



REPORT

ON



Assessment of extractable river bed material from River Kosi for the year 2021-22

FOR

**Uttarakhand Forest Development Corporation
(UKFDC), Ramnagar, Nainital (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, 2021)**



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Executive Summary

A study on consultancy basis was undertaken by ICAR-IISWC (formerly CSWCRTI), Dehradun during 2021 entitled "Assessment of extractable river bed material from river Kosi for the year 2021-22" for the UKFDC, Ramnagar, Nainital (Uttarakhand). The study area was river Kosi downstream to the barrage on Ramnagar – Haldwani highway at Ramnagar under jurisdiction of RM, UKFDC covering a length of 07 km. The area was critically examined for the entire length and the cross-sections were taken at the locations mentioned in the Fig. 2.

Based on the survey conducted and volume calculation for permissible extraction of deposited RBM is worked out **631121.23 cum**. It is also suggested that for estimation of RBM in the following year, a reassessment study will be required to be conducted during the post monsoon period.

It is recommended to confine the extraction of RBM from middle half of the river width in order to channelize the flow and for protecting the adjoining land from flood damages. The various depths of cut at different distance from the bank of the river have been mentioned in Table 3, which is strictly required to be followed for safe passage of river flow.

Hence, it is strongly recommended that extraction of RBM should be undertaken in a scientific and regulated manner by marking the extraction boundaries in order to improve the safe passage of flow and to protect the river ecosystem.

On request from UKFDC, Ramnagar, Nainital consultancy project was undertaken by IISWC, Dehradun to conduct a study on river Kosi with following objectives.

Objectives

1. Study the morphological profile (Cross section) of river Kosi for defined river reach.
2. Estimation of river bed material removal to improve the river flow passage.

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Assessment of extractable river bed material from river Kosi for the year 2021-22

Introduction

The Mountain Rivers of Himalayas bring down huge quantity of sediment material (sand, bajri, gravel and stones) from hilly catchments while flowing with high velocity on steep slopes. The river bed material (RBM) rolls over the surface and gets deposited while coming to the foothills with mild slopes due to reduction in flow velocity.

The RBM deposited on the river bed in the form of mounds/islands causes braiding of flow (i.e. flow through several small streams instead of confined one) and meandering of the river course. This process continues and the river encroaches on adjoining lands thus increasing the total width of the river, though the required width for actual flow is much less. Further, the encroachment of river along the banks damages valuable property, agricultural lands and forests during the monsoon period.

The extraction/removal of this erratic deposited material, therefore, needs to be done periodically from the river bed in order to channelize the flow and consequently prevent bank erosion and flood damages along the banks.

River Kosi

The river Kosi originates from the hills of Kausani and Binsar in Almora district of Uttarakhand and flows down in the foothills near Ramnagar, district Nainital in the area under jurisdiction of Uttarakhand Forest Development Corporation, Ramnagar, Uttarakhand. The river carries sediment/river bed material (RBM) consisting of sand, bajri, gravel and stones during every monsoon season.

The monthly discharges from the barrage are decreasing over the years resulting into reduction in quantity of RBM. Monthly discharges, as provided, from the barrage is presented Table : I.

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The Study Area

The study area is located at Ramnagar, district, Nainital (Uttarakhand) (Fig.1). It is situated at about 07 Km downstream of Kosi barrage in river Kosi, under jurisdiction of UKFDC near Ramnagar and extends up to a river length of 07 km (Fig. 2).

Methodology

A team from ICAR-IISWC, Dehradun consisting of Dr. P.R. Ojasvi, Pr. Sci, Er. S.S. Shrimali, Sr. Scientist, Er. S.K. Sharma, CTO, Sh. H.S. Bhatia, Technical Officer, Er. Amit Chauhan, Senior Technical Officer, did the detailed data analysis. The project site near Ramnagar was visited during 12.07.21-13.07.2021 for pre monsoon and 10-11 November, 2021 to conduct a detailed survey of the study area. The officials of UKFDC accompanied the team during the survey.

The study area was divided into different segments having different length to get the cross-sections for estimation of RBM. . Depth of fresh sediment brought by the river was determined by its distinguishable attributes such as; color, density and packing of the sediment. It is recommended that 25 per cent of the river bed width along each bank of river would be left untouched for extraction in order to protect the land adjoining the banks. Therefore, volume of extractable sediment within the middle 50 per cent of river width was worked out based on the average width of the segment and deposited sediment depth between pre and post monsoon surveys.

Analysis, Results and Discussion

1. The cross-section of river Kosi at different locations is shown in Fig.3. It is seen from the cross-sections that the sediment deposits occurring in the middle portion of the river (shown by hatched portion between $R_1 - L_1$) may be removed for the safe passage of flow in the middle of the stream.
2. The quantity of scientifically extractable RBM in different segments of the study area is shown in Table-2. The extractable quantity has been worked out as 631121.23 cum.
3. The deposition of RBM has raised the river bed and its haphazard deposition has resulted in overtopping of flow during the monsoon season and consequently scouring of the banks and flooding of the adjoining lands. Bank erosion was also seen at several places.

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4. The recommended depths in respect of different locations as mentioned in Table 3 should be strictly monitored during extraction of RBM.
5. Suitable river training measures need to be taken for prevention of bank erosion and protection of adjoining lands from flood damages.
6. Other environmental concerns may be addressed in consultation with relevant state Agencies.

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Recommendations

1. The estimated quantity of extractable RBM from allowable river bed area is 631121.23 cum.
2. The RBM deposited in the form of mounds/islands should be extracted (shown by hatched portion in Fig. 2) for maintaining a proper river course in order to channelize the river flow.
3. The extraction of RBM should be done from the middle 50% portion of the river width, leaving 25 per cent width on either side; up to the depth of sediment deposition i.e. recommended depths as shown in the Table 3.
4. Permanent RCC pillars should be established at every km length to mark the allowable area for extraction of RBM. They would be total of 4 in numbers across each cross-section, 2 along the banks and 2 indicating the middle 50 per cent portion of the river i.e. extraction zone. They should be marked as 1/1, 1/2, 1/3, 1/4; 2/1, 2/2, 2/3, 2/4... for easy identification.
5. Extraction should be carried out in such a way that ultimately a safe and smooth river course is maintained. Towards this goal, maximum depth of cut should be in the middle of the river course and it should be nil at the boundary of middle half of the river (Fig.4 a&b). Following this approach, the river would take a parabolic shape in the long run, which is an ideal cross-section for the river flow.
6. Suitable river training measures need to be taken wherever required for prevention of bank erosion and protecting the adjoining lands from flood damages.

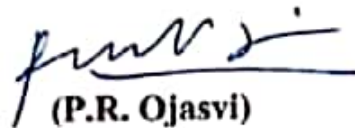
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Acknowledgements

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

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The help rendered by the Division of Hydrology & Engineering officers and staff on preparation of the project report is duly acknowledged.



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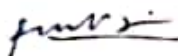


Table 1 : Discharge at Kosi Barrage, Ramnagar from 2007-2016 (in cusec)

Years	Months											
	January	February	March	April	May	June	July	August	September	October	November	December
2007	4026	11382	26952	8806	5832	12327	48799	144767	122988	60056	17044	9880
2008	8987	5115	4248	4404	3536	20156	97340	115373	81092	28081	12038	9048
2009	6268	6536	4394	4321	3777	3184	11686	48000	102418	41408	12871	9052
2010	5982	8616	4018	2515	2553	3619	65368	156172	322616	54232	17248	12336
2011	13687	8237	6238	5206	4413	15700	88664	258273	83590	25770	10828	8969
2012	9704	6665	5786	4027	3436	2025	28214	104032	70473	19841	8147	6508
2013	10172	26751	10625	5483	3238	74580	114256	102277	46006	22248	9400	6552
2014	9881	14139	21900	6117	5869	4628	127397	99751	45072	18652	7868	16289
2015	15441	7966	27549	19570	9136	16238	140220	89326	30606	16696	7617	6250
2016	5516	4236	5668	3378	4466	13607	91599	128777	41445	20448	7386	5295
2017	780	0	456	1707	47323	73152	86316	15295	-	-	-	-

Note: Discharge recorded at Kosi Barage, Ramnagar

Source: Assistant Engineer-I, Kosi Construction Division-II, Ramnagar (Nainital)

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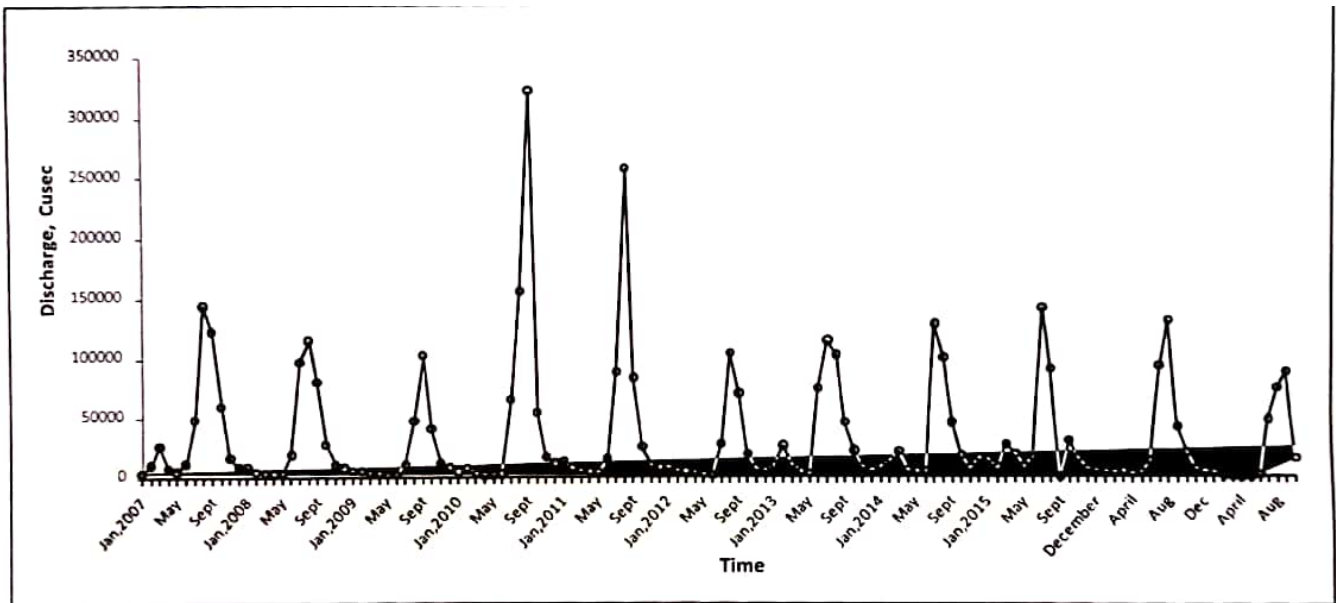


Fig.: Temporal variation of discharges at Barrage in River Kosi

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Table 2: Estimation of the extractable RBM for the defined river reach of River Kosi
Volume of safely extractionable RBM from River Kosi

Location	Length Segment (m)	Width of the river (m)	Extractable width (m)	Average Depth of Extraction	Cross Section (m2)	Average Cross section, (m2)	Volume (m3)	Cumulative Volume (m3)
CS1	0	634.43	317.21	0.45	142.75	0	0	0
CS2	705	421.63	210.81	0.32	67.46	105.10	74097.67	74097.67
CS3	820	629.40	314.70	0.43	135.32	101.39	83140.75	157238.42
CS4	1360	609.12	304.56	0.45	137.05	136.19	185214.22	342452.64
CS5	2000	469.46	234.73	0.47	110.32	123.69	247375.41	589828.05
CS6	2100	352.31	176.16	0.45	79.27	94.80	199073.48	788901.53
Total Volume								788901.53
Recommended volume of extraction (80% of total volume)								631121.23

Table 3: Distance and extraction depth across width

CS1	Distance	115.25	126.20	153.82	226.51	276.48	316.99	345.76				230.50
	Depth	0.21	0.16	0.03	0.18	0.53	0.72	0.48				0.33
CS2	Distance	148.65	172.90	193.01	203.74	214.55	239.31	261.20	289.54	305.60		156.95
	Depth	0.00	0.10	0.21	0.55	0.90	1.00	0.70	0.40	0.21		0.45
CS3	Distance	115.74	132.84	150.02	174.56	207.40	230.93	266.13	300.12	329.02	347.23	231.49
	Depth	0.33	0.38	0.52	0.35	0.03	0.90	0.30	1.13	0.07	0.06	0.41
CS4	Distance	130.27	140.16	159.80	190.65	233.71	263.47	280.32				150.04
	Depth	0.28	0.84	0.40	0.44	0.78	0.61	0.00				0.48
CS5	Distance	210.97	219.66	248.32	252.96	275.32	317.54	347.38	379.44			168.47
	Depth	0.00	0.37	0.31	0.36	0.61	0.80	0.05	0.13			0.33
CS6	Distance	280.01	299.87	314.72	379.33	409.54	457.46	472.08	192.07			192.07
	Depth	0.00	0.22	0.45	1.06	0.48	0.45	0.30	0.42			0.42

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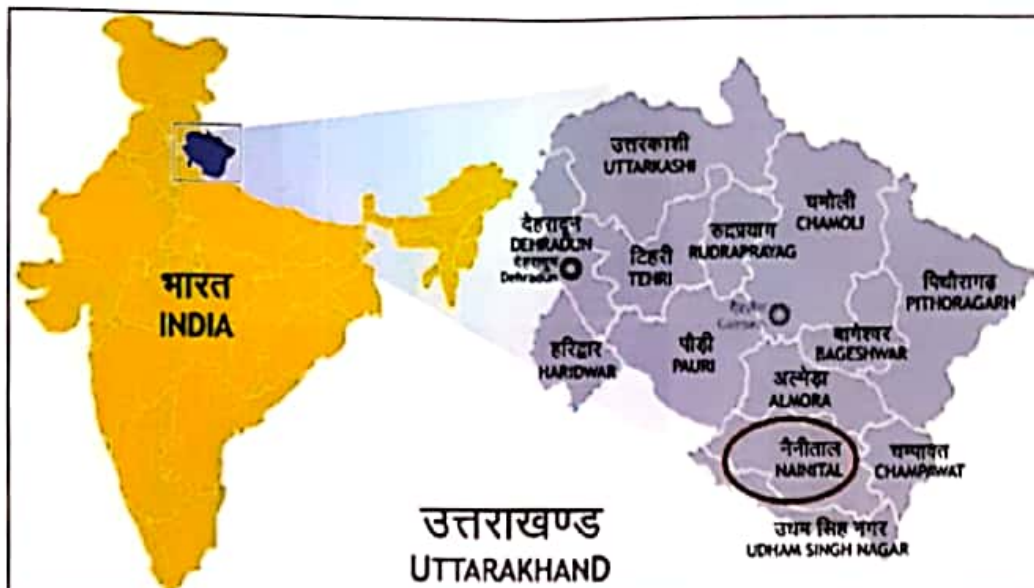


Fig.1: Location of the study area

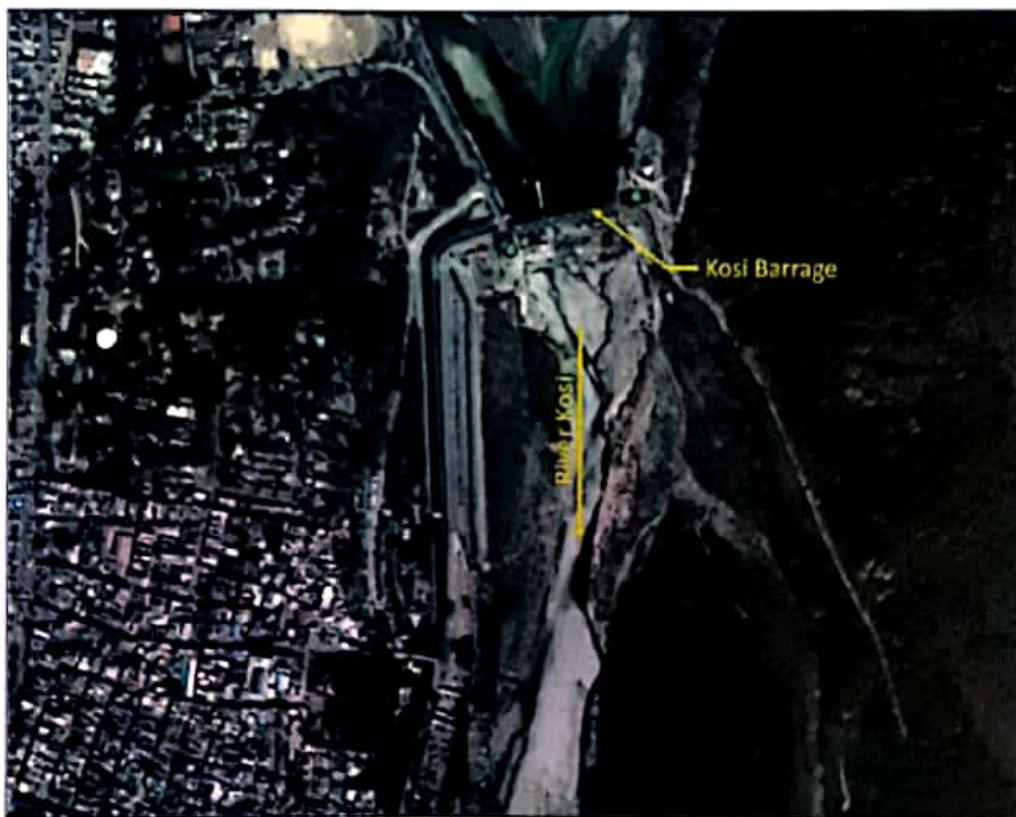


Fig. 1: Study Area

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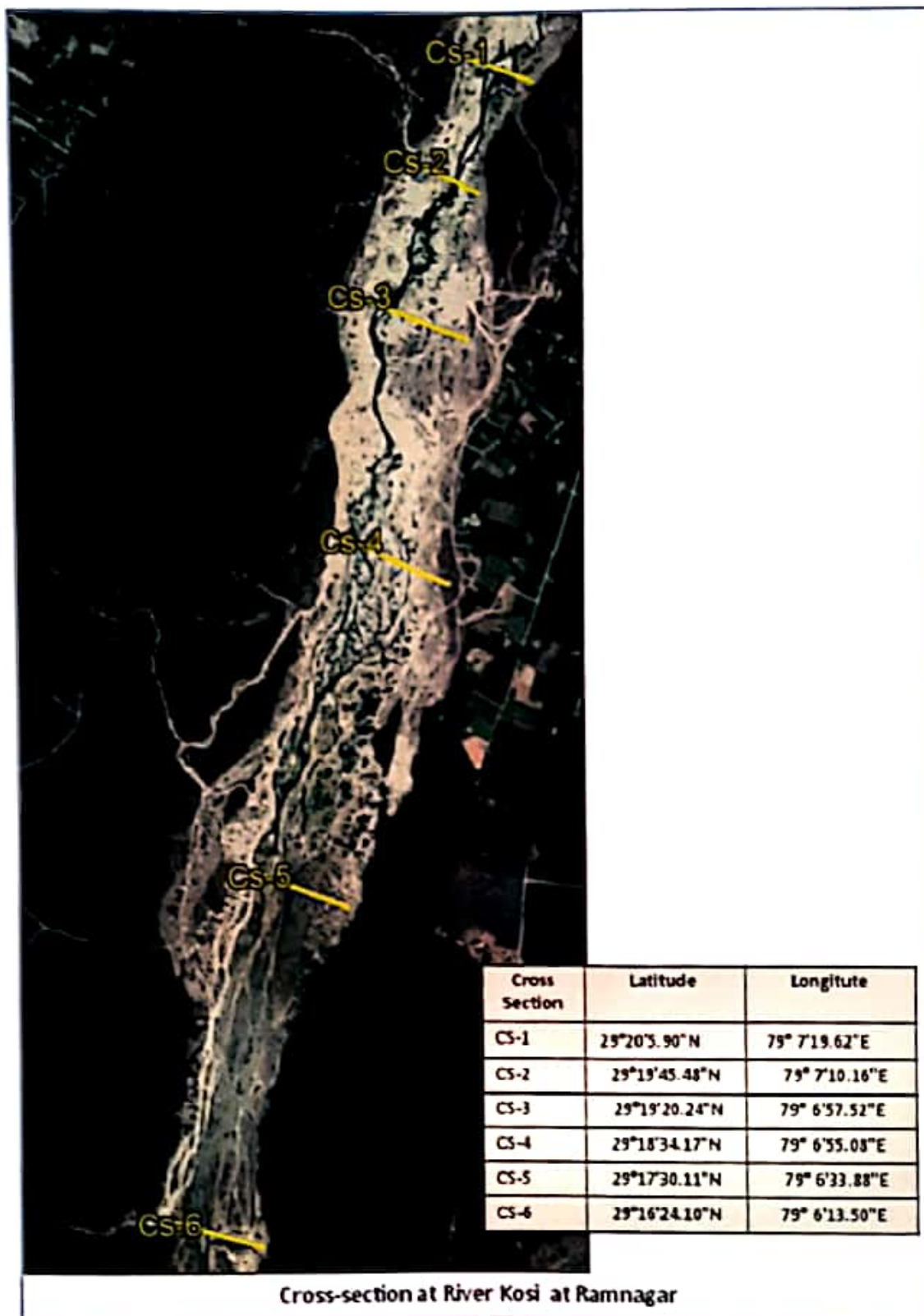
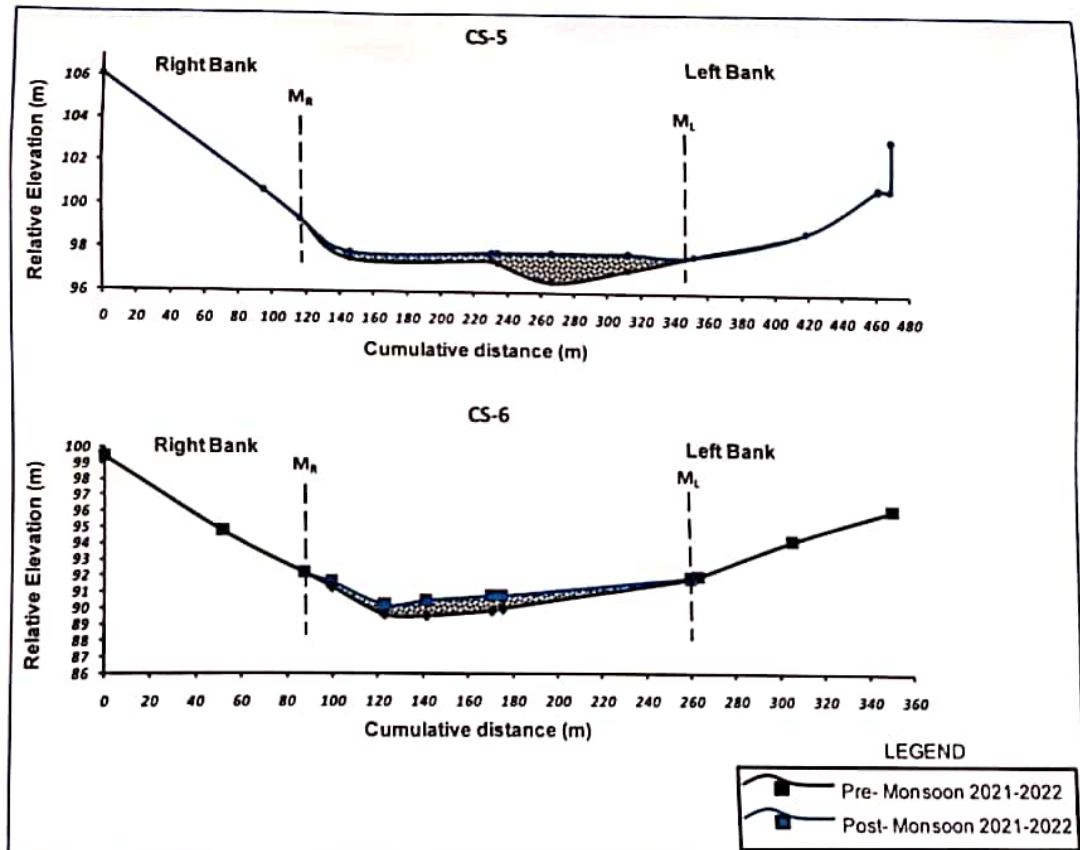
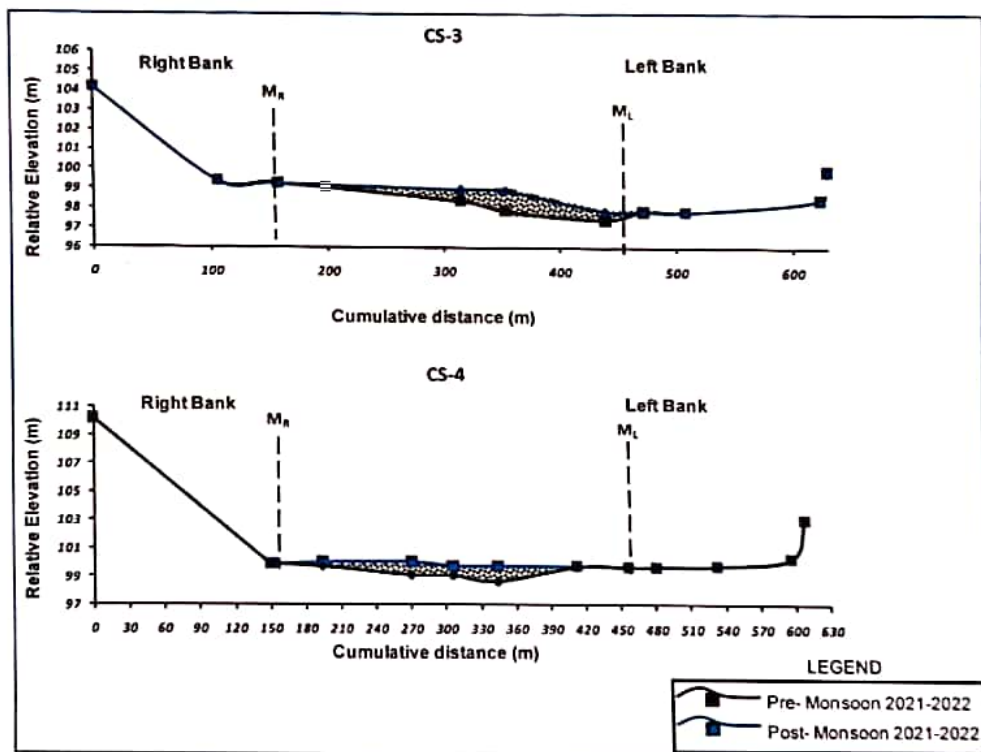


Fig. 2: Location of various cross sections along the river reaches

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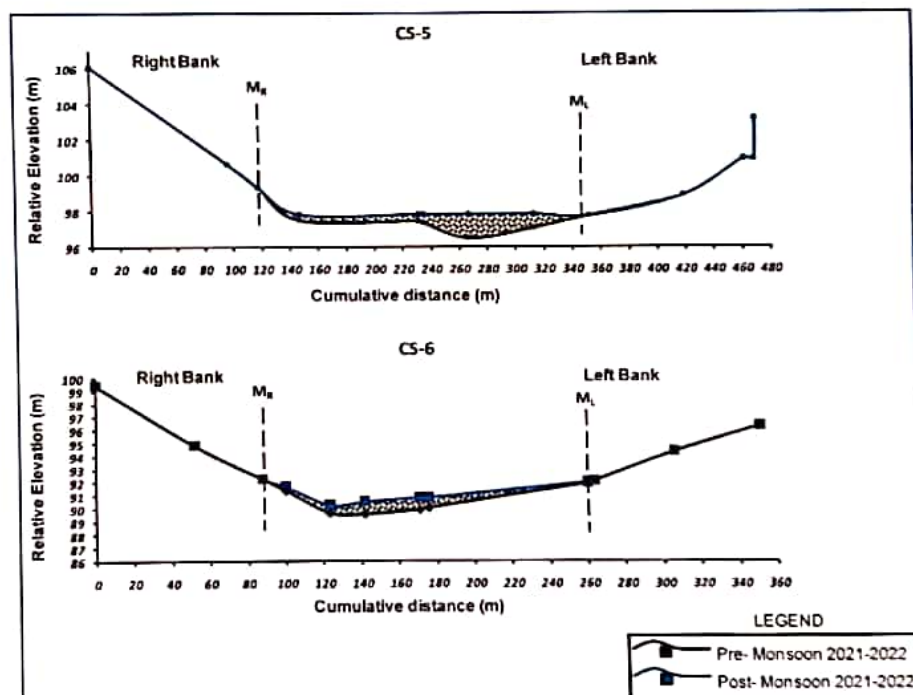


Fig. 3: Cross-section of river Kosi, Ramnagar at different locations showing the extractable RBM

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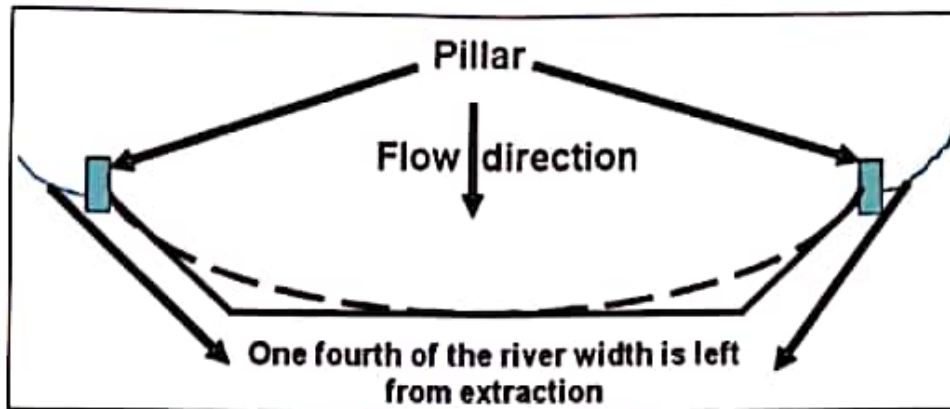


Fig. 4 (a): Procedure of extraction of river bed material

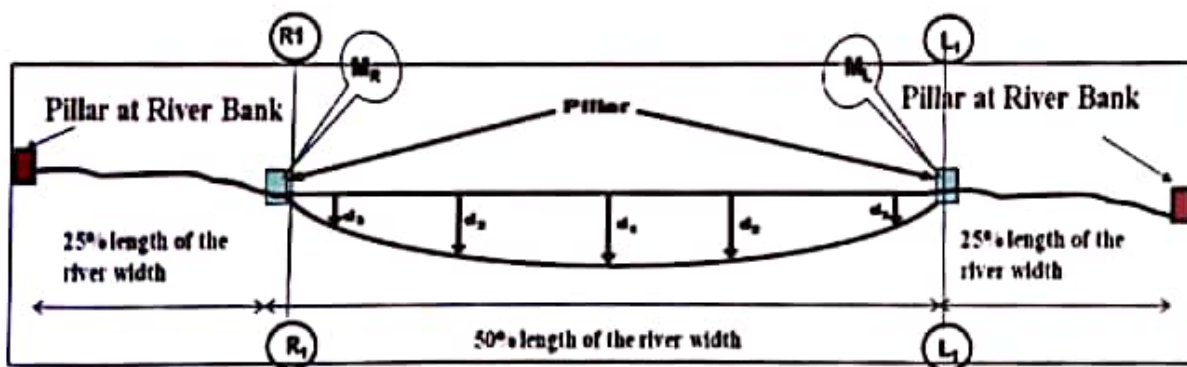
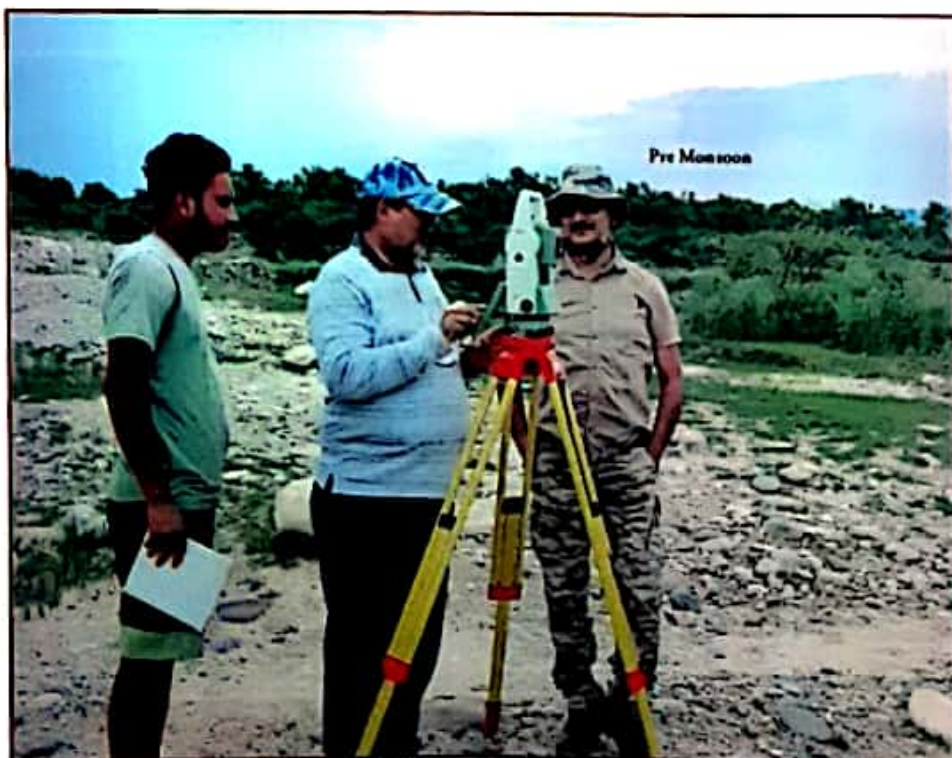
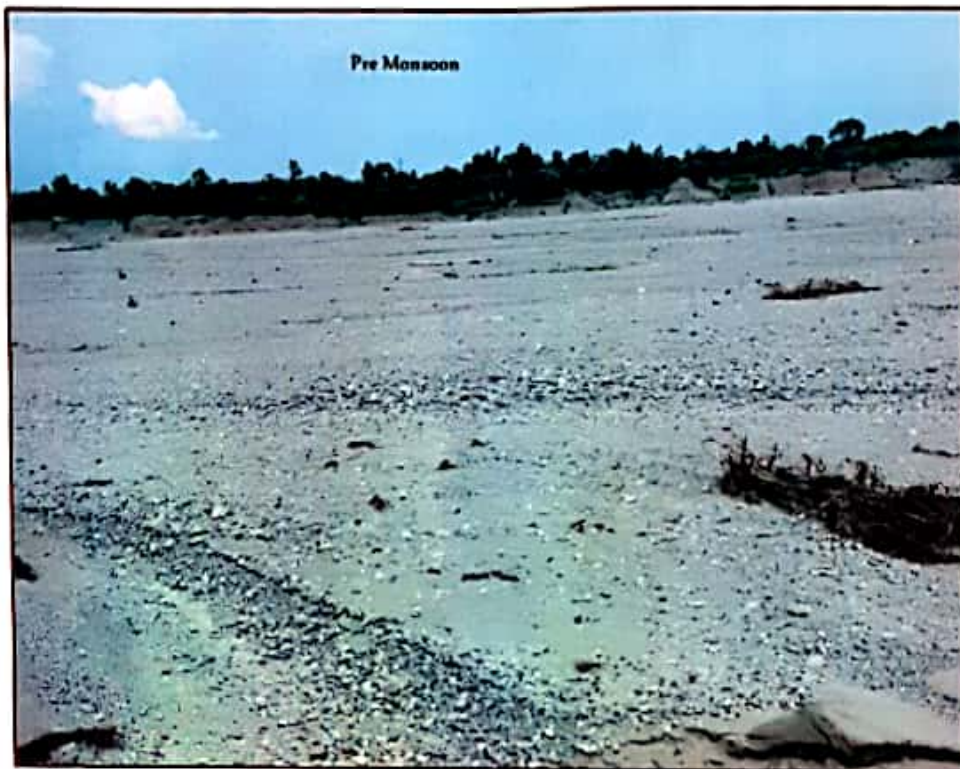


Fig. 4 (b): Anticipated shape of the river after proper extraction of river bed material

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Photo: Survey of RBM estimation

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