Vegetation Composition And Diversity In Oil And Gas Facility, Grissik Village, South Sumatra

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Abstract: Mining activities usually give negative impact to environment. Mining activities could give some effects on environment such as soil erosion, formation of sinkholes, biodiversity loss, and soil contamination, groundwater, and surface water by chemicals from mining processes. Mining companies in some countries are obliged to follow environmental restoration, make sure the exploited area is returned to its normal state. Oil and Gas facility which located in Grissik Village is one of the mining areas in South Sumatra surrounded by secondary forest. Several studies have been conducted in this area to find out how important the area is for flora and fauna habitats around the site. The objectives of this study include identifying plant species, measuring the index of species diversity, species evenness index in the study area, and calculate the importance value of plant species indices. The data collection of vegetation was conducted in two location plots and the observations applied a single plot method. Based on the results of the analysis, it is known that species diversity index is still relatively good. A high level of evenness index (> 80%) also indicates no plant species dominate both study areas.

Keywords: Diversity, evenness, habitat, plant, species, vegetation composition.

1 Introduction

1.1 Background

Mining activity is a promising business sector in terms of economy. Many countries have made mining industry as one of the main sectors for GDP contribution, as well as Indonesia. Since 1997 Asian monetary crisis that also caused major conflict in Indonesia's economy and business sector, the mining sector has become a dependable and important supplier to Indonesia's domestic income [1]. According to PwC (2016) [2], Indonesia is also one of important member in international mining industry with significant production of copper, gold, coal, nickel, and tin. Indonesia also become world's largest exporters of thermal coal. Global mining companies consistently rank Indonesian highly in terms of coal and mineral prospects [3]. However, usually, this business sector cannot be in line with environmental sustainability. Mining activity is often linked to activities that can damage the environment. Some types of mining operations may have environmental impacts, such as land clearing, waterways diversion, river bank breakdown, moreover, logging of couple of plants in excavation work [4]. In fact, biodiversity is essential thing for mining industries to show their dependencies and impacts on biodiversity and ecosystem services [5]. According to Morton et al (2014) [6], negative influences on biodiversity can accumulate when there are numerous mining activities within a region and regional development around mines can reach these negative effects across a wider area. Morton et al (2014) [6] more over stated that There are three main strategies to moderate the impact of mining on biodiversity: before mining begins, during the life of a mine, and when mines close. Mining is not industry with green prospects. Because of that, challenges are greater for some sectors of the mining industry than for others. Using land in greater sympathy with wildlife is such intrinsic practices to a more caring corporate culture and likely to promote attention and loyalty among some customers. Furthermore, these measures contribute to improving overall environmental performance and thereby attract lower regulatory serutiny and charges and enhance corporate reputation and perception of taking risk management seriously [7]. Oil and Gas Facility which located in Grissik Village is a gas mining area located in South Sumatera Province. Under the executed gas swamp agreement, it will deliver up to certain volume of gas from this Oil and Gas Facility. It located within Sumatra's forest ecosystems. Because of the mining activity, forest fragmentation occured where one patch of habitat is broken down into several other patches. Hill & Curran (2003) [8] argue that fragmentation and isolation may lead to a decrease in species numbers and changes in community composition due to reduced forested areas, changes in shape, and increased isolation of remaining forest fragments. The impacts arising from habitat isolation and fragmentation will vary and depend on the species concerned, both plant and animal. For plants, very heavy fragmentation and isolation (i.e. distances between very remote habitat patches and prolonged forest formations) will result in proportion enhancement of edge zones within a landscape, changing of micro-climatic conditions, and providing benefits to pioneer species. While, inland forest areas will be dominated by species that are tolerant to shade [9], [10].

1.2 Objectives

The objectives of this study are to:

1. Identify the types of plants found in the study area.
2. Measure the species diversity, evenness, and similarity indices of the vegetation community in the study area.
3. Identify the presence of plant species protected by Indonesian and/or endangered legislation according to the International Union for Conservation of Nature (IUCN) The Red List of Threatened Species and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix.

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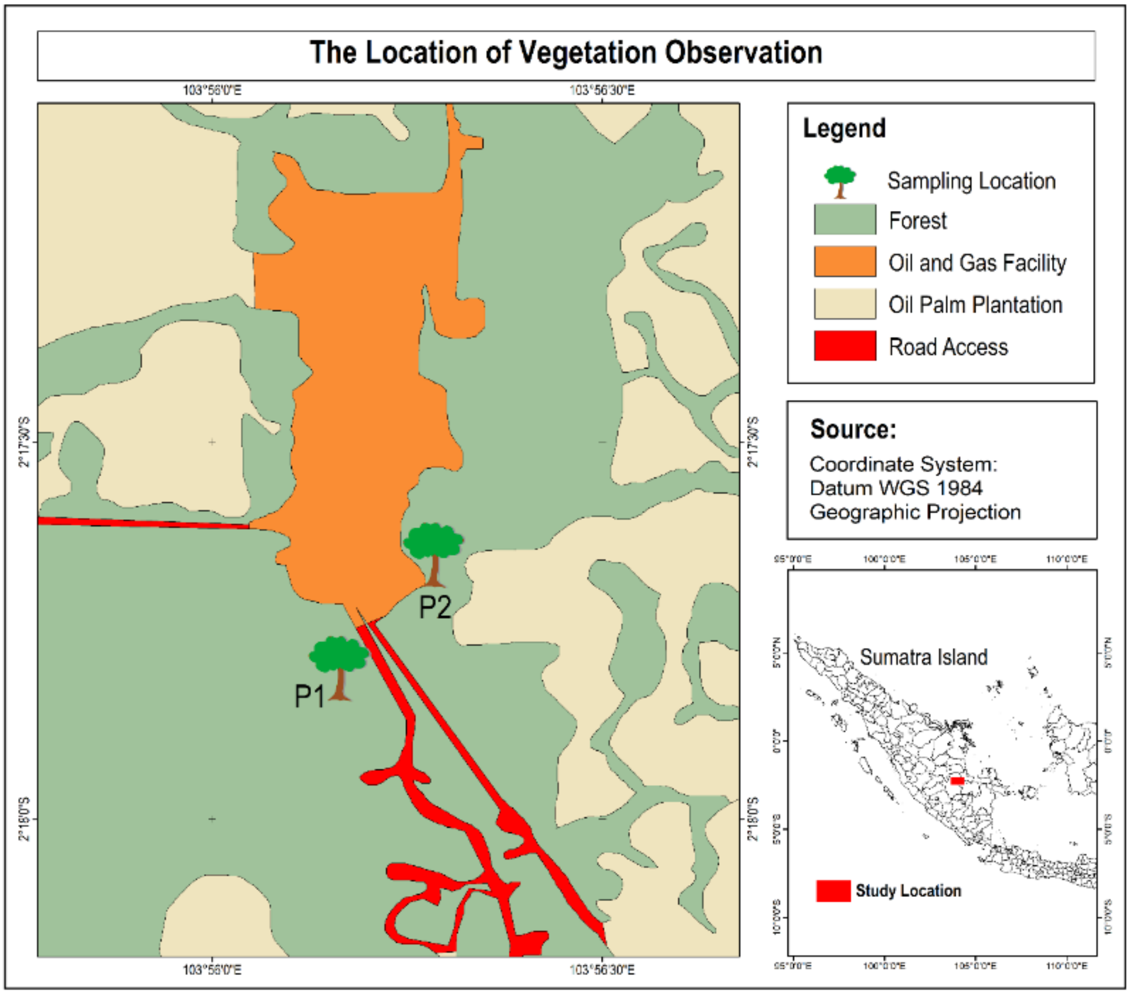

Fig. 1. *The location of vegetation observation.*

2 METHODS

2.1 Study Location

The survey was conducted on May 9-16, 2012 in Grissik Village, Banyuasin Regency, South Sumatra Province. The location of vegetation observation was generally in the remaining areas of forest (fragmented forest) in observation plot 1 (P1) and observation plot 2 (P2) (Fig. 1).

2.2 Data Collection

The vegetation data collection was conducted in two plot locations, plot 1 (P1) and plot 2 (P2) area. The sample observation unit applies a single plot method. Single-scale plots were generally regarded as cost-efficient, information-rich techniques that could be effectively used to describe many vegetation characteristics [12]. The forest structure is usually divided into small, medium, and large trees. The grouping of forest structures is further defined as seeds, young trees, poles, and trees. Forest structures were classified by size class grouping (Table 1). The method of vegetation analysis adopted the method developed by Soerianegara & Indrawan (1988) [14]. The observation of vegetation was conducted on a plot divided into 20 x 20 meters plot for observation on tree class, 10 m x 10 meters for observation on pole class, 5 x 5 meters for observation on sapling class, and 2 x 2 meters for observation on seedling class. Nested quadrat can be seen in Fig. 2.

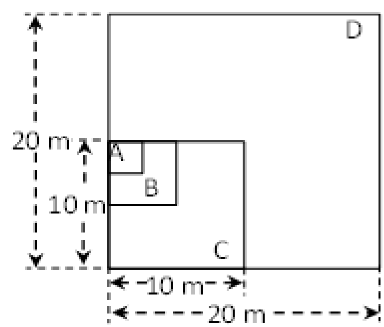

Fig. 2. *Nested quadrat*
Note: *(A: Seedling plot, B: Sapling plot, C: Pole plot, D: Tree plot).*

By using a nested quadrat, all vegetations recorded in the smallest segment of the quadrat would automatically be known to occur in the larger quadrat. Each new vegetation occurring in successively larger quadrats, in the nested quadrate frame, is recorded. The types of data recorded in the vegetation observation include the number of species and the number of individuals of each species at all observed growth rates. In addition, for pole and tree growth rates, measurements of stem diameter in breast height, total tree height, canopy distance, and canopy diameter must be conducted.

TABLE 1

THE SIZE CLASS GROUPING OF FOREST STRUCTURE [13].

Size Class Groupings	Diameter in Breast Height (DBH) in centimeters
Seedling	Up to 3
Saplings	3-10
Pole	10-19
Tree	20 and larger

2.3 Data Analysis

2.3.1 Species Richness and Diversity Index

Species richness refers to the number of biological types of species that can be found in a particular area [15]. Therefore, species richness does not have the standardization of sampling [16]. The diversity index is a mathematical measure for the diversity of species within a community. A diversity index summarises the structure, not the functioning of a community [17]. The diversity index combines the richness and evenness of the species into one value. Therefore, Peet (1974) [18] termed this index of diversity as an index of heterogeneity. The species diversity index used in this study is the Shannon-Wiener index [19] with the following equation:

$$H' = -\sum_{i=1}^{s} p_i . \ln(p_i)$$

Where H' = Shannon's diversity index, N = total number of entities in the datasets, pi = is the proportion of characters belonging to the ith, and s = total number of types in datasets.

2.3.2 Species Evenness

Species richness and evenness are two keys that need to be concerned in biodiversity. Species richness explains the difference in the number of species of individuals without their frequency values. The relatively abundant species or species similarity in society captures another aspect of diversity by determining diversity as a standard index of abundance of relative species [20]. A low fairness value indicates the occurrence of dominance by one or several species [21]. If all the species in the sample have the same abundance then intuitively indicates that the evenness index should be maximum and vice versa, if abundance is not the same for all species then this evenness index tends to decrease and close to zero as a result of the inverse relationship of species abundance. In this study the species evenness index will be calculated based on the Shannon-Wiener equation as follows:

E=H'⁄〖H'〗_max =H'⁄(ln(S))

The value of evenness (E) ranges from 0 to 1. The average value would be 0 if the study location contains only 1 patch (ie, no diversity) and would be 1 if the distribution area between the patch types has a proportional amount. The value will be close to 0 if the distribution between different patch types becomes more uneven or dominated by 1 type. Therefore, the evenness index is very relative. [18] or normalization of the diversity index [22]. Therefore the evenness measure should be interpreted along with the richness and diversity index [23]. Biotic Similarity. Many measures exist for the assessment of similarity between vegetation samples or quadrats. Similarity cofficients measure the degree to which the species compositions of quadrats or sample is alike [24]. The similarity of biota communities between habitats can be calculated using various methods or index [25]. In this study, the Horn-modified Morisita community similarity index was used, which is mathematically identical to the size of the overlap niche according to Levin, Pianka and MacArthur [26]. In this biodiversity study the community similarity index was calculated using the Morisita-Horn equation as follows:

$$IM_{jk} = \frac{2\sum_{i=1}^{S} x_{ij}x_{ik}}{\sum_{i=1}^{S} x_{ij}^2 + \sum_{i=1}^{S} x_{ik}^2}$$

Where xij = total number individual of ith species in jth habitat, xik = total number individual of ith species in kth habitat, and S = total number of species in jth and kth habitat. Beside using Morisita-Horn index, biotic similarity data analysis can also be carried out by using Ward Linkage method with Minitab software version 14.0.

3 DISCUSSSION

3.1Plant Identification

The study location were visited in 2012 and plant identification were carried out. Not less than 17 families were recorded from survey. Each species will be recorded in IUCN assessment. It is believed that the forests has uniform structure and species composition. Euphorbiaceae species were common, but spread out throughout the study location. In P1, plants at the sapling class dominate forest structure in the location. While on P2, trees dominate the forest structure (Table 2). Most of vegetation recorded in study area is the endemic flora of Sumatra. Malesia is a floristic region that included Indonesia, Malaysia, the Philippines, and New Guinea [27]. Malesia is known for certain plant families such as Fagaceae, Magnoliacea, Ctenolophonaceae, Elaeocarpaceae, has been alleged as far as the Mesozoic by several authors [28]. According to Ng et al. (1990) [29], endemism is highest within families where individuals generally represent lower structural ensembles (Annonaceae, Ebenaceae, Euphorbiaceae, Rubiaceae) or those which do not easily disperse (Dipterocarpaceae). An equally high rate of endemism can be observed for families such as Lauraceae, Clusiaceae, and Fabaceae (formerly Leguminoseae). While Myrtaceae, according to Whitten et al. (2000) [30] is family that characterized the upper montane forest in Sumatra. The development of oil and gas facility and oil palm plantation is indirectly causing the decrease of endemic flora around the study area. It might because of decrease of forest area that belongs to endemic flora' habitat.

3.2 Species Richness

Myrtaceae were two plant families that have the largest number of species among the species found with total number 7 species (18,92%) and 4 species (10,81%), respectively. Based on the survey location, in P1, forest structure consist of 47 species, while in the P2, 29 species was found. The distribution of the species number according to forest structure in P1 and P2 is presented in Table 3.

TABLE 2

LIST OF VEGETATION RECORDED IN STUDY LOCATION.

No.	Family	Latin Name	Local Name	P1				P2			
				1	2	3	4	1	2	3	4
1	Anacardiaceae	Spondias pinnata (L.f.) Kurz.	Kedondong hutan								X
2	Annonaceae	Phaeanthus splendens Miq.							X		
3	Annonaceae	Popowia bancana Scheff.	Sigam					X			
4	Apocynaceae	Alstonia scholaris (L.) R.Br.	Pulai			X					X
5	Araliaceae	Trevesia burckii Boerl.									X
6	Dilleniaceae	Dillenia excelsa Martelli		X							
7	Euphorbiaceae	Antidesma tetrandum Blume			X						
8	Euphorbiaceae	Baccaurea sumatrana Muell. Arg.			X						
9	Euphorbiaceae	Bridelia ovata Decne	Saga						X		
10	Euphorbiaceae	Croton argyratus Blume				X			X		
11	Euphorbiaceae	Glochidion arborescens Blume			X						
12	Euphorbiaceae	Macaranga sp.	Mahang	X			X				X
13	Euphorbiaceae	Microdesmis caseariaefolia Planch. ex Hook.						X	X		X
14	Fabaceae	Archidendron pauciflorum (Benth.) Nielsen	Jengkol			X	X				
15	Fabaceae	Pahudia rhomboidea Prain	Meribungan				X				X
16	Fagaceae	Castanopsis rhamnifolia (Miq.) A.DC.		X							
17	Hypericaceae	Cratoxylum sumatranum Blume			X						
18	Ixonanthaceae	Ixonanthes icosandra Jack							X		
19	Lauraceae	Litsea sp	Medang leso				X				
20	Lecythidaceae	Barringtonia lanceolata (Ridley) Payens			X						
21	Monimiaceae	Ficus fistulosa Reinw.	Kayu ara, lului	X	X		X	X		X	X
22	Monimiaceae	Kibara coriacea Hook.f. & Thoms.		X							
23	Moraceae	Artocarpus elasticus Reinw. ex Blume	Terep				X				X
24	Myristicaceae	Knema cinerea (Poir.) Warb.			X						
25	Myrtaceae	Rhodamnia cinerea Jack.	Jambu kalong	X	X						
26	Myrtaceae	Syzygium lineatum (DC.) Merr. & Perry		X	X	X					
27	Myrtaceae	Syzygium sp_1			X						
28	Myrtaceae	Syzygium sp_2	Jambu-jambu		X	X			X		
29	Olacaceae	Strombisia javanica Blume		X	X	X		X	X	X	

***Note:** 1 = seedling, 2 = sapling, 3= pole, 4 = tree; X= species recorded, P1= Plot 1, P2= Plot 2.*

TABLE 3

NUMBER OF SPECIES BASED ON FOREST STRUCTURE IN P1 AND P2.

Forest Structure	Location	
	P1	P2
Seedling	10	4
Saplings	14	9
Pole	11	3
Tree	12	13

According to Brown et al. (2007) [31], in small areas and optimal environmental conditions, species richness tends to be low due to high competition. The species richness can also decrease due to disruptions such as floods, fires, or other disturbances [32].

3.3 Species Diversity and Evenness Index

The highest Shannon's diversity index in P1 area is from sapling structure (2,4313). This indicates that the condition of vegetation in the area is relatively good. While in P2, highest value was coming from tree structure (2,1531). The Shannon diversity and evenness index are presented in Table 4. The distribution of species abundance and species list is ordinal. Meanwhile, the Shannon-Wiener and Simpson indices are cardinal. The cardinal index is useful for describing the diversity of species within a certain size class. Therefore, the index is considered unsuitable to describe the whole community because the use of rank for species is still a better choice. [17]. The highest value of evenness index was coming from sapling structure, both in P1 and P2 (0,9213 and 0,9040 respectively). This indicates that each plant species in sapling structure is tend to have the same number of individuals. A high level of evenness (> 80%) also indicates that there is no plant species dominate both study areas.

TABLE 4

SHANNON'S DIVERSITY INDEX AND EVENNESS INDEX.

Forest Structure	P1		P2	
	H'	E	H'	E
Seedling	1,9159	0,8321	1,2247	0,8834
Saplings	2,4313	0,9213	1,9863	0,9040
Pole	1,9249	0,8761	0,3984	0,3627
Tree	2,1531	0,8665	1,9408	0,7810

Note: H'= Shannon's diversity index, E = Evenness Index

3.4 Biotic Similarity

The level of similarity between plant communities in P1 and P2 is low. The highest value from analysis using Morisita-Horn index is only 46,46% on pole structure. These two location index didn't match relative abundances on a species-by-species basis. The biotic similarity at sapling structure has the lowest value which is only 1,95% that indicate there is a very real difference between plants at the mast level in area P1 with area P2. The value of biotic similarity index in the study area is presented in Table 5.

TABLE 5

BIOTIC SIMILARITY INDEX BASED ON FOREST STRUCTURE.

Forest Structure	Biotic Similarity Index P1-P2 (%)
Seedling	8,70
Saplings	1,95
Pole	46,46
Tree	16,64

3.5 Status of Species Protectionbiotic Similarity

In P1 and P2, there is no species is on the list of protected species based on Government Regulation No. 7/1999 on the Preservation of Plant and Animal Species. The results of cross-examination of the Appendices I, II and III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) published on April 3, 2012 also did not find the plant species included in those three Appendices. Cross-examination of the 2012 IUCN 2012.1 found two species that are assessed as Lower Risk / least concern (LR / lc), namely Alstonia scholaris (L.) R.Br. (Apocynaceae family) and Kibara coriacea (Blume) Tulasne (family Monimiaceae). While, other plants were listed in Not Evaluated (ne) category.

4 CONCLUSION

The total number of plant species found in the study area is 29 species. Most of species found in study area are endemic flora of Sumatra lowland forest. The plant diversity index ranges from 0,3984 to 2,4313 that indicates habitat is in the bad to moderate conditions. The development of oil and gas facility and oil palm plantation is indirectly causing the decreased of endemic flora around the study area. It might because of reduction of forest area that belongs to endemic flora' habitat. Analysis result showed high evenness index but the biotic similarity index showed the low value. While, based on examination using government regulation, CITES, and IUCN, there are no plant species that assessed as endangered.

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