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Study of Groundwater Physical Characteristics: A Case Study at District of Pekan, Pahang

M M M Hashim^{1,2}, M H Zawawi², K Samuding¹, J A Dominic¹, M H Zulkurnain¹ and K Mohamad¹

¹Waste Technology & Environment Division, Malaysian Nuclear Agency

²Department of Civil Engineering, Universiti Tenaga Nasional (UNITEN)

E-mail: mhafiz@uniten.edu.my

Abstract. A study of groundwater physical characteristic has been conducted at Pahang Tua, Pekan, Tanjung Batu and Nenasi, Pahang. There are several locations of tube well selected in this study. Four of five locations are situated in the coastal area and another one is located outside of coastal line. The purposes of this study are to identify the physical characteristic of groundwater (temperature, pH, electrical conductivity (EC), total dissolved solids (TDS) and salinity) and to identify the influence of sampling location and tube well depth to its physical characteristics. The results from the in-situ measurement were identified the physical characteristic groundwater for each tube well location. The result shows that temperature and pH for all groundwater samples almost in the same value but for the electrical conductivity, salinity and total dissolved solid have significant difference that related to location and depth of the tube well. The Pekan tube well with 80m depth and 2km distance from the sea have the highest value of EC, TDS and salinity (14460.53 μ S/cm, 7230.63 ppm and 8.32 PSU) compared to Nenasi with 30m depth of tube well and 0.65km distance from the sea. The EC, TDS and salinity value recorded are 1454.3253 μ S/cm, 727.00 ppm and 0.72 PSU. From the result of EC, TDS and salinity, it shows that the deeper tube well in the coastal area will obtained higher value of EC, TDS and salinity.

1. Introduction

Groundwater is type of freshwater that used to supply for rural and urban area [1]. 90% of freshwater source in the Earth are coming from groundwater [2]. Groundwater can be found in two type of storage that called alluvial aquifer and hardrock aquifers. Alluvial aquifers mostly found at east coast Malaysia such as Pekan and Rompin, Pahang and hardrock aquifers can be found at Perlis, Klang Valley and Central Perak [3]. This study aims to identify physical characteristics of groundwater which are include pH, electrical conductivity (EC), total dissolved solids (TDS) and salinity and to correlate the sampling location and depth of tube well to the physical characteristics of groundwater. pH is the one of the important factors in groundwater quality such as for drinking water in Malaysia whether for surface water of groundwater [4]. The electrical conductivity normally measured for salinity and its correlate with chloride content and levels of concentration of TDS [1][5]. Total dissolved solids are the concentration of chemical content in groundwater and its normally correlate with salinity [1]. Salinity of groundwater usually cause by seawater intrusion derive from tidal or increasing of seawater level and overpumping activities in the alluvial aquifer [6][7][8]. Salinity are measured using Practical Salinity Unit (PSU) that measure salt concentration in sea water. 1 PSU is equivalent to 1g/kg [9].



2. Description of Study Area

The study area is in the District of Pekan, Pahang between Longitude $103^{\circ}20'0''$ E to $103^{\circ}30'0''$ and Latitude $3^{\circ}40'0''$ N to $3^{\circ}10'0''$ N. The area of study is parallel to the coastal of South China Sea and covered an area of 450km^2 between the towns of Pekan in the north and Nenasi in the south. Base on Geological Map of Peninsular Malaysia 1985, the study area underlain by quarternary sediment consist of marine and continental deposit such as clay, silt, sand and peat with minor gravel (Figure 1). This study area also situated in the very high groundwater potential area (Figure 2). Four sampling locations were selected base on the existing of tube well in this area that can obtain groundwater samples. All the tube well has their purposes of usage. The tube well at Pahang Tua is used for research activities while the tube well for Tanjung Batu is used for chicken farm and Nenasi tube well is used for domestic freshwater supply. For the Pekan tube well, it is an abandon tube well.

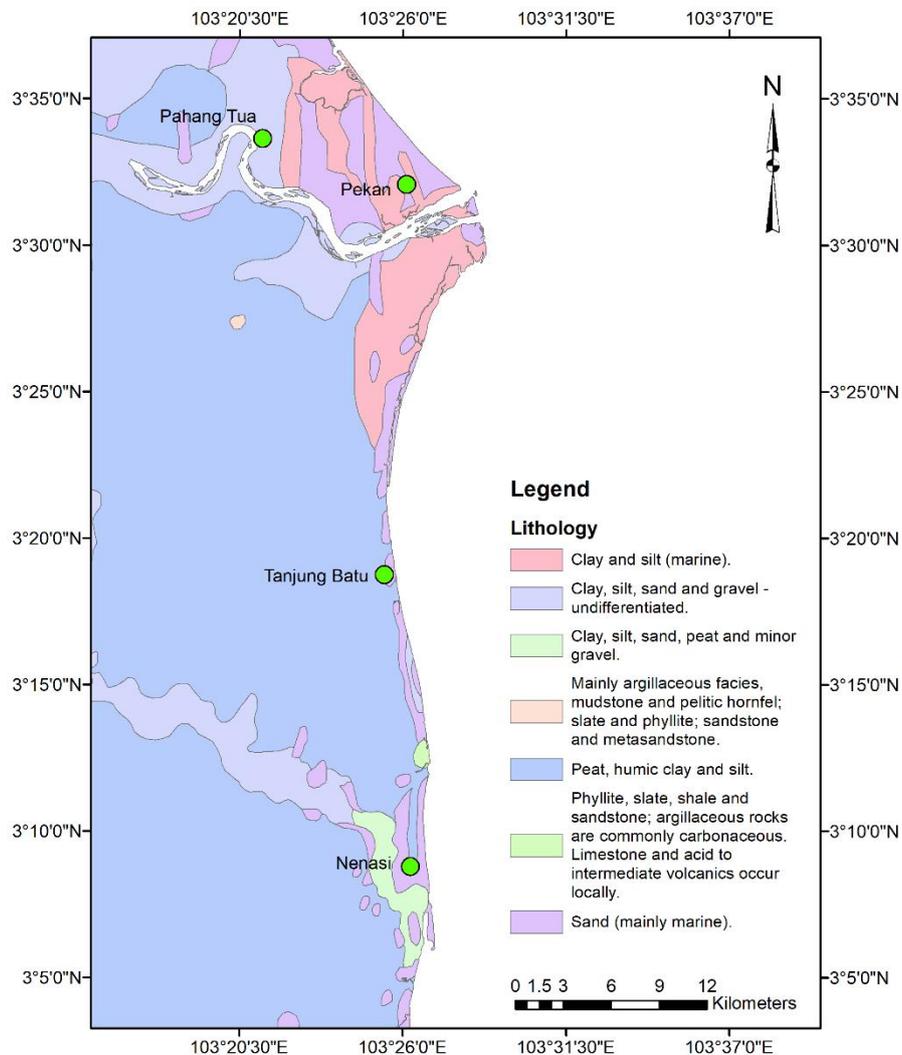


Figure 1. Geological map of study area with sampling location of groundwater located at Pahang Tua, Pekan, Tanjung Batu and Nenasi. Modified after Geological Map of Peninsular Malaysia 1985.

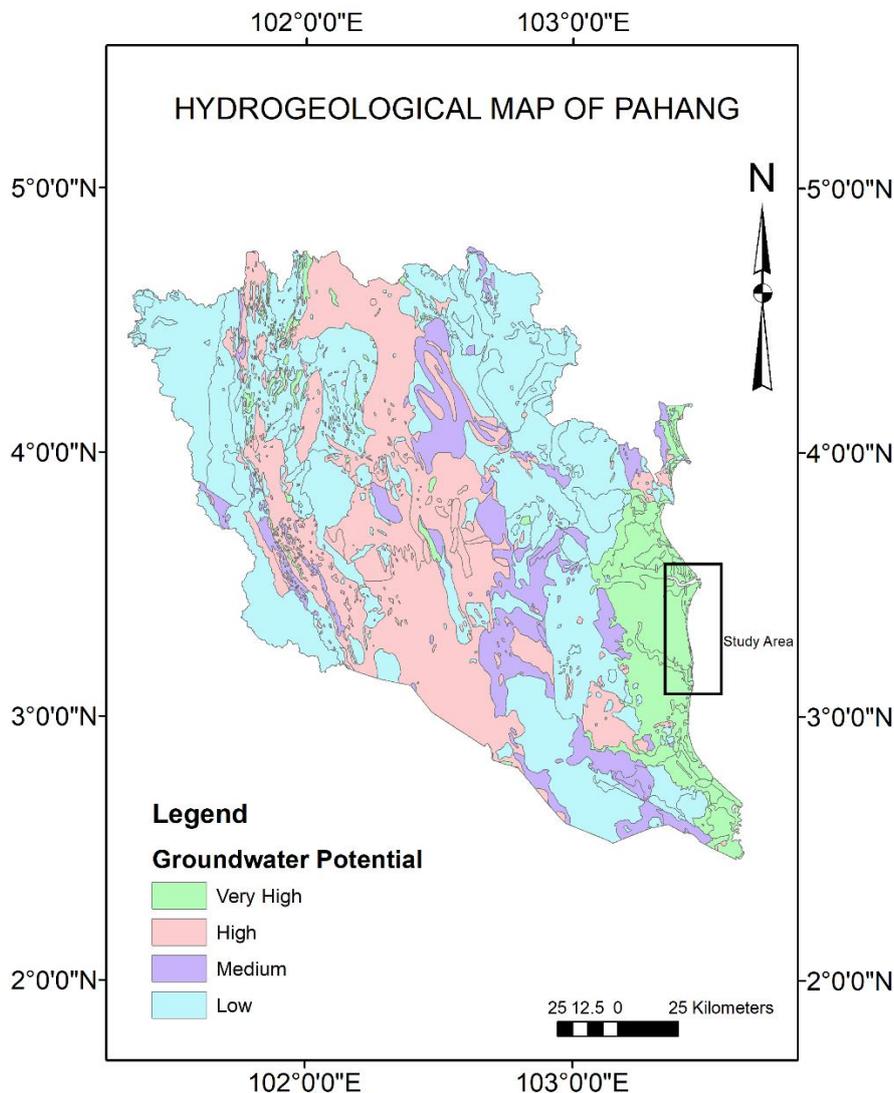


Figure 2. Hydrogeological Map of Pahang. The map shows the study area is located in the very high groundwater potential area. Modified after Hydrogeological Map of Peninsular Malaysia 1975.

3. Methodology

3.1. Groundwater sampling

In this study, the main material that must to measure is groundwater. Groundwater was extracted from the tube well by using portable engine pump. Sampling technique for groundwater are followed operating procedure for groundwater sampling [9]. The groundwater was pumped out at least three well volume to purge the groundwater to ensure the groundwater are not in the stagnant condition [10]. In the phase of stagnant, the physical characteristic is not the stable condition. Water purge technique also to provide representative sample of in-situ groundwater with minimum disturbance from the flow system of the aquifer [11]. The extracted groundwater was stored in plastic container before in-situ measurement is carried out.

3.2. In-situ measurement

For the data acquisition, a multiparameter equipment HI 9829 is used in this study. This equipment is a built-in multiple probe sensor with global positioning system that can measure pH, temperature, electrical conductivity, total dissolved solids and salinity and able locate the coordinate where the measurement is conducted. Before the measurement, the equipment is calibrated properly using quick calibration solution to ensure the accuracy of the data acquisition. After the groundwater were pumped out for three well volumes, the measurement was conducted immediately and the data acquisition was continued until the reading stabilized. The in-situ measurement is carried out by following standard operating procedure of in-situ water quality monitoring [12].

4. Result and Discussions

4.1. Physical Characteristic

Four groundwater samples were collected during this study. All the groundwater samples were measured in term of physical characteristic such as temperature, pH, electrical conductivity (EC), total dissolved solids (TDS) and salinity. The result for the measurement are shows in Table 1. The tube well depth and its distance to the sea are shows in Table 2.

Table 1 shows the highest temperature of groundwater samples was recorded at Nenasi with temperature 30.27°C followed by Pekan 29.99 °C, Pahang Tua 29.17 °C and Tanjung Batu 28.57 °C. From the result of temperature, there are no significant difference because the difference value for the maximum and the minimum temperature is 1.7 °C even though the tube well and its distance to the sea are varying. The maximum pH 6.81 is recorded at Pekan followed by Tanjung Batu 6.62, Pahang Tua 6.36 and Nenasi 6.22. All the groundwater samples have similar value for pH. So, there is no significant difference regardless of its sampling locations and tube well depth. The highest EC was recorded at Pekan with the value 14460.53 μS/cm. Tanjung Batu's EC is 1699.18 μS/cm followed by Nenasi 1454.32 μS/cm and the lowest EC at Pahang Tua with the value 768.76 μS/cm. There are significant different of EC value about 13691.54 μS/cm from the maximum and the minimum value of EC. The highest TDS measured for Pekan groundwater sample with the value of 7230 ppm while Tanjung Batu is 849.61 ppm. For Nenasi, TDS was recorded with the value of 727 ppm and the lowest TDS 384.32 ppm is for Pahang Tua. 6846.31 ppm is the different from the highest and the lowest TDS recorded in this study. It shows that TDS have significant different related to sampling location and the depth of tube well. The highest salinity was measured at Pekan with 8.32 PSU while three others location were obtained the value below 1 PSU. Tanjung Batu with 0.85 PSU while Nenasi is 0.72 PSU and the lowest with the value 0.37 PSU is Pahang Tua. In this study, salinity have significant different for the value that can be correlate to sampling location and depth of the tube well.

Table 1. List of sampling location and physical characteristics of groundwater samples

Sampling Location	Temperature	pH	Electrical conductivity (EC)	Total Dissolve Solids (TDS)	Salinity
Pekan	29.99	6.81	14460.53	7230.63	8.32
Tanjung Batu	28.57	6.62	1699.18	849.61	0.85
Nenasi	30.27	6.22	1454.32	727.00	0.72
Pahang Tua	29.17	6.36	768.76	384.32	0.37

Temp (degree Celsius), EC (microsiemens per centimeter), TDS (parts per million), salinity (practical salinity unit)

Table 2. Tube well depth and distance to sea

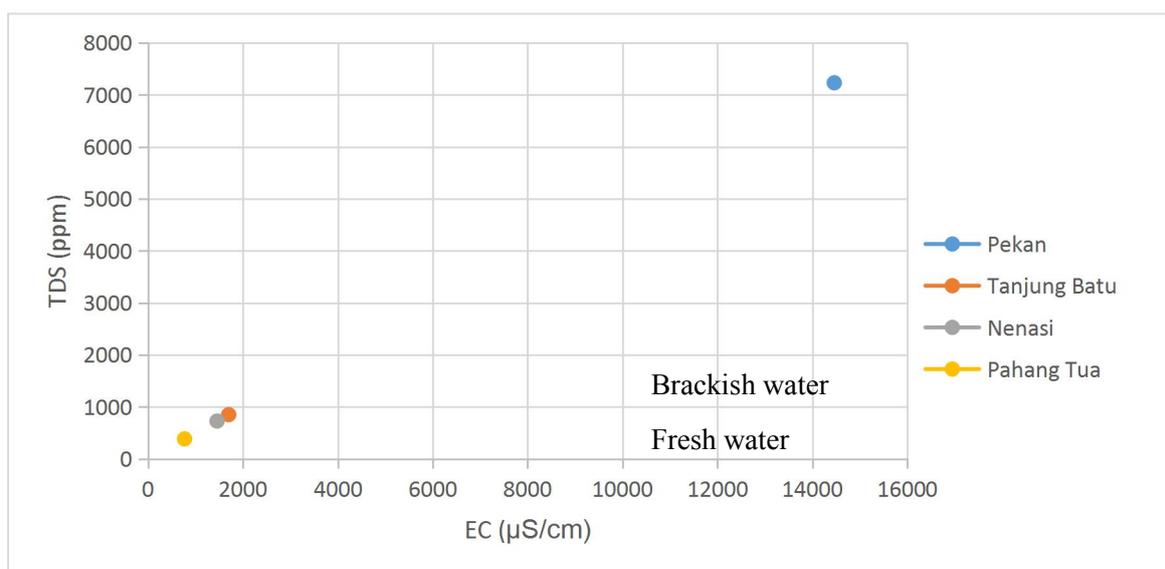
Sampling Location	Tube well depth (m)	Distance to sea (km)
Pekan	80	2.00
Tanjung Batu	30	0.50
Nenasi	30	0.65
Pahang Tua	80	7.00

4.2. Correlation of EC, TDS, salinity, tube well depth and distance to sea.

From the results of physical characteristic measurement in Table 1, its clearly shown that electrical conductivity, total dissolved solids and salinity were influenced directly to tube well depth and distance to the sea. Pekan is located 2km from the sea with 80m depth of tube well while Tanjung Batu and Nenasi which are located 0.5km and 0.65km from the sea with 30m depth of tube well, but the EC, TDS and salinity were higher for Pekan compared to Tanjung Batu and Nenasi. It shows that the tube well depth and distance to the sea are the factor for varying the value of physical characteristic of groundwater. It is an evidence of seawater intrusion are occurred in Pekan as well. From the TDS range value in Table 3, TDS value for Pekan categorized as brackish water where the value of TDS 1000 to 10,000 ppm is the range for brackish water [13], while Pahang Tua, Tanjung Batu and Nenasi are freshwater. Figure 3 and 4 shows that increasing of TDS and salinity will increase the EC value.

Table 3. Type of water on the basis TDS value. Modified after Sylus, K.J., *et al* 2015

TDS range (ppm)	Type of water
>1000	Freshwater
1000-10,000	Brackish water
10,000-100,000	Saline water

**Figure 3.** TDS vs EC in groundwater samples for all tube well location

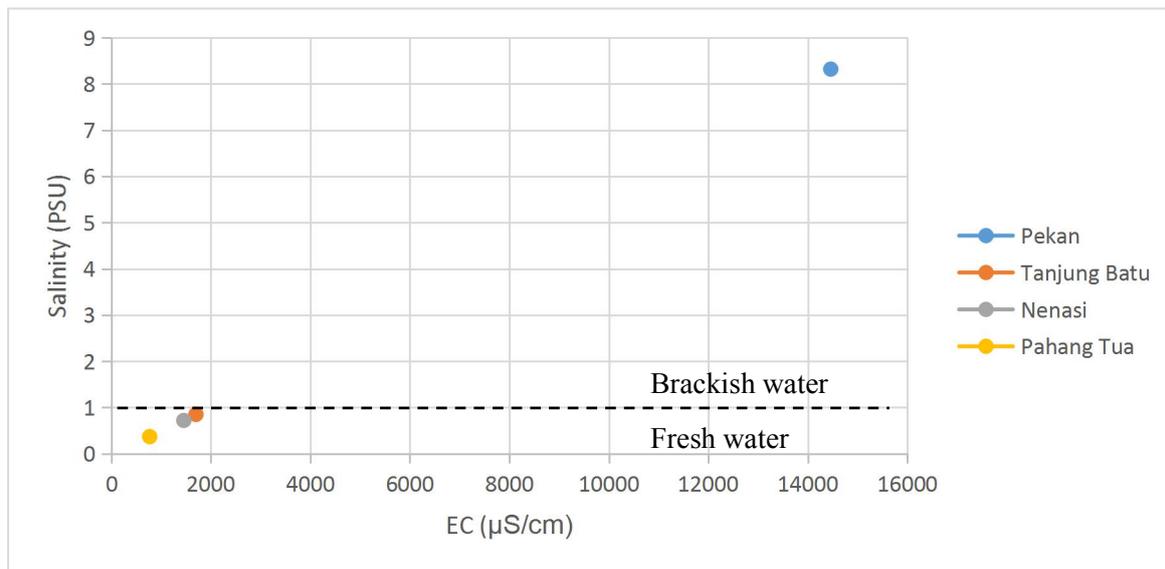


Figure 4. Salinity vs EC in groundwater samples for all tube well location

5. Conclusion

The physical characteristic of groundwater for the District of Pekan, Pahang has been identified by measurement of pH, electrical conductivity, total dissolved solids and salinity. The characteristic of groundwater is varied depends on tube well location and also the depth of tube well. The deeper tube well in the coastal area will obtained higher value of EC, TDS and salinity and vice versa. The result of Pekan tube well can be a evidence of saline water intrusion has occurred in that aquifer. Further study need to be carried out to support the evidence and to identify the origin of brackish water either it is a mixing of freshwater and seawater or from the others factors due to geological condition.

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