

VARIATIONS OF WATER QUALITY IN DEHIWALA, WELLAWATTA AND KIRULAPONE CANALS

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ABSTRACT

This study mainly based on three canals of Dehiwala, Wellawatta and Kirulapone and main objectives are to identify the variations of water quality and to identify the human health impact of water quality. Based on these objectives the study was segmented to locate the areas of waste dumping to the canals; to identify the variation of water quality in monthly basis; to identify the temporal variation of water quality; to examine whether there is a relationship between changes of land use and variation of water quality and to examine whether there is a relationship between rainfall and variations of water quality along with identifying the vulnerability on human health. Data collection again segmented as follows. First the observation research to identify the waste dumping sites, locations and also to study the physical conditions of the canal. Then a water quality survey was conducted to measure the water quality parameters, with special focus to e-coli test. Tertiary the questionnaire survey was conducted based on people who live adjacent to the canal to identify their health conditions. To study the land use changes a satellite map interpretation was used. Water quality parameters of the study were pH, Electrical conductivity, Salinity, Turbidity, Dissolved Oxygen, Ammonia levels, Nitrate levels, Phosphate levels, Chemical Oxygen Demand, Biological Oxygen Demand followed by a bacterial test. Main analytical tools of the study were statistical, Arc GIS 10.1 and ERDAS 2011.

Key words: water quality, LMI, positive definite, nonlinear

1. INTRODUCTION

This research is based on metro Colombo region focusing the water quality in drainage canals of the area. Since water is the most valuable source for all living beings after oxygen, it is important to conduct a study on water quality in an area where we consider as the heart of Sri Lanka, the region of Colombo. Main intention of the study is to identify the variations of water quality and how it impacts on the health of the people who live adjacent to the canals.

Many studies have been conducted throughout the world based on the topic water and health. Study based on Palugaswewa cascade system shows 76% of the wells out of 105 wells indicate high level of salinity exceeding the WHO standards. In the cascading system there is a clear fluctuation in salinity levels from upper parts to bottom. (Piyadasa, Weerakoon, Somadewa, Weerasinghe, Vipulasena, Vitharana, 2012) Another study has been conducted to identify the bacteria and other living colonies of bacteria in the water in South Africa based on e-coli and coliform test (Luyt, Tandlich, Wilhelmine, Muller and Brendan, 2012). Study based on south west Beira Lake in Colombo Sri Lanka shows clear fluctuation of Nitrate, pH and Conductivity levels

with the depth. (Nawalage, 2010) This Study is focused on the three canals of Dehiwala, Wellawatta and Kirulapone. Adjacent Grama Niladhari divisions along with the canals were specially focused in the area of study. Improperly discarded chemical wastes, poorly maintained septic systems and many land-disturbing activities add to the problems of quality of water in this canal system. This study will evaluate the location, distribution, movement and properties of water and its relationship with other parameters like rainfall and land use.

2. METHODOLOGY

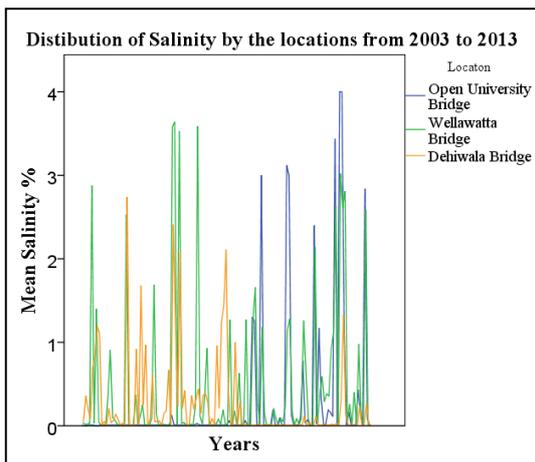
This study was based on both primary and secondary data. Methodology was segmented in to seven parts as data collection. Observational Survey to Collecting primary data on canal conditions; Questionnaire Survey Collecting primary data on health; Water quality survey to collecting primary data on water quality like e-coli; Interview to Collecting primary data on health; Satellite map interpretation and air photo interpretation to Collecting secondary data on land use; secondary data to collect past data on water quality and rainfall.

2.1. Procedure for Analysis

Analysis process can be identified under three main parts as observational, statistical and spatial analysis. Mainly the observation conducted was used to identify liquid and solid waste dumping locations of the canal system. Statistical analyses like central tendency, dispersion, regression and correlation were mainly used for both primary and secondary data, specially for water quality parameters and its relationships. Spatial analysis was mainly focused on identifying the spatial distribution, variation and distribution of water quality parameters as well as its relations with land use. Mainly used techniques are image classification under ERDAS 2011, aerial photographs and interpretation using stereoscope, along with GIS tools in Arc GIS 10.1.

3. RESULTS

Analysis process was based on twelve water quality parameters. They are Electrical Conductivity, pH value, Salinity, Turbidity, Temperature, Dissolved Oxygen, Ammonia, Nitrate, Phosphate, Chemical Oxygen Demand, Biological Oxygen Demand and E-coli coliform. When considering salinity it is a measure of the content of salts in water. These canals are open to the sea and the salt water intrusion occurs due to high tides and low tides. In this study levels of salinity clearly indicate a fluctuation based on three sample locations. Figure 1 illustrates the level of fluctuation in salinity over the decade.



Source: - Sri Lanka Land Reclamation and Development Corporation

Figure 1: Variations of Salinity levels at three sample points for past decade

At Dehiwala Bridge the levels are varying often throughout the decade. But At Wellawatta canal there is a sudden increase in salinity from 2009.

At the same time there is a sudden decline in salinity levels at Open University Bridge. If the salinity levels are < 0.05% they were recognized as fresh water. If salinity is between 0.05 – 3 % it is known as brackish water. Then the levels are between 3 – 5% salinity they are known as saline water and water where the salinity levels exceeding 5% known as brine waters. Based on that the water in these canals are mostly varying between brackish and saline water ranges. Again this fluctuation can be identified daily due to the tides process. Figure 2 below illustrates the high and low levels of salinity separately by the locations.

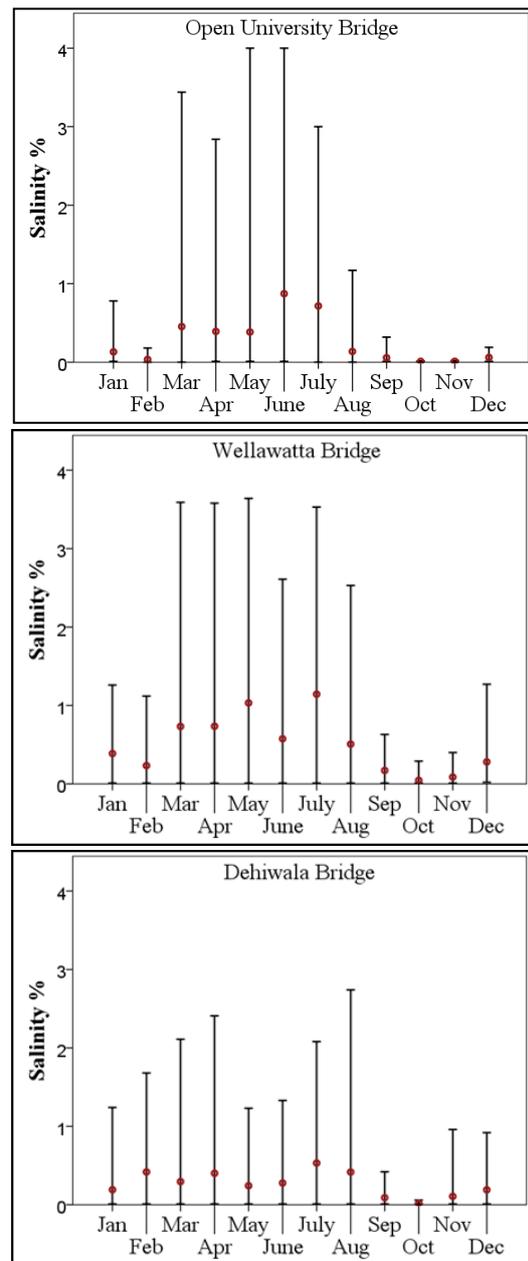


Figure 2: High – Low and Mean variation in Salinity of sample points

Each year by the middle of the year levels of Salinity shows an increasing closer to 3% of the level. Since people do not cultivate and no use of ground water in the region, the effect is not much felt by the people. Figure 3 shows the variations of salinity along with the rainfall.

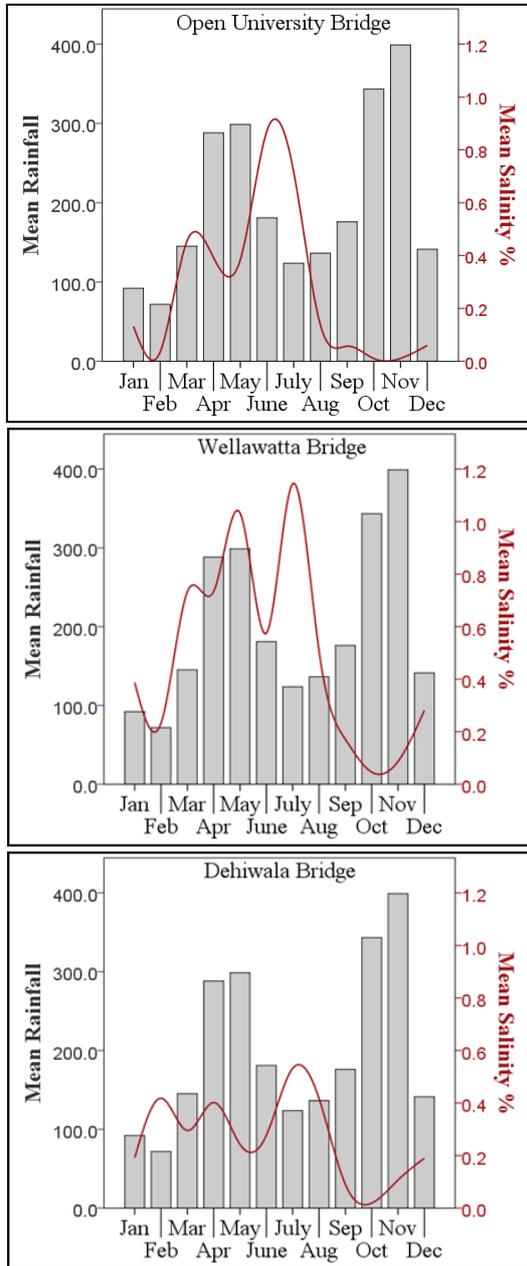


Figure 3: Variation of Salinity along with rainfall in monthly basis

As it is shown by the graphs there is a clear depletion on salinity levels in the months of October and November Since they indicate the highest levels of rainfall as well. It means rainfall has the ability to dilute the salinity conditions in the water and salinity levels will even decline

from the standard level sometimes. Both Open University bridge and Wellawatta bridge indicates declining trends in salinity in between January and February where the rainfall levels are also low. Figure 4 shows the distribution of salinity levels along with the rainfall throughout the decade.

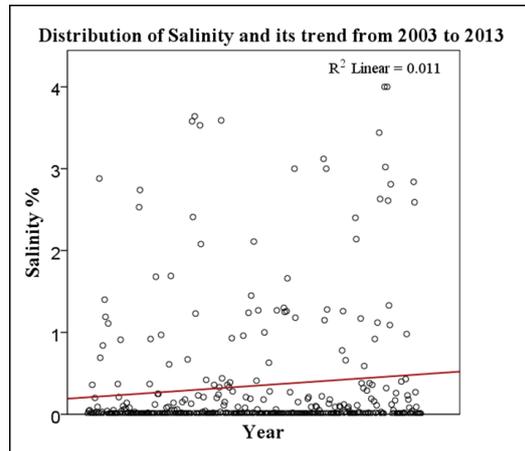


Figure 4: Trend of Salinity variation based on three sample points

There is a small trend depicted by the graph with r square value of 0.011 as positive, which means an increasing the levels of salinity in water. The higher pressure and density of saltwater causes it to move into coastal aquifers in a wedge shape under the freshwater. Ions commonly found in water include calcium, magnesium, potassium and sodium cations and bicarbonate, carbonate, chloride, nitrate, and sulfate anions. Amount of salt content will increase the ability to carry electrons. Therefore the levels of conductivity and Salinity have very close relationship. Figure 5 indicates the levels of Salinity and Conductivity by monthly basis.

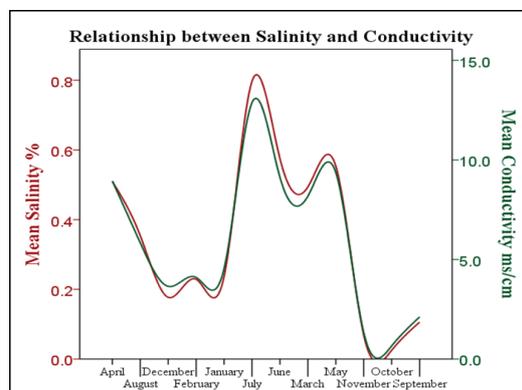


Figure 5: Relationship between Salinity and Conductivity

Graph clearly indicates that when levels of salinity increases or decreases the levels of conductivity also fluctuate along with that. It has only a slight difference between the curves. With sea water intrusion the salt particles which entered to the canal will break and produce more irons in water which gives the ability to translate an electric current. Likewise all other parameters were also analyzed based on same methods. Since one of the main objectives is to examine the health impact or the vulnerability on human health by this water an e-coli and coli form test was conducted. Main objective of this test is to find out the bacterial contamination of the water based on four sample points.

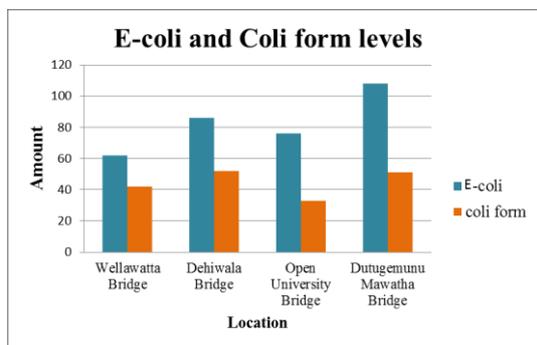


Figure 6: E-coli and Coli form levels of water

According to figure 06 levels of e-coli are extremely high in the water. In order to state that the water is quality there shouldn't be any records of e-coli bacteria in the water. Only possibility of been presence the e-coli bacteria by feces from human or animal. According to the observation survey it was proven that people do dump their lavatory waste in to the canal. As it is shown by the results highest levels of e-coli bacteria is presence at Dehiwala and Dutugemunu Mawatha Bridges. Recorded amount of e-coli bacteria are 52 and 51 respectively for 5 milliliters of water. Even the lowest recorded amount of e-coli is 33 at Open University Bridge.

According to the choices of people given in the questioner, none of the members in selected sample had mentioned the water quality as good. This clearly shows that people believe the water in these canals is polluted and very few have mentioned the water as normal. Over 95% had mentioned the quality of water to be bad or very bad, whereas over 50% had mentioned water quality as very bad. According to the sample the majority have mentioned the reason for water being polluted as waste. The most critical aspect of this is the people perception of waste from

toiletries affecting the quality level of water, as over 30% had selected it as the reason for water being polluted.

An observation is conducted on the canal in order to identify the solid and liquid waste dumping to the canal water. The survey was conduct with a boating trip from Open University Bridge to both Dehiwala Bridge and Wellawatta Bridge. Entire root was divided in to four parts. One Major component that effect water quality in canal is land use patterns. Based on land consumptions input matter to the canal water will vary. If there are so many industries located then the possibility of high accumulation of industrial waste can be seen. Therefore land use distribution will directly effect on the quality of the water. In this study the changes of the land use have been taken in to consideration in order to see whether there is a possibility of effecting on water quality.

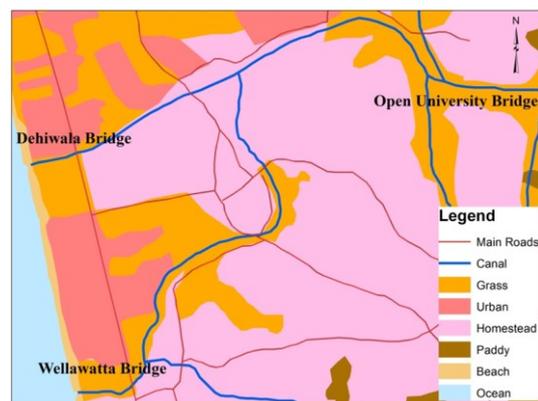


Figure 7: Land use map of the study area 1978

According to the map given above the land use in 1978 is total different from today. According to the map there are so many grasslands scattered all over the study area. Specially when it comes to Dehiwala canal and Kirulapone canals considerable amount of grassland can be seen. Therefore it can be assumed that the effect of pollution due to industrial urban runoff is minimum during those periods. Year 2000 was interpreted from the image taken by Landsat 7 and year 2013 was interpreted from the image taken by Landsat 8. These satellite maps were downloaded from www.ufgf.gov website and the classification of land use is done based on ERDAS 2011 software. Image was classified in to three main categories as vegetation, built up areas and water bodies. As it is shown by the figure 8 there are more vegetation and water bodies to be identified in year 2000 map which indicate by the green and blue patches of the

map. Those features have been reduced in year 2013 map and limited only to Sri Jayawardhanapura Kotte DS division. It indicates the urbanization of Colombo area had grown rapidly.

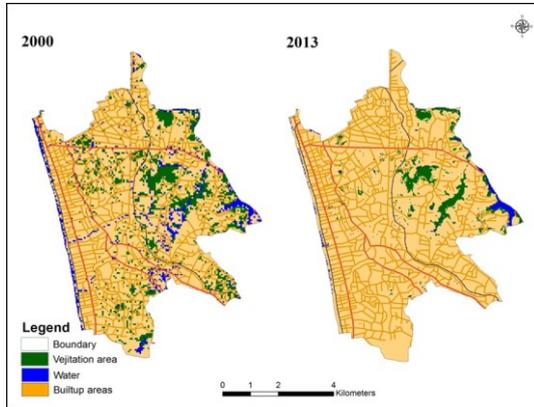


Figure 8: Comparison of land utilization map of 2000 and 2013

Since satellite images are capturing outgoing radiation or the reflected radiation of the sun, map created for year 2013 indicates that the radiation level doesn't indicate and greenery or water resources of the area. When there are taller buildings and other constructions sometimes it is hard to capture the reflected radiation by the canals. That's the reason for not indicating canals properly in the map.

4. CONCLUSION

This study mainly focused on the variation of water quality and how it has happened along the decade. According to the analysis it was clear that there are significant changes in the water quality parameters of the canal water and those changes are also depending on the location of the canal. First parameter of the analysis is electrical conductivity and it shows differences in conductivity levels by the sample locations. There is a clear increase which can be identified at the Open University Bridge whereas Dehiwala canal indicates a declining trend of conductivity from 2003 to 2013. Salinity levels are also varying from location to location. At Dehiwala Bridge the salinity levels are declining and at Open University Bridge the salinity levels are increasing in the recent past. Conductivity and salinity are so interdependent according to the analysis. There is a strong positive correlation between those two parameters with 0.99 of coefficient value. The levels of conductivity will depend on the sea water intrusion caused by the tides. At the beginning of the decade the turbidity

levels are seems to be very low. But after 2009 the turbidity levels are increasing rapidly. It can be assumed that the main reason for these changes is the reconstructions of the canal started after the war. Temperature levels of this water are varying between 26 Celsius to 35 Celsius degrees which is the normal variation of a tropical country. Even though there is no significant change in temperature there is a small declining trend in the months of October and November which have the highest rainfall. Dissolved Oxygen is also fluctuating through the decade. High levels of fluctuations are indicated at the Wellawatta canal and also Dehiwala canal. At Open University Bridge dissolved oxygen levels are rapidly increased after 2008. Ammonia levels of the canal indicate high fluctuation at all sample locations. At the beginning the levels of ammonia are high at three locations. But recently in Dehiwala canal the levels of ammonia indicate high levels due to pollution caused by solid and liquid waste along with lavatory disposals. Nitrate levels are also indicating high levels of fluctuation during the decade. As analysis shows the levels of COD are extremely higher than the Sri Lankan Standards 10 mg/l. Maximum levels of the COD are recorded as 150mg/l which indicate the levels of industrial pollution is extremely high. In questionnaire survey all most all the people believe that the water conditions are severely bad and there is vulnerability on human health. People who live adjacent to Dehiwala canal do dump their liquid waste as well as the solid waste in to the canal. According to the analysis based on land consumption it is clear that human activities are rapidly changing and causing the pollution in canal water.

5. REFERENCES

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