earlier, changes of 20% increase in discharge is denoted as Scenario 1 and 20% decrease is denoted as Scenario 2.

10.2.1 Changes in Area

Changes of cross sectional areas for Scenario 1 and 2 are shown in Table 10.7:

Table 10.7 Simulated Area for Scenario 1 and Scenario 2 in 21 Stations of the Kushiyara River

SL	Station(u/s to d/s)	Distance From downstream	Bankfull Area(m^2)	Reference year 2012 Area (m^2)	Scenario 1: Area (m^2)	Scenario 2: Area (m^2)
1	RS40	6000	2102	1806	2346	1800
2	RS39	12000	1928	1598	2130	1555
3	RS38	18000	1183	995	1361	980
4	RS37	24000	1456	1170	1674	1085
5	RS36	30000	1884	1449	2248	1302
6	RS35	36000	1193	1201	1461	1230
7	RS34	42000	2245	1674	1844	1360
8	RS33	48000	1568	1407	1789	1350
9	RS32	54000	1536	1410	1771	1559
10	RS31	60000	2211	2090	2038	2239
11	RS30	66000	1925	1884	2147	1947
12	RS29	72000	3341	3244	3712	3377
13	RS28	78000	2210	2162	2499	2038
14	RS27	84000	2180	2244	2544	2220
15	RS26	90000	2802	2869	2926	2818
16	RS25	96000	1936	1688	1682	1644
17	RS24	102000	2151	2334	2192	2165
18	RS23	108000	2726	3006	2664	2738
19	RS22	114000	6281	6682	6125	6292
20	RS21	120000	1942	2526	1724	1974
21	RS20	126000	1613	1745	1805	1611

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 40)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 40)

The 4 reference stations were selected as RS 40 (Upstream boundary), RS 20 (Downstream boundary) and RS 34 and RS 28 are intermediate calibrated Stations.

Analyzing Table 10.7 for selected stations RS 40, RS 34, RS 28 and RS 20, Table 10.8 has been developed; which shows the changes of area both in numerical value as well as percentage for both the Scenarios.

Table 10.8 Changes in Area for Scenario 1 and 2 for Four Selected Stations With Respect to Reference Year (2012) of the Kushiyara River

SL	Station from u/s to d/s	Distance from d/s (m)	Reference year 2012 Area (m^2)	Scenario 1: Increase (+) Decrease (-) Area (m^2)	Scenario 2: Increase (+) Decrease (-) Area (m^2)
1	RS40	6000	1806	2346 , (+29.9%)	1800,(-.33%)
2	RS34	42000	1674	1844, (+10.15%)	1360,(-18.75%)
3	RS28	78000	2162	2499, (+15.58%)	2038,(-5.73%)
4	RS20	126000	1745	1805,(+3.43%)	1611,(-7.67%)

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 40)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 40)
3: Developed from Table:10.7

It is seen that for Scenario 1, areas of RS 40, RS 34, RS 28 and RS 20 increase about 29.9%, 10.15%, 15.58% and 3.43% respectively with respect to the reference year 2012.

For Scenario 2, areas decrease about 33%, 18.75%, 5.73% and 7.67% for the stations RS 40, RS 34, RS 28 and RS 20 respectively.

The changes in area of 21 cross sections along the channel for Scenario 1 can be observed from the following graph (Figure 10.19).

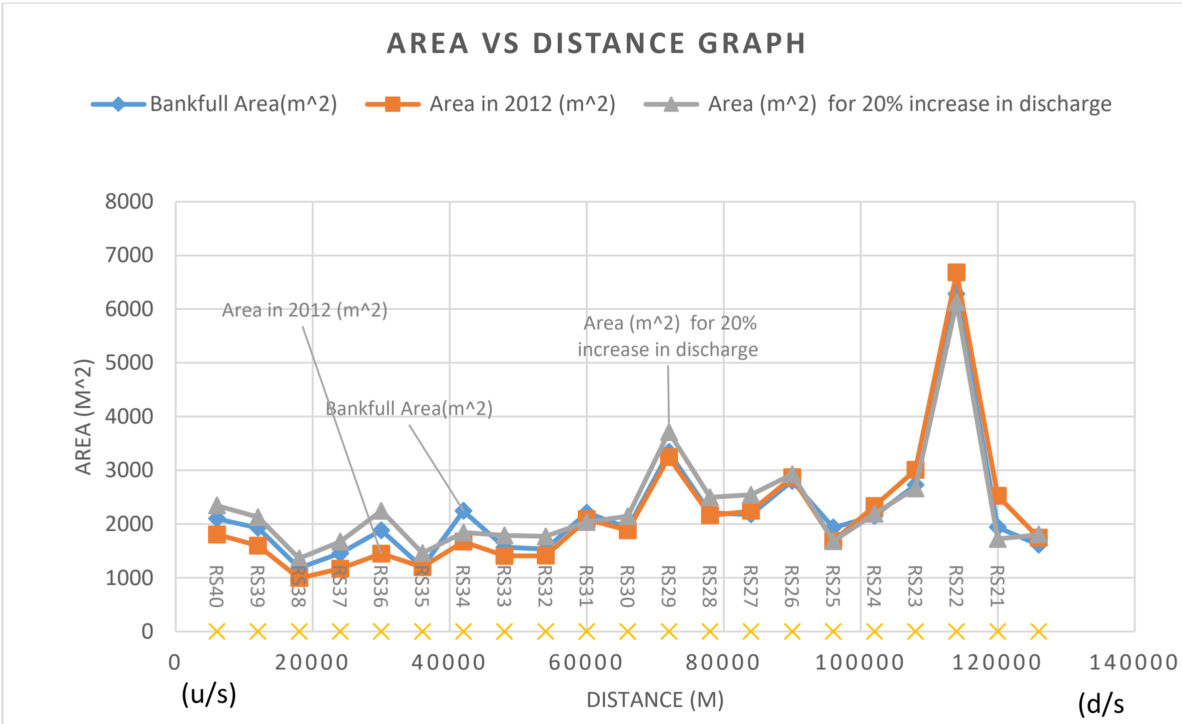

Figure 10-19 Area vs Distance for the Kushiyara (2012); Scenario 1

Similarly, for 20% decrease in discharge, that is Scenario 2, changes in area along the channel are shown in the following graph (Figure 10.20).

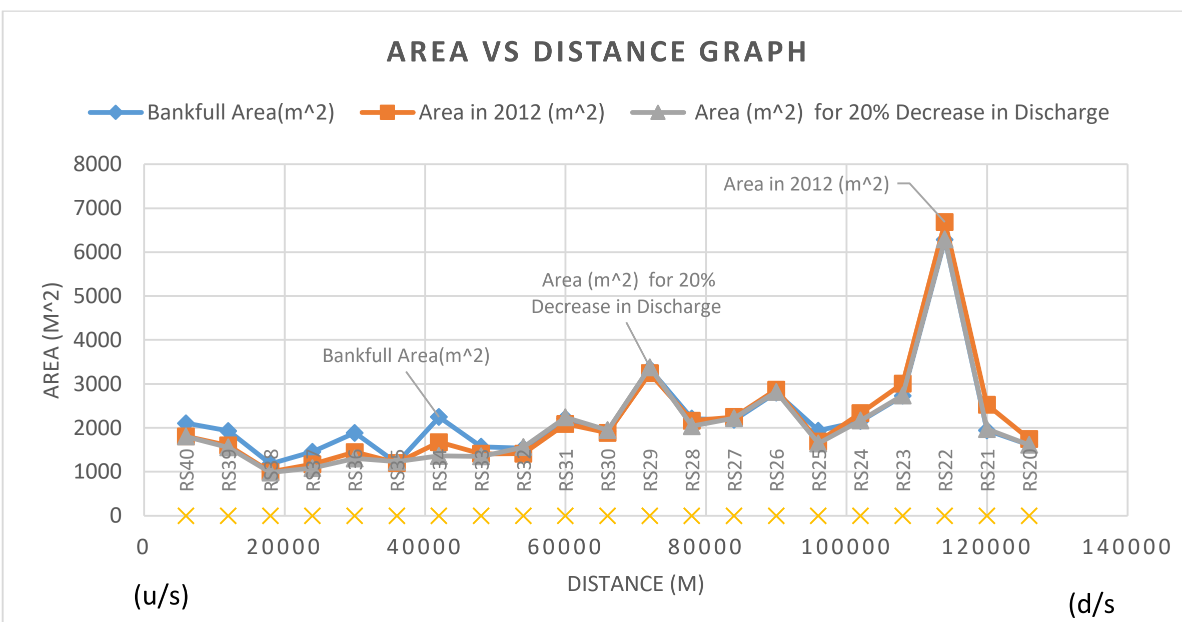

Figure 10-20 Area vs Distance for the Kushiyara (2012); Scenario 2

10.2.2 Changes in Discharge

Similar analysis was done to see the change in discharge. Changes in discharge are shown in the following table (Table 10.9):

Table 10.9 Simulated Discharge for Scenario 1 and 2 in 21 Stations of the Kushiyara River

SL	Station (up to down)	Distance from d/s (m)	Bank Full Discharge (m^3/s)	Reference year 2012 Discharge (m^3/s)	Scenario 1 Discharge (m^3/s)	Scenario 2 Discharge (m^3/s)
1	RS40	6000	1299	1702.24	2042	1361
2	RS39	12000	1300	1701	2034	1361
3	RS38	18000	1299	1692	1913	1358
4	RS37	24000	1221	1695	1686	1259
5	RS36	30000	1257	1665	1803	1334
6	RS35	36000	1287	1698	1904	1338
7	RS34	42000	1300	1655	2012	1285
8	RS33	48000	1292	1680	1960	1291
9	RS32	54000	1293	1622	1982	1351
10	RS31	60000	1299	1598	1942	1360
11	RS30	66000	1268	1595	1924	1323
12	RS29	72000	1230	1565	1882	1284
13	RS28	78000	1292	1682	2014	1352
14	RS27	84000	998	1434	1521	1040
15	RS26	90000	1292	1633	2024	1351
16	RS25	96000	1174	1671	1819	1226
17	RS24	102000	972	1359	1515	1015
18	RS23	108000	1262	1550	1987	1321
19	RS22	114000	600	808	973	627
20	RS21	120000	1049	1441	1743	1098
21	RS20	126000	161	1085	1100	985

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 40)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 40)

Changes in discharge in four selected cross sections are shown below (Table 10.10):

Table 10.10 Changes in Discharge for Scenario 1 and 2 for Four Selected Stations With Respect to Reference Year (2012) of the Kushiyara River[3]

SL	Station from u/s to d/s	Distance from d/s (m)	Reference year 2012 Discharge (m^3/s)	Scenario 1: Increase (+) Decrease (-) Discharge (m^3/s)	Scenario 2: Increase (+) Decrease (-) Discharge (m^3/s)
1	RS40	6000	1702.24	2042,(+19.95%)	1361,(-20.04%)
2	RS34	42000	1655	2012,(+21.57%)	1285,(-22.35%)
3	RS28	78000	1682	2014,(+19.73%)	1352,(-19.61%)
4	RS20	126000	1085	1100,(+1.38%)	985,(-9.21%)

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 40)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 40)
3: Developed from Table 10.9

The changes in discharge for **Scenario 1** along the cross section can be visible from the following graph (Figure 10.21).

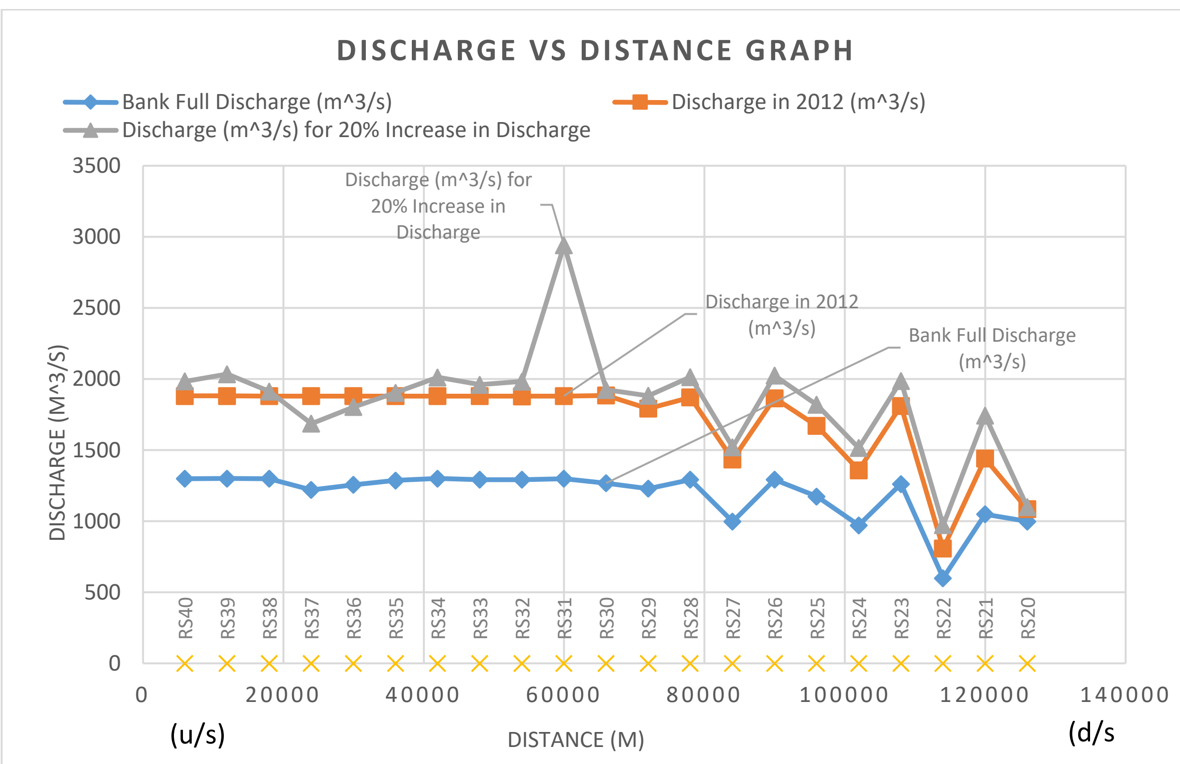

Figure 10-21 Discharge vs Distance for the Kushiyara (2012); Scenario 1

For **Scenario 2**, the graph is shown in Figure 10.22

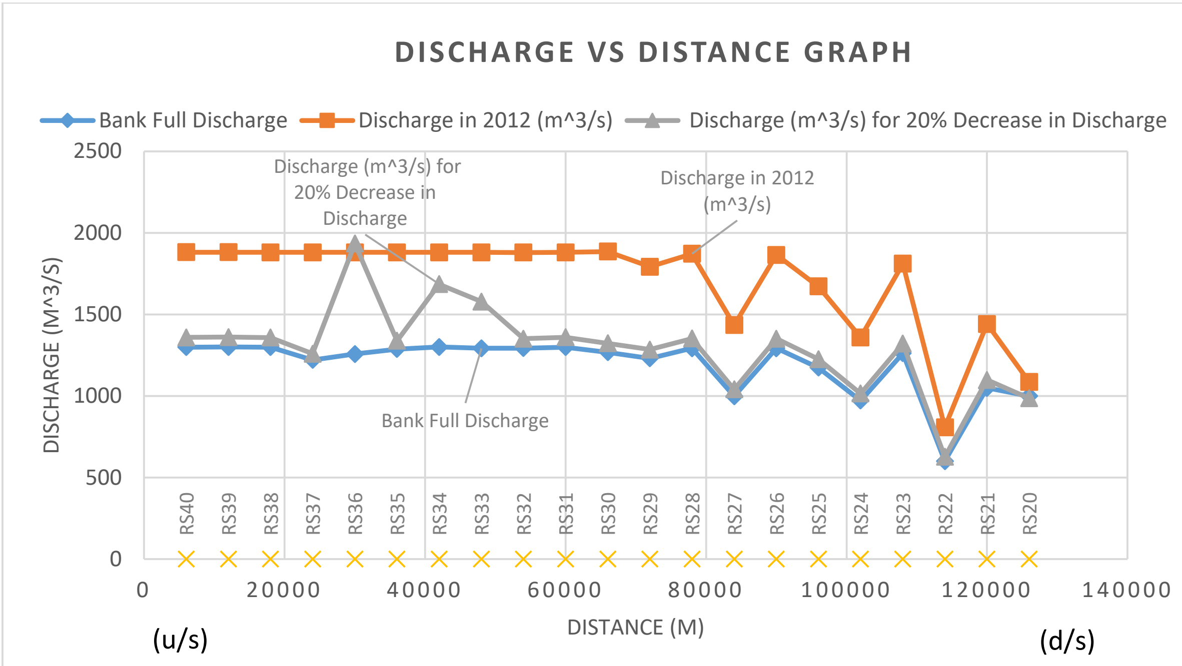

Figure 10-22 Discharge vs Distance for the Kushiyara (2012); Scenario 2

10.2.3 Changes in Water Level

Changes in water levels for Scenario 1 and Scenario 2 have been shown in Table 10.11.

Table 10.11 Simulated Water Level for Scenario 1 and 2 in 21 Stations of the Kushiyara River

SL	Station (from u/s to d/s)	Distance from d/s	Bankfull Water Level (m)	Reference year 2012 Water Level (m)	Scenario 1: Water Level (m)	Scenario 2: Water Level (m)
1	RS40	6000	12.02	10.2	13.4	10.1
2	RS39	12000	11.95	10.16	13.27	10.04
3	RS38	18000	11.74	9.94	12.96	9.85
4	RS37	24000	11.57	9.89	12.7	9.62
5	RS36	30000	11.38	9.85	12.51	9.45
6	RS35	36000	11	9.63	12.03	9.42
7	RS34	42000	10.57	9.64	11.58	9.55

8	RS33	48000	10.24	9.56	11.23	9.52
9	RS32	54000	10	9.49	10.88	9.45
10	RS31	60000	9.83	9.49	10.61	9.45
11	RS30	66000	9.7	9.44	10.39	9.4
12	RS29	72000	9.61	9.44	10.24	9.4
13	RS28	78000	9.48	9.39	10.01	9.35
14	RS27	84000	9.28	9.35	9.7	9.33
15	RS26	90000	9.13	9.31	9.47	9.18
16	RS25	96000	9.03	9.25	9.34	9.07
17	RS24	102000	8.92	9.23	9.27	8.95
18	RS23	108000	8.8	9.2	9.22	8.82
19	RS22	114000	8.75	9.14	9.18	8.76
20	RS21	120000	8.66	9.12	9.18	8.66
21	RS20	126000	8.5	9	9.16	8.94

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 40)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 40)

Changes in water level in four selected stations are shown in Table 10.12.

Table 10.12 Changes in Water Level for Scenario 1 and 2 for Four Selected Stations With Respect to Reference Year (2012) of the Kushiyara River[3]

SL	**Station from u/s to d/s**	**Distance from d/s (m)**	**Reference year 2012 Water level (m)**	**Scenario 1: Increase (+) Decrease (-) Water level (m)**	**Scenario 2: Increase (+) Decrease (-) Water level (m)**
1	RS40	6000	10.2	13.4,(+31.37%)	10.1,(-0.98%)
2	RS34	42000	9.64	11.58,(+20.12%)	9.55,(-0.93%)
3	RS28	78000	9.39	10.01,(+6.60%)	9.35,(-0.42%)
4	RS20	126000	9.00	9.16,(+1.77%)	8.94,(-0.66%)

Note: Scenario 1: 20% increase in Peak discharge at Upstream (RS 38)
Scenario 2: 20% decrease in Peak discharge at Upstream (RS 38)
3: Developed from Table 10.11

For **scenario 1**, In reference year 2012 flood of 50cm was observed in RS 20 but in stations RS 40, RS34, RS28. Under Scenario 1 there are floods in all the 4 Stations. Floods of 138 cm, 101 cm, 53 cm and 56 cm are observed in the Station RS 40, RS 38, RS 28 and RS 20 respectively. These can be seen from the plots of the simulated discharge results of the cross sections (Figure 10.23, 10.24, 10.25and 10.26).

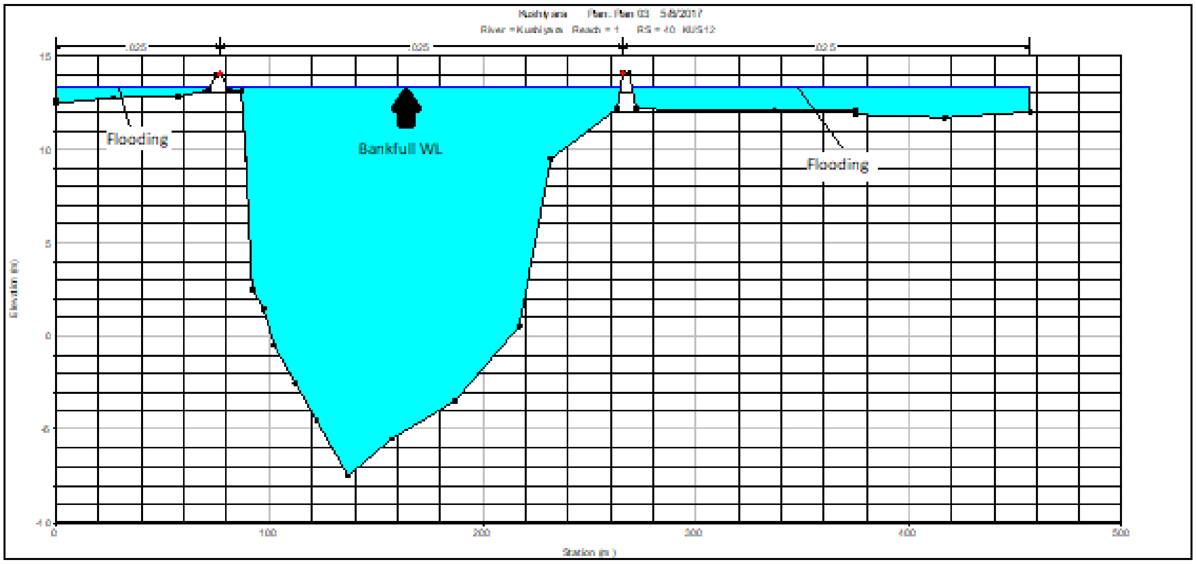

Figure 10-23 Changes in Water Level at RS 40 for Scenario 1, (The Kushiyara)

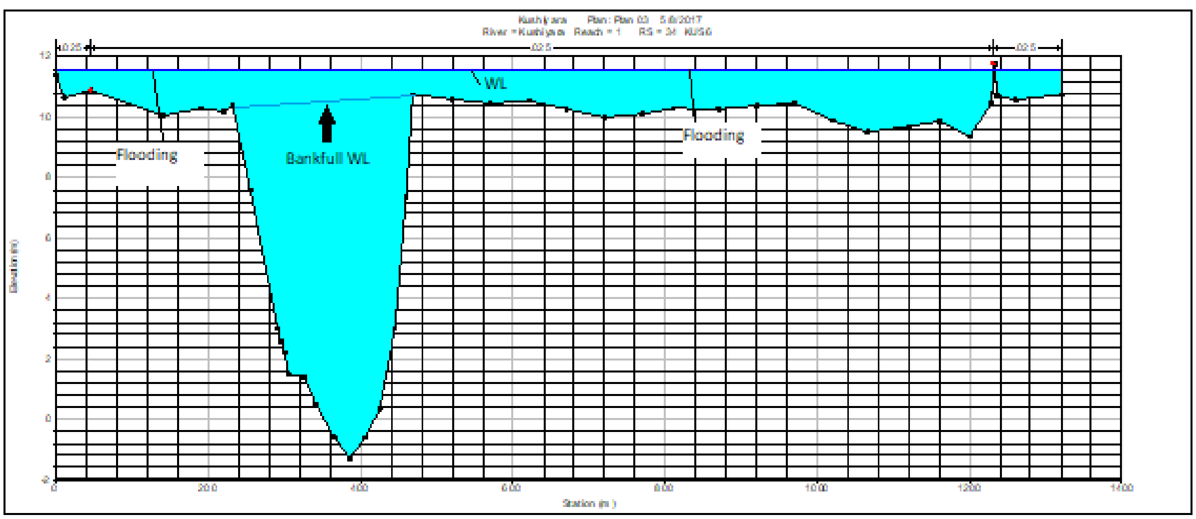

Figure 10-24 Changes in Water Level at RS 34 for Scenario 1,(The Kushiyara)

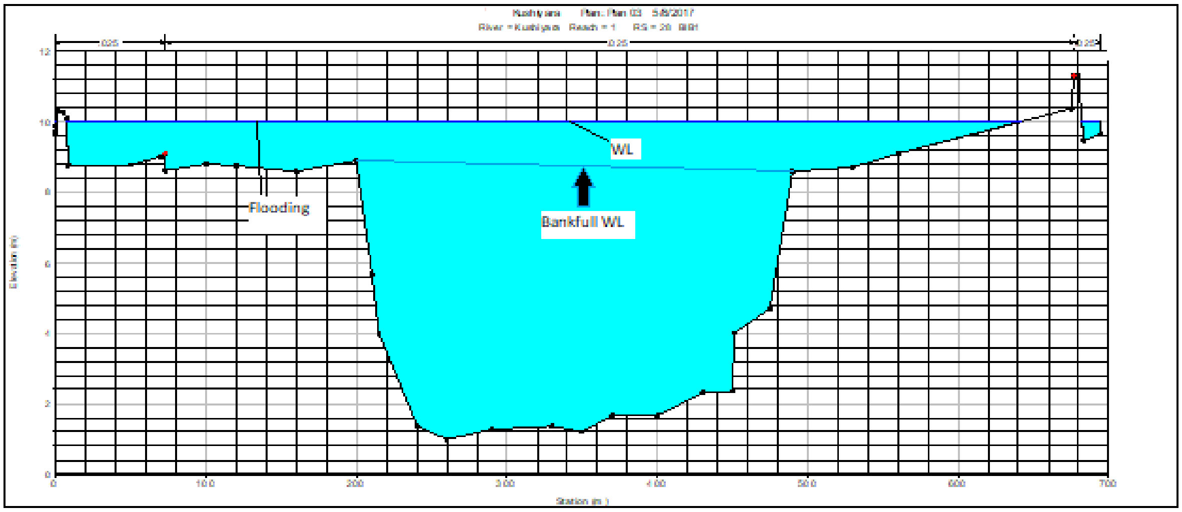

Figure 10-25 Changes in Water Level at RS 28 for Scenario 1,(The Kushiyara)

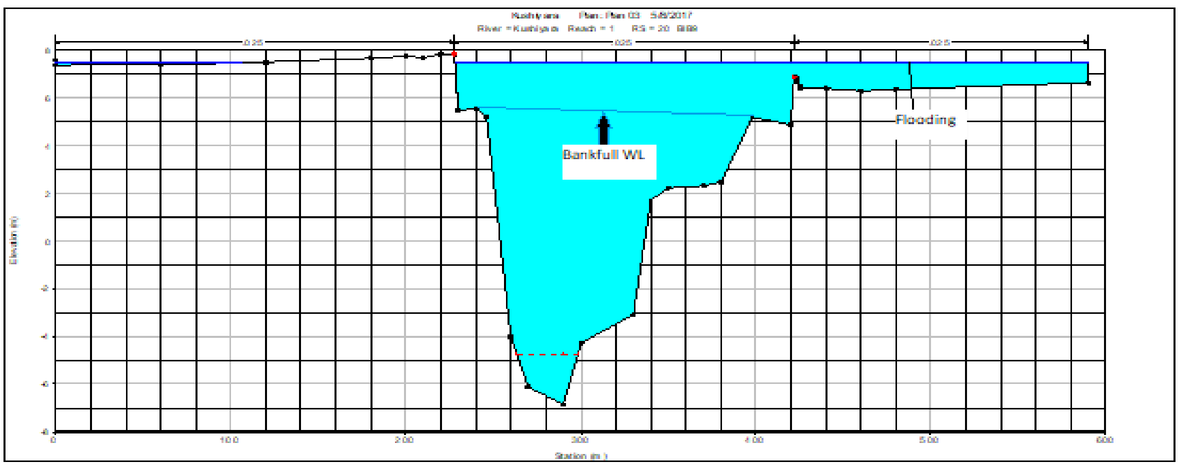

Figure 10-26 Changes in Water Level at RS 20 for Scenario 1,(The Kushiyara)

Similarly, for **scenario 2**, the simulated results are also shown. All the Stations show a decrease in WL. Water Level reduced by 10cm, 9 cm, 4 cm and 6 cm in Stations RS 40, RS 34, RS 28 and RS 20 respectively with respect to the reference year. Change in water levels are shown in Figure 10.27,10.28,10.29 and 10.30below.

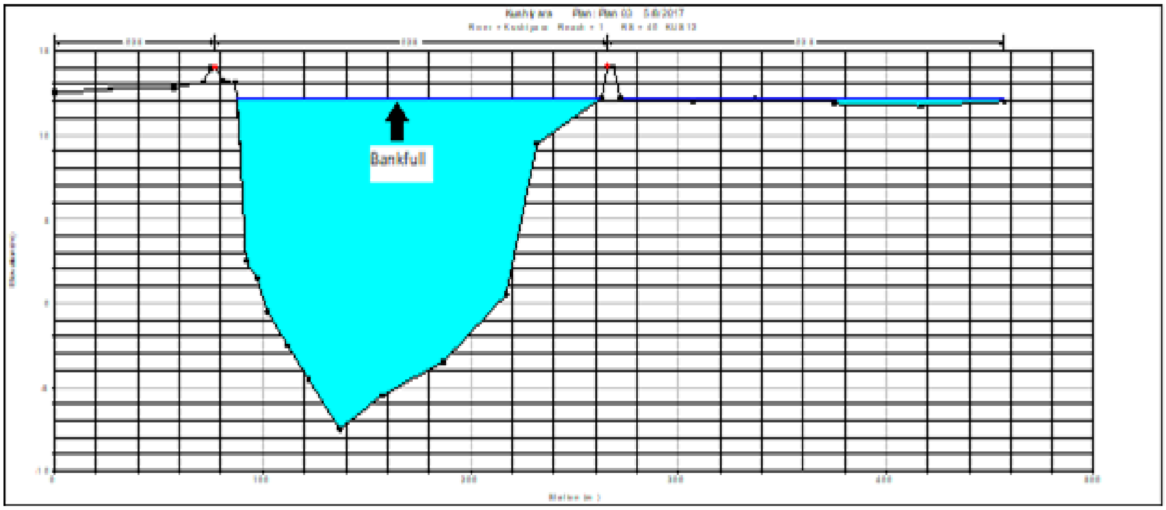

Figure 10-27 Changes in Water Level at RS 40 for Scenario 2,(The Kushiyara)

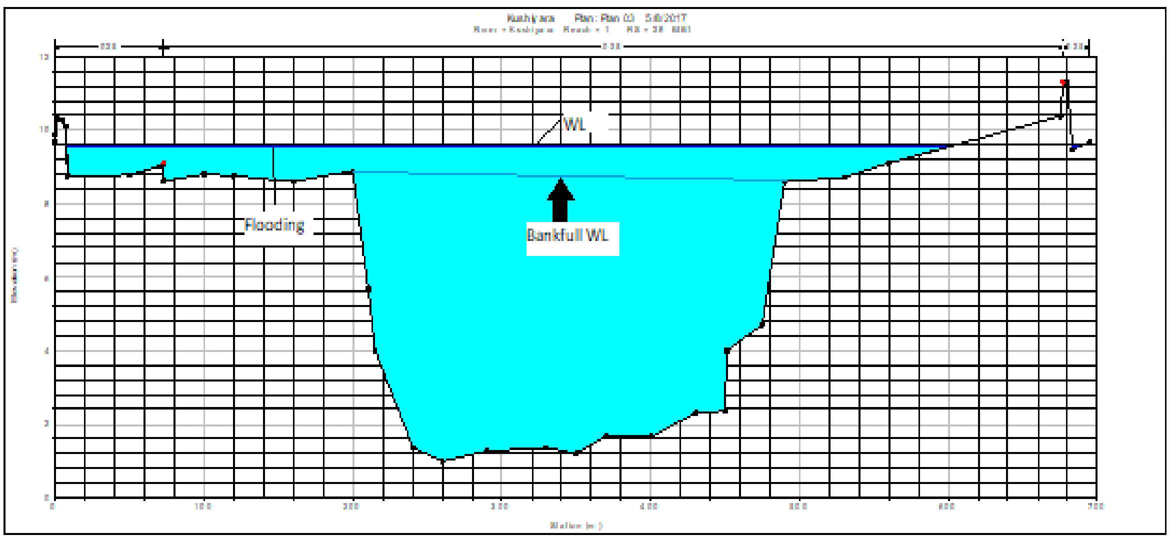

Figure 10-28 Changes in Water Level at RS 34 for Scenario 2,(The Kushiyara)

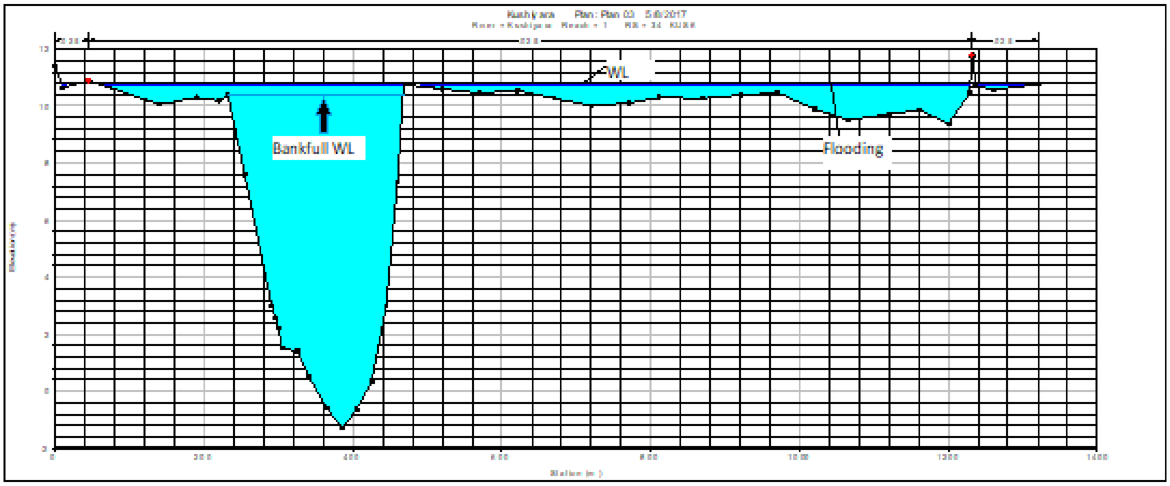

Figure 10-29 Changes in Water Level at RS 28 for Scenario 2,(The Kushiyara)

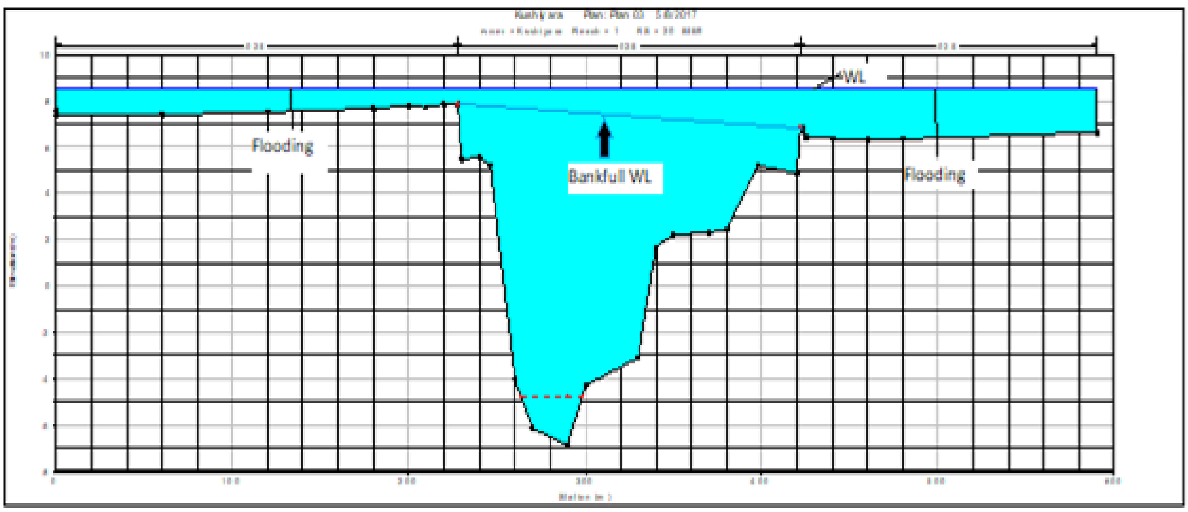

Figure 10-30 Changes in Water Level at RS 20 for Scenario 2,(The Kushiyara)

The changes in water level for Scenario 1 and 2 along the channel length can be seen from the plots (Figure 10.31and 10.32).

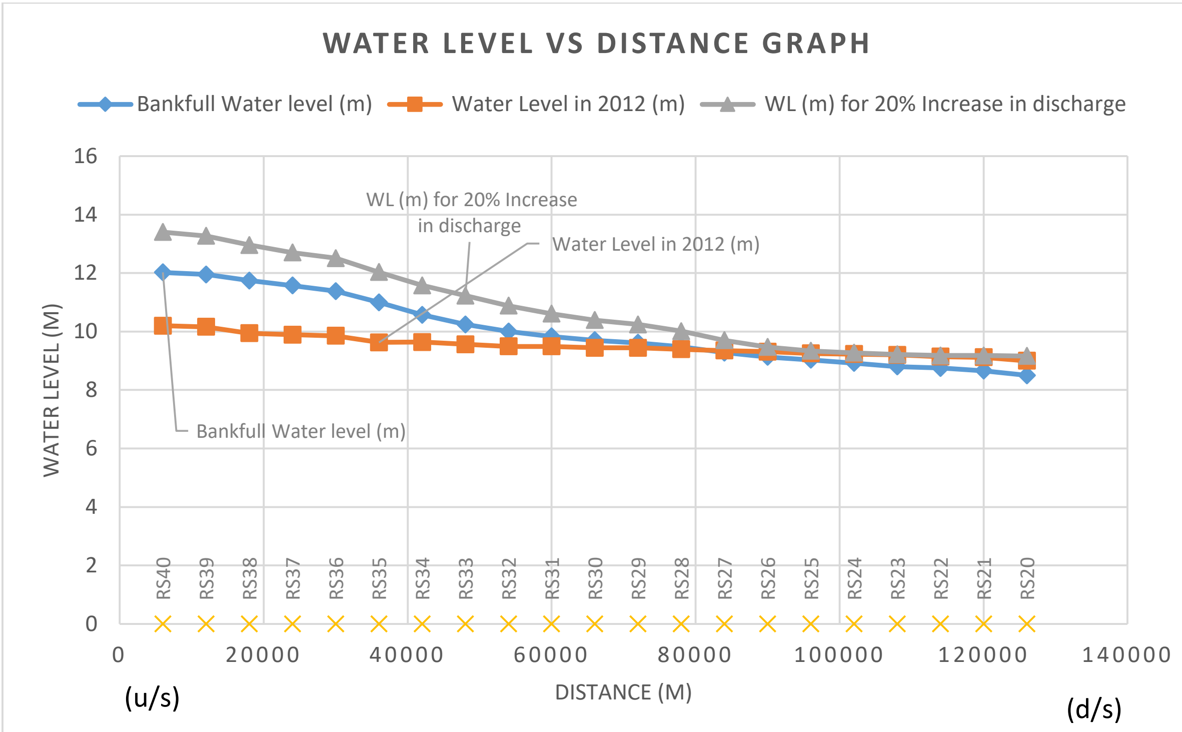

Figure 10-31 Water Level vs Distance for the Kushiyara (2012); Scenario 1

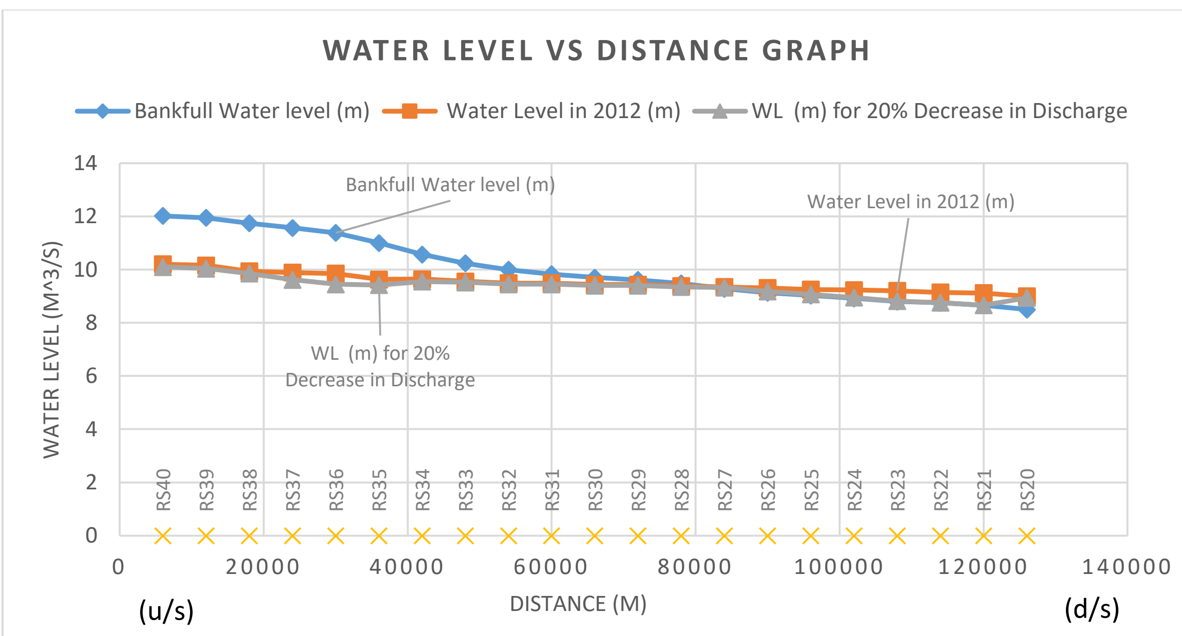

Figure 10-32 Water level vs distance for the Kushiyara (2012); Scenario 2

Remarks:

1. Under Scenario 1 when peak discharge increases at upstream, there is increase in simulated cross sections, discharges and water levels at downstream. As a result, new areas are flooded and in other places flood depths increase.
2. Under Scenario 2 with decrease of peak discharge at upstream, there is decrease in discharge, water level and cross section at the downstream. As a result, flood reduction is observed.

11 Major Findings and Recommendations

11.1 Major Findings

The major findings of the study are as follows:

1. The analysis confirms the acceptability of Hypothesis 1 for both the Surma and the Kushiyara rivers.
2. The Hypothesis 2 could not be (conclusively)established/validated.
   For the Surma and the Kushiyara it may be concluded that, the bankfull water levels at the downstream decrease, consequently there are changes in channel dimension, the change of both the area and the top width shows a scattered pattern and the change of average depth shows a decreasing trend towards downstream direction.
3. The Hypothesis 3 may be established/validated for the Kushiyara but not for the Surma. Detailed explanation has been given in Section 5.5.
   a) From conventional analysis: Hypotheses 3 may be considered as established/validated for both the Surma and the Kushiyara rivers.
   b) From Model output:
      I. From the analysis of seasonal variation of the Bed level gradient, it is observed that bed level slopes are almost same at both the dry and monsoon seasons. Hence Hypothesis 3 could not be established/validated for the Surma.
      II. For the Kushiyara from the analysis of bed level gradient, the Hypothesis 3 can be considered as established/validated.
4. Hypotheses 4 and 5 relate to the hypothetical 'Regime Condition' of the river.
   The analysis clearly demonstrates that **the Surma and Kushiyara rivers are not in 'Regime Condition'**. So the hypothesis could not be confirmed/validated through the model output. But since the 'Regime Condition' is a theoretical condition of a river, the validity of these two hypotheses (4 and 5) can be accepted on Theoretical explanation basis (details given in See 5.6).

5. Under Scenario 1, when Peak discharge increases (20%) at upstream, there are increase in simulated cross sections, discharges and water levels at downstream. Consequently, new areas are flooded and in other places flood depth increase.
6. Under Scenario 2, when Peak discharge decreases (20%) at upstream, there are decrease in cross sections, discharge and water levels at downstream. Consequently, flood reduction is observed.

11.2 Recommendations

1. Through the validation of the CEGIS conceptual Model the study has contributed towards enhancement of knowledge on hydro morphological process of the two major rivers of the Haor areas. The planners and the Government may use this for the implementation of the development plans in the Haor areas.
2. The BWDB should strengthen their Hydrology Unit and take continuous measurements.
3. Some permanent sediment and bed material collection stations should be established both on the rivers Surma and Kushiyara.
4. A routine program of bathymetric survey for the two rivers may be taken up. The survey should be carried out in 4 seasons (namely, Pre monsoon, Monsoon, Post monsoon and Dry).
5. Finer resolution satellite images should be collected for understanding of the shifting of the rivers.
6. A study may be taken up to develop a general model to simulate and predict the morphological behavior of the rivers of the Haor region.
7. A project may be taken up for morphological study of the rivers of the Haor area.
8. This HEC-RAS 5.0.3 model may be further updated to predict the changes in sediment deposition, erosion, discharge and water level in the downstream of the Surma and the Kushiyara rivers.
9. A study may be taken up to couple the two HEC-RAS Models developed under this study.

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FINAL REPORT

Government of the People's Republic of Bangladesh
Ministry of Water Resources
Department of Bangladesh Haor & Wetlands Development

Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Appendix 1: Feedback from the Stakeholders

June, 2017

Prosoil Foundation Consultant
Bangladesh

FINAL REPORT

Government of the People's Republic of Bangladesh
Ministry of Water Resources
Department of Bangladesh Haor & Wetlands Development

Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Appendix 1: Feedback from the Stakeholders

June, 2017

Prosoil Foundation Consultant
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Preface

The Volume 1 of the Report "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin" contains the Appendix 1 "Feedback from the Stakeholders" .

The 1st Technical Committee Meeting of the Project was held on 18th February, 2016 under the chairmanship of Mrs. Afroza Moazzam, (the then) Director General, Department of Bangladesh Haor and Wetlands Development and the Chairperson of the Technical Committee. A Monitoring Meeting was held on 23rd June, 2016 and the 2nd Technical Committee Meeting was held on 1st March, 2017 under the chairmanship of Mr. Majibur Rahman, Director General, DBHWD and the Chairperson of the Technical Committee. A workshop on (draft) Final Report was organized by the DBHWD in association with M/s Prosoil Foundation Consultant on 6th June, 2017 where Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR) was the Chief Guest and Mr. Majibur Rahman, Director General, DBHWD chaired the workshop. The 1st Steering Committee Meeting was held on 20th June, 2017 in the conference room of the "Ministry of Water Resources" under the chairmanship of Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR).

The Appendix 1 contains the minutes of all these meetings and the proceedings of the workshop. It also contains the decisions made at the meetings and workshop as well as the responses to the decisions.

The team deeply acknowledge the co-operation and guidance of the Technical Committee of the project. The team also acknowledge the DBHWD for providing logistic supports and helping the team to prepare the Report.

We are thankful to Mr. Majibur Rahman, Director General, Department of Bangladesh Haor and Wetlands Development and Mrs. Afroza Moazzam, former Director General, Department of Bangladesh Haor and Wetlands Development for their active support and co-operation. We appreciate the co-operation of Mr. Md. Nazmul Ahsan, Project Director and Md. Nurul Amin, Director (Admin and Finance), of the Department of Bangladesh Haor and Wetlands Development.

We acknowledge with deep appreciation the co-operation by M/S Globe Survey Company in carrying out the field survey works. We also thank the local people, particularly of the Northeast Region who in various ways helped the study team in conducting the field measurements and survey works.

H.S. Mozaddad Faruque
Senior Morphologist
And
Team Leader

Final Report

The Final Report on "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin", submitted in June, 2017 contains the following volumes:

Volume 1:	Main Report **Appendix 1: Feedback from the Stakeholders**
Volume 2:	Appendix 2: Bank Line Survey Report of the Surma and the Kushiyara Rivers
Volume 3:	Appendix 3: Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers

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5. Abul Kalam Azad
   Surveyor
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1 1st Technical Committee Meeting

1.1 Minutes of the 1st Meeting of the Technical Committee

The 1st Technical Committee Meeting of the Project ‘Model Validation of Hydro-Morphologic Process of the River System in the Subsiding Sylhet Basin’ was held on 18th February, 2016 in the conference room of the ‘Department of Bangladesh Haor and Wetlands Development’ under the chairmanship of Mrs. Afroza Moazzam, (the then) Director General, Department of Bangladesh Haor and Wetlands Development and the Chairperson of the Technical Committee. The minutes of the meeting is presented below.

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর

মহাপরিচালকের কার্যালয়

পানিসম্পদ মন্ত্রণালয়

৭২ গ্রীন রোড, ঢাকা-১২১৫

ফ্যাক্স : ৯১৪৪১৯৫, ওয়েব : www.bhwdb.gov.bd

বিষয়ঃ ১৮.২.২০১৬ তারিখে অনুষ্ঠিত 'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের কারিগরি কমিটির ১ম সভার কার্য বিবরণী।

'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের কারিগরি কমিটির ১ম সভা ১৮ ফেব্রুয়ারি ২০১৬ তারিখে বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরের সভাকক্ষে জনাব আফরোজা মোয়াজ্জেম, মহাপরিচালক, বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর এর সভাপতিত্বে অনুষ্ঠিত হয়। সভায় উপস্থিত সদস্যবৃন্দের তালিকা সংযুক্তি-১ এ দেয়া হয়েছে।

সভাপতি উপস্থিত সকলকে স্বাগত জানিয়ে সভার কার্যক্রম শুরু করেন। উপস্থিত সদস্যগণের পরিচিতি পর্ব শেষে তিনি 'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' প্রকল্পের পরামর্শক, মেসার্স Prosoil Foundation Consultants এর টিম লিডারকে সমীক্ষা প্রকল্পটি উপস্থাপনের জন্য অনুরোধ করেন।

পরামর্শক টিমলিডার জনাব এইচ. এস. মোজাদ্দাদ ফারুক PowerPoint এর মাধ্যমে খসড়া Inception Report টিটি উপস্থাপনা করেন। তিনি সভাকে অবহিত করেন যে প্রকল্পের খসড়া Inception Report প্রণয়নের কাজ প্রায় ৮০% সম্পন্ন হয়েছে। শুধুমাত্র ফিল্ড ভিজিটের কাজ অসমাপ্ত রয়েছে। ফেব্রুয়ারির শেষ সপ্তাহে ফিল্ড ভিজিট সম্পন্ন করে খসড়া Inception Report টি দাখিল করা হবে। তিনি জানান যে, সমীক্ষা কাজটি PSP বর্ণিত তারিখ হতে প্রায় ৫ মাস পরে শুরু হয়, অতএব PSP এর সময় বর্ধিত করার প্রয়োজন রয়েছে এবং মূল PSP এর উল্লিখিত ২৪ মাস সময় ধরেই কর্ম পরিকল্পনা (Work Plan) প্রণয়ন করা হয়েছে। PSP তে স্যাটেলাইট ইমেজ সংগ্রহের কোন সংস্থান না থাকার বিষয়টি তিনি গুরুত্বের সাথে উপস্থাপন করেন। তিনি আরো উল্লেখ করেন যে, বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরের

'Master Plan of Haor Area' প্রণয়নের সময় বেশকিছু ইমেজ ও ডাটা সংগ্রহ করা হয়েছিল যা CEGIS এ সংরক্ষিত রয়েছে।

তার উপস্থাপনা শেষে সভাপতি খসড়া Inception Report এ উপস্থাপিত কার্যপদ্ধতি ও অন্যান্য বিষয়ে মতামত প্রদানের জন্য কারিগিরি কমিটির সদস্যদের আহবান করেন। সভার সদস্যবৃন্দ প্রকল্পের বিষয়ে বিস্তারিত আলোচনা করেন। আলোচনা শেষে নিম্নবর্ণিত সিদ্ধান্তসমূহ গৃহীত হয়ঃ

<u>সিদ্ধান্তঃ</u>

১. কারিগরি কমিটিতেনিম্ন বর্ণিত সদস্যদের co-opt করা হবেঃ

i. মহাপরিচালক, পানিসম্পদ পরিকল্পনা সংস্থা, ৭২ গ্রীন রোড, ঢাকা এর প্রতিনিধি।
ii. পরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর, ৭২ গ্রীন রোড, ঢাকা।
iii. পরিচালক (জলাভূমি), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর, ৭২ গ্রীন রোড, ঢাকা
iv. অধ্যাপক সাব্বির মোস্তফা খান, পানিসম্পদ কৌশল বিভাগ, বাংলাদেশ প্রকৌশল বিশ্ববিদ্যালয়, ঢাকা।
v. ডঃ এম. এ. সাত্তার, সাবেক বিভাগীয় প্রধান, পরিবেশ বিজ্ঞান, বাংলাদেশ কৃষি বিশ্ববিদ্যালয় ও সাবেক ডিন, কৃষি অনুষদ, বাংলাদেশ কৃষি বিশ্ববিদ্যালয়।
vi. প্রধান প্রকৌশলী, পানি বিজ্ঞান, বাপাউবো, ৭২ গ্রীন রোড, ঢাকা।

২. বিভিন্ন সীমাবদ্ধতার কারনে প্রকল্পের সময় বৃদ্ধি করা হয়ত সম্ভব হবে না। অতএব, পরামর্শকগণ PSP বর্ণিত নির্দিষ্ট সময়ের মধ্যে কার্য সম্পাদন করবেন এবং সে অনুযায়ী কর্মপরিকল্পনা (WorkPlan) সংশোধন করবেন।

৩.বিভিন্ন CEGIS, IWM হতে প্রয়োজনীয় স্যাটেলাইট ইমেজ ও উপাত্ত সংগ্রহ করার বিষয়ে বাংলাদেশহাওরবাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর পরামর্শকগণকে সহায়তা প্রদান করবে।

৪. 'Master Plan of Haor Area' প্রণয়নের সময় সংগৃহীত তথ্যাদি, ম্যাপ, স্যাটেলাইট ইমেজ ইত্যাদি বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরে প্রেরণের জন্য CEGIS কে অনুরোধ জানানো হবে।

৫. সুরমা ও কুশিয়ারা নদীতে স্থাপিত বাংলাদেশ পানি উন্নয়ন বোর্ড এর Hydrologic Station এর তথ্যাদি খসড়া বর্তমান প্রকল্পে ব্যবহার করা হবে।এ বিষয়ে বাংলাদেশ পানি উন্নয়ন বোর্ডকে বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর হতে অনুরোধ জানানো হবে।

৬. বর্ণিত সিদ্ধান্তসমূহের আলোকে খসড়া Inception Report টি সংশোধন সাপেক্ষে অনুমোদনের জন্য কারিগরি কমিটি কর্তৃক সুপারিশ করা হল।

অতি অল্প সময়ের মধ্যে কারিগরি কমিটির সভা আহ্বান ও সার্বিক সহায়তা প্রদানের জন্য সার্বিকসহায়তাপ্রদানেরজন্যবাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরের মহাপরিচালক জনাব আফরোজা মোয়াজ্জেম ও প্রকল্প পরিচালক জনাব প্রকল্পপরিচালকজনাবমোহাম্মদ নাজমুল আহসান কে পরামর্শক টিম লিডার ধন্যবাদ জানান। কারিগরি কমিটির সম্মানিত সদস্যবৃন্দের সভায় অংশগ্রহণ ও মূল্যবান মতামত প্রদানের জন্যবানমতামতপ্রদানেরজন্য তিনি সকলকে পূনরায় ধন্যবাদ জানান।

পরিশেষে সভায় উপস্থিত উপস্থিত সকল সম্মানিত সদস্যবৃন্দ ও প্রকল্পের পরামর্শক টিমকে ধন্যবাদ জানিয়ে ধন্যবাদজানিয়েসভাপতি সভার সমাপ্তি ঘোষনা করেন।

স্বাক্ষরিত
তারিখঃ ০৩.০৩.২০১৬ খ্রিস্টাব্দ
আফরোজা মোয়াজ্জেম
মহাপরিচালক
বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন
অধিদপ্তর
ও
সভাপতি
কারিগরি কমিটি

স্মারক নং ৪২.০৪.০০০০.০০৩.১৪.৩১৯.১৫-১১৬
তারিখঃ ০৩.০৩.২০১৬ খ্রিস্টাব্দ

বিতরণ (জ্যেষ্ঠতার ভিত্তিতে নয়):

1| সচিব, মৎস্য ও প্রাণিসম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা (দৃ: আ: সহকারী সচিব (ফিশারিজ-৪))
2| বিভাগ প্রধান, কৃষি ও পল্লী প্রতিষ্ঠান বিভাগ, পরিকল্পনা কমিশন, শেরে বাংলা নগর, ঢাকা (দৃ:আ: যুগ্ম-প্রধান)।
3| মহাপরিচালক, পরিবেশ অধিদপ্তর, আগার গাওর, ঢাকা (দৃ:আ: পরিচালক (প্লানিং))।
4| মহাপরিচালক, কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ী, ফামগেট, ঢাকা (দৃ:আ: পরিচালক, ন্যাচারাল রিসোর্সেস ম্যানেজমেন্ট রিসার্চ)।

5| প্রধান বন সংরক্ষক, বন অধিদপ্তর, বন ভবন, আগার গাও, ঢাকা-১২০৫ (দৃ: আ: উপ প্রধান বন সংরক্ষক)।

6| মহাপরিচালক, মৎস্য অধিদপ্তর, মৎস্য ভবন, রমনা, ঢাকা (দৃ:আ: চিফ ফিশারিজ এক্সটেনশন অফিসার)।

7| মহাপরিচালক, আইএমইডি পরিকল্পনা মন্ত্রণালয়, শেরে বাংলানগর, ঢাকা (দৃ:আ: পরিচালক (এগ্রিকালচার, রুরাল ডেভেলপমেন্ট)।

8| মহাপরিচালক, পানি সম্পদ উন্নয়ন সংস্থা (ওয়ারপো), ৭২ গ্রীন রোড, ঢাকা (দৃ:আ: পরিচালক (প্লানিং))

9| কান্ট্রি ডিরেক্টর, ইন্টারন্যাশনাল ইউনিয়ন ফর ন্যাচারাল কনজারভেশন (আইইউসিএন), (দৃ: আ: প্রোগ্রাম কো-অর্ডিনেটর (বাংলাদেশ))

10| উপ-পরিচালক, বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর, ৭২ গ্রীন রোড, ঢাকা।

11| সহকারী প্রধান-১, পানি সম্পদ মন্ত্রণাল, বাংলাদেশ সচিবালয়, ঢাকা।

12| পরিচালক, প্রোসয়েল, ফাউন্ডেশন কনসালটেন্ট, ইন্দিরা রোড, ঢাকা।

মোহাম্মদ নাজমুল আহসান
উপপরিচালক (প্রশাসন ও অর্থ)
বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
ও
প্রকল্প পরিচালক
‘Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin’ শীর্ষক সমীক্ষা প্রকল্প

সংযুক্তি ১

১৮.২.২০১৬ তারিখে অনুষ্ঠিত **‘Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin’** শীর্ষক সমীক্ষা প্রকল্পের কারিগরি কমিটির ১ম সভায় উপস্থিতগণের তালিকাঃ

১. প্রধান বন সংরক্ষক, বন অধিদপ্তর, বনভবন, আগারগাঁও, ঢাকা এরপক্ষে

জনাব মোহসীনা বেগম, সহকারী বনসংরক্ষক, বনঅধিদপ্তর, বনভবন, আগারগাঁও, ঢাকা।

২. জনাব মোঃ নুরুজ্জামান, অতিরিক্ত পরিচালক (প্রকল্প পরিকল্পনা), কৃষিসম্প্রসারণ অধিদপ্তর, খামার বাড়ি, ঢাকা

৩. কান্ট্রি ডিরেক্টর, আইইউসিএন বাংলাদেশ এরপক্ষে

জনাব মোঃ ওয়াসিম নেওয়াজ, প্রোগ্রাম এসোসিয়েট, আইইউসিএন বাংলাদেশ।

৪. জনাব খায়রুননাহার, সহকারীপ্রধান, পানিসম্পদমন্ত্রনালয়।

৫. জনাব এস. এম. শাহাবুদ্দিন মাহমুদ, সচিব, ওয়ারপো।

৬. জনাব মোঃ নুরুল আমিন, পরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর ।

৭. ড. মোঃ রুহুল আমিন, পরিচালক (জলাভূমি), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর।

৮. জনাব মোহাম্ম নাজমুল আহসান, উপপরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর ও প্রকল্প পরিচালক, **‘Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin’** শীর্ষক সমীক্ষা প্রকল্প।

৯. জনাব এইচ. এস. মোজাদ্দাদ ফারুক, টিম লিডার, প্রোসয়েল, ফাউন্ডেশন কনসালটেন্ট, ইন্দিরা রোড, ঢাকা।

১০. ইঞ্জিঃ শামসুল আলম প্রবাল, পরামর্শক, প্রোসয়েল, ফাউন্ডেশন কনসালটেন্ট, ইন্দিরা রোড, ঢাকা।

১১. ইঞ্জিঃ সাজ্জাদ শাহরিয়র,পরামর্শক, প্রোসয়েল, ফাউন্ডেশন কনসালটেন্ট, ইন্দিরা রোড, ঢাকা।

১২. ইঞ্জিঃ রুম্মানআদিব, পরামর্শক, প্রোসয়েল, ফাউন্ডেশন কনসালটেন্ট, ইন্দিরা রোড, ঢাকা।

1.2 Decisions of the 1st T.C. Meeting and the Responses

SL	Decisions of the 1st T.C. Meeting held on 18/02/2016	Responses
1.	The following members will be co-opted in the Technical Committee 1. Representative of Director General, Water Resources Planning Organization 72, Green Road, Dhaka 2. Director (Admin & Finance) DBHWD 72, Green Road, Dhaka 3. Director (Wetlands), DBHWD 72 Green Road, Dhaka 4. Dr. Sabbir Mostafa Khan Professor, Dept. of Water Resources Engineering BUET 5. Dr. M.A. Sattar Former Dean, Faculty of Agriculture BAU & Former Head, Dept. of Environmental Science BAU 6. Chief Engineer, Hydrology BWDB 72 Green Road, Dhaka	The DBHWD has taken action.
2.	Due to certain constraints, it may not be possible to extend the time period of the project. So, the Consultants will complete the project within the time specified in PSP and adjust the workplan accordingly.	The consultants will try to complete the project within the time stated in the PSP.
3.	The DBHWD will help the Consultants in bringing satellite images and data from different organizations such as CEGIS, IWM.	We appreciate the gesture.

SL	Decisions of the 1st T.C. Meeting held on 18/02/2016	Responses
4.	The CEGIS will be requested to send the data, maps, satellite images etc., which were collected during the preparation of "Master Plan of Haor Area" to the DBHWD.	The DBHWD has taken action.
5.	The data of the Hydrologic Stations of BWDB established on the Surma and the Kushiyara rivers will be used in the current project. The DBHWD will request BWDB in this regard.	Action taken.
6.	The Inception Report is recommended for approval incorporating all the discussed corrections.	Thanks to the T.C. and the DBHWD. Incorporating the corrections, Final Inception Report was submitted to the DBHWD on 23/03/17.

2 Monitoring Meeting

2.1 Minutes of the Monitoring Meeting

The Monitoring Meeting of the Project 'Model Validation of Hydro-Morphologic Process of the River System in the Subsiding Sylhet Basin' was held on 23rd June, 2016 in the conference room of the 'Department of Bangladesh Haor and Wetlands Development' under the chairmanship of Mr. Majibur Rahman, Director General, Department of Bangladesh Haor and Wetlands Development and the Chairperson of the Technical Committee. The minutes of the meeting is presented below.

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
মহাপরিচালকের কার্যালয়
পানি সম্পদ মন্ত্রণালয়
৭২ গ্রীন রোড, ঢাকা-১২১৫।

বিষয়ঃ ২৩.০৬.২০১৬ তারিখে অনুষ্ঠিত 'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের মনিটরিং সভার কার্যবিবরণী।

Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের মনিটরিং সভা ২৩শে জুন, ২০১৬ তারিখে বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরের সভা কক্ষে জনাব মোঃ মজিবুর রহমান, মহাপরিচালক (বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর) এর সভাপতিত্বে অনুষ্ঠিত হয়। সভায় উপস্থিত সদস্য বৃন্দের তালিকা সংযুক্তি ১ এ দেয়া হয়েছে।

সভাপতি উপস্থিত সকলকে স্বাগত জানিয়ে প্রকল্পের পরামর্শক, মেসার্স Prosoil Foundation Consultants এর টিম লিডারকে সমীক্ষা প্রকল্পটি সম্পর্কে বক্তব্য প্রদানের অনুরোধ করেন। পরামর্শক টিম লিডার জনাব এইচ. এস. মোজাদ্দাদ ফারুক PowerPoint এর মাধ্যমে Status Report I উপস্থাপনা করেন। তিনি ৩১ শে মে, ২০১৬ পর্যন্ত প্রকল্পের অগ্রগতি সম্পর্কে মনিটরিং কমিটিকে অবহিত করেন। অতঃপর তিনি PowerPoint এর মাধ্যমে প্রকল্পের উপাত্ত সংগ্রহ এবং অগ্রগতি সম্পর্কে উপস্থাপনা করেন।

তার উপস্থাপনা শেষে সভাপতি সভায় উপস্থাপিত কার্যপদ্ধতি ও অন্যান্য বিষয়ে মতামত প্রদানের জন্য মনিটরিং কমিটির সদস্যদের আহ্বান করেন। সভার সদস্য বৃন্দ প্রকল্পের বিষয়ে বিস্তারিত আলোচনা করেন। আলোচনা শেষে নিম্নবর্ণিত সিদ্ধান্ত সমূহ গৃহীত হয়।

সিদ্ধান্তঃ

১. সভায় উপস্থাপিত উপাত্ত সংগ্রহের কার্যপদ্ধতি এবং অগ্রগতি সম্পর্কে মনিটরিং কমিটি সন্তুষ্টি প্রকাশ করেন।

২. পরামর্শক দল উপাত্ত সংগ্রহের অগ্রগতি পর্যবেক্ষণের জন্য মহাপরিচালক ও প্রকল্প পরিচালক মহোদয়কে Field Visit করার আমন্ত্রণ জানান।

(মোঃ মজিবুর রহমান)
মহাপরিচালক
ফোন ৯১৩৭৩১২

স্মারক নং ৪২.০৪.০০০০.০০৩.১৪.৩১৯.১৫-৪২৩

তারিখঃ ২৬.০৭.২০১৬ খ্রিঃ

বিতরণ জ্যেষ্ঠতার ভিত্তিতে নয়:

১. মোঃ নুরুল আমিন, পরিচালক (প্রশাসন), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
২. ড. মোঃ নুরুল আমিন, পরিচালক (জলাভূমি), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
৩. মোঃ নাজমুল আহসান, উপ-পরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর ও প্রকল্প পরিচালক, ৭২ গ্রীন রোড, ঢাকা।
৪. এইচ. এস. মোজাদ্দাদ ফারুক, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।
৫. ইঞ্জিঃ শামসুল আলম প্রবাল, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।
৬. আশফাক আহমেদ, অধ্যাপক, উদ্ভিদ বিজ্ঞান বিভাগ, ঢাকা বিশ্ববিদ্যালয়, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।
৭. ইঞ্জিঃ সাজ্জাদ শাহরিয়ার, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।
৮. ইঞ্জিঃ রুম্মান আবিদ, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।
৯. ইঞ্জিঃ সামিরা জাহান চৌধুরী, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি ইন্দিরা রোড, ঢাকা।

2.2 Decisions of the Monitoring Meeting and the Responses

SL	Decisions of the Monitoring Meeting held on 23/06/2016	Responses
1.	The Monitoring Committee expressed their satisfaction about the procedure and progress of data collection.	Thanks for the appreciation.
2.	The consultants invited the Director General and Project Director to visit the survey works.	-

3 2nd Technical Committee Meeting

3.1 Minutes of the 2nd Meeting of the Technical Committee

The 2nd Technical Committee Meeting of the Project 'Model Validation of Hydro-Morphologic Process of the River System in the Subsiding Sylhet Basin' was held on 1st March, 2017 in the conference room of the 'Department of Bangladesh Haor and Wetlands Development' under the chairmanship of Mr. Majibur Rahman, Director General, Department of Bangladesh Haor and Wetlands Development and the Chairperson of the Technical Committee. The minutes of the meeting is presented below.

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
পানি সম্পদ মন্ত্রণালয়
৭২গ্রীনরোড, ঢাকা-১২১৫।

বিষয়: গত ১.৩.২০১৭ তারিখে অনুষ্ঠিত 'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের কারিগরি কমিটির ২য় সভার কার্যবিবরণী।

'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের কারিগরি কমিটির ২য় সভা ১ মার্চ, ২০১৭ তারিখে বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তরের সভাকক্ষে জনাব মোঃ মজিবুর রহমান, মহাপরিচালক, বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর এর সভাপতিত্বে অনুষ্ঠিত হয়। সভায় উপস্থিত সদস্যবৃন্দের তালিকা সংযুক্তি ১ এ সংযুক্ত রয়েছে।

০২. সভাপতি উপস্থিত সকলকে স্বাগত জানিয়ে সভার কার্যক্রম শুরু করেন। উপস্থিত সদস্যদের পরিচিতি পর্ব শেষে প্রকল্প পরিচালক জনাব মোহাম্মদ নাজমুল আহসান, প্রকল্পের একটি সংক্ষিপ্ত বিবরণী পেশ করেন। তিনি প্রকল্পের পরামর্শক সংস্থা মেসার্স Prosoil Foundation Consultants এর ব্যবস্থাপনা পরিচালক, ইঞ্জিঃ শামসুল আলম প্রধানকে পরামর্শক সংস্থা সম্পর্কে বক্তব্য প্রদানের অনুরোধ করেন। ইঞ্জিঃ শামসুল আলম প্রধান PowerPoint এর মাধ্যমে Prosoil Foundation Consultants এর কাজ এবং পরিচিতি তুলে ধরেন। তার উপস্থাপনা শেষে সভাপতি মহোদয় তাকে ধন্যবাদ জানান। অতঃপর প্রকল্পের পরামর্শক, মেসার্স Prosoil Foundation Consultants এর টিম লিডারকে প্রকল্পের Status Report ও Mid Term Report উপস্থাপনের জন্য তিনি অনুরোধ করেন।

০৩. পরামর্শক টিমলিডার জনাব এইচ. এস. মোজাদ্দাদ ফারুক PowerPoint এর মাধ্যমে প্রথমে ২য় Status Report উপস্থাপন করেন এবং প্রকল্পের সার্বিক অগ্রগতি নিয়ে আলোচনা করেন। তিনি সভাকে অবহিত করেন যে প্রকল্পের কাজ প্রায় ৬৫% সম্পন্ন হয়েছে। নিউমেরিক্যাল মডেল ক্যালিব্রেশন ও ভ্যালিডেশনের কাজ অসমাপ্ত রয়েছে। তিনি জানান যে, সমীক্ষা কাজটি PSP বর্ণিত তারিখ হতে প্রায় ৫ মাস পরে শুরু হয়, অতএব PSP এর সময় বর্ধিত করার প্রয়োজন রয়েছে এবং তিনি মহাপরিচালক মহোদয়কে প্রকল্পের সময় ডিসেম্বর ২০১৭ পর্যন্ত বর্ধিত করার জন্য অনুরোধ করেন। এ বিষয়ে প্রকল্প পরিচালক জানান এ পর্যায়ে প্রকল্পের সময়সীমা বৃদ্ধির কোন সুযোগ নেই।

০৪. অতঃপর পরামর্শক টিমলিডার PowerPoint এর মাধ্যমে Mid Term Report উপস্থাপন করেন। তার উপস্থাপনা চলাকালীন উপস্থিত কারিগরি কমিটির সদস্যবৃন্দ প্রকল্পের কার্যপদ্ধতি ও অন্যান্য বিষয়ে বিস্তারিত আলোচনা করেন এবং মতামত প্রদান করেন। পরামর্শক টিমলিডার উত্থাপিত মতামতের তাৎক্ষণিক উত্তর/ব্যাখ্যা প্রদান করেন। তাছাড়া ও প্রকল্প পরিচালক বিভিন্ন বিষয়ে clarification/ব্যাখ্যা প্রদান করেন। আলোচনা শেষে নিম্নবর্ণিত সিদ্ধান্তসমূহ গৃহীত হয়:

০৫. সিদ্ধান্ত

৫.১. প্রকল্পের বাস্তব ও আর্থিক অগ্রগতি সন্তোষজনক। নির্ধারিত সময় ও ব্যয়ের মধ্যে প্রকল্প সমাপ্ত করার বিষয়ে সংশ্লিষ্টগণ ব্যবস্থা গ্রহণ করবেন।

৫.২. বিভিন্ন সীমাবদ্ধতার কারণে প্রকল্পের সময় বর্ধিত করার কোন সুযোগ নেই। সে প্রেক্ষিতে, পরামর্শকগণ PSP বর্ণিত নির্দিষ্ট সময়ের মধ্যে কার্য সম্পাদন করার চেষ্টা করবেন।

৫.৩. কমিটির সদস্যবৃন্দ প্রযোজ্য ক্ষেত্রে আগামী ৭ দিনের মধ্যে তাহাদের লিখিত মতামত প্রদান করতে পারবেন। পরামর্শকগণ চূড়ান্ত খসড়া প্রতিবেদনে মন্তব্যসমূহের প্রতিফলন করবেন।

৫.৪. Mid Term Report টি কারিগরি কমিটি কর্তৃক অনুমোদনের সুপারিশ করা হল।

৫.৫. প্রকল্পের পরবর্তী Workshop-এ CEGIS, IWM, BUET এবং যৌথ নদী কমিশনের প্রতিনিধিসহ সংশ্লিষ্টগণকে আমন্ত্রণ জানানো হবে।

৫.৬. চূড়ান্ত রিপোর্টে ভবিষ্যৎ মডেলটি প্রকল্প/পরিকল্পনা বাস্তবায়নের কোন কোন ক্ষেত্রে প্রযোজ্য হতে পারে সেই বিষয়ে উল্লেখ করতে হবে।

০৬. পরিশেষে সভায় উপস্থিত সকল সম্মানিত সদস্যবৃন্দ ও প্রকল্পের পরামর্শক টিমকে ধন্যবাদ জানিয়ে সভাপতি সভার সমাপ্তি ঘোষণা করেন।

স্বাক্ষরিত/-
তারিখ: ০৮.০৩.২০১৭
(মোঃ মজিবুর রহমান)
মহাপরিচালক
বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর
ও
সভাপতি
Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক প্রকল্প
কারিগরি কমিটি

স্মারক-৪২,০৪,০০০০,০০৩,১৪,০১১,১২-১৫৩ তারিখঃ ০৮.০৩.২০১৭ খ্রি:

বিতরণ (জেষ্ঠতার ভিত্তিতে নয়):

১. জনাব মোঃ নুরুল আমিন, পরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর,৭২ গ্রীন রোড, ঢাকা।
২. ডঃ মোঃ নুরুল আমিন, পরিচালক (জলাভূমি), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর,৭২ গ্রীন রোড, ঢাকা।
৩. ডঃ মোঃ সাব্বির মোস্তফা খান, অধ্যাপক, পানিসম্পদ কৌশল বিভাগ, বুয়েট, ঢাকা।
৪. জনাব মোঃ মফিদুর রহমান, তত্ত্বাবধায়ক প্রকৌশলী, হাইড্রোলজি, বাংলাদেশ পানি উন্নয়ন বোর্ড, ৭২ গ্রীনরোড, ঢাকা।
৫. জনাব উত্তম কুমার সাহা, বন সংরক্ষক (প্রশাসন ও অর্থ), বন অধিদপ্তর, আগারগাঁও, ঢাকা-১২০৭
৬. কাজী মো. সাইফুল ইসলাম, উপপরিচালক (সম্প্রসারণ), সরেজমিন উইং,কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ী ঢাকা
৭. মোঃ এক্রামউল্লাহ, পিএসও, ওয়ারপো, ৭২ গ্রীনরোড, ঢাকা।
৮. ডঃ মোঃ নুরুল আলম, উপ-পরিচালক (কৃষি ও মৎস্য), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর,৭২ গ্রীন রোড,ঢাকা
৯. জনাব মোহাম্মদ নাজমুল আহসান, উপ-পরিচালক (প্রশাসন ও অর্থ), বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর,৭২ গ্রীন রোড, ঢাকা।
১০. এইচ. এস. মোজাদ্দাদ ফারুক, পরামর্শক, Prosoil Foundation Consultants, ৮৮/বি, কাফরুল, ঢাকা।
১১. মোঃ মাহবুবুল হাসান, সহকারী পরিচালক, বাস্তবায়ন পরিবীক্ষণ ও মূল্যায়ন বিভাগ, পরিকল্পনা কমিশন, শেরেবাংলা নগর ঢাকা।
১২. উম্মে কুলসুম ফেরদৌসি, সহকারী পরিচালক, বন অধিদপ্তর, আগারগাঁও, ঢাকা-১২০৭।
১৩. মোঃ মাহবুবুর রাহমান, সিনিয়র সহকারী প্রধান, পরিকল্পনা কমিশন, শেরে বাংলা নগর, ঢাকা।
১৪. খায়রুন নাহার, সহকারী প্রধান, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

সদয় অবগতির জন্য অনুলিপি (জ্যেষ্ঠতার ভিত্তিতে নয়):

১. সিনিয়র সচিব মহোদয়ের একান্ত সচিব, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
২. অফিস কপি।

০৮/০৩/২০১৭
(মোহাম্মদ নাজমুল আহসান)
প্রকল্প পরিচালক
'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor basin' শীর্ষক প্রকল্প
ফোন:০২-৪৪৮১১০৭৮

3.2 Decisions of the 2nd T.C. Meeting and the Responses

SL	Decisions of the T.C. Meeting held on 01/03/2017	Responses
1.	The physical and financial progress of the project is satisfactory.	Thanks for the appreciation.
2.	Due to certain constraints, the timeline of the project cannot be extended. The Consultants will try to complete the project within the PSP specified time.	The consultants completed the work and submitted the (draft) Final Report on 01/06/17.
3.	The members of committee can send their written comments within the next 7 days. The Consultants will reflect their comments in the (draft) Final Report.	No written comments were received.
4.	The Mid Term Report is recommended for approval.	Thanks for approval.
5.	Representatives from IWM, CEGIS, BUET and JRC will be invited in the next workshop/meeting of the project.	Action has been taken accordingly.
6.	The applicability of the theoretical model in the practical fields should be indicated in the Final Report.	Actions taken accordingly. A sub-section 8.3 Applicability of the Model has been included.

4 Workshop

A workshop on (draft) Final Report on "Model Validation on Hydro-morphological process of the River System in the Subsiding Sylhet Haor Basin" was organized by the Department of Haor and Wetlands Development (DBHWD) in association with M/s Prosoil Foundation Consultant on 6th June, 2017 to disseminate and discuss the report with stakeholders and various experts. Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR) was the Chief Guest. Mr. Majibur Rahman, Director General, Department of Haor and Wetlands Development chaired the workshop.

The proceedings of the workshop as well as the feedback from the stakeholders are given in the following sections.

4.1 Proceedings of the Workshop

Workshop on (draft) Final Report

of

‘Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin’

6th June, 2017

Venue: WARPO Conference Room, Dhaka

Organized by:

Department of Bangladesh Haor and Wetlands Development

Ministry of Water Resources

Government of the People’s Republic of Bangladesh

In association with:

Prosoil Foundation Consultant

Preface

The Department of Bangladesh Haor and Wetlands Development (DBHWD) appointed M/S Prosoil Foundation Consultants for carrying out the study on 'Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin'.

The study team submitted the (draft) Final Report of the project on 1st June, 2017. The Report has 3 volumes, one Main Volume containing the main report and an Appendix and other 2 volumes containing 2 Appendices. Earlier the DBHWD distributed the report to the Technical Committee Members, and other stakeholders including various Government organizations/ Departments.

The workshop was organized by the DBHWD in association with M/s Prosoil Foundation Consultant on 6th June, 2017 to disseminate and discuss the report with stakeholders and various experts.

Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR) was the Chief Guest. Mr. Md. Majibur Rahman, Director General, DBHWD chaired the workshop, while Mr. Md. Humayun Kabir, Additional Secretary, MoWR was the moderator of the Technical Session. Mr. H. S. Mozaddad Faruque delivered the Key Note Speech.

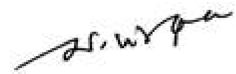
The Proceedings contains the Key Note Speech as well as documentation of the lively discussion of the workshop including the responses of the consultants.

We acknowledge with great appreciation Ministry of Water Resources and GoB for initiating the project. We are grateful to Water Resources Planning Organization (WARPO) for helping us to organize the workshop at the WARPO Conference Room. We thank the Chief Guest, Dr. Zafar Ahmed Khan, for honoring the workshop through his presence and active participation in the discussion. We thank Mr. Md. Humayun Kabir, Additional Secretary, MoWR for his contribution.

We also thank all the participants for attending the workshop. We are also grateful to the members of different committees and other well-wishers for their encouragements and inputs for the success of the programme.

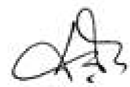
Mohammad Nazmul Ahsan

Project Director



H.S Mozaddad Faruque

Team Leader



Md. Majibur Rahman

Director General, DBHWD

Dhaka, The 13th June, 2017

Proceedings

A workshop on (draft) Final Report on "Model Validation on Hydro-morphological process of the River System in the Subsiding Sylhet Haor Basin" was organized by the Department of Haor and Wetlands Development (DBHWD) in association with M/s Prosoil Foundation Consultant on 6th June, 2017 to disseminate and discuss the report with stakeholders and various experts. **Dr. Zafar Ahmed Khan,** Senior Secretary, Ministry of Water Resources (MoWR) was the Chief Guest. **Mr. Majibur Rahman,** Director General, Department of Haor and Wetlands Development chaired the workshop. The list of the participants is given in Appendix 1.

Dr. Zafar Ahmed Khan congratulated the DBHWD and the Consultant Team for conducting the research project. He made some valuable opening remarks, which are:

- The opinions of the local people should be taken into consideration.
- All the future development activities should be based on scientific data/information and research.

Taking participation in the discussion Dr. Umme Kulsum Navera, Professor, Department of WRE, BUET, mentioned that a holistic approach needs to be followed in planning and implementation of water resources projects. She re-iterated the need of scientific research before taking any projects for implementation.

The Chair then requested Mr. H. S. Mozaddad Faruque, Team Leader to give a brief account of the research findings. Mr. Faruque mentioned that the project has 3 components;

1. Validation of the Center for Environmental and Geographic Information Services (CEGIS) Conceptual Model.
2. Collection of Sediment and Bed Material samples and their analysis.
3. Bank Line Survey of the River Surma and Kushiyara (150 km reach of each river).

Mr. Faruque further mentioned that during the preparation of the "Master Plan of Haor Area" in 2012, the CEGIS conducted morphological studies of the rivers of the Haor area. During the study the CEGIS developed a qualitative Conceptual Model on the evolution of the rivers of the Haor basin. But that model was not validated.

Under this study, the Conceptual Model was examined/validated from 3 perspectives:

1. Theoretical
2. Conventional Data Analysis and
3. Through Model Output

Two HEC-RAS 5.0.3 Models were developed, one for the Surma and the other for the Kushiyara River. Five hypotheses were extracted from the CEGIS Conceptual Model and for each of the hypothesis, validation criteria were developed. The hypotheses were examined against these criteria. Detailed methods, analysis and findings have been presented in the (draft) Final Report (consisting of 3 volumes). He specifically mentioned about the inadequacy of data availability. **The Chief Guest** then gave some general guidelines:

- The BWDB should strengthen their Hydrology Unit and take regular hydrological measurements.
- In the report, policy level recommendations should be made.

The Team Leader informed the workshop that the report has chapter on Major Findings and Recommendations.

Then the Chief Guest requested the Team Leader to give a PowerPoint presentation of the report. Mr. Faruque made a PowerPoint presentation of the report (Appendix-B).

After his presentation, an open discussion was held moderated by **Mr. Humayun Kabir,** Additional Secretary, MoWR. The following participants took active part in the discussion:

- **Dr. M. Mubarak Hossain, Professor, Department of Applied Mathematics, Dhaka University**

  Comments/ Suggestions:

  1. Hydrological data should be collected continuously to carry out any kind of morphological study with accuracy.
  2. The quality of data collection should be improved.
  3. The report is highly appreciated. The research followed scientific approach. It clearly spelled the findings of the research.

- **Mr. Md. Saiful Hossain, SE, PFFC, Bangladesh Water Development Board (BWDB)**

  Comments/ Suggestions:

4. BWDB is maintaining hydrological data in a scientific way. They have plan to strengthen the Hydrologic Unit for which Government approval is required. It is reported that some projects are/will be implemented by JICA funding.
5. If the height of the submerged earthen embankments around the Sylhet Basin is increased or the earthen embankments are carpeted with brick or otherwise, it will cause an adverse impact on the morphology of the Sylhet Basin. A study can be taken up considering this issue.

- **Dr. Anwar Zahid, Deputy Director, BWDB**

  Comments / Suggestions:

6. Whether any Geological/Morphological studies done for the rivers of the Haor Basin?
7. The BWDB has initiated a project for collection of hydrologic data.
8. O&M funding will be required for continuous data collection.

- **Dr. Maminul Haque Sarkar, Dy. Executive Director CEGIS**

  Comments /Suggestions:

9. When rivers enter into the Sylhet Basin, they behave differently. The sediment discharge decreases near Bhairab Bazar.
10. The CEGIS has studied Subsidence in the Sylhet Basin. Although, social evidence suggests there is no subsidence, but scientific study or literature reviews suggest that there is subsidence of about 2-4 mm/yr.
11. The name of the author should be given in the reference for the book titled "Inland Navigation and Integrated Water Resources Management, 2014".
12. The CEGIS Conceptual Model is not a Mathematical Model rather a Quantitative Model. CEGIS expects qualitative analysis of the said Conceptual Model.

- **Mr. Mahbubur Rahman, Senior Assistant Chief, Planning Commission**

  Comments /Suggestions:

13. He wanted to know whether the recommendations/decisions of the 2nd Technical Committee meeting have been incorporated in the (draft) Final Report or not.

- **Mr. Md. Masud Alam, PSO, Water Resources Planning Organization (WARPO)**

  Comments /Suggestions:

14. What are the validations done with? What are the assumptions? Which assumptions were validated?
15. Prior to the model setup, was the morphology of the Surma-Kushiyara River checked by studying their geology?
16. How much erosion/deposition will occur in future, how the morphology of the river respond to any future change- was it analyzed? What was the bank erosion pattern?
17. Was there any sediment model to know the sediment gradient, upstream/downstream sediment condition etc.?
18. It is important to know how much sedimentation has occurred in the Haor basin in the last decades and how this sedimentation is contributing in the recent flood incidents.

- **Mr. Md. Delowar Hossain Molla, Director, Soil Resources Development Institute (SRDI)**

  Comments /Suggestions:

19. SRDI prepares Land Type Maps and updates them every 10 years.
20. How much sedimentation occurs in the Haor area?
21. The flood of this year in the haor areas deserves special attention and the causes of flooding should be found out.
22. The recommendations made in the report are highly appreciated.

- **Mr. Md. Sarafat Hossain Khan, Director General, WARPO**

  Comments /Suggestions:

23. Is the model ready for application after proper calibration and validation?
24. Is the model setup including the bathymetry correct? The results depend on the accurate setup of the model.
25. A study should not be completed with limited or incomplete set of data. The results generated from those types of dataset often give unrealistic results which are eventually detrimental to the policy makers. The study could have been stopped if there was lack of data and proposals could have been issued for further data collection.

26. What does it mean by Conceptual Model? The hydro-dynamics should be explained clearly.
27. Proper gradient should be established first.
28. When bank full regime condition was mentioned, did it consider a bank full condition with embankment or in a natural condition?
29. There should be further study on this topic as there are some data limitations so the results can be applied accurately.

- **Mr. Md. Rezaul Karim, PSO, WARPO**

  Comments /Suggestions:

30. Accuracy of HEC-RAS model should be checked.

- **Mr. Gautam Chandra Mridha, Senior Specialist, Institute of Water Modelling (IWM)**

  Comments:

31. Why in the model setup, two ‘n’ values have been used for two different seasons for the Surma River?
32. Whether Flood Depth Maps have been prepared.
33. Why HEC-RAS Model has been used?
34. Result of this model should be compared to the results from other models to check the accuracy.
35. There are many rivers in the Haor Basin. A study considering all these rivers could produce much better results.

- **Mr. Md. Nurul Amin, Director, DBHWD**

  Comments /Suggestions:

36. He cited examples of Barisal Irrigation Project (BIP) of the BWDB. The project could not give desired results for different causes. Now some agricultural land has been forced to be transformed to fish ponds. People should be motivated for achieving desired goals.

- **Mr. Md. Majibur Rahman, Director General, DBHWD**

  Comments/Suggestions:

37. He observed with much worries that in the Haor region, roads are being made in east-west direction which can cause catastrophic consequences such as water logging and change in the Haor characteristics.
38. Study can be taken up regarding this issue.

Mr. Humayun Kabir, Additional Secretary, MoWR, requested the Team Leader to give a quick response to the comments and suggestions of the participants.

Mr. H.S. Mozaddad Faruque, Team Leader, thanked the Chair and all the participants for their valuable comments and suggestions. He mentioned that the learned participants raised several issues of the water sector particularly of the Haor Areas. He preferred to give response to the comments/suggestions related to this project/report only.

He mentioned that:

1. The Consultants have made recommendations for future studies (Chapter 11).
2. The recommendation chapter will be revisited to incorporate the suggestion/comments.
3. All the decisions of the 2nd T.C. Meeting have been incorporated in the (draft) Final Report.
4. Detailed study of the river morphology of the haor area, bank erosion pattern, quantification of sediment, flood depth mapping etc were beyond the scope of the TOR of the study.
5. The rational of using HECRAS Model has been adequately discussed in the Report (Chapter 8).
6. The CEGIS Conceptual Model was examined/validated in the study.
7. The HEC-RAS Models developed under the study were also validated.
8. It was mentioned earlier that the CEGIS Conceptual Model was examined in 3 perspectives. During examination/ validation, some quantification of river characteristics was made both in the case of conventional as well as model output. However, the consultants had to carry out their study with the available data and maintaining time schedule within the stipulated TOR framework.
9. Detailed explanations have been given on selection of manning’s n (in Sec 8.2.6.1.)

He once again thanked the Chief Guest, the Chair, the Moderator of the open discussion session and the participants. He also thanked different organizations for extending cooperation and help to the study team. He thanked the DBHWD for cooperation and logistic supports. He thanked CEGIS, WARPO, BUET, and IWM for allowing the Study Team to use their libraries. He also expressed his gratitude towards the Ministry of Water Resources. He finally thanked his Study Team for their hard work and dedication towards the study.

Mr. Humayun Kabir, Additional Secretary, MoWR, thanked the participants, Consultants and the DBHWD. He then handed over the floor to the DG, DBHWD for his concluding speech. Mr. Md. Majibur Rahman, Director General, DBHWD, thanked all the participants. He specially thanked the Consultants for timely completion of their tasks and submitting the Reports. He then declared the following recommendations/decisions of the workshop:

1. The Consultant will try to incorporate the comments and suggestions while finalizing the report.
2. The (draft) Final Report is recommended for approval

Then the Chair declared the closure of the workshop.

Enclosure:

1. Appendix A: Participants List
2. Appendix B: Power Point Presentation of the Report
3. Appendix C: Photo Gallery

Appendix A

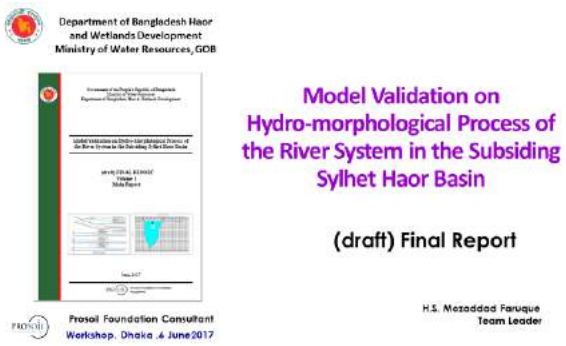
List of the Participants

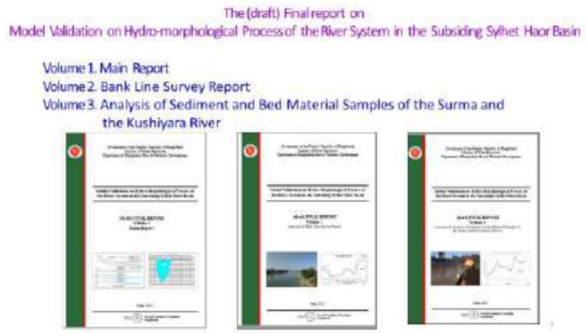
1. Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources
2. Md. Humayun Kabir, Additional Secretary, Ministry of Water Resources
3. Mr. Md. Majibur Rahman, Director General, DBHWD
4. Dr. Md. Nurul Alom, Deputy Director, DBHWD
5. Mr. Mantu Kumar Biswas, Joint Chief, Ministry of Water Resources
6. S.M. Shahab Uddin Mahmood, Secretary, WARPO
7. Md. Delwar Hossain Akhand, Senior Engineer, SWHC, BWDB
8. Dr. Anwar Zahid, Deputy Director, BWDB
9. Mr. Md. Nurul Amin, Director (Admn. & Fin.), DBHWD
10. Md. Mofazzal Hossain, member, Joint River Commission Bangladesh
11. Mr. S M Feroz Alam, Director (Planning), WARPO
12. Md. Abdul Hai, Accounts Officer, CAO Office, Ministry of Water Resources
13. Mr. Md. Humayun Kabir, Additional Secretary, Ministry of Water Resources
14. Dr. Md. Ruhul Amin, Director (Wetlands), DBHWD
15. Md. Masud Alam, PSO, WARPO
16. Dr. Umme Kulsum Navera, Professor, DWRE, BUET
17. Mr. Md. Jahid Hossain Jahangir, Member, Joint River Commission
18. Md. Aktarujjaman Khan, Auditor, CAO Office, Ministry of Water Resources
19. Sharmistha Rani Dey, Super, CAO Office, Ministry of Water Resources
20. Krishna Chandra Bhadra, Senior, Scientific Officer, WARPO
21. Engr. Md. Anisur Rahman, PSO, WARPO
22. Mr. Md. Jan-E-Alam, Deputy Chief – 2, Ministry of Water Resources
23. Md. Delwar Hossain Mondal, Director, SRDI
24. Dr. M. Mubarak Hossain, Professor of Applied Mathematics, University of Dhaka
25. Mr. Md. Rezaul Karim, PSO, Monitoring & Evaluation Section, WARPO
26. Nikhil Kumar Das, Deputy Chief, Agriculture Sector, PC
27. Md. Mahbubur Rahman, Sr. Assistant Chief, Planning Commission, Ministry of Planning
28. Dr. Md. A. Salam, Additional Director, FSW, DAE
29. Mohammad Aminul Islam, ACCP, Prosoil Depth.
30. Rokeya Sharmin, Assistant Engineer, BWDB
31. Dr. Maminul Haque Sarker, Deputy Executive Director, CEGIS
32. Md. Saiful Hossain, Senior Engineer, PFFC, BWDB
33. Goutam Chandra Mridha, SS, IWM
34. Dr. Aminul Haque, PSO, WARPO

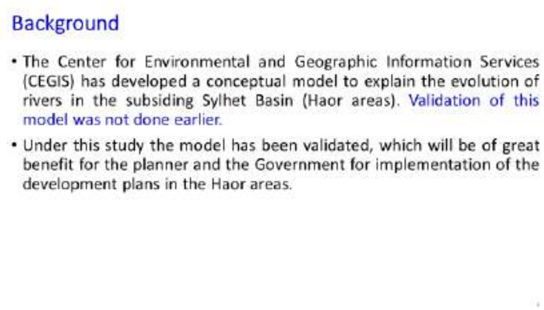
35. Md. Ekram Ullah, PSO, WARPO
36. Engr. Md. Tanvir Akkas, AD, IMED
37. Halima Khatun, Senior Engineer, Hydrology Dept, BWDB
38. Md. Shamsul Islam, Managing Director, Prosoil Foundation Consultant
39. Engr. H.S. Mozaddad Faruque, Team Leader and Senior Morphologist, Prosoil Foundation Consultant
40. Engr. Rumman Adib, Prosoil Foundation Consultant
41. Engr. Samia Jahan Chowdhury, Prosoil Foundation Consultant
42. Engr. Gokul Chandra Paul, Prosoil Foundation Consultant
43. Engr. Purnima Das, Prosoil Foundation Consultant
44. Engr. Sabrina Mehzabin, Prosoil Foundation Consultant

Appendix B

Power Point Presentation of the Report







Study Area

- The general study area is the Sylhet basin, located in the north-east hydrological zone of Bangladesh.
- The Surma and the Kushiyara rivers have been studied for the validation of the CEGIS Model. A reach of 150 km each for both the rivers starting from Kanaighat for Surma and Shaola for Kushiyara have been considered.
- The hydro-meteorology of the North East Hydrological Region of Bangladesh is quite different from other parts of the country.
- **The region is a tectonically active area and the rate of subsidence in this area is much higher than the deltaic-plains elsewhere in the country. Literature review strongly suggests that the rate of subsidence is 2-4 mm/yr.**

Study Area

Objectives

- Enhance the knowledge on hydro-morphological behavior of the Surma and Kushiyara rivers in the Sylhet basin.
- Validate the existing conceptual model of CEGIS

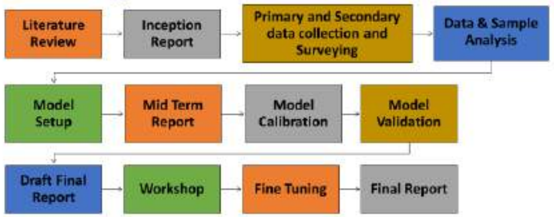
Scope of Works

- Review the literatures on evolution process of rivers on especially on the north-eastern part of Bangladesh.
- Routine measurement of discharge and sediment concentration in the Kushiyara and Surma River at fixed sections which will cover one hydrologic cycle.
- Bank line survey in both the Surma and the Kushiyara rivers which is 150 km in each river.
- Secondary data collection, such as water level, discharge, cross sections, satellite images.
- Analyze the primary and secondary data for further elaborating and validating the existing conceptual model for the evolution of the rivers in Haor areas.
- Development of 1D Hydro-Dynamic Numerical Model (HEC-RAS) of the Surma and Kushiyara rivers.
- Assess the applicability of the validated model with the enhanced knowledge on prevailing physical processes of the rivers.

Constraints and Limitations

- Primary data of stage, discharge and sediments were collected for only one year
- Due to the limitation of time and financial resources, most of the study were carried out by using data of secondary sources.
- Satellite images of finer resolution are required to understand the avulsion and branching processes of the river. But budget does not include the cost of the images.
- In the approved PSP (2015), the study period was shown as 24 months (July, 2015- June 2017). But the works of consultants started with a lag of 5 months (December, 2015)and had to complete the works within the stipulated time.

Methodology



Flowchart

Note: The general approach and methodology of the study was described in the Inception Report and was approved by the technical committee and the DBHWD.

The Sylhet Basin

- Regional Physiographic Setting
  - Old Brahmaputra Floodplain
  - Jamuna (Young Brahmaputra) Floodplain
  - Haor Basin
  - Surma-Kushiyara Floodplain
  - Meghna Floodplain
  - Northern and Eastern Piedmont Plains
  - Northern and Eastern Hills
- Hydrological Setting
- Subsidence of Sylhet Basin

Bangal Basin (Source: Banglapedia,2003)

Literature Review

Different publications, reports, documents, policies, acts etc. have been reviewed by the research team in order to understand the complex characteristics of the morphological process of the North Eastern Region. Some of the notable documents are:

- Morphology of Haor Areas, CEGIS, 2011
- Inland Navigation and Integrated Water Resources Management, 2014
- Manuals of Different Numerical Models
- Master Plan of Haor Area, 2012
- National Water Management Plan, 2004
- Northeast Regional Water Management Plan (FAP 6), 1994
- Mathematical Modelling Study (Groundwater and Surface Water) to Asses Upazilla Wise Surface Water and Groundwater Resources and Changes in Groundwater Level Distribution due to Withdrawal of Groundwater in the Study Area (Package-1), IWM, 2013
- Mathematical Modelling & Topographic Survey for Integrated Water Resources Management of Chalan Beel Area Including Beel Halti Development Project, IWM, 2007

Assumptions:

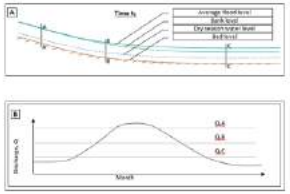
1. *The river reaches at the upstream of the Sylhet basin are in Regime condition*
2. *Flood profile of the river is assumed to be parallel to the bank line*

Hypothesis 1: The bankfull water level of the channel in concern varies in the downstream direction. At the upstream, it is high and close to water level corresponding to annual average flood discharge.*(Assumed : No Sedimentation)*

This implies that in most days in a year, the river flow is confined within the bank. On the other hand, the bank full water level at the downstream is much less and the overbank flow occurs for several months during the monsoon.

In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C.

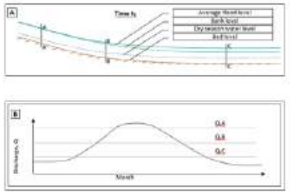
CEGIS Conceptual Model



(A) the long profile of the river reach with the sections A-A, B-B and C-C and (B) a simplified discharge hydrograph showing bankfull water levels of different reaches of the river at time t_i

Validation Criteria Hypothesis 1

- If it is found that at bankfull water level $Y_A > Y_B > Y_C$, then the hypothesis is accepted, where Y_A, Y_B and Y_C are the bankfull water levels at sections A-A, B-B and C-C respectively (upstream to downstream sections).
- If it is found that months of overflow at downstream is greater than that of the upstream then the Hypothesis 1 can be accepted.

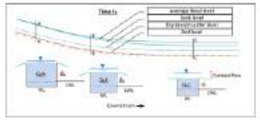


(A) the long profile of the river reach with the sections A-A, B-B and C-C and (B) a simplified discharge hydrograph showing bankfull water levels of different reaches of the river at time t_i

CEGIS Conceptual Model

Hypothesis 2: Decrease in the bankfull water level at the downstream, however, indicates a decrease in channel dimensions i.e. the width and depth.*(Assumed : No Sedimentation)*

This might be the reason why the width of the river decreases while it enters into the Sylhet Basin as observed in the satellite images. Figure shows the channel dimensions without any influence of sediment. From Figure, it can be observed that the width and depth in the upstream section A-A is significantly larger than the width and depth in the downstream sections; B-B and C-C, i.e. $W_A>W_B>W_C$ and $d_A>d_B>d_C$.

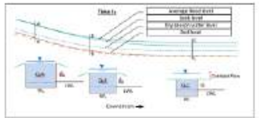


In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C.

Validation Criteria Hypothesis 2

- Let us consider sections A, b and C located from upstream to downstream direction.
- If it is found that,
  - $A_{bA}>A_{bB}>A_{bC}$
  - $d_{bA}>d_{bB}>d_{bC}$
  - $W_{bA}>W_{bB}>W_{bC}$

  Then the Hypothesis is accepted
- Where, A_{bA}, A_{bB} and A_{bC} are the bankfull cross sectional area at section A, B and C respectively,
  d_{bA}, d_{bB} and d_{bC} are the bankfull water depths at section A, B and C respectively. And W_{bA}, W_{bB} and W_{bC} are the bankfull width of the section A, B and C respectively.



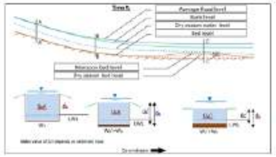
In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C.

CEGIS Conceptual Model

Hypothesis 3: The shallow depth caused to increase the high gradient during the dry season and thus increase the dry season water level at the upstream.
(Considering Sedimentation)

The processes of sedimentation on the long profile and channel dimensions at different reaches are shown in Figure.

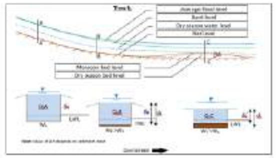
In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C. d_B' and d_C' are the water depths at sections B-B and C-C after sedimentation.



Validation Criteria Hypothesis 3

- If it is found that
  a)The channel slope from upstream to downstream is greater in dry season than that of the monsoon season
  b)There is backwater effect towards upstream

Then the Hypothesis 3 can be considered accepted.

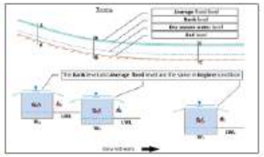


In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C. d_B' and d_C' are the water depths at sections B-B and C-C after sedimentation.

CEGIS Conceptual Model

•Hypothesis 4: After several years/decades (at time tα) as the river will be able to raise its levee and reach regime condition, the flood level will be close to the bank level, i.e. bankfull water level will be the same along the whole river stretch.

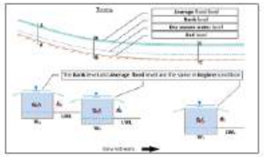
Hypothesis 5: At regime condition, the channel dimensions will be nearly the same at the upstream and downstream and no sedimentation would be expected during monsoon.



In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C.

Validation Criteria Hypothesis 4 and 5

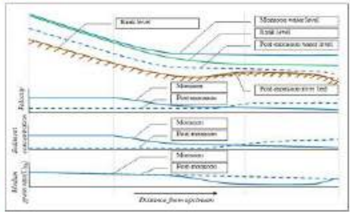
- If there is no variation in bank full water level at different sections of the river reach, the river is in regime (equilibrium) condition.
- If it is found that X-sectional areas at different sections do not change/vary then the river is in regime condition.
- If there is no variation in sediment concentration, then the river reach is in regime condition.
- If there is no variation in Median grain size (D_{50}), then the river reach is in regime condition.



In the figure, Q_bA, Q_bB and Q_bC are the bankfull discharge in the sections A-A, B-B and C-C. d_A, d_B and d_C are the water depths at the sections A-A, B-B and C-C. W_A, W_B and W_C are the channel widths at the sections A-A, B-B and C-C.

CEGIS Conceptual Model

A simplified diagram is however, presented in Figure for showing the spatial variation of river gradient, flood profile, bank profile, riverbed profile, flow velocity, sediment concentration, bed material sizes both in monsoon and dry season of a river, which is approaching towards regime conditions after its avulsion into the Sylhet Basin.



Data Collection

- Data of the Surma and the Kushiyara Rivers were collected from both the primary and secondary data sources.
- Primary data includes the following:
  - Routine Measurement of Discharge (monthly, in a fixed section)
  - Routine measurement of Sediment Concentration (monthly, in a fixed section)
  - Measurement of Sediment Concentration (3 measurements, in 9 stations)
  - Bank line Survey (150 km in each river)

Installed Water Level Gauge on the Surma (Station ID: S-06) at Sylhet-Sunamganj Bypass Bridge

Installed Water Level Gauge on the Kushiyara (Station ID: K-03)

Secondary Data Collection

River	Water level *(Daily Data)*	Discharge and Velocity *(Fortnightly Data)*	Cross-section (Yearly; once in 2/3 years)	Satellite Images
Source	***BWDB***	***BWDB***	**BWDB**	**USGS**
The Surma River	7 BWDB Stations 1985 to 2016	3 BWDB Stations 1986 to 2016	42 Stations 2009, 2011, 2013 and 2014	November, 2015 and December, 2015
The Kushiyara River	4 BWDB Stations 1985 to 2016	3 BWDB Stations 1986 to 2016	15 Stations 2004, 2006, 2008 and 2010	November, 2015 and December, 2015

Historical Data Analysis

- Historical data (cross-section, water level and discharge) analysis has been done for both the Surma and the Kushiyara rivers
- For the Surma:
  - Cross-section at RMS38 and RMS10
  - water level and discharge at SW 266, SW 269
- For the Kushiyara:
  - Cross-section at RMKUS12 and RMKUS1
  - water level and discharge at SW 173, SW 175.5

Cross-section Stations

Water level and discharge stations

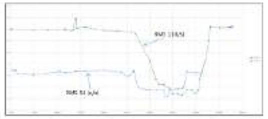
Analysis of Secondary Data

Historical Data Analysis

The Surma River

Cross section

The cross section data have been analyzed for the years 2009, 2011, 2013 and 2014. Cross sections at upstream and downstream sections have been plotted.



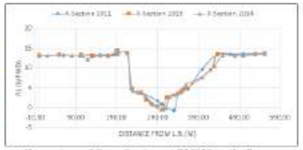
Cross Section Analysis of 2014 (Nov-Dec)

Historical Data Analysis

The River Surma (at Upstream)

The cross sections are taken at the upstream boundary, RMS38. The data at this station are available for the years 2011, 2013 and 2014.

After plotting the cross sections, it is observed that the shape of the left bank of the river remains almost same throughout the period. The main channel is getting narrower. At the right bank, the channel gets wider throughout the years. This implies that the river bank is shifting towards the north.



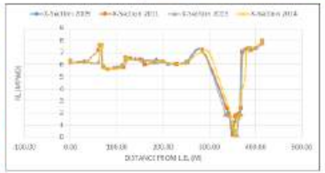
Comparison of Cross Sections at RMS38 on the Surma

Historical Data Analysis

The River Surma (at Downstream)

The cross sections are taken at the downstream boundary, RMS10. The data at this station are available for the years 2009, 2011, 2013 and 2014.

After plotting the cross sections, it is observed that the shape of the left bank of the river remains almost same throughout the period, except in 2011 where there is a sharp slope in left of the road. The shape of the main channel remains almost the same. At the right bank, the channel gets wider in 2014 which implies that the right bank is moving towards the north-east.



Comparison of Cross Sections at RMS10 on the Surma

Analysis of Secondary Data

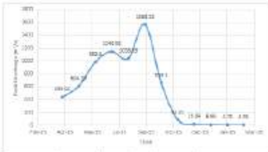
Historical Data Analysis

The Surma River

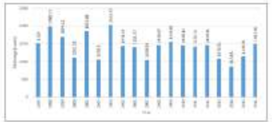
Discharge Hydrographs

Discharge hydrographs for each of the three sections on Surma have been plotted for 2010-2015.

Similar Data Analysis has made for the Kushiyara River.



Discharge Hydrograph of SW266 for 2015



Comparison of Average Discharge, the Surma (1996-2016)

Data Analysis

Analysis of Secondary Data

River data analysis

The Surma River

Upstream (RS38)

Water Level:

Comparison of Average Water Level of July from 1996 to 2016 has made.

Similar analysis has made for the **downstream (RS 11)** of the Surma river.

Comparison of Average Water Level, the Surma (1996-2016)

Analysis of Secondary Data

Historical Data Analysis

The Surma River

Velocity Analysis

- There are 3 discharge stations on the Surma River (SW266, Kanaighat, SW267, Sylhet and SW269, Sunamganj).
- The average velocities of Monsoon season and dry season for the last 20 years (1996-2016) have been plotted.

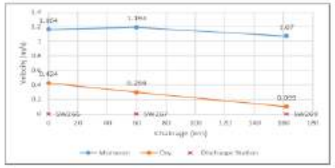


Fig. (Average) Velocity Analysis, The Surma, (1996-2016)

Primary Data Analysis

Analysis of Primary Data carried out for both the Surma & the Kushiyara

- Analysis of Sediment concentration
- Median grain size and
- Bank Line Survey

Sediment Concentration Analysis

- Sediment concentration samples of both the Surma and the Kushiyara were collected in three selected seasons (Dry, Pre-monsoon and Monsoon).
- The sediment concentration has been determined at the Prosoil Laboratory by using the ASTM Standard Test Method D 3977-97
- The detailed Report is presented in Volume 3

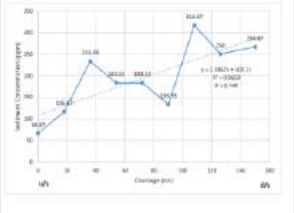
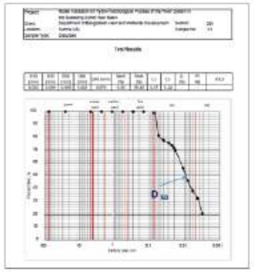


Figure 8-72 Analysis of Sediment Concentration of the Surma (August 2016, Monsoon Season)

Median Grain Size

- The bed material samples have been analyzed in the Prosoil Laboratory to determine the Median Grain Size (D_{50}) values for both the rivers
- The Median Grain Size has been determined at the Prosoil Laboratory following the ASTM Standard Test Method D 42-63.
- The detailed Report is presented in Volume 3



Bank Line Survey

- Bank line survey of both the sides of the rivers were carried out by Total Station, GPS and Automatic Level .
- The detailed Report is presented in Volume 2

Model Setup

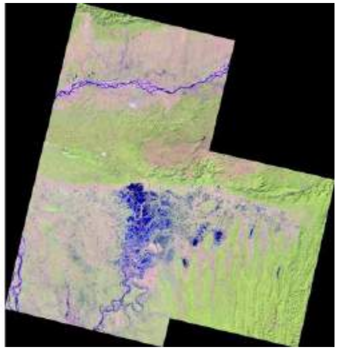
Selection of Model

- Two most commonly used one-dimensional modeling tools are HEC-RAS and MIKE11. The other models which are also widely used are Delft3D and Delft3D FM
- In this study, the model will be used only for validation of the CEGIS Conceptual Model in a qualitative way. Hence, a user friendly model, requiring data on water level, discharge and sediment concentration has been chosen.
- HEC-RAS is available for download for free of charge. MIKE 11 on the other hand, is high in cost. The Budget of the project does not include any separate cost for purchase of a modelling software.
- After thorough evaluation, HEC-RAS 5.0.3 Model developed by US Army Corps of Engineers has been considered for carrying out the study. The HEC-RAS system contains four one-dimensional river analysis components for:
  - Steady flow water surface profile computations;
  - Unsteady flow simulation
  - Movable boundary sediment transport computations; and
  - Water quality analysis

Model Setup

Collection of Satellite Images

- Satellite images of the Surma and the Kushiyara have been collected.
- Images are Landsat-8 Satellite images of WRS Path-Row 136-43, 135-43, 135-42. The Images have been collected from United States Geological Survey (USGS).
- These images are of 30mX30m resolution and dated from 30th November, 2015 to 16th December, 2015.

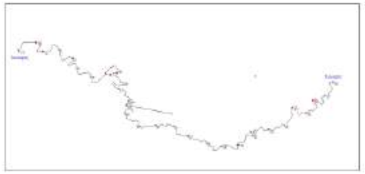


Model Setup

River Schematics

The Surma River

- For the Surma river, a total reach length of 179.36 km has been considered starting from Kanaighat (BWDB station: SW266) to Sunamganj (BWDB station: SW269).
- The river schematic setup of the Surma River has been completed



The Surma River Schematic in HECRAS Geometry Editor

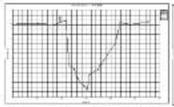
Model Setup

Cross Section Geometry

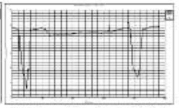
The Surma River:

- Cross Sections collected from the BWDB have been used to setup the geometry of model.
- BWDB cross sections from RMS38 to RMS10 (total 29 cross sections) were used to set up the model geometry of the Surma River.
- These cross sections are of year 2013.
- BWDB collects cross sections at an interval of approximately 6km. So reach lengths of 6km have been used in this model.

Locations of Cross Sections on the Surma



The Surma Cross Section RMS38 (2013)



The Surma Cross Section RMS11 (2013)

Model Setup:

Rating Curve

The Surma River

❖A rating Curve has been plotted for monthly average data of 20 years (1995-2014) for upstream section of the Surma river, Kanaighat (SW 266) and the equation becomes

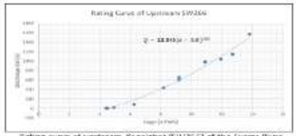
$$Q = 13.845(h-3.8)^{2.05}$$

Now using this equation, the daily discharge data with respect to daily stage data were calculated and used in the model.

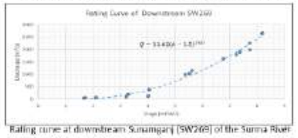
❖Similarly, a rating curve at downstream station (SW 269) has been plotted and the equation becomes

$$Q = 11.62(h-1.5)^{2.567}$$

Now using this equation, daily stage data with respect to the daily discharge data were calculated and used in the model.



Rating curve at upstream Kanaighat (SW266) of the Surma River



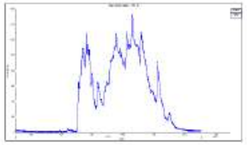
Rating curve at downstream Sunamganj (SW269) of the Surma River

Model Setup:

Boundary Conditions

Upstream Boundary Condition: The Surma River

- For setting up an unsteady hydrodynamic model, a flow hydrograph of discharge versus time has been considered as Upstream Boundary Condition.
- In case of the Surma River, Kanaighat (SW266; Lat. 25.004°, Long. 92.270°) is the upstream discharge station.
- Flow (discharge) hydrograph of the year 2013 of Kanaighat station has been used as Upstream Boundary Condition for the Surma River.



Flow Hydrograph (Q vs Month) at station SW 266 on The Surma River

Model Setup:

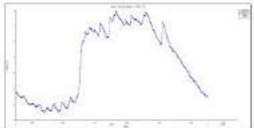
Boundary Conditions

Downstream Boundary Condition: The Surma River

•A stage hydrograph of water surface elevation versus time was used as the downstream boundary condition.

•For the Surma river, Sunamganj Station (SW269; Lat. 25.071°, Long. 91.410°) is at the downstream end of the Model.

•Stage hydrograph of the year 2013 of Sunamganj station was used as a Downstream Boundary Condition.



Stage Hydrograph (WL vs Month) at station SW 269 on The Surma River

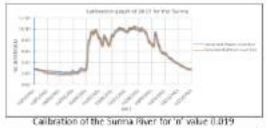
Model Setup:

Calibration of Model: Done for the year 2013

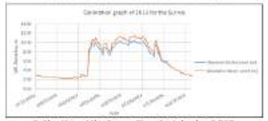
$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

The Surma River

- For Mannings n value of 0.019, the maximum deviation between the observed water level and the Simulated water level in wet season (May to October) was ±4.5% (±50 cm) and in dry season (November to April) (-)18% (-56 cm).
- which can claim that the model is well calibrated for the Surma river.
- When the 'n' value was changed from 0.019 to 0.020, a very well calibrated graph for dry season was observed. But in case of wet season large variation (+)10% (+ 120 cm) between the Simulated and Observed water level is obtained.
- For the Surma if the point of interest is the wet season flow (May-Oct), 'n' value of 0.019 may be used, on the other hand if the point of interest is the dry season flow (Nov-April), n value of 0.020 may be used.
- In this study for model simulation 'n' value of 0.019 has been selected as it is the best fit through all the seasons, and the interest was the bankfull discharge.



Calibration of the Surma River for 'n' value 0.019



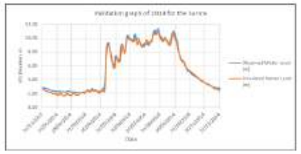
Calibration of the Surma River for 'n' value 0.020

Model Setup:

Validation of model : For the Surma done for the year 2014

The Surma River

The maximum deviation between the observed water level and the Simulated water level in wet season (May to October) is ±6% (±60 cm) and in dry season (November to April) is ±20% (±55 cm).
Which shows that the model is well validated for simulation of the water level of the Surma river.



Validation of the Surma River

Hypothesis 1 :Conventional Analysis (Surma River)

- The bankfull water levels at the downstream sections of the river reach are always lower than the bankfull water levels at the upsteam sections of the river reach.

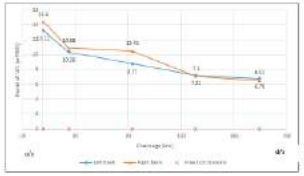


Fig:Bankfull Water Level of the Surma (2009)

Hypothesis 1 :Model Output Analysis (Surma)

- Simulation was done for July 2014 and resulting bankfull water levels at upstream (section RS 38), at downstream (RS 11) and three intermediate stations at RS 31, 26 and 20 have been observed.
- The bankfull water levels at the downstream sections of the river reach are always lower than the bankfull water levels at the upsteam sections of the river reach

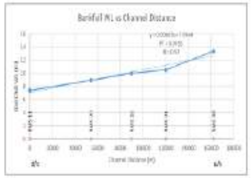


Fig:Bankfull Water Level vs Channel Distance of the Surma (2014)

Hypothesis 2: Conventional Analysis (the Surma river)

Findings

- The bankfull water level decreases in the downstream direction.
- There are changes of channel area but the change shows scattered pattern. The trend line shows slight increase in area towards d/s (R=0.017), which is not statistically significant. This contradicts the Hypothesis
- There are changes of average depth. But the changes show a scattered pattern. The trend line shows a decrease in depth towards downstream. the trend line is not statistically significant. This is in line with the Hypothesis
- There is change of top width, but it shows a scattered pattern. However the trend line shows slight increase towards downstream (R= 0.306). This contradicts the Hypothesis

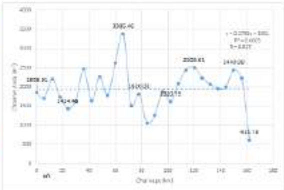


Fig: Channel Area vs Chainage Plot for the Surma River (2013)

Hypothesis 2: Model output (the Surma River)

- Among the 28 cross sections of the river Surma calibrations were done for 5 stations namely, Rs 38, RS 31, RS 26 and RS 20.
- The HECRAS model generated bank full water levels and cross sectional area of these Stations are shown.

Findings:

- The bank full areas show a scattered pattern for 28 cross sections , however the trend line shows slight increase from d/s to u/s.
- This contradicts the Hypothesis

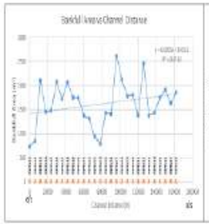


Fig: Bank full Area vs Channel Distance for 28 Stations of the Surma (2014)

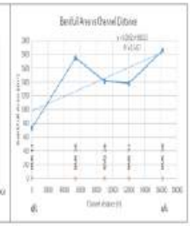


Fig: Bank full Area vs. Channel Distance for Selected 5 Stations of the Surma (2014)

Hypothesis 2: Model output (the Surma river)

Findings

- When only 5 stations were considered, there is a decreasing trend towards downstream but in case of plot for all the 28 stations, the trend is increasing.
- Hence it may be concluded that the changes of top widths are of scattered pattern.
- This contradicts the Hypothesis 2

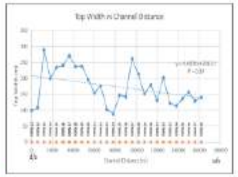


Fig:Top Width vs Channel Distance for 28 Stations of the Surma (2014)

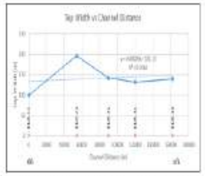


Fig:Top Width vs Channel Distance for Selected 5 Station of the Surma (2014)

Hypothesis 2: Model output (the Surma River)

Findings

- The trend line shows a change of the average depth along the channel length an increasing trend towards upstream.
- This is in line with the Hypothesis

Fig:Average Depth vs Channel Distance for 28 Station of the Surma (2014)

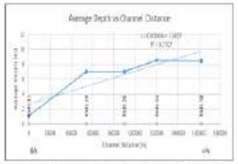


Fig: Average Depth vs Channel Distance for Selected 5 Station of the Surma (2014)

Hypothesis 3:Conventional Analysis (the Surma River)

Conventional Analysis

- The monsoon season water level gradient and dry season water level gradient are shown in the Table.
- Assumption: For simplicity it is assumed that WL gradient and Bed level gradient are same for two Successive sections

Table : Water Depth and Water Level Gradient for the Surma, 2013

Stations	Water Level (mPWD)		Bed Level (mPWD)	Water Depth (m)		WL Gradient between 2 Successive Stations (m/km)	
	Monsoon	Dry		Monsoon	Dry	Monsoon	Dry
SW266	11.32	4.8	2.41	8.91	2.39	-	-
SW267	9.24	2.89	-1.27	10.51	4.16	-0.0267	-0.0295
SW268	7.82	2.46	-3.05	10.87	5.51	-0.0060	-0.0225
SW269	7.03	2.14	-7.4	14.43	9.54	-0.0593	-0.0672
SW269.5	6.42	2.04	-0.1	6.52	2.14	0.1198	0.1121

Findings:

- The dry season water level gradient is greater than the monsoon season gradients in 3 reaches
- However in one reach dry season gradient is slightly lower than that of the monsoon season
- The analysis suggests that the Hypothesis 3 can be validated/established for the Surma River under the above over simplified assumption

Hypothesis 3:Model Out put (the Surma River)

- Bed level gradients for the two seasons (Dry and Monsoon) are presented .

Findings:

- Bed slope at both the seasons are almost same.
- The Hypothesis 3 could not be established/validated for the Surma from bed level slope consideration.

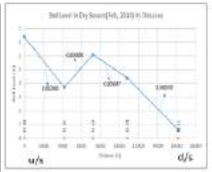


Fig: Bed Level Gradient Graph for Dry Season of the Surma(2014)

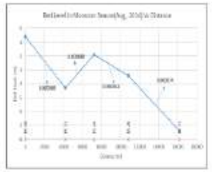


Fig: Bed Level Gradient Graph forMonsoon Season of the Surma(2014)

Hypothesis 3:Model Out put (the Kushiyara River)

- Bed level gradations for the two seasons (Dry and Monsoon) are presented .

Findings

- In most cases the dry season bed level gradient is greater than that of the monsoon season.
- So Hypothesis 3 can be considered as established/validated from the consideration of bed level gradient.

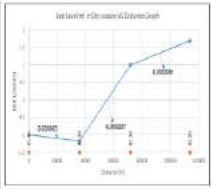


Fig:Average Bed Level Gradient Graph for Dry Season of the Kushiyara(2012)

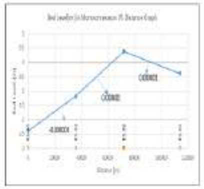


Fig:Average Bed Level Gradient Graph for Monsoon Season of the Kushiyara(2012)

Hypothesis 4 and 5:Conventional Analysis (Surma River)

Conventional Analysis

Findings:

- The trend of change in sediment concentration from upstream to downstream in the Surma river does not follow the hypothetical trend of regime condition as described in the Conceptual model
- The trend line of change in sediment concentration is rather opposite to which is described in the conceptual model
- This clearly shows that the Surma river is not in regime condition.

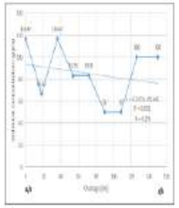


Fig: Analysis of Sediment Concentration of the Surma (January 2017, Dry Season)

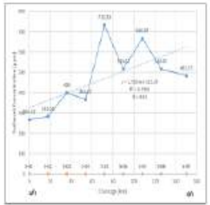


Fig: Analysis of Sediment Concentration of the Surma (April 2017, Pre Monsoon Season)

Hypothesis 4 and 5:Conventional Analysis (the Surma river)

Conventional Analysis

Findings:

- The Median Grain Size along the river course shows a scattered pattern.
- In both the seasons the median grain size value is decreasing in the downstream sections,
- It confirms that the river Surma is not in regime condition

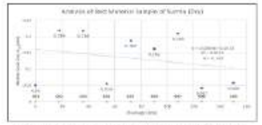


Fig: Analysis of Bed Material of the Surma river (January 2017, Dry season)

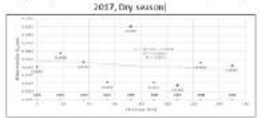


Fig: Analysis of Bed Material of the Surma river (April 2017, Pre Monsoon season)

Hypothesis 4 and 5: Model output (the Surma River)

- The bankfull water levels at different sections are different. The bank level at the d/s sections are lower than the average flood level (Hypothesis 1).
- There are variations in X-sectional Areas, width and depth (Hypothesis 2).
- There are variations in the sediment concentration(Conventional analysis for Hypothesis 4 and 5).
- There are variations in the silt size (D_{50}) concentration(Conventional analysis for Hypothesis 4 and 5).
- For the above observation it may be concluded that the Surma river is not in "Regime" condition.
- Similar analysis had also been done for the Kushiyara river.
- The Kushiyara river is not in "Regime" condition.

Scenario Generation

Due to impact of Global climate change or in a very wet year the discharge at the u/s may increase. Similarly, for a very dry year or withdrawal of upstream water the discharge at the u/s may decrease. Two scenarios were generated using the HEC-RAS Model to observe likely changes of cross-sectional area, discharge and water levels at different stations due to 2 hypothetical conditions.

- **The Scenario-1**, considered 20% increase of peak discharge at the u/s station RS 38 for the Surma and RS 40 for the Kushiyara.
- **The Scenario-2**, considered 20% decrease of peak discharge at the u/s station RS 38 for the Surma and RS 40 for the Kushiyara.

Scenario Generation

The Surma River

Changes in Cross Sectional Area:

The changes in area of 28 cross sections along the channel for Scenario 1 and 2 can be observed from the following plots.

- Under Scenario 1 when peak discharge increases at upstream, there is increase in simulated cross sections at downstream (+17.87% at RS38 and +11.75% at Rs 20)
- Under Scenario 2 with decrease of peak discharge at upstream, there is decrease in cross section at the downstream.(- 10.76% at RS 38 and - 5.51% at RS 20)

Area vs Distance for the Surma (2014): Scenario 1

Area vs Distance for the Surma (2014): Scenario 2

Scenario Generation

The Surma River

Changes in Discharge:

The changes in discharge for Scenario 1 and 2 along the cross section can be visible from the following plots.

- Under Scenario 1 when peak discharge increases at upstream, there is increase in simulated discharge at downstream (+20.25% at RS38 and +35.80% at Rs 20)
- Under Scenario 2 with decrease of peak discharge at upstream, there is decrease in discharge at the downstream.(- 15.17% at RS 38 and -7.88% at RS 20)

Discharge vs Distance for the Surma (2014): Scenario 1

Discharge vs Distance for the Surma (2014): Scenario 2

Scenario Generation

The Surma River

Changes in Water Level:

The changes in water level for Scenario 1 and 2 along the cross section can be visible from the following plots.

- Under Scenario 1 when peak discharge increases at upstream, there is increase in simulated water levels at downstream (+ 11.06% at Rs 38 and 8.18% at RS 20). As a result, new areas are flooded and in other places flood depths increase.
- Under Scenario 2 with decrease of peak discharge at upstream, there is decrease in water level at the downstream (-6.83% at Rs 38 and4.20% at RS 20). As a result, flood reduction is observed

Water Level vs Distance for the Surma (2014): Scenario 1

Water Level vs Distance for the Surma (2014): Scenario 2

Major Findings

1. The analysis confirms the acceptability of Hypothesis 1 for both the Surma and the Kushiyara rivers.
2. The Hypothesis 2 could not be (conclusively)established/validated.

   For the Surma and the Kushiyara it may be concluded that, the bank full water levels at the downstream decrease ,consequently there are changes in channel dimension, the change of both the area and the top width shows a scattered pattern and the change of average depth shows a decreasing trend towards downstream direction.

Major Findings

3. The Hypothesis 3 may be established/validated for the Kushiyara but not for the Surma.
   (1). From conventional analysis:
   Hypotheses 3 may be considered as established/validated for both the Surma and the Kushiyara rivers.
   (2)From Model output:
   - From the analysis of seasonal variation of the Bed level gradient, it is observed that bed level slopes are almost same at both the dry and monsoon seasons. Hence Hypothesis 3 could not be established/validated for the Surma.
   - For the Kushiyara from the analysis of bed level gradient, the Hypothesis 3 can be considered as established/validated.

Major Findings

4. Hypotheses 4 and 5 relate to the hypothetical 'Regime Condition' of the river.
   The analysis clearly demonstrates that the Surma and Kushiyara rivers are not in 'Regime Condition'. So the hypothesis could not be confirmed/validated through the model output.
5. But since the 'Regime Condition' is a theoretical condition of a river, the validity of these two hypotheses (4 and 5) can be accepted on Theoretical explanation basis (details given in See 5.6).
6. Under Scenario 1, when Peak discharge increases (20%) at upstream, there are increase in simulated cross sections, discharges and water levels at downstream. Consequently, new areas are flooded and in other places flood depth increase.
7. Under Scenario 2, when Peak discharge decreases (20%) at upstream, there are decrease in cross sections, discharge and water levels at downstream. Consequently, flood reduction is observed

Recommendations

1. Through the validation of the CEGIS conceptual Model, the study has contributed towards enhancement of knowledge on hydro morphological process of the two major rivers, planners and Government may use this for the implementation of the development plans in the Haor areas.
2. This HEC-RAS 5.0.3 model may be further updated to predict the changes in sediment deposition, erosion, discharge and water level in the downstream of the Surma and the Kushiyara rivers.
3. A study may be taken up to couple the two HEC-RAS Models developed under this study.
4. A study may be taken up to develop a general model to simulate and predict the morphological behaviour of the rivers of the Haor region.
5. Finer resolution satellite images should be collected for understanding of the shifting of the rivers.
6. Some permanent sediment and bed material collection stations should be established both on the rivers Surma and Kushiyara.
7. A routine program of bathymetric survey for the two rivers may be taken up. The survey should be carried out in 4 seasons (namely, Pre monsoon, Monsoon, Post monsoon and Dry).

Appendix C

Photo Gallery

Figure 1: Dr. Zafar Ahmed Khan, Sr. Secretary, MoWR and chief guest delivering his speech

Figure 2: Participants of the workshop

Figure 3: Participants of the workshop

Figure 4: Mr. H.S. Mozaddad Faruque, Team Leader delivering key note speech

Figure 5: Dr. Zafar Ahmed Khan, Sr. Secretary, MoWR discussing the report with the participants

Figure 6: Dr. Anwar Zahid, Deputy Director, BWDB taking part in the open discussion.

Figure 7: Md. Mahbubur Rahman, Sr. Assistant Chief, Planning Commission taking part in the open discussion

Figure 8: Md. Delwar Hossain Akhand, Senior Engineer, SWHC, BWDB taking part in the open discussion

Figure 9: Md. Humayun Kabir, Additional Secretary, MoWR taking part in the open discussion

Figure 10: Dr. Maminul Haque Sarker, Deputy Executive Director, CEGIS taking part in the open discussion

Figure 11: Mr. Md. Nurul Amin, Director, DBHWD taking part in the open discussion

Figure 12: Mr. Md. Majibur Rahman, DG, DBHWD and chair of the workshop delivering the concluding speech

Figure 13: (Front Row from left) Mr. H. S. Mozaddad Faruque, Team Leader, Mr. Md. Majibur Rahman, DG, DBHWD, Dr. M. Mubarak Hossain, Professor of Applied Mathematics, University of Dhaka, Dr. Maminul Haque Sarker, Deputy Executive Director, CEGIS, (Back Row from left) Purnima Das, Junior Morphologist, Prosoil Foundation Consultant, Gokul Chandra Paul, Junior Morphologist, Prosoil Foundation Consultant, Rumman Adib, Junior Morphologist, Prosoil Foundation Consultant, Mr. Mohammad Nazmul Ahsan, Project Director, Mr. Md. Shamsul Islam (Probal), Chief Executive, Prosoil Foundation Consultant, Dr. Md. Nurul Alom, DD, DBHWD, Dr. Anwar Zahid, Deputy Director, BWDB, Samia Jahan Chowdhury, Junior Morphologist, Prosoil Foundation Consultant and Sabrina Mehzabin, Junior Morphologist, Prosoil Foundation Consultant

Figure 14: The Consultant Team

4.2 Feedback from the Workshop

Comments/suggestions of the participants of the Workshop on (draft) final Report on "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin" and the Responses of the consultants:

Comments/ Suggestions	Responses
Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR)	
1. The opinions of the local people should be taken into consideration.	General guideline
2. All the future development activities should be based on scientific data/information and research	General guideline
3. The BWDB should strengthen their Hydrology Unit and take regular hydrological measurements.	-General guideline -Recommendation has been made Sec 11.2 (sl 2)
4. In the report, policy level recommendations should be made.	The report contains a chapter on Major Findings and Recommendations
Dr. Umme Kulsum Navera, Professor, DWRE, BUET	
5. Holistic approach needs to be followed in planning and implementation of water resources projects.	General guideline
6. Scientific research should be carried out before strting any project and implementation.	Recommendation and scientific research have been made Sec 11.2 (sl 1,2,3 and 4)
Dr. M. Mubarak Hossain, Professor, Department of Applied Mathematics, DU	
7. Hydrological data should be collected continuously to carry out any kind of morphological study with accuracy.	Recommendation has been made Sec 11.2 (sl 2)

Comments/ Suggestions	Responses
8. The quality of data collection should be improved.	A general concern
9. The report is highly appreciated. The research followed scientific approach. It clearly spelled the findings of the research.	Thanks for **Appreciation**
Mr. Md. Saiful Hossain, SE, PFFC, BWDB	
10. BWDB is maintaining hydrological data in a scientific way. They have planned to strengthen the Hydrologic Unit for which Government approval is required. It is reported that some projects are/will be implemented by JICA funding.	-General information - Recommendation has been made For collection of Hydrological data Sec 11.2 (sl 2,3,4)
11. If the height of the submerged earthen embankments around the Sylhet Basin is increased or the earthen embankments are carpeted with brick or otherwise, it will cause an adverse impact on the morphology of the Sylhet Basin. A study can be taken up considering this issue.	A general concern
Dr.Anwar Zahid, DD, BWDB	
12. Whether any Geological/Morphological studies done for the rivers of the Haor Basin?	Detailed study of the river morphology of the haor area was beyond the scope of the TOR of the study.
13. The BWDB has initiated a project for collection of hydrologic data.	-General information
14. O&M funding will be required for continuous data collection.	A general concern

Comments/ Suggestions	Responses
Dr. Maminul Haque Sarkar, CEGIS	
15. When rivers enter into the Sylhet Basin, they behave differently. The sediment discharge decreases near Bhairab Bazar.	-General information
16. The CEGIS has studied Subsidence in the Sylhet Basin. Although, social evidence suggests there is no subsidence, but scientific study or literature reviews suggest that there is subsidence of about 2-4 mm/yr.	-General information - The Report also mentioned (referring literature review) the subsidence of 2-4 mm/yr
17. The name of the author should be given in the reference for the book titled "Inland Navigation and Integrated Water Resources Management, 2014".	Has been incorporated Ref. no 19
18. The CEGIS Conceptual Model is not a Mathematical Model rather a Quantitative Model. CEGIS expects qualitative analysis of the said Conceptual Model.	It was mentioned in the report that; the CEGIS Conceptual Model was examined from 3 perspectives. During examination/ validation, some quantification of river characteristics was made both in the case of conventional as well as model output. Pl see Ch- 9
Mr. Mahbubur Rahman, Senior Assistant Chief, Planning Commission	
19. Whether the recommendations/ decisions of the 2nd Technical Committee meeting have been incorporated in the (draft) Final Report or not.	All the decisions of the 2nd T.C. Meeting have been incorporated in the (draft) Final Report
Mr. Md.MasudAlam, PSO, WARPO	
20. What are the validations done with? What are the assumptions? Which assumptions were validated?	-The CEGIS conceptual Model was validated/ examined. -The details have been given in Ch 5

Comments/ Suggestions	Responses
21. Prior to the model setup, was the morphology of the Surma-Kushiyara river checked by studying their geology?	Detailed study of the river morphology of the rivers were beyond the scope of the TOR of the study
22. How much erosion/deposition will occur in future, how the morphology of the river respond to any future change- were they analyzed? What was the bank erosion pattern?	Detailed study of the river morphology of the haor area, bank erosion pattern, quantification of sediment, flood depth mapping etc were beyond Detailed study of the river morphology of the haor area, bank erosion pattern, quantification of sediment, flood depth mapping etc were beyond the scope of the TOR of the study
23. Was there any sediment model to know the sediment gradient, upstream/downstream sediment condition etc.?	The HECRAS model developed under this study was given run to find the water level gradients and bed level gradients during dry and monsoon seasons. Pl see Sec 9.3.2
24. It is important to know how much sedimentation has occurred in the Haor basin in the last decades and how this sedimentation is contributing in the recent flood incidents.	-A general concern - It was beyond the scope of the TOR of the study
Mr. Md. Delowar Hossain Molla, Director, SRDI	
25. SRDI prepares Land Type Maps and updates them every 10 years.	-General information
26. How much sedimentation occurs in the Haor area?	It was beyond the scope of the TOR of the study
27. The flood of this year in the haor areas deserves special attention and the causes of flooding should be found out.	A general concern
28. The recommendations made in the report are highly appreciated.	Thanks for **Appreciation**

Comments/ Suggestions	Responses
Mr. Md. Majibur Rahman, Director General, DBHWD	
29. Roads are made in east-west direction in the Haor Area, which can be catastrophic as it will change the Haor characteristics.	A general concern of the Haor Region
30. Study can be taken up regarding this issue.	The Department of Haor and Wetlands Development may take up a project
Mr. Md. Sarafat Hossain Khan, Director General, WARPO	
31. Is the model ready for application after proper calibration and validation?	To validate/ examine the CEGIS conceptual model, HECRAS models were developed. The models were calibrated and validated. Pl. see Ch 8
32. Is the model setup including the bathymetry correct as the results depend on the accurate setup of the model?	The consultants developed the HECRAS Model with very limited data. It has been mentioned in the Recommendations for updating the model and also for detailed bathymetric survey. (pl. see Sec 11.3)
33. A study should not be completed with limited or incomplete set of data. The result generated from those types of dataset often gives unrealistic results which are eventually detrimental to the policy makers. The study could have been stopped if there was lack of data and proposals could have been issued for further data collection.	The consultants had to carry out their study with the available data and maintaining time schedule within the stipulated TOR framework and scope of study.
34. What does it mean by Conceptual Model? The hydro-dynamics should be explained clearly.	Detailed explanation/elaboration has been given in Ch 5

Comments/ Suggestions	Responses
35. Proper gradient should be established at first. It is because high gradient increases the velocity which eventually results in low sediment flow and vice versa.	Water level and Bed level Gradient analysis has been given in Sec 9.3
36. When bankfull regime condition was mentioned, did it consider a bank full condition with embankment or in a natural condition?	Natural bank full condition was considered
37. There should be further study on this topic as there are some data limitations so the results can be applied accurately.	Recommendation has been made to take up a project on Morphological study of the rivers of the Haor area. Sec 11.2 (sl 7)
Mr. Md. Rezaul Karim, PSO, WARPO	
38. Accuracy of HEC-RAS model should be checked.	The model has been calibrated and validated. The results are given in Ch-8
Mr. Gautam Chandra Mridha, Senior Specialist, IWM	
39. Why in the model setup, two ‘n’ values have been used for two different seasons for the Surma River?	Detailed explanations have been given on selection of manning’s n (in Sec 8.2.6.1.)
40. Whether Flood Depth Maps have been prepared.	It was beyond the scope of the TOR of the study
41. Why HEC-RAS Model has been used?	The rational of using HECRAS Model has been adequately discussed in the Report (Chapter 8).
42. Result of this model should be compared to the results from other models to check the accuracy.	This can be done in some future studies

Comments/ Suggestions	Responses
43. There are many rivers in the Haor Basin. A study considering all these rivers could produce much better results.	Recommendation has been made to take up a project on Morphological study of the rivers of the Haor area. Sec 11.2 (sl 7)
Mr. Md. Nurul Amin, Director, DBHWD	
44. He cited examples of Barisal Irrigation Project (BIP) of the BWDB. The project could not give desired results for different causes. Now some agricultural land has been forced to be transformed to fish ponds. People should be motivated for achieving desired goals.	A general concern of the water sector.
Mr. Humayun Kabir, Additional Secretary, MoWR	
45. It is appreciated that the consultants completed their task in time. It is appreciated that the participants took so much interest and made valuable comments and suggestions	Thanks for **Appreciation**
Recommendations of the Workshop	
46. The Consultant will try to incorporate the comments and suggestions while finalizing the report.	Action Taken. Recommendation for new studies have been made. Pl see Sec 11.2 (sl. 7 and 9)
47. The (draft) Final Report is recommended for approval	**Thanks**

5 1st Steering Committee Meeting

5.1 Minutes of the 1st Meeting of the Steering Committee

The 1st Steering Committee Meeting of the Project “Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin” was held on 20th June, 2017 in the conference room of the “Ministry of Water Resources” under the chairmanship of Dr. Zafar Ahmed Khan, Senior Secretary, Ministry of Water Resources (MoWR). The minutes of the meeting are presented below.

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পানি সম্পদ মন্ত্রণালয়
উন্নয়ন-০৪ অধিশাখা
বাংলাদেশ সচিবালয়, ঢাকা
www.mowr.gov.bd

বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর কর্তৃক বাস্তবায়নাধীন 'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor basin' শীর্ষক সমীক্ষা প্রকল্পের স্টিয়ারিং কমিটির ২০.০৬.২০১৭ তারিখে অনুষ্ঠিত সভার কার্যবিবরণী।

সভাপতি	ঃ	ড: জাফর আহমদ খান, সিনিয়র সচিব, পানি সম্পদ মন্ত্রণালয়।
সভার তারিখ	ঃ	২০ জুন ২০১৭।
সময়	ঃ	বেলা ১১:৩০ ঘটিকা।
স্থান	ঃ	পানি সম্পদ মন্ত্রণালয়ের সভা কক্ষ।

সভায় উপস্থিত কর্মকর্তাগণের নামের তালিকা পরিশিষ্ট-'ক'-তে সংযুক্ত করা হলো।

০২. সভাপতি উপস্থিত সকলকে স্বাগত জানিয়ে সভার কার্যক্রম শুরু করেন। এ পর্যায়ে তিনি প্রকল্প পরিচালককে প্রকল্প সম্পর্কে সভাকে অভিহিত করার জন্য অনুরোধ জানান। প্রকল্প পরিচালক প্রকল্পের সার্বিক অগ্রগতি সভাকে অবহিত করেন।

০.৩ অতঃপর সভাপতি ''Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor basin' প্রকল্পের পরামর্শক, মেসার্স Prosoil Foundation Consultants এর টিম লিডারকে সমীক্ষা প্রকল্পটি উপস্থাপনের জন্য অনুরোধ করেন। পরামর্শক টিমলিডার জনাব এইচ. এস. মোজাদ্দাদ ফারুক উপস্থাপনা করেন। তিনি প্রকল্পের সার্বিক অগ্রগতি সম্পর্কে সভাকে অবহিত করেন। তিনি উল্লেখ করেন যে খসড়া Final Report এর সর্বমোট তিনটি ভলিউমের মধ্যে একটি Main Report এবং বাকি দুটি ভলিউমে দুটি Annexure সংযুক্ত করা হয়েছে। টিম লিডার আরো উল্লেখ করেন যে Final Report এর উপর গত ০৬/০৬/২০১৭ তারিখে অনুষ্ঠিত ওয়ার্কশপের মতামত ও পরামর্শসহ বিভিন্ন স্টেকহোল্ডারদের কাছ থেকে আসা সকল মতামত ও পরামর্শ পর্যালোচনা করা হয়েছে এবং খসড়া Final Report টি সেই অনুযায়ী প্রণয়ন করা হয়েছে। সভায় অতিরিক্ত সচিব (উন্নয়ন), পানি সম্পদ মন্ত্রণালয় সংক্ষিপ্তভাবে Executive Summary এর বঙ্গানুবাদ এবং চূড়ান্ত প্রতিবেদনের ভলিউম তিনটি একটি পুস্তকাকারে প্রস্তুত করার জন্য টিম লিডারকে অনুরোধ করেন। টিম লিডার সভায় Executive Summary এর বঙ্গানুবাদ Final Report এ যোগ করে দেয়া হবে মর্মে সভাকে অবহিত করেন।

০.৪ সভায় সামগ্রিক আলোচনা শেষে নিম্নবর্ণিত সিদ্ধান্তসমূহ গৃহীত হয়ঃ

সিদ্ধান্তঃ

(ক) কারিগরি কমিটি কর্তৃক পুঙ্খানুপুঙ্খভাবে নিরীক্ষাপূর্বক অনুমোদনের সুপারিশ থাকায় উপস্থিত সকলে চূড়ান্ত খসড়া প্রতিবেদনটি অনুমোদন প্রদানে ঐকমত্য পোষণ করেন;

(খ) চূড়ান্ত প্রতিবেদনটির তিনটি খণ্ডের মূল প্রতিবেদনসহ সকল এনেক্সার একটি বই আকারে প্রকাশ এবং Executive Summary বঙ্গানুবাদ পূর্বক চূড়ান্ত প্রতিবেদনে অন্তর্ভুক্ত করার বিষয়ে টিম লিডার ব্যবস্থা গ্রহণ করবেন।

(গ) সংশ্লিষ্ট সকল সংস্থাকে (কৃষি মন্ত্রণালয়, নৌ পরিবহন মন্ত্রণালয়, পরিবেশ মন্ত্রণালয়, মৎস্য ও প্রাণি সম্পদ মন্ত্রণালয়, বুয়েটসহ অন্যান্য সংস্থা) চূড়ান্ত প্রতিবেদন প্রেরণের বিষয়ে বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর ব্যবস্থা গ্রহণ করবে।

০.৫ প্রকল্পটি সমাপ্ত করায় সভাপতি প্রকল্প সংশ্লিষ্ট সকলকে ধন্যবাদ জানান। একই সাথে, স্টিয়ারিং কমিটির সম্মানিত সদস্যবৃন্দের সভায় অংশগ্রহণ ও মূল্যবান মতামত প্রদানের জন্য তিনি সকলকে পুনরায় ধন্যবাদ জানান।

০.৬ পরিশেষে সভায় উপস্থিত সকল সম্মানিত সদস্যবৃন্দ ও প্রকল্পের পরামর্শক টিমকে ধন্যবাদ জানিয়ে সভাপতি সভার সমাপ্তি ঘোষণা করেন।

স্বাক্ষরিত/-
২২/০৬/২০১৭
(ড: জাফর আহমদ খান)
সিনিয়র সচিব, পানি সম্পদ মন্ত্রণালয়
ও
সভাপতি
'Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor basin'
শীর্ষক সমীক্ষা প্রকল্পের স্টিয়ারিং কমিটি।

নং-৪২.০০.০০০০.০৩৭.০১৪.০৪.২০১৫-১৭৫

১৪ আষাঢ় ১৪২৪
তারিখ:-----------------
২৮ জুন ২০১৭

বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর কর্তৃক বাস্তবায়নাধীন 'Model Validation on Hydro-Morphological process of the River System in the Subsiding Sylhet Haor Basin' শীর্ষক সমীক্ষা প্রকল্পের স্টিয়ারিং কমিটির গত ২০ জুন, ২০১৭ তারিখে পানি সম্পদ মন্ত্রণালয়ের সিনিয়র সচিব মহোদয়ের সভাপতিত্বে অনুষ্ঠিত সভার কার্যবিবরণী পরবর্তী প্রয়োজনীয় ব্যবস্থা গ্রহণের নিমিত্ত এতদসংগে প্রেরণ করা হল।

২৮.৬.২০১৭
(হামিদা চৌধুরী)
যুগ্ম-সচিব
ফোনঃ ৯৫৭৬৫১০।
ই-মেইলঃ dev4mowr@gmail.com

বিতরণ (জ্যেষ্ঠতার ক্রমানুসারে নয়):

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৬. অতিরিক্ত সচিব (উন্নয়ন), পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
৭. মহাপরিচালক, বাংলাদেশ হাওর ও জলাভূমি উন্নয়ন অধিদপ্তর, ৭২ গ্রীন রোড, ঢাকা।
৮. যুগ্ম প্রধান, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
৯. উপ প্রধান-১, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
১০. উপ প্রধান-২, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
১১. সহকারী প্রধান-১, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
১২. সহকারী প্রধান-৪, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

অনুলিপিঃ

১. মাননীয় মন্ত্রী/ প্রতিমন্ত্রীর একান্ত সচিব, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।
২. সিনিয়র সচিবের একান্ত সচিব, পানি সম্পদ মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

5.2 Decisions of the 1st Meeting of the S.C and the Responses

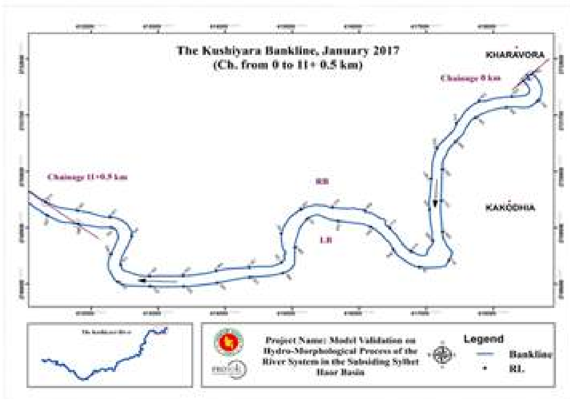
SL	Decisions of the 1st Steering Committee Meeting held on 20/06/2017	Responses
1.	As the Technical Committee inttensively scrutinized the report and recommended for its approval. The Steering Committee unanimously approved the (draft) Final Report.	Thanks for the approval.
2.	All the three volumes and the appendixes of the report may be combined together as one book.	Acion taken accordingly.
3.	The Executive Summary should be translated in Bengali and attached to the Final Report. The Team Leader should take necessary actions.	Acion taken accordingly. See Volume 1.
4.	The Final Report should be distributed to all concerned organizations (Ministry of Agriculture, Ministry of Shipping, Ministry of Environment, Ministry of Fisheries, BUET etc.) and the DBHWD will take necessary steps to distribute the Final Report.	The DBHWD will take necessary actions.

FINAL REPORT

Government of the People's Republic of Bangladesh
Ministry of Water Resources
Department of Bangladesh Haor & Wetlands Development

Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Volume 2
Appendix 2: Bank Line Survey Report



June, 2017

Prosoil Foundation Consultant
Bangladesh

FINAL REPORT

Government of the People's Republic of Bangladesh
Ministry of Water Resources
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Model Validation on Hydro-Morphological Process of the River System in the Subsiding Sylhet Haor Basin

Volume 2
Appendix 2: Bank Line Survey Report

June, 2017

Prosoil Foundation Consultant
Bangladesh

Preface

The Volume 2 of the Report "Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin" contains the Appendix 2 "Bank Line Survey Report of the Surma and Kushiyara Rivers".

The Appendix 2 contains the Bank Line Survey report with maps of the banks showing RLs of both the rivers. The Bank Line survey work was carried out in January 2017.

The team deeply acknowledge the co-operation and guidance of the Technical Committee of the project. The team also acknowledge the 'Department of Bangladesh Haor and Wetlands Development' for providing logistic supports and helping the team to prepare the Report.

We are thankful to Mr. Majibur Rahman, Director General, Department of Bangladesh Haor and Wetlands Development and Mrs. Afroza Moazzam, former Director General, Department of Bangladesh Haor and Wetlands Development for their active support and co-operation. We appreciate the co-operation of Mr. Md. Nazmul Ahsan, Project Director and Md. Nurul Amin, Director (Admin and Finance) of the Department of Bangladesh Haor and Wetlands Development.

We acknowledge with deep appreciation the co-operation by M/S Globe Survey Company in carrying out the field survey works. We also thank the local people, particularly of the Northeast Region who in various ways helped the study team in conducting the field measurements and survey works.

H.S. Mozaddad Faruque
Senior Morphologist and Team Leader

Study Team:

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7. Abul Kalam Azad
   Surveyor
8. Survey Team

Model Validation on Hydro-morphological Process of the River System in the Subsiding Sylhet Haor Basin

Volume. 1:	Main Report Appendix 1: Feedback from the Stakeholders
Volume 2:	**Appendix 2: Bank Line Survey Report of the Surma and the Kushiyara Rivers**
Volume 3:	Appendix 3: Analysis of Sediment and Bed Material Samples of the Surma and the Kushiyara Rivers

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1 Introduction

The Surma and Kushiyara are two of the most important transboundary rivers of Bangladesh. The ID No. of Surma is NE-83 and ID No. of Kushiyara is NE-17 (BWDB, 2011). The off-take of both the rivers is Borak river of India. The Borak river splits into two rivers at Amalshidh, Jakiganj of Sylhet district. Both the rivers are perennial.

The Rivers of Haor areas are very dynamic in nature. They are continuously changing their course, width, length, bed level etc. As a result, flash flooding, wetland degradation, river bank erosion etc. is very frequent in the Sylhet basin. So, considering the dynamic nature of the Sylhet basin, this project has included the bank line survey of the Surma and Kushiyara rivers to document the present status of the rivers. This survey report may be used in future as a valuable reference document. Prosoil Foundation Consultants has carried out the survey works with the help of M/s Globe Survey Company.

2 Location

One hundred and fifty km reach of each of the river has been surveyed; 150 sections have been selected along the reach, with a distance of 1 km between each section. The total length of the Surma river is 249 km, whereas the total length of the Kushiyara River is 288 km (BWDB, 2011). The 150 km river reach for the Surma and the Kushiyara are shown in Figure 1 (bold blue lines indicate the surveyed river reach). Measurements were taken on both the banks of the rivers at the specified sections. Bank Line Survey was conducted during January 14, 2017 to January 24, 2017. The summary of bank line survey works on the Surma and the Kushiyara rivers is given below:

- Data collected: RL, GPS location and limited topographic survey
- 1 measurement during the project period
- 150 km reach on both the Surma and Kushiyara rivers
- 150 sections on each river (every section 1 km apart)
- 2 measurements on each section (one on each bank)
- Timeline: Jan 14, 2017 to Jan 24, 2017

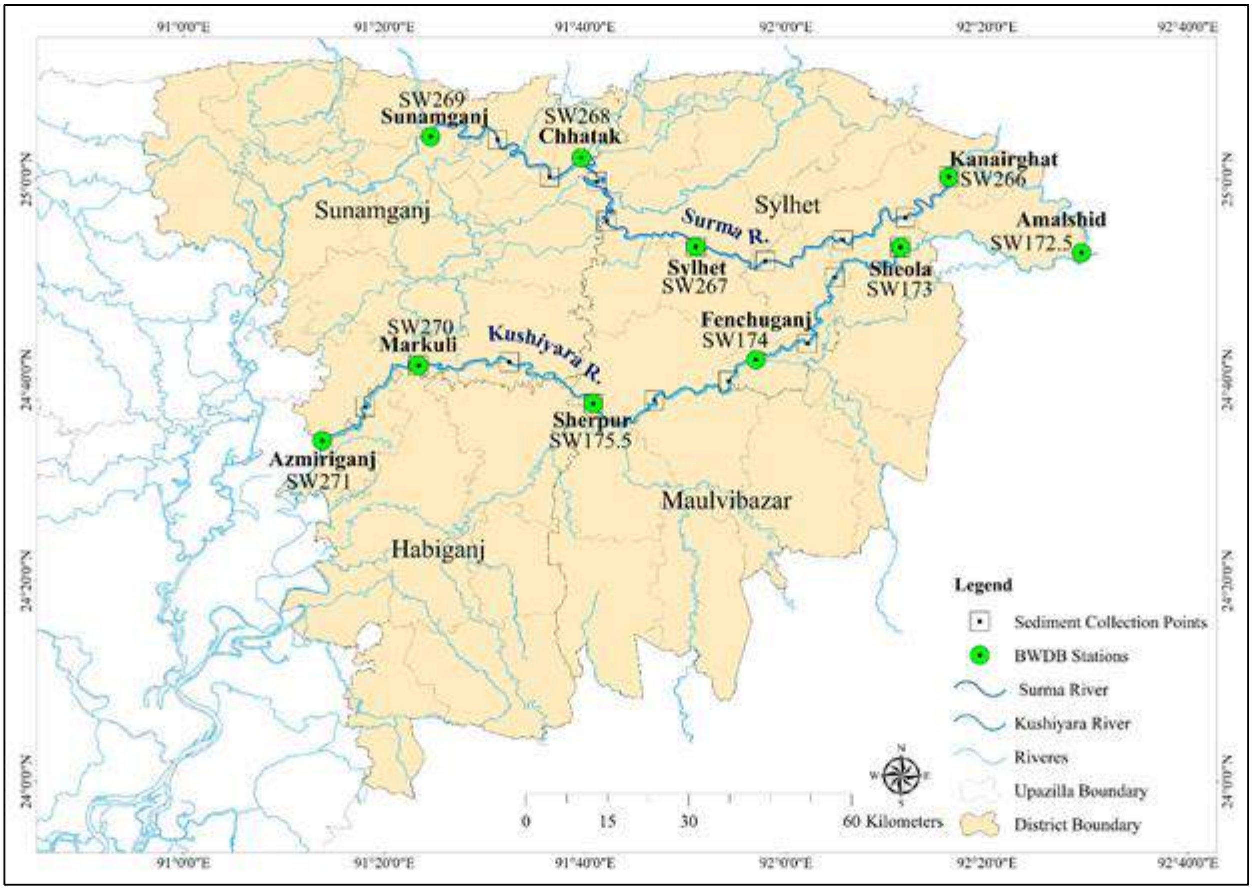

Figure 1: River Reaches for Bank Line Survey on the Surma and the Kushiyara

3 Methodology

Bank line survey of both the sides of the rivers have been done by Total Station, GPS and Automatic Level and has been mapped by ArcGIS.

To have the precision in the survey work, each 150 km river reach was divided into 15 section. After every 1 km, two points on each of the banks of the river were established by RTK GPS and the coordinates of the points were established. RTK GPS is a Sophisticated survey equipment which can read the position with millimeter accuracy and heights with centimeter accuracy. More over the position and RL of the point was checked through by connecting it to the nearest SOB pillars with the help of Digital Leveling Instrument. The heights were also checked whenever there was another SOB benchmark close to the river bank. Electronic Total Station were set up in one of the point targeting it with the other one. Two reflector man were engaged on both bank to record the position (RL) of the bank. The 150km length of the river bank was thus surveyed with help of Total Station, GPS and Automatic Level machine.

4 Mapping

The mapping of both the rivers was done using ArcGIS. The map shows RL of the points. The maps of the Surma are given in pages X to X of this volume. The maps of the Kushiyara are given in pages X to X of this volume.

5 Photo Gallery

Figure 2: Establishment of Coordinates With RTK GPS

Figure 3: Riverbank Survey by Electronic Total Station

Figure 4: Checking the Heights With the Help of Digital Leveling Instrument

Figure 5: Establishing a Point by RTK GPS

Figure 6: Establishing a Point by RTK GPS

Figure 7: Riverbank Survey by Electronic Total Station

6 Survey Data Sheet

The locations of the points of the Surma and Kushiyara rivers are presented in Table 1 and Table 2 respectively.

Table 1: Survey Data Sheet of the Surma River

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
1	0+000	441323.1127	2763999.139	13.20	14.32
2	0+500	440336.059	2763841.657	13.20	14.33
3	1+000	439353.427	2763659.144	13.20	14.35
4	1+500	438409.1842	2763700.245	13.40	14.48
5	2+000	438118.8645	2764591.189	13.54	14.68
6	2+500	437489.1622	2765361.048	13.57	14.99
7	3+000	436803.7228	2766087.986	13.25	15.03
8	3+500	436048.3808	2766432.071	13.25	15.01
9	4+000	435145.4346	2766014.466	13.20	14.36
10	4+500	434159.0119	2765903.349	13.04	13.33
11	5+000	433192.2539	2765918.786	13.04	14.39
12	5+500	432647.0809	2765349.854	12.97	14.44
13	6+000	432100.6809	2766153.745	13.20	14.59
14	6+500	431754.3329	2767077.296	13.07	14.56
15	7+000	430787.1011	2767220.087	13.08	14.63
16	7+500	430025.6685	2767847.495	13.10	14.22
17	8+000	429076.0916	2768126.842	13.24	14.36
18	8+500	428076.792	2768153.091	13.21	14.59
19	9+000	427115.5356	2767918.788	13.20	14.75
20	9+500	426450.823	2767199.427	13.41	14.68
21	10+000	426502.2138	2766219.779	13.56	14.63
22	10+500	426506.4319	2765427.475	13.51	14.59
23	11+000	425514.3651	2765450.302	13.54	14.25
24	11+500	425522.2432	2764711.563	13.81	14.33
25	12+000	426232.4613	2764016.105	14.20	13.96
26	12+500	425733.8117	2763229.235	14.14	13.96
27	13+000	425159.1017	2762434.175	14.35	13.98
28	13+500	424341.2164	2762126.212	14.49	14.28
29	14+000	423446.2588	2761830.053	14.32	14.23
30	14+500	423548.7427	2760887.211	14.65	14.55
31	15+000	423284.3586	2760005.636	13.52	14.38
32	15+500	422491.6042	2760483.4	14.46	14.33
33	16+000	421701.1361	2761091.941	13.25	14.22
34	16+500	420766.9724	2761091.712	14.21	14.31

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
35	17+000	421190.079	2760362.595	13.25	14.38
36	17+500	421928.2944	2759726.243	14.01	14.23
37	18+000	421359.2126	2759026.358	13.24	14.02
38	18+500	420612.3792	2758424.381	13.84	14.05
39	19+000	419694.8838	2758654.062	13.42	14.08
40	19+500	419071.7423	2757949.32	13.74	14.07
41	20+000	418081.5913	2758070.238	12.96	14.08
42	20+500	417246.0651	2757581.119	13.57	14.25
43	21+000	416484.8579	2757853.713	13.24	14.35
44	21+500	416225.2119	2758813.161	13.47	14.33
45	22+000	415916.6757	2759750.264	13.35	14.2
46	22+500	415099.7554	2759297.328	13.40	14.33
47	23+000	414868.5384	2758394.346	12.38	13.47
48	23+500	415005.307	2757405.323	13.19	13.58
49	24+000	414479.226	2756623.514	12.95	13.96
50	24+500	413783.9814	2755914.653	13.09	13.85
51	25+000	413777.3804	2754926.433	12.86	14.35
52	25+500	412920.2381	2754868.705	12.99	14.22
53	26+000	412068.4583	2755057.791	12.96	13.56
54	26+500	411242.8405	2754571.089	12.92	14.28
55	27+000	410293.9421	2754397.033	13.55	15.05
56	27+500	409904.3889	2753489.855	12.91	15.02
57	28+000	409119.0832	2753230.928	13.56	15.03
58	28+500	408497.8659	2754004.942	12.92	15.25
59	29+000	407732.7476	2753899.743	13.66	15.48
60	29+500	406955.1346	2754026.726	12.93	15.55
61	30+000	406260.7571	2754527.007	13.95	15.06
62	30+500	405517.6009	2753866.364	12.97	14.99
63	31+000	405024.5731	2753012.346	14.02	14.69
64	31+500	404141.4638	2752665.27	13.02	14.58
65	32+000	403142.8041	2752708.909	14.35	14.38
66	32+500	402182.2207	2752686.663	13.10	14.58
67	33+000	401956.4382	2751724.525	14.92	14.56
68	33+500	401478.6263	2750871.13	13.22	14.26
69	34+000	400498.9277	2750907.383	13.20	14.38
70	34+500	399857.6239	2750301.921	13.19	14.48
71	35+000	399976.2865	2749338.884	13.65	14.68
72	35+500	399044.8732	2749345.703	13.20	14.58
73	36+000	398146.796	2749779.56	13.58	14.68

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
74	36+500	397215.933	2750132.893	13.20	14.35
75	37+000	396228.8887	2750228.476	13.96	14.25
76	37+500	395255.6796	2750025.361	13.24	14.85
77	38+000	394483.8004	2749422.039	13.58	13.95
78	38+500	393673.7764	2748871.712	13.24	13.9
79	39+000	392762.2968	2749078.413	13.58	13.85
80	39+500	392955.9337	2750008.651	13.24	13.78
81	40+000	391999.1947	2750270.647	13.46	13.58
82	40+500	391135.2803	2750731.96	13.24	13.28
83	41+000	390563.1467	2751534.286	13.58	13.14
84	41+500	389696.2241	2751175.524	13.25	13.16
85	42+000	388782.4092	2751564.447	13.68	13.24
86	42+500	387798.6253	2751638.99	13.26	13.24
87	43+000	386902.6456	2752071.094	13.08	13.24
88	43+500	386101.7054	2752651.55	13.23	13.25
89	44+000	385163.6702	2752763.443	12.58	13.27
90	44+500	384187.2065	2752902.114	13.18	13.27
91	45+000	383194.307	2752987.475	13.15	13.27
92	45+500	382694.4855	2753601.812	13.16	13.15
93	46+000	382638.0222	2754416.599	13.28	13.14
94	46+500	381862.748	2755046.875	13.15	13.12
95	47+000	380939.5971	2755407.399	12.39	13.09
96	47+500	380053.9726	2755468.144	13.09	13.25
97	48+000	379652.9262	2754950.358	12.95	13.45
98	48+500	378824.3187	2755486.814	13.07	13.5
99	49+000	378110.6674	2754999.868	12.95	13.54
100	49+500	377220.5242	2755334.082	13.04	13.33
101	50+000	376455.8731	2755064.037	13.03	13.22
102	50+500	375474.9613	2755198.889	13.02	13.39
103	51+000	374476.6304	2755180.629	11.38	13.25
104	51+500	373554.4397	2754814.667	12.93	12.99
105	52+000	372593.2094	2754640.72	12.91	13.22
106	52+500	371824.0048	2755054.56	12.90	13.06
107	53+000	372247.715	2755912.441	11.34	13.05
108	53+500	371677.5403	2756640.9	12.81	12.98
109	54+000	370742.0525	2756427.255	12.65	13.08
110	54+500	369810.3907	2756787.707	12.78	13.88
111	55+000	368976.6069	2757296.252	13.25	12.95
112	55+500	368789.3366	2758247.635	12.78	12.78

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
113	56+000	368340.5198	2758722.999	13.04	12.68
114	56+500	368870.2606	2759317.013	12.76	12.47
115	57+000	369719.8571	2759534.768	12.37	12.37
116	57+500	369583.4028	2759973.18	12.72	12.02
117	58+000	368804.3253	2760339.774	12.37	11.96
118	58+500	369377.1894	2761091.277	12.69	12.22
119	59+000	369793.4864	2761938.188	13.27	12.56
120	59+500	368985.4082	2762431.955	12.69	12.88
121	60+000	368327.5487	2763135.882	12.95	13.02
122	60+500	368983.9732	2763496.435	12.67	12.28
123	61+000	368117.7881	2763914.074	13.08	12.15
124	61+500	367198.5952	2764306.123	12.67	12.28
125	62+000	366237.8726	2764558.598	13.45	12.46
126	62+500	365437.4119	2765149.048	12.67	12.58
127	63+000	365102.2222	2766018.241	13.54	13.08
128	63+500	365946.6489	2765682.976	12.68	13.25
129	64+000	366813.9839	2765219.723	12.68	13.35
130	64+500	367801.1155	2765306.657	12.66	13.25
131	65+000	368472.6102	2765776.353	12.65	13.23
132	65+500	367479.4247	2765806.853	12.64	13.12
133	66+000	367068.5559	2766696.515	12.35	13.04
134	66+500	366321.4067	2767328.103	12.61	12.15
135	67+000	365464.4282	2767829.801	12.54	11.65
136	67+500	365773.8276	2768364.569	12.59	11.48
137	68+000	366773.0736	2768356.445	12.58	11.37
138	68+500	366601.1034	2769144.009	12.57	11.45
139	69+000	365995.1881	2769925.507	12.68	11.5
140	69+500	441629.572	2764179.156	12.55	11.13
141	70+000	440650.3098	2764067.902	11.96	11.4
142	70+500	439670.458	2763868.604	12.51	11.28
143	71+000	438686.4831	2763741.175	11.58	11.58
144	71+500	438322.2394	2764587.513	12.46	11.63
145	72+000	437683.7648	2765352.602	11.56	11.65
146	72+500	437040.5708	2766114.621	12.41	11.64
147	73+000	436297.9666	2766724.555	11.58	11.63
148	73+500	435394.2313	2766302.988	12.36	11.64
149	74+000	434433.9713	2766056.461	12.03	11.65
150	74+500	433447.9053	2766185.416	12.32	11.11
151	75+000	432752.7601	2765553.916	11.56	11.09

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
152	75+500	432208.3465	2766306.408	12.28	11.25
153	76+000	431824.3921	2767207.571	11.50	11.35
154	76+500	430848.9268	2767361.093	12.23	11.33
155	77+000	430175.5593	2768037.861	12.65	10.95
156	77+500	429217.1623	2768313.726	12.22	10.88
157	78+000	428217.3419	2768324.458	12.20	10.93
158	78+500	427246.3485	2768122.208	12.19	10.25
159	79+000	426453.6052	2767544.791	12.05	10.36
160	79+500	426247.4445	2766596.979	12.16	10.86
161	80+000	426569.3026	2765660.358	12.05	10.69
162	80+500	425640.4496	2765594.2	12.14	10.99
163	81+000	425199.2545	2765032.396	12.35	11.56
164	81+500	425758.2732	2764225.259	12.12	10.15
165	82+000	425838.2654	2763514.22	11.95	10.05
166	82+500	425184.3172	2762780.935	12.09	10.88
167	83+000	424496.2693	2762270.679	12.05	11.35
168	83+500	423545.307	2762125.91	12.06	11.11
169	84+000	423324.7627	2761270.192	11.30	10.95
170	84+500	423395.2363	2760281.49	12.02	10.88
171	85+000	422649.7816	2760528.291	11.24	10.65
172	85+500	421886.3565	2761172.843	11.97	11.52
173	86+000	420940.7032	2761324.997	10.95	12.03
174	86+500	420676.9122	2760606.19	11.92	11.32
175	87+000	421483.7359	2760020.024	11.35	11.35
176	87+500	421511.9305	2759295.035	11.88	11.22
177	88+000	420768.4301	2758642.39	11.95	11.08
178	88+500	419856.284	2758864.104	11.85	11.85
179	89+000	419190.4923	2758161.631	12.35	11.95
180	89+500	418225.2239	2758218.299	11.84	12.33
181	90+000	417339.5182	2757844.522	13.25	13.09
182	90+500	416623.5196	2757929.069	11.85	12.15
183	91+000	416334.3912	2758882.051	10.25	11.25
184	91+500	416047.1276	2759831.154	11.79	12.22
185	92+000	415181.5176	2759592.963	11.58	13.25
186	92+500	414685.7849	2758785.066	11.75	12.11
187	93+000	414815.1401	2757794.474	12.03	11.25
188	93+500	414551.4211	2756941.676	11.74	11.12
189	94+000	413842.0083	2756240.832	12.65	12.35
190	94+500	413613.2439	2755311.291	11.73	12.35

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
191	95+000	413085.1632	2755025.133	12.54	12.35
192	95+500	412223.3969	2755369.924	11.72	12.29
193	96+000	411458.1787	2754738.017	12.37	11.65
194	96+500	410478.6891	2754645.553	11.71	11.65
195	97+000	409876.7665	2753900.168	12.04	12.35
196	97+500	409311.8413	2753277.142	11.70	11.28
197	98+000	408666.6927	2754027.269	12.35	10.35
198	98+500	407899.3481	2754204.58	11.69	10.22
199	99+000	407091.5994	2754008.352	12.05	10.34
200	99+500	406501.4089	2754729.194	11.67	10.32
201	100+000	405736.0787	2754270.177	11.95	10.23
202	100+500	405102.6542	2753512.776	11.62	10.22
203	101+000	404479.6863	2752805.56	11.95	10.23
204	101+500	403480.8585	2752839.376	11.61	10.49
205	102+000	402484.8948	2752923.807	11.30	10.56
206	102+500	401881.5404	2752289.728	11.57	10.38
207	103+000	401645.2962	2751324.991	10.40	10.24
208	103+500	400859.7107	2751064.019	11.52	10.28
209	104+000	399931.179	2750799.149	10.30	11.35
210	104+500	399798.1391	2749879.752	11.46	11.25
211	105+000	399350.6293	2749387.51	11.35	11.05
212	105+500	398438.089	2749793.506	11.43	10.99
213	106+000	397537.8889	2750224.105	11.68	10.35
214	106+500	396565.3892	2750417.578	11.41	10.43
215	107+000	395574.492	2750299.555	10.38	10.45
216	107+500	394679.2832	2749887.003	10.36	10.32
217	108+000	393976.1151	2749181.175	10.26	10.12
218	108+500	393017.1904	2749039.278	10.21	10.22
219	109+000	393135.1339	2749881.032	10.02	10.35
220	109+500	392359.4987	2750296.107	9.99	10.18
221	110+000	391455.8466	2750696.865	10.80	10.16
222	110+500	390883.4615	2751507.374	10.33	10.22
223	111+000	390028.6205	2751444.865	10.34	10.42
224	111+500	389171.1193	2751594.051	10.35	10.15
225	112+000	388208.0875	2751704.145	10.36	10.42
226	112+500	387302.6045	2752070.712	10.37	10.22
227	113+000	386431.6567	2752548.999	10.80	10.16
228	113+500	385596.8631	2752943.518	10.52	10.28
229	114+000	384603.0268	2752968.263	10.37	10.58

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
230	114+500	383621.5605	2753121.308	10.52	10.45
231	115+000	382793.2597	2753445.957	10.54	10.35
232	115+500	382958.3977	2754328.513	10.56	10.23
233	116+000	382239.6923	2755021.244	10.56	10.25
234	116+500	381338.2581	2755435.46	10.59	10.85
235	117+000	380391.9432	2755724.004	10.37	10.8
236	117+500	379890.7507	2755073.79	10.59	10.78
237	118+000	379201.1952	2755554.334	10.80	10.54
238	118+500	378360.3957	2755480.794	10.65	10.44
239	119+000	377546.122	2755208.421	10.56	10.35
240	119+500	376728.4034	2755504.863	10.67	10.42
241	120+000	375865.1919	2755313.286	10.37	10.47
242	120+500	374866.0528	2755343.388	10.66	10.236
243	121+000	373900.3009	2755139.346	10.08	10.35
244	121+500	372967.5183	2754791.804	10.61	10.44
245	122+000	372020.5403	2754945.619	10.10	10.23
246	122+500	372380.8086	2755807.491	10.56	10.55
247	123+000	371960.4044	2756659.208	10.58	10.34
248	123+500	371017.8588	2756596.498	10.58	10.22
249	124+000	370072.927	2756817.858	10.35	10.35
250	124+500	369173.37	2757246.498	10.57	10.44
251	125+000	369006.0409	2758162.283	10.54	10.54
252	125+500	368433.4323	2758608.851	10.57	10.15
253	126+000	368957.2282	2759199.133	10.05	10.03
254	126+500	369763.4255	2759426.615	10.53	10.29
255	127+000	369845.227	2760103.218	10.95	10.85
256	127+500	368930.0003	2760273.674	10.58	10.78
257	128+000	369447.0415	2761037.038	10.40	10.42
258	128+500	369956.4952	2761822.277	10.58	10.85
259	129+000	369321.6686	2762452.498	10.54	10.95
260	129+500	368512.2646	2763002.484	10.58	10.71
261	130+000	369109.812	2763448.787	10.40	10.32
262	130+500	368435.3509	2764031.314	10.58	10.22
263	131+000	367508.1008	2764405.634	10.14	10
264	131+500	366534.6975	2764631.402	10.55	10.22
265	132+000	365674.5605	2765129.159	10.30	10
266	132+500	365322.9824	2765909.737	10.54	10.12
267	133+000	366118.1422	2765329.039	10.65	10.9
268	133+500	367063.4484	2765075.512	10.55	10.35

Serial No.	Chainage (km)	Easting (m)	Northing (m)	RL of LB (mPWD)	RL of RB (mPWD)
269	134+000	368048.0342	2765204.309	10.24	10.65
270	134+500	368690.8922	2765843.725	10.53	10.85
271	135+000	367718.3328	2765937.3	10.65	10.9
272	135+500	367269.0179	2766695.821	10.55	10.28
273	136+000	366574.7439	2767377.649	10.24	10.34
274	136+500	365692.5843	2767841.642	10.53	10.32
275	137+000	365932.8288	2768214.869	10.20	10.31
276	137+500	366918.7621	2768188.147	10.51	10.12
277	138+000	366872.6433	2769068.492	10.54	10.3
278	138+500	366293.4632	2769875.005	10.52	10.45
279	139+000	366546.0105	2770081.861	10.58	10.96
280	139+500	378133.4026	2758371.791	10.53	10.05
281	140+000	377984.0793	2758368.078	10.25	10.02
282	140+500	377834.756	2758364.365	10.51	10.12
283	141+000	377685.4326	2758360.652	10.38	10.55
284	141+500	377536.1093	2758356.939	10.51	10.33
285	142+000	377386.7859	2758353.225	10.08	10.99
286	142+500	377237.4626	2758349.512	10.49	10.15
287	143+000	377088.1392	2758345.799	10.20	10.08
288	143+500	376938.8159	2758342.086	10.47	10.12
289	144+000	376789.4926	2758338.373	11.54	10.35
290	144+500	376640.1692	2758334.659	10.53	10.35
291	145+000	376490.8459	2758330.946	10.54	10.35
292	145+500	376341.5225	2758327.233	10.53	10.36
293	146+000	376192.1992	2758323.52	10.36	10.34
294	146+500	376042.8758	2758319.806	10.53	10.36
295	147+000	375893.5525	2758316.093	10.54	11.35
296	147+500	375744.2292	2758312.38	10.53	10.55
297	148+000	375594.9058	2758308.667	10.35	10.65
298	148+500	375445.5825	2758304.954	10.52	10.22
299	149+000	375296.2591	2758301.24	10.24	11.36
300	149+500	375146.9358	2758297.527	10.51	10.58
301	150+000	374997.6124	2758293.814	10.09	11.6

Table 2: Survey Data Sheet of the Kushiyara River

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
1	0+000	418573.4198	2752359.5478	8.000	8.793
2	0+500	418671.1077	2751928.5550	8.759	7.505
3	1+000	418206.9807	2751822.6097	7.596	9.062
4	1+500	417740.1148	2751662.1607	8.365	8.919
5	2+000	417438.0127	2751276.1570	8.695	9.076
6	2+500	417239.7493	2750835.1855	9.456	8.941
7	3+000	417223.6008	2750335.4659	8.775	9.106
8	3+500	417243.5651	2749836.7122	7.669	9.086
9	4+000	417345.2809	2749384.5941	7.650	8.814
10	4+500	416905.6417	2749267.2321	5.460	8.777
11	5+000	416514.9780	2749550.9382	6.998	8.889
12	5+500	416174.7701	2749906.6575	7.568	7.478
13	6+000	415688.4410	2750006.3227	8.426	9.042
14	6+500	415226.4031	2750039.7418	8.030	7.287
15	7+000	415040.0229	2749588.0108	6.965	9.192
16	7+500	414866.6691	2749173.9061	7.998	7.301
17	8+000	414373.6273	2749105.6139	8.223	8.984
18	8+500	413882.0984	2749015.7043	8.446	8.785
19	9+000	413385.6487	2748961.2054	7.635	7.188
20	9+500	412885.8783	2748961.7524	8.032	8.723
21	10+000	412399.9698	2749026.8203	6.879	7.046
22	10+500	412295.3278	2749474.3525	7.665	8.621
23	11+000	412304.1502	2749899.7829	7.145	7.081
24	11+500	411812.8374	2749958.3863	7.968	7.215
25	12+000	411345.0573	2750097.9619	8.236	7.274
26	12+500	410950.8591	2750391.3585	7.246	7.181
27	13+000	410469.6708	2750412.3068	7.777	7.026
28	13+500	409990.7012	2750292.6549	7.365	7.019
29	14+000	409506.2976	2750359.1586	8.523	7.071
30	14+500	409033.3242	2750251.8265	7.665	7.207
31	15+000	408562.5906	2750115.9868	7.968	7.219
32	15+500	408314.1691	2749739.5572	8.425	7.395
33	16+000	408382.8543	2749246.6420	8.889	8.677
34	16+500	408269.7897	2748773.2391	8.563	7.437
35	17+000	407893.3576	2748448.4322	8.144	8.694
36	17+500	407500.2901	2748144.3676	7.568	8.663
37	18+000	407427.6563	2747656.0529	7.664	8.820

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
38	18+500	407206.5013	2747235.8755	8.000	8.911
39	19+000	406764.3588	2747064.6054	6.596	8.722
40	19+500	406581.2924	2746604.3733	6.896	7.472
41	20+000	406290.5040	2746198.9827	6.597	7.511
42	20+500	406084.2850	2745744.8325	7.689	7.366
43	21+000	405913.7962	2745275.3473	8.456	8.919
44	21+500	405908.6249	2744782.9929	7.336	7.298
45	22+000	406194.3413	2744379.9278	6.987	7.374
46	22+500	406562.8767	2744044.1121	6.664	7.061
47	23+000	406653.1458	2743617.0576	7.680	7.156
48	23+500	406210.5040	2743698.5218	5.789	7.144
49	24+000	406192.3571	2743466.1736	7.223	7.028
50	24+500	406385.7872	2743024.9944	6.775	8.199
51	25+000	406248.4462	2742574.7159	5.360	8.887
52	25+500	405816.6804	2742671.3014	5.980	7.679
53	26+000	405385.8974	2742695.2631	6.480	7.775
54	26+500	405181.4867	2742259.8737	7.360	7.415
55	27+000	404735.6475	2742081.9235	8.642	8.134
56	27+500	404282.0003	2741885.0460	7.569	8.273
57	28+000	404008.1208	2741480.5586	7.665	8.538
58	28+500	403880.2954	2740997.5261	7.889	8.341
59	29+000	403859.3897	2740502.8834	7.223	8.245
60	29+500	403906.4565	2740005.9945	6.998	7.143
61	30+000	403959.0621	2739532.0053	6.578	7.975
62	30+500	404372.1549	2739763.5830	6.465	7.285
63	31+000	404813.3483	2739775.1856	7.324	8.830
64	31+500	404888.1608	2739305.0155	7.213	8.245
65	32+000	404542.2355	2738958.1673	7.365	8.266
66	32+500	404099.6327	2738727.2172	6.578	8.409
67	33+000	403744.8401	2738371.3336	6.425	8.338
68	33+500	403338.5147	2738089.9986	6.445	8.597
69	34+000	403115.3470	2737723.5138	6.000	8.435
70	34+500	403566.0538	2737545.3504	6.335	8.611
71	35+000	403963.2303	2737256.8838	6.458	8.598
72	35+500	404019.4884	2736781.0337	6.879	8.590
73	36+000	403647.5724	2736459.3053	7.120	8.598
74	36+500	403244.4147	2736173.7289	7.365	8.388
75	37+000	402973.3918	2735755.8813	7.315	8.673

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
76	37+500	402777.9870	2735295.8182	7.036	8.924
77	38+000	402439.1689	2735017.4343	7.000	8.352
78	38+500	402014.2255	2735232.9322	7.885	8.495
79	39+000	401824.6662	2735693.8108	6.480	7.961
80	39+500	401403.0682	2735688.2986	8.756	8.316
81	40+000	400930.4140	2735538.8452	5.968	7.810
82	40+500	400456.0061	2735429.0241	6.889	7.480
83	41+000	400157.8167	2735036.9871	7.332	8.381
84	41+500	399894.6252	2734612.0889	7.321	8.327
85	42+000	399565.4838	2734238.5275	6.456	8.259
86	42+500	399134.7712	2733992.9183	8.426	8.128
87	43+000	398645.1173	2734011.6836	8.997	8.165
88	43+500	398306.0485	2734363.1385	8.463	7.944
89	44+000	397987.7771	2734650.7813	6.987	8.102
90	44+500	397886.8950	2734202.1285	7.536	8.297
91	45+000	397566.7859	2733829.2414	6.480	8.198
92	45+500	397207.5412	2733492.2744	5.987	7.316
93	46+000	396897.8509	2733100.9410	7.895	7.002
94	46+500	396471.8231	2733050.0014	6.649	8.068
95	47+000	396063.8986	2733096.6800	6.544	7.106
96	47+500	395668.9997	2732852.1173	6.666	7.528
97	48+000	395349.8644	2733195.3047	6.854	7.171
98	48+500	394961.0367	2733202.9274	7.056	7.101
99	49+000	394509.2215	2732993.2292	6.781	7.091
100	49+500	394133.6709	2732672.2937	6.913	8.031
101	50+000	393726.2288	2732383.8068	6.714	7.919
102	50+500	393239.0924	2732272.3883	6.765	8.363
103	51+000	392749.3767	2732172.6692	7.437	8.426
104	51+500	392304.3957	2731951.3707	7.235	8.260
105	52+000	391871.9284	2731701.8309	7.134	8.229
106	52+500	391436.0824	2731461.4570	7.252	8.256
107	53+000	390964.5399	2731295.3711	6.992	8.195
108	53+500	390515.7971	2731078.6637	6.751	8.159
109	54+000	390332.5116	2730632.7997	6.668	8.204
110	54+500	390368.6828	2730134.3657	6.738	8.018
111	55+000	390344.5198	2729640.9627	6.644	7.806
112	55+500	390003.1489	2729288.0900	6.652	7.456
113	56+000	389627.3988	2728969.0277	6.622	7.078

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
114	56+500	389371.6892	2728540.0108	6.806	7.149
115	57+000	389234.5150	2728066.0059	6.858	7.080
116	57+500	389269.3566	2727569.1052	6.989	7.282
117	58+000	389287.8875	2727075.1998	6.802	7.398
118	58+500	389064.5651	2726635.1444	6.695	7.176
119	59+000	388679.5807	2726321.0009	6.747	7.230
120	59+500	388206.4242	2726164.1130	6.484	5.937
121	60+000	387721.8862	2726108.0781	6.805	6.058
122	60+500	387533.0581	2726533.9620	6.804	5.507
123	61+000	387533.0581	2727030.9405	6.815	5.748
124	61+500	387313.8146	2727472.2339	6.670	4.676
125	62+000	386848.8115	2727584.0165	6.694	5.748
126	62+500	386483.3361	2727254.8873	6.554	5.037
127	63+000	386032.7035	2727388.6419	6.727	4.727
128	63+500	385569.2893	2727532.0694	6.913	5.631
129	64+000	385257.7472	2727248.2045	7.092	5.810
130	64+500	385146.0665	2726780.4890	6.707	4.265
131	65+000	384725.5733	2726525.6808	6.794	5.944
132	65+500	384264.3630	2726333.0509	6.564	4.782
133	66+000	383804.6186	2726136.8095	6.628	6.305
134	66+500	383326.1304	2726002.1931	6.549	6.268
135	67+000	383131.1674	2726406.1257	6.737	5.293
136	67+500	382892.8717	2726809.6821	7.054	4.968
137	68+000	382414.4638	2726951.3679	6.755	5.670
138	68+500	381921.0513	2727020.1808	6.743	5.256
139	69+000	381434.0162	2726931.8068	6.700	5.119
140	69+500	380983.3767	2726718.3561	6.743	4.892
141	70+000	380590.3809	2726410.7359	6.716	5.336
142	70+500	380199.7942	2726100.5063	6.449	6.136
143	71+000	379812.2287	2725817.2079	6.603	5.986
144	71+500	379391.3731	2725547.6067	6.627	5.589
145	72+000	378950.1226	2725313.4621	6.440	5.615
146	72+500	378514.5125	2725217.7003	6.879	6.253
147	73+000	378259.6376	2725613.5016	6.713	5.475
148	73+500	378146.6657	2726094.3384	7.185	5.363
149	74+000	377705.7262	2726073.9095	7.181	6.186
150	74+500	377225.0964	2725938.1436	7.383	5.591
151	75+000	376818.1838	2725656.3559	7.086	5.862

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
152	75+500	376682.3897	2725211.8967	6.919	6.128
153	76+000	376838.7675	2724744.0462	5.930	6.096
154	76+500	377046.7189	2724294.5875	6.812	5.629
155	77+000	376754.8758	2723975.9225	6.704	6.295
156	77+500	376260.7903	2724042.0671	6.798	5.713
157	78+000	375766.6135	2724114.1951	6.617	6.035
158	78+500	375816.4722	2723794.1748	6.532	6.234
159	79+000	375669.7821	2723351.6457	6.645	6.180
160	79+500	375244.2251	2723093.1412	6.571	6.317
161	80+000	374808.1050	2722851.4399	6.166	6.130
162	80+500	374382.0321	2722592.3221	6.007	6.189
163	81+000	374006.9545	2722262.1384	6.553	5.890
164	81+500	373699.3283	2721869.2102	6.334	5.868
165	82+000	373436.8171	2721445.1792	6.131	5.852
166	82+500	373301.5022	2720967.9830	6.233	6.002
167	83+000	372875.8415	2720804.5963	6.289	6.039
168	83+500	372561.8183	2721175.6331	6.163	6.316
169	84+000	372088.6402	2721230.7730	6.322	6.242
170	84+500	371663.3283	2720970.7135	6.736	6.231
171	85+000	371241.9273	2720702.1978	6.783	6.316
172	85+500	370760.8063	2720590.6718	6.431	6.022
173	86+000	370286.3266	2720741.6359	6.534	6.116
174	86+500	369812.4901	2720901.1754	6.465	5.959
175	87+000	369341.3967	2721068.0151	6.49	5.941
176	87+500	368900.8333	2721304.0675	6.782	5.812
177	88+000	368482.5868	2721577.3597	6.626	5.846
178	88+500	368060.7255	2721843.2889	6.839	5.984
179	89+000	367695.6375	2722182.9654	6.891	6.115
180	89+500	367428.7536	2722597.6338	6.531	5.907
181	90+000	367188.9395	2723025.7690	6.717	5.571
182	90+500	366869.4087	2723408.2582	6.734	5.982
183	91+000	366599.9574	2723829.1442	6.912	5.786
184	91+500	366435.6267	2724299.7940	6.969	5.908
185	92+000	366273.7735	2724771.3011	6.891	6.061
186	92+500	366003.2906	2725190.0619	6.771	6.179
187	93+000	365693.4302	2725579.1346	6.942	5.968
188	93+500	365269.4295	2725836.4750	6.922	5.850
189	94+000	364781.7256	2725861.6418	6.972	5.283

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
190	94+500	364301.3620	2725724.0722	6.994	5.907
191	95+000	363817.1188	2725620.4777	6.100	5.898
192	95+500	363328.8285	2725714.3449	6.296	5.966
193	96+000	362916.6597	2725985.5998	6.503	6.172
194	96+500	362711.8045	2726431.3994	6.460	5.982
195	97+000	362561.7659	2726900.8174	6.913	4.915
196	97+500	362258.2436	2727294.3984	6.223	4.339
197	98+000	361824.8794	2727542.1600	6.172	4.300
198	98+500	361481.2743	2727900.4343	6.517	5.342
199	99+000	361181.2059	2728295.4474	6.235	4.927
200	99+500	360816.6373	2728630.5737	6.719	5.324
201	100+000	360433.0628	2728944.8907	6.470	5.543
202	100+500	359938.9442	2728943.0590	6.736	5.863
203	101+000	359618.6538	2729228.7496	6.391	6.013
204	101+500	359817.6951	2729671.9985	6.856	6.068
205	102+000	359728.7306	2730030.1435	6.611	5.505
206	102+500	359231.5953	2729984.6299	6.687	5.056
207	103+000	358748.8483	2729890.7279	5.222	5.592
208	103+500	358334.1841	2729633.4078	5.485	5.444
209	104+000	358151.6697	2729170.4199	5.696	4.870
210	104+500	357725.0678	2729092.3224	4.945	5.452
211	105+000	357408.3807	2729472.0779	5.541	6.081
212	105+500	357028.9718	2729787.5531	5.101	4.978
213	106+000	356549.9334	2729915.5452	5.512	6.178
214	106+500	356053.1531	2729880.1886	5.292	5.877
215	107+000	355557.1327	2729827.5294	5.490	6.066
216	107+500	355082.0892	2729938.8830	5.583	5.667
217	108+000	355009.1884	2730415.6679	5.509	4.768
218	108+500	355282.3905	2730813.8317	5.371	6.207
219	109+000	355720.6837	2731043.1149	5.537	5.956
220	109+500	356103.6017	2731351.2588	5.543	5.929
221	110+000	355852.2730	2731751.2514	5.674	6.258
222	110+500	355383.6000	2731866.3632	5.511	5.837
223	111+000	354906.2051	2731722.0069	5.341	6.331
224	111+500	354416.4845	2731641.8612	5.227	5.463
225	112+000	353928.3403	2731540.6736	5.288	5.241
226	112+500	353450.9712	2731407.7103	5.412	5.254
227	113+000	352998.8293	2731546.7255	5.681	5.871

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
228	113+500	352592.7852	2731830.2231	5.547	5.996
229	114+000	352174.5235	2732103.2327	5.100	6.221
230	114+500	351805.0106	2732439.0862	5.591	6.296
231	115+000	351440.6699	2732780.5892	5.589	6.016
232	115+500	350994.0796	2732990.2758	5.571	6.239
233	116+000	350574.7632	2732789.1998	5.475	5.927
234	116+500	350385.3470	2732330.6872	5.363	6.033
235	117+000	350003.5408	2732034.8491	5.336	5.396
236	117+500	349565.4482	2731796.0866	5.293	5.944
237	118+000	349142.9565	2731530.3179	5.283	5.777
238	118+500	348661.2835	2731438.9570	5.256	5.549
239	119+000	348340.6341	2731751.1138	5.119	6.095
240	119+500	348596.8067	2732167.5885	4.968	5.887
241	120+000	348420.7557	2732603.2319	4.892	6.308
242	120+500	347972.6809	2732611.6369	4.200	4.800
243	121+000	347773.3408	2732948.7304	5.509	6.066
244	121+500	347548.7986	2733214.8989	5.371	6.667
245	122+000	347324.2565	2733481.0673	5.354	4.768
246	122+500	347099.7143	2733747.2357	5.543	6.234
247	123+000	346875.1721	2734013.4041	6.674	6.180
248	123+500	346650.6300	2734279.5725	5.511	6.317
249	124+000	346426.0878	2734545.7409	5.341	6.130
250	124+500	346201.5457	2734811.9093	5.227	6.189
251	125+000	345977.0035	2735078.0777	5.228	5.890
252	125+500	345752.4614	2735344.2461	5.412	5.868
253	126+000	345527.9192	2735610.4146	6.681	5.852
254	126+500	345303.3771	2735876.5830	5.547	6.002
255	127+000	345078.8349	2736142.7514	6.100	6.039
256	127+500	344854.2928	2736408.9198	5.591	6.316
257	128+000	344629.7506	2736675.0882	5.571	6.242
258	128+500	344405.2085	2736941.2566	5.475	6.231
259	129+000	344180.6663	2737207.4250	5.363	5.897
260	129+500	343956.1241	2737473.5934	6.223	4.339
261	130+000	343731.5820	2737739.7618	6.172	4.300
262	130+500	343507.0398	2738005.9303	6.517	5.342
263	131+000	343282.4977	2738272.0987	6.235	4.927
264	131+500	343057.9555	2738538.2671	6.719	5.324
265	132+000	342833.4134	2738804.4355	6.470	5.543

Serial No.	Chainage	Easting (m)	Northing (m)	Left Bank RL (mPWD)	Right Bank RL (mPWD)
266	132+500	342608.8712	2739070.6039	6.736	5.863
267	133+000	342384.3291	2739336.7723	6.131	5.852
268	133+500	342159.7869	2739602.9407	6.233	6.002
269	134+000	341935.2448	2739869.1091	6.289	6.039
270	134+500	341710.7026	2740135.2775	6.163	6.316
271	135+000	341486.1605	2740401.4460	6.322	6.242
272	135+500	341261.6183	2740667.6144	6.736	6.231
273	136+000	341037.0762	2740933.7828	6.783	6.316
274	136+500	340812.5340	2741199.9512	6.431	6.022
275	137+000	340587.9918	2741466.1196	6.534	6.116
276	137+500	340363.4497	2741732.2880	6.465	5.959
277	138+000	340138.9075	2741998.4564	6.49	5.941
278	138+500	339914.3654	2742264.6248	6.782	5.812
279	139+000	339689.8232	2742530.7933	6.626	5.846
280	139+500	339465.2811	2742796.9617	6.186	5.465
281	140+000	339240.7389	2743063.1301	5.978	4.229
282	140+500	339016.1968	2743329.2985	5.363	5.100
283	141+000	338791.6546	2743595.4669	5.396	5.780
284	141+500	338567.1125	2743861.6353	5.336	6.004
285	142+000	338342.5703	2744127.8037	5.978	5.980
286	142+500	338118.0282	2744393.9721	5.293	5.174
287	143+000	337893.4860	2744660.1405	5.298	5.225
288	143+500	337668.9438	2744926.3090	5.283	5.927
289	144+000	337444.4017	2745192.4774	2.279	6.033
290	144+500	337219.8595	2745458.6458	5.256	5.396
291	145+000	336995.3174	2745724.8142	5.132	5.944
292	145+500	336770.7752	2745990.9826	5.119	5.777
293	146+000	336546.2331	2746257.1510	4.798	5.549
294	146+500	336321.6909	2746523.3194	4.968	6.095
295	147+000	336097.1488	2746789.4878	4.811	5.914
296	147+500	335872.6066	2747055.6562	4.892	5.887
297	148+000	335648.0645	2747321.8247	4.665	5.986
298	148+500	335423.5223	2747587.9931	4.2	6.308
299	149+000	335198.9802	2747854.1615	4.750	4.76
300	149+500	334974.4380	2748120.3299	4.825	4.802
301	150+000	334749.8959	2748386.4983	5.100	4.8

7 Bank line Survey Maps

The bank line survey maps of Surma and Kushiyara rivers are presented in section 1.6.1 and 1.6.2 respectively. The chainage extent of each map is shown.

7.1 The Surma River

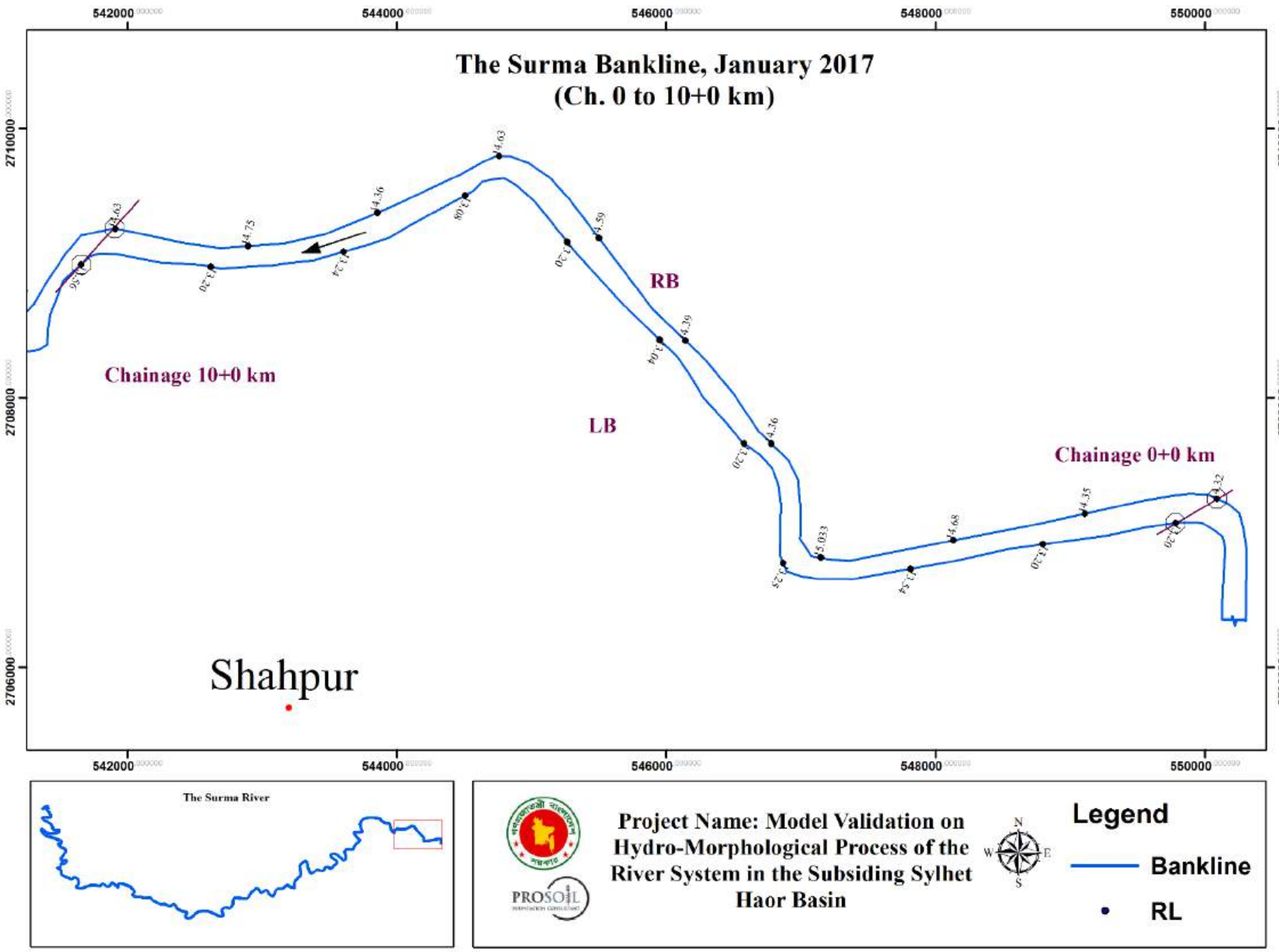

Figure 8: Bank Line Survey Map of Surma River (Chainage 0 to 10+0 Km)

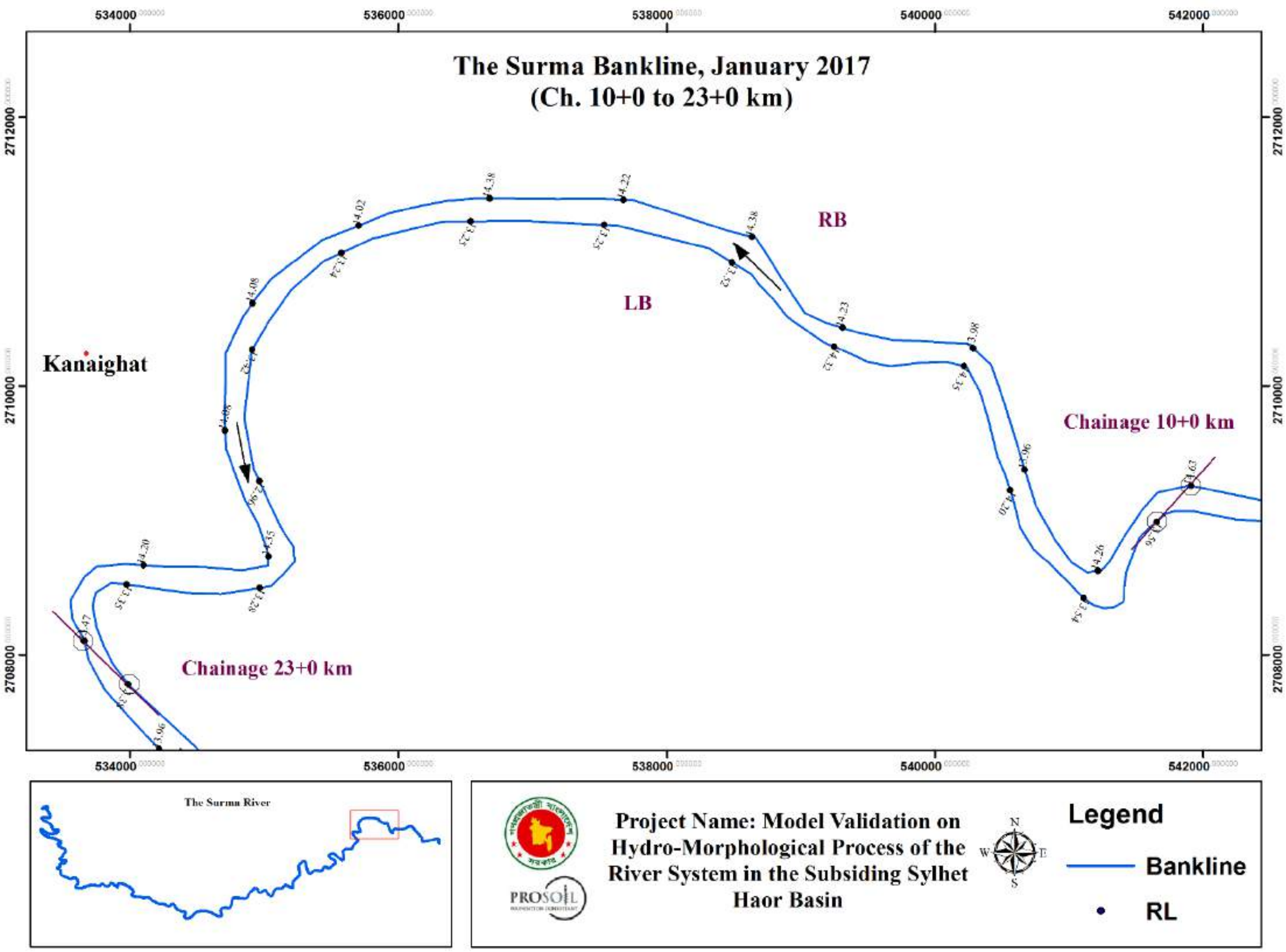

Figure 9: Bank Line Survey Map of Surma River (Chainage 10+0 to 23+0 Km)

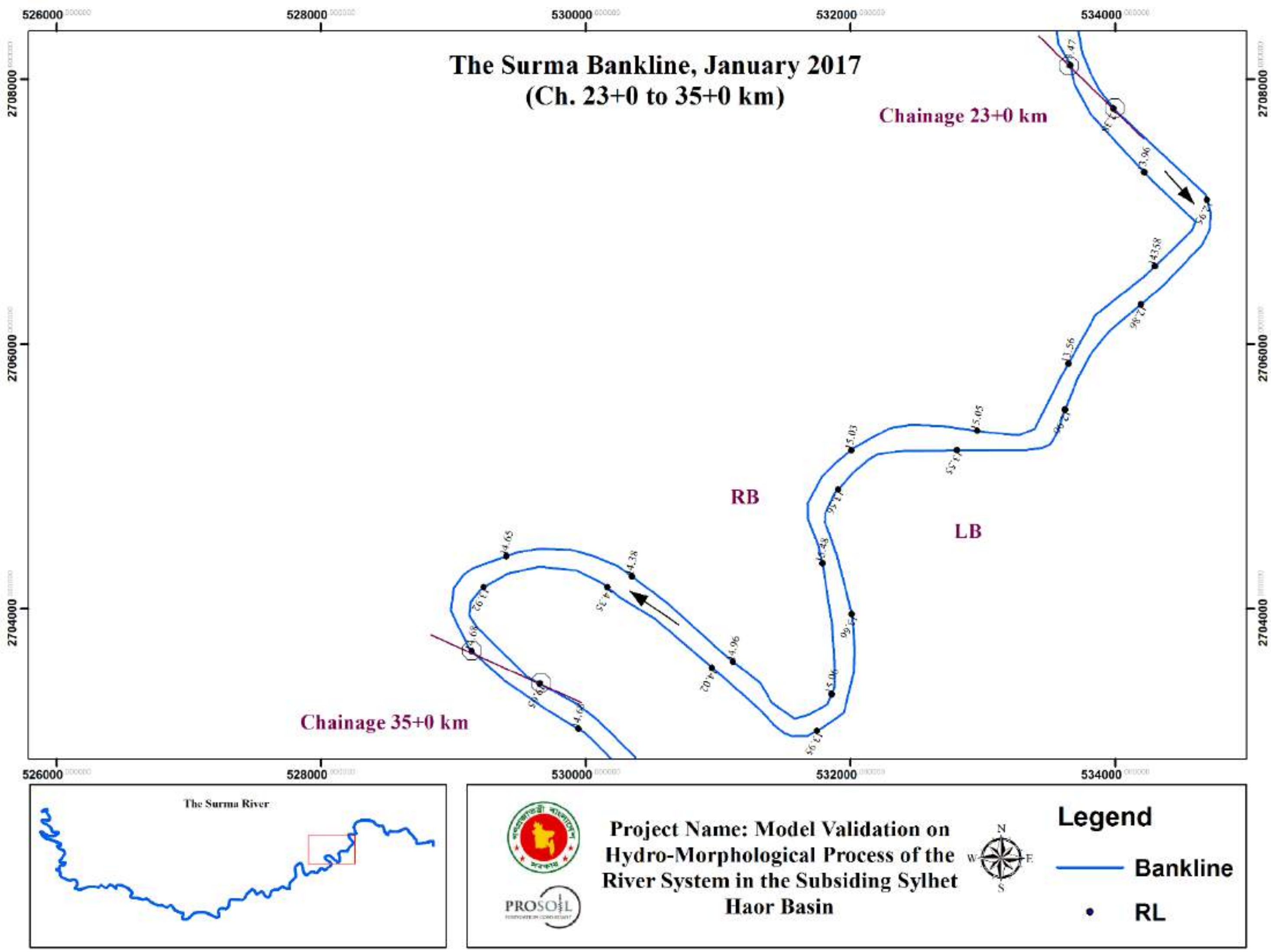

Figure 10: Bank Line Survey Map of Surma River (Chainage 23+0 to 35+0 Km)

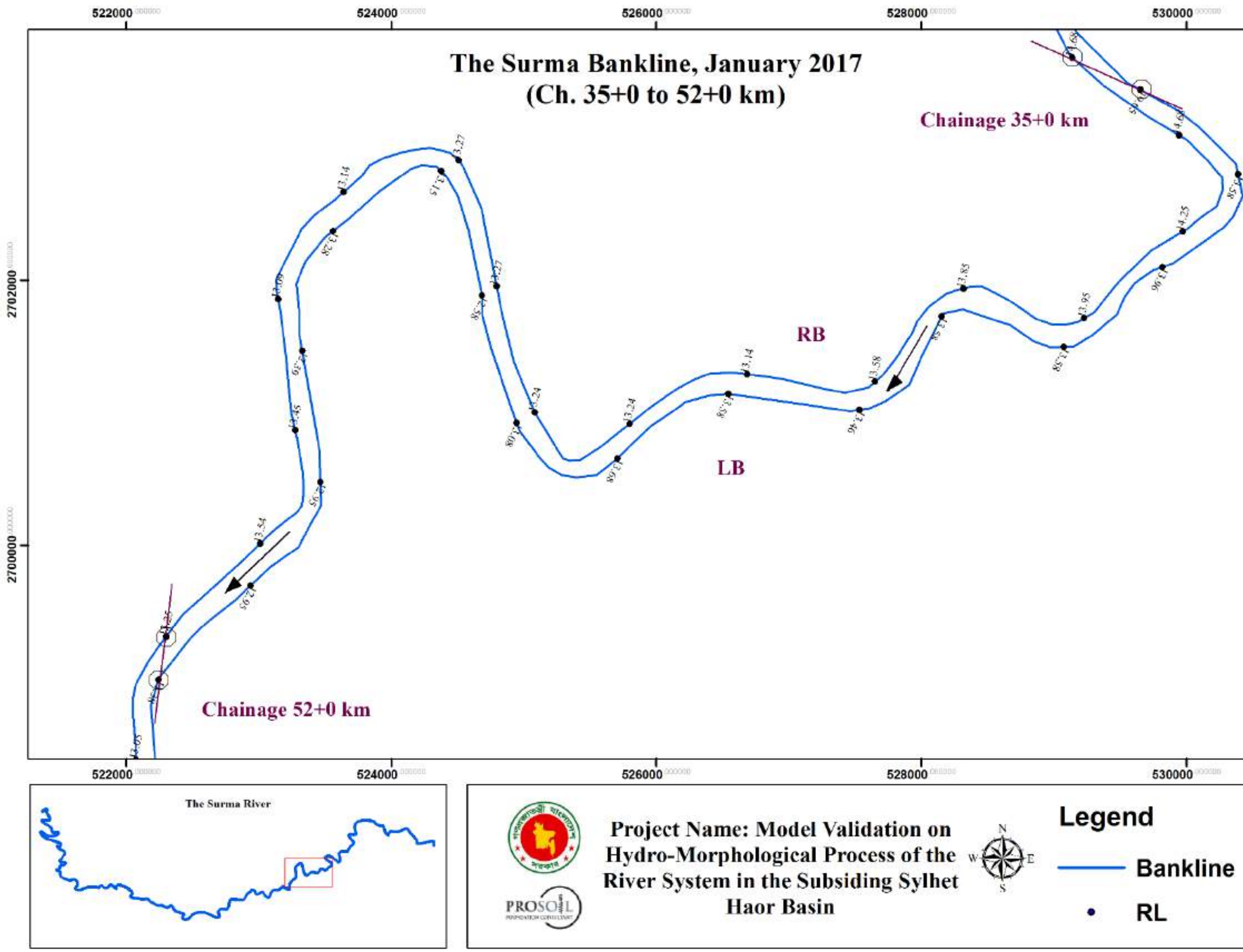

Figure 11: Bank Line Survey Map of Surma River (Chainage 35+0 to 52+0 Km)

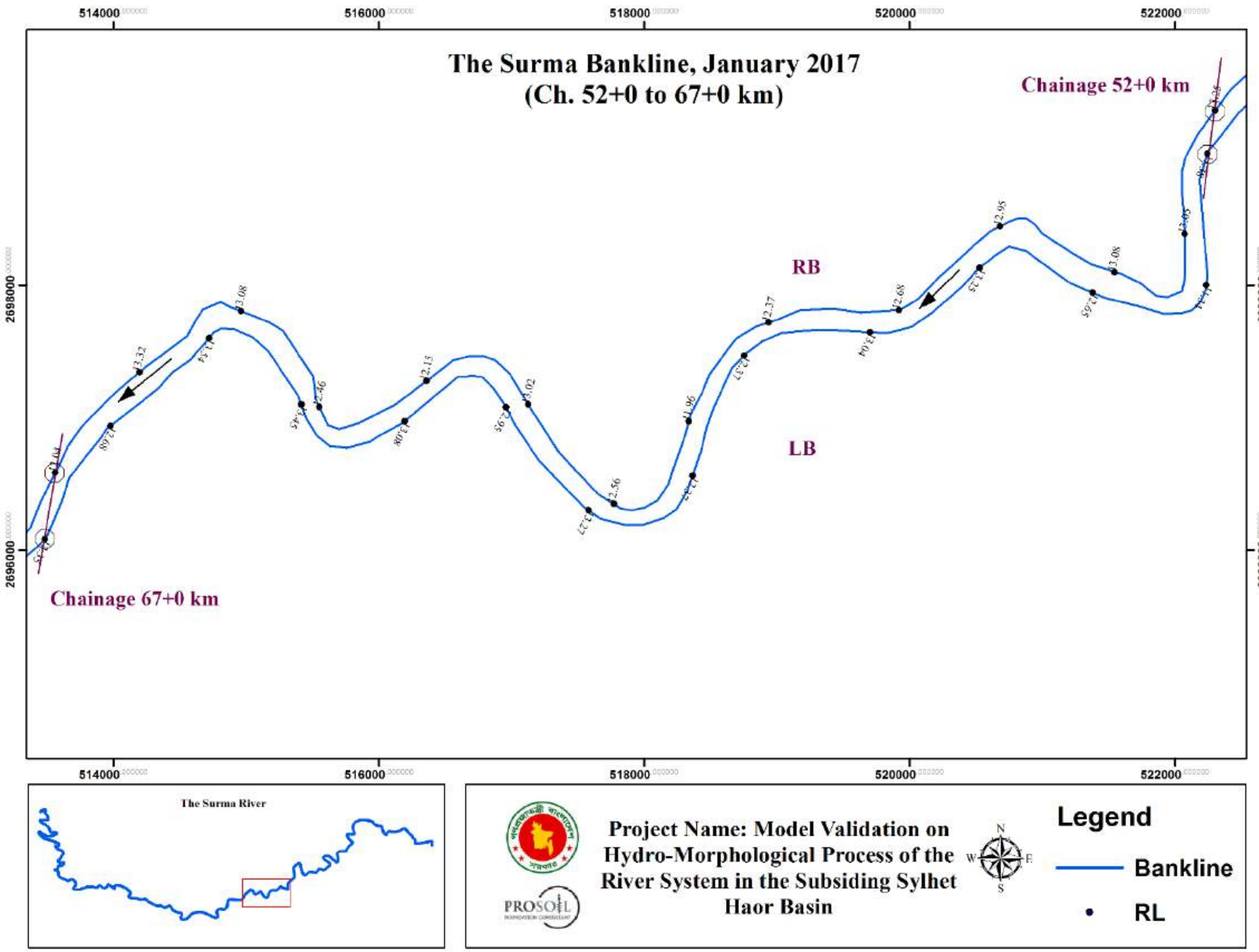

Figure 12: Bank Line Survey Map of Surma River (Chainage 52+0 to 67+0 Km)

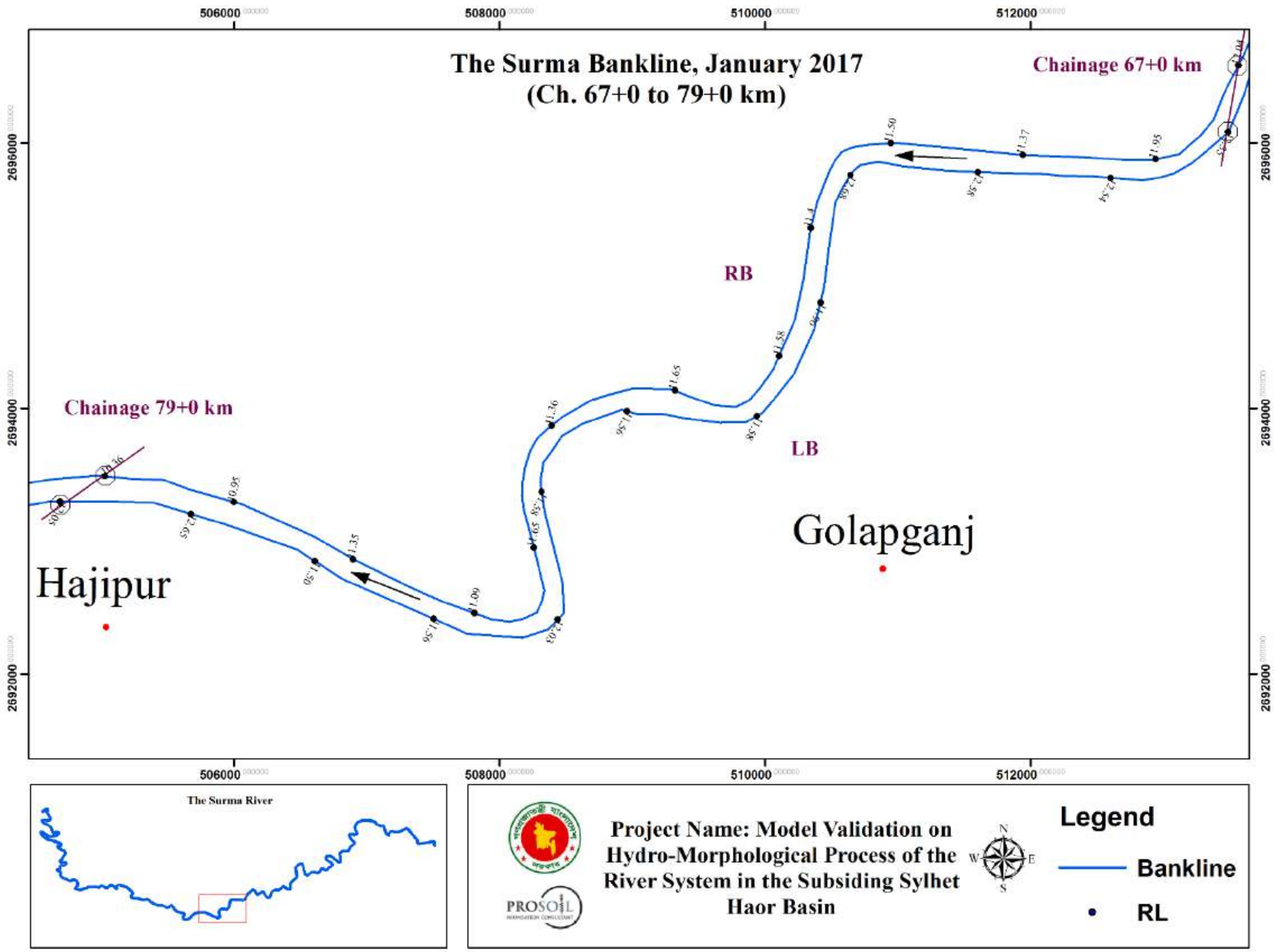

Figure 13: Bank Line Survey Map of Surma River (Chainage 67+0 to 79+0 Km)

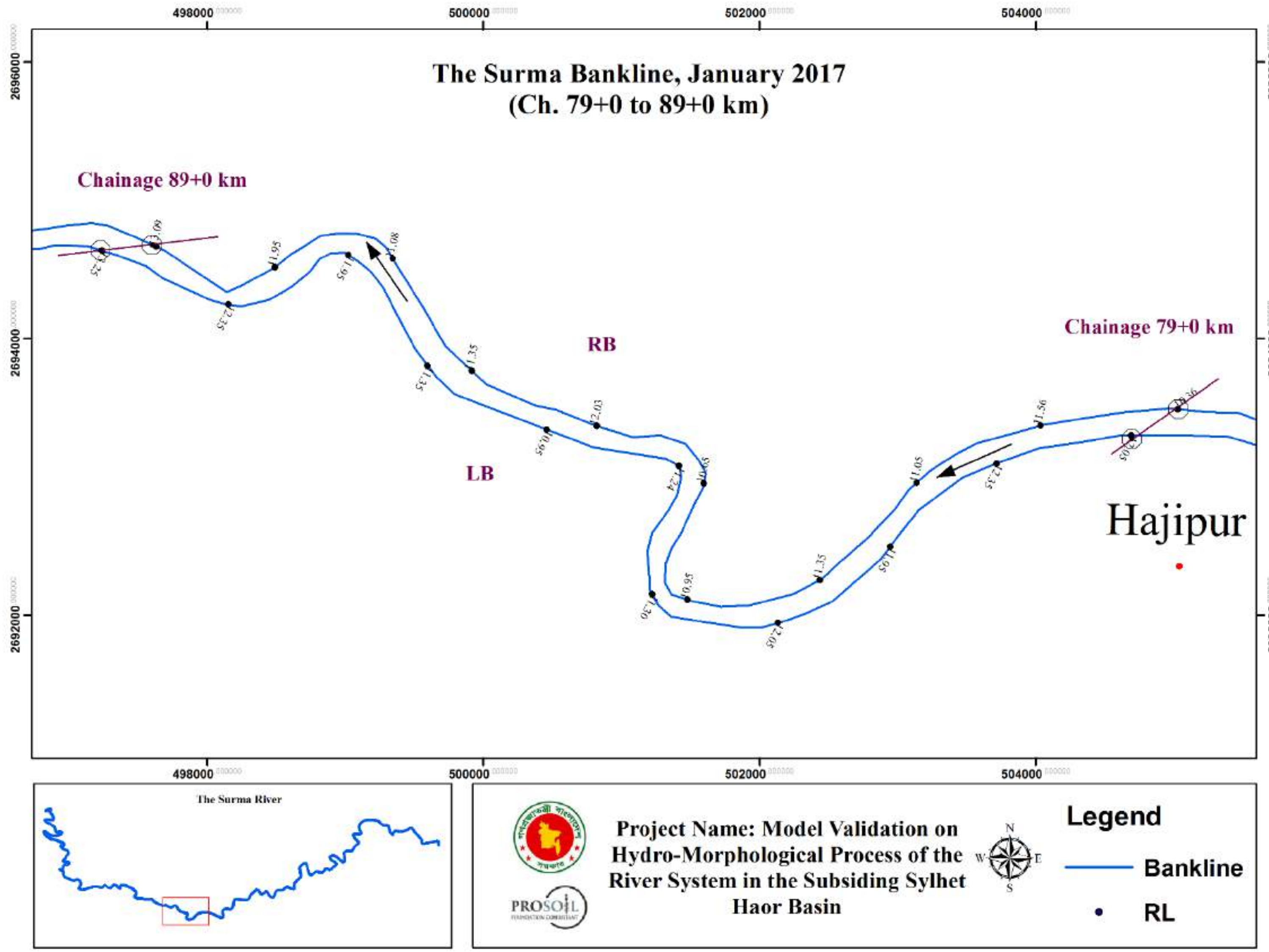

Figure 14: Bank Line Survey Map of Surma River (Chainage 79+0 to 89+0 Km)

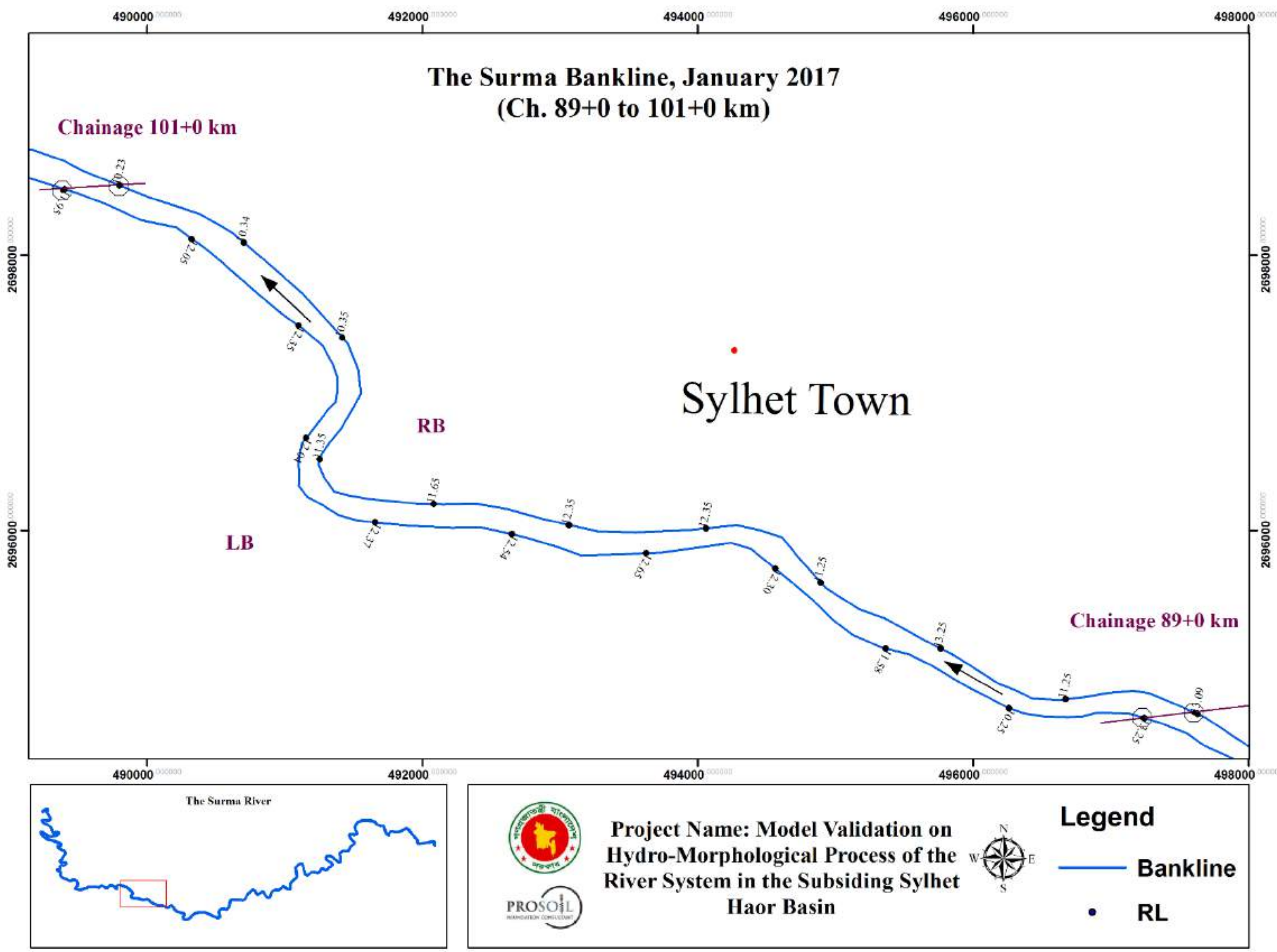

Figure 15: Bank Line Survey Map of Surma River (Chainage 89+0 to 101+0 Km)

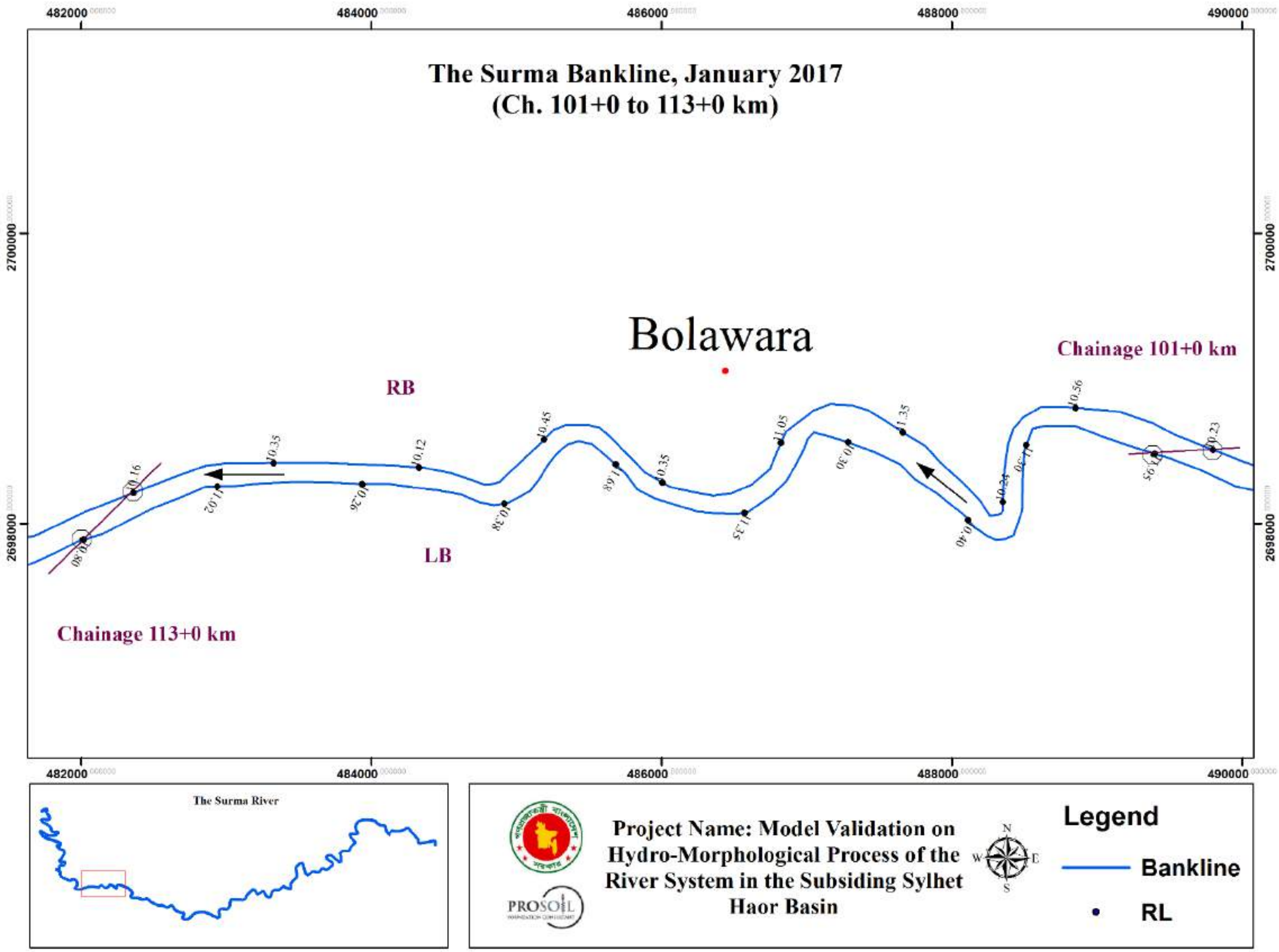

Figure 16: Bank Line Survey Map of Surma River (Chainage 101+0 to 113+0 Km)

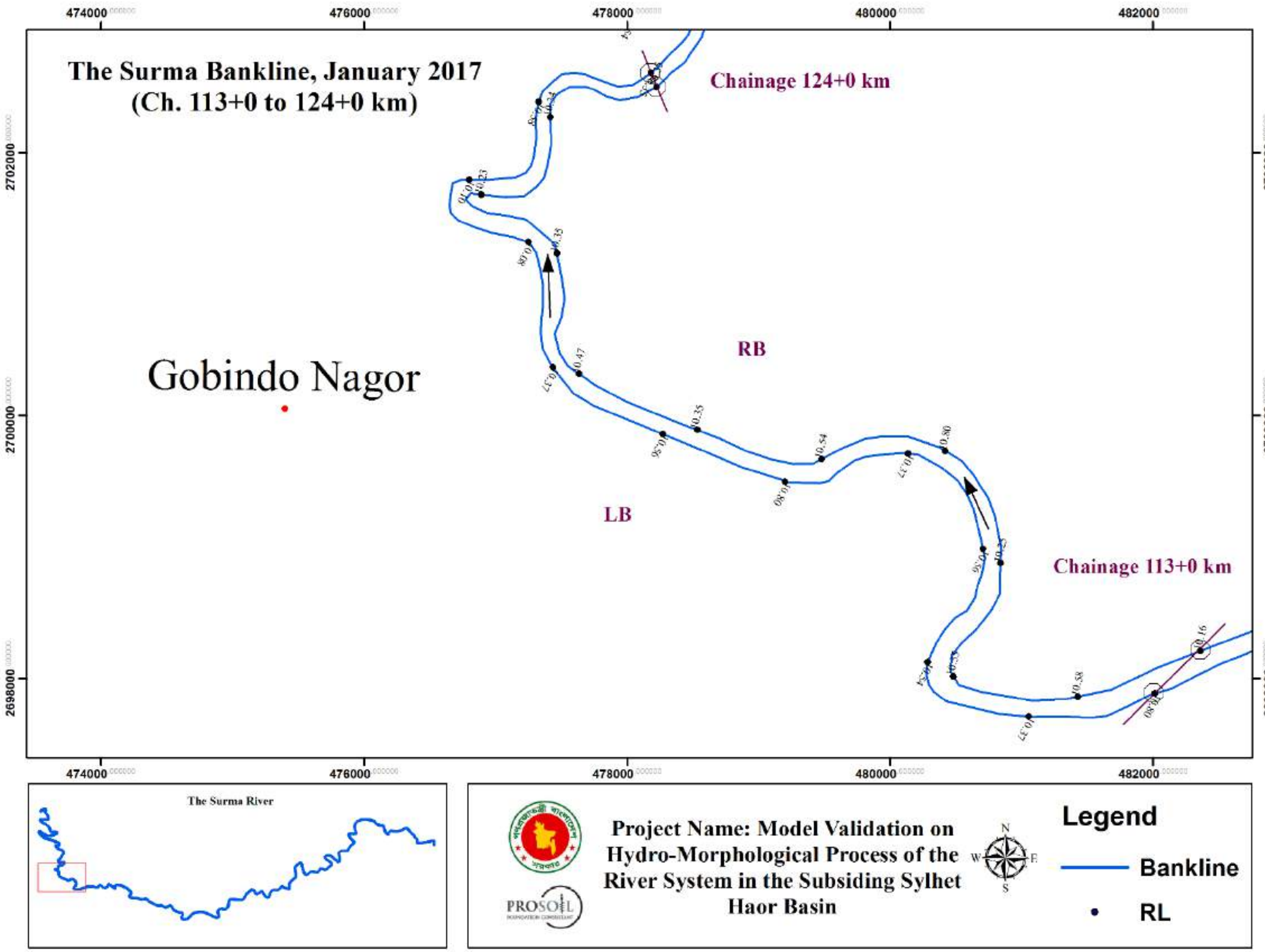

Figure 17: Bank Line Survey Map of Surma River (Chainage 113+0 to 124+0 Km)

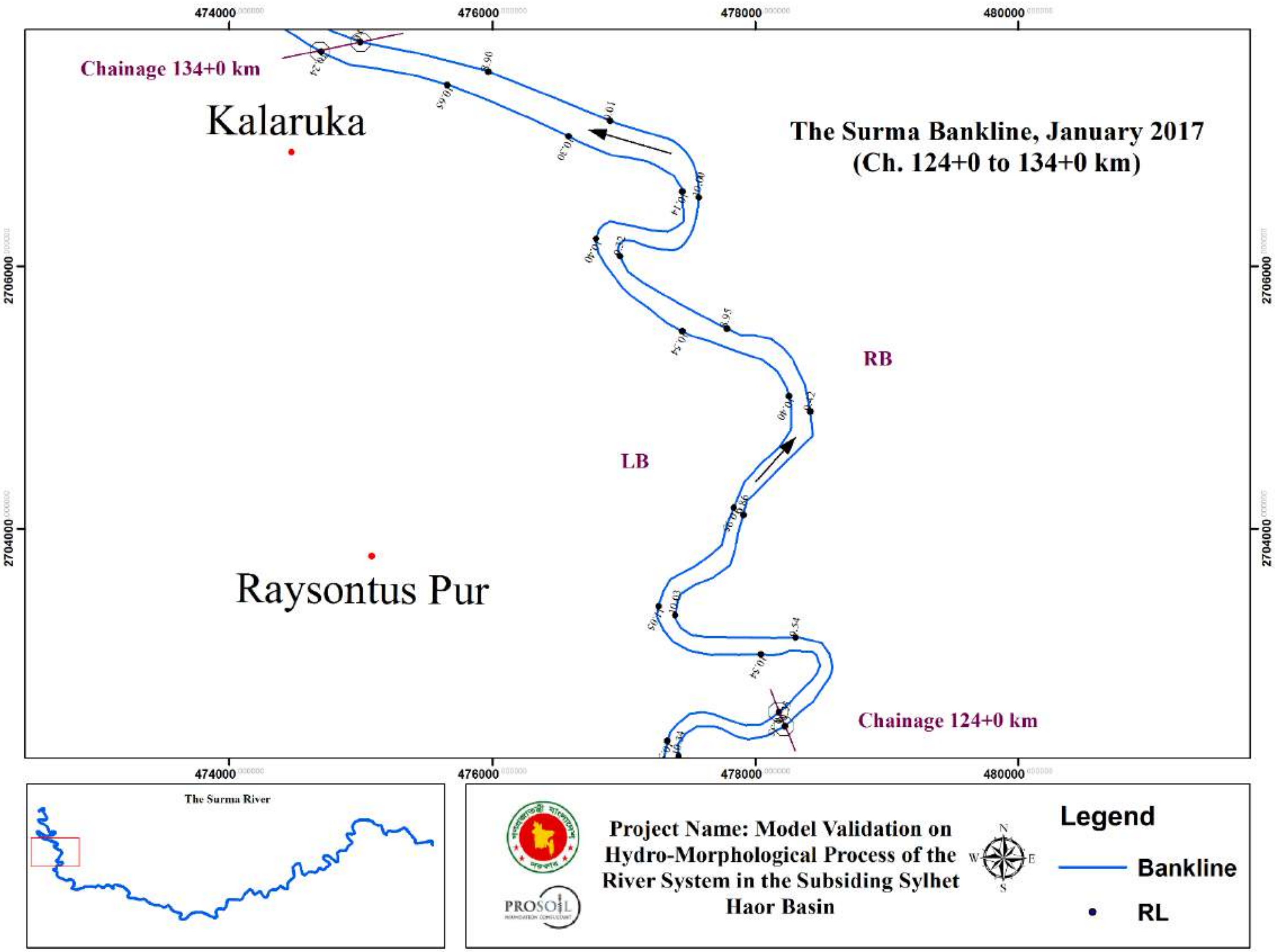

Figure 18: Bank Line Survey Map of Surma River (Chainage 124+0 to 134+0 Km)

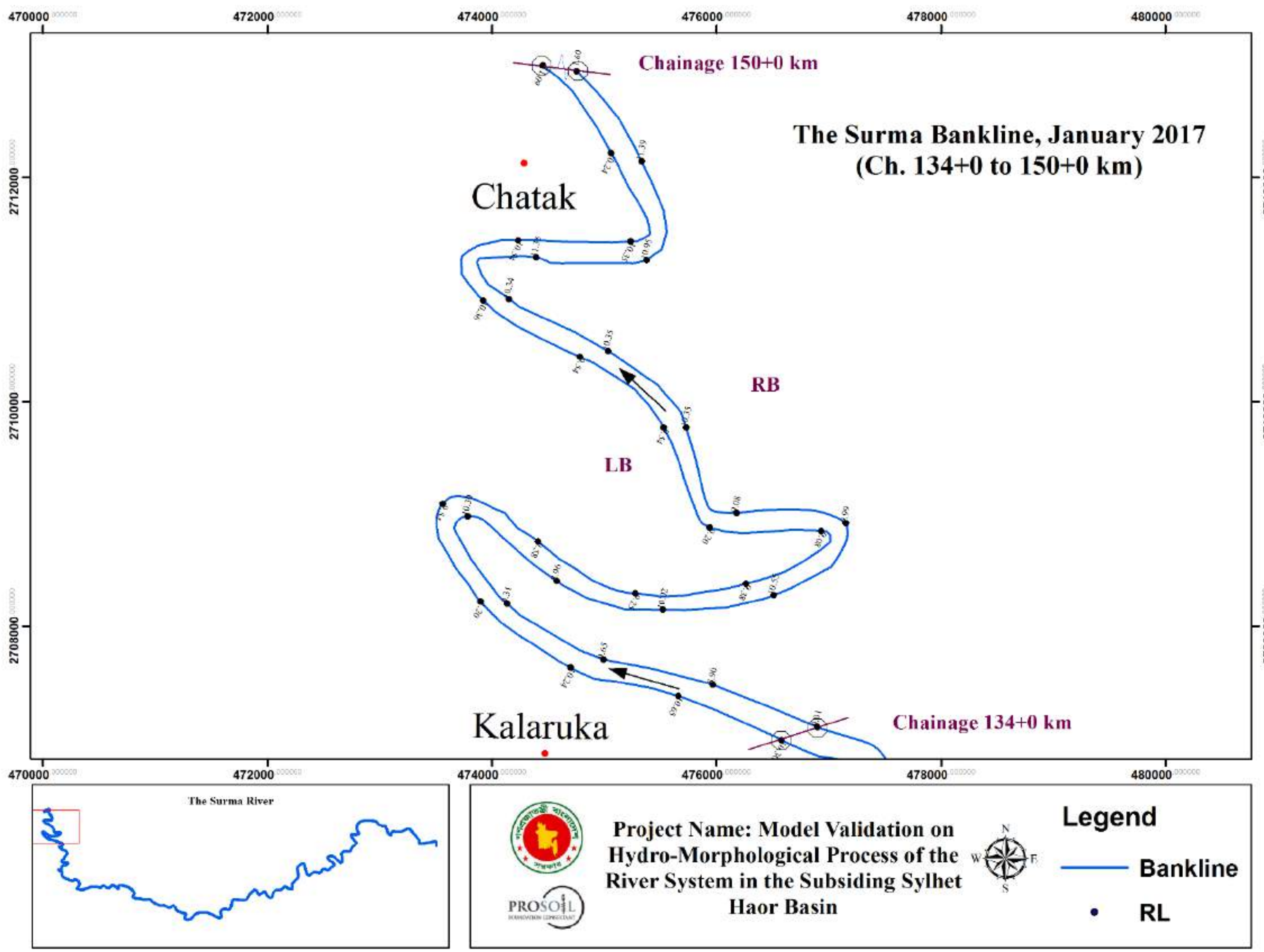

Figure 19: Bank Line Survey Map of Surma River (Chainage 134+0 to 150+0 Km)

7.2 The Kushiyara River

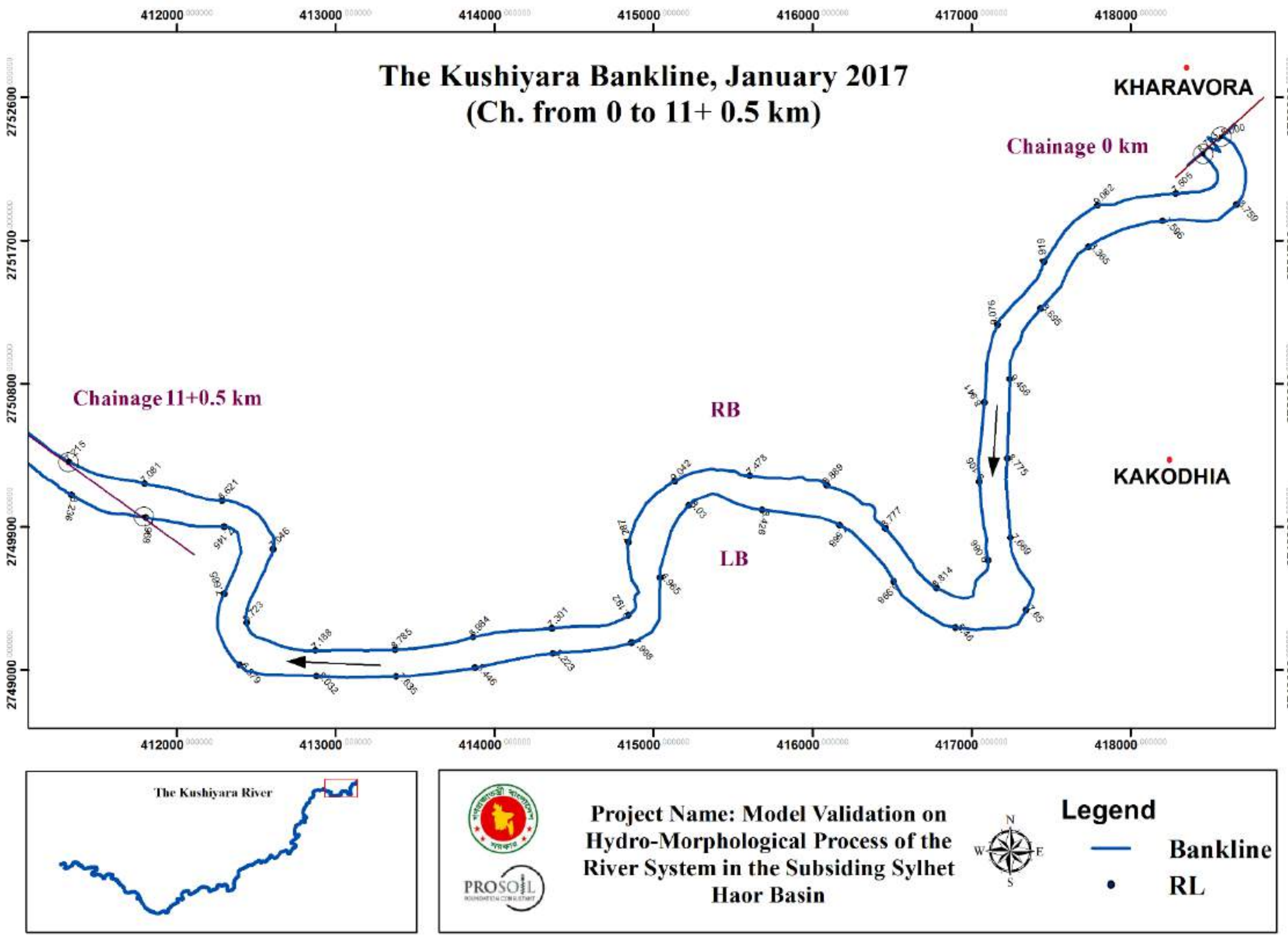

Figure 20: Bank Line Survey Map of Kushiyara River (Chainage 0+0 to 11+0.5 Km)

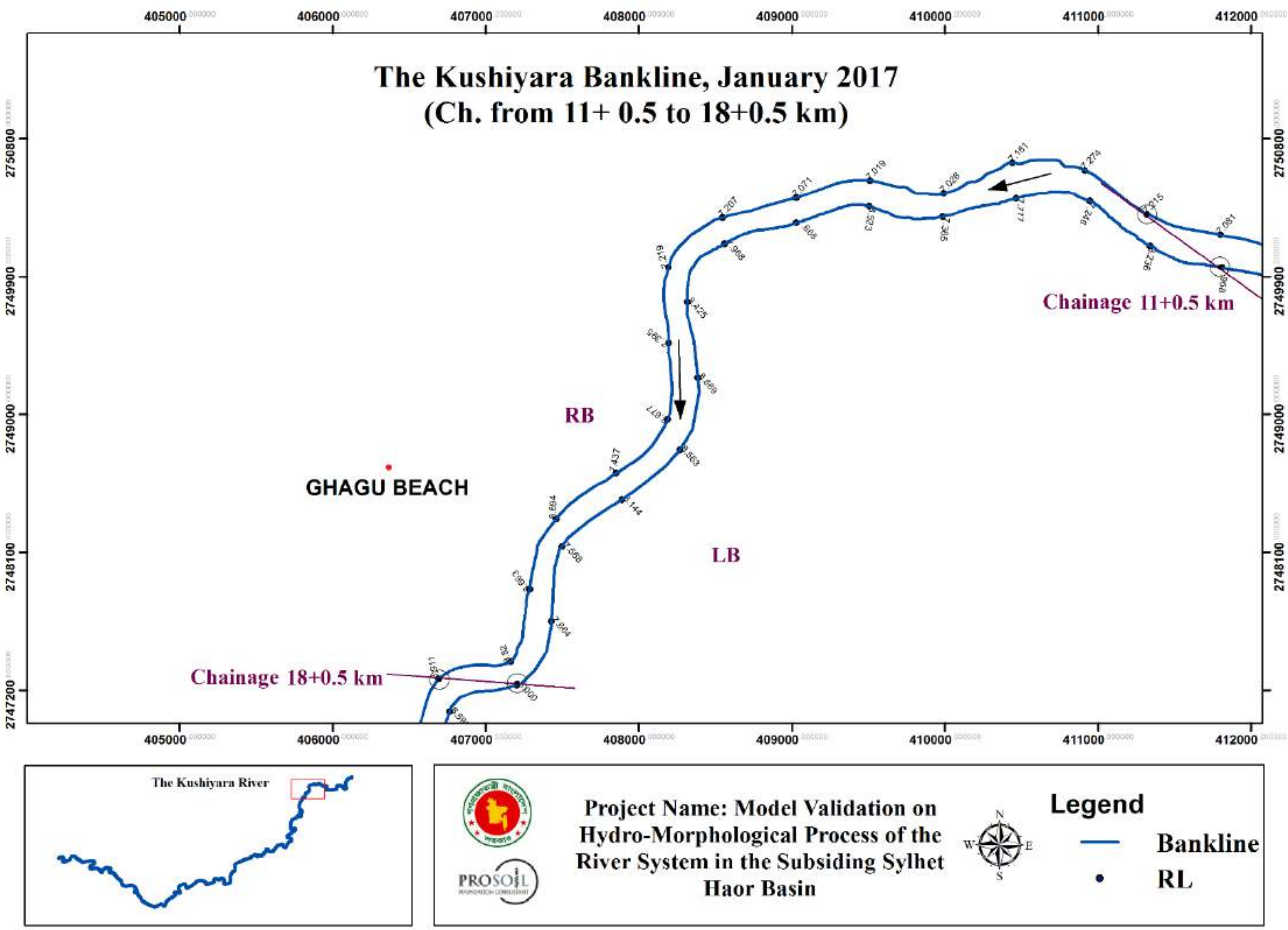

Figure 21: Bank Line Survey Map of Kushiyara River (Chainage 11.05 to 18+0.5 Km)

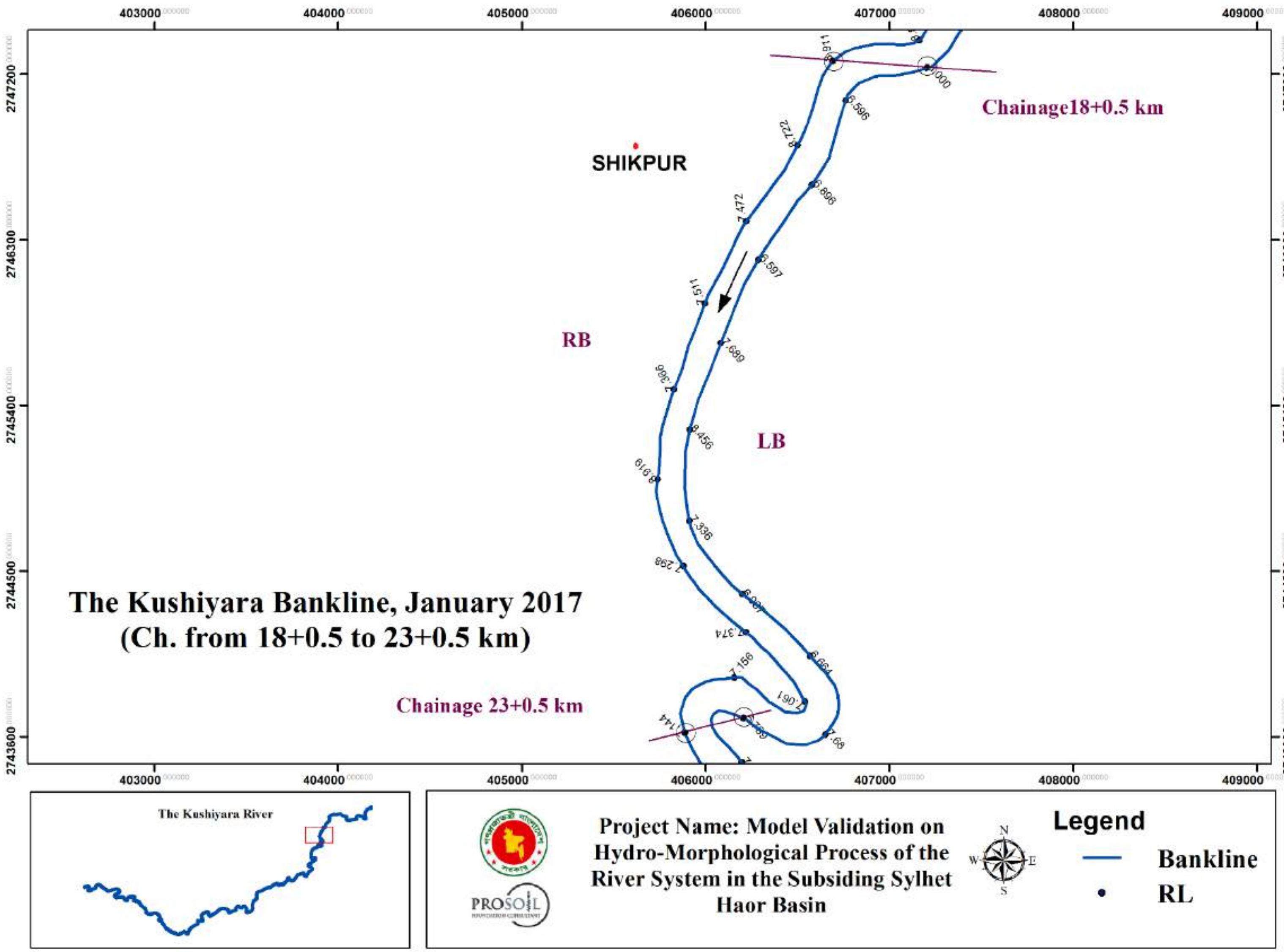

Figure 22: Bank Line Survey Map of Kushiyara River (Chainage 18.05 to 23+0.5 Km)

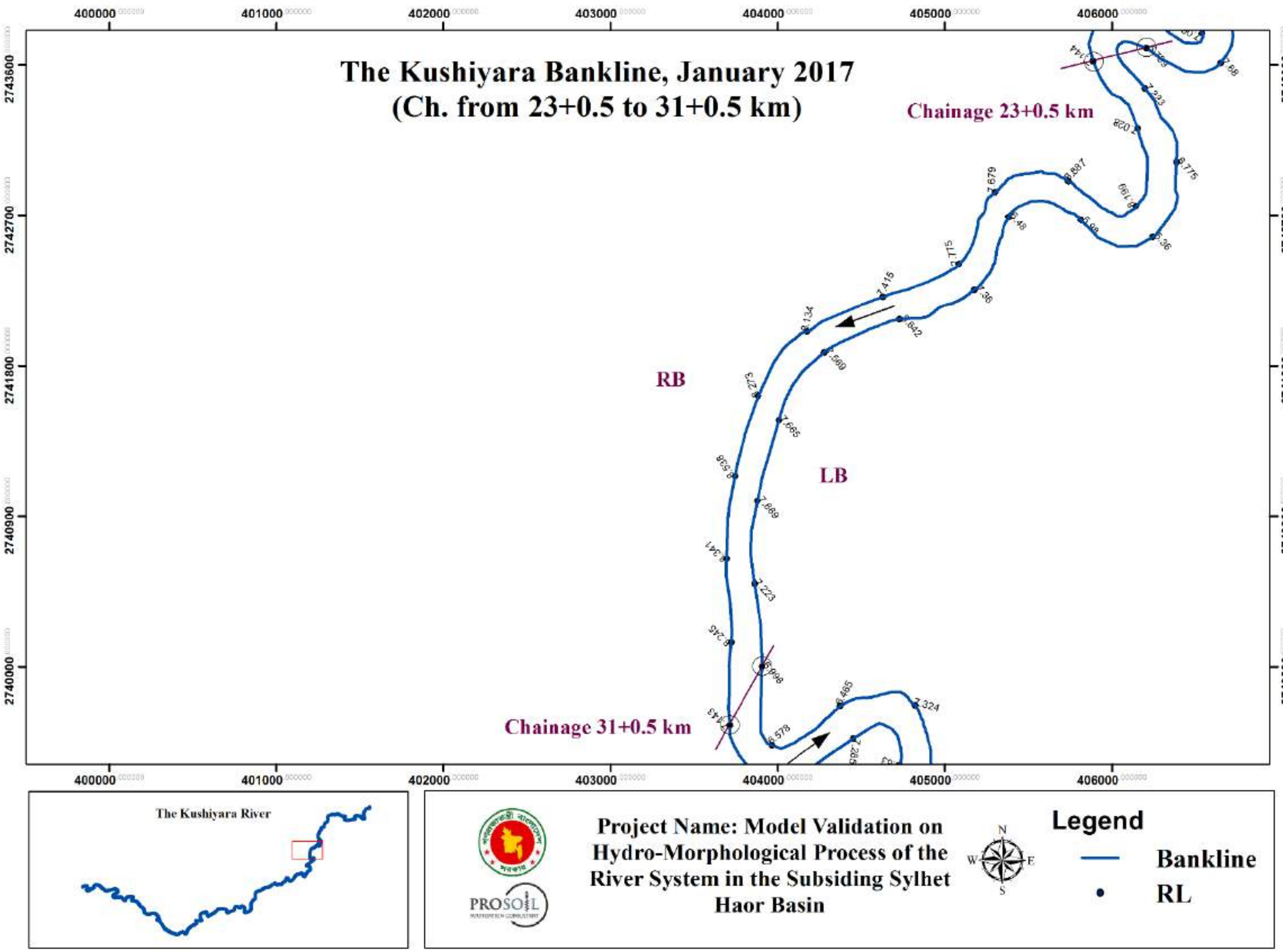

Figure 23: Bank Line Survey Map of Kushiyara River (Chainage 23.05 to 31+0.5 Km)

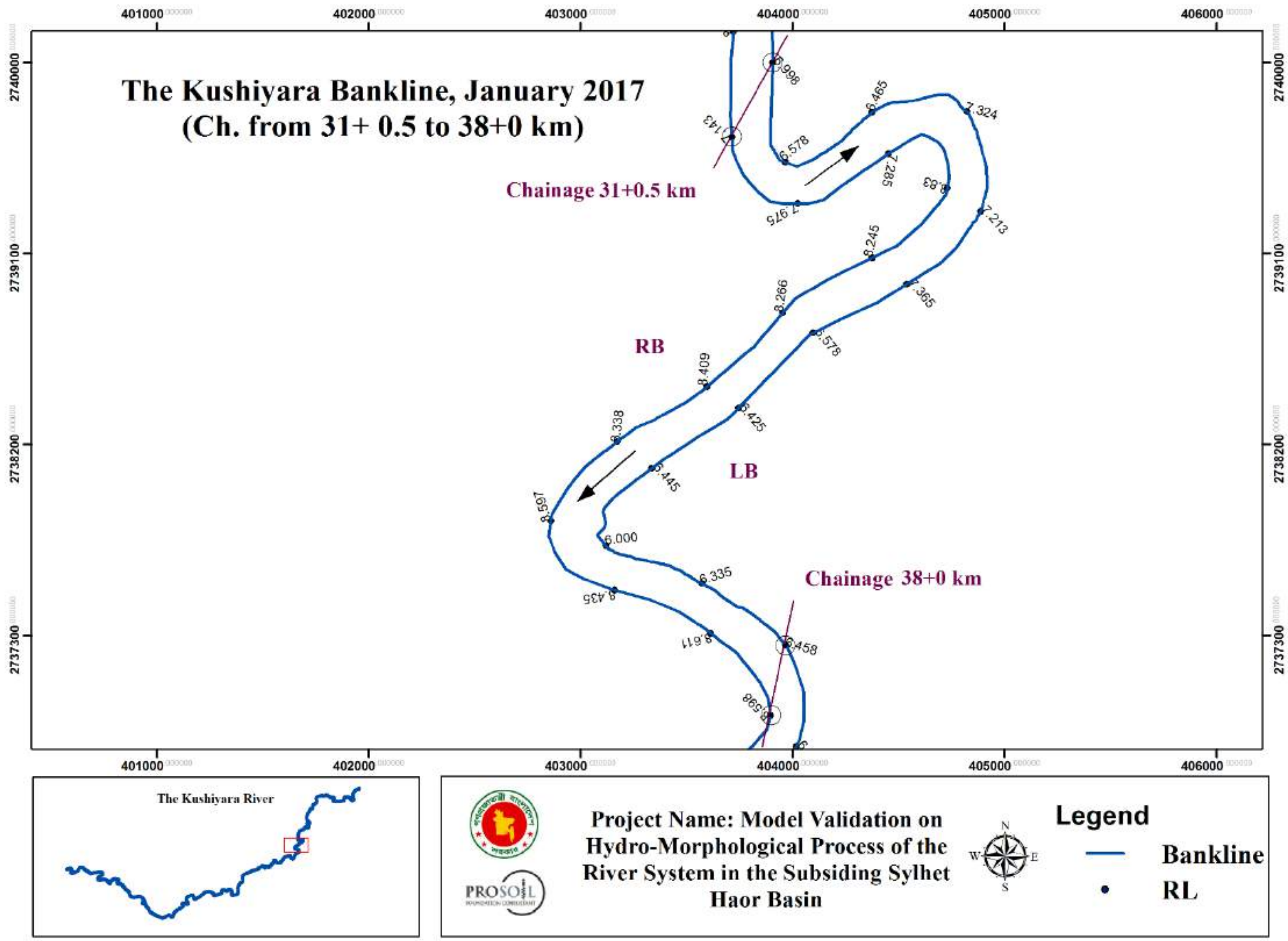

Figure 24: Bank Line Survey Map of Kushiyara River (Chainage 31.05 to 38+0 Km)

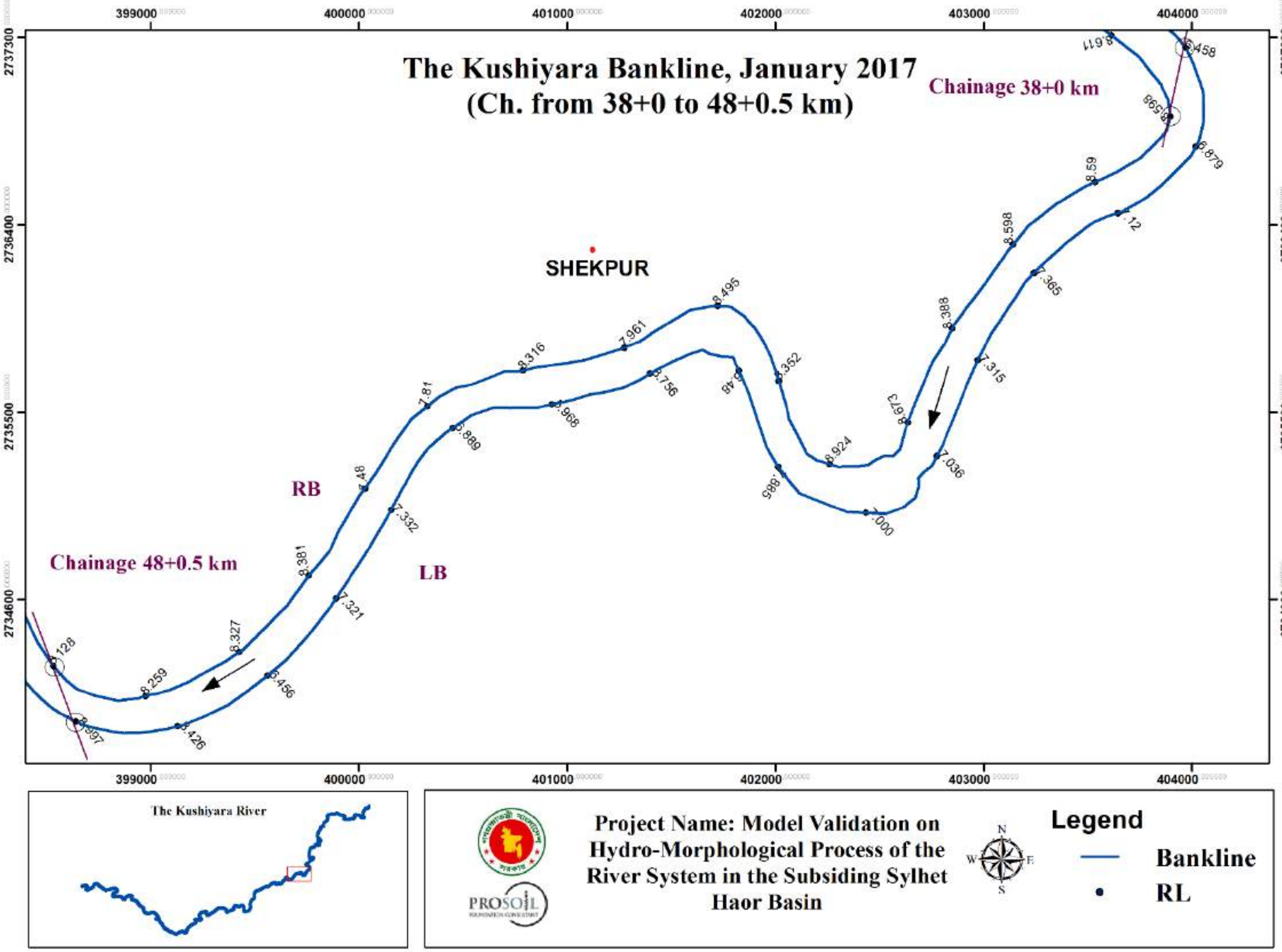

Figure 25: Bank Line Survey Map of Kushiyara River (Chainage 38+0 to 48+0.5 Km)

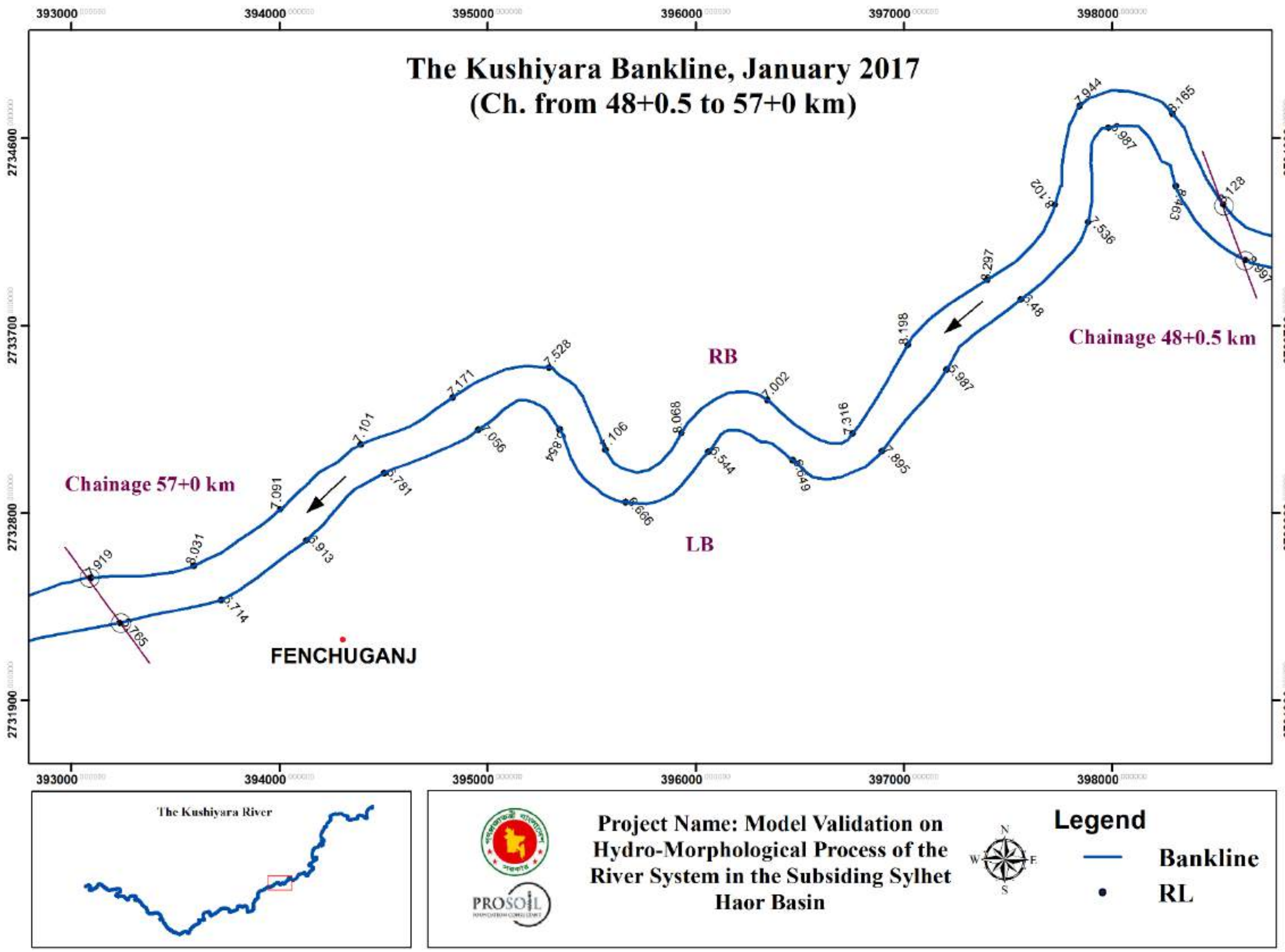

Figure 26: Bank Line Survey Map of Kushiyara River (Chainage 48+.05 to 57+0 Km)

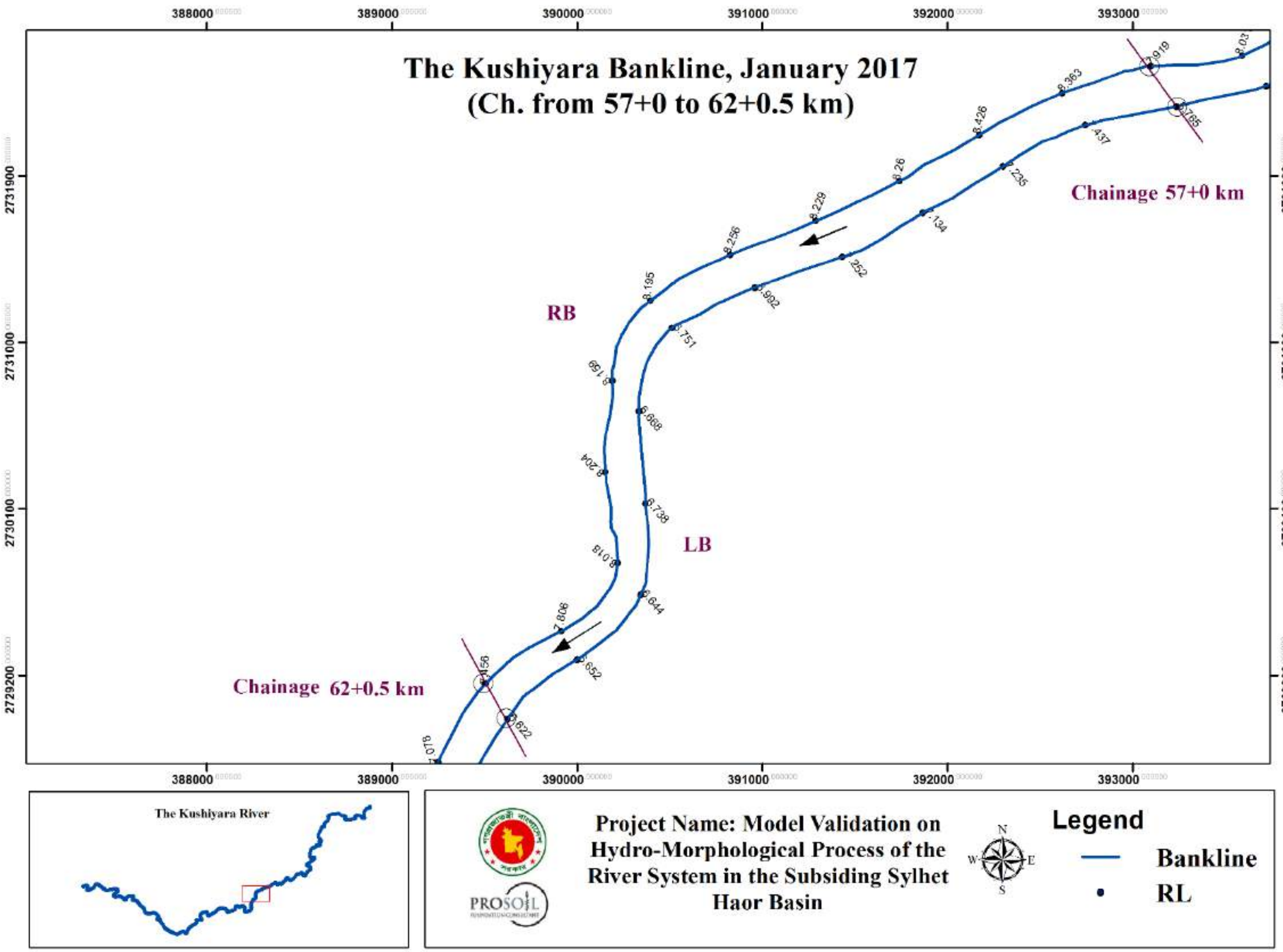

Figure 27: Bank Line Survey Map of Kushiyara River (Chainage 57+0 to 62+0.5 Km)

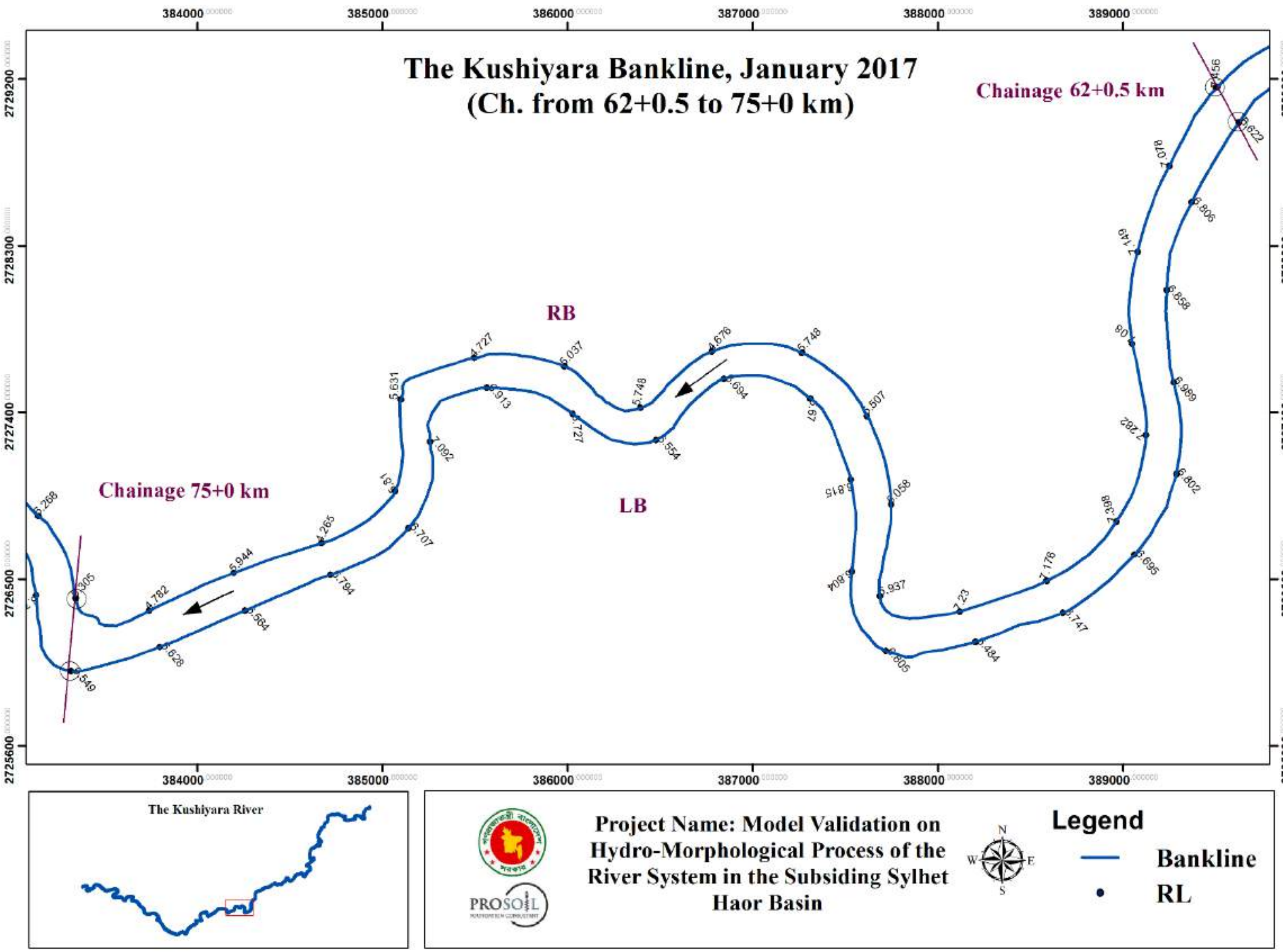

Figure 28: Bank Line Survey Map of Kushiyara River (Chainage 62+0.5 to 75+0 Km)

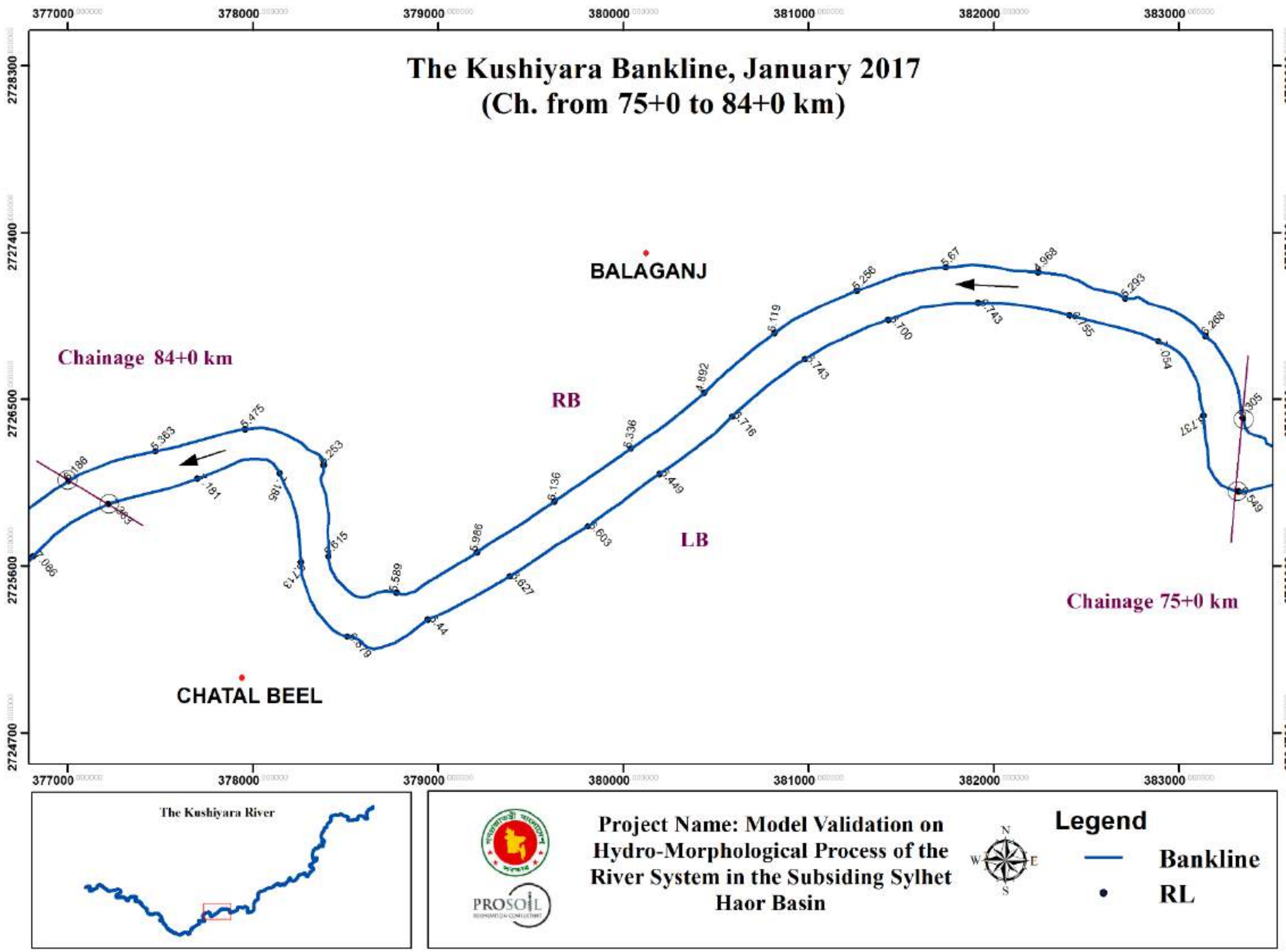

Figure 29: Bank Line Survey Map of Kushiyara River (Chainage 75+0 to 84+0 Km)

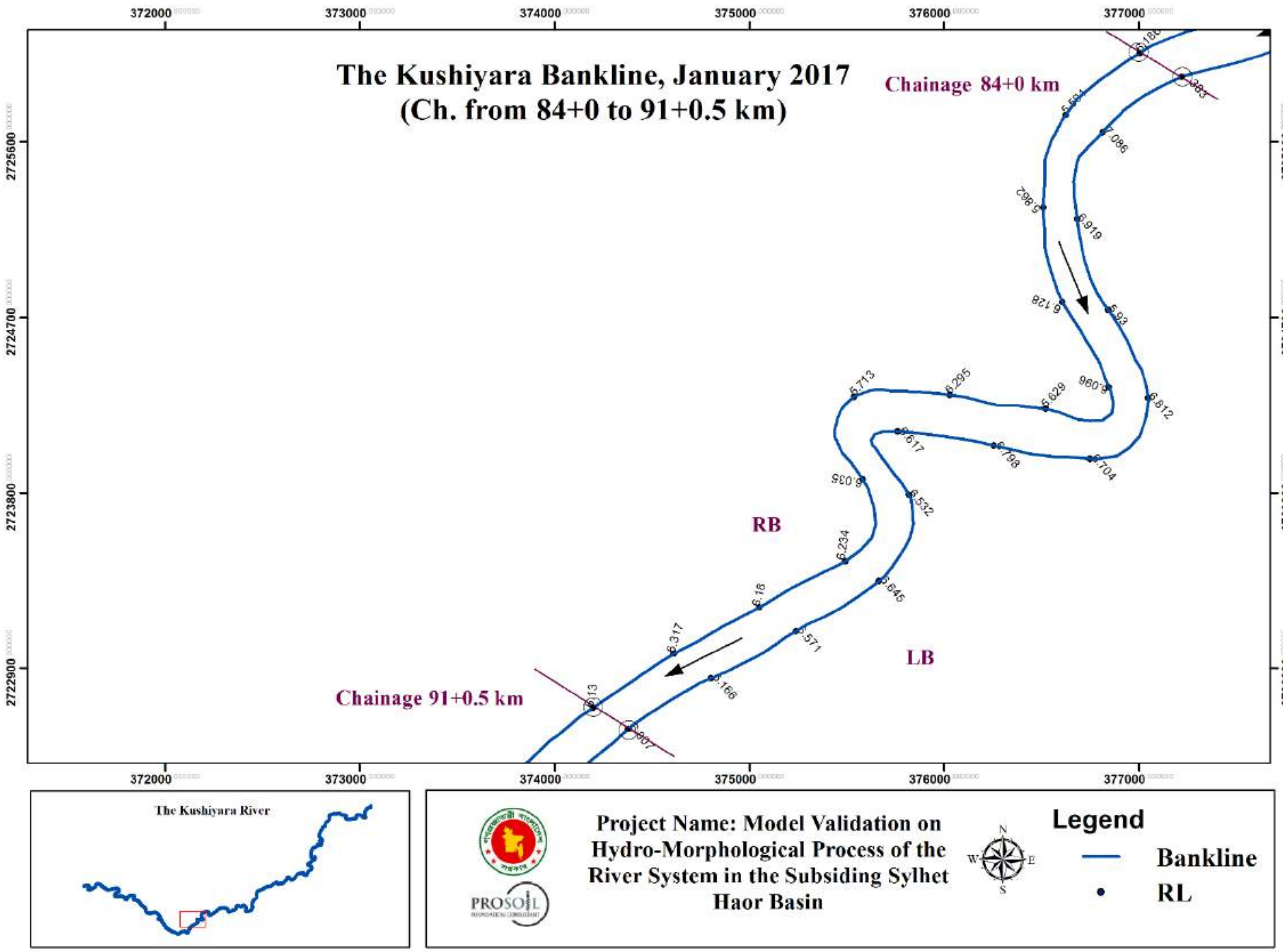

Figure 30: Bank Line Survey Map of Kushiyara River (Chainage 84+0 to 91+0.5 Km)

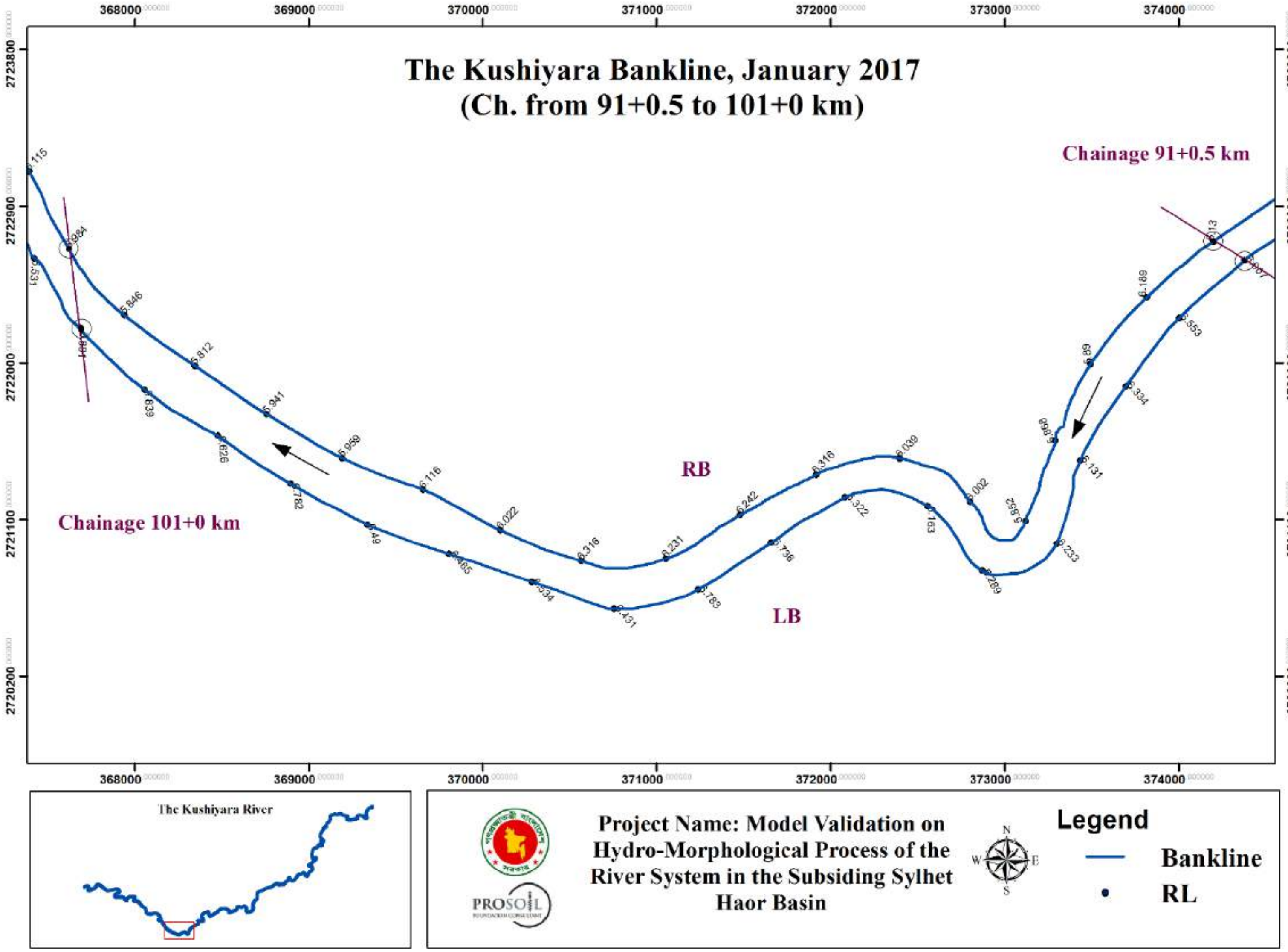

Figure 31: Bank Line Survey Map of Kushiyara River (Chainage 91+0.5 to 101+0 Km)

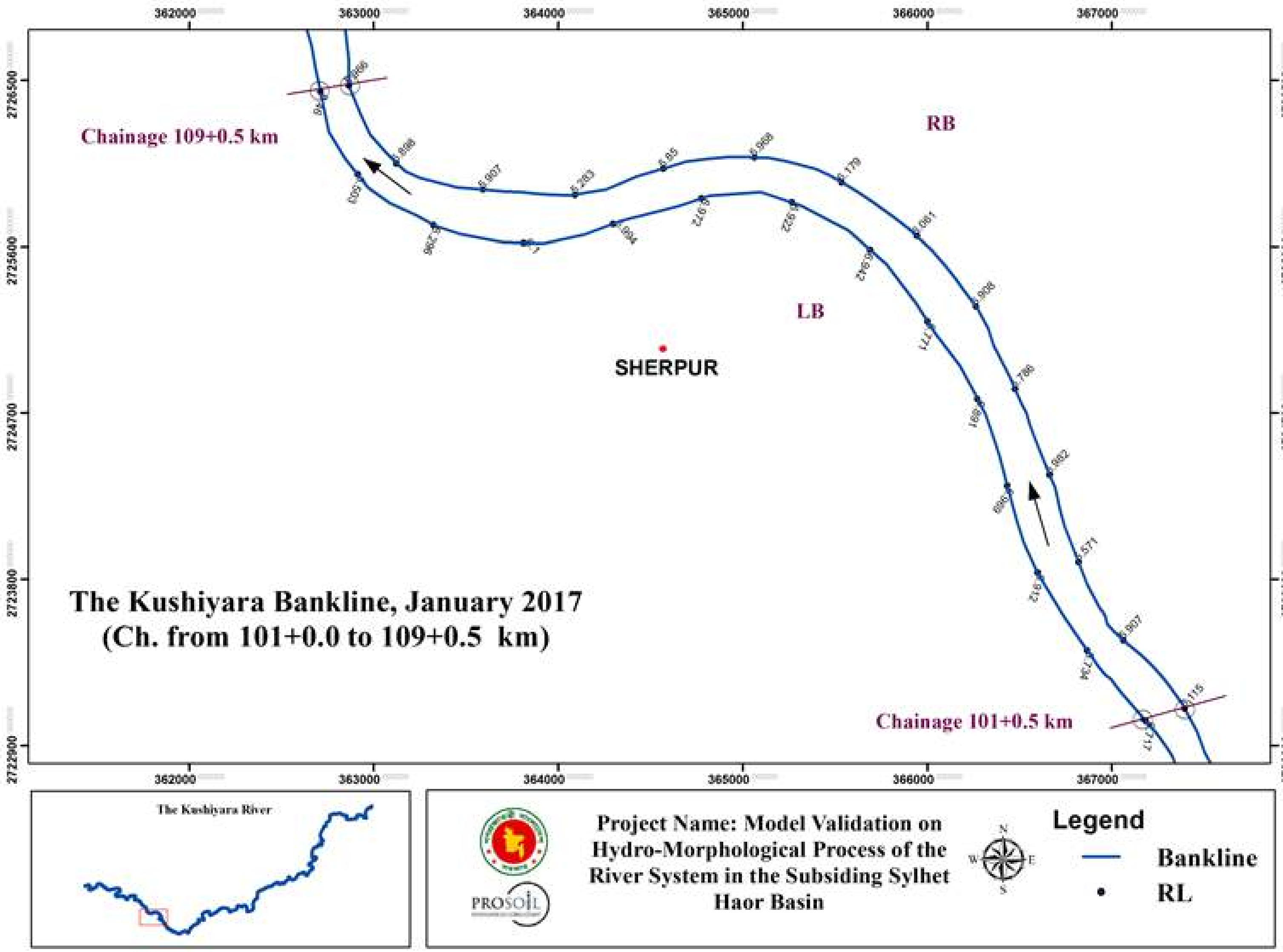

Figure 32: Bank Line Survey Map of Kushiyara River (Chainage 101+0 to 109+0.5 Km)

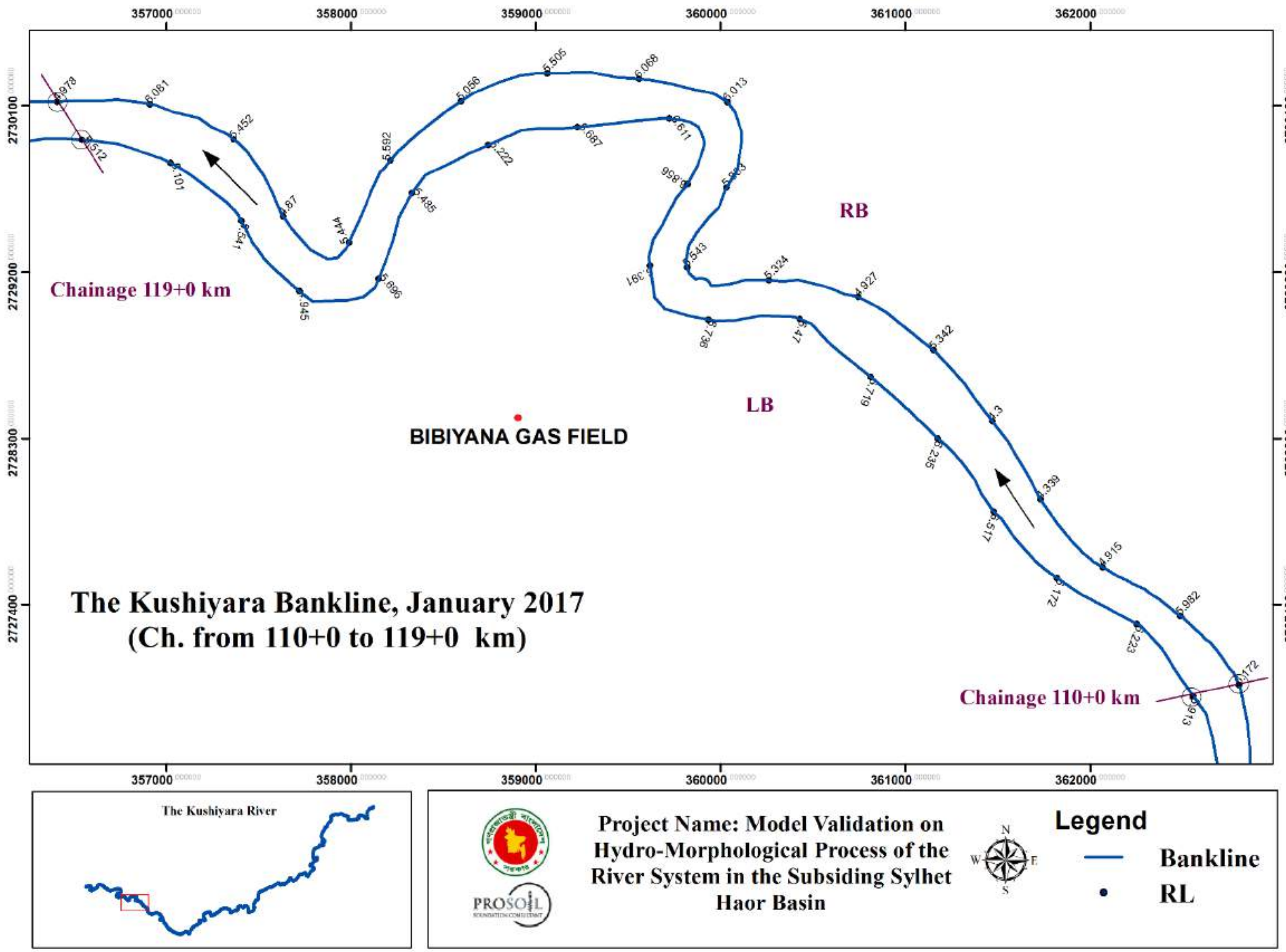

Figure 33: Bank Line Survey Map of Kushiyara River (Chainage 109+0.5 to 119+0 Km)

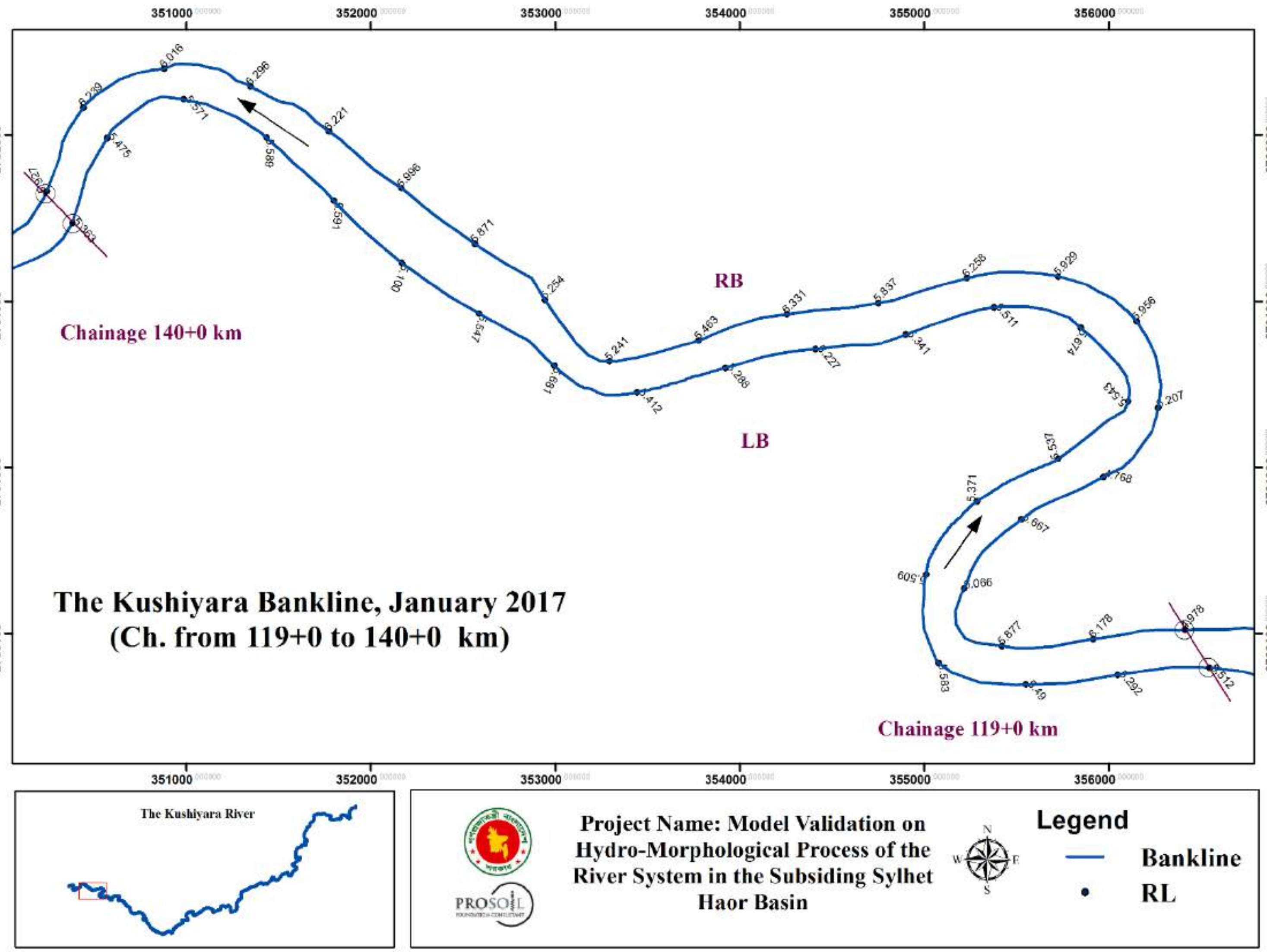

Figure 34: Bank Line Survey Map of Kushiyara River (Chainage 119+0 to 140+0 Km)

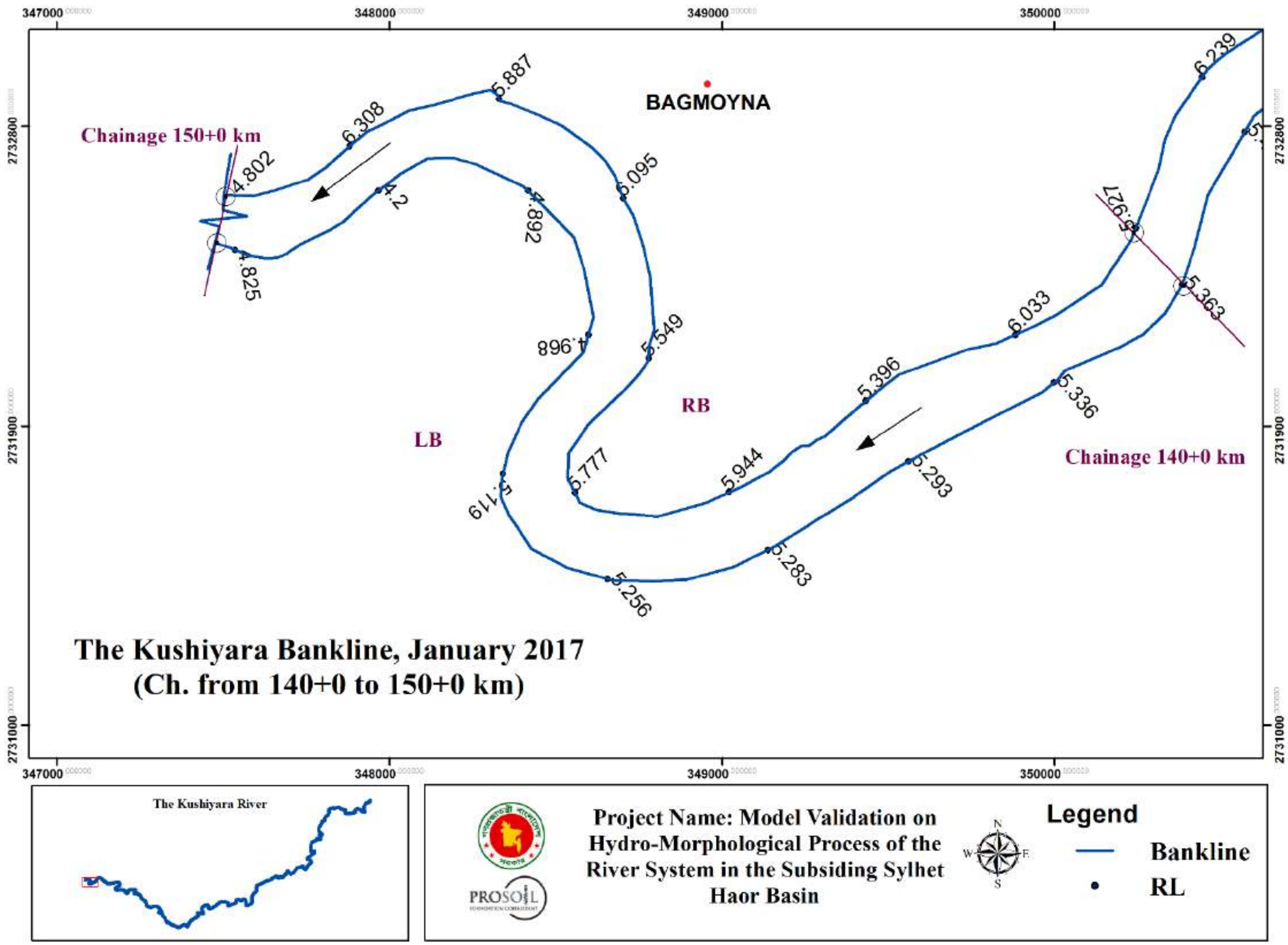

Figure 35: Bank Line Survey Map of Kushiyara River (Chainage 140+0 to 150+0 Km)