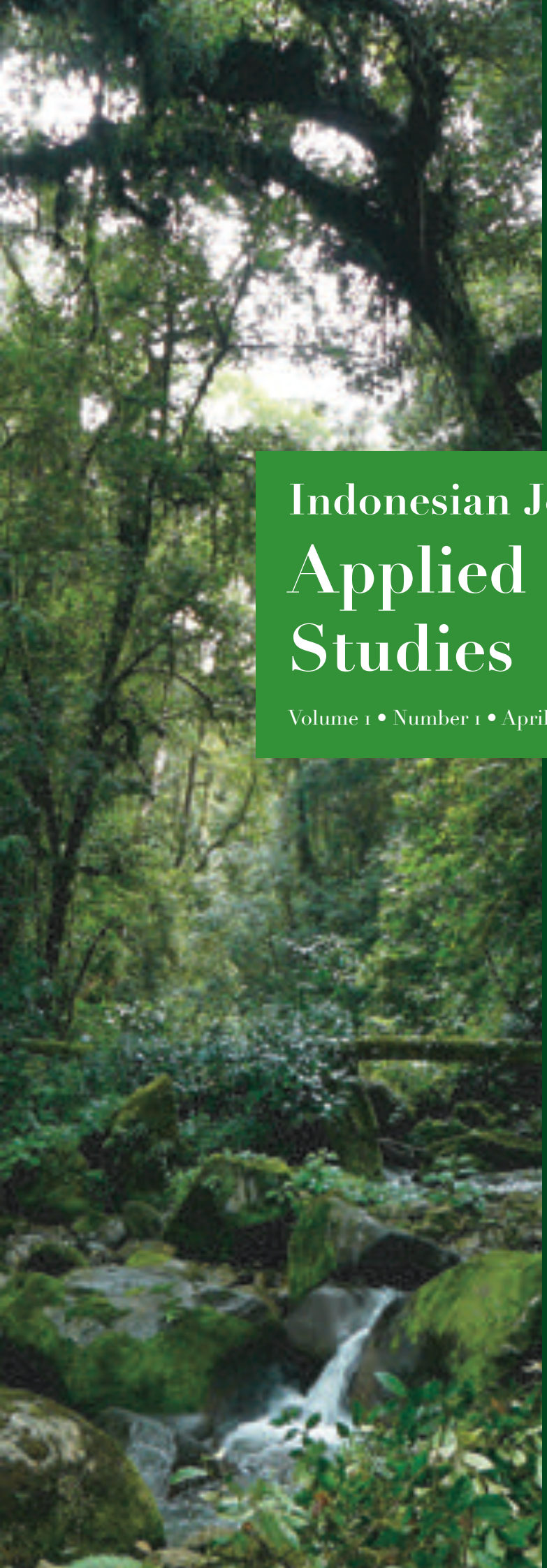

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GUEST EDITORIAL

Cultural diversity and biodiversity as foundation of sustainable development

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INTRODUCTION

We know that there is only one earth, there are many different worlds. Different worldviews do not only have significant political and socio-economic repercussions but they also determine the way in which people perceive and interact with nature, thus forming their specific culture. Natural ecosystems cannot be understood, conserved and managed without recognizing the human culture that shape them, since biological and cultural diversities are mutually reinforcing and interdependent. Together, cultural diversity and biological diversity hold the key to ensuring resilience in both social and ecological systems (Erdelen, 2003). Through the environmental sciences and cultural activities, in promoting awareness and understanding of the relationships between biological and cultural diversity as a key basis for sustainable development.

Beside has high biological diversity Indonesia also possesses high cultural diversity. It doesn't marvel that Indonesia is the world's largest archipelago, containing more than seventeen thousand island extending in an east-west direction for five thousand two hundred kilometers across the Sunda and Sahul continent shelves. The archipelago exhibits rich biodiversity that is unequalled in Asia (McNelly et al., 1990). Indonesia's territory cover 7.7 million square kilometer, of which approximately 5.8 million square kilometers (75.3 %) is comprised of marine and coastal waters. Indonesia is located between two of Earth's biogeographic regions: Indo-Malaya and Oceania. The Indo-Malaya region to the west includes Sumatra, Kalimantan, Java, and Bali, and the Oceanic region to the east includes Sulawesi, Moluccas, the eastern Sunda Islands, and West Papua.

The vegetation types to the east and the west of the Wallace line are divided by a biogeographical boundary that extends from north to south along the Sunda Shelf. The natural vegetation on the shelf it self is comprised principally of the Malesian type, dominated by the commercially important Dipterocarpaceae. Vegetation to the east has greater affinities with Oceanic Austro-Pacific zone and is dominated by mixed tropical hardwood species. Deciduous monsoon forest occurs in seasonally dry areas, particularly in the southern and eastern islands such as the Lesser Sunda and the southern part of Papua. The outer islands of Sumatra, Kalimantan, Sulawesi, Moluccas, and Papua comprise approximately 10 % of the world's tropical rainforest. Indonesia has more tropical forest than any other single Africa or Asia country, and is second only to Brazil in terms of tropical forest area. This country characterized by an enormously varied topography of shallow coastal water, swamp, lakes, alluvial plains, volcanoes, and High Mountain ranges. This country also presents at least forty-seven distinct natural and man-made ecosystems. These ecosystem types ranges from the ice mountain ecosystem and alpine grassland on the high mountains in Papua (Puncak Jaya Wijaya, at an altitude of over five thousand metres0 to variations of tropical rainforest ecosystems – from lowland to mountain landscape, shallow swamp to deep lakes, from mangroves to algae communities and coral reefs – as well as an ocean ecosystem reaching as deep as eight thousand meters below sea level (MoF/FAO, 1991).

Unfortunately, little respect has been given to the high diversity of the archipelago, resulting in disappearance of many of these cultures. Studies to

document and learn traditional wisdom are needed urgently, not least because traditional knowledge is often compatible with sustainable development objectives, as discussed in the World Summit on Sustainable Development, in Rio de Janeiro, 1992 and in Johannesburg in 2002. Meanwhile the deforestation in Indonesia occurs at an alarming rate. Forest cover decreased from about 193.7 million hectares in 1950s (Hannibal, 1950) to 119.7 million hectares in 1985 and to 100 million hectares in 1997 (GOI/World Bank, 2000) and only 98 million hectares remain (FWI/GWF, 2001).

The local knowledge of environment management and indigenous custom, as part of indigenous culture, is the product of long interaction between man and their environment and also results of their ability for application the technique adaptation to their environment. High biological diversity has utilized for economic reason, even though this national asset has not yet been fully developed.

Dynamic interaction between people and biodiversity in Indonesia let to the creation of many different cultures and thus languages and dialects. More than four hundred Indonesian ethnic groups are dispersed in different regions. Indonesia boasts 665 different languages and dialects, with Papua accounting for 250 of these, Moluccas 133, Sulawesi 105, Kalimantan 77, Nusa Tenggara (Lesser Sunda Islands) 53, Sumatra 38, Java and Bali 9 (Grimes, 1988). Such ethnics have specific knowledge about how to manage their environment and biodiversity surrounding them. Every ethnic has a specific culture, knowledge and local wisdom and technique adaptation to their various environments.

Concerning the cultural richness in Indonesian, besides have advantages also constitute weaknesses for biodiversity resource management. One of these advantages is that we have various referable traditional pattern and alternative selection of space management and we have material to design system admissible management by all societies and also government. Meanwhile its weakness is that each ethnic has specific pattern according to environmental condition and cultural level. But along with time developing marks sense decentralization of policy in Indonesian, therefore local or region policy that based on actual condition area and society is more elegant compared with uniformity management which hasn't obviously fastened by other area that has different culture and environmental condition.

CONCEPT OF NATURAL RESOURCES MANAGEMENT "LOCAL AND GOVERNMENT"

Basic concept of biodiversity resources management

Biodiversity concept consists of three principal dimensions (ecology, economic, and ethic), which are not exclusive but complementary. Every dimension has a different argumentation, which have to be developed before convinced by politic and public, which are necessary to conserve the biodiversity that threaten by human activities. The objective of this approach is likely to promote *in-situ* conservation in the sustainable development context. The ethic dimension consists of philosophic and religious aspects. They have a principle notice in which the biodiversity is a heritage of humanity, so that it has to be protected. For the scientific point of views, it has questions for years concerning the original of life form diversity, what kind of this diversity role in the ecosystem function, and what ecological consequence of the diversity reduction. The ecological dimension preoccupied their capacity in the biological system to find a comparable condition in their initial situation after perturbation or anthropisation. Ecologist called this condition as resilience. For the economical dimension, which relates to the biological diversity exploitation, we count the financial term on the actual use and potential of biodiversity. Without Manichaeism excessive, we can consider that the three dimensions also have different enter point which depends on interlocutors for scientific reason, and ecological dimension is a priority. For the economic dimension, the priority is a politic, and for NGO is related with ethic dimension.

Genetic resources have a crucial role in economic development and they must be conserved for present and future generations. Genetic resources-genetic material of actual or potential value performs many important functions as a genetic base for breeding programs, economic assets for future use, and part of the ecological attributes. Realizing the economic importance of genetic resources, there has been a growing concern among the developing world in conserving these resources through *in-situ* and *ex-situ* approach (Zakri, 1993). It means that some genetic

resources may be best conserved by growing them in nature reserves or genetic conservation areas and a few may be best kept as collections in stored seeds or advanced cultivars.

The biodiversity is a heritage of evolution that is constructed in the climatic and geomorphologic context in perpetual changes, vaporized also by speciation. In fact, distribution of biological diversity is a result of environment history, the climatic condition, and the ecologic distribution, which prevails locally. This heritage is threat by anthrophic activities, and may also by direct menace of the global changes.

However if these significant regions of the world in terms of biogeography and biodiversity are not managed wisely then these are undergoing rapid destruction. Many species of ecological and economic significance are liable to go extinct before their systematic and biology is studied scientifically. Potential sources of plants are likely to be lost forever. This happened to many remote areas in Indonesia where the unique and diverse plants suffer from the increasing land use and human impact.

Biodiversity resources management

In general, the problems of biodiversity resources management are: (1) *degradation of natural resources richness*; (2) *management aspects:* given biodiversity resources management rights to particular stake holder has evoked unfairness which caused conflict and social resentment; (3) *social-economic aspects:* natural resources exploitations have raised income for particular people consequently created social, economic, and cultural problem in local society around the exploitation area; (4) *socio-cultural aspects:* the proclivity differences in utilizing biodiversity resources have evoked socio-cultural problem and conflict; (5) *law aspect:* continuous conflict of biodiversity resources employed indicated a problem of law enforcement; (6) *environmental aspects:* environmental quality decrease because of erroneous exploitation of biodiversity resources; and (7) *knowledge aspects:* up to now we don't have enough information regarding our biodiversity richness, further more research on biodiversity research study kept scattered in many institutions.

It is so unfortunate that conservation area declared and stroke by goverment has been destroyed and log illegally. There are many conservation areas such as nature preservation, nature protection and national park is not succeeding as they intended because their applied conservation concept is a western-based concept. This concept style doesn't compatible with local culture. However many traditional protection area around the world have more respected and sustained. This is because managing protected area in traditional way has defense constant degradation of environment combined with local believe and culture.

In general regarding the biodiversity conservation area, the management and policy maker ignored local cultural concept because it has complex devotion. It has to be changed because we realize that human are part of life-included biodiversity, so it has to manage as one ecosystem. In the end the stability between functional and ecological aspect can be achieved.

The ethnoecology study has been done by LIPI in some Indonesian ethnics showed that people tradition can do management activity of natural resources, if they have access and control on their resources included tradition and common law that declared by their community as well as another community. The problem is two land tenure system in Indonesian applied: land tenure based state system and land tenure based community system where mutually discard if these two systems applied. In practice, if this two-land tenure system was employed, it will evoke conflict between societies and the government (conservation area management). Indeed this conflict won by government based on UU No. 5/1967 and UU no. 41/1999 which stated that forest custom ownership is part of forest State ownership. If this system regularly applied will create continues conflict on biodiversity resources management. Therefore in order to decrease the conflict, the management has to revitalize cultural value using indigenous knowledge adding with more scientific concepts.

The concept of conservation area management has been developed. Unfortunately to some extent still diminish local people involvement; even only give a kind of authorization on traditional management practices of natural resources detained by local people. Even the management conservation area priority program has changed in large scale conservation, accounted from how large area to be managed and also financial supported. But these strategies apparently more accentuate scholarships scientific support instead of weigh social reality of a

conservation area as management object. There is inclination not to include indigenous people because they seemingly difficult to collaborate under modern conservation strategy. According to Chapin (2004) *cited by* Rovihandono (2007) this condition has evoked conflict such as civil disruption or even violence. The impact of intervention management of conservation area for local people is decreasing local value and wisdom from generation to generations and influenced sustainability of natural resources management and in the end will eliminate the local culture itself.

In Indonesia, effort of conservation area management involving local people participation has been done through collaborative initiative program (co-management) by socio-economic development society, even the result far beyond expectation of increasing local people prosperity. For example ICDP approach (*Integrated Conservation Development Projects*) and IPAS (*Integrated Protected Areas*) that involving local people participation (co-management) at Bunaken National Park, North Sulawesi. Ineffectiveness implementation of this program is according Barber et al. (1997) *cit* by Rovihandono (2007) caused by ICDP activity doesn't lead to conservation principles and method failed because of incentive system is not enough to change society behavior in biodiversity resources exploitation.

From the policy aspect, government has tried to combine local concept and government concept of conservation by SK Menhut no. 783/Kpts II./1992 that arrange forest managements as Nature Reserve. Government, NGO and also local society hold the management. However in practice the impact of this management still dissatisfactory because government concept more overriding than local concept.

PRINCIPLES OF BIODIVERSITY MANAGEMENT AND SUSTAINABLE DEVELOPMENT

In recent decade, culture as well as sustainable use of biodiversity knowledge by local people has been developed. One series of biodiversity conservation action was established in Earths Summit in 1992 that highlighted three relevant development that environmentally sound, which is (1) all countries have role in reforestation and biodiversity conservation; (2) biodiversity have to be managed to meet the need of social, economy, ecology, cultural and spiritual of the actual generation and the future generation; and (3) biodiversity management policy have to support the cultures and rights of local people and societies surrounding the forests. Local society knowledge about biodiversity conservation and sustainable use has to be respected and included in forestry development program (biodiversity).

Concerning sustainable development: The question concerning an operational definition of sustainability has been raised on several occasions prompting repeated declarations to the effect that the wording provided by the WCED (The World Commission on Environment and Development), *"our common future"*, is appropriate. The sustainable define as "development that meets the needs of the present without comprising the ability of future generation to meet their own needs". By itself, the latter statement is unbounded and involves an appeal to *"inter-generational equity"* with the unbounded and involves an appeal to *"inter-generational equity"* with the consequent implicit assumption that the future will somehow be able to take care itself through increasingly effective and efficient technological adjustments regardless of the quality of available resource base (Harger, 1992). Sustainability development of biodiversity are constitute biodiversity's management form that have character result sustainable is showed by its indemnity bond productions functions, ecology and social-economy-culture of biodiversity for local societies. In principle that sustainable development of biodiversity means is biodiversity management that economically productive, social's ala fair, ecologically sustainable, politically participative, and and dynamic in cultural (dynamic culturally). Therefore each step of biodiversity's management shall get to render biodiversity's function balance as resource development and sustainable life system and efficient used to supporting sustainable development.

Sustainability implies: (1) improved economic well-being without jeopardizing future needs; (2) appropriate use resources without obvious degradation setting in; (3) resources use in a manner that would contribute to equity and social justice and avoid serious disruptions; and (4) appropriate use of resources in a manner that optimizes maintenance of cultural and biological diversity (Ramakrishnan, 2001 *cited by* Harger, 1992).

Major factors affecting "sustainability": one of the most difficult areas to deal with will be assessment

of the effects of natural resources exploitations. On the one hand, natural resources exploitation enrichment to human social systems is clearly used to promote increases in carrying capacity and the elaboration of counter-entropy structures. On the other, the act of natural resources exploitation and subsequent natural resources degradation promotes vast and as yet un-quantified negative environmental impacts and instabilities. Urgent work is required to assess the possible effects of increasing natural resources exploitation on global, regional and local systems, and to find the new solution natural resources management that sustainable.

CULTURAL DIVERSITY IN INDONESIA: LOCAL KNOWLEDGE IN NATURAL RESOURCE MANAGEMENT

Protection of area with reason to protect natural resources which have a vital benefit to society is with application of custom order, for example custom order execution for the protection of forest which is there are sources of wellspring, *sasi* execution to protect the type of resources involve like some marine product type like sea-cucumber, *batulaga* (kind of cockle), and other which have high economic value in order diminish abundant exploitation (Purwanto and Laumonier, 2004). This situation can be found as well in Bunaq society in East Nusa Tenggara, protecting sacred place spread over in the area with custom order. The reason of this protection is because of this sacred area has water resources and high plant diversity compared with other area (see Purwanto and Soedjito, 2004 and Friedberg et al., 2004). While example from Dayak society is determination of sacred forest and *tanah ulen*, especially by Dayak Kenyah society. Specially *tanah ulen*, although management system of this area is predominated by noble and have the exclusive character, but from exploiting aspect and conservation gave an advantage for society in general (*see* Purwanto and Soedjito, 2003).

Every ethnic or society group in Indonesia have planology concept which determine a planology unit as sacred area. Every sacred area has unique specification in every society and region. We need a "setting" and special criteria to identify and classify the sacred area applied and implemented, so that cultural conservation and natural resources can be accepted by society. Based on the perception in some society group like Baduy society in Banten, Tanimbar society in South-East West Moluccas, Kei society in South-East Moluccas, Bunaq society in NTT, Dani society in Baliem valley, Anak Dalam society in Jambi, Toro society in Middle Sulawesi and others indicate that protection area by custom or by sacred or by applying custom order can take care of environment further compared with formal regulation. Traditional society still esteems custom which becoming agreement and respects it. Magical dubious influence in character more adhered than a punishment in term of physical. Societies still tend to adhere custom rules, which made by the agreement than the formal regulation, which made by government.

For example Baduy society has been able to conduct the continuation of natural resources involve in its area based on zones system, which in harmony with modern management of zones system a biosphere pledge. Division of Baduy area zones system the core important relied on the sacred level and social function of Baduy society culture and economics. There are 3 zones: (1) nature patrimony forest zone or *arca domas* and *sasaka domas* sacred forest, this area is equal to zone central; (2) zone which is analogy with prop area that is outside sacred forest area dwelt by internal Baduy society (Tangtu); (3) area which the analogy is equal to transition area that is area outside Baduy is dwelt by external Baduy society (penamping/dangka area). Besides that, every hill, which is in prop and transition area, is also managed with sub-zones system. Through this traditional planology concept, in general Baduy society can manage natural resources self-supporting and have continuation (Iskandar, 2007).

This situation above also happened at Toro society in Lore Lindu National Park, Central Sulawesi. This Society can revitalize their relation with forest area around them. The Toro's has developed real effort which addressed problems met in their interaction with forest resources, namely Lore Lindu National Park. In these cases, Toro has revitalized the institution concerning the natural resources management. The institution revitalization is one of the Toro's adaptive strategies to response the environment changes (market intervention and public influences). As a whole the Toro institution prove its adequate ability managing and utilizing forest resources sustainable (Golar, 2007).

ADVANTAGE OF LOCAL KNOWLEDGE IN TRADITIONAL CONSERVATION

Management System of natural resources has relied on equality in principle benefit and reciprocal (reciprocity) to balance social compatibility with its environment. Conservation variety concept involves in Indonesia more knowledgeable based on concept from western. Indonesian conservation conception was applied first time in Arca Domas area in West Java by Netherlands in the year of 1921 as Nature Reserve. However actually, the Arca Domas area previously conserved by local people with their on way to sacred it. Similar matter happened in the entire region either in Java, Bali, NTT, NTB, Sumatra, Kalimantan, Sulawesi, Maluku, Irian Jaya and other regional where each region have their own distinctiveness. We analyze Indonesian traditional conservation concept more excellence, reasonable to be justified regarding conservation point of view and have more sustainable use. Furthermore the area itself has been managed reasonably so can give more valuable result to local people. An example of this can be seen in *Tanah Ulen* area by Dayak Kenyah society in East Kalimantan or applying of sign or *sasi* of prohibition order arranging natural resources exploiting in Maluku society, determination sacred area to protect natural resources and much more.

Based on local knowledge study of conservation concept in areas which is sacred or to be sacred, they actually have system when we look from the ecology aspect have high conservation value. In daily life local conservation system society related to religion and local trust is more respected than formal conservation system. As a religion society like Indonesian in general, they very respect to things, which in religion character, have a high place in their life. So it is not surprising if sacred places still stay conserved than other places, which is not sacred.

The area is becoming sacred or conserved locally because society as a whole has responsibility taking care of it and they share sense of belonging as well. Beside that, there is believe that collision to the area will get custom punishment or social punishment which psychologically will embarrassed him and his clan, so it is very obviated to brake the custom norm which have been agreed. This means social punishment is heavier than physical punishment by paying other physical penalty.

Cultural conservation based concept is very effective in its society. Unfortunately, this good concept doesn't get any acknowledgment and attention from the government so eroded by unbeneficial changes.

Some advantages of management conservation area based on local culture as follows:

1. *Conservation traditional area (sacred natural site) have great value for ecology conservation :* as area of high biology diversity, as sanctuaries for rare or threatened species and endemic, as sites that protect freshwater sources, areas and still prestine, as indicator sites showing potential natural vegetation in areas subject to environment degradation (important for restoration and rehabilitation of degraded ecosystem), as a natural representation of ecosystem and landscape of this areas, and gene pool of biodiversity.
2. *Having more everlasting conservation dimension/long-range (sustainable)* → Local society has protected the natural sacred area long time ago. When the natural sacred area on guard on a long term, the biological process of resources in this area more complete, so that can be made as "public awareness demonstration" area of environmental education in order to manage the system of natural resources conservation effort and continuation.
3. *Natural sacred area can be used as management sacred area model;* it has more holistic character especially related aspect between human being and natural resources as integrated form between natural value and culture in system management of resources. Beside that this sacred area also used as environmental management strategy or participative model through conceptual and also practical. In principle the management practice is togetherness or has a share to take care of area because all society experiences the benefit. As good as any model will not succeed if the model is not gave an advantage and accepted by society. So that in this context we earn to learn from formulation "buffer zone management" around sacred area. So that there are possibilities to integrate between conservation areas with local society and can improve advantage and repair society behavior as well as concerning conservation area regulation.

4 *Protection and taking care of traditional knowledge* → sacred area conservation saving effort represent cultural society and local knowledge conservation.

5 *Cultural Manifestation and cultural diversity* → local Conservation area or sacred areas have cultural value as well as a reference from culture, religion, and identity of society group and even identity of nation.

6 *Eco-tourism* → sacred areas represent the part of cultural properties and natural resources (heritage cultural and natural) from society group which have their own specification and can be made as eco-tourism object. But, it is need a special treatment in order not happened on the contrary.

7 *Sacred values* → Sacred area have religion value which have to be esteem, to be respected and protected as elementary manifestation from traditional trust, specific philosophy value and spiritual from local culture.

Although traditional conservation areas have some roles, advantages and function, but these areas have also menace and weakness to its occurrence such as:

1 *No confession:* from government in general and even there is a massif pressure about this area and still continue recently.

2 *The secret of sacred:* Traditional knowledge secret by custom society become one of the insufficiency or weakness from this area to be able to recognized and comprehended by other society.

3 *Choosing area which is "arbitrary:* From perspective of natural resources conservation and environment, election of sacred area has the character of "arbitrary" and not follow the systematic procedures in determining resource conservation area involve.

4 *Traditional conservation area or sacred area sometimes in the form of artificial ecosystem.*

5 *Cultural change:* As we know with human being culture have the character of dynamic influenced by education, technology, modernization, other cultural intervention which caused extinction of traditional conservation area. Traditional conservation area can give positive influence to natural conservation as long as the supporter community still makes the system of trust as an action reference. When trust aspect become a sacred bases fade or lose, the continuity of natural resources will immediately face threat if there is no cultural mechanism and other institute replace. This matter happened in Toro society and they can revitalize the institute of management area.

6 *Economic advantages:* Resource management is more oriented on economics that can cause decreasing the importance value of traditional conservation area.

7 *Traditional knowledge about ecology:* When traditional knowledge of ecology is applied in traditional conservation area, the traditional knowledge analysis and study about ecology only looked at the erudition aspect based on western knowledge point of view. Thus can cause spiritual assess become loss.

CONCLUSION

To support these efforts, a few challenges must be considered such as:

1 Management of biodiversity which giving room to local culture: In management of biodiversity resources we need to develop new paradigm by opening and giving opportunity to local society to role in every area. This is important to answer a friction of development paradigm from centralistic to decentralist. The modern combination idea based on science (western based) with local wisdom and knowledge based on society (wisdom community wisdom based) representing one way and need to be developed in Indonesia. Early step, need to be done through, is to study local knowledge about management the natural resources scientifically to prove its erudition. Hence if the local knowledge and management of natural resources concept is applied as modern concept. Excellency of applying local concept is that the concept have been comprehended and run by society during old times and become tradition. Besides local culture is to represent cultural expression and culture of society.

2 *Conservation program and sustainable use:* have always to see economic and cultural social aspect from society around conservation area. So that developed conservation program doesn't eliminate local culture and even this collaboration can give the advantage of both sides that is area remain conserve without loss or sacrifice tradition of using forest product.

3 *Need revitalize the cultural value* that is by boosting and utilizing existing local order and at the same time give meaning, which is contextual nowadays. This effort requires combination by introducing scientific way so the decision or agreement made can be justified scientifically and in the positive law if collision happened. To prompt the revitalize process needs effort to identify traditional mechanism in making decision at local institution. Assigning value and showing benefit and the role of conservation can get confession easily.

4 *Need confession to the local concept, which have been conducted by scientific study and apply it in management of local area.* Erudite of local knowledge with aim to rationalize local knowledge, so that we will get the way of newly conservation. Confession of the local concept at the same time-share local culture preservation way in managing natural resources and its environment.

5 Applying cultural based local concept represent one of new alternatives as management resources model and involving everlasting concept and sustainable use.

6 Every management step of biodiversity has to realize the balancing of biodiversity function (economic, cultural social and ecology) as development resources and life system prop everlastingly and utilize efficiently to support on going development concern. In order to strengthen sustainable use of biodiversity resources such steps to protect and maintain economic function, cultural social and ecology (ethic) of biodiversity is needed.

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The first issue of InJAST available in print and online

Dolly Priatna and **Kathryn A. Monk** (**Eds.**)

It is our great pleasure to announce that the very first issue of the Indonesian Journal of Applied Environmental Studies (InJAST) is now be available in both print and online. This journal has evolved from the Journal of Environmental Education which started in 2015, and was managed by the Study Programme of Population and Environmental Education, Graduate Programme of Pakuan University. Because this study programme has now become the Study Programme of Environmental Management, we have decided to establish this new journal to publish scientific articles covering broader environmental issues that are written by the Indonesian students of graduate programmes either in Pakuan and other universities or researchers. Meanwhile, the publication and management of the Journal of Environmental Education will be transferred to another relevant faculty or study programme within Pakuan University.

We intend the new InJAST to be published in English (with abstracts both in English and Bahasa) so that it can reach a wider readership internationally, and we hope encourage international environmental students and scientists working in Indonesia or on topics of specific relevance to Indonesia, to disseminate their research results and findings through this journal.

We are pleased to also announce that it has been agreed in principle that this new journal will be published collaboratively between the Graduate School of Pakuan University and PERWAKU (Perhimpunan Cendikiawan Pemerhati Lingkungan Indonesia, the Indonesian Association of Environmentalist Scholars). A formal Memorandum of Understanding between both parties will be signed in the near future.

In this occasion, we, as the chief editors of this new journal, would like to express our gratitude to various parties and individuals who have supported this initiative, especially to Prof. Dr. H. Bibin Rubini, M.Pd. (Chancellor of Pakuan University), Prof. Dr. Ing. H. Soewarto Hardhienata (Dean of Graduate School Pakuan University), and Prof. Jatna Supriatna, Ph.D. (Chairman of PERWAKU Indonesia). We would also like to express special thanks to our national and international colleagues at Pakuan University and elsewhere, who have so generously offered their time as members of the editorial board of the journal.

Last but not least, we hope that the Indonesian Journal of Applied Environmental Studies (InJAST) will provide new colour and perspectives the scientific journals published by Pakuan Univeristy, and become the vehicle of choice for environmental science students and scientists to disseminate of their work.

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NOTES

Top 100 research questions in SE Asia

Southeast (SE) Asia holds high regional biodiversity and endemism levels but is also one of the world's most threatened regions. Local, regional and global threats could have severe consequences for the future survival of many species and the provision of ecosystem services. In the face of myriad pressing environmental problems, we carried out a research prioritisation exercise involving 64 experts whose research relates to conservation biology and sustainability in SE Asia. Experts proposed the most pressing research questions which, if answered, would advance the goals of biodiversity conservation and sustainable development in SE Asia. We received a total of 333 questions through three rounds of elicitation, ranked them (by votes) following a workshop and grouped them into themes. The top 100 questions depict SE Asia as a region where strong pressures on biodiversity interact in complex and poorly understood ways. They point to a lack of information about multiple facets of the environment, while exposing the many threats to biodiversity and human wellbeing. The themes that emerged indicate the need to evaluate specific drivers of biodiversity loss (wildlife harvesting, agricultural expansion, climate change, infrastructure development, pollution) and even to identify which species and habitats are most at risk. They also suggest the need to study the effectiveness of practice-based solutions (protected areas, ecological restoration), the human dimension (social interventions, organisational systems and processes and, the impacts of biodiversity loss and conservation interventions on people). Finally, they highlight gaps in fundamental knowledge of ecosystem function. These 100 questions should help prioritise and coordinate research, conservation, education and outreach activities and the distribution of scarce conservation resources in SE Asia.

Coleman et al. (2019). Top 100 research questions for biodiversity conservation in Southeast Asia. *Biological Conservation* **234**:211-220.

Forest fires and soil GHG emissions

Wildfires strongly regulate carbon (C) cycling and storage in boreal forests and account for almost 10% of global fire C emissions. However, the anticipated effects of climate change on fire regimes may destabilize current C-climate feedbacks and switch the systems to new stability domains. Since most of these forests are located in upland soils where permafrost is widespread, the expected climate warming and drying combined with more active fires may alter the greenhouse gas (GHG) budgets of boreal forests and trigger unprecedented changes in the global C balance. Therefore, a better understanding of the effects of fires on the various spatial and temporal patterns of GHG fluxes of different physical environments (permafrost and nonpermafrost soils) is fundamental to an understanding of the role played by fire in future climate feedbacks. While large amounts of C are released during fires, postfire GHG fluxes play an important role in boreal C budgets over the short and long term. The timescale over which the vegetation cover regenerates seems to drive the recovery of C emissions after both low- and high-severity fires, regardless of fire-induced changes in soil decomposition. In soils underlain by permafrost, fires increase the active layer depth for several years, which may alter the soil dynamics regulating soil GHG exchange. In a scenario of global warming, prolonged exposition of previously immobilized C could result in higher carbon dioxide emission during the early fire succession. However, without knowledge of the contribution of each respiration component combined with assessment of the warming and drying effects on both labile and recalcitrant soil organic matter throughout the soil profile, we cannot advance on the most relevant feedbacks involving fire and permafrost. Fires seem to have either negligible effects on methane (CH_4) fluxes or a slight increase in CH_4 uptake. However, permafrost thawing driven by climate or fire could turn upland boreal soils into temporary CH_4 sources, depending on how fast the transition from moist to drier soils occurs. Most studies indicate a slight decrease or no significant change in postfire nitrous oxide (N_2O) fluxes. However, simulations have shown that the temperature sensitivity of denitrification exceeds that of soil respiration; thus, the effects of warming on soil N_2O emissions may be greater than on C emissions.

Ribeiro-Kumara et al. (2020). How do forest fires affect soil greenhouse gas emissions in upland boreal forests? A review. *Environmental Research* **184**:1-10.

Natural regeneration on degraded tropical peatland

Restoration of peat swamp forest (PSF) on degraded Southeast Asian peatlands could reduce global carbon emissions and biodiversity loss. However, multiple ecological barriers are believed to hinder natural regeneration of native trees on degraded peatland and make restoration expensive. We evaluated if natural PSF regeneration occurs and what factors may influence it on eight different land use and land cover (LULC) classes with different types of disturbance, including drainage and fire, in a retired *Acacia crassicarpa Benth*. (*Acacia*) plantation landscape. The study involved 42 plots inside five PSF LULCs – intact, logged, burnt (1997, 2015), remnant and 212 plots at distances up to 2 km from the PSF edge in three *Acacia* plantation LULCs – unharvested, harvested, and burnt. The number of species per plot were similar between intact PSF (25 ± 6 (SD) per 20 m × 10 m plot), logged forest (30 ± 6) and 1997 burnt forest (30 ± 13) but lower in 2015 burnt forest (11 ± 10) and remnant forest (18 ± 11). Regeneration away from the PSF across all degraded LULCs varied from fern dominated areas with no regeneration to clusters with high stem densities. The plantation LULCs, unharvested (94 species) and harvested *Acacia* (71 species), had similar overall species diversity after 3–4 years of regeneration to the intact and logged PSF (90 species). In unharvested *Acacia*, total species diversity, species per plot and stem density decreased with distance from forest edge (1–300 m – 87 species; 9 ± 6 (SD) species per 20 m × 10 m plot; 1,056 stems/ha; 301–500 m – 33; 5 ± 2; 511 and >500 m – 38; 6 ± 3; 683). In harvested *Acacia*, there was low plot species diversity irrespective of distance from the forest (1–300 m – 51; 4 ± 2; 578; 301–500 m – 17; 4 ± 2; 1,100; >500 m – 48; 4 ± 2; 780). Factors which may influence regeneration differed between different LULCs, but there was a clear influence of distance from forest edge and dispersal mechanism – i.e. whether a tree was bird or mammal dispersed and the interaction between these two factors. While our study suggests that if not further disturbed by logging, drainage and/or fire, degraded PSF could regenerate naturally to a similar species diversity as intact PSF, the lower levels of natural regeneration further away from the forest may warrant selective planting of species which do not disperse over long distances. More study is needed on the factors facilitating natural regeneration, whether it leads to restoration of PSF ecosystem functioning and the role of *Acacia* as a potential regeneration catalyst.

Wijedasa et al. (2020). Distance to forest, mammal and bird dispersal drive natural regeneration on degraded tropical peatland. *Forest Ecology and Management* **461**:1-10.

Water resources and climate changes

The present study evaluates the applicability performance of the Soil and Water Assessment Tool (SWAT) in small forested watersheds (less than 1000 km2). This open-source software is widely used in investigations focused on water availability and quality. Overall, SWAT model performance ranges between satisfactory to good. Normally, underestimates daily peak discharges. The limitations of the model are related to the accuracy of climate data used and to the time period used for validation. Watershed area, forest cover and streamflow spatial distribution have an important influence on modeling processes. Overall, from the analyzed studies, we observed for discharge a decreasing tendency, more pronounced towards the end of the 21st century (up to −54%). For surface runoff, was noticed the same decreasing tendency up to 41%. Regarding sediment yield, the results vary within very wide limits. These findings vary according to watershed location, scenarios adopted, and the eligible period of time.

Marin et al. (2020). Assessing the vulnerability of water resources in the context of climate changes in a small forested watershed using SWAT: A review. *Environmental Research* **184**:1-10.

Residential surrounding green, air pollution and traffic noise

Self-perceived general health (SGH) is one of the most inclusive and widely used measures of health status and a powerful predictor of mortality. However, only a limited number of studies evaluated associations of combined environmental exposures on SGH. Our aim was to evaluate associations of combined residential exposure to surrounding green, air pollution and traffic noise with poor SGH in the Netherlands. We linked data on long-term residential exposure to surrounding green based on the Normalized Difference Vegetation Index (NDVI) and a land-use database (TOP10NL), air pollutant concentrations (including particulate matter (PM_{10}, $PM_{2.5}$), and nitrogen dioxide (NO_2) and road- and rail-traffic noise with a Dutch national health survey,

resulting in a study population of 354,827 adults. We analyzed associations of single and combined exposures with poor SGH. In single-exposure models, NDVI within 300 m was inversely associated with poor SGH [odds ratio (OR) = 0.91, 95% CI: 0.89, 0.94 per IQR increase], while NO2 was positively associated with poor SGH (OR = 1.07, 95% CI: 1.04, 1.11 per IQR increase). In multi-exposure models, associations with surrounding green and air pollution generally remained, but attenuated. Joint odds ratios (JOR) of combined exposure to air pollution, rail-traffic noise and decreased surrounding green were higher than the odds ratios of single-exposure models. Studies including only one of these correlated exposures may overestimate the risk of poor SGH attributed to the studied exposure, while underestimating the risk of combined exposures.

Klompmaker et al. (2019). Residential surrounding green, air pollution, traffic noise and self-perceived general health. *Environmental Research* **179**:1-9.

The effects of compost

Incorporation of compost into soil can significantly alter soil physical properties, nutrient dynamics, and vegetation establishment. Strategic compost application to disturbed, degraded urban soil may provide benefits to soil properties. This review compared twenty-five peer-reviewed studies that evaluated changes in soil bulk density, infiltration rate, hydraulic conductivity, and water retention where compost was incorporated into urban soils. A wide range of compost rates and incorporation depths were evaluated in these studies across many soil types. Compost incorporation generally reduced bulk density, enhanced infiltration and hydraulic conductivity, and increased water content and plant available water, compared to unamended controls. In the four studies on runoff water quality, compost incorporation often resulted in higher initial nutrient content in runoff water, but also enhanced grass growth and reduced sediment loss. Few studies evaluated multiple compost application rates or incorporation depths, and the ways in which compost application rates were reported varied widely between studies making it difficult to directly compare them. Four studies investigated the long-term effects of compost incorporation, and there was no clear pattern of why some soils display enhanced physical properties over time and others do not. Compost was largely reported to have a positive effect on degraded urban soils. Little research has focused on the longevity of compost in urban soils after one application, and thus, this would be a valuable topic of further investigation.

Kranz et al. (2020). The effects of compost incorporation on soil physical properties in urban soils – A concise review. *Journal of Environmental Management* **261**:1-10.

Ecologically functional riparian zones

Riparian zones contribute with biodiversity and ecosystem functions of fundamental importance for regulating flow and nutrient transport in waterways. However, agricultural land-use and physical changes made to improve crop productivity and yield have resulted in modified hydrology and displaced natural vegetation. The modification to the hydrology and natural vegetation have affected the biodiversity and many ecosystem functions provided by riparian zones. Here we review the literature to provide state-of-the-art recommendations for riparian zones in agricultural landscapes. We analysed all available publications since 1984 that have quantified services provided by riparian zones and use this information to recommend minimum buffer widths. We also analysed publications that gave buffer width recommendations to sustain different groups of organisms. We found that drainage size matters for nutrient and sediment removal, but also that a 3 m wide buffer zone acts as a basic nutrient filter. However, to maintain a high floral diversity, a 24 m buffer zone is required, while a 144 m buffer is needed to preserve bird diversity. Based on the analysis, we developed the concept of "Ecologically Functional Riparian Zones" (ERZ) and provide a step-by-step framework that managers can use to balance agricultural needs and environmental protection of waterways from negative impacts. By applying ERZ in already existing agricultural areas, we can better meet small targets and move towards the long-term goal of achieving a more functional land management and better environmental status of waterways.

Lind et al. (2019). Towards ecologically functional riparian zones: A meta-analysis to develop guidelines for protecting ecosystem functions and biodiversity in agricultural landscapes. *Journal of Environmental Management* **249**:1-8.

Novel entities and technologies: Environmental benefits and risks

Novel technologies are continually being developed every day. Lessons from the past show that some resulted in unintended harm to the Earth's system. The challenge for organizations working at the interface of the environment, technology, and society is, therefore, how to best harness the environmental benefits from new technologies while minimizing their potential adverse effects. Here, we identify some of the emerging technologies that the international development community needs to consider as it seeks to take advantage of new technologies to promote sustainable development. There are several innovations – such as blockchain, nanotechnology, synthetic biology, cellular agriculture, and gene editing techniques that could either positively or negatively affect the environment, food security, human health, and the transition to clean energy. Some of their benefits and potential environmental and socio-economic concerns are discussed. We further suggest actions that can be taken by organizations involved in sustainable development, such as the United Nations and other global and regional bodies, to exploit the benefits from novel technologies and mitigate their risks.

Bierbaum et al. (2020). Novel entities and technologies: Environmental benefits and risks. *Environmental Science & Policy* **105**:134-143.

EVENTS

2020 World Environmental Day Spotlight on Biodiversity

World Environment Day is celebrated every year on 5 June to focus the world's attention on a pressing environmental issue. The Day strives to raise awareness and encourage action for the environment. It offers an opportunity to reflect on accomplishments and renew our resolve in overcoming the environmental challenges facing the world today. Held annually since 1974, World Environment Day is a vital platform for promoting progress on the environmental dimensions of the Sustainable Development Goals.

The 2020 World Environment Day global campaign highlights how we as humans are inextricably linked to and depend on nature for our existence and quality of life. The United Nations Environment Programme (UNEP) is calling on governments, businesses and civil society to join hands in building global understanding of biodiversity and nature's key contribution to our survival. Nature shapes human cultures, inspiration and learning, physical and psychological experiences, and identities. The campaign will be launched in April 2020 to draw attention to the need for restoring nature and reversing biodiversity loss. It will feature a distinct visual identity and will run using the hashtag #ForNature. A key objective of the campaign will be to build understanding on how all living things on Earth are connected in the web of life. The campaign will develop many assets, including interactive visual stories to showcase the interdependence of all life on Earth, tied together through biodiversity chains. These links make up the fabric of nature—weakening or removing one form of life impacts the entire biodiversity chain, making species vulnerable to extinction and natural systems less resilient. As part of the campaign, UNEP will also be producing communication toolkits for partners, including the private sector, that will contain key messages and actions.

To celebrate World Environment Day (starting from 25 May and running through 5 June), UNEP invites the global community—families, friends, peers, neighborhoods, government and non-governmental organizations, and small and large businesses—to show their commitment to protecting nature and to the sustainable use of nature's resources. Since our connections to nature and biodiversity are anchored by our connections to each other, we are calling on partners to form chains of individuals and to share this powerful visual advocacy message with the wider community. Our goal is to underscore our resolve #ForNature and to amplify the plea of the 1 million species facing extinction by 2030. People can form these chains inside their office buildings or homes, outside in parks or playgrounds, or on the street. Chains can form a phrase or logo, a silhouette of a plant or an animal, run around trees or around a sustainable production unit or product. The more creative the better—the scope is to send a strong message in support of protecting nature. #ForNature human chains are a way to demonstrate our resolve to protect diversity of life on Earth and demand from world leaders' bold decisions and concrete actions. @UNEP will highlight these global efforts through its own channels and also through the use of #WorldEnvironmentDay and #ForNature hashtags.

2020 is a critical year for biodiversity. It's a year of crucial decisions for planet and people, and all other forms of life on Earth. While 2020 also concludes the United Nations Decade on Biodiversity, the scientific community continues to sound the alarm bells on global biodiversity breakdown. Living in harmony with nature—a goal world leaders have set for 2050—cannot be achieved unless we stop the loss of the planet's biodiversity by 2030. This leaves us with a decade for action, which will start with the 2020 United Nations Convention on Biological Diversity in October in Kunming, China and the design of a new 10-year framework for biodiversity. World Environment Day celebrations will help build momentum and rally the world community behind a more ambitious and robust framework that can lead to significant change.

IUCN World Conservation Congress 2020 postponed

Paris, France, 3 April 2020 - In light of the ongoing COVID-19 pandemic and to ensure the safety of participants and visitors, the International Union for Conservation of Nature (IUCN) and the French government have decided to postpone the IUCN World Conservation Congress 2020. Previously scheduled for 11 to 19 June 2020, it will now take place from 7 to 15 January 2021 in Marseille.

The COP 26 UN Climate Change Conferences Postponed

Bonn, 1 April 2020 - The COP26 UN climate change conference set to take place in Glasgow in November has been postponed due to COVID-19. This decision has been taken by the COP Bureau of the UNFCCC (United Nations Framework Convention on Climate Change), with the UK and its Italian partners. Dates for a rescheduled conference in 2021, hosted in Glasgow by the UK in partnership with Italy, will be set out in due course following further discussion with parties. In light of the ongoing, worldwide effects of COVID-19, holding an ambitious, inclusive COP26 in November 2020 is no longer possible.

Postponement of the 2nd World Environmental Law Congress

In light of rapid developments in the global health risks posed by COVID-19 and increasing complications for travel, the organizing committee has decided to postpone the 2nd World Environmental Law Congress, the 3rd General Assembly for the Global Judicial Institute on the Environment, and associated events planned from 23 to 27 March 2020 in Rio de Janeiro, Brazil.

6th International EcoSummit Congress - EcoSummit 2020

The congress will take place at The Gold Coast Convention Centre, Gold Coast, Australia, from 21st-25th June 2020.

EcoSummit 2020 will have a focus on coastal and marine ecosystems including adjacent terrestrial ecosystems and all habitats that are integrated within those ecosystems, including river networks, wetlands and catchments. We expect all aspects of environmental modelling, engineering, science, and policy to be covered under the focus of climate adaptation and the need for developing socio-economic and environmental resilience and sustainable prosperity around the world. Further focus will be placed on fragile systems that are more likely to suffer the consequences of climate change and anthropogenic pressure such as islands, coastal communities and arid landscapes.

Seed briquette composition for the direct seeding of Gmelina *Gmelina arborea* Roxb.

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ABSTRACT

The study of the effect of briquette composition on the seedling survival and growth of Gmelina in the field with the Randomized Group Design (RGD) experimental method. The parameters observed in the seed briquette composition test in the field were seedling diameter, seedling height and life percentage. The data were analyzed by Analysis of Variance (ANOVA) and Duncan's Test using SAS and SPSS programmes to determine the success of the seed briquette composition test. The composition of seed briquette has a significant effect on the survival percentage and growth of direct seeding Gmelina in the field. The application of the composition of B-5 with land preparation in the form of cleaning gives the best percentage of life and growth of Gmelina seedlings. This composition also gave a high growth of 45.29 cm, a diameter of 5.16 cm and a percentage of life of 58.33%. The composition of the B-5 seed briquettes has a proportional composition of the main ingredients in the form of soil and compost which is 20% and 40% as a growing medium and a source of nutrition for Gmelina seedling growth.

ABSTRAK

Penelitian tentang pengaruh komposisi briket terhadap persen hidup serta pertumbuhan Gmelina di lapangan dengan metode eksperimen Rancangan Acak Kelompok (RAK). Parameter yang diamati pada uji komposisi briket benih di lapangan adalah diameter semai, tinggi semai dan persentase hidup. Data dianalisis dengan Analisis Ragam dan Uji Duncan dengan menggunakan program SAS dan SPSS untuk mengetahui keberhasilan dari uji komposisi briket benih. Komposisi briket benih berpengaruh nyata terhadap persentase hidup dan pertumbuhan *direct seeding* Gmelina di lapangan. Penerapan komposisi B-5 dengan persiapan lahan berupa pembersihan memberikan persentase hidup dan pertumbuhan semai Gmelina terbaik. Komposisi ini juga memberikan pertumbuhan tinggi sebesar 45,29 cm, diameter sebesar 5,16 cm dan persen hidup sebesar 58,33%. Komposisi briket benih B-5 memiliki komposisi bahan utama berupa tanah dan kompos yang proporsional yaitu sebesar 20% dan 40% sebagai media tanam dan sumber nutrisi untuk pertumbuhan semai Gmelina.

Keywords: Direct seeding, seed briquette, Gmelia

INTRODUCTION

The extent of degraded land is a sign of unsustainable natural resource management that causes disruption to water systems, high erosion and sedimentation, and increases the potential for natural disasters such as floods, droughts and landslides. According to data from the Ministry of Environment and Forestry (2017), the area of critical land reaches 24.30 million hectares with a rate of degradation of forest land reaching 700-800 thousand hectares per year.

So far, land rehabilitation activities in Indonesia have used planting methods using seedlings in polybag containers. However, the extent of degraded land and difficult accessibility to most degraded land areas make the land rehabilitation efforts are not optimal and it requires other alternative methods that are practical and can be applied on a large scale, involving little labor and are relatively inexpensive. One planting technique that has great potential to use on a large scale is direct seeding (Willoughby et al., 2007). Direct seeding for reforestation is a long-standing practice that has redeveloped considering the high costs for nurseries in nursery farms (Woods and Elliott, 2004) and operational planting in the field (Sudrajat et al., 2018). This technique is easier, simpler and cheaper than planting seedlings and has been adopted in the restoration of

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degraded tropical lands (Woods and Elliott, 2004; Garcia-Orth and Martinez-Ramos, 2008). The problem that often arises in the application of direct seeding is the low viability and vigor of the seed when it is sown directly in the field so that the activities of direct seeding is often ended in failure.

In the application of direct seeding, seed germination and seedling development are the initial stages of the plant life cycles (Vieira and Scariot, 2006), and the failure at this stage can be caused by seed predators, herbivores, competition and biotic factors (extreme temperatures, drought and excessive sunlight). This failure can be reduced by seed treatment (Birkedal, 2010) and desiccation (Woods and Elliott, 2004), appropriate sowing methods (Woods and Elliott, 2004; Nurhasybi and Sudrajat, 2013), sowing time (Vieira et al., 2008), and a combination of these techniques.

Seed briquette technology is one of the seed treatments that can be applied to improve the success of direct seeding (Sudrajat et al., 2015; Sudrajat et al., 2018). The use of seed briquettes can improve biological control capacity (Choong et al., 2006), increase the percentage and speed of seed germination (Podlaski and Wyszkowska, 2003) and increase drought resistance (Abusuwar and Eldin, 2013). Seed briquette technology combined with land management techniques and the addition of a water absorbent material (aquasorb) is expected to increase the success of direct seeding which allows the seeds to germinate more quickly, avoid seed predators, make the seedlings develop faster and are more drought resistant (Sudrajat et al., 2015; Sudrajat et al., 2016a).

The selection of suitable species for direct seeding is important (Engel and Parrota, 2001). Species with large seed sizes, such as *Gmelina arborea* (Gmelina), are an option in the application of direct seeding because they are able to compete with weeds. Large seeds have sufficient food reserves to support the early growth of seedlings (St-Denis et al., 2013). Production of Gmelina seeds is also quite high (between 30 kg and 170 kg /hectare/year (Rachmawati et al., 2002) so that it will be able to support the application of direct seeding for a broad scale. In addition, Gmelina is also a potential species for rehabilitation of degraded land through direct seeding (Engel and Parrota, 2001; Tuheteru et al., 2010). Gmelina is also a kind of potential and has good economic value as a type of wood producer.

The purpose of this study was to determine the composition of seed briquettes on the growth of Gmelina (*Gmelina arborea*) seeds in the field.

METHODS

Research location and time

This research was carried out in a Special Area with Special Purpose (KHDTK) Parung Panjang, at the Forest Plant Seed Technology Research and Development Center (BP2TPTH), Research Development and Innovation Agency (BLI), Ministry of Environment and Forestry (KLHK). The location is located between 106° 06' East Longitude and 06° 20' South Latitude, at an altitude of 51.71 m above sea level. The topography is relatively flat (slope <15%) with haplik podsolic soil types. It has low soil fertility (low N, P, K content) with a pH between 4.2 and 4.8. The initial vegetation is in the form of Puspa (*Schima* sp.) clusters, shrubs and reeds which has fast growth after weed removal (Sudrajat et al., 2016b). The study was conducted in April 2019 until August 2019.

Materials and equipment

Material used was Gmelina (*Gmelina arborea*) seeds that had been given wet extraction treatment. The ingredients for seed briquettes are soil, compost, husk charcoal, plant lime and tapioca. The tools used are the equipment for making seed briquettes (mixing tanks, shovels and seed briquettes) and planting equipment in the field (hoes, ground forks, stakes and mines).

Table 1. Seed briquette composition at each field treatment during field study in KHDTK.

T	Composition
B-0	Seed
B-1	40% compost, 30% rice husk charcoal, 20% lime, 10% tapioca
B-2	5% soil, 45% compost, 30% rice husk charcoal, 15% lime, 5% tapioca
B-3	10% soil, 45% compost, 25% rice husk charcoal, 10% lime, 10% tapioca
B-4	15% soil, 40% compost, 25% rice husk charcoal, 10% lime, 10% tapioca
B-5	20% soil, 40 %compost, 25% rice husk charcoal, 10% lime, 5% tapioca

Research design

The research design used was Randomized Group Design (RGD) with three planting blocks. Field treatment (T) experiment of seed briquette composition in KHDTK Parung Panjang is as seen on Table 1.

Growth parameters measured in the test composition of seed briquettes in the field is life percentage, height and diameter.

Production of seed briquette

Briquettes are produced with different ingredients. Tapioca as an adhesive is dissolved in boiling water and allowed to cool. Tapioca solution is mixed with other ingredients and stirred evenly, then manually printed using a round hand with a diameter of 5 cm and 3 cm thickness (Figure 1). Seed briquettes that have been printed were directly dried in the sun for two days. Seed briquettes are filled with one Gmelina seed.

Figure 1. Production process of seed briquettes.

Figure 2. Seed briquettes in field experiment.

Sowing of seed briquettes in the field

The process of sowing of seed briquettes in the field is carried out by land preparation in the form of land clearing in the circle with diameter of about 30 cm. Land clearing can increase the percentage of seedling life as reported by Nurhasybi and Sudrajat (2013). Gmelina seed briquettes are sown around the stake that have prepared with a spacing of 2 m x 1 m (Figure 2).

Data collection

Measurement of Gmelina seedling growth was carried out at the Parung Panjang KHDTK. Gmelina seedling growth was observed for three months period. The parameters measured are life percentage, height and diameter.

Data Analysis

Data were analyzed by ANOVA and Duncan Test using SAS and SPSS programme to determine the success of seed briquette composition experiment.

RESULTS

The results of the diversity analysis showed that the composition of the seed briquettes significantly affect the growth parameters (height, diameter and life percentage) of Gmelina. The diversity that arises due to differences in site (soil quality), topography and other factors even though the block treatment has been arranged in relatively uniform conditions. Further information can be seen in Table 2.

Table 2. Anova of seed briquette composition experiment in the field against growth parameter.

Parameters	Significance		
	Height	Diameter	%life
Block	1942.10 **	9.28*	16067.3 **
Briquette Composit	863.82 **	6.90*	2822.21 **

Note: * = very significant effect on the level of 5%
** = very significant effect on the level of 1%

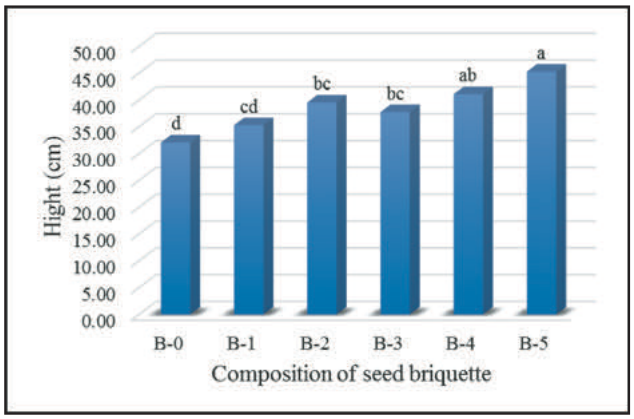
To determine the difference in response among the compositions of seed briquette, then the analysis was continued with Duncan's Test of the mean value of the growth parameters at each observation block.

Growth of seedling height

Based on Duncan's Test results, the composition of seed briquettes gave a significant difference to the highest growth height parameters shown in the treatment of seeds with a B-5 briquette composition of 45.29 cm, but did not show any significant difference with B-4 of 41.09 cm. Significant differences were shown in the control (B-0) with a

height of 32.08 cm, briquette composition B-1 (height 35.31 cm), B-2 (height 39.54 cm) and B-3 (height 37.75 cm) as presented in Figure 3.

Briquette composition B-5 is composed of 20% soil, 40% compost, 25% rice husk charcoal, 10% lime and 5% tapioca, while B-4 briquette composition is composed of 15% soil, 40% compost, 25% rice husk charcoal, 10% lime and 10% tapioca. From the composition of the soil and compost in the composition of seed briquettes B-5 and B-4, it can be seen that the composition of the soil B-5 (20%) is greater than the composition of the soil in seed briquette B-4 (15%). The combination of the main composition of the briquettes namely soil and compost is shown by the B-5 seed briquettes which can help Gmelina seed germination in the process of finding energy from sunlight.

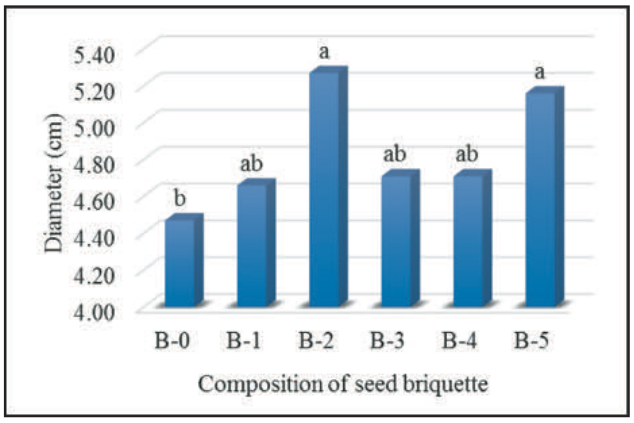


Note: the numbers followed by the same letters show results that are not significantly different at 99% confidence level based on Duncan's multiple interval test.

Figure 3. The height of Gmelina seedlings in the seed briquette composition experiment in field.

Growth of seedling diameter

Further test results using Duncan, in general Gmelina diameter growth show the significant differences with the control seed briquette composition (B-0). There is no significant effect between the composition of the briquettes on the diameter growth parameters. The highest significant effect was shown by the composition of the B-2 briquettes at 5.27 cm, but did not show any significant difference with B-1, B-3, B-4 and B-5 briquettes (Figure 4). The growth in diameter requires nutrition in stem formation. Briquette composition that influences the diameter growth is soil and compost.

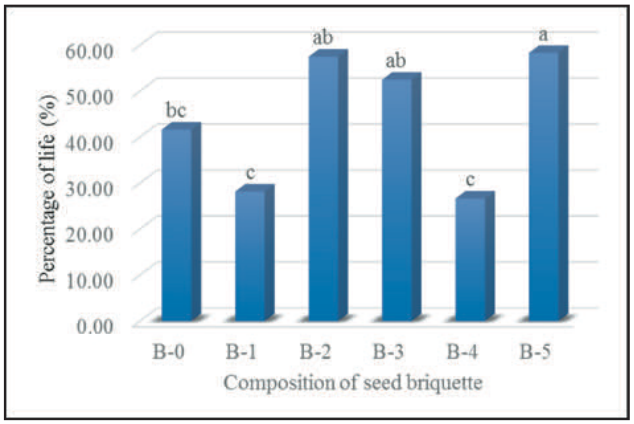


Note: the numbers followed by the same letters show results that are not significantly different at 99% confidence level based on Duncan's multiple interval test.

Figure 4. The diameter of Gmelina seedlings in the seed briquette composition experiment in the field.

Percent of seedling life

The results of Duncan's further tests show that the treatment briquette composition gives a real difference to the percentage of Gmelina seedling life. The composition of the briquettes with the highest percentage of life was shown in the treatment of seeds with the composition of the briquette B-5 of 58.33%, but did not show any significant difference with the briquette B-2 (percentage of life 57.50%) and B-3 (percentage of life 52.50%).



Note: the numbers followed by the same letters show results that are not significantly different at 99% confidence level based on Duncan's multiple interval test.

Figure 5. Percentage of Gmelina seedling life in the experiment of seed briquette composition in the field.

Significant differences were shown in the B-0 control (percentage of life 41.67%), briquette composition B-1 (percentage of life 28.18%) and B-4 (percentage of 26.67%) as seen in Figure 5. Percentage of Gmelina seed survival is mostly dependent on nutrition and environmental factors. The media is one of the most important factors in growth because sprouts require nutrients.

In the B-2 briquettes, it was seen that the percentage of compost (45%) was higher compared to B-5 (40%). The composition of the B-2 briquettes has less soil composition when compared to the composition of the B-5 soil by only 5%. High soil composition and compost is very required for plants to grow.

DISCUSSION

From the results of the field research, the most significant results were obtained between the compositions of the seed briquettes with growth parameters. Thus, it can be concluded that Ho is rejected and Ha is accepted. This is meaning that the composition of the seed briquettes have affected all growth parameters namely height, diameter and percentage of life. To determine the best composition in the test of the composition of the seed briquettes in the field against growth parameters determined based on Table 3.

Table 3. Table of Test Results of the Composition of Seed Briquettes against Growth Parameters in the Field

Briquette Composition	Height	Diameter	%life
B-0			
B-1			
B-2		X	
B-3			
B-4			
B-5	x	X	x

Note: x = shows the highest significance difference.

Based on the further Duncan's test results of seed briquette composition experiment, the composition obtained B-5 briquette gives the highest significant difference for all Gmelina seed growth parameters in the field.

CONCLUSION

The composition of seed briquettes significantly affected the growth of direct seeding Gmelina (*Gmelina arborea*) in the field. The best composition of seed briquettes with land preparation in the form of clearing and shaping is B-5 seed briquettes that composed of 20% soil, 40% compost, 25% rice husk charcoal, 10% lime and 5% tapioca. The composition of the B-5 seed briquettes gave a height growth of 45.29 cm, a diameter of 5.16 cm and the survival or life percentage of 58.33%.

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Relationship between disaster knowledge and environmental culture with disaster preparedness behaviour

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ABSTRACT

This research consists of two independent variables, the disaster knowledge and environmental culture, and a dependent variable of disaster preparedness behaviour. The objective is to determine the relationship between disaster knowledge and environmental culture with disaster preparedness behaviour, as well as the relationship between both of the together with disaster preparedness behaviour. The study was conducted through 166 students of three senior high schools in the District of West Karawang, West Java, which taken by proportional random sampling. The method of survey was employed in this study and the data analyzed by statistical test of correlation and simple linier regression as well as multiple linear correlation and regression, which was conducted at significance level of $\alpha = 0.01$ and $\alpha = 0.05$. Based on the results, it was found that there was a positive and significant relationship between disaster knowledge and disaster preparedness behaviour with a correlation coefficient value of $ry_1 = 0.22$ and a coefficient of determination value of $(r^2) = 0.049$. There is a positive and significant relationship between environmental culture and disaster preparedness behaviour with a correlation coefficient value of $ry^2 = 0.25$ and a coefficient of determination value of $(r^2) = 0.064$. There is a positive and significant relationship between disaster knowledge and environmental culture together with disaster preparedness behaviour with a correlation coefficient value of $ry_{12} = 0.32$ and a coefficient of determination value of $(r^2) = 0.097$. Thus, it can be concluded that student's disaster preparedness behaviour can be improved through either disaster knowledge and environmental culture.

ABSTRAK

Penelitian ini terdiri atas dua variabel bebas, pengetahuan kebencanaan dan budaya lingkungan, serta satu variabel terikat yaitu perilaku siaga bencana. Tujuannya untuk mengetahui hubungan antara pengetahuan kebencanaan, budaya lingkungan dengan perilaku siaga bencana, serta hubungan keduanya secara bersama-sama dengan perilaku siaga bencana. Penelitian dilaksanakan melalui 166 siswa di tiga sekolah menengah atas, Kecamatan Karawang Barat, yang diambil secara proporsional random sampling. Metode survey digunakan dan data dianalisis dengan uji statistik korelasi dan regresi sederhana serta korelasi dan regresi linear ganda, dilakukan pada taraf signifikansi $\alpha = 0{,}01$ dan $\alpha = 0{,}05$. Hasil menunjukkan bahwa terdapat hubungan positif dan signifikan antara pengetahuan kebencanaan dengan perilaku siaga bencana dengan nilai koefisien korelasi $ry_1 = 0{,}22$ dan koefisien determinasi $(r^2) = 0{,}049$. Terdapat hubungan positif dan signifikan antara budaya lingkungan dengan perilaku siaga bencana dengan nilai koefisien korelasi $ry_2 = 0{,}25$ dan koefisien determinasi $(r^2) = 0{,}064$. Terdapat hubungan positif dan signifikan antara pengetahuan kebencanaan dan budaya lingkungan secara bersama-sama dengan perilaku siaga bencana, dengan nilai koefisien korelasi $ry_{12} = 0{,}32$ dan koefisien determinasi $(r^2) = 0{,}097$. Jadi, dapat disimpulkan bahwa perilaku siaga bencana siswa dapat ditingkatkan melalui pengetahuan kebencanaan dan budaya lingkungan.

Keywords: Direct seeding, seed briquette, Gmelia

INTRODUCTION

Indonesia is a country that is in the path of the most active earthquake in the world because it is surrounded by the Pacific Ring of Fire and are on top of three continental plates colliding, namely, Indo-Australia from the south, Eurasia from the north, and the Pacific from the east. T his geographical condition on the one hand makes Indonesia an area prone to volcanic eruptions, earthquakes and tsunamis.

Based on data on Indonesian disaster information released by the National Disaster Management Agency (BNPB) during the past five

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years, disaster events have increased in 2017 recorded 2,853 events and those that experienced the greatest impact occurred in 2018 with the number of people affected by disasters by 10,333. 309, as many as 4,814 people were killed and 1,736 units of school facilities damaged.

Karawang Regency, West Java, Indonesia, is located at thecoordinates between 107^0 02' - 1070 40' East and 5^0 56' - 6^0 34' South, bordering Bekasi and Bogor Regencies in the west side, Java Sea in the northern side, Subang Regency in the east, Purwakarta Regency in southeast, and Cianjur Regency in the southern side. The size of the area of Karawang Regency is 1,737.53 km^2 with a population of 2,125,234 people. Most of the Karawang regency area is in the lowland, and only a small part is plateau in the southern region.

Based on Indonesian disaster information data that was released by BNPB during the past ten years, the type of disaster that occurred in Karawang Regency i.e. 42 events of flooding that affected 752,333 people, then the *putting beliung* tornado disaster 23 events which affected 657 people, then landslides 3 events that affected 73 people, while last one was drought.

Therefore, seeing the data presented above shows that our country is susceptible to disasters. In general, the level of preparedness of the community and regional government in dealing with major disasters is not yet ready. Disaster mitigation, disaster preparedness and disaster risk reduction still need to be improved. Disaster risk reduction must be interpreted as an investment in national development. Without the preparedness, the impact of disasters will always cause heavy casualties and huge economic losses.

Chang-Richards et al. (2017) suggested that disaster preparedness is often referred to as action taken before an event that reduces or can help reduce and eliminate the severity of natural disasters by preparing communities or people through developing contingency plans for response and recovery, quick plans and effective, and ongoing public awareness about hazards and risks.

Community preparedness tends to be ignored by the government who will make decisions (Dodon, 2013). So far, there are still many people who depend on preparedness and mitigation to the government by ignoring their personal preparedness.

Pebriati and Erly (2013) argued that disaster knowledge is the ability to remember events or series of events that threaten and disrupt people's lives and livelihoods caused, both by natural and / or non-natural factors as well as human factors that can result in human casualties, environmental damage, property loss, and psychological impacts.

Duval and Bovalino (2000) suggested that to reduce the risk of disaster, its highly important to increase the understanding it through the knowledge. One way to increase awareness is to improve someone's knowledge of something. For example, when children's knowledge of disasters is good, it can create a generation that is resilient to disasters and has good preparedness for disasters.

Rivai and Mulyadi (2010) suggested that environmental culture as a philosophy that discusses human responsibilities and obligations. Elena (2015) suggested that environmental culture is an integral category that includes many components, among which the most frequently mentioned are cognitive, emotional aesthetic, semantic and active values.

Disasters are events that are caused by natural factors and non-natural factors are also caused by human factors themselves so that disaster preparedness behaviour is very important in anticipating the threat of danger and appropriate action when a disaster occurs in order to minimize the incidence of fatalities, environmental damage, property losses and psychological impacts. Disaster preparedness behaviour is not only needed for people in disaster-prone areas, but it is also needed for everyone, this is because disaster events cannot be predicted when and where they will occur, with the provision of disaster preparedness behaviour owned, someone will be prepared in facing disasters. anytime and anywhere.

Based on previous research, disaster knowledge and environmental culture influence disaster preparedness behaviour. Someone who has the knowledge of disaster and environmental culture attitudes in their daily lives will influence someone's behaviour to be prepared in anticipating disasters and carry out protection activities or preparedness efforts. Therefore, the better of the knowledge of disaster and the environment culture of someone, then the disaster preparedness behaviour will also be good.

The availability of special subjects on disaster-based environmental education does not yet exist in formal education, so there is insufficient

awareness of the younger generation to care for the preservation of their surrounding environment. When the maintenance and preservation of the environment has become their culture, then over time the disaster preparedness behaviour will also be good. Thus, disaster-based environmental education to reduce disaster risk is very important.

Based on the description above, it is deemed necessary to conduct further research related to disaster preparedness behaviour in the education sector. So far, studies related to disaster preparedness behaviour are still very little, particularly in-depth study related to disaster knowledge and environmental culture of students' disaster preparedness behaviour.

Based on this background, this paper raises the study of disaster preparedness behaviour in relation to disaster knowledge and environmental culture within high school students in the District of Karawang Barat, Karawang, West Java. Objectives of this study is first, to seek the relationship between disaster knowledge and disaster preparedness behaviour. Second, to understand the relationship between environmental culture and disaster preparedness behaviour Third, to find out the relationship between disaster knowledge and environmental culture both together with disaster preparedness behaviour.

METHODS

This research was conducted within three state senior high schools in West Karawang District, Karawang Regency, West Java. This study employed a survey method with a correlational approach. The research variables consisted of two independent variables namely disaster knowledge (X_1) and environmental culture (X_2) and a dependent variable namely disaster alert behaviour (Y).

The population of this study was 258 students of class XII IPS that scattered in West Karawang District, Karawang Regency. The sample in this study was taken using the proportional random sampling, which is a technique for proportional populations.

Field data collection was carried out with a questionnaire to obtain data about disaster preparedness behaviour, disaster knowledge, and environmental culture. Data analysis was conducted using descriptive statistical analysis techniques, analysis prerequisite tests which include normality tests and homogeneity tests. Simple correlation test of analysis techniques and multiple correlation tests as well as the analysis of the coefficient of determination were employed to test the research hypothesis.

RESULTS

Based on the results of hypothesis testing, there is an evidence that the three hypotheses proposed can be significantly accepted. Overall this study shows there is a positive relationship between, 1) the relationship between disaster knowledge and disaster preparedness behaviour, 2) the relationship between environmental culture and disaster preparedness behaviour, 3) the relationship between disaster knowledge and environmental culture both together with disaster preparedness behaviour.

1. Relationship between disaster knowledge and disaster preparedness behaviour

The result shows that there was a positive and significant relationship between disaster knowledge (X_1) and disaster preparedness behaviour (Y) as indicated by the correlation coefficient value r_{y1} = 0.22. The coefficient of determination r^2_{y1} = 0.049 and the simple linear regression equation $\hat{Y}$ = 51.45 + 0.94 X_1 means that disaster knowledge (X_1) contributes to disaster preparedness behaviour of 4.9%.

2. Relationship between environmental culture and disaster preparedness behaviour

The result shows that there was a positive and significant relationship between environmental culture variables (X_2) with disaster alert behaviour variable (Y). This is indicated by the correlation coefficient r_{y2} = 0.25, and the coefficient of determination r^2_{y2} = 0.064 on simple linear regression equation y = 11.98 + 0,50X_2 which means that the contribution of environmental culture (X_2) to disaster alert behaviour of 6.4%.

3. Relationship between disaster knowledge and environmental culture both together with disaster preparedness behaviour

The result of the study shows that there is a positive and significant relationship between disaster knowledge (X_1) and environmental culture (X_2) variables both together with the disaster preparedness behaviour variable (Y), which is indicated by the value the correlation coefficient r_{y12} = 0.31. The coefficient of determination r^2_{y12} = 0.097 indicates that disaster knowledge (X_1) and environmental culture (X_2) both

together contribute to disaster preparedness behaviour (Y) of 9.7%.

DISSCUSION

1. Relationship between disaster knowledge and disaster preparedness behaviour

Based on simple linear regression equation y = 51.45 + 0,94X_1 predicted that every increase in one score of disaster knowledge will cause an increase of 0.94 score on disaster alert behaviour at a constant of 51.45. The result of this study concluded that the disaster knowledge possessed made a positive contribution that significantly affected the disaster preparedness behaviour (Bhosale, 2015).

Based on the fact and data findings in the analysis of this study, the strength of the relationship between disaster knowledge and disaster preparedness is weak. Based on data descriptions the average score of students' disaster knowledge is 25 and the average score of students' disaster preparedness behaviour is 75, this shows that students' knowledge of disaster preparedness and behaviour is still low. Based on the observation, it was found out that students got disaster knowledge when they learned in class precisely on the subject of Geography and the material is only one chapter and that knowledge has not been fully applied in daily life due to lack of training or simulations in practicing disaster preparedness behaviour both in the school environment, their residence or in the community.

Based on the results of research and discussion above, it can be indicated that one of effort to improve disaster preparedness behaviour is to increase or develop disaster knowledge and conduct simulations or exercises regularly (Alonso et al., 2017).

2. Relationship between environmental culture and disaster preparedness behaviour

The pattern of relationships between environmental cultural variables with behavioural variables declared that the disaster preparedness with equation simple linear regression is 11.98 + 0,50X_2. It is predicted that each increase in one score environmental culture will cause an increase of 0.50 score disaster preparedness behaviour at constant of 11.98. The existence of a positive relationship between environmental culture and disaster preparedness behaviour shows that the role of environmental culture will help achieve disaster preparedness behaviour.

The fact and data findings in the analysis of this study, the strength of the relationship between environmental culture and disaster preparedness is weak. Based on the data description the average score of students' disaster preparedness behaviour is 75, this shows that the students' disaster alert behaviour is still low (Carter, 2008). Based on the search that the environmental culture that students do in the form of attitude towards environmental conditions and not fully the attitude is followed up or applied in daily life in relation to disaster preparedness behaviour both in schools and residences, as well as in the community.

3. Relationship between disaster knowledge and environmental culture both together with disaster preparedness behaviour

The findings of this study indicate that disaster knowledge and environmental culture both together are mutually supporting factors to achieve maximum disaster preparedness behaviour. With good disaster knowledge and with the support of a good environmental culture, a student will increase his disaster preparedness behaviour (Hunt, 2006; Issa et al., 2017).

DISSCUSION

There is a very significantly positive relationship between disaster knowledge and disaster preparedness behaviour. The level of the relationship is indicated by the correlation coefficient of 0.22 while the coefficient of determination of 0.049. This means that the contribution of disaster knowledge to the variable of disaster preparedness is 4.9%. The functional relationship between disaster knowledge and disaster preparedness behaviour meets the regression equation Y = 51.446 + 0,9406X_1 and the association is significant. Second, there is a very significantly positive relationship between environmental culture and disaster preparedness behaviour. The level of the relationship is indicated by the correlation coefficient of 0.25 while the coefficient of determination of 0.064. This means that the level of the contribution of environmental culture variables to the variable of disaster preparedness behaviour is 6.4%. The functional relationship between the environmental culture and disaster preparedness behaviour meets the regression equation Y = 11.976 + 0,5047X_2 and the association is significant. Third, there is a very significantly positive relationship between disaster knowledge and

environmental culture both together with the disaster preparedness behaviour. The level of the relationship is indicated by the correlation coefficient of 0.32 while the coefficient of determination of 0.097. This means that the level of the contribution of disaster knowledge and environmental culture variables both together to the variable of disaster preparedness behaviour is 9.7%.

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Diversity and abundance of insects at industrial plantation forest and natural forest ecosystems in Siak, Riau Province

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ABSTRACT

The objective of research is to find out the differences and similarities of insect diversity, abundance and composition between in industrial plantation forest (HTI) and natural forest (Arboretum) ecosystems. Field research was carried out in the Rasau Kuning area, Perawang Barat Regency, Riau Province, while specimens identification conducted at LIPI Biology Research Center Laboratory in February - March 2019. Line transect sampling technique and fluorescent light traps were used as methods for collecting insects from both two different ecosystems with three replications. The results found five order of insects i.e. Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera which consisting of 35 species in plantation forest ecosystem, and 26 species in natural forest ecosystem where both ecosystems dominated by Lepidoptera. Statistical analysis of research results show that two average insects species diversity index within both plantation forest (HTI) and natural forest (Arboretum) ecosystems is not different ($t = 1,419$; $p>0,05$). The similarity index found very similar (23,56%) between both ecosystems. Predatory insects which was found in this study is *Sycanus* sp. (Hemiptera: Reduviidae) from the order of Lepidoptera.

ABSTRAK

Penelitian ini bertujuan untuk mengungkapkan perbedaan dan kesamaan keanekaragaman jenis, kelimpahan, dan komposisi jenis serangga antara di ekosistem hutan tanaman industry (HTI) dengan ekosistem hutan alam (Arboretum). Penelitian lapang dilakukan di areal Rasau Kuning, Kabupaten Perawang Barat, Provinsi Riau, sementara identifikasi specimen dilakukan di Laboratorium Pusat Penelitian Biologi LIPI, pada bulan Pebruari - Maret 2019. Metode sampling line transect dan perangkap cahaya berflouresen digunakan untuk menangkap serangga di kedua ekosistem tersebut melalui 3 kali ulangan. Hasil studi menemukan 5 ordo serangga yaitu Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera, dengan masing-masing 25 spesies terdapat di ekosistem hutan tanaman (HTI) dan 26 spesies di ekostem alam (Arboretum), yang mana keduanya didominasi ordo Lepidoptera. Melalui analisis statistik, hasil penelitian menunjukkan bahwa pada kedua ekosistem tidak terlihat adanya perbedaan indeks keanekaragaman jenis ($t = 1,419$; $p>0,05$). Begitu juga dengan indeks kesamaan menunjukan tingkat yang sangat sama (23,56%) antara kedua ekosistem tersebut. Pada kajian ini juga ditemukan spesies serangga predator yaitu *Sycanus* sp. ((Hemiptera; Reduviidae) dari ordo Lepidoptera.

Keywords: Insects, diversity, similarity, abundance, plantation forest, ecosystem, predatory insects

INTRODUCTION

Every organism's activity within its community always interact with the activities of other organisms in a complex linkages and dependency that creating a stable community. Interaction between those organisms can be antagonistic, competitive, or positive as symbiotic (Untung, 2006).

The concept of biological control emerged and developed as a correction to conventional pest control policies, which are very important in the use of pesticides. This policy results in inappropriate and excessive use of pesticides by farmers, and this method can increase production costs and cause adverse side effects on the environment and the health of farmers themselves and the community at large.

In natural forests, biological control mechanisms through natural enemies can develop naturally and can spread to industrial plantation forests, which is difficult to prove scientifically but the forest ecosystem has always had such a balance mechanism.

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Prevention action in industrial plantations with the use of clones that are resistant to pests and diseases has been done in most countries, such as the United States, Australia, Europe, South Africa and South American countries, like in Brazil where the clone of Eucalyptus was founded, including its hybrids that have high growth and good resistance to pests and diseases. But it must be realized that along with the development of time, pathogens or pests also adapt to their environment. Therefore, monitoring pests and diseases as a step to determine the development of pests and diseases must be carried out.

The role of insects in community is varied such as pollinators, phytophagous, and predators, and there is also a species of insect that only come temporarily in plants or plantations. Species of insects that damage trees will give a large-scale losses to attack plants.

The survey which was conducted at Rasau Kuning area, Perawang Barat, Riau, found that there was an abundance of insects that ranging from caterpillars, grasshoppers, lices and grubs, while the symptoms of damaged by caterpillars usually attacking leaves which cause different levels of damage.

The use of natural enemies is an efficient control that has the lowest impact at a cost that is not too large. With the diversity of pests found in Eucalyptus plantations, research to find natural enemies in Eucalyptus can be used as an alternative in implementing integrated pest control.

Therefore, researchers used research related to the determination of insects as a reference material of what species are found in the industrial plantation forest ecosystem (HTI) and in natural forest ecosystem (Arboretum) through analysis of the species diversity and abundance of insects.

Research questions that carried out consist of:

1. Is there any differences of insect diversity between the HTI forest and natural forest ecosystems?
2. Is there any differences of insect abundance between the HTI forest and natural forest ecosystems?
3. Is there any differences of insect similarity between the HTI forest and natural forest ecosystem?

The objective of this research is to determine differences in species diversity and abundance based on the order found and determine the level of differences in insect species based on the Sorensen similarity index both in industrial plantation forests (HTI) and natural forest (Arboretum) ecosystem. It is expected that the results of this study can provide information about pests and natural predators insects which have the potential as Biological Control of pest species.

METHODS

This research was conducted in two places. Firstly, field work carried out in Rasau Kuning area, inside the industrial plantation forest (HTI) concession of PT. Arara Abadi, Perawang, Riau Province, to collect the data and specimens of insects at industrial plantation forest (HTI) ecosystem and at natural forest ecosystem (Arboretum). Secondly, the samples of insect specimens collected then identified in LIPI Biology Research Center Laboratory. Both research activities conducted in February - March 2019.

Industrial plantation forest ecosystem in Rasau Kuning area is mostly planted with *Eucalyptus pelita* but in some places there is still an area planted with *Pinus merkusii*. (Lisnawati et al., 2014). Sampling of insects in natural forest ecosystem conducted in Arboretum Forest of PT. Arara Abadi, a secondary natural forest with the size of 173 hectare, and is dominated by Kulim trees (*Scorodocarpus borneensis*). The topography in the study area mostly flat (0-8%) to undulating (8-15%) area. The elevation variation ranging between 8 - 80 m above sea level. Climate classification in the study area according to Schmidt and Ferguson (1951) is a type of Climate A. While the air temperature in this region ranges from 26.3° - 27.8° C.

Purposive random sampling technique was used to determine sampling location in both HTI and Arboretum areas (Muslim et al., 2017). A 500 meters observation transect was made in HTI and in Arboretum. Then fluorescent light traps were installed along the Transect at intervals of 100 meters.

Florescent light traps that installed in 10 plot locations (five location in HTI and five locations in Arboretum) opened 12 hours to capture insects starting from 6 pm (afternoon) until 6 am in the next

morning. This activity was repeated until three replications at both HTI and Arboretum.

All specimens collected then it was identified until species level using electron microscopes and the insect guide book at the LIPI Biology Research Center Laboratory.

RESULTS AND DISCUSSION

From data collected found five order of insects such as Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera. The highest abundance is Lepidoptera and lowest are Hymenoptera and Orthoptera (Table 1.).

Table 1. Number of insect species found in industrial forest plantation and natural forest ecosystems in study area.

Ecosystem	Order	Observation		
		I	II	III
HTI (Industrial plantation forest)	Lepidoptera	69	34	41
	Hemiptera	2	1	0
	Coleoptera	4	4	5
	Orthoptera	0	1	1
	Hymenoptera	1	0	0
Arboretrum (Natural forest)	Lepidoptera	63	56	66
	Hemiptera	0	0	0
	Coleoptera	0	1	1
	Orthoptera	1	1	1
	Hymenoptera	0	0	0

Table 2. Insect's diversity index at two different ecosystems in the study area. Number that followed by the same letter showing no significant difference at the test level of 5%.

Ecosystem	Diversity Index			Av. of divers. index
	Obs. I	Obs. II	Obs. III	
HTI (Industrial plantation forest)	2.400	2.953	3.005	2.786[a]
Arboretrum (Natural forest)	2.208	2.551	2.615	2.458[a]

Statistical analysis conducted to the results of two average number of insect species in the HTI and Arboretrum ecosystems showed that t_{count} = 3.500 (significantly different at α level 5%) α level 5%.

The average of insect diversity index for each location is shown in Table 2. The results of the statistical analysis of t against the two average insects species diversity index in HTI ecosystem and Arboretrum ecosystem obtained t_{count} = 1.419. From the distribution list of Student (t distribution) is known t_{table} 0.95 (4) = 2.776. When compared the value of t_{count} with t_{table} it turns out that $t_{count} < t_{table}$, it means that the average diversity of insects in the HTI ecosystem is not significantly different from the Arboretum ecosystem at the test level of 5%.

According to Barnes et al. (1997), that endemic species are often significant contributors to regional diversity, so that there is no significant difference in insect diversity within a limited area or at the level of alpha diversity (less than one to several hundred hectares) can be categorized as not yet occurring pressure or pollution. Pressure or pollution causes the number of species to decrease while the number of individuals rises. Pollution causes the emergence of rare species and increases populations of species that are resistant to stress (Odum, 1983).

Based on species diversity and the number of species obtained, the Equitability index (Odum, 1983) was obtained, which is used to calculate the level of uniformity.

From the results of catching insects in HTI ecosystem, the insect species found is *Trichoptera aquatic* which indicated that the environment was not yet polluted because these insects could not live in habitats that were already polluted (Samways, 1994). Many found Formicidae (ants), it can also be used as an indicator of the condition of agroecosystems in an area (Peck et al., 1998: Rizali et al., 2002). Showing this result means that the industrial plantation forest (HTI) ecosystem in Rasau Kuning has not been much polluted by chemicals.

Insect diversity in the two ecosystems is categorized as moderate, this is due to the presence of bottom vegetation as ground cover that serves as a shelter for the organism. With this soil cover, soil fertility can be maintained by utilizing soil organisms, including insects. As stated by Arief (2001), most of the beneficial results of trees and shrubs are the result of the characteristics of soil fauna (Lisnawati et al., 2014).

The frequency of the presence of fauna species in a habitat indicates the presence or absence of that species in that habitat. The frequency of attendance is calculated and the proportion of the number of sample units in which a species can be found in all sample units is expressed in percent (Suin, 1997).

High frequency of presence means that the species is often found in the habitat (Suin, 1997). The greater the frequency of attendance means the more often the species is obtained. If a species is often found in a place, it means that the place is a habitat for that species. Therefore, the frequency of presence can be a clue to determine the habitat of a species. Heddy and Kumiati (1996) mention that organism habitat is a place where an organism lives or a place where humans can find the organism.

According to Suin (1997) the frequency of attendance is often expressed by a constant. The value of a constant can be grouped into four groups, i.e. Accidental if the frequency of attendance is 0-25%, the constant accessory is 25-50%, the constant type is 50-75% and the absolute type if the constant are more than 75%.

Some species of insects whose frequency of presence or constant reaches the absolute level of observations I, II and III in the HTI ecosystem are *Bocchoris insperpasalis* (Lepidoptera: Pyralidae) and *Xantomelaena* sp. (Lepidoptera: Pyralidae). While in Arboretum ecosystem whose frequency of presence or constant reaches absolute levels from observations I, II and III are *Tanaorhinus rafflesi* (Lepidoptera: Geometridae).

Based on the description above it is known that there are no insect species whose level of presence reaches absolute levels at the two locations observed.

The types of insects whose level of presence reaches an absolute level in the industrial plantation forest (HTI) ecosystem are included in the group of beneficial insects as predators (predators for others) so that a balance is reached in the ecosystem.

According to Suin (1997) The highest similarity index that can be achieved between the two habitats compared is 100%, that is, if both habitats live the same species of fauna. Magurran (2004) states that the similarity index >75% means most similar, 50 - 75% similar, 25 - 50% are not similar and <25% are very not similar.

From the research results, the average index of insect species similarity in the HTI Forest with Arboretum is 23.56%, less than 25%, which is categorized as very not similar.

The existence of this dissimilarity is caused by differences in biotic factors, namely the types of plants that exist as staple plants and undergrowth under forest stands and physical and chemical factors, such as air temperature, soil temperature, humidity, organic content and soil acidity (pH).

With the very low index of insect species similarity between HTI Forest and Arboretum, there has been a shift in species occupying the area following the changes in ecosystems.

Predator insects are one of the pest insect controllers that have the potential to be used as natural enemies of pest insects because they are able to prey on insect pests quite a lot at a time. Predatory insects can suppress the development and population of pest insects so that damage caused by pest insects can be reduced in other words large yield losses can be avoided because it will not exceed the economic threshold value of an agricultural product.

Predatory insects found in this study i.e. *Sycanus* sp. (Hemiptera: Reduviidae), it is a predator insect which is quite potential to be used in biological control of pest insects, especially from the order of Lepidoptera naturally. The spread of ladybug predators *Sycanus* sp. is only found in the HTI ecosystem. The number of *Sycanus* sp. found in the first observation was 2, then in the second observation was 1, while in the third observation was not found.

Sycanus sp. preyed on insects by jabbing the stylet into the soft parts of the insect's body parts, after which the captured insects would soon be paralyzed due to toxins released through stylet. *Sycanus* sp. can be a virus vector that is toxic to insect pests. One of virus that is spread i.e. Nuclear Polyhedrosis Virus (NPV). Predator in the research sites supported by the planting of beneficial plant that is *Tumera* sp. which is a source of nectar for added feed besides pest larva.

CONCLUSION

1. There is no differences in insect species diversity in the industrial plantation forest and natural forest ecosystems.
2. There is no difference in species abundance based on the order found in the industrial plantation forest and natural forest ecosystems which is dominated by the Lepidoptera order.
3. There is similarity in composition of insect species based on the Sorensen similarity index

between each industrial plantation forest and natural forest ecosystems.

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Differences of terrestrial mammal species diversity between natural forest and edge forest areas in Batutegi Protected Forest, Lampung, Indonesia

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ABSTRACT

This research is an explorative quantitative survey by testing differences in species of terrestrial mammals found in natural forest (core) and edge forest (ecoton) areas. The data collection was obtained by using camera traps installed for 3 months based on a grid cell 2 x 2 km, with a total of 16 camera traps placed in core area and another 17 were in ecotone. The object of this research was medium (>0.3 kg) to large terrestrial mammals. The t test was used to determine the differences the species diversity of mammals between two research areas. The study shows that there are 22 species of terrestrial mammals with a total of 552 individuals, which is distributed in both research areas. In the core area there are 18 species with 237 individuals, while in the ecotone there are 18 species with 315 individuals. Analyses the species richness index was 17.8171 for the core area while 17.8262 for the ecotone area. Similarity index in both study areas ranged from 0.7106 to 1. While the value of diversity index (Shannon-Wiener) in the core area H '= 2.2038 and in the ecotone area H' = 2.0541. Three species with the greatest relative abundance values are Porcupine (*Hystrix brachyura*), Barking Deer (*Muntiacus muntjak*), and Wild Boar (*Sus scrofa*). Based on the t tests of the two research areas, which are core area and ecotone, obtained t_{count} 0.41365 ($p < 0.05$), it can be interpreted that the diversity of terrestrial mammals species in the core and ecotone areas is not the same.

ABSTRAK

Penelitian ini merupakan penelitian kuantitatif survei eksploratif dengan melakukan pengujian perbedaan terhadap jenis mamalia teresterial yang ditemukan di wilayah hutan alam (inti) dan wilayah hutan tepi (ekoton). Pendataan mamalia teresterial menggunakan camera trap yang dipasang selama 3 bulan berdasarkan grid cell 2 x 2 km, dengan 16 camera trap dipasang di areal inti dan 17 lainnya di ekoton. Objek penelitian adalah mamalia teresterial berukuran sedang (>0,3 kg) hingga mamalia besar. Uji t digunakan untuk menentukan perbadaan keragaman jenis mamalia teresterial pada dua areal penelitian. Hasil penelitian menunjukkan terdapat 22 jenis mamalia teresterial dengan total 552 individu, yang tersebar di kedua areal penelitian. Pada areal inti terdapat 18 jenis dengan 237 individu, sedangkan pada areal ekoton ditemukan 18 jenis dengan 315 individu. Analisis indeks kekayaaan jenis menunjukkan nilai 17,8171 untuk areal inti dan 17,8262 untuk areal ekoton. Indeks kemerataan pada kedua areal penelitian berkisar antara 0,7106 hingga 1. Sedangkan nilai indeks keragaman (Shannon-Wiener) pada areal inti H' = 2,2038 dan pada areal ekoton H'= 2,0541. Tiga jenis mamalia teresterial dengan kelimpahan relatif terbesar yaitu Landak (*Hystrix brachyura*), Kijang (*Muntiacus muntjak*), dan Babi hutan (*Sus scrofa*). Berdasarkan uji beda terhadap dua areal penelitian yaitu areal hutan alam (areal inti) dan areal tepi hutan (ekoton) didapatkan t_{hitung} 0,41365 ($p < 0,05$), maka dapat diartikan bahwa keragaman jenis mamalia teresterial di areal inti dan ekoton tidak sama.

Keywords: Terrestrial mammals, diversity, natural forest, ecotone, Batutegi, Lampung

INTRODUCTION

Indonesia is home to around 720 species of mammals or more than 13% of the world's mammals, whilst 275 species of mammals found in the main island of Sumatra (Widjaya et al., 2011). Sumatra's geographical location which is located in Sunda shelf has created the uniqueness of mammal species diversity on this island, and different from other places in Indonesia. Varying in ecosystem types and large size of the island resulting in a unique zoogeographic distribution pattern (Whitten et al., 2000), thus it is placing the island in second order in the diversity of mammal species after Kalimantan Island (Widjaja et al., 2011).

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As a habitat for mammals, the forest provides a very important role. However, not all forest habitats are suitable for certain types of mammals due to diverse forest habitat conditions (Alikodra, 2002). The types of mammals found in primary forests will be different from disturbed forests because there are differences in the structure of vegetation. Vegetation structure is an important biotic component in a habitat as it plays a role in the movement and distribution of mammals (Kartono, et al., 2009). The diversity of habitat types and quality of a habitat will affect the number and type of mammals in an area (Kasayev et al., 2018). Some species of living mammals are limited to areas that are still in good condition and depend on highly variable habitat features so that the sensitivity and response arising from environmental changes also varies (Kartono, 2015).

Changes in forest landscape has affected terrestrial mammal species. Forest interior mammals need special resources to support their survival, while generalist mammals will be able to adapt to changes that occur within their habitat (Prasetyo, 2017). Alikodra (2010) stated that the management of forest areas is related to wildlife conservation and the determination of the status of forest areas is one of these management strategies. However, the efforts in wildlife management cover broad and complex aspects. The insistence of human activities on forest areas makes forest areas increasingly narrowed and fragmented. In a forest landscape that is fragmented by human activity, the periphery is one of the habitats favored by generalist species while forest specialist species will migrate into the core area of the forest to obtain life support resources. The explosion of mammal populations in the periphery can be a threat of conflict between human and wildlife, while populations that are concentrated in the core of the forest and unable to move to other locations will encourage the local extinction of the species.

An important and interesting community character to be studied more deeply both in concept and application is species diversity (Dharmawan et al., 2005). Diversity is a stability indicator of an ecosystem. If the diversity of an ecosystem is high, then the condition of that ecosystem tends to be stable.

The objective of this study is to identify the species of terrestrial mammals that inhabitant to natural forest area (core area) and in the forest edge area (ecotone), as well as to determine the distribution of specialist and generalist species of terrestrial mammals in Batutegi Protected Forest in Lampung Province, Indonesia.

METHODS

Research location

The study was conducted in the core block (+10,000 ha) of the Batutegi Protected Forest, Lampung Province, Sumatra. Geographically this area is located at the coordinates of 104° 27' - 104° 54' East and 05° 05' - 05° 22' South (Figure 1). Administratively, this area is included into four regencies i.e. Tanggamus, West Lampung, Central Lampung, and Pringsewu.

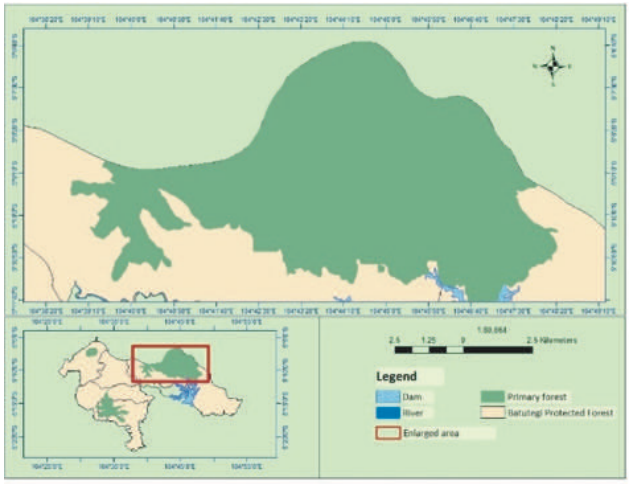

Figure 1. Location of the study area within natural forest (core area) and forest edge (ecotone) in Batutegi Protected Forest, Lampung, Sumatra, Indonesia.

This protected forest area in general has experienced changes in land use. Most of it has been turned into plantation land, but around 17.4% of the total area is still natural forest (KPHL Batutegi, 2016). In the natural forest area, there is still abundant of natural vegetation such as *Shorea* sp., *Lithocarpus* sp., and *Schima wallichii*. In this area can also be found many important species of animals such as 13 species of carnivorous mammals, including Sumatran Tiger (*Panthera tigris*), Asiatic Golden Cat (*Catopuma temminckii*), Malayan Sun Bear (*Helarctos malayanus*) and Banded Linsang (*Prionodon linsang*). In addition, it can easily find several species of primates such as Siamang Gibbon (*Symphalangus syndactylus*), Pig-tailed Macaque (*Macaca nemestrina*), Long-tailed Macaque

(*Macaca fascicularis*), Sumatran Surili (*Presbytis melalophos*), Lutung (*Trachypithecus cristatus*), Slow Loris (*Nycticebus coucang coucang*) (Shancez et al., 2010; Huda et al., 2018).

Data collection

The object of this research is medium to large with weights of 0.3 kg and above (Ariyanto, 2007). 33 camera traps which are placed based on grid cells of 2x2 km, were employed to support in data collection. 16 camera traps installed in natural forest area (core area) while another 17 camera traps installed in forest edge area (ecotone) for three months period in April-June 2019 (Figure 2).

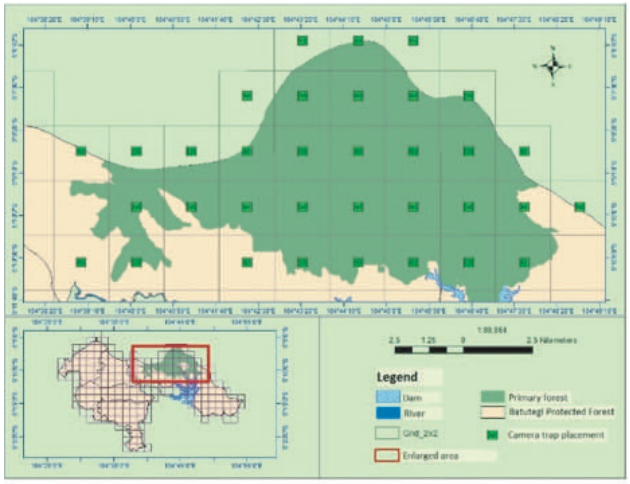

Figure 2. Placement of 33 camera traps during the study in core and ecotone areas in Batutegi Protected Forest, Lampung, Sumatra, Indonesia.

Data Analysis

Data from the trapping camera results were analyzed using *Jim Software*, then they were calculated using several parameters of diversity such as species richness, similarity, dominance, diversity index and abundance (Magurran, 2004). T-test was used to compare the two results obtained from core area and ecotone.

Species richness in a habitat can be determined by using the Margalef Richness Index (Santosa, 1995) is as follows:

$$R = \frac{(S - 1)}{(\text{Ln } (NO))}$$

Note:
R = index of species richness; S = total number of species in a habitat (species per habitat); NO = number of individuals in a habitat (individuals per habitat).

Similarity index uses the formula from Hill (Santosa,1995) below:

$$E=1/Si \quad \frac{1 / Si}{eH'}$$

Note:
E = index of similarity; H' = Shannon index of diversity;
Si = Simpson Indix of diversity

The Shannon-Wiener Index (H') is calculated by a modified formula from Magurran (2004) is as follow:

$$H' = - \Sigma s \text{ (pi ln pi) where pi} = ni / N$$

Note:
H' = Shannon-Wiener index; ni = number of individuals of each species; N = number of individuals of all species where pi is the proportion of the number of photographs in the species until-i divided by the total of all photographs

Species dominance index is calculated using the Simpson dominance index (Odum, 1983) below:

$$C = \sum (Pi)\ 2$$

Note:
C = Dominance index
Pi = (ni / N) ni = proportion of a species in a community;
N = number of all species

Relative abundance index is calculated through below formula:

$$RAI = \frac{ni}{\sum TN} \text{ X } 100$$

Note:
RAI = Relative abundance index (/100 trap nights);
ni = number of independent picture of the species to-i;
ΣTN = number of nights of camera active.

RESULTS

There were 33 camera traps that had been installed in the field during the study. However, there were only 28 cameras working properly, while the other 5 cameras were damaged and did not get any pictures. All camera traps placed for three months period with a total trapping effort of 2,259 trap nights with obtaining 4,101 individuals and there were 1,434 pictures of terrestrial mammals. Then based on the results of grouping using Jim Software programme (Sanderson and Harris, 2013), a 1,669 independent photographs (552 terrestrial mammal photographs) were obtained, with assumption that independent photograph of each species at each location is along 60 minutes.

Based on unequal test towards two study areas of ecotone and core areas, then t_{count} was obtained of 0.41365 ($p < 0.05$). Thus, H0 is rejected and it can be interpreted that the diversity of terrestrial mammal species in the ecotone and core areas is not the same.

Calculation of richness index in each areas is obtained where in ecotone at 17.8262 and core area at 17.8171. Diversity index (Shannon-Wiener Index) H' = 2.2038 for the core area and H' = 2.0541 for the ecotone area. The values of similarity index is 0.7106 for the ecotone while for the core area is 0.7625. Dominance index value for ecotone is 0.1758 and for the core area is 0.1719 (Table 1).

Table 1. Indexes of Richness, diversity, similarity, and dominance in core area and ecotone at the study area in Batutegi Protected Forest.

Index	Type of habitat	
	Natural forest	Edge forest
Richness	17.8171	17.8262
Diversity	2.2038	2.0541
Similarity	0.7625	0.7106
Dominance	0.1719	0.1758

Based on the calculation of the relative abundance index (RAI) of each species in natural forest or core area, Porcupine (*Hystrix brachyura*) has the highest RAI compared to other species (with RAI = 3.41). Followed by Barking Deer (*Muntiacus muntjak*) with RAI = 2.17, Wild Boar (*Sus scrofa*) with RAI = 1.11, and Short-tailed Mongoose (*Herpestes brachyurus*) with RAI = 0.04. Whereas in the edge forest or ecotone area, Wild Boar (*Sus scrofa*) has the highest RAI compared to the other species with a value of RAI = 4.12. Then, followed by Barking Deer (*Muntiacus muntjak*) with RAI = 2.66 and Malayan Tapir (*Tapirus indicus*) with a value of RAI = 0.04.

DISSCUSION

Based on the data obtained, there are 22 species of medium-large terrestrial mammals in the core and ecotone areas. Those species of mammals are distributed within two study areas, but not all species distributed evenly. The diversity index (Shannon-Wiener Index) in each region obtained was H' = 2.2038 for the core area and H' = 2.0541 for the ecotone. From the categories determined by Odum (1983), the two regions fall into the category of moderate species diversity, which is in the range between 1.5 - 3. It also means that habitat features largely affect the presence of species found. While the results of the calculation of the richness index of the two regions obtained different values, in the ecotone area of 17.8262 and the core area of 17.8171.

The results of this study found a similar with the study conducted by Idrus (2018) who obtained a value of H'= 2.15 at the Way Canguk Research Center in Bukit Barisan Selatan National Park. The study of Kasayev et al. (2018) found H' = 2.06 in swampy habitat in the Rimbo Panti Nature Reserve, West Sumatra. Santosa et al. (2008) also found that the diversity of mammals species in lowland and swamp habitats at the Pondok Ambung Research Station in Tanjung Puting National Park, Central Kalimantan, has a medium-value with H' = 2,179. A karst area in East Kalimantan has a value of H' = 2.38 (Kartono, 2015).

Diversity is identical to the stability of an ecosystem. When the diversity of an ecosystem is relatively high then the condition of that ecosystem tends to be stable (Odum, 1983; Fachrul, 2012). Indriyatno (2006) stated that the species diversity is high if the community is composed of many species with an abundance of the same species or almost the same species diversity, resulting in high complexity, because the interactions that occur within the community are very high.

Based on the species diversity of unequal test between core and ecotone area obtained t_{count} 0.41365 ($p < 0.05$). This result is different from the study conducted by Kartono (2015) which states that the three research sites, namely secondary forests, oil palm plantations and karst areas, have no real difference in diversity of mammals. However, Kartono (2015) in his research stated that the diversity index of mammal species in karst forest habitat has a greater value (H'= 2.38) compared to secondary forest and oil palm plantation.

Similarity index (E) in two areas, found that the value of 0.7106 for the ecotone area and 0.7625 for the core area, or for both areas the value is in the range between 0.7106 and 1. This means that in the habitat there is individuals of a species still dominate the area but in small numbers. According to Santosa et al. (2008), similarity of species has an indicator value of E = 1. If the value of E = 1 means that in the habitat there are no species of mammals that dominate. While the Jaccard similarity Index (JI)

scores 0.6363. Means that these values approach the similarities between communities. The dominance index value obtained in this study is 0.1758 for the ecotone area and the core area is 0.1719. This means that in the two areas there was dominance with a low value.

Based on the research of Santosa et al., (2008) in lowland, desert/bush and swamp habitat at the Pondok Ambung Research Station, Tanjung Puting National Park in Central Kalimantan, it was found that the similarity index index was in the range of 0.8442 - 1. While the community similarity value the highest is in the type of desert/ bush habitat with post-burnt habitat. In this study, although the location used is different from this study, it can be seen that there is a big possibility that the similarity of the location of the vegetation and its environment in the area, which are namely ecotone and core, affects the similarity and similarity of species found. In addition, the low species dominance in each region also affects the similarity of the species. This is in accordance with the statement of Magurran (2004) that the dominance of certain species and the unequal distribution of species causes the similarity of species to decrease. Low similarity (uneven) is caused by competition in utilizing available resources. This is also influenced by the availability of feed in the habitats that are occupied is one of the main factors for population presence.

Based on the calculation of the relative abundance index in the two areas, the values obtained were different either for each species of mammals as well as the areas. In the core area, Procupine (*Hystrix brachyura*) is a mammal that has the highest RAI value, followed by Barking Deer (*Muntiacus muntjak*), and Wild Boar (*Sus scrofa*). Whilst the Sumatran Tiger (*Panthera tigris sumatrae*), as the top predators in the region, has the position of 15th rank of RAI with a value of 0.13. Whereas in the ecotone area, Wild Boar (*Sus scrofa*) placed at the first rank, followed by Barking Deer (*Muntiacus muntjak*), and Porcupine (*Hystrix brachyura*). In ecotone area, Sumatran Tiger (*Panthera tigris sumatrae*) placed at 8th rank with a RAI value of 0.18. Based on trophic level (based on the type of food) which is divided into three categories i.e. herbivores, carnivores and omnivores, the relative abundance of herbivores has a high value. Therefore, the pyramid of food web will be formed properly and the balance of the ecosystem in the research location will be occurred. This is in line with the study of Santosa et al. (2008) which obtained 14 species of herbivores, five species of carnivores, and three species of omnivores.

Conservation values of terrestrial mammals

Based on the results of the study, there were 22 species of medium to large-sized terrestrial mammals. Among of those, 13 species are protected under the law of the Republic of Indonesia. In addition, two species are categorized as Critically Endangered (CR) and one species as Endangered (EN) according to IUCN's red list.

In species conservation efforts, the determination of umbrella species is very important because when an umbrella species is protected, the effort will also be protecting the other species (Choudhury, 2013). The establishment of umbrella species is expected to minimize the need for human resources and funding that is still low to support wildlife conservation (Kiffner et al., 2015). As a top predator, the Felids family can be used as an umbrella species in species conservation efforts in the area of Batutegi Protected Forest.

Based on the results of this study, the Felids were found in both areas of core and ecotone, namely Leopard Cat (*Prionailurus bengalensis*), Marbled Cat (*Pardofelis marmorata*), Asiatic Golden Cat (*Pardofelis temminckii*), and Sumatran Tiger (*Panthera tigris sumatrae*). Sumatran Tiger abundance core area (natural forest) is 0.13 while in the ecotone area is 0.18. The presence of tigers in the two regions is possible because of both areas are part of their home range, and prey species in both areas is also abundant. Many prey species of Sumatran Tiger in the area including birds, reptiles, amphibians, fish and invertebrates, but the main prey species are Wild Boar (*Sus scrofa*.), Sambar Deer (*Cervus unicolor*), Barking Deer (*M. muntjak*), Greater Mouse-deer (*Tragulus napu*.), Serow (*Capricornis sumatraensis*), and Malayan Tapir (*Tapirus indicus*) (Dinata and Sugardjito, 2008). Some other smaller mammals such as Porcupine (*Hystrix brachyura*) is an alternative prey species when ungulates difficult to hunt. Sumatran Tiger home range for adult females ranges from 40-70 km^2 and adult males around 180 km^2. The home range includes the home range of two adult females (Franklin et al., 1999; Griffith, 1994). The home range and abundance of tigers are also affected by the availability of prey species (Hutajulu, 2007).

The total area of the Batutegi Protected Forest is 58,174 ha and the remaining around 10,000 ha is still natural forest, while the rest of area has been cultivated by the community in the social forestry scheme (KPHL Batutegi, 2012). In addition to the narrow natural forest area, this area is also not free from illegal human activities in the core area (natural). As found in this study, there is hunting activity in the core area. Poaching of tiger prey can result in reducing the tiger food, and this cause that the tigers to roam more extensively to the outside of the area, especially the core area. As a result, it can cause conflict between human and tigers. According to Hutajulu (2007) an effective conservation efforts require accurate information on population size in an area, geographical distribution of species, connectivity between areas, as well as ecological and biological aspects of species. This information is needed to find out suitable habitat, population size and threats to develop a short-term, medium-term and long-term conservation strategy in an area.

CONCLUSIONS

From the results of the research can be concluded that, using unequal test known that there is a significantly different on species diversity of terrestrial mammals between in natural forest (core) area and within forest edge (ecotone) area. There is not different significantly on species richness between core and ecotone areas. Species similarity is significantly different between in natural forest and in edge forest areas. In core area terrestrial mammals species are distributed evenly, while in ecotone area they are distributed less evenly. Value of species diversity is not significantly different either in core area and in ecotone. Both areas has moderate category in species diversity index. Value of dominance index is not significantly different in both study areas. Either in core and ecotone areas, there are three species that stay in highest rank of relative abundance index, i.e. Porcupine (*Hystrix brachyura*), Barking Deer (*Muntiacus muntjak*), and Wild Boar (*Sus scrofa*). There is not significantly different in the dominance of terrestrial mammals species between in natural forest and in ecotone. Both areas included into category of low in species dominance.

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Feasibility analysis of lake ex-andesite stone mining as geo-tourism area at Tegalega Village, Cigudeg, Bogor

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ABSTRACT

The existence of large wallow which is an ex-mining of andesite stone that is not manage properly became the focus of this study. The objective of this study was to analyse the potential of geo-tourism object at the land of ex-andesite stone mining (Setu Jayamix), as well as to find out the feasibility value of geo-tourism object at the lake of ex-andesite stone mining (Setu Jayamix). Mix methods, which is a combination of qualitative and quantitative methods with the research design of sequential exploratory was used in this study. Sequential exploratory design is a research model where the qualitative data is collected and analyzed, then followed by the collection and analysis of quantitative data, which aims to strengthen the results of the study. The results showed that the potentials of geo-tourism in ex-andesite stone mining area i.e. lake waters, the uniqueness of andesitic stone outcrops, and the view of landscape that overgrown by various plantation crops. Based on the results of the feasibility analyses of geo-tourism, then obtained a feasible value for the geological criteria of physical components (score = 26.334), sustainable for the economic components (score = 20.114), sustainable for the conservation components (score = 10.971), and educative (score = 8.518). Meanwhile, for the accessibility component is declared to be less feasible (score = 61.446).

ABSTRAK

Keberadaan kubangan besar yang merupakan area bekas penambangan batu andesit yang tidak terkelola secara maksimal menjadi fokus penelitian ini. Penelitian ini bertujuan untuk mengkaji potensi obyek geowisata pada lahan di kawasan bekas tambang batu andesit (Setu Jayamix), serta mengetahui nilai kelayakan obyek geowisata di kawasan danau bekas tambang batu andesit tersebut (Setu Jayamix). Metode kombinasi (mix methods), yaitu gabungan antara metode kualitatif dan kuantitatif dengan model penelitian sequential exploratory design digunakan dalam penelitian ini. Sequential exploratory design merupakan model penelitian dimana data kualitatif dikumpulkan dan dianalisis, kemudian diikuti dengan pengumpulan dan analisis terhadap data kuantitatif, yang tujuannya untuk memperkuat hasil penelitian. Hasil penelitian menunjukan bahwa potensi-potensi geowisata yang terdapat di kawasan lahan bekas tambang batu andesit (Setu Jayamix) adalah perairan setu, keunikan singkapan batu andesit, serta pemandangan lanskap kawasan yang ditumbuhi berbagai tanaman perkebunan. Berdasarkan hasil analisis kelayakan geowisata, maka diperoleh nilai layak untuk kriteria geologis komponen fisik (skor = 26,334), berkelanjutan untuk komponen ekonomi (skor = 20,114), berkelanjutan untuk komponen konservasi (skor = 10,971), serta edukatif (dengan skor = 8,518). Sedangkan untuk komponen aksesibilitas dinyatakan kurang layak (skor = 61,446).

Keywords: Geo-tourism, ex-mining, feasibility analysis, Bogor

INTRODUCTION

The potentials of mining and energy materials in Bogor Regency are quite diverse. Based on the types of minerals or production they produce can be distinguished such as, a) Excavation materials "C", which is based on mining permit issued by the local government of Bogor Regency consists of limestone, clay, andesite, sand, gravel, feldspar, and backfilled, with a total production around 18.5 million tones in 2002, and b) Excavated materials "B" which consists of gold and silver with total production of around 29 kg in 2002.

By looking at the potential of excavation materials "C" in Bogor Regency which is quite large, the mining system using the most open method

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becomes the system that is mostly carried out by mining operators. As it is known, the last process of mining activities using the open method is in the form of gaping holes and damage to the surrounding ecosystem.

One of the large mining pits is located in Nanggaherang area, Tegalega Village, District of Cigudeg, Bogor Regency. This large hole is an ex-andesite stone mining conducted by PT. Jaya Readymix, which has been exploited since 2012, and since the condition of the big hole has been left, it has been filled with rain water and springs below and has formed like a little lake. Therefore, the surrounding communities call that little lake as Setu Jayamix (taken from the company of PT. Jaya Readymix) or Setu Tambang.

According to Hendratno (2002) and Kubalikova (2013), there are several earth phenomena that can be used as a basis for geo-tourism promotion activities, such as:

a. Active earth processes, including volcanic eruptions and their products, earthquake-prone, rock movements that are still active so as to produce fields fault, a manifestation of geothermal and prone to landslides.

b. Natural beauty that is formed due to the geodynamic processes of the past, such as mountains, rivers, beaches, karst, plateaus and coral reefs.

c. Cultural aspects of the past that are influenced by geodynamic developments, such as the formation of ancient sites due to natural disasters that occur.

d. Geological resource exploitation activities, such as the exploitation of valuable hydrocarbons and mineral mines (gold, copper, silver, etc.) in both large and small scale.

e. Geological resource exploitation activities which cause problems to the surrounding environmental conditions.

According to Wood (2002) and (Arafat and Flamin, 2012) the nature tourism should have some principles such as nature base, ecologically sustainable, environmentally educative, useful for the local community, and tourist.

From those problems describe above, then an optimal management effort is extremely needed so that the existence of ex-andesite stone mining can be functioned further. For this reason, a study needs to be conducted to assess the available potentials in the area of ex-andesite stone mining to determine their eligibility as an Geo-tourism Tourism Destination (DTW).

The objective of this study was to analyse the potential of geo-tourism object at the land of ex-andesite stone mining (Setu Jayamix), as well as to find out the feasibility value of geo-tourism object at the lake of ex-andesite stone mining (Lake Jayamix).

METHODS

This study was conducted in April-May 2019 in the area of ex-andesite stone mining that is known as Setu Jayamix. It is located in Tegalega Village, Cigudeg District, Bogor Regency, West Java.

All variables that was analyzed in this study refer to the guidelines for operationalizing variables from geo-tourism of Dowling and Newsome (2006), in the form of five characteristics so that the development and geo-tourism management can take place continuously for a long period of time, with components that will be recorded and assessed namely geological, sustainable, educative, community participatory and tourist satisfaction.

Three types of methodology were used during the data collection. Firstly, data collection conducted by observation, interview and questionnaire delivery. Secondly, literature review was done through studying literatures, reports, scientific works, journals and research articles that related to this research. Thirdly, field documentation method to obtain data directly from the research site.

The data were analyzed using three methods. First, using descriptive qualitative analysis, which is an analysis method that aims to describe and explain the potential of geo-tourism objects in the area of ex-andesite stone mining. Second, using the Geo-tourism Feasibility Assessment method with the evaluation criteria according to the Director General of the Regional Nature Tourism Object Attraction and Attraction (ADO-ODTWA) (Departemen Kehutanan, 2003; Arafat and Flamin, 2012). Third, was creating and verifying conclusion which could answer the problems that formulated since the beginning.

RESULTS AND DISCUSSION

Geo-tourism potential

Geological variable

Sub variable: Physical

If we enter Setu Jayamix area, we will be welcomed with a stretch of lake which is always filled with water that sourced from springs at the bottom of the lake and rainwater. The water runoff of the mining when it is fully charged will flow graphically through the community channel to the Ciater River located in Binong Hamlet at Tegalega Village. The total area area of the lake is almost 1.5 ha with a depth of water estimated around 27 meters with greenish waters, giving rise to a very beautiful panorama and has its own charm.

The greenish color of the water is so beautiful and it is also supported by the quality of lake water which is not polluted, in accordance with the results of the lake water quality test conducted on April 10, 2019 that for all surface water quality test parameters meet the environmental quality standard (BML) based on Government Regulation No. 82/2001 concerning management of water quality and water pollution control. This is also strengthened by the evidence that the large number and various species of fish that live in large waters, so that this place is used as a fishing area by surrounding communities.

The beauty of the existing lake water combined with views of andesite stone outcrops on the walls of lake, which is a gray andesite stone mining process. It is a type of igneous stone of the middle category as a result of melting magma diorite formation.

Landscape within the study area is in good condition. It is known that the soil type is Andosol which has fertile properties that can be cultivated for mixed gardens.

Species of fauna found during field observation such as butterfly (*Delias fruhstorferi*), dragonfly (*Aesha* sp.), some small birds, some reptile, and leaf-monkey.

Sub variable: Accessibility

The variability of road condition to the Setu Jayamix area was observed from the provincial capital of West Java Province (Bandung) to the location of the activity consisted of several conditions, as follows:

1. From the provincial capital (Bandung) using the Purbaleunyi toll road to the Yasmin Bogor toll exit, passed the Jagorawi toll road and the BORR toll. Distance traveled ± 190.1 km with excellent road conditions, generally flat.
2. From Yasmin, Bogor, driving through a non-toll road (in the city) heading to Ciseeng intersection. Distance traveled ± 19.1 km with a road condition that is in sufficient condition, with little or no holes but uneven road surfaces.
3. From Ciseeng crossroad using the district road to the study site in Tegalega Village, Cigudeg District, it is ± 19.7 km away with the condition of the road being in bad condition, with many holes in it.

The damage of the road approaching the research site is caused by the traverse of large vehicles such as large trucks carrying heavy loads in the form of sand and stone material. Therefore, the road conditions are quite alarming, especially in the rainy season. The road conditions are very muddy and slippery in rainy season and is full of dust in dry season.

The trip to the Jayamix area can be reached by ± 4 hours 39 minutes from the capital city of West Java Province (Bandung), with total distance of ± 228.90 km. The route used was through the Purbaleunyi toll road to enter Jakarta, then using the Jagorawi toll road to enter the Bogor area, continued by using the BORR toll road to get to the Yasmin junction and continue with the normal road to the Semplak intersection or the Parung market towards the Rumpin District. From the Parung market location, go straight to the three intersection of Rumpin. After crossing three intersections, turn right toward BDK-Bogor, Rumpin. Just follow the road straight and if you find a signpost written of PT. Lotus SG Lestari and just follow it. After passing through various types and conditions of the road as well as several settlements of residents and several mining areas, we will arrive at the destination.

If using public transportation, we will only reach the center of Cigudeg District, and to continue the journey we can use motorcycle taxi or rent a car.

The type of road for the width of the lane without the median barrier that will be traversed to the location observed from the Ciseeng junction is a concrete road with a road width of >11 meters. However, although this road is quite wide, but because the area that we pass is in the sand and stone mining area of several mining companies that every day use this road as a haul road for large vehicles of

their mining business, the road conditions are always congested with huge vehicles so you have to be more careful.

Sustainability variable

Sub variable: Accessibility

From the results of interviews with several staff of Tegalega Village, Cigudeg District, it was conveyed that the types of jobs or the biggest livelihoods of the Tegalega villagers is farmers and became daily laborers out of the mining business, while the livelihoods of other types of work were very few such as trading, self-employment and motorbike taxi driver. What is of concern is the number of village people who do not have permanent work or unemployed is very large. It can be seen from the demographic data of Tegalega village in 2018 for the type of work or livelihood that from the working age community (15 to 64 years) as many as 4,138 people where there are 1,072 people (26%) who do not have permanent jobs or who do not work (unemployed).

In the Bogor Regency Regional Indicator Target Book 2014 - 2018, that monthly income earned by the people of West Bogor including Tegalega Village was Rp. 14,850,000 per year or Rp. 1,237,500 per month.

The Tegalega Village apparatus quite welcomed to the information that there is a tourism potential that can be developed from natural conditions in the form of lake of ex-mining activities that have been abandoned by the company, namely Setu Jayamix, which will later be able to open new jobs and will also increase community income, including working as tour officers, ticket guards, security personnel, janitors, food vendors, souvenirs, photographers, motorbike taxi, tour guides and other workers that will be needed for the operation of a tourist area, and it can increase village cash income from ticket prices paid by the end of tourist area.

Sub variable: Conservation

From observations in the field there are at least eight components in the natural ecosystem that can be maintained with this geo-tourism development plan, namely water, terrestrial plants, aquatic plants, terrestrial fauna, aquatic fauna, soil, air temperature and stones (landscape).

Educative variable

Within the Setu Jayamix area there are a number of attractions that can be included in interesting and educative interpretation media and can increase tourist awareness about environmental conservation educatively, including at least four attractions that can be included in interesting and educative interpretation media as follows:

1. Beautifully colored waters and uncontaminated quality that contain elements of a lake aquatic ecosystem education.
2. Outcrops of andesite from mining processes that are unique and interesting that contain elements of geological education.
3. Introduction of a variety of terrestrial and aquatic plants that thrive in locations that contain educational elements of terrestrial and aquatic ecosystems.
4. Introduction of various aquatic and terrestrial animals that can live and thrive in lake waters which contain elements of lake waters ecosystem education.

All components can be used as an interesting interpretation media and educational material for tourists who will visit later.

Analyses results show that Setu Jayamix area is very potential and feasible to be developed and made a tourist destination. This is concluded in accordance with the criteria the eligibility determined in each class states that almost all classes are declared worthy of each criteria value, namely, geological variable for physical components with a score of 26.334, geological variable for accessibility components with a score of 61.446 (Table 1), sustainable variable for economic components with a score of 20.114, sustainable variable for the conservation components with a score of 10.971 (Table 2), and educative with a value of 8.518 (Table 3). The level of eligibility for each class varies based on the interval of each class.

From the Tabel 1. it can also be seen that conservation criterion achieving the maximum score score of 10.971, compared to the other criterion. This indicates that at least eight components in the natural ecosystem contained in the geo-tourism development plan area, namely water, terrestrial plants, aquatic plants, terrestrial fauna, aquatic fauna, soil, air temperature and stones (landscape), this will be maintained through conservation-based tourism activities and management. Furthermore, for the economic, physical and educational geological components it is also close to the maximum score,

indicating that the high number of unemployment and low income levels can also be used as opportunities for the development of geo-tourism potential in the region by involving the Tegalega Village communities in maximum area management, so that the number of unemployment can be reduced and the level of community income can be increased.

For physical components of geology variable that will show the beauty of the waters of lake, the uniqueness of ex-mining andesite stones and the landscape conditions that are grown with a variety of plants that thrive because they are on Andosol soil type that are well cultivated for plantation areas if managed properly will make this geo-tourism area will very interesting for tourists to visit.

Geo-tourism Assessment

Table 1. Assessment results of the geological variable in ex-andesite stone mining of Setu Jayamix area.

No.	Element	Sub element	Weight	Value	Total score*
Geological: Physical components					
1	Condition of water	Water quality	0.2926	40	11.704
2	Uniqueness of andesite	Uniqueness	0.2926	20	5.852
3	Landscape (flora)	Existence of plants	0.2926	30	8.778
			Total score:	**90**	**26.334**
Geological: Accessibility components					
1	Road condition	Level of road damage:			
		Distance 190.1 km of the total distance of 228.90 km	0.2926	40	11.704
		Distance 19.1 km of total distance 228.90 km	0.2926	60	17.556
		Distance 19.7 km from total distance 228.90 km	0.2926	40	11.704
2	Distance from the city	Distance from the provincial capital	0.2926	15	4.389
3	Type of road	Width lane road without median divider	0.2926	40	11.704
4	Travel time	long trip	0.2926	15	4.389
			Total score:	**210**	**61.446**

Table 2. Assessment results of the sustainable variable in ex-andesite stone mining of Setu Jayamix area.

No.	Element	Sub element	Weight	Value	Total score*
Sustainability: Economic components					
1	Livelihoods/occupation	There will be alternative livelihoods/occupation and reduced unemployment	0.3657	30	10.971
2	Level of income	Perception that there will an increase of community income	0.3657	25	9.1425
			Total score:	**55**	**20.114**
Sustainability: Conservation components					
3	Natural ecosystems that can be maintained or managed through conservation-based tourism	Presence of natural ecosystem that can be maintained or managed through conservation-based tourism	0.3657	30	10.971
			Total score:	**30**	**10.971**

Table 3. Assessment results of the educative variable in ex-andesite stone mining of Setu Jayamix area.

No.	Element	Sub element	Weight	Value	Total score*
1	Educative	Educative media interpretation	0.3407	25	8.5175
			Total score:		**8.5175**

For the educative component that will present interesting and educative interpretative media in the form of beautiful colored waters and uncontaminated quality that contains elements of education in the lake ecosystems, outcrops of andesite from the mining process that are unique and interesting that contain elements of geological education, introduction of various terrestrial plants and water that thrives in locations that contain elements of terrestrial and aquatic ecosystem education and the introduction of a variety of aquatic animals and terrestrial animals that can live and thrive in lake waters that contain elements of lake aquatic ecosystems if properly managed will make this geo-tourism area very interesting for tourists to visit while increasing tourist awareness about environmental conservation.

However, for the geological variable of accessibility which gets a fairly low score below the maximum score of 61.444, this indicates that judging from the condition of the road (level of damage to the road), distance from the provincial capital, type of road (width of the lane road without median boundaries), as well as travel time are in unfavorable conditions to be developed into an geo-tourism area, but with the planning of improvement and good accessibility management and supported by other good geo-tourism components, this geo-tourism area will still be attractive to tourists to visit.

Geo-tourism feasibility analysis

Table 4. Assessment results of object and geo-tourism attractiveness of ex-andesite stone mining of Setu Jayamix area.

Variable	Max. Score	Min. Score	Interval *	** Feasibility criteria	Total score ***	Remarks
Geological:						
Physical	29.260	7.135	7.315	Feasible: 21.945 - 29.260 Feasible enough: 14.63 – 21.945 Less feasible: 7.315 - 14.63	26.334	Feasible
Accessibility	87.780	24.871	20.970	Feasible: 66.81 – 87.780 Feasible enough: 45.84 - 66.81 Less feasible: 24.871 to 45.84	61.444	Feasible enough
Sustainability:						
Economy	21.924	9.143	4.260	Feasible: 17,664 to 21,924 Feasible enough: 13.404 - 17.664 Less feasible: 9.143 - 13.404	20.114	Less feasible
Conservation	10.971	3.657	2.438	Feasible: 8.533 s / d 10.971 Feasible enough: 6.095 - 8.533 Less feasible: 3.657 - 6.095	10.971	Feasible
Educative	10.221	3.407	2.271	Feasible: 7.950 - 10.221 Feasible enough: 5.68 – 7.950 Less feasible: 3.407 to 5.68	8.518	Eligible

CONCLUSION

1. Setu Jayamix, a Lake ex-andesite stone mining has the potentials of geo-tourism object (Table 4). Those potentials include as follows:
   - The beauty of greenish unpolluted lake waters, the uniqueness of ex-mining andesite stones outcrops, and the landscape surrounding which grown by variety of fertile plants.
   - At least eight natural ecosystem components that contained around the lake such as water, terrestrial and aquatic plants, terrestrial and aquatic fauna, soil, air temperature and stones (landscape), which can be maintained through conservation-based tourism activities.
   - The high number of unemployment and the low level of income of the people around the lake can be used as opportunities for the development of the potential for geo-tourism in this region by involving the community in the management of geo-tourism.
   - Interesting and educative interpretation media in the form of beautiful colored unpolluted lake water that contains element of education of lake's ecosystem, andesite stone outcrops that are unique and interesting of mining processes that contain element of geological education, introduction of various plants and fauna which contains elements of terrestrial and aquatic ecosystems education.
2. Currently, there are not many surrounding communities can be involved in the existence of Setu Jayamix, as the area formally is not open for the public. The area is still managed by PT. Jaya Readymix, but they are not carried out any activities on the land.
3. Based on feasibility assessment, Setu Jayamix area is feasible to be developed for geo-tourism that considered from geology variable for physical component, sustainability variable for economic component, sustainability for conservation component, and educative component. Meanwhile, accessibility component is stated to be less feasible.

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