Mapping of Landforms in the South-West Coast of Sri Lanka

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ABSTRACT

The natural environment of the South-west coast of Sri Lanka has been created various kinds of coastal landforms which are useful to establish the specific socio-economic activities and they also contribute to preserve coastal landscape and environment. This study was undertaken to map the landforms and their changes influenced by various types of coastal agents. Through the interpretation of aerial photographs and satellite images, geomorphologic maps were constructed and identified coastal landforms were elaborated by means of field checking. They were classified into six categories as marine, fluvial, fluvio-marine, denudational, structural and manmade on the basis of former and recent coastal processes. Beaches and allied features such as, beach cusp, sand spits, sand barriers, raised beach, barriers, headlands, sea cliffs, beachrocks, corals, bay pocket beach and coastal plain are the prominent geomorphological features which are distributed in the area. Among these coastal features, raised beaches, former barriers, beachrocks, dead coral reefs and former lagoons etc. are the mostly distributed landforms originated by the Mid-Holocene marine transgression. Mapping of these coastal landforms, can be used for many environmental projects and planning.

KEYWORDS: *landforms, aerial photographs, satellite images, geomorphologic maps, interpretation.*

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1. INTRODUCTION

In many coastal management situations, the most useful contribution of the geomorphologist is the provision of a geomorphological map. This is particularly true where information is required concerning the distribution of landforms, soils and rock materials or features created by surface processes. Such mapping has been used to considerable advantage on many engineering, planning and land management projects.

The natural landscape of the South-west coast of Sri Lanka has been created various kinds of coastal landforms such as beach, sand bar, lagoon and estuary, beach rocks, bays, headlands, islets, islands mangroves and corals. These features are useful to establish the specific socio-economic activities. Also they contribute to preserve coastal scenery and environment. Geomorphological maps are important to identify the above mentioned coastal landforms and their distribution. On the other hand, detailed mapping of specific processes, materials and landforms, as in geomorphological mapping may be essential for many projects. In the last decades, geomorphological maps with details of landforms have been included to environmental engineering and geological mapping. They also have a role to play in terrain mapping for Environmental Impact Assessment (EIA) and scenic evaluation. The landform mapping is useful in monitoring shoreline changes historically and at present. Charting shoreline changes to produce sequences of coastal evolution might appear to be straight forward, especially where historical sources are abundant.

Although the geomorphologic maps can be used as a basic tool in the classification of land suitability, soil survey, road constructions and coastal recourse management, the usage of them is very rare in Sri Lanka as compared to other countries in the world. Therefore, in this study, special attention has been paid to mapping coastal landforms into geomorphologic maps in the South-west Coast of Sri Lanka.

2. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to determine the geomorphological units and their distribution pattern, mapping of landforms and allied features in the South-west coast of Sri Lanka. In order to fulfill this aim the study attempts to meet the following objectives;

1. Identification of coastal landforms and their allied features
2. Investigation of geographical factors in differentiation of coastal features
3. Investigation of materials to determine the former coastal processe

3. LOCATION OF THE STUDY SITE

The site of this study was conducted in the South-west Coast of Sri Lanka stretching from Ambalangoda to Kalutara river outfall which covers mean sea level in the west and base of the mountain of landward in the east. It is a narrow coastal belt and located between 6°, 35' north and 79°, 58'-80°, 3' east covering approximately of 45km from south to north (Fig.01). It represent in Galle and Kalutara districts. The elevation is not more than 30m. The terrain in the west is composed of gently seaward sloping surfaces and smooth ridges, where as steeper slope and few escarpment dominates in the eastern part of the area.

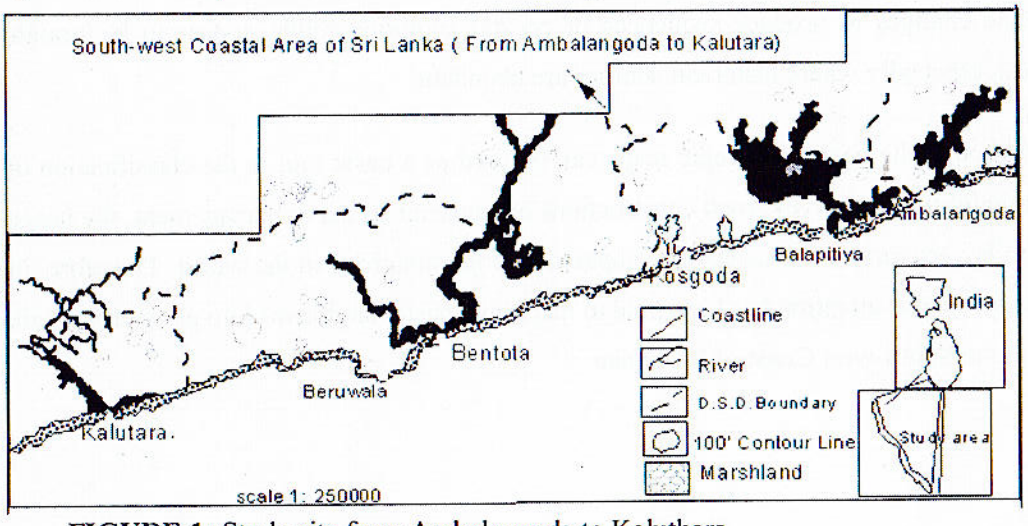

FIGURE 1: Study site from Ambalangoda to Kaluthara

This coastal area directly faces the South-west monsoons which prevail during the May-October period. Because of the high wind velocity of the monsoon, rough seas are widespread leading to easterly or westerly oriented long shore currents which severely erode the beaches. The long shore drift may vary towards the south or east the changing direction of waves. The inter monsoon period is clearly characterized by eastern or northern swells which normally.

4. METHODS OF DATA COLLECTION AND ANALYSIS

This study was undertaken to identify the landforms and there changes influenced by various types of coastal agents such as sea waves, rivers, winds and denudation. The study was carried out on the basis of the interpretation of aerial photographs and satellite images in 1956, 1987 and 2005 focusing on photographic characteristics such as tone, pattern, mottling, texture and shape of coastal features (Van Zuidam, 1983). Through the interpretation of aerial photographs, tentative geomorphologic maps were constructed to identify the coastal landforms, their distribution and changes and, identified coastal landforms were classified into six categories on the basis of former and recent coastal processes. They are marine, fluvial, fluvio-marine, denudational, Structural and manmade factors. The tentative maps compiled by the interpretation of aerial photographs and satellite images were elaborated by means of field checking and they were compiled into final geomorphologic maps. The landforms and geomorphological features were introduced using ITC system and following pre studies (Swan, 1967, Weerakkody, 1987). In order to identify the former geomorphologic features, some fossilized marine materials such as finger coral debris, beach rocks, and soil samples were collected as representing the all area. Further, laboratory testing on the collected sediment samples was being carried out to identify the landforms originated by the Mid-Holocene marine transgression. It has described under the section 4.1.

Materials

The significant sedimentary deposits since the Precambrian recorded as sandstones and mudstones crop out prominently at several places on the area as well as any other parts of the country. Most of them originated by the first major marine transgression over the western and northwestern parts of the Island, deposited largely the fossilliferious sedimentary carbonate rocks. This region of the Island was affected by several minor changes of the sea level since Pleiostocene and Holocene Epoch in the quaternary era (Cooray,1984). The miner sea level changes during the greater part of these periods led to deposition of few sedimentary deposits of marine origin and a large amount of terrestrial deposits derived from the land by the action of rain surface run-off. These deposits occurring as partly consolidated on unconsolidated gravel, sand, silt and clay are distributed extensively on beaches, coastal flood plains, lagoons and estuaries. Most of these deposits overlie the Jurassic and Miocene beds as also partly the lateritic capping of the crystalline basement rocks.

Geomorphologically, these quaternary sediments are divided into two broad groups older and younger. Both of groups are recognizable by their characteristic sediment composition. They can be found covering the large part of the island especially on the northern and northwestern coastal areas. Most of the near shore sediments forming barriers, Bars, spits and sand dunes, lagoons and estuaries deposits in these low lying areas (Fig 03).

Sedimentary deposits of limestone, carbonaceous shale and sandstones belonging to the Holocene age are distributed in this area and most of them smaller scattered patches of limestone. (Katupotha, 1988a,1988b and Weerakkody, 1985-1990)

They were well distributed areas on Seenigama, Akurala, Telwatta, Beruwala and Induruwa. Former landforms such as lagoons, former barrier, raished beaches induced by sea level changes can be identified using these deposits. Therefore, these materials are evidence for the sea level changes and former land formation.

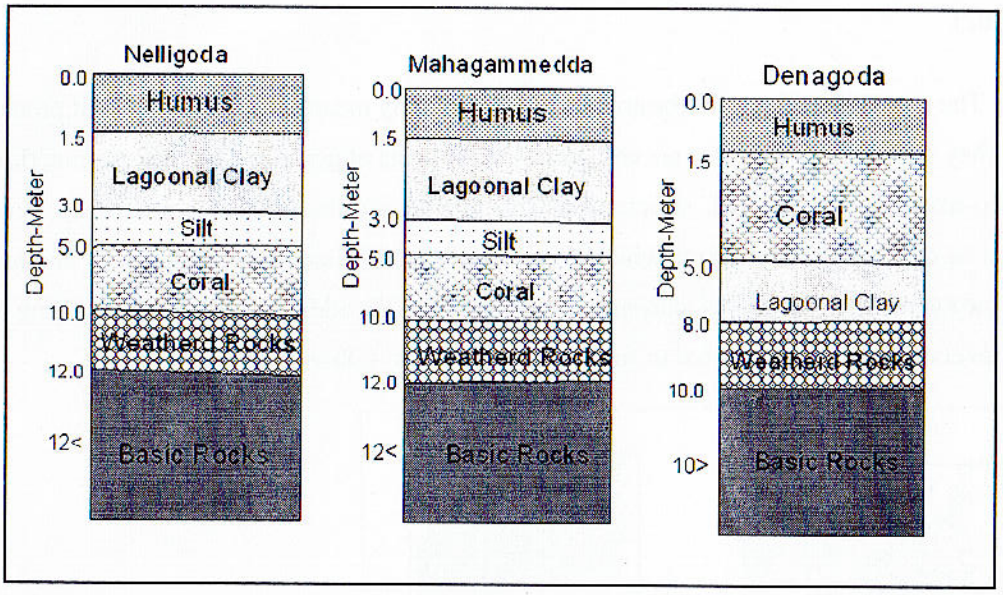

FIGURE 2: Sedimentary Deposits in the Study area

5. FACTORS IN DIFFERENTIATION OF COASTAL FEATURES

The landscape of South-west coast of Sri Lanka exhibit considerable diversity. Some coastal areas are characterized by bays, headlands, beach rocks, rock outcrops and sandy beaches. Most of shores are created by raised beaches (BR), lagoons (L), fluvial deposits and denudation. The area consist of diverse landforms assemblages. These have been produced through the interaction of several variables over different time scale. Some of produced over shorter and others over longer time. Many coastal phenomena developed with reference to sea level changes and it responds to wind, storm and changes of atmospheric pressure and temperature. More important are the tides. Coastline alterations result from the penetration of the sea landward of high water mark as with coastal erosion and from deposition which causes the coastline to advance (Cooke, and Doornkamp 1990). According to that, spatial variations of coastal landforms of the study area are related to several factors of the genesis geological setting relative chronology, materials etc. The results of the geomorphological survey based

on above factors were compiled into a map showing landforms and geomorphological features (fig 02).

The coastal landforms of the area were identified by means of various kinds of processes and they were categorized into six categories on the basis of genesis. They are marine, fluvial, fluvio-marine, denudational, structural and manmade activities. Marine process is a major agent to develop the landforms which were mostly distributed and it consists of number of marine agents such as, waves, currents, winds and tides. In addition, short term and long term sea level changes have affected to form coastal features. (Dharmasena, 1997)

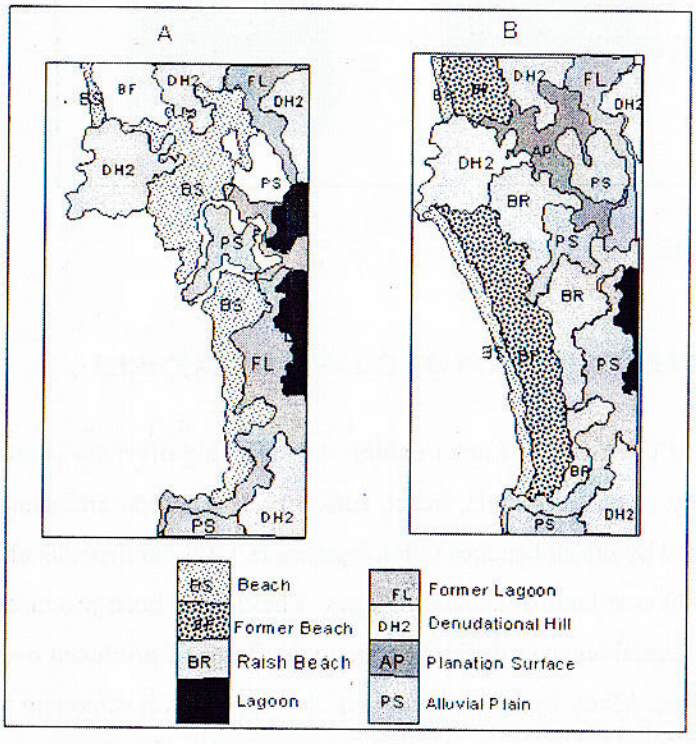

FIGURE 3: Distribution of landforms from Ahungalla to Balapitiya

A-Former bay beach developed with the Holocene sea level rise

B-Development of barrier beaches with the Holocene sea level changes

Waves are the most important agent of these processes. When wind blows across water there is a transfer of energy from the former to the later and the interface is thrown into waves (Swan, 1983). Waves are characterized by their form; dimensions and frequency of importance are wave length, the distance between successive crest and frequency, commonly given as wave period, the interval in second between successive waves (Swan, 1983).

These features are variable from place to place depending essentially upon the intensity and direction of wind coastal materials and degrees of resistance to wave action. During the period of South-west monsoon wind velocities are large enough to begin the movement of sediment, first in oscillatory factions and later with a distinct component in the showered direction. The energy of the waves of the study area is moderate when comparisons are made with other regions.

Tides are response of the ocean to gravitational attraction of the sun and moon. The moon, being closer to the earth than the sun is, exerts the greater influence of the two. Because of the earth rotation on its axis, the movement of the moon around the earth and earth around the sun, the tides are generated (Swan, 1967, 1983). Tides along the study area vary between 0.6m and 0.25m during spring and around 0.25m during neap tides having the average range at about 0.35m.

Ocean currents are of many types at the largest scale there are those related to the regional oceanic circulation, which dominate waters belong the continental shelf. In the study area during the period of the south west monsoon, large scale ocean circulation currents play an important role equally along the total stretch of the coastline.

Fluvial and fluvio-marine are the dominant processes in creating landforms in addition to marine process. Rivers are the main source of formation of landforms and sediment materials to the coast. There are three river systems, four major lagoons and swamps in the area. Most of them play an important role to origination of landforms not only in the socio-economic activity but also to fresh water supply to domestic, agricultural or industrial needs. The amount of materials brought through the Madampe, Ramdobe, Kalu Ganga and Bentota

Ganga deposited to form to landforms. Lagoons (L) and flood plains (Fp) are originated as a result of alluvial plains.

The denudation of the earth take place when the weathered material transported by water, wind and wave action, and deposits in lowlands (Bird, 1976). Denudation also takes place by mass wasting. In addition, land use and other human activities supporting to the denudation. The landforms of denudational origin consist of denudational hills (DH), planation surfaces (PS) and rock outcrops (RO). Human activities have effect on the changes of landforms in the coastal area similar to natural processes. The changes made by engineering constructions are prominent among human activities. Headlands (HL) and Revertments (RT) and Groynes (G) are some examples of structural and manmade landforms.

6. GEOMORPHOLOGICAL FEATURES OF THE SAMPLE COASTAL AREA

The South-west coast of Sri Lanka shows two distinct physical features of hill country and low country with two low lying coastal plains. The coastal plain is the main physical feature which is stretching parallel to the coastline from south to north and different kinds of landforms and river systems are distributed along the coastline.

The coastal feathers observed in the study area are largely due to simultaneous wave braking and surf action leading to differential erosion. The other submarine process which is largely dependent on the aberrational process builds up most of the accumulation forms by the action of waves and currents. However, a greater part of the west coast had undergone pronounced shoreline changes in the recent geologic past indicating submergence of the coast at many places (United Nations, 1985). Bays on the south indicate partial submergence of the coast. The gentle areas composed of hard and resistant rocks are the prominent erosion features and these areas are prominently indicated by the cliff faces in the backshore.

Geomorphologically, coastal landforms can be divided into two generic types. They are erosional and depositional. These types of landforms are originated by means of several processes like fluvial, fluvio-marine, marine, denudational, structural and manmade. Beaches

and allied features such as, beach cusp (BP), sand spits (SS), sand barriers (SB), raised beach (RB), former barriers (FB), beachrocks (BR), corals (C), bay (B), pocket beach (PB) and coastal plain CP) are the prominent geomorphological features which are distributed in the area originated by marine process. They are mostly extended parallel to the coastline from south to north. It is 60% of total landforms in the study area.

There are four river systems in the area and most of them flow into the sea creating some fluvial and fluvio-marine landforms. Alluvial plain (AP), flood plain (FP), marshland (MR), lagoons (L) and estuaries (ES), fluvio-marine plains (FMP) are the main featuers originated by fluvial and fluvio-marine processes. That is about 30% of the areas of total landforms.

The coastal features of denudational and structural origin, consists of Headlands (HL), sea cliffs (SC), denudational hills (DH), planation surfaces (PS) and rock outcrops (RO). Most of them are mostly extended towards the land area from the coastline. In addition, manmade features broadly extended in this area. Revertments and groynes are the some examples of landforms which are created through the biogenic and manmade process. Among these coastal features, raised beaches, former barriers, beachrocks, dead coral reefs and former lagoons etc. are the mostly distributed landforms originated by the Mid-Holocene marine transgression.

4. CONCLUSIONS

Coastal landforms of the study area were compiled into geomorphological maps in order to identify the variation of coastal features. They were identified using aerial photographs and field surveying and a classification of landforms included in the legend of the map is based on the genesis. Accordingly, six categories of landforms were investigated and mapped as marine, fluvial, fluvio-marine, denudational, structural and manmade origin. Beaches and allied features such as, beach cusp, sand spits, sand barriers, raised beach, former barriers, beachrocks, corals, bay, pocket beach and coastal plain are the prominent geomorphological features which are distributed in the area originated by marine process. They are mostly extended parallel to the coastline from south to north. It is 60% of total landforms in the study

area. Among these coastal features, raised beaches, former barriers, beachrocks, dead coral reefs and former lagoons etc. are the mostly distributed landforms originated by the Mid-Holocene marine transgression. Further classification of each category of landforms was based on the location and relative chronology. Accordingly, thirty five landforms were identified and included in the map. Since the landforms are demarcated with boundaries and geomorphologic details, this would be used as a based map for other surveys into terrain. On the other hand, detailed mapping of specific processes, materials and landforms, as in geomorphologic mapping can be used for many environmental projects and planning.

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