dispersed by wind. The seedlings of pioneer species tend to grow rapidly [9]. However, Williams [10] found that no seeds of *A. muelleriana* germinated from the soil seed bank after fire. Consequently, the number of seedlings of *A. muelleriana* was relatively low compared to other rainforest pioneer species. Williams [10] also found that *A. muelleriana* was re-sprouting very well before and after fire, and was abundant in several areas of wet sclerophyll forest in north Queensland. The ability to resprout is fairly unusual for pioneer species. It appears that this regeneration pattern is favoured by fire disturbances. This ability will not only affect the abundance of a species but also its distribution (spatial demography) [11]. Therefore, more studies of the population dynamics of this species are required. An understanding of age class distribution and resprouting ability in response to fire will assist management of this species in natural ecosystems.

Material and Methods

Study species

Alstonia muelleriana Domin (Apocynaceae) occurs in north-east Queensland, as well as in Papua New Guinea. It may reach a height of 15 m and trunk diameter at breast height may be as much as 30 cm. It is a pioneer species that grows in rainforest, rainforest margins and in open areas near rainforest [12].

Study site and design

This study was conducted by comparing the population structure of *A. muelleriana* in two areas with different fire regimes in the Wallaman Falls section of the Girringun National Park, north Queensland, Australia (600 m altitude), in the Wet Tropics World Heritage Area (Figure 1). The average rainfall is about 2000 mm per year. The Wallaman Falls area consists of rainforest vegetation surrounded by wet sclerophyll forest.

The study was conducted in areas with two different fire histories. The first study area, designated as the “unburnt” area, was last burnt in the early 1990s. The second area, which was regularly burnt from the early 1990s until 2003, is designated as the “burnt” area. Six 10 x 10 m plots were randomly established in each area, resulting in twelve plots.

For the purpose of analysis, plants of *A. muelleriana* were divided into 4 size classes based on diameter, i.e. Class 1: 0 – 2 cm, Class 2: 2 - 5 cm, Class 3: 5 – 10 cm, and Class 4: > 10 cm. All *A. muelleriana* observed in the sampling plots were counted and measured for diameter, height and number of stems. Diameter of size class 1 was measured basally. The diameter of size classes 2 and 3 was measured at about 30 cm height above ground and diameter at breast height (d.b.h) was measured for size class 4. The number of dead stems per individual was also recorded.

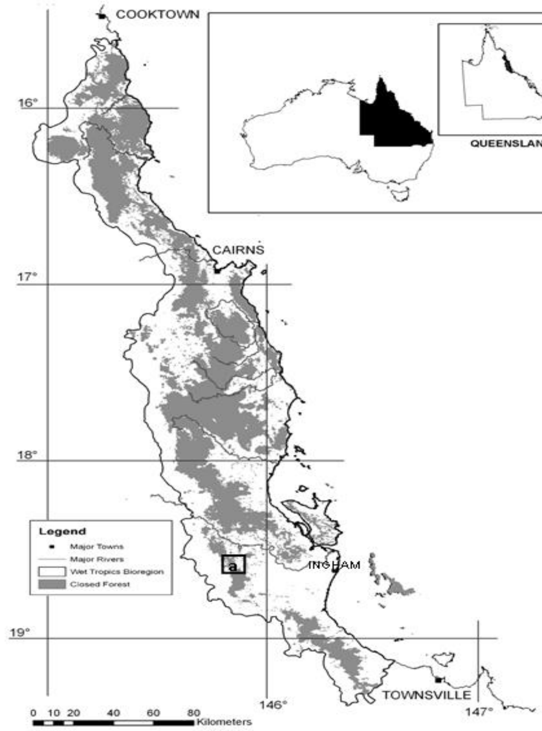

Figure. 1. Map of the Wet Tropics area of north Queensland, showing study locations (a) in the Wallaman Falls section of the Girringun National Park [13].

Statistical analyses

Differences between total abundance of *A. muelleriana* in the two fire regimes were determined by applying a Student's *t*-test [14]. The differences in mean height and diameter of the three size classes of *A. muelleriana* in the two fire regimes were determined by a Mann-Whitney *U* test [14]. Graphical analysis was employed in order to visualize the relative contribution of different size classes to the overall population structure. Basic data manipulation was carried using Microsoft Excel and statistical analyses were carried using the SPSS package.

Results and Discussion

The population structure of *A. muelleriana* was affected by fire, which is indicated by differences in the size class compositions of the burnt and unburnt areas (Figure 2). Both of these areas were dominated by small plants; however, there was an absence of the two larger size classes in the burnt area: i.e. size classes 3 (diameter = 5 to $\leq$ 10 cm) and 4 (> 10 cm). This suggests that the fires had burnt larger stems, and they were replaced by several smaller stems. The populations of *A. muelleriana* at the two sites differed significantly in height (Mann-Whitney Test, U = 5429.5, $p<0.05$). The frequency distributions of height indicate that there were high proportions of short individuals in both the burnt and unburnt areas, (Figure 3). In the unburnt areas, the majority (71.8%) of *A. muelleriana* were less than 5 m tall, although some were more than 10 m in height: this resulted in a positively skewed height distribution at the unburnt site. In the burnt area, almost all (99.2%) individuals were less then 3 m tall.

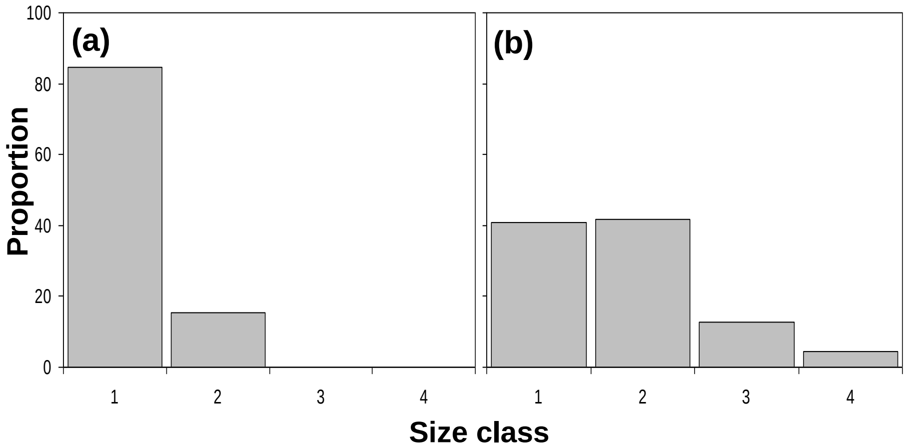

Figure 2. Size class distributions based on diameters of *A. muelleriana* populations under two different fire regimes - (a) burnt and (b) unburnt. Class 1: 0 – 2 cm, Class 2: 2 - 5 cm, Class 3: 5 – 10 cm, and Class 4: > 10 cm.

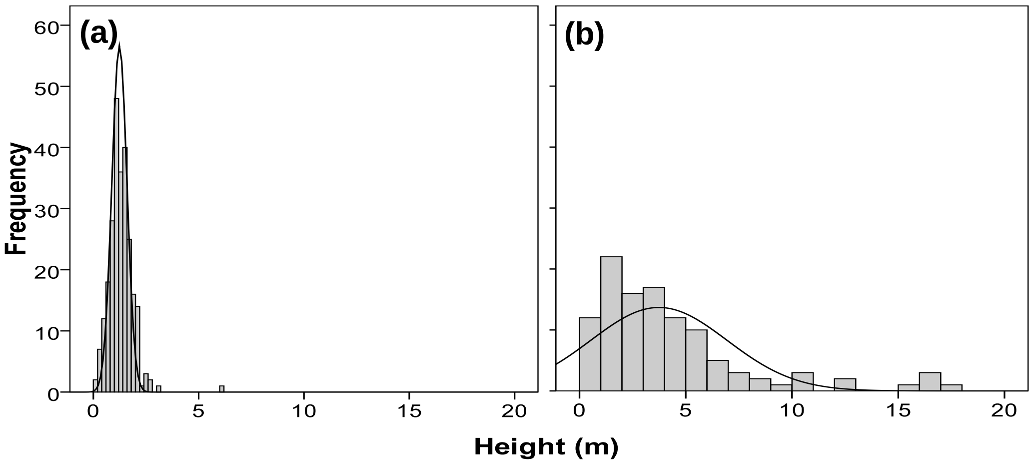

Figure. 3. The distribution of heights of *A. muelleriana* under two different fire regimes - (a) burnt and (b) unburnt.

The abundance of *A. muelleriana* at the two sites was significantly different, with an average of 18.33 and 42.33 individuals per 100 m^2 for unburnt and burnt areas respectively (t_{10}= -3.003, P<0.05) (Table 1). In the burnt area, *A. muelleriana* was very dense with an average 112.5 stems per 100 m^2. By contrast, there were only 25 stems per 100 m^2 in the unburnt area. Fire stimulated the resprouting of *A. muelleriana*, which resulted in multi-stemmed growth of this species. The burnt area contained individuals with a large number of stems, where the average was 2.66 stems per individual, ranging from 1 to 9. In comparison, individuals in the unburnt area had an average of 1.36 stems per individual, ranging from 1 to 4. Observation suggests that the resprouting came from below ground and root suckering. Furthermore, there were no seedlings found in the plots in the burnt area. Some small size individuals resulted from root suckering. The differences in the average number of individuals and number of stems per individual of *A. muelleriana* in the unburnt and the burnt areas indicated that self-thinning was occurring in this species population in the area. It is supported by findings showing that about 9.1% and 12.3% stems in the burnt and the unburnt areas were dead, respectively.

Table 1. The abundance of *A. muelleriana* and abundances of four size classes in the burnt and unburnt areas

Area	Average number of individuals per 100 m^2	Average number of stems per 100 m^2	Number of individuals for each size class per 100 m^2			
			1	2	3	4
Unburnt area	18.33	25	7.83	8	1.67	0.83
Burnt area	42.33	112.5	37.83	4.5	0	0

This study indicates that fire favours the establishment of *A. muelleriana*. As a rapidly growing species, it occupied the area readily and created a very dense population. The number of *A. muelleriana* individuals in the burnt site was more than twice that in the unburnt site. The presence of grasses, such as *Imperata cylindrica* and *Themeda triandra*, and other fast growing species, i.e. *Allocasuarina littoralis* and *Acacia* spp., did not seem to affect the invasion of *A. muelleriana* into the burnt area. Fires create open areas with full sunlight which is favoured by pioneer species [9] [15].

Frequent fires also did not appear to kill *A. muelleriana, as* it resprouted and formed dense clumps in the burnt area. Resprouting created many stems per individual. After fire, as many as 9 stems per individual were observed, with an average of 2.66 stems per individual. By comparison, the largest number of *A. muelleriana* stems in the unburnt area was 4 stems per individual (an average 1.36 stems per individual). Resprouting has permitted this species to regenerate after fire and maintain populations. Resprouting is widely recognized as a regenerative behaviour that provides self-maintenance ability in plants [16].

Low seedling recruitment in *A. muelleriana* appears to be the trade-off for resprouting after fire. This study found no seedlings in the burnt area. There were some small individuals but they established from root suckering. Williams [10] found that no seeds of *A. muelleriana* germinated from the seed bank after fire. By contrast, seedlings were found in the unburnt area. One of the special features of resprouters is that they can maintain their presence in the community when the fire interval is too short for significant seed production [17], or seedling recruitment is likely to fail completely, even after fire. Although mature plants of *Alstonia* produce large number of wind-dispersed seeds, they only remain viable for a short period (pers. obs.).

One aim of applying prescribed burns is to reduce the fuel loads and decrease the risk of fire. This allows the maintenance of biological diversity and precludes invasion by exotic species. On the other hand, the expansion of rainforest species into wet sclerophyll forest has become a problem that needs to be addressed in the Wet Tropics area, and land managers use fire to limit the spread of rainforest species into more open vegetation types. This means that the fire regimes, including frequency and intensity, should be applied in the area carefully.

Conclusions

A. muelleriana is favoured by fire. It grows very quickly by resprouting and root suckering and creates a dense clump after fire. This study suggests that frequent fire will allow this species to dominate the area. The resprouting ability of species should be considered in the conservation and management of species, because non-resprouters are more vulnerable to recruitment failure due to severe disturbances. This failure is associated with the absence of pollination or dispersal agents after fire and problems related to small population size. Conversely, resprouters will not suffer from such problems since they can reproduce vegetatively; hence, they resist disturbances. They also tend to tolerate long periods of little or no recruitment [18]. In short, frequent fires may allow *A. muelleriana* to dominate the area. A long period of fire absence might be needed to decrease the domination of this species in the area.

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A STUDY ON THE MECHANISM OF CELLULOSE DEGRADATION BY ENZYME

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Abstract

As the petroleum-based fuel faces the threat of scarcity due to over consumption, increase attention has been put on finding alternative sources for fuel. One of the alternatives is to turn into cellulose as the ultimate source for bioethanol. Cellulose microfibrils have both high crystalline regions and less-ordered amorphous regions. More ordered or crystalline cellulose is less soluble and less degradable. Enzymatic hydrolysis has attracted increasing attention as an alternative to chemical hydrolysis because the process is highly specific, can be performed under milder reaction conditions with lower energy consumption and lower environmental impact. Usually, lignocellulosic materials must be pretreated prior to enzymatic hydrolysis in order to make the cellulose more accessible to enzymes. This paper relates to a study on the mechanism of cellulose degradation by enzyme. Literature review on the structure of lignocellulosic biomass as well as previous researches on cellulose hydrolysis and cellulosic conversion for ethanol production by enzymes are necessary to gain deeper understanding on the degradation mechanisms of cellulose by enzymes.

Keywords: *bioethanol, cellulase, cellulose, enzymatic hydrolysis, saccharification*

Introduction

Making cost-effective ethanol from cellulose is a national priority and a scientific challenge. Natural cellulases, or improvements thereof that have been achieved by conventional techniques, do not have adequate efficacy to make enzymatic cellulosic ethanol production economically viable at this time.

Indonesian congress has passed the Energy Independence and Security Act of 2007 that mandates production of 36 billion gallons of bioethanol: 20 billions from starch (currently 9 billions) and 16 billions from cellulose (currently none) by 2022, as the answer to anticipate the scarcity and increasing price of petroleum-based fuel. Starch (mostly corn) has received negative attention as a source of ethanol for three reasons: (a) the net energy benefit of corn-based ethanol is only 26% due to the subtraction of the energy needed to make fertilizers and pesticides (M. Montenegro, Grist Env. News 2006); (b) according to Nobel Laureate Paul Curtzen, starch based ethanol has a net climate warming effect when one considers the nitrous oxide that is released from the use of chemical fertilizers; and (c) competition for food that make many people call starch-based ethanol as a “devil’s trade, food versus fuel”. Hence the focus is increasingly turning to cellulose (over one half of all global biomass) as the ultimate source for bioethanol.

Lignocellulose Structure

Lignocellulosic biomass comprising forestry, agricultural and agro-industrial wastes are abundant, renewable and inexpensive energy sources. Therefore, due to their chemical composition based on sugars and other compounds of interest, they could be utilized for the production of a number of value added products, such as ethanol, food additives, organic acids, enzymes and others. The major constituents of lignocelluloses are cellulose, hemicelluloses and lignin, as the polymers that are closely associated with each other constituting the cellular complex of the vegetal biomass. Basically, cellulose forms a skeleton which is surrounded by hemicelluloses and lignin.

Cellulose is a high molecular weight linear homopolymer of repeated units of cellobiose (two anhydrous glucose rings joined via a β-1,4 glycosidic linkage) [1]. The long-chain cellulose polymers are linked together by hydrogen and van der Walls bonds, which cause the cellulose to be packed into microfibrils [2]. By forming these hydrogen bounds, the chains tend to arrange in parallel and form a crystalline structure. Therefore, cellulose microfibrils have both highly crystalline regions (around 2/3 of the total cellulose) and less-ordered amorphous regions. More ordered or crystalline cellulose is less soluble and less degradable [3,4].

Hemicellulose is a linear and branched heterogeneous polymer typically made up of five different sugars – L-arabinose, D-galactose, D-glucose, D-mannose and D-xylose – as well as other components such as acetic, glucuronic and ferulic acids. The backbone of the chains of hemicelluloses can be a homopolymer (generally consists of single sugar repeating unit) or a heteropolymer (mixture of different sugars). According to the main sugar residue in the backbone, hemicelluloses have different classifications e.g., xylans, mannans, glucans, glucuronoxylans, arabinoxylans, glucomannans, galactomannans, galacto-glucomannans, β-glucans and xyloglucans. When compared to cellulose, hemicelluloses differ by composition of sugar units, by presence of shorter chains, by branching of main chain molecules and to be amorphous [5], which make their structure easier to hydrolyze than that of cellulose.

Lignin is a very complex molecule constructed of phenylpropane units linked in a large three-dimensional structure. Three phenyl propionic alcohols exist as monomers of lignin: p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol. Lignin is closely bound to cellulose and hemicelluloses and its function is to provide rigidity and cohesion to the material cell wall, to confer water impermeability to xylem vessels, and to form a physic–chemical barrier against microbial attack [5]. Due to its molecular configuration, lignin is extremely resistant to chemical and enzymatic degradation [6].

The amounts of carbohydrate polymers and lignin vary from one plant species to another. In addition, the ratios between various constituents in a single plant may also vary with age, stage of growth, and other conditions. However, cellulose is usually the dominant structural polysaccharide of plant cell walls (35~50%), followed by hemicelluloses (20~35%) and lignin (10~25%) [7].

Cellulose Hydrolysis

Selective and effective separation of the main fractions present in lignocellulosic biomass is of great interest, mainly when submerged fermentation process will be subsequently performed, because the by-products obtained during hydrolysis of these materials may affect the fermentation yield and also because valuable sources are lost if other fractions are partially hydrolyzed. Due to the structural differences among these fractions, separation of cellulose, hemicelluloses and lignin from lignocellulosic biomass requires the use of specific processes, which may be physical, physico-chemical, chemical or biological. There is a variety of methods that have been proven to be efficient for the lignocellulose hydrolysis.

Chemical and enzymatic methods are the most common techniques for hydrolyzing cellulose. The chemical method, also known as concentrated acid hydrolysis, is conducted with mineral acids such as H_2SO_4 or HCl (in the range of 10~30%), at temperatures of about 160ºC and pressures of about 10 atm [8,9]. These harsh conditions (high temperature and acid concentration) are needed to liberate glucose from the tightly associated chains, because most cellulose is crystalline. In this process, acid concentration, temperature and time are crucial factors, and must be controlled to avoid sugars and lignin degradation to by-products [10]. If present in the raw material to be hydrolyzed, hemicelluloses are also removed by using concentrated acids [11].

Enzymatic hydrolysis has attracted increasing attention as an alternative to concentrated acid hydrolysis because the process is highly specific, can be performed under milder reaction conditions (pH around 5 and temperature less than 50ºC) with lower energy consumption and lower environmental impact. In addition, it does not present corrosion problem and gives high yield of pure glucose with low formation of by-products that is favorable for the subsequent hydrolysate used in fermentation processes [12,13,14]. Enzymatic hydrolysis of cellulose is a reaction carried out by cellulase enzymes, which corresponds to a mixture of several enzymes, among which at least three major groups are involved in the hydrolysis of cellulose: (1) β-1-4-endoglucanase (EC 3.2.1.4.), which attacks regions of low crystallinity in the cellulose fiber creating free chain ends; (2) β-1-4-exoglucanase or cellobiohydrolase (EC 3.2.1.91.), which degrades the molecule further by removing cellobiose units from the free chain ends; (3) β-glucosidase (EC 3.2.1.21.), which hydrolyzes cellobiose to produce glucose [8,15,16]. A wide variety of cellulolytic fungi and bacteria have been reported. Among them, the enzyme system secreted by the filamentous fungus *Trichoderma reesei* has been intensively studied. Generally, lignocellulosic materials must be pretreated prior to the enzymatic hydrolysis in order to make the cellulose more accessible to enzymes [13,17,18].

Cellulosic Conversion for Ethanol Production by Enzymes

Currently, ethanol production is one of the most studied and promising alternative of cellulosic biomass conversion, due to the large incentive that has been given to biofuels used in replacement of gasoline. In addition, ethanol production from lignocellulosic wastes is very attractive because of their low cost and abundance, and non-competition with foodstuffs. Therefore, a large variety of lignocellulosic materials including wood, straws, agricultural wastes, and crop residues have been evaluated for use in this bioconversion process. The basic process step in producing ethanol from cellulose biomass consist of an initial treatment (for example, diluted acid, alkaline or steam explosion) to render cellulose more accessible to the subsequent step of enzymatic hydrolysis, which break down polysaccharides to simple sugars [19]. The glucose solution obtained is fermented to ethanol by microorganisms; *Saccharomyces cerevisiae* being the most currently used since it gives high ethanol yields from glucose.

All processes for enzymatic conversion of cellulose start with a thermochemical pretreatment, the most common among them being the so called “steam explosion process” and the “ammonia expansion process”, the purpose of which is to solubilize the hemicelluloses, set the cellulose micofibrils free from their matrix of lignin coating and increase their surface area so as to expose them to improved accessibility by enzymes. Though both starch and cellulose are polymers of the glucose unit, the former is more readily (100x) biodegradable than the latter. In cellulose, which is the structural component of plant cell walls, evolution seems to have balanced the need for stability with that of carbon recycling by making cellulases less potent enzymes than the starch degrading enzymes. The slow and delayed enzymatic degradation of cellulose appears to be due to the β-glycosidic linkages (versus α in starch) that allow compact crystalline packing of the cellulose chains through inter-chain hydrogen bonding, making penetration by hydrolytic enzymes rather difficult. Today, the biggest barrier to cellulosic ethanol is the cost of the enzyme, 20~25 cents/gallon ethanol versus 1~2 cents/gallon ethanol in case of starch. Hence the emphasis is on improving cellulase efficacies.

Cellulases as they occur in fungi and certain bacteria consist of at least three enzymes, the endocellulase, the exocellulase and the cellobiase. Cellobiase causing slower enzymatic degradation of cellulose lies between the other two enzymes. The endocellulase acts on the tightly packed cellulose chains and breaks them randomly along their length. This process disrupts the inter-chain hydrogen bonds and causes the bundles to swell. The exocellulases, then acting progressively either from the non-reducing end or the reducing end, break down the exposed polysaccharide chains to disaccharides (cellobiose). Cellulose is not always the same material. Depending upon its source it may differ in the lengths of its polysaccharide chains, compactness of their crystalline packing, and surface area of the fibrils. Similarly, depending on their sources, there are many variants of both endo- and exocellulases. Between these two classes, the actions of endocellulases are often considered to be the rate determining steps [20]. However, since it is known that the catalytic and binding domains (CD and CBD) of cellulases act independently [21] and the absorption of cellulase on cellulose is a rather facile process [22], the key rate determining step is the catalytic hydrolysis of the glycosidic bonds by the endocellulase on solid cellulose.

Fermentation of hemicellulosic hydrolysates is usually more complicated than fermentation of cellulosic hydrolysates, due to the presence of pentose sugars such as xylose, which is not metabolized by large number of microorganisms. However, efforts have been directed to the use of this fraction from lignocelluloses. Currently, one of the technologies that have been strongly investigated for conversion of hemicellulose sugars is for ethanol production. During the process for ethanol production from cellulose, a hemicellulosic hydrolysate is generated in the first step of raw material treatment (usually performed with dilute acids or steam explosion). Utilization of the sugars released during this stage (hemicellulose sugars) is considered essential for efficient and cost-effective conversion of lignocellulose to ethanol. The main challenge of this process is that *Saccharomyces cerevisiae*, which is the most widely used microorganism for ethanol production, does not utilize pentose sugars. *Pichia stipitis* has been described as a promising microorganism for this bioprocess since this yeast is able of transforming both pentose and hexose sugars into ethanol, which is an important advantage since both kinds of sugars are currently found in hemicellulosic hydrolysates [23]. Some bacteria, such as *Escherichia coli*, *Klebsiella*, *Erwinia*, *Lactobacillus*, *Bacillus*, and *Clostridia*, can utilize mixed sugars but produce no, or only a limited quantity of ethanol [7]. Some attempts have also been made to genetically modify *S. cerevisiae* and other microorganisms in order to produce ethanol with high yields from both, hexoses and pentoses [24].

Conclusion

Enzymatic hydrolysis of cellulose is a promising step in bioethanol production. It is highly specific, cost effective and environmentally friendly. However, due to the complex structure of plant cell wall and the cellulose itself, pretreatment is usually required to facilitate the enzymatic action by cellulase. The main challenge is to find both the most suitable microorganism that can produce cellulase for specific biomass and the microorganism that can effectively ferment the sugar produced into ethanol in the particular environment.

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POLYELECTROLYTE MEMBRANE BASED ON FIBER OF WASTE OF PALM OIL INDUSTRY

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Abstract

Polyelectrolyte membranes based on cellulose fiber derived from waste of palm oil industry, bunch press fiber, has been synthesized. Before synthesis, the cellulose obtained was determined for its solubility, degree of polymerization, X-raydiffraction pattern, and its functional groups using FTIR. Subsequently, sulfonation was conducted using trimethylsilyl chlorosulfonic as sulfonation agent under nitrogen gas. Polyelectrolyte membrane was prepared by mixing cellulose and phosphoric acid as a dopant in mole ratio of x = 0.125, x = 0.25 and x = 0.5. Activation energy of polyelectrolyte was determined at several temperatures.

Keywords: *Activation energy, bunch press fiber, polyelectrolyte membranes, sulfonated cellulose*.

Introduction

Polymer electrolytes under intermediate temperatures have become crucial as the membranes for polymer electrolyte membrane fuel cells (PEMFC). Recently, water-free proton conductors have been searched for the substitution into hydrated perfluorosulfonic acid polymers to maintain stable conductivity at higher temperatures. Moreover, the operation of fuel cells at higher temperatures provides additional advantages such as, improvement of CO tolerance and higher efficiency [1].

The first approach toward water-free proton conductors was the polymer–acid complexes where neutral or basic polymers were blended with strong acids (H_3PO_4 or H_2SO_4) and high proton conductivity was obtained in the anhydrous state [2,3]. The main disadvantage of the polymer-acid systems is leaching out of the acids that caused the decrease of the proton conductivity of the membranes during fuel cell operation.

Applications of biopolymers in electrical devices are not only interesting but also important for environmental safety. Additionally, the production cost of the polymer electrolyte membranes can be optimized using a biopolymer instead of expensive sulfonated aromatic polymers. In that respect, cellulose fiber is a highly specialized basic biopolymer which was established as the main industrial.

Some renewable energy sources have been found and promising, for example fuel cells. Fuel cells use an electrochemical conversion basis, which convert chemical energy to directly produce electricity. Fuel cells work with high efficiency and environmentally friendly. One of the components of the fuel cell is the polyelectrolyte membrane. Research on polymer has been developed rapidly at this time, including the process of synthesis and proton conducting polymer products, such as sulfonated polymer.

According to Directorate General of Estate Crops, Ministry of Agriculture (2006) [4], there is 83.583 Ha of oil palm plantations in Bengkulu province, with 12 units of palm oil plants having production capacity of 546 tonnes of fresh fruit bunches per hour. PT. Bio Nusantara in the current production capacity 45 tonnes of fresh fruit bunches per hour. Production of 1 tonne of fresh fruit bunches will be generate 230 kg of fiber derived from oil palm empty fruit bunches.

The amount of bunch press fiber waste is very supportive to diversify its utilization. This fiber contains cellulose as the main component. a There are also minor components such as lignin, fats, waxes, terpenes, terpenoids, steroid, phenolic compounds, protein and starch contained in the fiber.

Minor components can be removed by solvent extraction method and soaking. Currently, the fiber is only used as boiler fuel at palm oil plant or as natural fertilizer in oil palm plantations. Some is still left unutilized. The abundance of the fiber will continue to increase along with the growth and development of oil palm plantations in Indonesia.

In order to bettre utilize the fiber, study on the synthesis of polyelectrolyte membrane uisngbunch press fiber was conducted.

Materials and Methods

Materials

Fiber of waste palm oil industry, in this case bunch press fiber, was obtained from PT. Bio Nusantara. Other chemicals, upri ethylenediamine (CED), phosphoric acid, methanol, sodium Hydroxide, and n-hexane were from merck, while trimethylsilyl chlorosulfonic (TMSCS) was from Aldrich.

Methods

The bunch press fiber was separated from impurities, then it wassoaked in n-hexane for one night to eliminate residual palm oil contained in the fiber. Then, the fiber was dried at room temperature for 12 hours, and in an oven at ...C. The dried fibers were immersed in a solution of 18% sodium hydroxide at 135 ºC for 4 hours. Cellulose fiber obtained was then washed with distilled water until neutral. The fiber obtained was determined for its degree of polymerization,relative molecular mass of cellulose fibers, FTIR spectra, and XRD diffraction patterns.

Cellulose fibers were dissolved in cupri ethylenediamine at a temperature of 25 °C under a stream of nitrogen gas. Trimethylsilyl chlorosulfonic as sulfonating agent was added to solution of polymer at room temperature. Nitrogen gas flow was maintained during the sulfonation reaction. Mole ratio between cellulose and sulfonating agent was 1: 0.25 with a reaction time of 10 hours.

The reaction was stopped by adding methanol to obtain sulfonated cellulose. Then the material was washed with methanol and rinsed with distilled water. The residual solvents were evaporated and then the material was dried in an oven at 110 °C. The dried sulfonated cellulose was then determined for its degree of sulfonation.

Membrane preparation was done by adding phosphoric acid as dopant on sulfonated cellulose. Sulfonated cellulose and the dopant were mixed with the stoichiometric mole ratio of x = 0.125, x = 0.25 and x = 0.5. In order to obtain a homogeneous polymer, the solution was stirred for 12 hours at room temperature. Membrane was produced by casting technique, that was pouring a solution of polymer on glass plates. The solvent was evaporated slowly at a temperature of 50 °C for 24 hours. Themembrane was then transferred to the oven for 24 hours to evaporate the residual solvent. Activation energy has been determined using a viscometer based on the semi-empirical Arrhenius equation as in Eq. 1 and Eq. 2. Viscosity was measured at temperature of 70, 80, 90, and 110 °C.

$$\text{viscosity}, \quad \eta = Ao\ e^{-Ea/KT} \tag{1}$$

$$\ln \eta = \ln Ao - Ea/KT \tag{2}$$

Results and Discussion

FTIR spectra

Purification results using n-hexane and sodium hydroxide was approximately 46% cellulose fibers. Analysis using FTIR assures that the functional groups and the spectrum obtained were those characteristics of cellulose. **Figure 1** showed the spectrum of cellulose fibers produced from bunch press fiber.

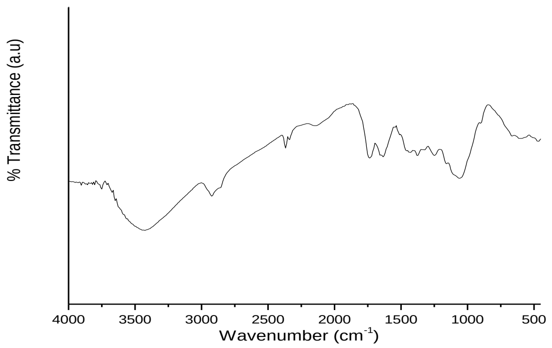

Figure 1. FTIR spectrum of cellulose fiber from bunch press fiber.

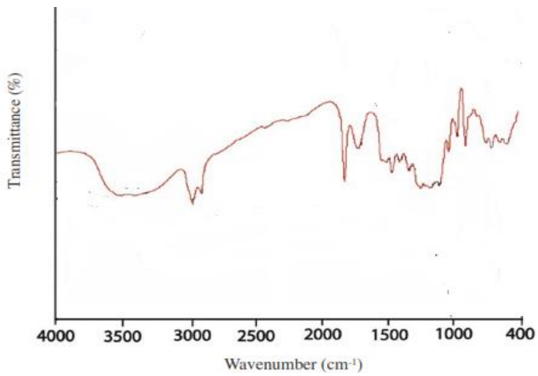

Figure 2. FTIR spectrum of cellulose fiber from palm kernel [4].

Characterization of functional groups of cellulose fiber produced showeds distinctive peaks at 3350 cm^{-1} region are -OH stretching vibration, 2944 cm^{-1} CH stretching vibrations, 1647,1 cm^{-1} OH bending vibration, area around 1379 - 1431 cm^{-1} CH bending vibration of methylene and methyl, area around 1250 cm^{-1} OH bending vibration, approximately 962 - 1150 cm^{-1} CO stretching region for C - OC and C - OH cellulose stating glycoside bond and the area around 420-871 cm^{-1} is a vibration ring. The results have shown that the spectrum was obtained is cellulose fibers, this spectrum has similarities with the FTIR spectrum has been reported (**Figure2**) of material palm kernel [4].

XRD diffractogram

Crystallinity of the polyelectrolyte will affect its properties and uses. The degree of crystallinity of the polyelectrolyte membrane determined by X-ray diffraction as shown in Figure 3. Compared with bacterial cellulose has been reported similarly on crystallinity [5]. Difractogram pattern of the cellulose fiber of oil palm empty fruit bunches showed that at 2θ between 10º and 20º there was a wide pattern shape than that between 20º and 25º. The peaks of the two regions angle exposing amorph and crystalline regions This suggested that the cellulose obtained in showed that this study was a semi crystalline polymer.

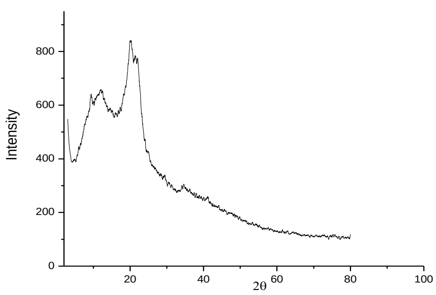

Figure 3. X-ray diffractogram of cellulose fiber from bunch press fiber.

Degree of polymerization

Determination of the degree of polymerization was done empirically using the viscosity method. The degree of polymerization describes of a monomer repeat unit number listed along the polymer main chain or backbone. Solvents used in the determination of the viscosity was CED. Cellulose fiber was dissolved in a solvent at various concentrations. The degree of polymerization was obtained by extrapolating the straight-line equation to get the value of intrinsic viscosity [η_{ins}] from curve a of reduced viscosity versus concentration (**Figure 4)**.

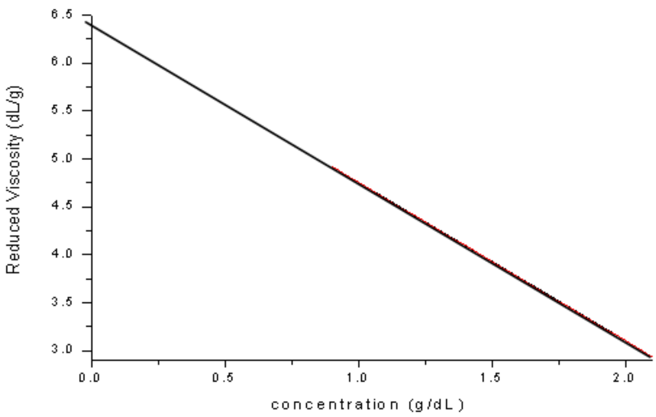

Figure 4. Curve of reduced viscosity (dL/g) versus concentration (g/dL).

Equation obtained from the straight-line curve:

$$Y = - 1.6533 x + 6.4 \qquad (3)$$

Intrinsic viscosity [η_{ins}] obtained was 6.4 dL/ g or 640 mL/g
By using the equation from previous research [6]

$$Dp^{0.9} = 1,6 \times [\eta_{ins}] \qquad (4)$$

Thus, the degree of polymerization of cellulose fiber from bunch press fiber of oil palm was 2195. Based on the degree of polymerization, information aabout relative molecular mass of cellulose could be obtained, which was 355,590 g/mol.

Solublity of cellulose

Solubility of cellulose was performed using CED solvents at various concentrations. Table 1 showed that at lower concentrations, cellulose was not soluble. This was because there was much more hydrogen bonds contained in the cellulose molecule. At lower concentrations equivalent mole between solvent and cellulose were not balanced. When theconcentrations were low, cellulose mole equivalent was higher than that of the solvent. Therefore, it was necessary to dissolve cellulose with a higher solvent mol equivalent. This also can be seen from the results of characterization, which showed thatthe degree of polymerization of cellulose was high enough, consisted of 2195 units of glucose. Hydrogen bonds formed between the fibers (intrafibril) can also occur within the fiber itself (interfibril). Cellulose structure can be seen in **Figure 5**.

Table 1. Solubility of cellulose at various concentrations

No	ShakingTime (hours)	Concentration (M)	Solubility
1	24	0.75	Not soluble
2	24	2.00	Not soluble
3	24	2.50	Partially soluble
4	24	5	Soluble

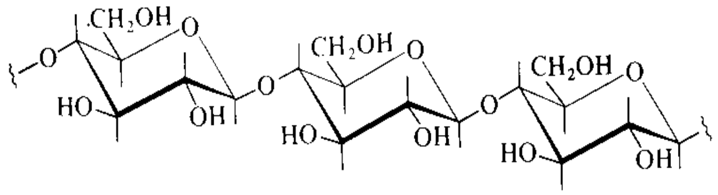

Figure 5. Structure of cellulose.

Polyelectrolyte membrane

Results of sulfonation of cellulose from bunch press fiber yielded up to 177%. Proton at C6-OH group has been substituted by-SO3H. Sulfonation degree of 100% indicates all protons at C6-OH group have been substituted by-SO3H. If the degree of sulfonation was more than 100%, it mean that the next position, proton at C3-OH was substituted. Reactivity of this cluster has been reported in previous study [7].

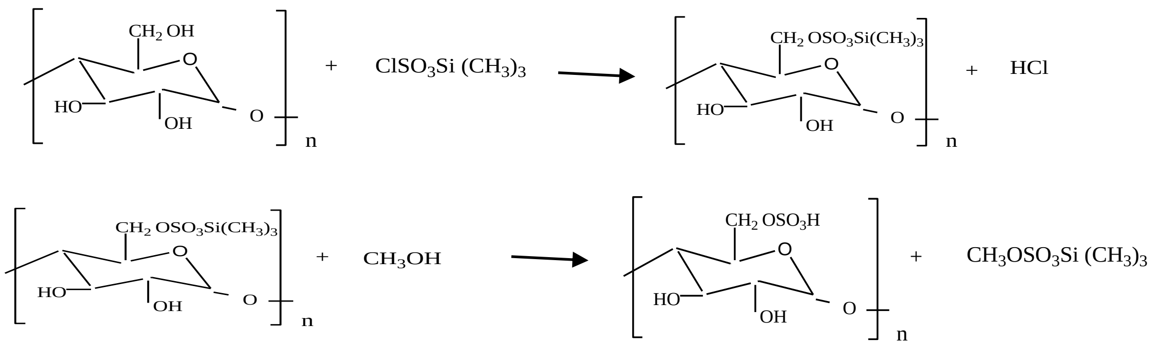

Figure 6. Mechanism of sulfonation of cellulose

Activation energy of polyelectrolyte membrane has been determined at several temperatures. Activation energy obtained were 0.055 eV, 0.092 eV and 0.069 eV, for x = 0.125, x = 0.25 and x = 0.5 respectively. Activation energy on the polyelectrolyte is the minimum energy required to do promotions in relation to the conduction of protons. From the experimental results, the lowest activation energy was obtained in the mole ratio x = 0.125, followed by x = 0.5 and x = 0:25. This was probably related with the conductivity mechanism that occured in a low mole ratios. Proton conductivity mechanism occurs through a combination of vehicle mechanism and Grotthus mechanism. While the mole ratio x = 0.25 may be due to the added dopants increases so will hinder the promotion of proton conductivity.

The decrease in the activation energy from x = 0.25 to x = 0.5, conductivity mechanism that occurs involves hopping protons known as Grotthus mechanism. In the vehicle mechanism hydronium ion will carry a positive charge through hydrogen bonding, while in Grotthus mechanism it occurs while hopping from one protonated site to another protonated site. Previous research also mentioned that the activation energy decreased at higher dopant containing samples was attributed to threshold composition of dopant [8].

Conclusion

Polyelectrolyte membrane based on sulfonated cellulose and phosphoric acid has been prepared. FT-IR spectroscopy clearly indicated the functional groups of cellulose. The cellulose obtained in this study was a semi crystalline polymer. The proton migration was mediated by acidic protons through hydrogen bonding network and condensation of acidic units blocked the proton transport resulted in a decrease in the activation energy.

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NATURAL RUBBER-BASED WOOD ADHESIVE TO SUPPORT GREEN BUILDINGS

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Abstract

Natural rubber is a biopolymer obtained from the sap of *Hevea braziliensis*. The material is abundantly available in Indonesia. It has long been known and used as an adhesive, even though it has poor adhesion and cohesion properties, and poor resistance to stress, heat and moisture. However, when technology is applied to the natural rubber, it can improve the qualiy of natural rubber as an adhesive, so that natural rubber-based adhesives of good adhesion property is produced. Wood adhesive is one of important parts in wood panels or wood composites industries. It has a great contribution on the price of wood panels, because it can reach as much as 80% of the total production cost of the panels. Recently, the most widely used wood adhesives are synthetic and formaldehyde bearing adhesives, which might be harmful to human due to formaldehyde emission during the process and the service life of the adhesives. The use of natural rubber as an alternative source of wood adhesive contributes to the development of greener buildings and environment, because the material is renewable, water-based, and has very low or no formaldehyde emission.

Keywords: *biopolymer; green buildings; natural rubber; renewable, wood adhesive.*

Introduction

Natural rubber is originated from the Amazon, Brazil, and was brought to Asia by the British. Southeast Asia is now leading as natural rubber producer. Indonesia is the second largest producer of natural rubber after Thailand. Natural rubber is a biopolymer (poly *cis*-1,4-isoprene) derived from the sap of rubber tree (*Hevea braziliensis*). Although there are so many synthetic rubbers produced, the role of natural rubber is still strategic, because in some applications natural rubber cannot be replaced by synthetic rubbers due to its outstanding properties, such as its elasticity, resilience, flexibility at low temperatures, resistances to abrasion, impact and corrosion, facile adhesion to textile and steel, impermeability, insulating properties, and ability to disperse heat [1]. Its tack property makes natural rubber one of the earliest materials used in formulating adhesives. Natural rubber adhesives are commonly used in bonding non metalic materials, such as leather, fabrics, rubber products, wood and paper. The performance of natural rubber as wood adhesive is low compared to that of other wood adhesive such as formaldehyde bearing wood adhesives, because it has poor resistance to stress and heat and fair resistance to moisture [2]. However, the performance of natural rubber can be improved by applying some technologies, so that it can be used as an exterior grade wood adhesive.

The most common wood adhesives used recently are formaldehyde bearing wood adhesives, such as phenol formaldehyde (PF), melamine formaldehyde (MF), phenol resorcinol formaldehyde (PRF), and urea formaldehyde (UF), due to their low prices. The formaldehyde emitted from the wood construction materials or wood furniture might have undesirable effects on human health. There are growing concerns regarding the toxic emissions in the importing countries. Therefore, there should be efforts to reduce the use of formaldehyde bearing wood adhesives, and to encourage the use of environmentally friendlier wood adhesives.

Green building, sometimes also called green construction or sustainable building, is defined as a building designed to be ecologically correct by using resources efficiently, using internal recycling, renewable energy resources, recyclable or biodegradable construction materials, and blending in with the local environment, particularly in out-of-town locations [3]. Although practices in green building may differ from region to region, there are fundamental principles of green building include siting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization, and waste and toxic reduction. One or more of these principles should be optimized. Due to an increasing interest in green building, recently a number of organizations have developed standards, codes and rating systems that let government regulators, building professionals and consumers confidently adopt green building. There are some green building rating systems that have been established, for example Building Research Establishment Environmental Assessment Method (BREEAM) in the UK, Leadership in Energy and Environmental Design (LEED) in the USA and Canada, Deutsche Geselschaft fur Nachlaltiges Bauen (DGNB) or German Sustainable Building Council in Germany, and Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan. In Indonesia the Green Building Council Indonesia (GBCI), which was established in 2009, has an authority in the certification of green building in the country using a rating system, called Greenship. So far, there are three rating system manuals produced, the Greenship New Building, Greenship Existing Building, and Greenship Interior Space.

Production and Characteristics of Natural Rubber

Natural rubber is one of important commodities produced in Indonesia. The total area of rubber plantation and the production of natural rubber in the country is relatively constant in the last five years, except the production in 2011, which increased significantly compared to those in the previous years (Table 1) [4]. With this amount of product, Indonesia becomes the second highest producer of natural rubber in the world after Thailand, while Malaysia is in the third rank. Thailand could produce more natural rubber than Indonesia although the harvested area of rubber in Thailand is lower than that in Indonesia, which indicates a better productivity in Thailand’s plantation. The world production of natural rubber has increased from 2000 until 2006, but did not change significantly during the last five years, while that of synthetic rubber was increased steadily from 2000 until 2012 (Table 2). The total production of synthetic rubber is also higher than that of natural rubber. These mean that there is a tendency of demand increase for rubber, but since the demand cannot be fulfilled by natural rubber which might be caused by the shortage of rubber plantation, the synthetic rubber has to fulfill the increasing demand for rubber.

Table 1. Harvested area of rubber plantation and rubber production from Thailand, Indonesia and Malaysia [4]

Year	Harvested area (Ha)			Production (tonnes)		
	Thailand	Indonesia	Malaysia	Thailand	Indonesia	Malaysia
2000	1,462,076	2,400,000	1,300,000	2,278,653	1,501,430	928,000
2001	1,503,944	2,599,470	1,250,000	2,522,508	1,607,460	882,000
2002	1,553,764	2,634,720	1,250,000	2,633,124	1,630,360	890,000
2003	1,600,640	2,675,060	1,315,000	2,860,093	1,792,350	985,600
2004	1,655,991	2,675,060	1,275,000	3,006,720	2,065,820	1,168,700
2005	1,691,099	3,279,391	1,237,000	2,979,722	2,270,891	1,126,000
2006	1,742,896	2,725,858	1,251,000	3,070,520	2,637,231	1,283,600
2007	1,766,849	2,775,546	1,248,000	3,024,207	2,755,172	1,199,600
2008	1,819,502	3,424,217	1,247,000	3,166,910	2,751,286	1,072,400
2009	1,856,072	3,435,270	1,058,000	3,090,280	2,440,347	857,019
2010	1,929,257	3,445,121	1,081,953	3,051,781	2,734,900	899,001
2011	2,042,502	3,456,100	1,117,392	3,348,897	3,088,400	996,673

Table 2. World rubber production [5]

Year	Natural Rubber	Synthetic Rubber	Total Rubber
2000	6,762	10,870	17,632
2001	7,332	10,483	17,815

2002	7,326	10,877	18,203
2003	8,006	11,338	19,344
2004	8,744	11,977	20,721
2005	8,907	12,073	20,980
2006	9,827	12,612	22,439
2007	9,890	13,347	23,237
2008	10,128	12,711	22,839
2009	9,690	12,385	22,075
2010	10,428	14,082	24,510
2011	11,031	15,104	26,135
2012	11,383	15,094	26,477

Natural rubbber is obtained after tapping rubber trees. A milky white solution, called field latex, will flow from the trees. Characteristics of natural rubber latex (NRL) are as follows [6]. The latex has a pH of 6.5-7 with colloidal property, where natural rubber particles or polyisoprene and non rubber substances are dispersed in an aqueous serum phase. The compositions of the field latex are 30-45% dry rubber, 3-5% non rubber substances, which consists of protein, lipid, and metal ions, and about 53 % serum. Rubber particles contain 90-95% natural rubber with sizes ranging from 0.15 up to 3 µm and a molecular weight distribution of 10^5-10^7 g/mol. The field latex is usually preserved by adding ammonia solution to prevent coagulation. At the processing factory, the field latex is concentrated to obtain concentrated latex having total solid content of about 60%, or coagulated to produce rubber goods such as tyres, crepe sheets, etc. Mechanical stability of latex is one of the most important properties of NR latex, because it is an indicator of the resistance of the latex against flocculation or coagulation during processing of the latex. Some other important properties are latex viscosity, magnesium content, and stability in the presence of zinc ions. Natural rubber has double bonds in its structure, which is useful for chemical modification purposes. This unsaturated structure also makes natural rubber relatively unstable compared to other elastomers, such as EPDM rubber, which are almost fully saturated.

Natural Rubber-Based Wood Adhesives

There are two types of rubber adhesives, solvent base and emulsion [2]. Some solvents usually used are benzene, toluene and naphta. Since the solvents are volatiles, it is important to pay attention to the vaporization of each component to prevent blushing, a condition in which the more volatile fraction of a solvent evaporates faster than the others, cause cooling on the surface, which makes the moisture from the air condensed on the glue film. Rubber emulsion is a dispersion of small rubber globules in water, which is called latex. It needs emulsifiers to maintain good dispersioan of a non polar material in a polar liquid. The solvent systems have a lower concentration of rubber solid (10-25%), but higher viscosity than emulsion systems with rubber solid >40%. The higher solid content and larger particulate sizes in the emulsion systems make the systems have less penetration when applied to porous surfaces. On the other hand, with lower solid content, solvent systems have greater penetrating ability, which allows a deeper greep on the substrate. However, the higher solid content in the emulsion systems make the surface area covered per unit volume is much greater than the solvent systems. Therefore, it needs more than one coat of solvent systems be applied in order to build a film of sufficient thickness attach to two surfaces of materials to be adhered. Due to volatile solvents contained in the solvent systems, the assembly time of the solvent systems are usually much shorter (5-10 minutes) than that of emulsion systems (about 60 minutes at ambient). The solvents are also toxic and flammable, so that good ventilation and precautions are needed to prevent toxicants inhalation and avoid the risk of fire.

As we mentioned earlier, natural rubber by itself is not a good adhesive. In order to improve its adhesion quality, some technologies could be applied, for example blending with commercial adhesives, chemical modifications, or combinations of chemical modification and blending. Blending with commercial adhesives is the easiest and the most simple way in improving adhesion quality of natural rubber. The natural rubber latex (NRL) could be blended with formaldehyde bearing adhesives, such as urea formaldehyde, melamine formaldehyde or phenol formaldehyde, as well as with non-formaldehyde adhesives, such as Aqueous Polymer Isocyanate (API) adhesive. Chemical modifications mean that the rubber is modified chemically, for example by grafting with polystyrene (PS) or polymethyl methacrylate (PMMA), or by making an epoxidized natural rubber (ENR). The modified rubber also can be blended with other commercial adhesives and produce adhesives of good bond strength.

According to Marra (1992) [2], blending of phenolic resins and rubber will combine the strong, durable and good adhesion properties of phenolics with elastomeric properties of rubber. This combination can produce a tough and durable bond which are able to facilitate the differential movements of different materials, such as wood to metal. The combination of resorcinolic resins with rubber can produce the same properties at room temperature. Weeraratne et al. (1972) [7] has used NR latex–resin blends as plywood adhesives. Blends of NR, UF and Kaolin (NR/UF/Kaolin 65/35/100) was successfully used for binding 10 timber species usually used for plywood production in Sri Lanka. They also found that the replacement of 25% UF by MF could increase failing load of plywood from 194 to 250 psi, while blending one part of PF solution (1 part PF in 4/5 parts water) and one part of NR (dry rubber content 53.7%) with 5% paraformaldehyde satisfied the bond strength requirements for commercial plywood for exterior application with failing load 279-295 psi. Another study also shows that blending of NRL with PF could produce exterior grade plywood adhesive [8]. NRL can be blended with PVOH and used as base polymers of API adhesive. Addition of polymeric isocyanate crosslinkers to this polymer blend will produce adhesive with good bonding quality. Results of a study shows that API adhesive prepared from the blend of NRL (solid content 40%) with PVOH (solid content 15%) at ratio 1/1 (w/w) as base polymers and isocyanate crosslinker (15-20% of the weight of base polymers) could produce plywood that could meet standard for exterior application with shear strength after cyclic boiling test 7-8 kg/cm^2 [9]. NR-rubber-based adhesive was also prepared by dissolving rubber compound that consisted of NR, MgO, wood rosin, PF resin and Accinox TQ in toluene and applied the solution (40% soild content) for binding wood pieces. The increase of PF resin in the rubber compound up to 35% could increase lap shear strength, but further increase of PF resin did not give any significant increase in lap shear strength [10].

Chemical structure of NR shows that it is a non polar polymer which contains doble bonds. The non polar property makes NR not quite suitable to be applied as wood adhesive, which contains polar polymers. Chemical modification at double bonds by introducing hydrophylic goups along the NR backbone is one way to increase the application of NR as adhesive of polar material, such as wood. Introduction of epoxirane ring in NR structure to produce ENR reduces the number of double bonds and increase the hydrophylicity of NR. The adhesion of ENR to wood is produced after crosslinking of the ENR with a multifunctional amine compound, such as p-phenylene diamine, or via a sulphur curing system. The ENR based adhesives with amine crosslinking agent could produce particle board with superior properties than unmodified NR, and ENR with higher level of epoxide group (30 mole %) shows superior properties to that of lower level of epoxide group (20 mole%) [11]. Another study shows that ENR adhesive with sulphur crosslinker applied on wood produces higher tensile strength than that with phtalic anhydride and both sulphur and phtalic anhydride crosslinkers [12].

Another method of improving adhesive quality of NR is by grafting copolymerization of the NRL by PMMA or PS. The copolymerization had been conducted using ordinary chemical process [13,14] or radiation technique [15]. The application of this adhesive in plywood production resulted in interior grade plywood [13,16,17]. The addition of PF resin (5-7.5% w/w) to the adhesive could markedly improve the bonding quality of the adhesive in plywood product [14]. Further study shows that there was different bond quality produced when the adhesive was applied on different wood species. The application of the adhesive in the production of red meranti plywood resulted in better bonding performance (shear strength 7.16-9.12 kgf/cm^2) than that of albizzia plywood (shear strength 3.74-4.77 kgf/cm^2) after dipping in water at 60°C for 3 hours [18]. Even, after cyclic boiling test the adhesive applied in red meranti plywood could maintain its bonding performance with shear strength value of 7.08-9.90 kgf/cm^2, which means that it could meet the standard for exterior application (shear strength > 7 kg/cm^2). Studies on blending of some high temperature setting commercial adhesives, such as MF, PF, and API, with NRL-St show that the adhesive blends could produce plywood with bond strength higher than that produced using PF or API, which are known as good wood adhesives (Table 3).

Table 3. Bond strength of natural rubber latex (NRL) – based and commercial wood adhesives as plywood

adhesive

Wood Adhesives	Wood Veneers	Bond Strength*) (kgf/cm2)	References
NRL-based Adhesives			
NRL	Albizzia (*Paraserianthes falcataria*)	1.5	[13]
NRL-St	Red Meranti (*Shorea* sp.)	7.08-9.90	[18]
NRL–St / PF (9:1)	Red Meranti (*Shorea* sp.)	10.08	[14]
NRL-St / MF (8:2)	Red Meranti (*Shorea* sp.)	8.18	[19]
NRL-St /API $_{HTS}$ (9:1)	Red Meranti (*Shorea* sp.)	15.1	[20]
API (NRL-based)	Red Meranti (*Shorea* sp.)	9.12	[9]
Commercial Wood Ahesives			
PF	Red Meranti (*Shorea* sp.)	>7	[14]
API $_{HTS}$	Red Meranti (*Shorea* sp.)	6.45	[20]

HTS = High Temperature Setting
*) Exterior I Grade Testing according to Indonesian National Standard (SNI) 01-2704-1992
Bond Strength according to SNI should be □7 kgf/cm^2

The NRL-St adhesive cannot be used for products such as laminated wood and laminated veneer lumber, that are pressed at room temperature. The shear strength of laminated rubber and acacia wood glued with this adhesive were only 1.17 and 0.02 MPa, respectively, which were very much lower than that produced using commercial low temperature setting adhesives, such as resorcinol based adhesive and API adhesive (Table 4). However, blend of this adhesive with other low temperature setting commercial adhesive could improve bonding performance of laminated wood produced. Blend of NRL-St with PRF and another resorcinol based adhesive resulted in laminated wood with shear strength of 3.96 and 3.06 MPa, which is suitable for home fixtures, but not for structural woods [21,22]. Higher shear strengths (>6 MPa) were obtained when NRL-St was blended with API adhesive. The Japan Agricultural Standard (JAS) requirement regarding bond strength of laminated wood is higher than 5.4 MPa with delamination ratio less than 10%. Therefore, blend of NRL-St with API adhesive has a good prospect to be applied as laminated wood adhesive, which could reduce the cost of API adhesive as well as provide non formaldehyde wood adhesive.

Natural Rubber-Based Wood Adhesives and Green Buildings

Green building concept such as stated in Greenship Indonesia includes "material resources and cycle" as one of criteria in the evaluation of a building. There should be priority in the use of green materials, which was listed in the Greenship document, for example regional production, certified SNI/ISO/Ecolabel, recyclability of a material, renewable material, lights that do not contain mercury, and composite wood products without formaldehyde. The use of NR-based adhesive could reduce the risk of formaldehyde emission, which might be harmful to human. Even though blend of NR-based adhesive with formaldehyde bearing adhesives could improve bond strength, caution must be taken since the adhesive emits formaldehyde, especially the one blended with MF or UF (Table 5). European Standard classifies formaldehyde emission into three classes, E1 (less than 0.1 ppm), E2 (0.1-1 ppm), and E3 (more than 1 ppm) [23]. The acceptable product should be in E1 or E2 class. Meanwhile, JAS classifies formaldehyde emission from glue laminated timber into four classes, F**** (average 0.3 mg/L, maximum 0.4 mg/L), F*** (average 0.5 mg/L, maximum 0.7 mg/L), F** (average 1.5 mg/L, maximum 2.1 g/L), and F*S (average 3.0 mg/L, maximum 4.2 mg/L) [24]. Analysis of some wood panels produced using NR-based adhesive shows that the formaldehyde emissions from the wood panels were still in the range of tolerable amount if NR-based adhesive is used as sole adhesive or if it is blended with PF, PRF or API adhesive (Table 5). Therefore, the use of NR-based wood adhesive can give some contributions in the application of green building concept in Indonesia.

Table 4 Bond strength of natural rubber latex (NRL) – based and commercial wood adhesives as laminated wood adhesive

Wood Adhesives	Wood	Bond Strength*) (MPa)	Delamination ratio (%)		References
			Cold water	Boiling water	
NRL-based Adhesives					
NRL-St	Rubber wood (*Hevea braziliensis*)	1.17	88.93	100	[22]
NRL-St	Acacia (*Acacia mangium*)	0.02	92.35	100	[22]
NRL-St/PRF (1:1)	*Dryobalanops aromatica*	3.96	2.11	86.67	[21]
NRL-St/ Resorcinol based (6:4)	Rubber wood (*Hevea braziliensis*)	3.05	14.89	4.66	[22]
NRL-St/ API_{LTS} (6:4)	Rubber wood (*Hevea braziliensis*)	6.20	6.71	3.49	[22]
NRL-St/ API_{LTS} (6:4)	Acacia (*Acacia mangium*)	4.3	0	30	[22]
NRL-St /API_{LTS} (1:1)	Acacia (*Acacia mangium*)	7.06	0	5	[25]
Commercial Wood Adhesives					
Resorcinol based	Rubber wood (*Hevea braziliensis*)	6.34	5.70	15.02	[22]
API_{LTS}	Rubber wood (*Hevea braziliensis*)	9.04	15.41	0	[22]
API_{LTS}	Acacia (*Acacia mangium*)	6.89	0	20.21	[25]

LTS = Low Temperature Setting
Japanese Agricultural Standard (JAS) for Glued Laminated Timber requirements:
Bond strength >5.4 Mpa
Delamination ratio <10%

Table 5. Formaldehyde emissions of NRL-based adhesives

NRL-based adhesive	Products	Formaldehyde emission (ppm)	Class	References
NRL-St	Plywood of *Shorea* sp.	<0.1	E1	[14]
NRL–St / PF (9:1)	Plywood of *Shorea* sp.	0.362	E2	[14]
NRL-St / MF (9:1)	Plywood of *Shorea* sp.	6.127	E3	[19]
NRL-St / MF (8:2)	Plywood of *Shorea* sp.	11.680	E3	[19]
NRL-St / UF (9:1)	Plywood of *Shorea* sp.	7	E3	Unpublished data
NRL-St/PRF (1:1)	Laminated wood of *Dryobalanops aromatica*	0.127	F****	[21]
NRL-St/API_{LTS} (6:4)	Laminated wood of *Hevea brasiliensis*	0.036	F****	[22]

Conclusions

Natural rubber-based adhesive is a potential wood adhesive to be developed in Indonesia, since it can produce wood panels with good bond strength and very low formaldehyde emission. Besides, the raw material, natural rubber latex, is abundantly available in Indonesia. The use of NR-based adhesive could support the concept of green building by providing better environment quality inside the building and providing renewable material produced inside the country.

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DECAY PERFORMANCE OF TERMITE MUSHROOM, *Termitomyces eurrhizus* AND THE SEM OBSERVATION OF DECAYED WOOD

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Abstract

A termite mushroom, *Termitomyces eurrhizus*, is distributed in tropical and subtropical region from Africa to South-East Asia. Since *T. eurrhizus* completely depends on the symbiotic termite nutritionally, its growth on artificial media is very slow and subtle. We are carrying out tests to examine the various factors relating to the nutritional characteristic of *T. eurrhizus*. In this study, we collected a group of strains of *T. eurrhizus* to conduct decay tests using commercially available wood in Japan. Five strains of *T. eurrhizus*, one white-rot fungus and brown-rot fungus were used in this study. Heartwood and sapwood of four wood species were used as wood samples. For the heartwood of softwood samples, *T. eurrhizus* showed relatively large mass losses, varying in from 10.2 % to 4.4 % (w/w). But they showed lower mass loss in hardwood samples. These results suggest that *T. eurrhizus* has decay ability against heartwood of softwood species, and it may be used as a feeder of artificial cultivation media. In addition, we observed the decayed wood with a scanning electron microscope (SEM). From the surfaces analysis of *T. eurrhizus*, the test samples were well covered with mycelia, but little amount of mycelia were penetrated into the samples. It might indicate that decayed by *T. eurrhizus* was limited to wood surface layers due to slow development.

Keywords: *Termitomyces, wood decay test, SEM*

Introduction

A termite mushroom *Termitomyces eurrhizus* is distributed in tropical and subtropical region from Africa to South-East Asia [1]. *Termitomyces* fungi have a symbiosis relationship with Macrotermitinae termites. They inhabit only fungus gardens in the termite nest in nature. In Japan, *T. eurrhizus* is found only in a part of Okinawa Prefecture with symbiotic relationship to *Odontotermes formosanus* [2, 3]. This is a very tasty mushroom, but its ecological / physiological profiles are not well known due to limited inhabitation in Japan.

Since *Termitomyces* fungi completely depend on symbiotic termites nutritionally, they are difficult to be cultivated and no one succeeded in obtaining the fruiting body *in vitro* so far. Now, we are carrying out a variety of tests to examine the various factors in terms of the nutritional characteristics of *T. eurrhizus* under the artificial conditions. In this study, we conducted decay tests with commercially available wood in Japan to verify the possibility as the artificial culture media. Additionally we observed the decayed wood with a scanning electron microscope (SEM) to know the penetrating manner of the fungus.

Materials and Methods / Experimental

Wood decay test

Five strains of *T. eurrhizus*, NBRC 33275, T3, T11, T25, and T26, which were collected in Okinawa Prefectiure, Japan, were used in this test. A white-rot fungus, *Trametes versicolor*, and a brown-rot fungus, *Fomitopsis palustris*, were used as control. Heartwood and sapwood of Japanese cypress (*Chamaecyparis obtusa*), Japanese cedar (*Cryptomeria japonica*), Japanese red pine (*Pinus densiflora*) and Japanese beech (*Fagus crenata*) were used as wood samples. Fungi media was prepared in accordance with JIS K 1571-2010 [4] (Fig. 1). Sample size was 10 mm (R) × 10 mm (T) × 5 mm (L). Six samples were employed for each test.

After the 8 weeks' exposure to monocultures of the fungi, mass losses of the samples were calculated.

SEM observation

Wood samples were stabilized by the solvent replacement method: immersing in ethanol series (10, 20, 40, 60, 80, 90, and 100 % (v/v)), aceton, and n-pentan for 15 min. The samples were cut with razors. For comparison of penetration manner of *T. eurrhizus*, we observed the decayed wood with a scanning electron microscope (SEM) (JSM-5310, Japan Electron Optics Laboratory Ltd. (JEOL), Tokyo, Japan) at 10 kV.

Results and Discussion

Wood decay test

The results of the decay tests are presented in Fig. 2. For heartwood of Japanese cypress (A) and Japanese cedar (B), some strains of *T. eurrhizus* showed higher mass losses than those of the brown rot fungus, *F. palustris*. Regarding sapwood samples, on the contrary, all strains showed lower mass losses than those of brown rot fungus, *F. palustris*. When compared with the white rot fungus, *T. versicolor*, *T. eurrhizus* did not show any clear tendency in mass losses. *T. eurrhizus* showed lower mass losses than those of *F. palustris* in heartwood samples of Japanese red pine, but there was no significant difference in sapwood samples (C). In both heartwood and sapwood samples of Japanese beech, all *T. eurrhizus* strains showed considerably lower mass losses than those of *T. versicolor* and *F. palustris* (D).

These results clearly suggest that some strains of *T. eurrhizus* have decay ability against softwood species as much as *T. versicolor* and *F. palustris*, and softwood may be used as artificial cultivation media. Since Japanese beech is well known to have very poor resistance against decay fungi [5], it is interesting that *T. eurrhizus* showed very low mass losses when using Japanese beech samples. In nature, *T. eurrhizus* grows only in the fungus garden inside the nest of fungus-growing termite, and the fungus garden is known to consist basically of half-digested plant-based materials [1]. *O. formosanus* attacks agronomic crops and numerous trees [6]. The reason why *T. eurrhizus* strongly degrades softwood species than Japanese beech must be clarified in order to establish the effective artificial cultivation methods.

SEM observation

The surfaces of test wood samples were well covered with *T. eurrhizus* mycelia, however, under SEM analysis, a very little amount of mycelia were observed inside of the wood samples (Fig. 3). The growths of *T. eurrhizus* mycelia were slower than those of *T. versicolor* and *F. palustris*. It might indicate that *T. eurrhizus* can only penetrate into the wood surface layer during 8 weeks of experiment. Chips or sow-dusts are strongly recommended when attempting the artificial cultivation of the fungus with wood materials.

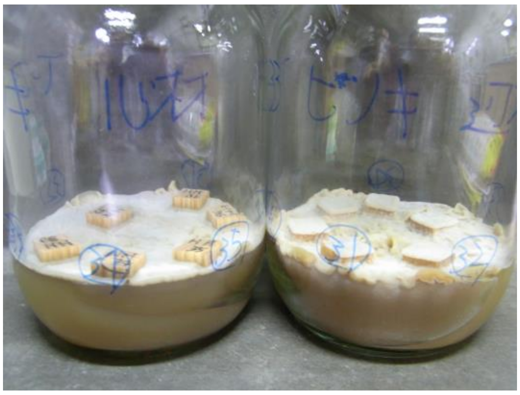

Figure 1. The wood decay test with *T. eurrhizus*.
Strain: T3, samples: heartwood (left) and sapwood (right) of Japanese cypress

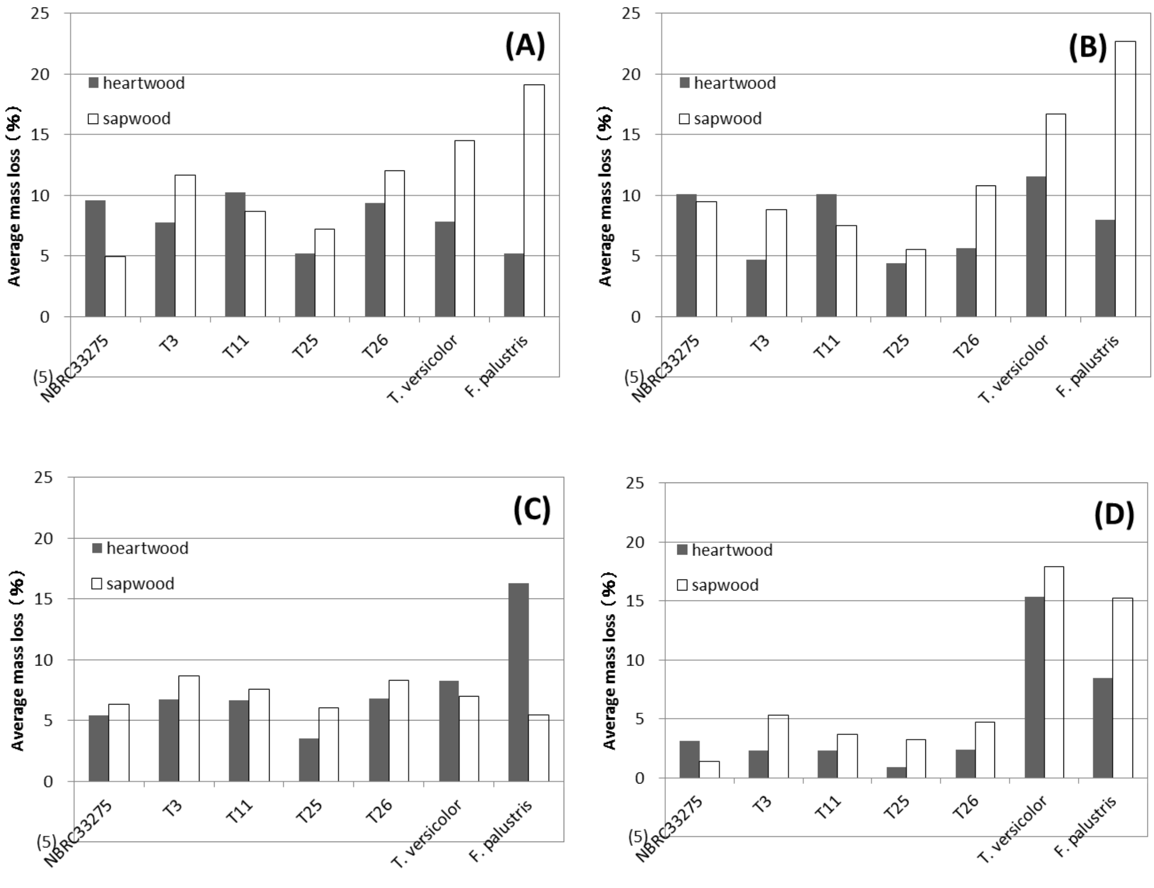

Figure 2. Average of mass losses of wood samples after 8weeks' exposure to 5 strains of *T. eurrhizus*.
A: Japanese cypress, B: Japanese cedar, C: Japanese red pine, D: Japanese beech

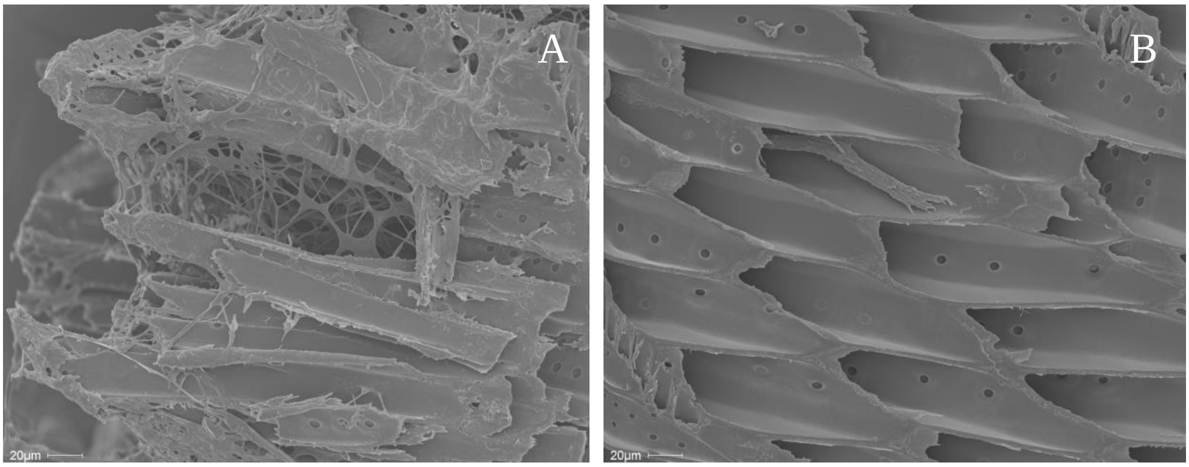

Figure 3. Scanning electron micrographs of sapwood of Japanese cedar after 8weeks' exposure to *T. eurrhizus* (T26).
A: surface, B: center of wood sample

Conclusion

Some strains of *T. eurrhizus* showed high mass losses against heartwood of Japanese cypress and Japanese cedar. These species might be the optimal wood sources for the artificial cultivation media of *T. eurrhizus*. Since these two species are most commonly planted in Japan and from the plantation forest management the thinning timber can be supplied for mushroom production in low cost.

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THE USE OF COCONUT FIBRE AND ARBUSCULAR MYCORRHIZAL FUNGI TO ENHANCE PISANG BARANGAN SEEDLING RESISTANCE TO BLOOD DISEASE BACTERIUM AND *Fusarium Oxysporum* F SP. CUBENSE

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Abstract

Screening soil-less medium culture coconut fibre and indigenous mycorrhizal fungi that enhance pisang Barangan seedling resistance status to blood disease and Fusarium wilt in North Sumatera is important for sustainable production systems of pisang Barangan (*Musa parasidiaca* L.). The objective of this research was to evaluate the potencial resistance enhance of both coconut fibre substrates and arbuscular mycorrhizal fungi (AMF) to blood disease bacterium (BDB) and *Fusarium oxysporum* f sp. *cubense* (Foc). This experiment was conducted in wirehouse with randomized block design by coconut fibre substrates (v:v) with six treatments : B0 = 100 % soil medium; B1 = 50% soil+50% coconut fibre; B2 = 50% soil+25% coconut fibre+25% sand; B3 = 25% soil+50% coconut fibre+25% sand B4 = 75% coconut fibre+25% sand; B5 = 100% coconut fiber. Every treatment with 15 polybags consists of three replication. The soil medium from banana wilt plantation was contaminated by the BDB and Foc propagul pathogens. The 14-day old seedling infected by AMF transplantion to polybag with coconut fibre substrate and maintained until 119 days. The results indicated the treatment had enhanced banana resistance to BDB, thought the banana seedlings treated have infected by Foc 5 -10% and control 100%. Mycorrhizal colonization was higher in coconut fibre combination than soil and coconut fibre only. The combination applied of coconut fibre and AMF enhanced banana seedling resistance to BDB and Foc.

Keywords: *arbuscular mycorrhizal fungi; blood disease bacterium; coconut fiber; plant resistance ; pisang Barangan seedling*

Introduction

In North Sumatera, pisang Barangan which is superior in color, flavor and texture, is a very important commodity. However, since the 1990s, banana plantation was badly damaged by wilt disease. The decreasing in production and unproductive land due to contamination of infective propagules of blood disease bacterium (BDB) and Fusarium wilt caused by *Fusarium oxysporum* f sp. *cubense* (Foc). The pathogens are the major constraint in rehabilitating the damage of banana plantation [1], and attacked entire of stadia growth (seedlings, mature plants or plants that have shaped bunches) [2] and systematically lethal with vascular plants infection [3]. The control of both pathogens are difficult because the infective propagules BDB able to last up to 1-2 years in the soil, Foc able to last up to 20-40 years in the soil and infected plant tissue without losing the virulence and spread in various ways. Less method of controlling these pathogens is economically successful until now [4] . One of developable alternative methods in controlling this pathogen is the usage of biological agents Arbuscular Mycorrhizal Fungi (AMF) and using the substrate organic coconut fiber. Introduction of banana plantlets during acclimatization is needed [5] due to the culture of banana plant tissue have a high dependence on the AMF. In other hand, banana plant has hairy roots and shallow root systems that are very vulnerable to water stress (deficiency and excess of water).

AMF association with crop components in culture systems have been reported to have a great impact on soil structure [6; 7; 8; 9; 10] through the enmeshing effects of hyphae, AMF bind soil microaggregates into macroaggregates [11; 12], produces glomalin which upon accumulation in soils, sticks hyphae to soil directly [13], release exudates into the soil, and promote aggregate stability as a result of rapid hyphal turnover which provide C to other soil micro organisms [14; 15; 16].

The adding of organic matter in banana seedling growth media has been proposed as a possible alternative to peat in growth media due to its suitable physical and chemical properties. Coir/coconut fibre has been tested as a horticulture medium for several ornamental and agronomic crops with acceptable results [17; 18; 19]. The particular structure of coconut fibres and their physical and chemical properties, make them suitable for media purposes in greenhouse. Coir/fibre contains equal portions of lignin and cellulose and is rich in potassium and the micro nutrients Fe, Mn, Zn and Cu. Due to the high potassium content of the media a reduction in potassium fertilization has been shown to produce beneficial results. Soilless media have proven popular with the majority of producers because of consistency, excellent aeration, reproducibility, and low bulk density that reduce shipping and handling costs of the medium itself. To balance the low bulk density of many soilless mixes in some situations a component with high bulk density, such as sand or soil is needed [20].

Materials And Methods

Stock cultures of multispore mycorrhizae were maintained on corn (*Zea mays*. L) plants in pot culture. Two months-day-old inoculants AMF multispores were harvested. Twenty g inoculum containing about 100 spores and infected root segments were inoculated in each pisang Barangan root in 10 cm x 15 cm polybags containing 300 g sterilized rice husk and soil. The banana plantlet polybags were placed in a plastic box with 75 percent humidity and 70% light intensity. The pisang Barangan plantlets without AMF inoculum served as control. Fourteen-day-old pisang Barangan seedlings AMF infected were transplanted in polybag 20 cm x 25 cm with variated soilless medium and coconut fibre, B0 = 100% soil ; B1 = 50% soil + 50% coconut fibre; B2 = 50% soil + 25% coconut fibre + 25% sand; B3 = 25% soil + 50% coconut fibre + 25% sand; B4 = 75% coconut fibre + 25% sand; B5 = 100% coconut fibre, with three replicates. The soil was used from banana endemic area contaminated BDB and Foc propaguls in Sempakata, Medan Selayang district.

In the same time banana seedlings fertilized with 25% banana fertilizer recommended. The banana seedlings were maintained until 120 days old. The increasing of plant resistance against the both wilt pathogens BDB and Foc based on the efficacy and the effectiveness of slower incubation period and suppression intensity that is calculated by the formula of Sivan and Chet (1986) with formula Em = (MPc-MPt)/MPc x 100%, Em = the effectiveness of AMF, MPc = incubation period in control (without AMF) and MPt = incubation period with treatments.

The attack intensity of Foc depends on the criteria according to Baharuddin [21] with scales 0 = Healthy leaves, 1 = 1 leaf wilt/dried, 2 = 2-3 leaves wilt/dried, 3 = 4-5 leaves wilt/dried and 4 = >5 leaves wilt/dried/dead plants. Emphasis on population density BDB and Foc to the growing media is also an indication of increased resistance of pisang Barangan seedlings after the AMF application. The propagul pathogens density was performed on days 15, 30 and 45 days after acclimation employed the modified formula of Klement *et al*.. The improvement of banana seedling resilience was verified by AMF development in roots seedling by observing the level of AMF colonization (percentage, colonization intensity and spore density). The AMF colonization was calculated with slide method. The data were statistically analyzed. A noticeable difference will be followed by Duncan's New Multiple Range Test (DNMRT) at the level of 5%.

Results and Discussion

Determination of increasing plant resistance effect against BDB and Foc and AMF colonization

Generally, biofertilizer mycorrhiza enhanced pisang Barangan plants health and vigor and minimized stress caused by BDB and Foc in all coconut fibre variations. There was no banana seedling infected by BDB and Foc that was lower than that of the control. Wilt symptoms on seedlings without AMF applications is faster 20 dap (days after planting) than treated plants (40 dap). The percentage of attack suppress effectiveness 75% - 100%, effectiveness decrease severity 50% - 100% and incubation period suppress effectiveness 100% (**Table 1**).

Table 1. Percentage of attack, severity and the incubation period of Foc on banana seedlings with AMF application in coconut fibre variations

AMF	percentage of attack	effectiveness (%)	severity	effectiveness (%)	incubation period (day)	effectiveness (%)
B0*	20	-	10	-	20	-
B1	5	75	5	50	40	100
B2	5	75	5	50	40	100
B3	5	75	5	50	40	100
B4	0	100	0	100	no infected	
B5	5	75	5	50	40	100

Description: B0* = 100% soil ; B1 = 50% soil + 50% coconut fibre; B2 = 50% soil + 25% coconut fibre + 25% sand; B3 = 25% soil + 50% coconut fibre + 25% sand; B4 = 75% coconut fibre + 25% sand; B5 = 100% coconut fibre

The less appearance of disease symptoms in pisang Barangan seedling (AMF treated) is associated with the both decreased bacterial and fungi density on pisang Barangan seedling root. The lower population of BDB and Foc has found on banana rhizosphere with AMF treated than control plant (untreated AMF). The highest pathogens (BDB and Foc) density were observed in control (100% soil) compared to the other pot mixtures. Lowest BDB density (7.04) and Foc density (7.98) was observed on plants grown on 100% coconut fibre (**Table 2**).

AMF isolates have distinct capacities in suppressing the population growth of both BDB and Foc. The colonization of AMF on roots plant is effectively lowering the density of fungi and bacteria propagule on rhizosphere rooting that coincided with the increasing level of AMF colonization.

Table 2. The density of BDB and Foc with coconut fibre and AMF applicated on 28 dap

Treatment	Code	The density of BDB and Foc on 28 dap (log cfu/g medium)	
		BDB	Foc
100% soil	B0	9.81a	11.74a
50% soil + 50% coconut fibre	B1	7.53b	8.65b
50% soil + 25% coconut fibre + 25% sand	B2	7.56b	8.57b
25% soil + 50% coconut fibre + 25% sand	B3	7.48b	8.51b
75% coconut fibre + 25% sand	B4	7.40b	8.89b
100% coconut fibre	B5	7.04bc	7.98bc

Description: The same letters on each line of the variables are not significantly different by DMRT (P <0.05)

The roots of banana have well colonized by AMF isolates under microscopic observation that apparently seen from the high percentage of AMF effectiveness and intensity on colonization and spore density (**Table 3**). The higher AMF colonization on banana roots responsible for external hyphae of a thin membrane that serves as a barrier to the entry of pathogenic bacteria that disabled to penetrate by the pathogen because of the failure to compete with the AMF. This occurrence resists the root pathogens development minimize the infection revealed that penetration and colonization of AMF reduces membrane permeability and release lower root exudates that improper for the pathogens development. This was confirmed by Brundrett stated AMF structure serve as a biological shield against the root pathogen because of (1) the presence of a thin membrane hypae as a barrier to the entry of the pathogens, (2) Mycorrhizae employe almost all of the excess carbs and another exudates that create unsuitable environment for the pathogens, (3) AMF produces an antibiotic that inhibit the pathogens growth.

The AMF application in acclimatization period has made colonization faster and more effective control because AMF colonisation occured before attack by the pathogen. AMF association has been reported to have a great impact in soil structure [6; 7; 8; 9; 10] through the enmeshing effects of hyphae, AMF bind soil microaggregates into macroaggregates [11; 12], produces glomalin which upon accumulation in soils, sticks hyphae to soil directly [13], release exudates into the soil, and promote aggregate stability as a result of rapid hyphal turnover which provide C to other soil microorganisms [14; 15; 16].

AMF growth is indicated by hyphae, arbuscular structure, and spores on cortex of banana roots under microscopically observation. The existences of external hyphae structure that colonize the roots increase the surface area and volume of absorption. AMF grow in root cortex where it intensively colonized by hyphae and formed arbuscular structure, intraradical spores, vesicule and metrical extra hypae (**Figure 1**)

Table 3. The mean of percentage, intensity of colonization, and spore density of AMF on 28 dap and 84 dap with coconut fibre after application.

Description: PC * = Percentage of colonization, IC = Intensity of colonization, DS = Density of spores per 10 grams

Treatment	The mean of percentage, intensity of colonization, and spore density of AMF on 28 dap and 84 dap						
	Code	28 dap			84 dap		
		PC	IC	DS	PC	IC	DS
100% soil	B0	5	2	5	7	4	60
50% soil + 50% coconut fibre	B1	25	2	70	80	4	90
50% soil + 25% coconut fibre + 25% sand	B2	25	2	70	80	4	85
25% soil + 50% coconut fibre + 25% sand	B3	25	2	75	80	4	99
75% coconut fibre + 25% sand	B4	25	2	70	80	4	90
100% coconut fibre	B5	15	2	60	80	2	30

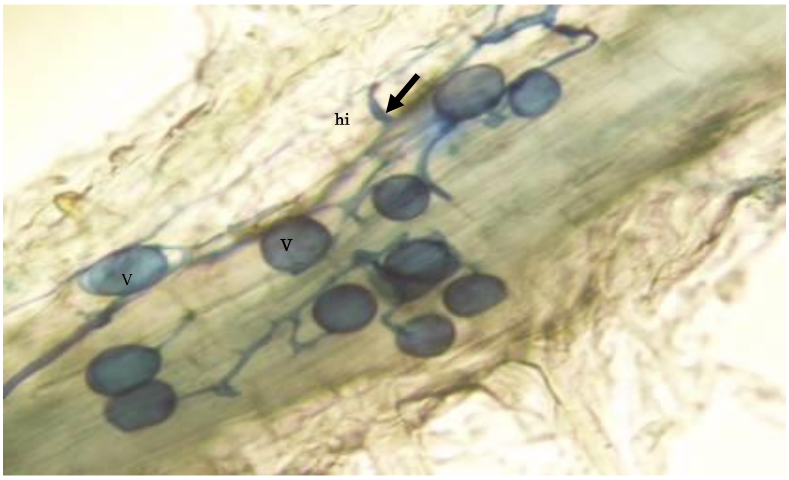

Figure 1. The structure of AMF colonization in the cortex of banana seedling roots on 84 dap. Description: A. Structure of AMF multispora hi = internal hyphae, v = vesicular (100x magnification).

AMF introduction on banana plantlets during acclimatization are responsible for systemic induce of resistance against the BDB. The earlier AMF colonize the roots, the higher of AMF protective effect against pathogen infection. The high protective effect of AMF on induced pisang Barangan positively correlated with the improving growth of mycorrhizal structures in banana roots. AMF protective effect on the plant occurred in conditions of high colonization. According to Graham and Menge, the introduction of AMF on wheat increase the resistance against *Gaeumannomyces graminis* with higher AMF colonization and the reverse occurred with lower level. Besides, the number and thickness of AMF induced roots has increased. Berta *et al* and Copetta *et al*. revealed that AMF colonization responsible for the diversity of host root structural that lead to obstruction of pathogen colonization in mycorrhizal root. The mycorrizal roots are able to improve the nutrient capture capacity for roots longevity that longer colonized, and degree of branching and root diameter becomes larger that expanding the absorption surface area. External hyphae (diameter of AMF hyphal = 2-10 μm) have a higher capacity to absorb nutrients than root hairs (root diameter > 300 μm) particularly to the elements that has lower mobility such as P.

The lower level of attacks on AMF introduced plants most likely due to changes of patterns exudation on mycorrhizal plant. Vierheilig and Piche and Vierheilig stated the changes in mycorrhizal root exudation patterns involved in the expression of mycorrhizae bioprotective effect on soil borne pathogens. The content of carbohydrates and amino acids in mycorrhizal root exudates reduced for growth of AMF. This occurrence inhibits the root pathogens development and minimize the infection.

Brundrett confirmed that AMF structure serve as a biological shield against the root phatogen because of (1) the presence of a thin membrane hypae as a barrier to the entry of the pathogens, (2) Mycorrhizae employe almost all of the excess carbs and another exudates that create unsuitable environment for the pathogens.

Introduction of AMF isolates reduced the development of disease symptoms in suppressing the incubation period, the percentage and severity of Foc attacks. Suppression of the development symptoms caused by induced plant produces phenolic compounds or phytoalecsin that pathogens is not able to thrive in the plant tissue and due to inhibition of bacterial/fungi population growth in plant tissue. Colonization of *G. mosseae* on tomato plants induced plant resistance by reducing the colony-forming units of *E. carotovora* and *P. syringae*. AMF introductions inhibit the production of *Thielaviopsis basicola klamidospora*, depressed the growth of *F. oxysporum* f.sp. *lycopersicum* on tomato, inhibited the zoosporangium and zoospores release of *Phytophthora parasitica* on citrus root that reduce root damage.

The treatment of different combinations coconut fibre/coir and AMF enhanced pisang Barangan resistance, soil structure and the benefits of plant growth and development.

Conclusion

It can be conclude that the biofertilizer AMF introduction and organic material coconut fibre improved the pisang Barangan banana resistance against BDB and Foc in seedling growth phase. Mycorrhiza improved soil structure, enhance plant health and vigor and minimize stress caused by Foc and BDB pathogenic.

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ANALYSIS OF FUNGAL DIVERSITY EXISTING IN NATURAL AGARWOOD (JINKOU) OF *Aquilaria malacensis* FROM BENGKULU, SUMATERA USING DENATURING GRADIENT GEL ELECTROPHORESIS

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Abstracts

Agarwood, a dark resinous part found in the trees of South East Asia such as *Aquilaria* spp., has been traditionally used for incense and perfumes. Since agarwood is a biological product of defense reaction against fungal infection, a human-inducible stimulation, which mimics the fungal infection phenomenon to trees in nature, is necessary for industrial production of agarwood. For this purpose, identification of the fungi responsible for agarwood formation is required. In the present study, we investigated the fungal community existing in agarwood of *Aquilaria malacensis* by Polymerase Chain Reaction-Denaturing Gradient Gel Electrophoresis (PCR-DGGE). Eight wounded trees *Aquilaria malacensis* in a forest at Bengkulu, Indonesia were collected. Genomic DNAs were extracted from 90 mg of milled wood samples. PCR was done with primers (ITS1-F and ITS4). After the reaction, PCR products were applied for DGGE analysis using 8% polyacrylamide gel. The separated DNA fragments were applied for sequencing analysis. The determined nucleotide sequences were used for BLAST search using blastn algorithm at NCBI website.

In almost all samples, ITS regions of fungi were successfully amplified by PCR. When the PCR products were applied for DGGE analysis, total 85 of DNA bands were separated. Among them, nucleotide sequences of 40 of DNA fragments (29 fragments from resinous wood, and 11 fragments from white wood) were identical with those from filamentous fungi. Consequently, 16 fungal species were found in resinous wood, while just 2 species were identified in white healthy wood. Several fungi were isolated from agarwood by previous studies. In the present study, we identified 20 different fungal species.

Keywords: *Aquilaria malaccensis*, *Agarwood, Fungi, PCR-DGGE.*

Introduction

Agarwood is a forest product with high economical value compared to other forest products. Agarwood, is produced in trees belonging to the genus *Aquilaria* from family *Thymeleceae*. It is native to Cambodia, Laos, Vietnam, Indonesia and Northern India, but resources in many of these areas have suffered from unchecked exploitation in recent times. The high price of agarwood resulted in the overexploitation of its wild resources. *Aquilaria* species have also been listed in The Red List of Threatened Plants published by the International Union for Conservation of Nature (IUCN) since 1998 [1]. New technology to accelerate agarwood production is needed. One way to conserve this valuable tree taxon would be to produce agarwood in a sustainable manner by mass planting the trees and collecting agarwood in a non-destructive manner. This also includes enhancing agarwood formation in trees using artificial methods with the help of microorganisms, such as making artificial compatible fungi injection to accelerate agarwood formation in the tree trunk [2]

Agarwood is actually a product in the form of solid lump with color ranging from blackish brown to black, and has fragrant smell occurring in the wood and roots of the host plants that have undergone physical and chemical change due to infection by a kind of fungi. Agarwood has been considered to be a pathological product of defense reaction. Agarwood formation takes place in the stem or main branches of the tree where an injury has occurred. It is believed that the tree is first attacked by a pathogenic fungus, which causes it to weaken. Other factors such as tree age, genetic background, seasonal and environmental variation, may be important in agarwood formation [3]. Generally fungi are viewed as the main microbial component responsible for agarwood formation. Identification of fungal diversity in agarwood trees is needed as the first step to make artificial compatible fungi injection in effort to increase agarwood production. The identified species can be candidate pathogens that are responsible for agarwood formation in *A.malacensis*.

In the present study, we investigated the fungal community existing in agarwood of *A.malacensis* by Polymerase Chain Reaction-Denaturing Gradient Gel Electrophoresis (PCR-DGGE). Originally, application of DGGE with environmental samples was used to analysis the genetic diversity of bacterial populations, but recently it has been developed for the study of fungal communities.DGGE is a rapid and efficient separation technique of same length DNA fragments (amplified by PCR). The fragments separated by DGGE can be excised, cloned and sequenced for identification. It is possible to identify constituents that represent only 1 % of the total community.

Materials and Methods

Sample preparation

From the each infected tree two sites for dark wood (R1, R2) that contained agarwood inside, and two sites for white wood (W1, W2) or healthy wood without agarwood inside were selected. From each site three chip samples were taken. As a result from one tree 12 chip samples were collected. Totally 96 samples from eight trees were obtained. All of the samples were taken by chopper after 70% ethanol sterilization of wood surface to avoid contamination. The collected samples were frozen by liquid nitrogen, and powdered by vibrating sample mill (Vita-Mix Blender, Japan). The powdered sample was transferred to a 1.5 mL micro-centrifuge tube.

DNA extraction and PCR-DGGE analysis

Genomic DNAs were extracted from 90 mg of the powdered samples using DNeasy Plant Mini Kit (Qiagen, Netherlands), and finally 50 µl DNA specimen were obtained. After having the DNA specimens Polymer chain reaction (PCR) was conducted. Amplification of the internal transcribed spacer (ITS) region in the ribosomal DNA was performed by following the method of Gardes and Bruns [4]. The forward primer was ITS1-F (5′ CTT GGT CAT TTA GAG GAA GTA A 3′) and the reverse primer was ITS4 (5′ TCC TCC GCT TAT TGA TAT G 3′). PCR was done in a reaction volume of 50 µl containing 2 mM of dNTPs, 25 mM $MgSO_4$, 10x PCR Buffer for KOD ver. 2, 1U of KOD plus ver. 2 DNA polymerase, 10 µM of primers (ITS1-F and ITS4), and the DNA specimens. PCR amplification was performed in a thermal cycler as follows: an initial 94°C denaturation for 120 s, followed by 35 amplification cycles consisting of 10 s of denaturation at 98°C, 30 s of annealing at 60°C, and 30s of extension at 68°C.

After the reaction, PCR products were analyzed by electrophoresis on 1% agarose gel for 20 min. The gel was visualized under a UV transilluminator to evaluate the quality of PCR products. After confirming that the PCR products had good enough quality with clear and single band in gel analysis, the 5µL of PCR product was loaded on DGGE with 8% polyacrylamide gel containing 20-70% of concentration gradient of denaturant (100% denaturant contains 40% formamide and 7M urea), and processed for 15h. After stopping the electrophoresis and having the separated gel plates, the gel attached to one plate was removed with 200 ml 1X TAE buffer and 40µL SYBR Green I reagent was applied to stained the gel with shaking for 1 hour in 37ºC. Recently SYBR Green I was introduced as an alternative to ethidium bromide [5]. The advantage of SYBR Green I is the lack of background staining, which makes it possible to observe less dominant DNA fragments. A more sensitive detection method is silver staining [6]. However, silver stained gels cannot be used for subsequent hybridization analysis [7]. The gel was visualized under a UV transilluminator.

The DNA band was excised from the gel using a sterile pipet tip, then a fresh PCR reaction with the DNA adhering to the tip was conducted. The DNA was cleaned up from any enzymatic reactions using the DNA Purification Kit with followed the manufactured protocol (Qiagen, Netherlands) and stored at −20°C. After the purification, the DGGE product was applied for PCR process again with the purpose to make sure that the excised band is correct. Then final purification for PCR product was conducted. The DNA concentration was measured before the sequencing analysis.

Sequencing analysis

Sequencing was performed by a commercial lab using the ITS4 primer. The determined nucleotide sequences were then analysed using the BLAST algorithm software at the National Center for Biotechnology Information (NCBI) website (http://www. ncbi.nlm.nih.gov) to identify the PCR products. The obtained sequences and reference sequences from the GenBank were aligned using CLUSTALW [8].

Results and Discussion

Any variation of DNA sequences will result in different melting temperatures, and thus cause different sequences to migrate at different position in the gel. When the PCR products were applied for DGGE analysis, total 85 of DNA bands were separated with the different mobility on the gel. Among them, nucleotide sequences of 40 of DNA fragments consisted of 29 fragments from dark resinous wood and 11 of DNA fragments from white wood were identical with those from filamentous fungi. For sequence analysis the isolates formed with a majority of the bootstrap values well above 90%, reflecting an accurate phylogeny for over all sample. In this study Ascomycetes were only discovered in the dark resinous wood sample while Basidiomycets were discovered in both the samples (**Figure 1**).

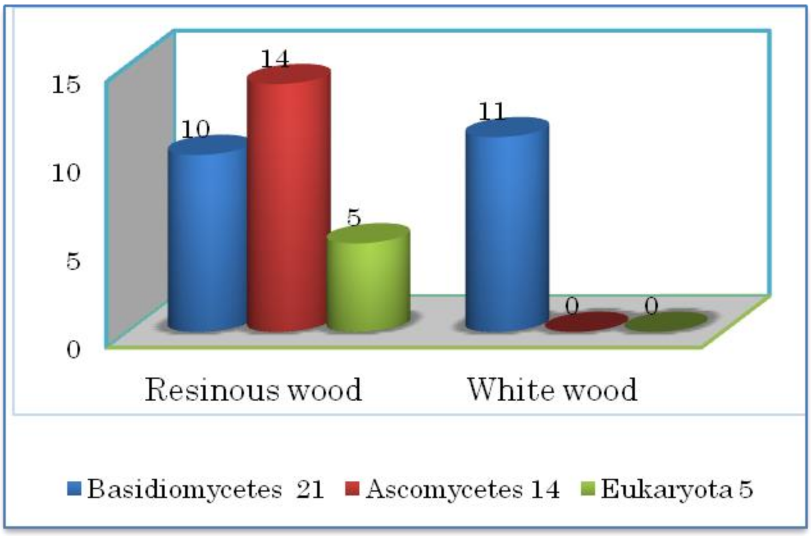

Figure 1. Phylum classification of fungi obtained from *A.malacensis* samples.

In the resinous wood samples 29 fungal from16 fungal species were identified, consisting of 9 fungal species from phylum Ascomycetes, 6 fungal species from phylum Basidiomycetes, and one fungal species from uncultured fungus which is classified as Eukaryota fungi respectively. From white wood samples 11 fungi from 2 species were identified. These 2 species are members of phylum Basidiomycetes. The most major fungi found in the resinous woods was *Hymenochaete muroiana* belonging to phylum Basidiomycetes.

This study shows the advantages of DGGE technique. PCR-DGGE obtained overall data of fungi species that exist in natural agarwood. Some researchers have been working to identify fungal diversity in agarwood by using culture-based methodology which only allows us to identify some common fungal isolates from wounded stems of *A.malaccensis*. However, since these samples were from the natural environment, there would be a chance of contamination in the isolation process. In addition, to opportunistic fungi, may prevent Basidiomycetes the growth of actual pathogens or slow growing fungi. Consequently, slow growing fungi will be out-competed by the fast growers or will go undetected by this technique [9]. It also can be the reason why using Culture-based methodology fungi Basidiomycetes would not be identified. While using PCR-DGGE method we were able to identify Basidiomycetes fungi.

Conclusion

In addition to the results of preceding reports, several fungi were isolated from agarwood. In the present study, we identified more fungal species by the PCR-DGGE method, suggesting that multiple fungi might have roles on agarwood formation. Fungi from phylum Ascomycetes were found as the major fungi, but still Basidiomycetes seems to have a role in agarwood formation.

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EVALUATION OF NEST-FOUNDING BEHAVIOR OF PRIMARY REPRODUCTIVES OF THE INVASIVE FRYWOOD TERMITE *Incisitermes minor* (Hagen) (Isoptera: Kalotermitidae) BY X-RAY TOMOGRAPHY

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Abstract

Nest-founding behavior of pairing primary reproductives of the western drywood termite, *Incisitermes minor* (Hagen) in the natural situation was thoroughly evaluated by X-ray tomography. Two commercial timbers, 40 Sugi (*Crytomeria japonica* D. Don) timbers and 60 Spruce *Picea sitchensis* (Bong.) Carriere) timbers, with the dimension of 50 (R) x 50 (T) x 1000 mm (L) and the combination of sapwood and heartwood portion on each timber, were randomly placed in the attic area of four heavily infested houses. Two spruce timbers were infested by primary pair reproductives: one timber was infested by four royal pairs on four different penetration spots and the other was infested by one royal pair. The infested timbers were imaged by X-ray computer tomography (CT) to evaluate the establishment of royal cell. CT images showed that *I. minor* reproductives particularly chose the springwood part of the sapwood to excavate the entrance hole and established the pear-shaped royal cell. These results indicated that *I. minor* primary reproductives showed particular nest-founding behavior: preference to spruce timbers and anatomical selectivity on establishing first royal cell and foraging.

Keywords: *nest-founding behavior, drywood termite, Incisitermes minor* (Hagen), *X-ray computer tomography*

Introduction

The western drywood termite, *Incisitermes minor* (Hagen) is considered as one of the most economically important pest[1], but its life biology is poorly known. Harvey [2] provided detail description of *I. minor* distribution and biology eight decades ago and since then very little adequate scientific information can be found about the life biology of this cryptic insect. Direct dissection is difficult to assess nest-founding activites of drywood termite because it will damage recently excavated royal cells and terminate continuous development of nest-gallery. Reliable indirect method such as computer tomography (CT) is promising approach that allows the observation and visualization of nest-founding activities without damaging its structure. Fuchs et al. showed the CT-scan method was able to provide three dimensional (3D) image reconstruction of drywood termite *Cryptotermes secundus* nest-gallery and display the inner part of wood [3].

This study aimed to observe the nest-founding behavior of the primary reproductive of the western drywood termite, *I. minor*, in the natural situation. We hypothesize that the nest-founding through swarming activities may related to the nutritional ecology and feeding preference. Eventhough life cycle is similar in all termite: a colony produces winged reproductives to disperse; mate and establish a new colony, to understand detail mechanisms of the nest-founding activity of primary reproductives is very important not only from biological perspective but also from pest-management perspective.

Materials and Methods / Experimental

Wood specimens

Two commercial timbers, Sugi (*Crytomeria japonica* D. Don) and Spruce (*Picea sitchensis* (Bong.) Carriere) were used in this study. Forty Sugi timbers and 60 spruce timbers were prepared with the dimension 50 (R) x 50 (T) x 1000 mm (L) and the combination of sapwood and heartwood portion on each timber were set in the attic area of four heavily infested houses at Wakayama Prefecture, Japan. Ten pieces of Sugi timbers (S) and 15 pieces of Spruce timbers (P) were placed on each house at five different highly infested areas. Each test area consist of 5 pieces of timbers, with "P-S-P-S-P" arrangement and narrow gap between timbers (Fig.1). The experimental set up was conducted on August 3, 2012, one month ahead of *I. minor* swarming season at Wakayama area which was reported as in September[4].

Nest-founding evaluation

All of the infested timbers were brought back to the laboratory and prepared for X-ray CT scan analysis (Y.CT Modular, YXLON International GmBH, Germany) at Kyushu National Museum. The data were reconstructed into three-dimensional (3D) image and two dimensional (2-D) section image using volume graphics software (VGStudio MAX 2.1, Volume Graphics GmbH, Germany), with digital data thickness 1 mm, 1024 x 1024 pixels, 3.17 2-D image slice per mm.

Results and Discussion

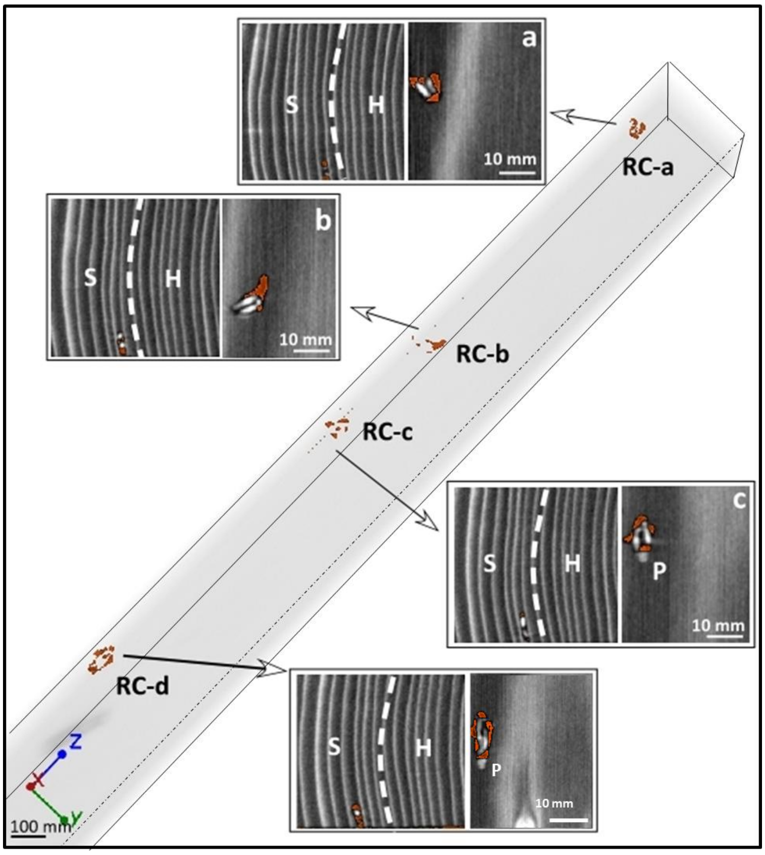

Figure 1. Three dimensional CT image reconstruction of four royal chambers (RC-a; RC-b; RC-c; and RC-d) found on P-13 timber. **a, b, c** and **d** *left*: 2D image of cross section cut indicated the royal chambers were excavated throughout springwood part of annual growth ring and sapwood part of the timber. **a, b, c** and **d** *right*: 2D image of tangential section cut showed the shape and depth of the royal chambers. **RC**: royal chamber; **S**: sapwood; **H**: heartwood; **P**: Pellets.

In the first monitoring conducted at two months after the swarming season, we found two Spruce timbers were infested by primary pair reproductives, while no attack found on the Sugi timbers. One timber (P-13) was infested by four royal pairs on four different penetration spots, and the other (P-32) was infested by one royal pair. Alate wings were found near the recently excavated entrance holes, indicating the pair of primary reproductives shed their wings before penetrating the timbers to create a mating chamber. The results suggested that Spruce timbers are preferred than Sugi timbers. This results support the previous feeding response study of *I. minor* by Indrayani et al. [5], in which Sugi was classified as resistant timber while Spruce is non-resistant.

Figure 1 showed 3D CT image reconstruction of four recently excavated royal chambers on P-13 timber. The royal pairs excavated the entrance hole with average ~1.8 mm diameter, and chewed powder wood was placed at the surrounding of the entrance holes. The pairs did carefully chose particular nest-founding site: on the springwood part of the annual growth ring; and on the sapwood part of the timber (**Figure 1.a-d *left***). After the chamber was completed, the pair sealed the entrance hole using fecal pellets, enlarged a bit the diameter and length of the chambers sufficient for the pair and to store fecal pellets (**Figure 1.c-d *right***). Nest establishment was excavated in the plane of springwood and avoided the summerwood part. Royal chamber has oval pear-shape, supported the description given by Harvey[2] and Morimoto[6], with 6~7 mm elongated narrow diameter, 8~16 mm length and excavated 6~12 mm beneath the surface (**Figure 1.a-d *right***).

Figure 2 showed 3D CT image reconstruction of newly excavated chamber by royal pair on the P-32 timber. The chamber is elongated oval-shape with narrow diameter 4.59 mm and 13.01 mm length, excavated throughout the springwood part of annual growth ring (**Figure 2.a**), on the sapwood part (**Figure 2.b**) and 6.72 mm depth (**Figure 2.c**) below the surface. Dealate reproductives selected particular spot with fairly wide annual growth ring to initiate the nest excavation (**Figure 2.c-d**).

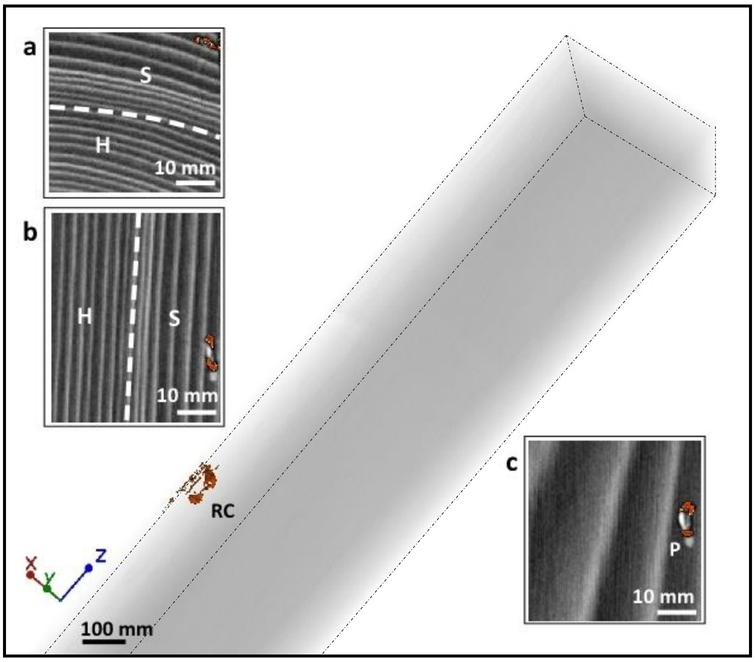

Figure 2. Three dimensional CT image reconstruction of recently excavated royal chamber found on P-32 timber. **a**: 2D image of cross section cut showed the royal chamber was excavated througout the springwood part of annual growth ring. **b**: 2D image of radial section cut displayed the nest-site selection on the sapwood part of the timber. **c**: 2D image of tangential cut showed the depth and shape of the royal chamber. **RC**: royal chamber; **S**: sapwood, **H**: heartwood, **P**: pellets.

These results indicated that nest-founding activities seemed to follow certain pattern. The fact that termites particularly excavated the entrance holes on the springwood part as well as the royal chambers, has raised presumption about wood preference and anatomical selectivity. Two timbers, Sugi and Spruce, were randomly placed side by side on the attic area, but *I. minor* particularly chose Spruce instead of Sugi. More interestingly, two spruce timbers were infested from different points of the timber (P -13 and P-32 were infested by dealate reproductives from the side and the bottom, respectively), but both infestations accomplished the particular part of timber, springwood part of annual growth ring and sapwood part of the timber.

These results also implied that *I. minor* chose their particular target timber, contrast with the common perception that termites are voracious indiscriminant eaters. Wood selection mechanism is suggested to be affected by wood chemistry and nutritional value [7, 8], as termite forage on cellulosic resources. Drywood termite was reported to have abilities to assess physiochemical properties of their food using vibratory signal [9] and chemosensory protein [10]. Sustainable CT-scan analysis to monitor development of the nest-gallery system would lead to deeper understanding on the foraging behavior of *I. minor*, which may lead to formulate novel strategy for integrated management of drywood termite.

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AGGREGATION BEHAVIOR OF THE POWDER POST BEETLE, *Lyctus africanus* (LESNE)

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Abstract

A power post beetle, *Lyctus africanus*, was observed to aggregate in a group. The aggregation behavior of this beetle was studied by chemical approach. To examine the potential chemical compounds in aggregation behavior of *Lyctus africanus*, 24-hours solvent extraction of separated adult male and female by using hexane were prepared. In a closed Petri dish, adult *Lyctus africanus* were exposed based on selected extraction for choice test. For chemical analysis, Gas Chromatography/Mass Spectrometry was used.
The observation showed the male extraction induced the aggregation behavior for both sex. On the other hand, the female extraction showed no significant difference on aggregation behavior with control based on t-test analysis. In this research, male extraction possibly contained particular compounds which induced the aggregation behavior of *Lyctus africanus*. According to the GC/MS analysis, ester compounds were discovered from male extraction. Some hydrocarbons were also detected from both male and female extraction. Further analysis using those chemical compounds should be conducted to verify the hypothesis of research.

Keywords: *Aggregation behavior, chemical compound, extraction, GC/MS, Lyctus africanus*

Introduction

Powder post beetles are common pests in dry wood, and is able to convert the wood component of sapwood into small particle, formed as powdery frass. *Lyctus* powder-post beetle is a Lyctinae member in the Bostrichidae family [1]. The beetle is a cosmopolitan powder post beetle which is common found in Africa, South East Asia, North America, European countries [2], Australia [3] and Japan [4] as a native or even an introduced species. In Japan, *Lyctus africanus* is increasing in numbers that is frequently found in some prefectures [5]. *Lyctus africanus* is considered as one of the major pests of timber and timber products, including plywood [2], furniture, door, ceiling and others [6]. *Lyctus* damage is slow and inconspicuous, thus the infestation is mostly identified belatedly by reason of poor knowledge to locate and monitor the infestation.

To determine the *Lyctus* population in its natural habitat, it is required to examine the degree of infestation. Some monitoring techniques have been developed to inspect insect population regularly. The use of insect traps for monitoring has been widely used in pest management. Traps enable insects to be detected at very early stages of infestation and improve chances of preventing damage. Generally, insect trap is a combination of attractant and killing/retention system. Some attractants are widely used, including food baits, pheromones, light and colored surfaces [7]. Unfortunately, there is no device to detect and monitor *Lyctus* beetle in the field so far. The monitoring technique of this beetle is urgent to develop controlling strategies by examining the *Lyctus* ecology.

In laboratory, *Lyctus* beetles were observed to aggregate in a group. Studying the aggregate behavior of *Lyctus* beetle is crucial to understand the ecological aspect of the beetle. In this study, the behavior was determined by chemical approach for further understanding of *Lyctus* ecology. The information will be useful to develop monitoring techniques for *Lyctus* beetle.

Materials and Methods / Experimental

Insect sources

The adults of *L. africanus* were used in this study. The insect is a laboratory culture reared in 26°C and 65% in relative humidity (RH). The adult males and females were separated based on the visible apical hairs along the hind margin of abdominal segment of the adult female [8].

Preparation of extraction

Newly emerged beetles were used for extraction. In a separate tube, either 50 males or 50 females were extracted by using 1 mL hexane for 24 hours at 26ºC and 65 % RH. The extract of each male and female extraction was transferred into the new tube [9].

Bioassay

To determine the activity extract of each male and female was applied to a paper disc (Ø 10 mm, Advantec type 27, Toyo Roshi Kaisha, Japan) with the same amount of the paper disc weight. The same volume of hexane was applied to the control paper disc, then the discs were air dried for 1 minute. The one pair of paper discs was placed diametrically with 6 cm in distance in a Petri dish (Ø 9 cm) covered with a filter paper (Ø 9 cm, Whatman No. 1, GE Healthcare, UK). In a closed Petri dish, 20 females and males of *L. africanus* were put into the center of the paired discs. The bioassays were conducted in several combinations: male extract (ME) – control, female extract (FE) – control, and ME – FE. The number of beetles located onto the particular paper disc were counted. This behavior was recorded for 15 minutes for each combination. The assay was conducted in a dark room at 26ºC and 65% RH. Ten replicates were made in each combination. The active extract was then analyzed with GC/MS.

Chemical Analyses

The chemical analysis was conducted to determine the active compounds from extracts with single beetle in 10 µL hexane for five minutes extraction. To run the analysis, one µL of extract was injected into GC/MS instrument. The GC/MS analyses were conducted with a Network GC System (6890N; Agilent Technologies, USA) coupled with a mass selective detector (5975 Inert XL; Agilent Technologies) operated at 70 eV. The column used was an HP-5MS capillary column (Agilent Technologies, 0.25 mm I.D. x 30 m, 0.25 µm film thickness). The carrier gas was Helium with 1.00 ml/min of constant flow rate. Samples were analyzed in the splitless mode with temperature programmed to change from 60ºC (2 min) to 290ºC at a rate of 10ºC/min. The final temperature (290ºC) was then maintained for five minutes. The GC-MS data were recorded using Chemstation (Agilent Technologies) with reference to an MS data base (Agilent NIST05 mass spectral library, Agilent Technologies).

Results and Discussion

Responses of beetles after the extraction exposure were illustrated in the **Table 1**:

Table 1. The response of *L. africanus* to FE and ME extracts—treated paper discs for 15 minutes.

Extract	Tested beetles	Average no. of bettle (%)		P
		Treated	Control	
FE vs Control	Females	22.75	13.79	< 0.05
	Males	17.28	10.29	< 0.05
ME vs Control	Females	53.15	3.30	< 0.05*
	Males	40.89	7.20	< 0.05*
Extract Preference				
		FE	ME	P
FE vs ME	Females	4.17	35.80	< 0.05*
	Males	6.97	22.72	< 0.05*

* significantly different according to t-Test: Paired Two Sample for Means.

Results of the bioassay shown in **Table 1** indicated that the FE did not stimulate both males and females to aggregate on the paper disc. For example, in **Table 1**, few males and females responded to FE-treated discs. On the other hand, the ME-treated discs were observed to significantly arouse either female or male to aggregate on the discs. In **Table 1**., the choice test between FE and ME showed the significant preference of males and females to ME. In this research, ME possibly contained particular compounds which induced the aggregation behavior of *L. africanus*. Similar result was reported in the closely related Bostrichidae (Coleoptera) insects. Males of lesser grain borer (*Rhyzopertha dominica*) and larger grain borer (*Prostephanus truncatus*) produced particular attractants which acted as a population aggregating pheromone because it could attract females and males conspecifics [10, 11]. Those two stored-product insects produced aggregation pheromone to locate food sources suitable for feeding and breeding [12, 13].

In stored-product insects, the long-lived (>1 month) adult relied on male-produced aggregation pheromone for long distance communication [14]. Regarding the long developmental period of the insect, aggregation pheromone had a significant role for signalling the presence of both food sources and mates [14]. The lyctines, including *L. africanus*, are considered as long-live adult insects. The adult of lyctines lived for three to six weeks[15, 16, 17]. The similar phenomenon of aggregation pheromone in stored-product insects could be obtained from lyctine members.

By the GC/MS, different major compounds were identified in either FE and ME. Hydrocarbons (C_{25}, C_{27}, C_{29} and C_{31}) were identified in the FE, while esters (isopropyl C_{12} and 2-methyl butyl C_{12} ester) were recognized in the ME. Generally, the hydrocarbons comprise of a significant portion of the cuticular lipids of insects. The compound could prevent desiccation and are also important in chemical communication [18]. Some insects utilized hydrocarbons as sex attractants which produced by females [19, 20, 21]. Some esters were reported as insect pheromone in *Dermestes* sp. [22]. In butterfly, some esters were identified as major component in the wings of male *Colias philodice* [23]. In that study, the esters were important in species recognition. The closely related species, *R. dominica and P. truncates*, also produced esters as pheromones [10, 24, 25]. In our study, ester compounds were suggested to provoke adult *L. africanus* to aggregate in a group. However, the importance of either hydrocarbons or esters need to be evaluated for further understanding of aggregation phenomenon in *L. africanus*.

Conclusion

Ester compounds produced by adult male were suggested to provoke either male or female adult *L. africanus* to aggregate in a group.

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THE STUDY OF SUPPRESSIVE EFFECT BIOFUMIGANT BRASSICACEAE AND MYCORRHIZAE FUNGI INDIGENOUS TO BLOOD DISEASE BACTERIUM ON PISANG BARANGAN SEEDLING

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Abstract

The suppressive effects of different biofumigant Brassicaceae and arbuscular mycorrhizal fungi (AMF) on blood disease caused by soil-borne plant pathogens blood disease bacterium (BDB) were investigated in wirehouse trials. Three different of family Brassicaceae and BDB pathogens were examined as model organisms. The biofumigant crops were: cauliflower (*Brassicae oleracea* var. *botrytis*); cabbage (*B. oleracea* var. *capitata*) and mustard (*B. juncea*). Blood disease is a major soil borne diseases of banana (*Musa parasidiaca* L.). It causes serious stand and production loss of banana in Indonesia. The objective of this research was to evaluate the potential inhibition of biofumigant Brassicaceae (cauliflower (*Brassicae oleracea* var. *botrytis*); cabbage (*B. oleracea* var. *capitata*), mustard (*B. juncea*)) and Arbuscular Mycorrhizal Fungi (FMA) to BDB. The greenhouse experiment was conducted in 500 polybags in with 150 polybags per kind of Brassicaceae employed three replications and 50 polybags control. The Brassicaceae concentration used 375 g/kg soil contaminated BDB. The Brassicaceae plant was chopped and blended with 100 ml water and sprayed to soil media, the tip of polybag wrapped with plastic and incubated for two weeks. The banana seedlings were treated by AMF replanting to soil medium and applied 25% fertilizer as recommendation after incubation. The results of this research indicated that both biofumigant Brassicaceae plants and mycorrhizae indigenous inhibited BDB development. None of the pisang Barangan seedlings applied both Brassicaceae and AMF have infected BDB while being control 50% percentage. The AMF percentage, intensity colonization and spore population are higher inside the banana root treated AMF than others. The combination applied of three kinds Brassicaceae and AMF is able to suppress the BDB development in pisang Barangan seedlings.

Keywords: *arbuscular mycorrhizal; biofumigant; blood disease bacterium; Brassicaceae fungi; pisang Barangan seedling*

Introduction

Blood disease caused by blood disease bacterium (BDB) is the major cause of production loss of banana in Indonesia. The pathogen are the major constraint in rehabilitating the damage of banana plantation [1], and attacked entire of growth stages (seedlings, mature plants or plants that have shaped bunches) [2] and systematically lethal with vascular plants infection [3]. The control the pathogen is difficult because the infective propagules BDB able to last up to 1-2 years in the soil and infected plant tissue without losing the virulence and spread in various ways. Less method of controlling these pathogens is economically successful until now [4]. Restrictions on the use of the chemical pesticides due to the damage and cause in the environment have prompted a search for new plant protection methods. The use of plant material from several species within the family Brassicaceae is potentially a very interesting alternative way to fight these soil-borne plant diseases. Among these Brassica species, cauliflower (*Brassicae oleracea* var. *botrytis*); cabbage (*B. oleracea* var. *capitata*) and mustard (*B. juncea*) have been the focus of interest and recent studies which is shown that biomass or seed meal from brassicas has a suppressive effect on some soil pathogens.

One of developable alternative ways in controlling this pathogen is the usage of biofumigant Brassicaceae and biological agents Arbuscular Mycorrhizal Fungi (AMF). Biofumigation and AMF treatment are possible solutions to control soil borne pathogen such BDB. Biofumigation is the suppression of soil borne pest by toxic compounds that are released from soil-incorporation *Brassica* tissue. Plants of Brassicaceae family contain glucosinolates (GLs) degradation products such as alcohol, aldehyde, isothyocyanates (ITCs), and nitriles which are produced through enzymatic hydrolysis of GLs by myrosine (thioglucoside glucohydrolase, EC3.2.3.1) [5]. Residues of *Brassica* crops have been shown to have biotoxic activity against many soil borne pathogens and pests. ITCs, mainly allyl isothiocyanate (AITC), contributes to the majority of toxic effect observed in decomposing *Brassica*.

Application of indigenous AMF (Glomus type-1 and type Acaulospora-4) derived from the rhizosphere of Pisang Kepok on the endemic in West Sumatera significantly increased plant resistance to BDB in greenhouse experiment. The research of Maharadingga et al., (2009) revealed that the isolated AMF was capable to suppress the *Fusarium oxysporum* f sp. *cubense* (Foc) disease, extended the period incubation of BDB on Cavendish. According to Suharti et al., (2010), the application of indigenous AMF on ginger rhizosphere levelled up the resistance against *R. solanacearum* ras 4. AMF was also responsible for inducing plant resistance to pathogens by activating local reactions and systemic resistance. Induction of a susceptible plant resistance is one of the biological control mechanisms that potentially developed for more practical (applied to the seed/seedling), efficient (no repetition in treatment), economically and better environmental impact.

Materials and Methods / Experimental

Experimental procedures

Stock cultures of multispore mycorrhizae were maintained on corn (*Zea mays* L.) plants in pot cultures. Two months-old inoculants of AMF multispores were harvested. Twenty grams inoculum containing about 100 spores and infected root segments were inoculated on each pisang Barangan root in 10 cm x 15 cm polybags containing 300 g sterilized rice husk and soil. Furthermore, the banana plantlet polybags were placed in a plastic box with 75% humidity and 70% light intensity. The pisang Barangan plantlets without AMF inoculum served as control. The Brassicaceae concentrated 375 g/kg soil contaminated BDB. The soil was used from banana endemic area contaminated BDB in Sempakata, Medan Selayang district. The Brassicaceae plant chopped and blended with 100 ml water and sprayed to soil media, the tip of polybag wrapped with plastic and incubated for two weeks. After incubation the banana seedlings treated by AMF replanted to soil medium and applied 25% fertilizer as recommendation. The plant was under treated for three months by watering and manual weeding in wirehouse. The parameter of observation encompass: BDB propagul density and AMF development (percentage, colonize intensity, spore density and colonize structure).

Results and Discussion

The results revealed three kinds Brassica act as biofumigants (cauliflower, cabbage & mustard) combined with multispora AMF able to improve the BDB seedling resistances of Barangan. Less found BDB infected plants after 120 dap while 50% plants were infected in control group. It related to the BDB propagul population in banana rhizosphere. The highest infection found in control (10.8 cfu/g soil), *B. oleracea* var. *capitata* (7.75 cfu/g soil), *Brassicae oleracea* var. *botrytis* (7.28 cfu/g soil) and *B. juncea* (7.18 cfu/g soil) (Figure 1). BDB population on banana plant without AMF application was significantly different with Brassica application. The decreasing number of BDB population with Brassica application was accordance with other research findings. The application of Brassica for vary of plant treated as green fertilizer or plant rotation suppressed the population of soil borne pathogen.

Kirkeegard, (2007) wrote many of Brassicacea family that rotated with Solanaceae plant control the infection of *R. solanacearum* to tomato as high as 15% compared with control plant as 80%. According to Charron and Sams (1999) & Marwar and Lodha (2002), the Brassicaceae family have been reported to suppress the activity of *Pythium ultimum*, *Fusarium oxysporum* f. sp *cumini* and *Rhizoctonia solani*. [6,7]

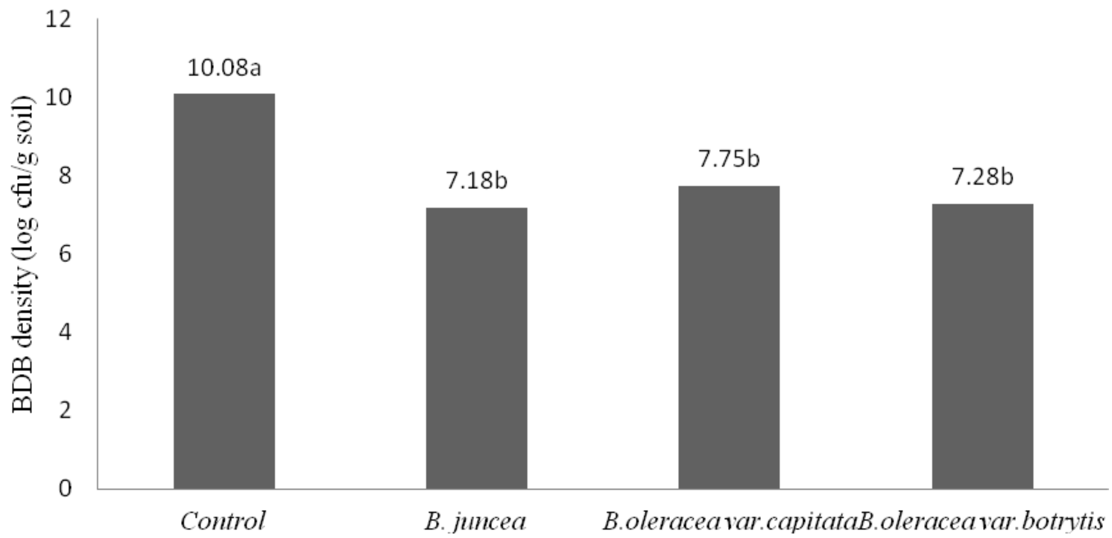

Figure 1. The density of BDB with AMF treated and Brassicaceae on 60 dap.

Larkin & Griffin (2007) investigated the application of three Brassica with different levels of GSLs *B. juncea* with (high GSL content), *Raphanus sativus* and *Sinapis alba* (moderate GSL content) and *B. napus* (low GSL content) suppress of various soil borne potato pathogens. The decomposition of Brassica tissues has released glucosinolates, and hydrolysis of these volatile compounds lead to the formation of isothiocyanates (ITCs), which have fumigant properties similar to metham-sodium [8]. Isothiocyanates and other secondary compounds of glucosinolates act either as biocides or suppress the growth of a wide range of soil-borne disease organisms [9]. Glucosinolate-containing tissues from the Brassicaceae family have been reported to suppress activity of *Pythium ultimum*, *Fusarium oxysporum* f. sp *cumini* and *Rhizoctonia solani* [6,7]. According to Larkin & Honeycutt (2005) the effects of Brassica as crop rotation reduced pathogen activity due to three possible mechanisms: 1) breaking the life cycle of the pathogen, 2) changing in the soil characteristics that stimulate microbial activity, making the soil less appropriate for pathogen survival or 3) directly inhibiting of the pathogen through toxic substances released from plant residues or through stimulation of microbial antagonisms.

The less appearance of disease symptoms in pisang Barangan seedling (AMF treated and Brassica applied) is associated with the decreased bacterial on pisang Barangan seedling root. The lower population of BDB has found on banana rhizosphere with AMF than control plant (untreated AMF). The highest BDB density was observed in control (100% soil) compared to the three Brassica addition and AMF treatment. AMF isolates have distinct capacities in suppressing the population growth of BDB. The colonization of AMF on roots plant is effectively lowering the density of bacteria propagule on rhizosphere rooting that coincided with the increasing level of AMF colonization.

The roots of banana have well colonized by AMF isolates under microscopic observation that apparently seen from the high percentage of AMF effectiveness and intensity on colonization and spore density (Table 3). The higher AMF colonization on banana roots responsible for external hyphae of a thin membrane that serves as a barrier to the entry of pathogenic bacteria disabled to penetrate by the pathogen because failure to compete with the AMF. This occurrence resists the root pathogens developments that minimize the infection [10]. Smith (1988) revealed that penetration and colonization of AMF reduces membrane permeability and release lower root exudates that improper for the pathogens development. This was confirmed by Brundrett (1994) stated AMF structure serve as a biological shield against the root phatogen because of (1) the presence of a thin membrane hypae as a barrier to the entry of the pathogens, (2) Mycorrhizae employe almost all of the excess carbs and another exudates that create improper environment for the pathogens, (3) AMF produces an antibiotic that inhibit the pathogens growth [11].

Table 1. The mean of percentage, intensity of colonization, and spore density of AMF on 60 dap and 119 dap with AMF treated and Brassicaceae

Treatment	The mean of percentage, intensity of colonization, and spore density of AMF on 60 dap and 119 dap						
	Code	60 dap			119 dap		
		PC	IC	DS	PC	IC	DS
B. juncea	BJ	25	2	60	70	4	65
B . oleracea var. *capitata*	Boc	25	2	80	80	4	81
B. oleracea var. *botrytis*	Bob	25	2	80	80	4	92
control	C	5	2	7	7	2	12

Description: PC * = Percentage of colonization, IC = Intensity of colonization, DS = Density of spores per 10 grams

The AMF application in acclimatization period has made colonization faster and most effective control because AMF colonization took place before attack by the pathogen [12,13]. AMF association have been reported for a great impact in decreasing soil borne disease [14,15,16,17,18,19,20].

AMF introductions on banana plantlets during acclimatization are responsible for induced systemic resistance against the BDB. The earlier AMF colonize the roots, the higher of AMF protective effect against pathogen infection. The high protective effect of AMF on induced Barangan positively correlated with the improving growth of mycorrhizal structures in banana roots. AMF protective effect on the plant occurred in conditions of high colonization. According to Graham and Menge (1982), the introduction of AMF on wheat increased the resistance against Gaeumannomyces graminis with higher AMF colonization and the reverse occurred with lower level [10]. Besides, the number and thickness of AMF induced roots has increased. Berta et al. (1995) and Copetta et al. (2006) revealed that AMF colonization responsible for the diversity of host root structural that lead to obstruction of pathogen colonization in mycorrhizal root. The mycorrizal roots are able to improve the nutrient capture capacity for roots longevity that longer colonized, and degree of branching and root diameter becomes larger that expanding the absorption surface area. External hyphae (diameter of AMF hyphal = 2-10µm) have a higher capacity to absorb nutrients than root hairs (root diameter > 300 µm) particularly to the elements that has lower mobility such as P.

AMF growth is indicated by hyphae, arbuscular structure, and spores on cortex of banana roots under microscopically observation. The existences of external hyphae structure that colonize the roots increase the surface area and volume of absorption. AMF grow in root cortex where it intensively colonized by hyphae and formed arbuscular structure, intraradical spores, vesicule and metrical extra hypae (Figure 1).

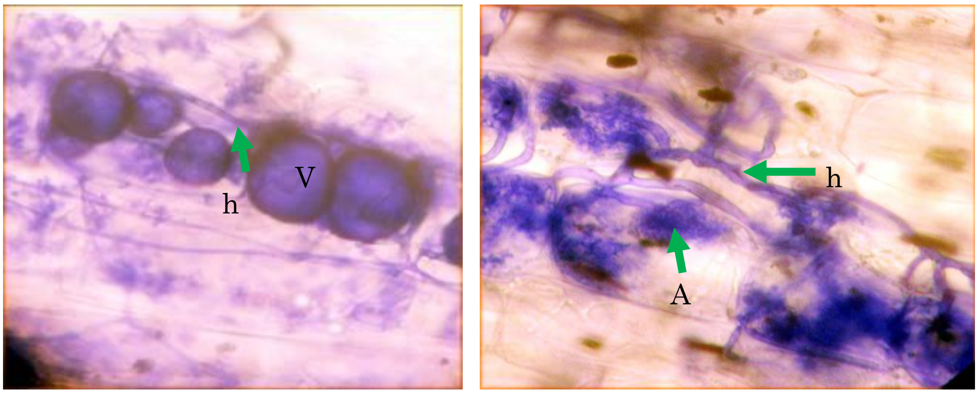

Figure 1. The structure of AMF colonization in the cortex of banana seedling roots 60 dap. Description: hi= internal hypha, V=vesicular, A= arbuscular, (100x magnification)

Conclusion

To conclude, the both three Brassicaceae and AMF introduction have enhanced the pisang Barangan resistance against BDB in seedling growth phase by reducing BDB density and increased AMF colonization.

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SPECIES ABUNDANCE AND DIVERSITY OF PREDATORY SPIDERS FOR INSECT PEST OF RATOONING RICE APPLIED BY MYCOINSECTICIDE AND WITHOUT MYCOINSECTICIDE

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Abstract

Mycoinsecticide containing the active ingredient of conidia of entomopathogenic fungus, *Beauveria bassiana* with carrier using solid and compost extract was effective to control insect pests. The mycoinsecticide has been tested in laboratory and effective in controlling insect pests of rice, such as the rice bug, leafhoppers, and stem borer. This research aimed to compare the abundance and diversity of species of predatory spiders from rice field applied by mycoinsecticide and without mycoinsecticide. Application of mycoinsecide with active ingredient conidia of *B. bassiana* was done in ratooning rice. Other treatment using mycoinsecticide with liquid culture liquid medium of *B. bassiana*, and control using liquid compost extracts without the fungus. The results of the research found that the abundance of spiders on ratooning rice in plots applied with mycoinsecticide were 187 spiders during a rice season, while the plot applied with liquid medium fungus reached 177 spiders, and the control plots applied with compost extract reached 162 spiders. Number of the species in the plots applied by mycoinsecticide averaged 4,875 species per observation, the plot applied by liquid medium fungus averaged 5 species/observation, and lowest found in the control plots averaged 4.5 species/observation. Thus, the application of the mycoinsecticide was not adversely affect the abundance and number of species of predatory spider of rice insect pests.

Keywords: *spiders, mycoinsecticide, ratooning rice*

Introduction

Most currently used mycoinsecticide to control pest attack consisted of *Beauveria bassiana* and *Metarhizium anisopliae* [1,2,3]. Mycoinsecticide is insecticide having active ingredient from toxin or conidium of this fungus. Mycoinsecticide of these fungi had been proved capable to control several species of pest [4,5,6]. High capability to kill mycoinsecticide had raised question whether their application in the field will have detrimental impact on non-target arthropod community.

Non-target arthropods are available in very abundant numbers on primary and ratoon rice plantings. The ratoon rice is previously harvest rice that regrowth to yield new tillers [7]. Study results from [8] showed that more than 70% arthropod which available at paddy field rice ecosystem in Cianjur was dominated by arthropods that have a role as natural predator for pest insect of rice crop. The most abundance arthropods that have a role as predator are spiders and predator insects. The dominant species of spiders are *Pardosa pseudoannulata*, *Pardosa. Birmanica*, *Tetragnatha javana* and *Atypena adelinae* [8,6].

Spider is very important in decreasing the development of grasshopper pest population or other pest insects [9]. Information related to capability of *P. pseudoannulata* in preying brown grasshopper [8] or stem borer [10] is limited. Thus, disturbance toward spiders' life will result in dominance of pest insects. Therefore, it is important to study whether mycoinsecticide application can affect the life of those spider community. The objective of this study was to determine the effect of mycoinsecticide application on the abundance and species diversity of spiders in ratoon rice cultivation.

Materials and Methods / Experimental

This study was conducted at paddy field rice center of tidal swamp area of South Sumatra located in Mulia Sari Village, Banyuasin District from March to July 2013. Land area for this study was 3 ha by using ratoon cultivation system. This land was divided into 3 plots (each plot was 1 ha) and subsequently each plot was divided into 4 subplots (used as replication). Each plot had treatments as follows: A). Mycoinsecticide with dose of 2 L/ha/application, B). Compost extracts with dose of 2 L/ha/application, and C). Mycoinsecticide and compost extract with dose of 2 L/ha/application.

Mycoinsecticide application

Mycoinsecticide used in this study was made according to the method of [11]. Active ingredient of this mycoinsecticide was from conidium of *B. bassiana* and as carrier substance was compost extract from shrimp's skin powder. Compost extract used in this study was from shrimp's skin which is milled into powder and subsequently was fermented according to method of [12]. Mycoinsecticide and compost extract were applied on the crown of crop rice in the afternoon every week starting from 2, 15, 29, 36 and 42 days old of ratoon rice. Observation of canopy inhabiting and soil surface spiders were conducted tow days after application.

Observation of canopy inhabiting spiders

Observation of canopy inhabiting spiders was conducted by using double swing net. The net was swinged on rice crop canopy with frequency of 15 times per subplot. Sampling of canopy inhabiting spiders was conducted every week starting from 3, 17, 31, 38, 45, 52 and 59 days old of ratoon rice as well as 14 days after ratoon rice was harvested. The catched spiders were subsequently sorted and cleaned from other foreign materials as well as put into vial bottle containing 70% alcohol. Spiders were then identified in Entomology Laboratory, Crop Pest and Disease Department, Agricultural Faculty, Sriwijaya University. Spiders' identification was conducted by using identification reference manual from [13].

Observation of soil dwelling spiders

Observation of soil dwelling spiders was conducted by using pitfall traps. Pitfall traps were installed at soil surface with density of 12 pitfall traps per ha. Pitfall traps installation was conducted every week starting from 3, 17, 31, 38, 45, 52 and 59 days old of ratoon rice as well as 14 days after ratoon rice was harvested at the same time with of canopy inhabiting spiders sampling. The catched spiders were subsequently sorted and cleaned from other foreign materials as well as put into vial bottle containing 70% alcohol. Spiders were then identified in Entomology Laboratory, Crop Pest and Disease Department, Agricultural Faculty, Sriwijaya University. Spiders' identification was conducted by using identification reference manual from [13].

Data analysis

Data of species composition and individual number of spiders was used to analyze species diversity and abundance of predator spiders on ratoon rice. The used diversity measures were consisted of species diversity index from Shannon Wienner, species dominance index from Berger-Parker and species homogeneity from Pielou [14].

Results and Discussion

The predator spiders family of ratoon rice pest insect found on ratoon rice canopy and soil surface at rice field of tidal swamp land in South Sumatra were consisted of Lycosidae, Araneidae, Tetragnathidae, Oxyopidae, Theridiidae and Clubionidae. Five families found on ratoon rice canopy were Lycosidae, Araneidae, Tetragnathidae, Oxyopidae and Clubionidae (Table 1), whereas families found at soil surface were Lycosidae, Araneidae and Theridiidae (Table 2). More family numbers which found on rice crop canopy were due to capability of hunting spiders and web spiders in reaching rice canopy, whereas soil surface had only hunting spiders. The family numbers on plots applied with and without mycoinsecticide were not affected by these treatments. The dominant spider families found on ratoon rice canopy were Tetragnathidae and Lycosidae, whereas dominant spider family found on soil surface of paddy field rice at tidal swamp area was Lycosidae.

Species numbers of canopy dwelling spider on plot applied with and without mycoinsecticide had no specific trend in which no indication that mycoinsecticide application was capable to decrease the species numbers of canopy dwelling spider during 8 times observation. Individual numbers or abundance of canopy dwelling spiders was tend to be higher on plots treated with mycoinsecticide and compost extract than other treatments (Table 1). There was interesting matter related to spider abundance data found on rice canopy during one planting season of ratoon rice, in which there was a trend of abundance increase for canopy dwelling spiders during second observation period and was followed by subsequent abundance decrease of canopy dwelling spiders. The study results from [6] also showed similar trend in which arthropods abundance was significantly increase during generative and milking maturity phases. This was due to the fact that many pest insects approached to rice crop area at generative phase so that spiders tend to assemble on habitat that had many preys [15].

Actively spiders found at soil surface were only three families which consisted of Lycosidae, Araneidae and Theridiidae (Table 2). Species numbers of spider found at soil surface were 4 species, whereas 7 species were found on rice canopy (Table 3 and 4). Individual number of spiders found at soil surface during one planting season of ratoon rice also showed similar trend with spiders found at rice canopy, i.e. there was an increase approaching and during generative phase as well as a decrease approaching harvest and after harvest periods.

Individual numbers and abundance of spiders found at rice canopy during one planting season showed relatively higher differences amongst plots applied with mycoinsecticide and plots without mycoinsecticide application. Plots applied with mycoinsecticide had highest spider abundance (187 numbers) followed by plots applied with mycoinsecticide + compost extract (177 numbers) and the lowest was found on plots applied with compost extract only (162 numbers). Spiders abundance found at soil surface tend to be lower than that of found on rice canopy. Spiders found at soil surface in plots applied with mycoinsecticide (46 numbers) and plots applied with mycoinsecticide + compost extract (47 numbers) were higher than that of plots applied with compost extract only 40 numbers). Results of this study showed that mycoinsecticide application was not decrease spiders abundance level at paddy field of tidal swamp land area.

Spiders species diversity found on rice canopy at plots applied with mycoinsecticide and without mycoinsecticide did not show difference (Table 3). Similar trend was also true for spider species diversity found at soil surface (Table 4). However, spider species diversity found on rice canopy was higher than that found at soil surface. This was due to the fact that rice canopy was a niche which supply diverse preys in abundant quantity so that many spiders species were inhabiting the rice canopy area. Spiders found at soil surface tend to have lower diversity because it had lower diverse preys as well as low prey species abundance.

Table 1. Relative abundance and spider families found at rice canopy applied with mycoinsecticide and compost extract on paddy field of tidal swamp area.

Paddy Aged (days)	Family	Mycoinsecticide			Compost Extract			Mycoinsecticide + Compost Extract		
		JS	JI	KR	JS	JI	KR	JS	JI	KR
3	Lycosidae	1	1	6.25	1	1	5.88	0	0	0
	Araneidae	3	10	62.5	2	5	29.41	2	7	46.67
	Tetragnathidae	1	3	18.75	2	8	47.059	1	4	26.67
	Oxyopidae	1	2	12.5	1	3	17.65	1	3	20
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	1	1	6.67
	Total	6	16	100	6	17	100	5	15	100
17	Lycosidae	2	11	18.97	2	8	18.18	1	6	20
	Araneidae	2	11	18.97	2	6	13.64	1	13	43.33
	Tetragnathidae	2	35	60.34	2	26	59.09	1	6	20
	Oxyopidae	1	1	1.72	1	4	9.09	1	5	16.67

	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	7	58	100	7	44	100	4	30	100
31	Lycosidae	2	13	56.52	1	10	58.82	3	13	48.15
	Araneidae	1	5	21.74	1	5	29.41	1	5	18.52
	Tetragnathidae	1	5	21.74	1	2	11.76	1	9	33.33
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	4	23	100	3	17	100	5	27	100
38	Lycosidae	1	8	36.36	1	7	28	2	9	28.13
	Araneidae	1	3	13.64	1	5	20	1	6	18.75
	Tetragnathidae	2	7	31.82	2	8	32	3	6	18.75
	Oxyopidae	1	4	18.18	1	5	20	1	11	34.38
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	5	22	100	5	25	100	7	32	100
45	Lycosidae	2	6	22.22	1	4	18.18	1	3	12.50
	Araneidae	1	3	11.11	0	0	0	1	3	12.50
	Tetragnathidae	2	9	33.33	1	6	27.27	1	10	41.67
	Oxyopidae	1	9	33.33	1	12	54.54	1	8	33.33
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	6	27	100	3	22	100	4	24	100
52	Lycosidae	2	5	41.67	2	5	33.33	2	7	31.81
	Araneidae	0	0	0	0	0	0	1	1	4.54
	Tetragnathidae	1	3	25	1	2	13.33	1	6	27.27
	Oxyopidae	1	4	33.33	1	8	53.33	1	8	36.36
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	4	12	100	4	15	100	5	22	100
59	Lycosidae	1	1	9.09	1	1	33.33	2	5	55.56
	Araneidae	1	1	9.09	1	1	33.33	0	0	0
	Tetragnathidae	2	4	36.36	1	1	33.33	1	2	22.22
	Oxyopidae	1	5	45.45	0	0	0	1	2	22.22
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	5	11	100	3	3	100	4	9	100
PP	Lycosidae	2	8	38.09	1	3	21.43	1	2	11.76
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	1	6	28.57	1	3	21.43	2	7	41.18
	Oxyopidae	1	7	33.33	1	8	57.14	1	8	47.06
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	4	21	100	3	14	100	4	17	100

PP =14 days after harvesting, JS=Species number, KR=Relative abundance

Table 2. Relative abundance and spider families found on paddy field applied with mycoinsecticide and compost extract on paddy field of tidal swamp area.

Paddy Aged (days)	Family	Mycoinsecticide			Compost Extract			Mycoinsecticide + Compost Extract		
		JS	JI	KR	JS	JI	KR	JS	JI	KR
3	Lycosidae	3	4	100	4	7	100	3	5	83.33
	Araneidae	0	0	0	0	0	0	1	1	16.67
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	3	4	100	4	7	100	4	6	100
17	Lycosidae	1	7	100	1	7	100	1	13	100
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	1	7	100	1	7	100	1	13	100
31	Lycosidae	1	3	100	1	2	100	2	5	100
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	1	3	100	1	2	100	2	5	100
38	Lycosidae	2	4	100	2	4	100	3	5	100
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	2	4	100	2	4	100	3	5	100
45	Lycosidae	2	8	88.89	2	4	80	1	6	100
	Araneidae	1	1	11.11	1	1	20	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	3	9	100	3	5	100	1	6	100
52	Lycosidae	2	14	100	2	5	100	1	6	100
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0

	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	2	14	100	2	5	100	1	6	100
59	Lycosidae	1	3	100	0	0	0	1	1	100
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	0	0	0	0	0	0	0	0	0
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	1	3	100	0	0	0	1	1	100
PP	Lycosidae	1	1	50	2	6	60	2	4	80
	Araneidae	0	0	0	0	0	0	0	0	0
	Tetragnathidae	0	0	0	0	0	0	0	0	0
	Oxyopidae	0	0	0	0	0	0	0	0	0
	Theridiidae	1	1	50	1	4	40	1	1	20
	Clubionidae	0	0	0	0	0	0	0	0	0
	Total	2	2	100	3	10	100	3	5	100

PP =14 days after harvesting, JS=Species number, KR=Relative abundance

Table 3. Characteristics of spider community at rice canopy applied with mycoinsecticide and compost extract.

Characteristics of Spider Community	Paddy Aged (days)								
	3	17	31	38	45	52	59	PP	Total
Mycoinsecticide									
Abundance (N)	16	58	23	22	24	12	11	21	187
Species number	4	7	4	5	6	4	5	4	
Biodiversity index (H')	1.60	1.57	1.29	1.53	1.63	1.29	1.37	1.24	
Dominance Index (d)	0.38	0.31	0.43	0.36	0.33	0.33	0.45	1.00	
Evenness Index (E)	0.89	0.81	0.93	0.95	0.91	0.93	0.85	0.89	
Compost Extract									
Abundance (N)	17	44	20	25	24	15	3	14	162
Species number	6	7	4	5	4	4	3	3	
Biodiversity index (H')	1.65	1.64	1.21	1.58	1.20	1.19	1.10	0.98	
Dominance Index (d)	0.35	0.34	0.50	0.28	0.55	0.53	0.33	0.57	
Evenness Index (E)	0.92	0.84	0.87	0.98	0.86	0.86	1.00	0.89	
Mycoinsecticide + Compost Extract									
Abundance (N)	14	30	27	32	26	22	9	17	177
Species number	5	4	6	7	5	5	4	4	
Biodiversity index (H')	1.38	1.30	1.50	1.73	1.43	1.42	1.37	1.22	
Dominance Index (d)	0.29	0.43	0.41	0.34	0.38	0.36	0.33	0.47	
Evenness Index (E)	0.85	0.94	0.84	0.89	0.89	0.88	0.99	0.88	

PP =14 days after harvesting, JS=Species number, KR=Relative abundance

Table 4. Characteristics of spider community found on soil applied with mycoinsecticide and compost extract.

Characteristics of Spider Community	Paddy Aged (days)								
	3	17	31	38	45	52	59	PP	Total
Mycoinsecticide									
Abundance (N)	4	7	3	4	9	14	3	2	46
Species number	3	1	2	2	3	2	1	2	
Biodiversity index (H')	1.04	0.00	0.64	0.56	0.85	0.60	0.00	0.69	
Dominance Index (d)	0.5	1	0.67	0.75	0.67	0.71	1	0.5	
Evenness Index (E)	0.95	0	0.92	0.81	0.77	0.86	0	1	
Compost Extract									
Abundance (N)	7	7	2	4	5	5	0	10	40
Species number	4	1	1	2	3	2	0	3	
Biodiversity index (H')	1.28	0	0	0.56	1.05	0.67	0	0.94	
Dominance Index (d)	0.43	1	1	0.75	0.4	0.6	0	0.5	
Evenness Index (E)	0.92	0	0	0.81	0.96	0.97	0	0.86	
Mycoinsecticide + Compost Extract									
Abundance (N)	6	13	5	5	6	6	1	5	47
Species number	4	1	2	3	1	1	1	3	
Biodiversity index (H')	1.33	0	0.50	0.95	0	0	0	0.95	
Dominance Index (d)	0.33	1	0.80	0.60	1	1	1	0.60	
Evenness Index (E)	0.96	0	0.72	0.86	0	0	0	0.69	

PP =14 days after harvesting, JS=Species number, KR=Relative abundance

Conclusion

The abundance of spiders on ratooning rice in plots applied with mycoinsecticide were 187 spiders during a rice season, while the plot applied with liquid medium fungus reached 177 spiders, and the control plots applied with compost extract reached 162 spiders. Number of the species in the plots applied by mycoinsecticide averaged 4,875 species per observation, the plot applied by liquid medium fungus averaged 5 species/observation, and lowest found in the control plots averaged 4.5 species /observation. Thus, the application of the mycoinsecticide was not adversely affect the abundance and number of species of predatory spider of rice insect pests.

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MALARIA TRANSMISSION AS A PROBLEM OF DYNAMIC INTERACTION BETWEEN PEOPLE AND ECOSYSTEM AND ITS SOLUTION THROUGH QUANTITATIVE APPROACH CASE STUDY ON MALARIA TRANSMISSION IN BENGKULU CITY

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Abstract

Malaria is an infectious disease caused by protozoa parasite of the genus *Plasmodium* and endemic in most tropical and subtropical countries in America, Asia, and Africa. The disease has been transmitting in human community through the role of infectious female mosquitoes of the genus *Anopheles*. The epidemiology of malaria is influenced by dynamic relation among human as the main host, *Plasmodium* as the agent, mosquitoes as the vectors, and environments as media for the three biotic creatures to interact. The transmission is characterized by the parasite whose life cycle runs partially in human host and partially in vector host. The success of widespread transmission in human community is mostly also influenced by environmental conditions covering some factors such as temperature, humidity, rainfall, topography, water table, and wind speed with respect to sexual exogenous and population growth of mosquitoes. Therefore understanding the dynamic relation among the parameters and its involved variables of transmission constitutes an important stage to develop effective solution strategies for its prevention and control. One of approaches to develop the strategies is by mathematical modeling whose one of its steps is by building conceptual diagram describing the dynamic relation from which the mathematical model can be derived. So far mathematical modeling of malaria transmission has gone through one century but malaria is still endemic in most tropical and subtropical countries. It indicates that the existing mathematical models of malaria have not been able to describe the overall transmission dynamics. This paper focuses on evaluating some conceptual diagrams through reviewing some current relevant papers, analyzing secondary data and survey. As a result, we give a developed conceptual diagram that could lead to a better understanding on the overall transmission dynamics and therefore also its derivation in the form of mathematical model as the bases of developing the prevention and control strategy.

Keywords: *Anopheles, conceptual diagram, epidemiology of malaria, mathematical model, Plasmodium*

Introduction

Malaria is an infectious disease that most commonly spread in the world and endemic in most tropical and subtropical countries across the continents America, Asia, and Africa. The disease is induced by protozoa parasite of the genus *Plasmodium* although of the genus only four species causing the incidence of malaria, those are *P. falsifarum*, *P. vivax*, *P. ovale*, and *P. malariae*. The disease is transmitted among human through the bite of infectious female mosquitoes of the genus *Anopheles*. So far about 40% of the world's population is estimated at risk of being infected by malaria and of the risky population about 500 million people yearly is infected by malaria as well as of the yearly infectious people more than 1 million people die every year [2,9]. The risk has gotten increased due to increasing the number of drug-resistant *Plasmodium* and insecticide-resistant mosquitoes in line with the widespread use of the drug and insecticide in human community [1,2] and also due to the effect of diversity of social-economy conditions and distorted environment [14,16]. Therefore, although the transmission of malaria is caused by many complex factors, the conditions of social-economy and environment in endemic area of malaria need to get attention thoroughly as the basis of explaining the fluctuation of malaria incidence.

In Indonesia, more specifically in Bengkulu City whose population are 283,493 people, the number of malaria incidence in 2010 reached 15,630 people or equivalent to Annual Malaria Incidence (AMI) 53.13 which is categorized as holoendemic [3]. The rate of AMI could indicate a parameter representing a structure of Bengkulu's community that according to Romdiati, Noveria, and Handayani [13] can have vulnerability with index 3.8 covering population vulnerability with respect to densely populated area and economic vulnerability in terms of common household poverty. From the view point of population density 2035.3 people per km^2 for Bengkulu area 151.7 km^2, Bengkulu city is not densely populated. However the population of Bengkulu City of 283,493 people has agglomerated in area along its beach [4]. The agglomeration area constitutes habitat of pre-imago phase for mosquito growth. It indicates the correlation between social-economy factor and malaria endemicity.

Study for solving the problem of malaria control and prevention through quantitative approach has gone on for about one century since the introduction of Ross's initial mathematical model in 1911 that subsequently developed by MacDonald in 1957 as a basic model of malaria transmission [2,7,9]. The basic model has been studied and developed by many researchers with respect to different aspects of malaria transmission dynamics. The models have given some advantages to improve the comprehension of transmission characteristics as well as the quality of malaria control and its planning. Thus, the mathematical models of malaria transmission have played an important role in terms of its epidemiology development. However malaria is still endemic in most tropical and subtropical countries up to now. It means that the existing models are still need to develop in order to describe more comprehensively their transmission dynamics. Hence it is necessary to study the mathematical modeling of malaria transmission more thoroughly so that it is likely to get a more effective strategy for malaria control and its prevention.

Existing models of malaria transmission are built according to mechanism of interaction among three main factors of malaria epidemiology, those are human as host, mosquitoes as vector, and environment as media for human and vectors to interact. The differences between one model to another are viewed from four perspectives: (1) the differences of aspect to focus among three epidemiologic factors, (2) the dynamics of transmission in terms of sociological context for both human population and vector mosquito population, (3) perspective on steps of *Plasmodium* life cycle in both domain, human and vector mosquito, and (4) the approaches used to build models and their solution. However all the models are actually combinations of two or three of the four perspectives. Some models are more stressing the dynamical relation between human and mosquito population as variables and expressing the role of environment as parameters [2,6,9,10,11] while some others represent three factors of epidemiology by exploring the role of environment in terms of pre-imago phase of mosquitoes [7,14,16]. The differences between the former and the latter are determined by steps of *Plasmodium* cycle in both domains, human and mosquitoes, covering combination of susceptible, exposed, infectious, recovered, and dormant in human host and combination of susceptible, exposed, and infectious in mosquitoes. Some models express steps of exposed and infectious in human and mosquitoes as infectious through which different models are obtained [10,11]. The differences are strengthened by various approaches in building model consisting of deterministic, stochastic, or cellular automaton as well as by various approach of model solution covering numerical approach, dynamical system, or fuzzy logic.

Models in Ruiz *et al*. [14] and Hoshen and Morse [7] describe more comprehensively the involvement of three factors of malaria epidemiology. The differences between them are that the former explores less the phases of *Plasmodium* life cycle, especially the phase recovered which is claimed as always producing immunity although theoretically there is still non-zero probability for recovered human to remain non-immune [1,6,9], while the latter is built through stochastic approach based on time-series data so that all phases of *Plasmodium* life cycle are not explored explicitly. Moreover models in Chitnis, Cushing, Hyman [2] and Ducrot *et al*. [6] involve sociologically the transmission dynamics such as migration in human population albeit the role of environment is not explicitly expressed in model development except implicitly through model parameters. The weakness of models that do not explore environment factors, especially the correlation of social-economy conditions and environmental change, is that simulation by environmental changes such as social-economy condition and demography changes is difficult to do so that scenario choices for the effectiveness enhancement of malaria control strategy become limited.

The main research problem needs to solve is how to develop a mathematical model representing the interaction of human host-agent-vector mosquitoes-environment and covering thoroughly the phases of *Plasmodium* life cycle so that scenario of environment management can be designed such that vector mosquito population growth can be minimized in order to decrease malaria endemicity. To solve the problem, the key step is by building a conceptual diagram from which the mathematical model can be obtained. This paper objective is to build the diagram in order to facilitate the next study so that the model can be derived, solved, and simulated in order to develop a strategy of malaria control and prevention. The objective is achieved through analyzing relevant secondary data and literatures as well as field survey.

Materials and Methods

Malaria data

As happened in most countries of South East Asia, malaria is still a community problem that is not yet able to be eradicated in Indonesia and therefore is still an endemic disease. Ditjen PP-PL Ministry of Health, Indonesia [5] classifies malaria endemicity in Indonesia into four strata in terms of Annual Parasite Incidence (*API*), those are endemis tinggi for $API > 5$ per 1000 inhabitants, endemis sedang for $1 < API \leq 5$ per 1000 inhabitants, endemis rendah for $0 < API \leq 1$ per 1000 inhabitants, and non-endemis for $API = 0$ per 1000 inhabitants. The map of stratification based on API is shown by Figure 1. Nevertheless Ministry of Health is also use AMI to measure endemicity and to control malaria outside Provinces of Jawa-Bali with endemicity classification as endemis tinggi for $AMI > 50$ per 1000 inhabitants, endemis sedang for $30 < AMI \leq 50$ per 1000 inhabitants, endemis rendah for $10 < AMI \leq 30$ per 1000 inhabitants, and non-endemis for $AMI \leq 10$ $AMI \leq 10$ per 1000 inhabitants.

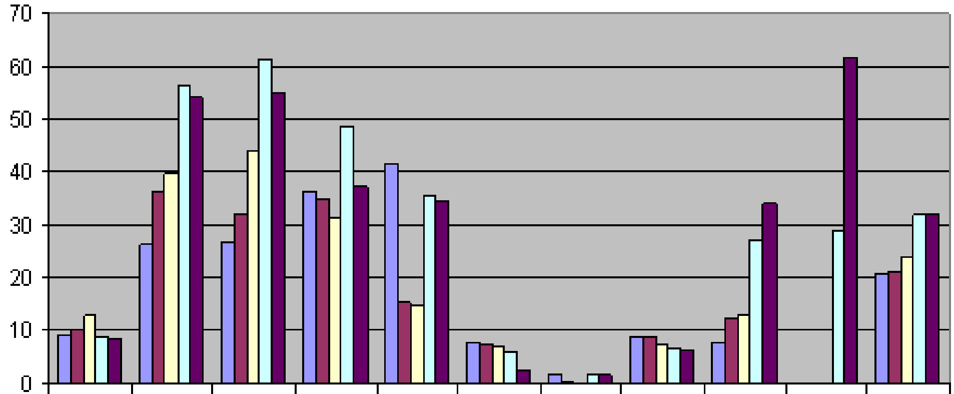
Source: Ditjen PP-PL, Ministry of Health, Indonesia (2010)

Figure 1. Stratification of malaria endemicity based on API in Indonesia in 2009

A bit different from Ministry of Health, Syafruddin *et al*. [15] classifies Indonesia's endemicity stratification into two areas of endemicity with respect to classification of Bruce-Chwatt [1] who divides endemicity into four kinds of stratification as holoendemic, hyperendemic, mesoendemic, and hypoendemic. The stratification is mentioned in decreasing order according to severity degree of endemicity. Therefore, holoendemic can be defined as a measurement describing malaria transmission of high degree intensity causing a considerable degree of immune response in all age groups, especially in adults, while hyperendemic is defined as description of high enough intensity for malaria transmission with seasonal pattern where immunity is not sufficient for all age groups to prevent the impact of malaria. Likewise mesoendemic can be understood as severity degree of endemicity where the intensity of transmission varies and depend on local conditions, while hypoendemic is intensity of malaria transmission in an area which does not give generally significant impact to population in the area. Based on the classification, Syafruddin divides endemicity of Indonesia into hypoendemic for provinces of Jawa-Bali and hyperendemic for other provinces.

Regardless of various measurement of endemicity, Indonesia as tropical archipelago country covering 17.504 islands has substantively broadly various endemicity which depend on environment conditions, transportation and its infrastructure, health service access, education and social-economy degree, as well as behavior and attitude of community to habitually of healthy life. Geographical characteristic of Indonesia as archipelago country located around equator with two seasons and supported by different acceleration of development over all areas has become complicated factors for various high degree of endemicity in Indonesia.

In Bengkulu Province, the level of malaria incidence has gone up for period 2006-2009 and decreased for 2010, see Figure 2. However, the number of clinical malaria in 2010 shown by Health Office of Bengkulu Province [3] is still high enough, that is 55,644 people whose AMI is equivalent to 31.76 which enter into classification as endemic tinggi but according to API with value 4.92 is classified into endemic sedang, see Table 1.



	Bengkulu Selatan	Bengkulu Utara	Kota Bengkulu	Muko-Muko	Seluma	Kepahyang	Lebong	Rejang Lebong	Kaur	Bengkulu Tengah	Provinsi
2006	8.97	26.15	26.68	36.1	41.65	7.84	1.86	8.89	7.9	0	20.52
2007	10.01	36.38	32.01	34.71	15.35	7.1	0.35	8.89	12.31	0	20.88
2008	12.8	39.8	44.0	31.2	14.8	6.9	-	7.4	13.0	0	23.7
2009	8.9	56.2	61.3	48.9	35.7	5.8	1.8	6.5	27.1	28.7	32
2010	8.4	53.9	55.1	37.3	34.2	2.6	1.5	6.4	33.9	61.6	31.8

Sumber: Health Office of Bengkulu Province (2011)

Figure 2. AMI per District in Bengkulu Province for 2006 – 2010

Figure 2 and Table 1 show that endemicity of Bengkulu Province based on AMI is categorized into three strata, endemis tinggi covering Bengkulu City and districts of Bengkulu Tengah and Bengkulu Utara; endemis sedang covering districts of Muko-Muko, Seluma, and Kaur; and endemic rendah comprising districts of Bengkulu Selatan, Reajang Lebong, Kepahiyang, and Lebong. District of Bengkulu Tengah has highest endemicity in terms of AMI but according to API it is classified as endemic sedang. Table 1 also shows that most species of *Plasmodium* causing malaria incidence in Bengkulu Province are *P. falsiparum* and *P. vivax* while most species of *Anopheles* transmitting malaria according to Husin [8] are *A. Maculatus*, *A. negerrimus*, and *A. sundaicus*.

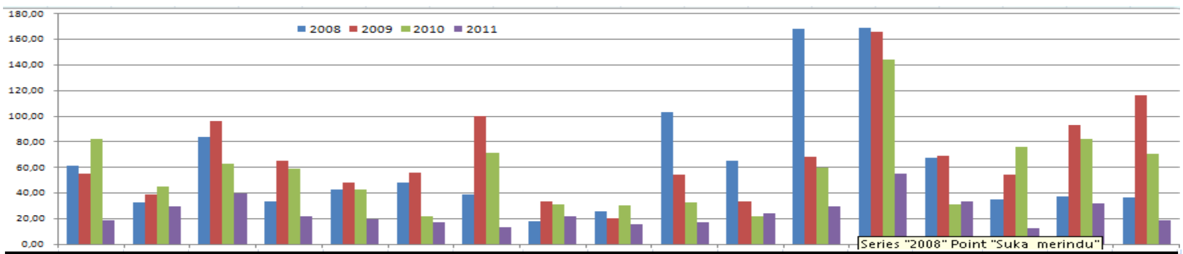
Two districts of Bengkulu Province with highest level of AMI are District of Bengkulu Tengah and Bengkulu City. The former constitues a new district founded in 2008 with population 104.750 people and the number of clinical malaria 6,453 people or equal to AMI 61.60 (>50) but equal to API 4.20 (<5). A large number of difference between AMI and API in the new district indicates that the district still faces a problem of infrastructure and health service access. On the contrary, Bengkulu City as capital city of Bengkulu Province has population 283,493 people, almost three times as population of Bengkulu Tengah, and better infrastructure and health service access but still faces a malaria problem as indicated by the high number of malaria incidence as 15,630 people or equivalent to AMI 55.13 (>50) and to API 6.68 (>5). Therefore, the difference between Bengkulu Tengah and Bengkulu City is shown by conformity of AMI and API in Bengkulu City and vice versa in Bengkulu Tengah. Hence, endemicity of Bengkulu City is necessary to study in order to find the main causal fa ctors. Since the main factors of malaria epidemiology are human as host, *Plasmodium* as agent, mosquitoes as vectors, and environment as driver or media that drives the interaction among the three biotic creatures, then the interaction among them in Bengkulu City needs to study.

Table 1. Malaria Klinis, AMI, dan API di Propinsi Bengkulu Tahun 2010

No	District	Population	Clinical Malaria	Positive	*Plasmodium*		AMI	API
					falsiparum	*vivax*		
1	Bengkulu Selatan	145.992	1.232	486	12	536	8,44	3,33
2	Bengkulu Utara	253.027	13.640	4.168	182	3.975	53,91	16,47
3	Kota Bengkulu	283.493	15.630	1.893	69	1.737	55,13	6,68
4	Muko-Muko	152.316	5.681	697	109	582	37,30	4,58
5	Seluma	186.959	6.403	760	165	601	34,25	4,07
6	Kepahyang	118.910	308	0	-	-	2,59	0,00
7	Lebong	112.078	172	2	-	2	1,53	0,02
8	Rejang Lebong	263.206	1.675	5	-	5	6,36	0,02
9	Kaur	131.183	4.450	165	89	62	33,92	1,26
10	Bengkulu Tengah	104.750	6.453	440	129	306	61,60	4,20
Total		1.751.914	55.644	8.616	755	7.806	31,76	4,92

Source: Health Office of Bengkulu Province (2011)

In the level of Bengkulu City, the number of malaria incidence reported by 20 Community Health Center (CHC or Puskesmas) in Bengkulu City for period 2008-2011 shows various endemicity in terms of AMI although its level is still high enough in 2008 and 2009 and folowed by decreasing period in 2010 and 2011, as shown by Figure 3. Of the data, for the year 2008-2010 malaria incidences of three CHC (Sidomulyo, Penurunan, and Bentiring) are not recorded at Health Office of Bengkulu City, but for the year 2011 incedences of all CHC are reported to Health Office of Bengkulu City although just for periods of last 7 months (April-December).



	Basuki Rahmad	Padang Serai	Betungan	Nusa Indah	Jalan Gedang	Kuala Lempuin	Jembatan Kecil	Lingkar Timur	Sawah Lebar	Lingkar Barat	Anggut Atas	Pasar Ikan	Suka merindu	Kampung Bali	Ratu Agung	Beringin Raya	Kandang
2008	61,08	32,96	84,04	33,34	42,55	48,32	38,48	17,76	25,50	103,00	65,13	167,98	169,29	67,39	34,97	37,39	36,57
2009	55,00	38,80	95,86	65,01	48,05	55,49	100,11	33,41	20,51	54,06	33,47	68,42	166,10	68,66	54,24	92,91	116,02
2010	82,60	45,05	62,52	58,68	42,93	21,50	71,56	31,22	30,00	32,90	21,71	59,60	144,24	31,14	76,36	82,09	70,82
2011	18,84	29,43	39,57	21,44	19,43	17,25	13,35	22,10	15,43	17,15	24,05	29,64	54,87	33,37	12,56	31,98	18,75

Source: Health Office of Bengkulu City (2012).

Figure 3. AMI per CHC in Bengkulu City for period 2008 – 2011

The number of malaria incidence in terms of AMI for all CHC in Bengkulu City is shown by Table 2. The data must be understood on the basis of coverage area of service where each CHC is located. Bengkulu City consists of nine sub-districts and 67 sub-subdistricts and also has 20 CHC each of which has different number of sub-subdistricts as coverage area of service. The data of Table 2 shows relatively population of all sub-subdistrict whose areas are covered for service by its related CHC.

Table 2. Clinical Malaria and AMI for each CHC in Bengkulu City for 2011

No	CHC	Population	Clinical Malaria	Positive	*Plasmodium*		AMI		
					falsi parum	*vivax*	CHC	Sub-District	
1	Ratu Agung	12.106	152	0	0	0	12,56	25,11	Muara Bangkahulu
2	Bentiring	4.752	134	10	0	8	28,20		
3	Beringin Raya	20.015	640	115	0	122	31,98		
4	Pasar Ikan	14.811	439	1	0	1	29,64	31,12	Teluk Segara
5	Kampung Bali	9.740	325	23	0	20	33,37		
6	Sukamerindu	22.472	1.233	257	0	232	54,87	54,87	Sungai Serut
7	Betungan	10.539	417	14	0	14	39,57	23,45	Selebar
8	Basuki Rahmad	36.787	693	33	11	22	18,84		
9	Kandang	16.693	313	18	0	18	18,75	23,32	Kampung Melayu
10	Padang Serai	12.470	367	14	0	11	29,43		
11	Jalan Gedang	15.181	295	19	0	18	19,43	15,14	Gading Cempaka
12	Lingkar Barat	15.572	267	13	1	12	17,15		
13	Sidomulyo	10.186	58	0	0	0	5,69		
14	Lingkar Timur	20.859	461	14	3	11	22,10	17,89	Singaran Pati
15	Jembatan Kecil	19.330	258	0	0	0	13,35		
16	Kuala Lempuing	3.943	68	3	0	3	17,25	18,43	Ratu Agung
17	Nusa Indah	24.021	515	176	0	46	21,44		
18	Sawah Lebar	22.554	348	17	0	14	15,43		
19	Anggut Atas	11.267	271	31	0	31	24,05	17,08	Ratu Samban
20	Penurunan	14.266	165	5	0	5	11,57		
Total & AMI of City		317.564	7.419	763	15	588		23,36	

Source: Health Office of Bengkulu City, 2011

The high endemicity of malaria in Bengkulu City may be caused by its specific topography which could be classified as mountainous or wavy such that there are so many hollow lands. The condition in line with high rain fall of Bengkulu City causes the availability of oxygenated water as habitat of Anopheles for pre-imago phase. According to four-year weather data (2008-2011) of Indonesian Agency for Meteorology, Climatology, and Geophysics of Bengkulu Office, the average rain fall per month is about 287.54, the average temperature per month is 26.56^{0}C, and the average humidity per month is 83.85%. The data depict the natural condition of Bengkulu City conforming to its high endemicity.

Conceptual diagram of mathematical model

So far literature survey lead us to models that can relatively be viewed as comprehensive models, those are model Chitnis, Cushing, Hyman [2] and model Ruiz *et al*. [3] which consecutively represent a deterministic model and a stochastic model. The conceptual diagram of the first model is shown by Figure 4 while the one of second model is conveyed by Figure 5. The first diagram uses pattern of

SEIRS (Susceptible-Exposed-Infectious-Recovered-Susceptible) where recovered phase definitely results in temporary immunity, different from Labadin, Kon, Yuan [9] whose recovered phase leads to two possibilities, temporary immunity and non-immunity. The two possibilities in [9] yields another conceptual diagram. Moreover Ducrot *et al.* [6] develops a model in which human population is initially divided into non-immune sub-population and immune sub-population with SEIS pattern for the first sub-population and SEIRS for the second sub-population. A more specific model is developed by Pongsumpun [10] that stresses for species *P. vivax* in whose phase should pass a step called as dormant, therefore the pattern becomes SIDRS (Susceptible, Infectious, Dormant, Recovered, Susceptible). In this pattern Pongsumpun [10,11,12] classifies infected and infectious as one phase called as infectious.

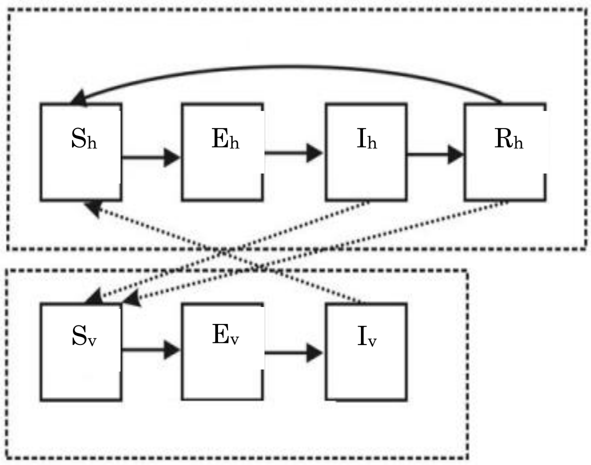


Figure 4. Conceptual Diagram Chitnis

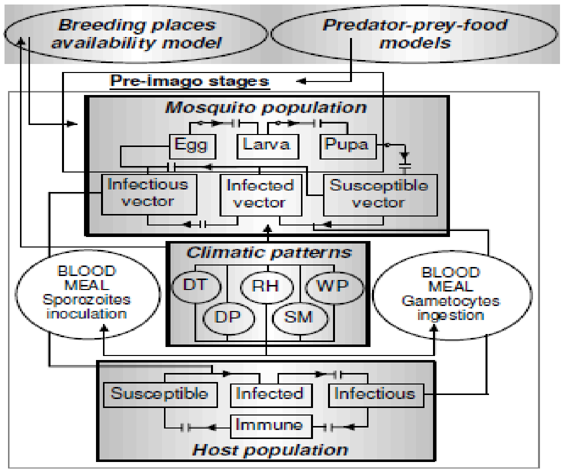


Figure 5. Conceptual Diagram Ruiz

Results and Discussion

From the view point of *Plasmodium*'s life cycle phases, virgin human who lives in malaria endemic area is called as susceptible. When a female infectious mosquito of species *Anopheles* bites the human, *Plasmodium* in the form of sporozoites will move to human with finite probability. The parasite is then brought by blood current to enter liver, then stay and develop there for a certain time period. In this step the human is called as exposed by malaria. The sporozoites develop into merozoites and enter blood current and also penetrate red blood cells followed by clinical symptoms with fever as the most common sign. In red blood cells merozoites develop into gametocytes consisting of macrogametocytes (female) and microgametocytes (male), of which human is called as infectious. For some certain time the infectious human will recover and enter a recovered phase that yields temporary immunity or non-immunity depending on some factors but he or she is possible to keep parasite inside his or her body to move to other humans through vector mosquitoes. Recovered human will move directly to susceptible if the human does not get immunity or if the immunity has disappeared.

A virgin female *Anopheles* living in malaria endemic areas is called as susceptible. When the mosquito bites an infectious human or a recovered human, then malaria parasite in the form of gametocyte moves to the mosquito with certain probability. Subsequently under latent period the mosquito an exposed phase. After the latent phase has ended, depending on temperature and humidity, the parasite develops into sporozoites and enter mosquito's salivary glands. In this step the mosquito is potential to transmit malaria and called as infectious. Once a mosquito is infectious, then it will be infectious forever due to its life time which relatively conform the life cycle part of *Plasmodium* in a mosquito. Therefore, mosquitoes leave population through dead with rate per mosquito depends on population density of mosquito.

The role of malaria vectors is strategic to move malaria parasites from a human to another human, and therefore the vector population has a significant influence to the effectiveness of malaria transmission. The role effectiveness of vector population is determined by the success of vector life for both imago phase and pre-imago phase in which their characteristic is interdependent. The success of pre-imago phase will increase the population of imago vector and on the other hand the success of imago vector life will increase population of eggs of the pre-imago phase. The success of imago phase of vectors depends on their easiness to obtain human blood, and subsequently it will be followed by ovarian development ended with egg-laying. Afterward the vectors' pre-imago phase begins through specific phases of eggs-larvae-pupae whose success will depend on the availability of oxygenated water where female Anopheles laid their eggs. In short the success of pre-imago phase is influenced by natural environment conditions such as demography and weather through which the phase takes place. Nevertheless social-economy conditions of community influence the behavior and attitude of community to the natural environment that could potentially be distorted to contribute the success of pre-imago phase. Its further implication is the increase of vector population growth.

Two important aspects that need to consider in developing a conceptual diagram of model are the aspect of interaction mechanism among three factors of malaria epidemiology, those are human population, vector population, and environment, and the aspect of parasite life cycle phases in both domains, human and malaria vector. The vector population on the other side is influenced by the success of pre-imago phase where natural environment conditions, weather, and social-economy conditions of community are influential. Likewise the success of parasite life cycle in vector domain, especially from exposed to infectious phase is influenced by weather, in particular humidity and temperature.

Based on the terms of references above the comprehensive conceptual diagram of further model is as followed, see Figure 6:

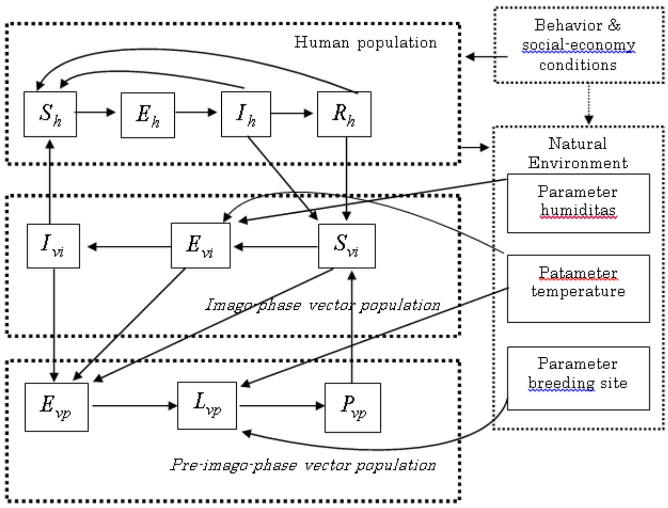


Figure 6. Conceptual Diagram of Malaria Transmission Model

Conclusion

This paper presents the last step from which the mathematical model of malaria transmission can be derived for further advantage as the basis of scenario development of malaria control and prevention. Next steps of research are measuring parameter related to environment but influenced by behavior and social-economy conditions of community, deriving model, followed by verifying-calibrating-validating model, solving the model, simulating and designing scenario of malaria control and prevention. The prominent differences of the diagram from the others are the accommodation of influences such as human behavior and their social economy conditions to natural environment change causing the emergence of habitat spots for pre-imago Anopheles at most areas of Bengkulu City.

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TECHNOLOGY TRANSFER FOR EMPOWERMENT OF SMALL SCALE FOOD PROCESSING ENTERPRISE

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Abstract

One of the strategies in optimizing local resources is through the development of small enterprises based on local potency. Food processing enterprises, in this matter, become the alternatives choosed by the local government and the community, because they use local product (agriculture, plantation, and fisheries) as their raw material. However, the technology used mostly still traditional (manually) which causing the un-efficient in production and low competitiveness of their products. The implementation of appropriate technology in small scale food processing enterprises, have aim to increase the productivity and product quality, through training and technical assisstency. Training conducted as the tools for transferring the technology need by the enterprise. Whereas technical assisstency was apply to assure the process of technology transfer. The study took place in Poso District of Central Sulawesi, was an evaluation study of community empowerment program through appropriate technology implementation, conducted from 2003-2005. From 20 people that were trained on food processing, equipped with technology, only 5 of them start their own enterprises. Due to many obstacles, only 2 of them managed to develop their enterprise. From the performance and development of the 2 enterprises, it can be derived factors that supporting their business: opportunity, time, motivation and innovativeness.

Keywords: *appropriate technology, innovativeness, small-scale food processing enterprises, technology transfer, training.*

Introduction

Development of small-scale enterprises on agro based or agroindustry is a strategy that can help the local government in optimizing their potency. Especially in the area that still rely on their natural resources or agriculture to stimulate economic growth [1]. Optimizing the natural resources is possible, because agricultural production here still sold as primary product, not processed. In this case, processing the agricultural products or food processing base on agricultural product is very important in increasing its value added and in creating job opportunity outside agriculture sector. Other benefit of the establishment of food processing industry, even if it is in small scale, is supporting the sustainability of agricultural production [2].

Many small-scale food enterprises grow in Poso of Central Sulawesi, but the technology used mostly still traditional (manually) which causing the un-efficient in production and low competitiveness of their products. Regarding the problem, increasing technology capacity of these small food processing enterprises becomes the alternative. Technology, however, is agreed as triggering factor to accelerate growth. But the implementation of technology in development program in a given community, is not always supporting, it could also create several social-cultural problems instead. People's response to the technology introduced is an adaptation and selection process and it needs time. Beside social and cultural background, its geography or the environments where a community live have an affect in the process of adaptation and selection. Therefore, its suitability and needs of a technology become important for the sustainability of a development program.

In development program, technology is a system used in transformation of natural resources into products that give benefit to the people. Or in other words it provides tools for the success of social-economic development through optimizing the resources efficiently. But in introducing a certain technology to the people, its suitability with social and culture of the people is very important, if not, it can create conflict or rejection. Therefore, the aim of a development activity should be focused on human orientation goals, technology that can be complemented culturally, and in the execution should also considers the capacity and limitation of the people in facing problems that occurs in the development process [3].

In considering the matter above, an empowerment in Poso Community of Central Sulawesi was applied through the implementation of appropriate technology from 2003-2005. The program aims on increasing technology capacity of the target community for developing income generating activity, and also strengthening local capacity, such as food processing enterprises. In consideration of of problems that may occur, technology intervention implemented based on the principle of people capacity to adapt something new as long as it give socio-economic benefits. With this principle, it is believed can minimized problems that may affect community, especially when the technology is considered to be part of their social system.

The capacity of people to adapt changes is natural in a community or culture. Therefore, understanding the community as a whole or a system, covering many aspects (social, economic, political, cultural, demographic, resource, and environmental geography), is a key in development programs through community empowerment, to ensure transfer of technology.

Methods

Transfer of technology is the aim of community empowerment applied in Poso. Target activity was empowering small scale food processing enterprises, in order to increase their quality and productivity, so they can compete in the market. Technology introduced and implemented for small scale food enterprises in Poso was selected based on local conditions and supporting facilities in the area. The so called appropriate technology then implemented, due to its suitability with the target enterprises.The method applied in transferring technologies for food processing were training and technical assistency.

Training is an activities or deliverables designed to enable end users to learn and use new processes, procedures, systems and other tools efficiently and effectively in the performance of their work. *Training involves an organized attempt to assist learning through instruction, observation, or practice* … [4]. While, technical assistance is an effort in implementing knowledge and skill to support the people/small enterprises in developing their capability and capacity. Wright defined technical assistance as "… *programs, activities, and services ... to strengthen the capacity of recipients to improve their performance with respect to an inherent or assigned function*" [5]. Through training and technical assisstency hopefully the small scale food enterprises in Poso are capable to develop their capacity in production and market development for their products. To achieve the above goals, steps taken were:

1. Identification of the target groups (Food Processing SMEs) and local resources.
2. Selection of technology to be implemented to increase the capacity of the SMEs.
3. Training the SMEs.
4. Supporting the SME that have high motivation to improve their enterprise through technical assistency, and the local government equipped it with technology needs by SMEs.
5. Monitoring was conducted during implementation activities together with local government, also evaluation, where local government has more role in support of SMEs development.

Results and Discussion

In the implementation, 20 people representing SMEs was trained on food processing using simple technology or appropriate technology and afterward the local government support them with technology needs for production. However, only 5 of them interest in developing their enterprise using technology that introduced through training:

1. SME in Kayamanya produce banana jam (*selai pisang*) and banana chewy (*dodol pisang*).
2. SME in Gebangrejo, produce waxy maize chewy (*dodol jagung pulut*).
3. SME in Lawanga, produce chili powder (*cabe bubuk*), fish floss (*abon ikan*) and snacks contains fish floss.

4. SME in Kawua, produce banana chewy (*dodol pisang*) and pumpkin chewy (*dodol labu kuning*).
5. SME in Poso, produce banana chewy (*dodol pisang*) and fish floss (*abon ikan*).

Banana, especially *Musa paradisiaca* (*pisang raja*) and pumpkin are abundant in Poso, they do not know what they can do with these commodities so they can get economic benefit from it, instead they just throw it away. With appropriate technology, those commodities can be processed as snacks and give economic benefit to the people.

Technology implemented here were process technology of: sweets production (*dodol* making), fish floss production, jam production, chili powder production. Other than that equipment that also introduce were spinner to separate oil contains in fish floss, 5 kg capacity blender for sweets production. All technologies that introduced were easy to operate and relatively cheap, therefore people give good response.

Technical assistance was given to those five SMEs to improve their capacity and increase their productivity. Also to evaluate how they adapt and utilize technologies and knowledge given in training. After two years, only 2 SMEs survive and still producing until now (evaluation in 2012). The 2 SMEs that manage to survive now already has certificate from Health Office (Badan POM) for their products which support their market and production activity, they are SME in Kayamanya which produce banana sweets and banana jam and SME in Lawanga which produce chili powder and fish floss. Each SME already has label for their production, i.e. Lestari for SME in Kayamanya (UKM Lestari) and Rezki for SME in Lawanga (UKM Rezki).

Actually these 5 SMEs have their own business, originally they sell cookies and daily needs, but could not optimally generate income. Therefore by participating in the training, hope they could increase their income through product development base on local resources. However, from the evaluation indicate that the other 3 SMEs did not survive because they could not find market for their products. While the 2 SMEs that manage to develop their product can find market for their products. These 2 SMEs able to optimize their old market (before they produce snacks learned from the training) to accept and buy their new products. But in this matter these 2 SMEs not only introduce their new products similar to what their learned in the training, adaptation and development has been made to increase the quality and variance of their products.

UKM Lestari beside produce cookies also produce banana jam and banana chewy at first but then develop other products base on food process technology learned in the training. UKM Lestari was able to produce several chewy (*dodol*) with different flavors i.e: banana, pumpkin, mango, soursoup, cassava, fermented sticky rice (*tape ketan*), and jackfruit. All of these products were the innovation of UKM Lestari through modification of the original recipe or formula, that is banana chewy. With this innovation, UKM Lestari becomes one of local government main focus and excellent examples of government program in support of SME development.

While UKM Rezki, also manage to develop their products, though not as much as UKM Lestari. The market for chili powder produce by UKM Rezki actually is not to high, only few people buy the products. Actually once there were demand of the product from large food industry in huge amount, but due to its small scale and simple technology, the demand could not be fulfilled. Considering the condition and the fondness of Poso people on hot food (*makanan pedas*), UKM Rezki then produce fish floss in original flavor and hot flavor, then they produce also chicken floss with two flavors, original and hot. Other variety develop by UKM Rezki is snacks (dry pastel) contain of fish and chicken floss with two flavor and got a very good respons from the community around and local government. The products from these two SMEs become souvenir or gift for visitor. From these two SMEs, we can derive factors that supporting their success in managing and developing their enterprises, i.e. opportunity, time, motivation and innovativeness.

Opportunity shown in their response in utilizing what they have got from training they participated into products development in their business/enterprises. With their enthusiasm in developing their business, the local government then supported them by help them to get technology they need such as sealer and good packaging and assisstency in management and also supported in getting certificates for their products so the market will be expanded. While other SMEs, not very active they were tend to be passive instead by waiting for government hand to help them.

Time in this case indicate that these 2 SMEs manage to optimize the time. Here the 2 SMEs were able to recognize the condition when the local government has program in supporting SMEs as tools in economic recovery from the destruction after conflicts take place in 1999-2002. By presenting their ability in managing and developing their enterprise optimizing government program, support from the government eventually goes to these 2 SMEs.

Motivation, shown by these 2 SMEs enthusiasm in training activity and production afterward. Also they were not hesitate to ask for assisstants if they have problem in their business, technical problem and also management problem. Here their motivation to progress was shown and therefore the local government also has no hesitation to give help and support them.

Innovativeness that shown by variance of products they produce. They were able to modified the process in producing the products and give them good quality products and variant of their products. From evaluation of these 2 SMEs and the other 3 SMEs, innovation is needed through products development and producing variety of products interest consumers to purchase their products hence expanding their market.

All those 4 factors were elements compliment each other so it could not be analized as separate element. These 4 elements from Poso experience has to be view as a whole or a system, as part of empowering the SMEs.

Figure 1. Assistency & Evaluation Activity

Figure 2. Evaluation and Visit to SME Rezki

Figure 3. Blender 5 kg Capacity

Conclusion

The implementation of community empowerment program through appropriate technology still focus on community and base on local resources, although technology (appropriate technology) becomes tools for community empowerment. Transfer of technology as the method here was build to attract people's full participation in the program, with the aim to encourage people's capability and capacity and creativity base on their potency. However in the implementation consideration of social, cultural and economic of the people is a must, to avoid cultural and social lag due to the use of unsuitable technology.

Training activity and appropriate technology implementation in the context of community empowerment, got a good respond beside problems that still occurs during the implementation. Problem occurs responsive to SMEs empowerment which is low accessibility and supporting facilities for SMEs development especially related to packaging technology and facility, also supporting material need for food processing activity.

One thing that should be remembered is that technology by itself could not guarantee for the success of SMEs development, although technology is the tool for development. In this case it is shown by the other 3 SMEs, lack of motivation and innovation, not to mention have no vision (not capable of recognizing the time and opportunity). Technical assistant actually also given to those 3 SMEs, but lacks of the 4 elements: opportunity, time, motivation and innovativeness have put them into position that not recognize by the government, hence lack of support from the government.

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DEVELOPING REMOTE SOIL MOISTURE MONITORING TECHNIQUES FOR IMPROVED DECISION MAKING ON IRRIGATION

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Abstract

Conventionally, soil moisture is measured by collecting soil samples, oven-drying them for at least 24-hours, and calculating weight differences between moist and oven-dry samples. Soil dielectric properties have been used recently for a quick in-situ measurement technique of soil moisture without sampling and drying processes. This paper aims to report results of previous studies on a dielectric technique of soil moisture measurement, and to use the results for the future development of remote techniques on soil moisture monitoring system. The electrical impedance values, Z (in ohm), of surface soils in Bengkulu region were measured using a modified digital multimeter, and at the same time gravimetric soil moisture values (θg in g g^{-1}) were measured conventionally by calculating weight differences between moist and oven-dry soil samples. The results showed that θg could be calculated from Z values using a non-linear regression of $\theta g = aZ^b$ ($R > 0.90$), where constants a and b varied with soil characteristics such as texture and organic matter content. For future studies, changes in Z values read by the multimeter may be transmitted into light bulbs with different colors (a traffic light system), and to satellites for a web browser based data acquisition system. Using information collected from the proposed techniques, growers can monitor fluctuations in soil moisture easily as they can make more informed irrigation decisions and increase the efficiency of the water used in agricultural land.

Keywords: *moisture, monitoring, remote, soil, technique.*

Introduction

Water-saving irrigation technologies and water management practices have been studied by many researchers and adopted worldwide to improve field-level water use efficiency especially in growing season. The need for water-use efficiency rises due to the water scarcity and continuous increase of water use outside the agricultural fields such as in industry and domestic life. Sprinkler irrigation technology, improved surface irrigation technology and irrigation scheduling are among water management pratices adopted by growers to improve water-use efficiency. The practices are particularly important in the deep-rooting planting areas such as perrenial crop fields because temporal variations in soil moisture for irrigation fields are considerably larger at the upper soil layers, for example a 0-60 cm layer, than what occurs at deeper depths [1]. Determination of temporal fluctuations in soil mositure, especially at the uppermost layers, then becomes crucial in applying water-saving technologies since addition of irrigation water to the soil depends entirely on the level of soil moisture.

Soil moisture or soil water content is one of the most important soil properties in agriculture, defining as the amount of water contained in soil, and expressed as a ratio ranging from 0 (oven dry) to about 0.6 g g^{-1} (saturated condition). Conventionally, soil moisture is measured using the gravimetric method by collecting soil samples, oven-drying them for about 48-hours, and calculating weight differences between moist and oven-dry samples. Soil moisture content can also be measured using the geophysical methods by relating neutron or electrical properties to water [2] and the satellite remote sensing method by using a large contrast of satellite microwave dielectric properties between the wet and dry soil to estimate soil moisture [3].

The need for in-situ measurement of soil moisture becomes urgent due to time-consuming procedures of conventionally-gravimetric method by using soil samples [4]. Soil dielectric properties such as conductivity, capacitance and resistivity or impedance of a porous medium vary with moisture content, therefore they have been used recently in the geophysical method as a quick in-situ measurement technique of soil moisture without sampling and drying processes. A model of the relations between soil dielectrical properties and soil moisture has been established about fifteen years ago by Friendman [5]. A research by Ozcep *et al.* in 2009 shows that a strong relation (R = 0.76) between soil electrical resistivity (R) and soil moisture content (θ) is found and follows a non-linear equation of $\theta = 49.2e^{-0.017R}$[6]. Our research on the use of electrical impedance to predict soil compaction and moisture shows that soil moisture decreases, while air inside pores increases the electrical impedance in the soil. The electrical impedance of soil correlates more to soil moisture content than to the degree of soil compaction [7].

Development and implementation of the remote monitoring techniques of soil moisture usually deal with a global soil moisture observation system based on sattelite data of electrical wave differences between wet and dry conditions of surface soils. The global observation of sattelite-based system may provide a real time-monitoring technique of soil moisture and other parameters (such as temperature, resistivity, and local weather) over large continental regions [8]. However, this system requires advancements in science and technology to validate the wave-based prediction on soil mositure with the actual soil moisture measured manually using the gravimetric method. On the other hand, dielectrical properties of soil such as the electrical impedance, a good geophysical method for soil moisture measurement [7], can be measured using sensors and transferred to sattelites. The use of more accurate electrical impedance as a soil moisture predictor may replace electrical waves for the remote monitoring techniques of soil moisture determination over smaller areas.

This paper aims to report results of previous studies on a dielectric technique of soil moisture measurement using the geophysical method. Results of dielectric measurement hence soil moisture content will be used for the future development of remote techniques on soil moisture monitoring system.

Materials and Methods / Experimental

Dielectrically-measured studies on soil moisture determination were conducted from 2000 to 2011 in several agricultural lands and soil types in Bengkulu Province, Indonesia. A pair of brass-made wire, acting as sensor probes, was inserted into a desire depth of soil profil and connected to an electric-producing digital multimeter as shown in Figure 1. The electrical current was injected from the modified digital multimeter, the current travelled through a 5-cm soil layer in thickness locating between the rubber-free parts of wire, and the impedance values, Z (in ohm), were then read from the multimeter. The measured Z values represent the soil electrical impedance at the depth in wich the rubber-free wires were located.

Conversion of Z values into soil moisture requires the instrument callibration to provide an equation of relating the two parameters. To callibrate the instrument, undisturbed soil samples were taken from corresponding sites at the same depth as for Z measurements. The in-situ procedure of Z measurement was applied to undisturbed soil samples, the weight of samples was measured after Z reading, the samples were then allowed to evaporate. The Z and weight readings were repeated every 24-hours until samples were close to air dry condition, samples were oven-dried for about 48-hours, and the gravimetric soil moisture values (θ_g in g g^{-1}) were then measured conventionally by calculating weight differences between moist and oven-dry soil samples. The Z – θ_g relations of soil samples were analyzed using regression equations, and the best equation resulted from the analysis was used to convert the Z values of in-situ measurements to soil moisture content.

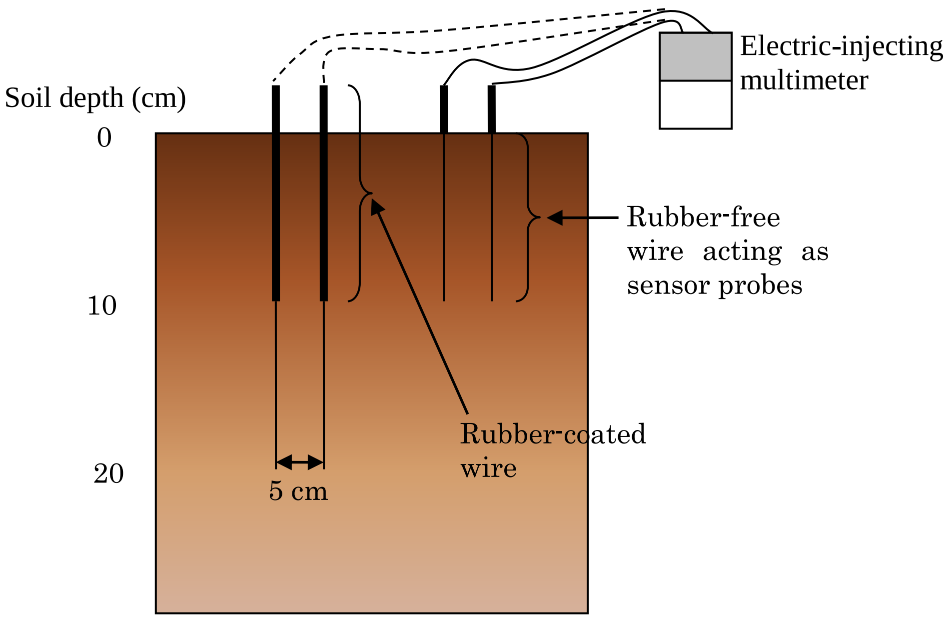

Figure 1. Illustration of in-situ measurements on soil electrical impedance [9]

Results and Discussion

A model for impedance-soil moisture relations

The results of previous studies show that θ_g could be calculated from Z values using a non-linear regression of:

$$\theta_g = aZ^b \quad \textbf{(1)}$$

where constants a and b vary with soil characteristics such as texture, degree of compaction and organic matter content. For a sandy loam soil, constant a ranges from 0.14 to 0.24, whereas the values decrease with increasing soil compaction, while constant b is -0,61. Therefore, equation 1 can be written as:

$$\theta_g = 0.14Z^{-0.61} \quad \textbf{(2)}$$

or

$$\theta_g = 0.24Z^{-0.61} \quad \textbf{(3)}$$

Equation 2 is found for relatively compact soils (bulk density of above 1.0 g cm^{-3}) and Equation 3 for loose soils (bulk density of less than 1,0 g cm^{-3}). The relations between the electrical impedance and soil moisture content as calculated using Equations 2 and 3 are shown in Figure 2.

Equations 2 and 3 give very strong relations between Z and θ_g values (R = 0,98) therefore have been used as a model to determine soil moisture content from the in-situ measured Z values. The model works well to monitor temporal variations in soil moisture in a certain site because it only requires one callibration at the beginning of the measurement. A moisture-monitoring study on a silty loam soil is conducted in bare, peanut and mung bean sites shows good predictions of soil moisture from the measured electrical soil impedance as shown in Figure 3. After callibration, constants a and b of Equation 1 for the study soil are found to be 0.55 and -0.19, respectively, and the electrical impedance measurements are conducted in six consecutive weeks. Higher value of constant a for silty loam than for sandy loam indicates that fine-textured soil has higher moisture content than coarse-textured soil [10]. Results in Figure 3 show that the electrical impedance values are lower hence soil moisture contents are consistently higher for bare soil compared to cropped soils during six-weeks measurements.

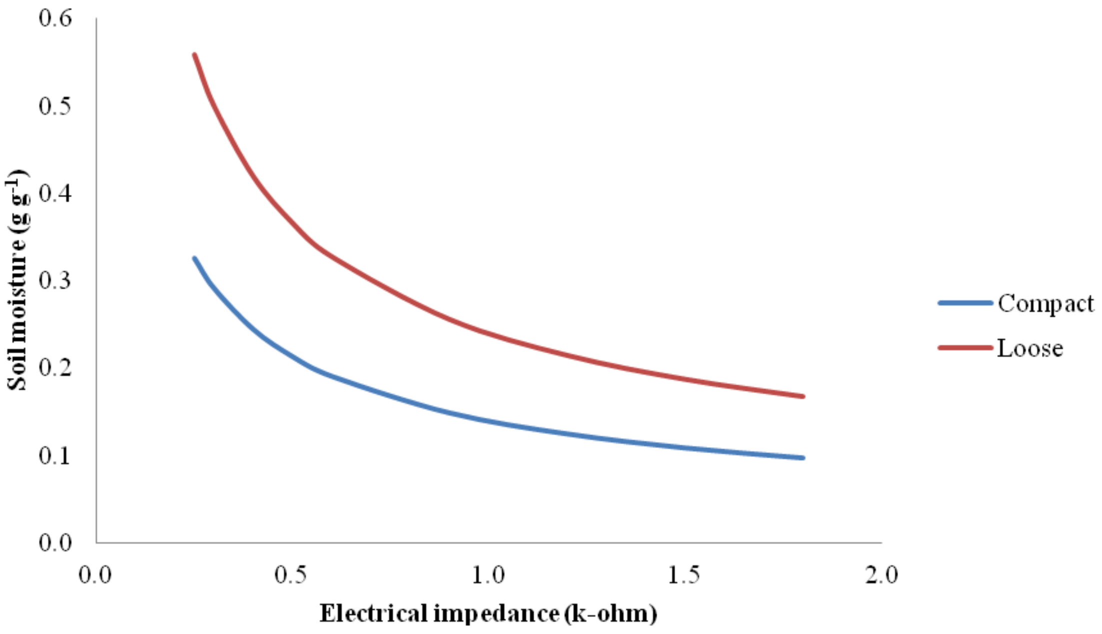

Figure 2. Predicted soil moisture content from the measured sandy loam soil impedance calculated using Equations 2 and 3 for compact and loose soils

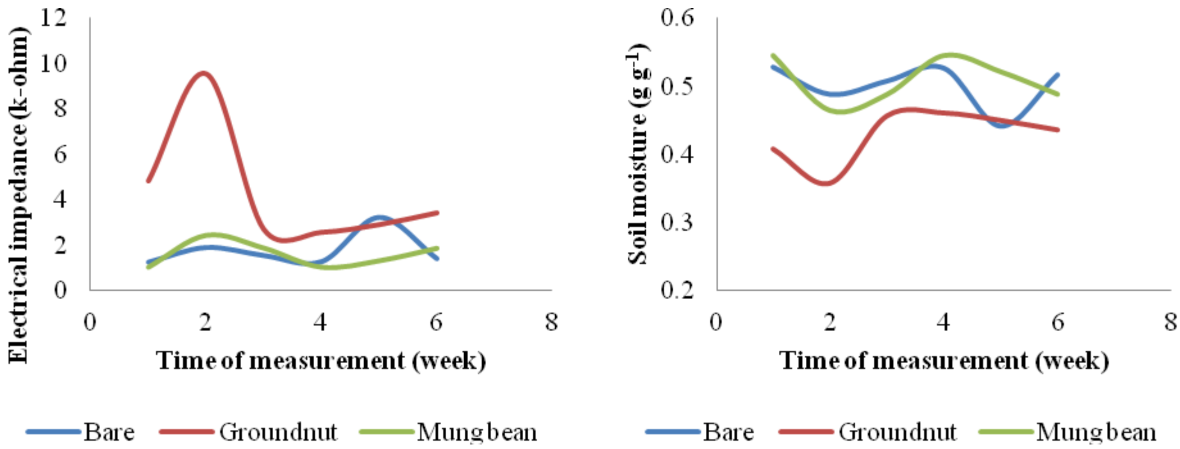

Figure 3. Measured electrical impedance (left) and predicted moisture content (right) of silty loam soil as calculated using Equation $\theta_g = 0.55Z^{-0.19}$

Transmitting Z for remote monitoring techniques of soil moisture

A study on semiarid conditions shows that full irrigation treatment is applied by local farmers and 70-percent treatment needs to be considered as a viable alternative for the development of reduced irrigation strategies where irrigation water supplies are limited [11]. However, reduced irrigation treatment may be accompanied with an appropriate scheduling approach in order to improve water use efficiency. Samania *et al.* (2011) suggest the use of remotely-determined evapotranspirations to schedule irrigation aplication of certain crops [12]. Using information on electrical impedance values collected from the proposed techniques, growers can monitor fluctuations in soil moisture easily as they can make more informed irrigation decisions and increase the efficiency of the water used in agricultural land. The deficit of soil moisture, hence the need for irrigation application can be determined precisely by measuring the soil electrical impedance. The critical electrical impedance values can then be set up to the level in which irigation water may be sprayed out to the field.

For future studies, changes in electrical impedance values as read by the multimeter will be used to develop several remote monitoring techniques of soil moisture. The values may be transmitted into light bulbs with different colours (a traffic light system) to indicate the levels of soil wetness. The bulb colour is set to green when the impedance value equals to the moisture content at field-capacity, is set to red when the impedance close to that of equivalent to permanent wilting point level, and is set to yellow when the electrical impedance is equivalent to that of between field-capacity and permanen wilting point conditions. When the traffic light located in the nearby cropping area changes from green into yellow or red, growers may apply irrigation treatments until it turns back into green (Figur 3). In this case, the use of irrigation techniques that capable of spreading water out uniformly in the cropping area, such as sprinkler irrigation, will be the most appropriate.

Another remote monitoring technique of soil moisture will be developed by transmitting the soil electrical impedance to satellites for a web browser based or mobile phone based data acquisition system as illustrated in Figure 3. Cropping fields will be divided into several sites according to their land characteristics such as slope and soil texture, then used as digitally mapping units. An electrical-measuring sensor device is set in each mapping unit, the electrical impedance values will then be transmitted to satellites and received by computers or hand phones. Field managers and growers may read soil witness conditions anytime and anywhere from their computers or hand phones to make several irrigation descisions.

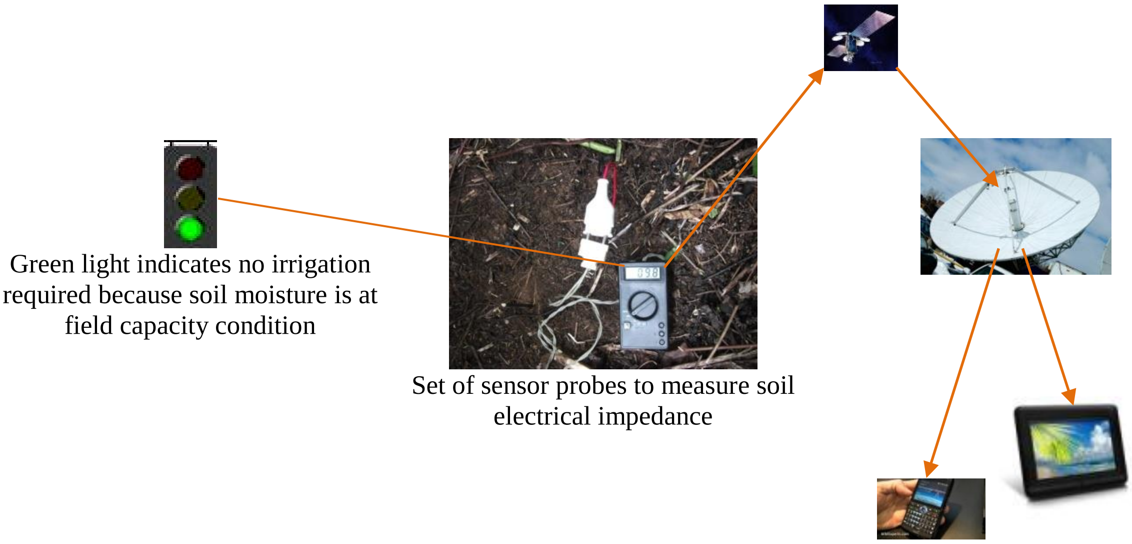

Figure 3. Schematic transmition system of soil electrical impedance values into a traffic light device (left) and satellite (right) to schedule irrigation treatments

Conclusion

Development of remote monitoring techniques of soil moisture can be conducted by measuring the moisture-related electrical impedance of soil and transmit it to remote devices. The relation between soil electrical impedance, Z, and moisture, θ_g, is found to be $\theta_g = aZ^b$, where constant a ranges from 0,14 to 0,55 and constant b from -0,61 to -0,19, depending on soil texture and compaction. Two possible remote devices into wich Z values may be transmitted are a traffic light unit for visual based and satellites for a web browser based or mobile phone based monitoring of soil moisture.

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ANALYSIS OF THE SOIL BEARING CAPACITY FOR SETTLEMENT IN THE CONSTRUCTED AREA IN WETLANDS (CASE STUDY IN SUB-DISTRICT OF MUARA BANGKAHULU, BENGKULU CITY)

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Abstract

Population growth is so fast in Bengkulu city that results in difficulties faced by the people in getting dry land for housing. They turn into wetland (swamp) as an alternative for home construction. Sub-district of Muara Bangkahulu is a development area that will serve as the administrative center of the Bengkulu city. People trend to build houses in the area is very high. This research aims to identify and map the value of the soil bearing capacity in this prospect area. The research was conducted on 18 points spreading on sub-District of Muara Bangkahulu provided for land settlement. The method used in this research is a direct survey on the ground for soil sampling every 1 meter to 3 meter depth and taking the coordinates of the research as well as a test of the soil samples in the laboratory. Results of laboratory tests show soil bulk density values ranged from 0.00159 – 0.00197 kg/cm^3, soil cohesion values between 0.04474 – 1.70296 kg/cm^2 which means a clay soil type and angle of friction soil values between 0,28308 - 22,46766°. Then we calculate the value of the soil bearing capacity in the two conditions, that is lane foundation design with width and depth of 80 cm, the second is square tread foundation design with width and depth of 100 cm. Obtained bearing values allowed for the lane foundation design of < 2.33 kg/cm^2 and for the square tread foundation design of < 3.04 kg/cm^2. Mapping is made in three forms, namely soil type maps, maps of soil bearing power values license for the lane foundation and map soil bearing power license for the square tread foundation.

Keywords: *soil bearing capacity, non engineered structure, wetland*

Introduction

Population growth is so fast in Bengkulu city that results in difficulties faced by the people in getting dry land for housing. They turn into wetland (swamp) as an alternative for home construction. Increased population growth rate demanded the government of Bengkulu City for doing facilities and infrastructure development as facility residents to develop the natural resources and human resources that are inside. Bengkulu city is active to increase economic development and economic. It can be seen from the the regional spatial plan of Bengkulu City dominated for residential area, trade industrial, and offices.

Sub-district of Muara Bangkahulu is a development area that will serve as the administrative center of the Bengkulu city, so that people potential to build houses in the area is very high. Housing construction, the central government and the economic center like the store home is an attempt realization of the regional spatial plan of Bengkulu city is gradually. But the development is going very fast pay less attention to the most important part of building components such as soil. In fact the geological conditions of Sub-district of Muara Bangkahulu consists of deposition of alluvium undak

(Qat), deposition of alluvium (Qa), deposition of swamp (Qs) and deposition of sediment (QTB) which is largely dominated by deposition of alluvium undak and deposition of alluvium. The deposition are soil composed of sand, silt, clay, mud and gravel formed by river sediments, coastal, and swamp. This sediment has a low bearing capacity [1].

In building the house necessary data about the amount of soil bearing capacity in the receiving load. Soil bearing capacity need to know to calculate and plan dimensions of the foundation that can support the load on the structure to be constructed. Therefore, researchers interested in conducting research on soil bearing capacity to residential land in the sub-district of Muara Bangkahulu, Bengkulu City. Results of analysis of soil bearing capacity will then be mapped using geographic information systems (GIS) to facilitate the public in choosing a good location to build that.

Materials and Methods / Experimental

Soil bearing capacity is the amount of ground in accepting loads building in above. To calculate the value of soil bearing capacity, variables we need to know is the content weight soil (γ), soil cohesion (c), soil shear angle (ϕ), depth of the foundation and width of the foundation then multiplied by a factor of bearing capacity N_c, N_q dan N_γ. Soil content weight values (γ), soil cohesion (c), soil shear angle (ϕ) obtained from the results soil investigations in the laboratory, while for the depth and width of foundation in this research using the assumption [2].

In this research, the data used for laboratory investigations are data from the result of land drilling "*handboring*". Land drilling is done to soil depth of 3 meters and soil sampling for laboratory tests conducted every 1 meter.

Material and tools

Research equipment consist of: A set of tools Handboring type "Auger iwan" which is used for soil sampling. Auger iwan, GPS (global position system) which is used to obtain coordinate points, *Direct Shear Test* is used to test the soil samples, *Camera digital* used for documentation of the research process, Stationery used to record the result of observations. Computers are used to process the results of data obtained. The main tool that are used is shown in Figure 1.

Direct Shear dan auger iwan

Figure 1. The main tool used

Procedure research

Take a sampling

Methods used in take a sampling is purposive sampling method which means that determination of the sample with respect to various considerations, the conditions and circumstances of research areas. In this the determination of sample points based on:

1) Observations in the field as a preliminary survey to determine the area and research point with considering the level of soil uniformity.
2) Geological conditions of sub-district of Muara Bangkahulu is dominated by deposition of alluvium railroad (Qat), deposition of alluvium (Qa), deposition of swamp (Qs) and deposition of

sediment (QTB) can be seen in Figure 2 below:

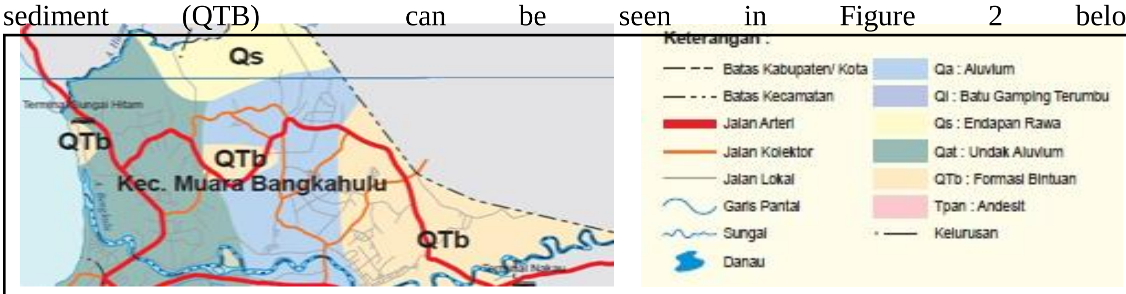

Figure 2 Geological map Sub-district of Muara Bangkahulu

After the field survey with considering to the area, the density of existing houses, land plan that will be built residential houses, then number of sampling points is as much as 18 points.

Before the conducted sampling must first know the location coordinates of the location of the research conducted using GPS. Soil sampling is done in the some point that has been determined using *Handboring*. The sampling stepsl; drilled land use types *handboring* "auger iwan" conducted with handlebar twist. After reaching a depth of 1 meter, *auger* replaced with a tube sampling. Then the samples were taken by pressing the handlebar. Then the tube appointed and is released from the handlebar drill. Both of sides of the tube is closed using plastic to keep the soil samples in the original condition and undisturbed. Repeat these steps the sampling for the depth of 2 meters and 3 meters.

Soil sampling conducted by using the tube after soil samples after soil were drilled using *handboring*. The soil sample taken of soil samples at a depth of and 3 meters of which is the original land or land undisturbed.

Testing of samples

Sample test steps are as follows:

Testing of the soil bulk density

Soil bulk density is the ratio between the weight of the soil with the soil volume. The test steps are as follows; measure the height, inside diameter and weight the sample ring. It is aimed to obtain the volume of soil. Furthermore soil samples inside tubes released using the sample of expenditures tool "*extruder*" and inserted into the sample ring. Then weigh it the sample to obtain weight soil and the next is calculation conducted.

Testing of direct shear

Testing of *direct shear* is intended to get the value of soil cohesion and soil friction angle. The testing procedure is as follows; Measure inside diameter and height of the print ring (D) to the nearest 0.1 mm then weigh heavily of print ring with a precision of 0.01 grams. Then released and print samples from sample tubes using a sample ring, flatten the top and bottom with a knife or wire saws, The next test object is weighed to the nearest 0.01 grams. Released the sliding box from the water bath, and pairs of locking bolt so that the bottom of the shear box and the top it became one. Then enter the rock pores on the bottom of the shear box, released the test object from the mold / ring with a expenditures tool, and then input into the shear box. Enter again the shear box in a water bath and set the position of shear box by tightening the two clamp bolts.

The next step pairs of stone pores on the sample to just above the loading test object and pairs of vertical exemption framework, lift the end of the arm to the framework can be set up in a vertical position. Pairs a dial for vertical movement measurement, set the zero position, and insert the dial to, measurements of horizontal movement and pairs the dial to, horizontal movement measurement, set the dial holder in order to touch the water bath, dial needle at zero position. Saturated test object it by filling tub with water until test object inside pores rocks completely submerged. Furthermore gave the first normal load corresponding to the load the required. Turn the crank driving, so the ground began to accept shear loads. Read proving ring dial and vertical dial every 40 div horizontal dial, to achieve the maximum load or deformation 10% of test object diameter. Repeat testing of twice with double the normal load and tripled normal load first.

Processing data

The data processing to test the sample conducted consists of; soil bulk density calculations, data from *direct shear* test results in the form of soil cohesion value and soil friction angle. Data calculation of the bulk density and *direct shear* the next used for the calculation of soil bearing capacity. Calculation of soil bearing capacity using Terzaghi formula. In addition to a simpler formula, the value of the soil bearing capacity is relatively smaller than other methods, so as can be said to be more secure [3].

After calculating the soil bearing capacity continued by map making the location of soil bearing capacity to be be differentiated in accordance the color and type of the soil by using a Geographic Information System application "ArcGIS 9.3".

Results and Discussion

Direct shear test

Results of testing of *direct shear* were conducted at 18 points in the in the Sub-district Muara Bangkahulu form of value of cohesion (c) the soil friction angle (ϕ). Soil samples were tested in the one point there were 3 that the soil samples at a depth of 1 meter, 2 meter and 3 meter.

Figure 3 describes the relationship between the vertical deformation and horizontal deformation with a large value of the first load of 3.167 kg, second load 6.334 kg and the third load 9.501 kg.

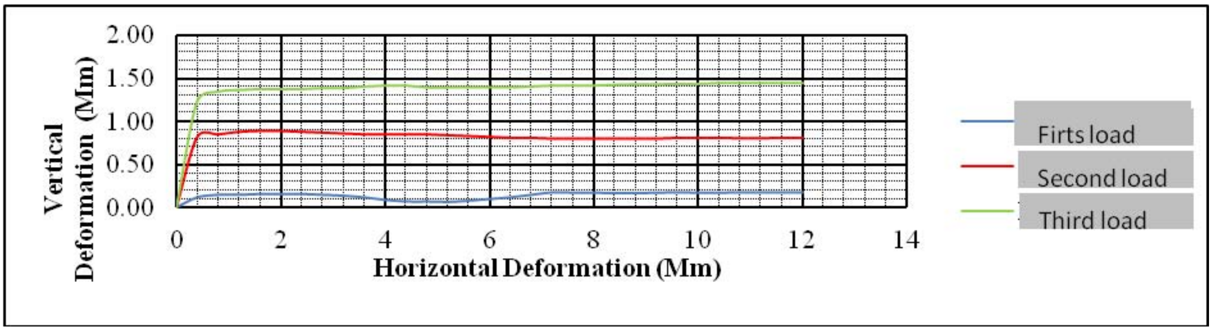

Figure 3. Graph of the relationship between vertical deformation and horizontal deformation

Figure 3 shows that of the three types of loads are used, the third load produces the greatest vertical deformation. Relationship shown between the vertical and horizontal deformation is greater horizontal deformation that occurs then the greater the vertical deformation that would result. In other words, the horizontal deformation is proportional to the vertical deformation. While the relationship between the horizontal deformation with shear stress can be seen in Figure 4 below:

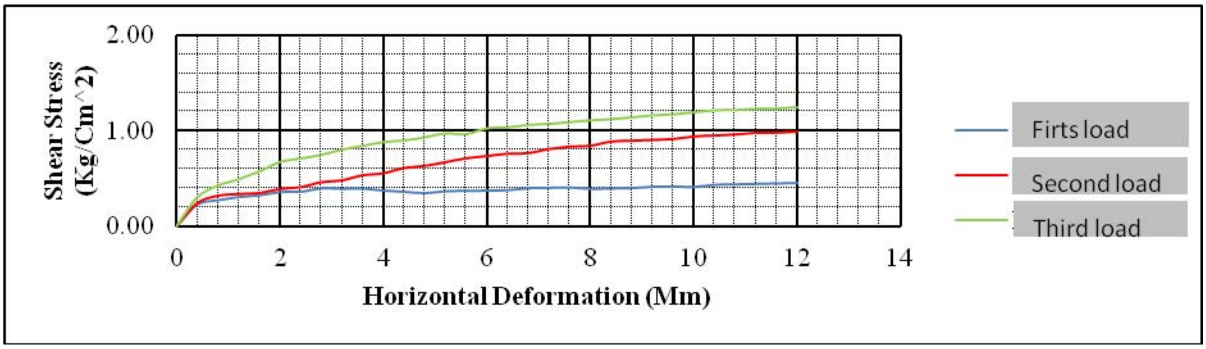

Figure 4. Graph of the relationship between horizontal deformation and shear stress

Figure 4 shows that the third load gives the shear stress value of the greatest. Horizontal deformation is directly proportional to shear stress, which means that the greater the horizontal deformation that occurs the greater the shear stress values obtained. To get the value of soil cohesion (c) and soil shear angle (ϕ), we need to graph the relationship between shear stress and normal stress.

Obtained the value of soil cohesion (c) and soil shear angle (ϕ) as in Table 1. Distribution of data obtained tend to linear, increase the value of the normal stress also lead to increase in shear stress. This indicates that the greater the soil density of shear stress occur also the larger.

Table 1. Result of linear regression calculation to value cohesion (c) and soil friction angle (φ)

Location	c (kg/cm^2)			ϕ (degree)		
	1 meter	2 meter	3 meter	1 meter	2 meter	3 meter
Point 1	0,10541	0,22308	0,08700	21,56700	11,60617	14,24960
Point 2	0,32861	0,55578	0,98356	8,07666	10,95518	8,68575
Point 3	0,49525	0,53505	0,64835	9,94500	3,11088	7,32013
Point 4	0,34916	1,70296	0,69393	1,41514	0,28308	20,37363
Point 5	0,63505	0,98818	1,09029	7,96286	5,92360	5,92360
Point 6	0,33755	1,69637	0,79744	1,98081	1,69802	17,62562
Point 7	0,38168	0,59657	0,17830	2,58479	7,11388	13,19889
Point 8	1,01086	0,98159	0,97171	13,70990	5,92360	10,90666
Point 9	0,37779	0,54227	0,63902	7,61402	1,28439	10,35977
Point 10	0,24824	0,69465	1,04196	12,13311	13,83855	11,01236
Point 11	0,44884	0,56584	0,67807	5,72888	1,76918	2,17123
Point 12	0,26210	0,71384	0,04474	7,60272	8,72772	22.46766
Point 13	0,76679	1,00490	0,49104	21,02708	9,47669	10,18763
Point 14	0,39362	1,24511	1,20287	1,30897	3,39305	9,38597
Point 15	1,36499	0,66922	0,54520	0,47983	1,67413	19,01374
Point 16	1,08101	0,49321	0,96065	0,50015	1,67413	2,10040
Point 17	0,66715	0,38210	0,47023	9,53587	16,25170	6,29155
Point 18	1,60744	0,73882	0,19920	0,56615	4,26572	11,02506

From the Table 1 shows that the value of soil cohesion (c) of the most and the value of the soil friction angle (φ) the smallest found in point 4, while the value of soil cohesion (c) the smallest and the value of soil friction angle (φ) are the greatest at point 12. Value of soil cohesion (c) ranged from 0.04474 kg/cm^2 - 1.70296 kg/cm^2 and the value of soil friction angle (φ) ranged from 0.28308 ° - 22.46766 °.

Bulk density test

Soil samples were weighed and the volume calculated to be able to know the bulk density of soil samples were taken at each point and each depth. From the result of Soil Bulk Density, soil bulk density values obtained ranged from 0,00159 kg/cm^3 – 0,00197 kg/cm^3 with a maximum value of bulk density contained at point 4 at a depth of 3 meters and a minimum value of bulk density contained in point 17 at a depth of 2 meters.

The value of soil bearing capacity

Soil bearing capacity to be calculated is the ultimate soil bearing capacity and the soil bearing capacity is allowed. Factor of the value of bearing capacity that is used is a factor Nc', Nq', and Nγ'. This is because of the results of laboratory *direct shear* test obtained value of soil friction angle (ϕ) < 25°, which means that the type of soil in each 1 meter to 3 meter is a kind of calculation of ultimate soil bearing capacity (qult) at 18 research points as in Table 2.

According to Hardiyatmo [4], the value of bearing capacity secure are determined from the results of ultimate bearing capacity divided by a safety factor prices of useful to provide security to things that the value of soil shear strength obtained very variety from each depth, precision of the value of soil shear strength test, damage to soil when the construction of the foundation that can lead to reduction of bearing capacity.

Table 2. Calculation of ultimate soil bearing capacity (q_{ult})

Location	q_{ult} (kg/cm^2) the lane foundation			q_{ult} (kg/cm^2) the tread foundation		
	1 meter	2 meter	3 meter	1 meter	2 meter	3 meter
Point 1	1,69016	1,62795	1,00970	2,11514	2,09132	1,27061
Point 2	1,88448	3,39177	5,27443	2,43791	4,39009	6,84453
Point 3	2,91041	2,42871	3,38874	3,77001	3,14897	4,39409

Point 4	1,55642	6,71132	6,38142	2,01535	8,71680	8,21461
Point 5	3,41634	4,81764	5,28791	4,42886	6,25125	6,86277
Point 6	1,53705	7,00169	6,32305	1,99009	9,09458	8,16375
Point 7	1,71978	3,05502	1,35941	2,21703	3,94703	1,72263
Point 8	6,67006	4,78654	5,71694	8,63330	6,21085	7,41138
Point 9	2,10151	2,33129	3,76498	2,72000	3,02208	4,87782
Point 10	1,80446	4,77213	6,12825	2,31869	6,16268	7,94585
Point 11	2,28937	2,45413	2,94480	2,96507	3,18216	3,82004
Point 12	1,52415	3,90963	1,16407	1,96977	5,06982	1,43423
Point 13	7,07327	5,52857	2,93193	9,12258	7,17450	3,79623

Continue…

Point 14	1,74161	5,48212	6,56213	2,25545	7,11815	8,51748
Point 15	5,43426	2,85541	4,79750	7,05725	3,70426	6,17200
Point 16	4,32697	2,14677	4,09431	5,61826	2,78295	5,31441
Point 17	3,77061	3,07808	2,41251	4,88872	3,95568	3,12619
Point 18	6,39948	3,42580	1,42357	8,31167	4,44411	1,83060

Based on the consideration that there are then taken the value of safety factor of 3. By dividing the value of ultimate bearing capacity with safety factor price, then soil bearing capacity license can be seen in Table 3.

Table 3. The result of calculation the value of bearing capacity license

Location	**q_a (kg/cm^2) the lane foundation**			**q_a (kg/cm^2) the tread foundation**		
	1 meter	**2 meter**	**3 meter**	**1 meter**	**2 meter**	**3 meter**
Point 1	0,56339	0,54265	0,33657	0,70505	0,69711	0,42354
Point 2	0,62816	1,13059	1,75814	0,81264	1,46336	2,28151
Point 3	0,97014	0,80957	1,12958	1,25667	1,04966	1,46470
Point 4	0,51881	2,23711	2,12714	0,67178	2,90560	2,73820
Point 5	1,13878	1,60588	1,76264	1,47629	2,08375	2,28759
Point 6	0,51235	2,33390	2,10768	0,66336	3,03153	2,72125
Point 7	0,57326	1,01834	0,45314	0,73901	1,31568	0,57421
Point 8	2,22335	1,59551	1,90565	2,87777	2,07028	2,47046
Point 9	0,70050	0,77710	1,25499	0,90667	1,00736	1,62594
Point 10	0,60149	1,59071	2,04275	0,77290	2,05423	2,64862
Point 11	0,76312	0,81804	0,98160	0,98836	1,06072	1,27335
Point 12	0,50805	1,30321	0,38802	0,65659	1,68994	0,47808
Point 13	2,35776	1,84286	0,97731	3,04086	2,39150	1,26541
Point 14	0,58054	1,82737	2,18738	0,75182	2,37272	2,83916
Point 15	1,81142	0,95180	1,59917	2,35242	1,23475	2,05733
Point 16	1,44232	0,71559	1,36477	1,87275	0,92765	1,77147
Point 17	1,25687	1,02603	0,80417	1,62957	1,31856	1,04206
Point 18	2,13316	1,14193	0,47452	2,77056	1,48137	0,61020

From the calculation of ultimate bearing capacity in Table 3 and bearing capacity license in Table 4 can be seen that the value given by the lane foundation with the depth and a width foundation of 80 cm have different results with the values given by the tread foundation with the depth and width of the foundation at 100 cm. It is stated that the amount of soil receiving loads building will be different between the tread foundation and the lane foundation, namely for the lane foundation with a depth of 80 cm and width is able to accept the load of <2.33 kg/cm^2 and for the tread foundation with depth and width at 100 cm is able to accept the load of <3.04 kg/cm^2.

Soil type

The relationship between the value of cohesion with the type of soil, obtained the type of soil at each point of any depth up to a depth of 3 meters. Soil type in 18 research points to a depth of 1 meter, 2 meter and 3 meter can be seen in Table 4.

Table 4. Soil type at 18 points each of the depth research

Location	Soil Type at the Depth		
	1 meter	2 meter	3 meter
Point 1	Very Soft Clay	Very Soft Clay	Very Soft Clay
Point 2	Very Soft Clay	Soft Clay	Medium Clay
Point 3	Soft Clay	Soft Clay	Soft Clay
Point 4	Very Soft Clay	Medium Clay	Soft Clay
Point 5	Soft Clay	Medium Clay	Medium Clay
Point 6	Very Soft Clay	Medium Clay	Soft Clay
Point 7	Very Soft Clay	Soft Clay	Very Soft Clay
Point 8	Medium Clay	Medium Clay	Medium Clay
Point 9	Very Soft Clay	Soft Clay	Soft Clay
Point 10	Very Soft Clay	Soft Clay	Medium Clay
Point 11	Very Soft Clay	Soft Clay	Soft Clay
Point 12	Very Soft Clay	Soft Clay	Very Soft Clay
Point 13	Soft Clay	Medium Clay	Soft Clay
Point 14	Very Soft Clay	Medium Clay	Medium Clay
Point 15	Medium Clay	Soft Clay	Soft Clay
Point 16	Medium Clay	Soft Clay	Medium Clay
Point 17	Soft Clay	Very Soft Clay	Very Soft Clay
Point 18	Medium Clay	Soft Clay	Very Soft Clay

Mapping of soil bearing power license

From the calculation of the soil bearing capacity and the results of taking coordinate points the location of the research, can be described in terms of the soil bearing capacity map. Bearing capacity map is divided into 6 sections (the maps can be described as in Figure 5), namely:

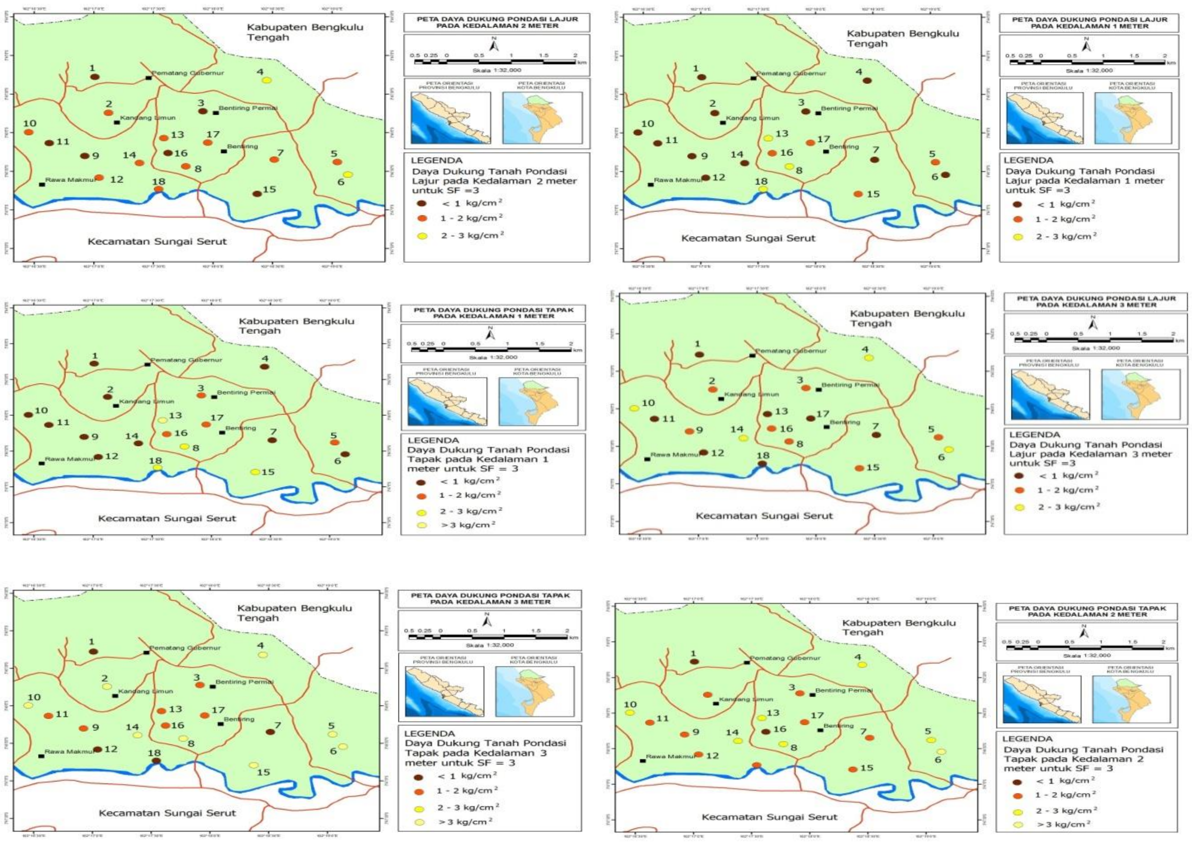

Figure 5. Bearing capacity map of the lane and the tread foundation the depth at 1m, 2 m and 3 m

Conclusion

From the research results the soil bearing capacity for settlement conducted at 18 points in Sub-District Muara Bangkahulu, Bengkulu City, can be some conclusions: the type of soil in Bangkahulu Muara District, the City of Bengkulu at a depth of 1 meter is dominated by very soft clay, at a depth of 2 meters and 3 meters dominated by soft clay. Bearing capacity lanes foundation at a depth of 1 meter can be seen that the value of permits carrying capacity is dominated by the value of <1 kg/cm^2. at a depth of 2 meters of carrying capacity permits carrying capacity is dominated by the value in the range of 1-2 kg/cm^2. While the train was in the Foundations Support a depth of 3 meters clearance of carrying capacity is dominated by the value of the carrying capacity in the range of 1-2 kg/cm^2 and 2-3 kg/cm^2.

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SOIL CARBON STOCK AS AFFECTED CONSERVATION FARMING SYSTEM APPLICATION ON SOYBEAN FARMING

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Abstract

In Indonesia, soil carbon stock is very important managed on dry land that used to cultivate soybean. Conservation farming systems including various village and cropping system can be used to increase soil organic carbon content. The objective of research was to evaluate soil carbon stock on difference stage of soybean growth in various tillage and cropping systems. The research was arranged in randomize block design with 5 (five) treatments and 4 (four) blocks. The treatments were no tillage (NT) with mulch and soybean monoculture (P1); NT with mulch and mixing soybean-corn (P2); minimum tillage (MT) with mulch and soybean monoculture (P3); MT with mulch and mixing soybean-corn (P4); and intensive tillage and soybean monoculture (P5). The blocks were determined based on slope. Data were statistically analyzed with analysis of variance and Duncan New Multiple Range Test (α =0.05). The result of research indicated that on the planting stage, combination of difference tillage and cropping systems effect on soil carbon stock was no significant. Meanwhile, on early vegetative stage, NT with mulch and mixed of soybean-corn was better than conventional farming system to increase soil carbon stock on soybean farming. The result of research indicated that on maximum vegetative stage, NT with mulch and soybean monoculture was better than conventional farming system to increase soil carbon stock on soybean farming.

Keywords: *carbon, conservation, cropping, soybean, and tillage*

Introduction

Soil carbon stock was one of terrestrial carbon stock component and indicator of soil fertility. Amount of soil carbon stock was interdependent with soil type, land cover, and management system [1, 2, 3], and [4]. Dry land has low soil carbon organic content and soil carbon saving capacity. On 0-10 cm depth, carbon stock of dry land was only 20-300 $Mgha^{-1}$ [5]. Whereas, In Indonesia area of dry land are 148 million ha or 78.64% of Indonesia terrestrial areas [6] and then it's potentially used to various using, including agriculture. In Indonesia, farming land is still dominated by dry land now.

In Indonesia, soybean is one of food crop that cultivated on dry land. Demand of soybean increase continuously because it's one of protein sources for community and basic materials of some food industries in Indonesia. But, production of soybean from Indonesia is still low and then Indonesia's soybean demands were largely (69.74%) fulfilled by import [7]. Therefore, Indonesia government determined policy to increase soybean production by increasing of cropping area. Carbon stock on farming land of food crop (for example soybean) is lower than land of plantation because biomass from farming land of food crop (soybean) is lower than land of plantation and it's always accompanied by intensive tillage. Tillage intensity affected on decreasing of soil organic carbon [8]. Therefore, carbon emission from farming land of food crop is higher than plantation land. Furthermore, dry land using for soybean development is predicted caused increasing of carbon emission in Indonesia, too.

Carbon emission from farming land can be reduced by increasing soil carbon stock. Soil conservation techniques can be used to maintain and increase soil organic carbon. On farming land of soybean, no tillage application have caused soil organic carbon content was higher (3.39-3.85%) than intensive tillage application (2.38-2.66%) [9]. Furthermore, no tillage application on farming land of corn caused increasing soil organic carbon content (0.1% every year) [10]. Besides, difference cropping system (corn-soybean rotation, switch grass burned annually, and switch grass burned every 5 years) caused difference soil organic carbon content [11]. Therefore, the objective of research was to evaluate soil carbon stock on difference stage of soybean growth in various tillage and cropping systems.

Materials and Methods of Experiment

Description of experiment plot location

The experiment was conducted at Experiment Field or Teaching Farm Area of Agriculture Faculty in Jambi University. The area of experiment plot is dry land that classified as Ultisol. Before, location of experiment plot was covered by shrub. Bulk density of soil was 1.33 gcm^{-3} and it soil organic carbon was 2.43%. The experiment was conducted at early rainy season.

Materials and tools

The experiment needed tools including mattock and chopping knife to prepare experiment plot, ring sampler and auger to take soil samples at each experiment plot. Besides, in the experiment was needed materials, for examples soybean seed (Petek Variety), manure, an organic fertilizer (Urea, SP-36, and KCl), and weeds (as mulch materials or source).

Experimental design

The research was arranged in randomized block design with 5 (five) treatments and 4 (four) blocks. The treatments of experiment were no tillage (NT) with mulch and soybean monoculture (P1); NT with mulch and mixing soybean-corn (P2); minimum tillage (MT) with mulch and soybean monoculture (P3); MT with mulch and mixing soybean-corn (P4); and intensive tillage and soybean monoculture or conventional farming system (P5). The blocks were determined based on slope. The size of experiment plot was 3m x 4m. Soybean was planted in range 75cm x 20cm (for monoculture cropping) and 40cm x 20cm (for mixing soybean-corn). Corn was planted in range 160cm x 40cm (only on mixing soybean-corn plot). Dosage of manure was 10 $Mgha^{-1}$and applied for every experiment plot. Dosage of mulch was the same as dosage of manure, but it was not applied for all experiment plot (only P1, P2, P3, and P4).

Type and collection method of data

Data collection by experiment including bulk density, soil carbon organic content, and soil carbon stock on planting, early vegetative growth of soybean (a week after planting), and maximum vegetative growth of soybean stage (5 weeks after planting). Therefore, soil sampling was conducted on each stage. Soil sample include disturbed and undisturbed sample.

Data was got by soil sample analysis at laboratory. Soil bulk density was got base on analysis of undisturbed soil sample by gravimetric (ring sample) method. Soil organic carbon content was got base on analysis of disturbed soil sample by wet ashing (Walkey and Black) method. Furthermore, soil carbon stock (SCS) in $Mgha^{-1}$ was calculated based on soil organic carbon content (SOC) in %, soil bulk density (BD) in gcm^{-3}, and soil depth (d) in cm. That is formulated by equation 1.

$$SCS = SOC \ x \ BD \ x \ d \tag{1}$$

Statistical analysis

Data of soil carbon stock on each stage of observation was statistically analyzed by analysis of variance an Duncan New Multiple Range Test on α =0.05.

Results and Discussion

Effect of conservation farming systems on soil carbon stock at planting stage of soybean farming

Difference tillage and cropping systems application on planting stage at farming land affected soil bulk density. Soil compaction as affected no tillage with soybean monoculture and mixed of soybean-corn application was higher than soil compaction on conventional farming system. It’s caused intensive tillage have caused soil become loose. But, on planting stage under soybean farming land, difference tillage and cropping system effect on content of soil organic carbon was no significant (Table 1) because soil organic carbon was affected by plant root and litter on it surface and decomposition, too [12].

Tabel 1. Soil carbon stock as affected conservation farming system application on planting stage of soybean farming at Teaching Farm Area of Agricultural Faculty, Jambi Univesity, 2012.

Treatments	Bulk Density [gcm^{-3}]	Soil Organic Carbon [%]	Soil Carbon Stock [$Mgha^{-1}$]
P1	1.62 d	1.87 a	60.59 a
P2	1.36 c	2.10 ab	57.12 a
P3	1.16 b	2.27 ab	52.66 a
P4	1.13 ab	2.34 ab	52.88 a
P5	1.05 a	2.40 b	50.40 a

Note: P1 = NT with mulch and soybean monoculture; P2 = NT with mulch and mixed of soybean-corn; P3 = MT with mulch and soybean monoculture; P4 = MT with mulch and mixed of soybean-corn; and P5 = intensive tillage and soybean monoculture.
The value that followed with the same alphabet was no significant according to Duncan New Multiple Range test ($\alpha = 0.05$).

The result of research indicated that tillage intensity related to soil bulk density proportionally and related to soil organic carbon inversely. Therefore, conservation tillage effect on amount of soil carbon stock on planting stage of soybean was no significant (Table 1). Soil carbon stock was affected by crop that planted on surface of soil [2] and dynamic and turnover of soil carbon organic as affected tillage need long time [13].

Effect of conservation farming systems on soil carbon stock at early vegetative growth of soybean stage

The early vegetative growth of soybean is on a week after planting. The result of research showed that on this stage, application of tillage and cropping system conservation, especially no tillage with mulch and monoculture and multiple cropping systems affected on soil bulk density. But, effect of conservation and conventional farming system application was no significant on soil organic carbon content (Table 2). It means, in short time or one week, no tillage was only effect on soil bulk density, but it effect on soil organic carbon was no significant. The result of research on rubber farming land at Batang Bungo Watershed have showed that difference soil organic carbon content under various age of rubber [4].

Tabel 2. Soil carbon stock as affected conservation farming system application on early vegetative growth of soybean stage at Teaching Farm Area of Agricultural Faculty, Jambi Univesity, 2012.

Treatments	Bulk Density [gcm^{-3}]	Soil Organic Carbon [%]	Soil Carbon Stock [$Mgha^{-1}$]
P1	1.81 b	1.78 a	64,44 ab
P2	1.79 b	2.17 a	77.69 b
P3	1.48 ab	2.12 a	62.75 ab
P4	1.54 ab	2.08 a	64.06 ab
P5	1.22 a	1.96 a	47.82 a

Note: P1 = NT with mulch and soybean monoculture; P2 = NT with mulch and mixed of soybean-corn; P3 = MT with mulch and soybean monoculture; P4 = MT with mulch and mixed of soybean-corn; and P5 = intensive tillage and soybean monoculture.
The value that followed with the same alphabet was no significant according to Duncan New Multiple Range test ($\alpha = 0.05$).

Condition of soil bulk density and organic carbon on early vegetative growth ~~was~~ affected on soil carbon stock. The result of research showed that conservation farming system (especially no tillage and mixed of soybean-corn) application caused soil organic carbon was higher than soil carbon stock under the other conservation farming system and conventional farming system (Table 2). On early vegetative stage of soybean, no tillage with mulching and mixed of soybean-corn application caused land coverage was better and then oxidation of organic carbon was lower and there are chance of organic carbon addition by mulch decomposition. The result of research have showed that soil organic carbon content as affected no tillage and mulching (3.39-3.85%) was higher than intensive tillage and soybean monoculture (2.38-2.66%). Besides, multiple cropping system caused root and soil microorganism activities was more intensive [9]. Intensive activity of crop root affected on soil organic carbon [12].

Effect of conservation farming systems on soil carbon stock at maximum vegetative growth of soybean stage

On maximum vegetative stage, conservation farming system (no tillage with mulch and soybean monoculture) application affected on soil bulk density. But, on the same stage, difference tillage and cropping effect on soil organic carbon was no significant. Therefore, only no tillage with mulch and soybean monoculture application that showed difference effect on soil carbon stock with conventional farming system (Table 3).

Tabel 3. Soil carbon stock as affected conservation farming system application on maximum vegetative growth of soybean stage at Teaching Farm Area of Agricultural Faculty, Jambi Univesity, 2012.

Treatments	Bulk Density [gcm^{-3}]	Soil Organic Carbon [%]	Soil Carbon Stock [Mgha^{-1}]
P1	1.70 c	2.44 a	82.96 b
P2	1.30 b	2.35 a	61.10 a
P3	1.25 ab	2.25 a	56.25 a
P4	1.24 ab	2.48 a	61.50 ab
P5	1.06 a	2.49 a	52.79 a

Note: P1 = NT with mulch and soybean monoculture; P2 = NT with mulch and mixed of soybean-corn; P3 = MT with mulch and soybean monoculture; P4 = MT with mulch and mixed of soybean-corn; and P5 = intensive tillage and soybean monoculture.
The value that followed with the same alphabet was no significant according to Duncan New Multiple Range test (α = 0.05).

Land clearing and plant growth of soybean stages affected on nutrient cycle and soil conservation techniques effectiveness. The result of research showed that difference tillage and cropping system affected on soil carbon stock under various stages of soybean farming management. The research about difference age of oil palm and rubber impact on soil carbon showed the same phenomenon, too [14] and [4]. Besides, the result of research on timber estate of Acasia showed that time period affected on soil carbon stock [15].

Conclusion

On planting of soybean stage, there is no significant effect of difference tillage and cropping system on soil carbon stock. But, on early vegetative growth of soybean stage, soil carbon stock under no tillage with mulch and mixed of soybean-corn was different with soil carbon stock under the others tillage and cropping systems. Furthermore, on maximum vegetative growth of soybean stage, the amount of soil carbon stock under no tillage with mulch and soybean monoculture was higher than soil carbon stock under the others. Based on result of research, the maintaining and increasing of soil carbon stock on soybean farming land can be reached by no tillage with mulch and monoculture or multiple cropping system.

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INITIAL DETECTION OF SENSITIVITY OF UPLAND RICE CULTIVARS UNDER ALUMINUM STRESS

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Abstract

Many factors may be responsible to the limited productivity of upland rice such as, its genetic potential and soil fertility problems. The area of upland-field is usually dominated by ultisol soil which characterized by low nutrients, high acidity and high exchangeable aluminum. Therefore, the use of high quality seeds which especially aluminum tolerance can be regarded as the most appropriate approach to improve the yield of upland rice. The objective of this study was to evaluate the aluminum sensitivity of upland rice cultivars collected in Bengkulu. Research was conducted in the laboratory and greenhouse of the Agronomy Department, the University of Bengkulu from December 2010 to April 2011. Both studies were arranged in a completely randomized design with three replications of each. Seven local cultivars evaluated were Abang Pintal, Bunga Macang, Kancil, Segadang, Kijang, Sedane, and Gemulai. In the first experiment, seeds were germinated in the petridish using germinating paper as a growth media and treated with aluminum at 0.0, 1.0, 2.0, 4.0, and 8.0 mM. Data of germination rates, sprout and root length were collected 2 weeks after germination. The same varieties were also grown in 250-ml plastic pots using ultisol soil as a growth media. Before planted, the media were saturated with aluminum solution at 0.0, 0.5, 1.0, 1.5, and 2.0 mM. The plants were maintained in greenhouse. Data of plant height, shoot and root dry weight were collected at 4 weeks after planting. Data observed were analyzed by analysis of variance and the means were separated by Duncan's multiple ranged test. Based on the root growth of germination experiments, Bunga Macang, Segadang and Gemulai cultivars performed aluminium tolerance or unsensitive to aluminum up to 4.0 mM. However, based on root and shoot dried weight of seedlings, Abang Pintal and Kancil cultivars performed aluminum tolerance or unsensitive to aluminum at 2.0 mM.

Key words: *aluminum, cultivars, tolerance, upland rice.*

Introduction

One constraint in development of upland rice is the availability of high quality of seeds. In Bengkulu province, there are many type of upland rice cultivar grown by the farmer [1]. These cultivars have been able to adapt with local environment and climate. A reason to grow a certain cultivar continously is because the rice it grows has a delicious taste and good aroma. In an early study, 42 local cultivar of upland rice have been collected in the province of Bengkulu [2]. Although local cultivars have sufficiently adapted with local environment in the past, its productivity still remain low. In Indonesia the average production of upland rice is 2.56 ton ha^{-1} where this is far below the production of irrigated rice, 4.78 ton ha^{-1} [3].

Effort to increase upland rice productivity can be done through an exstensification program [4]. The area of dry land which has not been managed in Indonesia yet has reached 35 million ha. This area can become potent for growing upland rice. The widest areas lies in Sumatra Island, Kalimantan, Sulawesi, and West Irian [4]. Dry land which has not been exploited yet is dominated by ultisol soil. In Bengkulu province, 14.3 % from 1,978,870 ha of dry land's soil is ultisol [5]. Some characteristics of ultisol soil are low pH, low capacities to convert cation, saturated of low base, low content of nutrients like N, P, K, Ca, and Mg [4]. In ultisol soil with low pH, some elements like aluminum (Al), manganese (Mn), and iron (Fe) will become toxid to crops. The elements can adsorp nutrients, especially P (phosfor), potassium (K), sulphur (S), magnesium (Mg), and molybdenum (Mo). Hence, that not available to permeated by crop roots [6,7]. If dry land's constraints can be overcome by conducting agronomic techniques and is also supported by the available of pre-eminent seeds, the potency of dry land will help rice production reach its national target [4].

Breeding genetic materials of crops to get pre-eminent seeds should be done in order to increase crop adaptation. Genetics of upland rice that will able to grow at ultisol soil ought to adapt in the situation with extremely high aluminum content [8]. Effort in repair of genetics can be done by exploration, collection and selection of various upland rice cultivar in order to develop aluminum tolerant cultivar. In general, upland rice cultivars are sensitive to aluminum [9]. High content of aluminum have negative effect to the the growth and production of upland rice. The presence of aluminum at 50 ppm in the growth medium may inhibit root growth [6], or damage to root system including the resistant varieties [10,11]. Root damage also reported in other crops such as corn and wheat [12,13].

The symptom in the early growth of tomato affected of aluminum were depression of root growth, chlorosis, deficiencies of nutrients [14]. As a result, crops will become smaller. The major symptom of aluminum toxicity is destroying the growth of root because crop damages by aluminum were found more predominant in parts of root compared to shoot [13, 15, 16]. Other researchers reported the sympthom of aluminum to root such as growing short, thick, reddish or tan and damage of root caps [12]. Aluminum toxicity is one of the major limitation of crop production in dry acid land especially in tropical region [4,6].

There are two mechanism of crops that hinder aluminum toxicity. Firstly, an external mechanism called expulsion of aluminum. The other is an internal mechanism which is the ability of crop physiologically to neutralize aluminum [6,17]. The internal mechanism is related to the presence of organic compound in crop such as oxalat, cittrate, malat, several types of protein, and fenolics which capable to detoxify aluminum [14]. Crops capable to adapt at high aluminum concentration because of the crops have a molecular mechanism to depress the toxic influence of aluminum so there's no disturbance upon the absorption of nutrients, water, and inhibition of aluminum absorbtion and translocation through the crop [10].

Evaluation of crop responces to aluminum at the germination phase or in the early growth can predict the nature of crop tolerance to aluminum. This matter shorten the time of selection to look for more tolerant cultivar. The objective of this experiment is to select the aluminum tolerance at the early growth of upland rice cultivars collected in Bengkulu.

Materials and Methods

Researches to detect aluminum tolerant of upland rice cultivars collected in Bengkulu were conducted in two stages. These researches were is in the laboratory and greenhouse of the Department Agronomy, Faculty of Agriculture, the University of Bengkulu from December 2010 to April 2011. Seven local cultivars of upland rice collected in Bengkulu province in 2009 were used as genetic materials which were Abang Pintal, Bunga Macang, Kancil, Segadang, Kijang, Sedane, and Gemulai [2]. The second factor is aluminum (Al^{3+}) which consist of 5 concentration levels that were 0.0, 1.0, 2.0, 4.0, and 8.0 mM. Further, the experiments at early growth in greenhouse, aluminum concentratations were 0.0, 0.5, 1.0, 1.5, and 2.0 mM. There were 35 treatment combinations in each experiments. Both experiments were arranged in completely randomized design (CRD) and repeated 3 times.

Germination test

Two layers of germination paper which were used as growth media were placed on petridish (diameter of 10 cm). Five seeds of each cultivar of upland rice were planted on the paper media then saturated by 5 ml aluminum solution ($AlCl_3.6H_2O$) at a concentration as according to each treatment. After planting, the petridishes were covered by its lids and placed in the germination room. Humidity inside the petridishes were maintained by media sprayed with water daily. Growth of seeds were observed visually and data of germination rates, root length, and sprout length were collected at 2 weeks after planting. Data were analyzed statistically with analysis of variance (ANOVA) and the means were separated by Duncan's multiple range test (DMRT) at 5 percent.

Seedling growth

The media used for seedling growth is soil of ultisol type. Soil was ground and air dried, sieved at diameter up to 2.0 µm. One day before planting, 200 gram of soil were filled into each of 250 ml plastic pots. Three upland rice seeds were planted into the soil media of each pot with 2 cm deepness. Furadan 3G was added into plant hole to prevent the seeds from insect. Then, the seed holes were covered with soil and arranged in greenhouse by completely randomized design. Then the soil in each pot was saturated with aluminum solution as according to a concentration of each treatment. Seedlings were arranged in greenhouse and maintained based on the standard maintanence in the greenhouse experiments such as, watering as needed, weed control and pest control. Data were collected at 4 weeks after planting including seedling height, root dry weight, and shoot dry weight. Additional data of soil media were analyzed for pH, Al-exchangeable. Data were analyzed statistically by ANOVA and means of each treatment were separated by DMRT at 5 percent.

Result and Discussion

Germination test

Aluminum treatments have affected seed germination of upland rice cultivars collected in Bengkulu province. Visual observation indicated that increasing aluminum up to 8.0 mM will progressively affect the abnormalmality of germination seeds **(Figure 1)**. With the treatment at 8.0 mM aluminum, roots grew below abnormal, short, rust colored (chlorosis), dwindle like burnt, and run dry so that finally die **(Figure 1).**

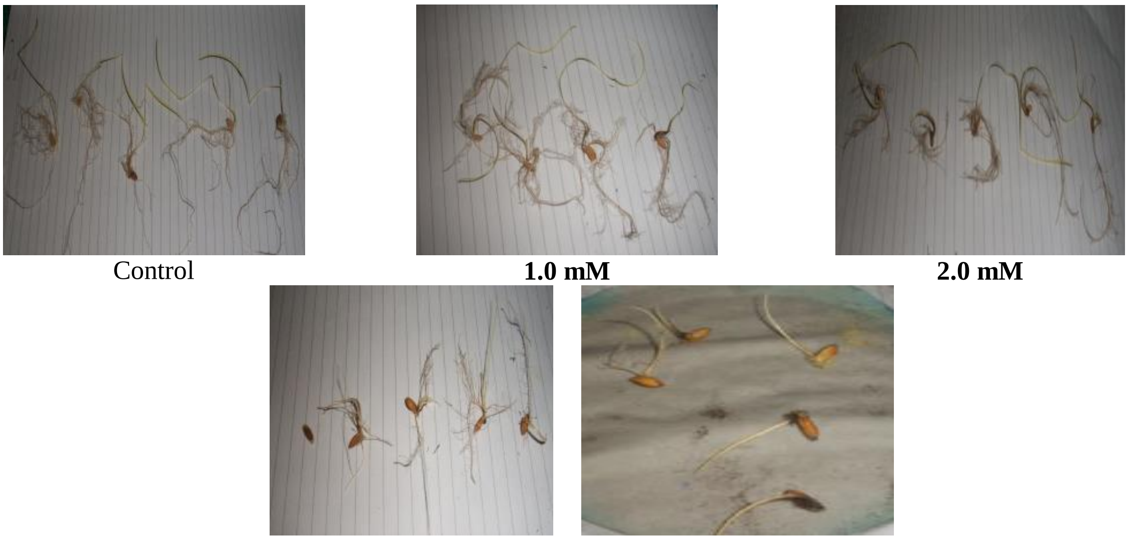

Figure 1. Germination of upland rice seeds of cultivar Abang Pintal with various concentration of aluminum at paper media in petridish.

Saturation of aluminum solution at germination media showed negative effect on germination rate, length of sprout and root. Data of germination rates, length of root and sprout were depicted in graph. Without treatment or control, the germination rate of cultivar Gemulai and Kancil were smaller than 60 percent and these rates were different from other cultivars. By increasing aluminum concentration, the germination decreased to all of tested cultivars. Treatment with 4.0 mM aluminum decreased the germination to 80 percent, and treatment with 8.0 mM aluminum decreased the germination to 60 percent **(Figure 2).**

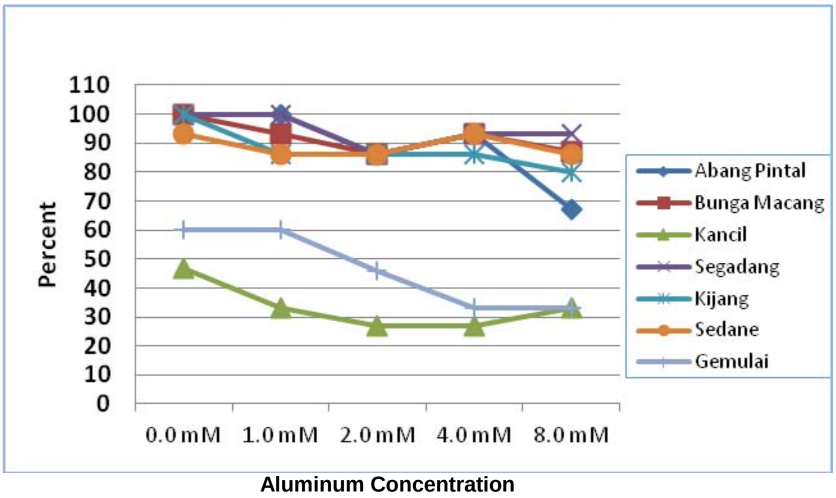

Figure 2. Response of germination rates of upland rice cultivars to different aluminum concentration at 2 weeks.

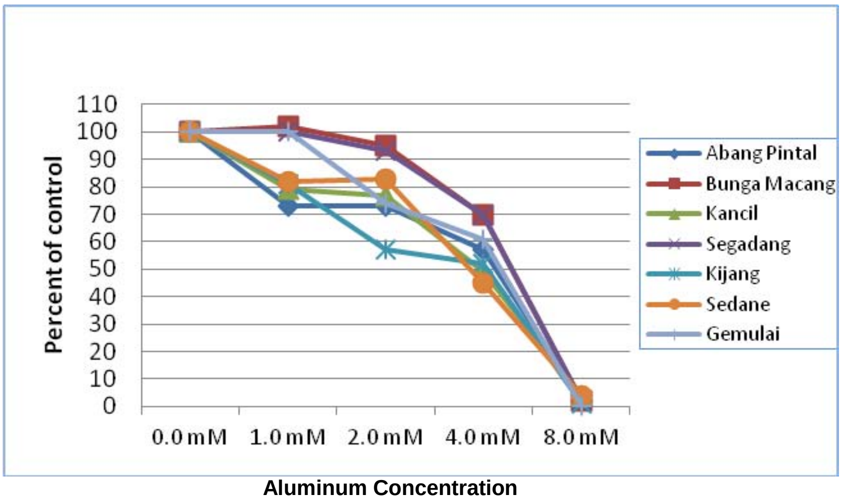

Figure 3. Response of roots lenght of sprout of upland rice cultivars to different aluminum concentration at 2 weeks.

Figure 3 and 4 described the influence of aluminum to the length of root and sprout at 2 week after planting, respectively. Growth of root tend to be more sensitive compared to sprout. Root grew till 4.0 mM aluminum, but at 8.0 mM the root became abnormal and oftenly died. At 4.0 mM aluminum, the root of some cultivars still grew more than 50 percent of control including cultivar of Bunga Macang, Segadang, Gemulai, and Abang Pintal **(Figure 3)**. Different from root, the lenght of sprout of cultivar Kancil, Sedane, Kijang, Bunga Macang, and Gemulai still grew more than 50 percent of control at 4.0 mM aluminum. However, at 8.0 mM the sprout grew lower than 50 percent of control **(Figure 4).**

Seven tested cultivar had been selected and grew well at the field of ultisol soil (pH 4.6 and exchangebale aluminum 5.20 ppm) [2]. These cultivars were clustered to a high productivity group (> 3.8 ton ha^{-1}). The pattern of graph in **Figure 3 and 4** indicates that these seven cultivars were aluminum tolerant because crop response did not show sensitivity at the lowest concentration (1.0 mM). The growth of root can be used as an early indicator for the selection of the most tolerance crop [12]. At a certain aluminum concentration, the greater root length identified that the crop is more tolerant progressively to aluminum [12,15,16].

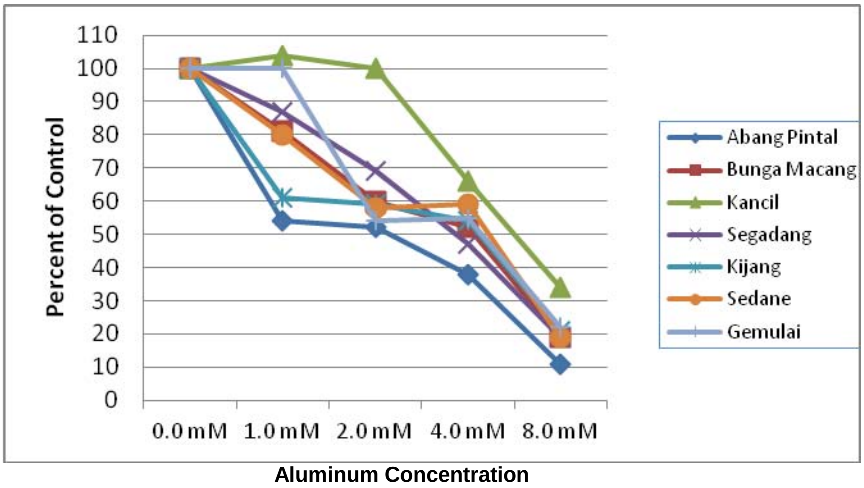

Figure 4. Response of shoot lenght of sprout of upland rice cultivars to different aluminum concentration at 2 weeks.

Each cultivar or crop species have a different reaction to aluminum concentration. This research indicates that some of cultivar still be tolerant in the growth of sprout and root more 50 percent at 4.0 mM aluminum. Previous researchers reported that aluminum at 5.0 mM still pursue growth of paddy root more than 50 percent [10,11].

Seedling growth

Aluminum concentration in this experiment was adjusted for ability of tested cultivar to grow well under the soil media of ultisol and greenhouse condition. Visual observation indicated that saturated of aluminum to the soil media affected the growth of upland rice. Statistical analysis indicated that seedling height, root, and shoot dry weight showed different responses to saturated treatment of aluminum. Result of DMRT test were presented at **Tables 1**, **2**, **and 3**.

Seedling heights at 4 weeks were decreased significantly by increasing aluminum concentration **(Table 1)**. The effects were also different among the examinee cultivars. The data of seedling height were converted to percentage of control. The more tolerant cultivar at 2.0 mM aluminum were Segadang, Abang Pintal, and Kancil where seedling height can still reach 48, 46, and 42 percent of control, respectively while sensitive kultivar such as Kijang, Gemulai, Bunga Macang, and Sedane experienced a height drop to 26, 16, 9, and 8 percen of control, respectively. Also, seedling height at early growth can be used as an indicator of aluminum tolerance. This was anticipated because crop have experienced of injury due to aluminum at the time of early germination.

Injury and stress from aluminum at the early growth may affect on root and shoot biomass. The existence of aluminum at low pH can adsorp essential nutrients to hinder absorbtion of root [9]. Degradation of root dry weight differenciate significantly among examinee cultivars **(Table 2).** At 2.0 mM aluminum, root dry weight of cultivar Abang Pintal, Kancil, Kijang and Gemulai grew more than 50 percent of control. However, Bunga Macang, Sedane and Segadang only grew less than 50 percent of control **(Table 2)**. Dry weight of root biomass also can be used as an indicator to evaluate the nature of aluminum tolerance [9]. Shoot dry weight also showed similar pattern of responce with root dry weight. Shoot dry weight of cultivar Abang Pintal, Kancil, and Segadang were not different between aluminum at 2.0 mM and control **(Table 3).**

This research indicates that the difference of aluminum tolerance of upland rice cultivar were able to be detected since germination and also at an early stage of seedling. This matter has been explained previously by [6,13]. They expressed that sensitivity of crop varietas to negative influence of aluminum was different at the early stage of growth. The difference of sensitivity level between research in laboratory and greenhouse is probably due to the difference of growth medias and environmental factors. In laboratory experiment, the media and environmental factors were more in control. In greenhouse, the media was the ultisol soil (pH 4.4 and exchangeable aluminum 5.29) with diverse environment factors (temperature and humidity). Temperature, humidity, nitrate content, and existence of organism also influenced crop responces to aluminium [6,14].

Conclusion

1. Cultivar tested were able to germinate more than 50 percent at 8.0 mM aluminum.
2. Cultivar of Bunga Macang, Segadang, and Gemulai were aluminum tolerance indicated by the growth of root lenght at 4.0 mM aluminum which were 70, 70, and 61 percent of control, respectively; while based on sprout length, cultivar Kancil, Sedane, and Gemulai were aluminum tolerance indicated with the sprout length at 4.0 mM aluminum which were 66, 59, and 55 percent of control, respectively
3. Cultivar of Segadang, Abang Pintal and Kijang were aluminum tolerant in ultisol media indicated by the shoot lenght of seedling in 2.0 mM aluminum which were 48, 46, and 42 percent of control, repectively. Cultivar of Abang Pintal and Kijang were nature aluminum tolerant because root and shoot dry weight of seedlings were not different significantly from control at the treatment of 20 mM aluminum.

Tabel 1. Response of seedling height of upland rice cultivars to different aluminum concentration at 4 weeks after planting *

Cultivar	Seedling height at :				
	Control	5.0 mM	1.0 mM	1.5 mM	2.0 mM
	-------------- cm / plant (*percent of control*) ----------------				
Abang Pintal	31.36 ^{abc}	19.30 ^{ghi}	20.23 ^{ghi}	11.60 ^{mno}	14.46 ^{jkl}
	(100)	*(62)*	*(65)*	*(37)*	*(46)*
Bunga Macang	28.33 ^{abc}	25.46 ^{cde}	21.56 ^{fgh}	14.56 ^{jkl}	2.63 ^{q}
	(100)	*(90)*	*(76)*	*(51)*	*(9)*
Kancil	25.83 ^{bcd}	21.03 ^{fgh}	20.96 ^{fgh}	10.86 ^{nop}	10.96 ^{nop}
	(100)	*(81)*	*(81)*	*(42)*	*(42)*
Segadang	28.83 ^{abc}	22.10 ^{fgh}	18.73 ^{ghi}	15.66 ^{ijk}	13.73 ^{klm}
	(100)	*(77)*	*(65)*	*(54)*	*(48)*
Padi Kijang	35.00 ^{a}	21.33 ^{fgh}	12.70 ^{lmn}	11.00 ^{nop}	8.96 ^{opq}
	(100)	*(61)*	*(36)*	*(31)*	*(26)*
Sedane	33.33 ^{ab}	22.63 ^{efg}	16.76 ^{hij}	15.36 ^{ijk}	2.80 ^{q}
	(100)	*(68)*	*(50)*	*(46)*	*(8)*
Padi Gemulai	31.90 ^{abc}	23.86 ^{def}	16.30 ^{hij}	9.93 ^{opq}	5.00 ^{qp}
	(100)	*(75)*	*(51)*	*(31)*	*(16)*

* Numbers which following by the same letters showed no difference at DMRT 5%

Tabel 2. Response of root dry weight of upland rice cultivars to different aluminum concentration at 4 weeks after planting *

Cultivar	Root dry weight at :				
	Control	0.5 mM	1.0 mM	1.5 mM	2.0 mM
	-------------------- (gram / plant) -----------------------				
Abang Pintal	0.43 ^{ijk}	0.46 ^{ijk}	0.47 ^{ij}	0.39 ^{ijk}	0.46 ^{ijk}
Bunga Macang	0.49 ^{i}	0.45 ^{ijk}	0.47 ^{ij}	0.45 ^{ijk}	0.11^{q}
Kancil	0.43 ^{ijk}	0.46 ^{ijk}	0.46 ^{ijk}	0.45 ^{ijk}	0.41^{ijk}
Segadang	0.41 ^{ijk}	0.33 ^{lmn}	0.31^{nop}	0.34 ^{lmn}	0.23 ^{p}
Padi Kijang	0.42 ^{ijk}	0.38 ^{jkl}	0.32 ^{mno}	0.33 ^{lmn}	0.34 ^{lmn}
Sedane	0.36 ^{klm}	0.36 ^{klm}	0.37 ^{jkl}	0.24 ^{op}	0.13 ^{pq}
Padi Gemulai	0.36 ^{klm}	0.39 ^{ijk}	0.36 ^{klm}	0.37 ^{jkl}	0.31^{nop}

* Numbers which following by the same letters showed no difference at DMRT 5%

Tabel 3. Response of shoot dry weight of upland rice cultivars to different aluminum concentration at 4 weeks after planting *

Cultivar	Shoot dry weight at : Control	0.5 mM	1.0 mM	1.5 mM	2.0 mM
		------------------	(gram / plant)	-------------------	
Abang Pintal	0.28 jkl	0.22 klm	0.22 klm	0.21 lmn	0.20 lmn
Bunga Macang	0.31 jk	0.24 klm	0.20 lmn	0.20 lmn	0.15 nop
Kancil	0.20 lmn	0.19 lmn	0.20 lmn	0.28 jkl	0.28 jkl
Segadang	0.29 jkl	0.24 klm	0.23 klm	0.22 klm	0.21 klm
Padi Kijang	0.33 j	0.21 klm	0.24 klm	0.28 jkl	0.20 lmn
Sedane	0.29 jkl	0.21 lmn	0.16 nop	0.18 mno	0.12 pq
Padi Gemulai	0.28 jkl	0.21 klm	0.14nop	0.09 q	0.13 opq

* Numbers which following by the same letters showed no difference at DMRT 5%

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THE EFFECTIVENESS OF *Metarhizium anisopliae* AND *Nomuraea rileyi* EXTRACT TOWARDS *Spodoptera litura* ON LABORATORY SCALE

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Abstract

This preliminary research was conducted to determinate the pathogenicity of Indonesian local isolates entomopathogenic fungi: *Metarhizium anisopliae* and *Nomuraea rileyi* against *Spodoptera litura* larvae on laboratory scale. The bioassay was designed by employing two methods of infection: sprayed and dipped methods. Both *M. anisopliae* and *N. rileyi*-crude extracts harvested from *Czapex-Dox* media could suppress 100% larvae in 12 days exposure time by using sprayed method. This research hopefully can be further researched towards different species of pest insects in order to provide the more through study.

Keywords: *Entomopathogenic fungi*, *Spodoptera litura*, *spayed and dipped methods*

Introduction

Spodoptera litura is one of the important agricultural pest in Indonesia. In contrast to *Plutella xylostella* that only attack crop plants belong to familia Brassicaceae, *S. Litura*'s larvae is polyphagus, which attack broader spectrum of crop plants such as tobacco, legumes, peppers, sweet potatoes, onions, cabbages, soybeans, green beans, and corn [1,2]. According to Marwoto and Suharsono [3], the infection of this pest can cause by 80% of economic loss on soybean only. Therefore, various methods which is eco-friendly to control this pest is essential to be studied.

One approach which is eco-friendlier to the enviroment than by applying inorganic pesticides is by using bio-control agents. The utilization of bio-control agents such as microorganisms has started to develop the last few decades in developed countries such as Japan and the United States. They established entomopathogenic fungi as bio-control agents upon termite and beetle populations since these organisms have the potential for controlling pest insects [4].

Some species of entomopathogenic fungi are *M. anisopliae* and *N. rileyi*. *M. anisopliae* has been reported to be effective to kill larva of *S. litura* by adjusting several factors such as types of media for sporulation, conidial density, the frequency of application, larval stages, the storage methods and the lifespan of fungi culture [2]. High pathogenicity of *N. rileyi* against *S. litura* also was pointed out by Padanad and Krishnaraj [5] whereas 10 isolates of the fungus was able to kill the 3rd larval stage of *S. litura* by up to 85-97%.

Highlighting the importance of studying entomopathogenic fungi as the future of a pest control method which is safer to the enviroment, research with topic about is an essential matter. This preliminary research has a purpose to determine briefly the pathogenicity of Indonesian isolates entomopathogenic fungi: *M. anisopliae* and *N. rileyi* to control *S. litura* larvae on laboratory scale. This study is expected can initiate the efforts in addressing pest insect infestation on crop plants.

Materials and Methods / Experimental

Fungal strain and submerged fermentation

M. anisopliae and *N. rileyi* was obtained from Microbial Culture Collection, Indonesian Institute of Sciences. The fungal strains were cultured in Czapex-Dox (CD) media. Three hundreds mililiter of the media was charged with 50 ml autoclaved Czapex-Dox liquid medium (KH_2PO_4, 0.5g/L; $MgSO_4.7H_2O$, 0.5 g/L; KCl, 0.5 g/L; $CaCl_2.2H_2O$, 0.1 g/L; and $NaNO_3$, 3 g/L). This media were prepared with different compositions of glucose and yeast extract as carbon and nitrogen sources (CN1 = 30 g/l glucose + 0 g/l yeast extract; CN2 = 25 g/l glucose + 5 g/l yeast extract; CN3 = 20 g/l glucose + 10 g/l yeast extract; CN4 = 15 g/l glucose + 15 g/l yeast extract; CN5 = 10 g/l glucose + 20 g/l yeast extract; CN6 = 5 g/l glucose + 25 g/l yeast extract; CN7 = 0 g/l glucose + 30 g/l yeast extract). Each fungal strain that have been cultured on PDA media for 7 days was inoculated by using cock borer (Ø 0.5 cm) and place in to conical flasks containing Czapex-Dox media. The flasks were agitated at 120 rpm in room temperature agitated at 120 rpm in room temperature for eight days. The fungal filtrates were harvested by separating its fungal residue with Whatman filter papers. The fungal filtrates were then centrifuged at 3000 *g* for 20 minutes. The filtrates were subsequently used in the bioassay tests.

Bioassays of entomopathogenic fungi against the larvae of Spodoptera litura

The bioassays were carried out by using sprayed and dipped methods. The sprayed method was conducted by spraying 250 µL of fungal extract on the integument of *S. litura* larva. Afterward, the artificial diet was given daily to the treated larva.

The other infection approach in this research is by using dipped method. The artificial diet size (1x1x1) cm was dipped for 3 seconds in to fungal filtrates and baited to the 4th larval stage of *S. litura* which had been previously fasted for 6 hours. The artificial diet was also provided daily after the treated diet were completely eaten.

Each bioassay either by employing *M. anisopliae* or *N. rileyi* and applied by using sprayed and dipped method was performed on 10 larva of *S. litura.* As the control the larva and the artificial diet was sprayed and dipped in sterile distilled water, respectively.

Results and Discussion

The pathogenicity of *M. anisopliae* and *N. rileyi* towards *S. litura*'s larva are displayed in Figure 1 and 2 below.

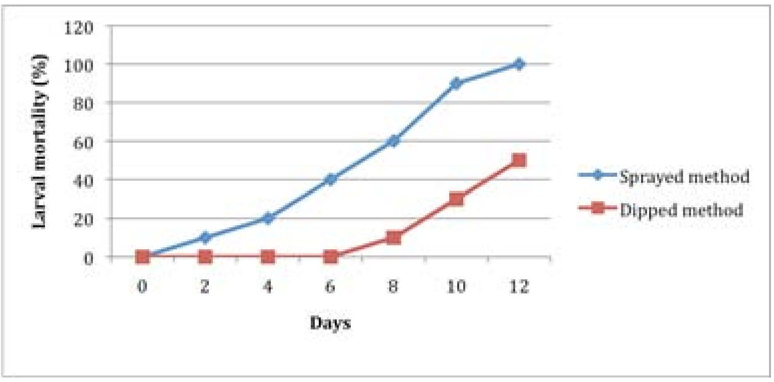

Figure 1. The mortality of *S. litura's* larva treated wih *N. rileyi*

It can be seen from Figure 1 and 2 that the infection of crude extracts using the sprayed method causes higher mortality of *S. litura*'s larvae than the dipped method for both fungal strain. The crude extract infection using the sprayed method causes 100% larval mortality in 12 days exposure time. This result is better than the application of fungal infections using the dipped method which only causes 50% and 0% larval mortality by *N. rileyi* and *M. anisopliae* respectively. The last mentioned result is relevant with research conducted by Padanad and Krishnaraj [5] using *Nomurea rileyi* which was employing contact method (topical method) and could control 85-97% of *S. litura*'s larvae in 10 days.

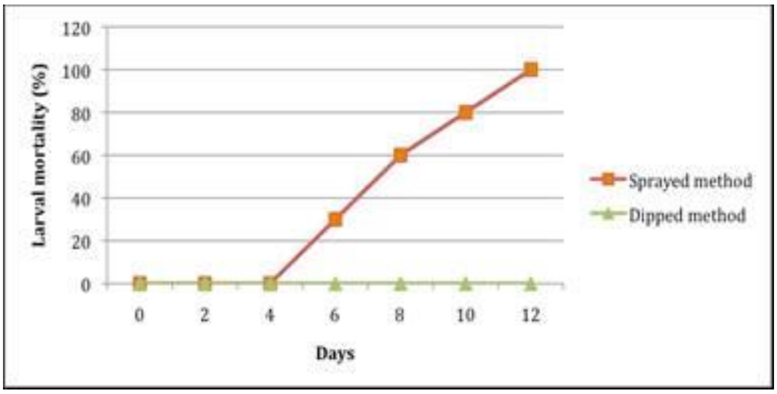

Figure 2. The larval mortality of *S. litura* treated with *M. anisopliae*

The application of using *M. anisopliae* filtrate in this study showed different results with the previous study [6]. The crude extract of *M. anisopliae* grown in PDB (*Potato Dextrose Broth*) media tend to be more toxic to *S. litura* larvae using dipped method than the sprayed one, although only caused 40% of larval mortality. It is likely because most of the fungal crude extract which acts as a stomach poison penetrate more completely in to the diet therefore may increase the larval mortality. However, technically, similar procedure was applied in the previous studies as well, thus the main factor that leads to the mortality percentage difference is likely the toxin level produced from different media.

Entomophatogenic fungi grown in Czapex-Dox are assumed able to produce more toxin than in PDB media. Each entomopatogenic fungi has a characteristic to produce a specific toxin, like wise *M. anisopliae* produces destuxin. Destruxin has been often recognized as one of the death cause of insect infected by *M. anisopliae* [7]. Wang *et al*. [8] reported that the difference carbon/nitrogen combinations stimulate higher concentration of peptone (>60%) in liquid media that favours toxin production. Comparatively, highest amount of toxins was produced when peptone is available as single nutrient source.

Figure 3. Healthy larva of *S. litura*

Figure 4. Dead larva of *S. litura* infected by entomopathogenic fungi

Figures 3 and 4 above show a comparison condition of the healthy (control) and fungus-infected larvae (with treatment). The larval body infected by entomopathogenic fungi seems dried up and covered with mycelium. The dried up larval body is likely due to the absorption of the larval body fluids by the fungi for growth.

Conclusion

The applications of entomopathogenic fungus filtrates of *Metarhizium anisopliae* and *Nomurea rileyi* on laboratory scale by using sprayed method was capable to kill larva of *Spodoptera litura* by up to 100% within 12 days.

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THE EFFECT OF GROWTH SITE FACTORS AND SILVICULTURAL TREATMENTS ON PRODUCTIVITY OF KAYU BAWANG (*Dysoxylum mollissimum* Blume) IN PRIVATE FOREST IN BENGKULU

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Abstract

Kayu bawang (*Dysoxylum mollissimum* Blume) is a local species which is considered as superior tree species in Bengkulu and is commonly used for construction wood. The wood of kayu bawang has good quality, such as resistance to termite attack. This species generally has straight stem and is categorized as fast growing spesies. Kayu bawang plantations have varied productivity. This research was aimed to examine the effect of growth site factors and silvicultural treatments on productivity of kayu bawang. This study had conducted on private forests in North and Central Bengkulu District, Bengkulu Province. In this research, principal component analysis was applied. Silvicultural treatments were qualitatively described. The results of the research showed that growth site factors, i.e. slope, altitude, and percentage of light intensity, were negatively correlated with productivity of kayu bawang. The optimum growth of kayu bawang in the research locations was observed at slopes ranging from 0 to 20%, altitude ranging from 45 to 65 m asl, and percentage of light intensity ranging between from 9 to19%. Productivity of kayu bawang at low quality sites could be improved through appropriate silvicultural treatments. However, silvicultural treatments practiced by the people were still not appropriate yet. Those inappropriate practices include the use of natural regeneration as planting stocks, unsystematic planting space. Soil tillage, weeding, and prunning were also hardly conducted. Furthermore, replacement of dead plants, application of fertilizers and thinning were never conducted.

Keywords: *Dysoxylum mollissimum; growth site factors; productivity; silvicultural; treatments*

Introduction

The development of privately owned forests is an effort to provide raw materials in order to fulfill the needs of the national consumption of wood, since the supply of raw materials from production of natural forests decreased. Indonesian environmental status in 2006 showed a national timber needs were 57.1 million m^3/year with the ability of natural forests and forest plantations to supply of 45.8 million m^3/year [1]. Based on these data, was occured the deficit of timber needs about 11.3 million m^3/year. The strategy to reduce the deficit happened of wood needs to develop and expand community forests in many regions. Type of wood that has been developed in private forests include sengon, pulai, gmelina, mindi, kayu afrika and kayu bawang.

Kayu bawang (Dysoxylum mollissimum Blume) is local species which is considered as superior tree spesies in North Bengkulu [2]. This species has the advantage as resistant to termite attack, has a smell like onions and bitter. Nuriyatin et al. [3] stated kayu bawang had a good quality wood, belong to resistance level B or resistance range from fairly resistant to resistant toward termite attack. Apriyanto [4] added the kayu bawang had a straight stem and categorized as relatively fast growing species.

Kayu bawang plantation in private forests had diverse productivity. At the age of 9 years, monoculture plantation of kayu bawang in community forests increased 24.42 m^3/ha/year in volume

[4]. This increment was higher than kayu bawang with kayu bawang in a polyculture with coffee, i.e. 13.98 m^3/ha/year, and a polyculture with coffee and rubber, i.e. 10.68 m^3/ha/year [5]. The volume increment differences had been caused by differences in the factors site and silvicultural treatments at each location. Therefore, this study was aim conducted to examine the effect of growth site factors and silvicultural treatments on productivity of kayu bawang which required for consideration in the cultivation of it, which result the optimum timber productivity in order to fullfil the needs of the wood.

Materials and Methods

Place and time of the research

The experiment was conducted in private forests of kayu bawang included in three village, Desa Pasar Pedati in Central Bengkulu District, Desa Sawang Lebar and Desa Dusun Curup in North Bengkulu District. Soil analysis carried out at the Laboratory of Soil Science, Faculty of Agriculture, University of Bengkulu. The time of the study was conducted in March to April 2010.

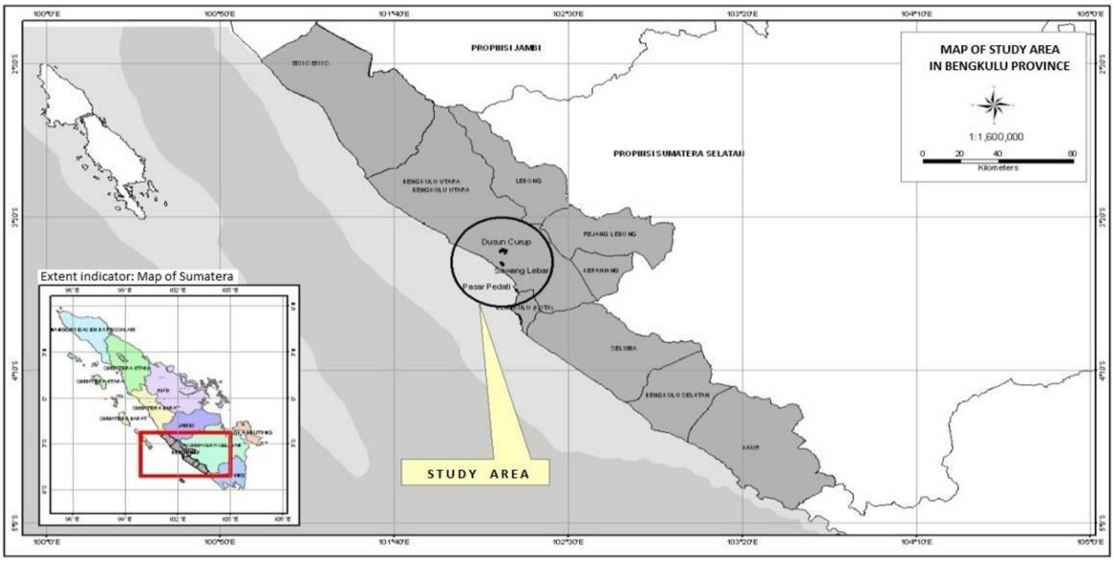


Figure 1. Map of the study site

Data collection

The object in this research is kayu bawang stands at 25 research plots, in size of 30 m x 30 m. Plots consisted of three agroforestry, kayu bawang combined with annual crops (**Figure 2)**, agroforestry kayu bawang combined with coffee (**Figure 3)**, and agroforestry kayu bawang combined with coffee and rubber (**Figure 4)**. Measurements were taken at each of the study plots used, the cultivation of crops (kayu bawang, banana, coffee and rubber) and undergrowth vegetation. The environment data consisted of topography (slope and altitude), light intensity and soil physical properties (content of clay, silt, sand and bulk density) and soil chemical properties (pH, total-C, total-N, organic matter (OM), CEC and base saturation (BS)). Data collection of silvicultural treatments that have been made public through studying literature and semi-structured interviews with a snowball sampling [6].

Data procedure

Density of trees are the number trees per plot divided by the area plot was as follows:

$$N = n / L_p \tag{1}$$

Note: N = Total number of trees per hectare; n = number trees per plot; L_p= plot area (ha)

Figure 2. Kayu bawang + banana

Figure 3. Kayu bawang + coffee (left); Coffee grows under kayu bawang stand (right)

Figure 4. (left) Kayu bawang + coffee + rubber; rubber was harvesting (right)

Basal area around the plant derived from the number of individual plant basal area in the plot divided by the area plot was as follows:

$$B = \sum_{i=1}^{n} B_i / L_p \quad \text{and} \quad B_i = \pi / 4 \frac{D_i^2}{10000} \tag{2}$$

Note: D_i = diameter of the to-i plant (cm); B = basal area all the plant (m^2/ha); B_i = basal area to-i (m^2); n = total plants in the plot; L_p = plot area (ha)

Volume of stand aquired from the total trees in plot divided by plot area as follows:

$$V = \sum_{i=1}^{n} V_i / L_p \tag{3}$$

The volume of trees individual in the plots obtained by allometric equation of kayu bawang volume [7]:

$$V_i = 0{,}0000501 D_i^{2{,}13} H_i^{0{,}769} \tag{4}$$

Note: D_i = diameter of to-i tree (cm); H_i = total height of the tree to-i (m); V = volume of the stand (m^3/ha); V_i = volume of first tree to the tip diameter of 10 cm with skin (m^3); n = number of trees in plot; L_p = plot area(ha)

Annual average increment is measured by dividing the volume generated at a certain age by the stand age, was as follows:

$$\text{Annual average increment} = V_A / A \tag{5}$$

Note : V_A = volume of the stand at a certain age (m^3/ha); A = stand age (years)

Kayu bawang plant biomass measurement using the following formula:

$$W = V \times Bj \tag{6}$$

Note: V = volume of kayu bawang (m^3); Bj = density of kayu bawang (0.56 g/cm^3); W = biomass of kayu bawang (kg)

Biomass of banana, coffee and rubber using allometric equation as follows:

Tabel 1. Allometric equation estimators biomass of banana, coffee and rubber

No.	Species	Equation	Source
1	Banana	$W = 0{,}03D^{2{,}13}$	Van Noordjwik *et al.*[8]
2	Coffee	$W = 0{,}281D^{2{,}06}$	Van Noordjwik *et al.* [8]
3	Rubber	$W = 0{,}095D^{2{,}62}$	Indrawan [9]

Note: D = diameter (0.5 m from ground level) of banana and coffee, dbh of rubber (cm), W = biomass of bananas, coffee and rubber (kg)

Total plant biomass using the formula:

$$W_t = \sum_{i=1}^{n} W_i / L_p \tag{7}$$

Note: W_i = biomass of to-i plant (kayu bawang, banana, coffee and rubber) (kg); Wt = total biomass of plants per the plot (kg / ha), Lp = plot area (ha)

To calculate the biomass plant, we can use the formula below:

$$BM = BK \times 10/L_p \tag{8}$$

Note: BBc = wet weight of sample (g); BKC = dry weight of sample (g); BK = dry weight (g), BB = wet weight (g); % KA = percent water content; BM = biomass (kg / ha); Lp = plot area (m2)

Data analysis

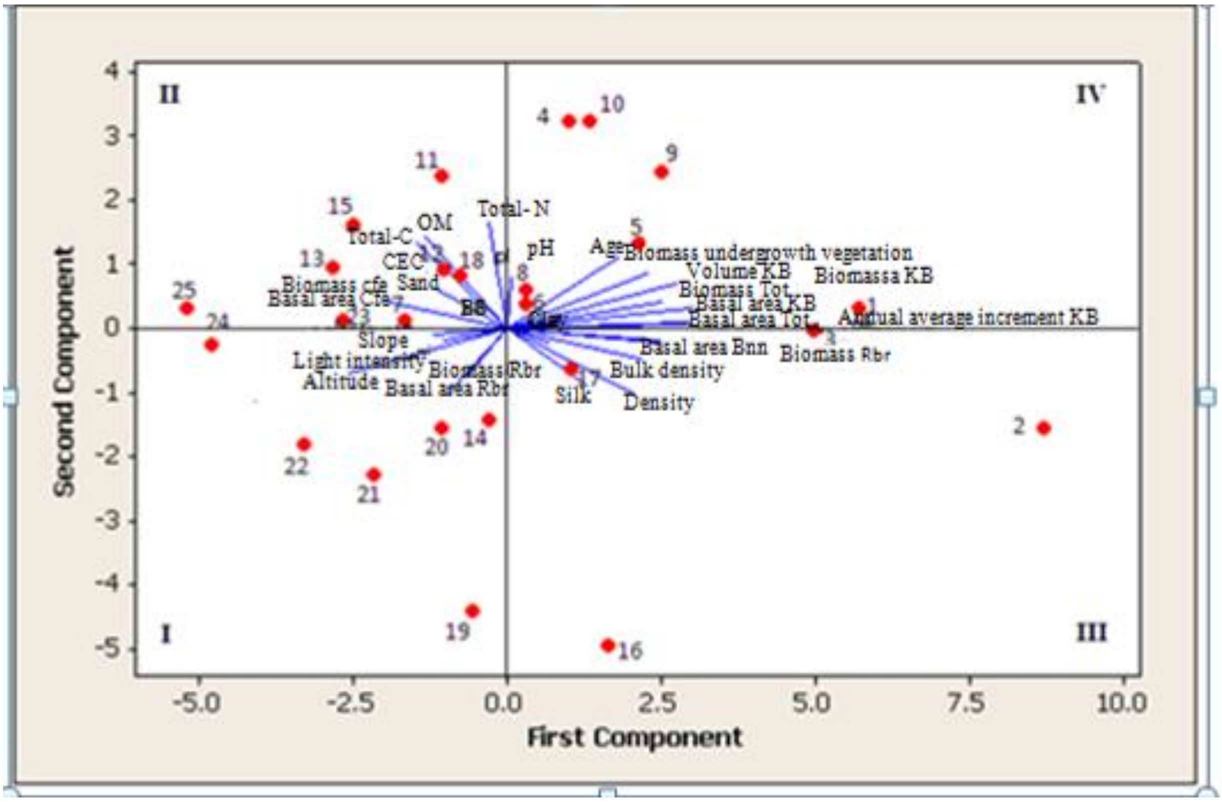
Silvicultural treatments were qualitatively described and the effect growth site factors on productivity of kayu bawang were analyzed by principal component analysis (PCA) using Minitab 15[10].

Results and Discussion

Factors of growth site

Contribution of First Component (PC1) of 36.4% and the Second Component (PC2) of 14.9%, so it can be said to be as much as 51.3% of the variance can be reflected in both of components. **Figure 5** showed the distribution patterns of research plots along the axis of PC1 and PC2, there are four groups. Research plots 14, 19, 20, 21, 22, 24 in group I; 7, 11, 12, 13, 15, 18, 23, 25 in group II, 2, 16, 17 in group III, 1, 3, 4, 5, 6, 8, 9, 10 in group IV.

Group IV of PC1 and PC2 had the higher value, the group I have PC1 and PC2 values had lower, whereas group II and III one their PC there are low and there is high. Productivity of kayu bawang, one of which can be seen from the volume. **Table 2** shows that on average the highest volume to the lowest row is 144.6 m^3/ha at group IV, 138.5 m^3/ha at group III, amounting to 67.3 m^3/ha at group II and 54, 5 m^3/ha at group I. High average volume group is strongly influenced by the average age of kayu bawang, group IV was 10.1 years, group III was 7.3 years, group II was 6.6 years and the group I was 5.3 years.



Figur 5 Biplot the effect growth site factors on productivity of kayu bawang

Topography and climate

Altitude, slope and lighting intensity has a tendency to correlate negatively with productivity of kayu bawang, indicated by the vector altitude, slope and lighting intensity which forms an obtuse angle with productivity of kayu bawang (**Figure 5**). By increasing altitude, slope and lighting intensity will reduce productivity of kayu bawang. Group I and II have an average altitude, slope and lighting intensity were higher than group III and IV (**Table 2**), furthermore the group III and IV had higher productivity.

According to Soekotjo [11] the land elevation from sea level affect the state of the environment in which to grow plants, especially temperature, humidity, oxygen levels in the air and on the ground. The circumstances in which further growth that affect the growth of trees. Increase in the slope of the land will increase runoff that can eventually lead to loss of surface soil (erosion). According to Hakim et al. [12] erosion will affect crop productivity. Light intensity relates to the photocyntetic rate. Salisbury & Ross [13] stated that if the light intensity was optimal, then water is likely to be the limiting factor for photosyntesis.

The properties of soil

Measurement of soil physical properties include bulk density, content of sand, silt and clay soil. While the chemical properties of soil include pH, CEC, base saturation, organic matter, total C and total N. Based on **Figure 5**, the physical properties of soil play a greater role in increasing productivity of kayu bawang. Bulk density, silt and clay content of the soil were positively correlated, whereas the sand content of the soil, CEC, base saturation, organic matter, total C negatively correlated. Organic matter negative correlation to productivity associated with an increase in slope, indicated that organic matter vector formed a narrow angle with the vector slope. Increase in slope will lead to increased erosion. Damage caused by erotion made the land where occurs in the form of setbacks chemical and biological soil properties such as nutrient loss and organic matter, and the increasing density and soil penetration resistance, decreasing soil infiltration capacity and the ability of soil to retain water. As a result of these events is declining soil productivity, and reduced groundwater recharging [14].

Table 2 showed the average of bulk density and content of sand, clay, silk were almost the same in each group. Total N and pH showed no correlation on productivity of kayu bawang (vector of total N and pH amost formed an angle of 90^0), this can be due to total N and pH of the soil at each study plot was uniform. Plots used in this study have the characteristics of a site to grow a nearly uniform, which is shown by the plot near the intersection between PC1 and PC2 at the point 0.

Criteria of assessing the results of the soil analysis showed a pH range of each study plot was very acid ($\leq$ 4.5). Cation exchange capacity (CEC) of study plots ranging between 6.7 to 14.3 me/100g. The CEC value indicates the ability of adsorb and exchange cations with the roots of plants in the study site is low. Base Saturation (BS) research plots were classified as very low to moderate. Organic Matter content (OM) ranging between 0.2 to 5.2 kg/m^2 and total C ranging between 0.1 to 3%, including very low to moderate [15]. Based on the above data, kayu bawang is a plant that can grow in poor soil, with low CEC and acid soil.

Silviculture treatments that have been carried out by people

Kayu bawang has been developed by people from generation to generation. In the beginning, a tradition of preparing kayu bawang wood for construction their homes and children into future investment. Kayu bawang silvicultural treatments performed on each plot the research are still not appropriate yet. Seed source is derived from trees around the village, with criteria of age $\geq$ 15 years, tall, straight, high free branched stem and bark cracks after aged $\geq$ 15 years. Seedlings were generally taken from natural regenerations. Planting space was unsystematically arranged. Soil tillage, weeding, and prunning were also hardly conducted. Furthermore, replacement of dead plants, application of fertilizers and thinning were never conducted.

The average volume kayu bawang group of III and IV at 138.5 m3/ha and 144.6 m^3/ha, higher than the average volume of the kayu bawang of group I and II was 54.5 m^3/ha and 67.3 m^3/ ha. This is because the group of III and IV have been doing silviculture treatments better than other groups. Seedlings planted in group of III and IV are generally derived from seeds were sown in polybags, while the other group from the seeds directly planted seeds or seedlings into the field or naturally regeneration which planted without the seedlings selection process. On land preparation activities group of III and IV had engaged scarify the soil, weeding conducted more regularly. Fertilization of kayu bawang at the study site has not been conducted, while fertilizing the crop, still a few people who do it. Fertilizer application in agricultural crops will also affect the kayu bawang.

The effect of growth site factors and silviculture treatments on productivity of Kayu Bawang

The high of volume average group of III and IV due to the average age and a higher density, the average altitude, slope and lower lighting intensity and silvicultural treatments that have conducted better than in group I and II. The optimum growth of kayu bawang was observed at slopes ranging between 0 to 20%, altitude ranging between 45 to 65 m asl and percentage of lighting intensity ranging between 9 to 19%. There were no significant differences between monoculture and polyculture plantations in terms of growth site factors, i.e. the average bulk density, clay content, silk, sand, pH, CEC, Base Saturation (BS), Organic Matter (OM), total C, and total N (**Table 2**).

Table 2. The effect of growth site factors and silvicultural treatments on productivity of kayu bawang

	Unit	Group I	Group II	Group III	Group IV
Age	Year	5.3	6.6	7.3	10.1
Density	trees/ha	467	293	815	467
Growth site factors					
Altitude	m asl	98.2	84.6	65.3	45.5
Slope	%	40	27.1	4	20
Light intensity	%	28.3	23.2	9.3	18.8
Bulk density	g/cm^3	1	1	1	1
Clay	%	26	29.2	34.7	30.7
Silk	%	13.4	9.9	14.4	10.3
Sand	%	60.1	60.9	51	59.6
pH		4	4	4.1	4.1
CEC	Me/100g	10	12.5	7.9	11
Base Saturation (BS)	%	3.6	34	34.8	35.1
Organic Matter (OM)	kg/m^2	3.3	4.6	2.2	3.8
Total C	%	1.9	2.6	1.3	2.2
Total N	%	0.1	0.2	0.1	0.2
Silvicultural Treatments					
Seedlings in polybag	%	14.2		54.5	
Soil tillage	%	21.4		54.5	
Planting space	%	14.2		27.3	
Weeding	%	100		100	
Fertilizing	%	14.2		27.3	
Prunning	%	28.6		63.6	
Volume average	m^3/ha	54.5	67.3	138.5	144.6

Table 2 showed 54.5% research plots group III and IV. Seedlings from seeds sown in the polybags, 54.5% conducted soil tilllage, 27.3% is grown using plant spacing, 27.3% conducted activities fertilization in crops and 63.6% conducted pruning. It can be seen that in silvicultural treatments had higher values in groups III and IV than in groups I and II. Therefore, productivity of groups III and IV are higher than groups I and II.

The use of polybag will simplify to control the seedling growth. According to Indriyanto [16] soil tilllage aim to improve soil psycal properties in order to improve drainage and aeration of the soil to be appropriate. Weeding activities have been conducted at each study the plot to control weeds so as not to interfere with plant growth. While pruning aimed at obtaining quality of wood, which is a high free branched stem and free from knots. Fertilization in agricultural crops will add the nutrients in the land so that the effect also on crops kayu bawang.

Conclusion

Factors of the growth site factors, i.e. slope, altitude, and percentage of light intensity, were negatively correlated with productivity of kayu bawang. The optimum growth of kayu bawang in the research locations was observed at slopes ranging between 0 to 20%, altitude ranging between 45 to 65 m asl, and percentage of light intensity ranging between between 9 to19%.

Silvicultural treatments practiced by the people were still not appropriate yet. Those inappropriate practices include the use of natural regeneration as planting stocks, unsystematic planting space. Soil tillage, weeding, and prunning were also hardly practiced. Furthermore, replacement of dead plants, application of fertilizers and thinning were never conducted. Productivity of kayu bawang at low quality sites could be improved through appropriate silvicultural treatments.

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ANATOMICAL AND PHYSICAL PROPERTIES OF FAST GROWING WOOD SPECIES FROM CENTRAL KALIMANTAN AS STRUCTURAL MATERIAL

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Abstract

Limited information of wood basic properties was believed as a dominant factor causing fast growing wood species to be rarely used until now. We try to analyse the anatomical and physical properties of several fast growing wood species from forest industries which have natural concession area in Central Kalimantan. The aim of this study was to investigate the anatomical and physical properties of wood as a guidance to determine its potential utilization. Each wood species has a unique charateristic from its anatomical properties that could affect wood processing. The range density of the wood species in wet, air dry, and oven dry were 0.48-0.73 g/cm^3, 0.5-0.79 g/cm^3, and 0.54-0.86 g/cm^3, respectively. The density of these woods were categorized as high density which were promising as raw materials for structural purposes. In term of the value of T/R ratio, there were 3 species having low value of T/R ratio: *Tristaniopsis whiteana*, *Bellucia pentandra*, and *Nauclea junghuhnii*.

Keywords: *anatomical properties, physical properties, density, fast growing wood species, T/R ratio*

Introduction

Increasing wood demand in last decades cannot be supported by wood supply from forest, both natural and plantation forest. On the other hand, the gap between wood demand and supply can increase illegal logging, which is used to fulfill the wood demand of Indonesia's wood industries [1]. According to the Indonesian Ministry of Forestry, wood supply from natural forest, plantation forest, and other wood sources are 5.7 million m^3, 19.95 million m^3, and 21.77 million m^3, respectively [2] whereas wood demand for industries are predicted to be about 60 million m^3 per year. So, there is still deficit of wood supply about 12.58 million m^3 per year.

Indonesia actually have a lot of wood species which are still not commonly used in recent days because of limited information about the properties of these woods, including lesser known and fast growing wood species. These kinds of wood species are promising to be used as raw materials for many kinds of wood industries in Indonesia. Case study in Indonesia's forest industries, which have natural forest concession areas in Central Kalimantan, there are a lot of species that yet unexplored that can affect the low rate of wood logging productivity. Wood exploration which has been done by forest industries at this time, are focusing to the Meranti group, mix of wood forest, and artistic wood like a Ramin wood. On the other hand, utilization of fast growing wood in the other region has increased. For example, the utilization of Sengon wood, one of the fast growing wood species, has increased in Java region, but this kind of wood is still not be used as one of wood logging focus in natural forest industries yet.

Limited information of wood basic properties is believed as a dominant factor causing the lesser known and fast growing wood species are not commonly used until now. Wood can be used for any purposes, but most of its utilization is for structural purposes. For this reason, anatomical and physical properties of wood are important to be studied. In this study, we tried to analyse several fast growing species that are unexplored in concession area of natural forest industries in Central Kalimantan. The aim of this study was to know the anatomical and physical properties of wood as a guidance to determine its potential utilization.

Materials and Methods

The wood samples used in this study were *Bellucia pentandra, Neonauclea gigantea, Tristaniopsis whiteana*, *Dillenia sp., Adinandra dumosa*, and *Nauclea junghuhnii*. These wood samples were taken from concession area of PT. Sari Bumi Kusuma, Central Kalimantan, with minimum diameter of wood was 10 cm. The anatomical properties, which were observed and reported, referred to the International Association of Wood Anatomist (IAWA) standard [3]. The types of analysis of physical properties in this study were 1) density in various condition of wood volume i.e., air dry, oven dry, and
wet condition; 2) Shrinkage: radial and tangential direction; and 3) Tangential/Radial (T/R) ratio. The physical properties were then used as a guidance to determine the suitability of wood for structural function. The method for physical analysis was referred to British Standard 373 (1957) [4].

Results and Discussion

Wood anatomical properties

Figure 1 to 6 are the transverse sections (10x) of wood samples used in this study, i.e. *Bellucia pentandra, Neonauclea gigantea, Tristaniopsis whiteana, Dillenia* sp., *Adinandra dumosa*, and *Nauclea junghuhnii*, respectively.

Figure 1. *Bellucia pentandra*

Figure 2. *Neonauclea gigantea*

Figure 3. *Tristaniopsis whiteana*

Figure 4. *Dillenia* sp.

Figure 5. *Adinandra dumosa*

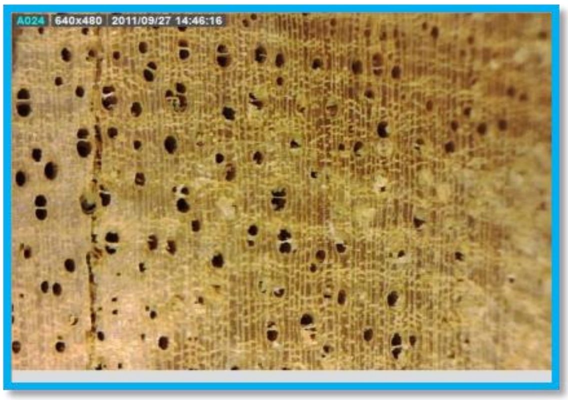

Figure 6. *Nauclea junghuhnii*

Anatomical properties of woods are important to distinguish the features of each wood. It could be used not only to identify the wood species, but also to determine their potential utilization. For example, the vessel type of wood could affect the infiltration of glue, preservative, etc. during wood processing. So, identifying the anatomical properties are needed before using the wood as raw material. The results of our study for the anatomical properties of the woods are shown as follow:

Bellucia pentandra (2, 5, 13, 22, 23, 33, 61, 68, 96, 105)

Growth ring boundaries indistinct or absent, wood diffuse-porous, radial multiplay 2-3, simple perforation rates, intervessel pits alternate, shape of intervessel pits polygonal, vessel-ray pits of two distinct size in the same ray cell, fibres with simple to minutely bordered pits, fibres with very thin-walled, ray exclusively uniseriate, all ray cells uprights and/or square.

Neonauclea gigantea (2, 5, 13, 22, 30, 62, 69, 89, 97, 105)

Growth ring boundaries indistinct or absent, wood diffuse-porous, 80% solitary, others in radial multiply 2-3, simple perforation rates, intervessel pits alternate, vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell, fibres with distinctly bordered pits, fibres thin to thick walled, axial parenchyma in marginal or in seemingly marginal bands, ray width 1-3 cells, all ray cells uprights and/or square.

Tristaniopsis whiteana (2, 5, 7, 9, 13, 22, 32, 61, 70, 79, 96, 104)

Growth ring boundaries indistinct or absent, wood diffuse-porous, vessel in diagonal and/or radial pattern, vessel exclusively solitary (90% or more), intervessel pits alternate, vessel-ray pits with much reduced border to apparently simple (vertical), fibres with simple to minutely bordered pits, fibres very thick walled, axial parenchyma vascicentric, ray exclusively uniseriate, all ray cells procumbent.

Dillenia sp. (2,5,9,14,18,20,31,61,69,97,104,105,129)

Growth ring boundaries indistinct or absent, wood diffuse-porous, vessel exclusively solitary (90% or more), scalariform perforation plates, intervessel pits scalariform, vessel-ray pits with much reduced border to apparently simple round, fibres with simple to minutely bordered pits, fibres thin to thick walled, ray width 1-3 cells, all ray cells procumbent, all ray cells uprights and/or square, axial canals diffuse.

Adinandra dumosa (2, 5, 9, 14, 18, 20, 32, 62, 63, 66, 69, 97, 104)

Growth ring boundaries indistinct or absent, wood diffuse-porous, vessel exclusively solitary (90% or more), scalariform perforation plates, intervessel pits scalariform, vessel-ray pits with much reduced border to apparently simple round, vessel-ray pits with much reduced border to apparently simple horizontal, with distinctly bordered pits, fibre pits common in both radial and tangential wall, non-septates fibre present, fibres thin to thick walled, ray width 1-3 cells.

Nauclea junghuhnii (2, 5, 13, 22, 23, 30, 61, 63, 68, 77, 97, 105, 107, 111)

Growth ring boundaries indistinct or absent, wood diffuse-porous, radial multiply, simple perforation rates, intervessel pits alternate, of intervessel pits polygonal, vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell, fibres with simple to minutely bordered pits, fibre pits common in both radial and tangential wall, fibres with very thin-walled, axial parenchyma diffuse in aggregates, ray width 1-2, all ray cells uprightsand/or square, body ray cells procumbent with mostly 2-4 rows of upright and/or square marginal cells, tiles cells present.

Density in various conditions and positions of wood

The densities of wood samples were presented in Table 1. We measured the density in various condition of wood volume (wet, air dry, and oven dry volume) and the radial direction, from bark to the bark on the other side.

Table 1. Density of woods in various condition of wood volume

Species	**Density (g/cm^3)**			**Moisture Content (%)**
	wet vol	**air dry vol**	**oven dry vol**	
Bellucia pentandra	0.50	0.51	0.55	13.97
Neonauclea gigantea	0.54	0.58	0.62	14.74
Tristaniopsis whiteana	0.73	0.79	0.86	15.97
Dillenia sp.	0.50	0.56	0.68	14.42
Adinandra dumosa	0.48	0.5	0.54	15.35
Nauclea junghuhnii	0.49	0.52	0.56	15.03

Table 1 shows that *Tristaniopsis whiteana* has the highest density while *Adinandra dumosa* has the lowest density in all conditions. Generally, density could be calculated in three conditions of wood volume, i.e. wet, air dry and oven dry volume as well as for the mass of wood [5]. Each condition of wood volume and mass has different purposes, for example determining the density in green weight and green volume is useful to calculate weights in transportation or construction [5]. Commonly, many researchers determine the density in oven dry of wood mass per wet volume wood based for construction purposes because it could represent wood real condition. Table 1 also shows that the density tends to increase from wet, air dry, and oven dry condition. Density decreases as moisture content decreases, but below fiber saturation point, the specific gravity increases as the moisture content decreases [5]. Density is mass per volume of wood. Decreasing moisture content from wet to oven dry condition makes the volume of wood tend to decrease because the water in wood will be loss during drying process, so that the density will increase.

It is interesting to note that fast growing wood species which were found and collected from Central Kalimantan could be classified as high density woods [6]. The densities of all the species are more than 0.5 g/cm^3. Most mechanical and physical properties of wood are closely correlated to specific gravity and density. The strength of wood as well as its stiffness increases with specific gravity [5]. Density is directly related to other properties, therefore it is important as an index of wood quality [7]. It means that all of wood samples were predicted to have a good strength for structural purposes. These species have unique characteristics because many researchers said that fast growing wood species usually have low density, short fiber length, large growth stress, large proportion of juvenile wood, etc [8]. So, there is an opportunity to use these species as raw materials for structural function. Since they can grow faster, these species are potential to be developed for plantation forest.

We also measured the density in the radial direction (bark to bark) and it is presented in Figure 7, 8, and 9 for wet, air dry, and oven dry condition, respectively.

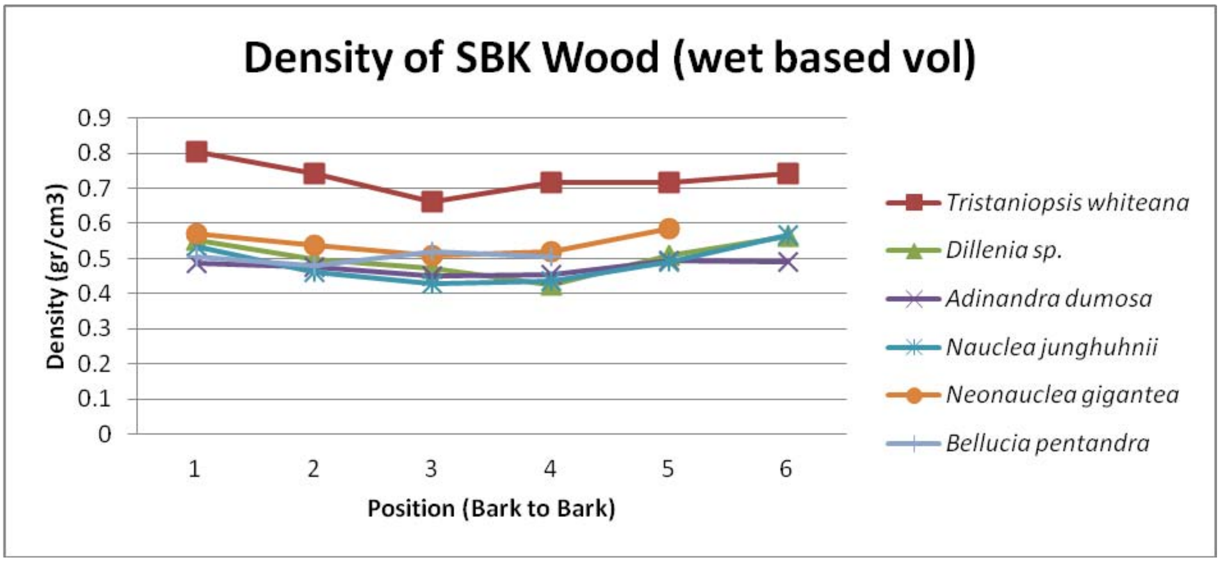

Figure 7. Density based on wet volume in radial direction

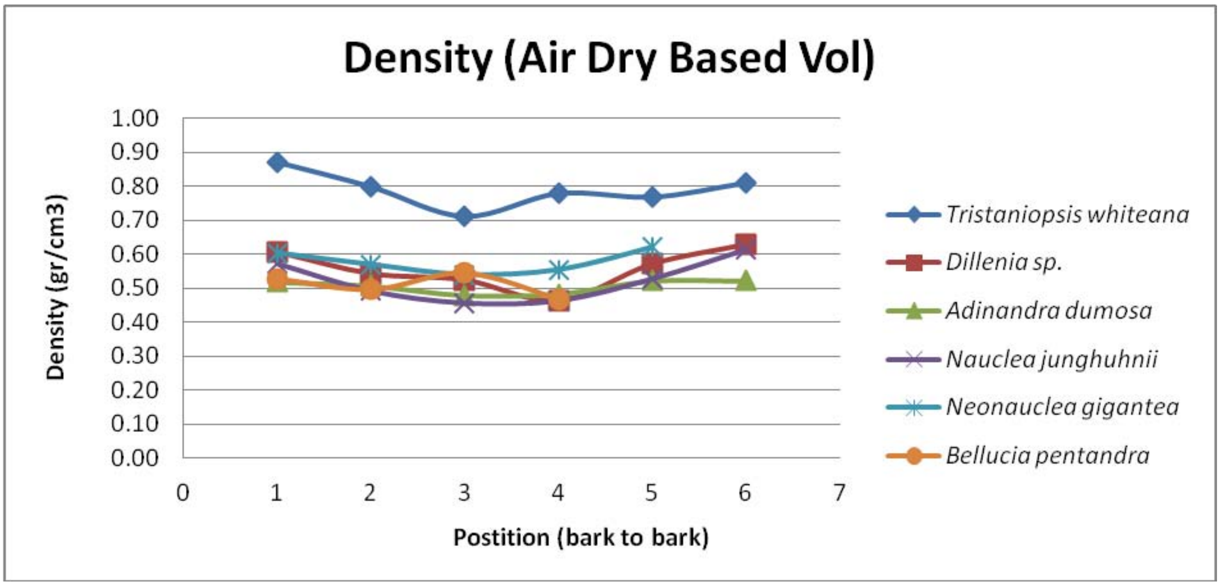

Figure 8. Density based on air-dry volume in radial direction

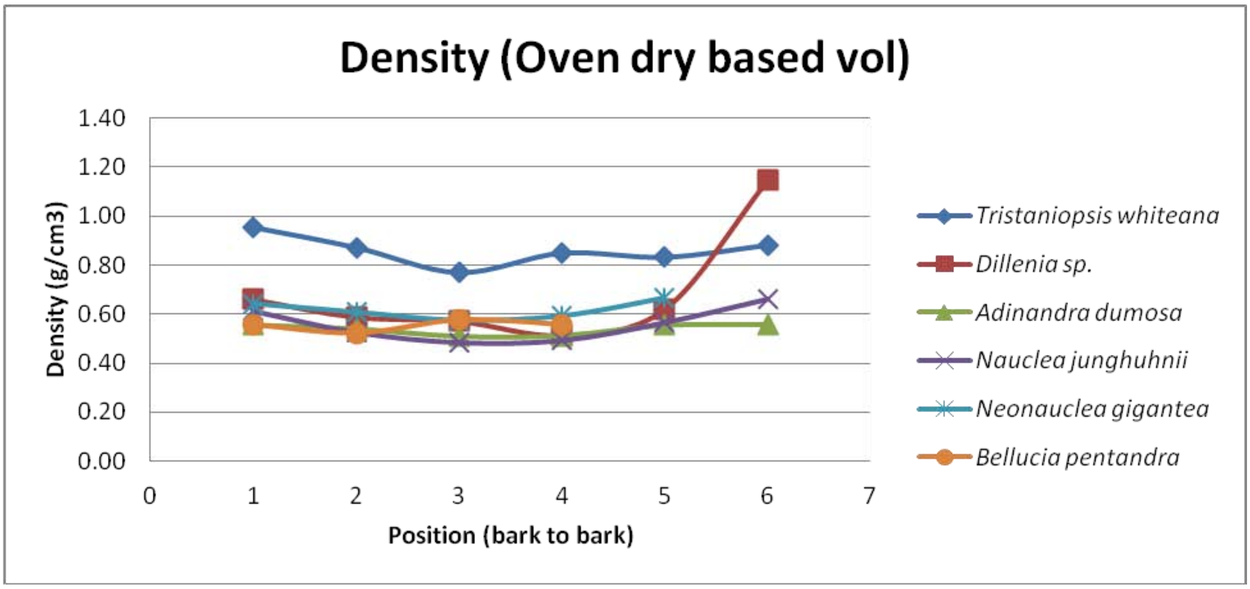

Figure 9. Density based on oven-dry volume in radial direction

Figure 7-9 show that the density tends to decrease from bark to pith and it will increase from pith to the bark on the other side. This phenomena occurs in all volume condition. Panshin and de Zeeuw (1980) said that the wood density will increase from the pith to the bark. It was caused by increasing the proportion of the latewood from the pith to the bark [6;7]. Cell wall in the latewood is usually thicker than in the juvenile wood.

Wood dimension stabilization

Since it is a hygroscopic material, wood can change its dimension due to environmental condition until moisture equilibrium with the air is obtained [Bowyer]. Wood can shrink and swell because water leaves and enters the cell wall. In this study, we focused on the dimensional change due to shrinkage because it is the most important physical property that affects structural application. Wood shrinkage happens if the wood dries below fiber saturation point and loses some water in the cell wall (loses bound water) [5]. Removal of moisture from the cell wall below the fiber saturation point causes the wall to shrink [6]. Radial and tangential shrinkage of wood samples from air dry to oven dry are shown in the Figure 10.

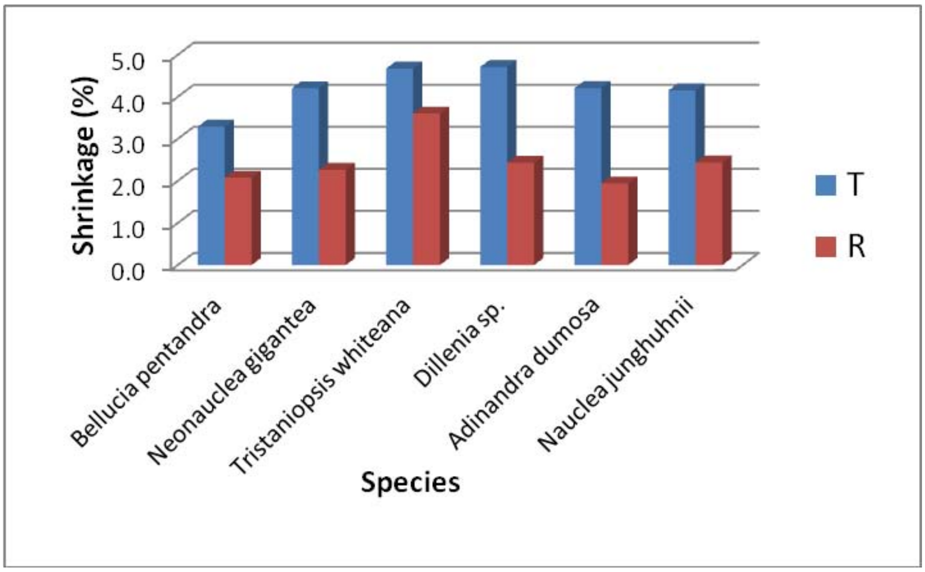

Figure 10. Shrinkage of wood samples (air dry to oven dry)

Figure 10 shows that *Tristaniopsis whiteana* and *Dillenia sp.* have higher shrinkage than the other species. One of the reasons that cause the results may be the density of wood. Dimensional changes are not only caused by moisture in wood, but also by the amount of the cell wall substance. The greater amount of material present, the larger the dimensional changes that are possible for the same percent moisture content change [6]. Wood which has higher density tends to have higher value of shrinkage than the one with lower density as well as the cell wall. It means that wood which has high density tend to have a thick cell wall. Since the shrinkage happens because of losing the water bound in the cell wall, wood which has higher density would lose the bound water greater than the one with lower density.

Tangential shrinkage is greater than radial shrinkage by a factor of 1.5 to 3.0 [5]. On the other hand, T/R ratio is about 1.4 to more than 2.0 [6]. Tangential/Radial shrinkage (T/R ratio) could be used as a value to determine the wood is stable. The lower the T/R ratio, the stable the wood dimension. The wood best suited for uses involving critical dimensional stability is the one with a low T/R ratio and with low absolute transverse dimensional changes [6]. T/R ratios of the wood samples are shown in the Table 2.

Table 2. T/R ratio of wood samples

Species	**T/R Ratio**	**Density (wet based vol)**
Bellucia pentandra	1.59	0.5
Neonauclea gigantea	1.86	0.54
Tristaniopsis whiteana	1.30	0.78
Dillenia sp.	1.94	0.5
Adinandra dumosa	2.17	0.48
Nauclea junghuhnii	1.70	0.49

Table 2 shows that the T/R ratios are 1.3 to 2.17. Table 2 also shows that *Tristaniopsis whiteana* has the lowest value of T/R ratio. It means that *Tristaniopsis whiteana* is predicted to have a stable dimension than the others. *Adinandra dumosa* has the highest T/R ratio and is predicted to have unstable dimension. For all of T/R ratio, it could be assumed that the wood species collected from Central Kalimantan can be used as raw materials for structural function, especially for *Tristaniopsis whiteana, Bellucia pentandra, Nauclea junghuhnii.*. Moreover, these species have high density (more than 0.5 g/cm^3).

Conclusion

Based on their anatomical properties, each wood species has a unique charateristic that can affect wood processing. The density of wood in all condition of wood volume can be classified as high density. It means that all of the woods are promising as raw materials for structural purposes. For the value of T/R ratio, there are 3 species which have a low value of ratio: *Tristaniopsis whiteana, Bellucia pentandra,* and *Nauclea junghuhnii*.

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FIBRILLATION PROCESS DEVELOPMENT OF FIBERS FROM MILLED EMPTY FRUIT BUNCH (EFB) AND CHARACTERISTICS OF POLYVINYL ALCOHOL/ EFB FIBERS COMPOSITES

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Abstract

Microfibrillated cellulose (MFC) is the smallest part of lignocellulosic material. Some treatments have been conducted such as mechanical, chemical, physical, even combination between -two or more of these treatments in order to isolate MFC from the origin. Hence, this work could provide the feature of process development materials that applied for automotive, medical, packaging, etc. Furthermore, this research aim (aimed) “was” to isolate MFC from Empty Fruit Bunches (EFB) fibers with combination of mechanical and physical treatment and investigate the mechanical properties of PVA composites reinforced with - EFB fibers. Dried EFB fiber was milled using disc mill in one circulation. Then, the fiber was sonicated with Sonic Ruptor 400 Ultrasonic Homogenizer which was operated based on cavitation from microbubble that fibrillate the fiber, particularly on fiber surface. Isolation with sonication is a harmless process that could not undermine the main part, cellulose, which is supporting part for bonding strength onto polymer matric. Fiber concentrations were done in 0.25; 0.5, and 1% dry based of milled fibers. Sonication process was determined in 40% of power level and various times in 20 and 40 minutes. In this case, Polyvinyl alcohol (PVA) was used as matrix and treated EFB fibers were acted as reinforcing agent. Treated fibers in 10% of concentration were constantly mixed at 300 rpm and 80^{O}C in temperature within 180 minutes. Light microscope (was used to investigate the fiber morphology while Universal Testing Machine was used to analyze composite mechanical properties in accordance with ASTM D 882) and Universal Testing Machine were used to investigate the fiber morphology and composite mechanical properties, respectively, in accordance with ASTM D 882. Milled EFB fibers treated with ultrasonication treatment could fibrillate the fibers even in 20 minutes of process. Mechanical properties were improved by the addition of treated fiber in term of tensile strength, modulus of elasticity, and elongation at break. Lower concentration and longer time of sonication produced better properties than other treatments.

Keywords: *composite, empty fruit bunches, milled fiber, polyvinyl alcohol, sonication*

Introduction

Microfibrillated cellulose (MFC), the smallest part of lignocellulosic material is isolated from natural fibers sources. It is recently explored since it has superior properties which were light, degradable, low cost production, and abundantly available in the nature. As the biggest oil palm plantation in the world, according to the data [1], oil palm plantation in Indonesia is covering 8.9 million hectares. Oil palm industries produce side products for instant empty fruit bunch, mesocarp palm fruit, and oil palm shell. Empty fruit bunch (EFB) is the biggest amount of by product, with predicted production up to 25 tonne per hectare, annually. As the same time, these fibers were less utilized. Whereas, through several treatments it could be used as reinforcement for composite uses, because of its potential properties.

Isolation MFC could be conducted in several kind of processes, including mechanical, chemical, physical, thermomechanical, and further by combination of these treatments. MFC become high rising research area because of its properties enhancement correspond to high aspect ratio. Aspect ratio was explained as comparison between length and width of fibers. Higher aspect ratio value means that lower width is obtained, and wide contact with polymer matrix is occured. For this purpose, mechanical treatment that worked with stator and rotor mechanism could be as primary process to peal first layer of the fibers such as refiner, mill, and grinder [2,3,4]. For further process to obtain uniform size of MFC in nano scale, the mechanical treatment used high pressure homogenizer with pressure drop gap principal [2,4,5]. In the other hand, mechanical treatment consume high energy, it should be minimalized in order to support sustainable and ecofriendly processing.

Ultrasonication is known as clean, harmless, and effective to isolate MFC even as primary or advanced process. The ultrasonication (is conducted)conducted in liquid process and potentially produced nanosize material slurries, dispersion, and emulsion because of deagglomeration. Microbubbles generated by ultrasonication wave in liquid media could result cavitation exposure that suddenly attack the object [6]. High intensity of ultrasonication (HIUS) could produce 53% of nanocellulose yield after 60 minutes and some of small and macro size [7]. Higher aspect ratio was achieved by HIUS and fiber under 100 nm was effectively produced [8,9]. Combination with chemical treatment and HIUS process could generate uniformly 10-20 nm in fiber scale [10].

Polyvinyl alcohol is potential as polymer matrix, because of its chemical resistance, hydrophilic, degradable and flexible that could be applied in automotive, medical, structure, and packaging area. This kind of polymer is commonly used for reinforcement agent since it has good hydrogen bonding with fibers in order to mechanical investigation of fiber treatment. Several kind of lignocellulosic source such as rutabaga, hemp, and flax were subjected in 10% of PVA solution and resulted tensile strength improvement up to 178 MPa [11]. Some studies also reported that the addition of treated fiber by chemical, mechanical, and physical treatment could enhance the PVA composite properties even in small amount of fiber loading. [9,12,13,14].

Commonly, mechanical treatment as pretreatment in combination method using refining process, could peal the outter part of fiber (i.e primary and first wall). Milling process could be done as pretreatment for this study, because it almost has same mechanism as refining process with different fiber condition. In refining process, the fibers were processed in wet condition, while milling in dry condition. Refining consume higher energy because it need several repeating cycles in a process while milling need just a cycle in a process. Principal of milling process is the same as refining that use rotor and stator mechanism for fiber disaggregation. The objectives of this research are to study the ultrasonication effect of milled EFB fibers and also investigate the mechanical properties for PVA composites.

Experimental

Empty Fruit Bunch (EFB) pulp was used to investigate the effect of mechanical treatment using disc mill and physical treatment using ultrasonication on the fiber fibrillation. First of all, EFB pulp was sun-dried until 10% of moisture content was reached. Mechanical treatment was then conducted using disc mill with 1 mm of particle selection filter in one circulation process. Subsequently, milled EFB fiber was treated by ultrasonication Sonic Ruptor Ultrasonic Homogenizer in 0.25; 0.5; and 1 % of fiber concentration. Process condition was done in 40% of power level at 20 and 40 minutes of sonication time. Condition for each ultrasonication treatment is presented on Table 1. The frequency of 20 kHz was applied to fibrillate the milled EFB fibers. Morphological investigation using light microscope was conducted for five preparates for each treatment samples.

As the matrix, Polyvinyl Alcohol (PVA) was used in technical grade. Milled EFB fibers treated by ultrasonication in some parameters were then subjected onto PVA solution. In this system, 10% of PVA solution was produced and treated fibers in 10% of dry based PVA was mixed in beaker glass. Mixing process was conducted at temperature of 80 ^oC , for 180 minutes with constantly stirring at 300 rpm. The compound was placed on 100 x 150 mm metal mold, and dried at ambient temperature for 24 hours then continued with oven drying at 60 ^oC for 15 hours. Universal Testing Machine was used for mechanical properties investigation. Test piece in 10 x 80 mm was tested in accordance with ASTM D 882 and run in 50 mm/minute of crosshead speed.

Table 1. Ultrasonication process condition of milled EFB fiber

Sample	Concentration (%)	Ultrasonication time (minute)	Power consumption (watt)
E1, 20	0.25	20	3,200
E1, 40	0.25	40	6,400
E2, 20	0.5	20	3,200
E2, 40	0.5	40	6,400
E3, 20	1	20	3,200
E3, 40	1	40	6,400

Result and Discussion

Fiber morphology characterization

Empty fruit bunch (EFB) as common with others fibers is consisted of cellulose, hemicellulose, and lignin in general part. Cellulose content of EFB fiber is reported as much as 41.72%, while the others part which are hemicellulose (24.26%), lignin (22.49%) and extractive (11.54%) [15]. Some treatments were conducted in order to disaggregate bundle of fiber and further to defibrillate the fibers in nanosize indeed. In this work, EFB dry pulp was firstly treated by milling process using disc mill then continued with ultrasonication which was worked by cavitation exposure. EFB fiber become bulker and lighter then dry pulp before milling (Fig 1a, 1b). Fiber disaggregation was occured during milling process, then treatment by ultrasonication process was conducted for fiber fibrillation purpose. High solution turbidity indicate that the fibers were well dispersed into water along ultrasonication process due to cavitation effect as shown in Fig 1c. Higher concentration revealed low turbidity then low concentration and some sediment of fibers still obtained.

Figure 1. EFB fiber appearance in dry condition before milling process (a), after milling process (b), after ultrasonication treatment (c)

Ultrasonication treatment is known as harmless, clean, and effective process for fiber fibrillation. Beside that, regarding to sustainable process and ecofriendly issues, ultrasonication become good alternative because of its low energy consumption. The mechanism include in liquid process of ultrasonication are dispersion, disggregation, and fibrillation. [16]. As depicted from Fig 2a, milled fibers mostly are still in bundle or big form, confirm that milling process only disaggregate the fibers. After ultrasonication process, the fibers gradually fibrillate both from the middle (Fig 2b, 2d, 2e, 2f) and the edge of the fibers (Fig 2c, 2g). Microbubbles resulted from sonication wave could generate cavitation exposure on the surface of fibers which could eliminate the amorphous part (i.e hemicellulose, lignin). In this case, cavitation exposure could selectively expose cellulose without damage its part. Fibrillation was occured in all ultrasonication treatment even in 20 minutes of time and high concentration.

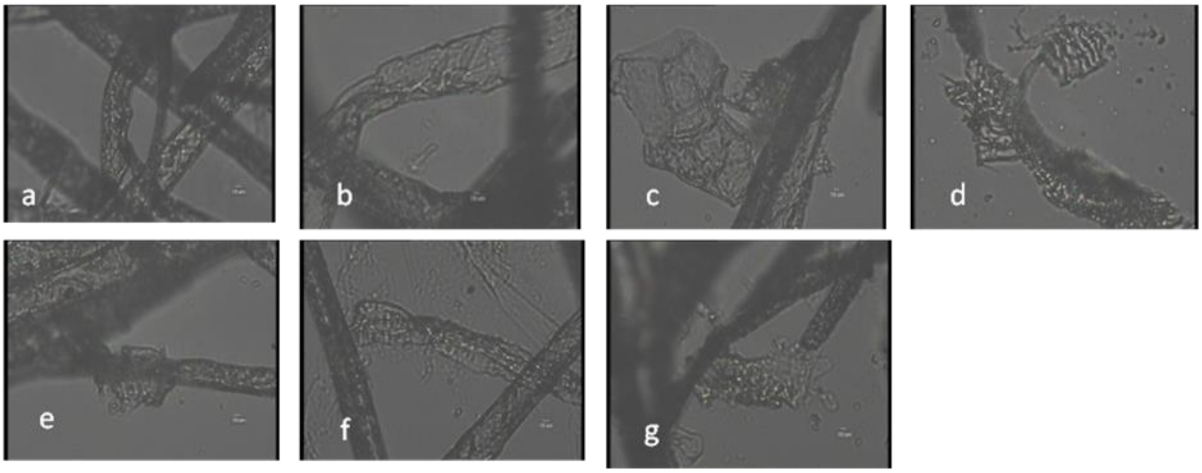

Figure 2. Morphology appearance of milled EFB fiber in 400 x of magnification (EFB DM), after ultrasonication treatment in several parameters E1, 20 (b), E1, 40 (c), E2, 20 (d), E2, 40 (e), E3, 20 (f), E3, 40 (g)

Composite characterization

Treated EFB fibers after milling and ultrasonication process was subjected onto Polyvinyl Alcohol matrix. PVA composite is plastis and has transparant form. After reinforcement with treated fibers, PVA composites density was reduced with no significant difference in composite thickness, as shown in Table 2. Fiber addition could lighter the PVA composites, since fibers is categorised as light material. It means, fibers addition into PVA are very useful for thin and light composites purposes. Composite relative moisture content were also reported decrease than neat PVA. This condition is related to drying step after mixing process, it is not gives different effect for ultrasonication parameters.

Table 2. Physical properties of PVA composites reinforced with treated EFB fiber

Sample	Thickness (mm)	Density (g/cm^3)	Moisture content (%)
Neat PVA	0.26	1.43	15.45
E1, 20	0.26	1.11	5.62
E1, 40	0.27	1.17	8.85
E2, 20	0.24	1.14	10.14
E2, 40	0.26	1.08	8.83
E3, 20	0.28	0.99	8.96
E3, 40	0.26	1.20	5.4

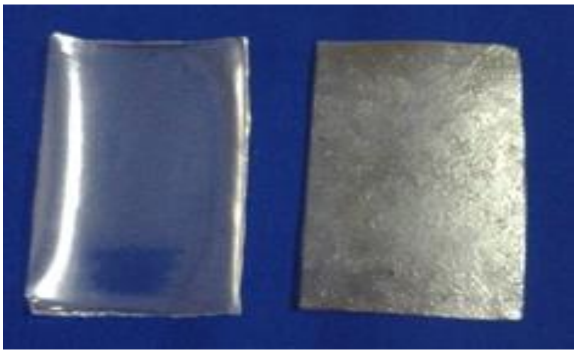

Figure 3. PVA composite appearance without fiber (a) and reinforced with 10% of treated milled EFB fiber (b)

Composite of PVA reinforced by treated fibers result unclear form otherwise still in plastis and transparant. It means that fibers colour and shape affect the composite appearance. Composite that filled with bleached EFB is clearer than filled with unbleached EFB in PVA composites. [17].

Mechanical properties were investigated for PVA composites reinforced with treated EFB fibers that include tensile strength, modulus of elasticity, and elongation at break. The strengthness enhanced with addition of EFB fiber which treated in condition E1,20; E1,40; E2,20; and E2,40 than neat PVA. As presented in Fig 4, different results were occured in E3,20 and E3,40 condition which were reported downward then neat PVA and other parameters. It could be because higher concentration inhibit the sonication wave and further cavitation exposure into fibers surface due to agglomeration. Moreover, lower aspect ratio caused by unfibrillated fiber result poor penetration to the PVA matrix. Whereas, higher aspect ratio and fibrillated fiber could facilitate hydrogen bonding between fibers and PVA matrix, since PVA is a hydrophilic polymer. Concentration strongly affect on the wave to reach the fiber surface and fibrillate the fibers. While, time of ultrasonication slightly contribute to fiber fibrillation in all treatments. However, the composite tensile strength increased eventhough the fibers were treated in 20 minutes ultrasonication at lower concentration. In the previous study, mechanical treatment using refining on EFB fibers resulted tensile strength of PVA composites were 15.10 N/mm^2; 10.93 N/mm^2; and 13.73 N/mm^2 respectively for fiber concentration at 0.25%; 0.5%, and 1% in 20 minutes ultrasonication pretreated by 30 times of refining circulation [16]. Another research reported strengthness enhancement due to addition of unbleached EFB fiber for about 75.41% with 60 minutes ultrasonication treatment and 56.13% with integrated treatment (60 minutes ultrasonication and 60 minutes ultraturrax) pretreated with 30 times of refining circulation. Specific value for these PVA composites are 21 N/mm^2 and 19 N/mm^2 for ultrasonication and integrated treatment, respectively [17]. These result explains that milling process moderately effective than refining process for unbleached EFB fiber.

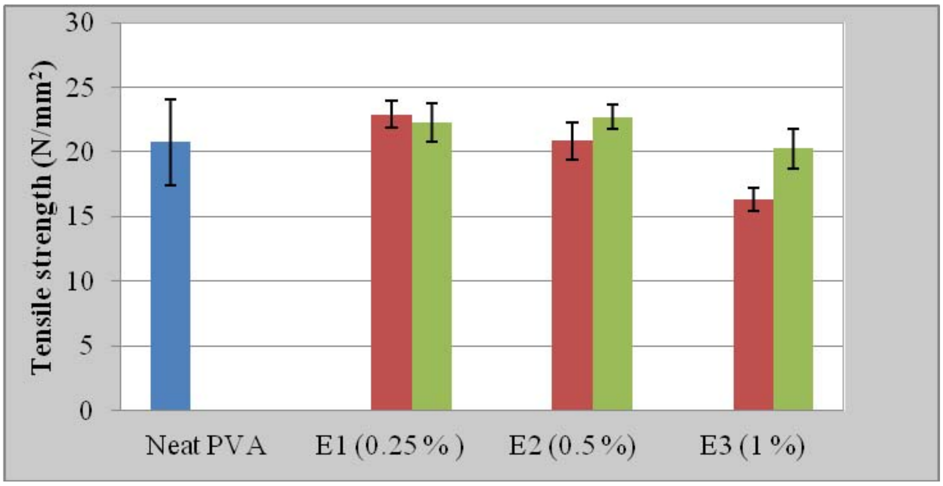

Figure 4. Tensile strength for PVA composites reinforced with treated EFB fiber

Treated fiber improve the PVA composites modulus of elasticity in all ultrasonication treatments compare to neat PVA as depicted in Fig 5. The enhancement of MOE is about 392.7%; 318.39%, and 104.35% for E1, 20; E2, 20; and E3, 20 respectively. Whereas for 40 minutes of ultrasonication time could reach 815.56%; 384.17%; and 234.91% respectively for E1, E2, and E3. Lower concentration and higher time of ultrasonication significantly affect MOE value. Several kinds of fiber sources such us rutabaga, hemp, and flax treated by alkali treatment and used as reinforcement in PVA matrix could enhance 4-5 times of MOE [11]. Some studies state that treated_fibers (refining followed by ultrasonication treatment) significantly improve MOE value. [16,17]. Higher fiber loading onto PVA matrix also increase MOE value for ultrasonication and integrated treatment. [18,19].

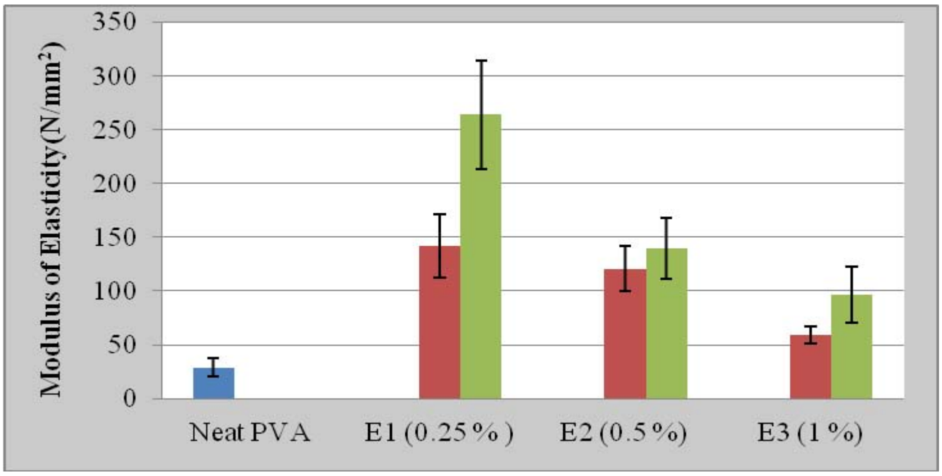

Figure 5. Modulus of Elasticity for PVA composites reinforced with treated EFB fiber

Elongation is important properties particularly for plastis polymer like PVA. In this study, addition of treated fiber onto PVA matrix lowered elongation properties as presented in Fig 6. It explain that the fibers after treatment have high crystallinity. Hence, the PVA composites become stiff than neat PVA. These properties, emphasize that cellulose in crystalline form could be exposed and the amorphous part could be degraded by ultrasonication treatment. As others properties, concentration and time of sonication affected amorphous part degradation. Lower concentration with longer time of sonication resulted stiff PVA composites than others treatments. Higher fiber loading of OPF fiber treated with ultrasonication also produced stiffer PVA composite [19].

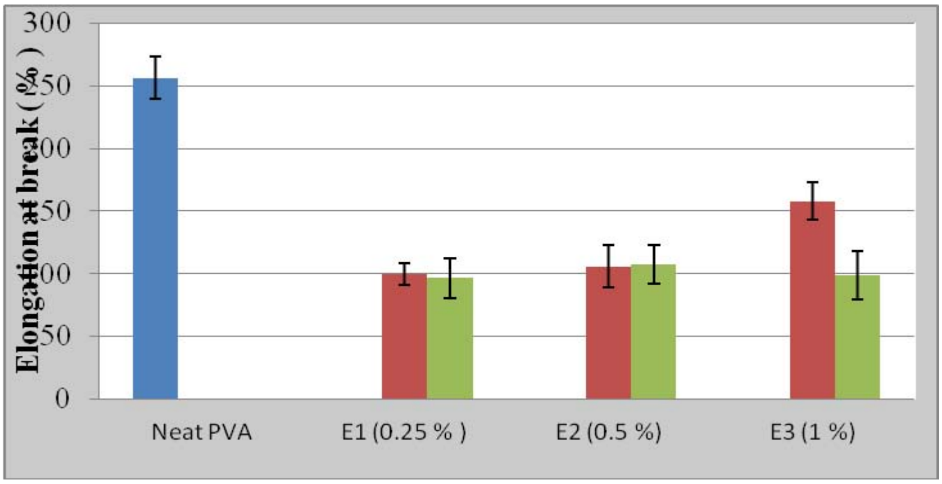

Figure 6. Elongation at break for PVA composites reinforced with treated EFB fiber

Conclusion

Combination treatment to isolate MFC from the origin of EFB fiber have been conducted. Mechanical treatment using milling process and physical treatment using ultrasonication wave resulted in fibrillated fibers for all parameters. The fibrillation was occured both from the middle and the edge of fibers. Addition of treated EFB fibers on PVA matrix could improve physical properties particularly in density, produced lighter composites than neat PVA. Mechanical properties also revealed enhancement include tensile strength, modulus of elasticity, and elongation at break. Concentration and time of sonication affected all mechanical properties parameters. Lower concentration make some changes in cavitation exposure on the fiber surface that further fibrillated fiber could be obtained. Longer time of sonication also give better result especially in modulus of elasticity and elongation at break, whereas slightly affect tensile strength properties. Ultrasonication could expose cellulose which has crystalline form from the EFB fiber and degrade amorphous part.

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PHYSICAL AND MECHANICAL PROPERTIES OF POLYLACTIC ACID-FILLED CHITIN OR CHITOSAN COMPOSITES

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Abstract

Polylactic acid (PLA) is a kind of biodegradable materials with low toxicity and excellent biocompatibility. PLA has a great potential to replace petroleum-based plastics due to its high stiffness and strength. Among many biodegradable polyesters, PLA has attracted the most attention because it is not only highly biodegradable, but can also be derived from renewable natural resources such as corn starch. In addition, PLA can be processed using similar equipments that used for convential plastics such as polypropylene (PP). However, the drawback of PLA is its low toughness. The purpose of this research was to examine the effect of addition of chitin or chitosan on the physical and mechanical properties of the composites. PLA was mixed with chitin or chitosan in acetone. After well mixed, the mixture was dried at room temperature for 24 hours followed by drying in an oven at 55° C for 12 hours. The physical properties of composites were evaluated by light microscope and the mechanical properties by Universal Testing Machine (UTM). Result showed that the tensile strength and elongation at break decreased but the tensile modulus of the composites increased with increasing of chitin or chitosan added.

Keywords: *polylactic acid, chitin, chitosan, composites, physical and mechanical properties*

Introduction

Polylactid acid (PLA) as a high strength, high modulus polymer has received much attention in the research of alternative biodegradable and biocompatible polymers produced from renewable resources. This fact is responsible for a growing interest in PLA for many applications, as it is expected to reduce an impact on the environment caused by the production and utilization of petrochemical polymers [1].

Amorphous PLA is rigid and brittle due to the high glass transition temperature (*Tg*) in the range of 50-60^{o} C. So below this temperature, the low deformation at break limits the application of PLA. Therefore, considerable efforts have been made to improve the ability of plastic deformation. Some chemical modifications with plasticizers have been done to improve the flexibility of PLA for example citrate ester [2], polypropylene glycol (PPG) [3], triacetine [4], oligomeric lactic acid and glycerol [5]. However, the addition of plasticizers generally deteriorates the precious strength and modulus of PLA.

Chitin and chitosan polymers are natural aminopolysaccharides having unique structures, multidimensional properties, highly sophisticated functions and wide ranging applications in biomedical and other industrial areas [6]. Some researches have been done to improve the properties of thermoplastic composites for example with chitin and chitosan as filler. According to Husseinsyah *et al.* [7], chitosan as filler with chemical modification by acrylic acid could increase the Young's modulus of PP composites. Therefore, the addition of chitin and chitosan as filler is expected to improve the properties of PLA composites with chemical treatment by acetone solvent.

The aims of this research was to investigate the characteristics of amorphous polylactid acid composites with chitin or chitosan as filler also chemical treatment with acetone solvent.

Materials and Methods

Amorphous polylactid acid (PLA) used in this study was of injection molding grade from Japan with code number H4060D. Chitin was obtained from Japan and chitosan was industrial grade obtained from PT. Biotech Surindo Cirebon Indonesia with degree of deacetylation (DD) of 90%. Technical acetone solution was used in this study.

A 45 g (90% w/w) of amorphous PLA was dissolved in 350 ml acetone solution at room temperature. The mixture was mechanically stirred for 4 hours in order to make it homogenous. After homogenous, the chitin or chitosan powder was added with concentration of 10% w/w (5 g). Mixing was continued for another 1 hour at overhead stirrer. After well mixed, the mixture was casted in a mold and dried at room temperature for 24 hours followed by drying in an oven at 55^{o} C for 12 hours. Then, the mixture was kneaded in the laboplastomill at 140^{o} C, 40 rpm for 10 minutes.

Samples of composites were molded in an electrically heated hydraulic press at 140^{o} C, 1 MPa for 15 minutes. In this study, chitin-amorphous PLA composites were made without dissolved in acetone solution previously. The mixture was directly kneaded in the laboplastomill at the same procedures. The physical properties of composites were evaluated by light microscope and the mechanical properties by Universal Testing Machine (UTM) according to ASTM D-638 and ASTM D-790.

Results and Discussion

Physically, all the material of thermoplastics composites has been mixed well during the mixing process in the laboplastomill. But, the results of imaging with light microscope for PLA-chitin or chitosan composites showed visible white spots originated from chitin or chitosan powder that has not decomposed perfectly (Figure 1: middle and right).

Figure 1. Composites of pure amorphus PLA (left), amorphus PLA + chitin (middle) and amorphous PLA + chitosan (right) at light microscope (50x)

The phenomenon of persistence of chitin or chitosan spots at composites related to the decomposition temperature of chitin or chitosan itself. Result of thermogravimetric analysis (TGA) test showed that chitin and chitosan are decomposed at approximately 270^{o} C-320^{o} C [8]. So, the mixing and hot pressing temparature at 140^{o} C have not been able to melt and composed chitin or chitosan powder completely. According to Kaban [9], chitin and chitosan tends to decompose rather than melt at the time of heating.

Figure 2 shows the effect of chitin or chitosan filler on the tensile strength of PLA composites. The results exhibit that with adding of polymer filler the tensile strength of composites decreased than pure PLA. Results of the test showed that composites with 5% chitin by unsolved in acetone-direct kneading posses the highest tensile strength which is 42.3 MPa and the lowest is 5% chitosan by dissolved in acetone-kneading which is approximately 24.6 MPa. This might be due to the poor interfacial bonding between filler and matrix polymer. The chemical treatment of chitin or chitosan with solved in acetone have not been able to improve the tensile strength of composites significantly. The tensile strength of composites with direct kneading and unsolved in acetone are higher than the other treatments.

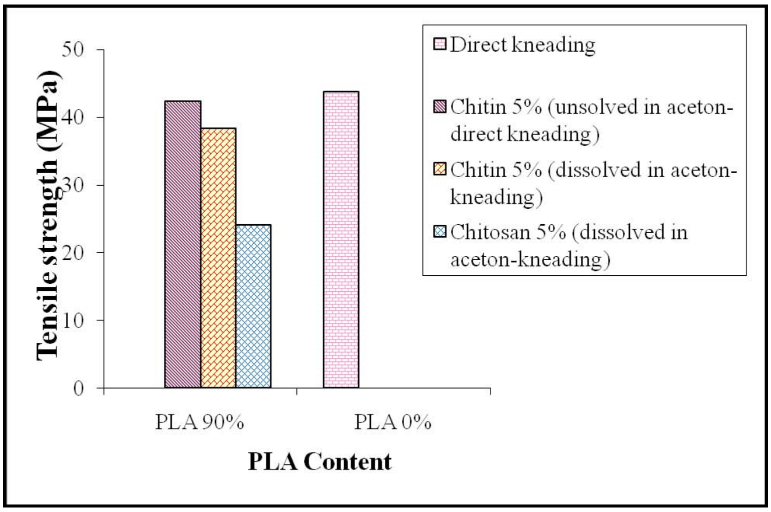

Figure 2. Tensile strength histogram of composites

According to Husseinsyah *et al.* [10], high chitosan percentage could reduced the tensile strength of composites. Chitin or chitosan as filler could reduced the stiffness and decreased deformability of composites so this condition related to the tensile strength of composites.

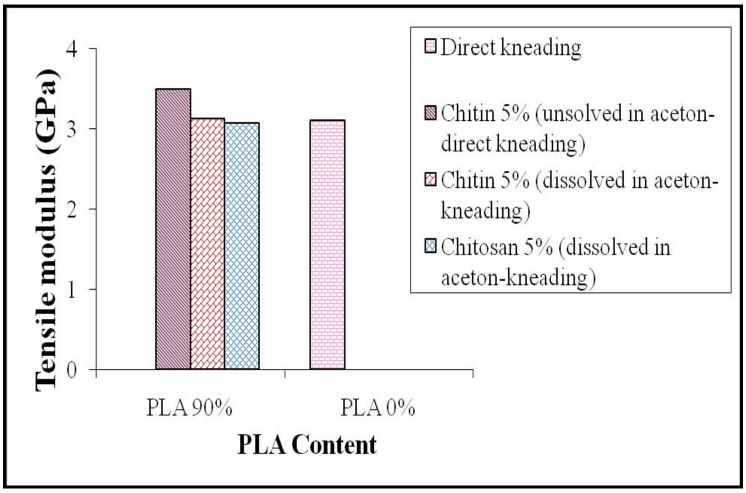

Figure 3. Tensile modulus histogram of composites

The tensile modulus (MOE) is one of the most important mechanical properties of composites. MOE describe the stiffness of materials. The higher MOE the higher stiffness of materials. Results of the test showed that composites with 5% chitin by unsolved in acetone-direct kneading posses the highest MOE which is 3.50 GPa and the lowest is 5% chitosan by dissolved in acetone -kneading which is approximately 3.08 GPa (Figure 3). Adding the filler chitin and chemical treatment by acetone could improve of composites than other processes. Though insignificant, it is believed that the modification of chitin and chitosan with acetone had a positive effect on the tensile modulus because it reduced agglomeration and increased interfacial adhesion between chitin or chitosan and the PLA matrix.

The effect of chitin or chitosan fillers adding on the elongation of composites is given in Figure 4. Adding the chitin or chitosan fillers and chemical treatment by acetone significantly reduced the elongation of composites than pure PLA. Results of the test showed that composites with 5% chitin by unsolved in acetone-direct kneading posses the highest elongation which is 3.14% and the lowest is 5% chitosan by dissolved in acetone-kneading with approximately 2.61%.

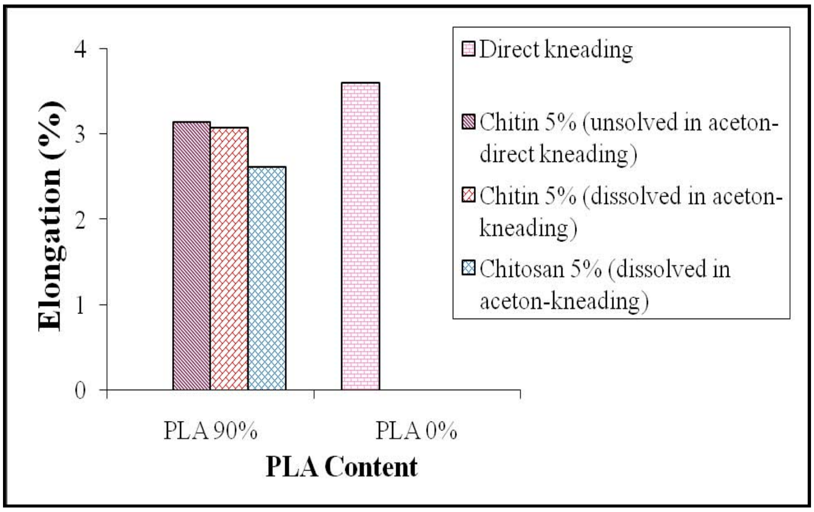

Figure 4. Elongation histogram of composites

This observation might be due to the stiffening effect of chitin or chitosan and decreased deformability of a rigid interface between filler and PLA matrix. Adding chitin or chitosan fillers and chemical treatment by acetone solvent resulted in good stress propagation and improved the tensile modulus but it caused the composites more brittle than the PLA matrix. This condition influenced the elongation of composites due to the decreased of their ductility.

Conclusion

Physically, composites with chitin or chitosan fillers have a good stress propagation but it caused the composites more brittle than the PLA matrix. The effect of chemical treatment with acetone solvent and adding of chitin or chitosan fillers improved the tensile modulus, however it reduced the tensile strength and the elongation of composites though–insignificant. The increased of tensile modulus was attributed to the improvement of interfacial adhesion between chitin or chitosan filler and the amorphous PLA matrix.

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ANATOMICAL CHARACTERISTICS OF WANGKAL WOOD (*Albizia procera* (Roxb.) Benth)

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Abstract

The increasing intensity of forest degradation and deforestation in Indonesia has endorsed the use of lesser-known wood species, which in potency are abundant and so far still not much utilized. Wangkal wood (*Albizia procera* (Roxb.) Benth) is one of the lesser known species which its existence is quite a lot in the community. The objective of this research was to study the anatomical characteristics of Wangkal wood through macroscopic and microscopic observations referring to the standard of International Association of Wood Anatomist (IAWA). The results of this study would be beneficial in providing information of its potential utilization. The material for this study was obtained from Ciamis region, West Java. The results of macroscopic observation showed that the hearth-wood of Wangkal wood was brownish while the sap-wood was greyish white to light brown; the wood was hard with rough texture; and the grain was straight to interlocked. The microscopic observation showed that the distribution of vessels cell was diffused with average of diameter 287.62 μm (183.20 – 338.92 μm)*;* 275.17 μm (206.10 – 423. 65 μm) in length; and the frequency of vessels cell was about 2-3 per mm^2. The average of fiber length was 1108.05 μm and 3,94 μm in diameters. The form of axial parenchyma was aliform until confluent, and the rays composed by 1-3 cells wide (lying cell). According to the derived values of fibers, Wangkal wood could be categorized into the quality class II as raw material for the production of pulp and paper.

Keywords: *Wangkal wood, anatomical characteristics, macroscopic, microscopic, IAWA*

Introduction

Recently, wood consumption increases along with rapid population growth and the development of wood industries. The community and industries, unfortunately, are still utilizing the commercial woods, whereas the availability of those woods nowadays tends to decrease due to high degradation and deforestation of natural forests, which are essentially the place where those woods are originated. On the contrary, the lesser known species, which are abundant but not yet much studied, seem to have a good prospect in their use as alternfative wood resources in the future.

The commercial fast growing wood species, e.g. Sengon and Acacia, belonged to be the exotic species. Nevertheless, previous studies have shown that those woods have a promising prospect [1]. Since then, they become commercial species and developed by community as well as many wood industries.

Wangkal wood (*Albizia procera* (Roxb.) Benth) is one of the lesser known species which its existence is quite a lot in the community. Wangkal wood, well-known as Ki Hiyang (Sundanese) or Weru (Javanese) belongs to the family of Fabaceae. Wangkal tree can reach 28-30 metres in height, with diameter up to 50 cm. It can grow well in areas with an altitude more than 1200 metres, and the distribution of this species in Indonesia were covers the entire of Java [2] and often grow in by clusters [3]. The objective of this research was to study the anatomical characteristics of Wangkal wood (*Albizia procera* (Roxb.) Benth) through macroscopic and microscopic observations referring to the standard of International Association of Wood Anatomist (IAWA) [4], and expectedly the results of this research would be beneficial in providing information of its potential utilization.

Materials and Methods

The material for this study was Wangkal wood with 28 cm in diameter, obtained from Ciamis region, West Java. The trunk of Wangkal wood was cut into 50 cm in length, and then fragmented into disc (5 cm in thickness) in cross section. The observation of anatomical properties was done in (1) Plant Anatomy Laboratory, Forest Products Research and Development Center, Ministry of Forestry of Indonesia; and (2) Laboratory of Wood Quality Enhancement Technology, Faculty of Forestry Bogor Agriculture University.

The observation of wood anatomical properties consisted of (1) the macroscopic (general) characteristics, i.e. color, texture, grain orientation, luster, and appearance of wood surface, as well as the odor [5]; and (2) the microscopic characteristics. The latter was observed from wood specimen on cross, radial, and tangential sections with 15 – 25 µm in thickness by using a microtome. The dehydration process was done simultaneously on the specimens by using alcohol in succession from 30%, 50%, 70% and an absolute concentration. The dehydrated specimens were then immersed for a while in carboxylol and toluene to obtain the transparent specimen and then mounted on the object glass [6]. The anatomical properties as observed were referred to the standard of International Association of Wood Anatomist (IAWA) [4]

The maceration was also conducted for evaluating fiber quality through the observation of its quantitative characteristic (fiber dimension). In this method, small wood sticks were put inside the tube which contained a solution of hydrogen peroxide (H_2O_2) and acetic anhydride glacial (1 : 1), and then heated using a water bath [7].

The quantitative characteristics were observed using 10-25 measurements (n) per sample, which depended on the variables such as (1) vessel diameter, n=25, (2) vessel frequency per mm^2, n=10, (3) rays frequency, n=10, (4) rays height, n=25, (5) fiber length, n=25, (6) fibers diameter and cell wall thickness, n=15. The fiber morphology/dimensions as obtained (e.g. fiber length, fiber diameter, cell wall thickness) were then used to determine their derived values as the parameter to classify the quality of fiber [8].

Results and Discussion

Macroscopic features

The results of macroscopic observation showed that there was a clear boundaries (striking) between sapwood and heartwood section on Wangkal wood (Figure 1A, B). The hearth-wood of Wangkal wood was brownish, similar to the heartwood of Merbau [9], while the sap-wood was greyish white to light brown. The wood was hard with rough texture, categorized into strength class II [2]. The grain was straight to interlocked, with decorative pattern. The pattern of wood could be caused by differences in the intensity of staining woody tissue layer which formed in a different time [5]. In dry conditions, there was no special odour from Wangkal wood. Based on the observations, there was a decreasing trend in the proportion of the heart-wood of Wangkal along with stem height (from the base to the top). In contrast, the sapwood proportion showed a tendency of increase from base to top (Figure 1).

Figure 1. Wangkal wood: (A) cross section; (B) longitudinal cross section

Microscopic features

According to the microscopic observation [4], the growth rings of Wangkal wood was indistinct (trait number "tn" 2), similar to wood from other family of fabaceae (Sengon, Kempas, Merbau, etc) Figure 2 showed that the vessel cells of Wangkal wood were diffused (tn.5), with diagonal or radial configurations (tn.7). Wangkal wood was composed by scattered pores, mostly made up of solitary pore and others of dual radial (2-4 pores) with spherical pore shape and oval. The frequency of vessels cell was about 2-3 per mm^2, and the perforation plate was simple (tn.13) (Figure 3).

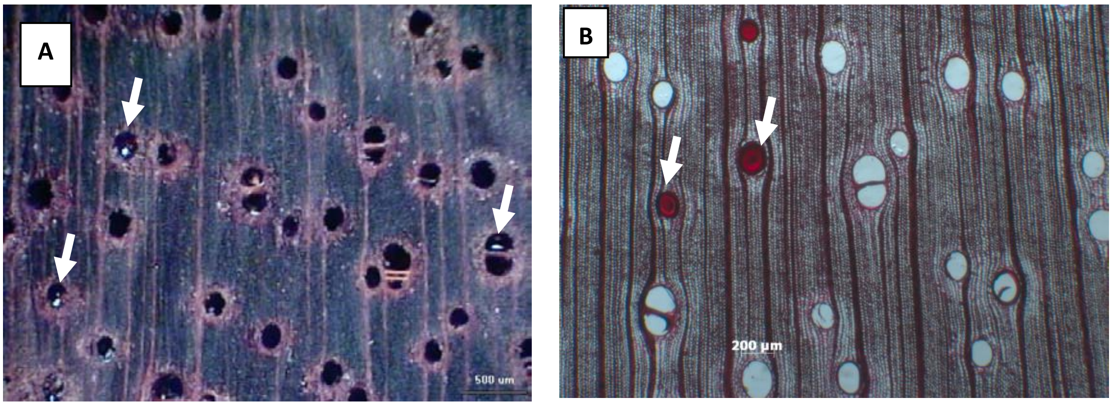


Figure 2. The cross section of Wangkal wood (magnification 25x): (A) tylosis; (B) sediment

The composition of inter-vessel pits was alternate (tn.22); and a tufted pits could be found (tn.29). The pit between the vessel and rays (vessel-ray pits) with a clear page, similar in size and shape of inter-vessel pits (tn.30). There was existence of tylosis (tn.56) that appears with translucent color (Figure 2A), and the presence of sediment inside the vessel was also found (tn.58), as shown in figure 2B.

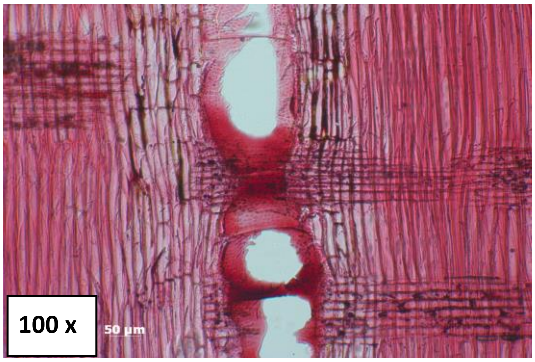


Figure 3. The simple perforation plate (mag. 100x)

The insulated fiber and fiber without the bulkhead were found in Wangkal wood (tn.65, 66). The cell walls of the fiber were thin to thick (tn.69). The axial parenchyma was paratracheal types, since most of the parenchyma located in contact with the vessel cells. The vasicentric paratracheal axial parenchyma, aliform, and confluent could also be found in Wangkal wood (tn.79, 80 and 83). Sighting of these type of parenchyma were similar to Merbau and Kempas wood [9]. Additionally, the insulated parenchyma was found with 2 numbers of cells per strand and 3-4 cells per strand of parenchyma (tn.91, 92) (Figure 4). The prismatic crystals were found inside the axial parenchyma chamber (tn.136, 142) (Figure 5). It contained a lot of calcium oxalate which could reflect shimmering color when exposed to the polarized light [4].

Figure 4. Tangensial section (mag.100x): insulated parenchyma

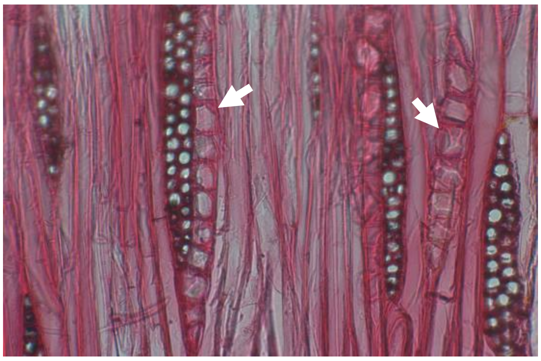


Figure 5. Tangensial section (mag.200x):the prismatic crystals

Figure 3 and 4 showed that the rays of Wangkal wood composed by 1-3 cells wide (tn. 97). The type of rays was homocelluler "lying cell" (tn.104) with the frequency for about 4-12 cells per mm (tn.115).

Fiber dimensions and their derived value

The results of the observation and measurement of fiber dimensions and calculation of their derived values are presented in Table 1

Table 1. Fibers Dimension and their Derived Value of Wangkal wood (*Albizia procera* (Roxb.) Benth)

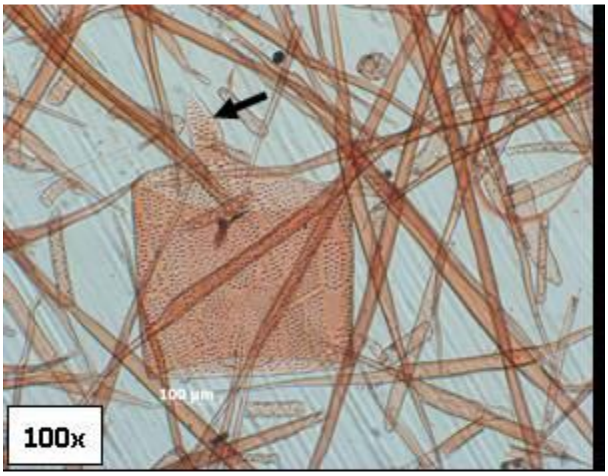
Species	Fibers Dimension (µm)				The Derived Values of Fiber Dimensions				
	L	d	l	w	Runkle Ratio	Felting Power	Flexibility Ratio	Coef. of Rigidity	Multshep Ratio
Wangkal (*Albizia procera* (Roxb.) Benth)	1108.05	26.51	18.64	3.94	0.43	42.46	0.70	0.15	0.50
Quality class [10]					II	III	II	II	II

Notes:

L = fiber length	Runkel ratio	= 2w/l
d = fiber diameter	Felting power	= L/d
w = cell wall thickness	Flexibility ratio	= l/d
l = lumen diameter	Coefficient of rigidity	= w/d
(l = d - 2w)	Multshep ratio	$= \frac{(d^2-l^2)}{d^2} \times 100\ \%$

According to Table 1, it was showed that in general the fiber quality of Wangkal wood could be categorized as quality class II. Pulp and paper quality that made from a type of wood was influenced by its dimensions. The fiber dimensions of Wangkal wood could be categorized as medium size (1108.05 μm in length and 3.94 μm in cell walls thickness). The fiber length affects the tear strength of paper [11], the longer the fiber size, the higher the tear strength. While the thinner the cell walls, the better for the raw materials of pulp and paper, since the fibers bond, whichwere formed, will be stronger [10].

From the results of maceration the shape and size of the vessels cells could also be observed (Figure 6). The average of vessel diameter was 287.62 μm (183.20 – 338.92 μm), and 275.17 μm (206.10 – 423.65 μm) in length. It could be implied that the ligullate extension (tongue-like shape at the end of the vessel tongue-like shape at the tip pambuluh) served as a hook/fastener against other vessels.



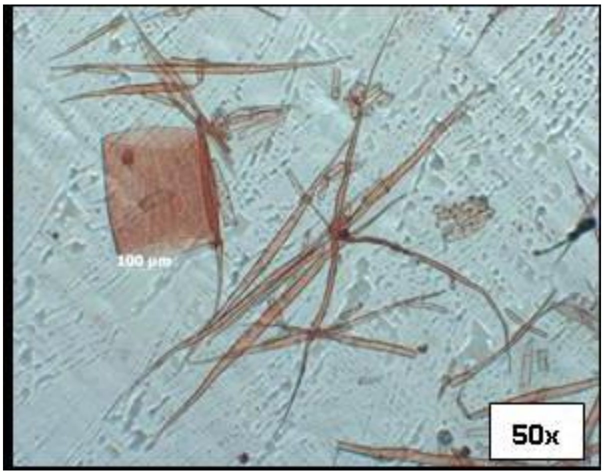


Figure 6. Fibers, Vessel Cells and ligullate extension of Wangkal wood

Conclusion

According to the derived values of fibers, Wangkal wood could be categorized into the quality class II as raw material for pulp and paper. However, due to the wood was quite hard (strength class II) and had a good decorative pattern; this wood was potential to be used for construction and furniture. The heartwood characteristic of this wood were almost similar to those of Merbau (*Instia palembanica* Nick)

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LARVICIDAL ACTIVITY OF *Cerbera manghas* EXTRACT AGAINST TWO MOSQUITO VECTORS, *Aedes aegypti* AND *Culex quinquefasciatus* (Diptera: *Culicidae*)

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Abstract

Mosquitoes are well known insects which able to transmit many dreadful diseases to human. *Aedes aegypti* is vector for dengue disease while *Culex quinquefasciatus* is vector for filariasis. The key method to prevent disease transmission is to cut the transmission cycle by controlling the vector. Vector control by chemical insecticide is effective but not environmentally preferable and in many cases, is resulting insecticidal resistance. To overcome this issue, vector control by natural compound is an alternative treatment, offer safer environmental impact and human health. This study aimed to evaluate larvicidal efficacy of *Cerbera manghas* against two mosquito vectors, *Ae. aegypti* and *C. quinquefasciatus*. The results showed that 1000 ppm concentration of seed kernel extract was able to cause 87,2% mortality of *Ae. aegypti* larvae, while the extract of bark, rind and leaves could only cause less than 25% larval mortality. Larvicidal efficacy of the extract of *C. manghas* against *C. quinquefascatus* showed higher mortality rate than *Aedes aegypti*. Seed kernel extract gave 91.2% mortality of *C. quinquefascatus* larvae at 250 ppm concentration, while 100% larval mortality was achieved at 500 ppm. Bark extract resulted 91.2% larval mortality at 1000 ppm, while at same concentration, rind and leaves extract only could deliver 64.8% and 82.4% larval mortality respectively. LC_{50} and LC_{90} value varied depended on which part of plant the extract was obtained and the mosquito larvae species. The lower the value, the higher efficacy level. Seed kernel extract provided the lowest LC_{50} and LC_{90} value, 517,3 ppm and 964,8 ppm against *Ae. aegypti* respectively; and 90,4 ppm and 214,4 ppm against *Culex quinquefasciatus* respectively.

Keywords: *larvicidal activity, Cerbera manghas, Aedes aegypti, Culex quinquefasciatus*

Introduction

Dengue fever is an infectious tropical disease caused by dengue virus, which in some cases develops into life-threatening dengue hemorrhagic fever or dengue shock syndrome [1]. Dengue is transmitted by several species of mosquito within the genus *Aedes*, principally *Aedes Aegypti*. Dengue has become a global problem since the Second World War and is endemic in more than 110 countries, and Indonesia is one of the countries with highest dengue cases. In 2007, it was reported that Indonesia has the highest number of cases and death caused by dengue fever in the world [2].

Another important mosquito vector, *C. quinquefasciatus* also massively found in urban environment in Indonesia. *C. quinquefasciatus* is known as the vector of many pathogens of humans, and both domestic and wild animals. Viruses transmitted by this species include WNv, SLEv and Western equine encephalitis virus (WEEv), and lymphatic filariasis caused by the filarial nematode *Wuchereria bancrofti* in the tropics and subtropics.

One of the key to prevent and overcome these diseases transmission is to cut transmission cycle by controlling the vector [3]. Vector control using chemical insecticides is effectively prove able to control the vector, but continuous use of synthetic chemicals is threatening environmental and human health, and resulting insecticidal resistance. Thus, finding alternative control with equal insecticidal efficacy which focus on environmentally friendly approach and the safety of human health is indispensable. Vector control by phytochemical insecticide has received attention as this treatment is considered as biodegradable and environmentally-safe [4]. Unlike synthetic insecticide which based on single active compound, the phytochemical extract consist of hundreds bioactive chemical compound and secondary metabolites [5]. Several plants have been reported to have larvicidal activity, such as *Melia azedarach* L. [6], *Ocimum canum* [7], *Azadirachta indica* [8], *Sapindus emarginatus* [9], *Carica papaya* [10], and aloe vera [11].

This study was carried out to evaluate larvicidal efficacy of *C. manghas* (Bintaro) against two mosquito vector, *Ae. aegypti* and *C. quinquefasciatus*. Eventhough Bintaro has been reported to have insecticidal actitvity such as growth inhibition against insect *Eurema* sp. [12], high toxicity against termite *Coptotermes gestroi* [13] and storage product pest *Sitophilus oryzae* [14], but their larvicidal activity is not yet thoroughly evaluated.

Materials and Method

Extraction process

Bintaro (*C. manghas*) has been obtained from Bogor, Indonesia. Leaves, bark, rind and seed kernel of *C. manghas* were sun dried and powdered into 40 mesh. Each part of *C. mangas* was macerated using methanol, and then filtrate collected and separated from residue. Then the filtrate evaporated by rotary evaporator (RV 10 Digital, IKA Works GmbH & Co., Germany) at 40 ^{0}C, and dried on waterbath to obtain dried extract.

The larvae colonies of Ae. aegypti dan C. quinquefasciatus

The eggs of *Ae. aegypti* and *C. quinquefasciatus* was purchased from laboratory of parasitology and health entomology, faculty of veterinary medicine, Bogor Agricultural University. The eggs were reared at laboratory of biodeterioration and pest-insect control, R&D Unit for Biomaterials LIPI. The larvae has been fed by dog food pellet.

Bioassay

Bioassay was carried out according to WHO protocol [15]. The extract from leaves, bark, rind, and seed kernel of *C. manghas* were prepared into various concentration: 100 ppm; 250 ppm; 500 ppm; and 1000 ppm, and 0,5 ml tween solution was subsequently added to each concentration as surfactant in order to completely dissolve the extract on the water. Twenty five 3rd and 4th instar of larvae of *Ae. aegypti* and *C quinquefasciatus* were subjected into 100 ml solution of each concentration, in 5 replication. The observation was conducted on 24 h and 48 h after subjection.

Results and Discussion

The yield of extraction from leaves, seed kernel, bark and rind of *C. manghas* was 8,46%, 10,11%, 10,62%, and 12,98%, respectively. Extract solution from each part of *C. manghas* showed different color and thickness. Leaves extract resulted dark green color, bark extract showed dark brown color, seed kernel showed brown color and rind extract showed less color. The color thickness is related with the concentration of chemical compound in the extract, but as shown on the fig.1 and fig. 2, the yield and color thickness were not related with the efficacy against the larvae of *Ae. aegypti* and *C. quinquefasciatus*. The efficacy was determined by the mortality level of the larvae at 24 h and 48 h after subjection.

Fig. 1 showed preliminary assessment of the extract of *C. manghas* from bark, seed kernel, rind, and leaves, against *Ae. aegypti* larvae. The extract concentration was prepared on 100 ppm, 250 ppm, 500 ppm and 1000 ppm. Larval mortality result indicated that seed kernel extract showed highest efficacy against *Ae. aegypti*, delivered 87,2% mortality at 1000 ppm after 48 h subjection (fig. 1.b). Bark extract showed the lowest efficacy; even at 1000 ppm concentration was only able to deliver 12% larval mortality (fig. 1.a). At highest concentration, rind and leaves extract gave 21,6% and 13,6% respectively (fig. 1.c-d). The results suggested that the extract of *C. manghas* showed moderate toxicity against *Ae. aegypti* larvae, and the chemical compound at seed kernel extract has highest efficacy compared to other part of the plant.

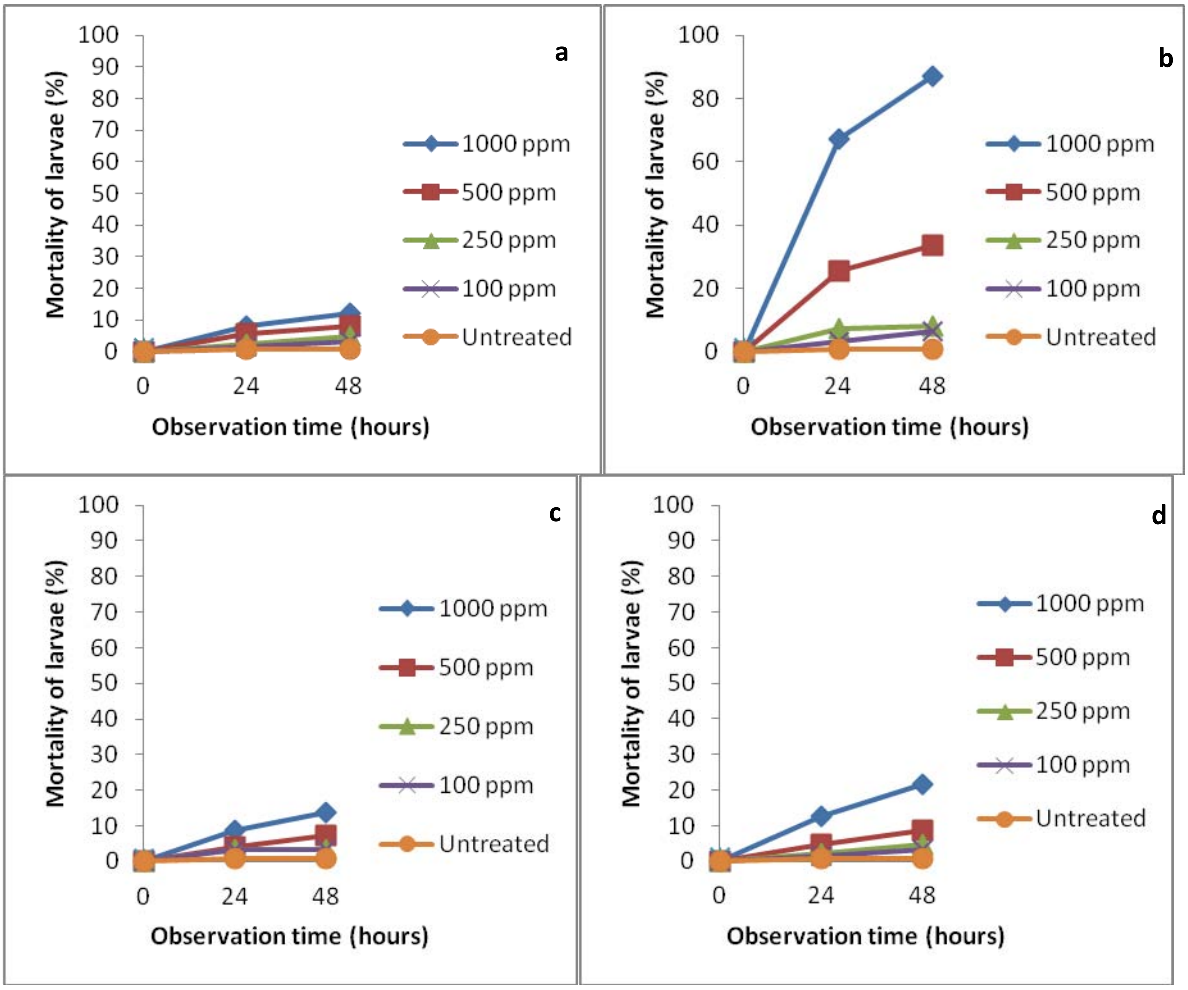

Figure 1. Mortality of *Ae. aegypti* larvae after subjected into the extract of *C. manghas*: **a** bark, **b** seed kernel, **c** rind, **d** leaves.

Fig. 2 displayed the efficacy of *C. manghas* extract against *C. quinquefasciatus* larvae. The results also indicated that bark extract gave the highest efficacy compared to other parts of the plant, delivered 100% larval mortality at 1000 ppm after 24 h subjection and 91,2% mortality at 500 ppm after 48 h subjection (fig. 2.b). At the highest concentration and 48 h subjection, extract of bark, leaves and rind delivered 91,2%, 82,4% and 64,8% larvae mortality, respectively (Fig. 2.a,c,d). Overall, *C. manghas* extract showed higher toxicity against *C. quinquefasciatus* larvae compared to *Ae. aegypti*.

Plant extracts have been reported to have good potency as natural larvicide. The results of bioassay against *Ae. aegypti* and *C. quinquefasciatus* suggested that *C. manghas* has lower efficacy compared to leaves extract of *Cassia fistula* Linn [16] and *Ageratum houstonianum* Mill [17], seed kernal extract of *Azadirachta indica* [18], leaves extract of *Acalypha indica*, *Achyranthes aspera* [19], and *Citrus sinensisI* [20]. Methanol extract of the leaves of *Cassia fistula*, *Acalypha indica*, and *Achyranthes aspera* delivered 100% larval mortality at 500 ppm, 409 ppm and 420 ppm respectively [16,19].

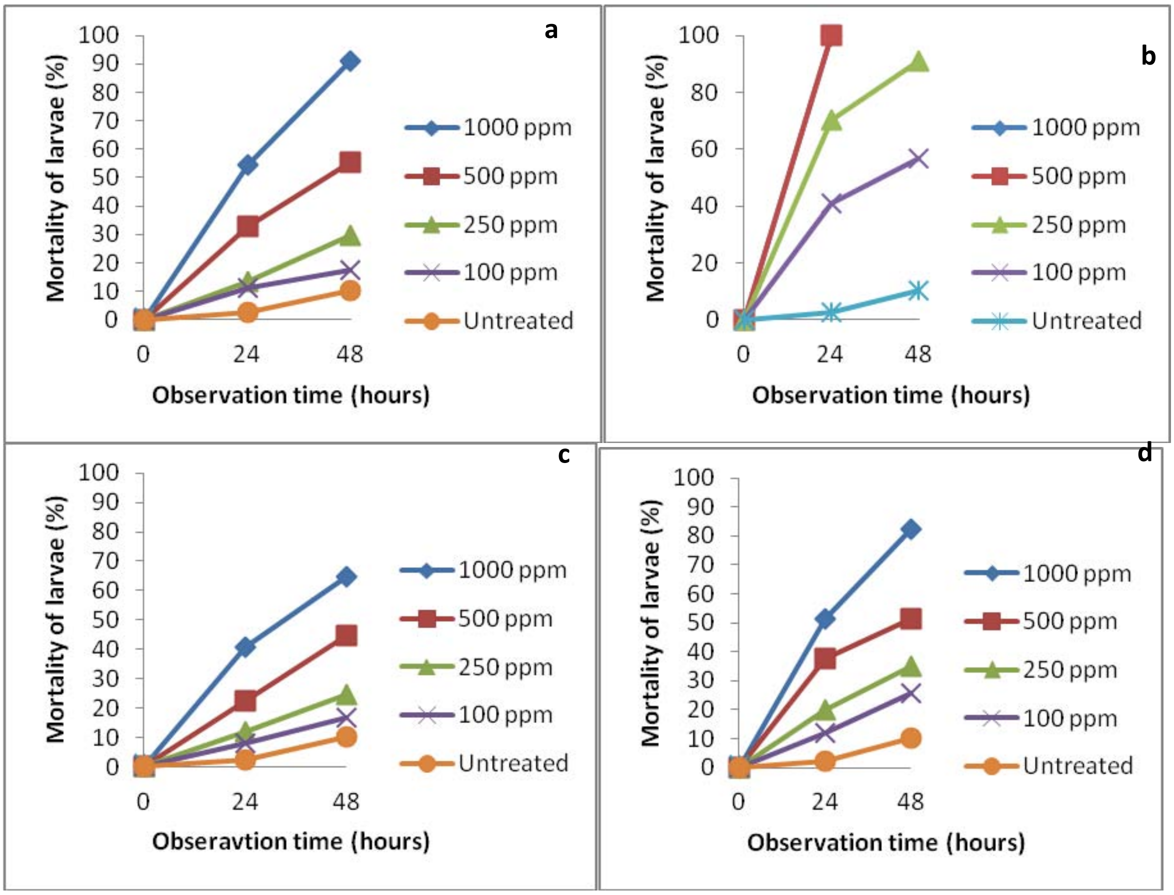

Figure 2. Mortality of *C. quinquefasciatus* larvae after subjected into the extract of *C. manghas*: **a** bark, **b** seed kernel, **c** rind, **d** leaves.

Table 1. LC_{50} value and LC_{90} value of *C. manghas* extract against *Ae. aegypti* and *C. quinquefasciatus*

Extract materials	Larvae	LC_{50} (ppm)		LC_{90} (ppm)	
		24 hours	48 hours	24 hours	48 hours
Steam bark	*Ae. aegypti*	3175,7	2198,3	13840,2	9469,3
	C. quinquefasciatus	923,4	409,2	5654,2	1245,7
Leaf	*Ae. aegypti*	6901,8	4889,6	64473,5	44252,4
	C. quinquefasciatus	956,6	354,9	9869,8	2504,9
Seed kernel	*Ae. aegypti*	760,6	517,3	2364,1	964,8
	C. quinquefasciatus	131,3	90,4	344,1	214,4
Rind	*Ae. aegypti*	5446,7	3056,5	38986,2	23092,6
	C. quinquefasciatus	956,6	354,9	9869,8	2504,9

Table 1 showed the value of lethal concentration, LC_{50} and LC_{90} values, from methanol extract of various part of *C. manghas* against *Ae. aegypti* and *C. quinquefasciatus*. The lower the value, the higher the efficacy. Seed kernel extract gave the lowest value of LC_{50} and LC_{90}: 517,3 ppm and 964,8 ppm against *Ae. aegypti* after 48 h subjection; and 90,4 ppm and 214,4 ppm against *C. quinquefasciatus* after 48 h, respectively. The results suggested that seed kernel extract has highest larvicidal potency compared to other part of the plant. The value also confirmed that *C. manghas* showed higher larvicidal efficacy against *C. quinquefasciatus* compared to *Ae. aegypti*. Among the various part of *C. manghas*, leaves extract showed the lowest larvicidal potency, followed by rind and bark part. LC_{50} value of seed kernel extract against *C. quinquefasciatus* indicated better larvicidal performance compared to methanol extract of *O. canum* [7], *M. charantia*, *T. anguina*, *Luffa acutangula*, *Benincasa cerifera* and *Citrullus vulgaris* [21] as those extracts were reported to deliver 99.42 ppm, 465.85 ppm, 567.81 ppm, 839.81 ppm, 1,189.30 ppm and1.636,04 ppm, respectively.

Conclusion

Seed kernel extract of *C. manghas* showed higher larvicidal efficacy against *C. quinquefasciatus* compared to *Ae. aegypti*. Seed kernel extract delivered 100% *C. quinquefasciatus* larval mortality at 1000 ppm after 24 h subjection and resulted LC_{50} value 90.4 ppm after 48 h subjection. Other parts of the plant showed less toxicity against *Ae. aegypti* and moderate toxicity against *C. quinquefasciatus*.

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CONTACT TRACING STRATEGY TO IMPROVE THE FINDING QUALITY OF TUBERCULOSIS (TB) SUSPECTS IN BENGKULU TENGAH DISTRICT

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Abstract

Tuberculosis (TB) is an infectious disease resulting a high number of mortality. Despite of the treatment has been carried out such as using antibiotics and vaccines, a number of TB cases are increasing in the several world regions. Finding out positive TB cases with ease and accuracy requires the quality of suspects. Suspect quality can be determined by using the contact tracing strategy.

Keywords: *Tuberculosis, Tuberculosis suspect, tracing contact.*

Introduction

Pulmonary Tuberculosis (TB) remains as health problems in the world, including Indonesia. Data from the World Health Organization (WHO) shows the high prevalence of pulmonary tuberculosis (TB) worldwide. In 1995, it was estimated that there were 9 million new TB patients and 3 millions died from TB attack around the world, the situation became worse as the number of cases of HIV/AIDS increased significantly. Based on Household Health Survey (HHS) 1995, TB was the third largest that caused death, that came after cardiovascular diseases and respiratory diseases and it was also number one in the infectious disease group [1].

Tuberculosis (TB) is an infectious disease that still has a quite high number of victims. The appearance of HIV/AIDS in the world is expected to increase TB patients. The female mortality caused by TB is more than the deaths due to pregnancy, childbirth and postpartum.

WHO mentioned that 90 % of pulmonary tuberculosis patients in the world attacked the low economy or the poor. Low socioeconomic conditions will cause a high residential density and poor environment, in addition to the nutritional problems and lack the ability to obtain adequate health care which are also a problem for lower socioeconomic groups.

Based on the data of World Health Organization (WHO) in 2007, Indonesia was the third that came after India and China. In 2009, Indonesia shifted down to the fifth after India, China, South Africa and Nigeria. WHO reported that total global TB cases in Indonesia were 294,731 cases [2].

Pulmonary TB disease is a major public health problem in Indonesia, and the productive age group and low economy income are largely targets that are attacked by the disease.

Reducing the problem of pulmonary tuberculosis in Indonesia in 1995 was recommended using the strategy of DOTS (Directly Observed Treatment Short-course) that implemented in all health care units. It was supported by active participation of various stakeholders that performed various innovative activities in accordance with local specific.

The pulmonary TB Control Program with DOTS strategy in Bengkulu province was commenced in 1995 with two pilot projects, namely North Bengkulu and South Bengkulu district. The current implementation of the TB control program has reached nine (9) districts and one (1) city in Bengkulu province with 169 health public centers (PRM 21, PPM 58 and PS 85) , while Hospitals have been implementing TB DOTS strategy program were 81 % (only 13 from 16 still existed).

Based on the data of Bengkulu Provincial Health Office in 2010, 2011, and 2012 mentioned that the indicator target achievement of the Case Detection Rate (CDR) began 65.9 %, 57.1 % and 62.5 %

while the national target was 75 %. In Bengkulu Tengah, the indicator target achievement of the Case Detection Rate (CDR) was 36.7 % started from 39 % and 35.4 % was still far from the national target of 75 % [3,4,5].

In order that the finding target and new tuberculosis case detection of new positive pulmonary TB can be improved, so the managers of the health public center program are encouraged to not only focus on routine activities and policies of the current TB control program (Passive Case Finding) but also discover other ways because they have been proven slowly to find TB suspects as early as possible. Because of that reason, all TB officials in Bengkulu Tengah District should be equipped with a new strategy to discover pulmonary TB suspects such as patients' contact tracing strategy (contact tracing), where TB officials are active to conduct a search of the contact tracing (positive BTA patients). The contact tracing strategy was very effective to find positive BTA patients [6].

As one of the districts of the division of Bengkulu province, Bengkulu Tengah District established at the end of 2008 with a population is around 104.750 people and have 7 public health centers and they have already implemented TB control programs of DOTS strategy. In relation with the latest needs, the local government has improved and increased an access for public health services, so Bengkulu Tengah has 19 public health centers and one general hospital. Based on the evaluation of the implementation of the TB program in 2009, 2010, 2011 and 2012 showed the number of suspect inventions and case discoveries were still low, clearly seen 39.2 %, 36.7 %, 39 % and 35.4 % while the national target was 75 %, it was caused the officials just carried out routine activities (Passive case Finding) in discovering TB suspects and there have not done other innovative activities yet such as Contact Tracing.

The objective of this research is to improve the finding quality of the positive TB BTA suspects, develop SOP of contact tracing and apply the implementation of TB contact tracing in public health central, Bengkulu Tengah.

Methods

This research uses analytic survey design that makes comparisons of finding quality of suspects and Positive TB BTA patients (before and after the research), the researchers simply do contact tracing strategy on positive pulmonary TB BTA cases which recorded in the last three months before the study began and at the time of the study started to do, the location of the research were in all public health centers in Bengkulu Tengah district, the samples were all contacts with positive TB BTA cases when the study was done.

Results and Discussion

Results

Table 1 shows the finding of cases of positive pulmonary TB BTA from 5 areas of the public health centers, there were 3 people from Kembang Seri, 3 from Pagar Jati, 3 from Pekik Nyaring, 1 from Sidodadi and 1 from Bentiring, so that 12 positive pulmonary TB BTA cases before the study were made as a basis of contact tracing. Spreading distribution of contacts was taken from 19 public health centers in Bengkulu Tengah district which have positive TB BTA cases before the study begun was public 5 health centers and after the research done there were 15 public health centers after the study, and it was also performed contact tracing that obtained 305 contacts. Most of the contacts were men that were 157 men (51.48 %) and 148 women (48.52 %). A number of suspects were caught from 305 contacts were as many as 94 people (30.8 %) and 211 people (69.2%) were not as suspects, after laboratory examination for 94 suspects were obtained 14 (14.9 %) patients with positive TB. There is no difference between numbers of male or female patients with positive TB suspects which were 7 persons for each gender.

Table 1. The distribution of contact tracing according to the areas of public health centers

Public Health Centers	BTA Post Before CT	Number of the Contacts	Sex Male	Suspect Yes	Positive BTA
Kembang Seri	3	18	8	2	-
Karang Tinggi	-	1	0	1	-
Taba Teret	-	30	19	7	-
Sukarami	-	93	47	0	-
Jamnu	-	7	4	1	-
Lubuk Unen	-	13	5	11	3
Rena Kandis	-	6	0	0	-
Pematang Tiga	-	26	14	8	2
Pagar Jati	3	38	19	35	1
Sekayun	-	1	0	0	-
Arga Indah II	-	12	9	1	-
Tanjung Dalam	-	15	7	4	2
Pekik Nyaring	3	18	11	18	6
Aturan Mumpo	-	3	1	0	-
Sidodadi	2	24	13	6	-
Sri Koncoro	-	-	-	-	-
Taba Lagan	-	-	-	-	-
Bentering	1	-	-	-	-
Ujung Karang	-	-	-	-	-
Total	12	305	157	94	14

The tabulation in table 2 shows two finding strategies of positive TB cases. From contact tracing strategies discovered as many as 94 people with TB suspects, there were 14 people (14.9%) from 94 suspects had positive and 80 (85.1%) negative TB, and from passive case finding strategies discovered as many as 209 people with TB suspects, and from 209 suspects that obtained 12 persons (5.7%) were found positive TB BTA cases and 197 (94.3%) were negative.

Table 2. Suspect finding strategy and discovery of positive TB BTA cases through contact tracing and passive case finding

TB Cases	Suspect Finding Strategy					p	OR CI 95%
	Contact Tracing	%	Passive case Finding	%	Total		(1.273-6.482)
Positive	14	14.9	12	5.7	26		
Negative	80	85.1	197	94.3	277	0.016	2.873
Total	94	100	209	100	303		

Statistics test results of chi-square obtained p = 0.016<0.05 means significant, it could be concluded that there are difference discoveries and inventions between TB suspects and positive BTA cases among the contact tracing strategies and passive case finding, or it could also be mentioned the finding quality of TB suspects with contact tracing strategy was better than passive case finding strategy.

The calculation results of odds ratios (OR) obtained values: OR = 2.873 which meant positive BTA case with contact tracing strategy increasing 2,873 times in comparison with the finding of positive BTA cases , it meant that the suspect quality obtained with contact tracing strategy was better or more qualified than the finding of TB suspects with passive case finding .

Discussion

Contact tracing strategy is an effective method in finding positive TB case. It was based on the results of the implementation of contact tracing strategy obtained that 305 respondents found 14 people (14.9 %) of 94 (30.8%) diagnosed positive TB. While the data obtained from the results of the finding that done by TB officials (Passive Case Finding) throughout the public health centers in Bengkulu Tengah in the last three months before the study conducted was 209 suspects and 12 persons (5.7 %) diagnosed positive TB. Both of these data show that the contact tracing strategy was able to catch up to 14.9 % of positive TB from 94 suspects but passive case finding was only able to have 5.7 % of positive TB from 209 suspects. The results of this research also pointed out that the suspect were caught through contact tracing was more qualified. The finding of suspects with contact tracing strategy directed officials to capture the suspects more selective based on the protocol contact tracing and special interview format to interview contacts. The result of the research was in line with the research of Effectiveness of Tuberculosis Contact Tracing among Migrants and The Foreign-Born Population that conducted by Klinkenberg and Mannnisero in 2009 which revealed that cases of TB from LTBI (Latent Tuberculosis Infection Yield) found higher in the group of migrants who did contact tracing than with the native people who did not do it.

Conclusion

Contact tracing strategy is more effective and qualified in finding the suspects and the discovery of positive pulmonary TB patients than strategies that have been implemented in public health centers, namely the strategy of Passive Case Finding Active Promotion. This strategy can also be detected groups of people who have a risk infected TB disease, and these groups are called the contact group. Population groups that have very high risk are infected by tuberculosis suspect group. Based on the epidemiological distribution above can be done the control planning of TB problems through the groups mentioned above which focus on any attention. This can be input to local government as a policy-maker of Bengkulu Tengah district in preventing TB cases.

Recommendation

a. The activities of tuberculosis control program conducted by the officials of the health public centers in Bengkulu Tengah in addition to catch TB cases with the Passive Case Finding Strategy can also use the Contact Tracing Strategy, thus it is expected to improve the finding quality of TB suspects and discover positive pulmonary TB.
b. Further studies need to be conducted to determine the required cost (Effective Cost) by doing extra activities such as contact tracing
c. Local Government of Bengkulu Tengah district as development program responsibility particularly in the health sector can make policies that support the implementation of Contact Tracing Strategy in Tuberculosis control programs in this area
d. Further studies need to be conducted to determine the model of spreading control of tuberculosis disease comprehensively.

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TOMATO PLANT RESPON TO DIFFERENT DOSAGE OF NPK PHONSKA FERTILIZER IN SUNGAI SERUT SUBDISTRICT, BENGKULU CITY

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Abstract

Generally, farmers use three types of single fertilizers to grows tomato N (Urea, Za), P (SP36) and K (KCl). The use of three types of fertilizer can be individually or mixed. efficiency of fertilizer needs to be done to reduce the use of labor and increasing nutrient uptake. Fertilizer effectiveness can be done by giving compound fertilizer can be used as an alternative to overcome the scarcity of single fertilizer. This study aims to determine the doses of Phonska fertilizer that gives enhancement on tomato yield. The study was conducted at the experimental farm BPTP Bengkulu from December 2012 to April 2013. Research using Complete Randomized Block Design which consists of a single factor that is doses of Phonska fertilizer, which is divided into 5 dose levels: P1 (control treatment / without fertilizers), P2 (dose of 400 kg / ha), P3 (dose 800kg / ha), P4 (dose 1200kg/ha)), P5 (dose 1600kg/ha). Variety used is Tantyna F-1. This study was repeated 5 times, each treatment plant using 5 samples. Variables observed included vegetative and generative parts of tomato plants. The highest amount of fruit on the P4 treatment with an average of 92 pieces, the highest weight of the fruit crop on treatment with an average of P5 1703.6 g and the maximum plant height at P4 treatment at 96 cm. Phonska with the increased application of fertilizer to 1,200 kg / ha is able to increase the yield of tomato plants.

Keywords: *Phonska 15-15-15 NPK fertilizer; fertilizers dosage; varieties tantyna F-1*

Introduction

Tomato is one of potential vegetables need to be developed in Indonesia [1]. This plant can be planted in low land - high land, can also be planted on former paddy fields and dry land. To achieve high yield, in addition to the use of varieties resistant to pests and diseases, also need to be considered proper cultivation techniques. National productivity of tomato in Indonesia is still low. It happens because technology application in cultivation is still low. One of the constraints on the tomato farm is fertilizer used which does not correspond to the specific soil conditions [2]. Tomato plants require macro nutrient elements N, P, K, Ca, Mg and micro nutrients Mn, Zn, B. In efforts to increase tomato production, the use of organic and inorganic fertilizer is needed. Generally tomato growers still use a single fertilizer urea, ZA, SP-36 and KCl, while in the market has been widely circulated NPK compound fertilizer. However, the need for secondary macro nutrients and micro nutrients are often ignored, so in the long term can lead to nutrient deficiencies and fertilizer efficiency is reduced as well as the low effectiveness of the applied fertilizer. Fertilization efficiency needs to be done in order minimize loss of fertilizer and increase the effectiveness of nutrient uptake. Complete compound fertilizer use can ensure the availability of a complete nutrient that plants need.

A complete compound fertilizer consisting of a complete nutrient elements (macro and micro) are arranged in a particular composition with the concentration ratio of N, P, and K, and contains elements of micro 15:15:15 B, Cu and Mn. The advantages of using this fertilizer are practical in use, mixed with nutrients, making it easier for the application. The use of a complete compound tablets fertilizer formula in plants can lower the dose of fertilizer use by 33.3% compared to the use of a conventional single fertilizer [3]. There have been some newly discovered species or variety of tomato plants has advantages in production, one of which is the variety tantyna F-1. Actions that can be done to improve the productivity of tomato plants is by way of fertilizer and compost. Tomato plants an grow and produce in various types of soil, but best in sandy clay. Good soil for growing tomatoes is rich humus soil, friable, acidity pH range 5-6, air circulation and.

Tomato plants need the open and full of light exposure during the day. Lack of sunlight will cause the elongated growth, weak and pale. For the survival of plants require 16 nutrients, including the primary nutrient elements N, P and K which is a necessary plant nutrient elements in relatively large amounts compared to other nutrient elements. Nitrogen fertilizers are generally very mobile in the soil, so that the nitrogen fertilization needs to consider various factors. When the nitrogen fertilizer applied to the soil, it should be not easily washed before being absorbed by plants. This loss can be overcome or reduced by incorporating manure into the soil about 5 cm and cover it with soil. As with nitrogen, phosphorus is essential for root development, early growth of plant roots, leaf area and speed up the harvest. Phosphorus-deficient plants showed symptoms of stunted plants, inhibition of the development of roots and branches, slowing harvest, the leaves change to bluish. Potassium is also the primary nutrient elements needed by plants. Symptoms of potassium deficiency start from the leaves yellowish to orange, then brown and dry. Potassium-deficient plants easily fall [4]. The purpose of this study to get a dose of NPK compound fertilizer which gives the growth and production of the highest tomato on tomato plants varieties tantyna F-1.

NPK fertilizer has many benefits for plant such as Hygroscopic; easily soluble in water make it easily absorbed by plants; suitable for various types of plants; can increase the production and quality of the crops; increase the plants resistance to pests, diseases and drought; boost root growth and root systems; stimulate the formation of flowers; accelerate harvesting time; increase the protein content; and make stem more erect, robust and can reduce the risk of fall.

Planting tomatoes in Indonesia are generally cultivated in the highlands with andosol soil types. Production is partly due to the low moisture conditions and soil structure optimally achieved due to organic fertilizer. Fertilization is one of the efforts in the cultivation of crops to increase yield by restoring or adding nutrient elements. Soil with good aeration is a necessary environment for plant growth.

Materials and Methods

The experiment was conducted at the field of BPTP Bengkulu, Village Semarang, Sungai Serut Subdistrict, Bengkulu Province from December 2012 to April 2013. Research using Randomized Complete (RAKL) which consists of a single factor that is dose of Phonska fertilizer, which is divided into 5 dose levels: P1 (control treatment / without fertilizers), P2 (dose 1.57 g NPK/plant equals to 400 kg / ha), P3 (dose 3.15 g NPK/plant equals to 800kg / ha), P4 (dose 4.72 g NPK/plant equals to 1200kg/ha), P5 (dose 6.3 g NPK/plant equals to 1600kg/ha). Each poly-bag/plant growing media consist of mixture of soil and organic fertilizer with ratio 4:1 soil and organic fertilizer. Each treatment was repeated 5 times, each treatment using 5 samples plant. Tomato varieties used are Tantyna F-1. Experiments conducted in 125 pieces poly-bag. Chicken manure is applied to all poly-bags before planting. To prevent potential pests and diseases, crops are sprayed with pesticides according to recommendations. Observed variables: (1) nutrient content of the soil prior to the study, (2) plant height at 30, 45, 60 and 75 DAP (measured using a tape measure and level to the ground growing points on the main stem of tomato plants, (3) the amount of fruit crops , (4) the weight of the fruit crop. Data were analyzed statistically and the differences between treatments were tested using Duncan's Multiple Range Test at the 95% significance level.

Results and Discussion

Soil used for the present study is the kind of red-yellow podzolic, where the soil color were reddish to yellow or yellowish. Consistency is loose at the top (top soil) and firmly at the bottom (subsoil). Organic content in the topsoil was less than 9 %, generally around 5%. Nutrient content of plants such as N, P, K and Ca are generally low and soil reaction (pH) is very low between 4 to 5.55. Chemical properties of the soil this is inappropriate for tomato, it requires additional nutrient elements for the growth of tomato plants. Addition of organic fertilizer and NPK Phonska fertilizer expected to improve the chemical properties of the soil to provide optimal yields for the growth of tomato plants. Tomatoes can be grown in all types of land, however, the most ideal soil is soil with high organic matter, type of fertile sandy loam, and easily bind water (porous). Soil type related to the circulation of oxygen in the soil.

Mg levels at 2:00 me/100 g is suitable for the cultivation of vegetables, only need the addition of N, P and K to increase production. Soil acidity (pH) also need to know because each plant needs a certain pH environments. There are plants that are tolerant to long pH shocks, but there are also plants that are not resistant to pH shock. Besides the direct effect on plants, pH also affects other factors such availibility of elements. Solubility of Al and Fe also influenced by soil acdity. At acidic pH, the solubility of Al and Fe is very high. As a result, the very low pH of plant growth is not normal because the pH is not suitables. If an acid soil will be planted with plants that love the neutral reactions such as tomato plants, then the land should be given material / fertilizer are biased to change the pH from acidic to neutral. The greater the difference in pH, the more fertilizer is needed. The degree of acidity (pH) of land suitable for tomato plants is pH 7 (neutral). In addition to affecting plant growth, the pH also affects the activity of soil organisms that play a role in the decomposition of organic matter and nutrient availability of substances in the soil.

Table 1. Initial soil analysis results

No	Type Analysis	Result	Information
01	Moisture content	5.00 %	
02	P-Bray	9.79 ppm	Moderate
03	C-Org	4.5 %	High
04	Ca	1.01 me/100 gr	Very Low
05	Mg	2.00 me/100 gr	Moderate
06	N-total	0,03 me/100 gr	Moderate
07	Na	0.13 me/100 gr	Low
08	K	0,04 me/100 gr	Very Low
09	pH H_2O	4.7	Sour

Initial soil analysis results results in Table 1 indicate that the phospor nutrients in the soil is less available so required the addition of other nutrient elements, where the land is used for growing tomatoes in a polybag each second layer of soil. Soil type also significant effect on the growth of tomato plants. Fertilization is one of the efforts in the cultivation of crops to increase yield by restoring or adding nutrients [5].

Table 2. Effect of NPK fertilizer on plant height

Fertilizer dose	**Average plant height**				
	15	**30**	**45**	**60**	**75**
P1 (Without fertilizer NPK)	25.30[a]	42.34[c]	67.46[b]	75.58[b]	85.60[a]
P2 (400 kg/ha NPK)	27.84[a]	47.68[ab]	75.52[a]	82.24[ab]	87.50[a]
P3 (800 kg/ha NPK)	28.24[a]	50.50[a]	76.26[a]	87.20[a]	94.74[a]
P4 (1200 kg/ha NPK)	27.14[a]	48.64[ab]	77.24[a]	80.94[ab]	94.76[a]
P5 (1600 kg/ha NPK)	24.56[a]	43.94[bc]	73.44[ab]	83.32[ab]	89.48[a]

The results of measurements of plant height in Table 2 shows that the measurement of 15 DAP and 70 DAP (last measurement) that among the treatments did not show significant differences, but the measurement of 30 DAP, 45 DAP and 60 DAP showed significant differences between treatments. At 30 DAP treatment measurement P2, P3 and P4 significantly different from P1 and P5 treatment but at the time of measurement 45 DAP and 60 DAP treatment P2, P3, P4, P5 significantly different from P1 treatment. The treatment of the four highest plant height is P4 treatment, whereas the lowest was P1 treatment with an average of 94.76 cm and 85.60 cm.

Judging from the growth of plants occurs as height of plants continuously even though the plant has entered the generative phase, because tantyna varieties of tomato plants an indeterminate type.

Interplay of the five treatments in favor vegetative growth. Plant height is a measure of the growth of the most easily seen, although the highest plant growth processes do not necessarily reflect the best growth and produce good fruit production.

Growth is a process of plant life resulting in greater changes in plant size and also higher. Increase the size of the plant body resulting in tissue accretion generated by the increase in cell size. Growing number of cells or cells growing space needs many cell materials are synthesized using the appropriate substrate. At the plant level, the substrate is limited to inorganic materials and other elements taken from the environment such as carbon dioxide plants, nutrients, water and sunlight [7].

Increased growth due to elements contained in Phonska NPK fertilizer (15-15-15) is able to carry out its role in cell division, elements of K plays a role in expediting the process of photosynthesis, which can be used to grows.

Table 3. The average number of fruit planting tomatoes due additions of multiple doses of NPK

Treatment	Number of fruit per plant
P1 (Without fertilizer NPK)	54.8a
P2 (400 kg/ha NPK)	56.2a
P3 (800 kg/ha NPK)	61.2a
P4 (1200 kg/ha NPK)	92.2a
P5 (1600 kg/ha NPK)	77.2a

From Table 3 known that the NPK compound fertilizer (15-15-15) at a dose of 1200 kg/ha have sufficient nutrients for the growth of tomato plants. Application of NPK compound fertilizer (15-15-15) at a dose of 1200 kg / ha gave the highest number of fruit crops, but not significantly different from other treatments.

Tomato plants need nitrogen, phosphorus and potassium in relatively large amount, therefore, three elements must be in nutrient available to plants according to crop needs. If all three of these nutrients are not available or are available too slow, or are not in balance, then the plant growth will be stopped.

Table 4. The average fruit weight of tomato crop due additions of multiple doses of NPK

Treatment	Number of (kg)
P1 (Without fertilizer NPK)	1.249b
P2 (400 kg/ha NPK)	1.655ab
P3 (800 kg/ha NPK)	1.523ab
P4 (1200 kg/ha NPK)	1.698a
P5 (1600 kg/ha NPK)	1.703a

From table 4 is known that addition of compound fertilizer NPK (15-15-15) with a heavy dose of 1600kg/ha provide for the highest crop but not significantly different from 1200kg/ha dose, but significantly different from other treatments. This is because each nutrient elements contained in the Compound fertilizer NPK (15-15-15) to support various processes of cell metabolism, photosynthesis and cellular respiration in order to increase the yield of fruit tomat [9]. The higher the dose NPK Phonska the higher the yields obtained for fruit weight.

Addition Fertilizer N, P, K increased crop production growth in both the number of fruit and fruit weight/ plant [10]. The recommended dosage of fertilizer manufacturers have not provided the best results, the recommended dose is 800 kg / ha. From the results of the study at a dose of 1200 kg / ha showed better results than commonly recommended doses. Conditions in this study still requires the addition of a single fertilizer, because despite the growing media has been added to the manure is still not able to meet the needs of tomato plants.

The low yield is due to the low availability of nutrients in the soil also affects the availability of nutrients in the soil, and can inhibit plant growth and reduce yield. Fruit weight is influenced by Phonska NPK fertilizer (15-15-15) with very real. High fertilizer dosing gives results higher fruit weight.

Conclusion

Use of NPK Phonska compound fertilizer (15-15-15) at different doses were applied to tomato plants varieties tantyna F-1 gives a real difference in plant height 1200kg/ha dose NPK Phonska (15-15-15) fertilizer that high tomato plants at the age of 60 and 75 DAP, respectively 80.94 cm and 94.75 cm. and heavy fruit crop at a dose of 1200 kg / ha which is 1,698 kg/dose of plant and 1600 kg/ha which is 1,703 kg/ha, while the number of fruit crops in each doses of NPK compound fertilizer (15-15-15) does not make a significant difference.

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SITE SPECIFIC FERTILIZATION OF RGL CITRUS IN LEBONG DISTRICT, PROVINCE OF BENGKULU

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Abstract

RGL citrus, better known by Gerga Lebong citrus, is one of Lebong District superior commodity, because it has competitive advantages such as its color, taste, and fruiting throughout the year. Main problem of the RGL production are its low productivity and quality, while research of RGL citrus cultivation technology has not been intensively conducted, such as site specific fertilizer. The fertilizer assessment has been conducted in 2012 in Rimbo Pengadang, Province of Bengkulu. The purpose of this study is to obtain site-specific fertilization technology to achieve optimal productivity and good quality of RGL citrus. This assessment used Randomized Block Design with 3 fertilizer treatments and 6 replications. Fertilizer treatments based on: 1) amounts of nutrients transported by fruit, 2) soil and plant tissue analysis, and 3) farmer 's technology. Observations were conducted on the condition of the soil and agroclimate, number of fruit, fruit weight, fruit perimeter and plant productivity. The data were analyzed with statistical tests . The assessment result shows that the fertilizer treatment based on analysis of soil and plant tissue achieved the best result with the highest number of fruits (132 fruits/plant) and the highest productivity (24.15 kg/plant).

Keywords: *Gerga Lebong; site-specific fertilization; Lebong District*

Introduction

Citrus sp. is one of the superior national fruits. This commodity has a strategic role in the trade map of agricultural products especially fruits in Indonesia. During the last 10 years, citrus agribusiness attract investors and farmers. National citrus productivity range was 17-25 ton/ha while the potential productivity could reach 25-40 ton/ha [1]. Citrus production in 2009 reached 2,131,768 tons with harvest area of 60,191 ha, while the productivity of citrus in 2009 was 35.42 ton/ha. Citrus consumption per capita in Indonesia increased from 2.60 to 3.07 kg / year (in 2008). In general, citrus fruit production at the farm level is still done traditionally and has not implemented the quality management of production which caused low quality fruits such as mottled rind and faint fruit.

Recommendation production technology is different for different varieties of citrus and also site-specific. To meet the optimal conditions for the growth and production of citrus, one of important aspects is fertilizing. Fertilization aims to add certain nutrients in the soil that was not enough for the needs of the plant. There is a tendency of increase in the amount and the type of nutrients or fertilizer to be supplied along with the length of the cultivation of crops on a plot of land. Fertilization should be based on the principle of balance.

Wide of Lebong District is 1.929.24 km2 or 9.75 % of the total area of Bengkulu [2]. In Rimbo Pengadang Sub-district will be developed RGL citrus plantation area. One type of citrus that was developed in the Lebong District is RGL citrus or better known as Gerga citrus. This citrus is the superior commodity in Lebong District because it has competitive advantages such as is yellow – orange colour of fruit, fruiting throughout the year and having high juice content. In addition, the Director General of Horticulture in 2011 has set citrus RGL as a national priority to develop citrus agribusiness areas for 6000 ha in the next five years.

In general, citrus fruit production at the farm level is still done traditionally and has not implemented the quality management of production so that fruit quality is low (mottled rind, various fruit flavors and so on). To overcome this problems, it is needed to study more intensive some aspects that affecting the citrus production. The purpose of this study is to obtain site-specific fertilization technology that can achieve optimal productivity of RGL citrus.

Materials and Methods/Experimental

The assessment was conducted in 2012 on the 2 years age of RGL citrus crop areas in the Rimbo Pengadang Village, Lebong District, Bengkulu Province. This activity carried out in dry land plateau at 830 m above sea level. Plants used are already fruiting plants (in the early assessment of the plant was about 2 years old). The design used is Randomized Block Design with 3 treatments and 6 replications. Fertilization treatments were based on: 1) amounts of nutrients are transported by fruit and 2) analysis of soil / plant, and 3) treatment by farmers. All treatments were given fertilizer every 3 (three) months. Center of horticultural research and development is using fertilizer dose determination based on the number of fruit harvested the previous year, which is 3 % of the total weight of fruit per plant in the form of NPK (3:1:2). Existing fertilization technology (the farmers) is giving a combination of 1 kg of Urea and NPK (yara) fertilizer with a ratio of 1:5 and 2 kg of manure per plant.

After the first soil and plant analysis, Dolomite and compost were spread on fertilizer treatment based on analysis of soil / plant and yield transported out. In the next two weeks, soil sample was taken again and was analyzed. The dosage of fertilizer treatment based on yields transported out was 250 g urea and 300 g NPK/plant/3 month (325 kg urea and 390 kg NPK / ha / year). Dosage of fertilizer based on the analysis of soil / plant was 60 g urea and 300 g NPK/plants/3 months (78 kg urea and 390 kg NPK / ha / year). Fertilizer was given on 5 holes which were dug around bottom of plant canopies. Plant population is 325 stems / ha. Liming application is not applied in the farmers treatment. Fertilizers used were 167 g urea and 833 g NPK/plant/3 month. The fertilizer was spread on the soil surface under the plant canopy.

Data collected in this study is primary data and secondary data. Parameter measured in this study was a component of generative plants (number of fruits, fruit weight and fruit diameter) and the productivity. Data were analyzed using ANOVA and LSD test at the 5% level.

Results and Discussion

Profile assessment location

Rimbo Pengadang Sub-district, Lebong District, has undulating to hilly topography with altitude range 500-900 m above sea level [2]. The total area of this sub-district is 7300 ha. In 2013, RGL citrus planting area was around 370 ha. The altitude of the assessment location is about 835 m above sea level. Average daily temperature during the day between 28-32 ° C and at night between 22-25 ° C. Based on Schmidt and Ferguson, this area has type B climate with rainfall 2500-4500 mm / year.

Fertilization recommendations determination method

Determination of fertilizer requirements for crops can be done with some approaches that based on: 1) visual deficiency symptoms; 2) trial assessment; 3) amounts of nutrients are transported by fruit; 4) availability of nutrients in the soil (soil analysis); and 5) the level of nutrient absorption by plant (plant tissue analysis). This assessment was only examined two methods (yield transported out and analysis of soil / plant tissue).

Effect of fertilization on RGL Citrus plants generative components

Among others, one effort that can be done to improve productivity is through fertilization. The phenomenon of citrus fruit quality is not satisfactory and nutrient deficiency symptoms in the leaves as a result of deterioration in the health of citrus production centers suggests that farmer effort to maintain soil fertility by applying fertilizer still does not meet the needs of plants. To make the fertilizers can be absorbed by plants efficiently and effectively, we need to understand at least four things, namely what kind of nutrients it is needed, what dosage, when it is needed, and how to apply [3].

Fertilization which is done by several fertilizer determination methods caused the differences in the generative components of RGL crop and also the productivity (Table 1). Fruit weight and fruit perimeter of RGL crops applying fertilizer treatment based on amount of nutrient transported by fruit (P1) and based on analysis of soil and plant tissue (P2) and farmer's technology (P3) were not significantly different. Number of fruits and crop productivity of RGL crops applying fertilizer treatment based on soil and plant tissue analysis was significantly different from fertilizer treatment based on amount of nutrient transported by fruit, but it was not significantly different from the farmer's treatment.

Table 1. Generative component of RGL citrus crops and productivity of crops in the fertilizer assessment in Rimbo Pengadang.

No	Fertilizer treatment	Mean			
		Fruit Weight (gr)	**Fruit Perimeter (cm)**	**Number of Fruit/plant**	**Crop producitivity/ plant (kg)**
1	P1 (amount of nutrients transported by fruit)	199,76a	25,5a	55b	12,13b
2	P2 (soil and plant tissue analysis)	189,76a	23,33a	132,33a	24,15a
3	P3 (existing technology)	208,44a	23,98a	84,83ab	18,28ab

Description:
P1 = 250 gr urea + 300 gr NPK/plant
P2 = 60 gr urea + 300 gr NPK/plant
P3 = 167 gr urea + 833 gr NPK/plant

- Figures followed by the same letter in the same column are not significantly different by LSD test at 5 % level

Fertilizer dose based on amount of nutrients transported by crop yields (Fruit)

Determination method based on the analysis of soil fertilizer / plant tissue follows a rule that fertilization will be applied if the amount of nutrients in the soil is lower than the required plant. The plant itself works to extract nutrients from the soil. To know the fertilizer needs, we need to analyze the amount of nutrients that extracted or absorbed by the plant and the amount of nutrients available in the soil [3]. A dose of fertilizer N, P and K are recommended based on N, P, K transported by crop yields (fruit) in Entisol pamelo Nambangan Sukomoro, Magetan is 150 % of the total NPK transported by fruit, equivalent to 2.775 % (2 N, 1 P_2O_5 and K_2O_4) of the weight of fruits harvested per year [4]. Estimate the amount of nutrients transported together in the harvest of 10 tons of citrus fruits is 29 kg N, 4 kg P, 63 kg K, and Ca 26 kg per hectare [5].

The assessment results in Rimbo Pengadang showed that the amount of fruit and plant productivity reached by applying fertilizer treatment based on amount of nutrients transported by fruit (P1) were 55 pieces and 12.13 kg/plant which is significantly different with the amount of fruit produced by applying fertilizer treatment based on analysis of soil and plant tissue (P2), but not significantly different from farmer' technology (P3). Perhaps, the reason of the low the amount of fruit was because the age of these plants was only 3 years. Results of this study showed that the use of fertilizers based on amount of nutrients transported by fruit could not be applied to RGL citrus planting which is only one or two times fruiting.

Fertilizer doses based on soil and plant tissue analysis

This method follows a rule that fertilization is applied if the amount of nutrients in the soil is lower than that needed by the plants. Translation of the rules are the lower levels of nutrients in the soil, the more nutrients to be added as a fertilizer, and vice versa. To determine the amount of fertilizer to be added firstly we need to know the relationship between the levels of certain nutrients.

The results of analysis of soil in the assessment showed that the content of Nitrogen (N) and Phosphorus are relatively low, while Potassium (K) is medium (Table 2). The data shows that applying lime (dolomite) and compost will increase the availability of nutrients content for N, P and K but will decrease total P (Table 2). This shows that the elements of P that can be released by ameliorant (dolomite and compost) as P available. This is due to the high power bound by soil P element in Rimbo Pengadang's soil.

Table 2. The results of soil analysis before and after applying lime and compost on RGL citrus assessment land in Rimbo Pengadang

Soil depth (0-20 cm)	P	K	pH H_2O	N	P	K-dd
	mg 100g-1			Ppm		
before applying lime and compost	16.27	6.38	3.92	0.09	9.87	0.20
after applying lime and compost	8.98	7.77	4.48	0.73	16.26	0.26

From the results of soil analysis, it shows that the amount of available phosphorus increased by liming. It suggested that on the assessment land, the fertilizer should not be spread over the surface under plant canopy, it should be applied in the channel trenches made around the bottom of the plant canopy or it will be better if it is given at 5 holes made around the bottom of the plant canopy. After applying fertilizer, it should be covered again with soil or compost. Nutrient uptake in leaves and citrus fruits RGL are presented in Table 3. The data show that citrus plant is in good condition in which the elements needed is sufficient.

Table 3. The results of RGL citrus plant tissue analysis in Rimbo Pengadang

Sample	Sampel of origin											
	Water content	N	P	K	Ca	Mg	Na	Fe	Mn	Cu	Zn	B
	%			%					Ppm			
Leaves	0	0.29	0.16	-	1.16	0.33	-	145	105	9	22	
Fruit	85.05	9.25	0.01	0.15	0.16	0.01	0.6	2	4	0.4	0.2	2

Fertilizer treatment based on the results of analysis of soil / plant tissue (P2) reaches the highest amount of fruit (132 fruits) with of 24.15 kg fruits/plant. It was significantly different with fertilizer treatment based on the amount of nutrients transported by fruit, but not significantly different from the farmer’s technology. By comparison the number of tangerines Selayar in Sulawesi reached 26 fruits with cultivation technology implementation.

The most ideal method of determining fertilizer needs of citrus is based on fertilization experiment. However, due to the limited locations fertilization experiment, to determine citrus crop nutrient needs based on soil analysis combined with plant analysis is an approach can be considered [6].

Based on existing technology

Citrus grower’s technology or existing technology for RGL citrus fertilization was using high doses and tend to over- fertilize. Farmers apply fertilizer by spreading it on the soil surface under plant canopy. This way is easier and faster. It is happened for several reasons such as limited manpower and spending less money. However the amount of fertilizer used was 2 times higher than the dose of fertilizer based on soil and plant tissue analysis.

The assessment result shows that the amount of fruit and the productivity is not significantly different with other fertilizer treatments, but the number of fruits and plant productivity was lower than the amount of fruit and the productivity by applying fertilizer treatment based on soil and plant tissue analysis.

The need of fertilizer micro

The assessment results shows that inspite of requiring macro nutrients like N, P , K , Mg, the RGL citrus plants also require micronutrients such as Zn and Mn. Applying micronutrients can be done through the soil and leaves with intensity once a year at the optimal vegetative phase [7]**.** Dose for micronutrients is 0.4 % (as a foliar fertilizer), 1 % through the soil in the form of TSP + Magnesium is given in the form of dolomite as much as 2-5 t / ha, but if the pH is almost neutral, the dose is given only 200 kg/ha. Mg fertilizer is given in the form of a concentration of 1 % MgSO4. By using a balanced fertilizer, the results obtained can be increased by 21.8 to 58.1 %.

After the assessment conducted, there was found micro nutrient deficiency symptoms in the RGL citrus plantation. However, the result of analyzed of micro nutrient content shows that the micro nutrient content is still above the critical threshold. Therefore, to answer these problems, we still needs further study, especially the study of micro-nutrients.

Conclusion

1. Fertilizer application based on soil and plant tissue analysis on RGL citrus crops in Rimbo Pengadang, Lebong District achieved the highest number of fruits (132 fruits/plant) and the highest productivity of fruit/plant (24.15 kg/plant).
2. The fertilization recommended for 2 years ages of RGL citrus crop is 450 gr/m2, dolomite, compost 40 kg / plant / year, 60 g urea and 300 g of NPK 15-15-15 given every 3 months. Dolomite and compost application by distributed them under the plant canopy, whereas chemical fertilizers are given in 5 holes around the bottom of the plant canopy.

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LAND SUITABILITY EVALUATION OF RUBBER PLANT, OIL-PALM AND ROBUSTA COFFEE AT KAYU AJARAN VILLAGE IN DISTRICT OF ULU MANNA SOUTH BENGKULU

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Abstract

Dry land is potential for expansion of estate crops, but the suitability of their land should be considered to get optimal growth and production. This study aims to evaluate the land suitability of rubber plants, oil palm and robusta coffee at Kayu Ajaran Village on district of Ulu Manna, South Bengkulu. Land suitability evaluation in this study was conducted by matching the characteristics of land to the crops growth requirement. The crops growth requirement was used as a criteria in the evaluation of land suitability. Land characteristics data was collected through field survey and analysis of soil samples was done in the laboratory. The results showed that land suitability classes at Kayu Ajaran Village in district Ulu Manna South Bengkulu for rubber plant was sufficient suitable land (S2) with limiting factors were availability of water, availability of oxygen, rooting media and nutrient retention; sufficient suitable land (S2) for oil palm with limiting factors were availability of water, rooting media and nutrient retention; marginal land (S3) for robusta coffee with a factor limiting was nutrient retention.

Key words: *rubber; oil palm; robusta coffee; land suitability; Kayu Ajaran village*

Introduction

Dry land has great potential for agricultural development, good crops, horticulture and plantation crops. In Indonesia, the spread of dry land sour quite extensive, especially in the wetter areas such as Sumatra, Kalimantan, and Papua. Based on the map of national agricultural spatial directives issued Puslitbangtanak 2001, wry dry land potentially suitable for development and agriculture (crops and annual / plantation) is only about 55.8 million ha [1].

Noteworthy land suitability for crop cultivation in order to obtain optimal growth, although the plant can seem to grow together in a region, but each plant has a character that requires different requirements. Production can be optimized so that it must be considered the suitability of land for agriculture and the growing requirements of each type of plant. The level of suitability of land is an area of land suitability for a particular use [2]. The land suitability can be assessed for the current condition (present) or after the holding of repair (improvement). In assessing the suitability of land there are several ways, one using the legal minimum match (matching) between land quality and soil characteristics as a parameter to the criteria of land suitability classes which have been prepared based on the requirements of growing plants evaluated. For example, land suitability study ever conducted in the area of South Sumatra to plant rice and soybean [3]. Similar research has also been done for abaca plant in East Kutai Regency [4] and oil palm plantations in Riau Kampar regency [5].

Wood Village is a village in the district teaching Ulu Manna South Bengkulu is a growing region with commodities such as rubber, palm oil and coffe. Suitability of land for plantations in the village is still very limited. Therefore the study of land suitability evaluation for crops needs to be done keeping in this area has a large area and the potential for the development of plantation information. Land suitability classes for plantation crops is expected that appropriate practical management alternative, to increase production and welfare of the people at Kayu Ajaran village in district of Ulu Manna of South Bengkulu. The purpose of this study is to evaluate the suitability of plantation land at Kayu

Ajaran village in district of Ulu Manna of South Bengkulu to some crops are rubber (Havea brasiliensis), Palm Oil (*Elaeis quenensis* Jacq) and Robusta coffee (*Coffea canephora*).

Materials and Methods

This study was conducted from July to December 2011. Research locations at Kayu Ajaran village in district of Ulu Manna of South Bengkulu. Research using primary data and secondary data include land characteristics, climate and growing conditions of rubber and oil palm. Primary data is data obtained directly from field survey and secondary data such as climate data (rainfall and humidity) were obtained from the climatological station closest to the study site. Land characteristics are land properties that can be measured or estimated, which includes air temperature, precipitation, humidity, drainage, soil texture, coarse material, soil depth and slope obtained from the results of field surveys while the cation exchange capacity (CEC) of clay, saturation alkaline, pH-H_2O and organic C derived from the analysis of soil samples in the laboratory.

Land suitability evaluation in the study of land use characteristics matching the requirements of growing crops (rubber, palm oil and coffee robusta) is formulated in the Technical Guidelines for the Evaluation of Agricultural Land [2]. Requirements grow rubber plants (Table 1), palm oil (Table 2) and coffee (Table 3) the criteria in the evaluation of land suitability.

Table 1. Land suitability criteria of rubber (*Havea brasiliensis*)

Terms of Use / Land Characteristics	Land Suitability Classes			
	S1	**S2**	**S3**	**N**
Temperature (tc)	26 – 30	30 – 34	–	> 34
Mean temperature (° C)		24 – 26	22 – 24	< 22
Availability of water (wa)	2.500 – 3.000	2.000 – 2.500	2.000 – 2.500	< 1.500
Rainfall (mm)		3.000 – 3.500	3.500 – 4.000	> 4.000
The length of the dry period (months)	1 – 2	2 – 3	3 - 4	> 4
Oxygen availability (oa) drainage	Good	moderate	somewhat hampered, hampered	severely hampered, fast
Rooting medium (rc)	smooth,	-	robust	
texture	somewhat subtle,			rough
Coarse material (%)	being < 15	15 - 35	35 - 60	> 60
Depth of soil (cm)	> 100	75 – 100	50 – 75	< 50
Turf Thickness (cm)	< 60	60 – 140	140 – 200	> 200
Thickness (cm), if any	< 140	140 – 200	200 – 400	> 400
Inserts a mineral / enrichment maturity	Saprik$^+$	saprik, hemik	hemik, fibrik$^+$	Fibrik
Nutrient retention (nr)	-	-	-	-
Clay CEC (cmol)	< 35	35 - 50	> 50	
Base saturation (%)	5,0 –6,0	6,0 – 6,5	> 6,5	
pH H_2O		4,5 – 5,0	< 4,5	
Organic-C (%)	> 0,8	≤ 0.8	-	
Toxicity (xc)				
Salinity (dS / m)	< 0,5	0,5 – 1	1 –2	> 2
Sodicity (xn)				
Alkalinity / ESP (%)	-	-	-	-
Danger sulfidic (xs)				
Sulfidic depth (cm	> 175	125 – 175	75 - 125	< 75
Erosion hazard (er)	< 8	8 –16	16 – 30	> 30
Slope (%)			16 - 45	> 45
erosion hazard	very low	low-moderat	heavy	very Heavy
Flood hazard (fh) pool	F0	-	F1	> F1
Land preparation (lp)				
Rocks at the surface (%)	< 5	5 – 15	15 – 40	> 40
Outcrop (%)	< 5	5 – 15	15 – 25	> 25

Sources: Djaenudin, et al (2003)

Information; FO = tampa flooding, FI = mild, F2 = moderate, F3 = somewhat severe, F4 = weight

The process of land suitability evaluation is done through: (1) preparation of land characteristics, (2) preparation plants growing requirements, (3) evaluation of land suitability (matching) between land characteristics and requirements of growing plants in order to obtain land suitability classes. Land suitability classification is determined based on the framework of FAO 6 differentiated according to the level of the order, class, subclass, and unit. At the classroom level, land belonging to the order corresponding (S) divided into three classes, namely: land highly suitable (S1), is quite suitable (S2), and the corresponding marginal (S3). While the land belonging to the order is not suitable (N) is not differentiated into class.

Table 2. Land suitability criteria for oil palm (*Elaeis quenensis Jacq*)

Terms of use / land characteristics	**Land suitability classes**			
	S1	**S2**	**S3**	**N**
Temperature (tc)	25 – 28	22 – 25	20 - 22	< 20
Mean temperature (° C)		28 – 32	32 – 35	> 35
Availability of water (wa)	1.700 – 2.500	1.450 –1.700	1.250 – 1.450	< 1.250
Rainfall (mm)		2.500 – 3.500	3.500 – 4.000	> 4.000
The length of the dry period (months)	1 – 2	2 – 3	3 - 4	> 4
Oxygen availability (oa) drainage	Good, moderat	somewhat hampered	hampered, rather quickly	severely hampered, quickly
Rooting medium (rc) texture	smooth, somewhat subtle, being < 15	-	robust	rough > 60
Coarse material (%)	> 100	15 - 35	35 - 60	< 50
Depth of soil (cm)		75 – 100	50 – 75	
turf				
Thickness (cm)	< 60	60 – 140	140 – 200	> 200
Thickness (cm), if any	< 140	140 – 200	200 – 400	> 400
Inserts a mineral / enrichment maturity	Saprik+	saprik, hemik	hemik, fibrik+	Fibrik
Nutrient retention (nr)	-	-	-	-
Clay CEC (cmol)	< 35	35 - 50	> 50	
Base saturation (%)	5,0 –6,0	6,0 – 6,5	> 6,5	
pH H2O		4,5 – 5,0	< 4,5	
Organic-C (%)	> 0,8	≤ 0.8	-	
Toxicity (xc)				
Salinity (dS / m)	< 0,5	0,5 – 1	1 –2	> 2
Sodicity (xn)				
Alkalinity / ESP (%)	-	-	-	-
Danger sulfidic (xs)				
Sulfidic depth (cm	> 175	125 – 175	75 - 125	< 75
Erosion hazard (er)	< 8	8 –16	16 – 30	> 30
Slope (%)			16 - 45	> 45
erosion hazard	very low	low-moderat	heavy	very Heavy
Flood hazard (fh)				
pool	F0	-	F1	> F1
Land preparation (lp)				
Rocks at the surface (%)	< 5	5 – 15	15 – 40	> 40
Outcrop (%	< 5	5 – 15	15 – 25	> 25

Sources: Djaenudin, et al (2003)
Information; FO = tampa flooding, FI = mild, F2 = moderate, F3 = somewhat severe, F4 = weight

Table 3. Crop land suitability criteria robusta coffee (*Coffea canephora*)

Terms of use / land characteristics	Land suitability classes			
	S1	S2	S3	N
Temperature (tc)	22 – 25	–	19 - 22	< 19
Mean temperature (° C)		25 – 28	28 – 32	> 32
Availability of water (wa)				
Rainfall (mm)	2.000 –3.000	1.450 –1.700	1.250 – 1.450	< 1.250
The length of the dry period		2.500 – 3.500	3.500 – 4.000	> 4.000
(months)	2 – 3	3 – 5	5 – 6	> 6
humidity (%)	45 – 80	80 – 90;35-45	>90;30-35	< 30
Oxygen availability (oa)				
drainage	Good	Moderat	somewhat hampered, rather quickly	hampered,severely hampered, quickly
Rooting medium (rc)				
texture	smooth, somewhat subtle, being	-	robust	Rough
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Depth of soil (cm)	> 100	75 – 100	50 – 75	< 50
turf				
Thickness (cm)	< 60	60 – 140	140 – 200	> 200
Thickness (cm), if any	< 140	140 – 200	200 – 400	> 400
Inserts a mineral / enrichment				
maturity	Saprik$^+$	saprik, hemik	hemik, fibrik$^+$	Fibrik
Nutrient retention (nr)				
Clay CEC (cmol)	-	-	-	-
Base saturation (%)	< 35	35 - 50	> 50	
pH H_2O	5,0 –6,0	6,0 – 6,5 4,5 – 5,0	> 6,5 < 4,5	
Organic-C (%)	> 0,8	≤ 0.8	-	
Toxicity (xc)				
Salinity (dS / m)	< 1	-	1 –2	> 2
Sodicity (xn)				
Alkalinity / ESP (%)	-	-	-	-
Danger sulfidic (xs)				
Sulfidic depth (cm	> 175	125 – 175	75 - 125	< 75
Erosion hazard (er)				
Slope (%)	< 8	8 –16	16 – 30 16 - 50	> 30 > 45
erosion hazard	very low	low-moderat	heavy	very Heavy
Flood hazard (fh)				
pool	F0	-	F1	> F1
Land preparation (lp)				
Rocks at the surface (%)	< 5	5 – 15	15 – 40	> 40
Outcrop (%	< 5	5 – 15	15 – 25	> 25

Sources: Djaenudin, et al (2003)
Information; FO = tampa flooding, FI = mild, F2 = moderate, F3 = somewhat severe, F4 = weight

Results and Discussion

Land characteristics

In the administration of the study site is located in South Bengkulu of Bengkulu province. South Bengkulu is located at 04^o 09 '39 "- 04^o 33' 34" South latitude (LS) and 102^o 47 '45 "- 103^o 17' 18" East Longitude (BT) is a potential for the development of rubber and oil palm. South Bengkulu area is 1186.10 km^2 (118 610 ha). South Bengkulu climate type is Type C with rainfall 3,238 mm / year with as many as 212 days of rain, temperatures between 21^o-31^{o}C with relative humidity of 80-88% [7].

Land characteristics at study sites which include temperature, rainfall, drainage, texture, coarse material, soil depth and slope, base saturation, pH-H_2O and organic C can be seen in Table 4. Data climate component is the average temperature of 26ºC while the 3,238 mm of rainfall. Drainage classes were moderate. Relatively smooth texture class. Ingredients was roughly <15%. Depth of soil / effectively included in (> 75%). 30.67 clay CEC and base saturation was 33.41%, including the C-organic medium, including acidic soil reaction and include a flat slope.

Table 4. Land characteristics at study sites

Land Characteristics	Land Characteristics data
Mean temperature (°C)	26
Rainfall (mm)	3.238
Drainage	moderate
Texture	clay
Coarse material (%)	Bit (15)
Depth of soil (cm)	75
CEC clay	30,67
CEC clay	33,41
pH H_2O	4,62
Organic-C (%)	2,94
Slope (%)	0 - 3

Rubber plant is a plant of the tropics, areas suitable for rubber plant is in a zone between 15°S and 15°N, when in the zone, its growth is rather slow, so that the production was much slower start [8]. Annual rainfall is suitable for the growth of rubber not less than 2,000 mm. Good rubber growth requires temperatures between 25-35°C, with optimum temperatures average 28° C. Coconut palm can grow well in wet tropical regions around the latitude of the north - south 12 degrees [9]. A good amount of precipitation is 2000-2500 mm / year, does not have a water deficit, precipitation somewhat evenly throughout the year. Rainfall should be suitable for coffee is 1500 to 2500 mm/ year, with an average of 1- 3 months and dry months the average temperature of 15 - 25ºC [10].

Soil properties are suitable for rubber plant is quite deep solum to 100 cm or more, good aeration and drainage, texture consisting of 35% clay and 30% sand, nutrient content of N, P and K are not enough and micronutrient deficiencies, pH 4,5 - 6.5 [8]. The physical properties of soil are good for palm oil is 80 cm thick solum, thick solum is a good medium for root development so that plant nutrient uptake efficiency would be better. Light texture, sand backfire have 20-60%, dust 10-40%, clay 20-50%. Oil palm can be grown at pH 4.0 to 6.0, but the best is from 5 to 5.5. Soil has a low pH can be increased by liming [9].

Land suitability

Evaluation of land suitability for the intended land use types of rubber, palm oil and coffee. Assessments of land suitability classes were conducted by matching the characteristics of the land with the growing requirements / land use. Results of land suitability is two actual and potential land suitability. Actual land suitability classes of land suitability is based on data from field survey to study the area and there has been no attempt to consider the suitability of land repair while potential land suitability is achieved after the efforts made improvements.

Land suitability for the rubber plant

After matched between the characteristics of the soil (Table 4) with the rubber crop land suitability criteria (Table 1), obtained land suitability classes like Table 5.

Table 5. Classes of land suitability for rubber plant

Land characteristics	Land suitability	
	actual	**potential**
temperature	**(S1)**	**(S1)**
mean temperature	S1	S1
availability of water	**(S2)**	**(S2)**
Rainfall (mm)	S2	S2
availability of oxygen	**(S2)**	**(S2)**
Drainage	S2	S2
rooting medium	**(S2)**	**(S2)**
texture	S1	S1
Coarse material (%)	S2	S2
Depth of soil (cm)	S2	S2
nutrient retention	**(S2)**	**(S1)**
Base saturation (%)	S1	S1
pH H_2O	S2*	S1
Organic-C (%)	S1	S1
erosion hazard	**(S1)**	**(S1)**
Slope (%)	S1	S1

Note : ** business improvements can be made, land suitability class up one level*

Actual land suitability class for the rubber plant S2 with the limiting factor of water availability, oxygen availability, rooting medium and nutrient retention. Efforts repairs can only be carried out on nutrient retention / soil fertility from S2 to S1 but rainfall, drainage, soil depth of coarse material and can not be repaired so that the potential land suitability class S2 by a factor limiting the availability of water, availability of oxygen and rooting medium. Factors limiting nutrient retention (soil fertility) that soil pH can be improved by administering lime to raise the soil pH. The limiting factor in the S2 class can usually be overcome by the farmers themselves. Land suitability class is quite suitable land has limiting factors and these factors will affect the productivity, require additional inputs (input) [2]. Such restraint can usually be overcome by the farmers themselves.

Land suitability for oil palm plant

After matched between the characteristics of the soil (Table 4) with the criteria of suitability for oil palm plantations (Table 2) are obtained land suitability classes like Table 6. Actual land suitability classes for palm oil crops namely S2 by a factor limiting the availability of water, rooting medium and nutrient retention. Efforts repairs can only be carried out on nutrient retention / soil fertility from S2 to S1, but rainfall, soil depth of coarse material can not be repaired so that the land suitability classes S2 with potential limiting factor of water availability and rooting medium. Factors limiting nutrient retention (soil fertility) that soil pH can be improved by administering lime to raise the soil pH, which factors can usually be overcome by farmers.

Table 6. Classes of land suitability for oil palm (*Elaeis quenensis Jacq*).

Land characteristics	Land suitability	
	actual	**potential**
Temperature	**(S1)**	**(S1)**
mean temperature	S1	S1
availability of water	**(S2)**	**(S2)**
Rainfall (mm)	S2	S2
availability of oxygen	**(S1)**	**(S1)**
Drainage	S1	S1
rooting medium	**(S2)**	**(S2)**
Texture	S1	S1
Coarse material (%)	S2	S2
Depth of soil (cm)	S2	S2
nutrient retention	**(S2)**	**(S1)**

CEC clay	S1	S1
Base saturation (%)	S1	S1
pH H_2O	S2*	S1
Organic-C (%)	S1	S1
erosion hazard	**(S1)**	**(S1)**
Slope (%)	S1	S1

Note: ** business improvements can be made, land suitability class up one level*

Land suitability for Robusta Coffee Plant

After matched between the characteristics of the soil (Table 4) with the criteria of suitability for robusta coffee crop (Table 3) then acquired the land suitability classes like Table 7. Actual land suitability classes for Robusta coffee plant is a limiting factor S3 with improved nutrient retention efforts on the retention of nutrients / soil fertility from S3 to S2, so that the potential land suitability class S2 by a factor limiting the availability of water, availability of oxygen, rooting medium and nutrient retention. Factors limiting nutrient retention (soil fertility) that soil pH can be improved by administering lime to raise the soil pH

S3 class land having severe and limiting factors affect productivity. Overcome limiting factors on S3 requires high capital, so the need for assistance or intervention government or private parties. The rainfall that suitable for coffee is 1500 to 2500 mm/year, with an average of 1-3 months and dry months the average temperature of 15-25^{o}C with land classes S1 and S2 [11].

Table 7. Land suitability classes for robusta coffee plant (*Coffea canephora*)

Land characteristics	Land suitability	
	actual	**potential**
temperature	**(S2)**	**(S2)**
mean temperature	S2	S2
availability of water	**(S2)**	**(S2)**
Rainfall (mm)	S2	S2
availability of oxygen	**(S2)**	**(S2)**
drainage	S2	S2
rooting medium	**(S2)**	**(S2)**
texture	S1	S1
Coarse material (%)	S1	S1
Depth of soil (cm)	S2	S2
nutrient retention	**(S3)**	**(S2)**
CEC clay	S1	S1
Base saturation (%)	S1	S1
pH H_2O	S3*	S2
Organic-C (%)	S1	S1
erosion hazard	**(S1)**	**(S1)**
Slope (%)	S1	S1

Conclusion

Land suitability classes at at Kayu Ajaran village in district of Ulu Manna South Bengkulu to plant rubber is quite suitable (S2) by a factor limiting the availability of water, availability of oxygen, rooting medium and nutrient retention; to plant oil palm is quite suitable (S2) with the limiting factor availability of water, rooting medium and nutrient retention; robusta coffee plant is to fit marginal (S3) by a factor limiting nutrient retention.

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INCREASING RICE PRODUCTION USING "JAJAR LEGOWO" PLANTING SYSTEM

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Abstract

Agriculture Institute for Research and Development of Ministry of Agriculture issued a recommendation implementation the package cropping systems for increasing rice productivity. An assessment was conducted in the Taba Anyar Village, South Lebong Sub district, Lebong, Bengkulu province from March up to June 2012, using Randomized Block Design (RBD) with a single factor, namely cropping systems: tile, legowo 2:1, legowo 4:1 and legowo 6:1with 5 replications. Rice varieties used are Inpari 13. Data was observed by vegetative growth (plant height and number of tillers) and yield components (panicle length, number of grain hollow, pithy amount of grain and 1000 grain weight). Analysis of the data was performed by analysis of variance (ANOVA) and if there are differences between treatments was further tested by Duncan's Multiple Range Test (DMRT). The results showed the parameters pithy amount of grain per panicle showed significant differences in treatment Legowo 2:1 compared to other planting systems, whereas other data have no differences between treatments.

Keywords: *rice production; planting system; legowo*

Introduction

Rice is the staple food of more than 95% of Indonesian people who can create about 20 million jobs of farmer in the villages [1]. To meet basic food needs, the government launched the National Rice Production Enhancement Program (P2BN). Government represented by the Ministry of Agriculture through Research and Development Agency issued a recommendation for the technology package applied to farmers. The recommended technology package is the approach of Integrated Crop Management (PTT). One of the recommendation is the implementation package cropping systems with spacing, known with legowo cropping systems.

Legowo cropping system is an attempt to manipulate the planting location so it will have a number of plants that verges more with a blank row. Legowo cropping systems can increase rice production by arranging the plant population to be 20-25% higher compared to the cropping system common [2]. For each type of cropping system legowo population increased by 30% (legowo 2:1), 20% (4:1 legowo), 14.3% (legowo 6:1) than the system commonly used tiles [3]. The more plant population, then the production will be higher.

Problems are still often encountered is the result of research from research institutes has not been fully adopted by farmers and users due to lack of a strategy to provide information to the users of research results. So the network of information technology resources to the users of technology in areas cut off. In addition to these problems, there are still many farmers who did not know rice productivity resulting from legowo cropping systems. Therefore there is need research to determine the productivity of the cropping system legowo.

In 2011 it was reported that the average productivity of rice in Bengkulu decreased compared to the year 2010 in the amount of 0.07 tons from 4,036 tons to 3,966 ton/ha [4]. Lebong district participated in contributing to an increase in productivity of paddy rice in particular because the District has a broad Lebong rice harvest amounted to 13,056 ha by producing 52 294 tons of dry grain harvest (GKP).

Therefore in this research, the application of appropriate PTT component which can be used as a reference for farmers, one of them by using a cropping system legowo. This is done to increase the productivity of rice in Lebong district by adopting planting systems legowo resulting in growth and an increase in rice production.

Materials and Methods

Research has been conducted in March-June 2012 in the Taba Anyar village, South Lebong District, Lebong Sub District, Bengkulu Province. Land that used is owned by cooperators of Source Seed Germination unit activity (UPBS), with an area of around 864m^2 plot research. Research using randomized block design (RBD) with a single factor that is planting system (ST) as 4 kinds of treatment are: tiles (ST1), legowo 2: 1 (ST2), legowo 4: 1 (ST3) and legowo 6: 1 (ST4) with each treatment was repeated 5 times.

Rice varieties are Inpari 13. Rice cultivation systems are implemented following the approach of PTT. Fertilization is done 3 times during the growing season at the age of 7-14 I fertilization Days after planting (DAP), fertilization II at the age of 21-25 HST and fertilizationIII at the age of 35-40 HST with urea fertilizer dose of 100 kg / ha and NPK Phonska 350 kg / ha.

Observed data is vegetative growth (plant height and number of tillers), and yield components (panicle length, number of empty grains, number of grains pithy, and weight of 1000 grains). Data were analyzed by analysis of variance (ANOVA) and further tested by DMRT to determine differences between treatments.

Results and Discussion

Research sites

The District of South Lebong has an area 23.494 ha with a population of 13.406 people. Lebong district consists of 13 districts. South Lebong districts is one of 13 districts in Lebong, which consists of four villages and six villages with topogafi at an altitude of 100-500 with an area of 21 205 ha MPL, altitude 500-1000 MPL with an area of 80 384 ha and at altitudes up to 1,000 MPL 91 335 wide ha [5].

Lebong climatic conditions in the district with an average of more than 19 rainy days per month. October and November are the most rainy day, while June is the least rainy months. While temperatures are 29-30 °C in Lebong district every month with an average temperature of 23.8 ° C every months [5].

Effect of cropping systems for improved plant growth

Plant height measurement results in Table 1 indicate that at week 2 and week 5 did not show any differences in the addition of the rice plant height (Table 1).

Table 1. The results of measurements of plant height (cm) from 1 to 8 Weeks After Planting (MST)

Treatment	Observation Week							
	1	2	3	4	5	6	7	8
ST1	29,87^{a}	32,90^{a}	43,37^{b}	53,10^{b}	67,40^{a}	79,47^{a}	84,47^{a}	85,13^{b}
ST2	32,13^{a}	32,90^{a}	49,43^{a}	60,03^{a}	69,83^{a}	77,60^{ab}	81,13^{ab}	97,20^{a}
ST3	28,43^{a}	30,40^{a}	45,47^{b}	55,60^{ab}	69,83^{a}	74,73^{bc}	78,93^{ab}	93,73^{ab}
ST4	21,57^{b}	30,07^{a}	40,40^{b}	55,60^{ab}	69,83^{a}	72,54^{c}	75,00^{b}	93,20^{b}

Description: ST1=tiles, ST2= legowo 2:1, ST3 and ST4 = legowo 4:1 = 6:1 legowo
The numbers in the same column followed by the same letter are not significantly different shows at 5% DMRT

ST2 on cropping systems generally showed the addition of a higher plant height compared to other crops. The treatment of the four highest plant height (97.20 cm) occurred in ST2 treatment while plant height was lowest in the treatment of tiles with an average 85.13 cm. Crop conditions in ST2 provides opportunities for optimal sunlight. Penelitian2 based on cropping systems and the use of P-legowo Starter stated that the highest plant and obtained the highest number of productive tillers in cropping systems tend legowo equal to 2:1 and 4:1 legowo. However, plant height is used as one of the selection criteria in rice, but the high growth of plant height can not guarantee the results obtained over large [6].

On the number of pups with observations, show significant differences in the first week until the 7th week. ST1 and ST2 treatment at week 4 to week 7 did not show any significant differences with ST3 and ST4. At week 8, the last observation for the four treatments, namely ST1, ST2, ST3 and ST4 tiller number was not significantly different. Treatment of the fourth highest number of chicks that ST2 is a treatment that is an average of 29 chicks, while the lowest is the treatment ST4 average tillers 25 tillers can be seen in Table 2 below:

Table 2. Results of counting the number of chicks from 1 to 8 MST MST.

Treatment	Observation Week							
	1	2	3	4	5	6	7	8
ST1	2^b	6^b	18^{ab}	27^a	27^a	27^a	27^a	27^a
ST2	3^{ab}	8^a	18^{ab}	27^a	27^a	27^a	27^a	29^a
ST3	3^a	8^a	21^a	26^{ab}	26^{ab}	26^{ab}	26^{ab}	26^a
ST4	2^b	6^b	16^b	23^b	23^b	23^b	23^b	25^a

Description: ST1 = tiles, ST2 = legowo 2:1, ST3 and ST4 = legowo 4:1 = 6:1 legowo The numbers in the same column followed by the same letter are not significantly different shows at 5% DMRT

The differences in plant height and number of tillers in each treatment, presumably because of the influence both inside and outside the plant itself, such as genetic factors comes from within and from outside like rainfall, humidity, light intensity and soil fertility. Influenced by the number of productive tillers spacing, wider spacing / spacing between the plants will be more many productive tillers [7].

Effect of cropping systems on crop components

For the results of all the component parameters were observed after statistically tested only on the parameters of the number of grains per panicle pithy that showed significant differences in the treatment of the treatment ST2 ST3, ST4 and S1 while the other parameters showed no differences between treatments can be seen in Table 3, as follows:

Table 3. Data on average influence of cropping systems on crop yield components high treatment

Treatment	Height Plants (cm)	Length Panicle (cm)	Number of pups (stem)	Total Filled Grain (grain)	Pithy Grain (grain)	B_1000 Grain (gr)
ST1	$95{,}67^a$	$19{,}92^a$	11^a	64^b	34^a	$27{,}81^a$
ST2	$103{,}40^a$	$21{,}09^a$	13^a	117^a	26^a	$28{,}42^a$
ST3	$101{,}13^a$	$20{,}92^a$	13^a	74^b	24^a	$28{,}40^a$
ST4	$96{,}20^a$	$19{,}94^a$	12^a	66^b	28^a	$27{,}89^a$

Description: ST1 = tiles, ST2 = legowo 2:1, ST3 and ST4 = legowo 4:1 = 6:1 legowo The numbers in the same column followed by the same letter are not significantly different shows at 5% DMRT

Plant height is similar to paddy description issued is 101 cm. Inpari 13 are classified as short crop rice. The average number of pups showed a decrease of 17 panicles but the field only produces 11-13 by clump.

Table 3 shows that the length of panicle, grain weight of 1000 grains pithy and who has the highest average all four treatment is the treatment of ST2. The rice crop yield component primarily determined by the number of grains / panicle, number of panicle / clump, percentage of grain pithy and 1000 grain weight [8]. Of some observed variables visible only real difference in the amount of grain produced pithy. The amount of grain produced on ST2 pithy higher than other treatments, it is alleged that the spacing of the ST2 allows optimal sunlight, so that the filling stage of rice pithy be more perfect. However, from the results of the research, the best cropping system to get the highest grain production achieved by legowo 4:1, and to get a quality grain seed grain is achieved by legowo 2:1 [9].

Competition between plants of the same type inter-species competition greater than the effect of competition on different plant species (inter-species competition) [10]. At the same types of plants competencies will have the kind of need the intensity of sunlight, nutrients, water and a place to grow have the same needs as the age and the same plant roots.

The level of competition depends on rainfall, varieties, soil conditions, weed density, the length of the plant, weed growth, and the age of the plant when weeds start bersaing [11]. Addition to competition between plant competition also occurs with the weed plant to maintain its life cycle. Weeds interact with plants through the competition to get one or more growth factors are limited, such as light, nutrients, and water at the farm level may lead to loss of rice yield reached 10-15%.

With the efficiency and increase productivity through technology demonstration plots of rice, farmers are expected to adopt the technology that will be introduced. The pace and level of technology adoption by farmers is determined by several factors, including: (1) technology is being introduced to help solve the problems of farmers, (2) the means necessary for the implementation of such technology readily available, and (3) technology has introduced a higher level of efficiency than the previous technology [12].

Conclusion

Based on this research by the addition of plant height and number of tillers showed the better growth on legowo 2:1 and did not look significantly different from 4:1 legowo. On yield components did not shown the influence of planting system conducted with crop production except for grain number pithy observations. The amount of grain produced in the most pithy legowo 2:1 planting system.

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POTENTIAL OF IMPROVED SWAMP RICE VARIETIES ON TIDAL SWAMP IN BENGKULU CITY

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Abstract

Improved variety is one of important component of technology in increasing rice production and farm income. Swamp and tidal swamp lands are alternative target in developing rice in Bengkulu Province. Many swamp rice varieties have been released by Indonesian research institutions, but information related with their adaptation on tidal swamp are still rarely found. Objective of this research was to determine proper and adaptive varieties to be developed on tidal swamp in Bengkulu Province. Field experiment was conducted on tidal swamp in Bengkulu City from December 2012 to April 2013. The experimental design used was a randomized complete block design (RCBD)with 6 treatments and 4 replications. The treatment consisted of 6 varieties, namely Inpara 1, Inpara 3, Inpara 4, Inpara 5, Indragiri and Banyuasin. Result showed that productivity of swamp rice ranged from 3.03 to 8.44 t ha-1. The highest yield was achieved by Inpara 5 (8.27 t ha-1) and Banyuasin (8.44 t ha-1). The Inpara 5 and Banyuasin varieties were recommended to be developed in Bengkulu Province.

Keywords: *improved variety; tidal swamp; production; ric*

Introduction

Area of tidal marsh saltwater is being part of the leading tidal marsh, which is directly related to the sea. Typically, these swamp areas are affected by Tide. Generally, soil influenced by brackish water have neutral pH (pH 6.5 – 7.5) [1]. Tidal land area in Indonesia is estimated 24.7 million ha mostly found in Sumatra, Kalimantan and Irian Jaya and 9.53 million ha of them have potential to be developed for agriculture [2]. Tidal swamp area in Bengkulu province are about 802 ha distributed in Seluma, Mukomuko, North Bengkulu, Central Bengkulu Regency and Bengkulu City [3] .

In Bengkulu Province, potential development of tidal swamp land for rice cultivatian is still opened. Increasing rice productivity on the tidal swamp land needs a proper technology. Improved varieties is one of important components of technology to increase rice production and farm income[4]. The improved rice variety is one of inexpensive technology preferred by farmers. Variety play important role in improving production and quality of agricultural products.

Global climate change related with unpredicted seasons and extreme climate such as droughts and floods needs to be anticipated. Tolerant rice varieties are important to anticipate extreme environment (climate, soil and pest). Indonesian Agency for Agricultural Research and Development (AARD) has released many adaptive improved rice varieties for swamp land areas. For examples are Inpara 1 to Inpara 5 [5].

Many rice varieties have been released but some of them are not developed and adopted broadly by farmers. Factors causing varieties are not adopted by farmers are as folow: (1) Varieties are intolerant for extreme environment conditions (soil, climate and pest), (2) Varieties have no characters preferred by farmers and market (3) Seeds are not available and difficult to be found in the market. Variety adaptation is important to be conducted to evaluate and determine proper and adaptive variety on the tidal swamp area. The objective of this research was to determine proper and adaptive varieties to be developed on tidal swamp in Bengkulu Province.

Experimentals

Field experiment was conducted in tidal swamp in Bengkulu City from December 2012 until April 2013. The experimental design used was a randomized complete block design with 6 treatments and 4 replications. Treatment consisted of 6 varieties namely Inpara 1, Inpara 3, Inpara 4, Inpara 5, Indragiri, Banyuasin. Plot size are 9.5 x 2 m and there are 24 experimental plots. The legowo 2:1 was applied in Rice planting. Seedlings age used were 20 days after sowing (DAS) with 3 seedlings per hole. Fertilizer doses applied were : Urea 200 kg ha^{-1}, SP-36 100 kg ha^{-1} and KCl 100 kg ha^{-1}. The first fertilization was applied Urea 50 kg ha^{-1}, SP-36 100 kg ha^{-1} and KCl 100 kg ha^{-1} on 7 days after transplanting (DAT). The next fertilization was done on 21 DAT (Urea 75 kg ha^{-1}) and on 45 DAT (Urea 75 kg ha^{-1}).

Data collected included plant height, number of tillers, panicle length and yield. Data were analyzed using analysis of variance (ANOVA) and further test with Duncan's Multiple Range Test (DMRT) to determine differences between treatments.

Results and Discussion

Performance of improved swamp rice varieties cultivated on the tidal swamp was presented on Table 1. Results showed that the varieties were significantly different in influencing growth and yield.

Table 1. The performance of improved swamp rice varieties on the tidal swamp land.

Treatment	Plant Hight* (cm)	Number of tiller/hill*	Panicle length (cm)*	Yied (t ha^{-1})*
Inpara 1	111.50 a	15.67 a	20.62 b	5,60 bc
Inpara 3	97.83 b	12.33 a	20.23 bc	3,03 d
Inpara 4	98.75 b	14.83 a	18.35 d	6,36 b
Inpara 5	87.08 c	14.88 a	22.50 a	8,27 a
Indragiri	111.17 a	14.83 a	19.06 cd	5,05 c
Banyuasin	108.17 a	12.25 a	18.62 d	8,44 a

*Means within columns followed by common letter are not significantly different at P <0.05 by theDMRT.

The plant height of improved swam rice varieties ranged from 87.08 to 111.50 cm. Inpara 5 had the lowest plant height (87.08 cm). Inpara 1, Indragiri and Banyuasin had higher plant hight than Inpara 5, Inpara 3, Inpara 5. Plant height of Inpara 1, Inpara 3, Inpara 4, Inpara 5, Indragiri and Banyuasin varieties are as follows 111 cm, 108 cm, 94 cm, 92 cm, 98-105 cm and 98-105 cm respectively [6]. This result showed that plant height was influenced by varieties (genetic). There were no corelation between plant height and yield. The higher plant height is not always followed by the higher yield.

The number of tiller hill ranged from 12.25 to15.67 tillers [7]. The varieties were not significant (P>0.05) to affect the number of tiller $hill^{-1}$. The panicle length ranged from 18.62 to 22.50 cm. The varieties were significant to affect the yield or productivity of rice. The yield ranged from 3.03 to 8.44 t ha^{-1}. The varieties were significant (0.05<P) to affect yield of rice planted on the tidal swamp land. This condition proved that growth and yield of rice were affected by genetic and environment factors [8]. The highest yield was achieved by Inpara 5 (8.27 t ha-^{1}) and Banyuasin (8.44 t ha-^{1}). This condition indicated that Inpara 5 and Banyuasin were adaptive on the tidal swamp land. The Inpara 5 and Banyuasin varieties were recommended to be developed in Bengkulu Province

Conclusion

Inpara 5 and Banyuasin were adaptive on the tidal swamp land. The Inpara 5 and Banyuasin varieties were recommended to be developed in Bengkulu Province

Acknoledgment

We are very grateful to Dr. Ir. Dedi Sugandi MP (Head of Bengkulu AIAT) for his invaluable assistance and guidance at all stage of my research and preparation this paper. We are also greatly indebted to technical staff of Bengkulu AIAI (Hendri Suyanto and Marzan) for their cooperation that led to the smoooth running of experiment.

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PRODUCTION OF GREEN COMPOSITES BASED ON POLYLACTIC ACID AND BLEACHED PULP FROM OIL PALM FRONDS

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Abstract

The main drawback of low toughness of polylactic acid (PLA) is addressed by using bleached pulp as reinforcement agent~~s~~ and glycerol tryacetine as a plasticizer, with the goal of producing green composite. The bleached pulp was produced from oil palm frond through pulping and bleaching process to remove lignin and hemicellulose. The green composites were prepared by mixing bleached pulp, plasticizer and PLA in an organic solvent with various bleached pulp content up to 15 wt% and various plasticizer amount up to 10 wt%. The effects of reinforcement agent~~s~~ and plasticizer on the mechanical properties of PLA composites were investigated. The mechanical properties data showed that the Young's modulus and tensile strength of PLA composites were increased with increased bleached pulp content. Furthermore, the addition of glycerol triacetate improved the elongation of PLA composites.

Keywords: *bleached pulp of oil palm frond; polylactic acid composite; mechanical and thermal properties.*

Introduction

Green materials from renewable resources have become major research topic in many countries, driven by eco-friendly development issues and environmental protection. Because of its extensive use, bioplastic~~s~~ is one kind of green materials that rapidly developed. Polylactic acid (PLA) is a bio-based thermoplastic polyester of lactic acid, which can be produced from fermented natural-polysaccharides such as corn or potato starch [1,2]. Compare to other bio-based plastic, PLA provides good clarity, high strength, moderate barrier properties and easy processability in most equipment [3], and is thus used in wide areas of practice such as textile applications, food packaging, film applications and interior automotive parts [4]. Nevertheless, the low heat resistance, brittleness and slow crystallization characteristics of PLA are its drawback.

Other scientists have investigated the reinforcement of PLA using retted flax fibers or recycled news paper fibers and found out that even though the tensile modulus of PLA increased significantly with an increase of fibers content, the strength decreased [5,6]. Many kinds of natural fibers have been applied as reinforcement in PLA composite, such as: rice straw, hemp, kenaf, oil palm empty fruit bunch fibers [7,8,9,10]. Natural fibers in PLA matrix were applied as long fibers [5], short fibers [9,11] and micro fibers [7,10,12,13]. Further processing of natural fibers to obtain cellulose in form of microcrystalline cellulose, microfibrillated cellulose or nano fibers were conducted to overcome cellulose fibers limitation when blended with PLA [1,14,15, 16].

In this study, we used bleached kraft pulp of oil palm fronds as reinforcement in PLA matrix. Kraft pulping is the most important industrial method in the world for chemical pulps production. The advantages of this process were rather insensitive to the type of wood species and the inorganic process chemicals can be efficiently recovered and reused. The resulting cellulosic fibers are strong and can be used in a large variety of paper and board products. However, the comparatively high amount of residual lignin that is still attached to the fibers must be removed in the subsequent bleaching-process [17]. Conventionally, paper industry used chlorine based chemical for bleaching process. Effluents of these processes contain chlorinated aliphatic and aromatic compound that could be toxic, mutagenic and carcinogenic. Environmental concerns about toxicity of chlorinated organic led to utilizing hydrogen peroxide as less harmful chemical bleaching. Afterward bleached kraft pulp of oil palm fronds were mechanically fibrillated to produce fibrillated pulp fiber that were utilized as reinforcement in PLA matrix.

Based on previous investigation, initial effect of pulp fibers addition into PLA matrix was improved tensile modulus of PLA but decreased the strength due to higher stiffness. Therefore, to improve composite mechanical properties, plasticizer such as glycerol triacetate ester was applied in PLA matrix along with pulp fibers, in order to increase PLA elongation, hence improved tensile modulus and strength. The potential of bleached kraft pulp of oil palm fronds and glycerol triacetate to improved PLA characteristics are therefore explored in this study.

Materials and Methods / Experimental

Materials

PLA trade name LACEA H-400 was supplied by Mitsui Chemical Inc., Japan. The average molecular-weight (Mw) was 210.000, the degree of dispersion (Mw/Mn) = 3.2 and L-body/D-body = 98.2/1.8. The glass transition temperature (Tg) was 57 °C and melting point (Tm) was 165 °C. Pulp fiber was kraft pulp of oil palm frond bleached. The pulp fibers were produced from oil palm fronds that were collected from oil palm plantation in West Java, Indonesia.

Preparation of pulp fiber

The leaves were cut off from oil palm fronds, then the fronds were processed with ring flaker and screened to produce strands with 1 ~ 2 cm length. The moisture content of strands was 13.55 %. To produce kraft pulp, oil palm fronds fibers were subjected to digester with ratio of liquor-to-materials was 8:1. Kraft pulping was carried out at 30% sulfidity and 19% effective alkali. Thus, Na_2S solution, NaOH solution and water with total of 2000 ml were added to digester after 250g OPF strands (dry basis). Pulping was conducted in 2 hours, at 170^{o}C. After cooling of the digester, the pulp was collected and washed with fresh water several times until neutralized.

For the bleaching process, 6 gram OPF pulp (dry basis) and 100ml distilled water were added in 250 ml erlenmeyer, then put in waterbath at 80^{o}C. The technical grade solution of 50% hydrogen peroxide was used as bleaching agent. Every 60 minutes, 4.5 ml of 50% hydrogen hydroxide was added into erlenmeyer, for 3 times. After 3 hours bleaching process, bleached pulp was collected and washed with fresh water then stored in cold storage in condition of 80% moisture content.

Composite preparation

Pulp fibrillation and water removal were conducted simultaneously in high speed blender. An adequate OPF bleached pulp (refer to Table 1) was stirred in 300ml technical grade of 96% ethanol for 20 minutes, followed by vacuum filtration to remove the liquid phase (water and ethanol). The process was repeated three times in order to remove water by ethanol. Next, 300ml acetone using the same procedure and repeating two times was used to completely remove water. Meanwhile, an amount of PLA (refer to Table 1) was dissolve in 300ml dichloromethane. The precipitate of bleached pulp was suspended gradually in dissolved PLA and stirred in a beaker until well mixed for 30 minutes. The OPF bleached pulp-PLA-dichloromethane mixture was spread in trays and the solvent was evaporated in fume hood at room temperature for 12h followed by oven drying at 60°C for 24h.

Table 1. Composition of the sample

Samples	PLA (g)	OPF bleached pulp (g)	Glycerol Triacetate (g)
Neat PLA	60		
PLA/pulp 5 wt%	57	3	
PLA/pulp 10 wt%	54	6	
PLA/pulp 15 wt%	51	9	
PLA/pulp 10 wt%/GTA 5 wt%	51	6	3
PLA/pulp 10 wt%/GTA 10 wt%	48	6	6

PLA/pulp 10 wt%/GTA 15 wt%	45	6	9

The mixture of PLA/OPF pulp and PLA/OPF pulp/GTA was kneaded by a twin rotary mixer (Rheomix, HAAKE polydrive) at 160 °C, 40 rpm for 8 min. The compound was crushed into small pieces and hot pressed into sheets at 160 °C in two steps: pre-heating for 5 min and 0.5 MPa for 3 min. Afterwards, sample was cooled at room temperature for another 15 min.

Morphology observation

Physical properties such as fiber diameter and cell-wall thickness were determined using 40-µm thick cross-sections of the fibrous strands and a polarized light microscope (Carl Zeiss Axio Imager A1) with 100x magnification. The cross-sections were prepared using microtome and put on the glass object before observed under microscope.

Microscope digital Dino-Eye with 200x magnification was used to observe oil palm frond bleached pulp fiber. For the sample preparation, a drop of diluted fiber in water suspension was put on microscope plate and observed under microscope.

Tensile test

The tensile properties of samples were measured using a Shimadzu universal testing machine (UTM) with loadcell of 1kN. The specimen gage length of about 20mm was measured with a caliper for each sample upon gripping and the crosshead speed was set at 1mm/min. The specimens were 40 mm long, 5 mm wide and 0.5 mm thick. All results presented are the average of five measurements.

Results and Discussion

Morphology observation

The OPF vascular bundles are widely imbedded in thin-wall parenchymatous ground tissue. Each bundle was made up of a fibrous sheath, vessels, fibers, phloems and parenchymatous tissue [18]. As Figure 1 shows, OPF vessels and phloems tissue are clearly distinguishable. The oil palm frond vessels were arranged in solitary (Figure 1a) or 2-3 paired cells (Figure 1b) in the core region. Kraft pulping was intended to collect OPF fibers in form of pulp that will be utilized as filler or reinforcing in PLA matrix.

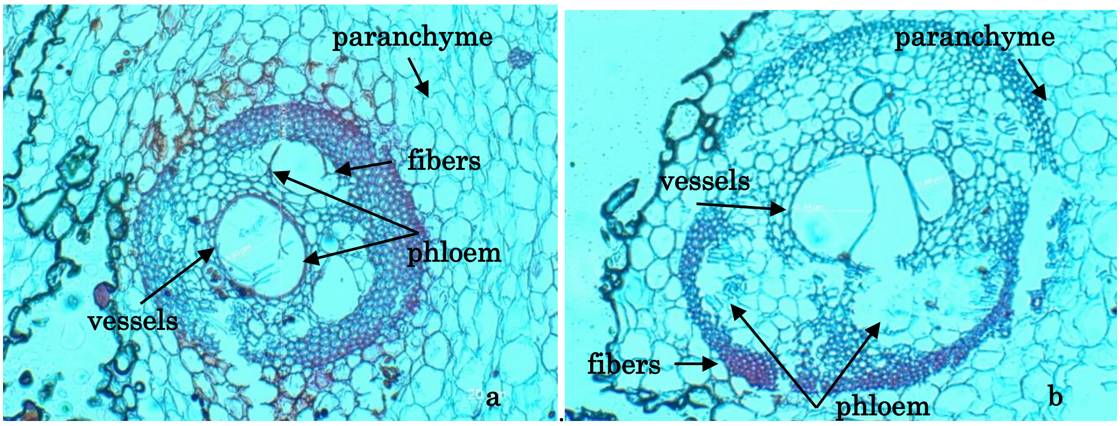

Figure 1. Cross section of oil palm frond strand with 100x magnification.'

Kraft pulping produce strong fibers but with high amount of residual lignin. Bleaching process using hydrogen peroxide, therefore was conducted to obtain OPF pulp fibers in bright color (Figure 2). After kraft pulping and bleaching process, diameter of OPF fibers was 13.3 µm, in average.

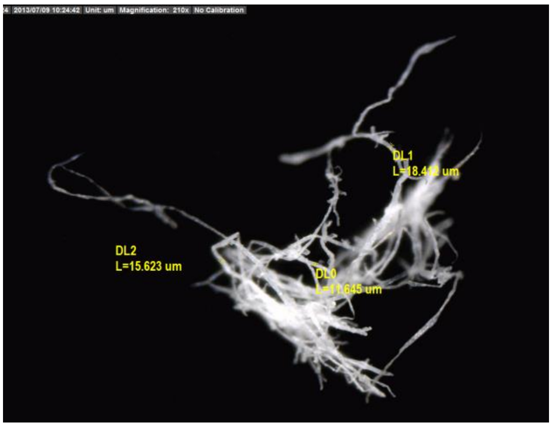

Figure 2. Oil palm frond bleached pulp fibers with 210x magnification.

Tensile properties

Mechanical properties of PLA reinforced by oil palm frond bleached pulp fibers are depicted in Fig. 3a. The mechanical properties of the composites are evaluated by 2 parameters, namely the tensile strength (MPa), and tensile modulus (GPa). Addition of bleached pulp into PLA matrix as much as 5 wt%, was inadequate to improve composite mechanical properties. The composite with 15 wt% bleached pulp produces the higher tensile strength and tensile modulus than that of PLA which were 11.20 MPa and 1.89 GPA, respectively.

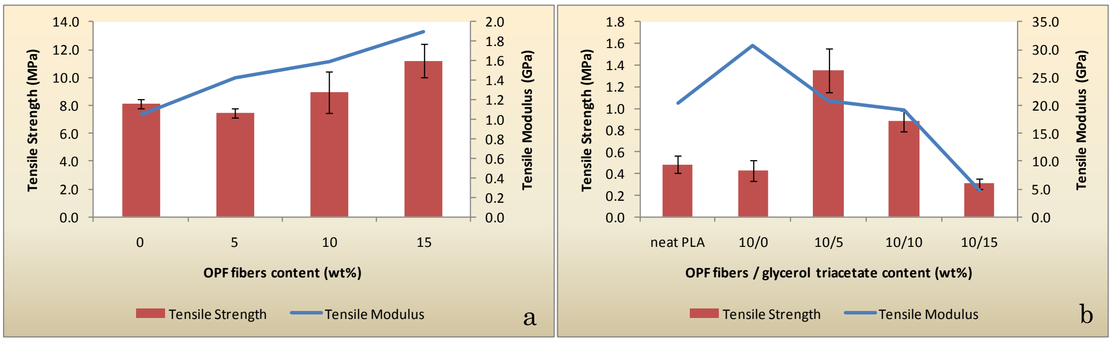

Figure 3. Tensile properties of PLA-OPF composite (a), and PLA-OPF-GTA composite (b)

The drawback of PLA rigidity was overcome by addition of plasticizer such as glycerol triacetate. In this study, bleached pulp fibers content in composite was held constant, 10 wt% and glycerol triacetin content were varied 5 wt%, 10wt% and 15 wt%. As observed at Fig. 3b, the composite of PLA reinforced with 10 wt% bleached pulp fibers and 5 wt% gylcerol triacetate exhibit the highest tensile strength, which was 26.31 MPa. However, the dramatic decline occurred in composite tensile strength at above 5 wt% glycerol triacetate. This is possibly due to the accumulation of glycerol triacetate at the interface between PLA and bleached pulp fibers.

The improvement of composite stiffness attributed by bleached pulp fibers was demonstrated by composite elongation reduction as seen in Fig. 4a. The decrease in elongation and strength of composite compared to pure polymers can be associated with inadequate wetting of the fiber with the matrix [19], uneven aligning of the cellulose fibers [20] and most probable poor adhesion between the filler and matrix [21]. The poor adhesion between matrix and fibers initiates numerous voids at the fiber matrix interface, and the stress transfer to the fibers, which are the load bearing entities, becomes inefficient leading to lower strength and elongation values.

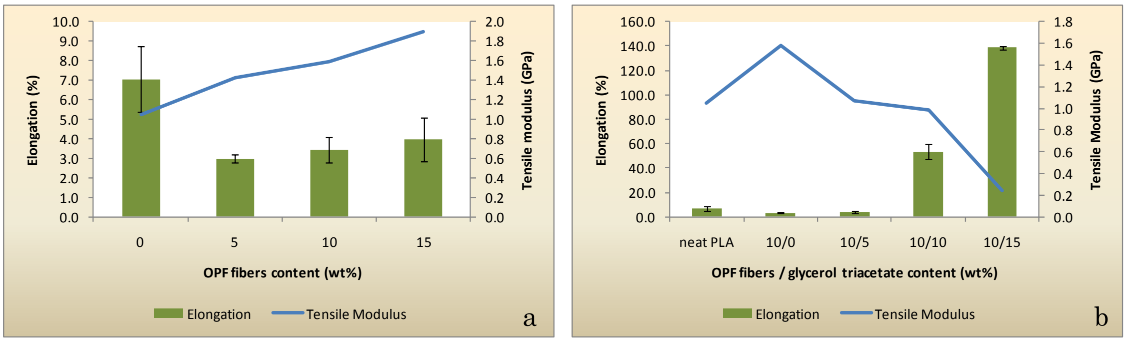

Figure 4. Elongation of PLA-OPF composite (a), and PLA-OPF-GTA composite (b)

As observed in Fig 4b, the elongation of PLA composite was dramatically improved in composite with 10 wt% and 15 wt% glycerol triacetate. As a plasticizer, glycerol triacetate molecules can penetrate into the composites and disrupt the binding force between PLA and cellulose fibers macromolecules that makes it easy for molecular chains to slide and move, consequently increasing the elongation.

Microscopy analysis of composite breakage

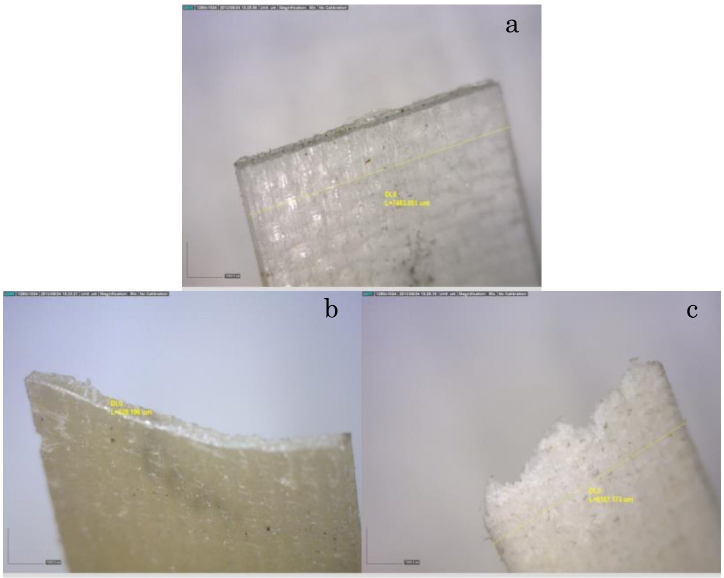

Figure 5. Composite surfaces fracture of PLA (a), PLA/OPF cellulose fibers composite (b) and PLA/OPF bleached pulp fibers/glycerol triacetate (c), with 50x magnification.

Microscopy images of fractured surfaces of PLA, PLA/OPF bleached pulp fibers composite, PLA/OPF bleached pulp fibers/ glycerol triacetate composite are shown in Fig 5a, 5b and 5c, respectively. Microscopy images of composite surfaces fractured was observed to study the failure mechanisms and to observe the interaction between different components during load bearing.

The fractured surface of pure PLA (Fig. 5a) could be categorized as brittle fracture, because the fibrils that still remained on the fractured surfaces has < 1µm long [22]. After OPF bleached pulp fibers was added in the PLA matrix, the tensile fracture surface of composites showed irregular protrusion (Fig. 5b). This is a clear indication of bleached pulp fibers poor dispersion in PLA matrix and poor interfacial adhesion between filler and matrix. This explain the decrease of composite elongation at break. Meanwhile the addition of glycerol triacetate could restrain bleached pulp fibers in PLA matrix during load application (Fig. 5c) and resulted the improvement of composite elongation at break.

Conclusions

The composite of PLA reinforced with 10 wt% bleached pulp fibers of oil palm frond and 5 wt% glycerol triacetate exhibited the highest tensile strength, which was 26.31 MPa. The elongation of PLA composite was dramatically improved in composite with 15 wt% glycerol triacetate.

Acknowledgements

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Symposium Schedule

Day 1
September 17th, 2013

08.00 – 08.45	Registration and Coffe break	
08.45 – 09.00	Opening Ceremony 1. Welcome speech from Rector/Dean of Faculty of Agriculture-Bengkulu 2. Welcome speech from representative of RISH Kyoto University 3. Welcome speech and opening remarks from Deputy of Life Science-LIPI	
	Keynotes Session	
09.00 – 09.30	RISH	
09.30 – 10.00	Dr. Siti Nuramaliati Prijono - Deputy of Life Science, LIPI	
10.00 – 10.15	Photo session	

Presentation Session
Topic A (Community-based Development and Social Economic Science)

10.15 – 10.40	Invited speaker from CSEAS	Dr. Motoko Shimagami
10.40 – 11.05	Invited speaker from CIFOR	Dr. Heri Purnomo
11.05 – 11.20	A – 01	Arianti Ina R. Hunga
11.20 – 11.35	A – 02	Inne Soesanti
11.35 – 11.50	A – 03	Savitri Dyah
11.50 – 12.05	A – 04	Ema Septaria
12.05 – 12.20	A – 05	Muhamad Abduh
12.20 – 13.00	Lunch	
13.00 – 13.30	Poster Presentation	

Presentation Session
Topic B (Atmospheric Science)

13.30 – 13.55	Invited speaker from RISH	Prof. Mamoru Yamamoto
13.55 – 14.10	B – 01	Baiturrahmah
14.10 – 14.25	B – 02	I Putu Dedy Pratama
14.25 – 14.40	B – 03	Muhamad Nur
14.40 – 14.55	B – 04	Fikri Bamahry
14.55 – 15.10	B – 05	Khomsin
15.15 – 15.30	Break	

Presentration Session
Topic C (Geosphere Science)

15.30 – 15.55	Invited speaker from LIPI	Dr. Ir. Munasri
15.55 – 16.10	C – 01	Gusta Gunawan
16.10 – 16.25	C – 02	Fahrudin
16.25 – 16.40	C – 03	Diyan Parwatiningtyas

16.40 – 16.55	C – 04	Sonny Aribowo
16.55 – 17.10	C – 05	Qurnia Wulan Sari
17.10 – 17.15	Closing day 1	

Day 2
September 18th, 2013

08.00 – 08.15	Registration	
	Keynotes Session	
08.15 – 08.45	Prof. Soekotjo, Faculty of Forestry, Gadjah Mada University	
08.45 – 09.15	Prof. Dr. Bambang Subiyanto, M.Agr, Head of Center of Innovation, LIPI	
09.15 – 09.30	Break	

Presentation Session Room I
Topic: Biosphere and Forest Science

	Session 1 Topic D: Biosphere Science	
09.30 – 09.55	Invited speaker from Rajamangala University	Dr. Chaisit Preecha
09.55 – 10.10	D – 01	Rita Kasrina Susanti
10.10 – 10.25	D – 02	Effendi O Sagala
10.25 – 10.40	D – 03	
10.40 – 10.55	D – 04	Yuwana
10.55 – 11.10	D – 05	Choirul Muslim
	Session 2 Topic E: Forest Science	
11.10 – 11.25	E – 01	Iin P. Handayani
11.25 – 11.40	E – 02	Haris Gunawan
11.40 – 11.55	E – 03	Hanifa Marisa
11.55 – 12.10	E – 04	Siti Latifah
12.10 – 12.25	E – 05	Widyatmani Sih Dewi
12.25 – 13.30	Lunch	
13.00 – 13.30	Poster Presentation	
	Session 3 Topic E: Forest Science	
13.30 – 13.55	Invited speaker from UNIB	Dr. Wiryono
13.55 – 14.10	E – 06	Septri Widiono
14.10 – 14.25	E – 07	Yansen
14.25 – 14.40	E – 08	Hery Suhartoyo
14.40 – 14.55	E – 09	Priyono Prawito
14.55 – 15.15	Coffee Break	
	Session 4 Topic D: Biosphere Science	
15.15 – 15.30	D – 06	Atra Romeida
15.30 – 15.45	D – 07	Dwi Wahyuni Ganefianti
15.45 – 16.00	D – 08	Mohammad Chozin
16.00 – 16. 15	D – 09	Marwanto

16.15 – 16.30	D – 10	Yudhi Harini Bertham
16.30 – 16.45	D – 11	Tunjung Pamekas
16.45 – 17.00	D – 12	Marlin

17.00 – 17.30 Closing Remark

Presentation Session Room II
Topic: Wood Science and Technology and Wood and Urban Pest Management

Session 1 Topic F: Wood Science and Technology

09.30 – 09.55	Invited speaker from CIFOR	Dr. Soo Min Lee
09.55 – 10.10	F – 01	Wahyu Dwianto
10.10 – 10.25	F – 02	Dian Susanthy
10.25 – 10.40	F – 03	Agus Haryono
10.40 – 10.55	F – 04	Irfan Gustian
10.55 – 11.10	F – 05	Euis Hermiati

Session 2 Topic G: Wood and Urban Pest Management

11.10 – 11.35	Invited speaker from USM	Prof. Chow-Yang Lee
11.35 – 11.50	G – 01	Kazuko Ono
11.50 – 12.05	G – 02	Suswati
12.05 – 12.20	G – 03	Munadian
12.20 – 12.35	G – 04	S. Khoirul Himmi

12.35 – 13.30 Lunch
13.00 – 13.30 Poster Presentation

Session 3 Topic G: Wood and Urban Pest Management

13.30 – 13.45	G – 05	Titik Kartika
13.45 – 14.00	G – 06	Asmah Indrawati
14.00 – 14.15	G – 07	Siti Herlinda
14.15 – 14.30	G – 08	Morina Adfa
14.30 – 14.45	G – 09	Fanani Haryo Widodo

14.45 – 15.15 Coffee Break

Session 4 Topic F: Wood Science and Technology

15.15 – 15.40	Invited speaker from RISH	
15.40 – 15.55	F – 06	Yenny Meliana
15.55 – 16.10	F – 07	Deliana Dahnum
16.10 – 16. 25	F – 08	Ridwan Yahya
16.25 – 16.40	F – 09	Deddy Triyono Nugroho A.
16.40 – 16.55	F – 10	Subyakto

17.00 – 17.30 Closing Remark