The Influence of Land Use Change toward Hydrological Aspect at Upper Site

by Pps Firman Hidayat

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Firman Hidayat*

Abstract--- *The effect of land-use exchange not best provide a few advantage to network but can also motive hassle, particularly: erosion, sedimentation, flooding and other. Erosion will reason silting of reservoirs, reducting irrigation channel capability, and disrupt electric power technology structures. excessive erosion, flooding inside the wet season no longer simplest have a poor effect on the biophysical components of natural assets and the environment however also the social aspects of the monetary effect on the community. several instances of adjustments in land use in a few watersheds in Indonesia is presented with a discussion of the causal courting of hydrological elements, mainly regarding the sporting ability of the watershed and the frequency of flooding. Hydrology and run off characteristics of a number of number one rivers in Indonesia (Java) supplied by way of using of land that growth timely. related with that case the studies could be taken. The objective is, to analisys affect of land use exchange to hidrological factors. at Mahat Hulu watershed, placed in the Lima Puluh kota district that 15 years antique (1995-2010) deforestation has taken significantly. In 1995 Watershed has woodland place approximarely 50.nine% and in 2010 decrease into 28% or from 14523 ha (1995) decrease to 7981 ha (2010) however blend garden increased from 17.1% (1995) to 43.8% (2010) or 4889 ha (1995) to 12508 ha (2010), therefore, which include runoff elevated, flooding, and drought in the course of the dry season, high erosion and sedimentation as well as a decline in productivity and earnings of farmers. In this case, special component that research, were the have an effect on of land use adjustments on the hydrological components along with coefficient of annual and seasonal runoff, and fluctuations. The method used quantitative and multiple regression check. result of evaluation are deforestation will increases coefficient run off, and fluctuations discharged. Coefficient runoff from 20% within the 1999-2002 to 24% in 2007-2010 and fluctuation of discharged (KRS) additionally extended from 2.four-five.5 (1999-2002) to five.9-10.7 (2007-2010) indicating DAS is critics. results of a couple of regression test showed a near correlation among the variables (0.nine) the method is C (%) = 975 - 11.2 htn - 15.three kbn cpr - 10.nine smk blkr + zero.forty three tgln dan R-Sq = 42.4%, for the stepwise regression test showed that wooded area area affect to run off. it is able to be showed from the equation is CRO = 31.5 - zero.370 htn, , R-Sq = five.3% Its mean, run off will extended cause by using forest location decreased.*

Keywords--- *Hydrology, Erosion, Sedimentation, Runoff.*

I. Introduction

The studies became carried out in the watershed upstream Mahat (28535.forty-nine ha) which has been degraded due to conversion of woodland lands into new agricultural regions and unlawful logging. Erosion degree on web site and rancid website sedimentation degree is because of the outlet of the land surface. This turned into pronounced through Berd I. (2003) because of a discount of 50.89% wooded area in 1995 to forty.24% in 2003 the erosion has reached 172.92 tonnes / ha / year which have an effect on the volume of the reservoir as soon as the turbine installed capability.

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DOI: 10.37200/IJPR/V24I5/PR201799
Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

Excessive quantity of runoff that would probably reason flooding downstream. that is in accordance with the opinion Irianto (2003) which states that the once a year rainfall gathered in a short duration (December-February) motive the land isn't capable of accommodate all of the extent of rainwater. therefore maximum of the rain water runoff, it's miles exacerbated by using the growing conversion of forests to other makes use of together with agricultural, residential, and industrial fields. that will motive good sized capability flooding in downstream regions. similarly it is said that the amount of surface runoff will even purpose excessive erosion, so it's going to directly reduce soil fertility. Decline in soil fertility will purpose the much less vegetation is able to develop nicely, so the diminishing wooded area cover. this could purpose a discount in charging (recharging) upstream water reserves which motive a drought all through the dry season.

In the meantime, in step with Arsyad (2010) floor drift (run-off) is water that flows over the ground surface. This runoff can motive soil erosion, being capable of carry part of the land in dispersed by raindrops. on this feel the go with the flow of run off is above floor level earlier than they reach the water inside the canal or river. elements influencing of run off residences are as follows; rainfall; (amount, charge, and distribution), temperature, soil: type, substratum, topography, broad basins, vegetation for canopy crop (type, quantity, and density), and land cultivation system. Controling of runoff will have impact at once to erosion, which in flip will affect the supply of water inside the dry season and the wet season flood prevention.

Converting area from wooded area into agricultural land diagnosed purpose many issues including decreased soil fertility, erosion, extinction of flowers and fauna, floods, droughts or even international environmental trade. This hassle will growth in the course of forest are transformed to other commercial enterprise future. (Banuwa, 2008) stated a relation between erosion and deforestation, particularly the erosion of a small catchment regions in French Guyana French, improved dramatically after deforestation (deforestation). Observations have been performed on small-scale plots also showed that the logging of natural plants has caused an growth in run-off coefficient of 25-one hundred times, at the same time as the erosion expanded as nicely to extra than 10 instances (Roose, 1986). Opened place reasons fluctuations in temperature and soil moisture regime turns into larger. This ends in elevated decline in soil natural count number (Lal, 1994). Run off is part of precipitation that flows at the surface and subsurface level and next attain to decrease region together with: lake or sea (Schwab et al., 1981).for that reason this studies became carried out. The goal is analisys of land use risk to hydrological factors at DAS Mahat Hulu watershed at Lima Pulub Kota District.

II. METHODS

The gear and substances used on this have a look at consisted of Geographical role system (GPS), cameras, laptop hardware laptop / laptop Toshiba Window Xp, software program, microsoft phrase 2007, microsoft excel, program ArcView model three.2, and ARC GIS.and Minitab 14. materials used inclusive of: information discharge, RBI maps, weather maps, maps land use, soil maps, geology maps, Landsat ETM7 1995, 2000, 2005 and 2010, Secondary information, together with records physic required on this have a look at includes the facts sorts of land use, topographic statistics, soil facts, discharged facts, and climate facts. weather data (rainfall) obtained from a Sicincin BMKG station each day records from the 12 months 1995 to 2010. at the same time as the discharge facts obtained from hydropower Koto Panjang and BWS II Inderagiri Hulu, a month-to-month discharge information in 1999 - 2010 and the every day discharge in 2004 - 2010 (table 1)

DOI: 10.37200/IJPR/V24I5/PR201799
Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

Table 1: Types, Sources and Uses of Data

No.	Data Type	Sources of Data	Usefulness of Data
A.	Secondary Data		
1.	Map-Map	BP DAS Indragiri Rokan (1995, 2000, 2005, and 2010), Riau Provincial Forestry Office, Bakosurtanal, Land Research Centre, Directorate of Land Use,	To arrange land units, which would then be used in the estimation of runoff and erosion
	ETM7 Landsat imagery (30 m resolution)		
	Land use maps (scale		
	Topographic maps		
	Map of soil types		
	Forest boundary map		
	Geological map		
	(Bf Scale: 1: 50,000)		
2.	Mahat watershed upstream discharge data	Hydroelectric Koto Panjang	To see the change in flow rate upstream sub-watershed Mahat due to changes in land use
		SWS II Inderagiri	
3.	Climate data (rainfall)	BMKG Sicincin	

Data Collection Techniques

At this stage, identity, stock, and procurement of substances and the essential information, which includes contour maps, map earth manner, the picture of Landsat 7 ETM guy pereka yr 1995, 2000, 2005, and 2010, soil map scale 1:50. 000, Map slopes digital elevation maps acquired through the model (DEM) scale 1: 50. 000 is processed via contour map scale of one: 50. 000 with the use of the program ArcView 3.2.

Land Use: Land use information obtained from photograph analysis of Landsat ETM 7, ok emudian conducted floor check / observation at pattern web sites within the discipline to see the improvement of current land-use exchange. records land use is analyzed land use facts are available the remaining 15 years (1995, 2000, 2005 and 2010)

Rainfall: Rainfall records is daily information, the information is accumulated from the Meteorology, Climatology and Geophysics enterprise (BMKG) Sicincin, beginning in 1995 via 2010

Mahat Discharge Upstream: Water discharged gathered is monthly information for 12 years (1999 -2010), and day by day information from 2004 to 2010, this statistics is used to peer the persevering with effect of land use change on hydrological factors.

Landsat photos were analyzed the usage of ERDAS V, 8.7 for getting land use statistics contained inside the image is performed klassifikasi the Landsat photo ETM recording 7 years 1990,1995,2000 and 2010. category technique used is the most similarity clasification supervised (maximum chance supervised class), in which every spectral class is described via a chance distribution in a multispectral area. Overlay analysis techniques using ArcView three.2 objectives to decide the type of the prevailing spatial adjustments between 1995 to 2010

To look the results of adjustments in land use or watershed reaction Mahat Hulu to hydrology factors this is enter into the discharge rain, it will likely be the evaluation of rainfall, waft evaluation and land-use

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exchange. Discharge data analysis can be achieved through searching on the trend of the affect of land use change on river discharge is generated. The technique used is the mathematical models specifically a couple of regression evaluation (more than one regression) to demonstrate the diploma of correlation among several unbiased variables and the established variable, discharge information is the statistics so as to be used month-to-month discharge series Mahat Hulu DAS 12 years (1999-2010)

Regression mathematical form as follows:

$$Q_{max} = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_n x_n + έ$$

$$Q_{min} = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_n x_n + έ$$

$$CRO = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_n x_n + έ$$

where x 1; x 2; x 3; x 4; x 5, and x n; was the proportion of each type of land use, β o, β 1, β 2, β 3, β 4, β 5 and β n coefficients regression of each variable x, while έ is the residual or error is assumed to be normally distributed with mean 0 and standard deviation close to certain.

III. RESULTS AND DISCUSSION

Land Use Change at Mahat Hulu Watershed

Analysis of land use changes of the image is done in three (3) periods of time ie 1999-2002, 2003-2006, and 2007-2010 for more details can be seen in the following table (Table 2)

Table 2: Changes in Land Use in the Watershed Upstream Mahat 1995-2010

		Periode		Periode		changes		Periode		changes	
		1999-2002	(%)	2003-2006	(%)	Ha	(%)	2007-2010	(%)	Ha	(%
1	Forest	11,200.2	39.3	9,683.8	33.9	(1,516.4)	(5.3)	8,447.6	29.6	(2,752.6)	(9.6)
2	Mix garden	8,443.3	29.6	10,408.0	36.5	1,964.6	6.9	11,976.0	42.0	3,532.7	12.4
3	shrubs	3,164.2	11.1	2,911.8	10.2	(252.4)	(0.9)	2,720.0	9.5	(444.2)	(1.6)
4	Dry lands	2,447.3	8.6	2,251.4	7.9	(195.9)	(0.7)	2,111.3	7.4	(335.9)	(1.2)
5	Wet lands	1,800.2	6.3	1,897.7	6.7	97.4	0.3	1,908.0	6.7	107.8	0.4
6	Settlement	65.1	0.2	68.4	0.2	3.3	0.0	69.7	0.2	4.6	0.0
7	Water	217.7	0.8	283.7	1.0	66.0	0.2	306.5	1.1	88.8	0.3
8	cloud	1,197.4	4.2	1,030.8	3.6	(166.7)	(0.6)	996.3	3.5	(201.2)	(0.7)
	Total	28,535.5	100.0	28,535.5	100.	(0.0)	(0.0)	28,535.5	100.0	(0.0)	(0.0)

Source: Results of Landsat imagery interpretation ETM7 (1995-2010)

Table 2 is seen that watershed land use Hulu Mahat period 1999-2002 consists of 6 (six) in addition to the use of water bodies and cloud are: a) forest, b) mixed garden, c) shrubs, d) dry land, e) wet land, and f) settlement. In this period DAS Mahat Hulu is still dominated by forest vegetation covering an area of 11200.2 ha (39.3%), and mixed garden 8443.3 ha (29.6%), while at the end of the period 2007-2010 forest area only 8447.6 ha (29.6%) decreased 9.6% (2752.6 ha), but 11976 ha of mixed gardens, increased 12.4% (3532.7 ha). For more visibility upstream Mahat watershed land use can be seen from Figure 1 map land use Hulu Mahat DAS 1995.and 2010. Deforestation cause by new agricultural land, especially for gambir.

DOI: 10.37200/IJPR/V24I5/PR201799
Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

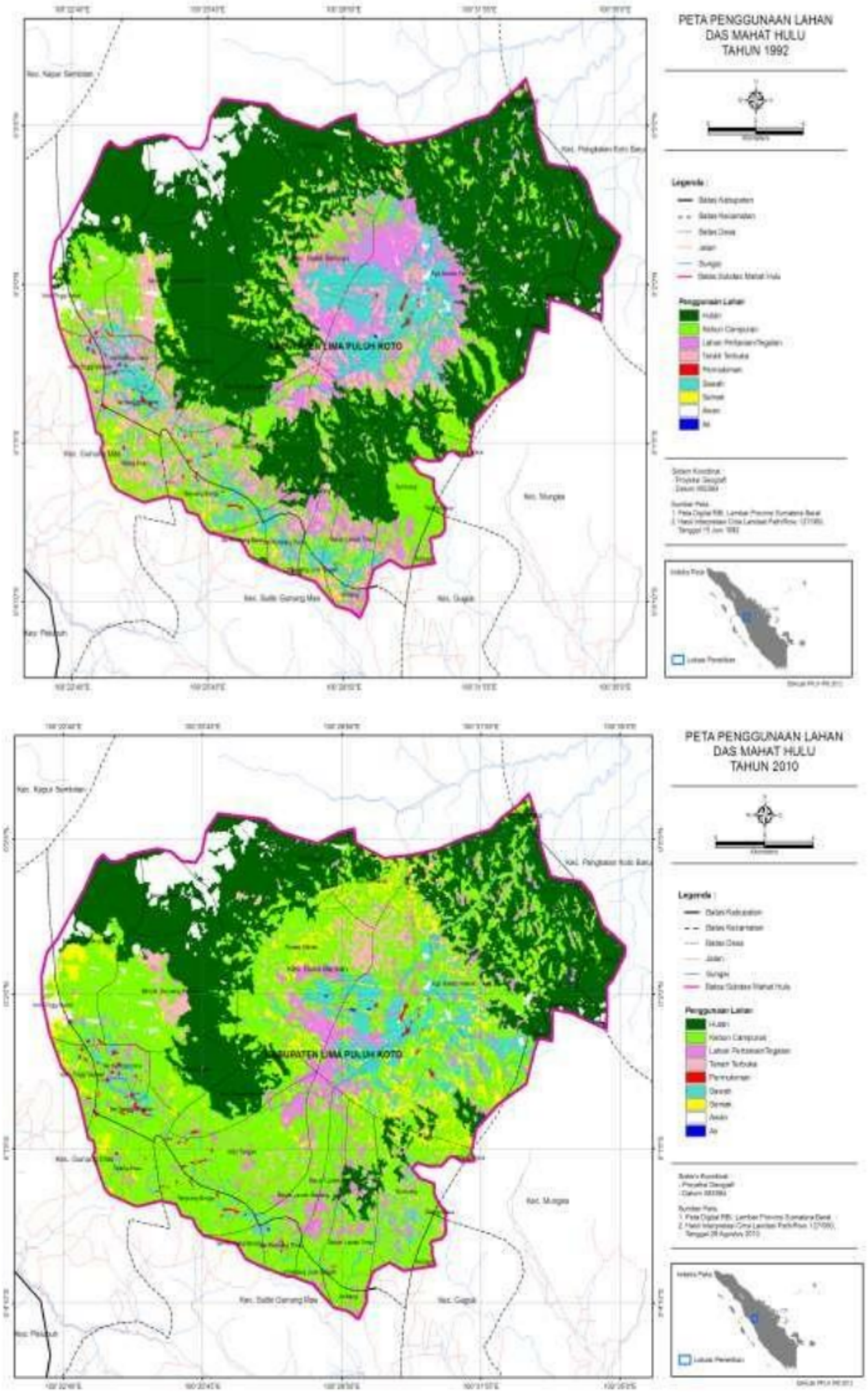

Figure 1: Land Use Map Mahat Hulu Watershed 1995 and 2010

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

Rainfall and Discharge at Mahat Hulu Watershed

Based on rainfall data for 15 (fifteen) years period 1995-2010, the magnitude of the average annual rainfall Mahat Hulu watershed is 1978 mm / year. Wet season generally occurs from the months of October to April, while in dry months from May to September. The highest monthly average rainfall occurred by 16 days in October and the lowest occurred in May 8th day of rain (Figure 2)

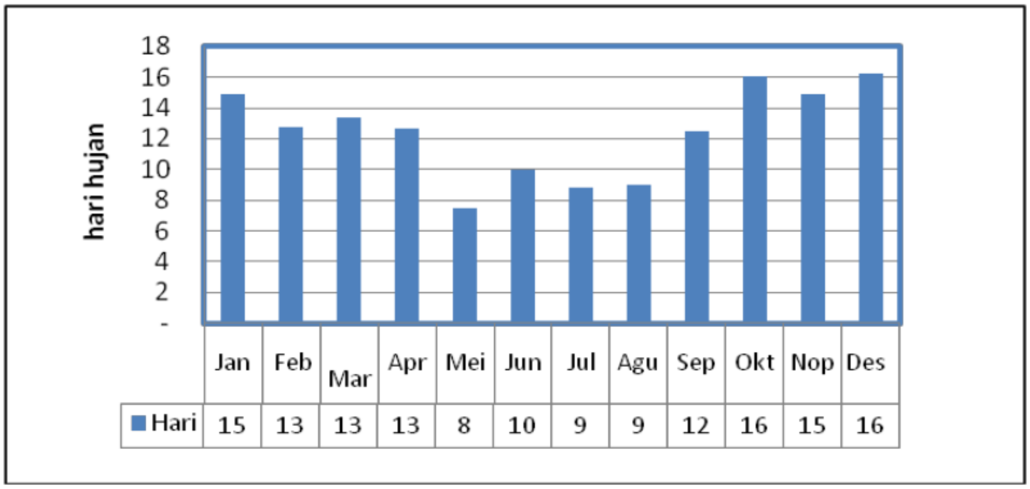

Figure 2: Day Average Monthly Rainfall Mahat Hulu Watershed (1995-2010)

Rainfall is the highest monthly average (259 mm) occurred in February and the lowest (71 mm) fell in July. Such rain patterns greatly affect the volume and distribution of river discharge. In wet season rainfall is very high and the otherwise very dry in dry season

The Influence of Land Use Change to Hydrological Aspects

Relatively high rainfall in the wet months are potentially increase runoff. This situation is also supported by a dwindling forests throughout the watershed Mahat Hulu. Changes in the use of forests to other land uses, causing the surface of the land to be open, with moderate clay content and low to moderate infiltration capacity. rain water more then at ground level or increased runoff. Similar with the statement Baver (1956) divides the influence of vegetation on surface flow and erosion into five parts, namely 1) Role in the interception, 2) Reducing speed and destructive power flow surface, 3) The influence of the root, 4) Biological aspects, and 5) Transpiration. While Arsyad (2010) says that the surface flow is strongly influenced by rainfall (amount, intensity and distribution), temperature, soil (type, type, layer of soil, and topography), watershed area, vegetation cover and soil management. However, because each factor has contributed a very complex one another, the estimation of runoff that is really close to the real situation is still relatively difficult.

Furthermore the average daily discharged for the period (1999 -2010) ranged from 11.19 to 15.07 m^3/sec Distribution pattern of the average daily discharge generally follow the pattern of rainfall in the Mahat Hulu watershed. Relationship between the magnitude of the average monthly rainfall with an average monthly streamflow upstream Mahat Hulu watershed shown in Figure 3 which shows the results of water (water yield) in the form of

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Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

volume and distribution of discharge that occurs in addition affected by the main input (rain), also influenced by the biophysical conditions DAS is concerned as the condition of land cover, soil type, and topography.Which states the existence of forests in controlling surface and the discharge is not infinite, but there are factors outside the forest that is the amount of rainfall, slope, geology (soil) and land use. If one of the factors that are experiencing changes in the hydrological conditions in question would change include surface runoff and river discharge (Pudjiharta. 2008).

Increased runoff curve also indicates an increase of the amount of rain that turned directly into the discharge. As a result the higher discharge during the wet season (October to April) and lower in the dry season (May to September) Suryani.E and F. Agus (2005) reported that in the period 1992-2002 in Cilajupang watershed (2792 ha) has been done deforestation by 2, 35% and approximately 7.27% mix garden, but at dry land increased by 5.64% and the settlements around 5 , 11%. The impact of land-use change that occurred was an increase in total annual water yield though not significant (+0.35%). Significant changes occur in the flow components. Total runoff increased by 12.37% and the basic flow decreased by 2:54%.

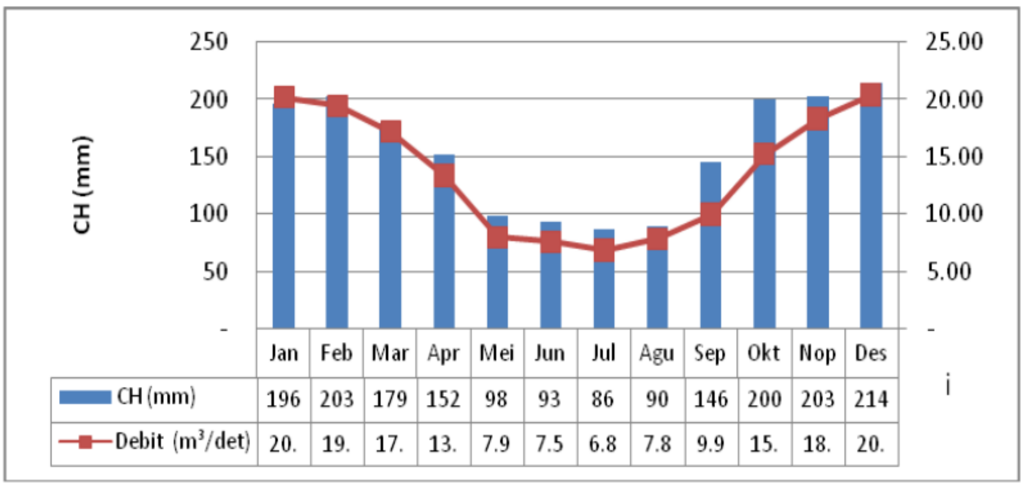

Figure 3: The Relationship between Monthly Rainfall 1999-2010 (mm) with an Average Daily Discharge Mahat Hulu Watershed 1999-2010 (m^3 / sec)

Land use changed has increased annual runoff coefficient (C) than the average 20% to 24% (Table 3). The amount of surface runoff coefficient that describes the loss of water can not be used, because the direct flow and thrown away without being able to be used. Such a large loss of water caused by changes in the use of forest land to other land uses, especially for mixed gardens, which are supposed to reduce infiltration capacity so that the amount of rain water into the surface flow is much greater than that infiltrated. To it is necessary forest rehabilitation and the application of agrotechnology to reduce runoff and increase infiltration at Mahat Hulu watershed. Like what is proposed by Suwardjo (1981) that the use of one application of mulch Agrotechnology very effectivet to reduce runoff and soil erosion, its effectiveness depends on the amount and durability of the decomposition process, one kind of straw mulch is effective enough on land with slopes up to 26 percent.

DOI: 10.37200/IJPR/V24I5/PR201799
Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

Table 3: Runoff Coefficient (C) DAS Mahat Hulu 4th Annual Periods

Period	Forest (ha)	Forest (%)	Mixed G (ha)	Mixed G (%)	RF (mm)	Disch. (m3/dtk)	RO (mm)	C (%)
1999-2002	11200.2	39.3 ^{a}	8443.3	29.6 ^{a}	2,202.8 ^{a}	161.6 ^{a}	1,451.5 ^{a}	20.0 ^{a}
2003-2006	9683.8	33.2 ^{ab}	10408	36.5 ^{ab}	1,603.6 ^{b}	175.6 ^{ab}	1,558.2 ^{ab}	21.0 ^{ab}
2007-2010	8447.6	29.6 ^{c}	11976	42 ^{c}	1,744.4 ^{b}	223.8 ^{c}	1,595.4 ^{c}	24.0 ^{c}

Remarks : Numbers followed by the same letter in the same coloum are not significantly different at α= 5%

The last periode (2007 - 2010) discharged of Mahat Hulu watershed more than the first periode (1999 - 2002) that was 223.8 m ^{3} / sec (periode 2007-2010) meanwhile in the periode 1999-2002 only 161.6 m ^{3} / s, which means rising 62.2 m ^{3} / sec. Results of water rose from 20 to 24, causing the larger the volume of water that can not be utilized and flows directly into the sea is estimated 113 million m ^{3} / sec (Figure 4)

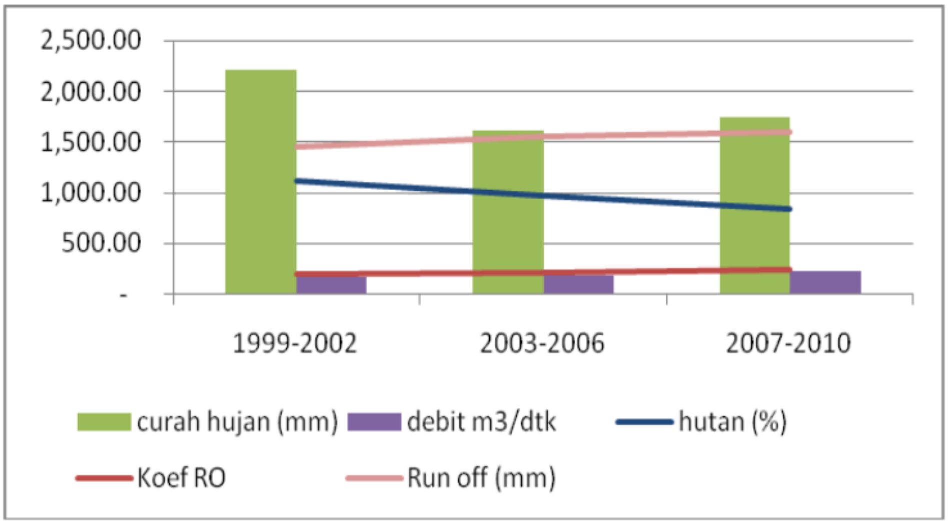

Figure 4: Forest and its Effect on Surface Runoff in Mahat Hulu Watershed

Run off Coefficient (C) during the rainy season is also different from the dry season in the same period. Table 4 shows the 1999-2002 period runoff coefficient (C%) is 20, while in the dry season 10. At the end of the period 2007 -2010 C (%) rainy season rose to 30%, while in the dry season is only 20%. This suggests that the impact deforestation during the rainy season led to increased surface flow is quite high compared to the dry season, which means also decrease the ability of the soil to infiltrate rainfall (Figure 5).

Table 4: Run off Coefficient (C) based on Season

Period	Forest (ha)		Rainy season				Dry season			
		Mixed G (ha)	RF (mm)	Disch (m3/dtk)	RO (mm)	C (%)	RF (mm)	Disch. (m3/dtk)	RO (mm)	C(%)
1999-2002	11200.2^{a}	8443.3 ^{a}	234.8^{a}	17.3^{a}	156.9^{a}	20^{a}	132.4^{a}	7.9^{a}	72.2^{a}	11^{a}
2003-2006	9683.8^{ab}	10408 ^{ab}	179.4^{b}	19.0^{a}	179.5^{ab}	27^{ab}	114.9^{b}	8.9^{ab}	80.8^{ab}	12^{ab}
2007-2010	8447.6^{c}	11976 ^{c}	175.8^{b}	20.4^{a}	185.1^{c}	32^{c}	111.3^{b}	11.3^{c}	102.8^{c}	24^{c}

Remarks: Numbers followed by the same letter in the same coloum are not significantly different at α= 5%

DOI: 10.37200/IJPR/V24I5/PR201799
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In the period 2007-2010 the forest area has been significantly reduced with the increase of mixed garden, this change implies that the higher erosion, discharge increased which in the rainy season 20.4. m3/sec and 11.3 m3/sec in the dry season. The high level of surface roughness and organic matter in the form of sarasah and dense canopy of the forest is the main factor reducing the effectiveness of forest runoff. Surface roughness, soil porosity and infiltration increased as a result of organic matter that accumulates on the surface and at the same time able to reduce run off.

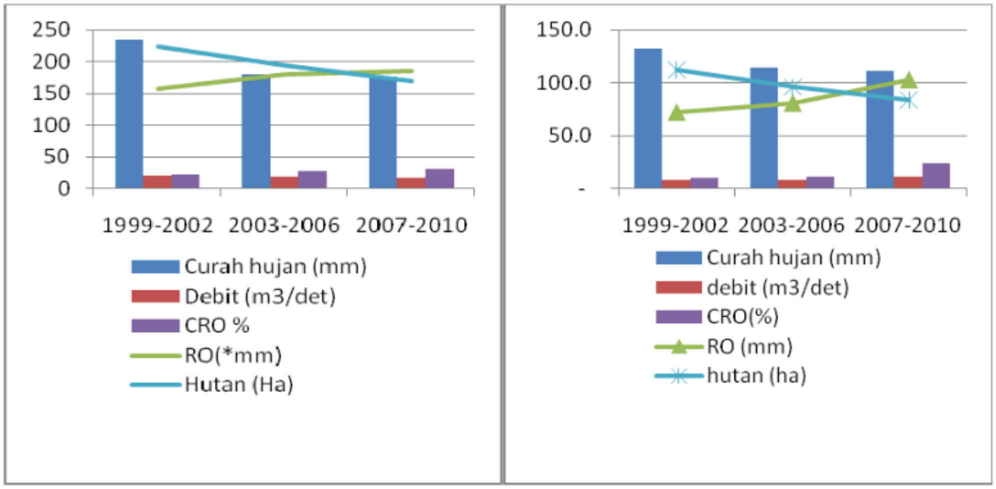

Figure 5: Forest and Run Off Coefficient (Rainy and Dry Season)

Tropudult typic soil types are dominant in the upstream watershed Mahat is also one type of soil that is dominated by clay and the ability to pass water infiltration is low to moderate (5.8 to 18.6 cm / h), permeability at speeds from 3.0 to 12 , 5 cm / h which characterizes the condition of the soil to pass a slow to moderate water, and dominated the slopes above 25% quasi characterize the biophysical conditions are not easily stored water and surface flow is quite high.

Further analysis of the impact of land use change on hydrological conditions is to look at the relationship (correlation) between the value of C (%) with watershed land use Hulu Mahat (%). First with multiple regression analysis (multiple regression) are presented in the following equation. C (%) = 975 - 11.2 Forest - 15.3 mixed G - 10.9 shrubsr + 0.43 dryland dan R-Sq = 42.4%, Stepwise Regression presented in the following equation C (%) = 31.5 - 0.370 dan R-Sq = 5,3%.

For regression was tested with a single and get the following equation: C (%) = 31.5 - 0.370 dan R-Sq = 5,3%..Conclusion forest turns negative effect on runoff. The more extensive the forest, the less runoff proved that the hypothesis is accepted (Figure 6)

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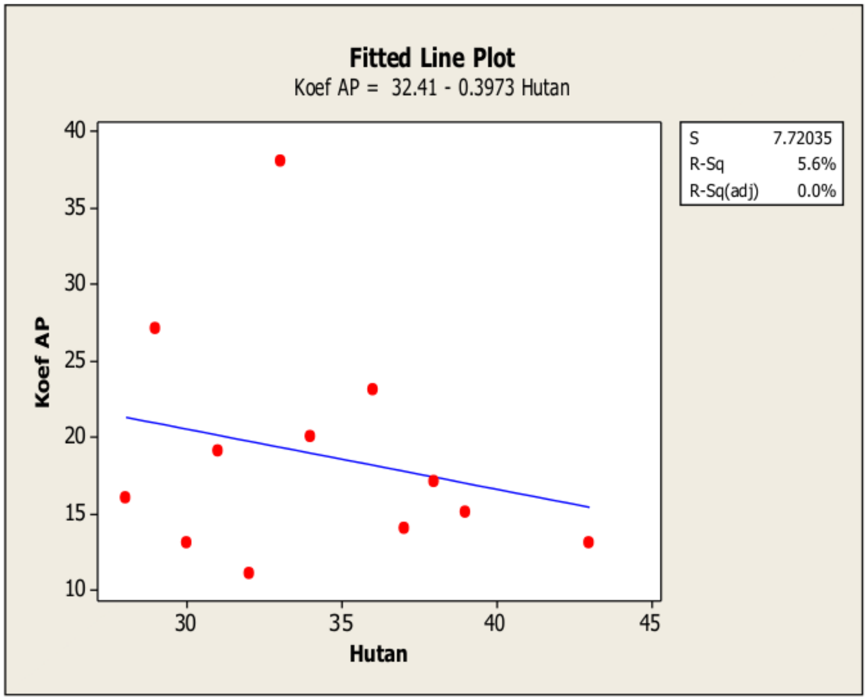

Figure 6: Simulation of Forest and Run Off

Furthermore, by the equation C (%) = 31.5 - 0.370 Forest on simulation to estimate the impact of changes in land use change in the proportion of forest cover in particular the runoff coefficient (C) and estimates the value of lost water and that can be exploited Table 5

Table 5: Simulation of Forest Land Use Change on (C) and the Estimation of Water Lost

No.	Forest (%)	C (%)	RF (M / yr)	Water is lost million m³ / yr	Value of water Billion / yr	Water used million m³ / yr	Value of water (Billion / yr)
1	20	24.5	1.6	113.0	67,801.6	387.0	464,396.8
2	25	22.5	1.6	103.8	62,299.3	396.2	475401.4
2	30	20.5	1.6	94.7	56,797.0	405.3	486,406.0
4	35	18.5	1.6	85.5	51,294.7	414.5	497,410.6
5	40	16.5	1.6	76.3	45,792.4	423.7	508,415.2
6	45	14.5	1.6	67.2	40,290.1	432.8	519,419.8
7	50	12.6	1.6	58.0	34,787.8	442.0	530,424.4

Sources: H acyl simulated forest area and runoff

price per m³ of water = Rp. 1200. - (2012)

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Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

The increase forest cover in a watershed can reduce surface runoff coefficient (C), which in turn can increase the amount of water that can be utilized. This is because the forest is able to reduce runoff and increase infiltration capacity (Table 5). In accordance with the statement of Hewlett and Nutter (1969) that the upstream region is covered with forests better then 80-85% of the total flow from the base flow is sustained by the flow slowly from the *zone of aeration* the rest is direct flow (15-20%). Thus, the development of water resources with forest rehabilitation activities (reforestation) are implemented on watershed Mahat Hulu will be able to increase the availability of water for downstream communities, especially for hydropower Koto Panjang. In accordance with Law No. 41 of 1999 on forest area in the watershed of at least 30%,. on research conducted fairly low runoff coefficient reached 20.5 %. To reduce runoff coefficient to be 1 0-15%, forested watershed areas to 45-50%. This is consistent with the results of the study Arief et, al (1991) showed that the *pine* forest watershed *Merkussi* have ground water reservoir thickness 312 mm and in agricultural watersheds on geological and topographical conditions of the same total soil water reservoir is only 27 mm while the watershed land cover mix in the area Cikapundung Gandok thick 241 mm soil water reservoir and the area Cigulung Marivaya on condition of mixed land cover 254 mm total water content, thus saving more forested watershed groundwater.

Subsequent analysis showed that changes in land use (PPL) or a decrease in forest area and increasing the use of mixed gardens and other cause the discharge increases the average daily maximum (Q max) and minimum discharge lowers the average daily (Q min) DAS Mahat Hulu. In this research, the testing of multiple regression analysis unakan use it again and get the equation Qmax HTN = 18 + 0.23 + 0.08 + 0.37 kbn.cmprn smk.blkr - 0.92 tgln. R-Sq = 1.0%. Results obtained turned out to woods, gardens and shrubs mixed Q shrub positive effect on the maximum and just moor negatife influential. But through a single regression test which turned out to increase forest cover affects the maximum increase in Q while decreasing forest area does not affect the increase in maximum Q. Regression equation as follows. Qmax = 26.8 - 0.042 kbn.cmprn. R-Sq = 0.5%

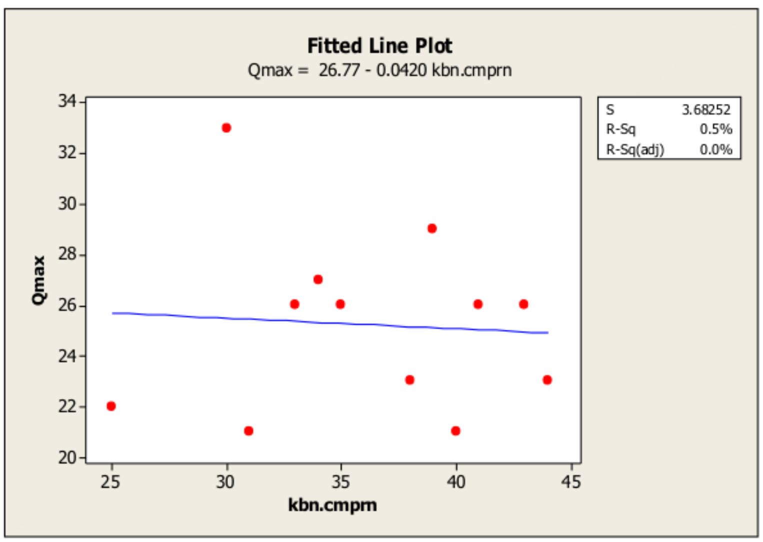
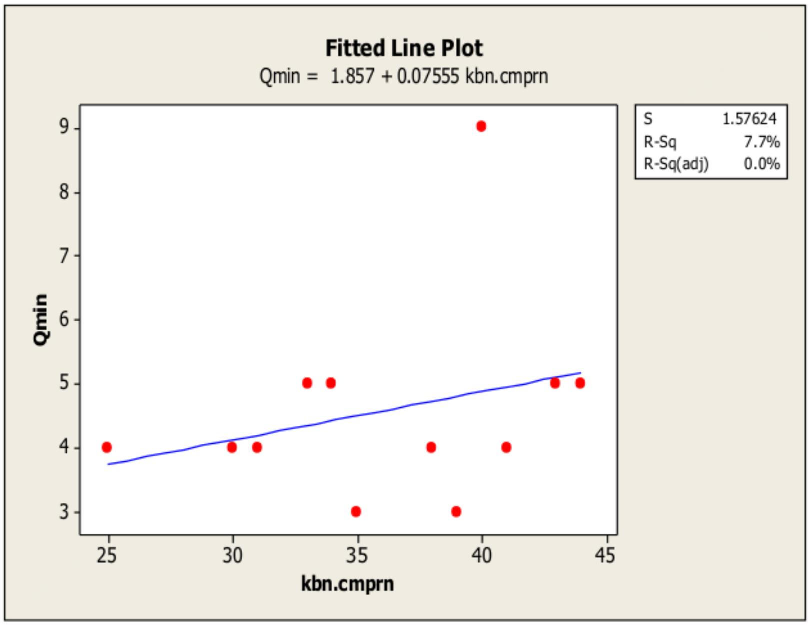


Fig. 7: Simulation Q max with Mixed Garden

DOI: 10.37200/IJPR/V24I5/PR201799
Received: 13 Feb 2020 | Revised: 07 Mar 2020 | Accepted: 23 Mar 2020



Fig, 8: Simulasi Q min with a Mixed Garden

Effects of changes in land primarily due to declining forest cover and increasing mixed gardens will also affect the minimum discharge (Q min). Regression test to get the following equation: Qmin = - 55.1 + HTN + 0.61 0.98 + 0.72 kbn.cmprn smk.blkr 0:35 tgln +, R-Sq = 19.0%. These results have not shown a variable effect on the minimum flow. To further stepwise test, but did not show satisfactory results, the next process via a single regression test found that the minimum Q would increase along with the breadth of mixed gardens (Figure 7 and 8). But the forest is inversely proportional, Qmin = 1857 + 0.07555 kbn.cmprn. R-Sq = 7.7%

According to Noordwijk VM. et al, (2004) Land cover by the tree in all its forms can affect water flow (discharge). Tree cover may be either a natural tree, plant or natural regeneration in the forest. Cultivated trees, trees as a hedge or tree monocultures (industrial plantations). Further, they say that the tree cover affects the flow of water in different stages such as: 1) interception, 2) protection of soil aggregates, 3) infiltration, 4) water uptake, and 5) landscape drainage.

This is consistent with the results of Pramod, I, B et.al (2010) who conducted a study in basin made from limestone parent KPH Cepu said that the peak discharge will change significantly involved in the event that the original forest area change 80% of the watershed area decreased to 53% watershed area, discharge peak rise of 30 l / sec / km ² becoming 67 l / sec / km ². fact shows that the changes in the use of forest land to other uses contributed immensely to the increase in the maximum discharge average and volume of runoff. Furthermore, identifying activities pentupan land, needs to be deepened to measure the quality of its closure. This is because according to its function as a regulator of the water system, the possibility of mixed gardens can work together with forest, in other words the response of vegetated land cover types may be similar to rain On the other hand this leads to decreased soil water storage that will directly lower the minimum flow daily average.

DOI: 10.37200/IJPR/V24I5/PR201799
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International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

Asdak, (2007) said that the function of the forest vegetation in regulating the hydrological environment occurs through the soil surface protection against the onslaught of rain kinetic energy, ie, through the 3 (three) layers of water storage areas, either by canopy strata (canopy) Sarasah forests, as well as pores forest soil, so that the water flow can be regulated. This is consistent with the proposed Sinukaban (2007), that the reduction in soil infiltration capacity erosion in the upper watershed caused replenishment (*recharge*) water under the ground (*ground water*) is also reduced, resulting in droughts in the dry season and floods during the rainy season .

Table 6: The Effect of Land Use Change to Discharged

Period		Discharged (m3/sec)		
	C (%)	Rainy season	Dry season	Fluctuation Disch. (Qmax/Qmin)
1999-2002	20[a]	17.3[a]	7.9[a]	2.4-5.5[a]
2003-2006	21[ab]	19.0[b]	8.9[b]	5.6-5-8[a]
2007-2010	24[c]	20.4[b]	11.3[b]	5.9-10.7[b]

Remarks : Numbers followed by the same letter in the same coloum are not significantly different at α= 5%

Land use changes in also causes increased fluctuation of the average daily Mahat Hulu watershed (1999-2010) that divided into 3 periode. For the first period (1999-2002) fluctuation of discharged only 2.4-5.5 but for the last periode (2007-2010) increased to 5.9-10.7. This proves that the land use change on the KRS is not only caused by reduced forest area but also due to the increased use of other mixed garden during the 12 years of observation of forest land use change to other land uses have made critical for Mahat Hulu watershed.

Ilyas (2000) reported that, the decline in the forest area in East Kalimantan Karangmumus watershed of the area of 18% to 10% can cause an increase in flood peak rate of 7.6% of the original condition. While Sinukaban N, Satjapradja, and Wastra (2007) states that the change in land use bush into *agroforestry* (mixed gardens) in Sub-watershed Manting East Java has led to an increase in the coefficient of river regime (KRS) or fluctuations in surface runoff from 9.7 in 1987 to 10.1 in 1988 and to 13.1 in 1999. This is because agroforestry or mixed gardens that applied causing some land to be open, so the impact on the increase in surface runoff.

IV. CONCLUSION

1. Mahat Hulu watershed forest decreased significantly over the last 15 years. During the early period 1999-2002 still dominant forest area is 11200.2 ha (39.3%), and mixed garden 8443.3 ha (29.6%), and another 8891.5 ha (31.111%), but in the last periode (2007-2010) the forest area decreased to 8447.6 ha (29.6%) fell 9.6% (2752.6 ha), mixed gardens increased to 11976 ha, up 12.4% (3532.7 ha) and another 8111.4 ha (28.43%).

2. Deforestation has been influence aspects of hidrology eg, a) Run off coefficient increasing from 20% in the 1999-2002 period to 24% in the period 2007-2010. b) increasing discharged from 161.6 m^3/sec (1999-2002) to 223.8 m^3/sec. c) Deforestation also increasing Q max.and d) Increasing discharged fluktuation from 2.4-5.5 (1999-2002) to 5.9-10.7 (2007-2010 and the last, water lost around 113 million m^3/year (Rp.67.8 M/year) cause by increasing run off coefficient

3. Land use change (deforestration) has led to high sedimentation in reservoirs PLTA Koto Panjang Koto

DOI: 10.37200/IJPR/V24I5/PR201799
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Panjang. Its impact is loss of hydropower from 3 GWh -30 GWh in a month.

4. Improving traditional mixed gardes systems by using agrotechnology strip cropping and mulch systems reduce erosion rate under tolerable erosion is 32.82 ton/ha/year meanwhile E-tol is 39.6 ton/ha/year.

SUGGESTION

1. Deforestation should stopped and to all stakeholders in the catchment area of the Mahat Hulu watershed already should cooperate in watershed management for the foreseeable future in order to avoid further. .
2. The concept of maintaining upstream and downstream pay compensation is a strategic step for DAS Mahat Hulu continues to function and the availability of water resources remain available. payment environment services especially for utilizing water

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DOI: 10.37200/IJPR/V24I5/PR201799
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