Model of Sustainable Forest Planning based-Watershed in KPHP Model Tanah Laut, South Kalimantan

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ABSTRACT

The quality and quantity of forest destruction has become a national problem. One major cause is the lack of planning and managers at the site level on areas outside the business license. Whereas, in the licensed area, forest planning spatial pattern that is applied is still based 'boxgrid'. Use of Watershed (DAS) as the smallest unit basis in sustainable forest planning is preferred. The research objective is to create a sustainable forest planning model based Watershed. The division of space is made based DAS. DEM processing into DAS used graphic modeler of QGIS. The potential of forest resources identified through a survey of flora and fauna. In-depth interviews conducted for potential forest disturbance and state forest planning now. Observation of physical condition and accessibility region also performed. NDVI analysis is used to determine land cover. AHP analysis is used to determine the priority forest rehabilitation. Results showed that 74% of informants agreed that boxgrid system is not suitable to be applied because their area of secondary forest. All informants agreed watershed-based pattern fits better. Total forest space that has formed is 103 compartments and 536 sub-compartments. Size of each compartment between 50-100ha. Compartments are numbered clockwise and should not be changed. Protected flora are Damar Kaca (Shorea javanica) and kemiri (Aleuritas moluccana), while the fauna is hirangan (mammals). Prediction of potential interference by forest communities to forests reached 38.8%. Non-forested acreage reached 70.7%. From the condition of the forest resources in each compartments, the implementation of community-based rehabilitation patterns overlay with compartments is the application of sustainable forest planning. All natural resources in forest enrolled into swaths through the overlay process. The result of this process is a model of sustainable forest planning. Sustainable forest planning model is presented in the form of maps and spatial databases.

Keywords: Forest-Planning, Compartment, Watershed, AHP.

INTRODUCTION

Floods, rising greenhouse gas emissions, increased sedimentation in water bodies, a decrease in income of rural communities around the forest, reduction in log production from natural forests is the result that occurs due to degradation and deforestation occur continuously. [1] pointed out that for more than three decades, rehabilitation activities carried out at more than 400 locations in Indonesia. However, in 2002 the total area of forest and degraded lands has reached 96.3 million hectares (54.6 million ha in the area of 41.7 million ha of forest and outside the forest area). [2] states deforestation is a change in the condition of land cover from forest to non-forest (including changes in the function of forest land for plantations, residential, industrial, etc.). Based on the results of the interpretation of satellite images LANDSAT ETM+7 years 2005/2006 and 2009/2010 the coverage area of deforestation in and outside forest areas across Indonesia respectively reached 610,376 ha/year and 221,751 ha/year. [3] convey the destruction of forests in Indonesia reached 3.5 million ha/year, but

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then the condition of the value decreased to 300,000 ha/year. This damage, more than offset by illegal logging.

Drivers of deforestation and land degradation are becoming increasingly complex and covers various aspects. There are two driving factors causing deforestation, the driving factors directly and indirectly driving factors. The direct causes are logging, illegal logging, and forest fires can not be controlled and often occur, especially in the long dry season. Indirect causes, among others, are market failures (eg, pricing of timber that is too low), and the failure of the policy [1]. [4]; [5] based on analysis of deforestation patterns 152 countries argued that the three dominant sources of deforestation were agricultural expansion, timber harvesting forests and infrastructure development. It interacts with the five main factors: demographics, macroeconomic, technological, policy (governance) and culture. [6] argued during the period from 1980 to 2000, the timber industry serve the purpose of economic, little consideration is given to achieve the volume of harvest of forest growth increment which is the starting point for sustainable forest management. [7] argued that based on the fishbone analysis we can identify some of the main causes of the problem of deforestation and forest degradation are weak forest planning, forest management unit ineffective, weak governance, the issue of tenure and legal basis as well as weak law enforcement.

Old pattern setting-forest products are connecting between volume per hectare per age of the plant with a total area. In practice, area compartment per year is divided rotation age, ie 100 ha/year or 25 ha/year. This pattern is only based on timber production have not noticed the social and environmental aspects [8]. Patterns of forest planning at HPH largely still apply the old pattern that is better known as the 'annual coupe' or a chessboard pattern in Indonesia [9]. This technique is ideal applied to the normal forest conditions in which the tree good and evenly spread [10]. [11] argued that the FMU is a new orientation in forestry development to save the forests and their functions, as well as being the basis of sustainable forest management. [12] argued that the land character of each ecoregion is a geospatial thematic basis for the management of ecosystem services by the River's watershed. [13] explain the watershed is the land that is bounded topographic form of a ridge or a mountain is collecting, storing and draining rainwater into the sea or a lake through the main river.

The research was conducted on KPHP Model Land Sea. This study aims to create a sustainable forest planning model based Watershed.

MATERIALS AND METHODS

Location research on KPHP Model Tanah Laut, DAS Tabunio, District Tanah Laut, South Kalimantan Province, Indonesia, as shown in the following figure 1. Study period reached 1.5 years.

Data collected through secondary data requests to the relevant agencies, field observations, interviews, surveys biophysical potential of the region, browsing the internet and secondary data processing. The necessary data in the form of primary and secondary data in both the spatial and non-spatial formats.

The needs of data in the form of data biophysical, socio-economic and environmental. For socio-economic aspects of society is the history of forest land use, land-conflict in forest areas and forest resource use, while the environmental aspects include watershed, a point out of the water in a river basin, flora and fauna.

The sampling method used was stratified random sampling to survey the location of flora and fauna in forested areas, purposive sampling for informants public figures and experts in forestry. Whereas, on the other biophysical object is field observation.

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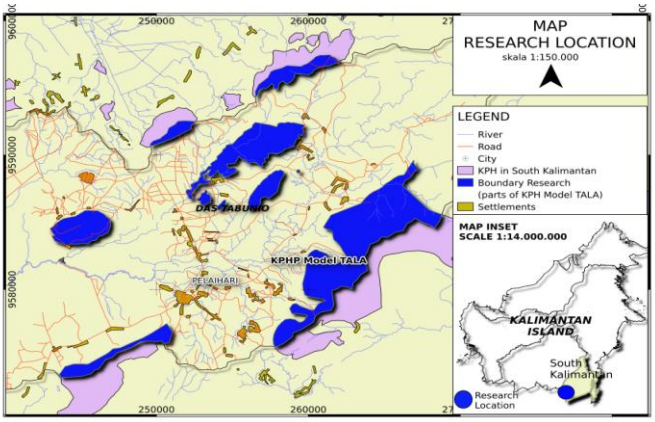

Figure 1. Reresearch Location

The analytical methods used for biophysical aspects, among others: Watershed Analysis, Geo-processing, Normalized Difference Vegetation Index (NDVI) analysis and spatial analysis of Analytical Hierarchy Process (AHP). Whereas, for the socio-economic field used scoring analysis.

The number of informants for in-depth interview for forest planning aspects as much as 31 forestry experts. Informants number of aspects of forest disturbance for a total of 32 people from 13 villages each taken 2-3 community leaders. Total area of sample to survey the potential of flora and fauna is 10 ha of the 2,140 ha of secondary forest or 0.5%.

RESULTS AND DISCUSSION

From the results of in-depth interviews that 74% of informants agree that the system boxgrid / chessboard has been less relevant applied for the state of our forests, which is now dominated by secondary forest (not as natural forest). And 100% of informants so agree watershed-based pattern should be applied, because it is more fulfilling and easier to aspects of monitoring changes in environmental quality at each outlet at each sub-watershed. In addition, the law also requires the use of ecological limits. This is in accordance with [14] Article 21, paragraph 2 requires that the division of forest area into blocks based ecosystem, types, functions and forest use plan. [15] suggested in the study of the sustainable utilization of the potential space that the space is as a barrier, in order to study the SDA objects in space can be more specific / homogeneous, efficient and economical and meet the ecological unity. Watershed is a unit of ecosystem management that must be managed in an integrated manner, both biophysical, socioeconomic, and institutional and cultural in a watershed [16].

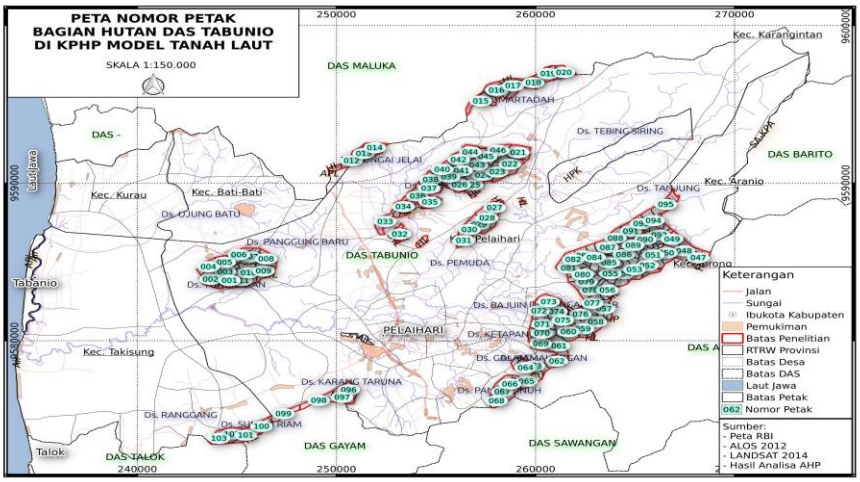

Figure 2. Forest Space division, and numbering compartment on Areal Research

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Figure 2 illustrates the distribution of compartment and the sub-compartment in KPHP Model Tanah Laut, DAS Tabunio. Each of these compartment and sub-compartment are numbered in the order clockwise. Size ranges from 50-100 ha each plot. Number of compartment within the watershed Tabunio reached 103 pieces and 536 pieces sub-compartment. A single compartment may consist of one sub-watershed or a combination. If the area of a sub-watershed too small (due to the cut off limit of the forest area) then combined with a sub-watershed next to them, it is for management efficiency.

To maintain the sustainability aspect, the numbering system used to be based on a relatively fixed space that watershed-based, not based administration boundary. For example, the position of compartment number 001 and number 001 sub-compartment that is at Tabunio Watershed is to have a number / codification, namely: 3207360001001 meaning number 3 = South Kalimantan, 2 = Forest section, 07 = KPH Tala, 360 = Tabunio Watershed, 001 = compartment number, 001 = number of sub-compartment. Giving a value of one digit in the number 3 for the island of Borneo, one digit for the forest section, 2-digit name KPH, and 3-digit number 360 for Tabunio watershed.

NDVI Value	NDVI Classes	Land Cover	Fuzzy Value	Forest Function			Total
				Forest Protection	Forest Production	Lim. Forest Production	
-0,9 - 0,00	1	Cloud, Water	1	268.0	29.0	0.0	297.0
0,00 – 0,10	2	Open area, Mining	1	139.0	28.0	0.2	167.2
0,10 – 0,20	3	Grass	2	270.0	41.0	0.3	311.3
0,20 – 0,30	4	Shrubs, grove	3	899.0	107.0	0.8	1006.8
0,30 – 0,40	5	Grove, young plantation	4	1132.0	145.0	1.9	1278.9
0,40 – 0,50	6	Old Plantation, Young Secondary Forest	4	1949.0	175.0	2.7	2126.7
0,50 – 0,60	7	Medium Secondary Forest	5	998.0	103.0	1.1	1102.1
0,60 – 0,70	8	Old Secondary Forest	5	899.0	139.0	0.0	1038.0
			Total	6554.0	767.0	7.0	7328.0

Table 1. The extent and distribution of land cover per class NDVI in some forest functions

The potential of forest resources and socio-economic aspects is the potential value of space in each compartment. The potential of existing resources is a secondary forest and fauna are protected. Potential wood reaches 72 m3 / ha and 39.8 m3 / ha for trees diameter 20 and above on NDVI class 8 and 7 (see Table 1). In the area of this survey is contained protected flora such as amber glass (*Shorea javanica)* and hazelnut (*Aleuritas moluccana*) and fauna are protected, namely hirangan from the class Mammal.

No.	Sub-District	Village	Village area (ha)	Forest Area (ha)	Forest. Desa (%)	potential interference (%)
1	BAJUIN	KETAPANG	1,000	131	13.1%	
2	BAJUIN	PAMALONGAN	900	418	46.4%	45%
3	BAJUIN	SUNGAI BAKAR	1,750	1,080	61.7%	40%
4	BAJUIN	TANJUNG	8,000	1,904	23.8%	40%
5	BAJUIN	TEBING SIRING	4,580	590	12.9%	15%
6	BATU AMPAR	PANTAI LINUH	1,000	196	19.6%	45%
7	PELAIHARI	AMBUNGAN	1,500	269	17.9%	
8	PELAIHARI	KARANG TARUNA	2,200	145	6.6%	40%
9	PELAIHARI	PANGGUNG BARU	1,900	140	7.4%	
10	PELAIHARI	PEMUDA	4,430	214	4.8%	35%
11	PELAIHARI	TELAGA	2,300	284	12.3%	25%
12	PELAIHARI	TUNGKARAN	2,775	364	13.1%	50%
13	PELAIHARI	UJUNG BATU	2,100	223	10.6%	50%
14	TAKISUNG	RANGGANG	1,130	56	5.0%	
15	TAMBANG ULANG	MARTADAH	4,603	1,002	21.8%	35%
16	TAMBANG ULANG	SUNGAI JELAI	1,575	297	18.9%	45%
	Total		41,743	7,313		38.8%

Tabel 2. Prediction of Potential Interference in the Forest in the Area of Research

From the results of in-depth interviews covering historical aspects of forest land use, land-conflict in forest areas and forest resource use is predicted average potential disruption to

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forests reached 38.8% (See Table 2). The village has the largest potential for disruption of the forest is the village of Ujung Batu and 'Tungkaran1' reaches 50%. It is suspected, because of the plant fruits, such as durian and other crops, such as rubber that had been planted by the community, in addition, most of the residential areas Tungkaran1 village located within the forest. Likewise with Jelai1 Village, the community still has a rubber plant in forest areas. Meanwhile, people from other villages, also recognizes this, but from analysis of ALOS 2012, LANDSAT 2014 and field surveys at the time of the study, state forests claimed by the community is no longer forested.

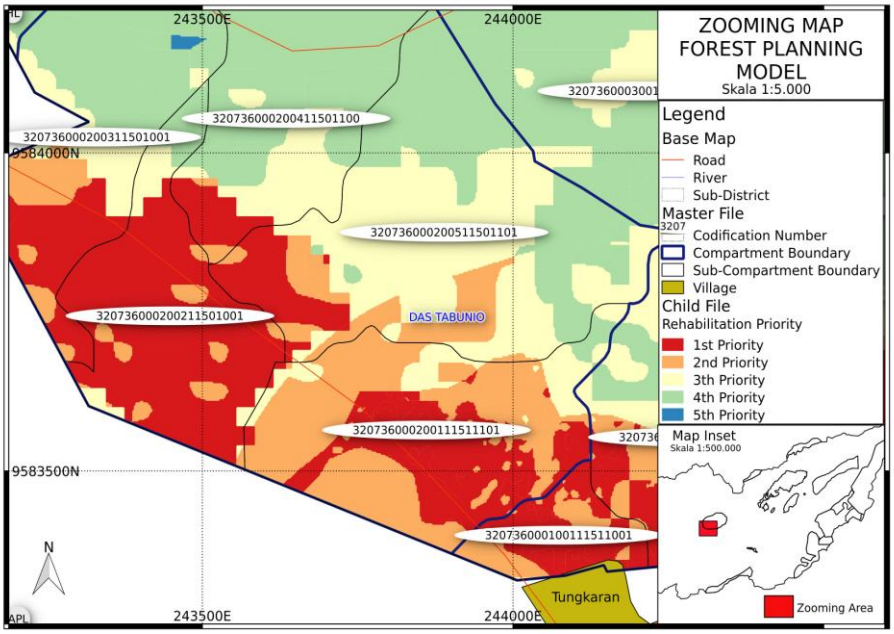

Figure 3. Enlargement of part of the contents of sustainable forest planning model map

The potential for interference by society on forests, the flora and fauna are protected, and the condition of the area to be rehabilitated requires the application of a community-based rehabilitation and based planning with a compartment-based DAS that was created for sustainable forest planning as described above. All the potential that is within the compartment, registered into the compartment, through the process of overlaying. The result of this process is a model of sustainable forest planning. Sustainable forest planning model is presented in map form and characteristics of the model presented in the database. Figure 3 presents an enlargement of part of the contents of sustainable forest planning model map. On the map it can be seen that the numbering system has been equipped with a code where the potential contents of the compartment. There is a difference between the value of the existence of the resource potential in the compartment, in contrast to the value of the resource in the compartment, the intention is for example in the compartment there is a potential timber, then simply expressed as a value of 1, whereas a detailed description of the potential of wood are on a separate database file (we call child-file). The master database file is containing compartment and the existence of potential resource. In the tabulation, Part of the contents of the parent and child database file is presented in Table 3. Thus, the database system created to support this model is a relational database with a pattern of 'one to many'.

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	Master File of database													Child-File	
	Codification		spatial pattern of forest			Contents / Potential in Space									
Record Number	*Codification Number**		Block of Forest, FMU & DAS	Compartement	Sub-Compartement	Forest Fucntion	Village Boundary	Exist. Of Settlement	Exist. Of Enviro. Services	Exist. Of Flora/Fauna	Exist. Of cultural sites	existence of colaboration area	Record Number	*Codification Number**	Level Interfence	Rehabilitation Priority
1	320736001900610401001	=>	3207360	019	006	1	04	0	1	0	0	1			2	3
2	320736001900610401001	=>	3207360	019	006	1	04	0	1	0	0	1			3	2
3	320736001900610401001	=>	3207360	019	006	1	04	0	1	0	0	1			3	3
391550	320736005900611001100	=>	3207360	059	006	1	10	0	1	1	0	0			3	4
391551	320736005900611001100	=>	3207360	059	006	1	10	0	1	1	0	0			3	4
391552	320736005900611001100	=>	3207360	059	006	1	10	0	1	1	0	0			2	4

Table 3. Some of the contents of the attributes on the primary database and child *Primary Key

CONCLUSION

1. The use of sub-watershed boundary as boundary compartments / sub-compartments in the model of sustainable forest planning more relevant. Area per compartment that is formed is 50-100 ha. one compartment has only one outlet, thus improving the efficiency of environmental quality monitoring. The number of compartments formed is 103 pieces compartments and sub-compartments as much as 536 pieces.
2. The results of the interviews showed that 74% of informants agree that the method boxgrid or chessboard is no longer relevant. And, 100% of respondents agreed Watershed-based planning is particularly relevant applicable today. From the results of in-depth interviews that the predictive potential of forest disturbance in study area reached 38.8%.
3. Model of sustainable forest planning is the result of the process of overlaying the compartment boundaries and the boundaries of space resource potential. Sustainable forest planning model is in the form of a map. Characteristics of the model presented in relational databases with pattern one to many.

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