Study Of Land Cover And Condition Catchment Area Groundwater Aquifer In Tanah Merah North Samarinda District Using Resistivity Geoelectric Sounding

Djayus, Sigit Hardwinarto, Lambang Subagiyo, Sumaryono

Abstract: Land cover is a biophysical cover that maintains land conditions in water balance. The purpose of this research is to know the condition of land cover, water catchment, groundwater aquifer and correlation. This research begins by collecting data on land cover, soil type, rainfall, slopes and groundwaterinformation. Field activities include observation and data collection of land cover, geological conditions, community wells and geoelectric sounding. Land cover data is classified according to circumstances and conditions. Geoelectric sounding data was analyzed with IP2WIN software, interpretation of lithologic variation of rocks and depth based on resistivity value. Plot the position of each lithology sounding with Surfer software obtained kontour rock field boundary and 3D model of the aquifer position.The results showed that the land cover consisted of vegetated areas: forests 272,21 Ha (40,32%) and agricultural land 183,36 Ha (27,16%) non-vegetation area: 98,80 Ha (14,64%) constructed land, , Open land 116.33 Ha (17.23%) and water body 4.35 Ha (0.64%) The condition of land cover in this water catchment area has decreased 68,38 Ha (10,14%) from the previous condition 340,59 Ha (50,46%) to 272,21 Ha (40,32%). Referring to Permenhut RI No. 32 in 2009, total score catchment area 33, including the somewhat critical condition. Groundwater aquifers based on 3D sounding geolistrik modeling consist of a free aquifer for shallow groundwater depth of water level between (2-30) m with thickness ± (2-65) m and a distorted aquifer for groundwaterin depth of water between 75-150 m With thickness ± (75-125) m, depth of community well ± (10-45) m. The transfer of land into open pit mines resulted in the destruction of the balance and water system, the decreasing / decreasing the discharge of the well water of the community drill, the failure and the lack of new water discharge of the new wells, the loss of groundwaterin several dug wells, landslides and mud floods on the farmland

Keywords: Land cover, the condition of catchment areas, geoelectric sounding, aquifer

INTRODUCTION

Water is a vital need of living things on earth both for direct consumption and utilization derivatives. Without water there can be no continuity and life. One source of water for living things is groundwater, the water contained in soil layers or rock pores. According to the Geological Agency of the Ministry of Energy and Mineral Resources (The Association of Groundwater Indonesia, 2016), groundwater utilization in Indonesia to date ranks first as a source of water for the population. Groundwater will experience degradation of quality and quantity if not managed properly. Decrease in quality will occur if the cachment area is damaged or polluted and the quantity decrease occurs when groundwater extraction is done on a large scale regardless of the sustainability and governance of groundwater. Samarinda as the Capital of East Kalimantan Province periodically every 5 to 6 years affected by elino caused salt water into the Mahakam river so that clean water production stopped. On the other side some areas Samarinda kontournya hills and not reachable PDAM network. Efforts to meet the community's water needs rely on rainwater and groundwater. The potential and availability of groundwatertoday requires more serious attention and study because some areas suffer from water catchment by land transfer to open pit and other land functions. One of the land use of water catchment area occurred in Tanah Merah Samarinda Utara.

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Water catchment areas or green open areas in the area have largely been transformed into former mining areas, active mines, settlements, cemeteries and other land conversion functions. Some of the impacts caused by the current damage to the water catchment areas are the dry season of groundwater on some dug wells, the decrease of discharge at the borehole, the failure of the new drilling well and the mudflow in the rice field or the lower land. To prevent larger disasters, groundwaterproblems are needed to study land cover and groundwater aquifers, and proper and careful handling so that water systems can return to normal natural conditions.

MATERIALS AND METHODS

Land cover, Vegetation and Water Catchment Area

Land cover is a biophysical attribute of the earth's surface in a region (such as grass, plants, buildings) (Lambin et al., 2001). Land cover is a biophysical cover on earth surface that can be observed (SNI 7645, 2010). Land cover is a physical appearance of a landscape, both natural appearance and man-made appearance. The cover class is divided into two parts: vegetated and non-vegetated (non-agricultural) areas (SNI 7645, 2010). Vegetation is a collection of several plant species that grow together in one place where between the constituent individuals there is a close interaction. Vegetation serves the production and regulators of water and protection against soil degradation by rain because vegetation can encourage the impregnation of water into the soil. Billions of tree stands with canopy and wide enough canopy will withstand rainwater eruption. The water catchment area is the area of water entry from the soil surface into the water saturated zone so as to form a flow of groundwater flowing into the lower area. The amount of water entering the soil depends on the nature, state and type of local rock, the amount of vegetation in the water catchment / catchment, the shape of the landscape (slopes) and the amount of water that falls to the earth as rainfall, snow and so on. (Noor, 2008)

Land Cover Condition
The determination of water catchment conditions in this study is based on the Regulation of the Minister of Forestry of the Republic of Indonesia number 32 of 2009 concerning Procedures for Formulation of Rehabilitation Plans for Forest and River Basin (RTkRLH-DAS) (Wibowo, 2006), each having influence on Condition of water catchment area. Parameters of groundwater infiltration include rainfall, soil type, slope inclination, land use distinguished by weight and harkat. The model of the groundwater infiltration condition is distinguished by the weighting method (scoring).

Groundwater Aquifers
Aquifers are a layer of saturated groundwater that can store and pass the groundwater in sufficient and economical quantities (PP RI No. 48, 2008). Groundwater is found in permeable (water-permeable) geological formations known as aquifers which form water-binding formations that allow large amounts of water to move through them (Seyhan, 1977).

Geoelectric Sounding Resistivity
The geoelectric method works based on the resistivity of the rock layer. The price of rock resistivity depends on material type, density, rock porosity, water content, water quality and temperature. Aquifers in the form of loose minerals have a reduced prisoner price if the greater the moisture content of the soil or the greater the salt content Based on the study to be achieved then the investigation, using Geolistrik resistivity sounding method. Geolistrik resistivity sounding method aims to study the vertical resistivity variation of the subsurface layer. In this method the measurement at a point of measurement is done by varying the distance of electrode MN and AB = 1:20 (maximum), until the target depth is to be reached. The apparent resistivity value (ρ) (figure 1) according to (Reynolds,1997) is formulated:

$$\rho = K\frac{V}{I}\left[\frac{1}{2\pi}\left(\frac{1}{r_1}-\frac{1}{r_2}-\frac{1}{r_3}-\frac{1}{r_4}\right)\right]^{-1}$$

$$\rho = K\frac{V}{I}$$

$$K = 2\pi\left[\left(\frac{1}{r_1}-\frac{1}{r_2}-\frac{1}{r_3}-\frac{1}{r_4}\right)\right]^{-1}$$

$$K = 2\pi\left[\left(\frac{1}{AM}-\frac{1}{MB}\right)-\left(\frac{1}{AN}+\frac{1}{NB}\right)\right]^{-1}$$

Where: MN = a (space potential electrode); AM = NB = n.a ; MB = AN = (n + 1).a

Value K for Schlumberger configuration, using the equation: K = n. (N + 1) π a with n = 1, 2, 3,4,5 ….

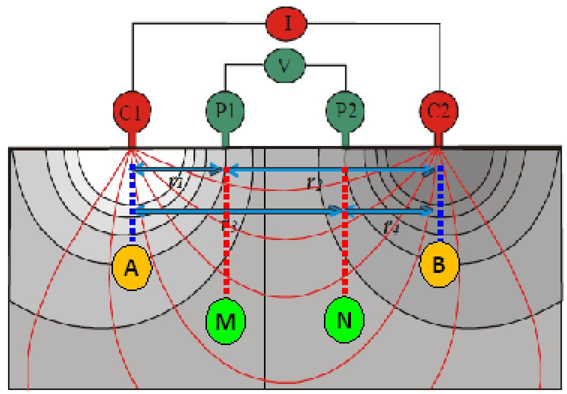

Figure 1. *Arrangement of current electrode and potential electrode*

METHOD
The steps and process of determining the analysis of the condition of the water catchment condition, the ground water aquifer model, the change of the water catchment area and the groundwater conditions (aquifer) are presented in the following diagram (figure 2).

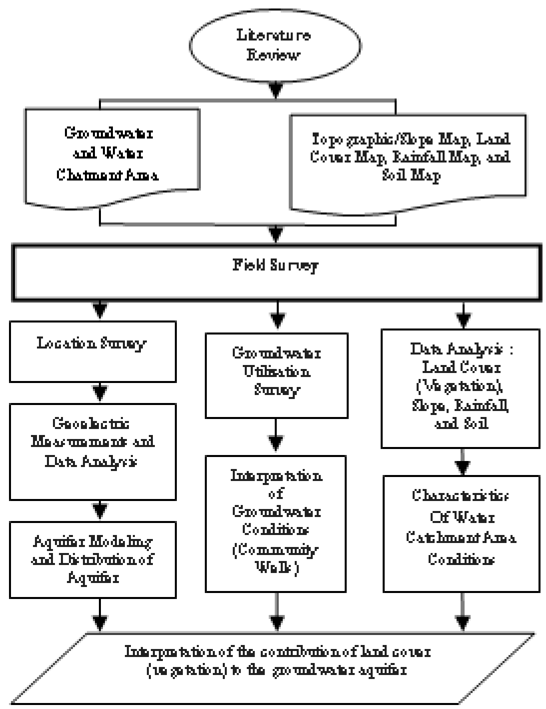

Figure 2. *Flowchart of research*

RESULTS AND DISCUSSION

Land Cover
Land cover in the study area consisted of vegetated and non-vegetated areas. Vegetation land in water catchment areas consists of forests and shrubs (shrubs, weeds, and weeds). Land cover in the southern watershed area is a hill area of Unmul Samarinda Botanical Garden (KRUS), in the western part is hilly with vegetation scrub the rest of the mine, and the eastern hills of protected areas of Tanah Merah waterfalls. Vegetation around the house (yard) is

dominated by banana, pineapple, salak, and perennials of rambutan, durian, jackfruit, cempedak, petai, mango, coconut and other wood species (sengon, mahoni, trembesi and bamboo), while agricultural land is dominated by rice and palawija. Non-vegetated land is dominated by settlements (homes and offices), road networks, active coal mining areas and coal mines, in the west-northwest direction there are Muslim burial grounds and Chinese cemeteries. Some non-vegetated land is a lake / reservoir / pond former coal mine, land use function shown Figure 3. The results of the initial land cover analysis are shown in Table 6 and the current conditions are shown in Table 2. Based on Table 1 before there is overturning into open pit areas the water catchment area in the form of forest and shrubs reaches 340.59 Ha or 50.46% Function to 272,21 Ha or 40,32% from total area of study 675,05 Ha. The facts on the ground over the function of water catchment areas continue to take place along with mining activities. While agricultural land in general area remains 183,36 Ha or 27,16%. In general, water catchment areas have a reduction of area of 68.38 Ha or 10.14% but because it occurs in the water catchment area it is very influential on the condition of groundwater balance. If the water catchment function continues, then in the next few decades the study area will likely experience a groundwater crisis.

Condition of water catchment area

The condition of water catchment area is determined by soil type, rainfall, land use and slope. The soil type in the study area is included in the red yellow podzolic group (Bapeda Samarinda, 2013), annual rainfall per year is 2,498 mm / yr (BPS, 2015-2016), land cover in watersheds in the form of forests and shrubs (Usage Map Land) Figure 3, Table 2 and slope of 8-15% (Bapeda Samarinda, 2013). The water catchment area conditions according to the Regulation of the Minister of Forestry of the Republic of Indonesia number 32 of 2009 on the Procedures of Preparation of the Rehabilitation and Rehabilitation Plans of the Watershed Area (RTkRLH-DAS) shall be determined based on their value and weight. The scoring result of the value and weight is shown in Table 3 and the results of the criteria are shown in table 4.

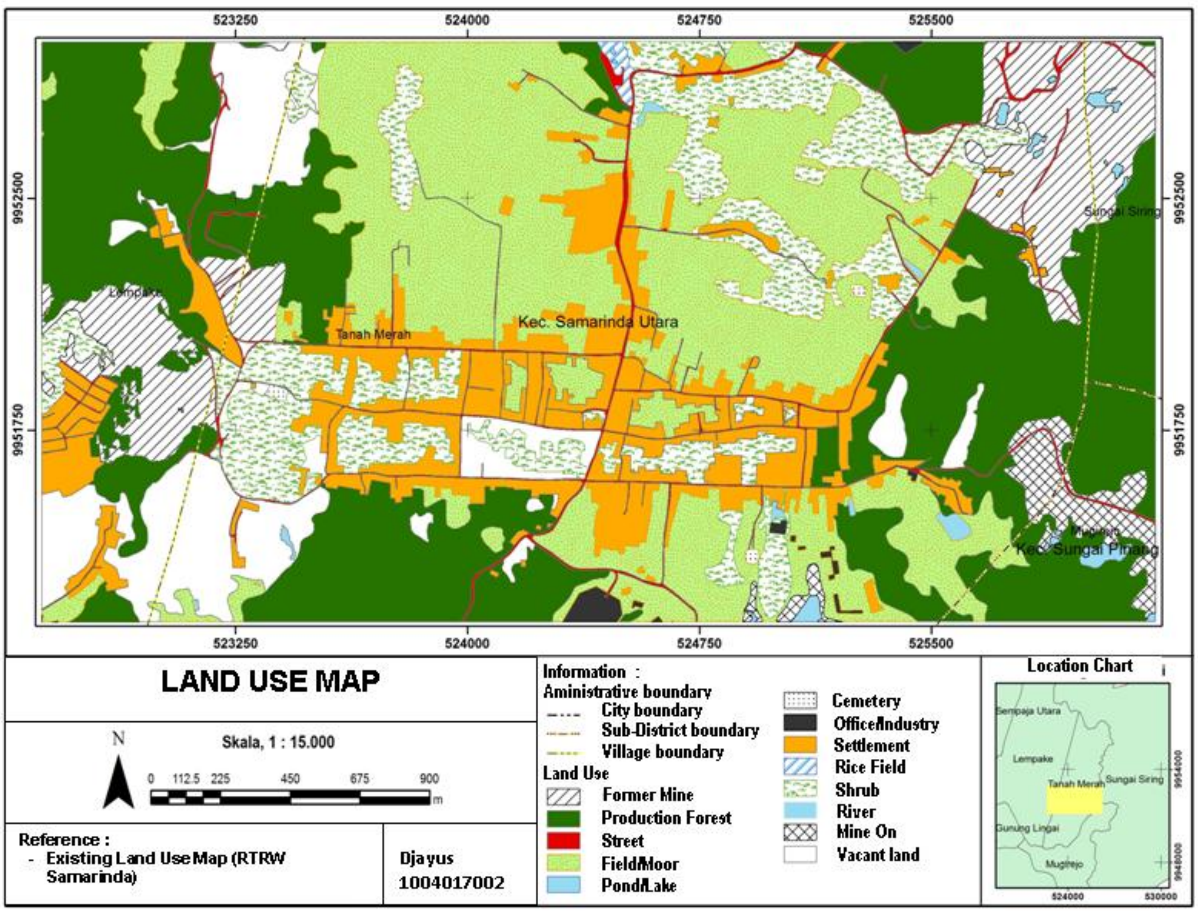

Figure 3. *Map of Land Use of Study Areas (Tanah Merah Sub-District North Samarinda)*

Table 1. *Results of Land Coverage Analysis Before Land Function Transfer*

No.	Land Use	Type of Land Cover	Large		Initial Land Use	
			Ha	%	Ha	%
1	Forest	Shrub	78,56	11,64	340,59	50,46
		Production Forest/conservation	262,03	38,82		
2	Agricultural Land	Rice Field Field/Lake	183,36	27,16	183,36	27,16
Land Area Vegetated					523,95	77,62
3	The land is awakened	Office	2,65	0,39	98,80	14,63
		Settlement	81,95	12,14		
		Street	14,20	2,10		
4	Open Land	Vacant Land	52,30	7,75	52,30	7,75
Land Area not Vegetated					151,10	22,38

Table 2. *Results of Land Coverage Analysis After Land Function Transfer*

No.	Land Use	Type of Land Cover	Large		Land Cover Now	
			Ha	%	Ha	%
1.	Forest	Shrub	78,56	11,64	272,21	40,32
		Production Forest/conservation	193,65	28,69		
2.	Agricultural Land	Rice Field Field/Lake	183,36	27,16	183,36	27,16
Land Area Vegetated					455,57	67,48
3.	The land is awakened	Office	2,65	0,39	98,80	14,64
		Settlement	81,95	12,14		
		Street	14,2	2,10		
4.	Open Land	Vacant Land	52,3	7,75	116,33	17,23
		Former Mine	51,65	7,65		
		Mine On	11,76	1,74		
		Cemetery	0,62	0,09		
5.	Water Body	Pond/Lake	4,35	0,64	4,35	0,64
Land Area not Vegetated					259,48	32,51

Table 3. *Calculation Result of harkat times The weight of water catchment area condition in Tanah Merah Sub-District North Samarinda*

Attribute	Criterion	Harkat x Weight
Soil Type	Podsolic	10
Rainfall	2.498 (mm/tahun)	8
Land Use	Forest and Shrub	9
Slope	8-25%	6
Total Value		**33**

Table 4. *Criteria Condition of Soil Absorption in Tanah Merah Sub-District North Samarinda*

Total Value	Criteria
> 48	Good condition
44 – 47	Normal natural conditions
40 – 43	Conditions begin to be critical
37 – 39	Condition is somewhat critical
< 32	Conditions are very critical

Real condition of the Water Chetment Area

The water catchment area conditions of the research areas outside the Unmul Samarinda Botanical Gardens (KRUS) have largely shifted to open mining areas (ex-mining and active mines) and other functions (funeral, office and business premises). Forms of former mining areas in the form of lakes and peat soil coverings that have not been reclaimed, while the transfer function in the settlement area in the dominance of land maturation for plot. The impact of the land conversion is the occurrence of mud-flooded flooding from the mine area to the farmland when the rain. When the drought arrives, it starts to feel less water source, drying some digging wells, decreasing / decreasing drilling well water wells and difficulty and lack of water flow from new well maker

Geoelectric

The result of soundproofing process with IP2WIN software is a graph of resistivity value and layer thickness. Interpretation of the sounding graph with the value of rock resitivity obtained by the sounding lithology of the rock shown in Figure 4. Based on the lithological plot of Figure 4 above, we obtain a description of the contour of the boundary layer boundary field model (upper limit of shallow aquifer), the depth contour of the well, the lower limit of the shallow aquifer, the upper limits of the deep aquifer are shown Figure 5. The result of groundwater modeling in the research area based on geoelectric interpretation consisted of shallow aquifer and aquifer in Fig. 5 and Fig. 6. A shallow aquifer is suspected to be a free aquifer with a depth of ± (5-30) m and a ± (2-65) m thickness and a deep aquifer Is a distressed aquifer with a depth of ± (75-250) m and thickness ± (75-125) m. The depth of the community's wellbore is at a depth of ± (10-45 m), indicating that the groundwater source of the community is in shallow water aquifer Figure 6. Based on the water catchment model located in the western area of the present study of the former open pit, the southern region as KRUS area, the eastern region of the waterfall. Groundwater aquifers and deep aquifers are evenly distributed, generally the north to east is relatively thicker and shallower.

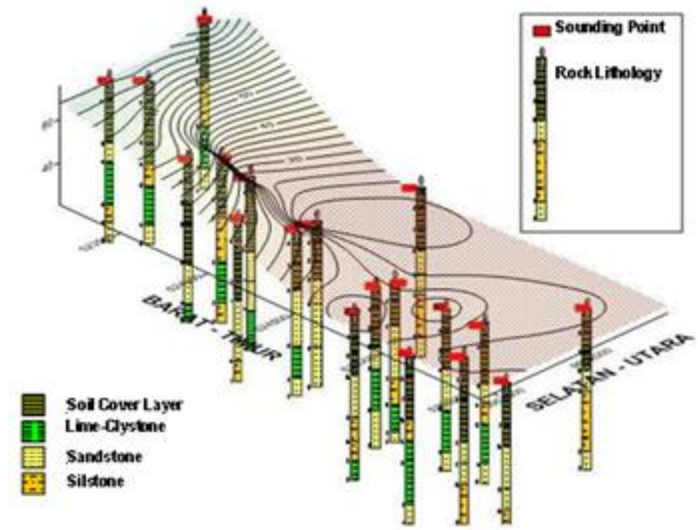

Figure 4. *Plot of rock lithology for each sounding point.*

Water flow on the surface generally leads to the center basin and leads north of the research area. Figure 5. Surface water flows from the relatively higher and steeper western part of the east and turns northward in the middle, from the south towards the north, and From the east to the west and turn north

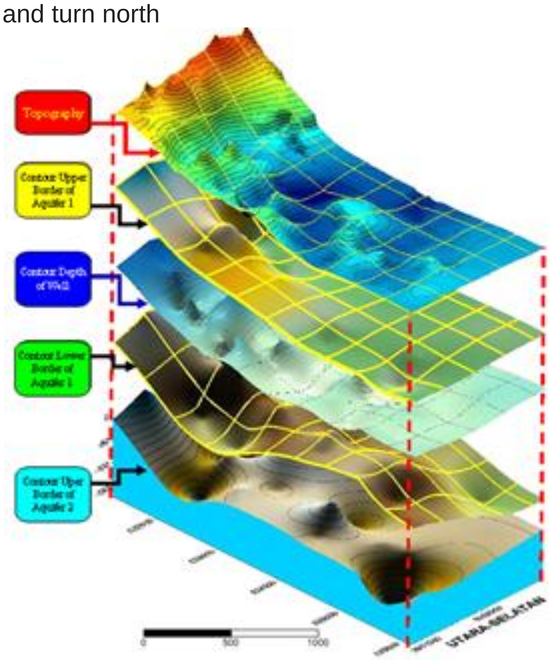

Figure 5. *Kontour field boundary groundwater aquifer.*

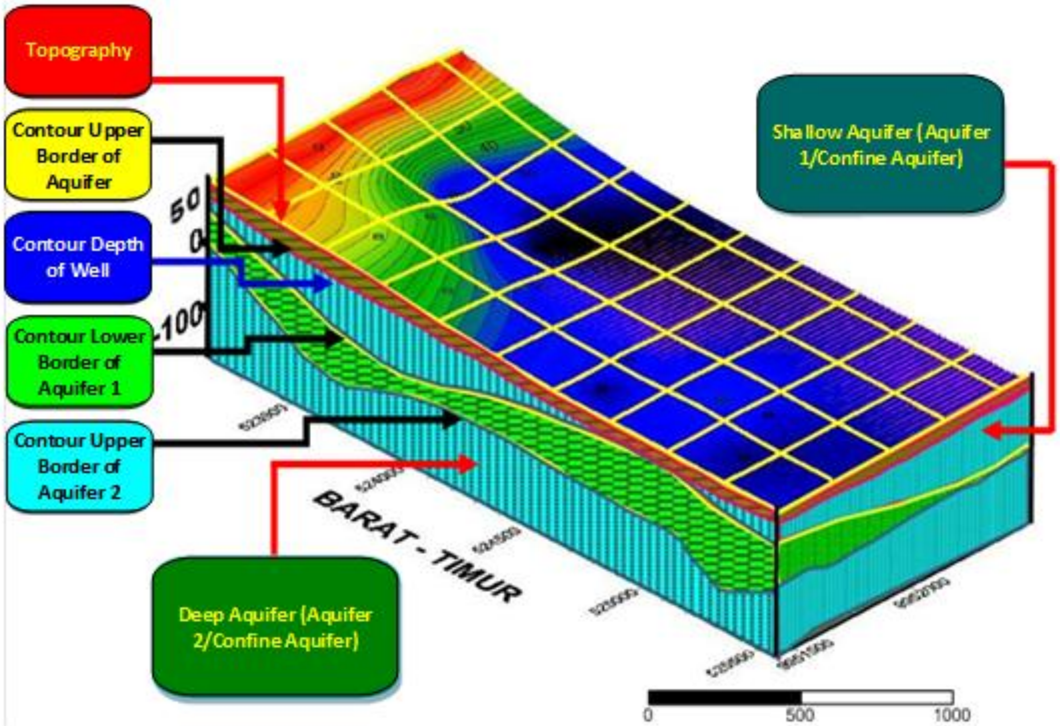

***Figure 6**. 3D model of groundwater aquifers in Tanah Merah Sub-District North Samarinda*

Groundwater aquifers, Land Cover and Water Condition

Based on the geolistrik estimation of shallow groundwater aquifer is at depth ± (5-30) m from the surface of the soil and the borehole of the community is at a depth of ± (10-45 m) of soil surface in equilibrium depth of shallow groundwater aquifer and the community bore well safe from Availability of water / groundwater discharge is sufficient. The fact of the field shows the discharge of the groundwater drill well in the last few years the discharge has decreased / decreased and is not sufficient for the pump, especially when entering the dry season. In general, it can be correlated that the damage and loss of land cover (vegetation) and the more critical water absorption areas resulted in fewer water additives, water can not be bound and bartahan in the recharge area even though the aquifers provide enough space for stored and drained soil water. On the other hand surface water passes by without being able to withstand this condition can be seen when not rain a few weeks of surface well water mongering. The decrease of groundwater discharge is not separated by the damaged and the loss of vegetation in the water catchment area, this situation is felt right ± 5 years before the previous residents who lived in the blood since 1960 never happened. In general, the research area has changed the balance of the water system where when the rainfall caused flood and when the drought is difficult to obtain.

CONCLUSION

Land cover (vegetation) in the study area consisted of vegetation area covering 272,21 Ha forest (40,32%) and agricultural land 183,36 Ha (27,16%) unvegeted area covering 98,80 Ha constructed land (14, 64%), open land 116,33 Ha (17,23%) and water body 4,35 Ha (0,64%). The condition of land cover in this water catchment area has decreased 68,38 Ha (10,13%) from the previous condition 340,59 Ha (50,46%) due to the existence of open mining activities and other functions transfer. The water catchment condition of the research area refers to Permenhut RI No. 32 in 2009, obtained a total score of 33, including a somewhat critical condition. This happens because the damaged water catchment area due to land conversion into mining and other functions. Groundwater aquifers research area based on sounding geoelectric modeling consists of free aquifer for shallow groundwater with water depth between 2-30 m with thickness ± (2-65) m and distorted aquifer for deep groundwater with depth of water level between 75-150 M and thickness ± (75-125) m. The depth of the community well ± (10-45) m in the balance of the well water debit of the community drill water is safe from the availability of groundwater. The transfer of land into open pit mines resulted in the destruction of water balance and water system, reduced / decreased discharge of drilled water wells, failures and lack of new well water discharge, groundwater loss in several dug wells, landslides and mud floods on farmland.

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