Long Term Coastal Erosion and Shoreline Positions of Sri Lanka

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Abstract: Coastal zone of Sri Lanka is key to the sustainable development of the country. However, the erosion of this coastal zone has been identified as a long term problem. Therefore, coastal sediment dynamics around the country has to be identified to develop an appropriate coastal zone management plan. Remote sensing and GIS techniques can be used for quantitative and qualitative analyses of coastal monitoring activities including understanding the coastal erosion and accretion trends. In this study, past and recent Google Earth satellite images have been used to analyze erosional and accretional trends in the coastal zone, all around Sri Lanka. Using these results, near shore sediment transportation directions along the coastline around the country were also predicted. Most of the south-western coastline of Sri Lanka shows considerable erosion during stormy conditions under south-western monsoon period, but mostly recovered during fair weather north-eastern monsoon conditions. Therefore, no any severe long term erosion conditions prevail in the western, south-western and north-western coasts. However, isolated locations in the north-eastern and eastern coastline shows considerable erosion. Predicted nearshore sediment transportation directions proved that it is mainly governed by wind and waves of southwest and northeast monsoons.

Keywords: Coastal Erosion, Coastal Sediment Dynamics, Coastline, Google Earth Images

1. Introduction

Being an island nation, Sri Lanka possesses 1620 km long, coastline all around the country, enriched with estuaries, lagoons, salt marshes, sandy beaches, coral reefs and beach mineral resources along with a significant biodiversity. All these resources provide immense support for the economic development of the country. Further, with the post-war rapid development activities, coastal zone has become pivotal. To attain sustainable development in the coastal zone, it is necessary to understand near shore process, particularly sediment dynamics. Erosional and accretional changes in a coastline are key to understand the sediment dynamics. Besides, preservation of this valuable coastal area has become a significant requirement because the erosion of this area was already identified as a longstanding problem in Sri Lanka. Only a few researches have previously carried out to understand the sediment dynamics of Sri Lankan coastal area [1, 2 and 3]. Under this research, an image analysis was done to investigate coastal erosion trends and near shore sediment transportation around the country, qualitatively.

2. Material and Methods

Historical Google Earth satellite images representing straight beaches, bays, river mouths and coastal areas with hard engineering structures were

considered for the study. Images used for long term changes had at least five year gap and taken at nearby months from the particular year to minimize seasonal variations due to monsoon. Image processing and analysis were performed by means of ArcGis software, and polygons were drawn on all images for a particular location, as per the Figure 1, by demarcating the wet - dry boundary as the shoreline [4].

A common polygon was drawn as per Figure 2 and combined it with other two polygons that were drawn in the images belong to two different time periods in the same location. Attribute tables of combined polygons were edited and a new grid code was defined by assigning 0 for water and 1 for land. Then, those polygons were converted into raster format, and raster calculations were performed. Final Raster maps are given in Figure 3. For seasonal change, two images were selected within two seasons representing south-western and south-eastern monsoon periods and the images were compared using above GIS method.

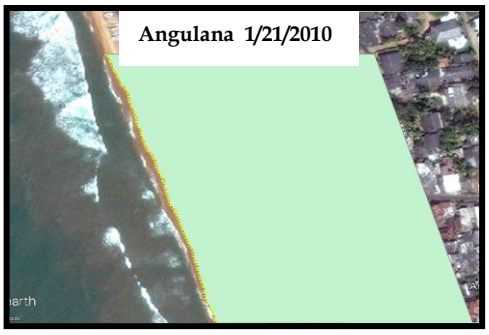

Figure 1: Polygon drawn by taking dry wet boundry as one edge

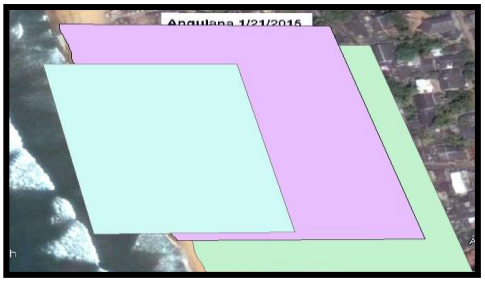

Figure 2: Common polygons

Figure3: Final output of accreted or eroded area

3. Results and Discussion

Selected all locations along the southwest coast, including Dehiwala, Mount Lavinia, Wellawatta, Wadduwa, Rathmalana and Hikkaduwa, show severe seasonal erosion, mainly during the southwest monsoon. As figure 4 and 5 shows, this erosion observed along the most parts of the south west coast is not a permanent feature. They vary only seasonally and accreted with the onset of fair weather north eastern monsoon.

Therefore, the south-western coastline is fairly stable and in a dynamic equilibrium without dominant long-term erosional trends. River mouths and hard engineering structures such as jetties, groins and breakwaters in the south-western coastal area are characterized by sediment deposition in the northern section whereas erosion in the southern section, implicating predominant sediment transportation towards north. Therefore, south-western coastal belt is

predominantly governed by the south-western monsoon winds which powers the northerly directed longshore transport.

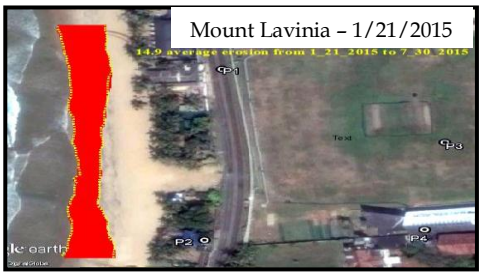

Figure 4: Mount Lavinia - seasonal erosion

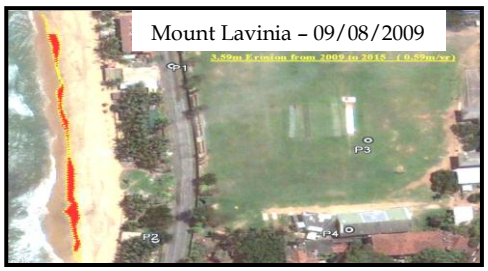

Figure 5: Mount Lavinia – long term erosion

Many locations in north-western coastlines such as in the case of Lansigama and Uswetakeiyawa were subjected to severe erosion before 2009 compared to the present [5 and 6]. This could mainly due to poor river sand supply to the coastal zones due to severe sand mining in Kelani River. However, since 2009, projects carried out to nourish the beaches and other hard engineering preventive methods, comparative development of beaches, from rocky to sandy beaches were observed. In addition, sediment deposition pattern associated with breakwaters in this area shows sand transportation predominantly towards north, similar to the western coastline.

Very narrow and stable beaches of Manner Island up to Poonaryn area indicate shortage of sediment supply into these beaches from the northerly nearshore drift, continuing from the south-western coasts towards south-eastern coasts. Therefore, this near shore northerly longshore sediment transportation should divert towards Manner Island and then to Danushkodi, India along the sand banks situated in the Gulf of Mannar area.

On the other hand, in the north-eastern coastline, severe long term erosions can be observed in some places, including Verugal, located 50km south of Trincomalee Bay, because of the beach mining at Pulmudai, causing poor downstream sediment supply. This could also be due to offshore transportation of near shore sediments towords the submarine canyon at Trincomalee.

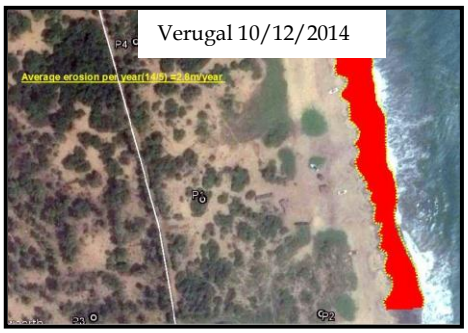

Figure 6: Verugal – longterm erosion

Along the south-eastern coast shows steady states, perhaps because less intensive north-eastern monsoon. Sediment deposition associated with rivers is characterized with predominant deposition in southern section compared to the northern section indicating dominant southerly driven longshore currents. Tables 1- 4 show qualitative and quantitative results obtained under this research.

Table 1: Longterm conditions of straight beaches

Location	Beach condition	Quantity (m/yr)
Wellawatta	Erosion	0.60
Dehiwala	Accretion	0.75
Rathmalana	Erosion	0.69
Mount lavinia	Erosion	0.59
Angulana	Accretion	2.35
Wadduwa	Accretion	2.76
Ambalangoda	Erosion	1.80
Hikkaduwa	Accretion	6.36
Matara	Erosion	1.26
Tangalle	Accretion	4.29
Kirinda	Accretion	5.13
Verugal	Erosion	2.80
Jafna	Accretion	0.90
Kuchchaweli	Accretion	0.60
Kalmunai	Accretion	2.10
Komari	Erosion	1.10
Arugambay	Accretion	0.80
Mulativu	Accretion	0.70
Puttalam	Accretion	0.40

Table 2: Longterm conditions near river mouths

Location	Condition	Quantity (m/yr)
Bolgoda Ganga		
Upstream	Accretion	14.59
Downstream	Accretion	11.19
Mahaweli Ganga		
Upstream	Erosion	7.47
Downstream	Erosion	3.04
Kalani River		
Upstream	Accretion	2.82
Downstream	Accretion	7.21
Deduru Oya		
Upstream	Accretion	6.76
Downstream	Accretion	3.11
Kalu Ganga		
Upstream	Erosion	4.88
Downstream	Erosion	0.83

Table 3: Longterm conditions near artificial structures

Location	Condition	Quantity (m/yr)
Wattala	Accretion	25
Nainamadama	Accretion	10

Table 4: Longterm conditions within bays

Location	Condition	Quantity (m/yr)
Koddiyar bay	Erosion	2.5
Weligama bay	Erosion	2.7
Marichchikaddi Bay	Accretion	1.5

5. Conclusion

This research concludes the sediment dynamics surrounding the country is governed by seasonal longshore currents generated due to waves and winds of southwest and north eastern monsoons.

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