

Current status of water quality and heavy metal monitoring in water and sediments in Negombo estuary

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Abstract

Water quality and heavy metals elements of the water and sediments of the Negombo estuary were investigated in the current study. The objectives of this study were to assess the variations of the water quality and sediment heavy metals with a view to identify the pollution sources. Different sampling points (n=16) were selected along the estuary. The study was conducted within a period of one year in 2013. Collected samples were taken to the laboratory, stored and analyzed using standard analytical methods. Result indicated that higher mean value of Chemical Oxygen Demand (380.5 ± 137.5 mg/l), Biochemical Oxygen Demand (28.1 ± 3.1 mg/l), Ammonia (0.26 ± 0.48 mg/l), Nitrate (0.8 ± 1.05 mg/l), Phosphate (0.45 ± 0.5 mg/l) and Total Suspended Solid (32.2 ± 2.7 mg/l) levels in the northern region of the estuary. In addition concentration of heavy metals in water and sediments were at high levels in the northern region. The result revealed the presence of large quantities of organic and inorganic pollutants in industrial, municipal and domestic wastes in the estuary water. Results are discussed with respect to the opening of waste canals into the estuary that carry organic and inorganic pollutants from the adjacent industries and households. This was expected due to the fact that the water of such canals receives high concentrations of organic and inorganic pollutants from industrial and domestic wastewater.

Keywords: water quality, aquatic pollution, heavy metals, sediment analysis

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Introduction

Most of the people in the Negombo area fulfill their protein requirement using fishery resources in the estuary. Negombo estuary is becoming polluted due to rapid industrialization and urbanization. Water pollution is thus a cosmopolitan problem that needs urgent attention and prevention (Ali M., and Soltan, M.1996). It resulted from many sources as accidental spillage or discharge of industrial sewerage effluents, agricultural drainage, and domestic wastewater. Water pollution is one of the principal environmental and public health problems in Negombo estuary in Sri Lanka (Silva, E. I. 1996). Along its two fresh water canals the estuary receives numerous non point and point source discharges. Some of these effects are the polluting activities, such as the discharge of domestic, industrial, urban and other wastewater into the watercourse

However, monitoring has also evolved to determine trends in the quality of the aquatic environment and how the environment is affected by the release of contaminants, by other human activities. Apart from water, sediments are also responsible for nutrient and pollutant transportation in aquatic environment (McCready, S. Birch G. F. and Long E. R. 2006). Combination of measurements of water and sediment quality can provide a good indication of conditions and potential risks to the water body. The metal levels in many aquatic ecosystems have been increased due to anthropogenic activities which raises the concerns of human health hazards. The objectives of this study were to assess the variations of the water quality and sediment heavy metals of the Negombo estuary with special reference to selected identify the pollution sources.

Material and Methods

Study site

The stations were selected to include the water channels entering into the estuary. The selected location of Negombo estuary namely, Maddabokka, Katunayake, Liyanagemulla, Dandugam Oya, Hamilton canal, Dungalpitiya, Middle of Lagoon, Bassiyawatta, Aquaculture cages, Pitipana fish market, Pitipana south animal farm, Sea mouth, Dutch canal, Thaladuwa, Munnakkaraya, and Kotugoda were selected for the study site (Figure 1).

Water Analysis

Water sample were collected monthly during the one year period in 2013. Water samples were kept in polyethylene bottle in ice and transported to analyze in the laboratory. The physical chemical parameters such as Chemical Oxygen Demand, Total Suspended solids, Biochemical Oxygen Demand, Ammonia, Nitrate, Phosphate, heavy metals in water and sediment were measured according to the Standard Methods for Examination of Water and Waste Water (20st Edition, APHA standard methods). Total Zn, Cu, Pb, Hg, Cr and Cd were measured using Atomic Absorption Spectrophotometer.

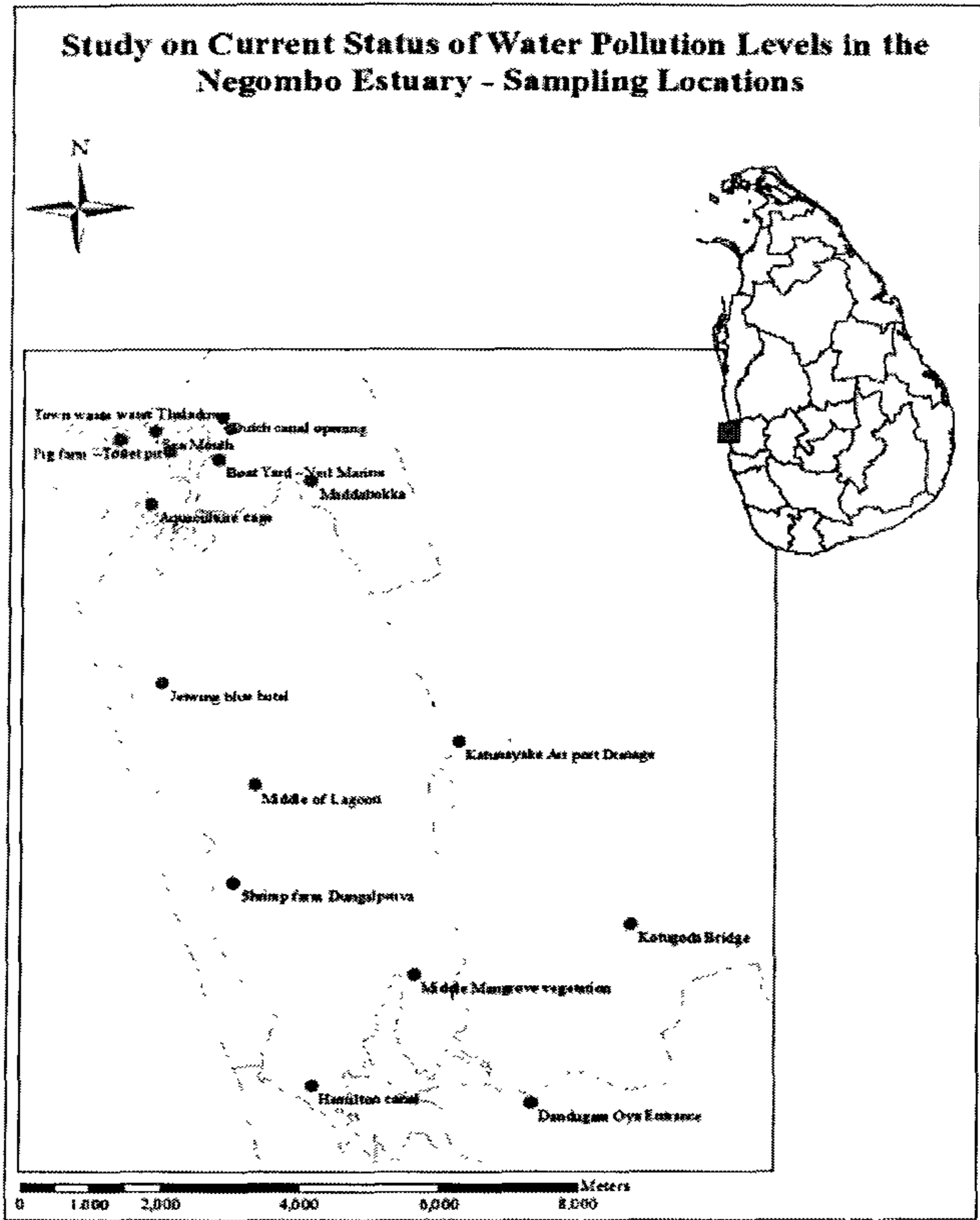


Figure 1: Sample location of Negombo Estuary

Sediment Analysis

Sediments were collected and kept in ice until analyzed. For total heavy metals, sediment samples were allowed to defrost, and then air dried in a circulating oven at 30°C and sieved mechanically using a 2 mm sieve. For the digestion of samples, one gram (01g) sieved sediment was digested with repeated addition of nitric acid and hydrogen peroxide. The elements of concern (Zn, Cu, Pb, Hg, Cr and Cd) in the samples were determined by Atomic Absorption Spectrophotometer (AAS).

Results and Discussion

Water Analysis

The results are of the studied physical and chemical parameters for water samples in the selected sixteen sites. Because of its great impact on aquatic life, such variations between different sites were mainly due to different sampling times. Electrical Conductivity showed lowest and the highest value range was recorded in 11.05 to 33.12 ms/cm⁻¹(Figure 2 and 3).The lowest and highest values of Chemical Oxygen

Demand were recorded in 108.5 to 380.5 mg/l (Figure 4 and 5). This may be due to the discharge of industrial effluents into the estuary by some untreated effluents release by factories in these areas, in addition to the discharge of municipal wastewater and other wastes into the estuary. Nitrate and ammonia are the most common forms of nitrogen in aquatic systems.

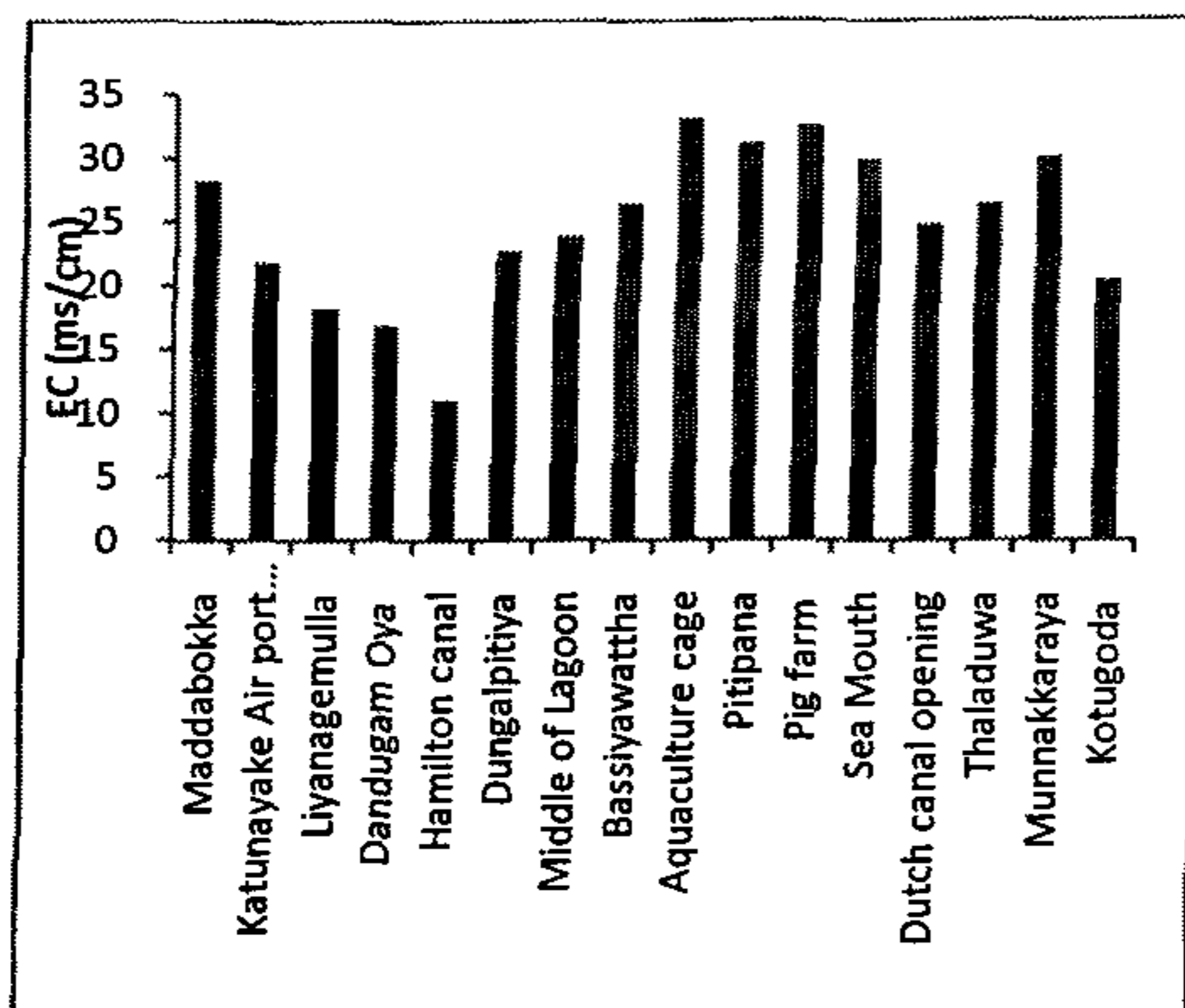


Figure 2: Variation of EC levels in locations

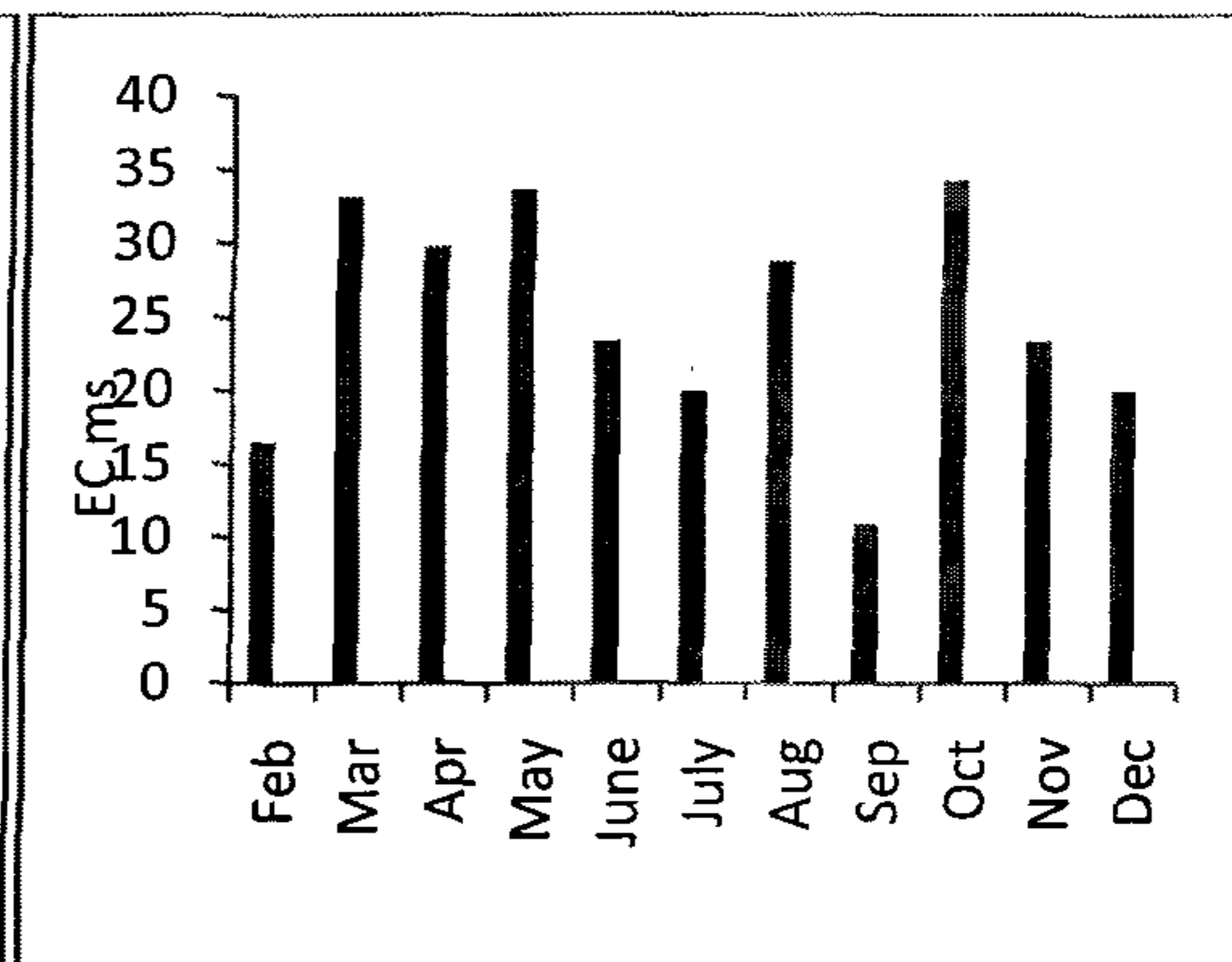


Figure 3: Monthly average EC ensample sampling locations

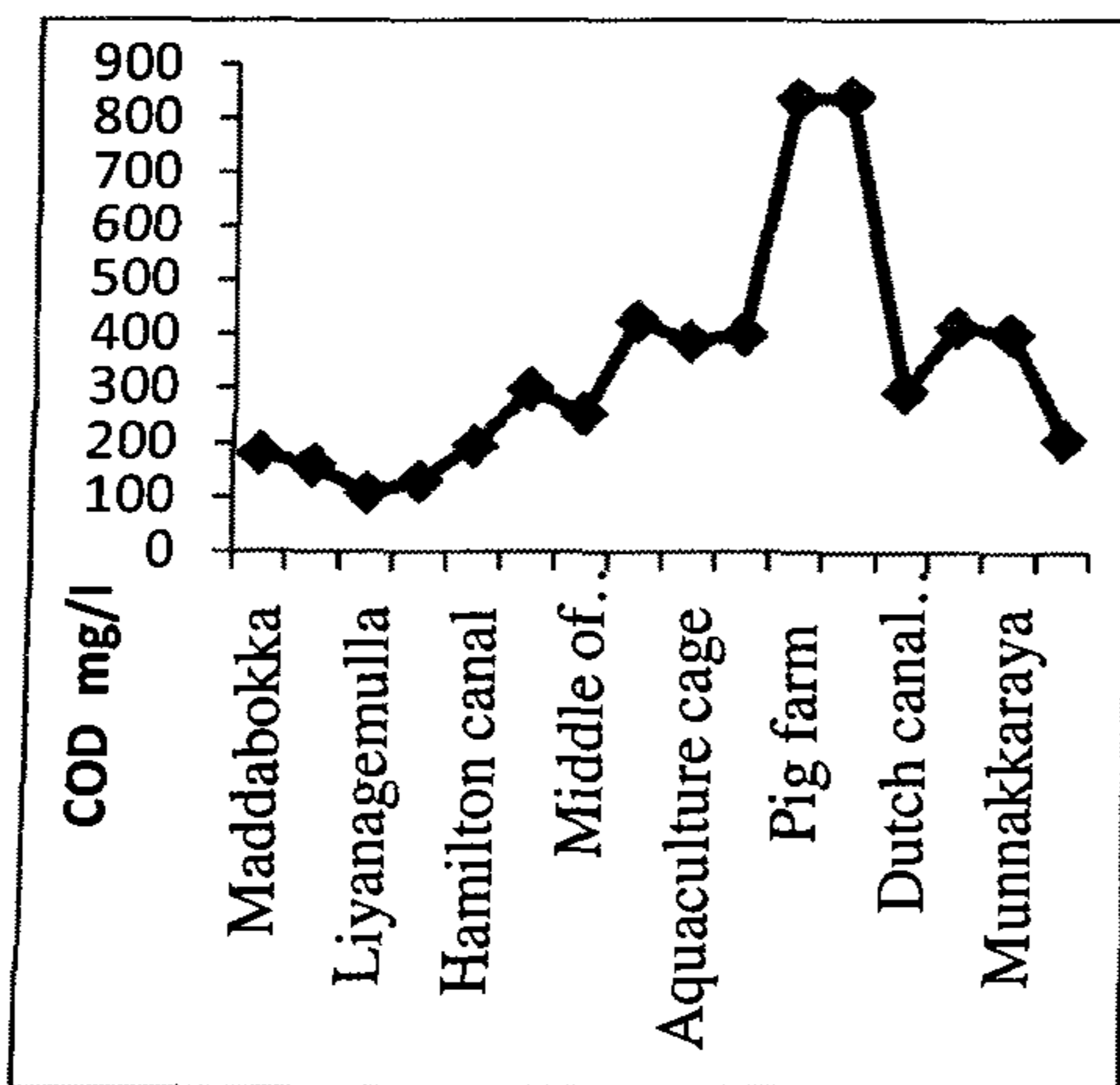


Figure 4: Variation of COD levels in sampling locations

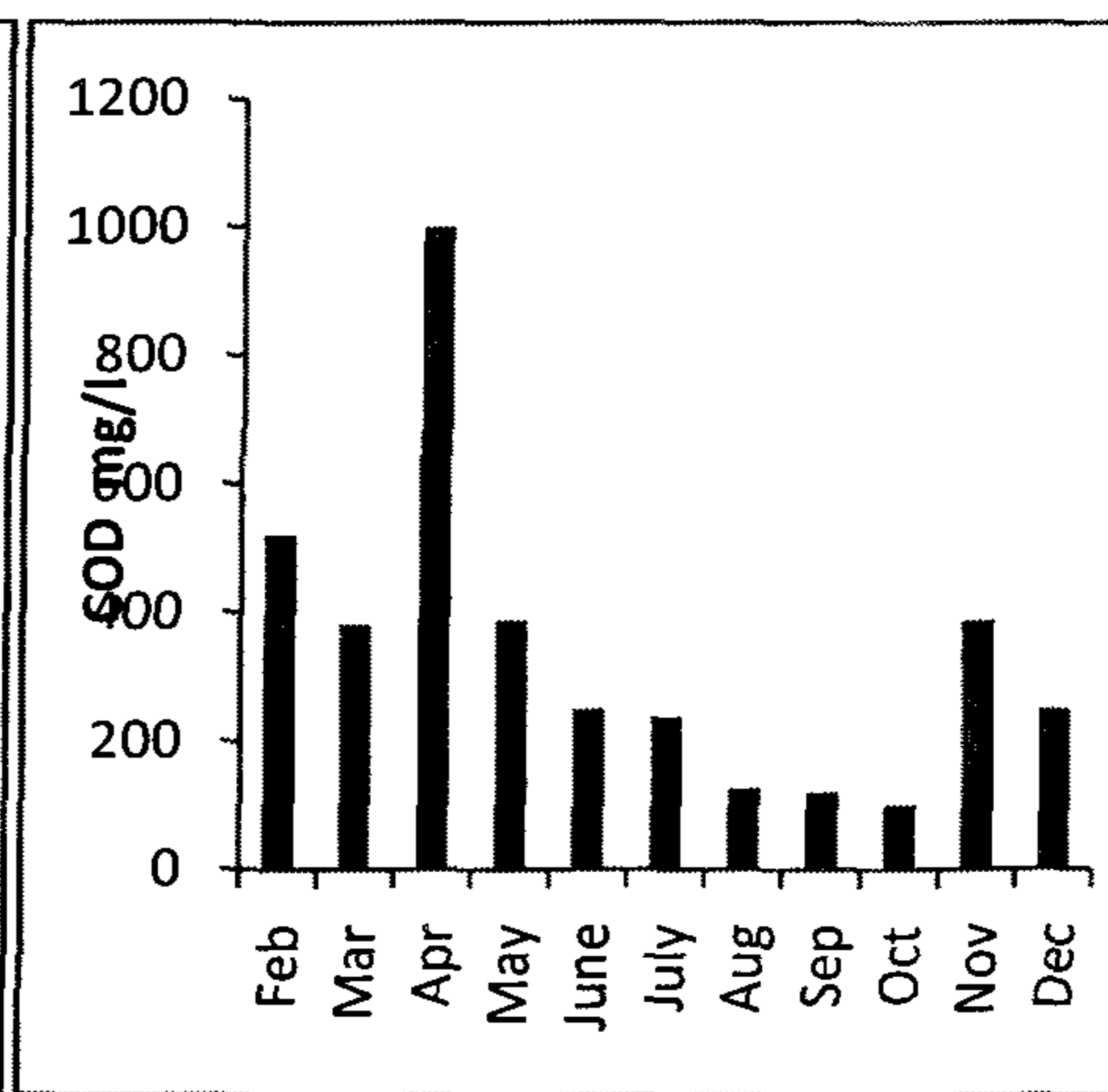


Figure 5: Monthly average COD in sample locations

Ammonia was recorded in a very low concentration in all sites, recording the value range 0.075-0.27 mg/l respectively. The values of nitrate fluctuated within a wide range and showed low levels during the whole period of investigation. The Nitrate value was recorded 0.60 to 1.37 mg/l respectively. This result also can explain the detection of the concentration of phosphate in the water 0.187 to 0.457 mg/l respectively.

Metal Levels in water and sediment

The level of heavy metal concentration (in $\mu\text{g L}^{-1}$) of the metal in water showed wide range of Pb, Cu, Cd, Cr were not detected. Hg below the detection limits and Zn value is 20-180 $\mu\text{g L}^{-1}$. The detection limits of the techniques for Pb, Cu, Cd, Cr and Zn 0.5, 0.5, 0.2, 0.2 and 10 respectively. The result indicates that the levels of Pb, Cu and Cd in water were comparatively low in the south region of the estuary. The levels of this metal in the west and the east region were similar levels in the north region. The range of the concentration of all six metals (in mg/kg^{-1}) in sediment were Pb 2.8 -30.0, Cu 3 - 26, Cd 0.001 - 0.23, Cr 18.3 - 60.5, Hg 0.2 - 1.2 and Zn 115 - 201. Cu and Hg levels were the highest in the sediments collected from the east and north region. Zn levels were high in the sampling site of west region.

Conclusion

Higher mean value of Chemical Oxygen Demand, Ammonia, Nitrate, Total Suspended Solid, orthophosphate and heavy metals in the water and heavy metals in sediments collected from north, west, south and east region of have to pool study sites into these regions. However, it was evident from our study that north site showed higher levels for the heavy metals.

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