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Research Paper

Analysis of Vegetation in Green Open Space of Gasing Industrial Area

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Abstract
The study aims to determine the diversity of vegetation in the Green Open Space of the Gasing Industrial Area. The study was conducted from April to July 2017. The method of analysis used quadratic method with two plots at different location with three repetitions, quantitative data analysis was done on density value, dominance, frequency, important value and diversity index of each plant species. The results showed that vegetation consists of 16 tribes and 19 species, dominated by Pteridophyta and Spermatophyta. Value of vegetation diversity (2,24) and uniformity value 0.30. The higher number of the species, the higher diversity index of the species. Such characteristics are caused by environmental influences such as organic matter content and low pH and factors derived from human intervention.

Keywords
Vegetation, Diversity, industrial area

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1. INTRODUCTION

South Sumatra is currently experiencing rapid growth, one of them in the field of industry field. Based on Regional Regulation of Bayuasin No. 28 on the year of 2012, to support the industrial progress the government set Gasing Banyuasin area as an industrial and warehousing area because of the location is close to the provincial capital. Gasing industrial and warehousing areas currently had already standing several factories such as, Food industry, rubber, palm oil and gas. Industrial development in Gasing area aims to expand employment, leveling business opportunities, increasing exports, increasing foreign exchange, supporting regional development, utilizing natural resources and energy, and human resources. The development of industry in addition to positive impacts also have negative impacts on the surrounding environment such as, growth of settlement around the industrial area, traffic jam, damaged of the protected areas, and decreased of the diversity of living things.

According to the Departemen Industri (2007), food industry produces a lot of liquid and solid wastes. Rahardjo and Nugro (2009), the palm oil industry produces solid and liquid wastes, Bahrin et al. (2011) rubber industry produces solid, liquid and gas wastes. If the wastes are above the standard in a long time will certainly have impacts on the presence of vegetation plants in place.

Vegetation is a complex system that interacts with various factors that influence each other. The existence of vegetation has a role and serves as a buffer of life, protecting the water resources, soil, both in preventing erosion, and maintaining the global climate stability and acting as the lungs of the world and maintaining the environmental stability. Vegetation will reduce the carbon in the atmosphere (CO_2) through the process of photosynthesis and store it in plant tissue. Until the time carbon is refluxed into the atmosphere, the carbon will occupy one of a number of carbon bags. All the components of vegetation such as trees, shrubs, lianas and epiphytes are part of the top the biomass surface (Putri et al., 2012).

To know the natural changes of the ecosystem in the area, it is necessary to do the data collection about the diversity of vegetation and then will be able to know the ability of the areas to generate the potential carbon before the land reclamation. This study aims to determine the diversity of vegetation in the Green Open Space of Gasing Industrial Area.

2. EXPERIMENTAL SECTION

2.1 Location and time of the study

The research was conducted in April - July 2017, located in Green Open Space of Gasing Industrial Area, Talang Kelapa Subdistrict, Banyuasin Regency (Figure 1).

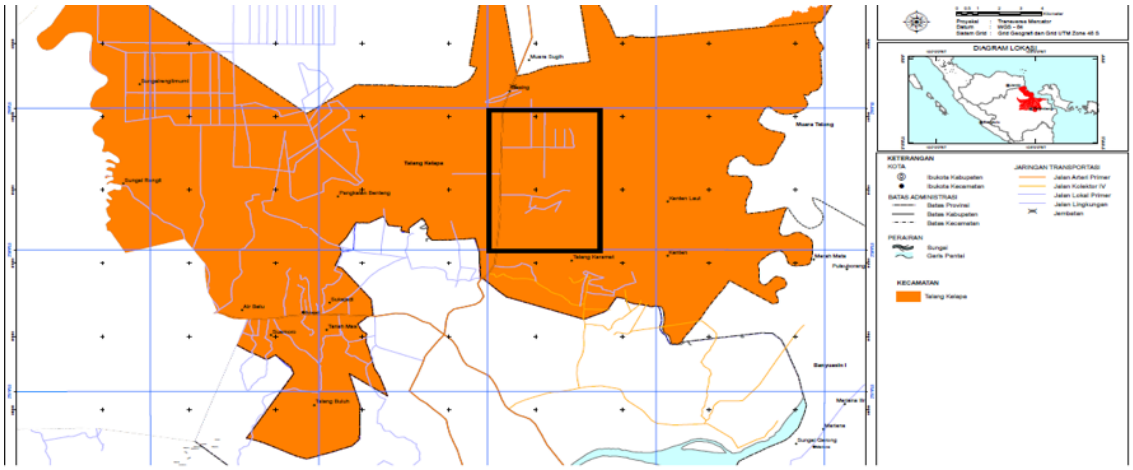

Figure 1. Location map (source Bapeda Banyuasin 2016)

2.2 Research methods

This research uses descriptive survey method with the aim to give a description about the vegetation in green open space of Gasing Industrial Area. The sampling method was used the quadratic method which was consisted of two plots (locations). Location 1 is in an area close to the waters with the coordinate point S 2 ° 48'27.9972", E 104 ° 43'44,4" and Location 2 is in the area far from the waters with the coordinate point 2 ° 52'37.5312" , E 104 ° 44'3.2388".

2.3 Tools and materials

The tools were used in this research are scissors, transparent plastic, newspaper, wood/iron, cardboard cartons, corrugated aluminum, strap/belt, hanging label, scissors, A3 paper, tape, digital camera, bench mark, yarn, needles and stationery.

2.4 Ways of working

Sampling was done by quadratic method. Put 2 plots in different locations with three repetitions each plot. The size of the plots was 20 x 20 m for the tree, 10 x 10 m for the shrub, 5 x 5 m for the bushes, 2 x 2 m for herbs. In each plot, the data were taken are the name, numbers and tree canopy (cover area) of each plant species to determine the density, hump and frequency. Plants which were found directly photographed in the area, specimens were collected include the form of plant specimens with complete body parts (roots, stems, leaves, flowers). Plant samples were taken and labeled. The specimens' collection based on the theory of Anderson (1999).

2.5 Identification and classification

Collected specimens were observed one by one by observing their morphology based on Purwoko (1991).

2.6 Data analysis

Quantitative analysis to determine the number of density, hump, frequency and important value was done using the calculation according to Mueller-Dombois and Ellenberg (1984). For the index of diversity is calculated according to the Shanon-Wiener's Diversity Index (Krebs, 1985).

2.6.1 Density

The results of the calculations gave an idea of the number of individuals in a particular area. This density was determined based on the number of individuals of a type divided by the map area, with the following formula:

$$Density = \frac{number\ of\ individuals}{area\ of\ the\ measurement\ plots} \quad (1)$$

$$Relativedensity = \frac{density\ of\ one\ type}{density\ of\ all\ types} \times 100\% \quad (2)$$

2.6.2 Shade (Domination)

The shade was calculated to illustrate the extent of the covered area by a plant species in an area, and also to describe the extent of the area were being controlled by a plant species.

$$Dominance = \frac{the\ covered\ area\ by\ a\ species}{plot\ area} \quad (3)$$

$$Relative\ dominance = \frac{dominance\ of\ a\ species}{dominance\ of\ all\ species} \times 100\% \quad (4)$$

2.6.3 Frequency

The frequency is the percentage of the presence of a type, can be calculated by the formula:

$$Frequency = \frac{number\ of\ plots\ of\ a\ species\ discovery}{total\ number\ of\ plots} \quad (5)$$

$$Relative\ Frequency = \frac{frequency\ of\ a\ species}{frequency\ of\ all\ species} \times 100\% \quad (6)$$

Important value is the sum of relative density, relative frequency and relative dominance, with the range values between 0 and 300 (Mueller-Dombois and Ellenberg, 1984). (Important value = Relative density + Relative frequency + Relative dominance)

The Shanon-Wiener's diversity index that exhibits species diversity (Putri, 1997) is calculated by the formula:

$$H' = -\sum \left(\frac{n_i}{N}\right) \ln \left(\frac{n_i}{N}\right) \quad (7)$$

$$H' = -\sum (P_i) \ln (P_i) \quad (8)$$

Where H' is Shannon-Wiener's diversity index, n_i is the number of individuals of a species, N is total number of individuals of all species, and $P_i = n_i \backslash N$.

The Uniformity Index is calculated by the formula:

$$E = \frac{H'}{H_{max}} \times a \quad (9)$$

Where E is Uniformity index, H' is the Diversity index, H_{max} is the maximum of uniformity index, as big as $\ln S$, and S is the number of family/species.

3. RESULTS AND DISCUSSION

The research was conducted on two different Plots (locations) in the green open space of Gasing Banyuasin industrial area. Location 1 is an area close to the river flow and Location 2 is an area far from the river. At location 1 found 13 species of plants belonging to 13 families with individual numbers are 1,094 individuals (Table 1).

Table 1 showed that the number of individuals belonging to trees has a greater number than the group of seedlings, bushes and shrubs. Individuals are mostly found on *Acacia mangium* species with individual numbers are 335 individuals, and then followed by *Melaleuca cajuputi* which has 215 individuals. And plants that have the lowest number in the seedlings and herbs types are *Stenochlaena palustris* Bedd with 3 individuals and 6 individuals, in the level of shrubs, *Mikania sp* with the number of 23 individuals and in the level of trees, *Cerbera odollam* with the numbers of to 18 individuals.

In Location 2 found 14 plant species belonging to 10 families with an individual numbers of 1,203 individuals, shown in Table 2.

Based on Table 2 can be seen that most plants are clumps. Individuals are mostly found on *Acacia mangium* species with the individual numbers are 306 individuals, and then followed by *Melaleuca cajuputi* which has 263 individuals.

From the two tables 1 and 2 above it can be seen that there are differences in the types and number of plants found in Locations 1 and Location 2. Tree-type plants more than herbs, bushes and shrubs (in Table 1) whereas at Location 2 the number and type of herbs and shrubs more than bushes and trees (in table 2).

3.1 Important Value Index

The result of the research at location 1 showed that the lowest relative density (KR) was found on Cerbera odollam type at tree level which had value 0.3%, while the highest was found on herbs type was Scleria sumatrensis with the value of 15.60%. The lowest relative dominance (DR) of the herbs species is Lygodium sp. with a value of 0.05% and the highest tree species namely Schima wallichii with the value of 19.83%. The lowest relative frequency was found in Stenochlaena palustris Bedd type is 0.28% and the highest found in Acacia mangium species is 31.21%. The lowest Important Value Index on the herbs species is Stenochlaena palustris Bedd with the value of 0.35%, while the highest was found in Acacia mangium species at the tree level with a value of 38.01%. For more details can be seen in Table 3.

In location 2, the lowest relative density (KR) was found on Lophopetalum at the tree level with the value of 0.13% while the highest was Acacia mangium, shrub level, with the value of 14,48%. The lowest relative dominance (DR) is Cyperus pulcherrimus at herb level with the value of 0,002% and the highest is Lophopetalum at level of tree as big as 31,91%. The lowest relative frequency (FR) is Cyperus pulcherrimus on herbs type as big as 0,30% and the highest is Acacia mangium at 25,44%. The lowest Importance Value Index is Dioscorea hispida at bush level with 3.57% value. And the highest value is Acacia mangium at the shrub level of 46.92% value. For more details can be seen in Table 4.

Based on the data from tables 3 and 4 it can be presented from the important value of plant habitat that is in the Location 1, the percentage of herbs as big as 1%, 5% bushes, 35% shrubs and 59% trees. While Based on data from table 4, then it can be presented from the important value of plant habitat that is in the location 2, the percentage of herbs is 16%, 9% bushes, 45% shrubs and 30% trees. For more details can be seen in Figure 2.

Density describes the number or the amount of individual types in a given area. This density is determined by the average number of individuals divided by the area of observation. Meanwhile, the relative density is determined based on the density of a species divided by the density of the whole number of species and then multiplied by 100%. The highest Relative Density (KR) value at location 1 was found in Scleria sumatrensis type with a value of 15.6% while the lowest in Cerbera odollam at the tree level has a value of 0.3%. In the location 2, the highest relative density values was Acacia mangium at the shrub level of 14.48% and the lowest value was Lophopetalum at the tree level having a value of 0.13%. The high of the values indicate the number of species in each location. The variety of relative density values is due to the location conditions that have high environmental variations.

Table 1. Types of plants found in Location 1 of Gasing Banyuasin industrial areas

Species	Family	Average amount
Herbs / Seedlings		
Stenochlaena palustris Bedd	Polypodiaceae	3
Scleria sumatrensis	Cyperaceae	8
Lygodium sp.	Lygodiaceae	4
Dicranopteris linearis	Gleicheniaceae	7
Bushes		
Stenochlaena palustris Bedd	Polypodiaceae	6
Scleria sumatrensis	Cyperaceae	8
Mikania sp.	Asteraceae	13
Eupatorium inulifolium	Asteraceae	22
Melastoma malabathricum	Melastomataceae	32
Shrubs		
Mikania sp.	Asteraceae	23
Eupatorium inulifolium	Asteraceae	51
Melastoma malabathricum	Melastomataceae	48
Melaleuca cajuputi	Myrtaceae	49
Acacia mangium	Fabaceae	50
Trees		
Melaleuca cajuputi	Myrtaceae	215
Acacia mangium	Fabaceae	335
Dillenia excelsa	Dilleniaceae	131
Lophopetalum	Celast raceae	19
Schima wallichii	Theaceae	33
Cerbera odollam	Apocynaceae	18
Total		1074

According to Loveless (1989), some plants can successfully grow in diverse environmental conditions so the plants tend to be widespread. Plants that occupy the highest density due to these plants are suitable for life and breed in the conditions of the land and the environment where the soil and the water contain a low pH. While in plants that have the lowest density, it is presumably because the land and the environmental factors are less suitable as a place for the species to grow, especially the pH of water and soil is acidic (low).

Domination describes the extent of cover or part of the land that is dominated by plants. The dominant value of a plant species is obtained by looking at the percentage of area covered or dominated by the plant species. The highest Relative Dominant Value at Location 1 is occupied by Schima wallichii type of 19.83%, whereas the lowest is herbs type of Lygodium palmatum with value of 0,05%. At Location 2 the highest value was occupied by Lophopetalum type with the value of 31.91% at tree level and the lowest was Cyperus pulcherrimus at the herbs level with value of 0.002%. The value of Dominant Relative shows the proportion between the areas covered by the plant species with the total area of the habitat and indicates the dominant plant species in the community (Irwanto, 2007). According to Odum (1993), the dominant species have large productivity, and in determining the dominant vegetation species, it should be known the diameter of the stems. The presence of dominant species at the research site becomes an indicator that the community is in an appropriate habitat and supports its growth.

Frequency describes the distribution or the spreading and the presence of a plant species to an area. Frequency can be calculated from the appearance of each plant species in each plot. The calculation is determined based on the number of plots that were being observed and then multiplied by 100%. Based on the value of FR can be seen the proportion between the number of a species with the number of other types in the community and can described the distribution of individuals within the community. The distribution and growth of individual trees is strongly influenced by seeding power, topography of soil conditions and other environmental factors. The seeds of trees scattered in areas that are poor in organic matter and with excessive light intensity such as those found in the green open areas of the Gasing industry can be bad and deadly for the growth of the seed. The highest relative frequency (FR) value at Location 1 is Acacia mangium of 31.21%, while the

Table 2. Types of plants found in Location 2 of Gasing Banyuasin industrial areas

Species	Family	Average amount
Herbs / Seedlings		
Lygodium sp.	Lygodiaceae	9
Lygodium palmatum	Lygodiaceae	6
Cyperus pulcherrimus	Cyperaceae	4
Eleocharis dulcis	Cyperaceae	4
Scleria sumatrensis	Cyperaceae	7
Dicranopteris linearis	Gleicheniaceae	7
Bushes		
Mikania sp.	Asteraceae	27
Eupatorium inulifolium	Asteraceae	14
Melastoma malabathricumÊ	Melastomataceae	21
Dioscorea hispida	Dioscoreaceae	10
Shrubs		
Mikania sp.	Asteraceae	91
Eupatorium inulifolium	Asteraceae	79
Melastoma malabathricumÊ	Melastomataceae	104
Melaleuca cajuputi	Myrtaceae	263
Acacia mangium	Fabaceae	306
Trees		
Melaleuca cajuputi	Myrtaceae	99
Acacia mangium	Fabaceae	122
Dillenia excelsaÊ	Dillenia excelsaÊ	17
Lophopetalum	Lophopetalum	11
Total		1203

lowest in Stenochlaena palustris Bedd type is 0.28%.

In Location 2, Acacia mangium was grown at 25.44%, while the lowest was Cyperus pulcherrimus on herbs type of 0.30%. From these values it can be seen that the highest frequency value in both locations is Acacia mangium widely found in green open areas of Gasing Industrial Area. These types can adapt to environmental conditions so that plants have the ability to spread. As a result, the presence of this type can be found in every area of observation. In addition, it was supposed that this plant have the ability to compete with other plants so that the distribution is relatively more evenly than other types. The homogeneous environment, pH and organic macro elements in these lands are suspected to support for the growth and development of this plant species. According to Senoaji (2009), this type breeds quickly with seeds. Such the way of breeding is thought to contribute to the ability of plant species to spread.

Frequency of presence is often expressed by constancy. The constancy or frequency of the presence of the organism can be grouped into four groups: the accidental type (frequency 0-25%), the accessory type (frequency 25-50%), the constant type (frequency 50-75%), and the absolute type (frequencies above 75 %) (Suin, 2002). Based on the above data it can be seen that most of the green open areas of the Gasing industry are included in the accidental category (FR 0-25%). This showed that the types distribution in the limited areas, and spreading of the seeds only in the vicinity of the forest where it grows. Monk et al. (2000), states that trees that grow below to the optimum height, generally rely on the supply of seeds from the higher trees.

An important value index of a plant species determines the role of the plant species in the plant community. The essential value of each plant species is determined based on the relative amount of density, relative dominance and relative frequency. Based on Table 3, the first and second highest importance index were found on the Acacia mangium species at the tree level with a value of 37.44% and Melaleuca cajuputi 25.90%. And in Table 4, the first and second highest Importance Value Indexes are Acacia mangium at the shrub level of 49.59% and Melaleuca cajuputi at the shrub level of 39.57%. According to Dombois and Ellenberg (1974), the name of the family of the type with the first and second largest importance values can represent the characteristics of the local vegetation so that it can be used to name the vegetation of the area. So, based to the importance value there is no difference between plant species in Location 1 and Location 2, it is only differ in group

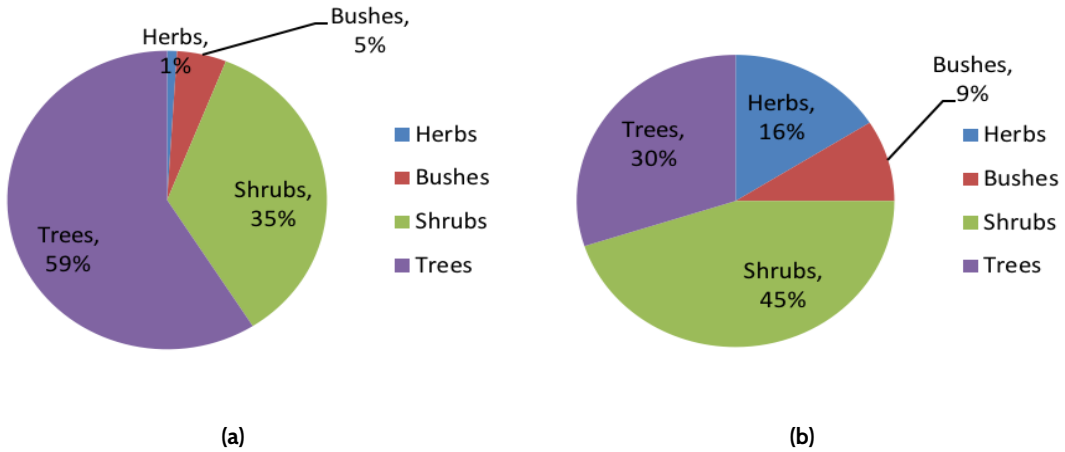

Figure 2. Graph of the species number of Each Habitat in (a) Location 1, and (b) Location 2

Table 3. Important location value index 1 in green open space of Gasing industrial area

Species	Family	Amount	KR	DR	FR	INP
Herbs / Seedling						
Stenochlaena palustrisÊBedd	Polypodiaceae	3	5.9	0.07	0.28	0.35
Scleria sumatrensis	Cyperaceae	8	15.6	0.06	0.74	0.8
Lygodium sp.	Lygodiaceae	4	8.5	0.05	0.4	0.45
Dicranopteris linearis	Gleicheniaceae	7	13	0.13	0.62	0.75
Bushes						
Stenochlaena palustrisÊBedd	Polypodiaceae	6	1.8	0.91	0.53	1.44
Scleria sumatrensis	Cyperaceae	8	2.4	0.7	0.71	1.41
Mikania sp.	Asteraceae	13	4	0.91	1.18	2.09
Eupatorium inulifolium	Asteraceae	22	7	0.51	2.08	2.59
Melastoma malabathricumÊ	Melastomataceae	32	9.9	1.15	2.95	4.1
Shrubs						
Mikania sp.	Asteraceae	23	1.8	13.59	2.17	15.77
Eupatorium inulifolium	Asteraceae	51	4	9.97	4.75	14.72
Melastoma malabathricumÊ	Melastomataceae	48	3.7	11.33	4.44	15.77
Melaleuca cajuputi	Myrtaceae	49	3.9	12.24	4.59	16.83
Acacia mangium	Fabaceae	50	3.9	12.69	4.69	17.37
Trees						
Melaleuca cajuputi	Myrtaceae	215	4.2	5.89	20.01	25.9
Acacia mangium	Fabaceae	335	6.6	6.8	31.21	38.01
Dillenia excelsaÊ	Dilleniaceae	131	2.6	8.5	12.22	20.72
Lophopetalum	Celastraceae	19	0.4	14.5	1.74	16.24
Schima wallichii	Theaceae	33	0.6	19.83	3.04	22.87
Cerbera odollam	Apocynaceae	18	0.3	11.9	1.64	13.54
Total		1074	100	100	100	300

Table 4. Important location value index 2 in Green Open Space of Gasing Industrial Area

Species	Families	Amount	KR	DR	FR	INP
Herbs / Seedlings						
Lygodium sp.	Lygodiaceae	9	11.04	0.33	0.78	12.14
Lygodium palmatum	Lygodiaceae	6	7.49	0.12	0.53	8.14
Cyperus pulcherrimus	Cyperaceae	4	4.34	0.002	0.3	4.64
Eleocharis dulcis	Cyperaceae	4	4.73	0.1	0.33	5.16
Dicranopteris linearis	Gleicheniaceae	7	7.88	0.28	0.55	8.72
Bushes						
Mikania sp.	Asteraceae	27	5.11	0.91	2.24	8.26
Eupatorium inulifolium	Asteraceae	14	2.65	1.99	1.16	5.81
Melastoma malabathricumÊ	Melastomataceae	21	4.04	2.52	1.77	8.33
Dioscorea hispida	Dioscoreaceae	10	1.96	0.78	0.86	3.59
Shrubs						
Mikania sp.	Asteraceae	91	4.32	4.49	7.59	16.4
Eupatorium inulifolium	Asteraceae	79	3.75	3.44	6.59	13.78
Melastoma malabathricumÊ	Melastomataceae	104	4.94	4.87	8.67	18.48
Melaleuca cajuputi	Myrtaceae	263	12.44	5.27	21.86	39.57
Acacia mangium	Fabaceae	306	14.48	7.01	25.44	46.92
Trees						
Melaleuca cajuputi	Myrtaceae	99	1.17	3.44	8.26	12.87
Acacia mangium	Fabaceae	122	1.45	21.47	10.17	33.09
Dillenia excelsaÊ	Dillenia excelsaÊ	17	0.21	10.95	1.44	12.6
Lophopetalum	Lophopetalum	11	0.13	31.91	0.89	32.92
Total		1203	100	100	100	300

Table 5. Index of diversity and uniformity

Location	Diversity Index	Uniformity Index
1	2.24	0.32
2	2.02	0.29

habitat in location 1. The highest important value index in the tree group is 59% (figure 1) whereas at Location 2 the highest important value index in the group of shrubof 47% (figure 2).

3.2 Index of Diversity and Uniformity

Based on research at Locations 1 and 2, were obtained the diversity index which was found at location 1 as big as 2.24 and location 2 as big as 2.02 while for uniformity index of Location 1 was 0.32 and Location 2 was 0.29. For more details can be seen in table 5.

Based on table 5, it can be seen that there is no big difference between location 1 and location 2 for diversity and uniformity index. According to Mason (1980), if the value of the Diversity Index is smaller than 1 it means there were low species diversity, if the index between 1-3 it means medium species diversity, if greater than 3 it means high species diversity. The higher number of species, the higher diversity index of the species. High species diversity is an indicator of the growth environments stability. High stability indicates a high level of complexity; this is due to the high interaction so it will have a higher ability in the face of interference to its components.

4. CONCLUSIONS

From the results of this research that has been done in the Green Open Space of Gasing Industrial Area can be drawn the following conclusions:

1. The diversity of swamp vegetation composed by Spermatophyta and Pteridophyta consists of 16 families and 19 species.
2. Based on the importance values and diversity index it can be seen that vegetation is diverse and evenly distributed with a low level of uniformity.
3. The condition of the vegetation caused by the environmental influences, which contain organic matter and low pH and factor derived from human intervention.

5. ACKNOWLEDGEMENT

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