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Feed Ratio Study Groundwater in Aquifer System Constrained Up for Urban Areas

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Abstract: **Determining the origin of groundwater are closely related to conservation and renewable groundwater resources. Research on the source of groundwater recharge would be based on a theoretical approach, the statistical methods Principle Component Analysis and mass-balanced mixing models. Both of these methods will be tested using secondary data naturally occurring isotope of water, deuterium and oxygen-18, and ions major cations and anions in the aquifer distressed over (depth of the well between 40 dan140 meters). Source recharge ground water to be tested consists of three sources that recharge rainwater, river water and ground water.**

This study aims to determine the ratio of the source of groundwater recharge using statistical methods and mass balance-mixing models. Where tracer affix source water using natural isotope parameters. In this study, physical and chemical parameters of water contained in the data of ground water, river water and rainwater are used to determine the origin or source of ground water recharge.

The results of mass balance calculation-mixing models using parameters δ^1H or δD and pH, to a rate of groundwater recharge source for the location of T_3, T_4, T_6 and T_{13} are as follows: 43% of riverwater, 33% rainwater and 23% groundwater. Research on the ratio of recharge sources provide some information about water sources that contribute to groundwater recharge in Jakarta and surrounding areas. There are two sources that recharge rainwater and river water Bogor area near the location of groundwater. Physical development is carried out in the Bogor area will result in reduced water that seeps into the groundwater, it will bring a reduced impact to the aquifer water supply in Jakarta.

Keywords: **Aquifer System, Conservation, Groundwater, Mixing Model, Renewable, Statistic Method.**

I. INTRODUCTION

Groundwater is one of the alternative sources of clean water and drinking water most of the population in Jakarta today. This is due to the limited supply of clean water supplied through the piping system by drinking water management institution. However, if the rate of soil water suction is greater than the rate of groundwater recharge, there will be a decrease in ground water level.

The groundwater is a natural resource that can be renewed, but in the process of formation takes the tens of thousands of years. If the ground water has damaged both quantity and quality, then the recovery process takes a long time also with high costs and complex technology can't even go back to its original state. Therefore, it takes an integrated management of aquifer systems. In the aquifer system takes information about the origin of groundwater in order to know the source of recharge water in the aquifer system. Mechanical natural isotopes 18O and 2H provide input in the form of real information about the origins, said groundwater areas where conventional techniques can't determine it. Determining the origin of groundwater recharge are closely related to conservation and renewable groundwater resources

Early research on the sources of groundwater recharge has been done based on the theoretical approach, the statistical method Principle Component Analysis and mass-balanced mixing models. Both of these methods were tested using secondary data naturally occurring isotope of water, deuterium and oxygen-18, and ions major cations (Na +, K +, Ca +, and Mg2 +) and anions (Cl-, SO42- and NO3-) in the aquifer depressed over (well depth between 40 and 140 meters). Source of groundwater recharge under test consists of three sources that recharge rainwater, river water and ground water (aquifer depressed over).

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Preliminary results (Mawardi, 2016) showed that this method is quite effective to determine the ratio of the source of aquifer recharge from the river water, rain water and groundwater flow from upstream. Thus, the method of the research results can be used to estimate groundwater recharge sources and determine the integrated management of aquifer systems are sustainable and environmentally friendly.

II. REVIEW OF LITERATURE AND RESEARCH METHODOLOGY

A. Groundwater:

The groundwater is water that moves in the soil contained in the space between grains of soil that seeped into the ground and joined to form soil layers called aquifers. Layers are easily traversed by so-called ground water permeable layer, such as coating found on sand or gravel, whereas a layer barely passable called ground water impermeable layer, such as a layer of clay or loam. Layers can catch and pass the water called aquifers (Herlambang, 1996).

Following the formation of ground water hydrological cycle, which is a natural process that takes place paada water in nature, experiencing displacement sequentially and continuously. In the hydrologic cycle, the water cycle in general from the ocean to the atmosphere through evaporation, then falls to the surface of the earth as rain. Rainwater that falls to the mainland, some will be absorbed by plants and some evaporates back into the atmosphere, and the rest flows in the ground and into rivers and flowing into the sea, as well as other seep into the ground.

Various aquifer permeability rock based constituent is as follows:

1. Free aquifer (Unconfined Aquifer):

The layer of water that passes only partially filled with water and were in the top layer of water-resistant. Surface soil aquifer is called the water table, the surface of the water that has the same hydrostatic pressure with the atmosphere.

2. Depressed Aquifer (Confined Aquifer):

That aquifer entire amount of water bounded by impermeable layers, both above and below, as well as having the saturation pressure greater than atmospheric pressure.

3. Semi pressured aquifer (Semi Confined Aquifer):

That is entirely saturated aquifer water, where the top layer is limited by spring water passes underneath an impermeable layer.

4. Aquifer Semi Free (Semi unconfined aquifer):

That aquifer underneath which is a water-resistant coating, while the upper part is fine grained material, so that the cover layer still allows the movement of water. Thus this aquifer is midway between the aquifer by aquifer semi-free depressed.

B. Content of Elements in Groundwater:

Rain water soak into the ground carrying the chemical elements that provide some influence on various activities. There are four groups of the composition of dissolved substances in groundwater (Hadipurwo 2006 in Geology and Environmental Planning Agency, 2013):

1. The main element (major constituents), containing 1.0 to 1000 mg/l, namely: sodium, calcium, magnesium, bicarbonate, sulfate, chloride, silica.

2. The element of secondary (secondary constituents), with a content of 0.01-10 mg/l, namely iron, strountium, potassium, karbonat, nitrate, fluoride, boron.

3. Elements minor (minor constituents), with a content of 0.0001 to 0.1 mg/l, which is atimon, aluminum, arsenic, barium, bromine, cadmium, chromium, cobalt, copper, germanium, jodium, lead, lithium, manganese , molibdiunum, nickel, phosphate, rubidium, selenium, titanium, uranium, vanadium, zinc.

4. Rare Elements (trace constituents), containing typically less than 0.001 mg/l, ie, beryllium, bismuth, cerium, cesium, gallium, gold, indium, lanthanum, niobium, platinum, radium, ruthenium, scandium, silver, thallium, tharium, tin, tungsten, yttrium, zirconium.

In this study will be used are the main elements that Na, K, Mg, HCO_3, SO_4, Cl and Si.

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C. Determination of Value Analysis Method Origin Groundwater:

Doing the analysis in stages namely: Phase 1, analysis of source/origin of groundwater consisting of rain water, river water and ground water; Phase 2, the ratio analysis groundwater origin. The parameters used for the analysis of groundwater resources is the value of ions and isotopes of each rainwater, river water and groundwater. The analytical method used is a statistical approach Principle Component Analysis (PCA). Before the data were analyzed first performed the standardization of data by way of a reduction in mean value and dividing by the standard deviation. Each component is the result of a linear combination with the weight of the variables, equation (1):

$$X_j = A_{1j}C_1 + A_{2j}C_2 + \ldots + A_{mj}C_m \qquad (1)$$

Each variable is the result of weighted linear combination of components, with equation (2):

$$C_i = W_{i1}X_1 + W_{i2}X_2 + \ldots + W_{ip}X_p \qquad (2)$$

a. b.

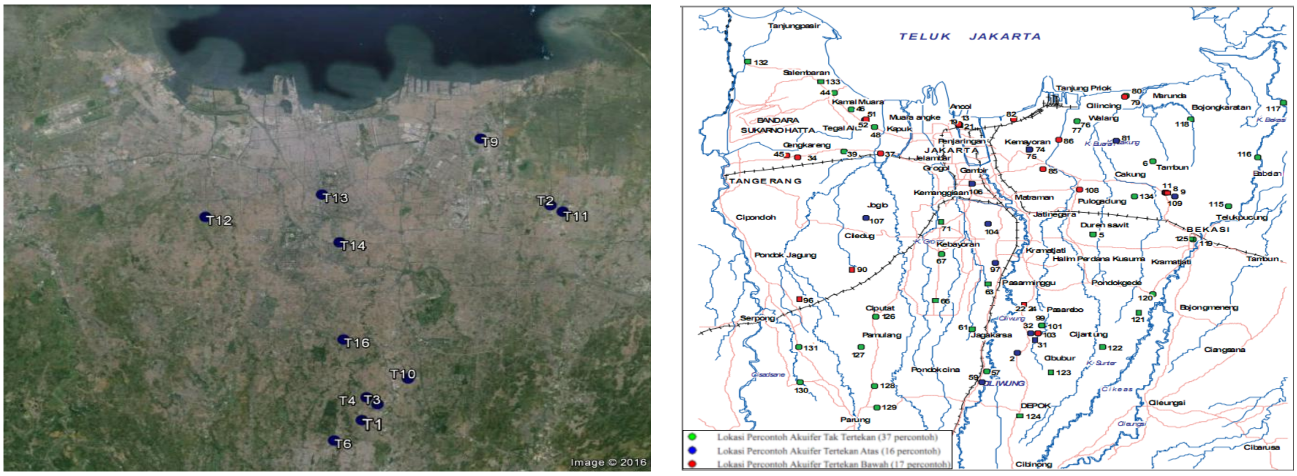

Figure 1. Location groundwater in this study there are 14 locations in Jakarta (a), taken from the map of the location of the sample aquifer pressure on (b).

The process of calculating the equations (1) and (2) above is done by using SPSS software. The output of this analysis are the two main sets of component values (principle component), which is the value of x-axis is plotted into a graph (component 2) and the y-axis (component 1) as an example in Figure 2.

Determined from this plot rain water, river water and groundwater as a source of groundwater which are three outermost points connected by lines to each other. Source-1 is the water source of the river, the source-2 is the source of rainwater, and the source-3 is the source of depth groundwater.

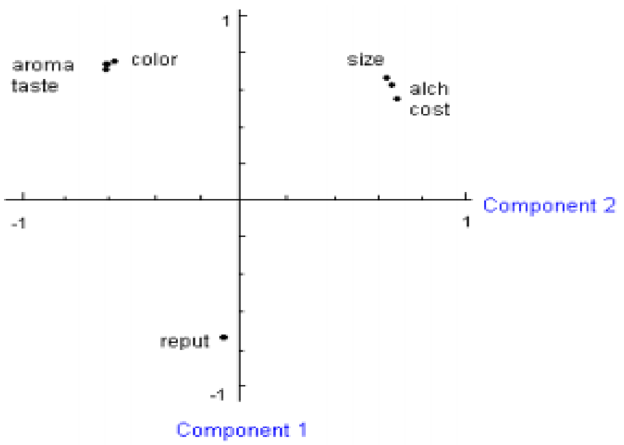

Figure 2. Sample plot component 1 and 2 in the PCA

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D. Method Ratio Analysis:

After determining the value of each source of groundwater, are used to determine the ratio of each source to recharge the groundwater by using a mass balance-mixing models. The calculation is performed at each well site. Thus obtained ratio of the source-one that is f_1, source-2 (f_2) and source-3 (f_3) for each well site. To obtain a source ratio in the aquifer recharge in the (40-110 m) do the average of the results on all the well site.

III. CONCLUSION

The results of mass balance calculation-mixing models using parameters δ^1H or δD and pH, to a rate of groundwater recharge source for the location of T_3, T_4, T_6 and T_{13} are as follows: 43% of river water, 33% rain water and 23% groundwater.

The results of the examination of the accuracy of the estimated ratio of recharge sources indicate, only the values for the parameters $\delta^{18}O$-H_2O which shows the estimated value of almost close to the value in the field for all locations, T_3, T_4, T_6 and T_{13}, with a mean value of the difference of 1.6 mg/L , As for the value of NO_3^- the location T_{13} showed the smallest difference of 0.7 mg/L and Cl^-, location of T6 that shows the estimated value of which is almost equal to the value in the field, which is equal to 0.3 mg/L. For the value of SO_4^{2+}, the location of T_3, T_4 and T_6 which has similarities between the estimate and the field.

Of the 14 groundwater locations, only 4 locations identified his source ratio recharge or just 28% of the total location of groundwater that can be identified. Therefore, it takes more appropriate parameters to be used as a tracer and chemical and physical parameters of the data is more complete than the river water and rainwater.

Research on the ratio of recharge sources provide some information about water sources that contribute to groundwater recharge in Jakarta and surrounding areas. There are two sources that recharge rainwater and river water Bogor area near the location of groundwater. Physical development is carried out in the Bogor area will result in reduced water that seeps into the groundwater, it will bring a reduced impact to the aquifer water supply in Jakarta. Source of river water that also contribute as much as about 30% of the groundwater recharge indicates that the water quality will be enough to affect the quality of ground water, thus improving the quality of river water in Jakarta will have an impact on improving the quality of groundwater.

REFERENCES

[1] Badan Geologi Dan Tata ingkungan, “Kandungan Unsur Dalam Air Tanah”, 2013.

[2] Fry, B. “Stable isotope ecology”, 3rd ed. Springer-Science Business Media, New York, 2006, pp.23

[3] Herlambang, A. 1996. Kualitas Air tanah Dangkal di Kabupaten Bekasi. Program Pascasarjana, IPB. Bogor.

[4] Kozaki D., Ozaki T., Nobutake N, Mori M., dan Tanaka K, “Utilization of Ion-Exclusion Chromatography for Water Quality Monitoring in a Suburban River in Jakarta, Indonesia, Water”, 2014, pp 1945 – 1960.

[5] Laaksoharju, S. M., Erik, C. S. “Multivariate mixing and mass balance (M3) calculations, a new tool for decoding hydrogeochemical information”. Applied Geochemistry, 14(7), 1999, 861-871.

[6] Matahelumual, C. Bethy. “Kajian kondisi air tanah Jakarta tahun 2010, Jurnal Lingkungan dan Bencana Geologi”, Vol. 1 No. 3 Desember 2010, 131-149

[7] Mawardi, Wijayanti. Y, “Laporan Akhir, Studi Rasio Imbuhan Air Tanah Akifer Terkekang Atas di Area Perkotaan”, Penelitian Internal Universitas Mercu Buana. 2016

[8] Meydam Gusnisar, Gabriel Andari Kristanto dan Irma Gusniani, “The Effect of Rainwater Harvesting to the Groundwater Quality in Faculty of Engineering University of Indonesia”, Thesis, Environmental Engineering Study Program, Civil Engineering Department, University of Indonesia, 2012, pp.8.

[9] Phillips, D. L., Koch, P. L. “Incorporating concentration dependence in stable isotope mixing models”. Oecologia, 130, 2002, 114–125.

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Vol. 3, Issue 2, pp: (59-63), Month: October 2016 – March 2017, Available at: www.paperpublications.org

[10] Pujindiyati E. R. "Investigation of Stable Isotop of 18O and 2H in Shallow Groundwater from Karawang Area, Indo". J. Chem., 8 (2), 2008, pp 136-140.

[11] Sidauruk, P., Syafalni and Satrio., ' Study of Interaction of Shallow Groundwater and River along the Cisadane and Ciliwung River of Jakarta Basin and Its Management using Environmental Isotopes', A Scientific Journal for the Applications of Isotopes and Radiation, Vol. 8 No.1, June, 2012, pp 63-72.

[12] Sueker, J. K. "Isotope Applications in Environmental Investigations: Theory and Use in Chlorinated Solvent and Petroleum Hydrocarbon Studies". Remediation Journal, Volume 12, Issue 1, 2001, pages 5–24.

[13] Susiloputri. "Pemanfaatan Air Tanah Untuk Memenuhi Air Irigasi Di Kabupaten Kudus Jawa Tengah". Skripsi S1. Universitas Diponegoro, Semarang. 2009

[14] Usmar, Hendra dan Hakim, Rega Tadeak. 2006. Pemanfaatan Air Tanah Untuk Keperluan Industri Di Wilayah Kota Semarang Bawah. Skripsi S1. Universitas Diponegoro, Semarang.

[15] Wandowo, Zainal Abidin, Alip dan Dijono., "Daerah REsapan Air Tanah Cekungan Jakarta, Risalah Pertemuan Ilmiah Penelitian dan Pengembangan Aplikasi Isotop dan Radiasi", Puslitbang Teknologi Isotop dan Radiasi, BATAM, Jakarta. 2001

[16] Zainal Abidin, Hudi Hastowo dan Aang Hanafiah. "Teknologi Isotop alam untuk Manajemen Eksplorasi dan Eksploitasi air tanah". A Scientific Journal for The Applications of Isotopes and Radiation Vol. 3 No. 2, 2007, 1 – 9