Assessment of Potential Diseases caused by Chemical Content of Groundwater in Northern Jakarta, Indonesia

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***Abstract*—Northern Jakarta is located in North Java coastline and one of the areas with adequate water quality concern. Groundwater drilling freely, seawater intrusion and crowded human properties settlement becomes threats of the society and causes many impacts on human health due to water quality deterioration. This study was conducted by observing groundwater condition of Northern Jakarta not only quantity but also quality through 33 locations of groundwater using its physico parameter and chemical elements, such as Fe, Mn, Na, NH_4, Cl, SO_4. Then the results of the analysis and observations associated with the Indonesia Ministry of Health Standard about health impacts arising from its chemical elements. Data results showing pH water value around 7 location were out of normal range that have potentially impacts to human body. Levels of iron, manganese, sodium and chloride have the different results which the normal and abnormal content. Based on the Regulation of the Minister of Health No:492/Menkes/Per/IV/2010 that the allowable parameters of the content of iron and manganese is below 0.3mg/l and 0.1mg/l. There are 24 of the 33 places that have ferrous content excess from maximum range which will lead to harm the intestinal wall and iritate the skin. 18 of the 33 locations are known to have a high content of manganese. Excess consumption of manganese will affect human neurological systems, such as excessive tremors, weak and had difficult to walk. 25 locations have abnormal sodium content and 18 locations have abnormal chloride content which excess 250 mg/l would result hypertension. From these data, analysis has been done and conclude that there are more than 50% of the study area have chemical content: Fe, Mn, Na and Cl that is not normal and have potential to the several diseases. We suggest to the people of Northern Jakarta to conduct the water treatment before using for drinking and daily use.**

***Keywords*— Chemical Element, Disease, Groundwater, Northern Jakarta, Water Treatment**

I. INTRODUCTION

Jakarta is not only a city, but rather a province with special status as the capital of Indonesia and megapolitan city. As a province, is includes into a regency and five cities. It occupied the northern of Java Island.[1,2] One of the cities is Northern Jakarta. Jakarta is a magnet to people who find the better living conditions.[3] The latest national census in 2010 put the city population at 9.58 million, with an annual growth of 1.4 percent, or 135,000 people per year. With its current population, Jakarta's 662-square-kilometer area has a population density of 14,476 people per square kilometre.[4]

Strong and sustained growth in Jakarta's population and economy have resulted in a vast increase in the urbanized area, and concomitant of land use change.[5] This condition makes the demand of water increases and will automatically affect the quality of groundwater. This has a correlation with the public health of people. The worst groundwater quality condition the worst public health of the area.[6]

Halving by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation is one of the millennium development goals established by the international community at the world summit on sustainable development in Johannesburg. The world health organization estimates that 1.1 billion people worldwide do not have access to safe drinking water, and 2.4 billion are without access to adequate sanitation. An increasing proportion of users without access to adequate water supplies live in urban areas.[7]

With all of the problems mentioned above, we should assess the quality of groundwater. The objective of this paper is to know the potential health impact that might happen to Northern Jakarta's people by assessing the chemical components of the groundwater.

II. Methodology

Research is done using hydrogeological maping in regions Northern Jakarta through groundwater manifestation analysis and monitoring of wells in the period 2009-2013 especially groundwater quantitity. Then, for groundwater quality, there are 33 groundwater samples gathered from wells during 2014. Technique of sampling conducted with getting groundwater in wells and filled up the samples systematically for analysis. The pH and Total Dissolve Solid (TDS) were measured by using tool in the field and the Fe, Mn, Na, NH_4, Cl, and SO_4 were analyzed in The Quality of Water Laboratory – (Central Water Resources and Environmental Geology, Geological Agency of Indonesia), using Standar Methods for The Examination of Water and Wastewater 21th Edition 2005 (SMEWW) and Indonesian National Standard 1991 (SNI). Groundwater assesment of potential disease was conducted by observing water quality of each samples using its chemical elements and associated with the Indonesia Ministry of Health Standard Republic of Indonesia and Open Sources Health Journal which correlated with health impacts of desease arising from its chemical elements of water.

Fig. 1. The 33 groundwater samples

III. RESULT AND DISCUSSION

The results of this study are groundwater quality and quantity monitoring on the research location. These data will help to analyse and interprete the condition of the groundwater impact to people's health. Quantitative monitoring such as hydrolics aspect has conducted to analyzed the movement pattern of groundwater and where the area of groundwater contaminated exposure.

A. *Hydrogeological Quantity of Northern Jakarta*

Groundwater level observation was conducted to determine the rise decline in groundwater levels in the area of Northern Jakarta and surrounding areas. Based on secondary data for 2009-2014 there is a tendency that the ground water level has decreased from year to year. Groundwater flow pattern is formed based on differences in ground water level, naturally and in normal conditions, water will flow from areas with higher groundwater level towards the lower ones (following the slope). In order to describe the groundwater flow pattern then be made isofreatik map that shows the relationship depth of the groundwater in the area of investigation. This is done to determine the direction of exposure to contaminated groundwater. Isofreatik map created in order to describe the groundwater flow pattern that connects the depth of the groundwater in the area of investigation.

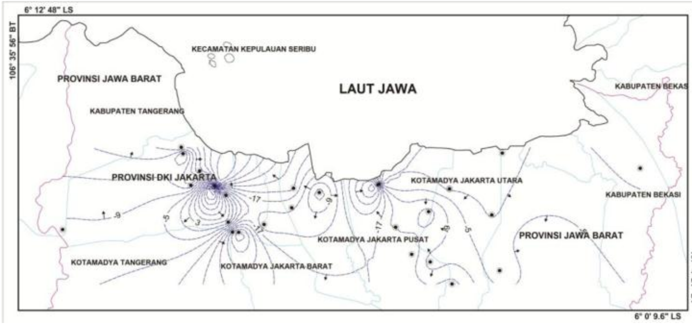

Fig. 2. Isofreatik Map of Northern Jakarta

B. *Hydrogeological Quality of Northern Jakarta*

Hydrogeological quality parameters are chemical element that is (Fe, Mn, Na, NH_4, Cl, SO_4) and physico parameters such as pH, total dissolved solids (TDS), and additional parameters such as Fe and Mn. From these data can be analyzed descriptively about the feasibility and impact factor of groundwater for human health. These parameters analysis performed to compare the composition of groundwater samples in the field with the standards which has been specified by Indonesia Ministry of Health Standard. From this analysis can be determined the potential diseases caused by groundwater contamination.

TABLE I
Physico-chemical characteristics of groundwater in the study area

Code	TDS (mg/L)	pH	Chemical Laboratory Measurements (mg/L)					
			Fe	Mn	Na	NH_4	Cl	SO_4
SBP1	2100	8,31	0,62	0,01	665,8	0,2	700,7	120,8
SBP2	3252	6,25	23,97	1,91	812,0	2	1585	126,7
SBP3	488	8,28	0,14	0,02	124,6	2	74,50	89,10
SBP4	672	8,81	0,43	0,03	228,5	0,1	103,0	26,40
SBP5	264	7,69	0,75	0,43	30,50	0,2	20,20	97,50
SBP6	996	7,69	0,77	0,09	267,6	3,3	351,8	76,60
SBP7	224	7,73	1,16	0,09	37,80	0	60,60	5,30
SBP8	1072	8,66	1,23	0,06	380,0	0,2	152,1	98,80
SBP9	-	8,56	0,28	0,01	114,6	0,1	38,40	79,40
SBP10	492	8,14	1,96	0,04	775,3	0,1	742,0	217,3
SBP11	2200	8,63	1,30	0,24	723,5	0,1	675,5	266,9
SBP13	2400	7,94	0,24	2,77	663,4	0,9	1387	49,70
SBP14	3084	7,58	17,01	0,34	263,1	0,3	384,3	202,2
SBP15	1244	7,81	0,83	4,39	3052	7,7	7458	539,5
SBP16	11576	6,43	5,07	5,25	1085	2,9	1697	630,1
SBP17	4564	7,00	19,54	5,44	2785	6,1	5794	13,80
SBP18	10880	6,77	0,11	0,03	215,6	0,5	110,1	20,0

SP1A	744	7.82	0.05	4.7	235.1	0.3	110.1	15.8
SP1B	700	7,86	0,33	0,11	295,6	0,3	214,7	89,20
SP.2	820	8,58	0,21	0,79	440,4	0,4	512,3	186,0
SP.3	1524	7,41	1,31	0,10	175,5	0,5	73,70	78,40
SBP19	2884	7.32	0.03	45.8	859.8	0.4	1116.2	50.0
SP4A	540	7,83	15,51	1,04	566,3	1	853,8	76,0
SP.4B	2144	7,34	1.45	0,13	42.2	1,1	70.1	164.0
BP.20	520	7.22	1.45	0.13	42.2	0.1	70.1	164.0
SP.5	2292	7,64	0.84	0.76	720.4	1,2	777.5	351.0
SP.6	13528	7.13	10.89	6.55	4512.5	1.3	9371.6	718.7
SP7A	832	8,29	0,06	0,04	256,70	0,5	84,0	20,0
SP7B	920	8,23	0,77	0,06	290,70	0,4	90,70	94,70
SBP21	324	8.78	12.22	0.39	88.3	1.7	11.9	7.6
SBP22	4508	7,75	19,59	0,70	1547	0,8	2357	12,80
SBP23	2432	7.88	2.51	0.21	770.1	0.7	1094.4	24.6
SBP24	2812	8.01	0.12	0.06	1155.6	2.5	901.3	7.3

1) Total Dissolve Solid (TDS)

Total dissolved solids in the study area has a value (224-13528 mg/L). Results of laboratory analysis of water above the maximum levels Solids Dissolved 1000 mg/L (Ministry of Health Regulation 907, 2002) is in the location SBP1, SBP2, SBP8, SBP11, SBP13, SBP14, SBP15, SBP16, SBP17, SBP18, SP3, SBP19, SP4B , SP5, SP6, SBP22, SBP23 and SBP24. 18 from 33 areas or about 54.55% places in Northern Jakarta have TDS above the normal reference.

TABLE II
Classification of groundwater based on TDS [8]

TDS(mg/l)	Water Type	(% of sample)
<500	Desirable for drinking	12,5
500-1000	Permissible for drinking	28,13
<1000	Not good for drinking	59,37

2) pH

The value of pure water pH = 7, the low pH will be acidic and corrosive. The range levels of pH according to the health ministry ordinance 907 of 2002 amounted to 6.5 to 8.5. From the analysis of water in the laboratory got some value above and below predetermined levels are SBP2, SBP4, SBP8, SBP9, SBP11, SBP16 and SP2. The possibility of this situation is caused by domestic waste from humans or house hold activity waste generated by industrial and geological conditions such as rocks that affect groundwater conditions. Water PH from 7 areas (21.21%) was out of normal value, either it's alkaline or acidic.

3) Iron (Fe)

Results of laboratory analysis of water above the maximum levels of iron of 0.3 mg/L (Ministry of Health Regulation 907, 2002) are in locations SBP1, SBP2, SBP4, SBP5, SBP6, SBP7, SBP8, SBP11, SBP13, SBP15, SBP16, SBP17, SBP18, SP1a, SP2, SP4A, SP4B, SBP20, SP5, SP6, SP7B, SBP21, SBP22 and SBP23. There are 24 areas (72.72%) were have greater Fe level than maximal value.

Fe resulted in corrosive, and yellow. Based on American College of Gastroenterology, too much iron can damage liver cells or aggravate liver damage caused by some viruses. This will occur in people who have chronic liver disease and/or cirrhosis.[9] Fe content can be lowered by filtration, aeration, precipitation, electrolytic, ion exchange and adsorption.

4) Mangan (Mn)

Results of laboratory analysis of water above the maximum levels of manganese 0.1 mg/L (Ministry of Health Regulation 907, 2002) are in locations SBP2, SBP5, SBP13, SBP14, SBP15, SBP16, SBP17, SBP18, SP1a, SP2, SP3, SBP19, SP4B, SBP20, SP5, SP6, SBP21 and SB23. There are 54.55% or 18 areas were have Mn level greater than maximal value. Number of reports indicate that oral exposure to manganese, especially from contaminated water sources, can produce significant health effects such as neurological effect especially in children.[10,11] High Mn causing toxins can be reduced by filtration, aeration, precipitation, electrolytic, ion exchange and adsorption.

5) Sodium (Na)

Results of laboratory analysis of water above the maximum levels of sodium 200 mg / L (Ministry of Health Regulation 907, 2002) are in locations SBP1, SBP2, SBP4, SBP6, SBP8, SBP11, SBP13, SBP14, SBP15, SBP16, SBP17, SBP18, SP1A, SP1B, SP2, SP3, SBP19, SP4B, SP5, SP6, SP7A, SP7B, SBP22, SBP23 dan SBP24. There are 25 areas (75.76%) were have Na level greater than maximal value. Na could elevates vascular resistance that directly produces high pressure in vascular wall and it will result hypertention. [12]

6) Chloride (Cl)

Results of laboratory analysis of water above the maximum levels of chloride 250 mg/L (Ministry of Health Regulation 907, 2002) are in locations SBP1, SBP2, SBP6, SBP11, SBP13, SBP14, SBP15, SBP16, SBP17, SBP18, SP3, SBP19, SP4B, SP5, SP6, SBP22, SBP23 dan SBP24. There are 18 areas (54.55%) were have Cl level greater than maximal value. Conditions causing an elevation of the serum chloride concentration and a concomitant elevation of the serum sodium concentration.[13] Dietary sodium chloride has been studied the most, and there is general consensus that increased sodium chloride intake increases blood pressure.[14] The origin of chloride in groundwater may be from diverse sources such as weathering, leaching of sedimentary rocks and soils, intrusion of saltwater, windblown salt inprecipitation, domestic and industrial waste discharges, municipal effluents, etc.[15]

7) Sulphate (SO_4)

The content of sulfate, determine the oxidation of sulfide minerals, to groundwater chemistry. Another source is gypsum ($CaSO_4.2H_2O$) and anhydrite (CaSO4) dissolves in water and becomes Ca^{2+} and SO_4^{2-}. Results of laboratory analysis of water above the maximum levels of sulphate 250 mg/L (Ministry of Health Regulation 907, 2002) are in locations SBP13, SBP16, SBP17, SP5 dan SP6. There are 15.15% or 5 areas were have SO_4 level greater than maximal value. Based on WHO there are no health-based guidelines value for sulfate in drinking water, but dehydration has also been reported as a common side-effect of ingestion large amount of sodium sulfate.[16]

8) Ammonia (NH_4)

Results of laboratory analysis of water above the maximum levels of ammonia 1,5 mg/L (Ministry of Health Regulation 907, 2002) are in locations SBP2, SBP3, SBP6, SBP16, SBP17, SBP18, SBP21 dan SBP24. There are 8 areas from total 33 places (24.24%) were have NH_4 level greater than maximal value. High ammonia levels may indicate contamination has occurred. There is no EPA mandated Maximum Contaminant Level (MCL) for ammonia. But ammonia is toxic to fish and the toxicity increase with high temperature and pH in water. Also in poor oxygen environments, can lead to gill damage, hyperplasia, and reduction in growth rates.[17]

IV. Conclusions

From these data, analysis has been done and conclude that there are more than 50% of the study area has the content of TDS and the chemical content of Fe, Mn, Na, Cl were above the normal reference value and have potential to the several diseases. We suggest to the people of Northern Jakarta to conduct the water treatment before using for drinking and daily use.

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