REPORT

ON

Study on the hydrological profile of River Sharda with respect to the impact of permissible extraction of River Bed Material (RBM) for the year 2020-21

FOR

Under Haldwani Forest Division (HFD), Haldwani (Uttarakhand)

BY

Er. S S Shrimali
Dr. P R Ojasvi
Er. S.K. Sharma
Sh H S Bhatia
Er. Amit Chauhan

ICAR-Indian Institute of Soil and Water Conservation,
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
218, KAULAGARH ROAD, DEHRADUN-248 195 (UTTARAKHAND)

(December, 2020)

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Executive Summary

The survey of the River Sharda was carried out in pre and post monsoon (Nov, 2020) period by Dr. P R. Ojasvi ,Er S.S. Shrimali, Sr. Scientist (CAA), Er. S.K. Sharma, Chief Technical officer and Sh. H. S. Bhatia, Technical Officer of ICAR-Indian Institute of Soil and Water Conservation, Dehradun along with the officials of Sharda Sub Division (Tanakpur), Haldwani Forest Division, DLM (Sharda) UKFDC, Tanakpur Uttrakahnd.

The River Sharda has two distinct segments from where the extraction is carried out. One segment is on the upstream of the Sharda (Tanakpur) barrage and other segment is on the downstream of the Sharda (Tanakpur) barrage

The study has been conducted with the following objectives:

1. Study of the hydrological profile of River Sharda (for the defined river reach namely from upstream and downstream of Sharda –Tanakpur barrage to a defined length) with respect to the extraction of river bed material.
2. Estimation of permissible extraction of river bed material (RBM) for the year 2020-21

Based on the survey and other considerations which include the past extraction pattern and safety to Sharda barrage, it has been assessed that about **462546.33 cubic meters** of RBM can be extracted (leaving about 500 m from barrage).

The ideal time of extraction of RBM from up stream of River Sharda (Tanakpur) barrage may be from December to March as after March the discharge from the River Sharda increases due to melting of snow and glaciers and from downstream from January to May.

The extraction / removal of the deposited river material should be done in a scientific manner which will help in channelization / centralization of the river flow. The maximum depth of cut should be from the middle of the river course and it should be nil at the boundary of the middle half of the river. If this method is adopted, the river is likely to take a trapezoidal shape. It will not happen in a year or two but the extraction / removal like this for years may lead to this ideal situation. However the river material brought due to a heavy discharge in a particular year of long duration probability may hamper this process.

Consultancy Project

on

Study on the hydrological profile of River Sharda with respect to the impact of permissible extraction of River Bed Material (RBM) for the year 2020-21

Under Haldwani Forest Division (HFD), Haldwani (Uttarakhand)

Introduction

The River Sharda has two distinct segments from where the extraction is carried out. One segment is on the upstream of the Sharda (Tanakpur) barrage and other segment is on the down stream of the Sharda (Tanakpur) barrage.The power channel taken out from the right hand side of the barrage, takes the river flow to the Tanakpur power station. There is practically no flow from River Sharda to the downstream of the barrage after monsoon season as all the river flow is diverted to the power station through power channel. During monsoon season also, the flow from River Sharda to the downstream of the barrage river is diverted/ allowed only when the discharge from the river at upstream is either more than the capacity of the power channel or else the sediment concentration in the river water is more than the critical limit of sediment allowed with the water to go through the power station to run the turbine. As such the river material bed (RBM) discharged to the downstream of the barrage is deposited down stream and can be quantified based on the cross section survey of the river once the monsoon ceases. The assessment of extraction of RBM has to be assessed separately for the upstream of the barrage and down stream of the barrage. The extraction of RBM from River Sharda (Sharda Forest Range, Sharda Tapu Beat, Tanakpur) made during 2000-01 to 2012-13 is given in Table 1 as provided by the Sub Divisional Officer (SDO), Sharda Sub Division (Tanakpur) which does not differentiate the extraction from upstream and downstream of the Tanakpur barrage

The upstream and downstream of the Sharda (Tanakpur) barrage has several islands which are of various sizes and of different age. Few of these islands serve as shelter for the birds and other fauna of the region. The capacity of the Sharda (Tanakpur) baarrage reservoir (which is source for the Tanakpur hydro power station) is getting reduced due to deposition of RBM. The consultancy project was for the assessment of RBM and its extraction which can be made during 2020-21 without disturbing the river hydrology.

The study has been conducted with the following objectives:

Objectives of the study

1. Study of the hydrological profile of River Sharda (for the defined river reach namely from upstream and downstream of Sharda –Tanakpur barrage to a defined length) with respect to the extraction of river bed material.
2. Estimation of permissible extraction of river bed material (RBM) for the year 2020-21

River Sharda, Barrage, Catchment, Rainfall and River Flow

The river Sharda originates from Zaskara glacier situated near Indo-Tibetan border in high mountainous Himalayas. The 120 MW Tanakpur Power Station was commissioned during 1992-93 by National Hydroelectric Power Corporation (NHPC) which is situated in the Champawat district of Uttarakhand state. The Tanakpur power station has been fed by diverting the river water through a power channel. The 475 m Tanakpur barrage was constructed to create a reservoir to supplement the flow to the power channel and also to function as stilling basin. The barrage has been designed for a peak rate of discharge of 19900 cumec. The high flood level of the reservoir is 246.7 m above msl.

The Tanakpur is located at about 5 km from a religious place of Bramhadeva located in plains after the river completes the journey of about 300 kms in meandering mountainous/hilly terrain. Nepal is situated on the left hand side of the river (Photo).

The catchment of river Sharda at the barrage is 15,100, 00 ha (15100 sq km) of which 1, 47,000 ha is snow covered. Average annual rainfall in the catchment is 1500 mm.

Extraction of RBM in past years

As per the information provided by Sub Divisional Officer (SDO), Sharda Sub Division (Tanakpur), the RBM extraction from River Sharda varied between 96,990 cubic meters (2009-2010) to 3, 85,966 cubic meters (2007-08) from 2000-01 to 20012-13 (Table 1). Separate volume of extraction from upstream and downstream is not available.

The main constituent of extracted RBM has been stone followed by sand (*reta*) and aggregated (*bajri*). Based on the above information, on an average extracted stone is 76.6 percent, sand (*reta*) is 19.3 per cent and aggregate (*bajri*) is 2.6 per cent. Small quantity of boulders (3.4 per cent) has also been extracted during past years (2007-13).

Possible extraction of RBM during 2020-21

The extraction of RBM from Sharda River at Tanakpur is made from upstream and downstream of River Sharda (Tanakpur) barrage. The extraction from both these segments requires different approach. The extraction from upstream of the barrage is encountered with establishment of various islands and the reservoir. Further the River Sharda has large flow during most part of the year including the duration when extraction is normally done (January to April). The downstream of the barrage does not have perennial flow but has one well established island in-between the segment from where the extraction is made. The extraction from both these segment is explained separately in the following paragraphs.

Extraction of RBM from Upstream of River Sharda (Tanakpur) Barrage

The extraction from the upstream of the barrage has to be done with utmost care as the faulty extraction is likely to lead to the damage of the islands. A well established and large island existing at about 4-5 Km upstream of the Tanakpur (River Sharda) barrage is classic example of this. The river flows from left hand side of this island throughout the year and the flow from right hand side is only during the monsoon season. As flow is intermittent at right hand side, hence quite sufficient quantity of RBM is deposited at this side whereas the deposition on left hand side is less as the RBM is further carried over to the reservoir due to continuous flow. The availability of RBM and non flow of river after the monsoon at right hand side attracts extraction of RBM. The river on left hand side of the island flows adjoining to island **.**The other side of the river is bordering Nepal border. Any further disturbance here is likely to damage the age old island. The damage may take place under natural condition also but the extraction of RBM at this location may accelerate the damage and may not provide natural time for stabilization.

During the preceding monsoon season there was deposition in the upstream reach. This resulted in flow diversion towards habitation .Hence it requires regulated extraction so that subsequent flows are confined to main river course.

Extraction of RBM from Downstream of River Sharda (Tanakpur) barrage

The downstream side of the barrage has vast potential for extraction. The source of the RBM coming to this region is, off course, through the barrage only. As the barrage is opened only during high/peak flow only, hence the deposition of RBM downstream of the barrage shows the carrying power of the flow. There is one very old well established island at downstream of the barrage. It is about 1800 m in length and has about 250 m width at the

centre. The extraction of RBM from the barrage (leaving about 500 m from barrage) up to this island and from both the sides of islands and then again from below the island is assessed (Table 2B).

Thus the total extraction of RBM from River Sharda at Tanakpur is assessed at **462546.33** cubic meters (Table 2B).

Methodology for assessment of cross section of extraction of RBM

In past Central Soil and Water Conservation Research and Training Institute, Dehradun (Now, ICAR-Indian Institute of Soil and water Conservation) has suggested that the extraction/removal of the deposited RBM from these rivers be made leaving 25 % width of the river on either side of the river. The recommendation to restrict the flow to the middle half of the river was to ensure the stability of the river bank and also to rehabilitate the reclaimed area by suitable plantation etc. This help in channelization and centralization of the river which is very much relevant from river training point of view. In absence of the periodical channelization / centralization of the river the RBM goes on depositing in the foot hill river thereby increasing the tendency of periodical flooding of the adjoining area on either side of the river bank. It further accelerates the stream bank cutting also. If proper methodology of RBM extraction is not followed, then the river is likely to initiate stream bank erosion. Suitable stream bank protection measures as spurs amounting to heavy expenditure are to be constructing to save establishment at the river bank.

In River Sharda, three points need to be followed regarding extraction of RBM.

1. Extraction from upstream and downstream of the Tanakpur barrage
2. Depth and method of extraction at various cross sections
3. Time of extraction

The location and depth of extraction of RBM at various widths in the respective surveyed cross section of the River Sharda is presented in (Figure 1 & 2 and Table 2). This cross section has been arrived based on the existing cross section and thereupon the possible depth of extraction from various widths of middle 50 percent of the river width in such a way as to help the river to flow subsequently in parabolic shape. It is not easy and simple but adoption of this methodology in subsequent years in future may result in providing desired shape of the river.

It is also recommended that deposited sand and bajri on the river bank should not be extracted.

1. Extraction from upstream and downstream of the Tanakpur Barrage

The details of extraction of RBM from upstream and downstream of the barrage have been explained earlier in the text.

2. Depth and method of extraction at various cross sections

The extraction / removal of the deposited river material should be done in a scientific way which will help in channelization / centralization of the river flow. The maximum depth of cut should be from the middle of the river course and it should be nil at the boundary of the middle half of the river (Diagram 1).

If this method is adopted, the river is likely to take a parabolic shape (Diagram 2). It will not happen in a year or two but the extraction / removal like this for years may lead to this ideal situation. However the river material brought due to a heavy discharge in a particular year of long duration probability may hamper this. But this is what we need to do.

3. Time of extraction

The ideal time of extraction of RBM from up stream of River Sharda (Tanakpur) barrage may be from January to March as after March the discharge from the River Sharda increases due to melting of snow and glaciers and from downstream from January to May.

Recommendations

1. As the method and depth of extraction of RBM to be made will depend upon the pattern and quantity of RBM deposited during the monsoon, hence the quantity of RBM extraction may be estimated by surveying the river before the monsoon (after extraction of RBM is over i.e. in the month of June) and after the monsoon is over (before the extraction of RBM starts) i.e. in the month of December.
2. The very big boulders in the river should not be removed from the junction of the hilly area and plain area as these big boulders serve for dissipating the energy of the flowing water.
3. The methodology of the extraction may be followed as explained in the text so as to minimize the risk of stream bank erosion.
4. Separate volume of extraction from upstream and downstream may be documented from this year onward.

Acknowledgement

The project team is grateful to Director, ICAR-IISWC, Dehradun for approving this project and providing necessary support and facilities.

The team is thankful to Sh. Harish Pal, DLM (Sharda) UKFDC, Tanakpur for sponsoring this project and providing all help and facilities for timely completion of this study. The logistics and field assistance provided by the officers and staff of Uttrakhand Forest Department Corporation is thankfully acknowledged.

Our thanks are due to Dr Harsh Mehta and staff of PME cell for their quick processing of this consultancy project. The help rendered by the Division of Hydrology & Engineering officers and staff in preparation of the project report for preparation of manuscript is duly acknowledged.

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Table 1: Extraction of River Material Bed (RBM) from River Sharda (Sharda Forest Range, Sharda Tapu Beat; 384.69 ha Tanakpur) during 2000-01 to 2009-10

Year	Extraction of RBM				
	Stone (cum)	Sand (cum)	Bajri (cum)	Boulder (cum)	Total (cum)
2000-01	162706	21847	12614	-	197167
2001-02	157485	24257	8685	-	190427
2002-03	178240	28696	10120	-	217056
2003-04	176208	50528	3264	-	230000
2004-05	202760	53032	4728	-	260520
2005-06	295366	49379	5253	-	349998
2006-07	276460	60125	10845	-	347430
2007-08	303759	72607	9554	45	385966
2008-09	183673	42191	2773	7	228644
2009-10	61147	34171	525	1147	96990
2010-11	65918.60	15579.67	84.64	97.50	81680.38
2011-12	152564.55	82566.31	7092.20	21703.49	263926.55
2012-13	131238.36	55720.61	4144	24508.25	215611.22
Total	**2347525.51**	**590699.59**	**79681.84**	**47508.24**	**3065416.15**
Average	**180578.89**	**45438.43**	**6129.37**	**6786.89**	**235801.24**

Table 2 A: Details of the stream width and width under extraction

	Total width	Width under Extraction
CS1	664.95	**332.48**
CS2	538.50	**214.76**
CS3	327.53	**163.76**
CS4	411.39	**214.12**
CS5	345.01	**172.51**
CS6	311.74	**155.87**
CS7	211.75	**105.88**
CS8	994.36	**497.18**

Table 2B: Details of depth of extraction at different location in river Sharda

	Distance	63	82	98	126	145	158	175	188					**125.00**
CS 1	Depth	0	1.1	0.5	1.1	0.6	0.5	0.33	0					**0.52**
	Distance	68	82	98	136	145	158	175	188	204				**136**
CS 2	Depth	0	0.7	0.8	0.5	0.6	0.5	0.33	0.26	0				**0.41**
	Distance	104	112	148	209	210	235	280	310	313				**209.00**
CS 3	Depth	0	0.7	0.6	0.6	0.6	0.5	0.23	0.06	0				**0.36**
	Distance	166.24	190.55	190.59	214.01	237.04	265.03	332.48	432.77	450.34	482.10	498.72		**332.48**
CS 4	Depth	0.00	0.63	0.63	0.82	0.65	0.48	0.78	0.56	0.73	0.46	0.00		**0.52**
	Distance	189.11	216.87	238.68	269.25	273.99	306.55	321.64	403.87					**214.76**
CS 5	Depth	0.00	0.21	0.67	0.40	0.40	0.50	0.62	0.00					**0.35**
	Distance	81.88	163.76	178.01	193.10	221.46	237.91	245.65						**163.76**
CS 6	Depth	0.00	0.70	0.81	0.86	0.63	0.27	0.00						**0.47**
	Distance	107.06	214.12	244.68	261.66	285.01	306.79	321.17						**214.12**
CS 7	Depth	0.00	0.33	0.44	0.81	0.85	0.50	0.00						**0.42**
	Distance	86.25	99.45	108.20	120.72	140.08	159.98	172.51	176.65	188.07	213.80	232.62	258.76	**172.51**
CS 8	Depth	0.00	0.25	0.46	0.58	0.66	0.71	0.90	0.90	0.77	0.51	0.32	0.00	**0.50**
	Distance	77.93	98.05	119.36	135.26	155.87	233.80							**155.87**
CS 9	Depth	0.00	0.29	0.44	0.56	1.15	0.00							**0.41**
	Distance	52.94	59.76	71.02	86.19	95.72	105.88	116.67	136.98	145.46	151.56	158.81		**105.88**
CS 10	Depth	0.00	0.11	0.54	0.49	0.64	1.00	1.26	0.27	0.60	0.11	0.00		**0.45**
	Distance	248.59	289.00	305.00	359.00	373.02	389.58	414.84	431.03	455.83	473.00	492.44		
CS 11	Depth	0.00	0.61	0.24	0.50	0.70	0.80	0.53	0.43	0.62	0.47	0.57		
		497.18	517.84	509.38	527.53	539.61	553.58	571.17	581.30	676.68	732.65	744.30	745.77	**497.18**
		0.56	0.24	0.30	0.26	0.10	0.10	0.10	0.10	0.40	0.10	0.10	0.00	**0.50**

Note: All dimensions are in meter.

Upstream

Location	Length Segment (m)	Width of the river (m)	Extractable width (m)	Average Depth of Extraction	Cross Section (m^2)	Average Cross section (m^2)	Volume (m^3)	Cumulative Volume (m^3)
CS1	0	253.00	**125.00**	**0.52**	65.00	0	0	0
CS2	235	272.00	**136.00**	**0.41**	55.76	60.38	14189.30	14189.30
CS3	127	418.00	**209.00**	**0.36**	75.24	65.50	8318.50	22507.80
							Total Volume	22507.80
							Recommended volume of extraction (90% of total volume)	**18006.24**

Volume of safely extractionable RBM from River Sharda downstream left side

Location	Length Segment (m)	Width of the river (m)	Extractable width (m)	Average Depth of Extraction	Cross Section (m^2)	Average Cross section (m^2)	Volume (m^3)	Cumulative Volume (m^3)
CS4	0	664.95	**332.48**	**0.52**	173.31	0	0	0
CS5	361	538.50	**214.76**	**0.35**	75.17	124.24	44850.01	44850.01
CS6	675	327.53	**163.76**	**0.47**	76.45	75.81	51168.93	96018.94
CS7	892	411.39	**214.12**	**0.42**	89.49	82.97	74006.07	170025.01
							Total Volume	170025.01
							Recommended volume of extraction (90% of total volume)	**136020.01**

Volume of safely extractionable RBM from River Sharda downstream right side

Location	Length Segment (m)	Width of the river (m)	Extractable width (m)	Average Depth of Extraction	Cross Section (m^2)	Average Cross section (m^2)	Volume (m^3)	Cumulative Volume (m^3)
CS8	0	345.01	**172.51**	**0.50**	86.99	0	0	0
CS9	378	311.74	**155.87**	**0.41**	63.43	75.21	28428.52	28428.52
CS10	1421	211.75	**105.88**	**0.45**	48.14	55.78	79268.48	107697.01
							Total Volume	107697.01
							Recommended volume of extraction (90% of total volume)	**86157.60**

Volume of safely extractionable RBM from River Sharda down stream

Location	Length Segment (m)	Width of the river (m)	Extractable width (m)	Average Depth of Extraction	Cross Section (m^2)	Average Cross section (m^2)	Volume (m^3)	Cumulative Volume (m^3)
CS 7+CS10	0	623.14	**479.99**	**0.44**	211.20	0.00	0	0
CS11	1462	994.36	**497.18**	**0.34**	169.04	190.12	277953.10	277953.10
							Total Volume	277953.10
							Recommended volume of extraction (90% of total volume)	**222362.48**

Total = 18006.24+136020.01+86157.60+222362.48 = <u>462546.33</u>

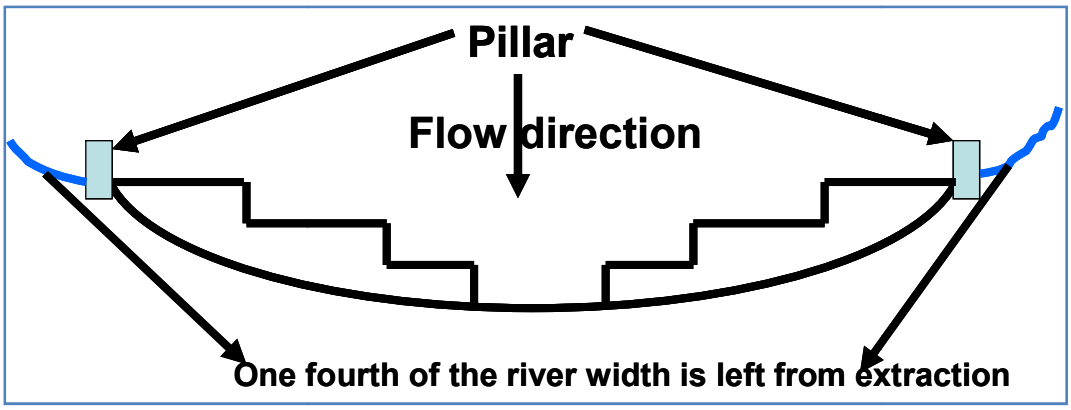


Diagram: 1. Procedure of extraction of river bed material

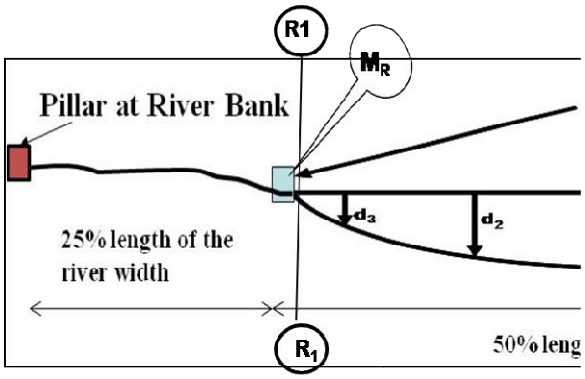


Diagram: 2. Anticipated shape of the river after proper extraction of river bed material

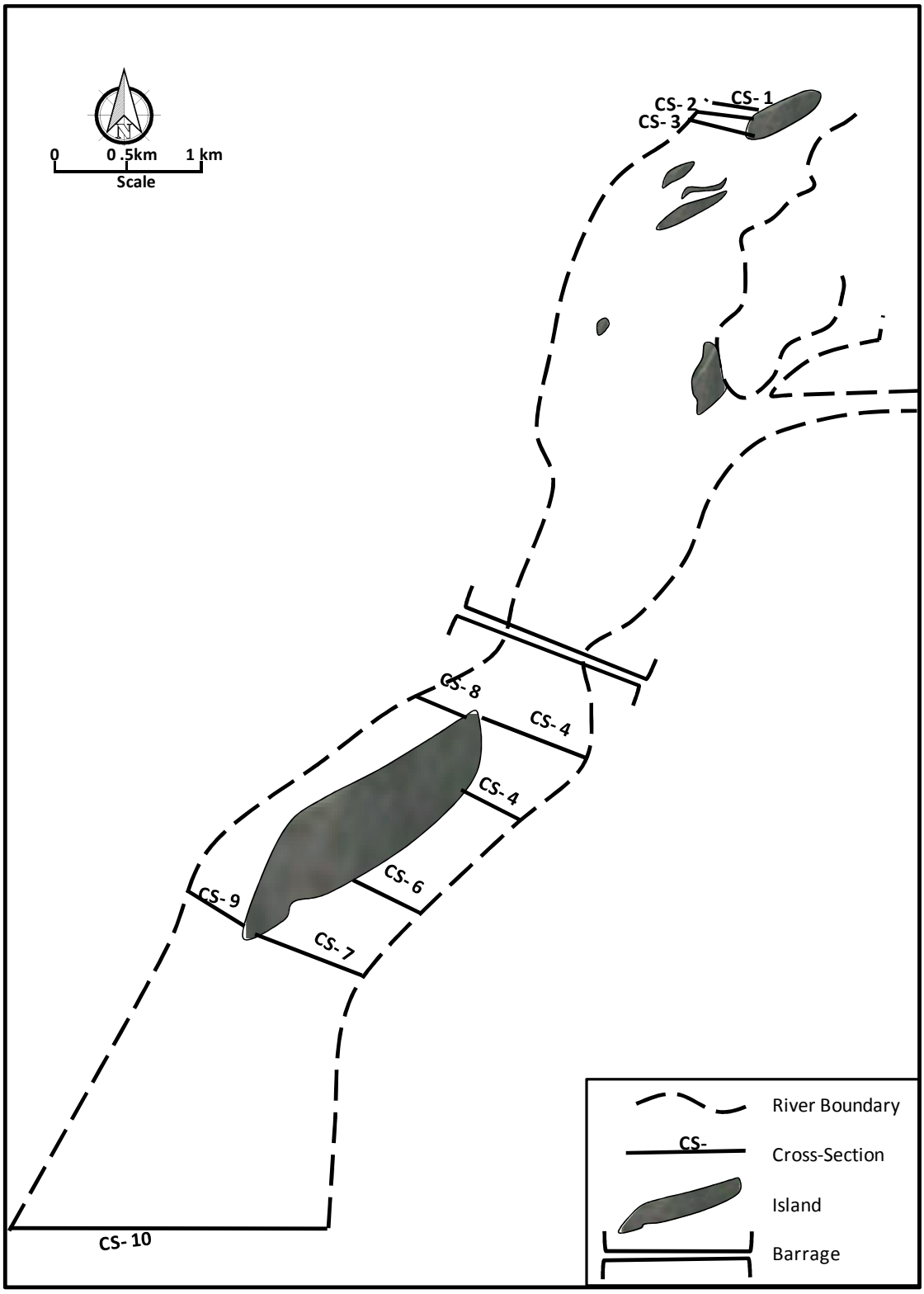
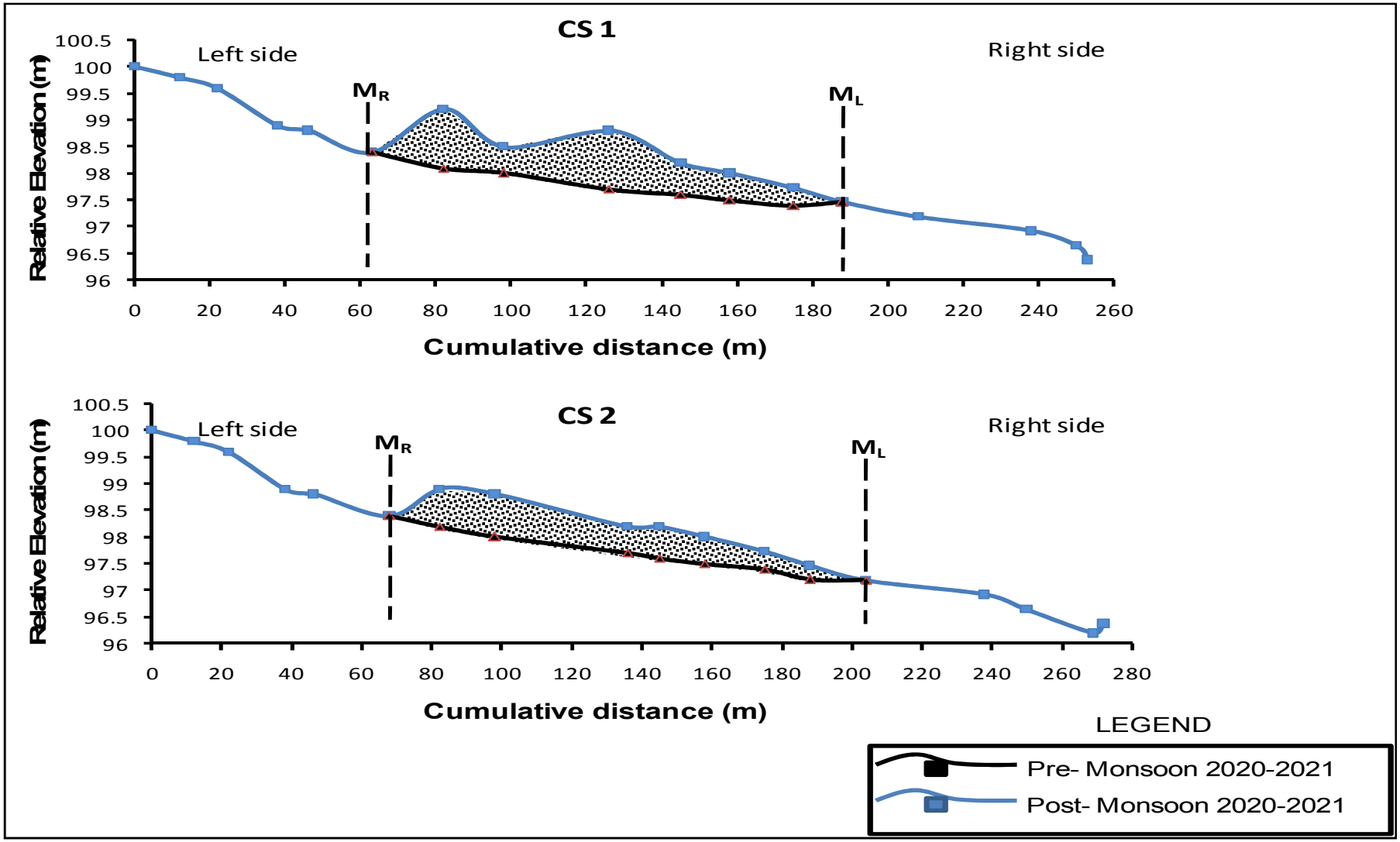
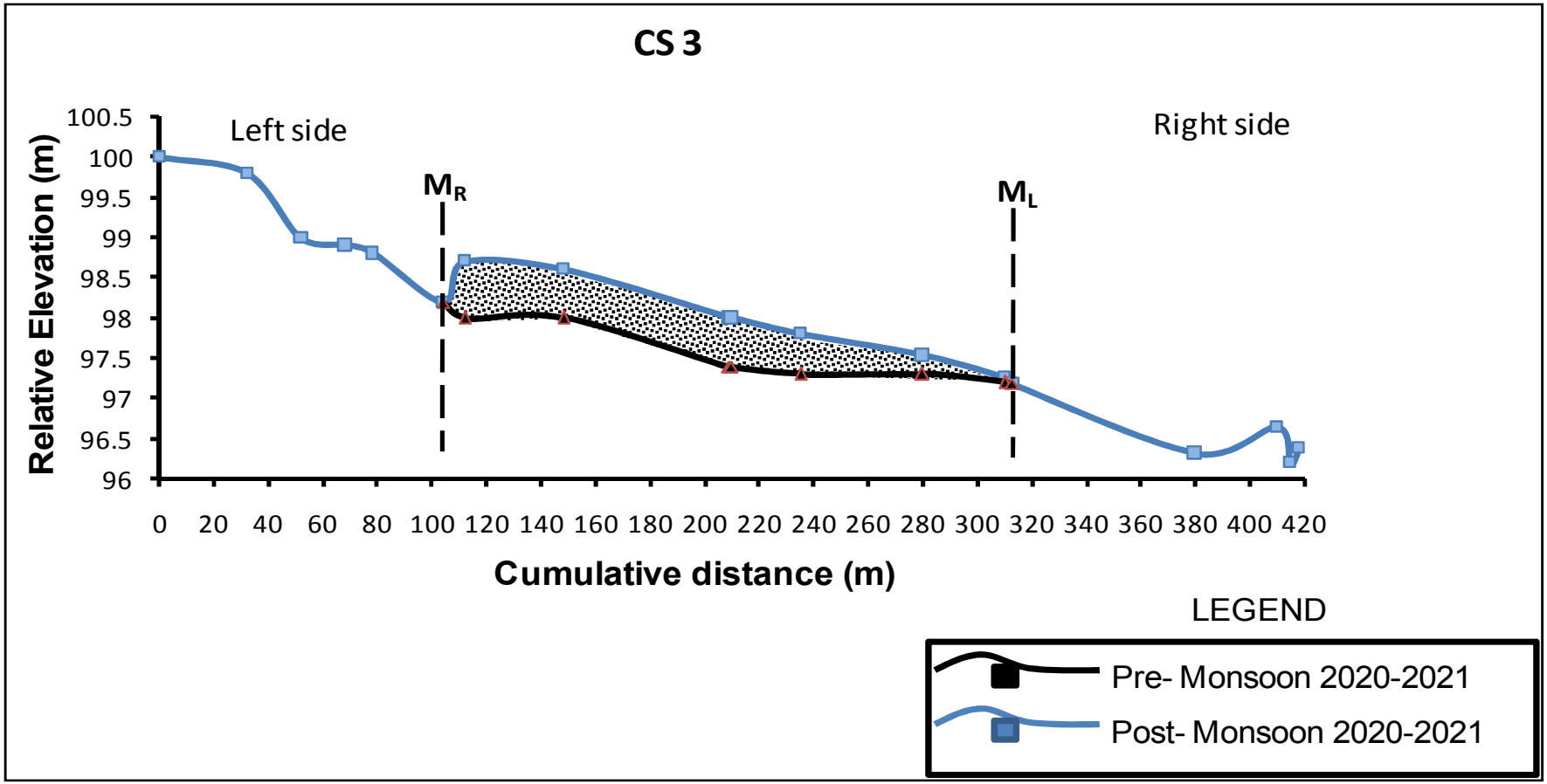
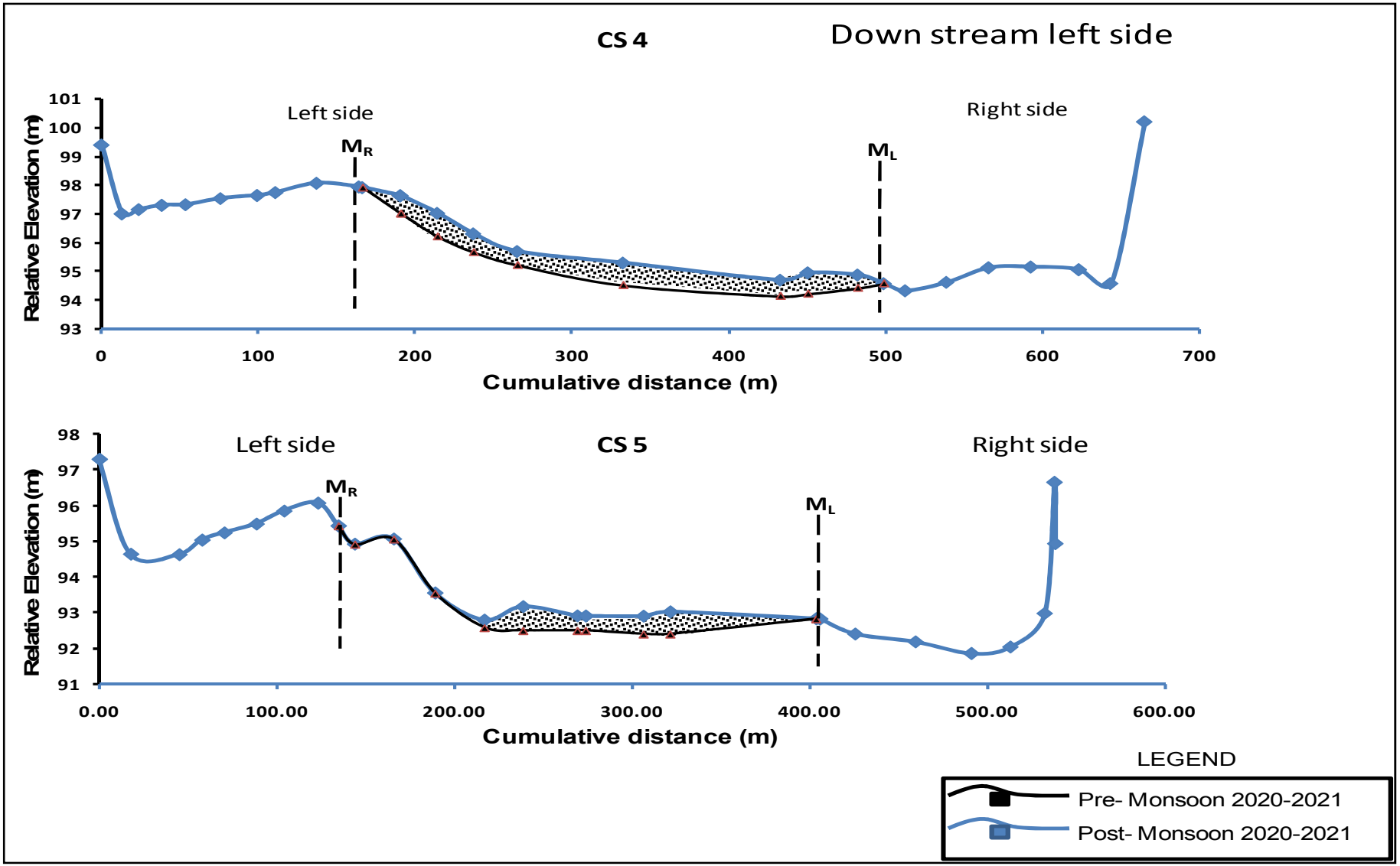
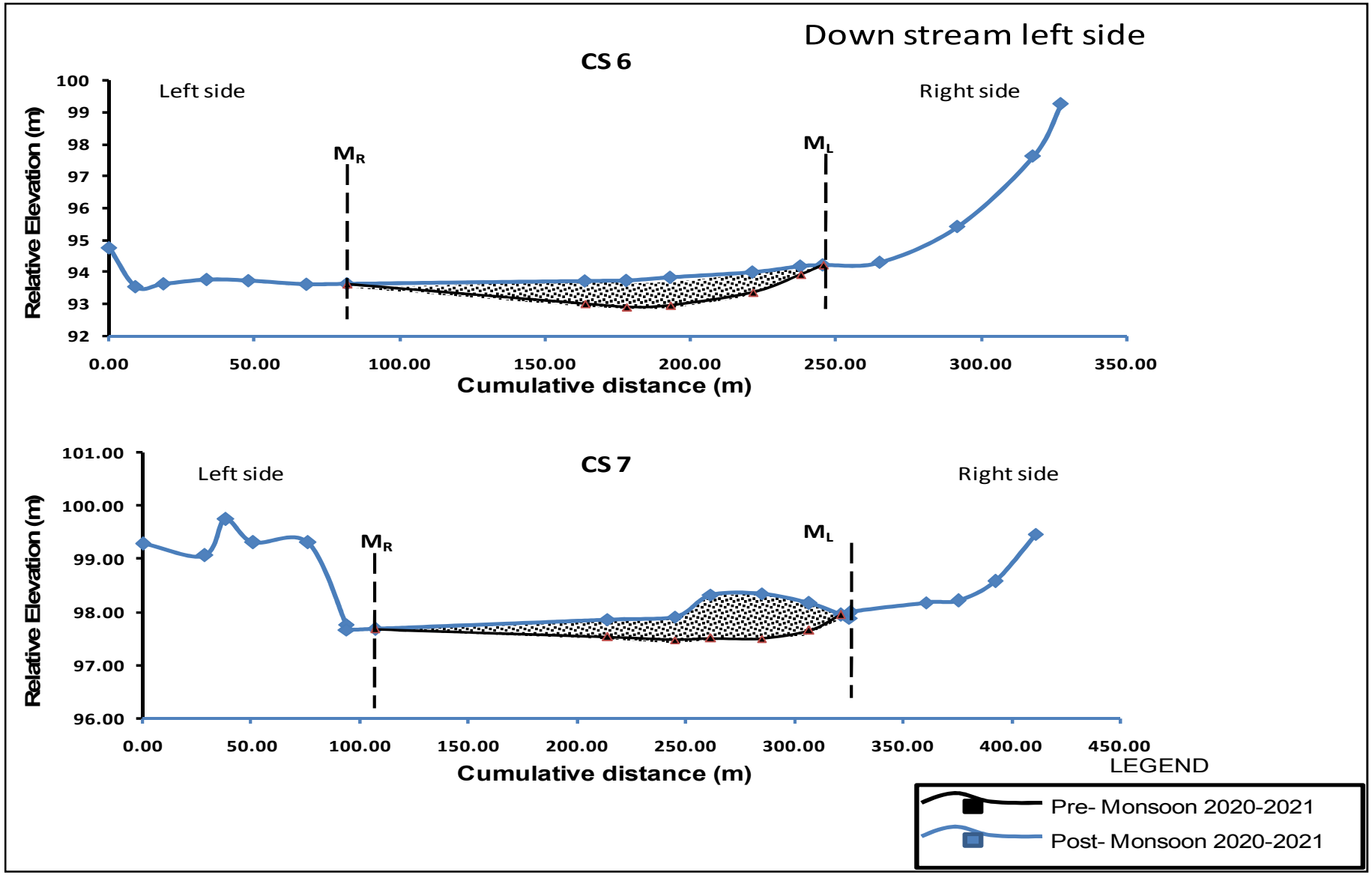


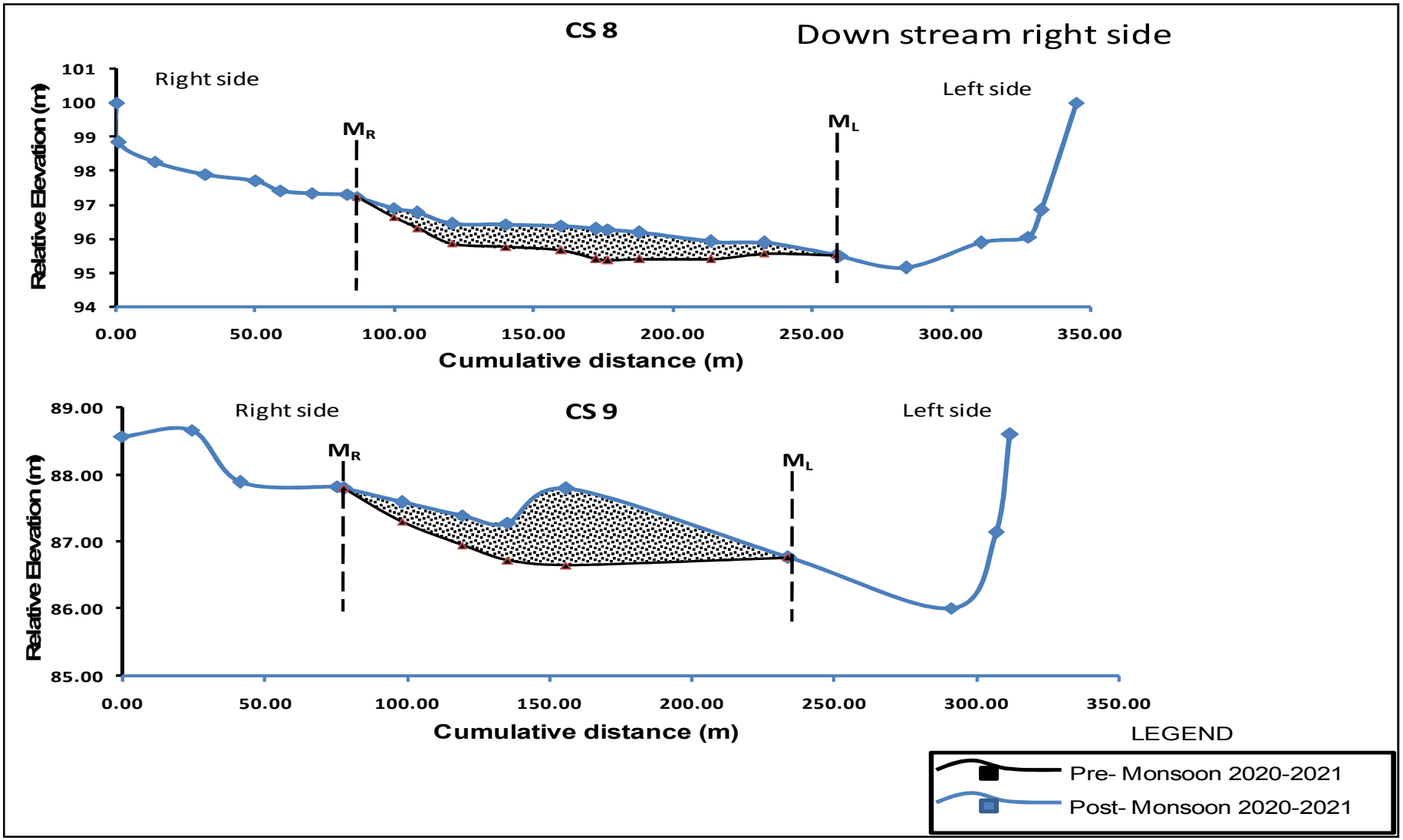
Fig. 1: Location of various cross section in river reach


CS 1
Left side
Right side
M_R
M_L
Relative Elevation (m)
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
0 20 40 60 80 100 120 140 160 180 200 220 240 260
Cumulative distance (m)
CS 2
Left side
Right side
M_R
M_L
Relative Elevation (m)
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Cumulative distance (m)
LEGEND
Pre- Monsoon 2020-2021
Post- Monsoon 2020-2021


CS 3
Left side
Right side
M_R
M_L
Relative Elevation (m)
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
Cumulative distance (m)
LEGEND
Pre- Monsoon 2020-2021
Post- Monsoon 2020-2021


CS 4
Down stream left side
Left side
Right side
M_R
M_L
Relative Elevation (m)
101
100
99
98
97
96
95
94
93
0
100
200
300
400
500
600
700
Cumulative distance (m)
CS 5
Left side
Right side
M_R
M_L
Relative Elevation (m)
98
97
96
95
94
93
92
91
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Cumulative distance (m)
LEGEND
Pre- Monsoon 2020-2021
Post- Monsoon 2020-2021


Down stream left side
CS 6
Left side
Right side
M_R
M_L
Relative Elevation (m)
100
99
98
97
96
95
94
93
92
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Cumulative distance (m)
CS 7
Left side
Right side
M_R
M_L
Relative Elevation (m)
101.00
100.00
99.00
98.00
97.00
96.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
Cumulative distance (m)
LEGEND
Pre- Monsoon 2020-2021
Post- Monsoon 2020-2021


CS 8
Down stream right side
Right side
Left side
M_R
M_L
Relative Elevation (m)
101
100
99
98
97
96
95
94
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Cumulative distance (m)
CS 9
Right side
Left side
M_R
M_L
Relative Elevation (m)
89.00
88.00
87.00
86.00
85.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Cumulative distance (m)
LEGEND
Pre- Monsoon 2020-2021
Post- Monsoon 2020-2021

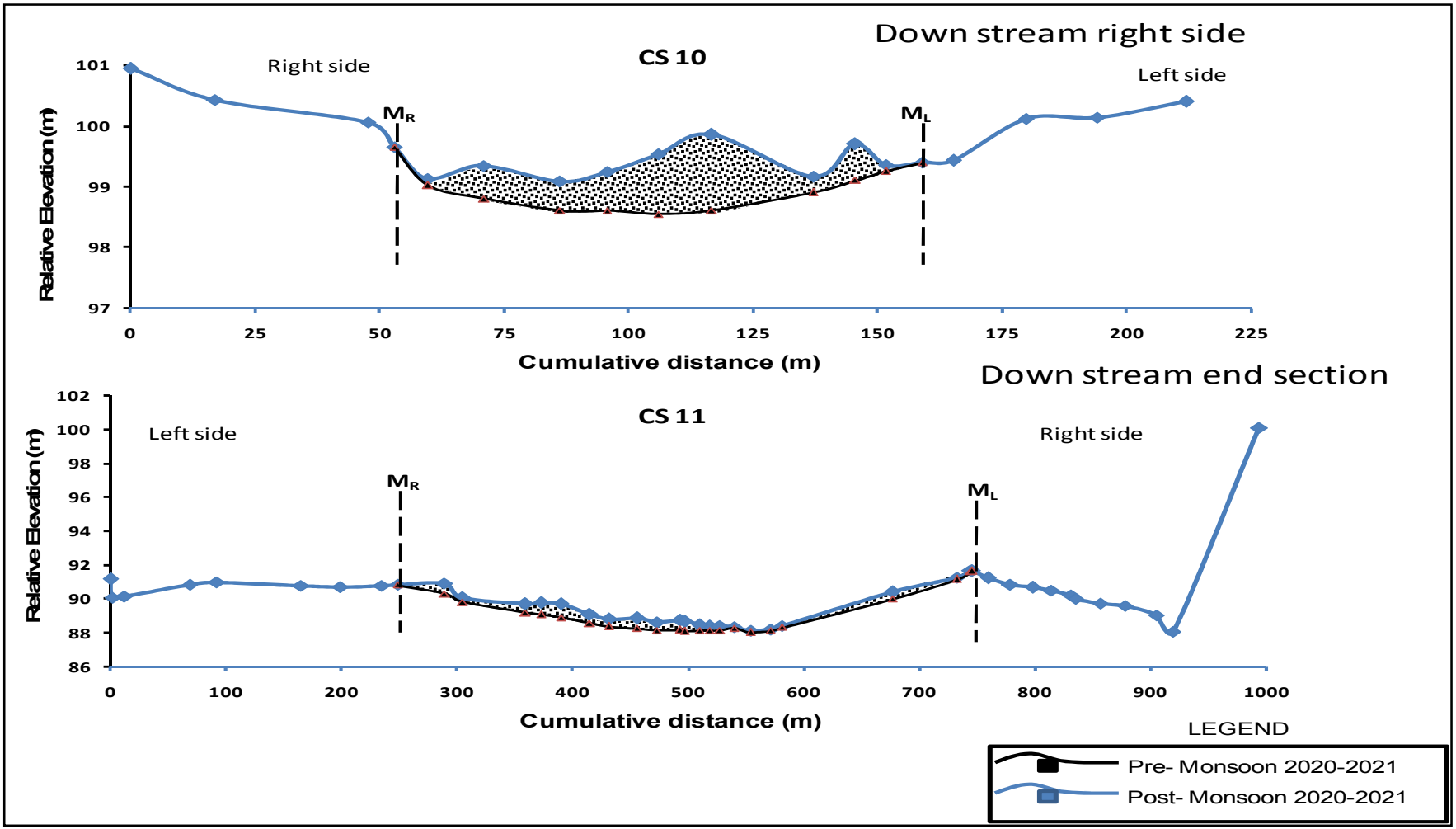


Fig. 2: Cross section of the River Sharda at recommended location and depth of extraction of RBM

Plate 1: Deposit of RBM in the river reach of the barrage

Plate 2: Survey of Deposit of RBM in the downstream river reach of the barrage