Potential of Groundwater Reserves in Jeneponto Regency of South Sulawesi Province

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Abstract--**The community, both individuals and groups, need water for daily and other needs. From the various types of needs, the water for drinking water is a top priority, above all other necessities.Excessive exploitation of groundwater that exceeds the ability of aquifers to provide groundwater due to competition for various interests can cause a continuous decline in groundwater level and will certainly reduce the potential for groundwater availability in the aquifer. In this research, the potential of groundwater in Jeneponto's aquifers in several locations is examined using in situ pumping test. From the pumping test results, it is known that the potential of groundwater reserve in Jeneponto Regency is quite significant and is spread in several districts with a minimum discharge supply of 4 litres per second. However, some procedures must be taken to protect the availability of groundwater in the regency from the technical aspects for example the determination of pumping location, the depth of groundwater pumping and the maximum pumping discharge allowed, and also all steps that support groundwater recharge.**

Keywords—Groundwater pumping, aquifer, pumping test.

I. Introduction

Humans, both individuals and groups, need water for drinking and for other daily necessities [1]. Of these various needs, water for drinking water is a top priority, above all other needs. This means that the function of water as drinking water must be assured in order to meet the quality and quantity as required.Currently, groundwater which is a renewable natural resource has an essential role which is the same as surface water in providing water supply, causing a shift in the value of groundwater itself [2]. Considering the increasingly important role of groundwater, its utilization must be based on the balance and sustainability principle, or in other words, the use of groundwater must be environmentally based and sustainable [3]. Groundwater is one of the choices of water sources that can be used in large quantities, but the amount of water that can be pumped cannot approach or exceed the amount of water that enters the ground [4]. The change in view on groundwatercan be determined by analyzing groundwater in the distinguished perspective in a wider context[5].Based on such conditions, efforts are required to determine the availability of groundwater in the aquifer to prevent over-exploitation in all area, including in Jeneponto Regency.

Jeneponto Regency is located in the southern part of South Sulawesi Province with a distance of about 90 km (about 2 hours to the south of Makassar City)[6]. Overall, the area of Jeneponto Regency is 74,979 ha (749.79 km^2) or only about 1.20 % of the total area of South Sulawesi Province (62,361.71 km^2). In Jeneponto Regency, there are nine districts. The availability of clean water is very important in thesezones, especially in the dry season so that data on the potential of groundwater is expected to be a solution in overcoming the problem of clean water availability. Groundwater pumping in Jeneponto Regency has not yet been based on groundwater potential so that land subsidence is possible to occur. Moreover, excessive groundwater pumping can also result in seawater intrusion. Therefore, there is a need for technical efforts to control this, that is, by conducting an assessment of the optimum potential of groundwater extraction in the Regency.

II. Research Methodology

This research was conducted at the coastal area of Jeneponto regency in South Sulawesi Province (see Figure 1). This research used ACTESLOV to calculate groundwater characteristic value in the aquifer. Pumping test was carried out, and MODFLOW was used to

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mapgroundwater level based on the real data. This analysis aimed to assess the optimum rate of groundwater pumping in the site.Nowadays, the presence of various analysis and diagnostic plots generates fantastic improvements on the aquifer test method. Renewing analysis of the previous test enables to increase the improvement of interpretation of data to gain more knowledge capabilities of prediction of water flow in the system[7]. In managing groundwater resource and for the purpose of planning, many people prefer to conduct parameters model analysis due to more commonly and more accurate results that can be obtained from the analysis [8].Mathematical for groundwater has been generally used to simulate all situations either in local or regional settings [9].Analysing groundwater system can be a solution for many questions. The best method to get information in assessing the aquifer is pumping test. It involves activity of removing water from a well at fluctuated water level and controlled pumping rate linked to time[10]. The formula used is;

$$T = 2.3 \frac{Q}{(4\pi\Delta s)} \qquad (1)$$

$$S = 2.25 \frac{Tt_0}{r.r} \qquad (2)$$

It needs adequate time to conduct this test. In Equation (1), T is transmissivity, Q is pumping rate and Δs is the change in piezometeric surface under pumping condition. While inEquation (2), S is storativity, t_0 is initial time and r is well radius. A straight line demonstrates data points and the slope (Δs) where a straight line has been applied. The time axis intercepts the straight line when the time (t_0) is drawn. The past development time and transient model was established using groundwater head's formula, started from a steady-state condition[11].

III. Results and Discussion

From tables 1to Table 7in this section, the results of data processing from pumping tests at each observation well were presented. The final result of this data processing is the ability of aquifers to provide water (potential) in litres per second. The magnitude of groundwater potential for each location in the observation point is reported in each data in the processing table.

Figure 1. Research location.

Table 1. SMJP4 Binamu X(E):119°43'46",Y(S):05°39'33

No	Time Visualitation (menit)	Depth (m)	Displacement (cm)	Time (menit)	Velocity (cm per minute)	status
1	0	-5.17	0			
2	0:15	-5.78	61			
3	0:30	-6.45	128			
4	0:45	-7.12	195			
5	1:00	-7.83	266			
6	1:15	-8.2	303			
7	1:30	-8.42	325	90	3.611	Pumping
8	1:45	-8.06	289			
9	2:00	-7.65	248			
10	2:15	-7.04	187			
11	2:30	-6.57	140			
12	2:45	-5.83	66			
13	3:00	-5.25	8	90	3.522	Recovery

Q = 4.95 litres per second

Because V Pumping> V Recovery, the potential for discharge is smaller than 4.95 litres per second. By using the interpolation method, the potential discharge at this point is 4.83 litres per second.

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Table 2. SMJP10 BinamuX(E):119°43'52.2",Y(S):05°39'40.5"

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-4.33	0			
2	0:15	-5.2	87			
3	0:30	-5.87	154			
4	0:45	-6.42	209			
5	1:00	-7.18	285			
6	1:15	-7.85	352			
7	1:30	-8.34	401			
8	1:45	-8.81	448			
9	2:00	-9.25	492			
10	2:15	-9.57	524			
11	2:30	-9.8	547	150	3.647	Pumping
12	3:00	-9.22	489			
13	3:15	-8.85	452			
14	3:30	-8.21	388	60	2.650	Recovery

Q = 4.15 litres per second

Because V Pumping> V Recovery, the potential for discharge is less than 4.15 litres per second. By using the interpolation method, a large potential discharge at this point is 3.02 litres per second.

Table 3. SDJP57 BinamuX(E):119°43'46",Y(S): 05°39'33.3"

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-7.28	0			
2	0:15	-8.43	115			
3	0:30	-9.77	249			
4	0:45	-10.35	307			
5	1:00	-11.12	384			
6	1:15	-11.65	437	75	5.83	Pumping
7	1:30	-10.86	358			
8	1:45	-10.13	285			
9	2:00	-9.8	252			
10	2:15	-9.15	187			
11	2:30	-8.34	106	75	4.41	Recovery

Q = 4.84 Litres per second

Because V Pumping> V Recovery, the potential for discharge is less than 4.84 litres per second. By using the interpolation method, the potential discharge at this point is 3.70 litres per second.

Table 4. SDJP269 Tamalate X(E):119°43'46",Y(S):05°39'33

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-15.58	0			
2	0:15	-16.23	65			
3	0:30	-16.96	138			
4	0:45	-17.4	182			
5	1:00	-18.27	269			
6	1:15	-19.33	375			
7	1:30	-19.87	429	90	4.767	Pumping
8	1:45	-18.9	332			
9	2:00	-18.04	246			
10	2:15	-17.32	174			
11	2:30	-16.67	109			
12	2:45	-16.12	54			
13	3:00	-15.78	20	90	4.544	Recovery

Q = 5.82 litres per second

Because V Pumping> V Recovery, the potential for discharge is smaller than 5.82 litres per second. By using the interpolation method, the potential discharge at this point is 5.55 litres per second.

Table 5. SDJP271 Tarowang X(E):119°52'09.0",Y(S):05°35'10.1"

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-30.12	0			
2	0:15	-30.87	75			
3	0:30	-31.34	122			
4	0:45	-31.96	184			
5	1:00	-32.3	218			
6	1:15	-32.73	261			
7	1:30	-33.2	308			
8	1:45	-33.65	353			
9	2:00	-33.87	375			
10	2:15	-34.18	406			
11	2:30	-34.47	435	150	2.900	Pumping
12	2:45	-33.94	382			
13	3:00	-33.34	322			
14	3:15	-32.87	275			
15	3:30	-32.23	211	60	3.733	Recovery

Q = 7.03 litres per second

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Because V Pumping <V Recovery, the potential for discharge is greater than 7.03 litres per second. By using the interpolation method, the potential discharge at this point is 9.01 litres per second.

Table 6. SDJP275 Tamalatea X(E):119°38'18.8",Y(S):05°37'19.7"

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-20.38	0			
2	0:15	-21.13	75			
3	0:30	-21.86	148			
4	0:45	-22.45	207			
5	1:00	-23.04	266			
6	1:15	-23.92	354			
7	1:30	-24.35	397			
8	1:45	-24.83	445	105	4.238	Pumping
9	2:00	-24.17	379			
10	2:15	-23.56	318			
11	2:30	-23.03	265			
12	2:45	-22.68	230			
13	3:00	-21.9	152	90	3.907	Recovery

Q = 6.21 litres per second

Because V Pumping> V Recovery, the potential for discharge is less than 6.21 litres per second. By using the interpolation method, the potential discharge at this point is 5.72 litres per second.

Table 7. SDJP392 Tarowang X(E):119°52'56.4",Y(S):05°35'36.5"

No	Time visuallitation (minute)	Depth (m)	Displacement (cm)	Time (minute)	V Velovity (cm per minute)	status
1	0	-48.53	0			
2	0:15	-49.14	61			
3	0:30	-49.68	115			
4	0:45	-50.25	172			
5	1:00	-50.87	234			
6	1:15	-51.44	291			
7	1:30	-52.03	350			
8	1:45	-52.6	407			
9	2:00	-52.91	438			
10	2:15	-53.15	462	135	3.422	Pumping
11	2:30	-52.62	409			
12	2:45	-52.23	370			
13	3:00	-51.74	321			
14	3:15	-51.2	267			
15	3:30	-50.77	224	75	3.173	Recovery

Q = 5.56 litres per second

Because V Pumping> V Recovery, the potential for discharge is smaller than 5.56 litres per second. By using the interpolation method, the potential discharge at this point is 5.16 litres per second.

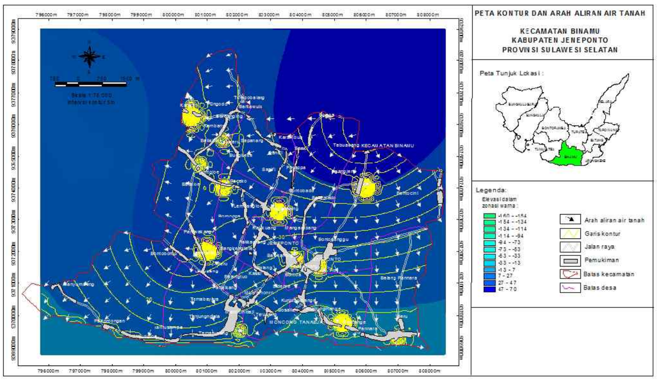

Figure2.Groundwater contour map for Binamu District in Jeneponto Regency

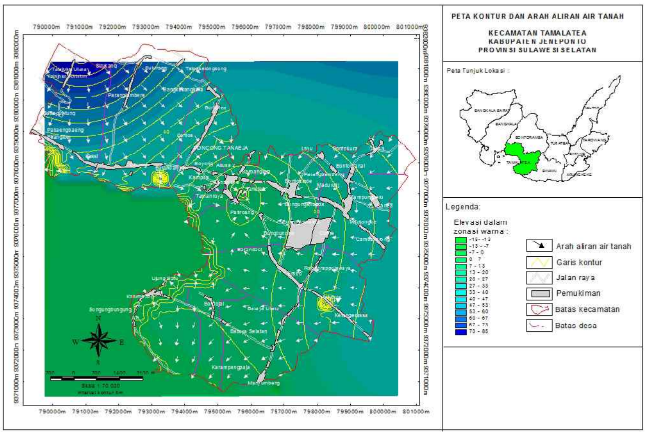

Figure 3. Groundwater contour map for Tamalatea District in Jeneponto Regency

From the pumping test results in all observation wells, it can be seen that there is a good potential for groundwater availability in Jeneponto Regency. The minimum amount of pumping rate that can be used is 4.15 litres per second in Binamu District while the maximum pumping rate that can be conducted is 7.03 litres per second in Tarowang District. Meanwhile, the groundwater level in Jeneponto regency is significantly varied due to the hilly soil surface contour which is dominant in the area.

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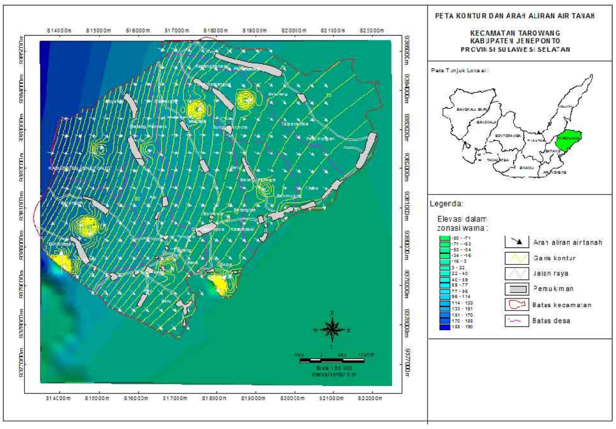

Figure 4. Groundwater contour map for Tarowang Ditrictin Jeneponto Regency

IV. Conclusion

Water is a basic human need. Humans cannot live without water. In addition to surface water, sources of water for human needs are also obtained through the water in the ground called groundwater. However, groundwater extraction is sometimes done excessively so that it damages the aquifer's ability to provide groundwater. Therefore, efforts are needed to determine the ability of groundwater aquifers in providing water for human needs. In this study, the potential of groundwater in Jeneponto Regency was investigated using the pumping test method.From the pumping test results, it can be seen that the groundwater potential of Jeneponto Regency is quite large and spread in several districts. The minimum supply of debit 4 litres per second was found in Binamu District. Meanwhile, the maximum water supply debit is 7 litres per second which was found in Tarowang District.Procedures and recommendations for control efforts from the technical aspects include; determination of pumping location Settings, depth of tapping, limitation of pumping discharge, addition to additives, determination of protected areas.

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