

**Climate Change and Anthropogenic Activities :
Impact on Coastal Development and Management**

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Anthropogenic Activities on Coastal Sand Dunes: Evidence From Panama to Sangamankanda Coastal Stretch, Sri Lanka

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Introduction

Progressively, dunes can grow, shrink, or move in the direction of prevailing winds, and dunes can be created and destroyed by either nature or humans. Coastal dune and lagoon system from Panama (6°44'39"N & 81°48'32"E) to Sangamankanda (7°1'22"N & 81°52'35"E) selected as a study area for the discussion of anthropogenic activities and their impact. The term anthropogenic designates an effect or object resulting from human activity. Thus, this paper examines the human activities and impacts on biophysical environments, biodiversity, and other resources of the Panama dune to Sangamankanda dunes stretch in Ampara District, Sri Lanka.

Methodology

For this study the primary and secondary data collected from individuals and the Department of Coast Conservation and Coastal Resources Management (DCC&CRM) from 28 February, 1st to 2nd March 2015 and from August to October, 2015. And also 1:50,000 topographic sheets 71&72 and 78 and Google Images also used. In order to explore primary data, the study was subdivided into key tasks by relevant professionals of team the DCC&CRM: (a) Assessment on dune geomorphology; (b) assessment of biophysical characteristics of coastal dune ecosystems; and (c) Social assessment. Preparation of a set of maps using GIS and RS and information database of the coastal habitats in the study coastal zone was undertaken by the team.

Results/Findings

Coastal geomorphology is the study of the morphological development and evolution of the coast as it acts under the influence of winds, waves, currents, tide levels and sea-level changes (Leatherman et al., 1990). It deals with the evolution of coastal landforms (such as cliffs, rocky shores, beaches, dunes, estuaries, lagoons and deltas), the processes at work on them and the changes taking place (Bird, 2008), and coastal geology is concerned with the rock formations, structures and sediments that are found in coastal stretches. The study area from Panama to Sangamankanda is a coastal stretch of accumulation and erosion actions occur due to the influence of above mentioned physical parameters.

The study coastal stretch differs from that of Mannar Island and other coastal stretches in Sri Lanka (Katupotha 2015 & 2016) due to the wider depositional tracts, lagoons and coastal lakes. Some lagoons carry beaches on the east coast, e.g. Pottuvil-Ureni, Arugam, Panama

etc. Beach rock underlies the barrier between Arugam Lagoon and Arugam Bay. Two submarine ridges, Komariya Ridge and Egerlya Patch, which arise within 5-6m and 13-15m below mean sea level (MSL) respectively, lie skew to the coastline and mark stages in the post-glacial transgression here (Swan, 1983). Morphological development of the study area shows a series of landforms mainly; (a) Contemporary beach and coastline; (b) High dunes and incipient dunes; (c) Headland-bay beaches; (d) Holocene beach ridges with runnels; (e) Waterways (channels), water holes, river mouths and lagoons.

Contemporary beach and coastline in the study are forming and changing due to prevailing monsoon wind pattern. During the 1st Inter-monsoon (March to April) and southwest monsoon period (May to September) accumulation of sands can be seen along the coast, and sometimes the beach is nearly 30m wide. During the northeast monsoon period (October to December) and the 2nd Inter-monsoon (January to February) severe erosion is obvious, and coastal advancing time, the sandy beach becomes 50-75m wide.

Incipient foredunes develop at the rear of the backshore active environments and generally comprise as shore-parallel, convex, symmetrical to asymmetrical dune ridges. Similarly, such foredunes develop as sand is trapped by pioneer plant species between the line of high tide and the established foredune. The evolution, ecological processes, aerodynamics, and morphology of incipient foredunes on the upper beach are significant feature along the coast this coastal stretch (Photos 1.5 to 1.8). From Panama to Sangamankanda coast, the main headlands are located at Pottuvil, Arugam and Sastrawela. There is an old long barrier bar has been developed between Pottuvil Town and the headland of Ureni Lagoon). The rocky outcrops at the southern end of the lagoon mouth are highly weathered and some boulders can be identified as erratic boulders. Sastrawela headland also appears as highly weathered rocky outcrop. Both sides of each headland have very attractive crescent shape beaches, and these are very useful for the geotourism.



Photos 1.1 to 1.4. Wide sandy contemporary beaches along the coastal stretch between Komari Lagoon mouth and Murungatena Lagoon (Photos were taken on March 01, 2015).



Photos 1.5 to 1.. Growths of vegetation cover on incipient dunes in coastal stretch of south of Komari Lagoon and in Ureni Beach (Photos were taken on March 01, 2015).

In Coastal Geomorphology, the Ridge and Runnel Systems (RRS) are formed due to the interaction of tides, currents, sediments (sand) and the beach topography. The Holocene RRS in the area are found as raised beaches, about 3.0-12.0m high in Ureni, Arugam headland,

Sastragala and Panama areas from the present MSL. These are formed due to the sea level fluctuations and climate changes since 10,300 yr B.P. and show the historical behavior. The nearest incipient dunes have ridge and runnels (about 2-4m in high) and are covered by creeping dune vegetation. The Holocene raised beach ridges with lower dune systems are about 2.0-4.0m and the upper inland sand dunes are 4.0m-12.0m high from MSL.

Table 1. Shows the location of lagoon in the coastal stretch between Komari and Panama

Lagoon: East Coast	Longitude (N)	Lattitude (E)	Area (km ²)	Perimeter (km)	SLD	Agro.	WME (km)
3.3 Komari (Ampara)	6° 59' 01.90"	81° 51' 18.74"	4.68	13.37	5.48	DL2	0.11
3.5 Murugetena (Ampara)	6° 57' 34.18"	81° 51' 31.71"	0.29	3.09	5.09	DL2	0.05
3.6 Putuvil-Ureni (Ampara)	6° 54' 34.76"	81° 50' 12.11"	24.49	64.23	12.22	DL2	0.17
3.7 Arugam (Ampara)	6° 51' 32.06"	81° 49' 23.70"	5.83	26.16	9.6	DL2	0.41
3.8 Panama (Ampara)	6° 46' 06.75"	81° 49' 08.25"	14.76	66.24	15.28	DL2	0.20

(Source: Silva et al, 2013).

Water ways, water holes, river mouths and lagoons have no proper directions or sizes and appear as low areas between beach or dune ridges. On individual beaches, these are called swell or holes; extend close or below the water table covered by freshwater or brackish water. In the study area freshwater conditions of these landforms emerge during the rainy season especially northeast monsoon period. From Komari to Panam a number of water ways are opened and connected with the sea mainly northeast monsoon period. A list of lagoons in this coastal stretch are shown in Table 1. Most of them are flowing to coastal lagoons and large flood waters cover the area during the severe rainfalls in the northeast monsoon period.

Anthropogenic Activities and impact

From Panama to Sangamankanda, small townships have developed with housing schemes; individual houses & home gardens; educational, religious and other cultural places; beach scene (*Madel*) and fishing camps and commercial activities. Geotourism is the main commercial activity in the study area, particularly around Arugam Bay and other crescent shaped beaches. Increasing natives and tourists; residing them in townships; encompassing the lagoons and beaches by boat fishing and other associated activities; improving the road network and infrastucture facilities etc. have rapidly developed during the past two-three decades. Mismanagement of this coastal area, could disturb the beach and dune ecosystems and have an adverse impact on coastal protection as well as biodiversity. Old coastal barriers

and sand dunes bulldozed and flattened. As a result, productive beaches have been destroyed and coastal settlements lead to submerge by flood water. Many garbage and fish waste sites; stagnant polluted water bodies; dumped dug wells; beach and dune sand mining sites; encroachment of dune lands for settlement and other construction (buildings, roads etc.); cultivation and for other purposes are the major visual threats. Most of these have been continued by individuals, government institutions as well as politicians and their followers.

Conclusions

The coastal stretch from Panama to Sangamankanda has beautiful places with white sands, heavy mineral sands and sand dunes, seagulls, and little lanes and fishing boats. The study area is probably the driest and most barren wetlands are suffered water deficit due to seasonal rainfall. Among the natural landform features such as irregular and straight shorelines; sandy shores and beaches; well developed dunes; waterways, water holes and lagoons can be observed. These morphological features and their formative processes are changing under the influence of the coastline configuration, monsoon winds, waves, currents, and sea-level changes. Most of the foredunes, back dunes and vegetated old dunes have been exploited by men or utilized for cultivation, housing schemes, building construction and for other purposes. Therefore, there is an urgent need to preserve and manage by the DCC&CRM and by other relevant agencies the remaining landforms for posterity.

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