J-1.1.3 The method of the vegetation classification using remote sensing

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The final goal of this research is to develop the method of vegetation survey using satellite data especially in tropical areas. For this purpose, the vegetation survey by using satellite imagery has been conducted in Gunung Halimun National Park in West Java, Indonesia. The park is one of the sites of the Biodiversity Conservation Project under the cooperation between Indonesia and Japan. The activities of the project in the park include fauna and flora inventory survey, vegetation survey and establishment of the park management plan, so vegetation data of the park is available for this survey.

METHODS

Study site

The study site was included western and eastern parts of the Gunung Halimun National Park. Three sites in western part were Muhara, Cisitu and Ciusul (between 6° 38' 28.6"-6° 47' 58.3" S and 106° 21' 42.9"-106° 26' 56.8" E) were selected as study sites. In the eastern part the study was conducted in 5 transects (from 6° 35' to 6° 55' S and 106° 30' to 106° 40' E), included Kabandungan-Cipeteuy-Cikaniki-Nirmala-Malasari; Cikaniki-Mt. Kendeng; Nirmala-Mt. Botol; Leuwiliang-Cianten-Cipeteuy; and Sirnarsa-Panenjoan-Gn. Halimun (Simbolon, 1998).

In general topography of study site is mainly hilly ranging from 600 to 1800 m above sea level. The soils are belongs to latosol type that can be derived furthermore into brown-latosol, red-latosol, yellowish-latosol and the associations among them (Djuansah, 1997).

The climate, as Gunung Halimun National Park in general, belongs to type A of Schmidt & Ferguson (1951) classification with the annual rainfall of 4000-6000 mm. The daily temperature varies between 18 and 26°C with a relatively high in humidity.

The vegetation in general was intact especially in eastern part, whereas in some sites of western

part was destroyed by illegal cutting. In addition the gold-mining activities also have resulted in heavy disturbed forest at some sites.

Reconnaissance study

The present study was carried out by analyzing a remote sensing data with computer and corrected by ground check. The available data were the original Landsat TM imagery data taken on June 23, 1996, Band 7.5.4. copied from Header CCT Master MERIDIAN/GICS into a CD ROM, produced by LAPAN. The geographical position of the available original Landsat TM imagery data was 106° 15' to 106° 40' E, and from 6° 35' to 6° 55' S. The data were than analyzed by Maximum Likelihood Enhanced Method in a computer using ER Mapper 5.5 software.
Unsupervised analysis conducted at the early stage to get the general overview of the land-use classification. The preliminary analyses on the available landsat imagery data have resulted in unclear vegetation/land-use type (class). The short field observation was conducted in order to check and compare of the preliminary unsupervised analysis results with actual vegetation/land-use in the field. The results of this field observation to be use for further tentative vegetation/land use classification.

An overview on available landsat imagery and combine with result of field observations, the training site were subjectively classified into 30 classes (isoclass unsupervised classification). Those unsupervised classification were then compared one to another with the percentage of unchanged dissimilarity of reflection colors as much as 98 %. From this analyses have resulted a tentative vegetation/land-use unsupervised classes. Each class was adjusted with the remote sensing data to predict tentative vegetation/land-use system. Tentative vegetation/land-use classes were printed-out into a hard copy and brought out to the field for further field checks. The actual field information was used as the sample for final supervised analyses.

Ground truth

Selection of sampling plot

Field survey was conducted in order to collect qualitative and quantitative data and information on actual land use classes to be use for further supervised classification analyses. The survey was carried out in three sites were Muhara, Cisitu and Ciusul. In each site some representative sampling points were selected and the data and information were recorded systematically from them. The sampling point was set up from 6° 38' 28.6" to 6° 47' 58.3" S and 106° 21' 42.9" to 106° 26' 56.8" E. Out of all sampling points, 36 of them were than selected as sampling plot for vegetation study where the qualitative data was collected.

There are three main vegetation types, i.e. primary forest, secondary forest and new secondary growth. In order to collect qualitative data of each vegetation type, some sampling plots for each vegetation type were selected. The size of sampling plot for each vegetation type varied depending on type of vegetation and conditions of habitat. In total there were 14 sampling plots in Muhara, 14 sampling plots in Cisitu and 8 sampling plots in Ciusul.

Methodology

Twenty-two sampling plots of 50m x 50m were set up in primary forest (13) and disturbed primary forest (9). The primary forest (PF) plots were set up in Muhara site (4 sampling plots), Cisitu site (6) and Ciusul site (3), whereas 2 disturbed primary forest (DPF) sampling plots were set up in Muhara site, 4 in Cisitu site and 3 in Ciusul site. Every sampling plot were than divided into 25 sub-plots of 10m x 10m. The girth breast-height (gbh) of each trees (gbh > 15 cm) and girth of 50 cm above ground of sapling (girth > 6 cm) within each sub-plot was identified, measured and their height was estimated.

Eleven sampling plots of 25m x 25m were set up in old-secondary forest that were located in Muhara (3), Cisitu (4) and Ciusul (2). Each sampling plot were divided into 25 sub-plots of 5m x 5m. Every individual of plant with girth over 6 cm within each sub-plot was identified; girth (50 cm above ground) and height was measured.

Four sampling plots of 10m x 10m were set up in young-secondary forest of Muhara site. Each sampling plot was divided into 25 sub-plots of 2m x2m. Every individual of plant with girth over 3 cm within each sub-plot was identified and measured.

The voucher specimens were collected for identification. By using these data, the total basal area, frequency, density and importance value (IV) of each plant species were calculated as proposed by Greigh-Smith (1964).

Finalizing of vegetation/land use map

The results of ground truth checks were then applied to supervising the classification for a final land-use/vegetation classification. The analytical out put was the actual coverage/land use map in form of Raster Base.

RESULTS

Based on the digital analysis, those 30 unsupervised vegetation/land use classes were divided into land cover systems, such as: Vegetation land cover system, included: primary and disturbed primary forests, young and old secondary forests, estate and agricultural lands (11 classes); Barren-land (6 classes); Settlement (4 classes); Water bodies/river (3 classes); Clouds (3 classes); Shadows (3 classes)

Table 1. Supervised classes of vegetation/land use in the Gunung Halimun National Park (6° 35' - 6° 47' S and 106° 21' - 106° 40' E)

No	Land-use/vegetation coverage (supervised classes)	Area (ha)
1	Undisturbed primary forest	54,103.860
2	Disturbed primary forest	548.190
3	Young secondary forest	5,195.610
4	Old secondary forest	49,852.170
5	Mixed vegetation	39,281.040
6	Plantation	117.000
7	Fruit gardens	87.120
8	Undergrowth vegetation	29,729.790
9	Paddy field / ladang	6,669.810
10	Settlement	50.490
11	Barren land	898.020
12	Water bodies	1,895.400
13	Clouds shadow	4,778.460
14	Clouds	7,253.550
	Total	201,941.190

After ground truth survey conducted in those sampling points, those 30 unsupervised classes were categorized into 14 supervised classes presented in Table 1. The supervised land use system and its distribution were presented in the Land Coverage Map. The present Land Coverage Map was supervised by ground truth check in the western part and combine with the previous study in eastern part of GHNP. At all the geographic position of surveyed area was between 6° 23' - 6° 35' S and 106° ' - 106° 40' E

Vegetation

Muhara site

Floristic composition

Based on 14 sampling plots in Muhara site 179 species of plant were recorded and belong to 104 genera and 47 families. The quantitative data of each sampling plot at each site presented in Appendix 2. Out of 47 families, 3 families were the most common families in this study site. The Fagaceae have the highest value of importance value for family (FIV) followed by Theaceae and Euphorbiaceae. The Fagaceae and Theaceae were dominant in basal area whereas Euphorbiaceae together with Lauraceae in number of species. The other common families such as Melastomataceae, Rhamnaceae and Asteraceae were dominant in number of individual.

The dominance the Fagaceae were mainly supported by Castanopsis acuminatissima, Quercus oidocarpa, Quercus gemelliflora and Lithocarpus ewyckii. Out of 179 species recorded from the

study site those 7 species were the common species. The Castanopsis acuminatissima, Quercus oidocarpa, Schima wallichii and Altingia excelsa were recorded as the most dominant species and together with Gironniera subaequalis, Litsea angulata, Quercus gemelliflora and Lithocarpus ewyckii recorded as prevalent species (occur in at least 6 of 14 sampling plots).

Forest type

There are 4 forest types can be recognized in Muhara site. The floristic composition among those 4 forest types varies, indicated by the highest similarity index between them was only 36.24 %. The number of species per unit area (sub-plot) shows the presence of difference in diversity among those forest types.

Forest structure

The forest structure can be expressed in their density, basal area, diameter distribution and height. The density and total basal area of each forest type in Muhara site presented in Table 10. The highest density was found in young-secondary forest and the basal area was found in primary forest. This might suggest that most plant in the primary forest was bigger in size compared to that recorded in other forest types. The distribution of individual diameter as presented in Table 11, fit the data. There were 4.51 % of individual in the primary forest with diameter greater than 50.0 cm, whereas in other forest type were only 1.14 %, and 0.86 % respectively.

Cisitu site

Floristic composition

Based on 14 sampling plots in Cisitu site 95 species of plant were recorded and belong to 64 genera and 37 families. Out of 37 families, 6 of them were the most common families in this study site. The Fagaceae have the highest value of importance value for family (FIV) followed by Theaceae and Hammamelidaceae. The Fagaceae was dominant in number of species, number of individual and basal area whereas Theaceae and Hammalidaceae in number of individual and basal area respectively. The other common families such as Euphorbiaceae together with Melastomataceae were dominant in number of species.

The dominance the Fagaceae was mainly supported by Castanopsis acuminatissima, Quercus linneata and Lithocarpus ewyckii. Out of 95 species recorded from the study site those 8 species were the most prevalent species. The Castanopsis acuminatissima and Schima wallichii were recorded as the most dominant species and together with Urophyllum glabrum and Litsea angulata occur in at least 6 of 14 sampling plots.

Forest type

There are 4 forests type can be recognized in Cisitu site. The floristic composition among those 4 forest types varies, where the highest index of similarity between them was only 38,45 %. The number of species per unit area shows the presence of difference in diversity among those forest types.

Seventy nine plant species were recorded in primary forest and 7 of them were the most prevalent species with mean important value of greater than 10.00 %. The Castanopsis acuminatissima and Quercus linneata were the most dominant species in the Cisitu primary forest followed by Altingia excelsa and Litsea angulata. Those species together with Polyosma integrifolia, Urophyllum glabrum and Buchanania arborescens were prevalent species and occur at least in 4 of 5 sampling plots. The others 6 species with IV 5-10 and 67 species with IV less than 5.

Forest structure

The highest density was recorded in old-secondary forest and the highest basal area was in primary forest. The interesting point that the lowest both in density and basal area was recorded in disturbed-primary forest. It was suggest that heavy destruction has occurred in this site. The distribution of individual diameter, showed that there was no individual with diameter greater than 60 cm recorded in disturbed-primary forest. On the other hand, more than 3 % of individuals with diameter > 60 cm recorded in the primary forest.

The plant high after analyzed followed Ogawa's et al. (1965) method showed that there were differences in stratification among forest type. The primary forest have 3 canopy layer, strata I between 24.6 and 30.0 m, strata II 16.6-24.5 m and strata III 8.1-16.5 m. Strata I was occupied by 1.44 % individuals, whereas strata II and III were 13.92 % and 36.42 % individuals respectively. The emergent plant (> 30 m) that occupied by 0.21 % individuals reaching up to 35 m represented by Prunus arborea, Castanopsis acuminatissima, Schima wallichii and Altingia excelsa.

Ciusul site

Floristic composition

Based on 8 sampling plots in Ciusul site 101 species of plant were recorded and belong to 61 genera and 37 families. Out of 37 families, 4 of them were the most common families in this study site. The Fagaceae have the highest value of importance value foe family (FIV) followed by Rosaceae, Hammamelidaceae and Lauraceae. The Fagaceae were dominant in basal area and number of individual, whereas Rosaceae and Hammamelidaceae in number of number individual and basal area respectively. The other common families such as Euphorbiaceae and Lauraceae were dominant in number of species.

The dominance the Fagaceae was supported by Castanopsis acuminatissima, Quercus gemelliflora, Quercus oidocarpa and Quercus lineata. Out of 88 species recorded from the study site those 10 species were the most prevalent species. The Castanopsis acuminatissima, Altingia excelsa, Gironniera subaequalis, Prunus arborea and Quercus gemelliflora were recorded as the most dominant species and together with Quercus lineata and Quercus oidocarpa occur in at least 5 of 14 sampling plots.

Forest type

There are 3 forest types can be recognized in Ciusul site. The floristic composition among those

3 forest types varies, where the highest index of similarity between them was only 44.68 %. The number of species per unit area shows the presence of differences in diversity among those forest types.

Forest structure

The following parameter such as density, basal area, diameter distribution and height of vegetation can be used to express their forest structure. The density and total basal area of each forest type in Ciusul site. The highest density basal area was found in disturbed-primary forest, whereas the lowest basal area recorded in old-secondary forest. The distribution of individual diameter, show that there were difference between forest type. About 6 % individual in the primary forest with dbh greater than 50 cm, whereas in other forest type were only 1.51 % and 0.07 % respectively.

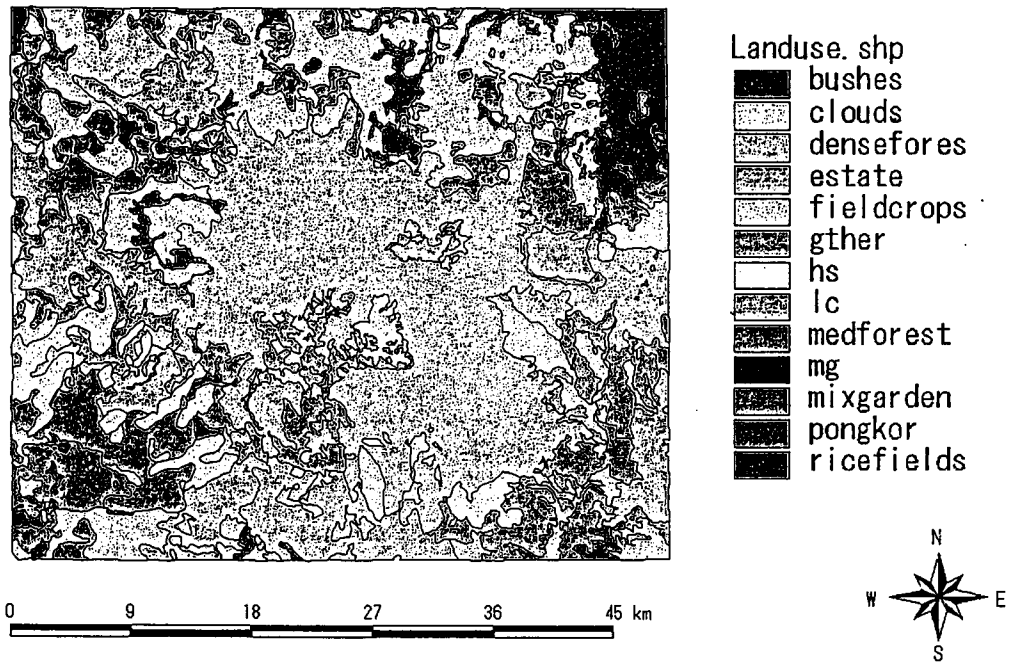
DISCUSSION

Analyses on data of 36 sampling plots, shows that in general forest in western part of Gunung halimun National Park were dominated by Fagaceae, represented by Castanopsis acuminatissima, Quercus oidocarpa, Quercus linneata, Lithocarpus ewyckii and Quercus gemmeliflora. The others predominant families were represented by Altingia excelsa (Hammamelidaceae), Schima wallichii (Theaceae) and Eugenia spp. (Myrtaceae). This results was similar to some previous studies (Simbolon & Mirmanto, 1997, Mirmanto & Simbolon, 1998, Suzuki et al., 1997) and suggested the general conditions of the Gunung Halimun National Park. However there were differences in the forest structure and floristic composition from one site to other site.

The most prevalent species were also recorded as the prevalent species in some study sites of montane forest in West Java (Kartawinata et al., 1985; Mirmanto, 1991). In addition those species also represented one of some bioclimate components (Kartawinata, 1975).

In total there were at least 6 types of vegetation coverage covers by disturbed-primary forest. The others vegetation coverage types were undisturbed-primary forest, secondary forest (young and old), unprotected gardens (fruits and coffee plantations), paddy field and under-growth vegetation (pure community of grasses and ferns or mixed of fern and grasses). Quantitative study mainly conducted in primary and secondary and in small section of new growth vegetation. The Quercus oidocarpa, Schima wallichii, Altingia excelsa and Castanopsis acuminatissima were the most dominant (highest in IV) species in primary forest at western part of GHNP. The Castanopsis acuminatissima was dominant in almost (6 of 8) study site, whereas Quercus oidocarpa only in Muhara site. The others two species were recorded as pre-dominant species in 2 and 3 study sites respectively. The summary of quantitative data from primary forest at some study site presented in Table 33. Muhara site was the highest in number of species and density, whereas Citorek site was highest in basala area but a relatively low in number of species. It was suggested that individual of plant in Citorek site relatively higher than other sites, as indicated in basal area per individual.

Fig.1 Vegetation map of Gunung Halimun National Park



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