

# Dynamics of the Madu-Ganga Estuary

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## Abstract

Among the estuaries in Sri Lanka, Madu-Ganga Estuary plays a significant role to generate a massive income through tourism. The existing tropical ecosystem attracts the tourists. However, this ecosystem faces problems of environmental deterioration problems which affect the tourism industry and income of the local community. Therefore, this research is mainly focused for understanding hydro dynamics and sediment dynamics process in Madu-Ganga Estuary. The four field visits were carried out to cover southwest and northeast monsoon periods. In situ and laboratory tests were conducted for surface and bottom water samples of Madu-Ganga Estuary to analyse the quality of the water. In addition, grab and core samples and sub-bottom profile data were used to identify sediment distribution patterns of the estuary. Moreover, time series satellite images were used to identify nearshore sediment dynamics along the western coast of Sri Lanka. Results show that a significant variation of water quality parameters under the estuary mouth opened and closed conditions. The spatial variation of chloride content also indicates that estuary mouth opened condition plays a major role to control seawater invasion in this aquatic system. Sub-bottom profile data shows cyclic/seasonal changes in accumulation of sediments in Madu-Ganga Estuary. Time series satellite images indicate that sand can probably receive from the southern region by predominant longshore currents during the southwest monsoon. Further studies are recommended to identify lake ecosystem responses to physicochemical changes and to design seasonal mining capability.

**Keywords:** Ecosystem, Estuarine circulation, Sub bottom profiles, Water quality profiles

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## 1. Introduction

Madu-Ganga Estuary is located in Balapitiya, Karandeniya area in Southern Province of Sri Lanka (Fig.1). This estuary is surrounded by mangrove-dominated wetlands. In addition, it can be identified as biodiversity rich ecosystem, due to occurrences of many endemics and nationally threatened species[1,2] Madu-Ganga Estuary can be identified

as one of the important ecological sites in tourism industry in which people living surround the estuary directly depends on the same. Therefore, degradation of the aquatic environment is mostly influenced by the local community including boat operators, local businessmen, etc. In geological view, the present geomorphology of surrounding coastal aquatic systems was probably developed after the middle Holocene

sea-level high stands [3,4,5]. In addition, the present geomorphological features indicate seasonal opened/closed conditions of the estuary mouth (Fig. 2). Such geomorphological changes are especially sensitive to water quality and the estuary [6,7,8,9]. To provide socioeconomic trajectories, it is important to know hydrodynamics and sediment dynamics in the Madu-Ganga Estuary. Therefore, in this study, the authors investigate water quality variations and sediment distributions in Madu-Ganga Estuary. In addition, satellite images were used for identifying erosion/accretion directions of sediments near to the estuary mouth.



Figure 1 - Map of Sri Lanka shows Madu-Ganga Estuary

## 2. Methodology

Four field works were carried out between September 2016 and February 2017. Therefore, these field works cover both southwest and northeast monsoons. Sampling locations were selected as per the Figure 3.



Figure 2 - Satellite images show Madu-Ganga Estuary opened (2016-07-23) and closed (2015-03-17) status

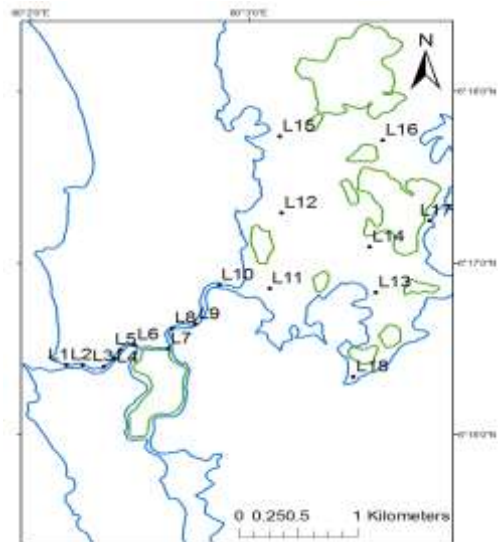


Figure 3 - Sampling locations for water quality measurements and sediment samples

In situ and laboratory water quality parameters such as dissolved oxygen and dissolved anion (e.g., nitrate, fluoride, chloride) were measured.

Contour maps were prepared for each water quality parameter using Arc GIS software.

Spatial and temporal changes of sedimentation patterns at the rivers spit were studied using satellite images, grab sampler, bathymetry and sub-bottom profiler.

### 3. Results and Discussion

#### 3.1 Direction of the sediment transportation

Sediment transportation directions were identified the surrounding coast using the time series satellite images (Fig. 4). It clearly indicates a significant amount of sand deposition in the southern part of the estuary mouth. Therefore, this pattern probably suggests the prominent clockwise (south to north) nearshore sediment transportation by longshore currents.



Figure 4 - Satellite images show sand deposition by longshore currents

#### 3.2 Water sample analysis

Dissolved oxygen values are high under estuary mouth opened condition in surface water samples. Similarly, dissolved oxygen values are

increased under estuary mouth opened condition in bottom water samples (Fig. 5). Therefore, water quality parameters can be seriously polluted under the estuary mouth closed condition.

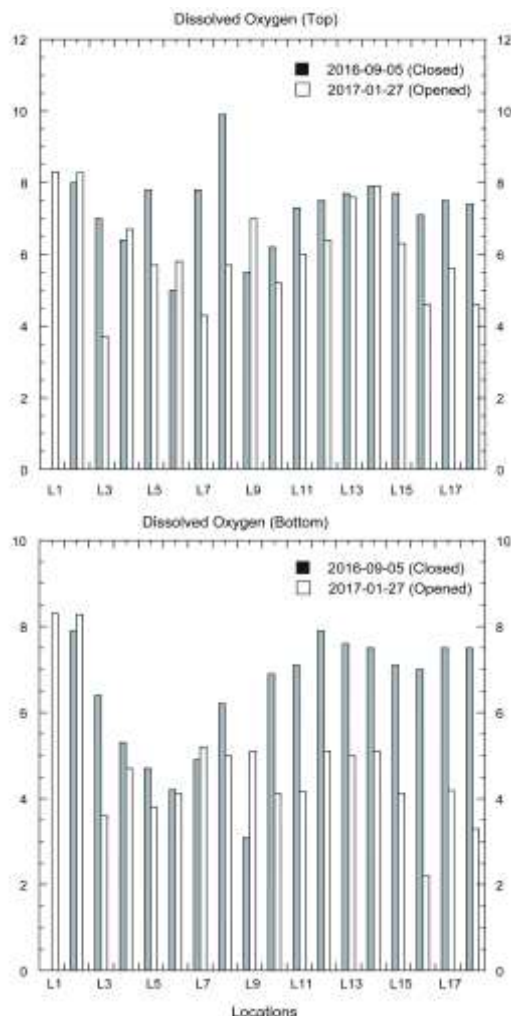


Figure 5 - Dissolved oxygen variation in surface and bottom water samples

Chloride values are gradually decreased from the estuary mouth to freshwater stream (Fig 6). It suggests the seawater invasion along the estuary mouth. Therefore, water quality of Madu-Ganga Estuary can probably enhance under sea-mouth

opened conditions, due to its well and continuous flushing nature [6].

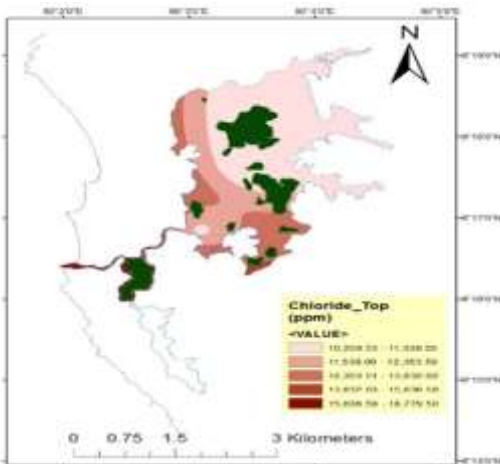


Figure 6 - Spatial variation of chloride content in surface water samples

### 3.3 Sub-bottom profiler and bathymetry images

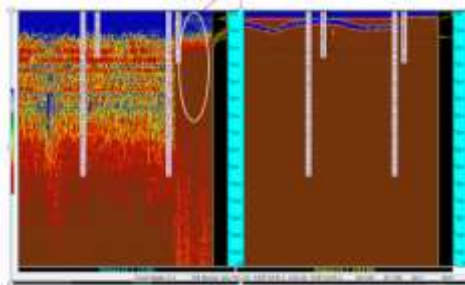


Figure 7 - Sub-bottom profiler and bathymetry images

Sediment layers can be clearly seen along Madu-Ganga Estuary. Therefore, these sedimentary layers are most probably an indication for estuary mouth opened and closed conditions (Fig 7). However, sediment layers are complex near to marine-terrestrial interface of sediments.

The estuary mouth is mainly composed of marine sand (Fig. 8). These sands can predominantly transport by longshore currents during the southwest monsoon, as

discussed earlier. In addition, it mainly consists of loosened and compacted sands in the upper and the lower parts of the core samples, respectively (Fig.8).



Figure 8 - Core samples taken from push corer near to the river mouth

## 4. Conclusion

Sea mouth opened and closed conditions directly responded in a complex way to changes in water quality parameters such as dissolved oxygen level and saltwater invasion. Therefore, sand deposition at the estuary mouth can be identified as one of the critical factor to control water quality of this tropical estuary. In the recommendation, detail monitoring program is highly necessary to understand the influence of water quality parameters for studying lake ecosystem responses. Sedimentological and geophysical investigations have been documented cyclic/seasonal geomorphological changes (i.e., sand deposition and erosion) in paleo-records of Madu-Ganga Estuary. Finally, further studied are highly necessary to design seasonal mining possibility and capacity of these beach sediments.

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