

Sustainable Forest Management Policy in Central Kalimantan, Indonesia

Wahyudi

Faculty of Agriculture, Department of Forestry, Palangka Raya University, Jl. Yos Sudarso Palangka Raya, Indonesia

Abstract: Indonesian Government has set aside 120.35 ha of forest regions that it comprised 20.50 million ha of conservation forest; 33.51 million ha of protection forest, 58.24 million ha of production forest, and another 8.1 million ha of conversion forest. Central Kalimantan Province has set aside 10,294,853,52 ha of forest regions or 64% from totalizing regional wide, it comprised 1,848,485.6 ha of conservation forest to parks and reserves; 766,392.06 ha of protection forest to safeguard critical watersheds; 8,038,792.02 ha of production forest to economics functions, and 5,003.8 ha of research and education forest. Sustainable forest management has been conducted on the all of the forest regions with different patterns of management according to their function. Conservation forests are used for the environment, fauna and flora conservation. Protection Forests are used for the soil and water stock protection. Production forests are used to produce forest product (wood and non wood) using a specific silvicultural system. Managing of forest regions in the Central Kalimantan Province is like in Indonesia as a whole, because Central Kalimantan's forest is part of Indonesia's forest. Forest regions must be determined and specified by regulation of Indonesian Government, forestry minister and so on. Stand forest must be managed with a great concern on environment and applied the principles of sustainable forest management. Somehow, the sustainable forest management in Indonesia will depend on the commitment and cooperation in the stakeholders and support of local communities, because there are the large number of peoples living surrounding or within forest regions, despitefully, challenges in the sustainable forest management have to can be overcome.

Keywords: Conservation forest, forest function, production forest, protection forest, sustainable forest management.

1. Introduction

According to the forestry regulations of Indonesian Government [1] the forest regions in Indonesia can be divided into three regions i.e conservation forest, protection forest and production forest. Indonesia has set aside 20.50 million ha (hectares) as conservation forest; 33.51 million ha as protection forest; 58.24 million ha as production forest, and another 8.1 million ha as conversion forest to other regions development [2].

Central Kalimantan Province as one of 33 provinces in Indonesia is third only to Papua and East Kalimantan's in size forest regions. According to Regional Planology of Central Kalimantan Province and based on Local Regulations of Central Kalimantan No. 8/2003, Central Kalimantan Province has 10,294,853.52 ha of forest regions or 64% from totalizing regional wide. Forest regions in this province can be grouped into 4 types of forest areas based on their functions, i.e. 1,848,485.6 ha of conservation forest to parks and reserves; 766,392.06 ha of protection forest to safeguard critical watersheds; 8,038,792.02 ha of production forest to economics functions, and 5,003.8 ha of research and education forest.

Forest management has been conducted on the all of the forest regions with patterns of different management. Conservation forests are used for the fauna - flora conservation and their ecosystem, especially endemic, scarce/rare species, biodiversity management and tourism development [2, 3]. Protection Forests are used for the soil and water stock protection, especially for slope area, sand soil, dom-peat forest, heath forest etc. and potency for tourism too [2]. Production forests are used for the production of forest product (wood and non wood) using a specific silvicultural system [4]. Even though, some of production forest areas, located in the steep slope area, to be used to safeguard critical watersheds too [2, 3, 4].

Managing of forest regions in the Central Kalimantan Province is like in Indonesia as a whole, because Central Kalimantan's forest is part of Indonesia's forest. Therefore, in this working paper, clarification about meaning, function and sustained forest in Central Kalimantan is also like or similar with clarification of meaning, function, and sustained forest in Indonesia.

2. Sustainable Protection Forest Management

Protection forest is the forest areas that used for the protection of organism life buffer, watersheds, preventing floods, controlling erosion, preventing marine intrusion, and conservation of land fertility [1, 2]. Location of protection forest specified by pursuant to some criterion, like regulation of Ministry of Agriculture Number 837/Kpts/Um/II/1980 and Number 683/Kpts/Um/8/1981, i.e. land scoring >175, slope \geq 40%, slope >15% in the sensitive land and altitude > 2000 m. Furthermore, ministry of forestry had been decided three critical factor to manage the forest areas according to their function, i.e. slope, depth of land, and erodibility of soil. Protection forests are 33.51 million ha in size widespread on most Indonesia's forest whereas 766,392.06 ha among other things located in Central Kalimantan Province.



Figure 1.1: Map of Central Kalimantan Province, Indonesia

In the general, determined protected areas according to slope classes, soil type and precipitation like seen at Table 2.1, 2.2, and, 2.3 in the following:

Table 2.1: Slope classes to determine land classification

Class	Slope (%)	Criterion	Score
1	< 8	Flat	20
2	15-Aug	Slope slightly	40
3	15-25	Steep slightly	60
4	25-45	Steep	80
5	> 45	Steepest	100

Table 2.2: Soil classification

Class	Soil type	Criterion	Score
1	Aluvial, Hidromorf, Laterik	Not sensitive	15
2	Latosol	Sensitive slightly	30
3	Mediteran	Sensitive slightly	45
4	Andosol, Laterik, Grumosol, Podsolik	Sensitive	60
5	Regusol, Litosol, Organosol, Renzina	Very sensitive	75

Table 2.3: Classified Precipitation

Kelas	Intensity of Precipitation (mm/Hr)	Criterion	Score
1	< 13.6	Very small	10
2	13.6 – 20,7	Small	20
3	20.7 – 27.7	Middle	30
4	27.7 – 34.8	High	40
5	> 34.8	Very high	50

Protected areas is determined pursuant to total score like in Table 1, 2, and 3:

1. Protected area: if score >174
2. Buffer area: if score 124 to 174
3. Annual crop (plantation) area: if score < 124
4. Season crop (agriculture) area: if score < 124 and suitable for agriculture
5. Settlement area: if score < 124, slope is 0 to 8%, and suitable for settlement

Furthermore, protection forest was determined pursuant to the followings; total score > 174, slope class > 45 %, soil is very sensitive, river border regions (that is 100 m in right and left of big river and 50 m in right and left of small river. Big river is river widely bigger than 30 m), wellspring areas by radius 200 m, and area with above height of 2000 m (altitude higher than 2000 asl).

Protection forest had been managed through determination of area and specified by regulation of forestry minister. Protection forest which have been specified to have the character of protected. In this area, prohibited to do in the following activity; forest concession, exploitation of forest – logging, land clearing to timber estate – forest plantation, moreover; illegal logging, illegal mining, agriculture, plantation, settlement and resettlement etc.

3. Sustainable Conservation Forest Management

Conservation forest are 20.50 million ha size widespread on most Indonesia’s forest [3] whereas 1,848,485.6 ha among other things located in Central Kalimantan, like Tanjung Puting National Park, Sebangau National Park, Bukit Baka

Bukit Raya National Park (a portion of this area in the West Kalimantan Province), Bukit Tangkiling Strict Nature Reserves, Bukit Tangkiling nature recreation park in the north of Palangka Raya City, Pararawen I and II strict nature reserves, and Bukit Sapat Hawung strict nature reserves (a portion of this area in the East Kalimantan Province) [3].

The conservation forests in Indonesia divided into six types [3], i.e.

- a. 249 units of strict nature reserves covering a total area of 4,928,929.92 ha (land: 214 units= 4,524,848.92 ha + water and land: 8 units= 404,080 ha)
- b. 77 units of wildlife sanctuaries covering a total area of 5,342,379.74 ha (land: 72 units= 5,004,629.74 ha + water and land: 5 units= 33,775 ha)
- c. 50 units of national parks covering a total area of 16,375,253.31 ha (land: 43 units= 12,330,204.61 ha + water and land: 7 units= 4,045,048.7 ha)
- d. 124 units of nature recreation parks covering a total area of 1.041.345,21 ha (land: 105 units= 271,224,5 ha + water and land: 19 units= 770,120.7 ha)
- e. 21 units of grand forest parks covering a total area of 347,427.34 ha in land
- f. 14 units of game reserves covering a total area of 224,816.04 ha in land.



Figure 3.1: Forest conservation in Kalimantan Island

Strict nature reserves are used to the flora and fauna conservation and their ecosystem and also as the organism life buffer. These areas applicable to biodiversity management (especially endemic, scarce species) and development of ecotourism. Wildlife sanctuaries are used as a place live of wildlife for the science and culture development. National parks are used to nature protections because their have the specific ecosystem. Nature recreation parks and grand forest parks are used to nature conservations and ecotourism. Game reserves are used to hunting or safari [3]. Indonesia is one of the signatories of the United Nations convention on biodiversity [5] and one of seven countries

with mega-biodiversity that has been identified as concentrations of world biodiversity.

3.1. Tanjung Puting National Park

Tanjung Puting National Park was specified pursuant to Ministry of Forestry regulation No. 096/Kpts-II/84 date of 12 Mei 1984 and No. 687/kpts-II/96 date of 25 October 1996 which it was comprised into two zone i.e. Tanjung Puting wildlife sanctuaries broadly 300,040 ha and production forest broadly 90,000 ha (ex. PT Hesubazah). This area has four zone i.e. main zone (229,088 ha), jungle zone (81,552 ha), using zone (15,211 ha), and rehabilitation zone (89,189 ha) that comprise of tropical-low land rain forest, swam forest, mangrove forest, coastal and secondary forest. National parks are used to nature protections because there have the specific flora, fauna and their ecosystem. Wildlife sanctuaries are used as a place live of wildlife for the science and culture development [3,6].

Some flora contained in Tanjung Puting National Park are jelutung (*Dyera costulata*), ramin (*Gonystylus bancanus*), meranti (*Shorea* sp.), keruing (*Dipterocarpus* sp.), rotan (*Calamus* sp), etc. Some endemic and protected fauna are orangutan (*Pongo satyrus*), bekantan (*Nasalis larvatus*), lutung merah (*Presbytis rubicunda rubida*), beruang (*Helarctos malayanus eurypilus*), kancil (*Tragulus javanicus klossi*), macan dahan (*Neofelis nebulosa*), dan kucing hutan (*Prionailurus bengalensis borneoensis*) [3].

3.2. Sebangau National Park

Sebangau National Park was specified pursuant to Ministry of Forestry regulation No. 423/Menhut-II/2004 date of 19 October 2004 which broadly 568,700 ha, located between Sebangau river and Katingan river. This National park that represent peat-swam forest is especially used to protect 106 species of flora; 116 species of birds; 35 species of mammals - before all are orangutan (*Pongo satyrus*), bekantan (*Nasalis larvatus*), lutung merah (*Presbytis rubicunda*), and grey monkey. This National park is used to nature (specific flora, fauna, and their ecosystem) protections and a place live of wildlife for the science and culture development. There is discourse of this place will be made as nature recreation parks [3].

3.3. Bukit Baka Bukit Raya National Park

Bukit Baka Bukit Raya National Park was specified pursuant to Ministry of Forestry regulation No. 281/Kpts-II/1992 date of 26 February 1992 which broadly 181,090 ha, located in two province, that is mount Bukit Raya in Central Kalimantan (District of Katingan and Gunung Mas) and mount of Bukit Baka in West Kalimantan. This National park represent some type of forest i.e. tropical low land forest (100-1000 asl), mixed hill forest (1000-1500 asl), mountain forest (higger than 1,500 asl).

Some flora contained in Bukit Baka Bukit Raya National Park comprise with 817 of flora in the 139 of family, like Dipterocarpaceae, Myrtaceae, Sapotaceae, Euphorbiaceae, Lauraceae, dan Ericaceae. Endemic flora in this area are *Symplocos rayae*, *Gluta sabahan*, *Dillenia beccariana*, *Lithocarpus coopertus*, *Selaginella magnifica*, and

Tetracera, glaberrima. Dominant flora in this area is family of Symplocaceae like *Symplocos adenophylla*, *Symplocos crassipis*, *Symplocos laeteviridis*, *Symplocos rayae*, and *Symplocos rubiginosa*. Some fauna are kijang (*Muntiacus muntjak*), kancil (*Tragulus javanicus*), rangkong (*Buceros* sp.), beruang madu (*Helarctos malayanus*), babi hutan (*Sus* sp.), ayam hutan (*Gallus yarius*), bekantan (*Nasalis larvatus*) etc. [3].

3.4. Bukit Tangkiling Strict Nature Reserves and Bukit Tangkiling Nature Recreation Park

Bukit Tangkiling Strict Nature Reserves and Nature Recreation Park was specified pursuant to Ministry of Agriculture regulation No. : 046/Kpts/Um/1/1977 date of 25 January 1977 which broadly 2,061 ha as Strict Nature Reserves and 533 ha as Nature Recreation Park, located 34 km from Palangka Raya city to northwest.

Some flora in this area are Palawan (*Tristania abovata*), meranti (*Shorea* sp), laban (*Vitex* sp), tengkawang (*Shorea* sp), gerunggang (*Cratoxylon arborescens*), pinus (*Pinus mercurii*), mahoni (*Sweetinia macropilla*), alau (*Dacrydium* sp) etc and some fauna are kera (*Macaca fascicularis*), musang (*Paradoxurus hermaproditus*), burung tekukur (*Streptopelia chinensis*), cucak rowo (*Pycnonotus zeylanicus*) etc. [3].

3.5. Pararawen I and II strict nature reserves

Pararawen I and II strict nature reserves was specified pursuant to Ministry of Forestry regulation No. 85/Kpts-II/1999 date of 25 February 1999 which broadly 5,855 ha, comprised of 2,015 ha to Pararawen I and 3,840 ha to Pararawen II, located in District of Barito Utara, Central Kalimantan Province. Some rare fauna in this area are kijang (*Muntiacus muntjak*), kancil (*Tragulus javanicus*), rangkong (*Buceros* sp.), beruang madu (*Helarctos malayanus*), ayam hutan (*Gallus galus*), rusa (*Cervus* sp), owa-owa (*Hylobates muelleri*), and bangkul (*Presbytis rubicunda*) [3]

3.6. Bukit Sapat Hawung strict nature reserves

Bukit Sapat Hawung strict nature reserves was specified pursuant to Ministry of Agriculture regulation No. 705/Kpts/Um/10/1982 date of 12 October 1982 jo. No. 174/Kpts/Um/3/1983 date of 10 March 1983 which broadly 239,000 ha, located in two province, that is in Central Kalimantan Provinve (District of Murung Raya) and in East Kalimantan. This National park represent type of high land tropical forest.

“Hawung” is from dayak language that mean is cloud, because this area appear to be cloudy forever. This area has 44 of medicine plant, 46 of vegetable and 26 of traditional wood for local ceremony. Some fauna in this area are kancil (*Tragulus javanicus*), rangkong (*Buceros* sp.), beruang madu (*Helarctos malayanus*), ayam hutan (*Gallus galus*), rusa (*Cervus* sp), owa-owa (*Hylobates muelleri*), orangutan (*Pongo satyrus*) etc. [3].

Ecotourism

Activities that visitors can enjoy in conservation forest regions are camping, mountain climbing, rafting, rowing (sport), exploring the forest, wildlife observation, and enjoying natural phenomena. The others activities on the natural tropical forests are filming and photography, caving, cultural and historical interest, research and science, education etc. [3].

4. Sustainable Production Forest Management

Production forests are used to produce forest product (wood and non wood) using a specific silvicultural system [2]. Managing of production forest has been conducted by forest concession (IUPHHK-HA and IUPHHK-HT) which are managed according to the principles of sustainable forest management [4,7]. Production forest (in the dry land) can be categorized into two groups according to their slope. First, fixed production forest which is located in slope 0 to 30%. In this location, logging activity be done using selective cutting with limit diameter equal or bigger than 40 cm. Second, limited production forest which is located in slope 0 to 40%. In this location, logging activity be done using selective cutting with limit diameter equal or bigger than 50 cm [7,8]. In the swam production forest, logging activity be done using selective cutting with limit diameter ≥ 30 cm, whereas in the mangrove production forest, logging activity be done using selective cutting with limit diameter ≥ 10 cm [8].

Silvicultural systems which have been used in Indonesian production forest involve 4 systems i.e. Indonesian Selective Cutting and Planting (TPTI), Selective Cutting and Strips Planting (TPTJ), Gaps Cutting (TR) and Clear Cutting and Planting (THPB) [4, 7]. Before 2009, some others silvicultural systems was applied in Indonesian production forest, like Indonesia Selective Cutting (TPI), Clear Cutting and Natural Regeneration (THPA), Intensified Indonesian Selective Cutting and Planting (TPTII), Strips Cutting and Planting (TJTK), Timber Estate-Cutting and Strips Planting (HTI-TTJ) etc. [4,7,8,9]. All silvicultural systems have principle and aimed to create sustainable forest management through some silvicultural technique like nursery, planting, tending (weeding, mulching, changed plant, fertilizing), vertical and horizontal liberating, thinning, plant protection and security technical.

The Indonesia Selective Cutting (TPI) system has used since year 1972 until 1989, according to the General Director of Forestry Regulation Number 35/Kpts/DD/I/1972 date of 13 March 1972. This sistem give priority to production aspect as compared to regeneration and tending aspects. Later, this system is difficult to conduct by manager who less be experienced because it has 3 limit diameters for cutting i.e. 30 cm, 40 cm and 50 cm as showed in Tabel 4.1.

Table 4.1: Limit diameters for cutting in Indonesian Selective Cutting system

Limit diameter(cm)	Cutting Cycle (year)	main regeneration trees total tree)	Diameter of main regeneration trees (cm)
50	35	25	> 35
40	45	25	> 35
30	55	40	> 20

The Indonesian Selective Cutting and Planting (TPTI) has used since year 1989 until now. Implementation of this sistem according to the Ministry of Forestry Regulation Number 485/Kpts-II/1989, General Director of Forest Concessionaires Regulations Number 564/Kpts/IV-BPHH/1989 and 151/Kpts/IV-BPHH/1993 date of 19 October 1993. This guideline is amelioration from TPI system.

Basically, TPTI system is same with TPI system, however in TPTI system has been determined two division to manage the forest area, that is equivalent production division and forest management division [9, 10]. In the revised edition at year 1993, have been added the good budget for forest management.

TPTI system involves 11 stages, i.e. structuring of forest (it was done at 3 years before cutting=Et-3), forest inventore before cutting (Et-2), logging road construction (Et-1), cutting (forest exploitation), Neating (it was done at 1 year after cutting=Et+1), liberating I, II, III (Et+1,3,5), nursery (Et+2), forest inventore after cutting (Et+2), enrichment planting (Et+3), tending I, II, III (Et+3,4,5), thinning I, II, III (Et+10,15,20)

Selective Cutting and Strips Planting (TPTJ) has used since year 2005 until now. Implementation of this system according to General Director of Forest Production Number 226/VI-BPHA/2005 date of 1 September 2005. This system was made to overcome the controlling problem, especially enrichmen-plantation result in the stand forest. Therefore, the plantation done in lengthwise direction with 3 m gap side. Strips planting technique is environment manipulation to increase growth and yield of seedling and saapling in strips planting. Now, both systems (TPTI and TPTJ) have been applied on the many unit management (forest concession), so it called Multiple Silvicultural System [9,10].

Even though, protection areas (some areas of production forest region) are to be used to safeguard critical watersheds too, like the protection forest. Production forests are 58,24 million ha in size widespread on the most Indonesia's forest [2]. Location of protection areas specified by pursuant to some criterion i.e. slope >40%; peat forest >3 m in height of layer; wathersheds areas, along the coastal lines are 100 m in breadth; parian are 50 to 100 m in breadth; reservoir (lake) buffer, water source, wildlife corridor, research plots and in-situ conservation areas.

Formula to determine the effective production areas (EP) in the forest concessionaires in Indonesia [11] is:

$$EP = T - P - NP$$

where:
T = Total areas (ha)
P = Protection areas (ha)
IP = Ineffective production area (ha)

For examples, PT Gunung Meranti is one of some forest concessions in the Central Kalimantan province has structured their production area as follow [12]:

EP (ha) = 95,265 ha – 16,540 – 1,640 ha = 77,085 ha. forest area of PT Gunung Meranti is 80.92% only. According their calculation, production area in the production



Figure 4.1: Flow chart of structuring areal in PT Gunung Meranti [12]

5. Challenges in the Sustainable Forest Management

In the future, Indonesian sustainable forest management need the preparation of the following input, i.e. permanent and clear demarcation of forest regions, especially conservation and protection regions; stratification of Indonesian mosaic forest; biodiversity management and tourism development [14]; human resources improvement; and value added for human and environment [10]. Therefore, success of these programs will depend on the cooperation and support of local communities [13].

Ministry of forestry and local government of forestry department in Central Kalimantan province had a lot of challenges to manage forestry, like rehabilitating 5,715,022.21 ha of critical land; 76,304.33 ha of unoccupied land; firing prevention; and empowering of local community surrounding forest areas. As a whole in Indonesia, productivity of natural production forest still lower of equal 0.25 to 1.4 m³/ha/year [15]. Since 2005, Ministry of forestry had developed Selective cutting and strips planting (SCSP). This silvicultural system is estimated can improve natural production forest productivity until 2.1 m³/ha/year [15].

Some problems on the sustainable forest management are shifting cultivation [13], illegal logging, forest fire, legal and illegal mining [10]. These weaknesses and threats can be overcome through the following stages; custody of forest areas, patrol periodical, cooperation and co-ordinate among stakeholder and low enforcement. Coal mining areas progressively increase in the Indonesian forest areas, included protection forest areas since applied some government regulations (GR) about mine in the forest regions, like GR No. 19/2004 and GR No. 2/2008 about rent of forest region for the mining in Indonesia. In the future, I think, this regulation better be revised because it cause degraded forest as direct impact from mining activity and

also indirect impact in the form of opening of forest area and invite community to conduct clearing forest areas broader.

6. Conclusion and Future Work

Forest regions in Indonesia can be divided into three regions i.e. conservation forest (20.50 million ha), protection forest (33.51 million ha), production forest (58.24 million ha), and conversion forest (8.1 million ha). Central Kalimantan Province as one of 33 provinces has 1,848,485.6 ha of conservation forest; 766,392.06 ha of protection forest; 8,038,792.02 ha of production forest, and 5,003.8 ha of research and education forest.

In the future, forestry sector in Indonesia, including in Kalimantan, require to develop plantation forest with productivity of equal 5 to 10 m³/ha/year at the same time with conserve natural forest, stratification of Indonesian mosaic forest; biodiversity management and tourism development; human resources improvement; and value added for human and environment. This will require continued improvement in the policies and incentives for tropical forest responsible behavior, especially conservation of biodiversity issue on the forest regions, by both the government and the private sector, and sustained efforts to strengthen the institutions responsible for sustainable forest and conservation of biodiversity planning and management.

References

- [1] Government of Indonesia Regulation, Government of Indonesia Regulation Number 41/1999 on "Forestry", Jakarta, 1999.
- [2] Forestry Research and Development Agency, "Profile of Forest and Natural Conservation Research and Development Centre", FORDA, Department of Forestry, Republic of Indonesia, Bogor, 2008.
- [3] General Director of Forest Protection and Nature

- Conservation, "The 50 National Parks of Indonesia", Department of Forestry, Jakarta, 2007.
- [4] Indonesia Ministry of Forestry, "Multiple Silvicultural System in Indonesia", Indonesia National Workshop on Multiple Silvicultural System, Theory and Implementation. Collaboration among Indonesia Ministry of Forestry and Bogor Agricultural University, Bogor, 2008.
- [5] Government of Indonesia Regulation 1994 Number 5/1994, "Endorsement of United Nations Convention on Biological Diversity". Jakarta, 1994.
- [6] Government of Central Kalimantan, "Restructuring the Forest Regions in Central Kalimantan", National Seminar of Forest Development in Kalimantan, 2013.
- [7] General Director of Production Forest Regulation Number P.6/IV-BPHA/2009 about "Guided Implementation of Silvicultural System in the Forest Concession", Jakarta 2009.
- [8] Ministry of Forestry Regulation Number: P.11/Menhut-II/2009 about "Silvicultural System in the Forest Concessions", Jakarta, 2009.
- [9] Wahjono D, Anwar, "Prospect of Multiple Silvicultural System on the Unit Management". Forest Research and Development Agency (FORDA), Bogor, 2008
- [10] Indrawan A., "The History of Multiple Silvicultural System in Indonesia", Indonesia National Workshop on Multiple Silvicultural System, Theory and Implementation. Collaboration among Indonesia Ministry of Forestry and Bogor Agricultural University, Bogor, 2008.
- [11] Wahyudi, "Indonesian Tropical Forest, Biodiversity Conservation and Ecotourism Development", Proceeding of the International German Alumni Summer School on Biodiversity Management and Tourism Management, Georg-August University of Goettingen and University of Mataram, Lombok Indonesia, pp. 223-231.
- [12] PT Gunung Meranti, "Management Planning of PT Gunung Meranti in 2007-2016", Banjarmasin, 2008.
- [13] Wahyudi, "Settled cultivation versus shifting cultivation to improve social prosperity and environmental quality surrounding forest region", In: *GAFORN- International Summer School*, Georg-August Universität Göttingen & Universität Dresden, Germany, 2009.
- [14] MacKinnon K, Hatta G, Hakimah H, Arthur M., "Ecology of Kalimantan", Book III. Canadian International Development Agency (CIDA), Prenhallindo, Jakarta, 2000.
- [15] Wahyudi, "Evaluating the Ideal Silvicultural System for Production Natural Forest Management" in Proceeding of 1st International Conference of Indonesia Forestry Researchers, Bogor, 2011.

Author Profile



Wahyudi, received Ph.D from Bogor Agricultural University. He is lecturer on Forest Management and Silviculture in Palangka Raya University, Palangka Raya, Kalimantan, Indonesia. He has been as silvicultural expert in Indonesia Ministry of Forestry since 2012-2014 and guide several research projects in sectors of forestry, mining reclamation, agroforestry etc.