A Cost-effective method for coastal erosion prediction in Western coast of Sri Lanka

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Abstract

Coastal erosion is a serious problem for a country, especially for an island like Sri Lanka. Recently the coastline from Chilaw to Negombo has been severely affected by erosion, mostly from the previous decade. Some countries have developed methods for evaluating and predicting the coastal erosion more scientifically. However, a suitable methodology for evaluating this disaster is not available in Sri Lanka.Coastal erosion in Sri Lanka has been addressed by several studies around the island. Predictions have been given by those studies several decades ago. But those predictions have been proved to be incorrect. USGS Digital Shoreline Analysis System (DSAS) tool can give several rates for predictions by depending on previous shoreline position data. Google images in different years were taken by screen prints and then MOSAIC them by using ArcMap for extracting the shoreline data. Historical images were taken with considerable time gaps for predicting the shoreline. Predicted shoreline for the year 2013 was generated by using the given rates from DSAS tool. A field survey was conducted in the study area for extracting the existing shoreline in 2013. The best erosion rate was selected by using the correlation between the existing shoreline and the predicted shorelines. The best erosion rate was EPR (End Point Rate) with 5m average error. Other rates were given more than 10m average error predictions. Predicted shoreline map was created by using that best rate. This prediction can be directly used for mitigating the hazard and awareness programmes can be conducted with this ultimate result.

Keywords: Coastal Erosion, Shoreline, DSAS Tool

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Introduction

Although Sri Lanka is a small country when compared to other countries it retains a large coastal area. This resource can be largely used for the economic development of the country. Unfortunately, it has been heavily affected by erosion for many decades leading to a reduction in the land area of the country. The objective of this study is mainly focused on introducing a cost-effective method for coastal erosion prediction in western coast of Sri Lanka and producing a predicted shoreline map. Then the research question was how to develop an accurate, profitable and easy method of prediction of coastal erosion in Sri Lanka.The study area was selected with the amount of the issue and the availability of the resources. The coastal area around Marawila and Lansigama were selected for the study.

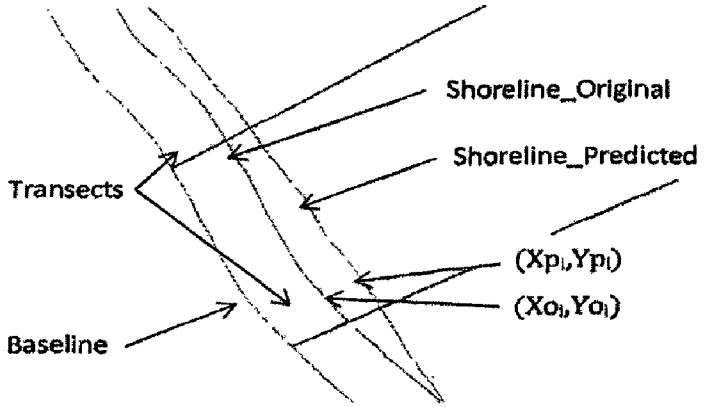
Materials and Methods

Google Earth was used to obtain the images of the study area from 2001, 2003, 2005, 2010 and 2012. Screen prints were taken throughout the area from each year and they were joined by using Mosaic tool in ArcGIS. A Field visit was done to collect GCPs and survey the shoreline. GCPs were collected by using the Handheld GPS and images were geo-referenced accordingly. Topographic data of the study area were collected to obtain the existing shoreline. The existing shore line was extracted to compare the predicted result.

The shorelines of each image were digitized by using ArcGIS. Wet-dry line was used in the digitizing of shoreline. The standard format of the feature class was maintained that is necessary to work with DSAS tool. A single feature class was created by appending all shorelines. An arbitrary baseline was created along the shoreline. Transects were drawn and erosion rates were obtained by using DSAS tool.

The shore line was predicted for year 2013. The predicted positions of the shoreline along the transects were calculated by using Microsoft Excel. These positions were predicted in different rates (EPR, JKR and LLR). Predicted shorelines were drawn in ZWCAD. The best shoreline was found by the similarity calculating between the predicted shorelines for year 2013 and the surveyed shoreline. It was selected as the best prediction and its rate was selected as the best rate given by the DSAS tool.

Figure 1: Calculation the Similarity between Two Shorelines



$$\frac{\sum_{i=1}^{n}\sqrt{(Xo_i - Xp_i)^2 + (Yo_i - Yp_i)^2}}{n}$$

X – X coordinate of the intersection point

Y–Y coordinate of the intersection point

o – Existing shoreline

p – Predicted shoreline

i –Transact number

n – Total number of transacts

The average shift per transact is given by this equation. The accuracy of the prediction is increased when the average shift is decreased.

Predicted shorelines were drawn for year 2015, 2020

Result

Table 1: Average error of different rates

Rate	Average error (m)
End Point Rate	5.3
Linear Regression Rate	6.8
Jackknife Rate	10.8

Conclusion

The easiest and cheapest method of extraction of shoreline is the using Google earth images. It is a time consuming method and the accuracy will be around 5m. But when it is compared with the other methods it is useful for academic purposes. Availability of historical images is a great advantage for this method. The Google earth images are not well geo-referenced. There is a shift between the available historical images also. The average shift of the shoreline will be 6.1m in 2015 and 12.7m in 2020.

Recommendation

High resolution images can be used to improve the accuracy of the study. If the low resolution images are used then the shoreline extraction must be done using the vegetation line. Wet-dry line extraction using low resolution images tend to increase the errors. The rate obtained by mathematical functions can be changed by using weights of different parameters such as DEM of the shore, Wind direction, Sea profile, which affect coastal erosion.

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