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Application of Cooper-Jacobs Method for Sustainable Water Potential Management in Tenayan Raya Sub-District, Pekanbaru City

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Abstract: *In this article, a method is proposed to determine the limits of sustainable aquifer exploitation and identify soil lithology. The proposed method is based on a constant level pumping test using the Cooper-Jacob method. From this parameter it can be determined the lithology and potential of the aquifer tested for sustainable groundwater exploitation. Interpretation and utilization of groundwater potential needs to be done so that the government can get input for environmental management policies on groundwater resources that are environmentally friendly.*

Keyword: *Aquifer, Cooper-Jacobs, Ground water, lithology, management.*

1. INTRODUCTION

Ground water as one part of water resources is the most desirable by humans. Ground water comes from a geological formation that can store and pass large amounts of water known as aquifers [1]. One of the advantages gained in using ground water as a source of needs is the variation in groundwater quality over time which is relatively stable [2]. One of the factors that influence the availability of ground water is its uneven distribution in each region. Some areas have large groundwater potential, but there are also areas with little potential, depending on the size of the rainfall, the amount of vegetation, the slope and the degree of porosity and permeability of the rock making up the aquifer. The rate of groundwater extraction especially for various human needs is another factor that must be considered in the context of water resources management. Excessive groundwater extraction and not balanced with appropriate conservation measures causes the long-term availability of groundwater to run low [3].

Based on Law number 32 of 2009 concerning Environmental Management, the carrying capacity of the environment is its ability to support the life of living things. The ecological context of supporting the environment of an ecosystem is a measure of the population or community.

One way to investigate the potential of water that can be carried out underground is the pumping test method. This method focuses on measuring the flow of water through the process of observing the continuity of water sources and their availability from the source itself [4]. What is at the heart of the pumping test is the comparison between the decrease in water level during the pumping process and the rise in water level during recovery in the same deadline. The results of pumping tests that are processed by the Cooper-Jacobs method can predict the potential of groundwater in the city of Pekanbaru. The data is expected to be used as a consideration in managing and preserving groundwater potential.

This study aims to interpret the utilization and analysis of underground water potential in the Tenayan Raya District, Pekanbaru City.

2. LITERATURE REVIEW

2.1 Groundwater

Ground water is water that is in the aquifer layer or saturated zone (saturated zone). Whereas soil water is water that is in the unsaturated zone. Vertical distribution of water passes through 2 zones, namely the zone of aeration (zone of not being full of water) and the zone of saturatio (zone of full of water) or better known as aquifer. Characteristics of geological formations that exist under the ground based on the attitude of rocks to water, including [5]:

1. Aquiklud (waterproof rock layer) is a layer of water-saturated rock that contains water but is unable to release it in significant quantities such as clay.
2. Aquitard (a slow rocky layer of water) is a layer of rock that is slightly graduated in water and unable to release water in the horizontal direction, but is capable of releasing significant ait towards verticles, for example sandy loam.
3. Aquiflug (waterproof layer) is a waterproof rock layer that is unable to contain and carry on water, for example granite.

Aquifer is a saturated geological formation that can be used as a supplier of water in economic quantities because this formation is able to store and pass water. Another term for aquifers is water bearing formation or groundwater reservoirs. Based on the physical properties and position in the Earth's crust. Aquifers can be divided into four types, namely unconfined aquifer, leakage aquifer (leakage aquifer), perched aquifer and perched aquifer and confined aquifer).

2.2 Groundwater Flow

According to Darcy's law, flux (q) or apparent flow density is directly proportional to the hydraulic gradient (dh / dl):

$$q = -Kx\frac{dh}{dl} \quad (1)$$

The value of hydraulic conductivity (K) has a large enough range, for example for the type of sand soil the value of hydraulic conductivity ranges from 10-4 to 1 cm / s. The value of hydraulic conductivity depends on the porosity, the relationship between rock pores and the nature of the liquid present soil is the thickness and structure and texture of the soil [6].

The aquifer quantity depends on the texture including grain size, grain shape, grain structure, compaction and thickness. All of these parameters are porosity factors. In addition to the porosity of the aquifer quantity can also be expressed by the value of hydraulic conductivity. The use of hydraulic conductivity is better than porosity, because rocks that have large porosity may not necessarily contain large amounts of water [7].

2.3 Pumping Test

Pumping test is a method that is often used to determine the potential of water in aquifers to flow into wells. The way it works is by pumping wells with a predetermined pumping power and seeing the effect of pumping on water levels. This is done to determine aquifer characteristics such as the ability of aquifers to escape and store groundwater, assist in evaluating groundwater potential in a basin, know the ability of wells when pumped for a long time to determine the appropriate type of pump and estimate the pumping costs.

Pumping tests are carried out both in wells where the water radiates outwards and those that do not radiate out which this process can provide data on aquifer conditions and pumping power in accordance with the conditions of the aquifer.

3. RESEARCH METHODS

This study uses a field experiment method, a field measurement process to obtain biophysical data and comprehensive location coordinates using. Resistivity meter and GPS. Whereas to obtain socioeconomic data the survey method was carried out related institutions such as BPS and the office in the District of Tenayan Raya Pekanbaru City and direct observation in the field.

Cooper-Jacob method is one of the methods used to determine the transmissivity value and the coefficient of storativity of a groundwater well in an unstable flow (unsteady-state flow). The Cooper-Jacob method is also known as the straight-line method. This method can be used with the assumption that the tested aquifer is a distressed aquifer, homogeneous and isotropic aquifers, aquifers are pumped with constant discharge, the flow in the well is in the form of non-soft flow, small u values ($u < 0.01$) where $u = r^2S/4Tt$. However, in practice the hydraulic parameters obtained are quite sufficient to the value of $u < 0.1$ [4].

The Cooper-Jacobs equation can be applied if between the time period t since pumping began and the decrease in water level in the observation well is more or less a straight line, so that a straight line slope can be drawn from the s vs log t graph [4].

If the pumping test is carried out using more than one piezometer (at least two), the hydraulic parameters sought can be derived through the Composite Straight Line, which is a straight line obtained by plotting data s vs log r^2/t of all piezometers in one graph.

4. RESULTS AND DISCUSSION

Pumping Test and Analysis of Water Drop at 30 Ring Wells

Pumping test is carried out at 30 (thirty) ring well points located in Tenayan Raya District, Pekanbaru City. The points made in the District Tenayan Raya are in four villages, namely Sail Village, Tangkerang Timur Village, Rejosari Village and Kulim Village. The villages will be taken points - used for pumping tests, including eight ring wells in Tangkerang Timur Village, eight ring wells in Sail Village, seven ring wells in Rejosari and seven ring wells in Kulim. Pumping tests were carried out using a Shimizu pump engine with a 50 Hz pump frequency within 3 weeks during the rainy season.

The results of measurements of the decrease in the value of the well water level and the collected water discharge that have been carried out in the Tenayan Raya District of Pekanbaru City using the pumping test method.

The drawdown of the ring well (S) is measured by meter tape in centimeters combined with a water detection sensor.

Table 1: *Data from the measurement of the decline in the level of the ring wells and the flow of water collected in the well in Sail Village*

Time	**S (m)**	**Q (m^3/day)**	**S/Q (day/m^2)**
1 menit	1.7800	5.0528	0.3523
3 menit	1.8000	5.0528	0.3562
5 menit	1.8100	5.0528	0.3582
10 menit	1.8300	5.0528	0.3622
15 menit	1.8600	5.0528	0.3681
20 menit	1.8800	5.0528	0.3721
25 menit	1.8900	5.0528	0.3741
30 menit	1.9100	5.0528	0.3780

The decline in well water is done with a duration of 1 minute, 3 minutes, 5 minutes, 10 minutes, 15 minutes, 20 minutes, 25 minutes and 30 minutes. The study was conducted at 30 (thirty) points of the ring well in order to get a more accurate value. The overall volume of water that is collected during pumping will be calculated to be the overall water discharge Q. Table 1 is one of the data from the research well where the other wells are more than 30 m apart. The data in Table 1 is one of 30 wells that have been examined which are located in Jalan Kenanga, Sail Village, namely on ring well 1.

The data at the time of pumping began at the first minute, the distance of the well's lip to the surface of the water was 178 cm, at the third minute the distance of the well's lip to the water's surface was 180 cm, at the fifth minute, the distance of the well's lip to the water's surface was 181 cm, at the tenth minute , the distance of the well lip to the water surface is 183 cm, at the fifteenth minute, the distance of the well lip to the water surface is 186 cm, at the twentieth minute, the distance of the well lip to the water surface is 188 cm, at the twenty-fifth minute, the distance of the well lip to the surface of the water is 189 cm and at the thirtieth minute, the distance of the well's lip to the surface of the water is 191 cm.

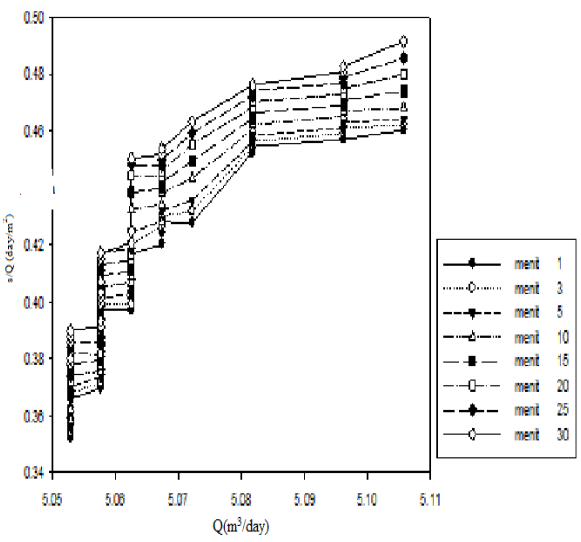

Figure 1: *Relationship of drawdown s to water discharge capacity*

Figure 1 shows the relationship of drawdown s to the water discharge capacity Q obtained a straight line value that intersects the s / Q axis (drawdown to the water discharge capacity) 'A', gradient 'C' and determinant d2 for the 30 (thirty) ring wells. After all data is obtained, transmittivity can be calculated by entering the transmissiveness formula from the Cooper-Jacob method. Determination of n and n-i can be seen from the gradient value of C that is close to each other, namely n at minute 15 while n-i is at minute 1. The value of C to 15 is 2,300 while the value of C at minute 1 is 2,295.

Decrease in average ring well water level in the first minute is 2.0407 m, decrease in average ring well water level in the 3rd minute is 2.0520 m, decrease in average ring well water level in the 5th minute is 2, 0637m, the decrease in the average ring wells in the 10th minute was 2.0853m, the decrease in the average ring wells in the 15th minute was 2.1073m, the decrease in the average ring wells in the minutes the 20th is 2.1280 m, the average decrease in ring well water level in the 25th minute is 2.1457 m, the average decrease in ring well water level in the 30th minute is 2.1610 m.

5. CONCLUSIONS

The ring well that has the most water level decline is ring well 30 which is located on Jalan Kadiri in Kulim Village with an average well water level decline of 2.1610 m. A large drop in water level indicates the potential for ground water on Jalan presence is the lowest among the 30 ring wells tested. Ring wells that have the lowest average water level decline, namely ring well 1 on Jalan Gunung Kidul, Tangkerang Timur Village, with an average well water level decrease of 2.0407 m so that the groundwater potential on Jalan Gunung Kidul is the highest among 30 wells tested. The smaller the value of the decline in well water level, the faster the ground water recovery. The faster the ground water does the recovery, the groundwater potential in the ring well will be better and vice versa.

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