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ජිනදාස කටුපොත
භූගෝලවිද්‍යා දෙපාර්තමේන්තුව, ශ්‍රී ජයවර්ධනපුර විශ්වවිද්‍යාලය

සාරාංශය

අවසාන ග්ලැසියර උපරිමය, එනම් අදින් වසර 30,000-19,000 කාලයට පෙර ගොඩබිම හා සම්බන්ධව තිබූ අයිස් තලාවන්ගෙන් ඝන කිලෝමීටර් දශලක්ෂ 5.0 ක පමණ ප්‍රමාණයක් දියවීම හේතු කොටගෙන එතෙක් මීටර් 130.0-180.0 ක් පමණ පහතින් තිබූ ගෝලීය මුහුදු මට්ටම ඉහළට එසවිණි. ඉහත කාලය වන විට ශ්‍රී ලංකාවේ භූමි ස්කන්ධය වර්තමානයට වඩා විශාල වූ අතර එහි සීමාව බඹ 100 (මීටර් 180) සම ගැඹුරු රේඛාව දක්වා විහිදිණි. එම ප්‍රදේශය වර්තමාන වෙරළ ඉම සිට හඳුනාගත්තේ 'ගිළුන අඩතැන්නක් ' වශයෙනි. ප්ලැන්ඩ්‍රියන් මුහුදු ගැල්ම (*Flandrian Transgression*) වශයෙන් අයිස් තලාවන් දියවීමෙන් වූ මුහුදු ජල මට්ටම නැගීම හඳුන්වනු ලබන අතර ගෝලීය මට්ටමේ බොහෝ ප්‍රදේශවල වර්ෂ 19,000-18,000 කාලයේ සිට එම සිදුවීම සිද්ධ විය. මෙම ක්‍රියාවලිය ධ්‍රැව (pole), මහාද්වීපික හා කඳු ගිරිද ග්ලැසියර දියවීම හේතු කොට ගෙන වූ අතර ඒ නිසාම නිවර්තන හා උප නිවර්තන ප්‍රදේශවල මහාද්වීපික තටක නිර්මාණය විණි. කෙසේ නමුත් අයිස් තලාවන් නිසා මුහුදු ජල මට්ටමේ නැගීම කාලයත් සමඟ එක සමාන නොවූ අතර උණුසුම් කාලවලදී මුහුදු මට්ටම ක්ෂණිකවද, ශීත කාලවලදී ජල මට්ටමේ නැගීම පැවතීම හෝ තාවකාලිකව පහත වැටීම ඇති විය. මුහුදු ජල මට්ටමේ නැගීම් පිළිබඳව මොසැම්බික්, පර්සියන් බොක්ක, ඉන්දියාව හා ශ්‍රී ලංකාවේ බටහිර හා දකුණුදිග වෙරළට අදාළව හොලෝසීන කාලයේ ඇති මුහුදු ජල මට්ටමේ වෙනස්කම් පිළිබිඹු කරන වක්‍ර මගින් එම වෙනස්වීම් පිළිබඳවද සාගරික දූපත්වල වූ විනාශවීම් ගැනද දැනගැනීමට හැක. ප්ලැන්ඩ්‍රියන් මුහුදු ගැල්ම මගින් ශිලාජනනය වූ තිරුවාන හා ජෛවීය කාබනික අවසාදිත, පැරණි ගංගා ගැලූ මාර්ගද වේදිත ශේෂ, වනාන්තර, තෙත් බිම් සහිත ශ්‍රී ලංකාවේ පහල අඩතැන්න ගිලීමට භාජනය විණි. ඒ අනුව වර්තමාන ශ්‍රී ලංකාවේ හැඩරුව හා වෙරළබඩ තැන්නේ ක්ෂුද්‍ර භූ රූප නිර්මාණය හා පරිණාමය ඇති විණි. මෙලෙස ප්ලැන්ඩ්‍රියන් මුහුදු ගැල්මට කලින් ඇති වූ භූ රූපමය රටාව මුන්දලම කලපුව හරහා දිවෙන පැතිකඩක් තුළින් හඳුනා ගැනීම මෙම අධ්‍යයනයේ අරමුණ වේ.

Palaeoenvironmental evidence in northwest Sri Lanka: Evidence from Mundal Lake and its environs

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Abstract: *During the Last Glacial Maximum (LGM), between 30,000 and 19,000 years ago, about 50 million cubic kilometres of ice that melted from land-based ice sheets, have raised global sea level by 130-180 metres. During the LGM Sri Lanka's landmass was larger than the present time, as it extended to100 fathom line (180m) below the present coastline identified as the "submerged peneplain". The name "Flandrian Transgression (FTG)" has been applied to the current sea level rise affecting the coastal regions around the globe, which began approximately 19,000-18,000 years ago. This rise in sea level was directly related to the melting of the continental polar and mountain piedmont glaciers forming present* *continental shelves in tropical and subtropical regions. However, the rate of melting and proportional sea level rise was not constant through time, and sea level rose quickly during warm periods, but stopped or even temporarily fell during cold periods. The few sea-level curves available indicate that slight emergence predominated during the late Holocene along the coasts of Mozambique, on the southern shores of the Persian Gulf, west India and west and south Sri Lanka, whereas evidence of emergence is missing in oceanic islands.*

The FTG submerged the lithogenic quartz and biogenic carbonate sediments, former river courses, erosional remnants, scrublands, forests, wetlands etc. of the lowest peneplain, of Sri Lanka. Accordingly, the present configuration of Sri Lanka and micro landforms on the present coastal plain evolved. An approximate landforms configuration that existed in Sri Lanka prior to the FTG is now identifiable in a west-east profile across Mundal Lake.

INTRODUCTION

The flat continental shelf, a straight coastline with wide beaches, berms and sand dunes lies on the western margin of Mundal Lake, while old raised beaches with Red Beds dune ridges are found along its eastern margin. The Mundal Lake and the associated wetlands are significant features lying in between these two landform areas. Most of these formations have been marked by sea level and climatic fluctuations, evidenced in micro morphology as well as in regional stratigraphic sequences. This paper attempts to presents an assessment of sequential palaeoenvironmental changes during the Late Pleistocene Epoch in the west coast of Sri Lanka focusing on Mundal Lake and its environs.

It is observed that low-lying ridges, troughs and different levels of marine terraces between the continental slope and present coastlines in tropical coasts including Sri Lanka have been formed during the Late Pleistocene Epoch, especially in the mid-Wisconsin Period (42,000–21,000 B.P) due to the rapid rise of sea-level (the Flandrian Transgression) during c.17,000 BP to Early Holocene (c.11,700 BP). Recent oceanographic investigations along the western continental zone reveal that the development of coralline algae, limestone and calcareous sandstone reefs had occurred on the present submerged peneplain, as well as, on the present coastal zone. It is suggested that the desert-like conditions of the low country in Sri Lanka during the LGM could have been very similar to the Pleistocene aridity in tropical Africa, Australia and Asia.

The western margin of Mundal Lake consists of a straight coastline with wide beaches, berms and sand dunes, and the old raised Red Beds (dune ridges) bound the eastern margin of the lake. Between these two morphological zones the lake and its associated wetlands are a significant feature in the area.

The raised beaches and dune ridge formations in Sri Lanka are few of the distinctive entities of the Quaternary System. They are observed as a clayey sand or loam with a characteristic brick-red colour, and forms low, narrow elongated ridges or domes. Originally, these features were collectively named as ‘Red Earth’. However, the name was later changed to ‘Red Beds’ because it could be confused with the name of the Great Soil Group ‘Reddish Brown Earths’ (Cooray, 2003). In Sri Lanka, these windblown brick-red coloured Red Beds are often found overlying archaeological sites of coastal lowlands that contain human artifacts of early stone-age (Paleolithic) man. According to

Wayland (1919), desert-like conditions prevailed in much of the low country. The thickness of the Red Beds formation varies from place to place, but ranges between 5.0m to 25.0m. It may, however, attain thicknesses of over 30.0m to 35.0m as at Aruakkalu (Wayland, 1919; Coates, 1935; Cooray, 1984 and personal observation 2008). The formation of Red Beds has long been of interest to geologists and pedologists. It has been suggested that the nature, degree and progress of reddening in dune sands can be a useful indicator of its relative age and environmental history (Pye, 1981).

SIGNIFICANCE OF THE STUDY

Sedimentary deposits of Pleistocene and Holocene Epochs have disappeared from most parts of Sri Lanka, particularly along western and southern coasts due to agricultural practices, urban development, demarcation of small land-parcels for housing schemes and other development activities, shrimp farming and implementation of *ad hoc*, and often illegal, land-destructive practices. These practices destroy evidences of palaeogeography, palaeoclimatology, geoarchaeological, and palaeoecology events, denying all attempts at reconstruction.

Recreating past basement conditions and constituents of the morphology of the near-shore, present beaches, wetlands (mangrove swamps, brackish and salt marshes), old raised beaches, lagoonal sediments and sand ridges could help local development activities and preservation of suitable sites for future research work related to sedimentology, biodiversity, palaeontology etc. Consequently, the results would be of critical need to Government Planners and related policy enforcers such as the Ministries of Environment, Water Supply & Drainage, Fisheries and Aquatic Resource Development, Land and Land Development, Local Government & Provincial Councils of the Northwestern Province, and the Urban Development Authority for making informed decisions on regional development issues. Accordingly, the main objective of this study is to examine, the palaeoenvironmental development from the near-shore, present coast (Holocene beaches) across Mundal Lake and associated wetlands, and the old Red Beds ridges to the margin of the Flat Terrain.

STUDY AREA

Mundal Lake and its environs consist of invaluable coastal wetlands with a diversity of physical and human environments. As mentioned previously, the western margin of the Mundal Lake consists of a straight coastline with wide beaches, berms and sand dunes. The old raised Red Beds dune ridges define the eastern margin of the lake. Hence, the study involves the area between latitudes 7° 42’ N and 7° 48’ N longitudes 79° 46" E and 79° 51’ E and the adjoining continental shelf (Figure 1). The water in Mundal Lake is brackish, but it is surrounded by patches of rice paddies, coconut plantations and scrublands. The land has been converted to shrimp farming ponds in preference to paddy fields (Katupotha, 1996).

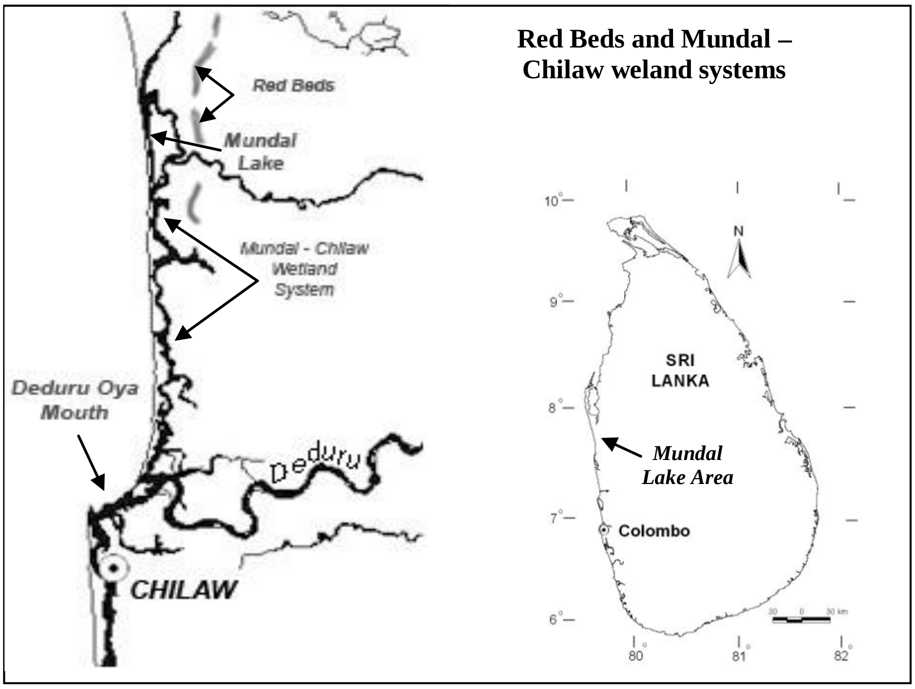


Figure 1. Location Map of the Mundal – Chilaw Coastal Area

The height of the Red Beds ridge, composed mainly of fine sand, varies from place to place with a maximum of 24m above MSL, and the thickness ranges between 5 to 6m. Its width varies from 400m at Kiryankalliya to 1.2 km at Mundalama. A clear terrace, undoubtedly a raised beach is visible near the Maternity Hospital at Kiriyankalli. The small, well rounded quartz grains indicate that the deposit is wind-blown (Cooray, 1987; Katupotha and Fernando, 2011).

Three west-flowing rivers namely, Madurankuli Aru, Kalagamu Oya and Ratambala Oya supply a considerable amount of terrestrial waters during the rainy seasons. The tidal creeks stretch along the narrow corridor and both terrestrial and tidal waters deposit layers of fine silt and mud forming thin tidal flats. The Tide Tables for the past 30-year period indicate that the average tidal amplitude along the west coast is about 80 cm (Katupotha 1988a).

The soil pH value in the area from Ambalaveli to Mundal Lake at different depths varies between 5.40 and 6.85 (NARA, 1994). The clay content of the area is high and varies from 36.00% to 48.80% at six sample points. At the same points, the sand content varies from 38.70% to 60.95% and silt content from 3.03% to 22.85%. Moreover, recorded water temperature, pH, dissolved oxygen and salinity in the lagoon ranged between 26^{o}-33^{o} C; 6.0-8.1; 4.5-9.0 ppm and 5.0-60.0 ppm respectively.

The area falls into the Dry Zone, having two rainy periods and two dry periods. The first season begins around April and peaks during May/June, receiving more rainfall than the second season, which occurs between October and November. These seasonal variations are important as they affect the hydrological characteristics of the area in terms of quantity and quality of the water and transportation as well as deposition of the sediments.

METHODOLOGY

Field observation was the principal technique used to collect field data. The fieldwork originated in 1983 and covered the coastal and near-hinterland area from Kalpitiya in the north to Deduru Oya in the south with special emphasis on geomorphological, environmental and stratigraphic aspects. Some results appear as secondary data (Katupotha 1988a, 2006). Similarly, the stratigraphic sequence of the Red Beds in the area was examined by Katupotha and Fernando (2011). The main constituents, the mineralogy and the physical properties, of this formation were identified using the following measurements/activities: (1) GPS measurements were taken at soil auger boreholes using SporTrak (Magellan), (2) Soil auger boreholes observations were conducted using hand auger, (3) Tube wells were drilled using 20 cm diameter core bit to obtain sub-surface soil, (4) The colour of the soils was described using the Revised Standard Soil Colour Charts (Oyama and Takehara, 1967), (5) Sieve and mineralogical analyses were carried out at the Geological Survey and Mines Bureau (GSMB) laboratories and (6) The identification of micro-relief, drainage patterns and some deposition patterns identified based on 1:50,000 Topographic maps, aerial photographs and Google Earth Image.

RESULTS AND DISCUSSION

The oscillations between glacial and interglacial climatic conditions over the past three million years have been characterized by a transfer of immense amounts of water between two of its largest reservoirs on Earth: the ice sheets and the oceans (Lambeck 2002). The last Glaciation of the Earth known as the Pleistocene Glaciation started around 2.58 Ma in which permanent ice sheets were established in the Northern Hemisphere (ICS 2009). Fluctuating ice sheets have formed, covering thousands of square kilometres including areas of Antarctica, Greenland, most of Canada, a large portion of the northern United States, Scandinavia and Eurasia between c.95,000 and c.20,000 yrs BP. Thus, the Pleistocene ice coverage extended as far south as approximately 38 degrees latitude in the mid-continent, and involved several major episodes of global cooling. Since the latest of these oscillations, the Last Glacial Maximum (between about 30,000 and 19,000 years ago), about 50 million cubic kilometres of ice has melted from the land-based ice sheets, raising global sea level by 130 metres (Lambeck at el, 2002). Such rapid glacio-eustatic changes in sea level are part of a complex pattern of interactions between the atmosphere, oceans, ice sheets and solid earth, all of which have different response timescales.

The Island of Sri Lanka has been subjected to at least four major upliftments during the Jurassic, Miocene, Pliocene and Pleistocene times. These processes broke up its sedimentary beds and altered the topography of Sri Lanka. As a result, the earlier sedimentary deposits have disappeared from a large part of Sri Lanka. However, the youngest, namely the Pleistocene one, have survived these changes, and are best in evidence in the strike valleys of the province of Sabaragamuwa (Deraniyagala, 1958).

Records from many tropical coasts show that the period prior to c.42,000 yr BP was characterized by warm climatic conditions similar to the present. This was followed by a change to cold dry conditions from 42,000 to 30,000 yr BP and cold and moist conditions from 30,000 to 21,000 yr BP. A desert-like dry climatic condition in Sri Lanka has been mentioned by Wayland (1919), which occurred in much of the low country and can be correlated with the above age sequences from 42,000 to 21,000 yr BP. Temperatures during the latter period leading to the Last Glacial Maximum (LGM) were probably 2 to 4.1°C lower and the sea level was c.130 metres lower than at present (Lambeck at el, 2002). Between c.21,000 and 12,500 yr BP, East Africa's environment was generally cool, punctuated by two significant episodes of prolonged desiccation (Kiage and Lue, 2006). This may be similar to that of formation of the present coastline around Sri Lanka due to the rapid rise of sea-level since c.17,000 yr BP to Early Holocene (c.11,700 yr BP), which is called the Post Glacial Transgression (PTG). Ice core records from East Africa document two significant and abrupt drought events in the East Africa region, one at c.8300 yr BP and the other at 5200 yr BP. The onset of a longer and more extensive desiccation period commencing c.4000 yr BP was registered at almost all sites (Kiage and Lue, 2006).

Recently obtained C^{14} dates of geologic samples from the west, south and east coasts of Sri Lanka by Katupotha (1988a, 1988b and 2011) correlates with Kiage and Lue's (2006) findings with the episodes of sea level fluctuations. Accordingly, the mid Holocene (6,240 - 5,130 yr BP) sea-level was at least 1.5-2.0m or more above that of the present level, but did not exceed 5.0m. Further, these C^{14} dates show that the sea-level around 4,700 yr BP was slightly below the present position, and slightly higher sea levels can be identified around 4,390 - 3,930 yr BP and 3,280 - 2,270 yr BPthis. In between these high sea level episodes there appeared 3.0-5.0m lower sea levels (Katupotha, 1988b & 1988c). East African events can at times be correlated with events in South Indian and other islands in the Indian Ocean as well as Sri Lanka (Katupotha, 1990). Due to the mid-Holocene high sea level, the sea water inundated the inland up to the 5.0m contour line but this level adequated to submerge former coastal forests and wetlands of the flat continental shelf, and drainage basins forming headland-bay-beaches.

The Continental Shelf (CS) to the west of Mundal Lake is flat, shallower and has no significant surface relief. Rock outcrops, coral reef, submerged sandstone reefs and former river courses are significant features on this CS. Its width varies from 5.0 to 40.0 km with an average depth of 70.0m below MSL (Cooray, 1984; Swan, 1983). The bathymetric charts of National Aquatic Resources Research & Development Agency (NARA 1989) indicate that the width of the CS near Kalpitiya is approximately 5 km, at Mundal Lake it is 15 km, at the Deduru Oya mouth area it is 16 km and close to the Kelani River mouth it is about 26 km (Figure 2). The outer margin of this CS beginning at a water depth of about 25m, is a straight line defining a north-south trending escarpment with a concaved slope down to 1,800m.

From its edge to about 200m depth, it CS is prominently furrowed. This depth level (20-30m to 200m) of the escarpment of the present CS around Sri Lanka, can be correlated with the 100 fathom line (180m approx.) margin of the submerged plateau described by Somerville (1907) and Deraniyagala (1958). This may be a result of fluctuation of water levels followed by climatic cycles especially from 42,000 yr BP towards the PTG. Wickramaratne et al (1988) reported that the western CS consists predominately of sand sized particles, 2 mm to 0.067 mm in diameter, composed of lithogenic quartz and biogenic carbonates. Most shelf sediments had been deposited in shallow water during the last low stand of sea-level than at present but with the rising sea level up to Early Holocene.

From the present beach to the east of Mundal Lake, a well developed wetlands system is observed. The Mundal Lake is the main water body of this system which covers an area of 20.0 sq. km with a depth range of 0.75 to 2.0m. It is approximately 12.0 km long and 1.3 km wide. The morphological sequence from the coastline to the east consists of various formations such as beach berms, low sand dunes, ridges and runnels, channel ways, high dunes, and mud flats with tidal creeks. In addition, mud flats, salt marshes, the Dutch Canal, ridges of Red Beds, alluvial valley plain with terrace gravel and basal ferruginous gravel beds extend eastwards beyond the lake (Figure 3). However, from the Puttalam Lagoon to the Deduru Oya outfall, it appears as a narrow corridor. All these features rest on the friable sandstone and Miocene limestone, which extend from the Kalpitiya Peninsula, and the Muthupantiya lagoon towards the Deduru Oya outfall (Katupotha & Dias, 2002). The Aruwakkalu bed dips from surface level towards Deduru Oya outfall at about 30m depth. Similar trends extend from Aruwakkalu area to the Kalpitiya Peninsula and towards the Arabian Sea.

Mud and clay deposits of the Mundal Lake area extends to lagoonal edges. Hand augered borehole soil samples reveal pale gray to bluish gray clay covered with fine to medium grained sand (Katupotha 1985; Cooray and Katupotha, 1991; Katupotha and Fernando 2011). Five hand auger boreholes (BH) at Muthupantiya Lagoon (7^o 42’ 39” N and 79^o 48’ 00” E about 5 km south of Mundal Lake), reveal that lagoonal sediments extend 6.0m to 11.0m. The near-surface horizons of BH-5 were mainly organic clay, peat and plastic clays terminating in sandstone at a depth of 13.60m. All these sequential depositions can be correlated with Late Holocene to Late Pleistocene Epochs. The sandstone itself appears fairly dense. It is found mixed with a layer of mudstone or sandstone, forming a consolidated horizon that terminated at 16.50 m. It was noted that a series of thin unconsolidated coarse sand (presumably marine sand) and fluvial worked gravels layers were encountered down to a depth of about 20m. Hard limestone was cored below 20m, where the core appeared very similar to the northwestern fossiliferous Miocene limestone. Below 21m the limestone become partially weathered and mixed with calcareous clay [Foundation & Waterwell Engineering (Pvt) Ltd, 1994].

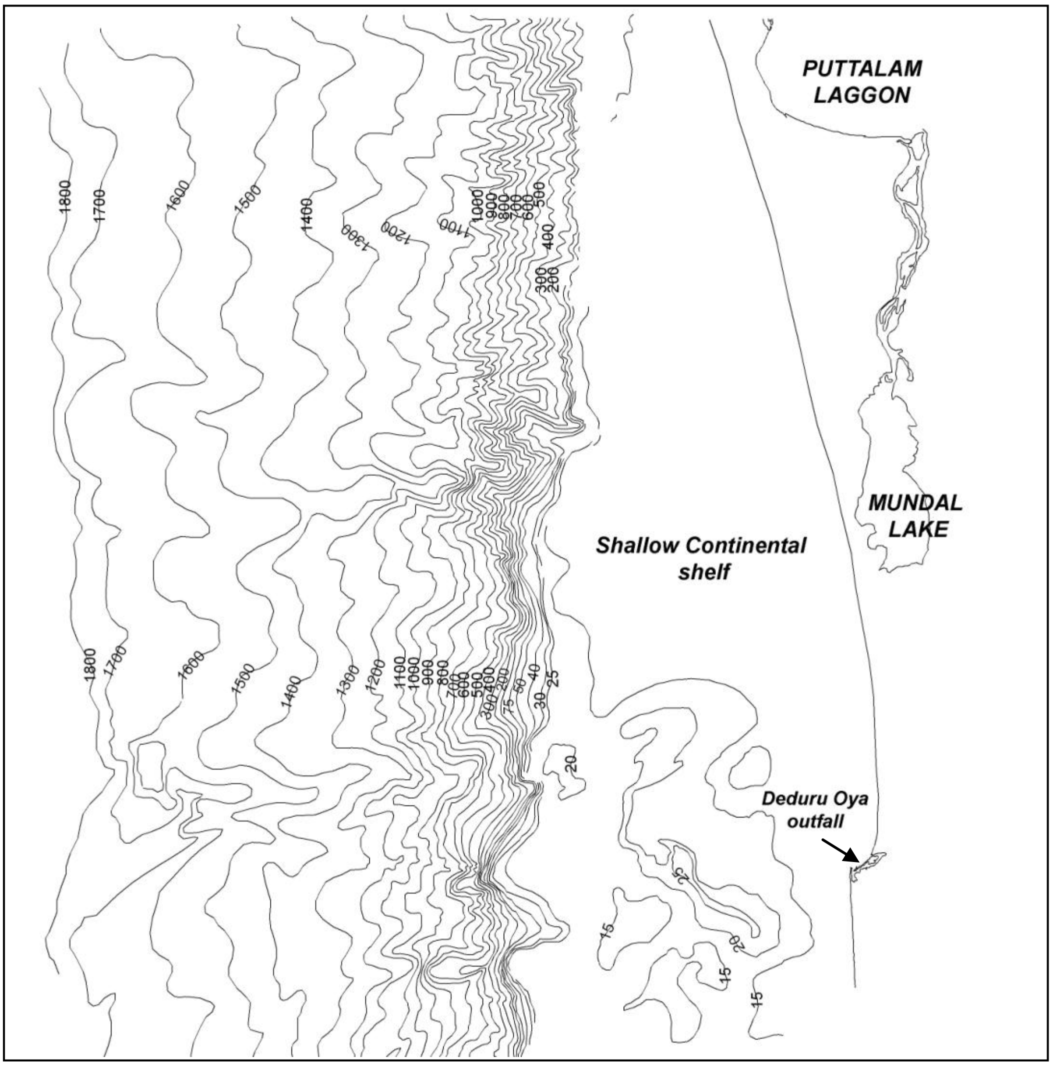
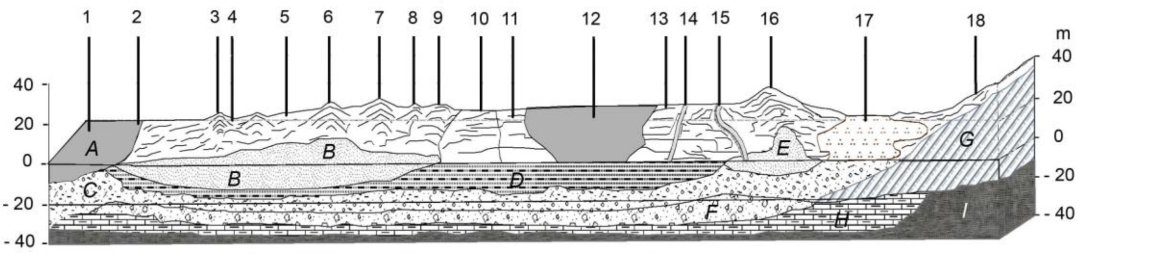


Figure 2. Bathymetry between Puttalam Lagoon and Deduru Oya outfall reveals a palaeo coastline (around 150 to -180m below present mean sea-level). This sharp edge can be correlated with the LGM, that occurred about 19,000–18,000 yr BP (Bathymetry from NARA, 1989).



A = Near-shore Zone (submerged), B = Dune sand (Holocene), C = Coarse sand with gravel, D = Lagoonal mud, E = Red Beds (Late Pleistocene), F= Well rounded gravel and pebble layer, G= Transported and/or weathered deposits mantled by wind blown sand, H = well-compacted precipitated colloidal silicaceous stratum (Late Miocene ?) and I = Weathered bedrock.

1 = Shallow near-shore zone, 2 = Coast line, 3 = Beach berms , 4&5 = Runnels, 6 – 9 = High dunes, 10&11 = Mud/Tidal flats, 12 = Mundal Lake, 13 = Mud/Tidal flats (inland), 14 = Dutch Canal, 15 = Chilaw – Puttalam Road, 16 = Red Bed ridge, 17 = Flood plain (paddy fieds) and 18 = Low hills and rises (undulating terrain).

Figure 3. Extension of micro landforms from near-shore zone towards inland (across Mundal Lake and its environs). Source: CEA, 1994; modified by Katupotha 2002.

To the east of Mundal Lake, the Red Beds ridge is a very significant feature. A tube-well, located to the north from the study area, at coordinates 07^{o} 54'10" N and 79^{o} 49'20"E, drilled down to 23m reveal the following sedimentary sequence (Katupotha and Fernando, 2011). The brownish black top soil layer with fine clay nearly 1m thick, is indicative of poorly drained marshy depositional environment. The level of this marshy bed can be correlated with the same bed of the Mundal Lake. Underneath this layer is a yellowish, fine to coarse sandy layer with some quartz gravel extending down to 17m from the surface. The sand had been piled up by diversions of drainage due to palaeo climate change. Beneath this sand layer is a well-compacted, precipitated colloidal silica bed interspersed with shells. Its thickness is deduced to be more than 6m as the tube-well has bottomed within the bed.

The sands of the Red Bed ridges are wind blown in origin and they have been deposited on an old beach. This old beach is a degraded coastal feature. It represents a former barrier beach or barrier island, backed by sand dunes (Katupotha 1985). The Red Beds formation on these beaches has been described by Wayland (1919). Samples from two tube wells (located TW-1 at co-ordinates 7° 47' 30" N and 79° 49' 51" E and drilled down to 12.0m and TW-2 at co-ordinates 7° 47' 30" N, and 79° 49' 50" E drilled down to 11.0m examined to ascertain stratigraphic sequences, colour and constituents, grain sizes and mineralogical analyses and results published by Katupotha and Fernando (2011). At both tube well locations, fine sands extend to 7 to 8m depth from surface level. The colour of these sands varies from reddish brown fine sand or to reddish brown fine sand, either to brown fine sand, orange fine sand mottled with pale brownish gray fine sand to pale gray fine sand at that level. Grain size analyses indicate a fine sand content of 75% to 86% and gravel content less than 2.6%. Mineralogical analysis was also conducted at the depth of 0.61m and 2.13m in tube well 2. Majority of ilmenite grains are sub-rounded. Garnets are sharply angular. Sillimanite is angular to sub-angular. Although, spinels have a 7.5-8.0 hardness, they are well rounded to sub-angular and large grains are well rounded. Hornblendes are angular. Rutile and zircon are sub-angular and sub-rounded. At a depth of 10.97m, ilmenite is sub-rounded to sub-angular in shape. Spinel, monazite, leucoxene and tourmaline are mostly rounded. Also, non-magnetic minerals such as sillimanite and rutile are sub-angular. Apart from these minerals, gold is available as trace, but it has no economic value at this depth and quantity. The physical behaviour and properties of these minerals show that they are windblown in origin and worn-out during the transportation process.

A dug well located to the east of the Red Beds ridge (at co-ordinates 07^{o} 47'50" N and 79^{o} 50'16" E) shows fine to medium sand with clay layers extending down to about 1.8m, and the soils are well compacted and mixed with highly weathered ferruginous gravel. These layers are 2.0 to 4.0 cm thick and show red colour due to oxidization. The soil composition points to a fluvial origin. Following this layer is one of coarse clayey sand that extends to a depth of 8m. These clayey sand profiles are relict completely decomposed bedrock, beyond which, the decomposing bed rock is encountered at about 9m depth. The weathered bedrock is rich in orthoclase feldspar and very coarse quartz sand.

CONCLUSION

Since Post Glacial Transgression, owing to the retreat of ice sheets, the sea level has risen about 130 metres. Measurements of such sea level fluctuations are difficult because of the influence of complex tectonic and isostatic upliftment and land subsidence. However, these changes have affected coastal ecosystems as well as the socio-economic conditions of coastal dwellers during the Late Plestocene and Holocene Epochs. A continental shelf in Sri Lanka is generally a shallow, flat and submerged portion of a land mass, extending to a point of steep descent in the ocean floor. Former coastal and fluvial landforms were once drowned due to sea-level fluctuations. Accordingly, in Late Pleistocene and in the recent past, sandstone, coral and beach rock reefs in the near shore zone; inland coral and shell deposits in palaeo headland bay beaches have been used to discuss sea level fluctuations in Sri Lanka. Bathymetric charts also have been very significant in the study of submerged relief of a continental shelf. Based on all these, a sequential landforms development such as a flat continental shelf with moderate relief, a straight coastline with wide beaches, berms and sand dunes in the present coastal zone, Mundal Lake and associated wetlands (mangrove swamps, brackish and salt water marshes and old raised beaches with Red Beds dune ridges can be identified from sea to landwards. Stratigraphic sequences, constituent material and age determinations also have close relationships with landforms in the study area.

ACKNOWLEDGMENTS

My profound thanks go to Mr. Nimal Ranasinghe, former Director, Geological Survey Department of Sri Lanka for his pertinent suggestions and diligent editing of the manuscript. I am deeply grateful to Ms. Samanmalee Fernando, Department of Geography, University of Sri Jayewardenepura for redrawing the figures. This study has been completed based on the Research and Development Allowance paid by University (Management Services Circular No: 44 and the Letter of UGC/C/PS/7 - dated 14 March, 2011).

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