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*Only in the deepest silence of night the stars
smile and whisper among themselves—‘vain
is this seeking! Unbroken perfection
is over all!’*

Rabindranath Tagore (1912)
Gitanjali (Hymn No. LXXVIII)

To the Islanders of the Thakuran Basin

Preface

The Thakuran River is one of the many highly seasonal and tidal rivers flowing along the south coast of West Bengal, eastern India. The river is tidal for its entire 80 km length from north to south. The channel is sinuous to meandering having connections with many salt water courses. In the strict sense, the Thakuran River, like many other so-called rivers, viz. the Saptamukhi and the Matla, is a large tidal creek in this low-lying coastal plain. It has no perennial freshwater source. The river is the result of tidal incursion and retreat. It drains through the recent alluvial sediments of the Bengal Basin and flows more or less parallel to the Hugli River in the west and Matla in the east. The Thakuran has a funnel-shaped estuary at its mouth having a width of approximately 8 km. During the dry season, the river regime is controlled by tidal water, whereas during rains, the headwater discharge has a strong influence over the river regime. Much of the estuarine plain is inundated by floodwater during wet seasons, but during dry seasons, the estuarine plains are completely dried up and even register evidence of desiccation with salt encrustation. During dry times, the tidal flows accumulate in the river channels. Discontinuous stretches of mangrove forests fringe the river.

The Thakuran River is truly a major tidal creek in the low-lying, tropical coastal plains of the Ganges–Brahmaputra delta. It is fed by to-and-fro moving flood and ebb flows without any headwater supply. Geomorphologically defined areas such as mid-channel bars or flood-tidal delta, the river mouth bar or ebb-tidal delta, point bars, swash platforms, wash-over flats, and riverbanks have been identified. These areas are delineated based on studies of their physical sedimentary structures, bioturbation structures, and granulometric properties.

The Thakuran is totally a tide-influenced creek in which the process of sediment movement is accomplished by bidirectional tidal flows and wind-induced waves. The luxuriant mangrove forests here belong to a tide-dominated setting. The macrotidal mangrove-fringed creeks and estuaries are typically funnel-shaped, and the wide-opening of the Thakuran River at the seaface is no exception to this rule. The width of this water course, on the other hand, decreases exponentially with increasing distance from the seaface.

Tidal marshes of the Thakuran Basin are characterised by natural halophytic vegetation and dwarf mangrove bushes in the upper intertidal to supratidal regions, which are important for understanding the hydrodynamics of marsh sedimentation and the role of vegetation as sediment baffles. They specify different environmental zones marginal to the creek. The mangrove swamps marginal to the river basin migrate with tidal rhythms and perform a vital role in binding the intertidal sediments. Both marsh and swamp vegetation play a major role in sediment baffling and accretion.

Depositional features typical of a tidal environment such as mud couplets, tidal bedding, and tidal bundles have been recognised. Both ebb-flood and neap-spring cycles have been established from the preserved physical sedimentary structures. A general increase in the thickness of cross-bedded and laminated sets with an increase of tidal amplitude has been observed. Macrobenthic animals include various species of gastropods, pelecypods, crustaceans, polychaetes, and fishes. They play a vital role in the formation of several surface and internal bioturbation structures which can be further used for identifying specific geomorphic zones. Supratidal and intertidal depositional features of the Thakuran River have been clearly separated. Mineral suits including both light and heavy fractions have been examined to infer the acidic igneous and metamorphic provenance. The assemblage of heavy minerals refers to a major Himalayan source derivation of the sediments together with contributions from the Precambrian terrains and Pleistocene terraces. It is expected that the findings of this study would be a potential contribution in the field of tidal sedimentation of the depositional environment of estuarine and coastal Sundarbans of eastern India.

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Contents

1 Thakuran Drainage Basin	1
1.1 Tectonic Set up.	2
1.2 Geological Framework	2
1.3 The Thakuran Drainage Basin	3
1.4 Braiding of the River	5
1.5 Formation of Islands.	7
1.6 Summary	7
References.	7
2 Climate and Hydrography	9
2.1 Wind, Temperature and Rainfall.	10
2.2 Tropical Cyclones.	11
2.3 Tides.	11
2.4 Tidal Flow Regime.	14
2.5 Summary	15
References.	16
3 Geomorphic Environments	17
3.1 Flow Patterns	18
3.2 Geomorphic Environments	18
3.3 Geomorphic Divisions	18
3.3.1 Description of the Geomorphic Divisions	19
3.4 Sand-Body Geometry of the Geomorphic Zone	31
3.5 Summary	32
References.	32
4 Sediment Composition	35
4.1 Lithogenic and Biogenic Components	36
4.2 Source Rock of River Sediments	39
4.3 Summary	40
References.	40

5	Mudflats and Tidal Creek Sedimentation	41
5.1	Physical Parameters of Muddy Sediments	42
5.2	Sedimentation Types on Mudflats.	44
5.3	Sedimentation on a Tidal Creek	44
5.3.1	Mud Ridges	45
5.3.2	Mud Microdelta	45
5.3.3	Mud Pellets and Mud Lumps	46
5.3.4	Wood Clumps on Mudflats	47
5.4	Stratification in Tidal Creek Deposits	48
5.4.1	Epsilon Cross-Stratification (ECS).	48
5.4.2	Alternate Sand-Mud Sequence (Heterolithic Sequence).	48
5.4.3	Convolute Lamination.	49
5.5	Summary	50
	References.	50
6	Sediment Texture	53
6.1	Shape of the Cumulative Curves	54
6.1.1	<i>Type I</i> : Cumulative Curves Having Size Range Within 0.0–4.0 phi, i.e. Within Sand Sizes	54
6.1.2	<i>Type II</i> : Cumulative Curves Having Size Range Within 2.5–9.5 phi, i.e. Ranging from Fine-Sand to Clay Sizes.	55
6.1.3	<i>Type III</i> : Cumulative Curves Having Size Range –1.0–9.0 phi, i.e. Ranging from Very Coarse-Sand to Clay Sizes.	63
6.2	Inter-relationship Between Grain Size and Morphological Units.	66
6.3	Classification of Sediment Types	66
6.4	Sediment-Trend Matrix of Grain-Size Relations	72
6.5	Sediment—Hydrodynamic Relation	73
6.6	A Bipartite Model of Grain-Size Distribution.	74
6.7	Interrelationship of Grain-Size Parameters and River Distance	76
6.8	Environment Sensitiveness of Size Parameters	78
6.9	Summary	79
	References.	80
7	Sedimentary Structures	83
7.1	Bedforms Characters.	84
7.2	Sedimentary Structures on the Mid-Channel Bars.	84
7.2.1	Megaripples.	84
7.2.2	Sandwaves	87
7.2.3	Internal Physical Structures of the Mid-Channel Bars	89
7.2.4	Modification-Features Resultant from Unsteady Flow in Tidal Environment.	95

7.2.5	Description of Small-Scale Bedforms	98
7.2.6	Some Characteristics Ripple Types and Other Structures of Tidal Origin	99
7.3	Sedimentary Structures of the Point Bars	107
7.3.1	Description of Bedforms	107
7.3.2	Description of Internal Structures	108
7.4	Sedimentary Structures of the Swash Platform	110
7.4.1	Description of Bedforms	110
7.5	Sedimentary Structures of Wash-Over Flats	113
7.5.1	Surface Features	113
7.5.2	Internal Sedimentary Structures of the Wash-Over Flat.	114
7.6	Remarks on Channel Configuration and Channel-Fill	118
7.7	Summary	118
	References.	119
8	Bioturbation Structures	123
8.1	Basis of Classification of Bioturbation Structures	124
8.2	The Classification	128
8.2.1	Surface Bioturbation Structures	128
8.2.2	Internal Bioturbation Structure	134
8.2.3	Dwelling Structures: Burrows and Tubes Made by Organisms in Which They Live or Use for Escape	135
8.3	Summary	139
	References.	139
9	Mangroves Swamp and Tidal-Marsh Sedimentation	141
9.1	Geomorphological Features of the Mangroves and Marshes	142
9.2	Mangrove Characteristics	142
9.3	Tidal Sedimentation on Mangrove Swamps	143
9.4	Tidal Marshes	147
9.5	Intertidal Marsh Sedimentation	149
9.6	Texture of the Marsh Sediments	149
9.7	Physical and Biogenic Structures	150
9.8	Summary	151
	References.	151

Abbreviations and Units

DO	Dissolved oxygen
IMD	Indian Meteorological Department
LOI	Loss on ignition
MAB	Man and Biosphere
ppm	Parts per million
ppt	Parts per thousand (‰)
ROOM	Readily oxidisable organic matter
SBR	Sundarbans Biosphere Reserve
STR	Sundarbans Tiger Reserve
TDS	Total dissolved solids

Chapter 1

Thakuran Drainage Basin

Abstract The most conspicuous geomorphic feature of the Sunderbans is a low, alluvial plain intersected by an intricate network of tidal rivers, creeks, estuaries and minor tidal-water courses. The Thakuran River is one of the most important tidal rivers of a meso-macrotidal regime having no perennial freshwater supply, and it forms a drainage basin covering about 900 km² in area. The meandering and bifurcating channel systems of the Thakuran Basin have given rise to the formations of various islands mainly by the settling down of particles on the river bed and also by being cutting off from the mainland due to the bifurcation of channels. Construction of embankments to prevent severe bank erosion has resulted in the changing courses of the Thakuran River and the hindrance to growth of mangroves along its river banks.

Keywords Geological framework · Tectonic set up · Braiding of the river · Formation of island · Meso-macrotidal setting · Embankments · Thakuran river · Sunderbans

The deltaic Sunderbans of eastern India are characterised by low, alluvial plains covered by natural mangroves swamps and marshes and are intersected by a large number of tidal rivers, tidal inlets and creeks, estuaries and a network of intricate minor saltwater courses. Many of these serve dual purposes of fresh-water discharge and the to-and-fro movement of the saline water wedge arising from the sea surface. The coastline of West Bengal is comprised of the tidal plains of a large number of estuaries and tidal inlets of which the Ganges-Brahmaputra tidal plain is the most important. Tidal flooding, river fluxes, waves, sea level change, regular episodic and non-episodic events like cyclones and storms are the dominant physical processes that continually modify this coast over the short- and long-term time scales.

The drainage basin of the Thakuran River (latitude 21°35'–22°10' N and longitude 88°25'–88°35' E), one of the many tidal water courses, is bounded by the Matla and the Saptamukhi Rivers in the east and the west respectively. In the strict sense, the Thakuran River, like many other so called rivers, viz. the Saptamukhi, the Matla etc., is a large tidal creek in this low-lying coastal plain. It has no perennial fresh-water source. The river is the result of tidal incursion and retreat. During this

process of to-and-fro movement of tidal water on a gently sloping plain, it is connected by many other creeks of lesser and lesser magnitude variously called locally as 'khal', 'gang' etc. The orientation, geomorphic setting and materials of the river deposits are resultant products of the complex interaction of several factors like the tectonic framework of the Bengal Basin, and geological, climatological, physical, chemical and biological processes. The geographical location of the river also acts as an important parameter as all other factors are subjected to change depending on its location. The morphodynamic changes of the coastline are assumed to be the outcome of: (i) long-term events like tectonic and geological processes and (ii) short-term events like tides and waves. Both these events act jointly in this highly-dynamic macrotidal coastline.

The river mouth widens into a funnel as it approaches the Bay of Bengal. This feature of the river, like many others, characterises this coast of West Bengal that causes its designation as a deltaic-estuarine coast. In all, there are twelve major tidal rivers, plus estuaries and many minor inlets and creeks, which have given rise to the much—indented nature of the coastal Sunderbans.

1.1 Tectonic Set up

The coastline of West Bengal belongs to the Amero trailing-edge coast (Inman and Nordstrom 1971; Davies 1972), whereas, the opposite continental coast is a collision coast. This plate-tectonics-related factor predominately control the evolution of the coastline of West Bengal. The present-day drainage pattern of this coastal area results from two distinct factors noticeable to-date throughout the Tertiary history of the Bengal Basin (Biswas 1963; Sengupta 1966). These are: (i) a regional southerly slope of the Bengal Basin due to the movement on the hinge zone at the edge of the shelf and (ii) the increasing rate of southerly tilt of the West Bengal part of the Bengal Basin due to a relatively greater rate of subsidence of the south-western part of the hinge. This tectonic control of the basin is further accentuated due to the presence of numerous faults, which have been intermittently active during the Quaternaries (Morgan 1970). The Thakuran River, along with all other river systems on the plains of the Bengal Basin, maintains a north to south trend and reflects the surficial manifestation of the subsurface southerly tilt of the Bengal Basin as a whole. This southerly tilt, however, has been thought to have been more effective right from the late seventeenth century (Sengupta 1966, 1972).

1.2 Geological Framework

Being situated on the delta of the Ganges and Brahmaputra Rivers, the depositional behaviour of the river is primarily controlled by the regional geology of delta formation involving both fluvial and coastal processes (Fig. 1.1). The deltaic zone

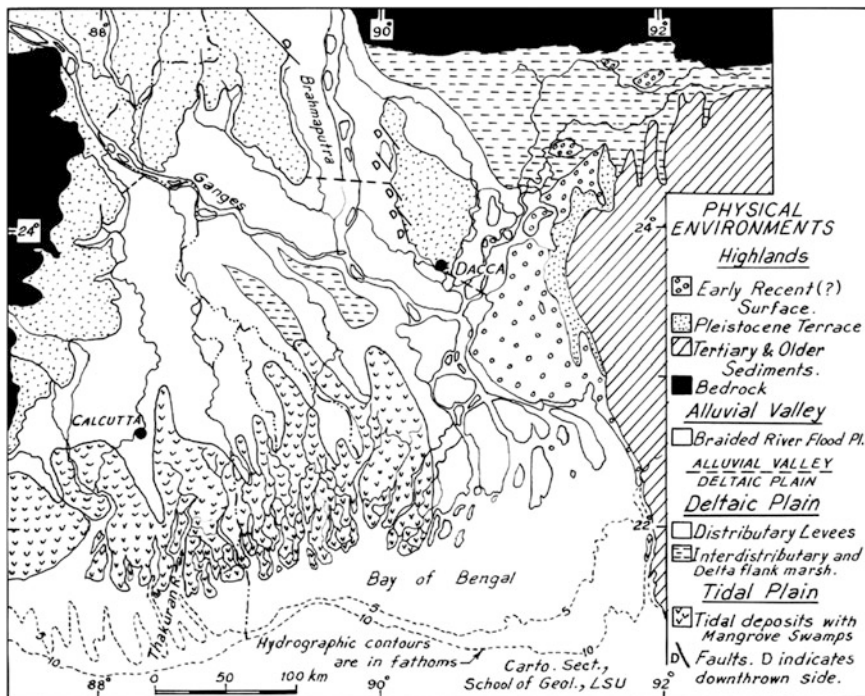


Fig. 1.1 River Thakuran in the depositional environments of the Ganges-Brahmaputradelta covering India and Bangladesh

represents a down-warped basin flanked by successively occurring older rocks from Tertiary and older sediments to younger Pleistocene Terraces into which the major river valleys have been incised (Morgan 1970). High macrotidal amplitudes (4.6–5.5 m spring tide) along the coast results in strong tidal currents leading to a network of deeply scoured (>30 m) tidal rivers and inlets and the formation of an overlapping tidal plain across the intermittently subsiding Bengal delta (Morgan 1970). The Thakuran River is one such tidally-scoured channel having a present-day thalweg level ranging from –10 to –20 m, particularly from its middle to the seaward stretches.

1.3 The Thakuran Drainage Basin

The Thakuran River occurs as an important drainage basin over the basement of alluvial and tidal sediments. It has a length of 80 km from north to south. From a very small width of less than 1 km at its northern uppermost part, the funnelled mouth of the river attains a width of about 8 km before meeting the Bay of Bengal