Preliminary Report on Investigation of Fish Kill in Hamilton Canal

National Aquatic Resources Research and Development Agency

May 2019

Contents

List of Tables

List of Figures

1. Introduction

The preliminary investigation study of the fish kill in Hamilton Canal was carried out by Environmental Studies Division together with Inland Aquatic Resources and Aquaculture Division of National Aquatic Resources Research and Development Agency (NARA), on 29th April 2019 as per the request of general public and the instructions given by Chairman / NARA. The second field visit was conducted for further investigations as per the request of Divisional Secretariat, Wattala Provincial Council on 6th May 2019. This report comprises the results of initial field observations, water quality analysis, conclusion and important recommendations.

2. Background

Fish kill incident in Hamilton canal was reported on 29th April 2019 to NARA by several government officials and general public. Hamilton canal is also known as Dutch canal starts from the Kelani river estuary at Elakanda, Hendala in Colombo North and ends at Puttalam with more than 120 km long. The Portuguese constructed the original canal in the 17th century after that Dutch East India Company who expanded the canal, in the next century (Wijesinghe, 2016). It is said that Dutch settlers also used the canal to transport pearls and spices from the north to Colombo. When the island was under British rule, a new Colombo- Negombo canal was built and commissioned and named, the Hamilton Canal in 1804, after the well-known English civil servant Garvin Hamilton (Wijesinghe, 2016). This fish kill incident had happened in Elakanda (Hekitta) to Negombo lagoon section (approx. 14.5 km long) of the Hamilton canal along Canal Road, passing Dikkovita, Muthurajawela, Uswetakeiyawa and Pamunugama.

(Retrieved from Wijesinghe, 2016)

Figure 1 : Map of the Hamilton Canal

3. Objectives

The objectives of the study were to investigate the causes of fish kill in Hamilton canal, understand the prevailing condition of the environment and provide recommendations for future remedial actions in order to avoid such situation.

4. Site Description

Hamilton canal is a manmade canal which connects Kelani River mouth with Negombo Estuary and located parallel to the western coast line of Sri Lanka. This canal forms the western boundary of a wetland known as Muthurajawela marsh (Dassanayake, 1993). Canal has been renovated in length of 3 Km from Elakanda. It reaches Muthurajawela march about 6 Km from Elaknada. Muthurajawela is an important wetland in 10-30 km north of Colombo which represents a large area of brakish water marshes, which is ecologically interdependent with Negombo lagoon. The study of Bambaradeniya *et al*., 2000 enabled to identify 192 species of flora, distributed over seven major vegetation communities at Muthurajawela; marsh, lentic flora, reed swamp, short grassland, scrubland, stream bank flora and mangrove swamp. The vertebrate fauna documented in the above study included 40 species of fish, 14 species of amphibians, 31 species of reptiles, 102 species of birds and 22 species of mammals (Bambaradeniya et al., 2000). Mudiyansage Ela encounters which flows inland and connects with the Hamilton Canal in Muthurajawela area. There are sub-surface drains as well as several sub canals coming from land side connecting to the canal.

The bank of the canal is populated mostly by fishing community. Several industrial factories and organizations also located bordering the area including Kerawalapitiya Industrial Zone, Ceylon Petroleum Storage Terminal Limited (CPSTL) Muthurajawela, etc. Also, Hamilton canal has been influenced by the Kelani-Maha Oya estuaries and Negombo lagoon estuary which in turn contaminated heavily due to increasing trend in anthropogenic activities in the surrounding area (Chandrasekara *et al*., 2018).

5. Methodology

During the field investigations, total of eight sampling locations were selected and the methods of sample collection, transport, storage and analysis of physico-chemical parameters were tested in conformity with the Standard Methods for the Examination of Water and Waste Water (22nd Edition, 2012).

In addition to that, field investigation team had several discussions with the people in adjacent areas. Field observations were also made in the vicinity to get aware about the surrounding environment of the Hamilton Canal.

5.1 Sample collection and laboratory analysis

Table 1: Description of the sampling locations

Sampling Location	Latitude	Longitude	Description
HC 1	7° 1'7.50"N	79°52'0.60"E	Hamilton canal at Dikkowita, Dead fish seen
HC 2	7° 2'10.70"N	79°51'51.50"E	Hamilton canal at Uswetakeiyawa, Dead fish seen
HC 3	7° 3'13.80"N	79°51'36.90"E	Hamilton canal at Bopitiya near Steel Factory, Dead fish seen
HC 4	7° 0'7.20"N	79°52'13.50"E	Hamilton canal at Elakanda
HC 5	7° 0'54.44"N	79°52'10.89"E	Sub canal connected to the Hamilton canal
HC 6	7° 0'52.80"N	79°52'2.68"E	Discharge point of the sub canal
HC 7	7° 0'53.00"N	79°52'3.44"E	Hamilton canal at Dikkowita, this location receives water from the sub canal
HC 8	7° 2'50.40"N	79°51'42.90"E	Hamilton canal at Nugape Junction

Figure 2: Sampling locations

Figure 3: Sampling points of the sub canal

Table 2: The parameters studied and methods used

Parameter	Principle	Methodology
Water temperature	Thermometric	EUTECH CyberScan 600 pH/mV Meter
pH	Potentiometric	EUTECH CyberScan 600 pH/mV Meter
Dissolved Oxygen	Electrometric	YSI ProODO Optical Dissolved Oxygen Meter
Salinity	-	Refractometer
Electrical Conductivity	Electrometric	HANNA HI-8633N Multi-range Conductivity Meter
Turbidity	Nephelometric method	EUTECH digital turbidity meter
Total Suspended Solids (TSS)	Gravimetric	2540 D Total Suspended Solids dried at 103 –105 °C (APHA, 2012)
Ammoniacal nitrogen	Colorimetric	4500-NH3 F Phenate method (APHA, 2012)
Nitrate nitrogen	Colorimetric	4500 E Cd Reduction Method (APHA, 2012)
Nitrite nitrogen.	Colorimetric	4500 B Colorimetric method NED/Sulphanilamide (APHA, 2012)
Dissolved Phosphate (Ortho-phosphorous)	Colorimetric	4500 –P E Ascorbic acid method (APHA 2012)
Bio-chemical Oxygen Demand (BOD)	Titrimetric	5210 Winkler method (APHA ,2012) (Modified)
Chemical Oxygen Demand (COD)	Titrimetric	5220 Open Reflux Method, (APHA, 2012)
Oil & Grease	Gravimetric	5520 B Liquid-Liquid partition Gravimetric Method,(APHA, 2012)

6. Results and Discussion

6.1 Field Observations:

When the time of field investigation, the water level of the Hamilton canal was low nearly up to 2.5 feet depth. Water has become black in colour, contaminated and smelly in the study area (from Elakanda to Pitipana). Dead fish were observed at the edges of the canal and all were belong to the *Oreochromis* spp (Thilapia). Most of the fish were moderate to large in size. Dead fish were decomposed and post-mortem investigations were not possible. Live fish collected were observed under the microscope and any symptom of disease conditions such as scale losses, haemorrhages, lesions, oedema or ulcers were not identified. Gills and internal organs of the fish were in a healthy condition. No nodules, internal haemorrhages or lesions observed and no internal or external parasites were observed to speculate that the mortality is due to any disease condition.

Figure 4: The water has become dark Black in colour

Figure 5: Dead fish near the canal

The residents nearby repeatedly complained that the water was clean until a few years ago and could be used for bathing. Residents complained that, the water has become dark and black in colour because of the leachate from the waste dumping site, and prominent in dry season.

The Muthurajawela waste dumping site has total area of 20 hectares with buildings and started in 2017 after the incident of Meethotamulla. Furthermore, the area

receives only sorted garbage with the total of 750 tonnes with 250 tonnes of degradable garbage. The leachate of the waste dumping site accumulates at the bottom of the landfill and percolates through the soil and overflowing to the canal nearby. There was a leachate filtering system before connect to the canal and it was not working at the time of observation and leachate directly entering to the canal without filtering.

Figure 6: Leachate filtering system connect to the nearby canal without filtering

Since it is an open dump area, liners may not be laid underneath to collect toxic leakage and seepage. Therefore, the heavy load of garbage leads to leeching and seepage into groundwater, and secondly, rainwater that comes into contact with garbage may contaminate surface water. The runoff naturally gets into various water bodies, and contaminate them. Furthermore, waste is often compacted and covered with soil.

Figure 7: Muthurajawela waste dumping site

Figure 8: Leachate from the waste Dumping site

Figure 9: Canal which connect to the dumping site and stay as stagnant with full of garbage

The connection of that stagnant water body to the Hamilaton canal was unclear and there was no access to observe through that canal to the Hamilton canal. But when the coordinates were plotted to the Google earth map area, it was observed that there is a connection from two sides of the garbage site to the Hamilton canal.

Figure 10: Sub canal which accumulate the leachate from the dumping site

Furthermore, from the site of "Proposed 10 MW Colombo Waste to Energy Project" site, there was a waste water outlet opening to the sub canal of Hamilton canal and the waste water released from the outlet was black in colour.

Figure 11 : Outlet from the " Proposed 10 MW Colombo Waste to Energy Project" site

Figure 12: Cast Net with the black colour bottom sediments of the Hamilton Canal

6.2 Water Quality Analysis

Table 3: Results of the water quality of first field inspection on 29/4/2019

Parameter	Unit	HC 1	HC 2	HC 3	Standard Limit (CEA, 2001)
Water temperature	^{0}C	30.8	31.2	31.1	-
pH	-	7.11	7.01	7.03	**6.0-8.5**
Dissolved Oxygen	mg/l	0.65	0.52	0.55	**3 mg/l, min at 25 ^{0}C**
Salinity	ppt	6	6	8	-
Electrical Conductivity	mS/cm	10.03	10.39	11.01	-
Turbidity	NTU	20.09	17.90	25.58	-
Total Suspended Solids	mg/l	29.6	24.4	26.4	-
Ammoniacal Nitrogen	mg/l	6.360	3.499	3.832	**0.94 mg/l**
Nitrate Nitrogen	mg/l	0.0115	0.0078	0.0126	**5 mg/l, max**
Nitrite nitrogen	mg/l	0.0072	0.0044	0.0052	-

Dissolved Phosphate	mg/l	0.0765	0.0392	0.0503	**0.4 mg/l, max**
Bio-chemical Oxygen Demand	mg/l	44	6	10	**4mg/l, max**
Chemical Oxygen Demand	mg/l	240	210	220	**15 mg/l**
Oil and Grease	mg/l	9.7	10.1	10.6	**10 mg/l**

According to the obtained results, pH, nitrate nitrogen, dissolved phosphate levels in water were within the ambient water quality standard limits stipulated by Central Environmental Authority.

However, dissolved Oxygen concentration, ammoniacal nitrogen, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and Grease exceeds the threshold permissible limits favorable for fish and aquatic life. Average Dissolved oxygen (DO) concentration in the Hamilton canal was very low and it was 0.64 mg/l during the study. This very low DO concentration is detrimental to aquatic life and fish mortality is obvious in such situation. Dissolve oxygen enters to water by diffusion and in the day time plankton and other aquatic plants produce oxygen by photosynthesis. However, the DO concentration in the canal was measured in the daytime and it was < 1mg/l. This indicates the consumption of DO in the canal is greater than the production. Other than the respiration of fish and aquatic life, DO also used for bacterial decomposition of organic matter. If there is an excess amount of organic matter in a water body, the oxygen will get used up quicker.

The high ammonia level (> 3 mg/l) together with turbidity and TSS levels indicate the organic pollution in the Hamilton canal. Ammonia gets into water by decomposition of plants and animals. An elevated ammonia level in the canal is due to the decomposition of dead fish after the fish kill incident and waste water via drainage lines.

BOD is also a measure of organic pollution in a water body. Generally, high BOD levels cause depletion in DO levels. BOD level of 44 mg/l at the HC 1 location was very high and it denotes heavy pollution in the canal. Quality of the landfill leachate is mainly related to the composition of waste and it may vary depending upon the duration of waste be stored and precipitation. Therefore the composition of waste might be the main reason for high BOD and COD levels. Oil and grease content in the canal water also exceed the standard limits for fish and aquatic life. They can enter into the water via waste water streams and heavy boat traffic in the canal.

Pollution in the canal is possible due to various points and non point sources occurring Hamilton canal surrounded area viz; industries, municipal solid waste, sewage, and drainage lines, fishing activities, etc. Heavy water pollution of the canal which leads to low dissolved oxygen, high Chemical and Biochemical Oxygen Demand, high turbidity, high oil & grease and high sediment levels with the prevailing heavy rain conditions.

The investigations revealed that, Hamilton canal is currently degraded and subjected to water pollution due to organic and inorganic pollutants owing to waste discharges from both point and non point source pollutants.

6.3 Past water quality studies in Hamilton Canal

Dassanayaka, 1993 stated that the water which flows through the Muthurajawela marsh ultimately reach the Hamilton Canal due to the pattern of drainage in the area. The water exchange between Hamilton Canal and the marsh takes place depending on the daily tidal variations. The results of the same study revealed that turbidity, nitrate nitrogen, nitrite nitrogen, phosphate, biochemical oxygen demand (BOD) and faecal coliform bacteria were significantly higher while salinity, electrical conductivity, and chlorophyll *a* levels were significantly lower during the rainy season (Dassanayaka, 1993). Also, variations of salinity, turbidity, suspended solids and faecal coliforms along the canal were statistically significant. These variations

could be due to the site specific sources i.e. human activities and influence of the sea (Dassanayaka, 1993). In addition, Chromium (Cr) was found in all sampling stations. The level of sewage pollution showed reduction towards the Negombo Lagoon as shown by the reduction of faecal coliforms. In comparison with the proposed Sri Lankan Standards for inland surface waters as well as for coastal waters, water quality parameters except faecal coliforms conformed to the minimum water quality standard. Therefore it is clear that the concentrations of pollutants in the Hamilton Canal had not reached the maximum levels at the time of the study from June 1991 to March 1992.

Chandrasekara *et al*., 2013, had studied water quality changes in the canal during 6 months from October 2012 to March 2013. According their results, electrical conductivity (EC) values of water in all three layers of the entire canal varied between 337 and 48,320 µS/cm. Spatial variation of the salinity of the water varied between 0.2 and 29.6 ppt. pH varied from 6.6 to 7.9 maintaining an environmentally sound level. Turbidity of the water ranged from 1 to 78 NTU while temperature fluctuated between 27-340 ^{o}C. Concentration of heavy metals was very low during the study period. Zinc (Zn) concentrations ranged between 0.25-0.54 ppb and Chromium (Cr) between 0.28-0.54 ppb. Copper (Cu) concentrations ranged between 0.22-0.65 ppm and concentration of all the cations were below the threshold level for human consumption.

Findings of another study conducted by Chandrasekara *et al*., 2018 revealed that average EC, turbidity, total hardness, total dissolved solids, F^{-}, Fe^{2+}, Cl^{-}, SO_4^{2-} and PO_4^{3-} (phosphate) of the canal water remained above the threshold limits of inland water standards. Concentrations of metals namely Lead (Pb) and Cadmium (Cd) were also above the standards in some locations. Oil and grease were in a very high level in water and sediments. In its conclusion, said that the water of the canal had been affected by nutrient, heavy metal and oil and grease pollution. Discharge of domestic, industrial, municipal wastes and sewage are the prominent reasons which had encouraged the deterioration of the quality of water in the canal.

According to the results of study conducted 2013-2014 by Chandrasekara *et al*., 2016, the segment of the Hamilton canal close to Negombo lagoonal estuary had the highest readings of EC, salinity, turbidity, F+, Na+, Mg+, Ca+, K+, Cl- , SO_4^{2-} and total hardness. The second highest readings identified close to the Kelani estuary. Although, nitrates and phosphates of the canal water is slightly high, a considerable spatial or seasonal pattern could not be identified. On an overall the EC, salinity, F+, Na+, Mg+, Ca+, K+, Cl-, SO_4^{2-} and total hardness levels are comparatively high in September 2013 and March 2014 during the low rainfall. Chandrasekara *et al*., 2012 stated that electrical conductivity (EC) values of Hamilton canal varied between 25500µS/cm and 989µs/cm while the highest value 25500 µS/cm of EC was recorded close to the Kelani estuary. This is due to the influence of intrusion of sea water through the Kelani River. The dynamics of EC, salinity, F+, Na+, Mg+, Ca+, K+, Cl- , SO4- - and total hardness levels in canal water have negative relationship with rainfall while turbidity and Fe^{2+} have positive relationship with rainfall. The water parameters in most locations of the canal except pH levels, are remained above the recommended levels of inland waters by CEA. Closer to the Negombo estuary the quality of water was comparatively low compared to other areas of the canal (Chandrasekara *et al*., 2016).

A recent study of Wickramasinghe *et al*., (2018) on impact of Municipal Solid Waste disposal on soil and water quality in Muthurajawela wetland found out that surface water samples and ground water samples taken from several locations contained higher nitrate, sulphate, phosphate, calcium and magnesium levels which were exceeding standard permissible levels. This study revealed that qualities of the soil, ground water and surface water of Muthurajawela had been affected due to improper waste dumping in the area.

7. Conclusion

The major reason for the fish kill incident was mainly due to heavy water pollution of the canal which leads to low dissolved oxygen, high Chemical and Biochemical Oxygen Demand, high turbidity, high oil & grease leve and high sedimentation with the prevailing heavy rain conditions. The investigations revealed that, Hamilton canal is currently degraded and subjected to water pollution due to organic and inorganic pollutants owing to waste discharges from both point and non point source pollutants. Comparing with the water quality from past studies, it can further conclude that the canal is subjected to continuous pollution.

8. Recommendations

- Frequent fish kills would happen during the peak of the dry season and onset of rains regularly unless proper measures should be taken to reduce the nutrient enrichment due to waste discharges.

- Water pollutant sources of the Hamilton canal, should be identified through proper monitoring programs & actions should be taken to prevent further damage to the water body.

- Prevent discharging effluents into the canal which do not follow the guidelines & general standards limits for discharge of effluents into inland surface waters using recommended dilution factors set by Central Environmental Authority.

- Consumption of the food fish from the Hamilton canal is currently unsafe and is possible to contaminate with chemical pollutants in canal waters and it might bio-accumulate via food chain posing health risks to the consumers.

- Therefore, it is suggested to halt the fisheries activities of the canal temporary until the quality of the canal waters is assured suitable for fish and aquatic life, through proper monitoring programmes.

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