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GEOSPATIAL ANALYSIS OF LAND USE AND LAND COVER CHANGES FOR DISCHARGE AT WAY KUALAGARUNTANG WATERSHED IN BANDAR LAMPUNG

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Abstract-*Land use and land cover change in a watershed might drive some impacts, such as high amounts of discharge fluctuations. Way Kuala Garuntang Watersheed is one of watershed in Bandar Lampung that has changed significantly. This study analyzed land use and land cover change to determine how much its influence on discharce fluctuations based on Geographics Information System. The method used in this study comprised of hidrology, spatial and sensitivity analysis. Hidrology analysis based on daily rainfall data. Spatial data analysis aims to present geospatial data related effects of land use and land cover change on the value of discharge. Sensitivity analysis is done by creating a land use and land cover simulation scenarios and sees its effect on the peak discharge events. The results of hidrology analysis in this study showed that the rainfall data obtained from the rainfall stations around the watershed were inconsistent and it needs to be repaired. It was found that the pattern of rainfall distribution in Bandar Lampung for 4 hours consists of 40%, 40%, 15% and 5% pattern. The results of spatial analysis in this study showed that there are 11 types of land cover on the existing condition and only has a protected area covering 4.72% of the total watershed. From the results of the sensitivity analysis showed that land use scenario with availability less than 30% of the area of green open space watershed may cause an increase in the value of the peak discharge. Instead, the scenario to maintain a 30% green open spaces of wide watershed did not make a significant change in peak discharge. This action is necessary to provide enough space for the infiltration of rain water on a particular area for the purpose of supplying the needs of ground water and flood control.*

Keywords— *land use and land cover change, discharge, Way Kuala Garuntang*

I. INTRODUCTION

Land use and land cover change is an effect of the development by countries that are developing, including Indonesia. Land use and land cover changes are the most substantial influence on the increase in value of the coefficient of runoff that impact in increased discharge is the use of forests to other uses such as agriculture, residential or industrial. Industrial activities, animal husbandry, agriculture and settlements arround the river produces a variety of wastes, both solid and liquid, into the river. This condition occurs more severe when the river reaches major cities in Indonesia .

Way Kuala Garuntang watershed is one watershed in Bandar Lampung which its direction flow through urban areas and has change significantly. According to Megawati (2005), Way Kuala Garuntang watershed has experienced in deforestation. There are resident and industry activities which throw their waste to the river. From the research, Way Kuala Garuntang watershed still able to accommodate the calculated discharge. However, from the research also mentioned that if there are land use and land cover changes may cause increase run off coefficient. It means the situation will lead to the greater flooding value. Based on this condition, it is necessary for the analysis of changes in land use to determine how much its influence for the discharge fluctuations. In order to make hydrology analysis, the research used hydrological and watershed parameter.

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Identification of land use and land cover change and hydrological function measurements in the field requires an understanding, so it consumes more effort, time and cost. Thus the availability of a system in the field of geospatial data presentation is supported by advances in computer network technology is indispensable. The ability of computer technology is growing to make today's computers can be used for a variety of fields, one of which is the field of geography, ie to create a geographic information system (GIS). GIS technology integrates common database operations operations, such as query and statistical analysis with visualization and analysis capabilities are uniquely owned by mapping (Sugandi, Dede and Sugito, NT, 2010) The ability is what distinguishes GIS with other information systems that make it a useful field presentation of geospatial data in order to assist us in studying the process of change in river flow due to changes in land use in a watershed.

II. METHODS

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

This research was conducted in the Way Kuala Garuntang watershed in Bandar Lampung.

The primary data in this study include the Ground Control Point (GCP) of rainfall stations with the first survey point rainfall stations using Global Positioning System (GPS) for the coordinates plotted on a map.

Secondary data on the research include a river map, topography map and precipitation data. The river map rise from screen digitation which was referenced from google earth 2006 year and river data from central river region mesuji sekampung. While topography map was taken from 2010 spatial plan (RTRW) of BAPPEDA.

There are three types analysis in the research. Hidrology analysis, spatial data analysis and sensitivity analysis of Land use and land cover changes.

III.

IV. RESULTS AND DISCUSSION

From the result of the formation of Way Kuala Garuntang watershed can be seen that DAS Way Kuala Garuntang has 11 tributaries that Way Kemiling, Way Langkapura, Way Pemanggilan, Way Balau, Way Kedaton, Way Penengahan, Way Awi, Way Simpur, Way Halim, Way Kedamaian, dan Way Kuala. After adding the administrative boundary layer on the map can be seen that the upstream on Kemiling districts and downstream on Teluk Betung Selatan. From the result of the formation of Way Kuala Garuntang Watershed can be seen that the area of the watershed Way Kuala Garuntang is 60.39 km^2. Land use and land cover Data of Way Kuala Garuntang watershed is based on Bandar Lampung Spatial Data 2010. After showing land use /cover layer and Way kuala garuntang watershed layer, obtained land use and lond cover in way Kuala Garuntang Watershed. From the formation of the land use and land cover data obtained 11 types of land use and land cover in the Way Kuala Garuntang Watershed that can be seen in appendix Land Use and Land Cover Map of Way Kuala Garuntang Watershed, with 0.4% is an area of mining, 54.14% is an area of resdidential, 4.10% is an area of industrial designation , 31.22% is an area of empty land, 1.79% is an area of trade area and services, 0.23% is an area of government offices, 0.04% is an area of tourism area, 0.38% is an area of industrial area, 0.46% is an area of protected area, 4.72% is an area of the land agriculture, 1.26% is an area of public services, 1.16% is an road area and 0.07% is a double railway line from Way Kuala Garuntang Watershed area of 60.392 km2.

Determination of rainfall stations whose data will be used for determination of rainfall on average watershed by first surveying point rainfall stations using GPS (global positioning system) to coordinate plotted on the map. From the results of plotting,can be seen that research area right in between of rainfall station and perfectly influenced by those rainfall stations, so the

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rainfall data of the 4 rainfall stations that will be used in this research.

Determination of the Area of Effect Rain Stations in this study was calculated using the method Poygon Thiessen. So, it can be seen percentage of rainfall area's influence of each watershed.

From the existing rainfall data, should checked the availability of rainfall data and consistency test. Missing rainfall data can lead to inconsistent rainfall data and need to completed using the reciprocal method. It's done by calculating the distance between stations. The equation used is

$$P_x = \frac{\sum_{i=1}^{n} \frac{p_i}{{L_i}^2}}{\sum_{i=1}^{n} \frac{1}{{L_i}^2}}$$

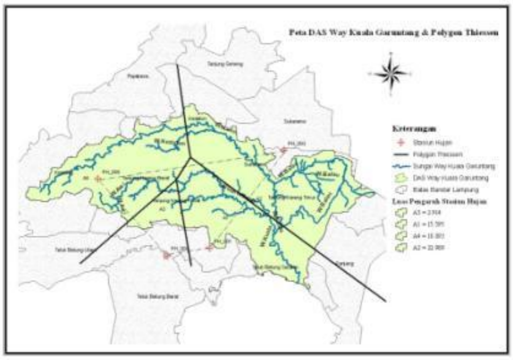

Fig.1 Way Kuala Garuntang Watershed and Polygon Thiessen

The distances between of rainfall stations can be seen on the map that was created using Geographic Information Systems. Rainfall data are already equipped need to test the consistency.

The analysis of rainfall area is intended to determine everage of ranfall that occurs in the watershed, such as by analyszing the maximum rainfall data that obtained from four rainfall stations. The method used in this analysis is the method of Thiessen Polygon as the following equation (Triatmodjo, 2008):

$$P_{rerata} = \frac{A_1P_1 + A_2P_2 + \ldots\ldots + A_nP_n}{A_1 + A_2 + \ldots. + A_n}$$

To be able to change the design rainfall into hourly rainfall amount must be obtained in a pattern of hourly rainfall distribution. Distribution pattern for Way Kuala Garuntang watershed obtained by doing observation of large rain events. By averaging the observed rainfall distribution pattern, and then obtained a further distribution pattern is considered to represent average rainfall conditions and serve as a template for the design to distributed rainfall into hourly rainfall amount.

Analysis of rainfall distribution patterns calculated using rainfall data Kotabaru and Panjang. From the calculation of rainfall distribution pattern obtained 90% of the rain in Bandar Lampung occurred at 3 hours, 4 hours, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours and 13 hours. However, most 90% of the rain events occurred at 3 hours, 4 hours and 5 hours. In Table 12, 13 and 14 are shown the results of the calculation of the percentage of hourly rainfall for 3 hours, 4 hours and 5 hours. From this point it is known that 90% of the rain in Bandar Lampung occurred within 4 hours with 40% in the distribution pattern of the first hour, 40% in the second hour, 15% in the third hour, and 5% in the fourth hour. The calculation of the intensity of rainfall using the rainfall distribution pattern that has been obtained and the calculation of the intensity of rainfall is presented in the following table:

TABLE 1.

THE CALCULATION RESULT RAINFALL INENSITY

T	R	90%.R	Rainfall Intensity			
			1hr	2hr	3hr	4hr
2	68,52	61,67	24,67	24,67	9,25	3,08
5	76,96	69,27	27,71	27,71	10,39	3,46
10	81,12	73,01	29,20	29,20	10,95	3,65
25	85,30	76,77	30,71	30,71	11,52	3,84
50	87,84	79,06	31,62	31,62	11,86	3,95
100	90,02	81,02	32,41	32,41	12,15	4,05
200	91,91	82,72	33,09	33,09	12,41	4,14

To determine the magnitude of the peak discharge rate changes that occurred in

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the Way Kuala Garuntang watershed due to land use and land cover changes need to be simulated with some scenarios of land use change. Scenarios does are :

1. The making of Scenario I: change 30% of empty land into green open spaces.
2. The making of Scenario II: change 30% of empty land in existing condition into green open spaces and convert 50% of agricultural land in existing condition into a residential area.
3. The making of Scenario III: change 30% of empty land into green space, 50% of agricultural land into residential areas and the remaining empty land into residential areas
4. The making of Scenario IV: change all the empty land in existing conditions into residential areas.
5. The making of Scenario V: change all the empty land in existing conditions into residential areas in existing condition into commercial areas and services.
6. The making of Scenario VI: change all the empty land on the existing condition into residential areas and 50% of residential areas in existing condition into industrial area.
7. The making of Scenario VII: change all the agricultural land in existing condition into residential areas and change a half of empty land into an industrial area

Run Off coefficient can be used to determine the physical conditions of the watershed. From the run off coefficient for 0,561, it can be stated that Way Kuala Garuntang watershed have unfavorable condition. This is consistent with the statement (Kodoatie and Syarif, 2005 at Girsang 2008) which states that the runoff coefficient is an indicator to determine the physical condition of a watershed. C values ranged between 0-1. Value of C = 0 indicates that all the rain water infiltrated into the soil and have interception, contrary to the value of C = 1 indicates that the rain water as surface runoff. The good watershed, C values close to 0 and getting worse of watershed C valeu closer to 1.

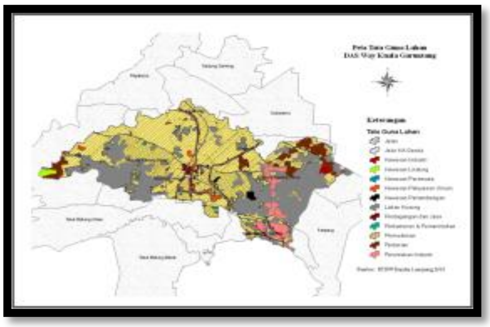

Fig.2 Land Use and Land Cover Of Way Kuala Garuntang Existing Condition

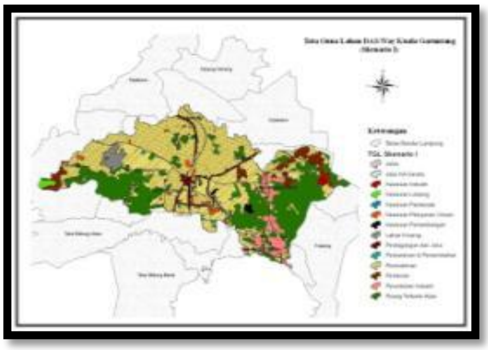

Fig.3 Scenario I Land Use and Land Cover Way Kuala Garuntang

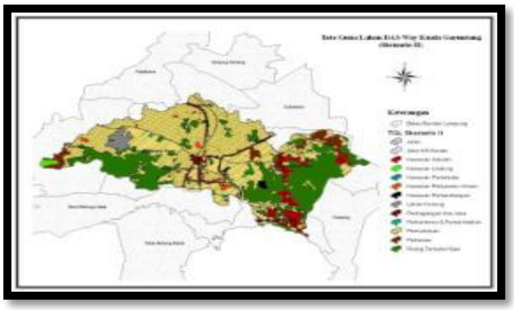

Fig.4 Scenario II Land Use and Land Cover Way Kuala Garuntang

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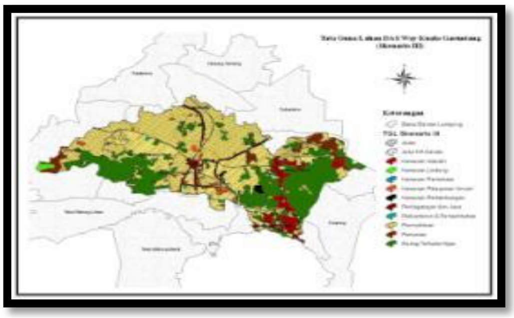

Fig.5 Scenario III Land Use and Land Cover Way Kuala Garuntang

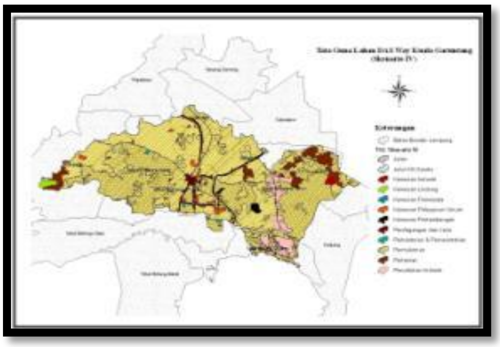

Fig.6 Scenario IV Land Use and Land Cover Way Kuala Garuntang

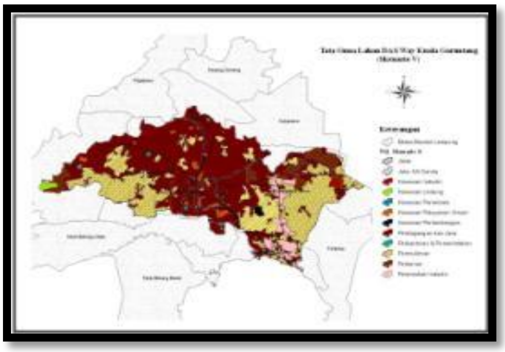

Fig.7 Scenario IV Land Use and Land Cover Way Kuala Garuntang

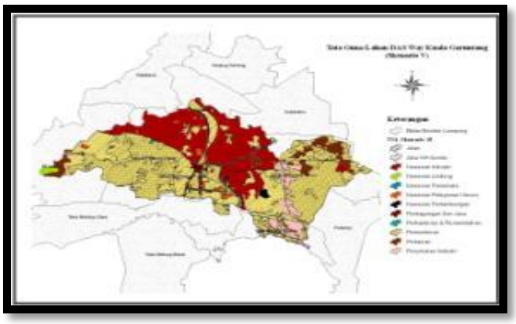

Fig.8 Scenario VI Land Use and Land Cover Way Kuala Garuntang

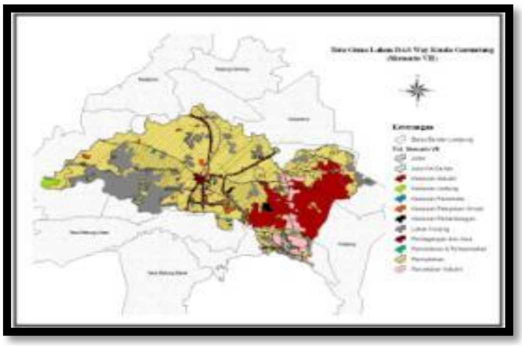

Fig.9 Scenario VII Land Use and Land Cover Way Kuala Garuntang

TABLE 2

RECAPITULATION OF LAND USE AND LAND COVER CHANGES EFFECT FOR DISCARGE

Ret. Per.	Discharge (m3/det)							
	Exist. Cond.	Scen I	Scen II	Scen III	Scen IV	Scen V	Scen VI	Scen VII
2	232,30	207,4	215,4	216,1	264,6	298,2	286,4	265,1
5	260,93	233,0	242,0	242,7	297,2	335,0	321,6	297,7
10	275,01	245,5	255,1	255,8	313,2	353,0	339,0	313,8
25	289,18	258,2	268,2	269,0	329,4	371,2	356,5	330,0
50	297,81	265,9	276,2	277,0	339,2	382,3	367,1	339,8
100	305,19	272,5	283,1	283,9	347,6	391,8	376,2	348,3
200	311,61	278,2	289,0	289,9	354,9	400,0	384,1	355,6

TABLE 3

RECAPITULATION OF LAND USE AND AND COVER CHANGES FOR PERCENTANGE OF DISCHARGE

Ret Per	Exist Cond	Discharge Changes (%)						
	Q	Scen I	Scen II	Scen III	Scen IV	Scen V	Scen VI	Scen VII
2	232,4							
5	260,8							
10	274,8							
25	288,8	-10,69	-7,239	-6,967	13,916	28,394	23,287	14,128
50	297,3							
100	304,6							
200	311,0							

From the simulation results can be seen that the ratio of the smallest discharge occurs in a condition in which scenario I made changes on empty land into an open green space. By doing simulations using this scenario I can be seen that the fluctuation of discharge becomes smaller because of the declining value of the run off coefficient (C), more water can be infiltrated by the land. Another simulation is done by keeping open green spaces are scenarios II and III. However, this scenario does not show a great influence. The result of discharge ratio is not much different from the first conditions, where the ratio of consecutive debits were -10.69%, -7.23% and 6.96%. It is because of the green area which is still 30% than watershed area. Moreover, the pattern of land usean land cover in scenarios II and III are not much different from first condition. An open green space is the area of land around the town whose existence must be established permanently and supported by strong regulations as green areas and free from building structures.

From the result of scenario simulation can be concluded that the actions that keeping the green open space for Way Kuala Garuntang Watershed very necessary. This action need to do for giving a sufficient space for rainfall infiltration in a particular area for the purpose of supplying the needs of ground water and flood mitigation, both the lower and the area concerned.

In the fourth scenario condition, discharge ratio reached a value of 13.91%. It can be interpreted that in this condition the discharge reaching unspread fluctuations. In this condition the availability of 30% green spaces was not keeped because there was a convertion all the empty land into residential area.

Land use and land cover alternative scenarios that show the ratio of great discharge occurs in scenario V an VI, where the ratio that resulting are 28,38% and 23,287%. In this condition the actions taken are equally partial change the residential area into commercial and service areas and also industrial areas, in addition to change a half of empty land into residential areas. Further more, there is no green spaces kept in this scenario. The result of this action is less water that soil can do a retention, so greater the rainfall that directly into discharge. The discharge will be higher in rainy season and lower in dry season due to reduced of groundwater recharging.It proves how the green spaces contribution for the water conservation, especially in relation to supply of stored water.

Scenario VI and VII that do not change the empty land into green space indicates the condition are not toodifferent altough still an increase in the ratio compared to scenario I, II and III that keeps the existence of a green space as much as 30% of watershed. This interpreted that changesin agricultural land into residential area or changes in empty land into residential area showed effects that are not much different to discharge fluctuations.

V. CONCLUSIONS

Way Balau, Way Kedaton Way Kuala Garuntang watershed is one of the major watershed in Bandar Lampung with an area 60,39 km^2 with 11 tributary.

Accordance with Bandar Lampung Spatial Plan 2010, Way Kuala Garuntang Watershed has 11 land cover types other than road and rail links with protected areas covering 4.72% of the total watershed.

After completion of missing rainfall data and consistency test, rainfall data in 2000 for the fourth rainfall stations can not demonstrate consistency of data there is no more rainfall data from four rainfall stations in that year.

Rainfall pattern in Bandar Lampung distributed to 40% in the first hour, 40% in the second hour, 15% in the third hour, and 5% in the fourth hour.

Accordance with Bandar Lampung Spatial Plan 2010, Way Kuala Garuntang watershed have run off coefficient (C) of 0.56.

Measures to maintain the green space for DAS Way Kuala Garuntang is necessary to provide enough space for the infiltration of water rainfall on a particular area for the purpose of supplying the needs of ground water and flood control.

Based on the simulation results using the scenarios I, II and III land use and land cover that keep 30% of the total watershed is green open space, seen a decrease in peak discharge and peak discharge changes significantly.

From the calculated discharge using the broad land use scenario IV, V, VI and

VII are no longer retain wide open green space as much as 30% of the watershed, seen a rise in the value of the peak discharge.

The most extreme flow changes seen in the changing scenario in part V of vacant land into residential areas and some residential land to the trade and services.

The less extensive green open spaces and protected areas in a watershed change in the value of the peak flow will increase.

The use of geographic information systems in the analysis of land use and land cover change on discharge of a watershed is very helpful and makes the system more efficient analysis processes.

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