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ASSESSING THE VALUE OF GROUNDWATER REVENUES AND DETERMINATION OF OPTIMUM RATES IN MAKASSAR CITY

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ABSTRACT

Ground water is defined as water that is in the ground and is water that moves and is present in the spaces between the grains of soil that make it up and rock crevices, where the initial part is called layer water and the latter is called fissure water. Water is one of the natural elements that are needed in the life activities of living things, especially humans. The purpose of this study is to assessing the value of groundwater revenues and determine of optimum rates in Makassar City. Data analysis method used is the analysis of groundwater value by referring to the Minister of Energy and Mineral Resources Regulation No.20 of 2017 concerning Guidelines for Establishing Groundwater Revenue Value and the marginal cost pricing method. The results showed that the average revenue of groundwater in Makassar City was IDR.690,276,939.35 with an average tax of IDR.138,055,387.87. The value of groundwater is quite high when compared to the revenue value of groundwater that has been determined by the Makassar City government at this time. The results of determining the optimum rates obtained for the user group 1 is IDR.9,661.96 per m3 per month, the user group 2 is IDR.13,973.63 per m3 per month, the user group 3 is IDR.10,866.67 per m3 per month, and the user group 4 is IDR.4,255.56 per m3 per month. Whereas the beneficiary group 5 has a higher average groundwater utilization cost when compared to the PDAM water rates. The results of research can become policy basis of the Makassar City local government in determining the value of groundwater.

Keywords: Groundwater, optimum rate, revenue, Makassar

INTRODUCTION

The main problem of ground water is related to its availability which includes; quality and quantity (Richey *et al.,* 2015). The problem of quantity and quality of ground water can occur either due to natural factors or due to human factors (antropogenic), it seems like other natural resources, and subsequently can cause conflicts with these resources (Daris *et al.,* 2019, 2020).Thus various approaches to management are needed, so that the availability of water is sustainable. The quantity of water is affected by water sources including groundwater, rainwater and lake/pond water. Whereas water quality is influenced surrounding environmental conditions, that is, local climate, atmospheric pollution, and so forth (Mauser & Ludwig, 2016).

Natural resources including groundwater are resources that not only have direct economic value but also economic value which is often difficult to quantify in monetary values. According to (Fauzi & Oxtavianus, 2014) that resources are defined as something that is considered to have economic value. It was further mentioned that besides natural resources produce goods and services that can be consumed either directly or indirectly can also produce environmental services that provide benefits in other forms, e.g. the benefits of convenience such as; panorama, sunrise, sunset, etc. These benefits are often referred to as the benefits of ecological functions which are often not quantified in a comprehensive calculation of the value of resources. This value is not only the market value of goods produced from a resource but also the value of environmental services caused by these resources (Rafik & Yuniarto, 2014).

Approaches to assessing the benefits of water generally follow a non-market or non-market valuating perspective (Arfanuzzaman & Rahman, 2017). In general, this approach can be divided into inductive and deductive approach. To assess the benefits of water, several methods can be used according to the characteristics of water use (Abu-Zreig *et al.,* 2019). One of the strategies for groundwater sustainability is the application of a groundwater utilization and harvesting tax for the purpose of water conservation (Biswas *et al.,* 2018). The method is based on (a) water is used as raw material to make other products so that water becomes an intermediate good; (b) water is used directly by humans, and (c) water benefits the community in general as public goods. According to (Thompson *et al.,* 2017) that efforts to provide value to water resources through various mechanisms such as; water treatment so that it reaches the hands of consumers and is safe to drink requires no small cost. Appropriate pricing through water

Table 1: Criteria for assessing the weight of groundwater user group

No	State	Ranking	Weight	Criteria
1	Groundwater quality is good and there is an alternative water source	4	16	Very high
2	Groundwater quality is good and there is no alternative water source	3	9	High
3	Groundwater quality is bad and there is an alternative water source	2	4	Medium
4	Groundwater quality is bad and there is no alternative water source	1	1	Low

Table 2: Value of groundwater revenues in Makassar City

Classification of Activities		Water use (IDR/m3)			
		1 s/d 10	10.1 s/d 20	20.1 s/d 50	50>
1	Social	IDR. 400	IDR.450	IDR.850	IDR.1.450
2	Government agencies	IDR.3.400	IDR. 5.100	IDR.6.700	IDR.11.000
3	Commerce	IDR.9.500	IDR.11.900	IDR.14.000	IDR.17.500
4.	Industry	IDR.9.300	IDR.10.700	IDR.12.700	IDR.16.100

Source: Makassar Mayor Regulation No.5/2015

Table 3: Estimation results of groundwater revenue value in Makassar City

User Group	Depth (m)	Debit (m3/day)	Volume (m3)	Raw Water Prices (IDR/m3)	Revenue (IDR.)	Tax (IDR.)
Group 1	122.50	50	18,250.00	1,397.26	664,174,816.44	132,834,963.29
Group 2	122.47	50	59,908.67	1,396.89	1,954,459,542.92	390,891,908.58
Group 3	52.67	50	15,208.33	631.96	178,180,183.50	35,636,036.70
Group 4	100.00	50	18,250.00	1,150.68	228,548,120.55	45,709,624.11
Group 5	30.88	50	93,531.25	393.15	426,022,033.36	85,204,406.67
Average					690,276,939.35	138,055,387.87
Group 5	30.88	50	93,531.25	393.15	426,022,033.36	85,204,406.67
Average					690,276,939.35	138,055,387.87

Source: Analysis results of Groundwater revenue value (2019).

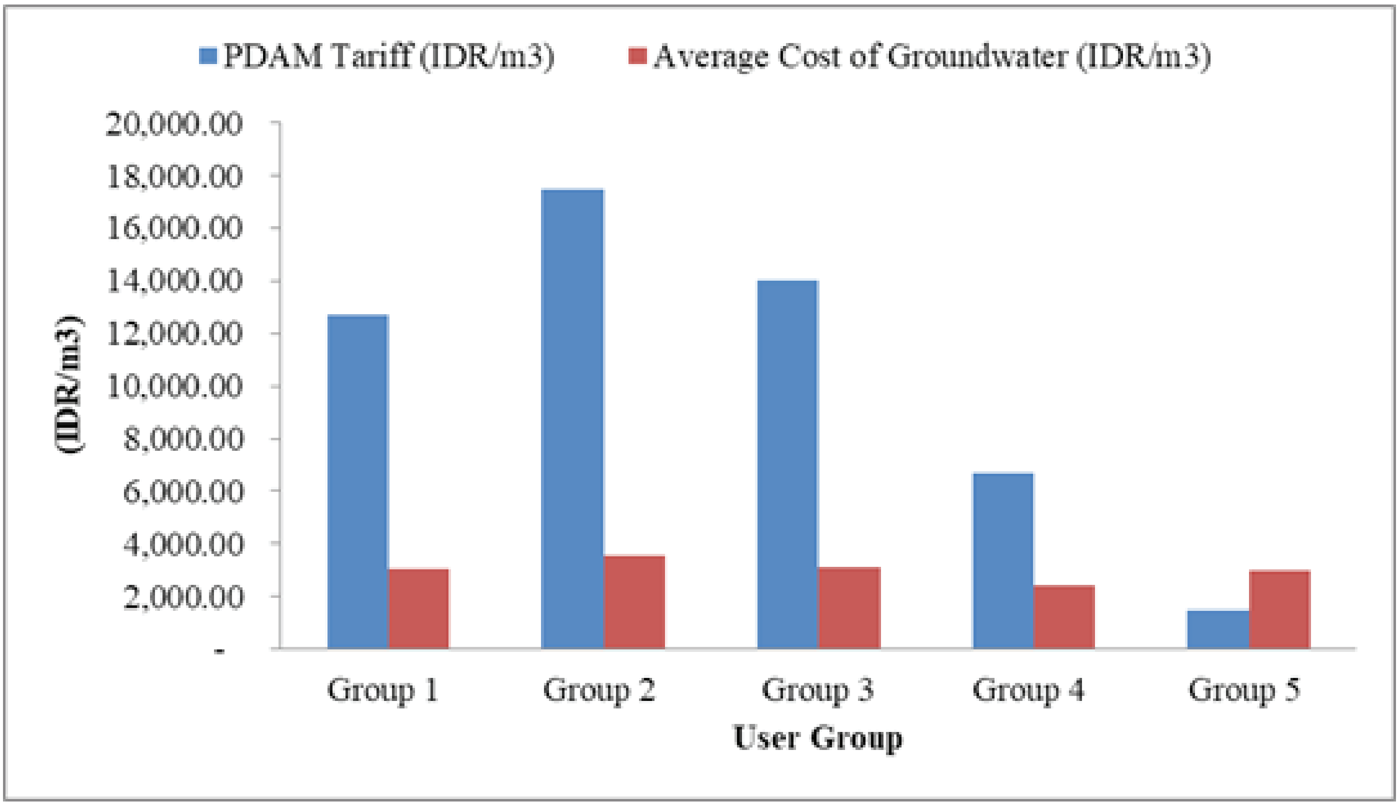

Figure 1: Graph of comparison between PDAM tariffs and average costs of groundwater utilization

pricing that reflects the true costs will give a signal to users about the value of water and can be an incentive for wiser use of water (Fuentes-Cortés *et al.,* 2018).

According to (Roy & Chakraborty, 2014) that one model of water resource allocation based on water pricing is Marginal Cost Pricing (MCP). This concept has been adopted by various countries as the most widely used water pricing mechanism (Veettil *et al.,* 2011). The MCP mechanism is based on the economic principle that socially optimal allocation of water sources is where the marginal social benefits derived from water consumption are equivalent to the marginal social costs incurred (Storm *et al.,* 2011). This marginal social benefit is characterized by a demand curve for water, while marginal social costs that configure the water supply curve configure costs to be paid by users to produce one additional unit of water. The marginal costs of this water resource include user costs or the cost of sacrificing the occurrence of resource depletion, and external costs, such as environmental costs and so on (Fauzi & Anna, 2013).

For this reason, an analytical approach is needed to determine the value of groundwater and optimum rates in Makassar City. Analysis of the value of groundwater revenue by referring to the Minister of Energy and Mineral Resources Regulation No.20 of 2017 concerning Guidelines for Setting Groundwater Revenue Value and the marginal cost pricing method, is considered good enough to answer the research objectives. The purpose of this study is to assessing the value of groundwater revenues and determine of optimum rates in Makassar City.

MATERIAL AND METHOD

Data types and sources. The type of data used in this study is primary and secondary data. Primary data obtained from filling out questionnaires by respondents. Respondents are people (business groups) using ground water in Makassar City. The number of respondents was 44 people. These data include; a) data on the volume of water produced per month, b) data on well depth, c) data on production costs, d) data on water use classes, and e) environmental data around the well. While secondary data obtained from related agencies or institutions, including; a) data on the cost of ground water tax per month, and b) data on water prices from PDAM (water operator).

Data analysis. The method of data analysis in the analysis of groundwater revenue value and the determination of the optimum rates in Makassar City is carried out with a quantitative descriptive approach with two methods namely the method of groundwater revenue value by referring to the Minister of Energy and Mineral Resources Regulation No.20 of 2017 concerning Guidelines for Determining the Value of Groundwater and Marginal Cost Pricing method.

Analysis of groundwater revenue value for each business activity based on the Minister of Energy and Mineral Resources Regulation No.20 of 2017 concerning Guidelines for Determination of Water Revenue Value, where the basis for the imposition of ground water tax is calculated from the water revenue value whose value is determined by some or all variables, include; a) alternative water sources, b) water quality, c) purpose of water extraction/utilization, d) volume/discharge of water extracted/utilized, e) depth of groundwater extraction, f) cost of groundwater extraction, and g) level of environmental damage. The variable is used as factors that influence the value of groundwater revenue. Determination of the amount of values used as a reference in determining the value of groundwater revenue is the availability of alternative water sources (presence/absence) and the quality of groundwater used (good/bad). More detailed as follows.

The table above is an overview of the classification of groundwater users, which are categorized into four categories, namely; criterion-1 (very high) is those who utilize groundwater with good water quality and there are alternative water sources, criterion-2 (high) groups that utilize groundwater with good water quality, but there is no alternative water source, criterion-3 (medium) is those who utilize groundwater with poor water quality, but there are alternative water sources, and criterion-4 (low) groups that utilize groundwater with poor water quality, and there is no alternative water source.

Whereas the assessment of the amount of water value for conservation purposes is estimated from the compensation costs for recovery, designation, and management efforts (compensation) based primarily on the groundwater revenue value taking into account the type of use (household/business) and volume of usage (m3 per month). The groundwater revenue value estimates in each of the groundwater utilization activities are calculated to using the groundwater revenue value calculation element consisting of the volume of withdrawals and water base price. The NPA estimation is carried out by referring to the formula in the Minister of Energy and Mineral Resources Regulation Number 20 of 2017, as follows:

$$NPA = V \; x \; HDA \qquad NPA = V \; x \; HDA$$

Where;

NPA = Groundwater revenue value

V = The volume of groundwater extraction in units of cubic meters (m3)

HDA = Water base price (IDR/m3).

Furthermore, the calculation element of HDA (Basic Water Price) consists of HAB (Raw Water Price) and FNA (Water Value Factor). HDA calculation is estimated using the formula in the Minister of Energy and Mineral Resources Regulation Number 20 of 2017, as follows:

$$HDA = HAB \; x \; FNA \qquad HDA = HAB \; x \; FNA$$

Where;

HDA = Basic Water Price (IDR./m3)

HAB = Raw Water Price (IDR./m3)

FNA = Water Value Factor

Furthermore, the HAB (Raw Water Price) is estimated from the value or total cost of extracting groundwater, including investment costs (drilling costs) and maintenance costs/ operational costs, divided by the total volume of water taken during the production life of the well (generally 5 years). The HAB calculation is estimated using the formula in the Minister of Energy and Mineral Resources Regulation Number 20 of 2017, as follows:

$$HAB = \frac{Total\ Cost}{Total\ Volume\ of\ Groundwater}$$

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Meanwhile, FNA (Water Value Factor) is determined based on the weight of the two components in the utilization of ground water based on the Regulation of the Minister of Energy and Mineral Resources (2017), namely; a) Natural resource component (weight = 60%) and b) Compensation component (weight = 40%). The FNA calculation is obtained by the formula in the Minister of Energy and Mineral Resources Regulation Number 20 of 2017, as follows:

$$FNA = 60\% + 40\%$$

$$FNA = 60\% + 40\%$$

If the groundwater revenue value for each business activity has been calculated or an groundwater revenue value assessment number is obtained, it will be a proposal to the Makassar City Government to be used as a basis for re-establishing the groundwater tax value that can be imposed on groundwater users. Whereas the analysis of the optimum rate is carried out using the MCP approach (Marginal Cost Pricing) (Monteiro, 2011). The MCP mechanism has several advantages, among others theoretically this mechanism is considered the most efficient and can avoid the occurrence of underpriced and over-use. However, MCP also has some weaknesses. One of the weaknesses is related to the aspect of equity. The MCP ignores this aspect because, at the time of water shortages (for example in the dry season), rising water prices at very high levels will have many negative impacts on low-income people (Lopes *et al.,* 2019). The estimation of determining the optimum rates is based on the average value of groundwater utilization costs. Estimated average groundwater utilization costs are calculated by dividing operational and managerial costs with the amount of ground water used by each respondent within one month so that the cost value per cubic meter of groundwater is obtained. Then the average value of the cost per cubic meter of ground water is taken, this value becomes the average figure of the costs incurred when carrying out groundwater use within a certain time period, such as one month. Analysis of average groundwater utilization costs is estimated by the formula in the Minister of Energy and Mineral Resources Regulation Number 20 of 2017, as follows:

$$RBP = \frac{BOp + BPj}{\sum AT}$$

$$RBP = \frac{BOp + BPj}{\sum AT}$$

Where:

RBP = The average cost of using groundwater (IDR/m3/ month)

BOp = Operational Cost (IDR/m3/ month)

BPj = Groundwater Tax Costs (IDR/m3/ month)

AT = Amount of ground water used (m3)

Furthermore, estimate the optimum ground water tariff using the Marginal Cost Pricing method, which is the average groundwater utilization cost for each user group, compared to the PDAM (water operator) water price based on the group. The difference between the PDAM water price and the average cost of using groundwater for each user group is the marginal cost value. This value is the basis for determining the optimum rates. To determine the optimum groundwater rates, a Focus Group Discussion (FGD) approach is adopted by involving various relevant stakeholders, including every business actor using groundwater, environmental observers, groundwater experts, Local Legislator members, and other stakeholders which can contribute to groundwater conservation efforts.

RESULTS AND DISCUSSION

Value of Groundwater Revenues. Determination of groundwater revenue value is based on Regulation of the Minister of Energy and Mineral Resources Number 20 of 2017 concerning Guidelines for Determination of Groundwater Revenue Value, the amount of groundwater tax is 20% of the value of groundwater revenues (NPA). The Makassar City Government has now established the Local Regulation Number 3 of 2010 concerning the Makassar City Regional Tax and the Local Regulation Number 5 of 2015 concerning the Amount of Groundwater Revenue Value which is the basis for the imposition of a ground water tax. The regulation mentioned 4 types of user groups namely; 1) social groups, 2) government agencies activity groups, 3) commercial activities groups, and 4) industrial activities groups. details of the amount of groundwater revenue value for the four types of groundwater users are detailed as follows:

To maintain the sustainability of groundwater in Makassar City, through various groundwater conservation efforts, one of the real efforts that can be done is to recalculate the value of groundwater revenues based on user groups. The amount of groundwater revenue value will determine the various efforts to conserve groundwater, especially those related to the amount of tax that must be paid by the users (Dyah & Irene, 2011).

The recalculation of the value of groundwater revenues in the City of Makassar is intended so that groundwater utilization activities are carried out responsibly, and pay attention to groundwater conservation efforts. Recalculation of the value of groundwater revenues is based on the class of water users that have been determined by PDAM Makassar City. Calculation of the value of obtaining ground water in the city of Makassar obtained the following results:

Based on the Table above, it is known that the average value of groundwater revenues in Makassar City is IDR.690,276,939.35 with an average tax of IDR.138,055,387.87. The highest water revenue occurred in group 2, about is IDR.1,954,459,542.92 with a tax amount of IDR.390,891,908.58. While the lowest water revenue is in group 3, about is IDR.178,180,183.50 with a tax amount of IDR.35,636,036.70.

The value of revenues is quite high when compared to the value of groundwater revenues that has been determined by the Makassar City government at this time. By using the assumption of groundwater use by industry groups or equivalent to group 1, the existing value of groundwater revenue (based on the Makassar City Government) is IDR.293,479,000.00 while the model (based on recalculation) is IDR.664,174,816.44. Thus, there is a significant difference in the value of tax revenue of IDR.74,139,163.29. The dispute is quite large for groundwater extraction activities. If this model NPA can be applied, then the tax revenue that originates from the underground water tax can contribute to a very large income, which in turn can be used to finance the implementation of groundwater conservation in Makassar City, which is sourced from the Groundwater Tax which is contained in local budget revenue of Makassar City.

Optimum Rates of Groundwater. Groundwater utilization cost represents several costs incurred in groundwater use. Water utilization costs consist of fixed costs, variable costs, and investment costs (Webber *et al.,* 2008). Fixed costs are costs incurred permanently at any given time unit in the production process. In this research, fixed costs are tax costs that must be paid each month according to the amount of groundwater usage for each user. Whereas variable costs are those directly related to groundwater utilization activities. Variable costs in research are operational costs in producing groundwater. Investment costs are costs that are only incurred at the beginning of a utilization activity or in a certain period. The investment costs in this study are the costs of making bore wells and the cost of purchasing machinery, installing machinery and pipes. However, in this research, investment costs are not included in the calculation, because most respondents have used groundwater pumps for a relatively long period, making it difficult to estimate the range of prices for the purchase and installation of pumping machines, so that if included in the calculation will lead to bias.

To estimate the average cost of groundwater utilization, a calculation is made by dividing between the total variable costs (operational costs plus groundwater tax fees paid per month) with the amount of groundwater used every month, so that the groundwater cost per cubic meter is obtained per month. Following are the results of the analysis of the average cost of using groundwater.

Based on the analysis results it was found that group 2 is the group of beneficiaries who have the highest average cost of IDR.3,526.37 per cubic meter per month, and the lowest in the group of beneficiaries 4 namely IDR.2,444.44 per cubic meter per month. The high average cost of groundwater utilization in group 2, due to the high monthly tax costs that must be paid namely the average tax of IDR.964,453.33 per month and the average operational cost of groundwater extraction reaching IDR.4,611,111.11 per month. Both of these cost factors are the main factors that cause the high average costs incurred by the users of groundwater.

The optimum rates are estimated by integrating the average cost of groundwater utilization into the PDAM tariffs (Ridwan, 2014). The difference in value from the average cost of using groundwater with the PDAM tariff is considered as the optimum rates of groundwater. The following are the results of the optimum estimation of groundwater rates.

Based on the estimation of optimum rates, it is found that 4 (four) groups of groundwater users in Makassar City are classified as those whose production/ pumping costs for groundwater are much lower (cheaper) compared to the tariffs of PDAM Makassar. The beneficiary group includes; groups 1-4. Whereas the beneficiary group whose production cost is greater (expensive) compared to the PDAM tariff is group 5, namely the user group which is categorized as a household and social group.

The cost factor of production or pumping groundwater which is lower (cheaper) than that of the PDAM causes the tendency of users of groundwater to continue to use large amounts of ground water. As an effort to prevent the occurrence of groundwater exploitation, the total cost of using groundwater must be balanced with the PDAM tariffs with the hope that groundwater users can switch their water usage from groundwater to PDAM. The following is a comparison chart between PDAM tariffs and the average cost of using groundwater

Based on the concept of marginal cost pricing, the average cost of utilizing ground water can reflect marginal private cost which is a direct cost that must be incurred in the utilization of ground water. The difference between the PDAM tariff and the average cost of using groundwater from the 4 user groups (groups 1-4) is IDR.4,255.56 per cubic meter to IDR.13,973.63 per cubic meter. The difference value illustrates the marginal user cost and marginal external cost of using groundwater. The difference in value should be the optimum rates that can be used as an environmental cost that must be reinvested in the environment and the people who are negatively affected by groundwater utilization. These environmental costs can be collected through an environmental tax mechanism. According to Berbel *et al.,* (2017) suggest the economy is a management instrument that encourages optimal water allocation for the welfare of as many parties as possible. Furthermore, Ansari & Umar (2019) stated that practically the application of economic instruments in water resources management is a technique of imposing costs on users so that the allocation of water can be utilized successfully. Costs incurred are in accordance with the costs incurred to manage and serve the water, which is commonly called the cost-recovery process. The benefit value of water is thus a positive externality of the water obtained. To create a water allocation that is self-sufficient, the costs borne by water users must be consistent with the benefits obtained (Shen, 2015).

Environmental tax is one of the financial instruments that play an important role in reducing environmental damage. According to (Lapworth *et al.,* 2017) that environmental tax is rationalized as an effort to internalize external costs/damage costs that are not included in the market price (Pigouvian tax) into private costs (company costs calculated based on income statements), so funds are available in environmental financing to reduce pollution and environmental damage that can be accompanied by increasing production efficiency. Therefore, environmental tax is the responsibility of the company or in this case the use of ground water. Furthermore according to (Galaz *et al.,* 2018) that environmental tax is an effective instrument to internalize the costs of externalities (the costs of damage and environmental services) included in the price of goods from economic activity. The environmental tax helps to exert economic pressure on those who damage the environment and in the same way, can reduce the economic burden on those who contribute to protecting the environment. The environmental tax creates incentives for producers and consumers to change their behavior towards eco-efficient in using natural resources.

Based on the Table above, it is known that the average value of groundwater revenues in Makassar City is IDR.690,276,939.35 with an average tax of IDR.138,055,387.87. The highest water revenue occurred in group 2, about is IDR.1,954,459,542.92 with a tax amount of IDR.390,891,908.58. While the lowest water revenue is in group 3, about is IDR.178,180,183.50 with a tax amount of IDR.35,636,036.70. The value of revenues is quite high when compared to the value of groundwater revenues that has been determined by the Makassar City government at this time. By using the assumption of groundwater use by industry groups or equivalent to group 1, the existing value of groundwater revenue (based on the Makassar City Government) is IDR.293,479,000.00 while the model (based on recalculation) is IDR.664,174,816.44. Thus, there is a significant difference in the value of tax revenue of IDR.74,139,163.29. The dispute is quite large for groundwater extraction activities. If this model NPA can be applied, then the tax revenue that originates from the underground water tax can contribute to a very large income, which in turn can be used to finance the implementation of groundwater conservation in Makassar City, which is sourced from the Groundwater Tax which is contained in local budget revenue of Makassar City.

CONCLUSION

The findings of the study are the discovery of a more rational value of groundwater and can be used as a basis for determining the price of water by the regional government to maintain the sustainability of water resources, especially in Makassar City. The average value of groundwater revenues in Makassar City is IDR.690,276,939.35 with an average tax of IDR.138,055,387.87. The value of obtaining the water is quite high when compared to the acquisition value of ground water that has been determined by the Makassar City government at this time. The optimum rates for user group 1 are IDR.9,661.96 per m3/month, user group 2 is IDR.13,973.63 per m3/month, user group 3 is IDR.10,866.67 per m3/month, and user group 4 is IDR.4,255.56 per m3/month. Whereas beneficiary group 5 has a higher average groundwater utilization cost when compared to the PDAM water price.

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