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# LANDSAT IMAGE ANALYSIS FOR GEOMORPHOLOGICAL MAPPING IN A FLAT TERRAIN: A CASE STUDY IN PARTS OF THE GANGES DELTA.

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ABSTRACT: Due to absence of relief and low diversity of land cover, geomorphological mapping in a flat deltaic terrain can be attempted by using multi-band and multi-seasonal images as demonstrated in this paper.

Landsat images of band 5 and band 7 for the months of December, 1973 and March, 1975 have been used for geomorphological mapping in the eastern part of the Ganges delta.

Based on depositional character three broad units — old alluvium (river terraces), new alluvium (flood plain) and fluvio-tidal alluvium (tidal flats) — have been separated. Each unit has further been classified and altogether 23 terrain units emerged in the process. It is observed that all the four imagery need to be used to bring out this map.

## 1.0 INTRODUCTION:

Application of landsat images for geomorphological mapping, both parametric and systematic (terrain type), is well established. While air photo provides the base for detailed mapping, the images help in conducting semi-detailed and reconnaissance level survey within a short span of time. Interpretation of geomorphic features/units from remote sensing imagery is a very direct type of interpretation because of the visibility of the object — the Land form, and hence geomorphological research has gained the central position in the utilisation of aerospace imagery (Verstappen, 1977).

In order to conduct a full scale geomorphological image interpretation the criteria used are form, density (greytone), location, pattern, key and analogues (Verstappen, 1977 and Townshend, 1981). Direct feature identtification obviously is a method in itself, and does not depend on the above mentioned criteria.

A terrain with significant variations in relief, hydrology, drainage pattern, soil and landuse provides good contrasts in images. Therefore, use of the identifying criteria to interpret monoscopic images is not so problematic. But in the case of a flat terrain with no or little relief and undiversified landuse the same set of principles can not be used in image in terpretation. Recognition of geomorphic/terrain features in the flat deltaic plains can be achieved by studying shape and form of depositional pattern from images of different seasons and bands.

## 1.1 STUDY AREA:

The study area covers about 14,500 km² in the eastern part of the Ganges

delta and adjoining plain. The Jamuna or Dhaleswari, the Lakhya, the Megna, the Padma and the Arial Khan are the major rivers. The Arial Khan, a distributary of the Padma, borders the Baghia and Satla bill before diverging in the Tetulia estuary. The Jamuna and the Lakhya merge together and join the Megna river which subsequently joins with the Padma to form the major Megna estuary. Topographically it is a flat area. Much of the land is little above sea level and is criss crossed by a number of river channels under various stages of decadence. The interfluve of the Lakha and Jamuna is characterised by patches of laterised alluvium. Further north this tract is referred to Madhupur jungle tract, The eastern part of the study area is a portion of the Megna plain. The rest of the study area comes under matured and active delta, as identified by Bagchi (1944). The marsh, Baghia and Satla bill, is the eastern extreme of the great marshy chain extending from the vicinity of Calcutta (Chattopadhyay, 1984).

The delta, as such, is subjected to various tectonic activities, shifting of river courses and resultant changes in depositional environment. The main alluvial Bengal basin is surrounded by a number of enechelon faults associated with the lateritic Barind plain. Formation of terraces is attributable to upward movements of the basin in different geological era (Morgan and McIntire (1959). Hirst (1916) suggested that both the Barind and Madhupur jungle tracts were elevated as compensation to a line of subsidence passing along the alignment of the present Megna river. The study area is mainly characterised by fluvial depositional features. The south and southwestern part show the influence of tidal action over fluvial deposits. Eastern part is comparatively elevated with some fan deposits mixed with old alluvium. Lateritisation of alluvium suggests that the deposits are significantly old. It also indicates contrasting geomorphic character of the adjoining terrains.

## 2.0 METERIALS AND METHODS:

Black and white landsat images of band 5 and band 7 of Dec. 1973 and band 5 and 7 of March 1975 (plates 1-4) have been used for the study. The images are of 1:500,000 scale with a ground resolution of 97 m x 79 m. The maps used are a) the Ganges delta map and b) drainage map (1:1,000,000).

## 2.1 INTERPRETATION TECHNIQUES:

Monoscopic visual interpretation of the four available images have been followed to delineate the various terrain units. The procedure adopted here is similar to the hierarchical structure of visual interpretatios as described by Townshend (1981). The fluvial features like cutoff channels, channel fills and drainage channels are directly marked from the images. The broad units of old alluvium (terraces), new alluvium (flood plain) and fluvio-tidal alluvium have been identified from Band 5 landsats on the basis of image character (tone and pattern) variations. The sub-untis under flood plain are delineated by using the criteria of depositional trend. Further divisions were achieved by considering variations in texture, tint, lineation, pattern and shape. Separation of fluvial dominated regime from the tidal affected areas is possible on the basis of land features, drainage pattern and

texture of the image. Comparing band 5 with band 7 extension of back swamps has been delimited. Considering the divergence of small channels, it is possible to demarcate the major levee. However it is not possible to demarcate all the levees from these images.

The sequence of depositional pattern was established by considering the density of depositional marks, grey tone and also location. Recent deposits are light toned due to high amount of silt and sand. The order of succession of former river courses was arranged by considering the indentation of the new course over the old one. The loop formed by the old one is normally interrupted by the comparatively new one and so on.

## 3.0 RESULTS AND DISCUSSION:

Three broad units — old alluvium, new alluvium and fluvio-tidal alluvium— emerged at the 1st level classification. Each of these units were further subdivided on the basis of depositional character. The new alluvium or floodplain unit has been initially classified under three river systems, namely, the Jamuna system, the Lakha-Megna system and the Padma-Megna system. This classification is possible by examining the trends of fluvial depositional features. Further, the Lakha-Megna system and the Padma-Megna system have been classified under five and eight mapping units respectively. An intermediate zone in the interfluve of the Jamuna and the Padma is recognised to be the area of mixed deposits. This zone has also been classified into two units — backswamp and interfluvial plain.

Under the fluvio-tidal unit, there are four sub-units. This unit comes under the Baghia and satla bill. Origin of this unit is attributable to the back tide deposition over a fluvial basis.

Altogether twenty three units were mapped (Fig. 1). The units along with descriptions are provided in Table-1.

The fluvial features like cutoff channels, ox-bows, channel fill etc. are quite prominent. The shifting of river channels in a delta plain is conspicuous. Old deposits have been reworked and superposed by new deposits in a number of places. Silt depositions of Arial Khas, (an offshoot of the Padma river) and the Padma-Megna system are overlapping, which also has modified some of the depositional marks.

## 4.0 CONCLUSION:

The present study brings out that landsat images can be used for mapping flat deltaic terrain. The main key in floodplain mapping is the trend of depositional features and their distribution. Multiband and multiseason images help to delimit the unit boundaries properly. Delimitation of levees are not so successful in this case. However, to have a semidetailed geomorphological map these images are highly useful.

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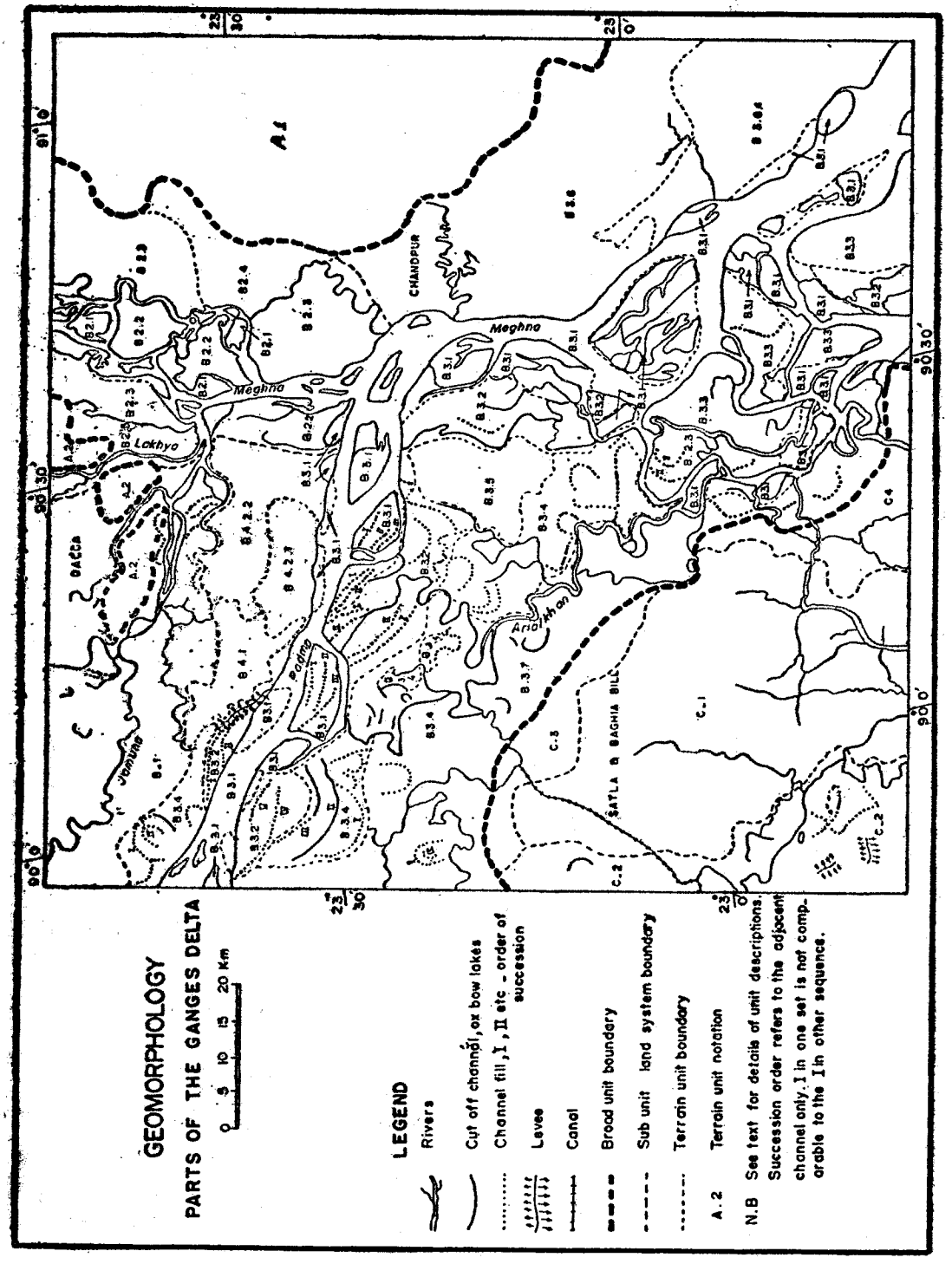

GEOMORPHOLOGY
PARTS OF THE GANGES DELTA
0 5 10 15 20 Km
LEGEND
Rivers
Cut off channel, ox bow lakes
Channel fill, I, II etc - order of succession
Levee
Canal
Broad unit boundary
Sub unit land system boundary
Terrain unit boundary
A.2 Terrain unit notation
N.B See text for details of unit descriptions. Succession order refers to the adjacent channel only. I in one set is not comparable to the I in other sequence.
DACCA
Jamuna
Lakhya
Meghna
Padma
Arial Khan
CHANDPUR
SATLA & BAGHIA BIL
90° 0'
90° 30'
91° 0'
23° 30'
23° 0'

Fig. 1

**Table : Description of Geomorphic Units.**

| Terrain System | Terrain unit | Mapping Symbol | Unit description | Image character |
|---|---|---|---|---|
| Old alluvium/ River terrace | Eastern plain | A1 | Old alluvium, mostly depositional terraces, adjacent to the eastern hilly tract | **Band-5** Coarse texture, dotted, light tone without any depositional mark. |
| | Madhupur Jungle tract | A2 | Lateritised old alluvium with erosional terraces, mostly beyond flood level. | **Band-7** Light grey tone medium texture. |
| New alluvium/ Flood plain deposits under | | | | |
| 1. Jamuna System | Flood plain | B1 | Flood plain deposits including recent and subrecent, characterised by basins, levees and cut off channels, deferred tributeries, aggraded alluvium ridges. | **Band-5** Light to medium grey coloured smooth texture. **Band-7** Medium grey, smooth texture. |
| 2. Lakha-Megna System | Flood plain deposits of differeent periods | B2.1 | Recent deposits with succession of point bars, meander scrolls, mostly unconsolidated. | **Band-5** Linear, black and white tints, medium grey, parallel to the river flow direction; (N-S), fanned type dispersed tints. Braided channel pattern. |
| | | B2.2 | Mostly consolidated recent deposits with chute and neck cutoffs, surrounded by rivers. | |
| | | B2.3 | Consolidated deposits, with prominents marks of filled up channels. | |

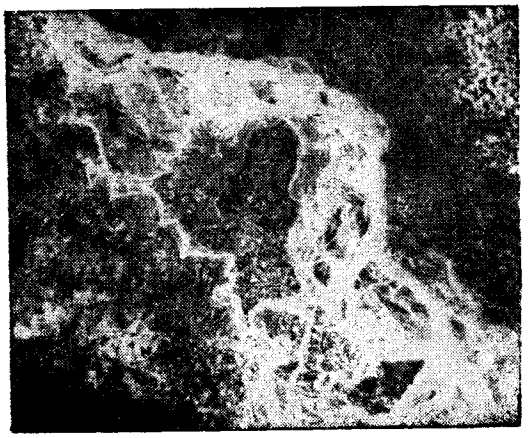
**Table 1 : Contd.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | B2.4 | Consolidated deposits adjacent to A1 comparatively higher than B2.3. Flood plains including levees of Lakha system adjacent to A2 unit occassional marks of filled up channels. | **Band-7** Light to medium grey, prominent water marks (black). |
| 3. Padma-Megna System | Flood plains deposits of the Padma-Megna system | B3.1 | Newly emerged land, recent unconsolidated deposits, successive points bars, meander scroll, island deposits towards south, channel bars. | **Band-5** Light to medium grey, high density of depositional marks (white and black longitudinal tints). Prominent marks of channel fills, Medium textured. Dark grey in some places. |
| | | B3.2 | Cutoff channels, partly filledup channels, mostly consolidated sediments. | |
| | | B3.3 | Consolidated deposits with prominest marks of filled up channels, ox bow lakes | |
| | | B3.4 | Consolidated deposits with marks of filled up abundant channels. | Comparatively smooth, light grey trend lines with prominent black coloured water bodies. |
| | | B3.5 | Matured plain with recent deposits in the outskirts, totally filled up cutoff channels with limited channel traces. | |
| | | B3.6 | Matured lower terrace adjacent to A1 in the east. | |
| | | B3.6.1 | Flood affected area of the unit B3.6. | **Band-5** Dark smooth surrounded by light grey tints (pattern) |
| | | B3.7 | Flood plain deposit of Arial Khan with oxbow and filled up channels. | |

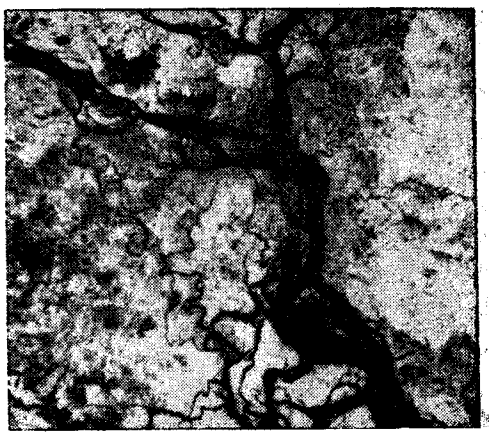
**Table 1 : Contd.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Interfluvial Back-swamp deposits | | B4.1 | Back swamp in the interfluves of Padma and Jamuna, mostly under water. Northern portion skirted by aggraded alluvial ridge, including crevasse splays. | **Band-7** Very light, smooth coloured surrounded by medium grey tone. with white pattern. |
| | Interfluvial plain | B4.2.1 | Characterised by the flood plain deposits of the Jamuna and Padma with prominent fanning marks of sediment distribution, accreted portion of B4.1. | |
| | | B4.2.2 | Characterised by the mixed flood plain deposits of Jamuna and Padma, well matured plain. | |
| Fluvio-tidal deposits | Tidal marsh/bill | C1 | Baghia and Satla bill near Barisal. Part of the great marshy chain, zone of unfinished deposition. Water logged, regularly recharged by tidal deposits. | **Band-5** Dark, smooth, without river marks for most of the places. **Band-7** Light to medium grey, smooth with criss-cross drainage net. |
| | | C2 | Western part of the bill with pronounced fluvial deposits. | |
| | | C3 | Comparatively elevated margin of the bill marged with levees and fluvial deposits of Arial Khan. | |
| | | C4 | Predominantly tidal deposits, tidal drainage. | |

Note: Image characteristics (Band 5 & 7) are given for the terrain unit as a whole.



1 Dec. 1973 Band 5



2 Dec. 1973 Band 7

3 March 1975 Band 5

4 March 1975 Band 7

Plates 1 to 4

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