LAND GAIN IN NORTHERN SRI LANKA

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ABSTRACT: Located perfectly in mid of the Indian Ocean, probably no island in the world has been more frequently mentioned than Sri Lanka, by the travelers during the early periods of history. The most interesting area for them was the morphology of it's coastline. The coastal morphology of the northern Sri Lanka exhibits remarkable difference in comparison with other coastal areas of the island. This zone is a developing or an advancing coastline. Earlier researchers have emphasized the formation of islands off the northern coastline during the Miocene era. These islands were later merged with the mainland by development of spits and bars.

As a preliminary study, aerial photographs dating back to year 1956 and recent Google earth images of northern Sri Lanka were assembled and analyzed visually and digitally. Observations made during this study confirmed Pooneryn peninsula as an area of land gain. Topography maps of 1936 and digital base maps of 1980 were studied to acquire greater details and to confirm the findings. The four sets of maps which were published within a span of more than seventy years were geo-referenced, digitized and overlain using ArcGIS software. Change detection technique, namely image differencing or subtract method was finally used to determine the extent of land gain in Pooneryn peninsula and a final map was produced with the use of computer based cartography.

The possible reasons have been discussed in order to forecast the future morphology of the Jaffna peninsula. Among them the most possible outcome would be the joining of Pooneryn and Jaffna peninsulas through developing sets of sand spits and bars in another hundred years.

KEYWORDS: Land gain, coastal morphology, change detection, Pooneryn peninsula,

Introduction

Settlements, harbours and industries were created along the coastline of Sri Lanka which is measured over 1700 kilometers and man has been living in the coastal zone since the dawn of it's history. The coastal zone of Sri Lanka has been studied in detail by Swan (1983) describing the remarkable diversity shown in the coastline features. The area between North and West has been developed on Miocene limestone beds (Figure 1). This area was identified as developing or advancing coastline in contrast with the degrading or retreating coastline of the other coastal areas (Madduma Bandara, 2002).

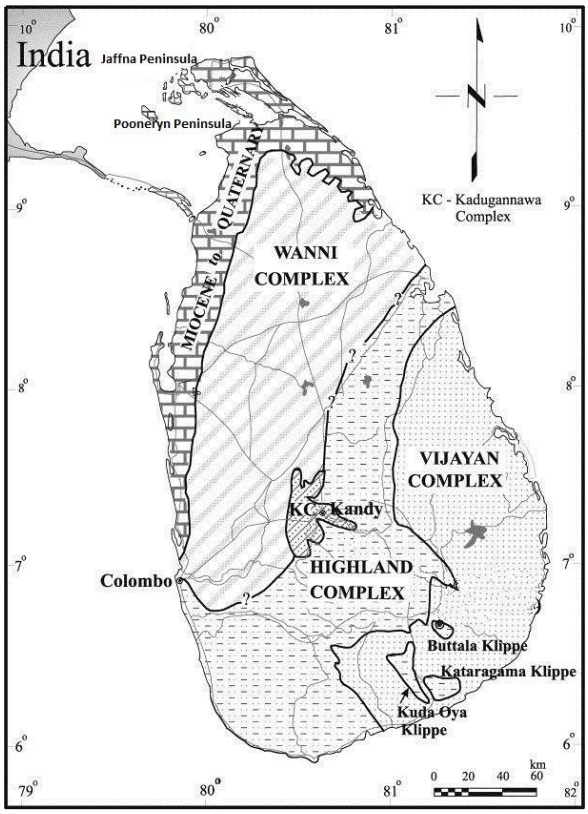

Figure 1: A simplified geological map of Sri Lanka showing the study area.

A belt of low sandy terrain which extends from Pooneryn town on the mainland northwestward is named Pooneryn peninsula. As a result of the tidal currents and the small waves and wavelets combined with the dry windy southwest monsoon, this particular feature has been gradually developed. The sand is carried by the winds from southwest towards the lagoon side of the peninsula. The depositional features were developed facing the Jaffna lagoon as sand bars, offshore islets and alluvium deposits (Swan, 1983). While studying the depositional patterns in Jaffna peninsula, a progressive formation of spits and lagoons were identified by Senaratne and Dissanayake (1982). By analyzing aerial photographs, the changes occurred in vegetation cover has been observed. A contrasting tonal variation was shown in the vegetation found on the emerging or gaining land. While focusing on Karaitivu Island as a case study, some recent depositional patterns were identified.

Cooray and Katupotha (1991) discussed about an evolution of Jaffna peninsula. It consists of a formation of islands off the northern coastline of Miocene times and attaching of these islands to the mainland by sand bars and sand spits. With this understanding, they have been explaining the changes that might take place in the future in next few thousand years. Namely, joining up of the western islands to the mainland by

sand bars and sand spits, extension of Mandaitivu spit northwards to join the mainland and the conversion of Jaffna Lake.

As it is the nature of a coastline to be dynamic, erosion is a general factor. Development within the limits of coastal area has induced erosion problems (Praseya, 2009). Hence land loss has been widely discussed suggesting a variety of precautions. The main objective of the study has been monitoring the morphological changes of a selected coastline and identifying the coastal features of the particular area within a time frame. The term "Land gain" has been introduced as the study emphasizes on "growing" or "increasing in area of" the coast. Land gain is somewhat rare and limited to areas of specific climatic conditions as well as the areas of less human impact. The main cause for such changes has been discussed using Geographic Information System (GIS). GIS methods been one of the best possible criteria to study morphological changes and also it's ability to display the analyzed data visually and dynamically was used in this study.

Method

Identifying the study area

When considering the coastal morphology of Sri Lanka, the vicinity of Jaffna peninsula is an area which was clearly subjected to drastic changes, hence identified as the best possible area to apply change detection. To concentrate on a specific area, visual interpretation has been considered as a primary base. As the first step, two sets of maps of the northern Sri Lanka were considered, namely 1956 aerial photographs and 2006 Google Earth images. The aerial photographs covering the entire Jaffna peninsula were photocopied and assembled. The Google Earth images of 2006 were printed as screen shots and assembled. These two maps which were of considerably large scale were displayed side by side on a wall. Because of the pattern of the coastal landform in Jaffna peninsula, the slightest change in coastal morphology was clearly visible to the naked eye in the large scale maps. Visual analyze comprising literature review, cartographic experience and personal interest indicated the noticeable development of sand bars, offshore islets and sand dunes on the lagoon side of Pooneryn peninsula facing Jaffna lagoon. This area was also identified as the main opening of Jaffna lagoon to the Indian Ocean.

Later the two displayed maps were photographed using Nikon D90 camera to acquire the first digital images (Figure 2). The digital view commended what was observed earlier in greater detail. Then the two maps were digitized separately for more observation (Figure 3) and Pooneryn peninsula has been identified and selected as the most suitable environment in northern Sri Lanka to discuss the term Land gain.

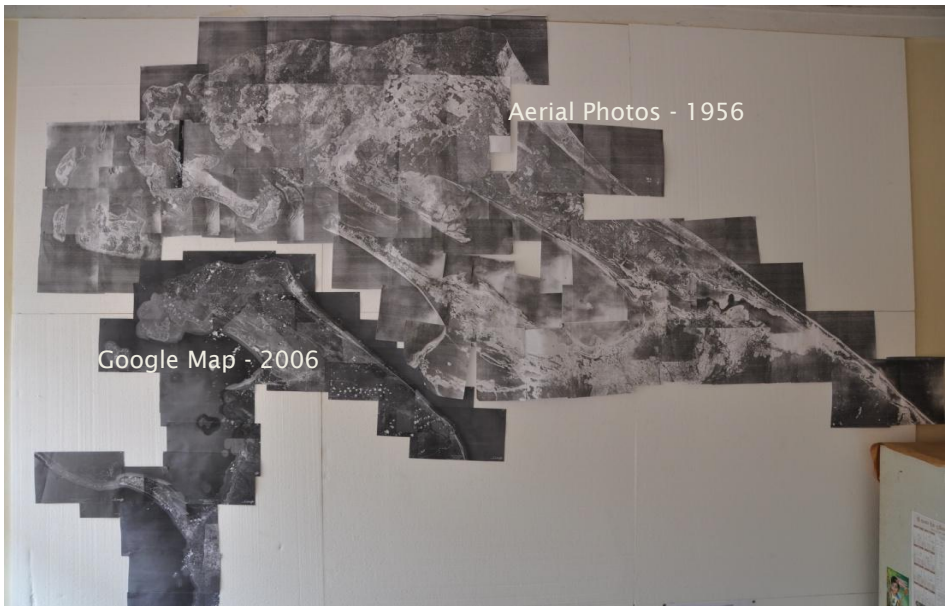

Figure 2: Displayed maps of the assembled aerial photographs and the Google Map.

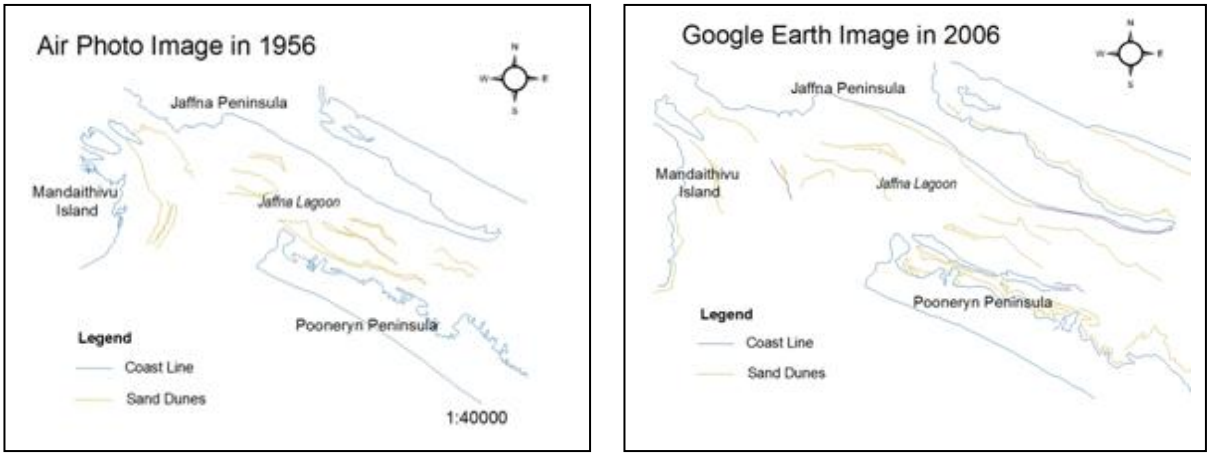

Figure 3: Digitized maps.

The study area

Pooneryn peninsula is within Kilinochchi district and Poonakary administrative division (Figure 4). Main town is Pooneryn. The geographic coordinates of the selected study area is from north latitudes 9^0 31' to 9^0 41' and east longitudes 80^0 01' to 80^0 11'. The altitude of the area is 30 meters from the mean sea level. The average annual rainfall in Pooneryn peninsula ranged from 1000-1250 millimeters (mm) and the average annual temperature varied from 25.0-27.5 degree Celsius (^{0}C). The area is recognized as shallow, karstic, aquifer since the drainage system could not be identified. The area is acquainted with it's lagoon condition and is revealed as an area with less natural vegetation (National Atlas of Sri Lanka, 2007).

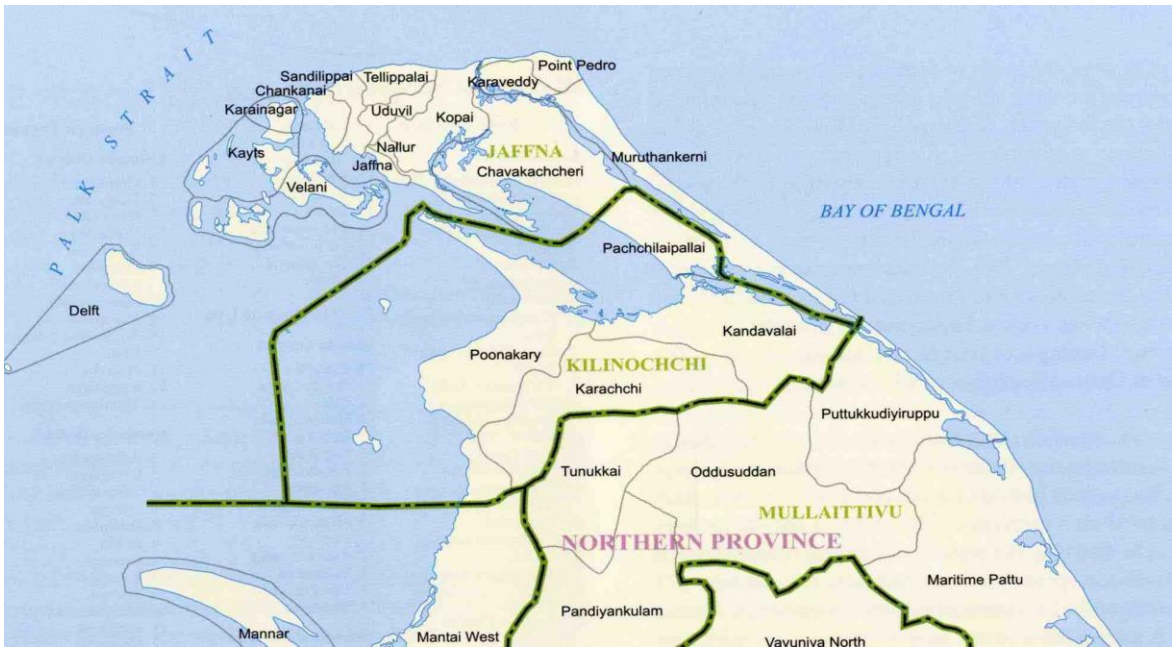

Figure 4: Administrative location of the study area. Source: National Atlas of Sri Lanka

Geologically the thick Jaffna limestone underlies the whole Jaffna peninsula including the surrounding islands and also extends southwards along the west coast of the mainland as a gradually narrowing belt (Cooray, 1984). Pooneryn peninsula consists of beach and dune sand, brown grey sand, alluvial and lagoonal deposits, clay, silt and sand (National Atlas of Sri Lanka, 2007).

The study area is important historically as well as archaeologically. The importance of Pooneryn was first observed by the Portuguese and then by the Dutch afterward. This northeastern coastal area of Sri Lanka had gained high attention during the colonial past, particularly during the Dutch administration. It has been garrisoned till the late 18th century and the British built a rest house in the area in 1805 (Paranavitana, 2008). Since 1983 due to civil war of the country the area was acquired by the defense forces of Sri Lankan government till it withdrew in 1991 leaving to the opposition, and were recaptured by the government of Sri Lanka in the year of 2009. Currently the area is less developed and the ruins of the fort is stayed behind in bad condition.

The research design

The research was designed to identify the land gained in the selected Pooneryn peninsula of northern Sri Lanka. The data has been obtained from four main sources. As mentioned earlier aerial photographs of 1956 and the satellite images from Google Earth 2006 were observed at the beginning. Apart from that one inch to one mile topographic map of 1936 and 1:50000 digital base map of 1980 were studied later to acquire greater detail (Figure 5). The four sets of maps which were published within a span of 70 years were geo-referenced, digitized and overlain using ArcGIS 9.3 software.

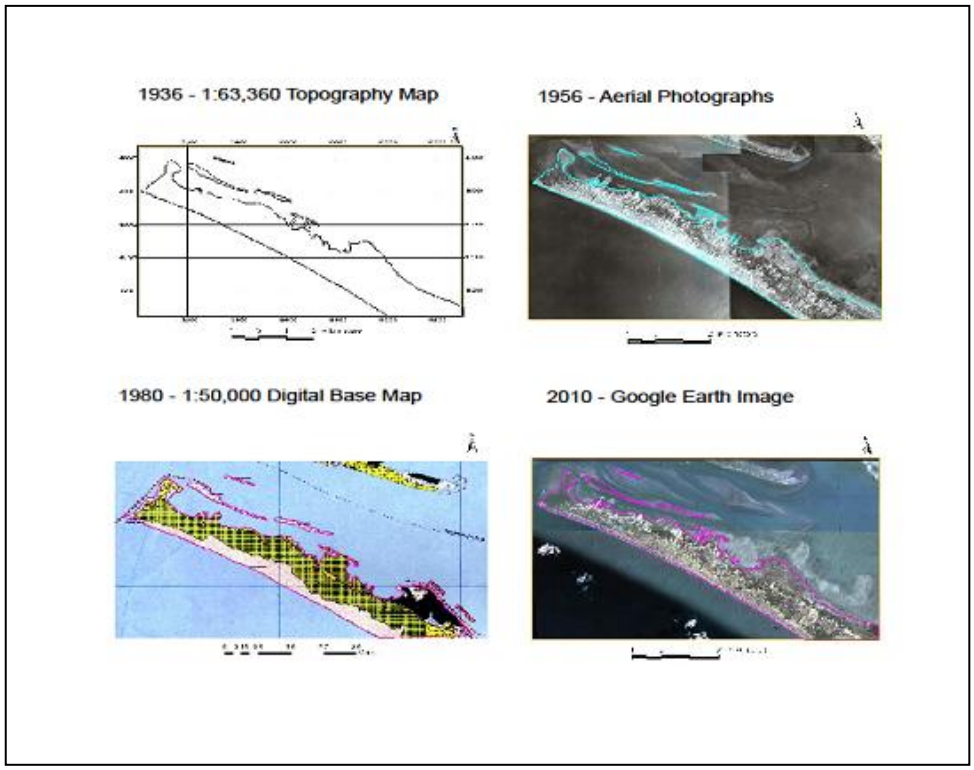

Figure 5: The four maps showing the digitized boundary lines of the study area.

Results and Discussion

Overlay analysis depicted that the lagoon side of the peninsula carries depositional features. Progressive formation of layers or land gaining could be clearly seen as developing sand spits and as filling up of small bay like features within the studied time span (Figure 6).

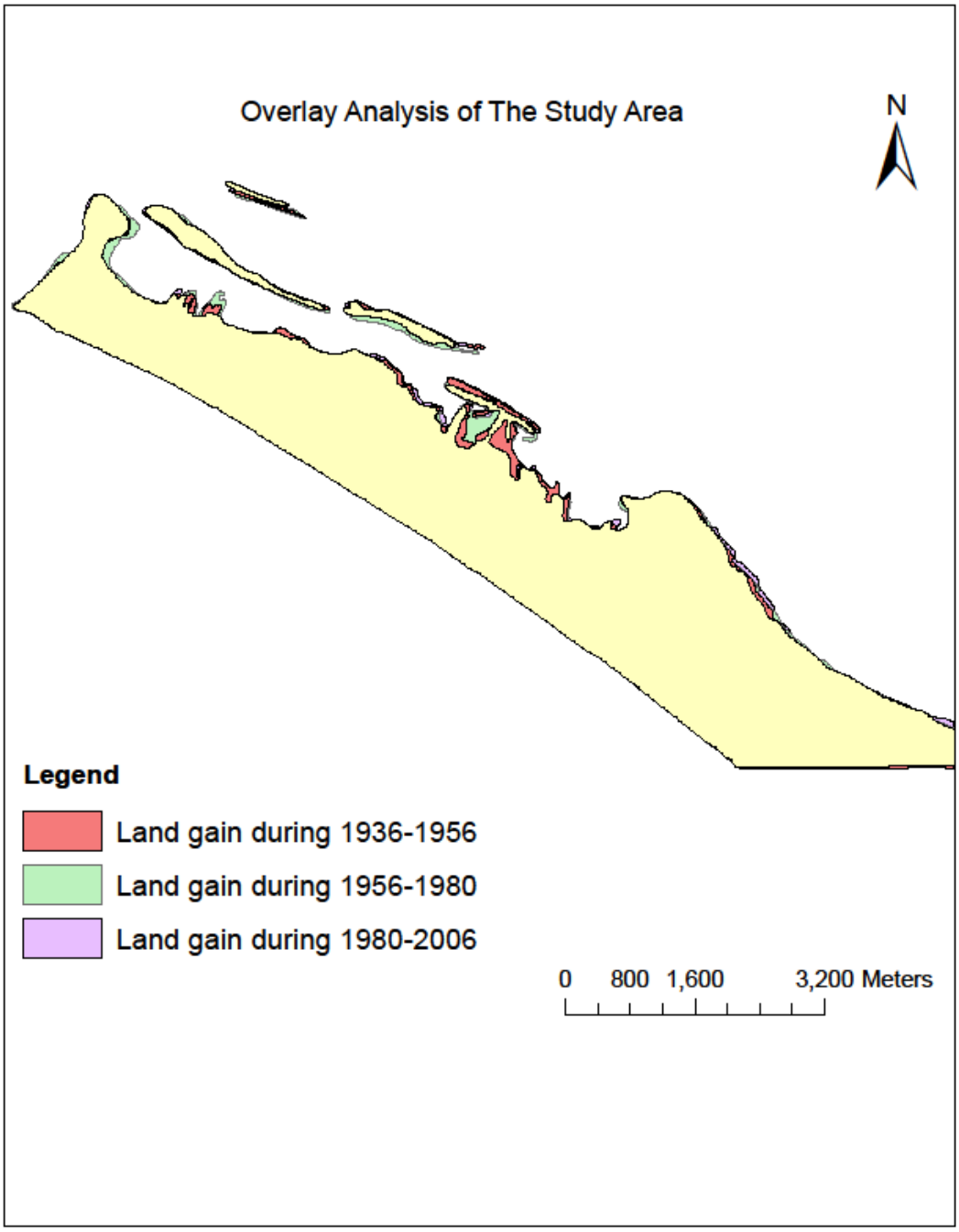

Figure 6: Overlay analysis of the study area.

The study area has been under the influence of the southwest monsoon as well as the northeast monsoon. The earlier researchers have emphasized that this feature has been built in response to the tidal currents and more particularly due to the influence of small waves and wavelets associated with the dry windy southwest monsoon. It has brought in sediments and has built up Pooneryn peninsula as a stable coast of sand facing southwest (Swan 1983). As the development of this flank progressed, it acted as a barrier to the southwest monsoon allowing the wind from the northeast monsoon to bring the sand into the lagoon making depositional patterns along the boundary facing the Jaffna lagoon. The abundance of sand in the Palk Strait accelerated this process. Two recent high resolution images namely, 2009 Advanced Land Observation Satellite image (ALOS) of 2.5m resolution (Figure 7) and 2010 colour aerial photograph of 0.5m resolution (Figure 8) have confirmed this hypothesis. The formation of underwater sand bodies north of the existing islands is clearly seen. However the construction of Sangupiddy Bridge in 2011 connecting Pooneryn town with the Jaffna peninsula might change the depositional trend within the study area.

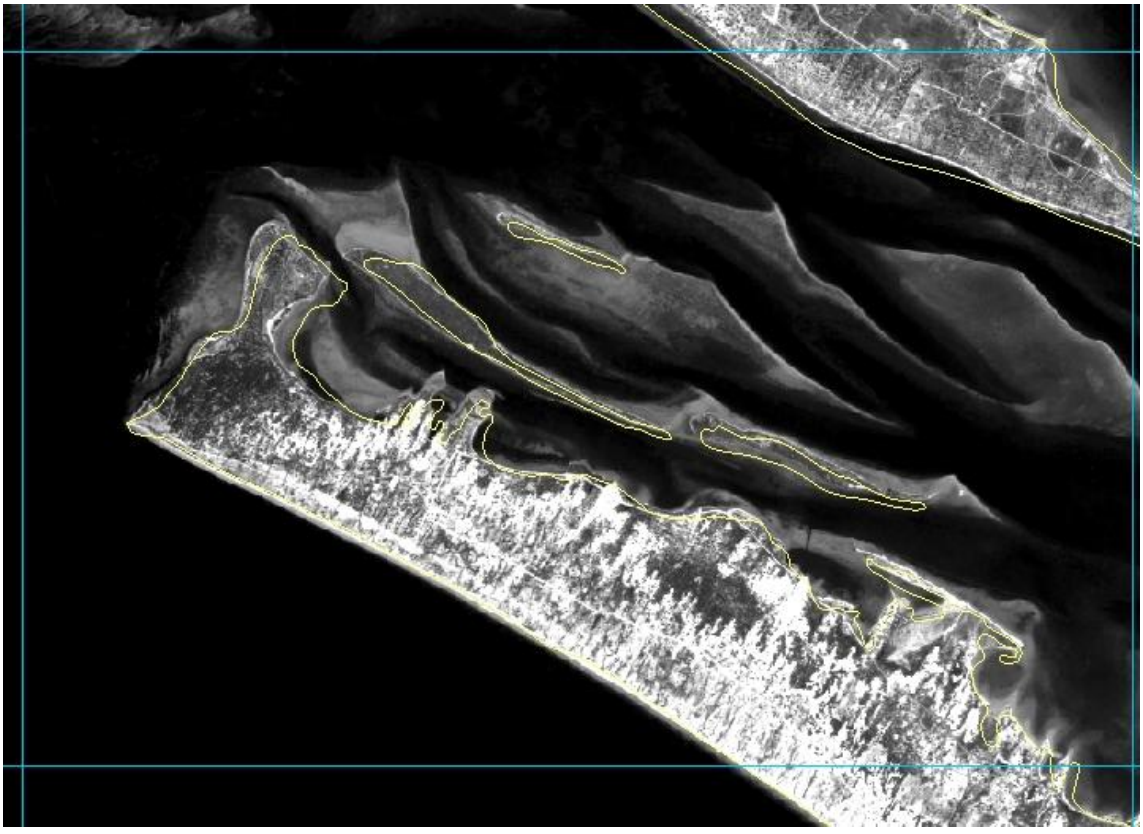

Figure 7: The digital image of 2009 Advanced Land Observation Satellite (ALOS) of 2.5m resolution.

Source: Survey Department, Colombo.

Figure 8: The digital image of 2010 colour aerial photograph of 0.5m resolution.

Source: Survey Department, Colombo.

Conclusions

The growth of the depositional features towards the Jaffna peninsula promotes the formation of a very shallow area within the Jaffna lagoon. It could possibly be converted primarily to a lake rather than a land. This could happen through developing sets of sand spits and bars in another hundred years.

References

Cooray, P. G. (1984) An Introduction to the Geology of Sri Lanka. *A publication of the National Museums Ceylon.*

Cooray, P. G. and Katupotha, J. (1991) Geological Evolution of the Coastal zones of Sri Lanka. *Proceedings of the Symposium on causes of Coastal Erosion in Sri Lanka. Pub. CCD-GTZ Coast Conservation Project, Colombo.* pp. 5-26

Madduma Bandara, C. M. (2002) Regional Technical Assistance for Coastal and Marine Resources Management and Poverty Reduction in South Asia. *Situation Analysis Report- Sri Lanka Component*.

National Atlas of Sri Lanka. (2007) *Survey Department of Sri Lanka.*

Paranavitana, K. D. (2008) mahawansa.wordpress.com/2008/11/23pooneryn's-past-by-prof-k-d-paranavitana/ Last visited 03/08/2012

Prasetya, G. The Role of Coastal Forest and Trees in Protecting against Coastal Erosion. *FAO Corporate Documentary Depository.* http://www.FAO.org Last visited 19/11/2011

Senaratne, A. and Dissanayake, C.B. (1982) Palaeogeographic Reconstruction of Jaffna Peninsula, Sri Lanka. *Journal Geological Society of India.* 23, pp. 545-550

Swan, Bernard. (1983) An Introduction to the Coastal Geomorphology of Sri Lanka. *A Publication of the National Museums of Sri Lanka.* pp. 1-11, 120-125.