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COASTAL PROCESSES AND BEACH MORPHODYNAMICS OF PURI COAST IN ORISSA, INDIA

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Abstract

The various landforms of coastal areas are almost exclusively the result of the action of ocean waves. Wave action creates some of the world's most spectacular erosional landforms. Where wave energy is reduced depositional landforms, like beaches, are created. *Coa*stal landforms, any of the relief features present along any coast, the result of a combination of processes, sediments, and the geology of the coast itself. The coastal environment of the world is made up of a wide variety of landforms manifested in a spectrum of sizes and shapes ranging from gently sloping beaches to high cliffs, yet coastal landforms are best considered in two broad categories: erosional and depositional. In fact, the overall nature of any coast may be described in terms of one or the other of these categories. It should be noted, however, that each of the two major landform types may occur on any given reach of coast. Present study focuses on relationship between coastal processes and coastal landforms of the study area.

Keywords: Landform, Ocean Waves, Coastal Environment, Erosion, Deposition.

1. INTRODUCTION

The coastal zone is that part of the land surface influenced by marine processes. It extends from the landward limit of tides, waves, and windblown coastal dunes, and seaward to the point at which waves interact significantly with the seabed. The coastal zone is a dynamic part of the Earth's surface where both marine and atmospheric processes produce rocky coasts, as well as beaches and dunes, barriers and tidal inlets, and shape deltas. The atmospheric processes include temperature, precipitation, and winds, while the major marine processes are waves and tides, together with water temperature and salinity. Beaches are wave-deposited accumulations of sediment located at the shoreline. They require a base to reside on, usually the bedrock geology, waves to shape them, sediment to form them, and most are also affected

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by tides. The beach extends from wave base where waves begin to feel bottom and shoal, across the near shore zone, though the surf zone to the upper limit of wave swash. In the coastal zone ocean waves are transformed by shoaling, breaking, and swash. In doing so they interact with the sea bed, and determine the beach morphology or shape, a process called beach morphodynamics.

2. OBJECTIVES

- To study the geomorphologic diversity of Puri open coast through beach cross profile.
- To identify different features of different landforms.
- To analysis and describe the causes and formation of these geomorphic features.

3. METHODOLOGY

Table-1: Methodology

Methods	Activities
Pre-field	• Satellite image • Topographical map collection on our study area Puri (open coast)
Field	• Identification of different beach morphological features. • Feature like cusp, horn, ripple mark, beach ridge, beach face, biogenic activities, runnel and berm. • Photo collection on these features • Dumpy level survey for drawing beach crosses profile.
Post-field	• Mapping of different features. • Interpret the beach morphological features. • Drawing of beach profiles.

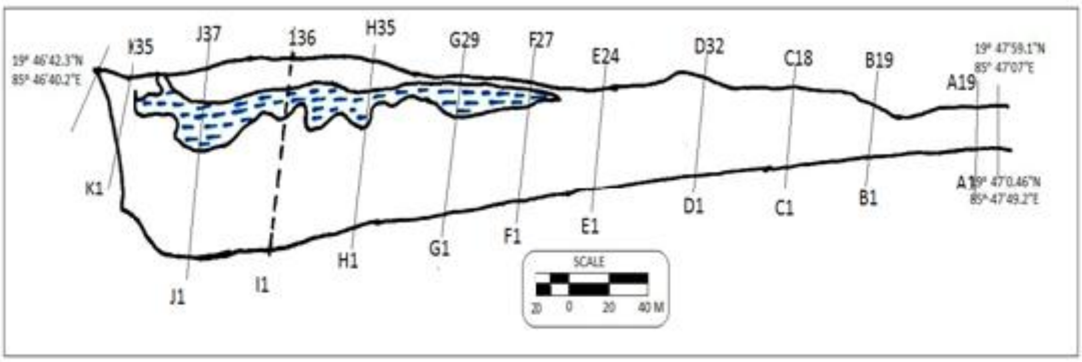

Figure – 1: Cross profiles along the sea beach

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4. STUDY AREA

Puri district is the southernmost district province of Orissa. The Puri coast is situating on the north western part of Bay of Bengal. The actual length of the Puri sea beach is 150.4 km. The study area consists of the estuarine coast. The open coast is extended in between 19^{o}47’07.6”N to 19^{o}46’56.3”N and 19^{o}47’04.6”N to 19^{o}46’07.1”N latitude. The longitudinal Extension of the open coast is 85^{o}47’47.4”E to 85^{o}46’08.91”E and 85^{o}47’49.2” to 85^{o}46’9.32”E.

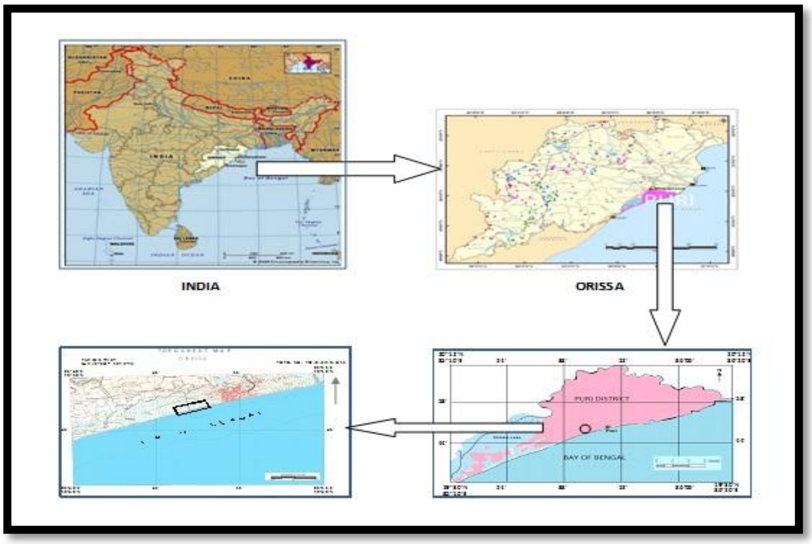

Figure – 2: Location map of the study area

5. COASTAL PROCESSES

There are three main processes at work in the sea. These are erosion, transportation and deposition.

5.1Erosion

Erosion is destructive waves wearing away the coast. There are four main processes which cause coastal erosion. These are corrasion/abrasion, hydraulic action, attrition and corrosion/solution. Corrasion/abrasion is when waves pick up beach material (e.g. pebbles) and hurl them at the base of a cliff. When waves hit the base of a cliff air is compressed into cracks. When the wave retreats the air rushes out of the gap. Often this causes cliff material to break away. This process is known as hydraulic action. Attrition is when waves cause rocks and pebbles to bump into each other and break up. Corrosion/solution is when certain types of cliff erode as a result of weak acids in the sea.

5.2 Transportation

Transportation is the movement of material in the sea and along the coast by waves. The movement of material along the coast is called longshore drift. Longshore drift is the movement of material along the shore by wave action. Longshore drift happens when waves moves towards the coast at an angle. The swash (waves moving up the beach) carries material up and along the beach. The backwash carries material back down the beach at right angles. This is the result of gravity. This process slowly moves material along the beach. Longshore drift provides a link between erosion and deposition. Material in one place is eroded, transported then deposited elsewhere.

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5.3 Deposition

Deposition is when eroded material is dropped by constructive waves. It happens because wave has less energy. Deposition creates a range of landforms.

6. BEACH MORPHODYNAMICS

Beaches are the most unlikely of landforms to be facing open sea (Pethick, 1995). Beaches are considered to be sparsely, populated, unproductive ecosystem (Maclslntyre, 1977).) As it is a pile of loose sand and shingle stability of it is highly affected by even disturbance of low magnitude

Beach is a more dynamic part of coastal region where the hydrology and morphology interact with each other and form beach morphodynamics. The morphology of beach changes through instantaneous time. This morphology is changed by wave, tide, current. Beach acts as a temporary buffer between two Storage pools, the dune and oceanic floor. Major characteristics of beach are as follows:

A. It is a zone where land and water meet.

B. It is the marginal part of the land towards the ocean.

C. Dynamic region.

D. Ecologically more sensitive, complex and fragile.

E. Consisted of sand, silt, clay and some beach are rodsy.

F. In our study area, beach is composed with medium size of sand, silt and clay.

G. Grain size changes with the variation of beach gradient.

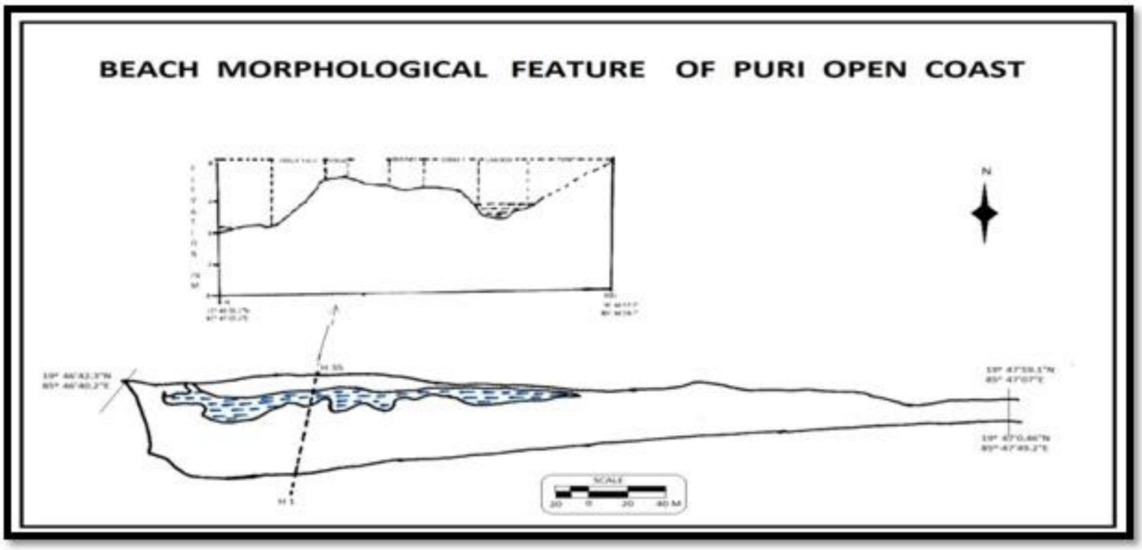

Figure – 3: Beach morphological feature

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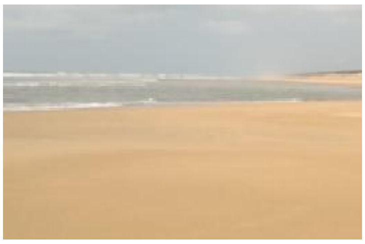

Figure – 4: Beach face

Figure – 5: Beach ridge

Figure – 6: Runnel

6.1 Beach face

In the study area (open coast), beach face is steep. The erosion of beach face is moderate to narrow. Steep beach face creates surging and plunging wave. On steep beach face we see concentration these waves. Coarser materials are deposited in beach face, dominated by high wave energy.

6.2 Beach ridge

Morphology of beach profile if variable within spatial limits. The term ridge is used for bar. A wide variety of ridges and troughs may appear on beach profile.

6.3 Runnel

Shallow beaches have flat wide lo tide terrace crossed by runnels. On the low tide terrace ridges may be broken by channels. This channel drains runnels at low tide

In the open coast study area, runnel is not formed widely. In few places (at 19°46'58.9''N, 85°47'12''E and 19°46'51.7''N, 85°47'E) runnels has been formed in beach profile.

6.4 Landform along the beach profile of open coast

Table – 2: Landforms along the beach profile

Figure sited	Location	Length (m.)	Slope	Feature identified	Involved process
Profile –A	1947'20.6''N 8547'28.9"E & 1947'20.7"N to 8547'28.5"E(A1-A19)	90	351'44.66 236'92.2'' 243'34.72''	Beach face	Shell and tidal Process
				Beach ridge	Very minor amount of shell
Profile –B	1977'N 8547'26.1"E to 1947'04.1"N 8547'25.1"E(B1-B19)	90	773'00.7'' 927'41.36'' 251'14.46''	Beach face	Presence of shell and tidal process
				Runnel	Sand waves pools are main features
				Berm	Aeolian process
Profile –C	1946'59.6" N 8547'22.8"E to 1947'02.7"N	85	445'09.11'' 132'56.37''	Long shore bar	Parallel bar and trough dominant

	8547'21.7"E(C1-C18)			Beach face	Shell presence and tidal process
				Ridge	Rip channel
				Berm	Aeolian process
Profile –D	1946'58.7"N 8547'19.5"Eto 1947'03.3"N8547'18"E (D1-D32)	155	541'38.10'' 050'33.09'' 773'04.6''	Long shore bar	Parallel bar and trough dominant
				Beach face	Shell presence and tidal process
				Berm	Aeolian process
Profile –E	1946'57.3'N8547'16"E to1946'57.01"N8547'15.5 "E(E1-E24)	115	423'05.34'' 445'49.1'' 235'53.37'' 041'47.21''	Beach face	Shell and tidal Process
				Beach ridge	Very minor amount of shell
Profile –F	1946'56.57"N8547'12.8"E to1947'00.1"E8547'08"E (F1-27)	130	348'50.67'' 475'00.6'' 917'44.36'' 874'33.7'' 115'70.3'' 445'49.1''	Beach face	Shell presence and tidal process
				Ridge	Rip channel
				Berm	Aeolian process
Profile –G	1946'55.1"N8547'10''Eto 1947'00.1''N 8547'08''E(G1-G29)	140	424'55.34'' 511'37.94'' 348'34.12'' 055'0.7'' 37595	Beach face	Tidal process
				Berm	Aeolian process
				Beach ridge	Very minor amount of shell
Profile –H	1946'53.2''N8547'07.3''E to1946'575''N 8546'58.7''E(H1-H35)	170	445'43.11'' 131'32.38'' 021'50.11'' 304'84.4''	Beach face	Tidal process
				Runnel	Sand waves,Poools are main features
				Berm	Aeolian process
				Beach ridge	Very minor amount of shell
Profile –I	1945'52.1''N854703.4''Et o1946'51.09''N 8547'04.01''E(I1-I33)	175	454'82.35'' 033'22.5'' 243'38.72''	Beach face	Presence of shell and tidal process
				Runnel	Sandwaves,Poools are main features
				Berm	Aeolian process
				Beach ridge	Very minor amount of shell
				Low tide Terrace	Low tide water
Profile -J	1946'50.6''N8547'01.47'' Eto1946'57.5''N 8546'58.7''E(J1-37)	180	321'59.26'' 125'55.55'' 136'92.2" 029'28.9''	Beach face	Presence of shell and tidal process
				Runnel	Main process is Sandwaves,Poool

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					water
				Berm	Aeolion process
				Beach ridge	Very minor amount of shell
Profile -K	1946’50.2’’N8547’57.7’’E to1946’55’’N 8546’54.4’’E(K1-K33)	160	2°45’49.11” 1°28’7.68” 5°11’39.94”	Beach face	Presence of shell and tidal process
				Runnel	Main process is Sandwaves,Poool water
				Berm	Aeolian process
				Beach ridge	Very minor amount of shell

6.5 Beach cusp and horn

Smallest rhythmic beach features are cusps which may range vary in size from (1m to 6m). The coarse sediment cusps or horns, separated from each other by small bays. The delusion of flow in swash causes a drop in velocity. It causes deposition of large sediment grains forming cusps and horn.

In the study area, Beach cusp and horn has been formed in between 19°46’57.6’’N, 85°47’14.3’’E and 19°46’54.3’’N, 85°44’05.1’’E. These are formed in middle portion of our study area, where wind, wave activities give funnel shape to cusp and horn. Here we find coarser deposition on cusp and horn, through original beach material consists of both coarser and finer grains.

Figure – 7: Horn and Cusp

Figure – 8: Ripple marks

Figure – 9: Biogenic activities

6.6 Ripple marks

Due to siltation and surface creep on beach plane, sand ripple is formed. These are regularly faced asymmetrical ridges 1 cm. to 2cm. high, with wave length of between 2cm. and 12cm. The ripple wave length increases as wind velocity increases, but they tend to flatten and disappear at high wind.

Table – 3: Location and size of Ripple marks

Ripple mark process involved	Ripple mean height in cm.	Ripple mean length in cm.	Covering area in Sq.m.	Location
Water activity	0.876	11.2	1	19°46’59.5’’N, 85°46’50.6’’E
Water activity	0.647	2.35	1.935	19°46’56.4’’N, 85°46’52.0’’E
Water activity	0.50	2.1	0.91	19°47’04.5’’N, 85°46’51.2’’E
Wind activity	0.594	6.127	-	In open coast at 19°46’52.5’’N, 85°47’01’’E
Biogenic activity	-	-	300.42sq.cm. per one hole	From 19°47.4’’E to 19°47.028’N, 85°47.429’E (Open coast)
Biogenic activity	-	-	Ripple mark are per one hole is 0.71sq.cm. and 0.20 sq.cm.	Estuarine coast

7. CONCLUSIONS

With respect to beach morphodynamics, a spectrum of morphodynamic states has been developed, ranging from reflective beaches at one end to dissipative beaches at the other. Reflective beaches are typically steep in profile with a narrow shoaling and surf zone, composed of coarse sediment, and characterized by surging breakers. Coarser sediment allows percolation during the swash part of the wave cycle, thus reducing the strength of backwash and allowing material to be deposited in the swash zone. At the other end of the continuum of beach states, dissipative beaches are wide and flat in profile, with a wide shoaling and surf zone, composed of finer sediment, and characterized by spilling breakers. Transitions between beach states are often caused by changes in wave energy, with storms causing reflective beach profiles to flatten (offshore movement of sediment under steeper waves), thus adopting a more dissipative profile.

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