Investigation of Salt Water Intrusion along the Bolgoda Estuary

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Abstract   Saltwater intrusion is a natural process that occurs in virtually all coastal water bodies. It causes various effects resulting high breeding of fish, prawns, water hyacinths and drinking water problems due to contamination of fresh water with saline water. Present study, focuses on the intrusion of saltwater along Bolgoda estuary. Objectives of this research are to determine the evidence of saltwater intrusion along the Bolgoda estuary and identify the social and ecological problems related thereto, such as the effects on riparian plants and aquatic life and the adoption of mitigatory measures. Investigation was carried out by measuring water quality parameters (Conductivity, pH, Dissolved-Oxygen, Temperature and Oxidation-Reduction Potential) along the estuary water in vertical profiles as well as water in nearby monitoring wells. Observations were made on different tidal periods to study the rate and extent of saltwater intrusion along the river. These vertical profiles of water quality parameters were taken along the river approximately around 50m intervals, starting from Panadura estuary towards the North direction of the estuary up to about 12 km. Results shows salt water intrusion is a prominent feature during the neap tide period than the spring tide period. Therefore, tidal variation does not control salt water intrusion for our sampling periods. However, salt water intrusion is lower in the periods with higher rainfall period. Therefore rainfall and possibly evaporation is the main controlling factor of the salt water intrusion at Bolgoda Estuary. Salt water intrusion in this estuary is an advantage to the surrounding community since salt water removes water hyacinth, and promotes prone farming.

Keywords: Conductivity, tidal period, water quality parameters.

1. Introduction

Saltwater intrusion is the introduction of saltwater into freshwater systems, often occurring in coastal systems. There are several areas such as: River mouths, Estuaries and artificial access to salt water such as sea level canals or drainage systems that get affected by salt water intrusion.

This behavior is caused by the fact that sea water has a higher density, because it carries more solutes than freshwater.

This higher density has the effect that the pressure beneath a column of saltwater is larger than that beneath a column of the same height of freshwater. If these columns were connected at the bottom, then the pressure difference

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would trigger a flow from the saltwater column to the freshwater column.

Saltwater can contaminate a freshwater aquifer or a water body through several pathways, including lateral intrusion from the ocean, by upward intrusion from deeper, more saline zones of a ground-water system; and by downward intrusion from coastal waters.

In this study, we have selected the Bolgoda Lake as a representative estuary for salt water intrusion. The Bolgoda Lake is a shallow brackish water body in the Bolgoda watershed that is located between the southern border of the Kalu Ganga basin and the northern border of the Kelani river basin in the wet zone of Sri Lanka.

The objectives of present study were to determine if there is evidence of saltwater intrusion along the Bolgoda estuary and the extent to which it has entered into the river and to determine the good and bad effects of saltwater intrusion and problems related thereto.

2. Methodology

Water quality parameters of Conductivity, pH, Temperature, Dissolved Oxygen and Oxidation Reduction Potential in the Lake water at 58 locations were measured by utilizing water quality meter (CTD instrument(ACETON-3000PONSEL)). Observations were made on different tidal periods (21st November 2007 represents a spring tide day while 1st February 2008 represents a neap tidal day) to study the rate and extent of saltwater intrusion to the river and water quality changes.

Measurements were taken along the river, started from Panadura estuary with stations of approximately equal distance of 50m. At each of these locations vertical profile of each station was obtained by measuring, water

quality parameters from surface to bottom level (Fig. 01) at approximately 1m depth intervals.
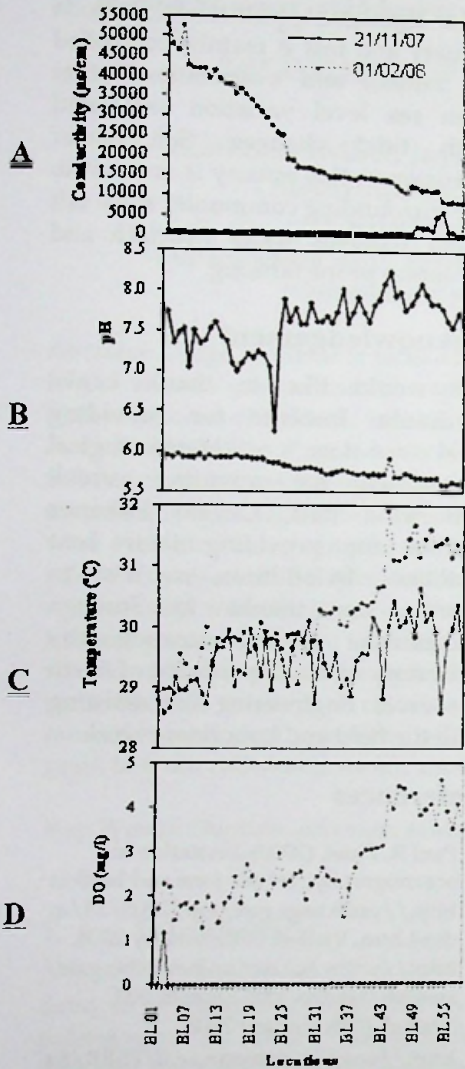

Figure 1- Sample locations along the river.

Water quality parameters were measured as well in monitoring wells located around the Lake on same sampling periods (07/11/2007, 21/11/2007 and 01/02/2008, 08/02/2008). All the well measurement was limited to surface, middle and bottom level measurements. Further, we have carried out a survey to recognize the merits or demerits associated with the surrounding community.

3. Results

Figure 2 shows the variation of different water quality parameters of the surface water for the two different tidal dates. Water quality

of the bottom level is also shows similar trends.

Sampling Locations (Bolgoda Lake)

Figure 2-Water quality parameters variation along the river

A. Conductivity variation,

B. pH variation,

C. Temperature variation,

D. DO variation along the lake

4. Discussion

Water quality of Lake Surface and bottom; indicate the conductivity values decreased with distance from the sea. This indicates the presence of saltwater which decreases with increasing distance from the sea mouth. In addition, vertical profiles shows increasing tendency of conductivity with increasing depth. During the spring tide (November 21st), salinity of water was low, both in surface and bottom level and there was no considerable variation along the river, as well. However in location 49 to 55 there was a certain deviation both in surface and bottom levels. In those locations a rapid increase in conductivity was observed which does not affected from the salt water intrusion but external circumstance. During the neap tide period (February 1st), salinity of water was comparatively high both in surface and bottom level than on November which also affected aquatic plants in the estuary. Most of the water hyacinths had died in that period which had a huge bloom all over the river on November. Even though the sea level is quite high during spring tide than neap tides, salt water intrusion is prominent at Bolgoda Estuary during the neap tide periods. However, rainfall patterns show increased values during the November measurements while lower values during February measurements. Therefore, controlling factors of salt water intrusion is rainfall and possibly evaporation.

In addition, salt water intrusion along the Bolgoda Lake has shown both positive and negative effects on the lives associated with the lake, such as fish growth rate (especially life cycle of the natural prawns), life cycle of the water hyacinths and the availability of different varieties of fishes.

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availability of different varieties of fishes.

Amount of salts in the fresh water is important factor for the growth of the natural prawns. According to the details collected from the people living around the Bolgoda Lake, especially those who are engaging in the fishing industry (mainly prawns), are expecting saline water since the availability of the prawns and some kinds of fish are high at the periods where the salt content is higher. When the amount of the salts in the lake water is reduced due to the effects of tidal variation and climate changes (rainfall and wind) the production or growth rate of the prawns is very low. Sometimes salinity affects negatively on the prawn life when it exceed normal oceanic conductivity value (According to the result 50ms/cm). Not only salinity, but also pH is an important factor for the prawn growth rate. (At the salinity of 12g/l, the highest hatching success is 92% at pH 7, but less than 13% at pH 6.5 or 7.5. (Refer: Paul R. Pinet, (2000). Invitation to oceanography, 2nd ed.) So the salt content should be within a considerable level (>30 ms/cm According to the results).

Dissolved Oxygen is a very important indicator of a water body's ability to support aquatic life. The illicit dumping of sawdust, from considerable number of timber mills (locations 13 and 17) in the locality reduces the amount of oxygen available to aquatic life. Healthy range of DO is within 5-11 mg/l (or ppm). But in Bolgoda Lake DO level was below 5mg/l. DO level of Bolgoda Lake increases along the river from sea mouth. This satisfies with decrease of conductivity along the river since oxygen dissolution decrease with increasing salinity.

5. Conclusion

This study shows salt water intrusion is a significant feature at Bolgoda estuary and this is mainly, controlled by rainfall and evaporation rather than sea level variation associated with tidal changes. Salt water intrusion in this estuary is an asset to the surrounding community since salt water removes water hyacinth and promotes prone farming.

Acknowledgement

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