

3. REMOTE SENSING AND AERIAL PHOTOGRAPHY FOR COASTAL GEOMORPHOLOGY

By

B. G. Wagle
National Institute of Oceanography
Dona Paula, Goa - 403004.

In this lecture I will discuss the use of Remote Sensing data for coastal geomorphological studies. And as a case study, I will briefly describe the results of the study of the Geomorphology of the Central West Coast of India, using aerial photographs and LANDSAT images.

The marine scientists and coastal engineers recognized the shorezone as an element of a highly dynamic physical system. The oscillations of the coastline either due to eustatic or tectonic phenomena and commonly giving rise to loss of land or gain of land area is a feature along the major parts of coastal belts of the world.

Aerial photographs and LANDSAT imageries provide a valuable, rapid and accurate tool for the study of coastal and nearshore geomorphological features. Generally greater details of the coastal configuration and nearshore features

are discernible on the photographs than can be observed in a comparable short time by painstaking field studies. From time-lapse or sequential aerial photography it is possible to observe and even quantify changes resulting from sediment shift during the interval between the dates of photographs. Considering the rapid development of Remote Sensing Seismic the need was felt to use the aerial photographs and LANDSAT imageries for coastal and nearshore studies.

Use of aerial photographs has increased the efficiency of many geomorphic mapping by adding speed, economy and accuracy as well as adding certain geomorphic information that is impossible, difficult or increasingly impractical to obtain by routine field mapping method.

In the present work attention has been restricted to:

- i. Recording of various coastal and nearshore geomorphological features and grouping them in different units.
- ii. Development of offshore bars, beach ridges, spits, tombolos, beach, dunes, tidal flats etc.
- iii. Origin and development of cliffs, wave-cut platforms and coastal plateaux.
- iv. Investigation of beach rock and their significance in connection with the sea level variations.
- v. Shifting of shoreline repeatedly back and forth for a considerable distance as a result of fluctuations of the sea level.

- vi. Working out lithological and structural influence on the geomorphology of the area.
- vii. Identification of lineaments and their overall control on the evolution of the coast and on the drainage.
- viii. Study the distribution, concentration and transport of turbid water plumes along the continental shelf based on LANDSAT data.

The study area comprises the coastal tract of Goa and Maharashtra midway along the West coast of India -- known as the Konkan coast.

Photo-element analysis such as tone, texture, shape, size, form, pattern and associated features aided considerably in identifying and describing the following geomorphic units .

<u>Marine</u>	<u>Fluvial</u>	<u>Aeolian</u>
Mesas	Drainage	Dunes
Cliffs	Ghat escarpment	(recent and old)
Wave-cut terraces	Denudational hills	
Tidal flats	and inselbergs.	
Beaches, Beachrocks	River terraces	
and Beach ridges	Channel bars	
Spits and Bars		
Waves		
Longshore drift		
Turbidity flow		

Mesas: Laterite mesas are recognised on air photos by their light to medium tone, relatively flat tops and negligible to gentle slope. The surface has a pitted appearance, sparse to thin vegetation but slopes are marked by dark tone due to dense vegetation.

Cliffs: The most prominent features of marine erosion seen in aerial photographs are cliffs. They range in height 5 to 40 m and have been formed by under-cutting and subsequent fall of large rock masses. Equally high abandoned cliffs upto 1 to 2 km inland have been also identified in the aerial photographs. These are no longer undergoing wave attack as a result of relative drop of sea level.

Wave-cut terraces: These are better seen in low tide photographs. They are present at the base of the cliffs and headlands. These can be marked on aerial photographs by their contrasting tone and texture. Some of these are in the intertidal zone but others are above the present high water line indicating earlier higher sea level.

Tidal flats: These are extensive, nearby horizontal, marshy or barren tract of land that are alternately covered and uncovered by the rise and fall of the tide. On air photos, the tidal flats show dark tonal contrast to the lighter channels, bordering the present river. Old tidal flats are marked by light tone. They are 2-3 m above the present sea level.

Beach: This unit is restricted to a narrow belt ranging from a few metres to about 100 m along the coast. Aerial photographs taken at the low tide display different features in detail and in some, submerged portions are also seen.

Beach Rocks: This rock has almost same general composition as the loose beach sand. It is friable to well cemented rock consisting of mineral grains, rock fragments and calcareous debris, cemented by calcium carbonate. It is formed only in the intertidal zone or spray zone.

Beach Ridges: These are subparallel ridges of sand, shell or pebble, varying in amplitude from a few inches to many metres. A number of beach ridges are identified far beyond the present shoreline. On aerial photographs beach ridges appear as light to medium grey speckled areas with medium texture.

Spits and bars: The term bar is used in a generic sense to include the various types of submerged or emerged embankments of sand and gravel built on the seafloor by waves and currents. One of the most common types of bar is spit. Along the Konkan coast, we have many impressive spits. These have been attributed to movement and deposition of materials by longshore currents.

Waves: Aerial photography provides a perspective for wave behaviour in the coastal zone not often available from

land-based or shipboard observations. Scales within the range of 1 : 20,000 to 1 : 60,000 have been found to provide enough detail to obtain many of the wave characteristics.

Longshore drift: sediment transport along shore is indicated in many areas by the form of depositional features and growth of spits across rivers. These geomorphic indicators, which determine net shore drift direction, gives a first hand information on drift direction.

Turbidity flow: One of the important uses of LANDSAT images in marine sciences has been in studies of the distribution and variation of turbid waters. Based on the tone which is related to the concentration of suspended sediments, three distinct types of water masses can be identified qualitatively:

- (1) - highly turbid water,
- (2) - turbid water; and
- (3) - clear water.

These are evidently related to the concentration of suspended sediments.

Drainage: Rivers are under tidal influence for most of their length towards the coast. They originate from the Sahyadri ranges. The rivers run mostly straight with sharp bends and meandering is a rare phenomenon. The area is mostly characterised by the dendritic type of drainage pattern.

Ghat Escarpment: The most outstanding geomorphological feature of the Peninsular India is a dissected margin of a long mountain range, popularly known as Western Ghats. From the coastal lowland they appear like abrupt vertical cliff or Ghat Escarpment. On small scale map their western face appears as a straight line but on LANDSAT images it is very sinuous, crenulated and highly dendritic.

Denudational Hills and Inselbergs: Because of differential weathering due to varying degree of resistance to erosion many outcrops of gneisses, basalts and laterites stand out prominently in the form of residual hills.

River Terraces: These are topographic surfaces marking the former levels of valley floor or flood plain. Field checks reveal that the horizontal or nearly horizontal alluvial terraces on either sides of the rivers are about 2 to 5 m above the present high water level and are covered with alluvial deposit.

Channel Bars: The deposits of sand and gravel along the river channel are designated as channel or meander bars, depending on their position and origin. On air photos, they are seen as streaky multiple channels while under stereomodels they appear to have some relief. The presence of meander bars on the convex side of the channels indicate the migration of the river towards the convex end.

Coastal Dunes: A series of sand dunes which vary

in size and degree of stability occur parallel to the coast. Within these dunes a set of old and recent or active dunes can be distinguished. Recent dunes exhibit a very light tone in airphotos, are located close to the beaches and rise to a height of about 10-15 m. The older dunes are marked by very dark tone. These dunes extend to about 1 to 2 km inland.

Remote sensing data can be used as an effective tool for identifying coastal geomorphic features. Above data proves that the coastal geomorphological studies can be fruitfully carried out using remote sensing data involving less time and cost. The time has certainly arrived when aerial and space images have become an indispensable aid for studying the evolution of littoral geomorphology. The optimum photographic scales to be chosen shall depend on the subject of study i.e. the scale should be in conformity with the size of the features to be interpreted.