



DEDICATED TO MY GRANDFATHER

(Late) Sri Atul Chandra Thokdar

STATUTORY DECLARATIONS

I hereby declare that the thesis titled "*A STUDY ON FLUVIAL DYNAMICS OF UPPER MAHANANDA RIVER BASIN IN DARJEELING DISTRICT, WEST BENGAL*", is the original research work and has been prepared by me under the guidance and supervision of Dr. Snehasish Saha, Associate Professor of the Department of Geography and Applied Geography, University of North Bengal. All the materials including literature, maps, diagrams, photo plates and any other materials embodied in this thesis submitted by myself is acknowledge and for academic purpose only. I ensure that no part of this thesis has been submitted for the award of any degree or fellowship previously, except a few parts for peer-reviewed journals to partially fulfill the need for Ph. D degree. The work of other authors or any other organizations/agencies wherever made use of, in this study has been duly acknowledged at relevant places with appropriate and possible recognition. The published works either in the form of direct or indirect utilization have also been used with proper Courtesy. Any mistake in doing so is purely unwanted and unintentional and subject to the proper acknowledgement to the concerned author(s), organization or agency etc., though there is hardly little chance of that.

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Date: 13.12.2023

Place: N. B. U.


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CERTIFICATE

This is to certify that **Mr. Tanmay Thokdar**, a Research Scholar of the Department of Geography & Applied Geography, University of North Bengal has carried out his Ph.D. thesis titled “*A STUDY ON FLUVIAL DYNAMICS OF UPPER MAHANANDA RIVER BASIN IN DARJEELING DISTRICT, WEST BENGAL*” under my supervision which is being submitted to the University of North Bengal for the award of Doctor of Philosophy (Ph.D.) in Geography & Applied Geography under the faculty of science.

To the best of my knowledge and belief it is his original research work based on extensive field survey and secondary sources of information done by the researcher.

This thesis as a whole or any part of it has not been submitted to any other University/ Institution for any other degree.

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PREFACE

Dynamism is one of the characteristics of life. Life without dynamics signifies that interaction with the environment is about to stop or has already been stopped. The same thing happens in the life of rivers. The term ‘fluvial’ is from the Latin word ‘fluvius’ a river (online, ‘your dictionary’). Fluvial means whatever outcomes through the action of a river or pertaining to a river or stream. It deals with the moving materials and the factors affecting the movement. Thus, fluvial dynamics basically deal with the water flow, sediment movement and also with the bed-form features resulting out of the interactions between flows and transporting materials within the channel system. The study of fluvial action and its dynamics of any channel especially foothill channels are related to the erosivity of the river, bed load character, entrainment of the load and processes that are operating within the valley. On the other hand, the alluvial channels show a wide variety of morphological forms in response to the complex interaction with the hydrological conditions.

Chapter I

The overall and fundamental introduction to the research was given in Chapter I, which talked about the problems of the study area, as well as the specific research objectives and methods that would be used to reach those goals. In later parts, the hypothesis was built up and expected for the further testing. Some relevant objectives aiming to justify the title and related conformal methodological aspects were taken up. Data is needed to prosecute any study and the probable sources of data have been discussed so far here, along with the detailed review of the literatures. Exploration of the work has been formulated with technical thought processes.

Chapter II

The primary aim of this chapter was to examine the basin personality as a whole. The utilization of morphometric techniques as means of comprehending the geophysical attributes of a basin has carried out with possible detailing. This chapter also introduces a geomorphological region characterized by a diverse array of drainage routes, such as hills, mountains, valleys, foothills, and spurs, within the basin's physical environment. Various geophysical characteristics, such as geology, soil composition, topography, river systems, drainage density, drainage texture, relative relief, dissection index, ruggedness

index, slope zone scenario, and cross profile of the channel, have been thoroughly examined. The geological structure of this region is quite complex, starting with the highly metamorphosed Darjeeling gneiss groups and ending with a more recent alluvium.

Chapter III

The primary aim of this chapter was to study the hydraulics for understanding the hydrological character of the river and rainfall characteristics of the river basin for spatio-temporal identification of rainfall characters as a prime factor of surface water flow along with the climatic variation of the basin area, changes in land use and land cover, various developmental measures on the river or within the basin area and also changing natural regime plus flow of the channel. These changes impact on the socio-economic and ecological conditions of the basin area. The chapter is dedicated to comprehend the idea and conceptualize the water resource of River Mahananda in view of explaining the erodibility and process form character of the river.

Chapter IV

The chapter is aimed to study the nature, pattern and behaviour of the river in terms of its spatio-temporal speculations to detect morphological changes of multithread channel pattern, consulting topographical map-outputs, downloaded satellite imageries and google earth image of different selected years. Some pattern related indices and one braiding related indice was used for the designated reaches viz. Hydraulic sinuosity index (HSI) (Mueller, 1967), Topographic sinuosity index (TSI) (Mueller, 1967) and Standard sinuosity index (SSI) (Mueller, 1967), Braiding index of Brice (1964) for calculating on the measures of the total oscillation and bar formation. In case of reach II, III and IV the braiding index is changeable over time and that directly proves the fact of dynamic behaviour. In all cases the standard sinuosity Index is very much dwindling and oscillatory in signifying the neo-tectonics character of the Darjeeling Himalayan foothills.

Chapter V

Channel behaviour is directly shaped up by its forms and morphodynamic processes and variabilities concerned and thereby extremely influenced by the climatic factors. To attest the seasonal influences, the approach here in this chapter was to framework the channel cross sections on pre & post monsoon periods (2017, 2018 & 2019) based on the field

database using auto level survey (December-Post-Monsoon & April-Pre-Monsoon) along the respective sites. Hydraulic geometry at a station is importantly viewed and documented here in this chapter for studying past and present impacts of discharge variability. Thus, few influential mechanisms have studied here to study the process-form outcome viz. Leliavesky's tractive force, Critical velocity Shear Stress and one or two more. Close examinations showed that mean flow velocity was not promising except few occurrences of heavy showers in rains for the case and very inefficient fluid driving force whereas optimum frictional resistance within the channel is responsible for flow retardation. Empirical relations and their equations between mean flow velocity vs. channel resistance shows an exceedance of resistance resulting into degenerations from time to time.

Chapter VI

The principal objective of this chapter was to know the load distribution and their characteristics among the selected sites and the nature and extent of load distribution in the downstream direction. Various cartographic and statistical techniques have been used for representing and comparing the acquired field data. The primary aim of this chapter was to ascertain the distribution of load among the chosen locations and to understand the characteristics and magnitude of load distribution in the downstream direction. Finally, as a result of this and associated lower the velocity during non-freshet times, mean and median bed load size are changing from the upstream to downstream direction. Actually, differences in the transport rate and size of bed load exist for the varying levels of in-channel flow in coarse-grained channels.

Chapter VII

The primary objective of this chapter was to know the impact of Flood and Bank Failures on Fluvial dynamics. This study examines the effects of erosion, accretion, and unaltered channel sections in response to the fluvial dynamics in the studied region. The primary focus of this study is to explore erosional processes. The association between river bank erosion and LULC change in the study area has been motivated to idealize here. An examination that combines many aspects of erosion, including its causes and methods of mitigation, is consistently important as a comprehensive document and strategic measure in order to adapt to the changes in fluvial dynamics within the study area. In the area that has been investigated, embankment breaching is a severe phenomenon that may also

happen in future. This problem directly impacts the nearby bank inhabitants. Most of the erosion-affected areas belong to active encroachment due to excessive population pressure in Siliguri and its surroundings has been focused here.

Chapter VIII

The main objective of this chapter was to evident the impact of human interference on modification of channel dynamics for both morphological, hydrological and other aspects. This chapter introduces the river bed mining scenario from 2004-2021 and water quality assessments of selected sites of the study area. To sum up the discussion one remarkable statement is to be uttered that the river is receiving serious efficacies of urbanization and unplanned reactions from the societies. Over time all hydrological and hydraulic feature of the river on the foothill plain section are losing their allometric growth as it has been disrupted resulting in vigorous deterioration of channel dynamics and hence the fate has turned into misfeasance towards the river Mahananda.

Chapter IX,

This chapter is dealing with the overview of the investigation on the fluvial dynamics of the upper Mahananda River basin in the Darjeeling Himalayas and which was conducted so far, and the outcomes of that study have been presented as a conclusive culmination.

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List of Figures

Figure No.	Description of the Figure	Page No.
1.1	Location of the Study Area	2
2.1	Geological Framework of the Upper Mahananda Basin in the lap of The Sub-Himalayan Forelands of Darjeeling-Sikkim Himalayas	23
2.2	Diagnostic Soil and Soil-sub-types of the Upper Mahananda Basin	26
2.3	Contour plan of the Upper Mahananda Basin	27
2.4	River Network and Stream Order Pattern of the Upper Mahananda Basin	30
2.5	Drainage Density Scenario of the Upper Mahananda Basin	32
2.6	Drainage Texture Scenario of the Upper Mahananda Basin	34
2.7	Comprehensive Relative Relief Characteristics of the Upper Mahananda Basin	36
2.8	Ruggedness Index as an erosional Scenario of the Upper Mahananda Basin	37
2.9	Dissection Index as a scenario of level of erosion of the Upper Mahananda Basin	39
2.10	Index Map displaying the Landscape Cross-Profiles of Upper Mahananda basin	40
2.11	Serial Landscape Profiles of River Mahananda along the CP1-26 (Ref. Fig. 2.10)	46
2.12	Slope-Zones as a scenario of Hill-Piedmont configuration of the Upper Mahananda Basin	48
3.1	Cross Section at Up reach of Mahananda and Gulma Khola Confluence on 11.06.2017(Upstream)	58
3.2	Cross Section at Down reach of Mahananda Gulma Khola Confluence on 04.06.2019 (Downstream)	60
3.3	Cross Section at 200 m upstream of Guage station at Champasari Bridge on 02.06.2019	61
3.4	Cross Section at 50 m North of Champasari Bridge on 30.07.2017	62

3.5	Cross Section at 200 m Downstream of Guage station at Champasari Bridge on 02.06.2019	63
3.6	Cross Section at Up reach of Noukaghat Bridge on 23.07.2017 (Upstream)	63
3.7	Cross Section at Down reach of Noukaghat Bridge on 28.05.2017 (Downstream)	63
3.8	River Gauge Location along Hill Cart Road over River Mahananda	70
3.9	Rainfall Gauge Level Status of Mahananda River in 2016	71
3.10	Rainfall Gauge Level Status of Mahananda River in 2017	72
3.11	Rainfall Gauge Level Status of Mahananda River in 2018	72
3.12	Three years Rainfall trend within the Mahananda Basin (2016-2018)	73
3.13	Rainfall Zones of Upper Mahananda River Basin in 1952	74
3.14	Rainfall Zones of Upper Mahananda River Basin in 1962	75
3.15	Rainfall Zones of Upper Mahananda River Basin in 1972	76
3.16	Rainfall Zones of Upper Mahananda River Basin in 1982	77
3.17	Rainfall Zones of Upper Mahananda River Basin in 1992	78
3.18	Rainfall Zones of Upper Mahananda River Basin in 2002	79
3.19	Rainfall Zones of Upper Mahananda River Basin in 2012	80
3.20	Rainfall Zones of Upper Mahananda River Basin in 2022	81
3.21	72 years Annual Average of Rainfall Zones of Upper Mahananda River Basin during 1951-2022	82
3.22	Monthly Average Rainfall in January of Upper Mahananda River Basin during 1951-2022	83
3.23	Monthly Average Rainfall in February of Upper Mahananda River Basin during 1951-2022	84
3.24	Monthly Average of Rainfall in March of Upper Mahananda River Basin during 1951-2022	85
3.25	Monthly Average Rainfall in April of Upper Mahananda River Basin during 1951-2022	86
3.26	Monthly Average Rainfall in May of Upper Mahananda River Basin during 1951-2022	87

3.27	Monthly Average Rainfall in June of Upper Mahananda River Basin during 1951-2022	88
3.28	Monthly Average Rainfall in July of Upper Mahananda River Basin during 1951-2022	89
<u>3.29</u>	Monthly Average Rainfall in August of Upper Mahananda River Basin during 1951-2022	90
3.30	Monthly Average Rainfall in September of Upper Mahananda River Basin during 1951-2022	91
3.31	Monthly Average Rainfall in October of Upper Mahananda River Basin during 1951-2022	92
3.32	Monthly Average Rainfall in November of Upper Mahananda River Basin during 1951-2022	93
3.33	Monthly Average Rainfall in December of Upper Mahananda River Basin during 1951-2022	94
3.34	Annual Decadal Maximum rainfall for the long assessment period 1952-2022	95
3.35	Annual Decadal Moderately High rainfall for the long assessment period 1952-2022	96
3.36	Annual Decadal Moderate rainfall for the long assessment period 1952-2022	96
3.37	Annual Decadal Minimum to Moderate rainfall for the long assessment period 1952-2022	97
3.38	Annual Decadal Minimum rainfall for the long assessment period 1952-2022	97
3.39	Category-wise distribution pattern of Rainfall in Upper Mahananda River basin	98
3.40	Temporal frames of Gauge Level GTS of Upper Mahananda River basin during 2016-2021	100

4.1a	Temporal shifting of river course at Reach-I from 1985 to 2022	109
4.1b	Megascopic view of temporal shifting of river course at Reach-I, 1985- 2022	110
4.2 a	Temporal shifting of river course at Reach-II from 1985 to 2022	111
4.2 b	Megascopic view of temporal shifting of river course at Reach-II, 1985- 2022	112
4.3 a	Temporal shifting of river course at reach-III from 1985 to 2022	114
4.3 b	Megascopic view of temporal shifting of river course at Reach-III, 1985- 2022	115
4.4 a	Temporal shifting of river course at Reach-IV from 1985 to 2022	117
4.4 b	Megascopic c view of temporal shifting of river course at Reach-IV, 1985- 2022	118
4.5	Temporal scenario of land loss and land gain (in m ²) due to fluvial Activities	123
5.1 a	Cross Section-wise Erosion rates in meter per year from upstream to downstream segment of River Mahananda (2011-2018)	137
5.1 b	Temporal variation of width from 2011 to 2018 of the same stretch of the River Mahananda	138
5.2	Location of Cross Sections for Hydraulic studies from Gulma to Noukaghat reach	139
5.3	Cross Section-wise temporal variability of Total Width (w) from 2011 to 2018	140
5.4	Total Channel Width vs. Mean Depth relation of River Mahananda from Gulma to Noukaghat Bridge	144
5.5	Surface Velocity vs. Water Density relation of River Mahananda from Gulma to Noukaghat Bridge	146
5.6	Total widths vs. Bed Slope relation in Linear Function of River Mahananda from Gulma to Noukaghat Bridge	147
5.7	Total widths vs. Bed Slope relation in Power Function of River Mahananda from Gulma to Noukaghat Bridge	147

5.8	Total widths vs. Bed Slope relation in Logarithmic Function of River Mahananda from Gulma to Noukaghat Bridge	148
5.9	Total widths vs. Bed Slope relation in Polynomial Function of River Mahananda from Gulma to Noukaghat Bridge	148
5.10	Velocity, Sub-Surface Velocity and Erosion Length relations of River Mahananda from Gulma to Noukaghat Bridge	149
5.11	Cross-Bed Transect: Below Gulma bridge site of Mahananda River bed profile 2017	150
5.12	Cross-Bed Transect: Below Gulma bridge site of Mahananda River bed profile 2018	150
5.13	Cross-Bed Transect: Below Gulma bridge site of Mahananda River bed profile 2019	151
5.14	Cross-Bed Transect: Salugara site of Mahananda River bed profile 2017	151
5.15	Cross-Bed Transect: Salugara site of Mahananda River bed profile 2018	152
5.16	Cross-Bed Transect: Salugara site of Mahananda River bed profile 2019	152
5.17	Cross-Bed Transect: D/S Champasari Bridge near Baghajatin Colony 2017	153
5.18	Cross-Bed Transect: D/S Champasari Bridge near Baghajatin Colony 2018	153
5.19	Cross-Bed Transect: D/S Champasari Bridge near Baghajatin Colony 2019	153
5.20	Cross Bed Transect: Near the confluence of river Panchanoi with river Mahananda 2017	154
5.21	Cross Bed Transect: Near the confluence of river Panchanoi with river Mahananda 2018	154
5.22	Cross Bed Transect: Near the confluence of river Panchanoi with river Mahananda 2019	154
6.1	Distribution percentages of bed load materials at site 1	164
6.2	Distribution percentages of bed load materials at site 2	168
6.3	(a) Pre and (b) Post Monsoon velocity differentials are negligible and their relation with load size resembling almost same trend with slight difference in R ²	171

6.4	Distribution percentages of bed load materials at site 3	172
6.5	Distribution percentages of bed load materials at site 4	175
6.6	Distribution percentages of bed load materials at site 5	178
6.7	Bradshaw's Conventional Model (1941) for river Mahananda	180
6.8	Dominant load types showing haphazard distribution but similar trend of Logarithmic distribution of varying magnitude	180
6.9	Area Plot of load types in a U/S to D/S direction within the selected reach of River Mahananda in Siliguri	183
6.10 a	Post Monsoon Suspended solid and dissolved load (gm lt ⁻¹) at site 1 in relation to gradually invaried velocity (m s ⁻¹)	184
6.10 b	Post Monsoon Suspended solid and dissolved load (gm lt ⁻¹) at site 5 in relation to gradually high invaried velocity (m s ⁻¹)	184
7.1	Location of the Mahananda River Basin and important bank erosion assessment sites	190
7.2	Schematic Drawing explaining basics of BEHI Technique	193
7.3	Mouzas under the influence of Bank erosion and channel shifting and Spatial Locations of Selected Reaches for Bank Erosion Hazard Index Studies of River Mahananda within the SMC region	197
7.4	Reach-wise identified Course pattern of River Mahananda showing the change from 1992 to 2021 and the bank characters	198
7.5	Transects of (1-29) bank-line migration Studies from Gulma to Noukaghat Bridge site	199
7.6	Transect-wise dislocation of Left Bank line from 1992 to 2020	200
7.7	Transect-wise dislocation of Right Bank line from 1992 to 2020	200
7.8	Statistical and parametric assessment of Erosion and Deposition scenario of River Mahananda	201
7.9	Channel Width Variation and evidences of River bank erosion	203
7.10	Bank line shifts and its east and west directions of shift for River Mahananda (1992 to 2021)	205
7.11 a	Acutely Flood Affected Areas in 2012 [Thokdar, Mandal & Sarkar,2012]	213

7.11 b	Reach-wise affected areas and the bank susceptibility condition of River Mahananda depicting eroded, depositional and unaltered river regime	214
7.12	Flood inundation scenario and affected areas (Purba Karaibari Chhat Karaibari, Sisabari, Mahishmari, Milan more, Jadu Bhitari Chhat, Dariagramer Chhat etc.) of 2012 Flood Havoc of River Mahananda	215
8.1	No Mining Scenario during 2004 at reach 1 below and above Gulma Bridge	223
8.2	Increasing Mining locations at reach 2 in 2004 below Gulma-Mahananda confluence	223
8.3	Channel Bed Mining locations at the reach 3 in 2004	224
8.4	Increasing areas of channel bed mining locations at reach 1 in 2017	224
8.5	River Bed Mining location at reach 2 in 2017	225
8.6	River Bed Mining locations at reach 3 in 2017	225
8.7	River Bed Mining locations at reach 1 in 2021	226
8.8	Increasing River Bed Mining locations and areal strength at reach 2 in 2021	226
8.9	Long practiced River Bed mining locations at reach 3 in 2021	227
8.10	Bed mining and purposes of sand lifting in Mahananda River bed (Cases of Salugara, Champasari, HC Road etc. Of selected sample respondents)	228
8.11	Seasonal Variation of bed load extraction works round the year based on respondent's views and experiences	229
8.12	Sectors and types of utilization of River Bed materials (studies of Champasari and HC Road areas)	229
8.13	LULC Scenario of River Mahananda basin exhibiting population growth and settlement agglomeration	231
8.14	LULC Scenario of River Mahananda basin exhibiting population growth and settlement agglomeration 2004- 2021	232
8.15	Occupational Pattern of the respondents directly associated with the riverine environment	238

8.16	Utilization of Water Resources by the local dwellers of River Mahananda in and around SMC area	238
8.17	Land use Perception of the respondents during field survey 2000	239
8.18	Human Intervention to the Riparian Environment causing Over dominance on Riverine Dynamics	240
8.19	Human Intervention in the form of Management Practices by Govt. concerns to altering Riparian Environment and imposing over dominance on Riverine Dynamics	240
8.20	Sewage down-pouring & its impact on channel dynamics	241
8.21	Estimated Waste Disposal of Riparian Dwellers to the river Mahananda	243
8.22	Location of waste discharge site (Reach 2, 2004)	243
8.23	Location of waste discharge site (Reach 2, 2021)	244
8.24	Location of waste discharge site (Reach 3, 2004)	244
8.25	Location of waste discharge site (Reach 3, 2021)	245
8.26	Effects of Dumping Practices in and around the banks of River Mahananda	245
8.27	River course dynamics and settlement modification scenario within the lower parts of Mahananda basin	246
8.28	Impact of Dumping practices on River Dynamics	246

List of Tables

Table No.	Description of the Table	Page No
3.1	Comparative Description of hydrological regime of some of the Himalayan Rivers	56
3.2	River Hydraulics of Mahananda for identification of Hydrological Regime (2017-2019 Assessment period)	67
3.3	River Hydraulics of Mahananda for identification of Hydrological Regime (2019-2021 Assessment period)	68
3.4	Discharge Differential and quantification of Hydrological Regime (2017-2021 Assessment periods)	68
3.5	Rainfall Variations and Guage Heights (m) at Hill Cart Road Site Location	70
3.6	Gauge level and Rainfall relation as per 2 Year Moving Average	73
3.7	Periodic Characteristics of Rainfall Patterns and Variations in Mahananda River Basin	95
4.1	Cross section wise temporal (1985-2022) changes (in meter) of bank line (right bank of Upper Mahananda)	119
4.2	Descriptive statistics on cross-section wise temporal (1985-2022) changes (in meter) of bank line (right bank of Upper Mahananda)	119
4.3	Cross section wise temporal (1985-2022) changes (in meter) of bank line (left bank of Upper Mahananda)	120
4.4	Descriptive statistics on cross-section wise temporal (1985-2022) changes (in meter) of bank line (left bank of Upper Mahananda)	120
4.5	Spatial variation of channel migration rate (my-1) for Right bank (1985 – 2022)	121
4.6	Statistics on spatial variation of channel migration rate (my-1) for Right bank (1985 – 2022)	121

4.7	Spatial variation of channel migration rate (my-1) for Left bank (1985 – 2022)	122
4.8	Statistics on spatial variation of channel migration rate (my-1) for Left bank (1985 – 2022)	122
4.9	Temporal scenario of land loss and land gain (in m2) due to fluvial activities	123
4.10	Calculation of channel sinuosity index values for Reach-I (1985 - 2022)	124
4.11	Calculation of channel sinuosity index values for Reach-II (1985 - 2022)	125
4.12	Calculation of channel sinuosity index values for Reach-III (1985-2022)	126
4.13	Calculation of channel sinuosity index values for Reach-IV (1985-2022)	127
4.14	Reach wise computations of Braided Index of the Upper Mahananda River	128
5.1	Hydraulic and Hydrologic measurements of River Mahananda (Foothill Section: Gulma Bridge to Nougaghat)	134
5.2	Different functions for pair-wise comparison of Total Channel width and bed slope and their suitable fitness	145
6.1	Detail of the Sample Sites	160
6.1a	Bed load sampling details of Site 1	161
6.1b	Bed load sampling details of Site 1	163
6.1c	Bed load sampling details of Site 1	163
6.1d	Bed load sampling details of Site 1	163
6.2a	Bed load sampling details of Site 2	165
6.2b	Bed load sampling details of Site 2	165
6.2c	Bed load sampling details of Site 2	166
6.2d	Bed load sampling details of Site 2	167
6.3a	Bed load sampling details of Site 3	169
6.3b	Bed load sampling details of Site 3	170
6.3c	Bed load sampling details of Site 3	170
6.3d	Bed load sampling details of Site 3	171
6.4a	Bed load sampling details of Site 4	172

6.4b	Bed load sampling details of Site 4	173
6.4c	Bed load sampling details of Site 4	173
6.4d	Bed load sampling details of Site 4	175
6.5a	Bed load sampling details of Site 5	176
6.5b	Bed load sampling details of Site 5	176
6.5c	Bed load sampling details of Site 5	177
6.5 d	Bed load sampling details of Site 5	177
6.6	Load and associated Hydraulic Characters of River Mahananda	178
6.7	Summary of Bed load materials in respect to their frequency of Appearance	182
7.1	Hydro-Geomorphological personality (HGP) attributing River Bank Erosion	189
7.2	Metadata or Identity Information of the USGS Satellite Imageries	191
7.3	Modified guidelines for field assessment of Bank Erosion Hazard Index (BEHI) [After Rosgen, 2001]	191
7.4	Site-specific and metrics entry and final computation of BEHI Index	193
7.5	Temporal Variation of Channel Width as evidential to bank erosion 1992-2021	202
8.1	Location of reaches for studying the Human Interference on Mahananda River in Siliguri Corporation Area	221
8.2	Spatio-Temporal Variations River bed mining site and areas (2004-2021)	227
8.3	Water Quality Results of River Mahananda and mean velocity during lean periods (Champasari-Salugara, HC Road locations)	233
8.4	Water Quality Results of River Balason and mean velocity during lean periods (Matigara bridge piers)	234
8.5	Viscosity Characteristics of Mahananda River flow at three sites within SMC	237
8.6	Reach-wise temporal width (m) variation	241

List of Plates

Plate No.	Description of the Plate	Page No
3.1	Preparation for field work at Lincon School site I	64
3.2	Human interventions causing distinctive ephemeral channels	64
3.3	Erratic loads showing incompetency of the river and almost no discharge during pre-monsoon near downstream of Gulma	64
3.4	Flow Regime at site II (04.06.2019)	65
3.5	Boulder Embankments protecting river Banks at 200 m upstream of Guage station at Champasari Bridge showing very tranquil flow character	65
3.6	Huge bank materials down pouring to the channel bed during non-monsoon summer near Champasari of River Mahananda	65
3.7	Hydrological Regime of the river during Freshet season near Champasari	65
3.8	Field works at 200 m upstream of Guage station at Champasari Bridge with Levelling Instruments	66
3.9	Setting the chainage line to compute the cross-sectional drawing of the channel at 200 m upstream of Guage station at Champasari Bridge	66
3.10	Hydrological Regime of the River Mahananda near 50 m North of Champasari Bridge	66
3.11	Early summer near site VI showing moderate hydrological regime and characterized by 3-5 m depth	66
3.12	Stagnancy showing meagre flow at left bank side of site VI	66
3.13	Field Works at site VII including the Supervisor	67
3.14	Dry and extensive sand dominated open channel bed profile showing incompetency of the river Mahananda during summer with feeble water regime	67
6.1a	Working with Survey Team near Gulma Khola site for load survey and Levelling Survey (Pre-Monsoon)	160
6.1b	Field measurement of load by tape for Cross verification (site 3)	160

6.2a	Random Sampling of transportable bed load by Pebble Count method (Site 1)	162
6.2b	Random Sampling of transportable bed load by Pebble Count method (Site 1)	162
6.2c	Monsoon discharge during after monsoon 2017	162
6.2d	Mahananda bed motorable during pre-monsoon 2018	162
6.2e	Large bed loads unwashed during pre-monsoon 2017	162
6.2f	Pit formation due to bed load extraction within the unwashed load of bed of post monsoon phase2017	162
6.3a	Bed load Sampling in descending order of Site 2	166
6.3b	Bed load Sampling in descending order of Site 2	166
6.3c	channel flow during pre-monsoon	166
6.3d	Channel flow during Post monsoon	166
6.2e	Load excavations associated with two tier river terraces displaying two phases of bed load deposition and medium to large size bed loads exposed during extraction	167
6.3a	Bed load measurement of site 3	169
6.3b	Bed load measurement of site 3	169
6.3c	cross-sectional survey during post monsoon	169
6.3d	Channel flow during pre-monsoon 2018	169
6.4a	Bed load sampling of Site 4	174
6.4b	Bed load sampling of Site 4	174
6.4c	Channel flow during monsoon	174
6.4d	Channel flow during pre-monsoon	174
6.4e	Pits are formed due to extraction near site 4	174
6.4f	Cross-sectional survey during monsoon 2018	174
6.5	River water samples of different sites from Upstream to downstream	181
6.6a	Cross-sectional survey during monsoon 2018 of Site 5	183
6.6b	Channel flow during pre-monsoon 2017	183

6.6c	Bed load material under unconsolidated silt and sand keeping prints of last flashy discharge deposits	183
6.6d	Category of bed load samples being measured by 6" Sliding Caliper	183
7.1	Outflanked River Mahananda after breaching the right bank Embankment near Gulma Bridge and in spate (2012)	206
7.2	Out flashing flood Discharge of river and inundation of institutional areas near Gulma-Karaibari approaching to Milan more area in 2012	206
7.3	Inundated houses in 2012 flood of River Mahananda	206
7.4	Soil erosion and river flashing through the institutional areas at Karaibai-Milanmore area	206
7.5	Breached parts of bund portions attaining newly spreaded clastic deposits	207
7.6	Receding flood from a coping local hut near Karaibari in flood 2012	207
7.7	Unabated flood water rushing towards Debidanga –Champasari-Milan more areas in Flood 2012	207
7.8	Evidences of inundation of Flood Havoc 2012 after 1968	207
7.9	Bank Protection work averagely 40 ft. height along the bank of River Mahananda at Ward No. 4.	209
7.10	Exposed High Bank at Debidanga area proximate to Champasari as on 14.04.2017 of River Mahananda being remnant of older bank profile resting along the old terrace	210
7.11	Whirling helical flow erosion along bank cavities of River Mahananda close to Champasari showing active river dynamics during rainy season	210
7.12	Settlement areas under threats of erosion composed of loose sands of more than 90% appearance near an exposed site of Debidanga showing negative impact on flow dynamics	211
7.13	Rotational bank Failure along a Bank composed of admixtures of Materials and exposed lithofacies of subsurface loose incoherent materials and over capping by silt-clay composites of river Mahananda near Salugara	211

7.14	Imprints of Distinct depositional layer of >80% silts overlying by inundation and flood deposits standing almost saved against impinge flow attacks but chanceful to areal collapse	212
7.15	Exposed Bank of River Mahananda after heavy shower in June 2017 along the confluence site of high bank of river Mahismari with the Mahananda	212
8.1	The researcher in the field collecting water samples for water quality test at River Balason during lean periods (Matigara bridge piers)	235
8.2	The researcher in the field collecting water samples for water quality test at River Mahananda during lean periods (Champasari-Salugara, HC Road locations)	235
8.3a	Idol immersion into the river Mahananda near Champasari	247
8.3b	Tea shop on the river bed of Mahananda near Shalugara	247
8.3c	Uprooted tree deposited on the river bed near Shalugara	247
8.3d	Bank erosion on the right bank of river Mahananda near Rupan Chhat	247
8.3e	embankment right bank of the river near Shalugara	247
8.3f	Red arrow shows toxic waste disposal from railway locomotive shell into the river Mahananda near Coolie Patti	247
8.3g	Blue arrow shows flow direction of river Mahananda and red arrow shows waste disposal into the river Mahananda.	247