

Analysis of the Appropriateness of Actual Land Use to Land Use in Spatial Planning in the Catchment Area of the Koto Panjang Hydro Power Plant Reservoir

The part of Dissertation

Nurdin¹, S. Bahri²

¹Student Doctor of Environmental Science UR, Pekanbaru

²Department of Chemical Engineering Faculty of Engineering UR, Pekanbaru

Abstract: *The Koto Panjang Hydro Power Plant Reservoir is located in three districts namely Kampar Regency of Riau Province, Pasaman Regency and Lima Puluh Kota of West Sumatera Province, so that the direction of actual land use is based on the spatial plan of three districts. The purpose of this study is to find out the land cover index by vegetation and the appropriateness between actual land use with spatial plan in the catchment area of Koto Panjang Hydro Power Plant Reservoir. The research was conducted by the method of interpretation of Landsat 8 image of 2014 recording which then overlaid on the combined spatial plan of Kampar, Pasaman and Lima Puluh Kota Regency in the catchment area of Koto Panjang Hydro Power Plant Reservoir processed using Geographic Information System technology. The result of Landsat 8 image interpretation in 2014 based on land use class in catchment area of Koto Panjang Hydro Power Plant Reservoir, to obtain land cover index value (IPL) by vegetation 97,16% greater 75%, meaning that the cover condition is in good condition. Spatial Plan of Kabupaten Kampar, Pasaman and Lima Puluh Kota in the catchment area Koto Panjang Hydro Power Plant Reservoir has wide use of forest land 209.587,36 ha or 65,86% from land area of Spatial Plan has forest forest area 140.392.22 ha or 44,12% from Land area of catchment area. The percentage of forest area in the Spatial Plan area is 65.86% and the actual land of 2014 or 41.12%, it has exceeded 30% as required by Law Number 41 Year 1999 on Forestry. While the result of Overlay between actual land use map year 2014 with map of Spatial Plan of of Koto Panjang Hydro Power Plant Reservoir of catchment area based on yield; The total land use in 2014 in accordance with the spatial plan based on the spatial pattern is 208,232.96 ha with the land use suitability of 65.44% and the 2014 land use area which is not in accordance with the spatial plan is 109,985.61 ha with land use mismatch 34.56%.*

Keywords: Land use, spatial plan, land use suitability

1. Introduction

The Koto Panjang Hydro Power Plant Reservoir is formed due to the construction of a dam that serves to generate electricity supply for West Sumatera and Riau, especially for Pekanbaru, Bangkinang and Payakumbuh areas. This dam is located in the Tanjung Alai Village, sub-district of XIII Koto Kampar, Kampar district. Based on PT. PLN (Persero) (2014), the dam of Koto Panjang Hydro Power Plant Reservoir is about 20 km from Bangkinang or 87 km from Pekanbaru, built in 1992 and inaugurated in 1997. The main water supply from Batang Kampar Kanan and Batang Mahat in Pangkalan Koto Baru District of Lima Puluh Kota-West Sumatera with an area of catchment area 3,337 km², and the pool area of the reservoir is 124 km² (12,400 ha). Based on delineation of boundary catchment area map of Koto Panjang Hydro Power Plant Reservoir sourced from Indragiri Rokan River Management Board, land area and water body located in the area is about 329,345.77 ha.

The catchment area of Koto Panjang Hydro Power Plant Reservoir is also part of the upstream Kampar basin. Koto Panjang Hydro Power Plant Reservoir consists of Sub Batang Kampar, Subaling, Batang Marang, Takui, Sei Kampar, Tanjung Alai. Rosalina et al (2014) said that the main function of the long Koto hydropower reservoir is as a

power plant, with side functions as a means of transportation, tourism object and the surrounding area is used by the community for fisheries, agriculture and toilet washing purposes. The spatial location of the study can be seen in Figure 1.

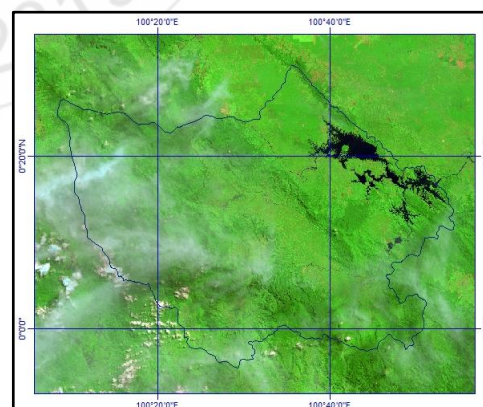


Figure 1. The catchment area of Koto Panjang Hydro Power Plant Reservoir

The problem of land use is a very dynamic thing as time passes. Land as a space on the surface of the earth is naturally limited by certain physical properties and landforms (Noor, 2006). Land is also a physical environment that includes soil, climate, relief, hydrology, and vegetation,

where these factors affect the potential use. Land resource based on FAO (1976) is a very important natural resource for human survival because natural resources are needed in every life (Widiatmaka, 2011). Mulyadi (2010), the result of Landsat image interpretation in 2002 of land cover in catchment area of Koto Panjang Hydro Power Plant Reservoir consist of shrubs / reeds is 407,723 hm², forest 1,167,080 km², mixed garden 632,921 km², open land 241,665 km², cultivated plant 668,981 km². Whereas according to Mustiono (2010), 8 years later the land cover at catchment area of Koto Panjang Hydro Power Plant Reservoir undergoes major changes. The results of Landsat imagery interpretation in 2010 of area of groves/reeds 530,123 km², forest 904,327 km², mixed garden 343,021 km², open land 374,204 km², cultivated area is 966,695 km².

As a result of this change in land use will have an impact on the continuity of water supply in Koto Panjang Hydro Power Plant Reservoir, it is necessary to see the size of the land use index by vegetation and actual land use suitability, to obtain a solution in order to restore land use conditions that refer to Spatial plan of the existing area in catchment area of Koto Panjang Hydro Power Plant Reservoir. The use of geographic information system software is very helpful in interpreting the image and the process of merging the map of spatial plan of Kampar, Pasaman and Lima Puluh Kota districts as the basis of analysis to achieve the objectives of this research, namely land cover index by vegetation and coefficient of use Actual land with the spatial plan of the area within the catchment area of Koto Panjang Hydro Power Plant Reservoir.

Geographic Information Systems is one of the most complex and generally non-stand alone systems integrated with other computer system environments at the functional and network level (Prahasta, 2009). Geographic Information Systems is also a computer-based system or technology built with the aim of collecting, storing, processing and analyzing, and presenting data and information of an object or phenomenon related to its location or existence on the surface of the earth (Ekadinata et al, 2008). According to Elly (2009) Geographic Information Systems is not a new technology in the world of computer science, its reliability in analyzing a problem spatially has attracted the interest of most people to implement this technology in various fields. Geographic Information Systems is one of the most advanced computer science products today, this is in line with the development of GIS itself since it was first developed by Tomlinson in 1967. Charter (2004) in his book says, Geogradhic Information system is more directed to information technology Is used for the collection, storage, analysis and appearance of spatial data and non-spatial data, with components consisting of software and hardware, spatial data (grid raster cells, dots, lines, and polygons), and data tabulators attribute.

2. Materials

The materials used consist of:

- 1) Administrative map of Kampar District, Pasaman and Lima Puluh Kota from Central Bureau of Statistics.

- 2) Map of 2011 usage from Indragiri Rokan river basin management agency.
- 3) Landsat Image 8 operational Land Imager (OLI) of 2014 from United States Geological Survey (USGS) is downloaded through the website <http://earthexplorer.usgs.gov> with scene numbers on patch 127 and row 59.
- 4) Map of spatial plan of Regional Development Planning Board Kampar Regency, Pasaman Regency and Regency of Lima Puluh Kota

3. Method

The method of analyzing land covering index by vegetation and land suitability is based on Regulation of Director General of Land Rehabilitation and Social Forestry Number: P. 04 / V-SET / 2009 dated March 5, 2009 concerning Guideline for Monitoring and Evaluation of Watersheds and Minister of Forestry Regulation Indonesia Momor: P. 32 / MENHUT-II / 2009 concerning the procedures for preparing technical plans for forest and land rehabilitation in watershed areas with the following stages. :

- a) Land cover index based on land area with permanent vegetation of catchment area Koto Panjang Hydro Power Plant Reservoir from Landsat image interpretation result 2014, using formula;

$$IPL = \frac{LVP}{Luas_DAS} \times 100\% \quad (1)$$

Where,

IPL = Land cover index,

LVP = Area of permanent vegetated land,

Luas _ DAS = Catchment area

Evaluation standards:

IPL > 75% (good),

30% < *IPL* < 75% (medium) and

ILP < 30% (Poor).

- b) To know the suitability of land use to the spatial plan using the formula;

$$KPL = \frac{LPS}{Luas_DAS} \times 100\% \quad (2)$$

Where,

KPL (%) = Suitability of land use,

LPS = area of land use,

Luas _ DAS = Catchment area

Evaluation standards:

KPL > 75% (Good),

40% < *KPL* < 75% (Medium), and

KPL < 40% (Bad).

4. Results and Discussion

4.1 Land Use

The names of land use based on Landsat 8 image interpretation are; Primary dryland forest (Pd), Secondary

dryland forest (Sd), Plantation (Pl), Dryland farming (Df), Dry land farming mixed with shrubs (Dm), Rice fields (Rf), Settlement (St), Shrubs (Sh), Open ground (Og), and Water body (Wb).

Overall land use Koto Panjang Hydro Power Plant Reservoir within the Provinces of Riau-West Sumatera 2014 is dominated by land use class Dryland farming as the widest class of use, which is 85,355.61 ha (26.82%) of the land area of catchment, While the smallest land use area is in the Bush / Grass clas 286,07 ha (0.09%). This shows that the dominance of land exploitation in catchment area of Koto Panjang Hydro Power Plant Reservoir is in the field of agricultural cultivation. The percentage graph of 2014 land use can be seen in Figure 2.

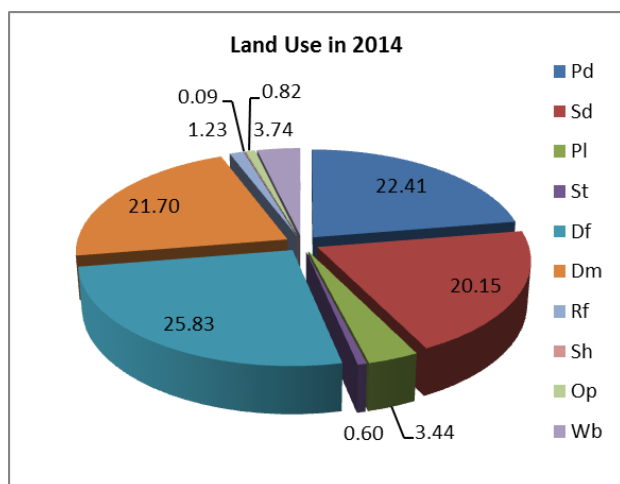


Figure 2: Graph of land use percentage in the catchment area of Koto Panjang Hydro Power Plant Reservoir 2014

4.2 Land Cover Index

Analysis of land cover index by vegetation (IPL) is conducted to determine the condition or quality of land with the components that must be known is the area of land with permanent vegetation and wide watershed. Land use in 2014 with IPL value obtained for Kampar area 81.20%, Pasaman 99.91%, and Lima Pluh Kota 96.20%. While the average IPL of Koto Panjang Hydroelectric Reserves 2014 is 93.53%. Judging from the size of the land cover index by the average vegetation obtained in 2014, ie 93.53% >75% which means that good quality. Much better than IPL Sungai Kelayan in 2009 by Widodo et al. (2012) which ranged from 8.11 - 32.18%). The Land Clearance Index (IPL) in the catchment area of Koto Panjang Hydropower Palnt Reservir 2014 is detailed in Table 1.

To keep the land cover index by the existing vegetation in the catchment area of Koto Panjang Water Reservoir can experience a minimum increase not decrease, based on the Management Board of Mahakam Berau River Basin (2014) can be carried out the following actions:

a) Restoration of existing protected forest functions to the types of plants used in reforestation or enrichment are long-term species, have deep roots and low evapotranspiration rate and produce latex, skin and fruit.

- b) To be able to restore the function of existing Conservation Forest, the type of plant used in reforestation or plant enrichment is of type with long-leaved characteristics, deep roots, low evapotranspiration, endemic /local and Multi Purpose tree species (MPTS) that can be utilized by the local community.
- c) Restoration of forest and land productivity in forests Production of crops used in reforestation and plant enrichment is a type with characteristics of rapid growth, high commercial value, silvicultural techniques have been mastered, facilitate the provision of quality seeds and seeds, and oriented According to market needs.
- d) Restoration of forests and land outside the protected function is intended to restore the protection function of the lower and the surrounding areas, so that the type of plant used with the characteristics has strong rooting characteristics, deep, and able to bind the soil, low evapotranspiration rate and strived to produce non-forest products wood.
- e) Recovery of forests and land on cultivation functions outside forest areas, selection of crops used in addition to considering other land and biophysical suitability, is also considering the type of selection desired by the community/ landowners.

Table 1: Land cover index by vegetation in the catchment area of Koto panjang hydropower plant reservoir 2014

Territory		Large (ha)		IPL
Province	Distric	Mainland	Permanent vegetation	(%)
Riau	Kampar	61.563,14	58.568,88	95,14
Sumatera Barat	Pasaman	54.624,61	54.573,52	99,91
	Lima Puluh Kota	200.850,60	194.891,60	97,03
Riau- Sumatera Barat	Mainland area	317.038,34	308.034,00	97,16

4.3 Land use suitability

Laws of the republic Indonesia No. 41 of 1999 requires that a watershed should have at least 30% of the watershed area. Based on the Regulation of the Minister of Public Works No. 16 / PRT / M / 2009 states that, spatial pattern is the distribution of spatial designation in a territory in the form of, allotment of space within a territory which includes allotment of space for the function of protection, and the allocation of space for cultivation functions.

In analyzing the conformity of existing land use in 2014 in catchment area of Koto Panjang Hydro Power Plant Reservoir with spatial plan of catchment area based on spatial pattern classification. The names of spatial plan areas in catchment area of Koto Panjang Water Reservoir for Kampar Regency are Protected Forest and Nature Reserve areas, Production Forest, Settlements, Large State Plantations, Large Private Plantations, Smallholdings and Agriculture. Pasaman Regency consists of protected forest, and limited production forest. While in Lima Puluh Kota District consists of Protected Forest / Nature Reserve, Production Forest, Conversion Production Forest, Limited Production Forest, Plantation, Settlement, Agriculture, Agricultural Horticulture, Fisheries, and Transmigration. While the names of land use classes in catchment area of Koto Panjang Hydropower Plant Reserves 2014 as existing

are primary dryland forests, secondary dryland forests, plantations, settlements, dryland farming, dryland farms mixed with shrubs, rice fields, shrubs, and soils open.

Regional Spatial Plan Kampar District, Pasaman and Lima Puluh Kota within the catchment area of Koto Panjang Hydropower Plant Reservoir have an area of 209,587.36 ha or 65.86% of the land area of catchment area, the area of non-forest land use is 103,826.50 ha or 32,63% of the land area of catchment area. The total area of forest land on actual land use in 2014 is 140,392.22 ha or 44.12% of catchment area, non-forest land use 177,826.34 ha or 55.88% from catchment area. Percentage of forest use area of 65.86% in Spatial Plan and 41.12% in actual land use in 2014 far exceeds 30% of that required by RI Law No. 41 of 1999 on Forestry.

Spatial plan of Kampar, Pasaman and Lima Puluh Kota in the catchment area of Koto Panjang Hydro Power Plant Reservoir have land use in the form of protected areas 157,042.91 ha or 50.11% of the land area of DTA, the area of cultivated land is 156,370.95 ha or 49.89% of the land area of catchment area. While the area of protected area on actual land use in 2014 is 73,786.59 ha or 23.19% from catchment area, with wide of land use area of cultivation 244,431.97 ha or 76.81% from catchment area.

Appropriateness of actual land use in 2014 with Spatial Plan in catchment area of Koto Panjang Hydro Power Plant obtained from wide of protected area land use in 2014 in accordance with Spatial Plan 62,355.37 ha with value of Suitability of land use (KPL) 19.60% from catchment area, and area Not in accordance with the Spatial Plan 11,431.22 ha or 3.59% of the land area of catchment area. Area of cultivated land use in 2014 in accordance with Spatial Plan 84,649.68 ha with value of Suitability of land use (KPL) 26.60% of catchment area, and area not in accordance with spatial plan 109,985.61 ha or 34.56% of catchment area so that, the total area of actual land use in 2014 in accordance with the Spatial Plan of 208,232.96 ha with value of Suitability of land use 65.44% of catchment area, while the area is not in accordance with the Spatial Plan 109,965.61 ha or 34.56% of catchment area. The actual land use 2014 with Spatial Plan 65.44% is in the range between 40 - 75%, indicating that the in 2014 in Dta Koto Panjang Water Reservoir is of medium quality.

Appropriateness of actual land use in 2014 with Spatial Plan in catchment area of Koto Panjang Hydro Power Plant Reservoir is dominated by three classes of land use, namely secondary dryland forest 64,366.83 ha with land use suitability 20.23% of catchment area, primary dryland forest 62,355.37 ha With land suitability of 19.60% of catchment area, and Dryland Farm 48,084.04 ha with land use 15.11% of catchment area. While the three classes that dominate the actual land use in 2014 which is not in accordance with the Spatial Plan in catchment area of Koto Panjang Hydro Power Plant Reservoir consists of dryland farming mixed with shrubs 56,323.63 ha with land use incompatibility 17.70% of catchment area, dryland farming 31,572, 46 ha with land use mismatches of 9.92%, and 11,431.22 ha primer forests with land use discrepancies of 3.59% of catchment area.

Land use mismatches caused by land clearing in the class Dryland farms are mixed with shrubs, and Dryland farming is the utilization of existing forest land. To minimize

nonconformities in actual land use in 2014 can be done by restoring forest functions through reforestation programs and outer areas by planting abandoned land, vacant land with conservative cultivation of plants, or enrichment on the lands according to technical and socioeconomic considerations enriched by Annual crop.

5. Conclusions

The conclusions obtained in obtaining the size of the land cover index (IPL) by vegetation and the level of land use suitability (KPL) that functioned protected or conservation in catchment area of Koto Panjang Hydro Power Plant Reservoir are as follows:

- a) The average land cover (IPL) index by vegetation in Koto Panjang Hydro Power Plant Reservoir in 2014 is 97.16% greater than 75%, (meaning that the land cover conditions are in good condition)
- b) Based on Spatial Plan of Kampar District, Pasaman and Lima Puluh Kota in catchment area of Koto Panjang Hydropower Plant Reservoir 2014 land use in accordance with Spatial Plan based on forest availability is 217,899.79 ha with land use suitability (KPL) of 68.47%, based on spatial pattern 208,232.96 ha with land use suitability (PKL) of 65.44%. Land use in 2014 that is inconsistent with Spatial Plan based on forest availability is 111,445.98 ha with land use incompatibility 35.02%, based on spatial pattern is 109,985.61 ha with land use incompatibility 34.56%.

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Author Profile

Nurdin, Lecturer in the Department of Civil Engineering with the field of remote sensing expertise at Engineering Faculty of Riau University, Pekanbaru. Currently he is completing his doctoral studies in the Environmental Science at graduate program of Riau University, Pekanbaru, Indonesia