Ethnoecology of Mandailing Tribe in Batang Gadis National Park

A Nasution¹, T Chikmawati¹*, E B Walujo¹ and E A M Zuhud²

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University 16680, Indonesia
²Department of Forest Resources Conservation and Ecotourism, Bogor Agricultural University 16680, Indonesia

*E-mail: tchikmawati@yahoo.com

Abstract. Mandailing tribe is an Indonesian ethnic group who lives around the Batang Gadis National Park (BGNP), North Sumatra. This community has local knowledge about the environment including taxonomy of topography and water flow. This study aimed to reveal the ethnoecology knowledge of Mandailing tribe. The study was conducted in November 2015 in four villages around the BGNP, Sibanggor Jae, Hutabaringin Julu, Pastap Jae and Botung Village. Data was obtained through interviewing to informants in every village as well as survey in the field through emic and ethic approaches. The results showed that Mandailing tribe classified their environment into 6 landscapes, harangan (forest), kobun (garden), saba (rice field), alaman (yard), huta (settlement) and aek (springs). There were 98 plant species in harangan, 93 plant species in kobun, 105 plant species in saba and 126 plant species in alaman that are utilized by Mandailing Tribe. Knowledge in environmental management including the implementation of terracing system in rice fields in areas of hills and the implementation of agroforestry systems on agricultural lands. The environmental knowledge of Mandailing tribe can be used as a recommendation in developing a policy around TNBG area that was mainly related to the management of conservation areas in the region.

Keywords: knowledge of environment, taxonomy of water flow, environmental unit.

1. Introduction

Humans are constantly interacting with their local ecosystems. These long-lasting interactions with the environment produce the local knowledge. This local knowledge can be revealed through an ethnoecological perspective, the study of the relationship of human culture to the surrounding organisms that related to natural resource management [1]. Ethnoecological research aims to understand the knowledge and perspective of the community on environmental management that depends on the type of ecosystem in which they live, climate, culture, economy, technology and politics [2].

Mandailing tribe are local inhabitants around the Batang Gadis National Park (BGNP), North Sumatra. Administratively, BGNP is located in Mandailing Natal District (Madina), surrounded by 68 villages and 13 sub-districts [3]. Flora in this area have been identified about 240 species [4]. This biodiversity may decrease due to forest destruction, given the high rate of deforestation inside and outside the forest area of North Sumatra Province in 2010-2012 period was 24,161.6 ha/year [5]. Therefore, conservation need to be improved to protect and conserve biodiversity around the park.
Mandailing tribe has knowledge of landscape units such as knowledge of water flow and environmental topography. They also run the local wisdom of *harangan rarangan* that aimed at protecting forest areas and water sources from damage. Local knowledge about the environment and local wisdom are important in forest conservation practices [6]. Several research results indicated that there is a link between local knowledge and conservation efforts [7-9]. Unfortunately, the knowledge and local wisdom of a community is only conveyed through oral from generation to generation [1], so that this knowledge can be lost from the community. Therefore, it is important to document local knowledge about the use of forest resources and environmental units in order to conserve and passed down to the next generation. This study aims to examine, analyse and synthesize the local knowledge of Mandailing communities around TNBG on their environment, both *corpus* (views) and *praxis* (spatial use practice).

2. Study sites and methods

2.1. Research site and time
The research was conducted from November 2015 to December 2016. The research sites were located in four villages: Sibanggor Jae Village and Hutabaringin Julu Village, Puncak Sorik Marapi Sub-district, Pastap Jae Village, Tambangan Sub-district, and Botung Village, Kotapahan Sub-District, Mandailing Natal District of North Sumatera (figure 1).

![Figure 1. Research site map.](image_url)

2.2. Data collection and data analysis
Data was collected through emic and ethical approach. *Corpus* (knowledge) of Mandailing communities regarding the management of landscape units was revealed by emic approach through interviews with informants in each village. Informants consist of community leaders, village heads and residents who have knowledge related to landscape unit management [10].

Data about *praxis* (practice) of the utilization of landscape units was collected through ethical approach using quadratic method. The plot was determined based on purposive sampling. The analysis
of vegetation in the forests, gardens and rice fields landscape was done using 20 x 20 m plot of 20 plots, then on the landscape of the yard was determined as much as 20 units of yards.

The community knowledge on the diversity of useful plants in each landscape unit was analyzed using the modification of assessment methods developed by Turner (1988) through the assessment of the Index of Cultural Significance (ICS). The importance value of each useful plant species was calculated based on the quality, intensity, and exclusivity of its use. The data obtained are then analysed descriptively qualitative. The plant was identified at Herbarium Bogoriense, Indonesian Institute of Sciences (LIPI), Cibinong. The standardization of botanical scientific names uses the basic reference from The Plant list page.

3. Results

3.1. Species diversity

A total of 262 plant species was recorded used by the inhabitants in the study area, spreaded in six landscape units namely harangan (forest), kobun (garden), saba (rice field), alaman (yard), huta (settlement) and aek (water source) (figure 2). Each landscape unit has the richness and diversity of different plant species.

![Figure 2](image-url)

**Figure 2.** Six landscape units in Mandailing (a) settlement, (b) yard, (c) rice field, (d) garden, (e) forest and (f) water source.

The landscape unit of yard has the largest number of plant species (126 species), followed by the landscape unit of rice field (105 species), the landscape unit of forest (98 species) as well the landscape unit of garden (93 species) (table 1). Of the 126 plant species in the alaman (yard), 28 species are also found in the harangan (forest) landscape, commonly forest trees and introduced species, 42 species in the kobun (garden) landscape (main commodity crops) and 53 species in the saba (rice fields) landscape (vegetables and spices).

Among all plant species growing in yard, a total of 53 species was used for food sources, and mostly planted species were cassava (*Manihot utilissima*), eggplant (*Solanum melongena*) and turkey berry (*Solanum torvum*). Many of them are wild plants and some of them are cultivated plants. The cultivated plants are used by Mandailing people for subsistence and for trade in the traditional markets. The community also used many species in the yard for medicines (37 species) e.g. galangal (*Alpinia galanga*), garden balsam (*Impatiens balsamina*), aromatic ginger (*Kaempferia galanga*) and ginger (*Zingiber officinale*). The latest species are used traditionally for many health problems.
Some plant species are also useful for spices, such as galangal (*Alpinia galanga*), red chili (*Capsicum annuum*), turmeric (*Curcuma domestica*) and ginger (*Zingiber officinale*). As many as 11 species are useful for firewood, for example rubber (*Hevea brasiliensis*), cinnamon (*Cinnamomum burmannii*), cocoa (*Theobroma cacao*) and suren toon (*Toona sureni*). Mandailing tribe still rely on plants as a source of energy. There are many plant species useful for animal feed (9 species), for example carpet-grass (*Axonopus compressus*), melastoma (*Melastoma malabathricum*), bitter vine (*Mikania cordata*) and taro (*Colocasia esculenta*). In addition, there are useful species for household appliances, agricultural equipment, handicrafts and arts, ritual materials, rope materials and wrapping.

The *saba* (rice field) landscape unit is dominated by a plant species, rice (*Oryza sativa*). This landscape unit was formed by clearing forestland. The native forest trees such as sugar palm (*Arenga pinnata*), coca (*Coca esculenta*), and buffalo grass (*Panicum maximum*) can be found in this landscape. Some crops are also commonly cultivated in this landscape unit such as maize (*Zea mays*), peanut (*Arachis hypogaea*) and string bean (*Phaseolus vulgaris*).

*Kobun* (garden) is the result of forest land transformation, dominated by a variety of important plant species such as rubber (*Hevea brasiliensis*), cinnamon (*Cinnamomum burmannii*), coffee (*Coffee sp*) and cocoa (*Theobroma cacao*). This landscape unit is also dominated by herbs, including goatweed (*Ageratum conyzoides*), carpet-grass (*Axonopus compressus*) and buffalo grass (*Panicum maximum*).

In the *harangan* (forest) landscape unit, there are 98 plant species, some of which are economically valuable species such as rubber (*Hevea brasiliensis*), suren toon (*Toona sureni*), and cinnamon (*Cinnamomum burmannii*). Some herbs in this landscape unit including melastoma (*Melastoma malabathricum*) and bitter vine (*Mikania micrantha*) as well as native species such as sugar palm (*Arenga pinnata*), burmese grape (*Baccaurea racemosa*), medang (*Liisea elliptica*) and hoteng batu (*Salacia miqueliana*).

### Table 1. The richness and diversity of plant species in the four landscape units.

| No | Landscape units | Species | Genus | Family | a | b | c | d | e | f | g | h |
|----|-----------------|---------|-------|--------|---|---|---|---|---|---|---|---|---|
| 1. | Harangan        | 98      | 91    | 52     | 23| 22| 24| 22| 4  | 7 | 9 | 16|
| 2. | Kobun           | 93      | 80    | 32     | 45| 16| 11| 11| 3  | 4 | 13| 11|
| 3. | Saba            | 105     | 92    | 45     | 47| 36| 5 | 10| 1  | 1 | 15| 20|
| 4. | Alaman          | 126     | 103   | 51     | 53| 37| 7 | 11| 2  | 3 | 9 | 15|

a: food, b: medicine, c: building, d: firewood, e: farm equipment, f: home appliances, g: animal feed, h: others (crafts and arts, rituals, ropes and wrapping, toxins, pest control)

3.2. Knowledge and management of landscape units

Mandailing tribe has knowledge about the environment including taxonomy of topography and water flow. Mandailing tribe has known that *mual* (springs) is an important component in building settlements. This knowledge is reflected in the idiom *ganop-ganop banua martano rura*, which means each *banua* (settlement) own land and water source. Therefore, the existence of *huta* (settlements) must be supported by water sources to meet subsistence needs. The settlement pattern that is built based on river flow is known as *jae* (downstream)-*julu* (upstream) and *dolok* (above)-*lombang* (bottom) terminology. Some terminology were made concerning the flow of water, the *mual* (springs), *rura* (river branch), *aek* (creeks) and *batang* (big river). This community also has terminology about topography including *napa* (plain), *untuk* (wavy ground), *tor* (hill), *dolok* (mountain boy) and *sorik* (mountain).

*Praxis* is reflected in the way of their environmental management techniques. In *saba* (rice field), the practice of terracing in hilly terrain is a form of adaptation to environmental biophysical conditions. The technique of cultivating the rice fields in the hills is done without machines or animals. Planting patterns are implemented simultaneously and always consider to the reproductive cycle of birds. The pattern is beneficial for farmers because plants are protected from the bird attacks.
Forests in the Hutabaringin Julu area, for example, are dominated by native species such as sugar palm (*Arenga pinnata*). High availability of some introduced plants that are deliberately cultivated also found in this landscape unit including coffee (*Coffea sp*), rubber (*Hevea brasiliensis*), mahogany (*Swietenia mahogani*), hayu goti (*Alstonia pneumatophora*) and sugar palm (*Arenga pinnata*). Various species are used for building materials, firewood, medicines or other needs. A similar pattern is also found in the *saba* (rice fields) landscape unit. People combine the main plant *rice* (*Oryza sativa*), other crops and native forest trees in rice fields. In general, people build rice fields by opening forest, so, the native forest trees like sugar palm (*Arenga pinnata*), burmese grape (*Baccaurea racemosa*), hayu randuk (*Litsea Elliptica*), lanzones (*Lansium parasiticum*) and hoteng batu (*Salacia Miquelina*) are still found in this landscape unit.

### 3.3. Important Value Index of useful plants in Mandailing environment

The Important Value Index (INP) describes the role of a species of vegetation in the ecosystem. If the INP of a species is high, then the species greatly affect the stability of the ecosystem. An important value index of 10 trees in the Mandailing forest is presented in table 2.

#### Table 2. The important values index of 10 trees in the forest

| No. | Species                     | S      | H     | P     | B     |
|-----|-----------------------------|--------|-------|-------|-------|
| 1.  | *Aleurites moluccanus*      | 24.91  | 10.29 | 12.68 |       |
| 2.  | *Arenga pinnata*            | 12.3   | 39.9  | 6.73  |       |
| 3.  | *Toona sureni*              | 19.84  | 29.88 |       | 30.84 |
| 4.  | *Alstonia macrophylla*      | 5.04   | 10.07 |       |       |
| 5.  | *Archidendron pauciflorum*  | 10.36  |       | 6.23  |       |
| 6.  | *Cinnamomum burmannii*      | 16.49  |       | 13.8  |       |
| 7.  | *Hevea brasiliensis*        | 149.33 |       | 81.25 |       |
| 8.  | *Litsea brachystachys*      |        | 21.69 | 6.95  |       |
| 9.  | *Macaranga javanica*        | 10.48  |       | 13    |       |
| 10. | *Piper aduncum*             | 10.15  |       | 6.23  |       |

*Ket*: S=Sibanggor Jae, H=Hutabaringin Julu, P=Pastap Jae, B=Botung

Based on the table 2, the forests of Sibanggor Jae and Pastap Jae are dominated by introduced species such as rubber (*Hevea brasiliensis*), suren toon (*Toona sureni*) and cinnamon (*Cinnamomum burmannii*). Human intervention by transforming of forest landscapes into productive land causes the high availability of some introduced plants that are deliberately cultivated. Both rubber (*Hevea brasiliensis*) and suren toon (*Toona sureni*) have high INP value due to high dominance, large numbers and its spread evenly.

Although introduced species dominate forests, many native species still found in these forests. Forests in the Hutabaringin Julu area, for example, are dominated by native species such as sugar palm.
(Arenga pinnata). The high INP value of sugar palm (Arenga pinnata) is due to this species growing very well in Hutabaringin Julu village (1194 m dpl). Other native species that grow in this village include gutta percha (Palaquium gutta), Quercus gemelliflora and medang (Litsea brachystachys).

Rubber (Hevea brasiliensis), suren toon (Toona sureni), coffee (Coffea sp) and cocoa (Theobroma cacao) spread over kobun (garden). The species have high INP value (table 3). They are the main commodities in Mandailing communities. Rubber (Hevea brasiliensis) sap has a high selling price that is cultivated in kobun (garden). The seed of coffee (Coffea sp) and cocoa (Theobroma cacao) are usually dried by drying in the yard. The profits from selling coffee (Coffea sp) and cocoa (Theobroma cacao) dried seeds are used to meet the daily needs and for school tuitions. The wood of suren toon (Toona sureni) is used by the community as raw material for furniture.

### Table 3. The important values index of trees in kobun (garden)

| Village        | Species               | INP   |
|----------------|-----------------------|-------|
| Sibanggor Jae  | Hevea brasiliensis    | 127.13|
|                | Theobroma cacao       | 59.17 |
|                | Coffea sp             | 34.46 |
| Hutabaringin Julu | Arenga pinnata      | 88.25 |
|                | Toona sureni          | 75.35 |
|                | Durio zibethinus      | 31.03 |
| Pastap Jae     | Aleurites mollucanus  | 98.48 |
|                | Durio zibethinus      | 36.11 |
|                | Theobroma cacao       | 35.04 |
| Botung         | Hevea brasiliensis    | 96.35 |
|                | Areca catechu         | 54.95 |
|                | Theobroma cacao       | 51.1  |

Besides rice (Oryza sativa), coconut (Cocos nucifera) had high INP in saba (rice field) landscape unit. The high INP value of coconut because this species has a large number in the research plot and spread evenly. Coconut (Cocos nucifera) is also used as a barrier of agricultural lands by Mandailing communities.

3.4. Index Cultural Significance in Mandailing environment

ICS value indicates the importance of a plant species based on its quality, exclusivity and intensity of use [11]. A species that have a high ICS value of the Mandailing forest is presented in figure 3.

The results of the analysis using ICS showed that Oryza sativa, Cinnamomum burmannii, Arenga pinnata, Areca catechu and Cocos nucifera are important species for community life in the four selected villages (figure 3). The most useful plant species that have the highest ICS values in all villages are rice (Oryza sativa). Mandailing tribe place rice (Oryza sativa) at the highest level because it has the main benefits as staple food. Furthermore the intensity of its utilization and the exclusivity is also higher since it is no replacement. Other uses of this species are as animal feed, fertilizer and ritual material. Rice straw is used as cattle feed, while rice used as feed for chickens. Rice straw is also used as organic fertilizer.

Coconut (Cocos nucifera) has the second highest ICS value in the Botung village. The species are also spread in the rice fields of Sibanggor Jae and Pastap Jae villages with ICS value of 72 and 68 respectively. The relative high value of ICS of this species indicates that coconut (Cocos nucifera) has high importance values according to Mandailing tribe culture. This species is used as a source of food, medicine, building, firewood, handicraft, household appliances, and agricultural tools. The high value of ICS coconut (Cocos nucifera) is supported by the high value of INP of this species especially in Sibanggor Jae and Botung Villages. Sugar palm (Arenga pinnata) has the second highest ICS in the Hutabaringin Julu village. This species is used for building materials, food, medicine and can be made into brown sugar. Coleus (Plectranthus scutellarioides), hard milkwood (Alstonia macrophylla) and hayu misang (Alangium kurzii) have low ICS value because it has not been widely used by the
community. These species are less dominant in landscape units so that these three species have low INP values.

![Graphic index of cultural significance in Mandai](image)

**Figure 3.** Graphic index of cultural significance in Mandailing Tribe

4. Discussion

The interaction of communities in the four selected villages with the surrounding environment and natural resources was identified and the results resembled those of Toledo [12], based on the cosmos-corpus-praxis. **Cosmos** represents trust, **corpus** with regard to knowledge and **praxis** with regard to environmental management practices. In general, **cosmos** and **corpus** affect **praxis** in utilizing and managing the environment.

One example of the **cosmos** (belief) is the prohibition of entering a forest *harangan rarangan* since people believe that it is inhabited by spirits. *Harangan rarangan* contain a high variety of plant species and water sources that are important for agricultural activity. This belief is one form of local wisdom. Other local wisdom that deals with the protection of water resources called *lubuk larangan* (prohibition of fishing at a specified time). This site is usually having a high diversity of plant species and water organisms, especially fish. Local wisdom like this is also found in the area of South Sumatra with the name *Lebak Lebung* [13]. Thus, Mandailing tribe has implemented conservation effort for forest and water resources through the local wisdom.

**Corpus** (knowledge) about the environment including determining the spring and river as a benchmark in the establishment of new settlements. They also use several terminologies to describe their water source and topography. This terminology shows that Mandailing tribe have knowledge about their environment. Mandailing tribes also know the different types of plant utilization, especially plants that are beneficial as food and medicine. This can be understood because food and medicine is their primary need. According to Zuhud [14], the high diversity of food and medicinal plants indicated that food and health are the main priorities of a community living near forest.

The diversity of plant species in each unit of the Mandailing tribe landscape is quite high. This is in line with several studies that showed the environment in local communities still has high biological diversity since most local communities have sustainable lifestyles [15].

**Praxis** (practice) of environmental utilization on Mandailing tribe including the implementation of terracing system in rice fields in areas of hills and the implementation of agroforestry systems on
agricultural lands. According to Mandailing tribe concepts, *harangan* (forest) does not only represent a natural forest, but also including the old gardens that consists of various species of trees and shrubs such as rubber (*Hevea brasiliensis*), sugar palm (*Arenga pinnata*), suren toon (*Toona sureni*), and cinnamon (*Cinnamomum burmanii*) associated with melastoma (*Melastoma malabathricum*) and bitter vine (*Mikania cordata*). The high INP of rubber and suren toon indicates that the forests in the Mandailing area have been managed by the Mandailing community to meet their living needs. Landscape units with such complex agroforestry systems can be categorized as secondary forests. Gouyon *et al.* [16] said that rubber gardens with main crops of rubber trees (*Hevea brasiliensis*) grown together with various species of tree and other grasses as a whole are similar to secondary forests. Characteristics of secondary forests dominated by such introduced crops are also found elsewhere in Indonesia, among others in the Kerinci community in Jambi [17].

Such agroforestry models are ecologically useful in improving soil fertility, suppressing erosion, preventing the spread of pests and diseases and suppressing weed populations [18]. Model of landscape unit management in Mandailing communities is in line with the theory of biocentrism and ecocentrism that recognizes the value of nature and the environment, so that humans appreciate the existence of their environment. This theory is the opposite of the theory of anthropocentrism that only recognizes the value that exists in humans, so that humans may exploit nature as much as possible [19].

Although dominated by introducing species, native species still found in these forests. Forests in the Hutabaringin Julu area, for example, are dominated by native species such as sugar palm (*Arenga pinnata*). The high INP value of sugar palm (*Arenga pinnata*) is due to this species growing very well in Hutabaringin Julu village (1194 m asl). According to Muhaemin [20], the most suitable habitat for sugar palm growth is the area with an altitude of 500-1200 asl. Sugar palm (*Arenga pinnata*) with shallow and wide roots is very useful to prevent soil erosion.

Mandailing tribe place rice (*Oryza sativa*) at the highest level of ICS because it has the main benefits as staple food. Furthermore the intensity of its utilization and the exclusivity is also higher because there is no replacement. Cikondang communities in West Java also place rice as a plant with the highest ICS value [21]. Level of knowledge on management and utilization of plant species of each tribe differs from other tribes. This matter caused by the level of culture and local environmental conditions [22], but generally local people in Indonesia put rice as the most important crop culturally because it is their staple food.

Based on the description above, we conclude that Mandailing tribe manage their environmental resources sustainably through local knowledge and local wisdom. This is because Mandailing tribe understands the importance of the existence of tree species. This is in line with the theory revealing that traditional communities generally manage the environment, especially forests in a sustainable way, because they understand and appreciate the importance of long-term integrity of forest ecosystems [23].

### 5. Conclusion

Mandailing communities have *cosmos* (beliefs) and *corpus* (knowledge) that affect environmental management (*praxis*). The *corpus* of landscape units consists of *harangan* (forests), *mual* (springs), *huta* (settlement), *alamani* (yard), *saba* (rice field) and *kobun* (garden). The establishment of artificial landscapes indicates that the community has been able to manage the environment to meet their subsistence needs. *Corpus* on the diversity of plants such as forest plants (101 species), gardens plants (92 species), rice fields plants (105 species) and garden plants (124 species). Food and medicinal plants are mostly found in all landscape units. The high diversity of food and medicinal plants proves that food and health are the main priority of a village located near the forest and a form of self-reliance of local communities in meeting their subsistence needs. Based on analysis of INP and ICS values, *bargot* (*Arenga pinnata*) has INP and ICS high in Hutabaringin Julu. Although often exploited, the species is maintained due to the influence of local knowledge and local wisdom. As the times progress, local knowledge and local wisdom can be lost.
Acknowledgements
This study was supported by domestic graduate scholarship program of directorate general of higher education, Ministry of Research, Technology and Higher Education.

References
[1] Anderson E N, Pearsall D M, Hunn E S and Turner N J 2011 Ethnobiology (United States of America (US): Willey Blackwell)
[2] Waluyo E B 2009 Etnobotani, memfasilitasi penghayatan, pemutakhiran pengetahuan dan kearifan lokal dengan menggunakan prinsip-prinsip dasar ilmu pengetahuan in Purwanto Y and Waluyo EB, editor Prosiding Seminar Etnobotani IV: Keanekaragaman Hayati, Budaya dan Ilmu Pengetahuan (Jakarta (ID): LIPI Press)
[3] BKSDA II Sumatera Utara 2005 Rencana Pengelolaan Taman Nasional Batang Gadis Kabupaten Madina Provinsi Sumatera Utara. (Medan (ID): Departemen Kehutanan)
[4] Kartawinata K, Afriastini J J, Heriyanto M and Samsoedin I 2004 A tree species inventory in a one hectare plot at the Batang Gadis National Park, North Sumatera, Indonesia Reindwardtia 12(2) 145-157
[5] Kementerian Kehutanan 2013 Statistik Kehutanan Indonesia 2012 (Jakarta (ID): Kementerian Kehutanan Republik Indonesia)
[6] Rist L, Shaanker R U, Gulland E J M and Ghazoul J 2010 Ecology and Society 15(1) 3.
[7] Siswadi, Taruna T and Purnaweni H 2011 Jurnal Ilmu Lingkungan 9(2) 63-68
[8] Utami S and Haneda N F 2010 JMHT 16(3) 143–147
[9] Oktavianti E and Hakim L 2013 J.Ind. Tour. Dev. Std 1(1) 39-45
[10] Martin G J 1998 Ethnobotany: A People and Plants Conservation Manual (London (GB): Chapman and Hall)
[11] Turner N J 1988 American Anthropologist 90(2) 272-290
[12] Toledo M V 1992 Ethnoecologica 1(1) 5–21
[13] Yanti E, Satria A and Sugihen B 2015 Jurnal Penyuluhan 11(2) 159-175
[14] Zuhud E A M 2011 Pengembangan Desa Konservasi Hutan Keanekaragaman Hayati untuk Mendukung Kedaulatan Pangan dan Obat Keluarga (POGA) Indonesia dalam Menghadapi Ancaman Krisis Baru Ekonomi Dunia di Era Globalisasi (Bogor (ID): Orasi Ilmiah Guru Besar IPB)
[15] Anderson and Posey 1989 New York Botanical Garden 159-173
[16] Gouyou, de Foresta A H and Leving 1993 Agroforestry System 22 181-206
[17] Sari D A 2011 Etnoekologi Masyarakat Kerinci di Kabupaten Kerinci, Provinsi Jambi [thesis] (Depok (ID): Program Pascasarjana UI)
[18] Young A 1989 Agroforestry for soil conservation science and practice of agrofoestry no. 4 (Nairobi: ICRAF)
[19] Keraf S 2010 Etika Lingkungan Hidup (Jakarta (ID): Kompas Media Nusantara)
[20] Muhaemin 2012 Budidaya Aren (Arenga saccharifera Labill. Syn. A. pinnata (Wurmb.) Merr) (Jakarta (ID): PBT Dirjen Tanaman Tahunan Ditjenbun)
[21] Ramdhani B 2014 Valuasi keanekaragaman hayati tumbuhan dalam heterogenitas spasial: studi kasus Kampung Adat Cikondang Jawa Barat [thesis] (Bogor (ID): SPs IPB)
[22] Purwanto 2007 Etnobiologi Ilmu Interdisipliner Metodologi Aplikasi dan Prosedurnya Dalam Pengembangan Sumberdaya Tumbuhan (Bogor (ID): Bogor Agricultural University)
[23] Barber C V, Johnson N C and Hafild E 1999 Menyelamatkan Sisa Hutan di Indonesia dan Amerika Serikat (Jakarta (ID): Yayasan Obor Indonesia)