GEOGRAPHY OF BANGLADESH

Haroun Er Rashid

ROUTLEDGE

GEOGRAPHY
OF
BANGLADESH

Also of Interest

Bangladesh: The Test Case for Development, Just Faaland and John Richard Parkinson

Principles of Social Structure: Southeast Asia, D. E. Brown

The Process of Priority Formulation: U.S. Foreign Policy in the Indo-Pakistani War of 1971, Dan Haendel

Southeast Asia and China: The End of Containment, Edwin W. Martin

Agriculture in the Third World: A Spatial Analysis, W. B. Morgan

About the Book and Author

Geography of Bangladesh
Haroun Er Rashid

In its struggle for independence, Bangladesh became the focal point of world attention in the early 1970s. It emerged victorious, but its development was hindered by the after-effects of the war—the destruction of much of its infrastructure, problems of governmental change, and the enormous difficulties faced by government and aid officials in assembling a data base for long-range planning. Professor Rashid's book—the first major comprehensive geographic inventory of Bangladesh—provides the key elements for such a base. Emphasizing the rural and agricultural characteristics of the country, it also covers in depth its physiography, hydrography, climate, soils, land utilization, migration and settlement patterns, transportation infrastructure, and human and natural resources.

Haroun Er Rashid holds advanced degrees from Cambridge University and Williams College. He was professor of geography at the University of Dacca, Bangladesh, and for ten years was an economist with the civil service of Pakistan. He joined the World Bank in 1969. He is currently a senior economist with the Food and Agriculture Organization in Rome.

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

GEOGRAPHY OF BANGLADESH

Haroun Er Rashid

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published 1977 by Westview Press, Inc.

Published 2018 by Routledge
52 Vanderbilt Avenue, New York, NY 10017
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

ISBN 13: 978-0-367-01823-8 (hbk)
Library of Congress Catalog Number: 78-19679

TO MY PARENTS

ACKNOWLEDGEMENTS

My thanks are first due to Messrs Zillur Rahman, Abdul Haleem Khan and Tarafdar Rabiul Islam. A decade ago they were my colleagues in the Planning Department and our association has continued since then. Due to my absence abroad it would not have been possible to prepare the text and maps without their help. To Zillur Rahman I owe much information, help with typing and cartography. Abdul Haleem Khan and Tarafdar Rabiul Islam helped in collecting and collating data. All of them were untiring in their helpfulness and I owe them a lot.

Amongst many friends who helped in this effort I must mention three others to whom I am especially indebted. Dr. A. K. M. Ghulam Rabbani helped readily and often in collecting the necessary statistics. Dr. M. Alamgir helped in obtaining some of the data on economics. Mr Mahbubudd'n Chowdhury was most helpful with information and statistics about the forest resources. To all of them my sincere thanks.

Thanks are due to Mr. Habibur Rahman of the University Press Limited for persevering with the publication of the book despite many difficulties. The printing of the book is largely due to his painstaking work.

I would like to acknowledge by debt to Mr. Anisur Rashid Khan for the cartography.

Thanks are also due to Khan Suwanee of Bangkok and Hilary Lamplough of Rome for typing parts of the manuscript despite their heavy schedule of work.

CONTENTS

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

LIST OF TABLES

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

LIST OF MAPS

The external boundaries of Bangladesh are according to the best information available and their alignment on these maps is not authoritative.

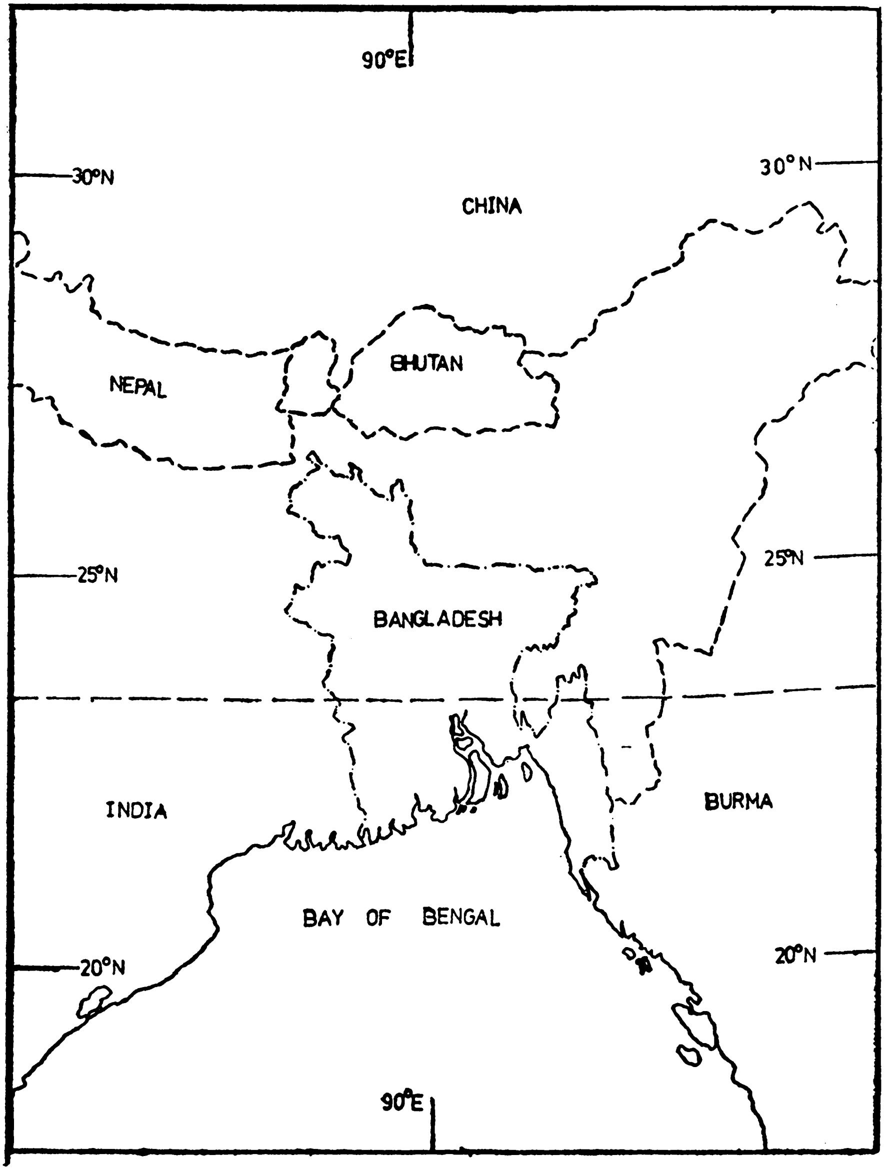
CHAPTER I

INTRODUCTION

For centuries Bengalis have called their homeland Bangladesh (=land of the Bengalis). In the cultural context this homeland stretches from Purulia in the west to Cachar in the east. Politically, however, it is fragmented between various Indian states and the newly-formed People's Republic of Bangladesh.

In this book we are concerned only with the People's Republic. It is a political creation, since its boundaries do not coincide with cultural or physical regions. However, it is the core of cultural Bangladesh, and being an independent country, it does form an economic region. To avoid confusion we will refer to cultural Bangladesh as Bengal, using the term Bangladesh only for the People's Republic.

Bengal is a transition zone between Southwest and Southeast Asia. Arabian, Persian and Turkish influences are noticeable in religious architecture, some art forms, ceremonial food, some of the clothing and in many words of the Bengali vocabulary. On the other hand, in common with Southeast Asia, rice and fish is the staple diet, betelnut and betel-leaf chewing is very common, the lungi (sarong) is the main dress for men, and there are similarities in the way many tropical articles, such as bamboo, are used. Bengal belongs naturally more to humid, tropical Southeast Asia than to the very alien, arid western parts of Asia. The western orientation is due to centuries of immigration, reinforced by the conversion of the majority of the people to Islam.



LOCATION OF BANGLADESH

Bengal forms the capstone of the arch formed by the Bay of Bengal, and because of the Tibetan massif to the north it is a comparatively narrow land-bridge between the subcontinent of India and the subcontinent of Southeast Asia. It has therefore a strategic position in South Asia. To place it more precisely the People's Republic of Bangladesh stretches latitudinally between 20°35'N and 26°75'N, and longitudinally between 88°03'E and 92°75'E. It is one of the most crowded rural areas in the world, with 75 million people (1974) within 55,126 square miles only.

Some of the biggest rivers in the world flow through the country and form the largest delta in the world. The Ganges-Brahmaputra river system forms in the Bengal Basin a delta of 25,000 square miles extent. It is therefore quite obvious that the monsoon rains, the rise and fall of river levels, floods, alluvion and diluvion and changes in river courses form the substance of both cultural and physical geography of the area.

Bangladesh has at present nineteen major administrative units known as Districts (Bengali = Jila). The Districts are divided into Sub-Divisions (Bengali = Mahakuma), of which there are 62. The next lower level of administration is the Thana, which is the smallest unit which can be conveniently used in a statistical description of distribution. There are 412 Thanas in the country. For spatial descriptions thanas have been referred to extensively in this work. For political and administrative purposes each Thana has several smaller units known as Unions. For revenue administration there are similar small units known as Mouzas. For convenience of description Bangladesh is often treated as composed of four major regions: Northern, Southern, Central and Eastern. The Northern Region is the Ganges-Brahmaptura paradelta, and coincides with historical Varendra. The Southern Region lies betwen the Hoogly river and the Podda-Meghna. It coincides with historical Vanga, which gave its name to the whole country. The Central Region is between the Brahmaputra-Jamuna and the Surma-Meghna. It does not coincide with any of the historical regions, but may have been divided between

Varendra and Samatata. The Eastern Region is the whole belt east of the Surma-Meghna rivers and to a large extent comprises of historical Samatata. These Regions are based primarily on the division of the country by the major rivers, but have also some basis in historical background.

The modern geographical study of Bengal may be said to have begun with James Rennell's Memoris of a Map of Hindoostan (Rennell 1792). However, almost a century passed before a properly compiled, statistically substantiated account of Bengal was published in eight volumes by W. W. Hunter (1875-77). This invaluable work has earned Hunter the right to be considered the first regional and historical geographer of modern Bengal. His big storehouse of information was generously mined when the Bengal District Gazetteers were written between 1905 and 1925. These small Gazetteers, in their turn, greatly added to the knowledge of the economy and industry of the people. The Gazetteers of Jessore, Pabna and Rajshahi are outstanding in this respect. All three were written by L. S. S. O'Malley, whose contributions to human and historical geography of Bengal are important.

Census Reports are available for every decade from 1872—1961. Few places outside Europe and North America have such complete census records for nearly a century. These decennial reports contain not only a survey of the human population, but in some instances a count of livestock, handlooms, wells and tanks, boats, village markets etc.

There has been a wealth of publications with geographical information by Government agencies and various consulting Firms. Much of this rich source is not readily available. It is regrettable that a properly classified collection of these Feasibility Reports, Commission Reports, Surveys and Censuses is not available, even to those in the Government. This only illustrates the difficulty of doing research in Bangladesh. Some of the main sources of research material are the libraries of the District Collectorates, the Secretariat in Dacca, the Government Colleges in Chittagong and Rajshahi, the Muranchand College in Sylhet, the Carmichael College in Rangpur, the Universities of Dacca and Rajshahi, and the Department of Geography in Dacca University. The Dacca University Department of Geography has the only collection of cadastral maps accessible to all research students. Their publication, the Oriental Geographer, is also a valuable source material.

Maps are usually very difficult to obtain. The Directorate of of Land Records publishes a large number of village, Thana and plot maps. They are useful for the study of land fragmentation, village groupings etc. The survey of Bangladesh publishes topographical maps in various scales up to 1:15,840, but these most essential aids are very restricted in use, apparently for security reasons. A very good set of maps of Bangladesh was published in December, 1971 under the direction of Wolfram Drewes by the International Bank for Reconstruction and Development. These were probably the first maps of the newly liberated Republic, and contained information on landuse never previously published. A great amount of information about the country is now being gathered by the Earth Resources Satellite (ERTS) program, through the developing science of imagery interpretation. It is a path-breaking method of cartography and resource inventory and as such a paper on this new science, by W. U. Drewes, is included as an appendix.

Despite the considerable amount of research material available in books, maps and other publications, so much of the country remains vaguely known, even to the development planner, that there is no substitute for actual travel to the areas being studied. Even satellite imagery needs 'ground truthing'. Most areas are difficult of access. Travel by four-wheeled vehicle or by boat is essential if any detailed study is to be made. Bullockcarts and cycles have to be used frequently and walking is the only possibility in many areas.

Needless to say the scope for further research into every aspect of geography is very considerrable. Statistics are often unreliable or misleading. A visit to the spot clarifies many things. The geographers and the development planners (and that includes economists too) would be well advised not only to make full use of the printed material, but also to go out and see for themselves whether their plans and projects come close to the realities of the situation.

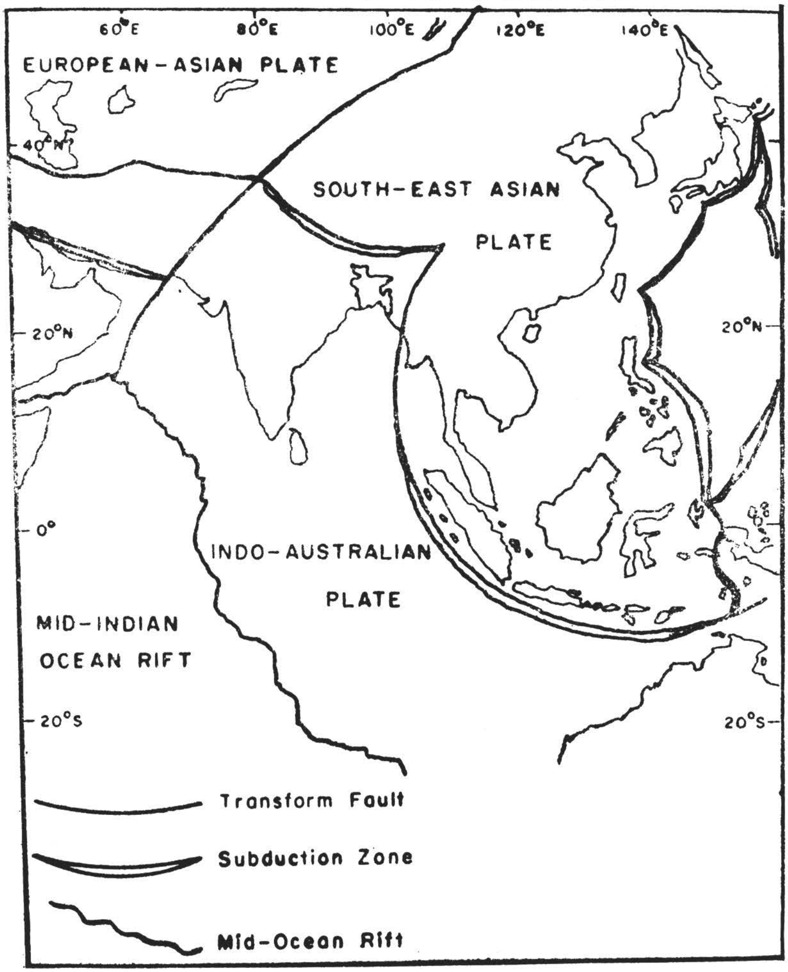
CHAPTER II

PHYSICAL FEATURES

GEOLOGICAL BASIS

It is only within the last twenty years that a considerable amount of data essentially supporting Wegener's theory of the movement of the continents has been collected. The crust of the earth, according to the recently developed theory of plate tectonics, is thought to be divided into a number of plates, each of which is considered to behave as a relatively rigid unit (Clark 1971). These plates shift due to sea-floor spreading and subduction. It now seems that the continental masses collected together, broke up and re-formed several times during the four and a half billion years of earth history. In the early Triassic Period (225 to 190 million years ago) most of the earth's land formed a single continental mass, called Pangaea, and was surrounded by one ocean, called Panthalassa. The latest continental break-up occurred about 200 million years ago (Gordon 1972), and the plates began moving in different directions. Pangaea split first into two masses, known as Laurasia and Gondwana. Laurasia later broke into three, the western-most forming North America and the eastern two forming most of the Asian-European landmass. Most of the Asian mass, it is postulated, is carried on two plates, the Eurasian and the East Asian. In the Jurassic Period (190 to 136 million years ago) the Indian portion of the Gondwana mass split off and began moving north towards Asia. Apparently the Indian portion of Gondwana is on the same plate as the continent of Australia, and both areas moved north as this plate shifted position due to sea-floor spreading in the newly

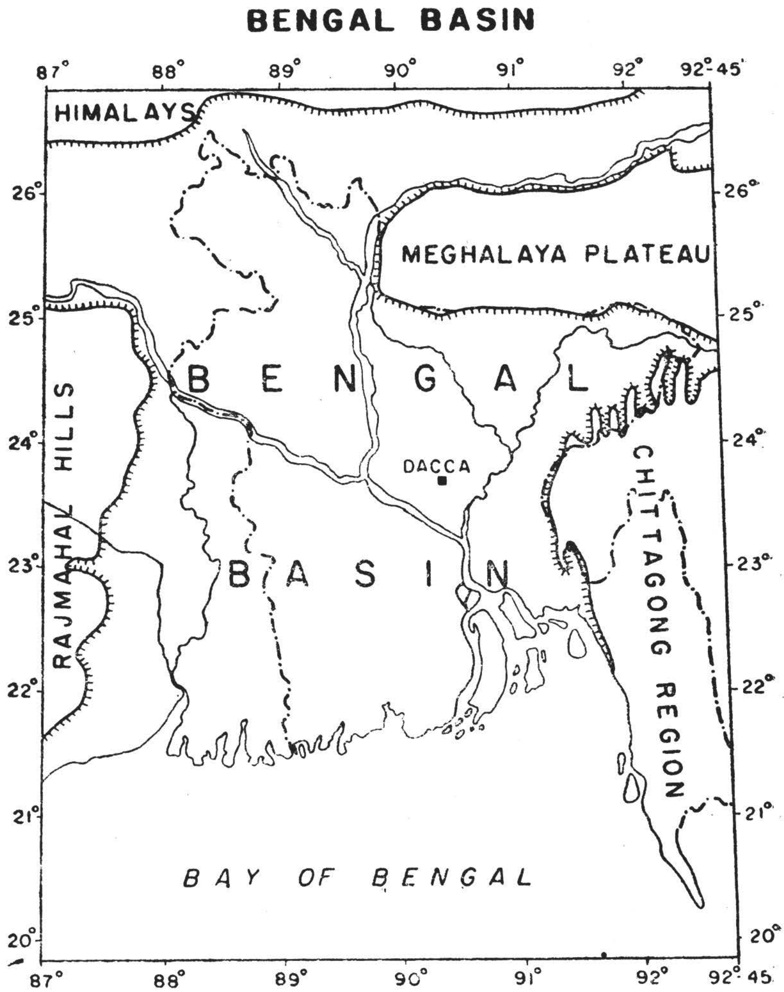
II.1 TECTONIC PLATES



formed Indian Ocean. The Indian portion however swung north faster and collided with the East Asian and Eurasian plates in the Eocene Period (54 to 38 million years ago). One of the results of this collision is the raising of the Himalayas and the Arakan Yomas. The Indo-Australian plate is subducted under the East Asian plate along the line of the Himalayas, but under the Arakan Yomas the two plates are only rubbing against each other along a transform fault (Map II.1).

In the Oligocene Period (38 to 26 million years ago), some time after the plates collided, a portion of the northeastern part of India fractured and sank below sea-level. This portion was filled up over the next 37 million years to form the Bengal Basin (Map II.2). Bangladesh is therefore formed on a mass of sediments underlain by the very old rocks of the Gondwana continent. On two sides of the Bengal Basin the old rocks crop up, in the east as the Meghalaya plateau and in the west as the Chhota Nagpur plateau. The narrow part of the Basin, in-between these two plateaux, is known as the Garo-Rajmahal gap. Along the line of this gap the old base rocks come closest to the surface in Rangpur and Naogaon. Due to its position, with one of the world's major subduction faults in the north and a major transform fault in the east, the Bengal Basin and its adjacent areas form one of the most active tectonic regions of the world. Large areas within Bangladesh have been uplifted in recent times and some areas are still sinking. It has been postulated that these tectonic may be due to the presence of a major fault at depth or a subsiding trough along the axis of the Jamuna-Podda-Meghna river system (Morgan and McIntire 1959). This subsiding structural zone may be the foredeep of the transform fault in the east.

The Bengal Basin has been filled by sediments washed down from the highlands on three sides of it, and especially from the Himalayas, where the slopes are steeper and the rocks less consolidated. The greater art of this land-building process must have been due to the Ganges and Brahmaputra rivers.

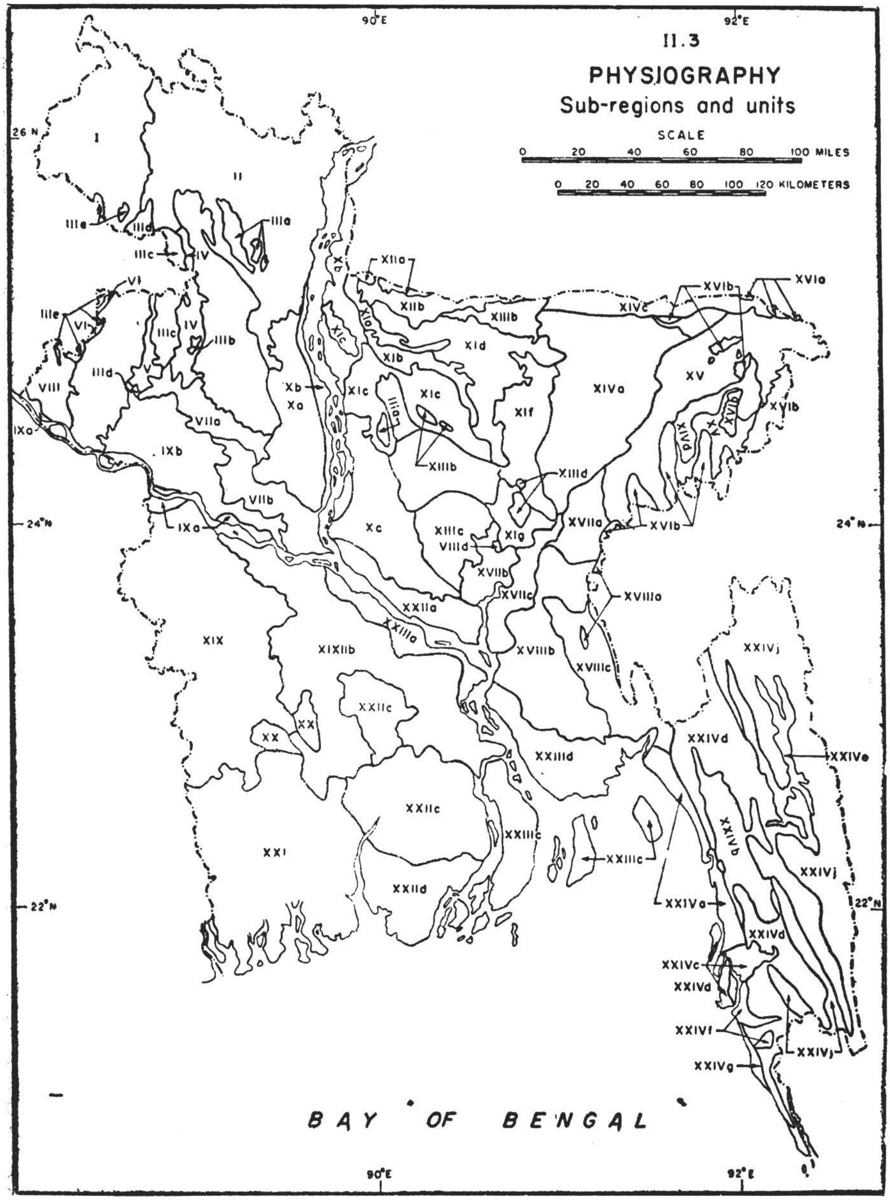

BENGAL BASIN
87°
88°
89°
90°
91°
92°
92°-45'
HIMALAYS
26°
25°
24°
23°
22°
21°
20°
MEGHALAYA PLATEAU
BENGAL
BASIN
DACCA
RAJMAHAL HILLS
CHITTAGONG REGION
BAY OF BENGAL

Map II. 2

The origin of the Ganges and Indus rivers is much debated. On the evidence of the Siwalik deposits (between 1 to 12 million years old) in the Indo-Gangetic Valley, E. H. Pascoe (1919) and G. E. Pilgrim (1919) advanced the hypothesis of an Indo-Brahm or Siwalik river flowing westward and southward to Sind and draining the vast plains. Post-Siwalik movements are said to have dismembered this river which broke up into the Indus, Ganges and Brahmaputra. The latter two reversed their flow and found a new course to the sea through the Garo-Rajmahal gap. This theory has been challenged (Krishnan and Aiyengar 1940), but not seriously shaken. If accepted, it means that most of the Bengal Basin formed on the reversal of the Indo-Brahm in the Pliocene period (7 to 25 million years ago). The hills to the east —mostly the outer ranges of the Arakan Yomas—date from the middle Miocene to the Pleistocene. In this latter period much of the Bengal Basin was complete: large remnants of it remain as the Barind Tract of the Northern Region and the Madhupur Tract of the Central Region. There are other scattered bits such as the Tripura Hills Piedmont. Much of the Pleistocene deposits have either been eroded away or have sunk below recent alluvial deposits, which cover three-fourths of Bangladesh. Most of the deltaic southern part of the Bengal Basin is probably not more than 10,000 years old.

PHYSIOGRAPHIC SUB-REGIONS

Spate (1954) outlined five physiographic sub-regions in the Bengal Basin. Of these, three only (II, III and V) fall in Bangladesh. He further sub-divided the Delta (V) into three parts—Moribund, Mature and Active. His outline regions were elaborated upon by B. L. C. Johnson (1957), who divided Bangladesh into five regions, with twelve subdivisions. The hillocks and mountains of Sylhet District and the Chittagong Region were left out completely. He recognised the individuality of what he named the Noakhali-Tippera Clay Plain, which was changed to Tippera Surface by Morgan and McIntire (1959).


II.3
PHYSIOGRAPHY
Sub-regions and units
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E
92°E
26°N
24°N
22°N
I
II
IIIa
IIIb
IIIc
IIId
IIIe
IV
V
VI
VIII
IXa
IXb
VIIa
VIIb
Xa
Xb
Xc
XIa
XIb
XIc
XId
XIf
XIg
XIIa
XIIb
XIIIb
XIIIc
XIIId
XIVa
XIVc
XV
XVIa
XVIb
XVIIa
XVIIb
XVIIc
XVIIIa
XVIIIb
XVIIIc
XIX
XIXIIb
XX
XXI
XXIIa
XXIIc
XXIId
XXIIIa
XXIIIc
XXIIId
XXIVa
XXIVb
XXIVc
XXIVd
XXIVe
XXIVf
XXIVg
XXIVj
BAY OF BENGAL

Johnson's map, however, contains several inaccuracies, especially in the distribution of the Barind and the lowlands to its south and south-east. Morgan and McIntire brought out the fourfold divison of the Barind and the Piedmont nature of the alluvial plains to the north. The divisions and subdividions listed below are an attempt to refine the previous attempts. They are based mainly on topographical features, and partly on considerations of drainage pattern, soil associations, morphology and landuse patterns.

Bangladesh can be divided into the following twenty-four sub-regions, with fifty-four units on the basis of physical features and drainage pattern (Map II.3):

I. Himalayan Piedmont Plains;
II. Tista Floodplain;
III. Barind Tract:
  (a) North-eastern outliers
  (b) Eastern Barind
  (c) East-Central Barind
  (d) West-Central Barind
  (e) Western Barind
IV. Little Jamuna Floodplain;
V. Middle Atrai Floodplain;
VI. Lower Purnabhaba Valley;
VII. Bhar Basin:
  (a) Western
  (b) Eastern
VIII. Lower Mahananda Floodplain;
IX. Ganges Floodplain:
  (a) Diaras and Chars;
  (b) North Ganges old floodplain
X. Brahmaputra-Jamuna Floodplain:
  (a) Bangali-Karatoa floodplain;
  (b) Diaras and Chars;
  (c) Jamuna-Kaliganaga floodplain;

XI. Old Brahmaputra Floodplain:
(a) High ridges
(b) Floodplain complex
(c) Western plain
(d) Northern plain
(e) Southern plain
(f) Eastern plain
(g) South eastern plain

XII. Susang Hills and Piedmont:
(a) Susang Hills
(b) Piedmont plains

XIII. Madhupur Tract:
(a) Northern tract
(b) Central tract
(c) Southern tract
(d) Eastern tract

XIV. Haor Basin:
(a) Central basin
(b) Susang Piedmont basins
(c) Meghalaya Piedmont depression
(d) Central Sylhet lowland

XV. Sylhet High Plains;

XVI. Sylhet Hills:
(a) Meghalaya foot-hills
(b) Tila ranges

XVII. Meghna Foold plain:
(a) Titas Basin low plain
(b) Meghna-Lakkha Doab
(c) Middle Meghna floodplain

XVIII. Tippera Surface:
(a) Eastern Piedmont strip and Lalmai range
(b) Low floodplain
(c) High floodplain

XIX. Moribund Delta;

XX. Central Delta Basins;

XXI. Immature Delta;

XXII. Mature Delta:

(a) Old Ganges floodplain
(b) Podda-Madhumati floodplain
(c) Non-saline tidal floodplain
(d) Saline tidal floodplain

XXIII. Active Delta:

(a) Active Podda floodplain
(b) Mehendiganj islands
(c) Meghna estuary islands and Chars
(d) Meghna estuarine floodplain

XXIV Chittagong Region

(a) Northern Coastal Plains
(b) Central Valley
(c) Matamori delta and coastal islands
(d) Western hills
(e) Middle Karnafuli System valleys
(f) Bakkhali river valley
(g) Southern Beach plain
(h) Nhila-Teknaf plains
(i) Jinjira islets and reefs
(j) Mountain ranges and eastern hills

I. Himalayan Piedmont Plains

These plains, rolling in parts, are the alluvial cones of the many rivers issuing from the terai region at the foot of the Himalayan ranges. The interfluves of the rivers are slightly domeshaped. This sub-region is bounded by the Mahananda river in the west and Dinajpur Karatoa in the east. In the north, it merges with the sub-montane terai, known here as the Duars (Spate's Region I). The rivers in this sub-region are entrenched in the recent alluvial deposits, mostly sandy silt. They flow towards the south, for the land slopes from a height of 317 ft.* in

* All heights, unless otherwise mentioned, are above mean sea-level, as calculated in the General Triangulation Survey (G. T. S.).

Tetulia Thana to 109 ft. at Dinajpur. The gradient is considerable, being 3 feet per mile. In the south, deposits overlie the pleistocene clays of the Barind Tract. The plain is undulating in parts, being most marked on either bank of the Kulik river.

II. Tista Floodplain

This big sub-region stretches from the high sandy levees of the Dinajpur-Karatoa to the right bank of the Brahmaputra. In the south a long outlier reaches down to Sherpur (Bogra) along the course of the ancient Tista. The relief is that of medium level ridges and shallow basins. Most of the land is shallowly flooded. There is a slight depression along the Ghaghat river, where flooding is of medium depth. The big river courses cut through the plain, that of the Tista, the Dharla and the Dudkumar. The active floodplain of these rivers, with their sandbanks and diaras, is usually less than four miles wide.

III. Barind Tract

The Barind Tract is one of the several terraces of Pleistocene age within the Bengal Basin. The contours of the Tract suggest that there may be two terrace levels—one at 130 ft. and the other between 65 and 75 ft. It is cut through by several rivers, of which three have carved valleys wide enough to separate it into four parts. This tract is characterised by its comparatively high elevation, reddish and yellowish clay soils (Khiyar in local terminology), entrenched dendritic stream pattern and a relative paucity of vegetation.

(a) *North-eastern outliers*: Three separate sections of the Barind Tract are surrounded by Tista deposits. These outliers differ from the main Tract in having deep red-brown soils. The relief is that of an almost level highland, except around Ahshula Bil, where it is irregular. The sharp edges of parts of these outliers suggests some block faulting.

(b) *Eastern Barind*: In the north, the eastern and east-central parts of the Barind are nearly joined together, for the dividing line between them, the Western Jamuna river is very narrow from Hili northwards. From this place southwards, the valley of this river is much wider. In the north this part of the Barind extends up to Darwani and Badarganj. The north-eastern boundary is roughly a line drawn from a point between Badarganj and Shampur to Gobindaganj. From there, the tract is bounded on the east by the Bogra-Karatoa river down to Taras Thana. The southern margin cuts to the north-west till the Western Jamuna river. The area thus enclosed is roughly 1,200 square miles, and cover the whole or parts of the Thanas of Taras, Singra, Nandigram, Raninagar, Adamdighi, Kahaloo, Khetlal, Sherpur, Bogra, Dupchanchia, Shibganj, Panchbibi, Joypurhat, Gobindaganj, Palashbari, Pirganj, Mithapukar, Badargamj, Saidpur, Parbatipur, Nawabganj (R), Ghoraghat and Hakimpur. This part of the Barind is mainly a level plain, with few undulations. One portion of this terrace in the north-east is cut off from the rest by the Karatoa fault. The height of the plain varies because of two faults; the northern one is over 40 miles long, in a north-west to south-west direction, and upthrown to the south-west by about 15 ft. This has greatly affected the Karatoa river, which used to flow in a north-south direction across the present fault, down to the Hurasagar river in Pabna District. In 1820, during a big flood, this river broke through to the Bangali river by the narrow Katakhali channel (Gupta 1910) and the portion below Gobindganj has since then progressively dried up. The flood alone could not have changed the course so suddenly; the existence of the Karatoa fault confirms that there were tectonic movements which favoured the sudden shift of channel. This fault was probably the result of the 1812 earthquake, for Buchanan-Hamilton wrote that even in 1810 the Karatoa was 'a very considerable river' (Buchanan-Hamilton 1833). Another fault, ten miles long, is ten miles to the north-west of Bogra town. Its direction is east-west and it is upthrown to the south. This has resulted in the drying up of the source of the Nagor river. There are, moreover, two other fault traces to the south-west of this portion of the tract. The height of this block varies from 117 feet near Parbatipur to about 90 ft. in the south.

(c) *The East-Central Barind*: The East-Central Barind is the narrowest of the four parts, being only seven miles in average width. Its length is sixty miles, from Chirirbandar Thana to Mahadebpur Thana. Out of its 420 sq. miles, 315 sq. miles are in Bangladesh. Between Chirirbandar and Parbatipur in Dinajpur District, there is no distinct break between II (a) and II (c); the tiny western Jamuna in its upper reaches is the partition. The whole of the western side of this section of the Barind is bounded by the Atrai river valley. In the south, it ends abruptly in the low Bhar Basin. Between Parbatipur and Chirirbandar in the north, the height is 127 ft. There are some undulations in this stretch of the Barind. The stream pattern is entrenched dendritic, as in all these raised terraces of Pleistocene alluvium. A twenty miles long fault can be traced north-west to south-east across the centre of this part of the terrace. It is upthrown to the south-west.

(d) *West-Central Barind*: This large section of the terrace is ninety miles long, and varies from ten to twenty-three miles in breadth. 1,100 sq. miles of it is in Bangladesh. It slopes up through the recent alluvial deposits of the Piedmont plains just south of Dinajpur, and continues in an unbroken mass to the Ganges river, where it appears as a stiff high northern (left) bank for about five miles. A bit of it appears east of Dinajpur Town between the Kankra and Atari rivers. This part of the terrace covers almost the whole of Godagari, Tanor, Niamatpur, Nachole and Porsha Thanas, and parts of Dinajpur, Mahadebpur, Gomastapur, Chapai-Nawabganj and Paba thanas. Its northern end is flat and so is the north-eastern margin for about six miles. The rest of it is undulating and broken up by many gullies (known as Khari). These undulations reach their maximum in the centre, near Porsha, where elevations of over 60 ft. are common. The simulation of hill scenery is enhanced by the entrenched streams which have cut deep. Undulations of similar amplitude continue south to the Ganges. The level of the northern end is about 100 ft., it gradually goes up to a maximum of 150 ft. in the centre and then slopes down to 117 ft. at Mahadebpur in the south-west. West to east also, this section is slightly dome-shaped, with the west tilted higher. The southern half of this part of the Barind is locally called Katal, which means 'thorn jungle'. Distinction is sometimes made between the flat and the undulating part of the terrace, the former areas being Khiyar and the latter Barind. Sometimes only the central part of this west-central part is referred to as the 'true' Barind. The Sanskrit name Varendra (Borendro in Bengali) has, however, always referred to the whole of this distinct group of older alluvial deposits. Barind, therefore, refers to all parts of this terrace. Khiyar refers to a type of soil and should not be confused with Barind, which is the name of a tract of country.

(e) *Western Barind*: Four small sections (in all comprising 50 sq. miles) of the Western Barind projects into Bangladesh, in Gomastapur and Porsha Thanas, along the Purnabahaba and Tangon rivers. Though the Tangon does form a small part of the boundary between India and Bangladesh, its valley ends in the Mahananda river flood-plain within India.

IV. LITTLE JAMUNA FLOODPLAIN

The Little Jamuna was once a large river, being one of the former channels of the Tista. Its valley is very narrow in Dinajpur District, but south of Hili it is from 5 to 10 miles wide. The recent alluvial soil is a greyish sandy-silt and greatly contrasts with the clays of the Barind. It is 10 to 15 feet thick, underneath which the reddish clays appear. The valley terminates in the Bils (deprsssions, mostly water filled) in south Naogaon Thana. It covers all, or parts of Thanas Phulbari, Joypurhat, Panchbibi, Adamdighi, Dhamoirhat, Patnitola, Badalgachhi, Mahadebpur and Naogaon. It reaches its widest extent in Badalgachhi, Joypurhat and Panchbibi Thanas. In Naogaon it covers only the northern half. In the other Thanas, it covers only a strip to the east or west. Part of the valley is in India. The area of the valley is about 400 sq. miles of which 330 sq. miles is in Bangladesh.

V. Middle Atrai Floodplain

This is a 50 mile long valley stretching from Chirirbandar to Mahadebpur, with the Barind Tract rising on both sides. Only half of the valley is in Bangladesh. The relief is that of low ridges and shallow basins. The ridges usually remain above flood level, but the lower areas are subject to flash floods. The river is to some extent entrenched, its bed being the khiyar soil of the Barind. Flash floods bring down considerable amounts of sand and much of the floodplain has sandy soils.

VI. Lower Purnabhaba river Valley

This valley, separating the West-Central Barind from the Western Barind begins 16 miles south of Dinajpur town, in Indian Dinajpur District. It ends at Rohanpur in Gomastapur Thana where the Purnabhaba river joins the Mahananda river. It is 50 miles long and 2 to 5 miles broad. The Barind on either side of it is higher than the terraces to the east, with the result that this valley looks more entrenched than the Àtrai valley. Locally the valley is known as Duba, i.e., swampy. Near Porsha, there is a re-entrant into the East-Central Barind, occupied by the Bara Mirzapur or Jabai Bil. Due to imperfect drainage, this valley is not so fertile as those to the east of it.

VII. Bhar Basin

Strictly speaking the Bhar (which means 'lowland') is the very low land in Atrai Thana. It can, however, be conveniently used to name the whole of the depression south of the Barind Tract. The other terms used, such as Chalan Bil Depression or Pabna Bils Region, are unsatisfactory for they refer to particular localities of this large low lying area. Bhar, referring to lowland in general, is more suitable, for this term is not common in other parts of Bangladesh.

This basin or depression has its 25 miles long base along the eastern side of the West-Central Barind, and its apex is nearly a hundred miles away where the Hurasagar river flows into the Jamuna river. This 1,200 sq. miles basin can be divided into two parts, on the basis of their relative height, and thus the normal depth to which they are inundated. This area is covered during the rainy season (June to October) by a sheet of water, varying from two to twelve feet in depth. It does not look like a lake however, for it is dotted with homesteads on raised mounds, and covered with long-stemmed rice or reeds and grasses.

(a) *Western*: The drainage of its western half collects around the large Chalan Bil, from where it passes through the broad sheet of water, known as the Failam, into several other water bodies and finally flows into the Jamuna river through the Hurasagar river. (This is explained in more detail in the next Chapter on Hydrography). Much of this basin is silting up, for here the many north-south streams coming through the Barind are checked and turned south-east. Due to the rapid change in course, these rivers and streams deposit much of their silt here, and as they choke, they change course only to silt up elsewhere. The continual changing of these water courses and their consequent silt deposits is raising the level of the basin slowly. This part of the basin floods deeply and often quicky. Near Manda, where the Atrai turns towards the south-east, there is an area of very irregular relief, with almost circular, deep basins. The soil here is mainly clay.

(b) *Eastern*: This part of the basin has more ridges. However, most of the land is deeply flooded in the rainy season. There is some influx of water from the Ganges when it is in flood. Lower areas drain slowly in the dry season.

VIII. Lower Mahananda Ganges Floodplain

The Mahananda river forms the western boundary of Bangladesh in two places along the Piedmont Plain in Dinajpur District. Further south, it flows along the northern side of Bholahat Thana and enters Bangladesh in Gomastapur Thana and winding through Chapai-Nawabganj Sub-Division, it falls into the Ganges south of Chapai-Nawabganj Town. The course below Chapai-

Nawabganj is in the Ganges Floodplain. Above it, the Mahananda floodplain varies in breadth from 5 to 7 miles west of the river and 1 to 3 miles east of it. This 250 sq. miles floodplain lies between the Barind and the Ganges floodplain. The river is slightly enternched.

IX. Ganges Floodplain

Throughout this work that stretch of the Ganges river, below its confluence with the Brahmaputra, is referred to as Podda, as is the practice in Bengal. Moreover those areas which could be included in the floodplain but are better treated as part of the delta, XVI (a) and XVII (a), have been left out.

(a) *Diaras and Chars*: By Diara the low bank of a river is generally meant. Here it is used for any alluvial accretion on the banks of any water body. Generally Char means any accretion in a river. Here it is used only for islets in the rivers. In such a large river as the Ganges, Diaras and Chars are plentiful. These accretions are, however, very rarely permanent, for courses of rivers in low alluvial plains are very liable to shift across their flood-plains. These Diaras and Chars often first appear as thin slivers of sand. On this is deposited layers of silt till a low bank is consolidated. Tamarisk bushes and spiny grasses establish a foot-hold and accelerate deposition. The people from either bank settle these accretions as soon as the river recedes in winter; the river flows being considerably seasonal. For several years the Diara or Char may be cultivable only in winter, till with a fresh flood either the level is raised above the normal flood level or the accretion is diluvated completely. Certain Chars and Diaras appear very substantial while others appear to be mere sand or mud-banks. Some are very flat, while others are undulating. There are three types of these accretions, according to the principal composition of their soil. The clay or mud Chars and Diaras are not easily cultivated, so they are genearlly used as pastures during winter. The sandy Chars and Diaras are infertile, but landless cultivators often try to raise a millet or pulse crop on them. These are also favoured for pastures. Those with silty soils are obviously the most prized: on some of them crops can be grown with practically no tillage. As a general rule, the accretions in the upper courses of the rivers within Bangladesh are sandy, those in the middle courses are silty, and those in the lower courses have a high proportion of clay. The Ganges Diaras and Chars within Bangladesh stretch from the south-west of Shibganj Thana to the south of Bera Thana, a distance of 165 winding miles. The Ganges here fluctuates between its high levees on either side, which are from three to twelve miles apart. There are large Diaras south-west and south-east of Shibpur Thana, north of Daulatpur Thana and south of Charghat, Ishurdi, ,Pabna and Shujanagar Thanas. Chars are numerous and shifting very often. The principal ones are south of Rajshahi and Shujanagar Thanas.

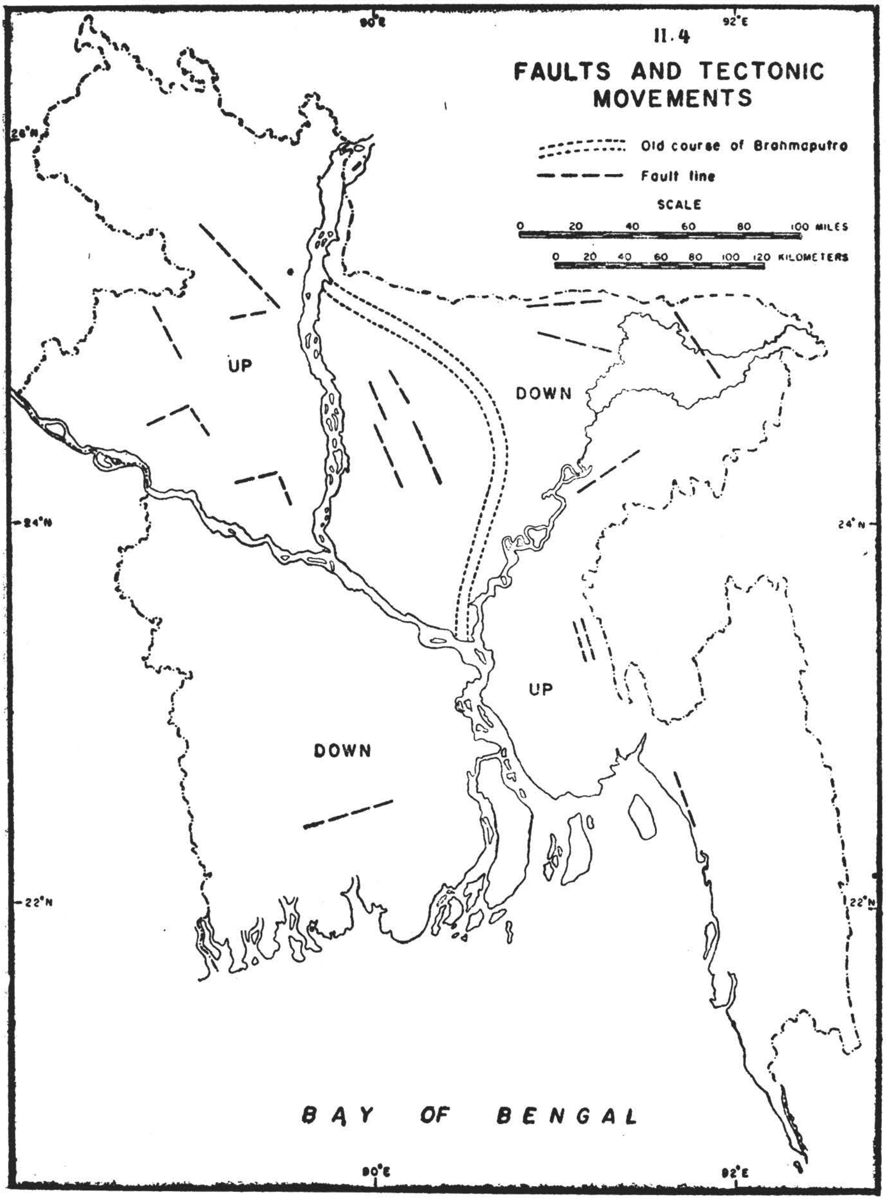
(b) *North Ganges old floodplain*: This broad high floodplain stretches from Premtali in Godagari Thana to Shujanagar Thana where it slopes into the Jamuna floodplain. The southern part of this floodplain is a levee. The northern part is lower. Because of the fluctuations in the course of the Ganges, the levee is not everywhere beside the river. In the south of Charghat Thana, the levee is far from the present course of the river, the intervening ground containing point bars, swales, and Diara accretions. Formerly the north Bengal rivers used to flow directly south into the Ganges, but during the eighteenth and nineteenth centuries the levee has built itself up rapidly. The starting point of this rapid built-up seems to have been the damming up of the Ganges by the first onrush of the newly formed Jamuna Branch of the Brahmaputra in the late eighteenth century. Since then, the levee has built itself up through the depositions of the Ganges and the Atrai and its tributaries. It varies in width from two to twelve miles, and its total area is about 170 sq. miles. Heights vary from 70 to 90 ft. The southern side presents an abrupt face where the Ganges cuts past it, but in the north it slopes gently into the 'backswamp' of the Bhar Basin.

The southern part covers Bagatipara, eastern Paba, northern

Puthia, Duragapur, Mohanpur and southern Bagmara Thanas. The land here is a succession of saucer-shaped basins, rimmed by old river levees and point bars. It was once the backswamp of the Ganges, but as that river built up its left bank levee, this area has become progressively drier. The small basins are silting up.

X. Brahmaputra-Jamuna Floodplain

A dual name is used for the mighty Brahmaputra river, because the Jamuna channel is comparatively new and this course must be clearly distinguished from that of the older Brahmaputra (Region XI). Before 1787, the Brahmaputra's course swung east to follow the course of the present old Brahmaputra (Map II.4). In that year, apparently, a severe flood had the effect of turning the course southwards along the Jenai and Konai rivers to form the broad, braided Jamuna channel. The change in course seems to have been completed by 1830. Fergusson (1863) suggested that the diversion may have been due to the uplift of the Madhupur Tract (called 'Madhupur Jungle' in most of the earlier writings). La Touche (1919) disagreed, and suggested that the change in course was directly due to an increase in the volume of water carried, when the Dihang tributary of the Brahmaputra cut back and beheaded the Tsangpo river of Tibet and thereby received an 'enormous accession of water'. That the Tsangpo, which flows through a dry plateau, is a small river by the standard of those in the Indian sub-continent, does not seem to have occurred to him. The accession of even two or three hundred thousand cusecs could not have made such a difference to a river which was even then well over a mile broad in its course through Mymensingh. Hirst (1916) advanced the more plausible concept of a zone of subsidence between the two large Pleistocene blocks of the Barind and Madhupur. He suggested that these two blocks had been elevated 'as compensation to a line of subsidence passing approximately from Jalpaiguri to the sea, down the alignment of the present Meghna river'. Hayden and Pascoe (1919) strongly attacked this concept and accepted the


II.4
FAULTS AND TECTONIC MOVEMENTS
Old course of Brahmaputra
Fault line
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E
92°E
26°N
24°N
22°N
UP
DOWN
DOWN
UP
BAY OF BENGAL

'rational' explanation of La Touche, which since then was not seriously challenged till the findings of Morgan and Mcintire (1959). In their stimulating paper, they put forward four points as evidence that there is most likely a zone of subsidence between the two large Pleistocene blocks. Firstly, the change in the course of the Brahmaputra is in response to a steeper gradient along the course of the present Jamuna. This gradient must have increased sufficiently by the 1780s to need only the trigger action of a single flood to divert the river. Secondly, there are faults on both sides of the hypothetical zone; there are six echelon faults west of the Madhupur Tract and a large fault north-east of the Barind Tract. Thirdly, the hypothetical Garo-Rajmahal gap stretched across the Northern Region, and sank only in the Oligocene period, and is quite possibly an unstable mass. Fourthly, the vast amount of sediment carried to sea by the Meghna river (the main mouth of the combined Ganges-Brahmaputra-Meghna rivers) for the last 200 years, at the least, has not built out the deltaic front appreciably. Subsidence in the estuary of the Meghna possibly hinders the rapid building of islands and Diaras. On the evidence avilable, Morgan and Mcintire accept and elaborate upon the theory of a zone of subsidence between the Barind and Madhupur Tracts, which in turn elevates the two tracts on either side.

(a) *Bangali-Karatoa floodplain :* This plain was once a part of the Tista floodplain, and now through the Bangali distributary of the Jamuna it is part of a bigger floodplain. The relief is that of broad ridges and basins. Some of the ridges are shallowly flooded but most of the ridges and all the basins are flooded more than 3 feet deep for about four months (mid-June—mid-October) during the monsoons.

(b) *Diaras and Chars :* Along the Brahmaputra-Jamuna, as along the Ganges, there are many Diaras and Chars. In fact there are more of them along this channel than in any other river in Bangladesh. There is a continuous line of Chars from where this river enters Bangladesh to the off-take point of the Dhaleshwari river. Both banks are punctuated by a profusion of Diaras. The largest of these are in Rahumari Thana where they form most of the land between the river and the abrupt faulted western end of the Meghalaya Plateau. There are other large Diaras on the opposite bank in Bhilmari Thana. Chars are profuse: there are so many of them where the river turns past the Meghalaya Plateau that the banks are 10 miles apart with several dozen shifting semi-permanent Chars in-between. This extremely braided course of the river is about 50 miles long. Below Fulchari-Ghat* there are several stretches with no Chars. There are, however, considerable Chars between Sirajganj and Jagannath-ganj-Ghat. As in the Ganges the soil and topography of the Chars and Diaras varies considerably. Some of the larger ones have point bars and swales. The elevation between the lowest and highest points of these accretions may be as much as 15 feet. The difference between them and the higher levees on either bank can be up to 20 feet.

(c) *Jamuna-Kaliganga floodplain :* This is the left bank floodplain of the Brahmaputra-Jamuna. Several distributaries of the Jamuna flow through here. The Kaliganga is by far the largest of them. The southern part of this sub-region was once a part of the Ganges floodplain (through the now moribund Buriganga channel). Most of this area is flooded more than 3 feet deep during the monsoons.

XI. OLD BRAHMAPUTRA FOODPLAIN

When the Brahmaputra turned south and adopted the Jamuna as its main channel, the old course between Bahadurabad and Bhairab shrank through silting into a small seasonal channel only a quarter of a mile broad (Chapter III). The old river had already built up fairly high levees on either side over which the present river rarely spills. The levees slope away to lower ground; in the north there is a long depression parallel to the alignment of the Meghalaya Plateau, and only a few miles from it; in the south the

* 'Ghat' means a landing place.

plain is more uniform in level, possibly because the Madhupur tract dips beneath it just where a backswamp would have been. There is however, a very conspicuous depression in the south of Ghaffargaon Thana between the old Brahmaputra river and the Madhupur tract.

(a) *High rides:* This sub-region begins at the foot of the Garo hills and curves along the old course of the Brahmaputra to end near Nakla. The relief here is of broad and narrow, high flood-plain ridges, with lower ridges and inter-ridge depressions between them.

(b) *Floodplain complex:* This long and narrow sub-region follows the course of the old Brahmaputra and has a relief of irregular ridges and depressions with some extensive areas of smooth ridges and basins. The higher ridges are on the northern side.

(c) *Western plain:* This part of the plains is cut off from the southern section by an arm of the old Brahmaputra. The active floodplain all around floods fairly deeply but most of this plain is only shallowly flooded within the rice field bunds.

(d) *Northern plain:* This large sub-region is roughly in the shape of a broad T, the east-west arm extending 70 miles from Mohanganj to Sherpur, and the north-south arm extending 60 miles from Purbadhala to Katiadi. This plain also has a relief of broad ridges and basins, locally irregular along old channels. Basins are usually flooded more than 3 feet deep, but the ridges are only shallowly flooded.

(e) *Southern plain:* This large section extends from the Brahmaputra-Jamuna to the old Brahmaputra and almost encloses the northern part of the Madhupur Tract. Three outliers of the Tract are within the plain. The relief is that of broad ridges and basins, except along the Modhupur Tract where it is often undulating. The plain is almost divided in half just east of Jamalpur, where seven broad undulations of the floodplain complex (b) almost join the northern-most spur of the Madhupur Tract. There are a few fairly deep basins within the plain, of which the one at Moshakhali is most prominent.

(f) *Eastern plain:* This sub-region has the broad ridges of the Northern plain, but the basins are deeper. The higher ridges are only shallowly flooded but all the basins are flooded more than 3 feet deep. Most soils have a strongly developed ploughpan impeding internal drainage.

(g) *South-eastern plain:* This section is a continuation of Northern plain across the Old Brahmaputra. It is cut off from the Southern plain by an extension of the Madhupur Tract. There are numerous small sandy patches on the ridges. Most of the area is only very shallowly flooded within the field punds. This plain contains several outliers of the Madhupur Tract, including the Eastern Sub-region (XIII. d).

XII. SUSANG HILLS AND PIEDMONT

(a) *Susang Hills:* This region extends in a thin line of some 100 miles length from the north of Jamalpur Sub-Division to the north of Sunamganj Sub-Division. It includes the hillocks at the base of the Meghalaya Plateau, which are within Bangladesh and the land in between and around them, which is high and sloping. Beds and outcrops of rocks of the Jaintia Series, of the Eocene age, occur (Wadia 1953). They are mainly sandstones and shales: recently limestone (of the Sylhet limestone stage) has been found in north Sunamganj Sub-Division. There are small quarries of nummulitic limestone in the north of Jamalpur Sub-Division. Large deposits of white clay have also been found here. The highest of the hillocks within Bangladesh are over 300 ft. The valleys are at a height of over 100 ft. Many entrenched mountain streams cut through this region, depositing sand plentifully. Over much of its length this narrow belt gives way very rapidly to low waterlogged land. In the eastern part of this region, the Meghalaya Plateau ends abruptly in a series of gigantic faults, over 2,000 ft. in height, and the narrow gravelly ledge at its base sinks down to the very low Haor Basin.

(b) *Piedmont Plains:* This sub-region covers most of Nalitabari, Haluaghat and Kalmakanda thanas and part of Durgapur thana. It has a gently sloping relief, with a line of extensive basins in the south. Most of the area is only very shallowly flooded in the monsoons, and that too due to field bunds to retain the rain water. A few basins in the south are deeply flooded. Occasional flash floods affect the whole area.

XIII. MADHUPUR TRACT

Like the Barind, this is another large Pleistocene inlier within the Bengal Basin, with an area of about 1,590 sq. miles. It is tilted towards the south-east. This elevated tract is probably the result of the very interesting tectonic movements to which the Bengal Basin is being subjected. The problem will be discussed further on.

(a) *Northern Tract:* The northern end of the tract (Map II.3) is characterised by its large plateaulike hillocks, known as Chala. They are 30 to 60 feet in elevation and have slightly dome-shaped tops. Between them are narrow winding valleys (mostly flattened and terraced for rice cultivation) known as Baid. The drainage pattern is dendritic. Morgan and McIntire (1959) found two faults on its western face, and five faults traces in it. The two faults are each some twelve miles long and upthrown to the east. Their elevation varies from 30 to 60 ft. The southern fault is the western face of a block slightly detached from the main one by a valley of recent deposits. The north-eastern side of this sub-region slopes into the overlapping recent sediments with a slight fault, and the south-east is largely bounded by a fault. From the northern end of the tract five spurs reach out to the old Brahmaputra river. They divide and sub-divide into a number of undulating ridges, with comparatively low flat land in between them. The area covered by these spurs and the land between them is about twenty-five square miles in area.

(b) *Central Tract:* This area can be divided into two parts. The eastern part of the block, about 150 sq. miles in area is bound on its west by a fault downthrown on the eastern side. It is characterised by chains of Chalas, with not very broad tops, and deep circular Baids, most of which are not connected with each other. The western part is highly dissected, being characterised by small Chalas and a profusion of winding Baids. The western side has four faults, downthrown to the west, and presenting an elevation from 20 to 50 ft. The drainage pattern is, of course, dendritic.

(c) *Southern Tract:* The large southern sub-region has a topography different from that of the other four sub-regions. Here, most of the terrace is almost flat in relief, except where streams have cut across it. The levelling for rice fields has gone a long way towards making the relief uniform. Besides the streams and especially along the Lakkha river, the terrace presents a marked elevation because of the entrenched drainage pattern and the dissected nature of the tract. In the south, the tract reaches the Buriganga and a small bit of it has been traced on the other bank. The level here (in and around Dacca City) is uniform mainly due to artificial levelling. There are extensive waterlogged Baids in the eastern part.

(d) *Eastern Tract:* Three bits of the terrace are detached from the main Tract by the Old Brahmaputra and Lakkha rivers. The southernmost, at Sonargaon, is very small. The northernmost at Egaro Shindur, is also small. South-east of the latter area is the third, fairly large, block in Monohardi and Shibpur Thanas. The drainage in this sub-region is not markedly dendritic, but definitely entrenched.

XIV. Haor Basin

This large basin takes its name from the multitude of large lake-like bodies, known as Haor, with which it is dotted. This sub-region stretches from the Mahadeo and Mogra rivers to the plain of Central Sylhet. Its greatest length, both east-west and north-south, is just over 70 miles. The area covered by the basin is about 2,800 sq. miles. The sinking of this large area into its present saucer-shape seems to be intimately connected with the rise of the Madhupur Tract. Local tradition has it that the land sank 30 to 40 feet in the last 200 years. Areas which used to grow floating rice fifty years ago cannot do so now due to the depth of flooding. Indications are that these areas sank 3-5 feet at least in this period. Morgan and McIntire (1959) also considered that this basin has sunk 'at least 30-40 feet within the last several hundred years'. Could it be that the earthquake of 1762 began the diastrophic sinking which is still going on?

(a) *Central Basin:* In the basin there are two very low areas: one near Sulla, more or less in the centre of the basin and the other along the north-central rim. The low area near Sulla and Khaliajuri has large tracts below 10 feet level. Most of the basin on all sides gradually rises higher. The basin itself is a succession of Bils and Haors of various sizes, interspersed with river cutoffs, scours, swales and long higher levees known as Kandha. The Kandhas in this central area are around 20 feet level. For seven months of the year the aspect is that of a vast lake, then all but the higher Kandhas go under water. This central area covers much of Khaliajuri, Sulla, Dirai, northern Baniachang and Jamalganj Thanas. The second very low area contains the Tangua Haor, directly to the north of the centre, at the foot of the Meghalaya Plateau. This area is as low as the centre, but the rim lands are higher (30 feet level). From the central very low area, the basin rises on all sides but imperceptibly. On the west the rise is fairly sharp at the edge of the Old Brahmaputra floodplain. In the north there is a fairly high rim of land between 30 and 45 feet level separating the two lowest areas. Around Gohala it rises over 50 ft. (This may be the remnant of low hills). In the east the basin rises very gradually. In the south-east the rise is gradual at first and then fairly steep. There are broad levees at Ajmiriganj and Bangalpara. The rim lands drain out earlier and fill later than the centre: in winter when the water-level falls the streams have the appearance of being entrenched.

(b) *Susang Piedmont basins:* There is a line of deep basins between the Susang piedmont plains (XIIb) and the Northern plains of the Old Brahmaputra (XI d). These basins merge into the deeper Haor areas to the east. Most of this area is seasonally deeply flooded.

(c) *Meghalaya Piedmont Depression:* This long depression stretches from the Rongra river in the west to the Lubha river in the east. A large fault along the southern edge of the Meghalaya Plateau is the cause of this long low strip of land: parts of it may still be sinking. The lowest part is the Tangua Haor area, which is at the foot of the tremendous fault scarp that extends from the Mahadeo river to the Jadukata river. The part of the depression to the west of it averages about 20 ft., on the Kandhas. In the east, the land gets higher and Kandhas are generally between 30 and 40 feet.

(d) *Central Sylhet Lowland:* This depression contains the Hakaluki Haors and Bils and the low-lands to its north-west and south east. The heavily silt-laden Juri and Kushiara rivers are filling up the low areas and in a couple of decades the water area will be greatly reduced.

XV. Sylhet High Plains

This region is in large measure the higher land between the three major sub-divisions of the Haor Basin. Over much of its length it is above 30 feet and the streams are fairly entrenched. In some parts there are Haors and Bils, but their level is higher than those of the Haor Basin and most of them drain out in early winter.

XVI. Sylhet Hills

Small areas of the Meghalaya Plateau foot-hills fall within Bangladesh. To the south of them there are four small hilly tracts and five hill ranges. The hilly tracts could be remnants of Pleistocene terraces. The hill ranges are anticlinally folded and continue south into the Chittagong Region.

(a) *Meghalaya Foot-Hills:* Along the northern border of Sylhet District, some of the foot-hills of the Meghalaya Plateau (the Khasi and Jaintia hills part) are within Bangladesh. Very small bits are within the border to the north of Tahirpur. North-east of Sunamganj there is an area of scattered hills both west and east of the Khasimara river. The Chhatak Hills to the south-east are actually a continuation of these. Further east there are two hills, one reaching 171 feet, close to Bholaganj. Near Bholaganj the alluvial fans yield a large amount of boulders and shingles. To the east of the Piyain river there is a five mile long hill area known as Jaflong. Here heights reach over 200 ft. To the south-east there is a continuous hilly area from Jaintiapur down to the point where the Surma river forms the border with India. Here the main hill groups are Jaintiapur (up to 176 feet), Shari (Dupi Tila 299 feet), Lalakhal (Kesara Pahar 501 feet), Bariyal (265 feet), Sonatan Pahar (294 feet), Numchara (over 200 feet), Lubhachara (over 300 ft.), Mulagul (Khasia Tila, 327 ft. and Chatal Tila, over 400 ft.), Dawkergul (263 ft.), and Dona (over 250 ft.).

These foot-hills are composed of the Jaintia series of sandstones and nummulitic lime-stones, and the Surma series of sandstones, sandy shales, mudstones and thin conglomerates, nummulitic lime-stone and pebble beds of the Pliocene. Dihing series are found in the gravelly alluvial fans.

(b) *Tila Ranges:* Tila is the name given to small hillocks. There are four main goups of hillocks in northern Sylhet District. The group at Chhatak has an area of 25 square miles. It reaches heights of 146 and 144 feet (Taramun Tila). This group has a north-west to south-east trend and is actually a continuation of the foot-hills along the Khasimara river. The group of Tilas at Sylhet form fairly well defined ranges with a north-east to south-west trend. South of the Surma river the highest point is Orthoki Tila (94′), North of the river the main heights are Abangi Tila (251′). Barutni Tila (260′) and Cherragong (300′). This group has an area of 72 square miles. A few miles to the south-east is the 30 square mile Dhakadakhin group of Tilas which reaches up to 209 feet at Kailash Tila and over 200′ north of the Surma river. A few miles to the east of this group are the Tilas of Beani Bazar, which cover 20 square miles and reach over 100 feet in places. These Tilas are actually an arm of the Patharia range to the east. Similarly the Dhakadakhin group seems to be an isolated remnant of a range that formerly joined the Ita range in the south to the Lalakhal foothills in the north. The Sylhet group may have once been joined to the Bhanugach range in the south and the Jaflong foot-hills in the north. The high plain of central Sylhet, with its entrenched streams may possibly be the remnant of these denuded ranges.

These Tilas have Pleistocene clays and sands over course ferruginous sandstones, mottled sandy clays and shales of middle Miocene age (Dupi Tila series). Petroliferous beds have been found in them: near Dwara Bazar in the Chhatak Tilas, at Panircherra in the Sylhet Tilas, and near Golapganj in the Dhakadakhin group.

Six hill ranges project into the south of sylhet District from the Indian State of Tripura. These ranges are, in a sense, the continuation of those which traverse the Chittagong Region in the south-east. These six ranges, which project into the plains from the south are, from east to west, the Patharia, Harargaj, Rajkandi-Ita, Bhanugach, Tarap and Raghunandan. The Patharia forms the eastern border for twenty-five miles and reaches heights of over 600 ft. (Kuleral Tila 682 ft.). The Haragaj is, in a sense, its continuation to the south-west. Sixteen miles of this range is in Bangladesh ; the central ridge reaches 1,102 ft. at Harargaj Peak. Twelve miles to the south-west is the Rajkadi-Ita range. In its forty miles length within Bangladesh a height of 436 ft. is reached. At the border there are higher peaks, such as Hiara (517′) and Parwatang (912′). The Rajkandi Range terminates at the valley of the Manu river, but re-appears on the northern side as the Ita Range which has a length of 14 miles and reaches a height of 215 ft. The broad Doloi Valley to the west of the Rajkandi Range is fairly high, the height at patrakhola being 115 ft. West of this valley is the Bhanugach or Balisira Range. It is 27 miles long, and reaches a maximum height of over 550 ft. in the south. In the south, this range is joined to the Tarap Range to the west, which is 30 miles long and reaches up to 200 ft. height at only a few places. The western-most range, the Raghunandan or Laskarpur, is 16 miles long and reaches heights of over 400 ft. in the south, but ts mostly below 150 ft. The valley between these ranges slope up from 50 to 150 height. The Raghunandan and Tarap ranges appear to be thickly mantled by Pleistocene deposits. The other ranges have a thinner mantle. Their origin and composition is more or less similar to the ranges of the Chittagong Region, which will be discussed later.

XVII. Meghna Flood-Plain

Much of the flood-plain of the Meghna was built up by the Old Brahmaputra river, when that carried the main stream. The Meghna continues to fill in the depressions left since then but is not building up any more north of its confluence with the Dholeshwari.

(a) *Titas Basin:* This plain is flooded by the Titas distributary of the Meghna, which leaves it near Chatlapur and re-joins it near Nabinagar. The low ground is in a sense the continuation of the Haor Basin Rim, but it does not slope towards the centre of that Basin. It is studded with point-bars.

(b) *Meghna-Lakkha Doab:* This large piece of land includes part of the Lakkha-Bangshi Doab to the west. This Doab is low and very fertile.

(c) *Middle Meghna floodplain:* Along the middle Meghna river, as is to be expected, there are many large Chars and Diaras, separated from those to the south because the latter are part of the Delta, while the former are not. There are several very big Chars between Bhairab Bazar and Daudkandi—which is opposite the Dholeshwari confluence. Whereas the Chars in the lower course of the Meghna river are liable to sudden changes, most of those in its upper course are fairly stable.

XVIII. Tippera Surface

The Tippera surface (named by Morgan and McIntire) or the Tippera-Noakhali Clay Plain (according to B.L.C. Johnson), is a distinctive physiographic unit. It has a rectangular drainage pattern in contrast to the braided and meandering pattern of the floodplain (see Chapter III Hydrography). The soil is slightly more oxidised than the flood-plain deposits. According to Morgan and McIntire (1959) the surface re-appears to the north at Habiganj, where it is limited on the north by a north-east to south-west fault trace. The semi-detailed survey by the Soil Survey units shows a more complicated topogarphical pattern than is suggested by Morgan and McIntire.*

(a) *Eastern Piedmont Strip and Lalmai Range:* This is a narrow strip of land along the base of the Tripura Hills, which are within India. This strip varies in width from half-a-mile to more than three miles within Bangladesh. It is mainly composed of Pleistocene sediments, overlain by sandy clays washed down from the hills. This Piedmont Strip, which is much broader in the Tripura State of India, is a Pleistocene terrace. The Lalmai range, a couple of miles west of Comilla town, is 9 miles in length and from half to one and a half miles wide. Its highest peaks are over 150 feet. It is bounded by faults on the western and eastern sides. The fault scarp on the east is up-thrown to the west and considerably dissected by drainage channels. On the west there are two parallel faults about a mile apart. Both are up-thrown on the east. The inner fault forms a well-defined valley. The outer (western-most) fault has a surface throw in excess of 100 ft. at several places (Morgan & McIntire 1959). Structurally this range is a horst, tilted to the east. The upper part of this horst is composed of oxidised clays and sands of Pleistocene age, which rest upon beds of sandy shales, coarse ferruginous sandstones and mottled clays and sands, probably of the Tipam Series. Fragments of fossil wood are plentiful. The eastward dip of the upper deposits is slight, but of the lower deposits quite steep.

* See the Reconnaissance soil survey reports for Noakhali district and Chandpur subdivision (1966) and Sadar North and South subdivisions Comilla district (1965): Directorate of Soil Survey, Dacca.

(b) *Low floodplain:* This long floodplain stretches from Nabinagar south to Maijdi. The relief is that of almost level broad ridges and basins, mainly deeply flooded by accumulated rainwater in the monsoon. Flooding is caused by the Meghna and also by the smaller rivers such as the Gumti and Dakatia. A long depression from Kachua to Maijdi marks an area of deeper flooding. There are extensive man-made raised land in the south-west, around Ramganj.

(c) *High floodplain:* This sub-region is mainly shallowly flooded, except in the extension in the north to Nabinagar, where half the land is deeply flooded. Most of the area has level, broad ridges and basins, with irregular narrow ridges and basins along the Gumti river. There is also a long, narrow depression along the Dakatia-Little Feni river which is seasonally deeply flooded. West of the Lalmai Hills there is some man-made raised land. Flash floods occur, especially in the Gumti and Silonia rivers. The Comilla Basin between the Lalmai range and the Tripura Hills is probably a graben.

XIX. MORIBUND DELTA

There are many different opinions as to how much of the Bengal Basin can be considered as the Ganges-Brahmaputra Delta. In fact it is even contended that there is not one delta but several deltas. Strickland's delimitation of the delta as the 'area of transcendent deposition' (Strickland 1940) is acceptable if only the upper floodplains of the rivers are not included and the Moribund Delta is included as an area with recent transcendent deposition. The delta of the Ganges-Brahmaputra rivers is here defined as that area included within the seaward distributaries of the Ganges and the Jamuna channel of the Brahmaputra (Map II.3).

The Moribund part of this Delta is characterised by rivers choked with sand and unable to carry much water except when the Ganges is in high flood; a profusion of ox-bow lakes; high plains well above normal flood-level, and interfluve depressions which are not filling up because of the absence of the annual spread of sediments (silt) which is of such great importance in the active part of the delta. This region can be conveniently classed as a high plain, with many crescent shaped basins (ox-bow lakes) which have water in them throughout the year. The rivers are slightly entreneched. They are almost dry most of the year; during the rainy season they drain the surface water primarily, and if their connection with the Ganges is not choked with sand, they may also carry some of its flood water as a distributary. An exception to the rule is the Gorai, which takes off a good part of the Ganges water into the Pussur and Baleshwor rivers. The north-west and south-west of this sub-region are higher than the rest, and their soil is also sandier.

XX. Central Delta Basins

This extensive basin in the heart of the delta cannot be satisfactorily explained by Strickland's hypothesis of a seaward ledge and its blocking of inland deposition. These large basins (also known as the Faridpur Bil Area) are about 1,200 sq. miles in area. The most satisfactory explanation to date has been advanced by Morgan and McIntire, whose hypothesis about the structural forces affecting the Bengal Basin has been referred to earlier. Their theory, that part of the Delta is subsiding as a compensation to the elevation of the Tippera Surface and the Barind Tract, is plausible. The origin of the Central Delta Basins, with their extensive Bils, lies probably in the absence of rapid deposition by the active distributaries (which flow towards its east) coupled with steady subsidence due to warping by torsional forces. The associated slightly higher land to the south of these Bils has been explained by Strickland (1940) as the zone where the rise of the tide (of 18 ft.) has led to rapid deposition of the silt carried by the once active rivers. The formation of this ledge has probably proceeded with compaction of the deposits, which made the depression along the east-west line to the north of it. The findings of Morgan and McIntire (1959) seem, however, to indicate a tectonic origin for these Bils.

XXI. Immature Delta

South of the Mature Delta, there is a broad belt of land, barely above sea level. Whereas the height of the southern edge of the Mature Delta is about 8 ft., the height a few miles to its south is only 3 ft. This very low land of some 3,000 mile area, contains the Sunderbans forest and the Sunderbans reclaimed estates (cultivated land). There are two possible causes for the existence of such a large very low estuarine area—insufficient deposition by the Ganges distributaries or subsidence. Till the seventeenth century the main Ganges distributary seems to have been the Hoogly-Bhagirathi. In the next century the Ganges sent more and more water down its more eastern distributaries, till the 1787 flood and the break-through of the Jamuna forced it back and the Gorai distributary was enlarged. The Ganges subsequently once again shifted east. Between the Hoogly-Bhagirathi and the Gorai (and its continuation, the Madhumati) the Ganges had two main distributaries, the Ichamati and the Bhairab, neither of which built up more than their own levees. The Jalangi and Mathabhanga rivers cut across the drainage lines of these rivers in the eighteenth century, but their work lasted only about a century. It seems, therefore, that the main distributaries of the Ganges never flowed through this region, and the small ones that did lasted a few centuries at most. The building up of this estuarine area is consequently not complete. The tides may have also contributed to the retardation by forcing the major part of the sediments to be deposited along the ledge, which extends from the levee of the Madhumati and Narail Thana west-south-westwards to the Hoogly-Bhagirathi at Calcutta.

It is also possible that subsidence has played a major part in depressing this area. There are many evidences of it, such as large ruins in the heart of the swampy estuarine areas (Shekertek, Bedkashi, etd.) (Fawcus 1927), and the presence of human artifacts and tree stumps, buired in the alluvium many feet below the level of the sea. Hunter (1875) recorded the presence of large tree trunks buried in the ground at Khulna Town, indicating a subsidence of 18 ft. During the foundation borings for the Khulna Shipyard Docks, decayed wood was found as far down as 99 feet (Morgan & McIntire 1959). Possibly compression of the sediments forced them so far down. Morgan and McIntire (1959) made many borings and found maximum indications of subsidence to the extent of 22 feet at Dhakikhal, 20 feet at Dubla Island, and 34.5 feet at Shekertak ruins near the Shibsha river. Similar evidence has been found in the Central Delta Basin and its western area. Fawcus (1927) records that the cross section of a tank dug beside of the Bils showed the following strata:

From ground level to 5 ft. below	Dry sandy soil
5 to 10 ,, ,,	Wet sand
10 to 15 ,, ,,	Mud
15 to 20 ,, ,,	Caked mud with fissures (i. e. drier)
20 to 21 ,, ,,	Peaty debris
21 to 23 ,, ,,	Mud with tree remains
23 to 24 ,, ,,	Peaty debris
24 to 26 ,, ,,	Mud with tree remains
26 to 29 ,, ,,	Peaty debris
Below 29 ,,	Clear sand

Most of the indications are that there has been subsidence to a maximum of 40 ft. both in this part of the Delta and in the central Delta Basin. Quite likely the Mature Delta has also been affected but that it has not sunk so low because the tidal action precipitated most of the silt of the several Ganges distributaries of that area fast enough to counteract the sinking. It seems that both the absence of adequate deposition and subsidence are responsible for the incomplete build-up of this region. As is to be expected only along the rivers the slightly higher levees afford places for settlements.

The sea-ward face of this region is a network of branching streams around roughly oblong shaped islands. When silt laden streams reach the sea, their velocity is checked and their sediment load is flocculated. Bars form at the mouths, and the streams branch off to either side. In time these branches too form their bars and are also divided. As this process goes on the branches unite and redivide and the bars coalesce into islands, which are sometimes cut apart. This process forms a network of channels.

The high tide ponds back the estuarine rivers and force them to break their banks and open out cross-channels. These are a marked feature of the low areas much affected by tides, for 'as the delta is elevated out of tidal influence, the cross-channels disappear' (Strickland 1940). The sea-face is in places marked by old beachridges, of a peculiar formation (Fawcus 1927). The sandy beach, usually facing south-west is backed by a ridge of sand dunes twenty to thirty feet high; behind this is a grassy plain, of about half-a-mile width and parallel to the beach; this plain is bordered by a belt of mud, usually with a stream and forest trees. Behind this mud-flat there is again a succession of sandy shelf (an old beach), sand dunes, grassy plain and mud flat. Some beach-ridges are as much as two miles inland. Their mode of formation depends upon the tide, which in this area ebbs towards the south-west. This makes the estuarine rivers build a south-west facing bar on the eastern side of their mouth since there the water is stiller. The summer tides and storms build up the sand dune ridges. The channel between the ridge and the mainland gradually fills up into a mud-flat and diverts the rivers' silting further down.

There are extensive shoals, extending ten or more miles out to sea, between the larger rivers. At the mouth of the Raimangal river, the shoals extend twenty miles from the land. Between the Haringhata and Marjata estuaries, shoals cover more than 30 square miles. A notable feature is that they are higher on their sea-ward sides than on their land-ward sides by two to three fathoms.

This stretch of the coast contains the big islands of Patni and Dubla.

XXII. MATURE DELTA

(a) *Old Ganges floodplain:* This sub-region lies to the north of the present channel of the Podda and receives flood water from both the Jamuna and the Podda. This area does not receive extensive silt deposits any more, nor is it subject to much diluvion. There are extensive man-made raised land near Munshiganj and a large depression known as the Arial Bil.

(b) *Podda-Madhumati floodplain:* Land levels in this large sub-region varies considerably, from very shallowly flooded land in the north-west to deeply flooded basins in the south-west. There is some overland flooding, but the essential feature of this area is that there is neither extensive alluvion nor diluvion. Much of this plain was built up by the Madhumati when it was the main channel of the Ganges, but with the shifting of the main channel the land building process has ceased.

(c) *Non-saline tidal floodplain:* This sub-region differs from (b) because of the strong tidal effect. The relief is that of shallow basins, with ridges (levees) along the rivers. Most of the area is seasonally shallowly flooded, with the depth of flooding varying with the tide. In the dry season only the deeper basins continue to be tidally flooded.

(d) *Saline tidal floodplain:* Here the tidal effect is much stronger than in (c) and in the dry season the river water turns brackish. Tidal flow is strong and the scouring effect is quite noticeable. Cross-channels between the larger rivers exist, as in the Immature delta. Some basins in the interior are deeply flooded in the monsoons. Slow deposition is continuing at the mouth of the larger rivers.

XXIII. ACTIVE DELTA

(a) *Active Podda floodplain:* This area is subject to flooding, alluvion and diluvion from the Podda. It includes Chars and Diarâs in and on both banks of the river. Most of the chars are of calcareous silts and sands. The large diara along the right bank of the river is mainly calcareous loams and clays. Flooding varies