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SEAWATER INTRUSION IN THE GROUND WATER AQUIFER IN THE KOTA BHARU DISTRICT, KELANTAN

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Abstract

Ground water is the most valuable natural water resource to the people in Kota Bharu for the dependence on this source. This paper discusses to what extent the seawater intrusion in the well in the research area by comparing the Chloride (Cl) content with the National Drinking Water Quality Standard 1983 that states that the permitted Cl content is 250 mg/l. The three years data of the Cl concentration in the ground water were used to observe the differences that are in 1990, 1999 and 2011. The parameter of Cl was used to identify the area that has a critical

intrusion. The two areas that were observed in this study are Pengkalan Chepa and Tanjung Mas. Pengkalan Chepa have five ground water observation wells that is KB 1, KB 2, KB 3, KB 4 and KB 5, while Tanjung Mas have six ground water observation wells that is KB 6, KB 9, KB 10, KB 11, KB 12 and KB 13. KB 5, KB 12 and KB 13 are considered the most problematic wells as all the Cl content from the data from the three years exceed the National Drinking Water Standard 1983. For KB 5, the Cl content in the ground water is too extreme with the reading 1,485 mg/l in the 1990 and increased to 1,778 mg/l (1999), but decreased to 1485 mg/l in 2011 but still exceed the National Drinking Water Standard 1983. Ongoing observation must be done to make sure the ground water source will not be contaminated with the sea water to ensure a sustainable water resource in the future.

Keywords

Ground Water, Seawater Intrusion and Chloride Content

1. Introduction

Ground water refers to water that inhabits all the pores, voids or cracks in geological formations comes from rain water catchment, rivers and lakes (Olumuyiwa I. Ojo., Fred A.O. Otieno., & George M. Ochieng, 2012). Ground water is defined as water in the saturated zone that fills the pore spaces between mineral grains or rock cracks in the sub-surface soil (Fitts 2002).

Sea water intrusion defined as the intrusion of the saltwater entering the ground water aquifers. Excessive mixing of sea water will cause chemical and physical properties of the fresh water in the aquifer will become brackish and salty. For areas with population density and dependence on the groundwater would result in an abstract resource exceed the recharge rate risk the threat of saltwater intrusion? However, this scenario is a threat to the aquifers that are near the coast.

2. Ground Water Quality Issues

Many people in the world live in the area near the coast where they depend with the fresh water from the coastal aquifer. The coastal aquifer is vulnerable to the seawater intrusion which also pushes towards the ground water well for example in Florida (United States). The excessive

pumping of the water resource will cause the reduction of the sea water level in the aquifer. When the ground water level decrease, then the risk for seawater intrusion is high because the level is higher than the resource (J.F. Rodrigo et al 2014).

Ground water in the coastal area around the world is backish and saline because of the sea water intrusion and marine transgression (Post & Abarca 2010, Werner, A.D.et al., 2013). Diffusion process will lead to saltwater penetrating groundwater aquifer system and cause the resources become salty as what happened to the coast in The Netherland (De Louw et al., 2011;Velstra et al., 2011), Belgium (Vandenbohede et al.,2010) and Po-delta , Italy (Antonellini et al. 2008).

The increasing demand for clean water for domestic uses, commercial, drinks and so open the space for the groundwater resources to be exploited in the area of Kota Bharu, Kelantan. The increasing population is also a major factor in this source is used in addition the region does not have adequate resource of the surface water. The water usage in the research area is 100 per cent not just an alternative source.

The sea water intrusion in the aquifer system is the existence of the sea salt in the aquifer. It can occur naturally in the research area because it is near the South China Sea. The sea water intrusion has become a major problem for the ground water resource in the coastal area for decades. The problem becomes critical during the drought season and requires a proper management to protect the ground water. Apart from the wells situated near the coastal area, another factor that is causing the salt water is the well's depth influence the existence of the salt.

3. Research Area and Methodology

Case studies have been conducted in Kota Bharu. There are two different locations seen in this study, namely Pengkalan Cheap and Tantung Mass. Pengkalan Cheap has five ground water observation wells, namely KB 1, KB 2, KB 3, KB 4 and KB 5, while Tantung Mas has six ground water observation wells which are KB 6, KB 9, KB 10, KB 11, KB 12, and KB 13. The Selection of two different locations was intended to see how far the distance between the wells and the coast affected sea salt content in the ground water.

The concentration of Cl usually is in all kinds of natural water. Increased Cl is influenced by the mineral content. Cl is in low quality in highlands and mountains. River and ground water contains relatively high concentrations of chloride (Sawyer et al., 2003). The presence of Cl in

the ground water is due to the water-soluble mineral deposits due to crystallization by evaporation of the sea water (Mohammad Ismail, 2004). The sea salts have access to natural water in various ways (Sawyer et al., 2003).

Secondary data of the Cl content in ground water was used in this research area. This secondary data were obtained from the Department of Mineral and Geosciences' Kelantan, to view the content of Cl in groundwater of the research area, comparison method will be made. Cl concentrations data will be compared with the National Drinking Water Quality Standards 1983. The value set by the Ministry of Health (1983) for the Cl content in drinking water should be at 250 mg/l. The ground water quality analysis will be carried out starting from 1990, 1999 and 2011 to see the effect of the entry of seawater into groundwater aquifers. This comparison is performed to see whether there is a exceeded value of Cl in groundwater due to the intrusion of sea water.

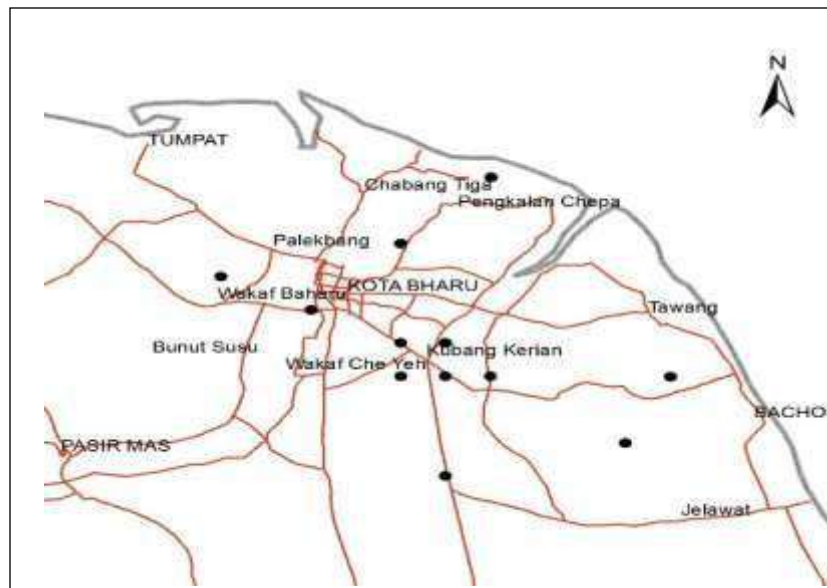


Figure 1: *Research Area*

4. Result

There are two areas in Kota Bharu district involved in the research, Pengkalan Cheap and Tantung Mast. The Chloride content of soil water Kota Bharuis worrying because the wells are close to the beach, the contents are far beyond the National Drinking Water Quality Standards 1983 set by the Ministry of Health at 250 mg/l. Five out of total eleven wells in the research exceeded the Cull content of which two are temporary and three more are rigid contamination. KB 5 is the ground water sample in Pengkalan Chepaarea and is the most problematic observation well. The concentration of Cull recorded in the three years of the research period stood at a rather extreme value which is far beyond the 250 mg/l set by the MOH. In 1990, the Cell content from KB 5 is 1,485 mg/l, increased to 1,778 mg/Lin 1999 and declined to 1485 mg/l in 2011, although the value declined but it still far exceeded the standard set.

In TantungMask, two wells have been violated Cell concentrations that exceeded the National Drinking Water Quality Standards in 1983 temporarily that is B10 and B11. Both of these wells exceeded the value in 1999 at 334 mg/land 304 mg/l. KB 13 has the highest value of Cell concentration in 1990 with 325 mg/l and increased to 519 mg/l in 1999, but decreased to 335 mg/l. Even though the concentration value decreased, it still met the standard set. It is the same with KB 12, with all the value are exceeded the standard. Starting in 1990, the concentration value is 310 mg/l and increased to 440 mg/l in 1999 but decreased to 355 mg/l in 2001. While for the areas far from the coast, the Cull content in ground water are in good condition and not exceeding the National Drinking Water Quality Standards 1983.

Table 1: Chloride Content Value in Ground Water

Sample No.	Cull (mg/l) 1990	Cl (mg/l) 1999	Cell (mg/l) 2011
KB 1	32	24	204
KB 2	32	29	53
KB 3	156	166	213
KB 4	196	186	205
KB 5	1485	1778	1485
KB 6	3	6	8

KB 9	1	26	25
KB 10	14	314	0.99
KB 11	34	301	135
KB 12	310	440	259
KB 13	325	519	335

5. Discussion

The distance between the coasts with the observation wells in Pengkalan Cheap is 3 km, while the wells in Tantung Mas are 6 Km. The distance between the wells and the coast areas affect the concentration of Cull in ground water. The rapid development in the coast areas caused the existence of the beach cities. Ground water is used as a source of fresh water to meet the needs of the domestic sector and the daily needs in the area. But ground water in the area is under the threat of saltwater intrusion. This is a great concern because it can lead to the declination of the groundwater quality (Adepelumi et al., 1995; Melloul et al., 1998; Elampooranam et al., 1999; Ozler, H.M., 2003; Terzic et al., 2008). Groundwater interaction with seawater is important to avoid too much pressure, especially in the area of increasing population in the coastal areas.

The wells in Kota Bharu that are considered the most problematic with the Cull content are KB 5, KB 12 and KB 13 which all the data from the three years exceed the National Drinking Water Standard 1983 that states that the permitted Cell content is 250 mg/l. Chloride content in the contaminated ground water is a serious health issue around the world. A high concentration of Cull had caused a serious poisoning endemic in Africa, Bangladesh, India, Mongolia and China (Gao XB et al., 2007; Wang YX et al., 2009).

6. Conclusion

In conclusion, only one well that is on risk to the frequent seawater intrusion that is KB 5, KB12 and KB 13. While eight more wells didn't exceed the Chloride content in the water sample. It shows that the ground water in the research areas are still safe to be used and the risk for the seawater intrusion is not so serious even though in the first two years, the values are too extreme but it didn't continue. The weather when the ground water samples are taken are also

most likely to influence the Cell content.

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