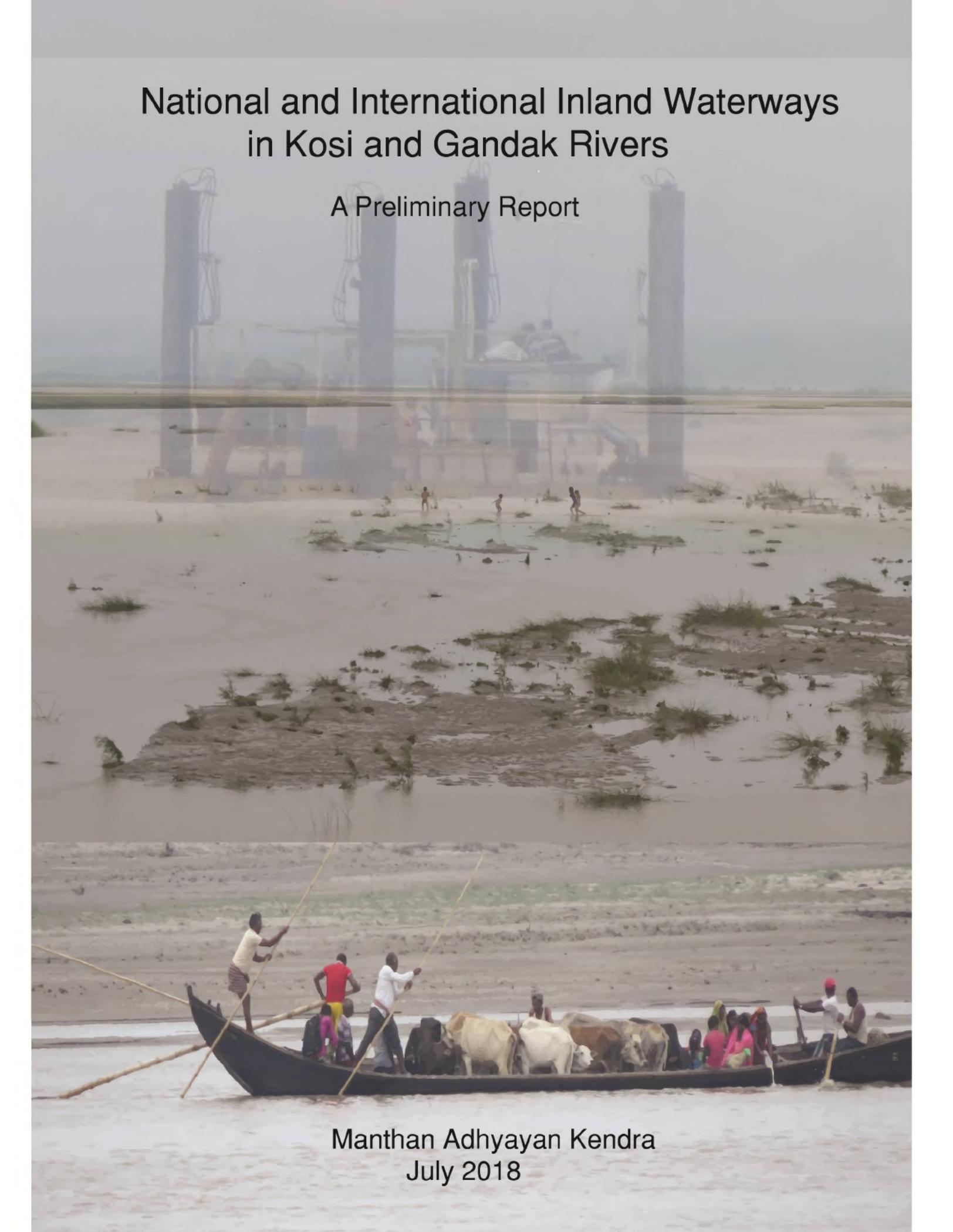


National and International Inland Waterways in Kosi and Gandak Rivers

A Preliminary Report

A wide, muddy river flows through a landscape. In the background, a large dam structure with several tall, cylindrical towers is visible. The water is brown and turbulent. In the foreground, a long, narrow boat is filled with people and several cows. The boat is being pushed or pulled by long wooden poles. The sky is overcast and grey.

Manthan Adhyayan Kendra
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National and International Inland Waterways in

Kosi and Gandak Rivers: A Preliminary Report

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Executive Summary

With the enactment of the National Waterways Act, 2016, India has declared 106 new national inland waterways in addition to the existing five already declared national waterways. This means that these waterways will be controlled and regulated by Central government through Inland Waterways Authority of India (IWAI). These rivers will be converted to waterways with large scale, commercial shipping and navigation systems for barges, cargo and passenger vessels.

In the state of Bihar alone, seven rivers have been declared as National Waterways (NW). These include Ganga, Gandak, Ghaghra, Kosi, Karamnasa, Punpun, and Sone rivers. This report focusses on the key issues and challenges of the development of waterways in Bihar, specifically on Gandak (NW-37) and Kosi (NW-58) and to some extent of Ganga (NW-1) rivers.

The reason to focus on these rivers is because these waterways on Ganga, Kosi and Gandak rivers are amongst the 37 waterways which are prioritised for development by 2019. Moreover, a recent joint announcement by the Governments of India and Nepal has declared that Kosi and possibly Gandak would be developed as international Indo-Nepal waterways, to provide sea connectivity to Nepal.

This report is based on a field visit carried out by Manthan in May 2018 to these two rivers, meetings with officials, local communities, representatives of civil society as well detailed study of related documents. Even though this report is based on detailed analysis, this report should be treated as a preliminary report as there are several aspects which we feel need to be studied further

National Waterways on Kosi, Gandak and Ganga in Bihar: An Overview

The Kosi waterway (NW 58) will be 236 km long, extending from Kosi Barrage at Hanuman Nagar on India-Nepal border to the confluence of Kosi with Ganga river at Kursela. Four terminals have been proposed for this waterway at Kalyanpur, Basibitti, Dambharaghat and Kursela.

The Gandak waterway (NW 37) is planned as a 300 km long waterway from Bhaisalotan barrage near Triveni Ghat at the India-Nepal border up to the Gandak and Ganga confluence at Hajipur. Four terminals are proposed for Gandak waterway at Bagaha, Bettiah, Kalyanpur and Vaishali.

The Ganga waterway (NW 1) is 1620 km long, extending from Haldia to Allahabad, passing through the states of Bengal, Bihar, Jharkhand and Uttar Pradesh.

The lengths of Gandak and Kosi waterways would increase if the proposed extension into Nepal is implemented.

National waterways on Gandak and Kosi rivers have been planned for the transport of cargo through self-propelled vessels of 100 ton capacity. According to the DPRs for Kosi and Gandak waterways, cargo to be transported on these waterways consist of construction material (cement, sand, stone, iron,

steel, etc), cereals/crops (wheat, rice, pulses, etc.), conventional fuels like coal and firewood, chemicals (fertilizer, acids etc), mineral ore (limestone, iron, etc.).

Key Issues:

1. Both Kosi and Gandak rivers are known for their heavy sediment loads. As the rivers deposit this silt on the plains, the river bed rises and a number of shoals and sandbars are formed along the channels of these rivers. This limits the width and depth of the navigation channels. Adequate depth and width of the fairway (water channel where the ships/vessels ply) will have to be created and maintained by processes like dredging and bandalling. Due to heavy silt loads, dredged navigational channels will also tend to fill up faster, leading to higher requirement of dredging. This can lead to higher costs and raise questions about viability of the waterway.
2. Both Kosi and Gandak rivers are characterised by braiding and meandering patterns. The main channel(s) and sand bars in the rivers are unstable and shift rapidly. This creates lot of difficulty for navigation as the channel is often shifting, requiring a continuous process to check the depths and navigability of the changing channel. Further, shifting channels could cause problems with related infrastructure like terminals which are fixed at one place. The issue of shifting channels imply at the least the need for heavy maintenance, raising questions about the viability or even the very feasibility of the waterways.

Apart from this, both the rivers are known for shifting their courses in the past. In spite of engineering interventions like embankments, the risk of course changing remains. This creates problems similar channel migration, but on a much higher scale.

3. The DPR is woefully inadequate in suggesting measures to address the above very serious problems. Suggestions in the DPR include inspection of channels on a continuous basis, shifting channel markers rapidly, channel bifurcation marks, an experimental solution by using the dredged material for providing the guidance to the flow of these rivers and so on.
4. No plans are available yet for the extension of waterways into Nepal. But it is clear that the issues resulting from heavy silt loads will pose challenges for the Nepal portion too, especially in Kosi. How the barrier posed by the barrages on the two rivers will be overcome is also not clear, as also whether the costs of any arrangement for same will affect the viability. People from Nepal also expressed concern that the regulation and control of the waterways should not be only in the hands of India as is the case with the barrages currently. Concern was also expressed that the waterways would require extensive customs and security arrangements which could severely impact the ease of movement and travel that is there today at the border, impacting economic, cultural and familial ties. The development of terminal at Kalughat near Hajipur to cater to cargo for Nepal also seems illogical as it is on the upstream from Kosi-Ganga confluence whereas vessels from Nepal would like to move downstream towards the sea.
5. During our field visit, we found that neither the local people nor the administration in Bihar have been consulted or even made aware about all these developments. Even the Government of Bihar feels that its key concerns related to the waterways, including the problem of silt, are not being addressed.

6. The waterways planned on Kosi and Gandak rivers will pass through some of the protected areas and ecologically sensitive areas like the Valmiki Tiger Reserve. Gangetic Dolphins are also found in Supaul stretch of the Kosi river. Fishing is also an important activity for the local communities. The development of waterways, activities like dredging and bandalling, associated infrastructure like jetties, terminals and approach roads may impact the biodiversity present in these protected areas as well as the fisheries. However, the impact of waterways on the ecology of the river, on the livelihood of local fisherfolks, etc. has not even been mentioned in the Detailed Project Report of these Waterways.
7. Even today, both Kosi and Gandak are being used for navigation. The DPR mentions that the Gandak river is navigable during monsoon by large boats up to 40 tonnes capacity. No details about Kosi are given in its DPR. Given that waterways requires huge amounts of interventions in the rivers, large financial outlays and have significant social and environmental impacts its important to explore whether it's possible to develop navigation and transport in the river using the naturally available flows and depths, with none or very small interventions. This would be an alternative to make waterways much more sustainable, financially, socially and environmentally. Unfortunately, this entire aspect is not even talked about or mentioned in the DPRs of either Kosi or Gandak waterways.

Way Forward

The interventions for the conversion of rivers into waterways will need huge financial resources, and have the potential of threatening the existing nature and morphology of these rivers, with large impacts on ecology and local communities. Heavy silt loads, and associated problems of shifting channels pose serious challenges, raising questions about the viability of the waterways. None of these issues are addressed adequately in the DPRs. Given this, the report suggests carrying out proper and comprehensive studies with respect to the issues of silt, changing river course, and shifting channels of the river, impacts of waterways on ecology and local livelihoods before any further development is undertaken with respect to waterways on these rivers. Studies should also explore alternatives which build on the existing navigation to develop water transport with minimal intervention, using the natural flow and depths of the rivers. Given the state of awareness of this project amongst the locals and other stakeholders, Manthan also recommends a wider reach, debate and consultation regarding this project with all the stakeholders –including the local people, civil society organisations, academicians, and the State Government regarding these developments.

Background

A total of 111 rivers and river stretches have been declared as national inland waterways under the National Waterways Act, 2016. Inland waterways have been proposed with the claims of inland water transport being environmental friendly, cost effective and sustainable mode of transport. The Inland Waterways Authority of India (IWAI) is the nodal agency for planning, developing and maintaining these waterways. IWAI has prioritised 37 waterways¹ out of these 111 for development by 2019.

Seven rivers in Bihar, namely Ganga, Kosi, Gandak, Ghaghra, Sone, Punpun and Karamnasa will be developed as National Inland Waterways². The Gandak Waterway (National Waterway- 37) and the Kosi Waterway (National Waterway-58) are amongst the 37 prioritised waterways.

In April 2018, the Prime Minister of Nepal Shri K.P. Sharma Oli visited India and met the Prime Minister of India Shri Narendra Modi. An “India-Nepal Statement on New Connectivity through Inland Waterways” issued after their discussions³ noted that “the two Prime Ministers took the landmark decision to develop the inland waterways for the movement of cargo, within the framework of trade and transit arrangements, providing additional access to sea for Nepal.”

This connectivity is likely to be provided by extending the proposed Kosi and Gandak waterways into Nepal, converting them into international waterways. The two waterways are proposed to be linked to the Ganga waterway (National Waterway-1) and through this, expected to provide sea connectivity to Nepal.

Manthan has been studying these two waterways and the Ganga waterway. A detailed analysis of the potential threats and benefits due to the development of waterways with some case studies has been documented in the [‘National Inland Waterways of India –A Strategic Status Report’](#) prepared by Manthan Adhyayan Kendra in 2017. Given the importance assumed by the waterways due to the recent developments, Manthan decided to carry out a field visit to these areas, to supplement the detailed study which we have been already engaged in.

The field visit was carried out from 23rd to 28th May 2018 and encompassed areas in India and Nepal. This report is based on the field visit, meetings with officials, local communities, representatives of civil society as well detailed study of related documents. Even though it’s based on detailed analysis, this report should be treated as a preliminary report as there are several aspects which we feel need to be studied further.

Field Visit

The field visit was planned with three basic objectives:

¹Jal Marg Vikas Project, Frequently Asked Questions and their answers, Inland Waterways Authority of India, <http://iwai.nic.in/showfile.php?lid=864>, Page 3

² National Inland Waterways Act, 2016, <http://egazette.nic.in/WriteReadData/2016/168716.pdf>

³ India Nepal Statement on new Connectivity through Inland Waterways, <http://pibphoto.nic.in/documents/rlink/2018/apr/p20184703.pdf>

1. To understand the basic nature of the rivers Kosi and Gandak on which national waterways (NW -58 and 37) are planned. These rivers are known for their braiding and meandering characteristics and heavy silt load. Both of these rivers have shifted their course in the past, hence planning of waterways on these rivers poses several challenges.
2. To evaluate the progress on the development of these waterways
3. To understand issues related to the feasibility of extending these waterways into Nepal.

The field visit covered the proposed Kalughat terminal on the Ganga river, the course of the Gandak river from its confluence with the Ganga to the Gandak barrage and some of its upstream areas in Nepal, the course of the Kosi river from its confluence with Ganga to the Kosi barrage and upstream in Nepal till Chatra, particularly visiting locations of some of the proposed terminals on these two rivers, and the IWAI terminal at Patna.

The documents studied for this report include the Detailed Project Reports (DPRs) for the Kosi and Gandak waterways, various reports related to the Ganga waterway (the Ganga waterway DPR is classified as confidential and was refused to us when asked under the RTI Act), various documents related to waterways in general, reports and studies by experts like Shri D K Mishra pertaining to Kosi and Gandak rivers, documents of the Bihar government, documents of the IWAI, etc.

The Kosi and Gandak Waterways

Detailed Project Reports (DPRs) were prepared in 2013 by RITES for the development of waterways on Kosi and Gandak rivers. We obtained copies of these reports from the IWAI through the use of the Right to Information Act. The study of these DPRs shows that development of Kosi and Gandak waterways has been planned in very similar ways. This is natural since both the rivers are similar in nature, and flow through regions that are geographically, politically and economically similar.

For instance, design and capacity of the proposed vessels (barges) on these waterways is the same. Cargo planned to be transported through these waterways is also similar. Moreover, both the waterways have the potential of being extended into Nepal.

Some of the challenges faced by these two waterways are also similar. Both waterways have the problem of shoals and sand-char formations due to heavy silt load in these rivers. Both Kosi and Gandak rivers have changed their course in the past; hence both of these waterways will have to deal with the shifting channels of the rivers.

The Kosi waterway (NW 58) as declared under the National Waterways Act, 2016 is a 236 km long waterway which extends from Kosi Barrage at Hanuman Nagar (Lat 26°31'40"N, Lon 86°55'29"E) to the confluence of Kosi with Ganga river at Kursela (Lat 25°24'40"N, Lon 87°15'14"E)⁴. [See Figure 1]. According to the DPR, four terminals have been proposed for this waterway at Kalyanpur, Basibitti, Dambharaghat and Kursela.

National Waterway-37 is 300 km long waterway planned on the Gandak river from Bhaisalotan barrage near Triveni Ghat at Lat 27°26'22"N, Lon 83°54'24"E to the Gandak and Ganga confluence at

⁴ National Waterways Act, 2016, <http://egazette.nic.in/WriteReadData/2016/168716.pdf>

Hajipur Lat 25 39°18'N, Lon 85°10'28"E⁵. [See Figure 1]. Four terminals are proposed for Gandak waterway at Bagaha, Bettiah, Kalyanpur and Vaishali.

According to the DPRs for Kosi and Gandak waterways, cargo to be transported on these waterways consist of construction material (cement, sand, stone, iron, steel, etc), cereals/crops (wheat, rice, pulses, etc.), conventional fuels like coal and firewood, chemicals (fertilizer, acids etc), mineral ore (limestone, iron, etc.).



Figure 1: Map showing Proposed National Inland Waterways on Kosi, Gandak and Ganga rivers. Two terminals (Vaishali and Kalyanpur) on the Gandak waterway are not shown in this map as their exact locations are not given in the DPR.

National waterways on Gandak and Kosi rivers have been planned for the transport of cargo through self-propelled vessels of 100 ton capacity. Details of the proposed vessel⁶ and channel dimensions⁷ as stated in the DPRs for these waterways are given in table 1 and 2 below.

Table 1: Details of Proposed Vessel

Length Over All	32.00 metres
Breadth	5.00 metres
Draft (depth to which the ship sinks)	1.00 metre

⁵ National Waterways Act, 2016, <http://egazette.nic.in/WriteReadData/2016/168716.pdf>

⁶Detailed Project Report for Development of IWT (Inland Water Transport) on River Kosi in Bihar, Transport Department, Government of Bihar, RITES LTD, Final Report, February 2013, <http://iwai.nic.in/WriteReadData/t82c7/Kosi%20DPR-93671250.pdf>, Page 63 (PDF); DPR for development of IWT on River Gandak in Bihar, Page 70 (PDF)

⁷Detailed Project Report for Development of IWT (Inland Water Transport) on River Gandak in Bihar, Transport Department, Government of Bihar, RITES LTD, Final Report, February 2013, <http://iwai.nic.in/WriteReadData/t82c7/Gandak%20DPR-64562459.pdf>, Page 116 (PDF); DPR for development of IWT on river Kosi in Bihar, Page 100 (PDF)

Cargo Capacity	100 tonnes when 1.0 m draft
Propulsion System	Marine Diesel Engines with propeller =2 nos, Output =100 BHP

Table 2: Design channel dimensions for National Waterways-37 and 58

Channel	100 tonnes vessel
Bottom width	25 m
Depth of the channel [below CD (SLWL)]	1.2 m
Side Slopes	1:5

This is the depth of water that is needed almost round the year to allow ships to navigate safely. Since this depth is not available naturally at all times along the entire course of the waterway, the channel will have to be created through extensive dredging. (This is called capital dredging). Such dredging will have to continue at regular intervals to keep the channel clear of sediments and silt (This is called maintenance dredging).

According to the DPR⁸, Estimated Annual Cargo Loads by Commodity for 2012-13 on Kosi river from Naugachhia to Nepal and Nepal to Naugachhia is 907,847 tonnes per annum. Similarly for Gandak⁹, the estimated annual cargo loads by commodity for 2012-13 for both directions between Patna and Nepal is 39,04,816 tonnes per annum.

It may be pointed out that the planned capacity of ships / cargo vessels on these two waterways is relatively small when compared with the vessels proposed in the Ganga waterway which are up to 1500-2000 ton capacity.

Moreover, this is the capacity proposed in the DPR which was prepared before the decision to extend these waterways to Nepal. It remains to be seen whether extending the waterways to Nepal will lead to any changes in the design and sizes of the vessels, of the channel etc.

Key Issues and Challenges

Sedimentation in the rivers

Kosi and Gandak rivers are known for their heavy sediment load. Gandak has an average sediment load of 79 million tons per year (Mt/ year) at Triveni which increases to 82 Mt/year at Dumariyaghat. Kosi has an average sediment load of 95 Mt/year¹⁰. Dr. D.K. Mishra in his book on Kosi river¹¹ describes the sediment load of Kosi as

⁸DPR for Development of IWT on river Kosi in Bihar Page 45 (PDF)

⁹ DPR for development of IWT on river Gandak in Bihar, Page 45 (PDF)

¹⁰ Another paper, by authors from Central Water Commission and IIT Roorkee, give different figures for the silt load in Kosi, at 187 million tons per year. Burele Sanjay A, Nayan Sharma, Z. Ahmad, I. D. Gupta (2014); *Morphological changes of River Kosi from Chatra to Nirmali*, in Hydraulics, Water Resources, Coastal and Environmental Engineering (HYDRO 2014). Paper Uploaded by authors in ResearchGate <https://www.researchgate.net/publication/277014394>

“The amount of sediments that annually come down the Kosi can be assessed from the fact that if a wall of one meter by one meter cross-section is constructed with them, it will go nearly two and half times round the equator.”

Additional silt is added to the river through its tributaries. In Kosi river, two of its tributaries- Kamla Balan¹² and Baghmatai¹³ contribute for its heavy silt content. Similarly in Gandak river, the sediment load increases and tends to get accumulated where streams/tributaries/Nallahs join the river.

The heavy silt load means that the channel will need to be dredged frequently as silt will tend to fill up the navigation channel.

When the river reaches in the plains, the bed slope of the river becomes flat. The considerable fall in the bed slope causes fall of velocity and ultimate reduction in silt carrying capacity of the river¹⁴. Because of high sediment load and reduced silt carrying capacity, the river bed rises and a number of shoals and sandbars are formed along the channels of these rivers.

Formation of sandbars limits the width and depth of the navigational channel. Since some of the sandbars are unstable and modify their size, shape and location from time to time, these become critical¹⁵ for navigation. According to the DPR¹⁶ of Kosi,

“Formation of shallow areas is generally noticed at the mouths of the streams join with the main Kosi river. The sand bars are formed below the point of confluence of streams. The formation of sand bars at these locations may recur periodically and intensity of bars depends upon the silt carrying capacity of the joining streams. Generally dredging is the only solution in such reaches, since formation of bars below tributary mouth is inherent nature of rivers. Thus, a combination of bandalling and dredging is proposed at these locations”.

Similar solution is ascribed in the DPR of Gandak¹⁷. Given the high volumes of sediment and the continuously changing locations and sizes of shoals, dredging as a solution to address the issue is likely to involve high costs.

The DPRs also suggest that aids to navigation¹⁸ have to be provided at various shoals present in rivers which create hazards to safe navigation to vessels/ship plying in the river. Details of prominent shoals that are encountered in the navigation channel of the river have to be properly marked for early warning to the navigator.

¹¹Dinesh Kumar Mishra (2008); *Trapped! Between the devil and the deep waters – The story of Bihar’s Kosi River*, People’s Science Institute, Dehra Dun, and South Asia Network on Dams, Rivers and People (SANDRP), Delhi

¹² The river Kamla Balan joins Kosi at about 111km downstream of Kosi barrage along the western embankment, and carries average sediment load of 8 million tons/year. (DPR for development of IWT on river Kosi in Bihar, Page 90 (PDF))

¹³ Baghmatai river, with its number of distributaries, meets Kosi along the western embankment at many locations; average sediment load of Baghmatai is 7 million tons/ year. (DPR for development of IWT on river Kosi in Bihar, Page 90 (PDF))

Dilip Kumar (2015), *Flood and Sediment Management in Kosi river*, available at <https://www.iwra.org/member/congress/resource/2989645.pdf>

¹⁵DPR for development of IWT on river Kosi in Bihar, Page 89 (PDF)

¹⁶ DPR for development of IWT on river Kosi in Bihar, Page 105 (PDF)

¹⁷DPR for development of IWT on river Gandak in Bihar, Page 120 (PDF)

¹⁸DPR for development of IWT on river Kosi in Bihar, Page 112 (PDF)

Shifting Channels

Both Kosi and Gandak rivers are characterised by braiding and meandering patterns. Braiding means that the water flows in a number of branching and reuniting channels, with one or two channels serving as the major channel. The mid-channel sand chars and sand banks shift rapidly with the ever changing flow regimes, and in consequence there is a day-to-day variation in channel configuration. The position of the main current in a braided stream is extremely unstable and causes the river course constantly to shift its position. High sediment load in large alluvial rivers like Kosi and Gandak contributes to their braiding characteristic. Meandering means that the entire channel of the river itself takes curves, bends or loops.

Kosi exhibits braided pattern from Kosi barrage to the Baghmati confluence, and shows meandering characteristics from downstream of Baghmati confluence to the confluence of Kosi with Ganga at Kursela¹⁹. Similarly, Gandak shows meandering pattern upto Tribeni Ghat near India-Nepal border, and shows braided pattern from downstream of the barrage at the India-Nepal border.

This creates serious problems for the stability and permanence of the navigational channel. Shifting of the main (and navigational) channel will require a continuous process to check the depths and navigability of the changing channel. The DPRs suggest the solution to this problem in the form of channel bifurcation marks, marking tools which will be provided in advance to warn the navigators.

The DPRs also suggest an 'experimental solution'²⁰ by using the dredged material for providing guidance to the flow of these rivers. The dredged soil obtained from capital or maintenance dredging is proposed to be dumped in strategic locations so as to divert the flow into the predetermined navigational channel. The DPRs further acknowledge the fact that greater part of the dumped material may flow back to the navigational channel if proper selection of dumping region is not done²¹.

Further, shifting channels could cause problems with related infrastructure like terminals which are fixed at one place. For example, a terminal is proposed in the Kosi waterway near Kursela. When it was surveyed and proposed some 4-5 years, one of the main channels of the Kosi was touching the bank at the proposed terminal sites. Yet, when our team visited the site in May 2018, the channel had moved away at least 500 m away from the bank. If the terminal had been constructed here, it would be literally left high and dry!

¹⁹DPR for development of IWT on river Kosi in Bihar, Page 90 (PDF)

²⁰DPR for development of IWT on river Kosi in Bihar, Page 131 (PDF)

²¹DPR for development of IWT on river Gandak in Bihar, Page 160 (PDF)



Figure 2: Photograph of the proposed terminal location for National Waterway - 58 at Kursela. The river has clearly shifted away from the bank.

The issue of shifting channels, and of shoals and sand chars will imply at the least the need for heavy maintenance, raising questions about its viability, and at worst raise issues regarding the very feasibility of the waterways. The DPR has been very inadequate in addressing this issue.

Changing Course of River

Apart from this, both the rivers are known for shifting their courses in the past. The problem of changing course of river has been highlighted in the DPRs of these waterways. For example, in the DPR of Gandak river it has been mentioned that:

“History shows that the Gandak river has shifted about 80 km to the east due to tilting in the last 5000 years²².”

Similarly, the DPR of Kosi river also mentions the shifting of river. It states that:

“The Kosi river is notorious for its heavy sediment load, brought down from its Himalyan Catchment and its shifting nature in the Gangetic plain, below the Chatra Gorge. The river flowing near Purnea in the east of 1736, shifted progressively towards west. The river now flows east of Saharsa. .The total shifting was about 112km between 1736 and 1954. The maximum rate of shift was 2.6km per year during the years 1922 and 1923²³.”

²²DPR for development of IWT on river Gandak in Bihar, Page 103 (PDF)

²³DPR for development of IWT on river Kosi in Bihar, Page 83 (PDF)

In order to contain the movement of the river, among other things²⁴, major interventions were commissioned on Kosi and Gandak rivers. Barrages were built on the Indo-Nepal border at Valmiki Nagar for Gandak river and at Bhimnagar for Kosi²⁵. Along with the barrages, embankments were built downstream of the barrage, and western and eastern canal systems were also commissioned in both Kosi and Gandak. However, nine major breaches²⁶ accompanied with flooding have occurred between 1963 and 2008 along the eastern as well as western embankments of the Kosi river. A major breach occurred in August 2008²⁷ at Kusaha in Nepal, on the left embankment of Kosi river. The river shifted its course and in that process many villages and town were severely affected. Similar breaches in the embankments of river Gandak were reported in 2010²⁸ and in 2017²⁹.

Hence, utility of engineering interventions like barrages and embankments on Kosi and Gandak in controlling the shifting course of these rivers remains questionable; and where they have been useful to an extent, there is a significant cost to be paid for that. For example, the DPR of Kosi states that

*“The Kosi Barrage was built at about 58km downstream of Tribeni during the period 1956-1963 and 468 km length of flood embankments were constructed on either side of the river to arrest the river shifting and to control the flood ravages. Besides, a series of spurs were constructed at vulnerable areas to prevent the breach in embankment by diverting the flow. **But the river continued shifting its course and flooding due to breaches of embankments (emphasis added).** It is proposed to construct a high dam near Barakshetra (about 8 km downstream of the Tribeni) across the narrow gorge of river Kosi and a barrage in the plains near Chatra, to control the vagaries of the Kosi by stabilizing it in one or more defined channels and also to provide facilities for diverting the river supplies for power generation, irrigation and navigation.”*

A report on the morphology of the Kosi river, by the Kosi Aayog of the Bihar Government notes³⁰:

“The physical phenomenon of prevention of the change of the course of the river beyond the limit set by the two marginal embankments is self evident. But it has to be remembered that in the post project condition, the river is carrying depositing silt in a limited space between the embankment, the implications of which has to be assessed...”

Further for the changing course of river, the DPR³¹ of Kosi states that

²⁴Dilip Kumar (2015), Flood and Sediment Management in Kosi river, available at <https://www.iwra.org/member/congress/resource/2989645.pdf>

²⁵Rajiv Sinha, K. Sripriyanka, Vikrant Jain, and Malay Mukul. "Avulsion threshold and planform dynamics of the Kosi River in north Bihar (India) and Nepal: A GIS framework." *Geomorphology* 216 (2014): 157-170, Available at <https://www.sciencedirect.com/science/article/pii/S0169555X1400169X>

²⁶Rajiv Sinha, K. Sripriyanka, Vikrant Jain, and Malay Mukul. "Avulsion threshold and planform dynamics of the Kosi River in north Bihar (India) and Nepal: A GIS framework." *Geomorphology* 216 (2014): 157-170, Available at <https://www.sciencedirect.com/science/article/pii/S0169555X1400169X>

²⁷DPR for development of IWT on river Kosi in Bihar, Page 85 (PDF)

²⁸<http://www.thehindu.com/todays-paper/tp-national/tp-newdelhi/River-Gandak-breaches-embankment-in-Bihar/article15952654.ece>

²⁹<https://www.hindustantimes.com/patna/embankment-breach-floods-many-villages-in-bihar-s-east-champanan-victims-protest-delay-in-relief/story-iiIv8rxuXLooQGZiDolhRP.html>

³⁰Morphology of the river Kosi, Page 28, available at <http://kosi-aayog.bih.nic.in/Docs/Morphology-of-the-Kosi-River.pdf>

“In general, the river has been shifted by about 1-4 km towards west over a period of about 30 years. The major shifting of the river of about 11km towards west is noticed at the confluence of Ganga. It means that the confluence point of river Kosi with Ganga is shifting towards west.

“ .. Because this process is now occurring on the extreme western end of the fan, there is a strong possibility that migration will now begin towards the east. A major shift to the east by avulsion would also be possible, were it not for massive artificial levees constructed to stabilize the river in its present position.”

Similarly, in the DPR³² prepared for the development of waterways on Gandak (National waterway - 37), it has been stated that,

“The position of the main current in the braided stream is extremely unstable and causes the river course constantly to shift its position.”

Dr. D.K. Mishra, an expert on the rivers of North Bihar, also confirmed³³ that that till such time as the massive silt load remains, the river will change course, in spite of the embankments and other interventions. The only mitigation to the problem of river shifting could be the construction of a high (storage) dam; this would also prove to be a short-lived solution as the life of such a dam would be short.

³¹DPR for development of IWT on river Kosi in Bihar, Page 84-86 (PDF)

³²DPR for development of IWT on river Gandak in Bihar, Page 109 (PDF)

³³Personal communication with the authors of this report



Figure 3: Maps showing shifting channels of Gandak river near proposed Bettiah terminal for NW-37. Google Earth images of Gandak river from 2012, 2017, and 2018 (top to bottom).

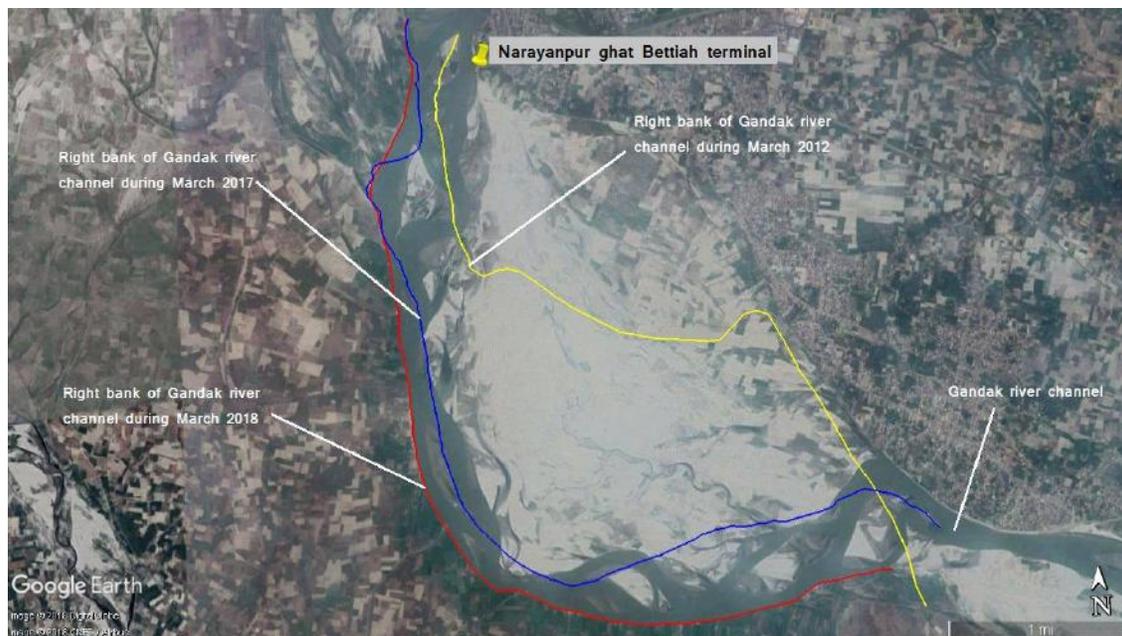


Figure 4: Map showing shifting channels and silt deposition for 2012, 2017 and 2018 in Gandak river near proposed Bettiah terminal for NW-37.

The DPR of Gandak waterway provides the basic solution of using navigational aids to the complex problem of shifting of rivers. Other than the navigational aids, the DPR suggests solutions like inspection of channels on a continuous basis, publishing river maps every 5 years, and making river notices available to the vessel operator, and training of masters and deck-hands etc.³⁴ While most of these measures may be able to address the issues of shifting river channels to some extent, but will not be able to address the problems caused by changing of the river course itself.

It is clear that tendency of the rivers to shift course remains in spite of all the engineering interventions, and this can create serious problems for the inland waterways. The solutions and methods provided in the DPR do not match the severity of this problem.

Measures to Maintain Channel Depth and Navigability

The DPRs for the development of national waterways on Gandak and Kosi propose mechanical dredging and short term river conservancy measures like bandalling to address the absence of adequate depth for the channel, and where shoals and sandbars are located.

Bandalling is short term river conservancy measure where bamboos and mats are driven into the river bed to close a minor channel and to indirectly increase the depth of the main navigational channel. It is suggested in the DPRs for the places where shoals and sand bars have been identified in the navigable channels For example, according to the DPR³⁵ of Gandak waterways:

“Bandals are proposed at the shoal areas to close a minor channel and indirectly improve the navigable depths in the main channel.”

³⁴DPR for development of IWT on river Gandak in Bihar, Page 126-128 (PDF)

³⁵DPR for development of IWT on river Gandak in Bihar, Page 119 (PDF)



Figure 5: Photograph of Bandals seen during the field visit at the IWAI Gaighat terminal. These Bandals are being used to divert silt away from the navigation channel. Accumulated silt can be seen on the upper right hand side of this picture.

However, at places it may not suffice. For example, formation of sandbars occurs periodically at the confluence of streams and their intensity is dependent on the silt carrying capacity of the joining streams. Hence, a combination of dredging and bandalling has been proposed for the development of waterways in the DPRs in such areas.

We saw the process of bandalling (Figure 5) at the Gaighat terminal site near the regional office of Inland Waterways Authority of India in Patna. The picture shows bandalling in the river Ganga where in the course of few weeks only, considerable silt has accumulated near the high jetty location of the terminal. This exemplifies how bandalling is likely to lead to silt depositions elsewhere in the river and could create problems.

Further, considerable dredging or mechanical excavation of the riverbed material has been proposed in the DPRs to create the water channel with adequate depth and width. Total capital dredging quantity for the water channel is 1.94 million cu m. and 1.88 cu m. for Kosi and Gandak waterways respectively. This is close to 2% of the total silt load in these rivers each!

It has been suggested in the DPR that the dredged material will be dumped at strategic locations to divert the flow of the water into the predetermined channel³⁶. However, this ‘predetermined’ channel has not been located in the DPR for Kosi or for Gandak waterways. Further, the DPR itself states that the dumped material may flow back to the predetermined channel if the selection of the dumping regions is not done carefully.

This raises questions on the efficacy of the dredging in creating the channel of adequate depth. The DPR³⁷s states that,

“Capital Dredging has been envisaged initially since adequate depths are not available for round the year navigation and river has silted up over the years. Since the siltation is a recurring phenomenon, a provision has been made in the operating cost for maintenance of the channel.”

Both these – the efficacy of the initial dredging, and the extent of maintenance dredging needed – will have serious impact on the viability of the proposed waterway.

³⁶DPR for development of IWT on river Kosi in Bihar, Page 132 (PDF)

³⁷DPR for development of IWT on river Gandak in Bihar, Page 307 (PDF)

We discussed this problem with various stakeholders in Bihar. The Principal Secretary of Water Resource Department of the State of Bihar had serious concerns about the feasibility of the waterways, mainly because of the recurring cost on the management of silt. He also highlighted the problem of silt as the major problem for the state Government. He added that the state is not opposed to the development of waterways; however, he suggested that silt as a problem needs to be solved first for flood management and to protect the agricultural land that gets destroyed due to silt. In the context of development of waterways in Bihar, he warned that the problem of silt is a huge and recurring process, hence it might not be financially viable to create and maintain waterways of adequate depth as this would require huge investment. This issue was also flagged by the State Government at the 'Aviral Ganga Consultation' that took place in Bihar in Feb 2017.

Similarly, a senior administrative officer in West Champaran district, where a terminal has been proposed for Gandak waterways, had apprehensions regarding the adequate depth required for the development of waterways on Gandak.

Extension of these waterways into Nepal

On 7th April 2018, an Indo-Nepal joint statement was released during the visit of the Prime Minister of Nepal to India³⁸. In this statement, it was declared that India will enhance the connectivity of Nepal to the sea through extending inland waterways into Nepal. It appears that the Kosi river and Kosi waterway is initially being considered for this. Earlier in 1997, the Kosi Study Agreement was signed between the governments of Nepal and India to conduct a detailed study of the 165 km long Kosi Navigation Canal³⁹ and development of waterways, linking Chatra in Nepal with the seaport, through the Ganges, Bhagirathi and Hooghly using the 'natural course of Kosi river.'

The DPR of the Gandak waterway also mentions that⁴⁰ "A provision has also been made for navigational locks both upstream and downstream of the barrage [at Valmikinagar on Indo-Nepal border] on the right bank for passage of boats across the barrage." This and the geography of the Gandak river indicates that it would also be a likely candidate for an Indo-Nepal waterway. Moreover, in the DPRs for the development of waterways on Kosi and Gandak river it is clearly mentioned that these rivers can be developed as 'international waterways'⁴¹ as these rivers traverse through Nepal.

To look at the issues involved in extending the proposed Gandak and Kosi waterways into Nepal and converting them into international waterways, we followed the course of the river Kosi and Gandak through the Indo-Nepal border at their respective barrages. We also spoke with some activists and local government authorities in Nepal to understand their perspective.

The exact distances to which these waterways are likely to extend into Nepal as also other details are not yet clear. Hence, our observations regarding the Nepal portion of these waterways are preliminary in nature.

³⁸PIB release 7th april 2018 <http://pib.nic.in/PressReleaseDetail.aspx?PRID=1528217>

³⁹A.B. Thapa (2009) *Access to Sea: Kosi Canal Waterway*. In: Dhungel D.N., Pun S.B. (eds) *The Nepal-India Water Relationship: Challenges*. Springer, Dordre https://link.springer.com/chapter/10.1007/978-1-4020-8403-4_7#citeas. The same is also recorded in the "Minute of the Second Meeting of the Joint Team of Experts (JTE) of Nepal and India on Sapta Kosi High Dam Multipurpose Project (Nepal) Held in Kathmandu, Nepal on January 7-9, 1997"

⁴⁰DPR for development of IWT on river Gandak in Bihar, Page 18 (PDF)

⁴¹DPR for development of IWT on river Gandak in Bihar, Page 345 (PDF); DPR for development of IWT on river Kosi in Bihar, Page 203 (PDF)

Much of the river course of the Gandak in Nepal is through gorges or hills, though near Devghat it enters in Chitawan (Inner Terai of plain) where the river just exits the foothills of the Mahabharat Range. Then the Gandak crosses the Chure Hills (Sivalik Hills) and enters the plains near Tribeni ghat. This means that issues related to silt, silt deposition, channel shifting etc. are less of a concern for any proposed waterway in the Nepal portion the river.

The DPR of the Gandak waterway mentions⁴² that “the Gandak is also navigable upstream of the barrage inside Nepal for about 70 km up to Narayan Ghat throughout the year by small cargo boats...”

As mentioned earlier, in Kosi, various available documents suggest that the waterway in Nepal would extend to Chatra, some 35-40 km upstream of the barrage at the Indo-Nepal border. As Chatra is the place where the Kosi emerges from the hills on to the plains⁴³, the issues of silt deposition start becoming of concern from here⁴⁴. Hence, any waterway in Nepal portion of the Kosi is likely to face challenges of heavy silt deposition, channel shifting etc. apart from other concerns that relate to creation and operation of waterways in rivers.

Badri Subedi, working with Indreni Samajik Vikas Manch on Gandak river in the Susta block of Nepal for some years, spoke about their concerns if the waterways are extended into Nepal. He said that the management and operational control of the waterways would be a matter of concern for the people of Nepal given their earlier experience. He said that the barrages on Kosi and Gandak at the Indo-Nepal border are both controlled by India. The people of Nepal have a sense that they are not involved in any manner in this. Further, he added that as this issue of the control and maintenance of canals and the barrage has not been addressed by India, it has emerged as an undercurrent of conflict. Hence, he said that there are genuine apprehensions related to the management in case of the extension of inland waterways in Nepal. He said that in such a case, the control and management of the waterways would have to be done strictly in a joint manner.

Another concern expressed by Badri Subedi was that while the waterways could be beneficial, we cannot take this as given. Before concluding that a waterway from Nepal to India on Kosi or Gandak would be beneficial, all the necessary social and environmental impact studies, apart from the economic and financial assessments need to be done. A similar opinion was expressed by Shri Keshav Ghimire, a journalist and water activist living near the Kosi barrage in Nepal.

When we spoke to the chairman of the Rural Panchayat of Susta, near the Gandak barrage in Nepal, he was welcoming of the waterways as waterways have the potential bring economic development for a land-locked nation. He however was not aware of any progress on the same.

One of the points made by both, the officials as well as civil society representatives we met in Nepal was that there was no official intimation or consultation regarding the waterways in Nepal in these areas where the waterways are being proposed. Thus, the local communities, media and even officials had little idea of what was planned, let alone the chance to get involved in the process. We found this situation to be the same in India also, as we later detail.

⁴²DPR for development of IWT on river Gandak in Bihar, Page 18 (PDF)

⁴³DPR for development of IWT on river Gandak in Bihar, Page 16 (PDF)

⁴⁴The chapter on “Morphology of the Kosi River” in the Kosi Aayog of Bihar Government also clearly states that “absent. The river begins to exhibit the deltaic characteristics immediately after it enters into the plains at Chatra” (Page 30) <http://kosi-aayog.bih.nic.in/Docs/Morphology-of-the-Kosi-River.pdf> Accessed 7 June 2018.

An interesting point was raised by the Director, IWAI Regional Office at Patna. He told us that the extension of waterways into Nepal is not possible since there are already barrages built at Kosi and Gandak river at the Indo-Nepal border. He implied that it would now be very difficult to construct a locks and gates arrangement at these barrages.



Figure 6: Kosi Barrage at the Indo-Nepal Border in Hanumannagar.

A senior administrative officer in West Champaran district in India raised a concern about the extensive customs and security arrangements that would be needed with the extension of waterways through Gandak river into Nepal. Indeed, such stringent customs and security regime would severely impact the ease of movement and travel that is there today at the border, which greatly helps the population on both the sides of the border to maintain economic, cultural and familial ties.

Role of Kalughat terminal proposed on National Waterway-1

Kalughat, in Parmanandpur village of Sonapur block in Saran District of Bihar, is the site of one of the terminals proposed on the National Waterway-1 (Ganga). Kalughat site is important as this terminal is being planned to handle cargo meant for Nepal only.

The Consolidated Environmental Impact Assessment report of the National Waterways -1 clearly mentions the purpose of the construction of Kalughat Terminal. It states that⁴⁵,

⁴⁵Consolidated Environment Impact Assessment (EIA) (Volume-3), Capacity Augmentation of National Waterways-1, Jal Marg Vikas Project, Environment Impact Assessment Reports (May 2016), Inland Waterways

“Since the terminal is proposed to handle only container cargo meant for Nepal, rail connectivity may not be required.”

When we visited the site, people residing in the vicinity of Kalughat confirmed surveys and negotiations for land required for the construction of terminal at Kalughat (Fig 7). A report in the Kathamandu Post dated May 10, 2018 also notes⁴⁶:

“A team of India’s Inland Water Navigation Authority will conduct a feasibility study for waterway navigation in Koshi River. The Indian team will conduct survey for inland water navigation from Kosi River to Kalughat in the Indian state of Bihar.

“India has informed that the nearest shipment point is Kalughat, Bihar.”



Figure 7: Kalughat Terminal Site for National Waterway-1 on river Ganga. This terminal will be used only for cargo to be transported to Nepal

However, the selection of Kalughat as the key terminal for the Indo-Nepal waterway and its link to the sea via the Ganga is puzzling. Kalughat is towards the west (or upstream side on the Ganga) from the confluence point of the Kosi and the Ganga (see Figure 1). This means that vessels coming in from Nepal via the Kosi would have to go westward (upstream) to Kalughat and then come back east

Authority of India, Ministry of Shipping, Government of India, EQMS India Private Limited, Page 128, <http://iwai.nic.in/showfile.php?lid=963>

⁴⁶ <http://annx.asianews.network/content/modi-visit-ink-railway-and-waterways-pacts-72545> Accessed 20 May 2018

(or downstream) to go towards the sea (Kolkata/Haldia). Why the proposed terminal at Kursela, which is very close to the Kosi – Ganga confluence cannot be used for as the connecting point is not clear. We hope that this issue will be clarified by the authorities along with many other issues, by putting out the details of the proposal in public domain.

How Relevant are the DPRs

While the details of the Kosi and Gandak waterways into Nepal are not available, for the Indian sections there are Detailed Project Reports for both the waterways. Yet, it seems that even these DPRs may only be indicative and the actual proposals are to be finalised.

When our team met the Director, IWAI, Patna Regional Office, we asked him about the status of the work on the Kosi and Gandak waterways. He said that the plans are still in the initial stages. When we pointed out that even the DPRs were ready, he disagreed and said no DPRs have been made. When we showed a copy to him, he suggested that these may have been made as preliminary plans for including the Kosi and Gandak waterways in the larger plan of National Inland Waterways.

When such a senior official of the IWAI, and the one under whose jurisdiction the Kosi and Gandak fall says this, then there are serious questions raised about the validity and relevance of the existing DPRs. This is again one of the important issues that needs immediate clarification from the IWAI.

Stakeholder Views

During our field visit along the proposed waterways of Kosi and Gandak, we gained insights from different stakeholders of the development of these waterways. We spoke with various authorities from the State of Bihar such as Principal Secretary of the Water Resource Department and administrative officers in West Champaran district. We also gained perspective from the people of Naya Tola Bishambarpur of Bettiah district on Gandak river. We also met with the director of regional office of IWAI at Gaighat, Patna.

Principal Secretary of the Water Resource Department said that he does not have any information about the progress of waterways in Bihar. He emphasised that state government is not being involved in the development of national waterways in the state of Bihar and commented that the waterways are being developed without the consultation of State Government. He added that the state government, though not opposed to the waterways, had many concerns related to the Ganga, Kosi and Gandak, including concerns related to the development of the waterways, and that these needed to be resolved before going further. The problem of vast quantities of silt was a major issue. He said that these concerns had been raised with the Government of India, but there has been no move by the central government to address these concerns.

He said that no detailed project report or feasibility report has been shared with their department. Further, he said that land acquisition is the only point of intervention for State Government in the development of waterways. Clearance from the state government is the first step to obtain wildlife clearance which is required due to the presence of Vikramshila Dolphin Sanctuary in Bihar on the

National Waterway-1. He said that state government has not been approached as yet for this wildlife clearance.

It may be recollected that the Chief Minister of Bihar Shri Nitish Kumar has raised serious concerns about the waterways in Bihar and the impact of dredging. In particular, the Declaration issued at the Aviral Ganga Conference organised by the Bihar Government in Feb 2017 states that⁴⁷

“Dredging for National Waterways – 1 is increasing erosion in Bihar. The project should be put on hold until a scientific study of impact of dredging on erosion is done.”

In West Champaran, an administrative officer told us that he was not sure if the passenger traffic would convert to waterways as extensive rail networks are already present in Bihar. For freight traffic he said, “only if they make the waterways operational for Ganga, it will take away considerable traffic from the roads.” He was not aware of any development on the waterways on Gandak. However, when we went the site of the proposed terminal of Gandak at Narayanpur Ghat, we were told by the locals that officials of IWAI were carrying out some survey at the Narayanpur Ghat; they were last seen at the terminal site two days before our visit.



Figure 8: Proposed Bettiah Terminal site at Narayanpurghat for National Waterway-37 (left); IWAI's floating pontoon (right) found at Narayanpurghat.

The director of IWAI, Patna regional office confirmed that no budget has been passed for the development of Kosi waterway till now.

If this is the case with officials, the situation of local communities is worse. There seems to have been no consultation with local communities on the proposed waterways. In fact, they have not even been informed about the proposals. The only information they have is from media, or when survey teams land up at specific places. This means that such a huge intervention in the rivers, being put forward as a development project, is being carried out without any consultation, let alone any participation of the local communities.

This presents a very disconnected picture of coordination between IWAI, which is the statutory body responsible for the development of national waterways, the officials from state government and local communities.

⁴⁷ http://incessantganga.com/patna_declaration_26thfeb.pdf Accessed 25 March 2017

Impact of Waterways and Associated infrastructure on the Ecology and Protected areas

Waterways planned on Kosi and Gandak rivers will pass through protected areas and ecologically sensitive areas. On the Gandak waterway, Valmiki Tiger Reserve is located very close to the Indo Nepal border, where a terminal should be expected as it is the last stop on the navigational route of the waterway. Gangetic Dolphins are also found in Supaul stretch of the Kosi river. The development of waterways and their associated infrastructure like jetties, terminals may impact the biodiversity present in these protected areas.

The movement of vessels in waterways along the main channel of the river would require restrictions on fishing nets along the navigational route. Further, process like bandalling will ensure that water flows through the navigational channel and other minor rivulets will be choked. Many people in this area engage in fishing for subsistence as well as for livelihood opportunities.

Dredging, bandalling and disposal of silt are all likely to restrict access of fisherpeople to fishing areas, and also impact the fish directly, reducing the diversity and quantity of fish.

Similarly, aggraded riverbed forms stable islands on which various crops are grown by people. With the development of waterways such islands may have to be dredged for the continuity of the waterways.

These are only some examples. Given that waterways represent major interventions in river, they are likely to have huge impacts. Our earlier report⁴⁸ “National Inland Waterways in India – A Strategic Status Report” outlines these impacts in detail, and also discusses issues that can impact the viability of waterways. Unfortunately, no such impact assessment has been carried out for the Kosi and Gandak waterways. The DPRs talk about many issues, but there is not even a word about the environmental and ecological impacts of the waterways.

Existing Navigation in Kosi and Gandak

The DPR for the Gandak waterway notes⁴⁹ that

“The river is navigable during monsoon by large boats up to 40 tonnes capacity from its confluence with the Ganga upstream to Chatighat...in the dry season, smaller boats of 10 tonnes capacity ply in the region. Above Chatighat and up to Tribeni Ghat on the Indo-Nepal border, a distance of 165 km, the river is navigable by boats of 20 tonnes capacity....The Gandak is also navigable upstream of the barrage inside Nepal for about 70 km... throughout the year by small cargo boats...”

The people in Bishambarpur tola told us of how local boats ply reasonable loads including 2 tractors at a time.

⁴⁸National Inland Waterways of India – A Strategic Status Report, Manthan Adhyayan Kendra (2017) Available at <http://www.manthan-india.org/wp-content/uploads/2018/04/Strategic-Status-Report-on-Inland-Waterways-V5-26-Apr-17-FINAL.pdf> (English) and http://www.manthan-india.org/wp-content/uploads/2018/04/Report-on-National-Waterways_Hindi.pdf (Hindi)

⁴⁹DPR for development of IWT on river Gandak in Bihar, Page 18 (PDF)

As we have seen, to develop the waterways requires huge amounts of interventions in the rivers, like dredging and channelising, need large financial outlays and has significant social and environmental impacts. Given this, one important aspect to explore is whether it's possible to develop navigation and transport in the river using the naturally available flows and depths, with none of very small interventions. This would be an alternative to make waterways much more sustainable, financially, socially and environmentally. In this context, the existing navigation becomes very important.

For example, given that already navigation of 40 tonnes is taking place in the Gandak, and even with all the expenses and interventions, the IWAI plans propose 100 tonne capacity vessels in the waterways to be developed, it would be very important to see if with minimal intervention the existing navigation capacity can be enhanced and stabilised and made efficient. It's quite likely that such an option may be found to be an optimal and a preferable option.

Unfortunately, this entire aspect is not even talked about or mentioned in the DPRs. The Kosi DPR in fact does not even document the existing navigation which the Gandak DPR at least mentions. Given the serious issues with the planned Kosi and Gandak waterways, it would be very important to include detailed exploration of building on existing navigation to create sustainable water transport in the two rivers using the natural flow and depths.

Gaps in the DPR

While it was in 2016 that the Kosi and Gandak were declared as National Waterways, the detailed project reports for the development of these waterways were prepared in 2013. There are several problems with the final DPRs for these waterways. These include:

1. The DPRs acknowledge the problems of silt load, changing course of river and shifting channels, but do not provide any concrete solution to these problems. There is no concrete plan for the disposal of dredged material.
2. The DPRs do not consider the environmental and social impacts of the waterways. Environmental and social cost benefit analysis or environmental or social impact assessment has not been carried out for the waterways nor presented in the DPRs.
3. The DPR does not account for the terminals where the waterways start such as at Valmiki Nagar and Bhimnagar where the barrages for Gandak and Kosi are located.
4. There are incorrect figures and calculations in the DPR.
5. There are few details of existing navigation on Kosi and Gandak Waterways. The options of developing these waterways in a sustainable manner with the natural flow and depths are not even considered.

Recommendations

Given the complexity of riverine processes, the development of waterways needs to proceed with caution. We recommend the following based on our observations and analysis:

1. Comprehensive and complete studies need to be carried out for the proposed waterways, especially focussing on the problems of silt deposition, channel shifting and course changing.

2. Simultaneously, studies should be carried out to assess the social and environmental impacts of developing these waterways.
3. Different option for the waterways should be explored, in particular, alternatives which build on the existing navigation to develop water transport with minimal intervention, using the natural flow and depths of the rivers.
4. All the studies and findings related to the project should be made available in Hindi and other local languages.
5. Carry out widespread consultations on the proposed waterways. Such a process of consultation should be a dialogue that includes the central government, state government, communities on the banks of rivers, civil society groups and independent experts.
6. The studies mentioned in points 1-3 above should also be carried out involving all the players mentioned above.
7. The concerns expressed by the Government of Bihar are genuine and are clearly based on ground realities of observed impacts of the silt load in the river, the water extractions upstream, the Farakka barrage downstream etc. These concerns need to be taken seriously and discussed and addressed.
8. A decision whether to go ahead with these waterways or not, and if so, in what manner, should be taken after thorough deliberations based on the results and findings of all the processes mentioned in the points above.
9. Till this, the work on these waterways other than that outlined above should be halted.

**National and International Inland Waterways in
Kosi and Gandak Rivers: A Preliminary Report**

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- Cover Photos:** Dredger near Kosi barrage while crossing from eastern to western bank; Kosi river; and a boat transporting people and cattle seen from one of the most vulnerable spurs on the eastern embankment of Kosi river at Koshi Taapu, Nepal (top to bottom).

(Text, Photos and Maps by Authors, Manthan Adhyayan Kendra, except where indicated)

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