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Study Of Groundwater Salinity Level And Distribution In Coastal Areas, Adimulyo Sub-district, Kebumen Regency, Central Java

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ABSTRAK

Kecamatan Adimulyo, Kabupaten Kebumen dengan topografi dataran rendah memiliki airtanah bebas dengan kedalaman permukaan airtanah berkisar antara 5 - 8 meter. Aktivitas manusia telah menjadi penyebab salinisasi airtanah di tempat ini. Selain itu, lokasi yang dekat dengan pesisir yang datar juga memperlambat aliran airtanah secara exfluent menuju daerah estuary sungai. Hal ini menyebabkan airtanah konsumsi sehari-hari rumah tangga menjadi terasa payau. Penelitian ini bertujuan untuk mengetahui bagaimana tingkat salinitas berdasarkan jarak dari estuary yang menyebabkan airtanah terasa payau. Analisis dilakukan pada data primer berupa kadar salinitas airtanah sumur terbuka yang menjadi konsumsi sehari hari rumah tangga. Salinitas airtanah tertinggi (4,45‰ – 10,15‰) terdapat di wilayah bagian tengah dan paling rendah (0,12‰ – 2,50‰) berada diwilayah selatan, salinitas airtanahnya rata-rata 0,80‰ – 2,87‰ dengan kategori menengah. Hal ini menunjukkan bahwa lokasi yang berjarak paling dekat estuary (<100 meter) memiliki kondisi paling tersalinisasi sedangkan yang paling dekat pesisir airtanahnya cenderung memiliki kadar salinisasi yang lebih rendah dari estuary. Lokasi bagian menengah diketahui bahwa telah mengalami pengambilan airtanah oleh rumah tangga yang tinggi dan tidak terkontrol. Sehingga salinisasi terjadi akibat berkurangnya airtanah tawar tergantikan oleh air payau secara exfluent dari sungai bagian estuary.

Kata Kunci: *Airtanah, Salinisasi, Estuary*

ABSTRACT

Adimulyo Subdistrict, Kebumen Regency with a lowland topography has free groundwater with a groundwater surface depth ranging from 5-8 meters. Human activity has become the cause of the salinization of groundwater in this place. In addition, the location close to the flat coast also slows down the flow of groundwater exfluently to the estuary area of the river. This causes the daily consumption of the household groundwater to feel brackish. This study will aim to find out how the level of salinity based on distance from the estuary causes the groundwater to feel brackish. The analysis was carried out on primary data in the form of salinity levels of open well groundwater which became the daily consumption of households. The highest salinity of groundwater (4.45‰ – 10.15‰) is found in the central and lowest regions (0.12‰ – 2.50‰) while the southernmost, the salinity of the groundwater is on average medium 0.80‰ – 2.87‰. This shows that the location that is closest to the estuary (<100 meters) actually has the most twisted

conditions while the one closest to the coast from the coastal groundwater tends to have a lower salinization rate than the estuary. The location of the intermediate part is known that it has undergone high and uncontrolled intake of groundwater by households. So that salinization occurs due to the reduction of fresh groundwater replaced by brackish water exfluently from the river part of the estuary.

Keywords: Groundwater, Salinization, Estuary

INTRODUCTION

Fulfillment of fresh water needs still depends on the fulfillment of groundwater because more than 97% of the fresh water on the planet earth consists of groundwater (Asdak, 1995). Groundwater is water that moves in the ground, found in the spaces between the soil grains that form and in rock cracks (Boakye, 2014). The growth in population and its activities demands a greater need for fresh water sources (Hendrayana, 2002). The main needs of water for humans include daily domestic needs such as cooking, bathing and washing. Other human water needs are for industry, agricultural irrigation, services, and urban water supply. This increase in water use can be found in densely populated areas, new residential areas and industrial areas (Nugraha, 2018).

Coastal populations around the world are still heavily dependent on coastal aquifers as their main source of fresh water. As a clean water resource, groundwater is very vulnerable to problems that include contamination from land and offshore pollutants (Michael in Kreyns, et al, 2020) Adimulyo Sub-district, Kebumen Regency with a plain topography that has free groundwater. The depth of the groundwater level in Adimulyo Sub-district, Kebumen Regency ranges from 5 - 8 meters. The groundwater in this area tastes salty throughout the village with different salinity levels. The condition of groundwater located in Adimulyo Sub-district, Kebumen Regency is turbid and smells a bit like mud. Increased use of groundwater to irrigate rice fields occurs during the dry season. Farmers in Adimulyo Sub-district need a lot of water to irrigate rice fields by drilling wells in the rice fields. Taking water with a pump which is then used to irrigate the rice fields is continuously carried out without thinking about its impact. Groundwater exploitation that continues and is increasing from time to time is thought to be one of the occurrences of sea water intrusion in aquifers (Gemilang et al, 2016).

Groundwater contamination in general that currently occurs is caused by human activities. Increased human activity in land use, household use and uncontrolled increase in waste production from both households and industries are the main factors causing a decrease in groundwater quality (Affum et al., 2015). The use of groundwater by way of excessive extraction, especially for the needs of the population, also exacerbates the high intensity of seawater infiltration into the land (Rejekiningrum, 2009). Basack et al. (2010) in (Purnama, 2017), the interface area is a water transition and diffusion between fresh water and salt water. The type of water below the interface is salt water, while above the interface is fresh groundwater.

Adimulyo Sub-district, Kebumen Regency has a population of 4158 people, consisting of 2108 male residents and 2050 female residents and consisting of 546 household heads. Based on the population data, it shows that residents in Adimulyo Sub-district, Kebumen Regency need a large enough amount of clean water to meet their daily needs (clean water).

Groundwater conditions are strongly influenced by the location of an area, for example groundwater in mountainous areas with groundwater in coastal areas, absolutely the conditions are different, especially in terms of chemical quality, for example in salinity (Yu et al., 2016; Kodoatie, 2012). In addition, the formation of groundwater facies is strongly influenced by hydrogeochemical processes in the form of leaching groundwater by percolation of rainwater, cation exchange, and mixing or infiltration of sea water (Setiawan, 2014). Meanwhile, groundwater availability is influenced by geological conditions related to the characteristics of groundwater basins or non-basins which are groundwater storage media (Kristanto, et al., 2020). Damage to water resources cannot be separated from damage to its surroundings, such as land degradation and unplanned use management which causes groundwater conditions to become damaged, especially due to sea water intrusion (Mirzavand, et al., 2020). Seawater intrusion can be prevented if the construction of wells to fulfill groundwater for residents is more than 2 km from the coastline (Wahyudi, 2009). Dug wells are a means of providing clean water that comes from a layer of soil that is relatively close to the surface of the soil, so it needs attention because it is easily polluted and contaminated through seepage (Sari & Huljana, 2019).

The condition of Adimulyo Sub-district, Kebumen Regency, which is located ± 3 kilometers from the Indonesian Ocean and has an elevation of 3 M dpal. Slope <2% or flat, with sandy soil texture. Adimulyo Sub-district, Kebumen Regency, has 6 rivers which are tributaries that flow into the main river close to the estuary. The river flow is very slow. It even looks like it is inundated because of its small hydraulic gradient. River water tastes salty because it is affected by the tidal currents of sea water. The river conditions in Adimulyo Sub-district during the rainy season the discharge of water overflows so that it inundates the land, while in the dry season the river experiences drought, and causes several rivers to dry up. Several rivers are still inundated due to the tidal cycle of sea water, so that the sea water enters the river flow. This incident made the river water salty.

The source of clean water to meet the needs of the population comes from groundwater. The water conditions are salty, turbid, and the relationship is like mud, so groundwater is only used for toilet purposes. Water needs for drinking and cooking water by buying clean water from outside the Village area. Based on these problems, This study aims to see the salinity distribution of groundwater in coastal areas based in Adimulyo District, Kebumen Regency.

RESEARCH METHOD

This study uses a survey method. The population in this study was groundwater in the Adimulyo Sub-district, Kebumen Regency, Central Java. The data analysis carried out in this study is based on primary data. Samples were selected purposively based on the distance to the location of the river and the coast. The sample criteria are in the southern part close to the coast, the middle part in settlements close to the river and the northern part in dense settlements. Itsalinity is measured for the content of saline solutions. This degree of salinity indicates the degree of salinity with the content of negative chloride ions. Sampling point as shown in **Figure 1**.

Figure 1. Distribution of sampling locations

Salinity can be defined as the total concentration of dissolved ions in water expressed in units of permil (‰) or ppt (parts per thousand) or grams / liter. Salinity is composed of seven main ions, namely sodium, potassium, potassium,

magnesium, chloride, sulfate, bicarbonate (Ambardhy in Palippui, 2019) therefore, in this study, the measurement of salinity was carried out through dissolved salt levels, namely the values of NaCl and DHL in groundwater. DHL (electrical conductivity) is a numerical description of the ability of water to pass on electricity. DHL water is an inverse resistance in ohms measured on the opposite ground face in cm x cm^3 at a temperature of 25^oC measured in µmhos. Hbetween electricity is the opposite of resistance, but because the magnitude of this DHL is very small it is usually expressed in µmhos whose magnitude is equal to 10-6mhos. (Arislan in Latifah et al., 2014). Standar used for the classification of groundwater with electrical conductivity is less than 900 µmhos/cm fresh groundwater (low DHL), 900-2000 µmhos/cm brackish (medium DHL), and greater than 2000µmhos/cm saltwater (high DHL) (Davis in Ruseffandi & Gusman, 2020)). The unit of salinity is per mile (‰), that is, the sum of the total weight (gr) of solid material such as NaCl contained in 1000 grams of seawater (Arief dalam Siltri et al., 2016). Freshwater salinity is worth <0.5 ‰, brackish water 0.5-5 ‰, and salt water 5-30‰ (Disbang DKI Jakarta in Prihartanto, 2017).

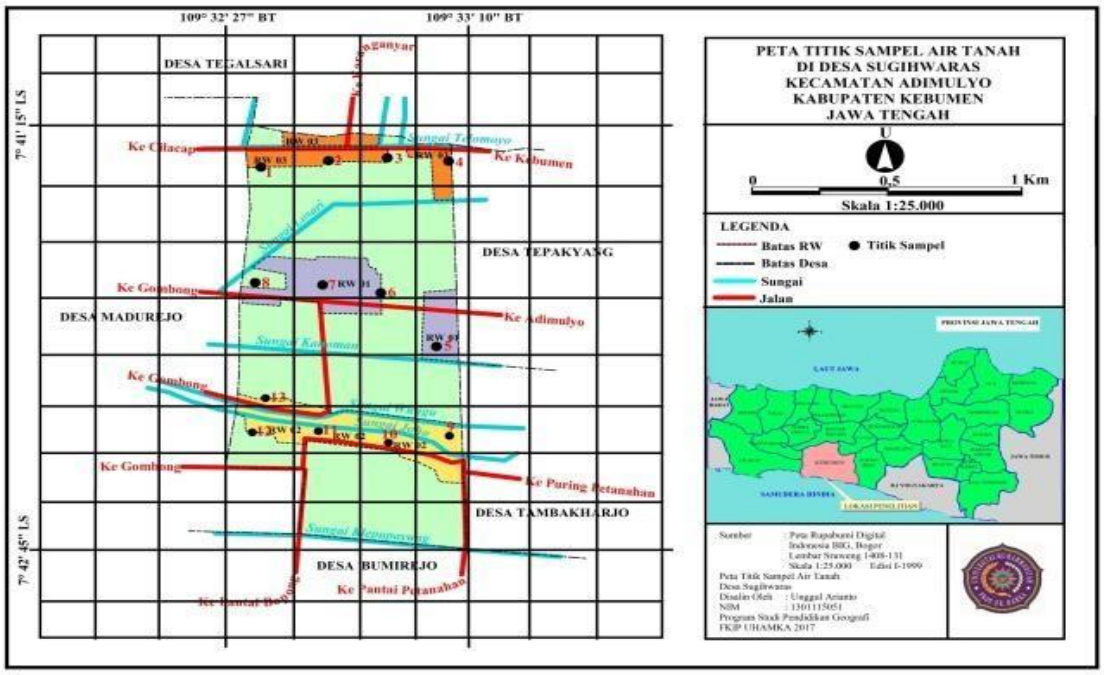

Figure 1. Research Area

The sampling technique is carried out by creating a map grid, that is, the research area is divided into several grids. For each grid, one groundwater sample is taken to measure its salinity, 13 sample points are taken and salinity is measured. The results of laboratory tests carried out in an environmental engineering laboratory with 4 elements analyzed from groundwater for each sample, namely chloride, DHL (Electrical Conductivity), pH and dissolved solids (TDS). These four elements are related to each other, mainly DHL and chloride, the higher the chloride, the higher the DHL. The water samples taken in this study were groundwater, 13 groundwater samples were taken from residents' wells in Adimulyo District, Kebumen Regency which was divided into 3 hamlets.

RESULT AND DISCUSSION

Shallow groundwater or phreatic is groundwater that is located not far from the ground and is above the impermeable layer (Prihartanto, 2017). Based on the results of data analysis used in this study, it can be seen that the salinity levels contained in groundwater in the Adimulyo Sub-district area. The salinity of groundwater can be determined from the chloride content in it (chlorinity). Determination of chloride levels using the salinity formula: Chlorinity X 1,817 (Hutabarat, 1984: 55). The sampling technique was made by making a map grid, namely the research area was divided into several grids. For each grid, one sample of groundwater was taken to measure its salinity, 13 sample points were taken and the salinity was measured. The results of laboratory tests conducted in the environmental engineering laboratory with 4 elements analyzed from groundwater for each sample, namely chloride, DHL (Electrical Conductivity). These four elements are related to each other, especially DHL and chloride, the higher the chloride, the higher the DHL. Water samples taken in this study were groundwater, 13 samples of groundwater were taken from resident wells in Adimulyo Sub-district, Kebumen Regency which were divided into 3 Hamlets.

Groundwater extraction at 13 sample points was taken in very sunny weather conditions, and was carried out from morning to noon, which was around 09:30 - 14:57 WIB, on the same date, namely 10 August 2019 with varying elevations of the groundwater sample points. The area with the lowest altitude is RW 03 which is about 3 meters at the sample point T.2 which is located at 7 ° -42'-27.8 "LS and longitude 109 ° -32'-43" East Longitude. This area is a low-lying area close to the Telomoyo River, so that every time the rainy season there is often a flood that overflows the villages. When the dry season arrives, there is a drought. Judging from the population density, this area is a densely populated area, so the groundwater extraction is very large. Restrictions on the use of groundwater by residents for various needs are needed to maintain the sustainability of groundwater fulfillment (Susanto, et al., 2014). The impact of this very large extraction of groundwater is that salt water enters the aquifer (intrusion) which results in high groundwater salinity, which causes the groundwater to become brackish to salty.

Laboratory tests of groundwater quality are carried out to determine the level of CI (Chloride), DHL (Electrical Conductivity), pH (Acidity Level). The measurement results of 13 groundwater samples can be seen in **Table 1**.

Groundwater quality laboratory tests were carried out to determine the level of CI (Chloride), DHL (Electrical Conductivity), pH (Acidity) and TDS (Dissolved Solids). The results of measurements of 13 groundwater samplescan be seen in Table 1 below:

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Table 1. Measurement Results of Chloride Levels & DHL, at 13 Groundwater Sample Points

Sample Point	Chloride (mg/lt)	Electrical Conductivity (mh/cm)	pH
T1	65,176	1937,453	7,03
T2	69,096	1683,263	7,0
T3	75,467	1089,538	7,02
T4	1421,15	2458,231	6,89
T5	74,977	818,716	7,49
	5586,5	12520,312	6,78
T7	2450,2	4978,959	7,26
T8	3381,3	7478,855	7,19
T9	539	1073,914	7,58
T10	1470,1	4135,244	6,98
T11	735,1	1046,831	7,07
T12	588,1	499,981	7,94
T13	441	566,643	7,41

The distribution of chloride levels at 13 sample points of groundwater in Adimulyo Sub-district, Kebumen Regency can be presented in **Figure 2**, Graph of Chloride levels.

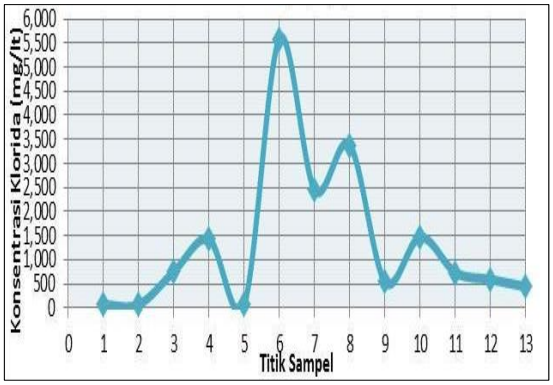

Figure 2. Graph of Groundwater Chloride Levels in research location
Source: Laboratory analityc, 2021.

The results of measuring chloride levels (chlorinity) are presented in **Table 2**. Based on **Table 2**, it can be seen that the salinity of groundwater at 13 sample points in the study area is presented in **Table 2** below.

Table 2. Chlorinity and Salinity Levels of Groundwater in Adimulyo

Sample Point	Chloride (mg/lt)	Chlorinity (‰)	Salinity (‰)
T1	65	0,065	0,12
T2	69	0,069	0,13
T3	755	0,755	1,37
T4	1421,15	1,42115	2,58
T5	75	0,075	0,13
T6	5586,5	5,5865	10,15
T7	2450,2	2,4502	4,45
T8	3381,3	3,3813	6,14
T9	539	0,539	0,97
T10	1470,1	1,4701	2,67
T11	735,1	0,7351	1,33
T12	588,1	0,5881	1,06
T13	441	0,441	0,80

Source: Laboratory Analityc 2021.

Based on the data from the measurement of groundwater salinity in Adimulyo Sub-district, Kebumen Regency, almost all of them have been affected by sea water. This condition has an impact on groundwater which feels brackish. The distribution of groundwater that feels brackish does not follow the pattern of distance from the coastline. This distribution pattern is indicated by the results of laboratory tests that the village in the middle is located in Halmet (RW) 01 where there is the highest level of salinity. In the Halmet (RW) 02 area that is closest to the coastline, the salinity level is lower than that in the Halmet (RW) 01 area. This pattern gives signs that there are factors that greatly influence the pattern of salinity distribution in Adimulyo District. The Halmet (RW) 01 area in the middle of the village has a high salinity level, which ranges from 4.45 ‰ - 10.15 ‰. The Halmet (RW) 02 area in the south which is closer to the coastline has a salinity ranging from 0.80 ‰ - 2.67 ‰, the distribution of salinity is presented in Figure 3 below. Table 4 presents the salinity classification in the study area.

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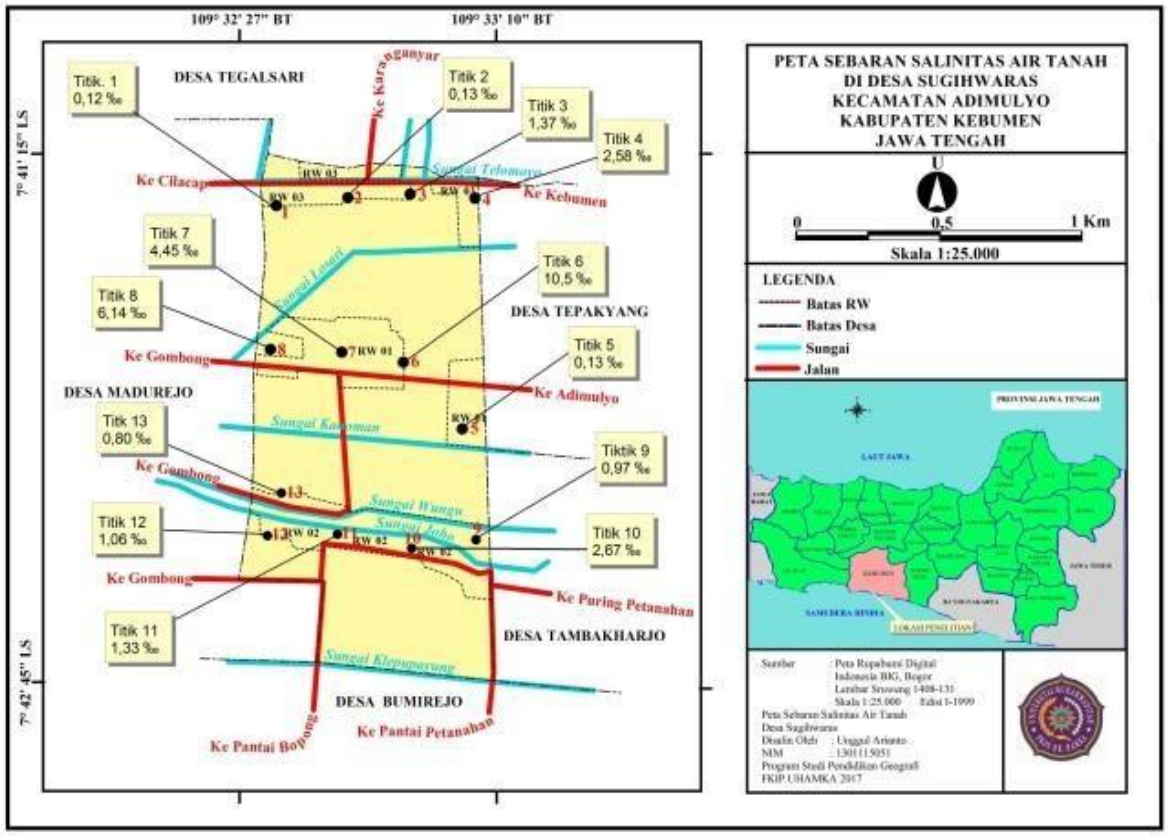

Figure 3. The value of groundwater salinity distribution in the Adimulyo district

Table 3. Salinity classification in groundwater samples

Sample Points	Chlorinity (‰)	Salinity (‰)	Water Types
T1	0,065	0,12	Fresh Water (*Air Tawar*)
T2	0,069	0,13	Fresh Water (*Air Tawar*)
T3	0,755	1,37	Oligohaline (*Payau Rendah*)
T4	1,421	2,58	Oligohaline (*Payau Rendah*)
T5	0,075	0,13	Fresh Water (*Air Tawar*)
T6	5,5865	10,15	Mesohaline (*Payau Menengah*)
T7	2,4502	4,45	Mesohaline (*Payau Menengah*)
T8	3,3813	6,14	Mesohaline (*Payau Menengah*)
T9	0,539	0,97	Oligohaline (*Payau Rendah*)
T10	1,4701	2,67	Oligohaline (*Payau Rendah*)
T11	0,7351	1,33	Oligohaline (*Payau Rendah*)
T12	0,5881	1,06	Oligohaline (*Payau Rendah*)
T13	0,441	0,80	Oligohaline (*Payau Rendah*)

Source: Laboratory Analityc 2021

CONCLUSION

Groundwater in the coastal area of Adimulyo Sub-district, Kebumen Regency has various salinity. The distribution pattern is random and does not follow the distance pattern from the coastline. The highest groundwater salinity is in the area of Adimulyo Sub-district, Central part of Kebumen Regency, which ranges from 4.45 ‰ - 10.15 10. There are other factors

besides the distance of the area from the coastline, namely brackish river water (estuary), and the large amount of groundwater withdrawal by the population. High groundwater extraction can increase the absorption of brackish river water (estuary) into groundwater. In the northern part of Adimulyo Sub-district, Kebumen Regency is an area that has the lowest groundwater salinity, which ranges from 0.12 ‰ - 2.50 ‰. In the Adimulyo Subdistrict, the southern part of Kebumen Regency has medium groundwater salinity, which ranges from 0.80 ‰ - 2.87 ‰.

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