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The Availability of Forest Ecosystem Services in Siak Regency

Suwondo[1*] Darmadi[1] Riyadi Mustofa[2]
1.Lecturer at the Faculty of Teacher Training and Education, University of Riau, Campus Binawidya KM.12,5 Simpang Baru, Tampan, Pekanbaru, Riau, 28296
2.Lecturer at STIE Persada Bunda, Diponegoro Street Number 42, Suka Mulia, Sail, Pekanbaru, Riau, 28116

Abstract
This study aimed at quantifying or valuating the use of provisioning, regulating, supporting, and cultural services of forestland in Siak Regency, Riau Province. The sample was taken by purposive sampling, and the overall research, including report, was carried out in 4 (four) months/ 120 calendar days (February-May 2018). The data analysis was done for primary and secondary data, in which the primary data was obtained from field interview and observation in the form of questionnaire and note-taking, that were tabulated. The secondary data taken were tabulated and classified based on the class of the land and forest land cover. The research result depicted the ability of Siak's forest in giving ecosystem services and the ability in providing biomass carbon stock as follows: 1) Giving ecosystem services in the category of very low, low, fair, high, and very high with each score was 22,35%, 9,68%, 32,60%, 27,84%, and 7,53% from the total land area, and 2) biomass carbon stock was 13.453.527,98 ton from the total of forest area.
Keywords: the use of provisioning, regulating, supporting, and cultural services of forestland in Siak Regency.

1. Introduction

Ecosystem services are a parameter used to measure the carrying capacity and environmental capacity of an area. Ministry of Environment and Forestry (*KLHK*) through *Pusat Pengkajian Ekoregion Sumatera (P3ES)* has identified and calculated carrying capacity and environmental capacity *(DDDT)* with the approach of ecosystem services of Sumatera Island. The assumption is the higher the ecosystem system, the higher the carrying capacity and environmental capacity. The ecosystem services in Earth's habitat is determined by the existence of endogen factor and the dynamic of exogenous factor which were shown by two components namely ecoregion condition and land cover as the estimator or proxy. Determining the carrying capacity of environment as the fundamental in the development of an area has been mandated since the establishment of Law Number 4 of 1984 about Principles of Environmental Management, that was later refined into Law Number 23 of 1997 about Environmental Protection and Management, and now becomes Law Number 32 of 2009 about Environmental Protection and Management. The mandate of environmental carrying capacity is included in some Articles in Law Number 1 of 2009, among them is Article 12 which stated that if Environmental Protection and Management Plan (*RPPLH*) has not been compiled, the utilization of natural resources is carried out based on the carrying capacity and environmental capacity.

This research was aimed at quantifying or valuating provisioning, regulating, supporting service as well as cultural services in forestland in Siak Regency, Riau Province. This research was aimed to obtain the mapping and data of carrying capacity and environmental capacity based on ecosystem services in forestland as well as the information of the utilization of ecosystem services in forestland for the clean water supply service, soil and vegetation carbon storage, and biodiversity. The significance of this research was expected to provide information for the ecosystem services availability in forestland in Siak Regency that covered the information availability of the mapping for carrying capacity and environmental capacity based on ecosystem services in forestland, the information availability for carrying capacity and environmental capacity description, and the information availability for the utilization of ecosystem services for the clean water supply service, soil and vegetation carbon storage, and biodiversity.

2. Literature Review

2.1 The Concept of Carrying Capacity and Environmental Capacity

The carrying capacity is the ability for the environment to support the life of human, other creatures, and the balance between them. While the environmental capacity is the ability of the environment to absorb the substance, energy, and/or other components that are included on it. The ecosystem services are the benefit obtained by human from various resources and natural process which are in the same time given by an ecosystem is divided into four categories namely provisioning services; regulating services for climate and disease control; supporting services, and cultural, spiritual, and recreational services.

2.2 Ecoregion

Ecoregion is geographical area which has the similarity of climate, soil, water, native flora and fauna, as well as the pattern of human interaction with nature that reflects the integrity of natural and environmental system.

Determining the ecoregion border was done by taking account of the landscape similarity, watershed, biodiversity, and sociocultural (Law Number 32 of 2009). In the discussion of ecosystem services, ecoregion has an important role as study analysis unit. It is caused by the ecoregion which is a natural component or endogen factor which is more static compared to the exogeneous factor that is more dynamic land cover. Therefore, ecoregion is necessary to be read and the reflection of potential from each ecosystem services category.

2.3 Land

Land can be defined as an area in the Earth surface that covers all biosphere components which is considered permanent or cyclical above and below that area, including atmosphere, soil, host rock, hydrology, plants and animals, and all the consequences caused by human activities in the past and present, all of which affect human land use now and in the future (Brinkman and Smyth, 1973; and FAO, 1976). Land can be seen as a system which is composed of (i) structural components which are often called as land characteristics, and (ii) functional components often called as land quality. The quality of this land is essentially complex attributes that determine the level of ability and suitability of land (FAO, 1976).

2.4 Forest

Generally, forest is a group consists of flora and fauna which is dominated by big trees that function as protection for ecosystem and biodiversity. Forest is a unity of ecosystem in a form of land containing natural resources dominated by trees in the natural environment that cannot be separated from each other (Law of the Republic of Indonesia Number 41 of 1999 about Forestry)

2.5 Carbon

Carbon is an important component that composes plant biomass. The summary of numerous studies about various trees estimated that the carbon levels are about 45-46% of dry components of the tree (Brown,1997). Tree is the main storage for carbon biomass, comprising the upper parts that are stem, branch, twig, leaf, flower, and fruit, the lower part which are root, necro mass, organic waste, soil, and those preserved in the form of wood product (Kumar and Nair, 2011). Thus, the existence of tree can be included as an indicator of the carbon biomass availability. In determining the carbon content, some indicators must become a priority which is live vegetation (above and below ground), fine litter, understorey, necro mass, and soil. Defining the level of carbon in live vegetation, fine litter, understorey, necro mass, and soil can be done by using biomass approach where 40-50% of biomass id carbon (Brown, 1997).

2.6 Geographic Information System

Geographic Information System (GIS) is as software that has the ability to create a “link” or relationship between *feature spatial* (dot, line, and polygon) with its data attribute which is stored in a basis of data. Generally, GIS is defined as a component which consists of hardware, software, data of geography and human resources that work together effectively to input, store, repair, renew, manage, manipulate, integrate, analyze, and present the data in geography-based information (Prahasta, Eddy. 2003).

2.7 Calculating Forest Carbon

Forest biomass is relevant to the issue of climate change. Forest biomass has significant role in the biogeochemical cycle, especially carbon cycle. From the overall forest carbon, there are 50% which are stored in forest vegetation. Aa a consequence, the forest damage, fire, illegal logging and others will add the number of carbon in the atmosphere. The dynamics of carbon in the nature can be simply explained by carbon cycle. The carbon cycle is biogeochemistry which comprises the exchange and movement of carbon among biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the earth. Carbon cycle is actually a complex process in which each process influences one another.

3. Research Method

3.1 Location and Time of Research

The research was taken place in Siak Regency, Riau Province. This place was chosen based on the increasing width of the palm plantation area in Siak in the recent five years. The morphology of Siak also consists of peatlands in both land and coastal area. The government has made some programs in the development of the plantation area and now is in the stage of replanting. The research was done in 4 (four) months/ 120 calendar days (February-May 2018), including the report.

3.2 Type and Source of Data

The analysis was done to primary and secondary data; in which primary data were taken from interview and field observation in a form of questionnaire and note-taking which were later tabulated. Secondary data was obtained

from tabulation and classification based category of land and land cover.

3.3 Data Analysis

The map overlay was analysed to create the mapping of carrying capacity based on ecosystem services and for the calculation of land or forest carbon.

3.3.1 The Analysis of Carrying Capacity and Environmental Capacity Based on Ecosystem Services.

According to the basic regulation of UUPPLH Number 32 of 2009, it is necessary to reaffirm that environmental protection and management activity use the ecoregional unit as the basis of analysis framework. The land area is the expanse of earth surface that covers interrelationship and interdependency among various components such as air, water, rock, soil, and flora-fauna, that influence the continuity of human life (Verstappen, 1983).

3.3.2 The Measurement of Land/ Forest Sector Carbon

After the measurement in the field done, the carbon stock was calculated. The calculation of carbon stocks was done by using the Allometric Formula. The determination of the allometric equation would be used in estimating biomass, in which an important step in the process of estimating biomass. Each allometric equation was developed based on the condition of the stand and certain types of variations that differ from one another. Thus, the use equation developed in a particular location was not necessarily suitable when applied in other areas. For example, the equation developed in temperate regions whose vegetation composition tends to be homogeneous, would be inappropriate when applied in tropical regions with high species variation, the equation developed in humid/wet areas were also not suitable when applied in dry areas or vice versa. A common equation that is often used for biomass studies is the equation compiled by Brown (1997). The equation was developed from data from 371 trees from 3 tropical regions with a diameter range between 5 - 148 cm collected from various sources.

Table 1. Regression Equation

Regression equation to estimate the tropical plant biomass. Y = biomass per tree (kg); D = *DBH* (cm); BA = Basal area (cm^2). Ref: Brown (1997).				
Climate Zone	Equation	Range of *DBH* (cm)	Number of sample tree	r^2
Dry	Y= exp[-1.996 +2.32 * In(D)] Y= 10^[-0.535 + $\log_{10}$ (BA)]	5 – 40 3 – 30	28 191	0.89 094
Humid	Y= 42.69 – 12.800(D) + 1.242 (D^2) Y= exp[-2.134 + 2.530 *In(D)]	5 – 148	170	0.84 0.97
Wet	Y= 21.297 – 6.935(D) + 0.740 (D^2)	4 – 112	169	0.92
The equation cannot be used to estimate biomass of tree which has diameter far above the range of the original data.				

The equation was intended for three different climate zones, such as dry, humid, and wet. A place was categorized as dry zone if the rainfall was lower than the evapotranspiration potential (such as rainfall <1500 mm/y and dry period for several months).

4. Result and Discussion

4.1 Pattern of Space

Result of delineation in the attachment map of Riau Province Regulation Number 10 of 2018 about Layout Plan of Riau Province of 2018-2023 showed that the biggest space allocation in Siak Regency was intended for Conservation Forest, Protected Forest, Conversion Production Forest, Limited Production Forest, Permanent Production Forest, Industry, Peatland Protection Forest, Water Infiltration Protection Area, Integrated Waste Management Area, Mining Area, Settlement, Waterscape, Large Plantation, Smallholder Plantation, Agriculture, Green Open Space, which were presented as follows:

Table 2. Map of Space Pattern in Siak Regency

No.	Space Pattern	Area (Ha)
1	Conservation Forest	71.781,44
2	Protected Forest	79,30
3	Conversion Production Forest	13.589,62
4	Limited Production Forest	4.591,68
5	Permanent Production Forest	321.609,36
6	Industry	7.240,10
7	Peatland Protection Area	118,58
8	Water Infiltration Protection Area	781,15
9	Integrated Waste Management Area	24,21
10	Mining Area	22.774,38
11	Settlement	8.449,85
12	Waterscape	8.256,70
13	Large Plantation	198.949,24
14	Smallholder Plantation	23.100,26
15	Agriculture	103.008,54
16	Green Open Space	42,56
Total		**784.396,97**

Source: KLHS RTRW of Riau Province 2017, modified

4.2 Ecoregion

The result on classification of geographical similarity was based on the similar features of the area. Based on the similarity of the natural landscape, watershed area, climate, native flora and fauna, and social, the ecoregion classification in Siak Regency as obtained as follows:

Table 3. Ecoregion of Siak Regency in 2015

No.	Ecoregion	Area (Ha)
1	Alluvial Plain	153.050,41
2	Fluvial Plain	17.400,88
3	Peat Land	371.673,36
4	Intermountain Basin	241.388,55
5	Waterscape	883,77
Total		**784.396,97**

Source: DDDTLH of Sumatera 2016, modified

4.3 Land Cover

Delineation result of land cover mapping in 2015 from the Ministry of Environment and Forestry showed that Riau Province had 22 criteria or categories of land cover. These criteria include: airport, primary dryland forest, primary mangrove forest, secondary mangrove forest, primary swamp forest, secondary swamp forest, secondary forest, plantation forest, plantation, settlement, mining area, dry land agriculture, mixed dryland agriculture, swamp, savanna / grassland, rice field , shrubs, swamp shrubs, ponds, open land, transmigration, and water bodies.

Table 4. Land Cover of Riau Province in 2015

No	Land Cover	Area
1	Airport	863,77
2	Primary Dryland Forest	161.763,16
3	Primary Mangrove Forest	4.728,08
4	Secondary Mangrove Forest	173.060,90
5	Primary Swamp Forest	67.547,85
6	Secondary Swamp Forest	973.927,36
7	Secondary Forest	321.073,72
8	Plantation Forest	861.617,42
9	Plantation	2.734.637,42
10	Settlement	145.469,87
11	Mining Area	36.250,71
12	Dry Land Agriculture	338.047,40
13	Mixed Dryland Agriculture	1.374.715,75
14	Swamp	26.601,30
15	Savanna / Grassland	765,74
16	Rice Field	166.850,39
17	Shrubs	37.471,17
18	Swamp Shrubs	928.495,00
19	Pond	2.131,79
20	Open Land	546.669,98
21	Transmigration	3.884,20
22	Water Bodies	112.493,12
Total		**9.019.066,10**

Source: KLHS RTRW Riau Province of 2017

Delineation result of land cover mapping of 2015 from the Environment and Forestry showed that Siak Regency had 18 criteria or categories that include: airport, primary mangrove forest, secondary mangrove forest, secondary swamp forest, secondary forest, plantation forest, plantation, settlement, mining area, dry land agriculture, mixed dryland agriculture, swamp, rice field , shrubs, swamp shrubs, ponds, open land, and water bodies.

Table 5. Land Cover of Siak Regency in 2015

No	Land Cover	Area (ha)
1	Airport	79,29
2	Primary Mangrove Forest	580,52
3	Secondary Mangrove Forest	13.960,92
4	Secondary Swamp Forest	141.424,15
5	Secondary Forest	273,61
6	Plantation Forest	143.777,09
7	Plantation	234.319,15
8	Settlement	12.686,47
9	Mining Area	16.013,68
10	Dry Land Agriculture	24.261,55
11	Mixed Dryland Agriculture	54.566,38
12	Swamp	1.917,92
13	Rice Field	15.228,28
14	Shrubs	1.704,23
15	Swamp Shrubs	54.828,20
16	Ponds	38,44
17	Open Land	60.536,39
18	Water Bodies	8.200,69
Total		**784.396,97**

Source: KLHK Land Cover Mapping of 2015, modified

Table 6. Forest Land Cover of Riau Province in 2015

No.	Land Cover	Area (ha)
1	Primary Dryland Forest	161.763,16
2	Primary Mangrove Forest	4.728,08
3	Secondary Mangrove Forest	173.060,90
4	Primary Swamp Forest	67.547,85
5	Secondary Swamp Forest	973.927,31
6	Secondary Forest	321.073,72
7	Plantation Forest	861.617,42
Total		**2.563.718,45**

Source: Land Cover Mapping of 2015, modified in 2018

The largest land cover was dominated by secondary swamp forest, while the smallest was primary mangrove forest.

Table 7. Forest Land Cover of Siak Regency in 2015

No.	Land Cover	Area (ha)
1	Secondary Mangrove Forest	580,52
2	Primary Swamp Forest	13.960,92
3	Secondary Swamp Forest	141.424,15
4	Secondary Forest	273,61
5	Plantation Forest	143.777,09
	Total	**300.016,29**

Source: KLHK Land Cover Mapping of 2015, modified

Observation result of forestland in various location that was considered as the representative of forestland, city forest, green open space (*RTH*), and mangrove forest which was made in a plot located in Siak Regency, Riau Province as follows:

a. Location of Observation 1 (plot 1)

Observation location of plot 1 was located in forestland around community forest part (*Tahura*) Minas and near smallholder plantation. From the observation, there were 11 tree stands (wood) which were *Gharu, Kandis, Kelat, Medang, Panai, Petatal, Sendok-Sendok, Simpur, SP A, Tempunik,* and *Terap* as presented in the table below:

Table 8. Vegetation Type in Plot 1

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	*Gharu*	26	115	2
2	*Kandis*	16	65	1
3	*Kelat*	11,3	318	7
4	*Medang*	15	50	1
5	*Panai*	113	312	7
6	*Petatal*	15	76	1
7	*Sendok-Sendok*	9,3	517	5
8	*Simpur*	23	132	1
9	*SP A*	19	64	1
10	*Tempunik*	4,0	216	2
11	*Terap*	9,0	378	4
Total				**32**

Source: Primary Data, 2018

b. Location of Observation 2 (plot 2)

The following observation was done in plot 2 that was located near the first plot. The observation area was located in the secondary forest near the border of community forest park and palm plantation owned by the community. There were 11 tree stands which were *Gharu, Kelat, Medang, Panai, Petatal, Pulasan, Sendok-Sendok, Siluk, Simpur, SP A,* and *Tempunik.*

Table 9. Vegetation Type in Plot 2

No.	Name of Tree	Height (M)	Diameter (Cm)	Number
1	*Gharu*	8,6	321	4
2	*Kelat*	4,7	208	3
3	*Medang*	21	87	1
4	*Panai*	19	51	1
5	*Petatal*	13	56	1
6	*Pulasan*	26	145	2
7	*Sendok-Sendok*	12,9	532	7
8	*Siluk*	8,1	305	5
9	*Simpur*	16	74	1
10	*SP A*	2,1	100	1
11	*Tempunik*	4,0	142	2
Number				**28**

Source: Primary Data, 2018

c. Location of Observation 3 (Koto Gasib)

The location for the third observation was in shrubs area in Koto Gasib District with swamp land and close to the palm plantation owned by the community. From the observation, there were four tree stands which were *Akasia, Mahang, Mahoni, and Matoa*.

Table 10. Koto Gasib

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	*Akasia*	34	597	5
2	*Mahang*	11,5	122	2
3	*Mahoni*	22,5	270	5
4	*Matoa*	9,5	63	4
Total				**16**

Source: Primary Data, 2018

d. Location of Observation 4 (Mangrove Forest)

Location of the fourth observation was in mangrove forest around waterscape of Kampung Rawa Mekar Jaya which was preserved and diverse.

Table 11. Mangrove Forest

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	Avicennia lanata	7	4	1
2	Avicennia lanata	7	29	1
3	Avicennia lanata	7	36	1
4	Avicennia lanata	8	22	1
5	Avicennia lanata	9	19	1
6	Avicennia lanata	9	20	2
7	Avicennia lanata	9	23	1
8	Avicennia lanata	9	29	1
9	Avicennia lanata	9	35	1
10	Avicennia lanata	10	15	1
11	Avicennia lanata	10	18	1
12	Avicennia lanata	10	24	1
13	Avicennia lanata	10	25	2
14	Avicennia lanata	10	29	1
15	Avicennia lanata	10	36	1
16	Avicennia lanata	11	20	1
17	Avicennia lanata	11	22	1
18	Avicennia lanata	11	25	1
19	Avicennia lanata	11	29	1
20	Avicennia lanata	11	36	1
21	Avicennia lanata	12	15	1
22	Avicennia lanata	12	19	1
23	Avicennia lanata	12	27	1
24	Avicennia lanata	12	28	1
25	Avicennia lanata	13	24	2
26	Avicennia lanata	13	39	1
27	Avicennia lanata	13	45	1
28	Avicennia lanata	14	23	1
29	Avicennia lanata	14	39	1
30	Avicennia lanata	14	40	1
31	Avicennia lanata	15	45	3
Total				36

Source: Primary Data, 2018

e. Location of Observation 5 (Mangrove Forest of Mengkapan)

This observation was carried out in the area of mangrove forest in Kampung Mengkapan, Sungai Apit District. Becoming the tourist destination, this mangrove forest was preserved well. Based on the observation, there were two kinds of mangrove: Avicennia Lanata and Rhizopora.

Table 12. Mangrove Forest of Mengkapan

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	Avicennia lanata	8	25	1
2	Avicennia lanata	9	24	1
3	Avicennia lanata	10	19	1
4	Avicennia lanata	10	20	1
5	Avicennia lanata	11	29	1
6	Avicennia lanata	12	15	1
7	Avicennia lanata	12	19	1
8	Avicennia lanata	12	23	1
9	Avicennia lanata	12	29	2
10	Avicennia lanata	13	25	1
11	Avicennia lanata	13	45	1
12	Avicennia lanata	15	20	3
13	Avicennia lanata	15	23	1
14	Avicennia lanata	15	24	1
15	Rhizopora	9	20	1
16	Rhizopora	9	39	1
17	Rhizopora	10	45	1
18	Rhizopora	11	36	1
19	Rhizopora	11	45	1
20	Rhizopora	13	24	1
21	Rhizopora	13	29	1
22	Rhizopora	14	36	1
23	Rhizopora	14	45	1
24	Rhizopora	15	29	1
	Total			27

Source: Primary Data, 2018

f. Location of Observation 6

This observation was taken place in the forest of Kota Siak. There were four tree stands namely *Buah roda, Pucuk Merah, Pulai, and Buah roda.*

Table 13. Forest of Kota Siak

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	*Buah roda*	22	202	4
2	*Pucuk Merah*	3,8	265	9
3	*Pulai*	18,5	857	15
4	*Buah roda*	22	202	4
	Total			28

Source: Primary Data, 2018

g. Location of Observation 6

The sixth observation was done in green open space (*RTH*) in Siak, where the data showed two kinds of tree stands that were *angsana* and *trembesi*.

Table 14. Open Green Space (RTH) Siak

No.	Name of Tree	Height (M)	Diameter (Cm)	Total
1	*Angsana*	9	46	1
2	*Angsana*	10	48	1
3	*Angsana*	10	50	1
4	*Angsana*	10	65	1
5	*Angsana*	12	39	1
6	*Angsana*	12	40	1
7	*Angsana*	12	59	1
8	*Angsana*	12	70	1
9	*Angsana*	13	49	1
10	*Angsana*	13	67	1
11	*Angsana*	14	45	1
12	*Trembesi*	9	55	1
13	*Trembesi*	10	40	1
14	*Trembesi*	10	60	1
15	*Trembesi*	10	68	1
16	*Trembesi*	11	67	1
17	*Trembesi*	12	58	1
18	*Trembesi*	12	65	1
19	*Trembesi*	13	59	1
20	*Trembesi*	14	60	1
21	*Trembesi*	14	63	1
22	*Trembesi*	15	62	1
23	*Trembesi*	16	60	1
	Total			23

Source: Primary Data, 2018

4.4 Ecosystem Services

Ecosystem services is the benefit obtained by human from many resources and natural processes that is given by an ecosystem in the same time (MA, 2005). The ecosystem services are divided into four categories, namely provisioning, regulating, cultural, and supporting services (MA, 2005).

Table 15. Percentage of Forest Ecosystem Services Category in Siak Regency

Service Category	Very Low	Low	Moderate	High	Very High
P1	15,40	72,45	11,34	0,61	0,19
P2	73,09	6,07	10,28	10,56	0,02
P3	65,78	7,35	11,10	0,59	15,18
P4	3,91	5,75	79,15	5,84	5,34
P5	3,87	0,95	27,94	66,50	0,73
R1	9,94	0,49	16,95	72,62	0
R2	3,87	0,68	28,37	10,49	56,59
R3	3,87	0,68	28,37	10,49	56,59
R4	5,85	11,84	76,15	5,98	0,18
R5	16,95	15,02	56,89	10,57	0,58
R6	4,49	10,89	27,23	57,39	0
R7	3,91	13,86	81,50	0,74	0
R8	3,05	0,82	8,34	82,29	5,50
C1	72,23	0,07	16,25	11,24	0,21
C2	82,49	16,12	1,38	0,02	0
C3	82,68	15,93	1,21	0,19	0
R1	3,09	0,82	13,84	76,75	5,50
S1	3,09	0,82	13,84	76,75	5,50
S2	3,05	3,41	82,22	10,74	0,57
S3	3,87	6,40	11,35	73,04	5,33
S4	4,82	12,77	80,92	1,32	0,17
Total	22,35	9,68	32,60	27,84	7,53

Source: Modified 2018

4.5 Providing Services

Providing services is a function of an ecosystem environment that is beneficial to the life of both human beings and other living things. The services produced are natural which are provided directly by the conditions of landscape and land cover in the form of forested land. When living things, especially humans, make use of it, it is expected that they are not exceeding the limits or capabilities of the land. Provision services consist of food supply services (P1), clean water (P2), fibre (P3), wood fuels and fossils (P4), and genetic resources (P5).

4.6 Regulating Services

Regulating ecosystem services are services owned by ecosystems to regulate environmental conditions. The ecosystem naturally have the function of climate regulation services, which includes temperature, humidity and rain, wind regulation, greenhouse gas control & carbon absorption. The function of climate regulation is influenced by the presence of biotic factors, especially vegetation, location and physiographic factors such as altitude and land shape. There are eight types of regulating ecosystem services, there are climate regulating ecosystem services (R1), water and flood flows (R2), protection from natural disasters (R3), water purification (R4), Waste Processing and Decomposition (R5), Air Quality Maintenance (R6), Natural Pollination (R7), and Pest and Disease Control (R8).

4.7 Culture Services

Culture is the product of human's creativity, sense and intention; it is a way of life that is developed and owned by a group of people and inherited through generations. On the other hand, culture is also something that influences the level of knowledge and includes the system of idea inside human thought. Thus, in daily life, culture is abstract. The culture is manifested in real things which are made by human beings as cultural society in a form of behaviour and real objects such as behaviour pattern, language, utensils, social organization, religion, art, and so on. All of them are made to help human in living the social life.

4.8 Supporting Services

Supporting service compensation is natural capability as supporting landscape of the main activity. These services can be useful in the life cycle of humans and other living things to breed and grow as their nature. The supporting services are in the form of soil layer formation and fertility maintenance (S1), nutrient cycle (S2), primary production (S3), and biodiversity or germplasm protection (S4).

4.9 Carbon

Forest acts as an ecosystem component that can reduce greenhouse gases, especially CO. Through the photosynthesis process of each plant, carbon dioxide (CO) from the air is bound by plants through chlorophyll which is then converted into organic compounds of the body such as carbohydrates, proteins and fats (Daniel, et al, 1995). In tree plants (woody), the carbon is partially converted into cellulose, hemicellulose, and lignin. As long as plants grow, carbon is bound to organic compounds into global carbon stocks. To make the estimation model, allometric equations are built based on the relationship between tree parameters, namely diameter breast high/ DBH, total stem height, and wood density with total upper biomass.

Table 16. Data Conversion of Carbon Biomass of Plot in Siak Regency

Total of Biomass in Six Plots (Kg)	Total of Biomass (kg)	Total of Biomass in Six Plots (Ton)	Total of Biomass (Ton)/ Number of Plot	Total of Biomass (Per ha)	Ton/Ha
Plot 1	9.602,85	9,60	1,60	40,01	20,01
Plot 2	7.044,45	7,04	1,17	29,35	14,68
Plot 3	1.581,52	1,58	0,26	6,59	3,29
Plot 4	876,37	0,88	0,15	3,65	1,83
Plot 5	672,01	0,67	0,11	2,80	1,40
Plot 6	1.747,29	1,75	0,29	7,28	3,64
Total	**21.524,48**	**21,52**	**3,59**	**89,69**	**44,84**

Source: Aallometric Equation of Arupa and ICCTF (Indonesia Climate Change Trust Fund) Team.

The overall forest area in Siak Regency was 300,016.29 ha, so the calculation of the total biomass produced by forest land in Siak District was 13,453,527.98 tons with the assumption that each hectare of forest produced 44.84 tons. This indicated that the existence of forests both primary, secondary and plantation forests played a very important role in the human life cycle through the resulting ecosystem services and carbon stocks provided for the human survival and the surrounding.

5. Conclusions and Recommendations

5.1 Conclusion

In sum, this research portrayed the ability of forest in Biak Regency in giving ecosystem services and ability to provide carbon biomass stock, namely:

- Giving ecosystem services in the categories of very low, low, moderate, high, very high, with each showed 22,35%, 9,68%, 32,60%, 27,84%, dan 7,53% from the total of forest area.
- Carbon biomass stock was13.453.527,98 ton of the total forest land.

5.2 Suggestion

The suggestion of this research are:

- With the existing ecosystem services given by the forest, it is expected that the government can make effort to control the forest use, especially the deforestation and land degradation.
- The carbon biomass stock in Siak Regency is the natural resources prosperity, so regulation is needed to make a sustainable land utilization in the terms of social, economy, and environment aspect.

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