Anthropogenic disturbance on nursery habitat function and with special reference to pollution in the Negombo Estuary

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Abstract

Estuaries serve as nursery grounds for many fish and crustacean species. However, increasing human activities within estuaries and surrounding areas lead to significant habitat loss for juveniles and decrease the quality of the remaining habitats. The present study was carried to assess the effects of anthropogenic disturbances on the nursery function of estuaries with a multispecific approach based on ecosystem. The objectives of the study were to measure the status of pollution of the water quality and identify the land based pollution sources.

Eight sampling sites were selected in Negombo estuary, mainly Negombo Pitipana, Aluthkuruwa, Sethapaduwa, Hamilton canal opening to estuary, Dandugam Oya opening to estuary, Liyanagemulla, Airport Garden Hotel Katunayake and Kurana. Indices of pH, turbidity, nutrients, dissolve oxygen, biochemical oxygen, total suspended solid, oil and grease and fecal coliform levels were used to estimate anthropogenic disturbances impacting this nursery habitat in seagrass habitats in the Negombo estuary.

There are two industrial zones established in the upstream of Negombo estuary. The treated effluent from the Katunayake Export Processing Zone is discharged into the Dandugam Oya and untreated industrial effluent from the enterprises in Ekala discharge to Ja-ela which finally flow into the Negombo Estuary. This industrial effluent may contain high load of organic matter, textile dyes and heavy metals.

The ammonia level range from 0.12 mg/l to 0.99 mg/l, nitrate level 0.24 mg/l to 0.55 mg/l nitrite 0.02 mg/l to 0.144 mg/l and phosphate level 0.11 mg/l to 0.58 mg/l, Biochemical Oxygen Demand range from 10 mg/l to 50 mg/l, Oil and Grease range from 28 mg/l to 1500 mg/l and Fecal coliform range from 16 mg/l to 1400 mg/l. The surrounding area of the Negombo Pitipana is densely populated and due to the lack of proper sanitary facilities, fecal pollution can be expected.

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Introduction

Estuaries are transitional zones of interaction between land and sea that present a very high level of productivity (Whittaker, 1975 and Costanza *et al*, 1997). Because of some of their features, such as high salinity variations, low depths, muddy grounds, warm water, higher turbidity, the present of various and rich habitats and high food availability, estuaries serve as nursery grounds for many marine fish and crustacean species (Peterson, 2003). Juveniles aggregate in these areas where their fitness is enhanced through better feeding conditions, optimal growth, refuge opportunities and high connectively with other habitats. Nevertheless, Negombo north and southern areas also characterized by a high level of human activity. The increasing urban and industrial development within these areas leads to significant habitat losses for the juveniles. Further more estuaries are the discharge point for all particles stemming from anthropogenic activities, carried out within the drainage basin, including urban and industrial development as well as intensive agriculture.

Therefore in addition to increasing quantities of nutrients and organic matter, lagoon waters and sediments accumulate heavy metals and organic contaminants, which tends to degrade the quantity of the remaining to the lagoon habitats for juvenile's fishes. As consequence the essential nursery function of estuarine areas may be reduced by these anthropogenic disturbances (Coasta and Cabral, 1999). Recruitment level and population size of the concerned marine species may then be dramatically affected (Peterson *et al*, 2000). To monitor the quality of water these zones, the use of biological indicators that take into account their ecological function is becoming a widespread methods (Coates *et al*, 2007). In particular, indicators based on fish communities are recognized as useful tools to assess anthropogenic impacts on estuaries.

The brackish waters of Sri Lanka estuaries and the open sea are used extensively for the disposal of various types of waters. Much public concern and debate has focused on the disposal of wastes such as industrial wastes relatively less attention has been given to other marine disposal activities such as the discharge of municipal effluents, agricultural and urban runoff. Some conventional and non conventional pollutants can contribute to excess nutrient levels (eutrophication) and low oxygen levels (hypoxia) particularly in estuaries, many metals and organic chemicals can cause severe, short term, acute,

impacts on marine organisms. More over, many organic chemicals and some forms of certain metals can dissolve and accumulate in the fatty tissues of these organisms.

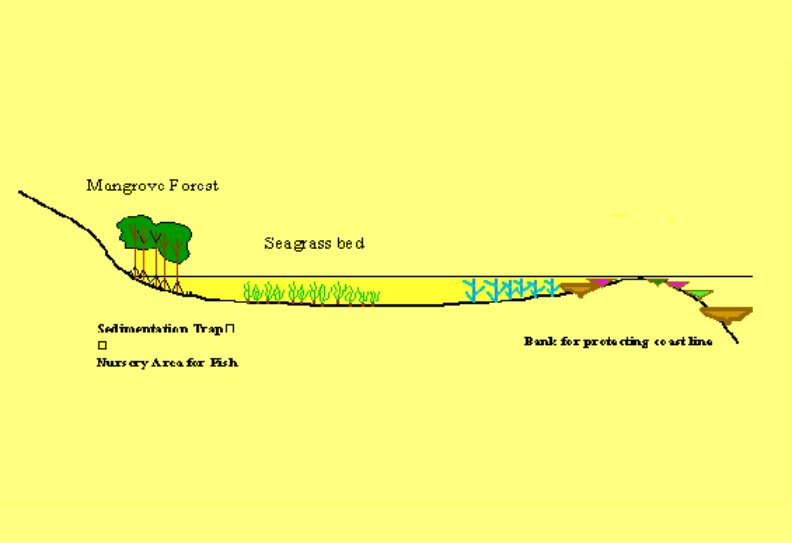

Figure 1 Mangrove and Sea grass habitats in Negombo Lagoon

Estuaries are susceptible to certain problems such as impacts on water quality, loss of submerged aquatic organisms, impacts on entire marine communities, accumulation of toxic pollutants in sediments and fatty tissues of aquatic organisms. Negombo Lagoon revere to semi enclosed bodies of water that have some connection to the open ocean and an input of fresh water that mixes with saltwater. Both ocean and land contributes to an ecosystem of specialized plants and animals. Estuaries provide habitat, nursery, productivity, water filtration and food control.

Projection of continued or increasing degradation is of great concern because estuaries and coastal waters are among the most important of all the marine environments with respect to their commercial resources, recreational uses and ecological roles. Therefore the ability to detect land based pollution and understands its causes can meet up with monitoring and basic research. Our study sites were subjected to this study of the effects of land based pollution in selected areas of Negombo Lagoon.

Negombo Lagoon is and productive brackish water body situated in the western province. It receives the water body of the Attanagalla Oya drainage basin. It is also considered to the estuarine part of the continued wetland system of the Muthurajawela swamp

Negombo lagoon (3164 ha) is connected by a single narrow opening with the open sea at its north mouth and its receives its fresh water from Attanagalla Oya which empties as the Dandugam Oya and Jaela as its southern most tip. At its eastern boundary is the Muthurajawela marsh where the Dutch canal line Muthurajawela and Kalani river. The Dandugam Oya drains a catchment of 727 km^2 and discharges at the junction of the lagoon and the marsh. The Muthurajawela marsh Negombo lagoon wetland system has served multiple uses including fishery, agriculture, trade, shipping and habitation. These uses have expanded with increasing urbanization and industrialization of the area.

The Southern part of the lagoon where Dandugam Oya and Ja-ela empty into lagoon is infect a swampy tidal delta and also receives fresh water from rainfall and occasionally due to high floods of Kalani river, Muthurajawela acts as a fresh water source to the lagoon. Sea water enters to the lagoon due to high tides through its inlets. Therefore salinity is balanced of various activities due to development and dense human settlement in Negombo Lagoon area has affects water quality and aquatic organisms and ecosystem. Hydrography of the lagoon has been affected by the canal system. Apparently a substantial amount of domestic sewage reaches the lagoon enhancing aquatic pollution. Industrial of Ekala estate discharge partially treated or untreated effluent to fresh water inflow (Ja-ela) directly or indirectly. Some of these industries are tannery, textile, battery manufacturing, distillery etc. and also there area a few tourist hotels located around the lagoon. However there may be a graduated increase in nutrient loading into the lagoon through the main inflows resulting from land based human activities and fertilizers from the upstream agricultural activities. The major sources of coastal and marine pollution originating from the land vary from country to country. The nature and intensity of development activities, the size of the human population, the state and type of industry and agriculture are but a few of the factors contributing to each country's unique pollution problems. Pollution is discharged either directly into the sea or enters the coastal waters through rivers and by atmospheric deposition in order to mitigate and control the impact of pollution on coastal and marine resources, it is essential that the type and load of pollutants be identified. This involves determination of the sources and their locations and the volume and concentration of pollutants. Point sources of pollution are sources that can be identified to one location such as industrial and sewage treatment plants. Point sources though easy to identify, account only for a fraction of the land based sources of pollution affecting coastal and marine environments. Non point sources are harder to identify and

include urban storm water run off and over flow discharges as well as run off from forest and agriculture. Pollution sources can be located relatively far away from coastal area and still have an impact, pollutant from sources and activities within a drainage area can be carried to the coast by rivers. Pollution from distant sources can also enter in to the marine environment through atmospheric deposition. Agriculture and urban activities are major sources of Phosphorous and Nitrogen to aquatic ecosystems. Atmospheric deposition further contributes as sources of nitrogen. These non point inputs of nutrients and difficult to measure and regulate because they derive from activities dispersed over wide area of land are variable in time due to effects of weather in aquatic ecosystems, these nutrients cause diverse problems such as toxic algal bloom, loss of aquatic plant beds and other problems. Nutrient enrichment seriously degrades aquatic ecosystems and impairs the use of water for drinking, industry, agriculture, recreation and other purposes. Based on our review of the scientific rivers bring a considerable amount of sediments into the coastal and marine ecosystems.

Natural geochemical processes control most of the suspended and dissolved materials carried by these rivers. However, human activities can increase the amount of sediment in the rivers. Impacts of waste disposal on marine resources determining the causes of impacts on marine resources can be difficult changes care results not only from waste disposal activities and runoff. But also from natural perturbations fishing or other human induced changes such as habitat destruction or fresh water diversions.

Objectives

To study the status of pollution of the water

To identify the land based pollution sources

To measure the impact of anthropogenic disturbances on the nursery function

Methodology

Eight sampling sites were selected in Negombo lagoon, for Negombo Pitipana, Aluthkuruwa, Sethapaduwa, Hamilton canal opening to lagoon, Dandugam Oya opening to lagoon, Liyanagemulla Airport Garden Hotel Katunayake and Kurana were carried out once a month from January 2007-January 2008 to collect data on water quality.

Physico chemical parameters of water

Physical Parameters

Three physical parameters (Temperature, pH, Turbidity, Salinity) were determined in each water body in monthly intervals. Surface water samples were collected and insitu analysis was carried out to determine these parameters. Temperature (^{0}C) was measured by using electrode thermometer, pH was measured by electrometric (Orion portable pH meter), was measured by electrometric method, Salinity was measured by Refractometer and Turbidity was measured by Turbidity meter HACH Model.

Chemical Parameters

Dissolved Oxygen, Ammoniacal-Nitrogen, Nitrate - Nitrogen, Nitrite-Nitrogen, Phosphate-Phosphorous, Biochemical Oxygen Demand, Oil and Grease and Heavy metals were the chemical properties, which were measured in the present study for determination of chemical properties water samples were fixed and the laboratory analysis were conducted immediately. Dissolved Oxygen (mg/l) was measured titrometrically by using Winkler's method. Ammoniacal Nitrogen was measured spectrophotiometrically using Phenolic method. Nitrate Nitrogen was measured spectrophotiometrically used cu/cd reduction methods. Nitrite Nitrogen was measured spectrophotiometrically using NED/Sulfanilamide method, Phosphate was also measured spectrophotometetrically using ascorbic acid//ammonium molibdate method. Biochemical Oxygen Demand was measured using Aqualytic BOD sensor Oil and grease was measured used gravimetric method and Heavy metal used to Atomic Absorption Spectrophotometer (APHA, 1998).

Biological Parameters

Total Coliforms used in Membrane filtration method

Data analysis

The Physical Chemical and biological parameters of Negombo Lagoon compared by normal distribution changes statistically analysis differences between sampling locations.

Results

Physical chemical and biological properties in Negombo lagoon are given in Table 1 they are graphically presented in figures.

Table 1 Summary of the mean statistical values of water quality parameters in Eight sampling location during the period from January 2008 to January 2009

Parameters	Negombo Pitipana	Aluthkuruwa	Sethapaduwa	Hamilton canal opening	Dandugam Oya	Liyanagemulla	Katunayake	Kurana
Temperature^{0}C	**30.25**	**29.9**	**30.41**	**27.79**	**27.5**	**28**	**29**	**29.94**
Salinity (ppt)	**23.4**	**24.56**	**25.74**	**18.88**	**16.3**	**18.1**	**20**	**30**
Ammoniacal-N (mg/l)	**0.822**	**0.321**	**0.274**	**0.216**	**0.99**	**0.12**	**0.16**	**0.159**
Nitrate-N (mg/l)	**0.55**	**0.305**	**0.378**	**0.542**	**0.437**	**0.3**	**0.24**	**0.389**
Nitrite-N (mg/l)	**0.044**	**0.065**	**0.065**	**0.042**	**0.02**	**0.05**	**0.02**	**0.144**
Phosphate-P(mg/l)	**0.589**	**0.138**	**0.148**	**0.321**	**0.232**	**0.16**	**0.11**	**0.087**
pH	**8.2**	**7.86**	**8.063**	**7.976**	**7.67**	**7.77**	**7.88**	**8.1**
DO (mg/l)	**6.59**	**6.49**	**7.2**	**8.4**	**8.29**	**7.92**	**6.64**	**6.47**
Turbidity (NTU)	**20.94**	**20.69**	**19.08**	**39.52**	**34.2**	**17.7**	**9.8**	**8.038**
BOD (mg/l)	**48**	**10.2**	**10.4**	**20**	**34**	**28**	**50**	**12**
TSS (mg/l)	**13.4**	**13**	**15**	**16**	**14**	**16**	**15**	**15**
Oil and Grease	**1500**	**320**	**800**	**77**	**90**	**28**	**40**	**38**
Fecal Coliform (mg/l)	**1400**	**30**	**25**	**18**	**47**	**16**	**40**	**18**
Hg (mg/l)	**<0.02**	**<0.02**	**<0.02**	**<0.02**	**<0.02**	**<0.02**	**<0.02**	**<0.02**
Cu (mg/l)	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**
Zn (mg/l)	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**
Cr (mg/l)	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**

Temperature

In eight location of the Negombo Lagoon the mean water Temperature ranged from 27 ^{0}C to 32 ^{0}C (Table 1).

Salinity

During the study period of mean salinity varied from in river mouth and sea mouth (Table 1). In locations of relatively high salinity of Negombo Pitipana were reported. The lowest mean salinity was recorded in Dandugam Oya possibly due to high fresh water inflow of Negombo Lagoon.

Ammoniacal Nitrogen

Mean Ammoniacal Nitrogen concentration in all location of Negombo lagoon observed were less than 1 mg/l (Table 1). Relatively higher Ammoniacal Nitrogen concentration 0.899 mg/l and 0.99 mg/l was observed in Negombo pitipana landing site and canal opening lagoon than those of other estuaries. This concentration would not release free ammonia. Which can exceed the tolerance limit of 1.2mg/l, which is the toxic level to the aquatic environment

Nitrate Nitrogen

Nitrate Nitrogen concentration in all locations of Negombo Lagoon were averaged less than 01 mg/l. Relatively high mean nitrate concentration were recorded Negombo Pitipana, Hamilton canal opening, Dandugam Oya sites (Table 1).

Nitrite Nitrogen

Highest nitrite levels were recorded in Canal opening area (Table 1). Nitrite concentrations of other locations are more or less similar.

Phosphate Phosphorous

Highest mean Phosphate level were recorded in Negombo Pitipana (0.589 mg/l) canal opening area (0.321 mg/l). Lowest concentration was observed in Katunayake and Kurana areas (Table 1).

pH

Thought on the study period in eight sampling location there was no marked variation in pH The relatively highest mean pH level was recorded in sea mouth and near the Thalahena. The relatively (Lowest mean pH level was recorded in 7.67 in Dandugum oya site (Table 1).

Dissolve Oxygen

Eight locations of Negombo lagoon mean dissolved oxygen range from **6.47** mg/l to 8.4 mg/l (Table 1).

Turbidity

Highest mean Turbidity was recorded in Hamilton canal opening (39.5 NTU) lowest mean Turbidity was recorded in Kurana centre before effluent releasing point of KEPZ Dandugam Oya (Table 1).

Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) level at the Pitipana site was the 48mg/l and highest level in 50 mg/l in the Katunayake Air port hotel area and 38mh/l in the Dandugam oya site (Table 1).

Oil and Grease

Very high levels of dispersed and dissolved oil were found in the water at landing site of Negombo Pitipana and sethapaduwa. Because of the oil are release in boat engine.

Fecal Coliform

The levels of fecal coliform bacteria are very high at Negombo Pitipana and Dandugam Oya sites. The analytical results show that the water quality at both sites, specially at landing site of Pitipana.

Discussion

Land base pollution in Negombo Lagoon was assessed by analyzing water quality parameters collected from January 2007 to January 2008. Water quality properties (Temperature, Salinity, pH, Turbidity, Dissolved Oxygen, Ammonia, Nitrate, Nitrite, Phosphate, BOD, Oil and Grease, Fecal Coliform) of selected locations of each water

body were measured, Land based pollution sources of each water body was too identified. The main land based pollution sources of above water identified as fish landing site lellama in Negombo domestic waste, boat repairing stations, tourist hotels, treated effluents of Katunayake Export processing zone, distillery breweries and illicit liquor breweries along the side of Dandugam Oya sampling location water quality reveals that nitrogen, phosphate, BOD and Fecal Coliform highest pollution levels are recorded. The Nutrient level range from ammonia 0.12 mg/l to 0.99 mg/l, Nitrate 0.24 mg/l to 0.55 mg/l , Nitrite 0.02mg/l to 0.144mg/l and Phosphate0.11mg/l to 0.58 mg/l, Biochemical Oxygen Demand range from 10 mg/l to 50 mg/l , Oil and Grease range from 28mg/l to 1500 mg/l, Fecal Coliform range from 16 mg/l 1400 mg/l. Highest nutrient levels were recorded at Negombo Pitipana and Dandugam Oya clearly attributed to land based pollution which originates mainly to anthropogenic activities.

References

ANON (1994). Conservation management plan: Muthurajawela marsh and Negombo Lagoon.

Wetland Conservation Project, Central Environmental Authority (Sri Lanka /Euro Consult Netherlands)129 p.

AMERICAN PUBLIC HEALTH ASSOCIATION (1998). Standard methods for the Examination of water and wastewater 20th edition, Published by American Water Works Association –Washington DC 20005.

CENTRAL ENVIRONMENTAL AUTHORITY, Standard (2001). Environmental quality standard and designation of water use in Sri Lanka.

Coates,S Waugh,A Anwer,A Robson M.(2007).Efficacy of a multimetric fish index as an analysis tool for the transitional fish component of the water Marine Pollution Bulletin 55,225-240.

Coataza R.D., (1997). The value of the world's ecosystem services and natural capital Nature 387,253-260.

Coleman, J.M.Huh, O.K. Dewitt.B2008.Wetland loss in world deltas journal of Coastal Research 24, 1-14

Peterson, C.H, (2000). Synthesis of linkages between benthic and shrimp communities as key to protecting essential fish habitats bulletin of marine science 66,754-774.

Peterson, M.S. (2003). Conceptual view of Environment habitat production linkages in tidal river estuaries reviews in fisheries Science 11, 291-313.

SILVA, E. I. (1996). Water Quality of Sri Lanka.

Whittaker, R.H (1995). Communities and ecosystems second ed.Macmillan London in Raven P.h.Johnson, G.B LOSOS. 2007.