

# Interference of Natural Coastal Sediment Dynamics due to the Colombo Harbour Expansion Project

Bandara M.S.D., Keegle P.V., Mallawa Arachchi M.A.K.M.,  
\*Ratnayaka N.P., Premasiri H.M.R., and Amalan K.

Department of Earth Resources Engineering, University of Moratuwa

Corresponding Author – email: nalinratna2010@gmail.com

**Abstract:** Man-made coastal structures directly affect sediment balance in the surrounding beaches. Ongoing South Colombo harbour expansion project has created 5 km long breakwater affecting the sediment dynamics of the Colombo beaches. Present study is focussed on quantitatively and qualitatively analyse the effect of Colombo harbour expansion project on economically important beaches in an around Colombo city area and to forecast possible consequences to the Colombo harbour itself. We have taken monthly variations of beach width, beach profile and the mean grain size of the sediments at mean sea level from selected 8 beaches. Data was processed and analysed to establish site-specific erosion vulnerability. Results shows cumulative beach erosion has high affinity to erosion causing drastic reduction of beach width after the construction of the breakwater. This study highlights necessity of proper mitigation plan to protect the beaches affected by the construction of southern Colombo harbour expansion project.

**Keywords:** Colombo, Coastal sediment dynamics, Colombo harbour expansion project, beach width, beach erosion, beach profile

## 1. Introduction

Colombo coastal belt is a highly populated, economically valuable coastal belt with five star hotels, recreational areas and the major harbor in Sri Lanka. Beach erosion was identified as one of the critical coastal problems at these beaches causing destruction on expensive-shoreline developments threatening the economic and social welfare of the beach-dependent coastal communities. Measures taken to

limit the erosion of the coast in the past have been inadequate and erosion continues, causing many economical, social and ecological problems.

During the last two years, beach dwellers complained significant acceleration of beach erosion in and around Colombo area. This erosion

*Bandara M.S.D, Keegle P.V Mallawa Arachchi M.A.K.M, Final year Undergraduate students in the Department of Earth Resources Engineering, University of Moratuwa*

could be due to the construction of 5 km long breakwater built almost perpendicular to the beach under the ongoing south Colombo harbour expansion project. El-Asmar and White 2002 report severe coastal erosion due to construction of a breakwater in a harbour at Nile Delta, Egypt. Such structures interfere with the natural movement of sand (Pinet 1999). Therefore it is highly necessary to carry out proper quantitative and qualitative long-time study to understand the coastal erosion due to the Colombo harbour expansion project to take required management decisions for such future constructions and establish erosion control mitigation strategies. In this research, we have investigated the monthly beach profile variation for one whole monsoon cycle and identified erosion and accretion patterns. These study propose required mitigation strategies to protect the beaches.

## 2. Methodology

Eight transects of beaches were selected from both sides at the breakwater repressing the important beaches in the Colombo area (Figure 1). At each location monthly beach profile variations were measured from 2011 March to 2013 June from 2 m beneath the mean sea level (MSL) to a fixed point in the backshore such as a lamp post or the railway line. At each profile locations, measurements were taken perpendicular to the shoreline from the fixed position. Therefore, the

positions of the transects and bearings were accurately reproduced at each repeated monthly measurements. Vertical measurements were taken with 1m

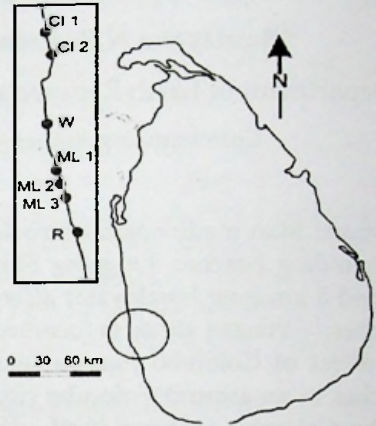


Figure 1. Studied beaches at Colombo area (CI 1- Crow Island 1, CI 2- Crow Island 2, W- Wellawatta, ML 1-Mt. Lavina 1, ML 2-Mt. Lavina 2, ML 3- Mt. Lavina 3, R-Rathmalana)

shore along intervals using surveying level. In addition, sediment samples were taken from the MSL of the each transect for the grain size analysis. Grain size analysis was carried out using 15 set of sieves with mesh size ranging from 2000 microns to 45 microns. GRADISTAT (version 4.0) software was used to analyse the particle sizes. Information on grain size characteristics were used to interpret the depositional environment and transport mechanism of sediments.

Changes in shoreline due to accretion and erosion were analysed by measuring the difference of the past shoreline data of year 2000 with year 2011 and 2012 data. Beach



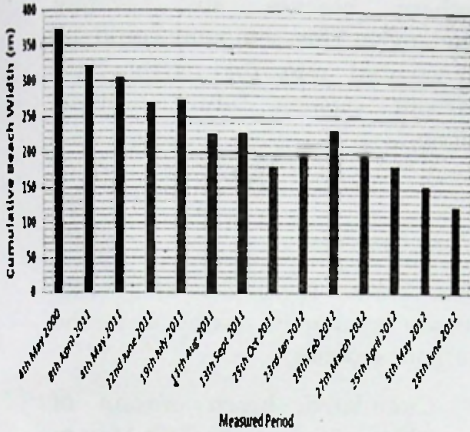


Figure 2. Cumulative Beach Width variations of the present study compared to the year 2000

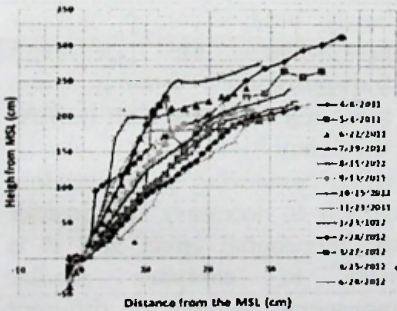


Figure 3. Monthly Beach profile changes from 2011 May to 2012 June at different Colombo beaches

width compared from a fixed location (Railway line) to MSL is used to calculate the rate of beach width change.

### 3. Results and Discussions

Results shows beach width and the profiles methodically changing (Fig. 2 and 3) with the seasonal changes due to monsoonal effects. Maximum beach widths were recorded during 2011 April-May, gradually decreased til the 2011 October, slightly increased up to February 2012 and decreased again up till the June 2012.

In general, all the beaches were wider and less steep during April May and gradually started to ten the width and increase the pness with time. Shortest and pest beaches were recorded during months of August and September. This could be because stormy rough condition during south western monsoon, beaches were subjected to severe erosion causing them to widen and flattened transporting eroded sediments cross shore direction and depositing them offshore as longshore ridges near the wave breaker zone (Fig. 2 and 3). During fair weather (north eastern monsoon), those sediments in the longshore ridges transport back to the beaches making them wider and less steep (Fig. 2 and 3). Usually, a large amount of sediment load is applied to the northern side of the olombo Harbour by Kelani River and transports them along the beaches towards both northern and southern direction as longshore currents. Since the newly built Colombo harbour breakwater, transportation of this sediment to the Sothern Colombo beaches was hindered promoting coastal erosion

in there. Present results confirm this by beach width variations trends during months of October and November (Fig. 2).

Widest cumulative beach widths in the 2011 were recorded from the month of May. Beach width variation during 2000 May to 2011 May is about 50m ( $\pm 35$ m). However, from 2011 May to 2012 May beaches have cumulatively eroded 200m ( $\pm 35$ m). Therefore, Colombo area has only lost 1.50 m to 5m of cumulative beach at each year for the period of 2000 May to 2011 May (for last 11 years). However since 2011 May to 2012 May for the last 1 year period along, it has lost a staggering 200 m of beach width. This sudden increase of beach erosion from 1.5-5m/year to 200m per year should be because of the building of the Colombo Harbour breakwater. There is no any other cause of natural or artificial change of sedimentation in the area for the last one year period. In addition, mean grain size at the mean sea level shows decreasing tendency from Rathmalana towards mount Lavinia indicating predominant northerly longshore transport direction. On the other hand, grain size decrease from crow island location 1 to Wellawatta indicates predominant southerly longshore current drift. Therefore, it is conclusive that Wellawatta situated at the southern section from the Harbour still receive sediments from Kelani River. However, due to the new breakwater sediment supply through the longshore transport from Kelani River towards the

Sothern beaches are severely hindered. This sediment could be transported into the newly built harbour causing future harbour filling.

## Conclusions

This study highlights staggering coastal erosion in nearby Colombo harbour beaches;

- Cumulative beach erosion of 200m ( $\pm 35$  m) from 2012 May to year 2011 May for the last 1 year period.
- Cumulative beach erosion is only 50 m for the 2000 May to 2011 May for the previous 11 year period.
- Beach profile/width variation trends during October due to newly built Colombo harbour breakwater on sediment transportation causing less southerly sediment supply from the Kelani River.
- when comparing past shoreline data it is necessary to consider the monsoonal effect and it is vital to compare similar monsoonal months of different years.

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