Where Kosi meets Ganga

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A dammed history of the Kosi

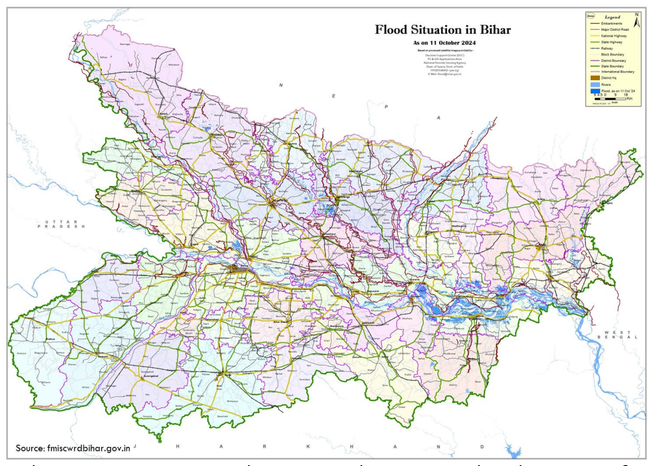
A decade after the catastrophic Kosi embankment breach, a look at the history of embankments in Nepal and northern India

https://www.firstpost.com

Rivers through time, as seen in Landsat images

Thanks to the Landsat program and Google Earth Engine, it is possible now to explore how the surface of the Earth has been changing through the last thirty years or so. Besides the obvious issues of interest, like…

https://zsylvester.github.io

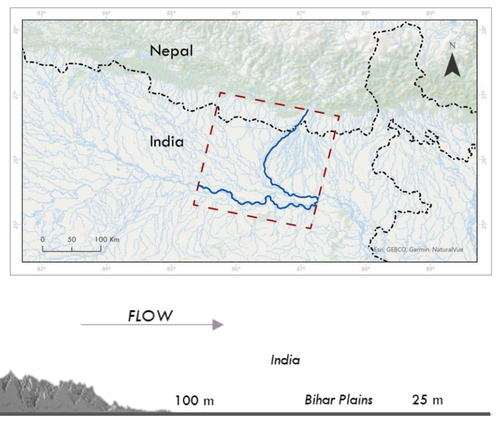


The average spacing between the two embankments of the Kosi is about 10 kilometers

Kosi-Ganga River, Bihar

The Kosi is formed by the merging of three major Himalayan rivers. After flowing through steep gradients in the Himalayas, the Kosi River emerges onto the flatter plains with a much lower gradient. This transition results in the deposition of millions of tons of silt in the plains section every year.

Inadequate maintenance and then failure of river embankments, continuous heavy rainfalls, has lead to rise in water levels which has cause redirection of the river's flow, extensive damage to infrastructure, agriculture, and homes. Villages submerged under floodwaters.



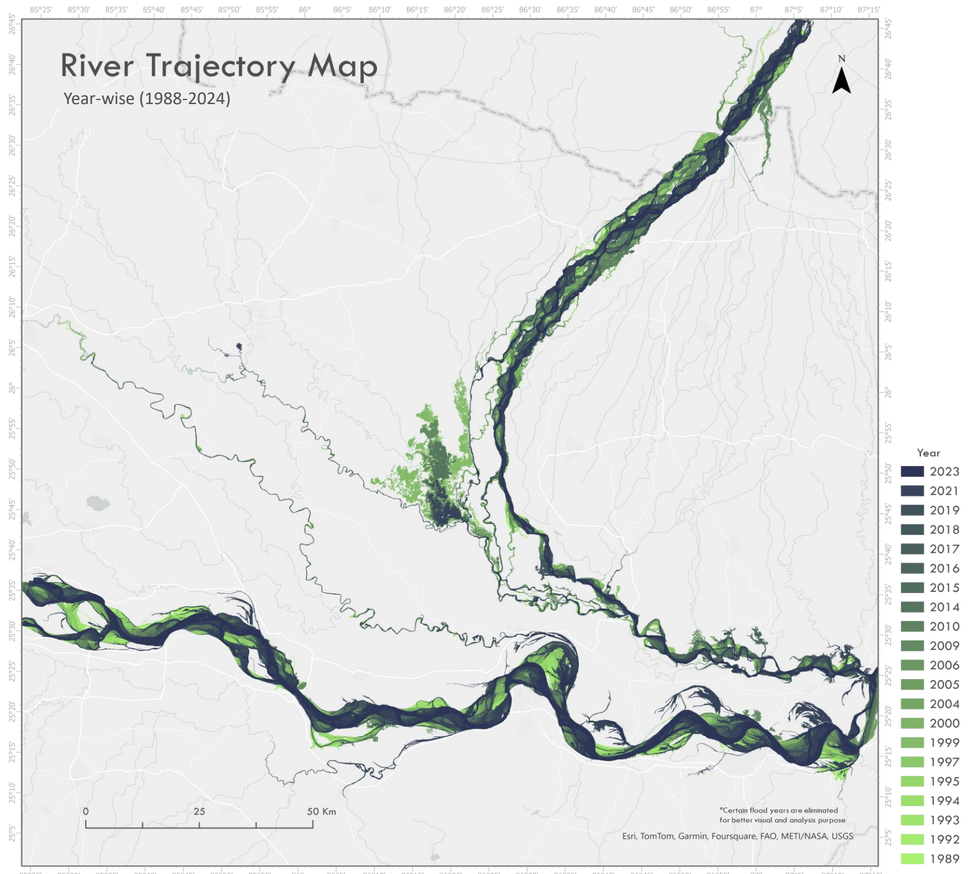
Aim: Analyze the temporal changes in river paths & visualize them using GIS mapping techniques.

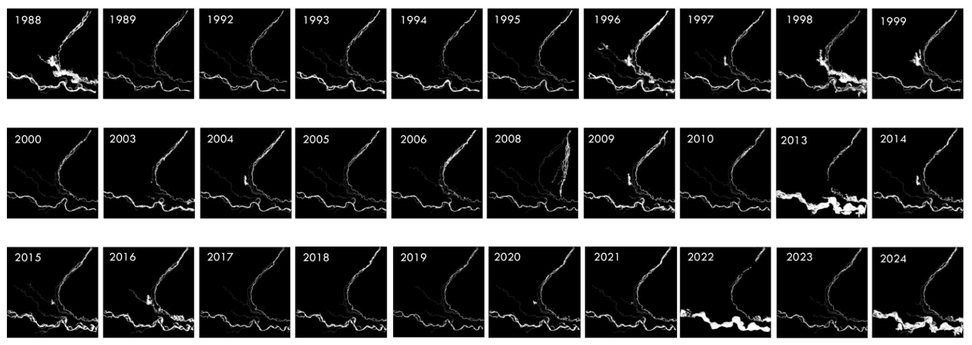
Objective:

- To map and analyze a major trajectory changes of the Kosi-Ganga River from 1988 to 2024 using GIS.
- To identify areas of sediment loads and evaluate changes in patterns of river's geometry.

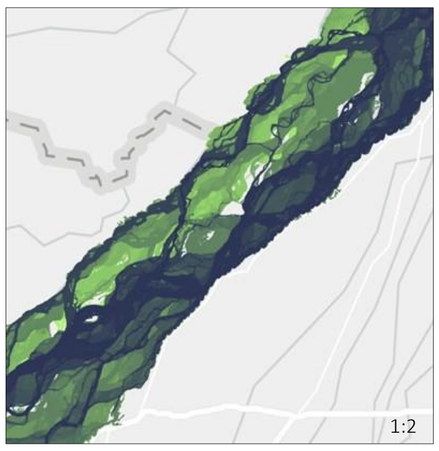
Data collection from Landsat series.

Application: To predict the next pattern of river course, understand the sediment deposit and manage them, to improve disaster preparedness, land-use planning, having a sustainable river basin management.

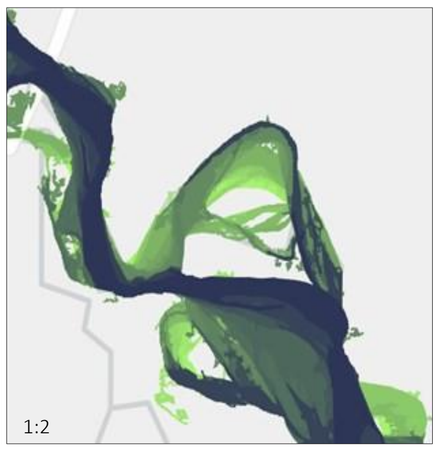




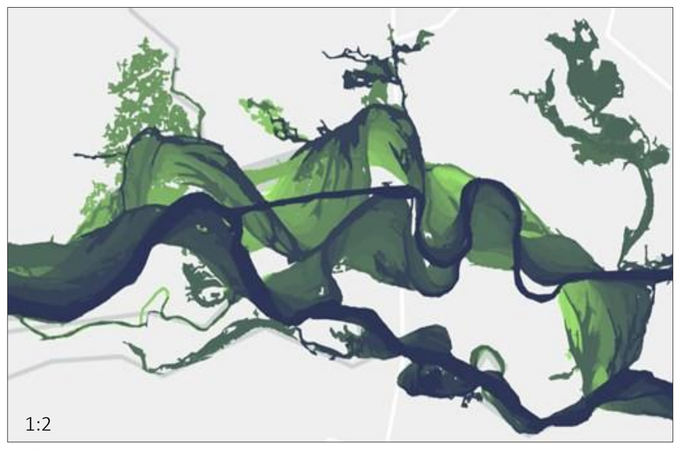
Time Series: year-wise River Trajectory Map (1988 – 2024)



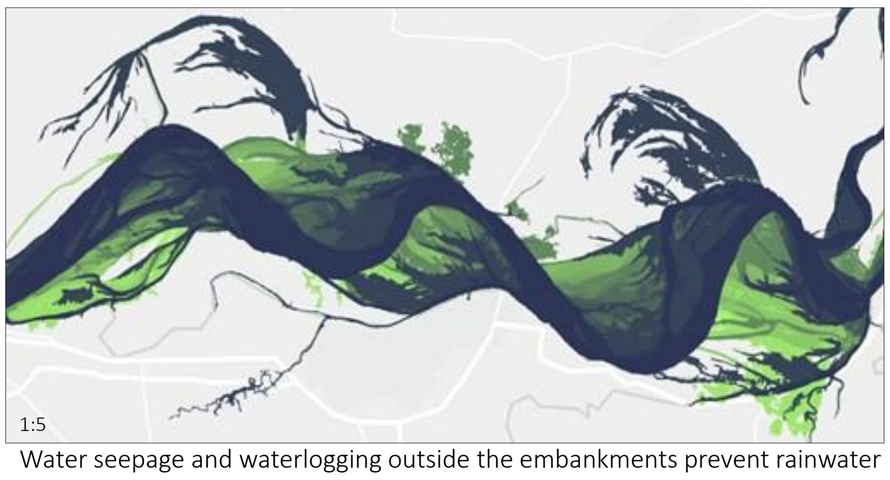
Highly instable zone of erosion and sedimentation activities



Significant lateral shifting of the river channels patterns.

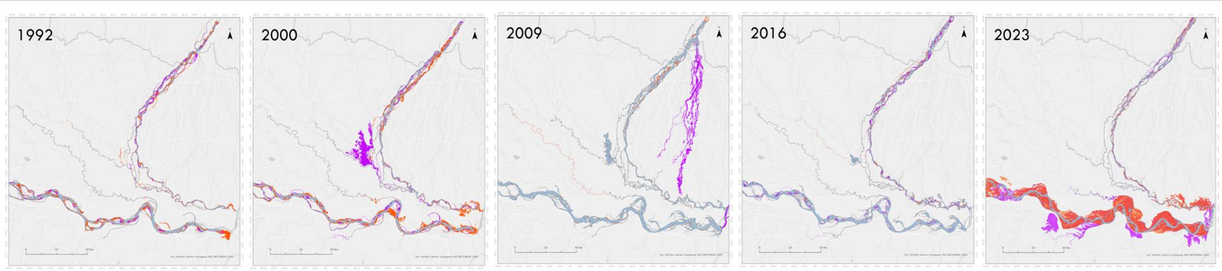


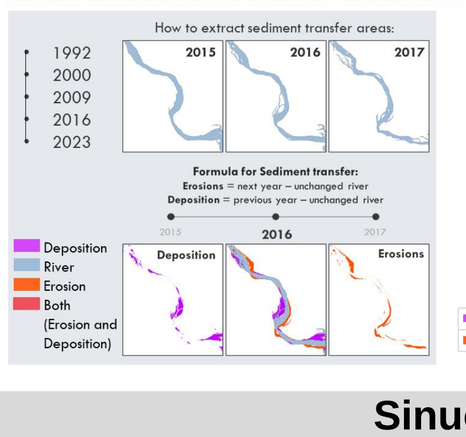
These changes reflect varying discharge, sediment deposition, and erosion patterns over time.

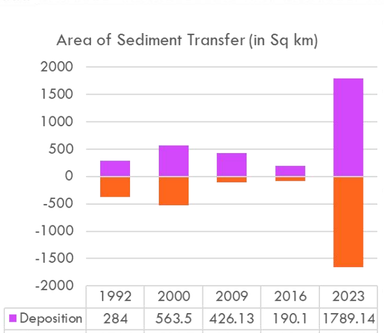


Water seepage and waterlogging outside the embankments prevent rainwater or floodwater from other areas from draining into the Kosi River.

Sediment transfer: Erosions and Depositions



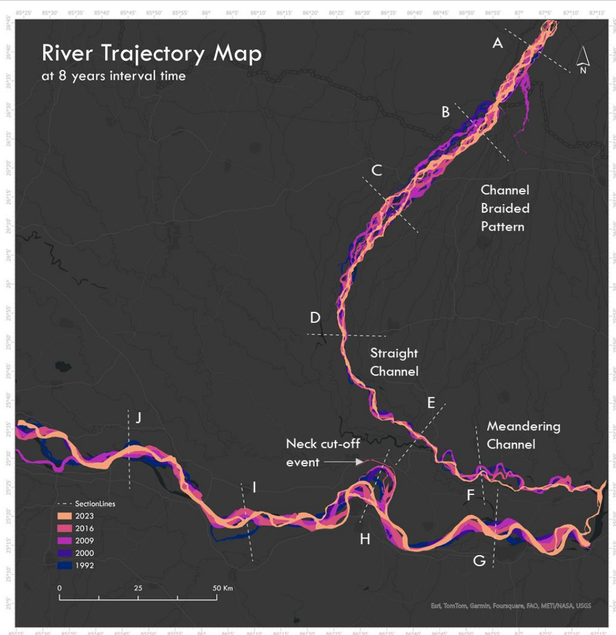


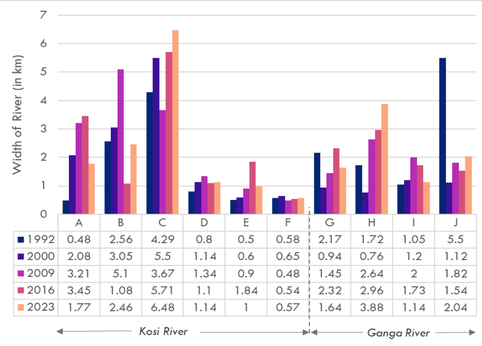


	1992	2000	2009	2016	2023
Deposition	284	563.5	426.13	190.1	1789.14
Erosion	-378.1	-532.7	-104.6	-89.4	-1,653.

- Deposition gradually increases comparing to erosion.
- There is a stable sediment transfer pattern with moderate and balanced erosion and deposition in 1992-2016.
- Due embankment failure, in 2008 flood we observe high deposition on unusual path of river.
- 2023 shows an unusual increase in both erosion and deposition, due to floods in 2022 and 2024.

Width of River





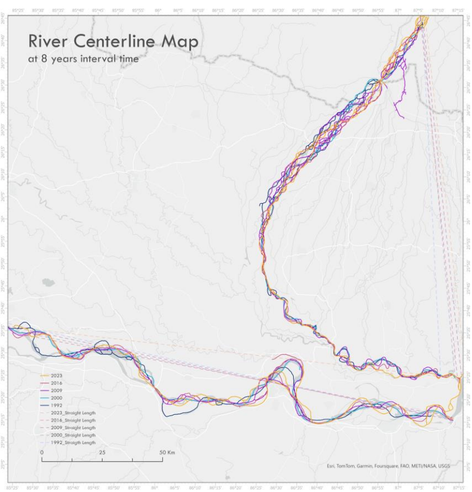
	A	B	C	D	E	F	G	H	I	J
1992	0.48	2.56	4.29	0.8	0.5	0.58	2.17	1.72	1.05	5.5
2000	2.08	3.05	5.5	1.14	0.6	0.65	0.94	0.76	1.2	1.12
2009	3.21	5.1	3.67	1.34	0.9	0.48	1.45	2.64	2	1.82
2016	3.45	1.08	5.71	1.1	1.84	0.54	2.32	2.96	1.73	1.54
2023	1.77	2.46	6.48	1.14	1	0.57	1.64	3.88	1.14	2.04

Kosi River | Ganga River

Kosi River: The width generally increased from 1992 to 2009, peaking in 2009. By 2023, the width has reduced in most sections, possibly indicating sedimentation or stabilization of flow.

Ganga River: By 2023, the width in some sections has narrowed, especially in sections G and I, suggesting similar stabilizing effects or controlled flow.

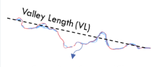
Sinuosity Index of River



How to calculate Sinuosity Index :

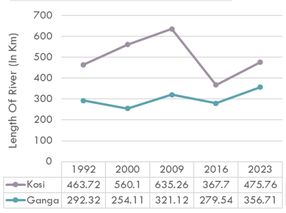
The Sinuosity Index (SI) is used for assigning channel pattern:

Sinuosity Index = Channel Length (CL) / Valley Length (VL)

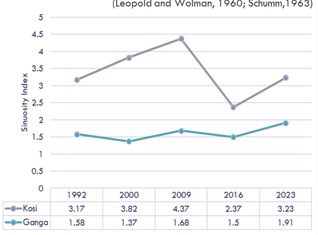


Straight channel	SI <1.05
Sinuous channel	1.05≤ SI <1.5
Meandering channel	SI >1.5

(Leopold and Wolman, 1960; Schumm,1963)



	1992	2000	2009	2016	2023
Kosi	463.72	560.1	635.26	367.7	475.76
Ganga	292.32	254.11	321.12	279.54	356.71



	1992	2000	2009	2016	2023
Kosi	3.17	3.82	4.37	2.37	3.23
Ganga	1.58	1.37	1.68	1.5	1.91

The Kosi river shows more variations in sinuosity, indicating a more active channel migration.

The Ganga river has been comparatively stable, with minor changes in sinuosity, suggesting a more controlled and less dynamic channel pattern.

Observations

	Kosi River	Ganga River
Sediment loads	High rates of sediment deposition than erosions	Unusual increase in sediment deposit due to flood events
Width of River	Wider sections, instability in braiding patterns	Stability in width indicates a more controlled flow
Length of River	Drastic change with time	Gradually increasing
Sinuosity Index	Frequent shifts in its path	Stable and controlled flow
Overall Trajectory Trend	Unstable trajectory due to sediment load and frequent course changes.	Stable trajectory with gradual morphological changes, influenced by natural flow and human activity.

Both rivers show variability with peaks and declines linked to sediment load, flood events and human intervention.

The changing trajectory of these rivers highlights the complex interplay between natural processes and human management.

Understanding these temporal patterns can aid in predicting future channel movements and designing sustainable floodplain management strategies

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