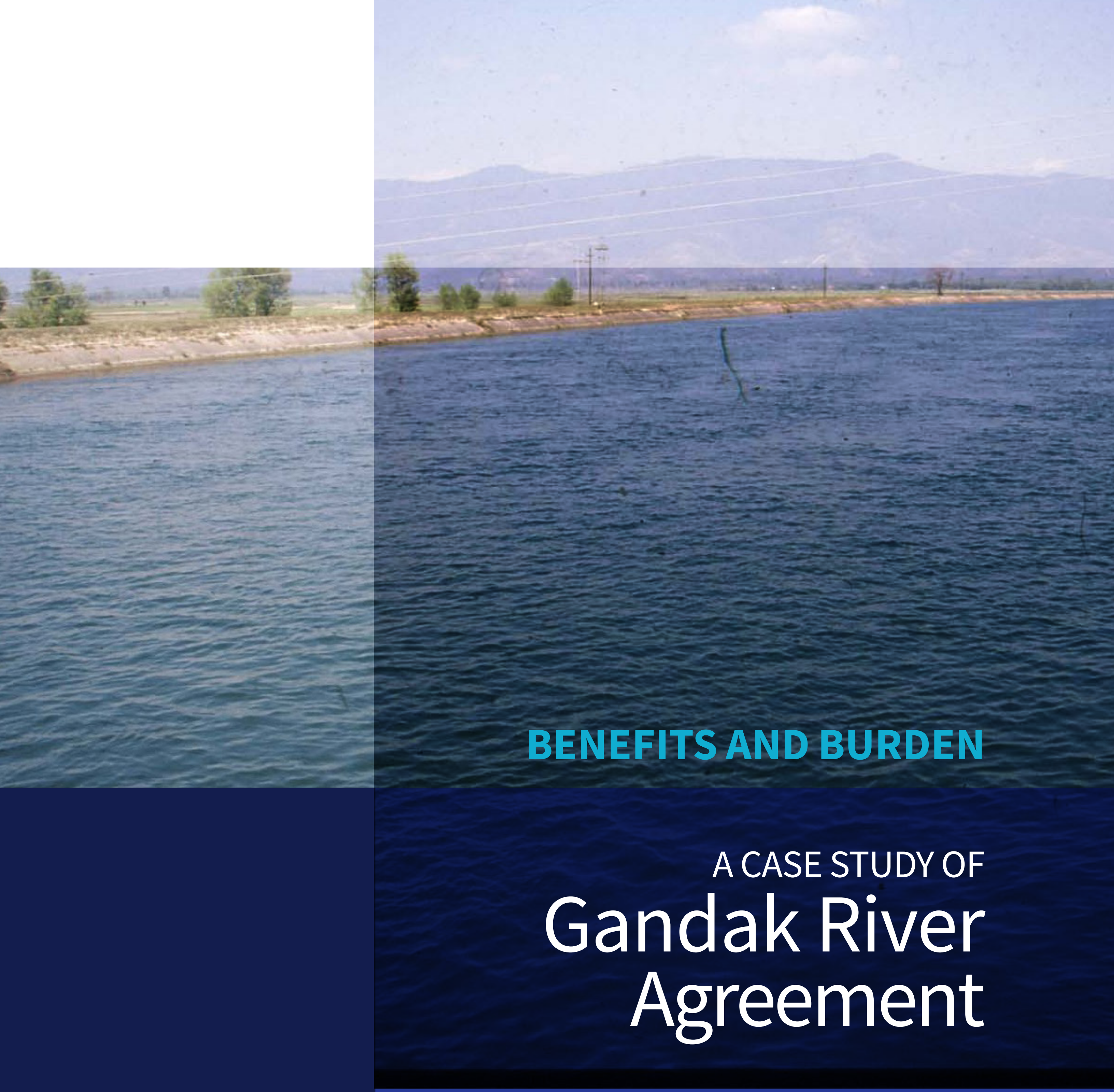

BENEFITS AND BURDEN

A CASE STUDY OF

Gandak River Agreement

AJAYA DIXIT
ASHUTOSH SHUKLA

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Executive Summary

This paper uses 1959 Gandak River Agreement between Nepal and India as a case study to assess performances of the infrastructure built under the treaty and their services in Nepal. The Gandak Irrigation and Power Project (GIPP) provides irrigation water to areas in Nepal through Nepal Gandak West canal (NGWC) and Nepal East Canal (NEC). The paper examines the context of irrigation, hydropower and flood mitigation issues in plain areas of Nepal's Nawalparasi District. The study has found that the development indicators of the households living with the command area served by the NGWC are lower than that of adjoining districts and at the national level.

The two governments signed the Agreement to harness water of the Gandak River for the benefits of the countries and people living on both side of the border. The low development indicators in the command area of NGWC suggests that the cooperative narrative on transboundary rivers have not yet included performance of the systems built under the agreement in meeting stated objectives of cooperation. The area served by GIPP faces degradation of local ecosystem, perpetual flood inundation and depleted well-being of communities living in the service area.

The discourse on transboundary water cooperation must recognize the prevailing local circumstances and performances of the infrastructure built. Cooperative efforts must also appreciate complexities of intra and inter governmental coordination as well as emerging challenges posed by degradation of water commons and climate change. Continuous examination of the emerging challenges need to continuously inform the discourse on transboundary water development and management.

Contents

CONTEXT

Water is intrinsic to ecosystems, lives and livelihoods. That 60 per cent of the human body contains water reveals the fact that human survival is not possible without it. We need water for drinking, growing food, generating electricity, and meeting recreational, cultural and religious needs. Water is a natural coolant as well as a solute that flushes out sweat from the human body and pollutants and dirt from human-built systems. Water in nature has the capacity to recuperate its quality loss as long as the pollutant loads do not exceed a threshold. Despite its fundamental role in nature and society, water is taken for granted. The approach to water development, use and management has not overcome its degradation.

The amount of water on the earth today is as much as it used to be millions of years ago. From space, the earth with its oceans looks blue and is rightly called the Blue Planet. But ocean water is saline and unfit for human use. Of the total water on earth, only 3% is fresh. If this amount of fresh water estimated at 36x106 km^3 were allocated for each inhabitant of this planet, he/she would have a share of five million cubic meters[1]. This mathematics, however, is meaningless because fresh water is neither evenly distributed on earth nor is available continuously for 24 hours, 365 days. Most of the water is available in areas where people do not live: Arctic, Antarctic, snow covered mountains and glaciers. The melt of glaciers and snow deposits sustain flows of rivers, which are also augmented by rainfall within regional hydrological cycles. Groundwater, lakes and ponds are other important sources of fresh water for a majority of the people.

The advent of the 19th century saw widespread use of science and technology to develop infrastructure such as dams, barrages and canals. In the industrialized west, these investments did meet the objectives for which they were implemented—drinking water, irrigation, hydropower and flood mitigation. Subsequently, the high cost of this approach on the ecosystem and the dependent downstream communities have been evident. The ecosystem faced irreversible damages while many local communities lost their means of living. In the developing world, the use of this approach has neither improved services nor maintained the health of fresh water bodies.

The applications and approaches to water development and management that progressed in the industrialized countries have not resonated well with the developing countries, who have different social, political and governance contexts. While the historical mismatch remains, high rates of urbanization, land-use alterations and global climate change have introduced new challenges. These relate to harnessing, use and equable management of water to meet various needs while also maintaining its overall quality. Use and management of trans-boundary rivers, lakes and groundwater are even more difficult. Countries sharing such freshwater sources have not been successful in ensuring quality of services from water infrastructure, reversing its degradation, and promoting stewardship in managing water at the local and basins scales.

The degradation of fresh water threatens millions living in Nepal, India and Bangladesh in the Ganga River Basin (GRB). The major tributaries and the Ganga River have been harnessed for irrigation, hydropower generation, and drinking water supply benefits to rural and urban areas. To obtain these benefits, Nepal and India have signed agreements on the Koshi, Gandaki and Mahakali rivers in 1954, 1959 and 1996, respectively. The first treaty on Mahakali concluded in 1920, was subsumed in the 1996 Integrated Treaty on the Mahakali River. These treaties have paved the way for construction of barrages, canals, hydropower plants and embankments and have brought some benefits. However, they have also resulted in many unintended consequences.

The performances of irrigation canals have been poor and embankments have led to waterlogging, while flood plains and settlements have become more vulnerable to floods. Mixed results have been observed where embankments have been built to save flood plains from overflowing and to save lives, properties and damage to infrastructure. At places they have brought some relief immediately after they were built but in many cases, they have caused waterlogging and prevented floodwaters from depositing fertile silt on land, in turn hampering soil build-up and gains in agricultural productivity.

Increasing urbanization, land-use changes, changes in flow regimes, floods, sedimentation and pollution further stress fresh water and affect hundreds of thousands of people in the GRB dependent on rivers, lakes and wetland for livelihood. Intertwining with social and political sources of vulnerabilities, these processes further threaten their

FIGURE 1

Ganga River Basin

livelihoods. Climate change induced increase in temperatures and evaporation are affecting patterns of rainfall and increasing threats of deadly heat waves and droughts in the GRB. The higher frequency and instances of extreme rainfall, impeded drainage and poor management have exacerbated flood disasters with serious consequences to people in both rural and urban areas in the GRB.

In addition, competing and often conflicting priorities add to the challenges of equitable use and management of water in a way that minimize its degradation and promote stewardship. To chart a new path for stewardship, answers to a number of questions are needed: What specific lessons do past projects, particularly trans-boundary investments, provide? Who has benefited from the investment? Who has faced the burden and why? Who pays? At what scale should solutions be sought? Other important questions are: How competing water needs can be reconciled? What adaptive measures can be promoted to deal with changes in the local and regional hydrological cycles emanating from rising concentration of green house gases? Past agreements on trans-boundary rivers have not critically assessed performances of the investment within countries. These efforts have also failed to assess the emerging challenges due to climate and other change processes.

To answer these questions and promote stewardship, lessons must be gleaned from the study of existing trans-boundary water development efforts: agreements, operations and management of infrastructure. It is important to promote public dialogues and conversations to help governments devise appropriate strategies to use and manage trans-boundary rivers that encompass these challenges. The dialogues must bring users, researchers, decision-makers and civil society actors as participants along with governments, their agencies, and the private sector. The dialogue platforms should encourage participants to examine assumptions behind policy-making, the performance and to suggest solution pathways agreed as equitable and sustainable.

This paper uses the Gandak Agreement between Nepal and India as a case to assess performance of the infrastructure built within its ambit and the value to the people at the local level. It examines the state of services provided by the infrastructure that serve Nepal's specific geographic region. The paper also presents the unintended consequences of the interventions and some of the ongoing dynamics. It presents a way forward for a more inclusive and deliberative process of conversation with the objective of promoting stewardship of water at local, national and trans-boundary scales.

River System

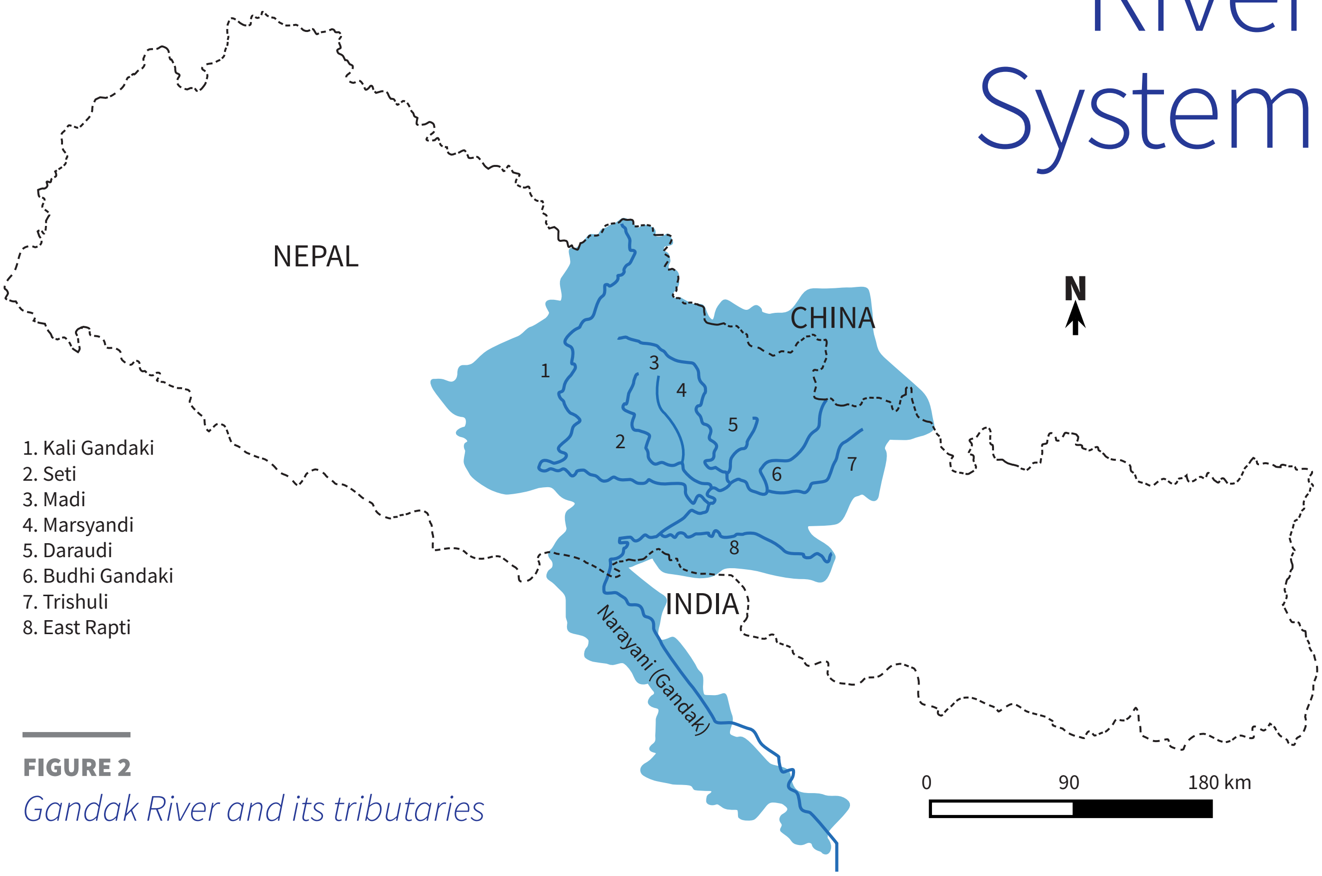


FIGURE 2

Gandak River and its tributaries

The Gandak River Basin (GaRB) drains Nepal's central region and lies between the Koshi and Karnali river basins. It has a total area of 34,960 km^2, 5,334 km^2 of which lies in Tibet. The basin includes high mountain peaks like Annapurna and Dhaulagiri as well as at least 338 glacial lakes[2]. The Gandak is one of the four snow-fed Himalayan Rivers of the GRB in Nepal and is fed by seven major tributaries: the Trishuli, Budhi Gandaki, Marsyangdi, Seti, Daraundi, Madi, and Kali Gandaki. The Kali Gandaki, which is also known as the Krishna Gandaki in Nepal, begins in the Tibetan plateau north of the Annapurna and Dhaulagiri ranges. It has a pre-historic origin: as the Himalayan range began to rise, following the collision of the Gondwana and Eurasian plates, the river began cutting through the range and flowing through what has become the deepest gorge in the world.

As the Kali Gandaki hurtles south towards what was once known as the Tethys Sea, six major waterways, and numerous smaller ones, draining Nepal's Middle Mountain region merge with it upstream of Devghat in Nepal, from where it enters the Tarai plains. From this point onwards, the river is called Sapta Gandaki (Seven Gandaki), or Narayani in Nepal. In India, the river is called the Gandak. As the river enters into the Chitwan Valley, it turns westward before again veering south through the Chure (Shiwalik) range and crossing the Nepal-India border at Bhaisalotan. Before entering into India, the East Rapti River and the Riu Khola join the Narayani in Chitwan Valley. The augmented river then cuts through the Chure-Daaunne hills and flows into West Champaran in North Bihar. The Gandak River joins the Ganga west of Patna in India.

The GaRB gets most of its rainfall from the moisture-laden monsoon winds that blow from the Bay of Bengal between June and September. This southwesterly monsoon brings 80% of the basin's annual precipitation in about 1,800 mm of rain. The remaining 20% of precipitation is the result of westerly disturbances and pre-monsoon convectional rainfall. The Chure range on the southernmost edge of the Himalaya produces a major transition in the morphology and flow of rivers coming from the mountains. During the monsoon, the region receives much rainfall, from a light drizzle to intense cloudburst at times. On high slopes, snowfall is common and its melt as well as that of glaciers sustain the flows in the dry season.

The topography has a significant influence on the temperatures and precipitation patterns of the basin. Rainfall has macro, meso, and micro characteristics as the orographic effect causes large local variations in rainfall within a single valley. A cloudburst over one ridge might generate more than 500 mm of rainfall in 24 hours while another ridge might be perfectly dry. The people in GaRB report that rainfall patterns are changing; their assertions are confirmed by historical trends. Unfortunately, Nepal has few rainfall stations to allow for detailed analyses of micro-climates and the ongoing changes. The mean flow of the Narayani River at Devghat is 1,600 m^3/s. The minimum and peak-flood flows are 190 m^3/s and 21,000 m^3/s respectively and the river transfers 7.5 million m^3 of sediment annually[3].

Gandak River Agreement

The governments of Nepal (GoN) and India (GoI) signed the Gandak Agreement in 1959, five years after they signed the treaty on the Koshi River in 1954. The colonial British government had been contemplating to use the Gandak River for irrigation from as early as the 1870s. During this period, North Bihar and North-eastern Uttar Pradesh faced recurrent monsoon failures and droughts. The persistent droughts intertwined with the prevailing political economy to heighten food deficiency, loss of local livelihoods and famine[4]. In 1871, an irrigation canal using Gandak River was planned but its construction could not be started immediately due to two reasons. Firstly, the investment involved was fairly large, and secondly, technical knowledge and capacity to build the structure did not exist, at least at that time. Basic information of river hydrology, sediment flow and behavior available were deficient. The construction of the canal with a side intake began in 1897 and was completed in 1914. The infrastructure included 98 km of main and 298 km of secondary canals providing seasonal irrigation to 109,200 ha of land in North-eastern Uttar Pradesh. Problems associated with intake, control and distribution of water made operation of the canal unsatisfactory. Thus, as expected, the canal system did not provide relief from drought. Providing dependable, reliable irrigation remained an incomplete goal[5] which set the stage for the Gandak barrage project.

The proposal took on a tangible shape in the late 1940s when a design for its construction was made and the Gandak Project was contemplated with an objective of providing year round irrigation in North-eastern Uttar Pradesh and Bihar. The barrage site would be located at Bhaisalotan, downstream of the Chure hills in Nepal. This was close to where the Gandak River debouched onto the Ganga plains. Earlier barrages had been built in the Koshi and (Mahakali) Sharada rivers in the Tarai piedmont along the Nepal-India border. These earlier investments provided the confidence to successfully undertake the design and development of the new barrage project. Unlike the two earlier barrages, the Gandak barrage was built on a narrower flood plain with comparatively fairly stable riverbed. The Nepal-India border passes through the middle of the barrage. Geography seemed to matter but location of all the three barrages along Nepal India border showed that political concerns were also influencing factors.

The agreement signed in 1959 formed the basis for the construction of barrage, canal systems serving in India and Nepal, a hydropower plant to supply power to Nepal as well as afflux bunds, spurs and embankments. The political parties and citizenry in Nepal questioned the inequitable provision of benefit sharing including restrictive arrangement on water and its rights in the agreement. Some saw them as contrary to the interests of the country. Later the certain provision of the agreement was revised.

One particularly objectionable provision was Clause 9: *"His Majesty's Government will continue to have the right to withdraw for irrigation or any other purpose from the river or its tributaries in Nepal and such supplies of water as may be required by them from time to time, and His Majesty's Government agree that they shall not exercise this right in such manner as is likely in the opinion of the parties hereto prejudicially to affect the water requirements of the Project as set out in the schedule annexed hereto."* The schedule affixed in Appendix II was as follows. The annex seemed to seek assurance of water demand in the eastern and western canals serving territories in India (Box 1).

System Elements

After the signing of the agreement, the construction of the project began in 1963 and was completed in 1968 at a total cost of IRs 520.3 million. Under the project, the following infrastructure were constructed (Table 1).

Irrigation: The Gandak Barrage Irrigation and Power Project (GIPP) was designed to provide irrigation in North-west Bihar as well as in the doab upstream of the confluence of the Ghaghara and Gandak rivers in North-east Uttar Pradesh. The total area to be irrigated in India was 1.784 million ha. Nepal, for its part, was to receive 8.5 m^3/s of water from the barrage via the Nepal Gandak West Canal (NGWC) to irrigate 8,700 ha of land in Nawalparasi District. In addition, the Don Canal that feeds into the Nepal Eastern Canal (NEC) was to provide 24.1 m^3/s water to irrigate 37,000 ha of land in Bara, Parsa and Rautahat districts. This latter command area is outside the Gandak Basin, therefore its context

BOX 1

SCHEDULE OF WATER REQUIREMENT VIDE CLAUSE 9 OF THE 1959 AGREEMENT

In 1964, Clause 9 was revised as follows: "*His Majesty's Government will continue to have the right to withdraw for irrigation or any other purpose from the river or its tributaries in Nepal and such supplies of water as may be required by them from time to time in the Valley. For the trans-valley uses of Gandak waters, separate agreements between His Majesty's Government and the Government of India will be entered into for the uses of waters in the months of February to April only.*" This revision gave Nepal the right to withdraw upstream water and use it for irrigation or other purposes. However, it did not allow trans-valley use in the pre-monsoon months of February, March and April without a separate agreement.

Clause 10 of the 1959 agreement provided for water allocation in the dry season when the river flow would be reduced, to be done on a pro rata basis, as follows: "*whenever the supply of water available for irrigation falls short of the requirements of the total area under the Project for which irrigation has to be provided, the shortage shall be shared on pro rata basis between the Government of India and His Majesty's Government*." This clause was removed in the revised agreement of 1964, and a new provision was added: "*Also, the head regulator of the Don Branch Canal shall be operated by His Majesty's Government keeping in view the irrigation requirements of areas irrigated by this branch canal in India and Nepal.*"

Schedule of water requirement vide clause 9 of the 1959 agreement

Months	Western canal system and power house in Nepal	Eastern canal system and power house in India	Total
January	6,960	4,540	11,500
February	6,100	3,900	10,000
March	5,960	3,690	9,650
April	5,760	4,3040	10,100
May	8,270	7,980	16,250
June	11,190	14,000	25,190
July	15,240	13980	29,220
August	14,980	14,000	28,980
September	14,980	14,000	28,980
October	16,060	14,110	30,170
November	11,070	13,240	24,310
December	10,410	9,290	19,700

TABLE 1

Infrastructure developed under Gandak Project

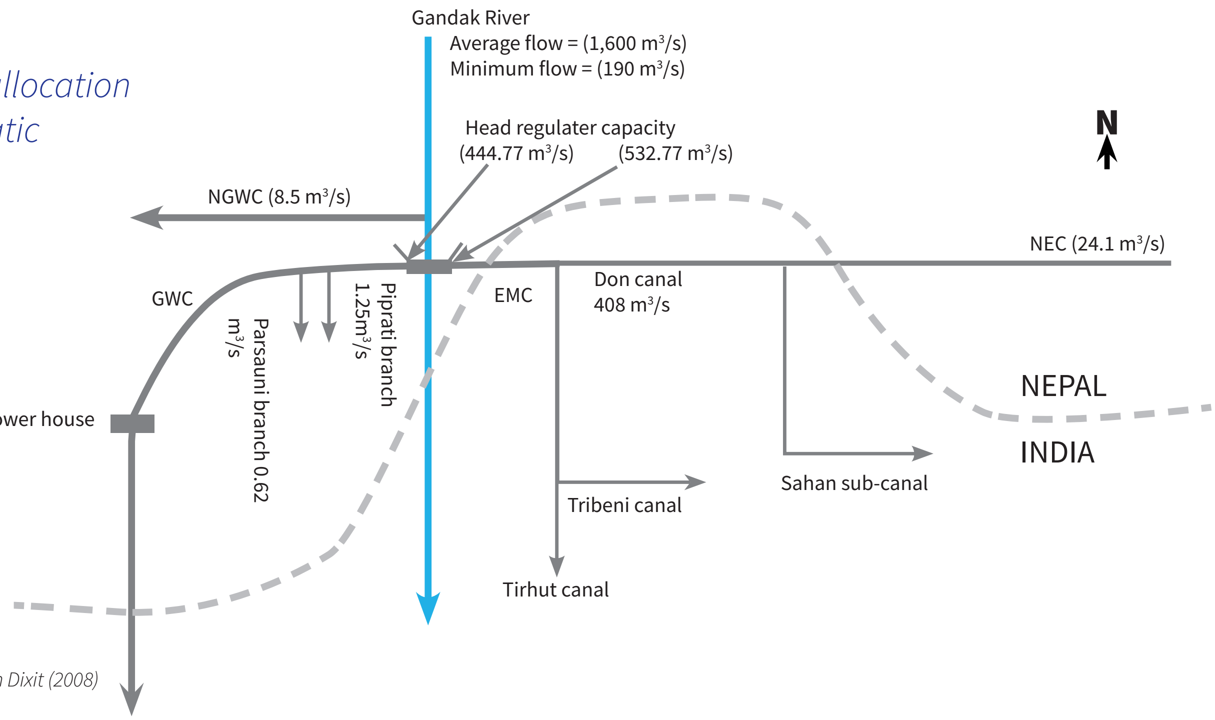
Infrastructure	Details	Details
Barrage	Length 739.33 m 36 bays each of 18.29 m span	
Left Bank Head Regulator	444.77 m³/s	Feeds Eastern Main Canal (EMC)
Right Bank Head Regulator	532.77 m³/s	Feeds West Gandak Canal (WGC)
Benefits in India		
Irrigation	Bihar: $152x10^6$ ha	Gopalgunj, Siwan, Saran, West and East Champaran, Mujjafarpur, Vaiali and Samastipur districts
	Uttar Pradesh: 0.3 million ha	Covers Maharajgunj, Gorakhpur, Deoria and Padrauna districts
Benefits Nepal		
Capacity= 8.5 m³/s	Nepal West Gandak Canal (NWGC)	Gross command Area: 16,000 ha
Capacity = 24.1 m³/s	Nepal East Canal (NEC)	Gross Command Area: 37,000 ha
Hydropower	15 MW	Surajpura

and impacts in Nepal are not discussed in this paper. In addition, the West Gandak Canal (WGC) that supplies water to Uttar Pradesh has outlets to feed into two smaller canals: Parsauni and Piparati canals. These have capacities of 0.62 m^3/s and 1.25 m^3/s, respectively.

Hydropower: Taking advantage of the canal drop in the WGC, a low-head (6.09 m) hydropower plant with a capacity of 15 MW, the first low-

FIGURE 4

Water allocation schematic



Adapted from Dixit (2008)

head plant in the country, was built at Surajpura, Nepal. The plant has three horizontal low-head, high-discharge turbines, each with a capacity of 5 MW. It was commissioned in 1979 with a design specifying an annual electricity-generating capacity of 106.38 GWh. NRs. 170 million was invested to develop the plant. The power generated is transmitted to the Integrated Nepal Power System (INPS) at Bardaghat[6].

Other Infrastructure: The GIPP also supported construction of bridge on the barrage, service roads on canals and crossings. Opened for the public, these service roads on the canal tops allowed vehicular traffic and made commuting easy within the command areas in Nepal. Connectivity was improved and subsequently the north-south roads linked the canal service roads with the East-West highway. Townships and markets emerged along the canal service and link roads. These towns function as centers for supply of agricultural inputs and outlets for agricultural produces.

The canal service road on WGC provides access to Maheshpur border checkpoint in Nepal and through this point, connectivity to Maharajgunj and Gorakhpur, the two major commercial and supply centers in Uttar Pradesh. Similarly, the bridge over the barrage provides alternative routes to travel to Mujjafarpur, Hajipur and Patna, major commercial centers in Bihar.

The Hulaki Sadak (Postal Road) connects the Project area with Bhairahwa and Kapilvastu, which is being upgraded with support from the GoI. In 2015, a 24 km section of the highway connected Sunauli, South of Bhairahawa with the East-West Highway near Bardghat. This new highway is a major development project to be implemented in Parasi following the Gandak Project. The opening of the road is likely to change the economic context of the Parasi region in the coming days.

Dynamics of Benefits and Burden

The emerging dynamics of benefits and burden from the GIPP highlighted in this section cover only small geography and demography in Nawalparasi District. The area served in Parsa, Bara and Rauthat districts by NEC are not the subject of the analysis though this area is hydraulically connected to the Project. This paper presents grounded evidence from WGC and NGWC to inform discourse on trans-boundary water resources development.

Irrigation and Agriculture: Before the NWGC was constructed, farmers in the area used small streams and natural drains to irrigate small areas in patches. The NWGC was designed to discharge 8.5 m^3/s and serve an area of 8,700 ha. In addition, two smaller canals from the WGC—the Piparpati System (1.25 m^3/s capacity) and the Parsauni System (0.62 m^3/s capacity)—were developed to irrigate an additional 1,600 ha. These canals were completed in 1976 and handed over to the GoN in 1979. Subsequently, they were brought into the administration and control of the Department of Irrigation (DoI). The DoI maintains an office in Semari, a town in the command area of NGWC from which it coordinates the operations and management of the system.

The GoI provided support in the construction of the main, secondary, and distributary canals in NGWC with capacities of over 620 l/s. The GoN and farmers were to develop lower order farm conveyance and distribution systems. When the irrigation system was handed over to the GoN, the canals served only half of the command area because distribution-level facilities had not yet been built. In 1982, the Command Area Development Project (CADP) was implemented with support from the Asian Development Bank (ADB) in areas served by NGWC. The aim of this project was to expand the area under irrigation by developing tertiary canals in 50 ha blocks and farm canals to serve 7 to 12 ha of land in each block. This project ended in 1989.

In 1992, the DoI brought the NGWC as well as the Piparpati and Parsauni canals under the Joint Management Program, which itself fell under the Participatory Irrigation Management Policy, a policy that aimed to share the responsibility for canal operations and management between organized groups of users and the DoI. After it was phased out of the CADP, the canal's capacity had declined to a mere 2.2 m^3/s and the area under irrigation command had reduced to 4,000 ha. From 1995 to 2000 the Irrigation Management Transfer Project (IMTP) with supported from the ADB aimed at strengthening joint management of the canal system and improvement of essential infrastructure[7].

With participation of the user farmers under joint management program the area under irrigation again increased. After 2000 when IMTP came to and end, the committees of users working at the main and secondary canal levels became defunct. Maintenance and upkeep did not suffice and irrigation coverage declined steadily. Currently, the canals and water control infrastructure in the system have deteriorated heavily at places. Although silt deposited in the main canal is removed annually, the distribution system is largely unmaintained. The results are decrease of the area under irrigation in the wet and dry seasons in the period of 1995-2003 (Table 2).

An examination of the NWGC's role in improving agricultural productivity is revealing. We compared the yields of major crops across the head, middle and tail reaches of the NWGC with the average yields for the Nawalparasi District. This district has four different ecosystems: Mountain, Siwalik, Valley and the Tarai. The figures of production averaged over the district, though useful for comparison, do not provide valid assessment of the agricultural performance in the command area of NWGC. The crop yields of adjoining Rupandehi District whose agro-ecology is similar to that of Parasi are more appropriate and used. It shows that the yields of major crops in the command of NWGC area are lower than the average crop yields of the Nawalparasi and Rupandehi districts and the national average (Table 3).

This comparison reveals that agricultural performance in the command area of the irrigation system fed by the project is below the irrigation potential. Although it was beyond the scope of the paper to examine time series of changes in the agricultural performance since the completion of Gandak Project, the canal and other infrastructures began functioning, and agricultural professionals working in Nawalparasi suggest that the pace of innovations in agriculture in the area has been slower than in other parts of the district. The slow pace of innovation persists even to this date despite availability of irrigation and despite the fact that the area is connected to major market centers in Nawalparasi and adjoining Rupandehi districts.

There are two reasons for the poor performance of the low irrigation benefit in NWGC. The first is that the intake of water in the main canal depends on the water level upstream of the barrage, a level which is determined by the operation of the barrage gate under the control of personnel deputed by the GoI. This level must be at least 365m for water to flow over the sill level of the main canal of NWGC. This level is not maintained at all times,

TABLE 2

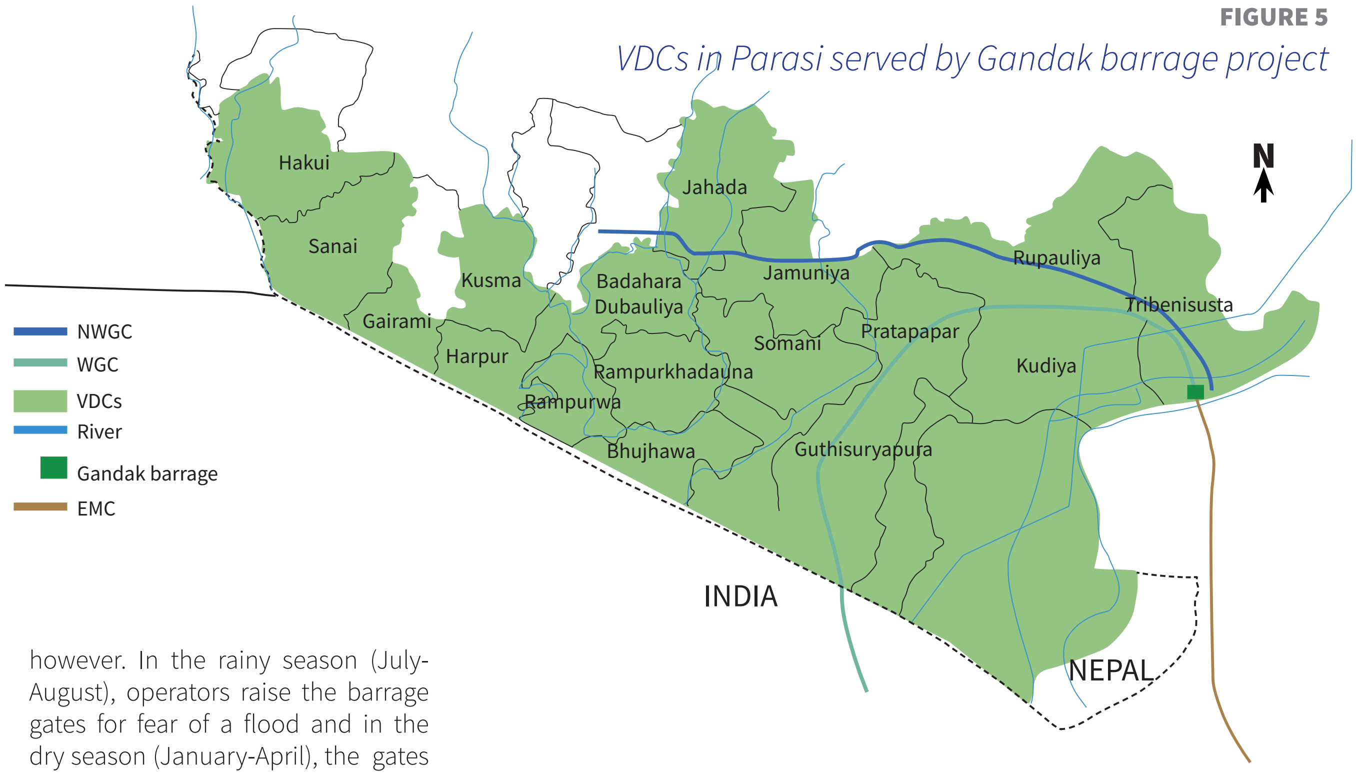
*Irrigation coverage in the NWGC (1995-2003)**

Season	Irrigation Coverage (ha)									
	1992	1995	1996	1997	1998	1999	2000	2001	2002	2003
Wet (monsoon cropping)	4,000	7,623	9,825	7,082	7,082	7,082	7,082	7,082	6,500	5,000
Dry (winter and spring cropping)		2,200	3,800	4,500	4,500	4,500	4,500	4,500	3,500	2,800

**Records for the period after 2003 are not available.*
Source: IOE/TU, 2003

FIGURE 5

VDCs in Parasi served by Gandak barrage project



however. In the rainy season (July-August), operators raise the barrage gates for fear of a flood and in the dry season (January-April), the gates in the canal head are also closed to dredge the reservoir, undertake repair and maintenance and remove silt deposited in WGC and EMC. Theoretically, the NWGC should not face any limitation in water supply in either the monsoon or the winter seasons, but, in reality, supply is unreliable and uncertain.

The second reason for low irrigation benefits is the deficient maintenance and upkeep of canals and water-control structures in the system.

TABLE 3

Yields of major crops in the NWGC command area

Crop	Crop yield (tons/ha) by Canal Reach[1]			Overall (tons/ha)	Yield ton/ha					
					Nawalparasi		Rupandehi		Chitwan / National Mean	
	Head	Middle	Tail	NWGC	2003	2015	2003	2015	2003	2015
Paddy	3.19	2.67	2.80	2.79	3.04[2]	4.02[2]	2.99[2]	4.50[2]	2.88[2]	3.37[2]
Wheat	1.04	1.50	1.96	1.50	2.29[2]	2.85[2]	2.50[2]	3.20[2]	2.06[2]	2.59[2]
Lentil	0.28	0.67	0.30	0.40	-	-	-	-	-	-
Rapeseed Mustard	0.28	-	0.71	0.30	0.75[2]	0.45[2]	0.70[2]	0.66[2]	0.71[2]	0.94[2]
Winter vegetables	-	3.01	3.01	3.01	12.0[3]	-	12.0[3]	-	10.95[2]	13.41[2]
Spring Maize	1.94	1.38	-	1.66	2.12[2]	1.77[2]	2.00[2]	4.11[2]	1.90[2]	2.43[2]
Sugarcane	28	24	22	24	42.5[2]	30.02[2]	52.55[2]	47.74[2]	37.69[2]	42.45[2]

Source: [1]- IOE/TU, 2003; [2]- CBS (2015); [3]-CBS (2003)

The NWGC at the intake, head and middle reaches is silted up and its cross-section is largely unmaintained. The canal system was designed to offer flexibility in the distribution of water. Therefore, check structures were provided at every turnout for farmers to receive water according to their needs. These check structures, however, have become cause for siltation in the main canal.

The irrigation performance of the Piparpati and Parsauni canals is no better than that of the NWGC. Both canals receive water from the outlets built in the WGC, and these smaller canals are served only when the required water level in the canal is maintained. This decision depends on the personnel deputed for operation of the canal. In addition, the canals are so heavily silted that their capacities are lower than those designed. Consequently, only half the designed area is irrigated[8]. The two canal systems receive no water in the late winter and spring seasons when the WGC is shut down for maintenance[9].

It had been expected that the NWGC, along with the Piparpati and Parsauni canals, by supporting year-round irrigation, would diversify the cropping and increase cropping intensity, agricultural productivity and the income levels of farmers. This water-agricultural productivity nexus was expected to enhance and transform the livelihoods of the farming communities in the area. As it turned out, the fact that unreliable water supplies in the canal have not encouraged farmers to diversify their cropping systems, introduce high value crops, or switch to commercial farming. The cropping system is largely cereal-based though some vegetable cultivation occurs in the middle and tail reaches. Only a small number of affluent farmers in this part of the canal command follow this practice. In the absence of dependable irrigation supply from the NWGC, large numbers of farmers have invested in developing shallow tube-wells for supplemental irrigation in the monsoon and to grow crops in the winter and spring seasons.

The completion of the canal did see an increase in the area under sugarcane cultivation after 1995. Initially Mahendra Sugar Mills, established in the late 1960s in Bhairahawa in adjoining Rupandehi District, encouraged the farmers to grow sugarcane. Subsequently three sugar factories were established in the plains of Nawalparasi District. Bagmati Sugar Mill and Indira Sugar Mill were built within the command area of the NWGC and Lumbini Sugar Mills, which is the largest sugar factory in the country, was constructed in Sunwal, a town north of the command area. In 2003, 420 thousand metric tons of sugarcane was produced in Nawalparasi District on 8,500 ha of land, but by 2013, production had declined to 266 thousand metric tons and the area cultivated was reduced to 7,020 ha[10]. Coverage had declined to 5,000 ha in 2016. One reason for the loss in cultivation of sugarcane is that sugar factory operators do not make payments to farmers on time. Payments are often delayed by six months and at times, for years, so farmers have little incentive to invest in sugarcane cultivation, which is more water-and-input-intensive, compared to cereal crops.

This picture of agricultural in the NWGC command demonstrates the need for concerted effort to improve performance. Firstly, the canal system has to be maintained well, and secondly, the reliability of the water supply in canals needs to be improved. That said, irrigation in itself is insufficient to bring about the desired changes in productivity, income gains and improvement in the livelihoods of the people. Other related services such as marketing, pricing and technology support to farmers needs to be simultaneously pursued.

Floods and Inundation: Flooding in the region has two dimensions. First is the case of land area around the NWGC and the WGC, which intercept the north-south flow of local streams whose natural draining are impeded. Because the cross-drainage works in the two canals are both deficient and poorly maintained, the area within NWGC remains inundated for more than three months in the monsoon and early winter, rendering a large swathe of land—about one-third of the command area in the south adjacent to the WGC—out of crop cultivation.

Regular flooding in the Gandak River aslo has impact and is pronounced on the lower region downstream of the barrage. Floods from the Rohini, Tinau, and Banaganga the rivers that drain the region west of Daunne hills, east of West Rapti valley and south of the Chure range regularly affect parts of the Parasi region, Rupandehi, Kapilvastu and downstream areas in Uttar Pradesh. The floods in the Tinau and Banaganga rivers affect the upper parts of the Gorakhpur and Maharajgunj districts in Uttar Pradesh. Floods in the Rohini and its eastern tributaries affect the Parasi region including its southern parts, along the Nepal-India border.

The 1998 monsoon flood in the Rohini River flowing west of the Gandak River had a devastating impact. The monsoon months were very wet that year and extreme rainfall led to widespread floods in Parasi and North-eastern Uttar Pradesh[11]. The floods affected 279 families in Nawalparasi District and washed away a large area of land, damaging property worth over Rs 680,000. India lost 1.393 million hectares of crops in the same flood. After a welcome hiatus of nine years, in 2007, then again in 2013 and 2014, the region suffered severe flooding during the monsoon.

Breaches in embankment and afflux bund are also common. In July, 2002, the right afflux bund near Tribeni Bazaar in Nepal breached 1.5 km upstream of the barrage when river discharge was about 600,000 cusecs (17,003.19 m^3/s). The afflux bund and embankment on the river bank were designed to safely withstand discharge of 850,000 cusecs (24,087.85 m^3/s)[12]. The floodwater flowing through the breach washed crops and properties affecting areas as far as Maharajgunj and Gorakhpur in India. In Nepal, the floodwater smashed NWGC and WGC submerging the land in between the canals for months.

The breaches in embankment raise questions about the ability of the structures embankments to hold swelling rivers and prevent their erosion even though designed to withstand highest level of discharge threshold. Had there been any learnings from this breach,

the Koshi embankment breach disaster would perhaps have been avoided. In August, 2008, the Koshi embankment at Kusaha Sunsari District, Nepal, was breached causing major disaster[13] .

Maintenance of canals and embankments in the Gandak Project, with the exception of the canals that serve areas in Nepal, rests with the GoI. This responsibility is executed through the Water Resources Departments of the states of Uttar Pradesh and Bihar. The canals and embankments are deficiently managed. Clogging of siphons meant to drain rainwater across the WGC, malfunctioning of the silt ejector, erosion of spur and consequently that of land and settlements along the river are perennial problems faced in the Nepali side.

The first 19 km section of the WGC laid in Nepal is poorly drained, and the seepage from it accumulates on land on both sides of the WGC. The lands are waterlogged. Nepali farmers have been highlighting the deficient maintenance of the embankments, canal and related problems, including the 2002 breach of the afflux bund. They began organizing themselves under the banner of Gandak *Nadi Niyantran Sangharsh Samiti* (Gandak River Control Struggle Committee) and putting pressure for proper operation and maintenance of the infrastructures built. They have demanded compensation for the loss of crops and land due to malfunctioning of the structures since the completion of the Gandak Project, and organized a protest on the WGC[14].

Because of one such protest, water was not released from the barrage into the WGC when farmers in Uttar Pradesh needed it for sugarcane plantation as well as for plantation of rice seedlings. The agitating Nepali farmers put forth a 21-point demand, relating to the damages that they faced due to the deficient maintenance of the canals and other structures. The committee framed its demand as follows: “with the construction of the Gandak Project there has been change in the direction of flow of Singaha and Rajpura drains and severe waterlogging has resulted in Paklihawa, Narsahi, Rupaulia, Pratappur, Somani, Khairatwa, Guthi Surapura, Bedauli and Bhujahawa VDCs”.

The farmers demanded that the problem be solved permanently and that losses be compensated for. After several rounds of negotiation with officials of the GoI, the Indian Embassy in Kathmandu and the GoN, a joint working group with experts from Nepal and India, was constituted. The group was assigned to study the problem and recommend actions. In addition, the GoN’s Ministry of Irrigation also examined the problem and reported that 13 villages in the area suffered crop loss and damage to the land. The affected villages were Jamunia, Paklihawa, Kudia, Bhujahawa, Thulo Khairatawa, Guthi Suryapura, Bedauli, Guthi Parsauni, Narsahi, Tribeni, Susta, Rupaulia, Pratappur and Somani. The losses in crops were worth NRs. 2,646.09 million, damages to land, NRs. 189.45 million, and to properties, NRs. 109.56 million. The total damage was estimated at NRs, 2,94 billion[15].

Electricity: The Surajpura Hydropower Plant, built under the Gandak Agreement in the WGC, faces technical problems which have lowered its performance. The problem relates to the complete shutdown of the plant twice a year when the WGC is closed for maintenance. At present, only one of the three units is in operation and in 2015/2016, the plant generated only 16.25 GWh of electricity, much lower than its designed capacity. The plant is being rehabilitated under the Energy Access and Efficiency Improvement Project (EAEIP) with a loan from the ADB [16].

Livelihoods: Contributions versus Disjunction

The infrastructure in Nepal under the GIPP—canals, hydropower plant, flood control embankments, river crossings and canal service roads—were built in the period from 1960 to 1976. In an ideal sense, they should have served to deliver services for the local people and help them develop their livelihood and higher income from irrigation. The systems built should have promoted social and economic development. When adjoining areas in Nawalparasi District and in other parts of the country had little access to irrigation, roads transport, electricity, and communication services, the command served by NWGC already had these facilities.

How have these infrastructure built under the project produced benefits for the local people and contributed to local economy is a question worth examining. This is also one of the objectives of this paper, although it is not possible to answer this question in its entirety. Two other important questions also emerge. The first one relates to the direct benefits to the people in Nepal by the GIPP. Did the people actually benefit from the project and how did these benefits contribute to social and economic changes? The second question relates to the obligations of the GoN and the GoI in maintaining and upgrading the built infrastructure. Only well-maintained infrastructure can deliver quality services, help families and individuals deal with various shocks and adapt. How does the project fare on these counts? Though important, exact answers to the above questions are beyond the scope of this paper given the lack of systematic information on different indicators to assess agricultural and economic development performance in NWGC area.

Yet an attempt has been made to examine the socio-economic conditions of the households of the 22 VDCs served by NWGC using some basic indicators. The indicators used are access to drinking water, energy for cooking and lighting, communication, literacy and educational attainment. They are then compared with that of adjoining districts and the country (Tables: 4, 5 and 6). The findings are not encouraging, however. In the four decades since the project was completed, only 12% of the households in the 22 VDCs have had access to piped drinking water supply, 28% have had toilets in their homestead, 91% have used firewood and cow dung cake to meet energy needs for cooking, 77% have been connected to electricity, 66% have had access to radio and television, 62% have had terrestrial or cellular mobile phones and 12% have had motorized means of transportation (four wheeled vehicle or motorbike) of their own (Table 6). Similarly, male and female literacy in the VDCs stands at 78.48% and 48.86% with overall rate at 60 per cent. Only 959 men and 341 women have made it through tertiary level education. The percentage of male and female population having passed secondary level education stands at 28% and 17% respectively. 30% male and 23% female have completed formal schooling from grades 4 to 6.

Thus, the VDCs served by the GIPP is poorer compared to Nawalparasi District and adjoining Chitwan and Rupandehi districts (Table 6) when access to amenities is examined and these statistics reveal very slow socio-economic development processes. Recurrent damages to lands and crops by flooding, poor irrigation coverage, lower crops yields, and low level of innovations in the diversification of cropping pattern partly explain the reasons for the low socio-economic development.

TABLE 4

Socio-economic status of households in Parasi served by NWGC

VDCs	Total House holds	Main source of drinking water			Households With toilets	Fuel used for coo	
		Tap/piped water	Tube-well / hand pump	Others		Firewood + cow dung	Biogas
Tribenisusta	2,029	504	1,350	159	1116	1764	57
Rupauliya	1,747	528	1,202	9	1054	1593	46
Kudiya	1,789	15	1,756	8	327	1690	14
Pratappur	1,258	16	1,206	31	363	1167	11
Jamuniya	1,698	29	1,641	16	783	1257	68
Narsahi	953	224	692	26	223	898	5
Pakalihawa	1,656	11	1,629	3	256	1591	1
Guthi Parsauni	1,248	9	1,191	32	192	1172	10
Baidauli	906	473	395	34	136	893	1
Guthisuryapura	827	219	577	24	114	803	2
Somani	1,143	23	1,084	20	235	1103	1
Thulo Khairatawa	746	80	641	21	113	705	1
Bhujahawa	1,088	14	1,064	6	171	1060	0
Rampur Khadauna	717	0	704	3	93	695	3
Badahara Dubauliya	1,251	7	1,219	6	144	1192	8
Jahada	1,698	20	1,650	16	939	1158	219
Kusma	1,079	15	1,053	2	271	1006	9
Harpur	1,086	30	1,049	3	172	1063	0
Gairami/ germi	1,006	255	740	6	112	983	2
Sanai	1,166	3	1,157	0	145	1120	10
Hakui	1,044	24	984	18	93	982	2
Total	26,135	2,463	22,984	443	7,052	23,895	470

oking	Source of lighting			Means of communication		Means of own conveyance	
LPG	Electricity	Renewable (Bio-gas and solar)	(Kerosene)	Telephone + cellular mobile	Radio+TV	Motorized	Non Motorized
186	1,586	120	307	1436	2159	216	1595
90	1,540	9	190	1123	1857	152	1440
34	1,410	3	365	1174	1080	169	1595
56	1,030	2	221	871	754	195	1097
274	1,443	9	234	1325	1426	365	1445
40	737	3	205	722	604	139	844
7	989	4	650	841	605	260	1353
33	650	6	158	314	591	146	1105
2	636	1	258	276	300	120	800
8	650	6	158	346	483	144	745
11	857	2	267	682	786	126	1044
2	517	3	222	148	258	63	681
10	726	6	351	557	479	122	929
4	471	3	233	208	289	66	611
18	850	7	375	793	739	107	1090
231	1,527	2	155	1430	1649	326	1434
43	863	12	195	800	495	190	926
18	892	8	182	722	604	119	940
8	862	3	134	599	394	129	884
17	928	3	228	734	497	104	1045
16	882	15	126	821	654	95	918
1,108	20,046	227	5,214	15,922	16,703	3,353	22,521

TABLE 5

Demographic details

Name of VDCs	Population		House-holds	Literacy Rate			Educational Attainment					
	Male	Female		Total	Male	Female	Primary (1-5)		Secondary (5-12)		Tertiary (Graduate and above)	
							Male	Female	Male	Female	Male	Female
Tribenisusta	4,489	5,273	2,029	68	75.84	62.03	959	676	813	363	33	16
Rupauliya	3,977	4,599	1,747	67	73.54	61.34	1268	1098	1161	1211	36	23
Kudiya	4,888	5,170	1,789	61	71.98	50.98	1700	1362	1137	731	39	14
Pratappur	3,697	3,704	1,258	61	72.92	48.87	1116	889	1211	720	64	27
Jamuniya	4,413	4,812	1,698	68	78.44	58	1324	1074	1591	1266	97	43
Narsahi	2,886	3,129	953	55.47	67.97	44.02	922	740	700	439	19	8
Pakalihawa	5,261	5,193	1,656	53	64.21	42.45	1773	1295	1242	694	30	12
Guthi Parsauni	4,036	3,797	1,248	53	63.8	41.92	1205	881	961	476	93	48
Baidauli	3,077	2,927	906	55	67.55	41.39	959	676	813	363	33	16
Guthisuryapura	2,796	2,677	827	61	73.88	46.85	847	609	930	475	52	18
Somani	3,333	3,438	1,143	63	76.99	49.26	1133	848	1052	614	37	5
Thulo Khairatawa	2,500	2,313	746	57	69.84	43.31	840	550	651	295	22	9
Bhujahawa	3,294	3,176	1,088	54	66.41	40.98	1012	690	795	374	47	13
Rampur Khadauna	2,272	2,226	717	53.01	65.15	40.54	656	491	672	322	36	9
Badahara Dubauliya	3,665	3,782	1,251	49	61.39	36.69	1098	782	889	466	39	5
Jahada	3,955	4,504	1,698	71	80.98	63.3	1009	990	1631	1463	74	21
Kusma	3,270	3,488	1,079	63	76.53	49.61	1082	909	904	431	56	19
Harpur	2,963	3,185	1,086	58	69.33	48.2	872	828	830	445	38	13
Gairami/ germi	3,008	3,037	1,006	56	68.19	44.07	864	703	829	406	33	9
Sanai	3,543	3,616	1,166	59	72.8	44.85	1059	861	1031	485	35	6
Hakui	3,016	3,300	1,044	61	74.95	49.01	848	777	998	535	27	0
Total/ Average	74339	77346	26,135	59	71.08	47.98	22,546	17,729	20,841	12,574	940	334

** The women population is not representative of Nepal's demography.*

TABLE 6

Socio-economic status of households in Parasi served by NWGC Nawalparasi , Rupandehi and Chitwan

Attributes	VDCs in Parasi served by Gandak Project	Districts		
		Nawalparasi	Rupandehi	Chitwan
Total Households	27,523 (100)	128,760 (100)	163,835 (100)	132,345 (100)
Households with piped drinking water	2,463 (12)	51,829 (40)	62,904 (38)	46,289 (35)
Households with toilet	7,052 (28)	79,826 (62)	95,883 (59)	124,523 (94)
Households using fuel wood and cow dung as energy for cooking	23,895 (91)	98,273 (76)	95,883 (59)	65,144 (49)
Households with electricity	20,046 (77)	104,202 (81)	132,073 (81)	113,728 (86)
Households with radio and television	16,703 (65)	118,814 (92)	132,054 (81)	132,000 (100)
Households with telephone and cellular mobile phone	15,922 (62)	104,656 (81)	143,106 (87)	122,341 (92)
Households with own motorize vehicle	3,353(12)	15,947 (12)	31,335 (19)	29,295 (22)
Literacy rate	59	70	80	87

BOX 2

GANDAK PROJECT IN INDIA

The Gandak Barrage serves an area of 1.4 million hectare in Bihar and Uttar Pradesh, an area facing poverty and food in-security. The Project, however, has not significantly improved agricultural productivity in its command areas: the utilization of irrigation potential ranges from 56 to 69 per cent. In 1975, the Government of Bihar (GoB) created Gandak Area Development Agency (GADA) for integrated development of command areas of canal systems in the state to coordinate efforts of agricultural intensification through infrastructure and technology support. This input led to increase in the cropping intensity: 115 per cent before GADA to 157 per cent by the end of 2000. The productivity of paddy increased from 0.76 t /ha to 1.37 t/ha and that of wheat in the same period from 1.48 t/ha to 1.98 t/ha. Yet, both are lower than achievable potential in areas with irrigation facilities. Not only has the potential remained unutilized, anecdotal evidence suggests that the farmers in the command area continue to face social and economic hardship[17].

Issues and Challenges

The above discussions highlight the following issues and challenges:

Benefits and Impacts: The benefits planned in the designs of the Gandak Project did not materialize. For instance, the canals serve a smaller area than planned and farmers complain that there is little coordination between them and the barrage operators. Water is released irregularly and without prior consultation though farmers have repeatedly requested the operators of the barrages to release it on schedule. As a result, the gains in agricultural productivity have been far less than anticipated. Farmers do not possess the capacity to ensure a regular supply though they recognize the importance of their participation in these tasks and need for capacity-building to undertake them.

In the GaRB, dialogue at a trans-boundary level are limited to the region around the barrage. The command areas in Nepal Tarai and in Uttar Pradesh face recurrent flooding but the issue is dealt with within the national boundaries. There is no trans-boundary mechanism to address the challenges of flooding except Nepal-India standing committee on inundation whose performances is questionable. Embankments and dykes are in use but they offer no respite. So, the governments of both India and Nepal repeatedly find themselves having to provide relief to those affected by floods. There is no synergy among the agencies of Nepal and those of Bihar and Uttar Pradesh in India to mitigate the impacts of flood disasters.

In the upper Gandak catchments, the focus on hydropower and the preference for electricity dominates other uses of water, and projects are being built by both private-sector and public-sector agencies. For instance, a proposal to develop a reservoir project on the Budhi Gandaki, one of the tributaries of the Gandak River, which will generate 1,200 MW of power, has been planned[18]. The reservoir will produce regulated flow but benefits on downstream regions have not been discussed.

Groundwater use : Unreliable availability of water from NWGC has led farmers to seek alternatives to irrigate their crops in winter and spring seasons. Farmers increasingly depend on conjunctive use of canal and groundwater for irrigation in monsoon and winter crops while groundwater is the only source in the spring season. Although exact information is not available, more than half of the farmers maintain one or more shallow tube-wells. The smallholders, who do not have tube wells and pumps of their own, irrigate crops by paying rental for tube well and pump to those who own the equipment leading to growth of a groundwater market. Most shallow tube wells are 30 to 60 feet deep with casing pipe of PVC, 4 inch in diameter and slotted mild steel screen and well plug are common materials used. The cost of installing a shallow tube well is of NRs. 60,000 to 100,000 and the local artisans drill the shallow tube wells. A 5 to 8 HP diesel or electric pump, which costs additional NRs. 60,000-80,000 depending on the model that pump water at an average of about 12 liters per second is used. Availability of low cost Chinese make pumps in the local market has increased affordability of technology even to smallholders.

There are two visible consequences of increased dependence of farmers on groundwater for irrigation. The first is the increase in the cost of crop production, where small holders are put to disadvantage, as they cannot compete with the larger producers in the market. In addition, agricultural products from across the border get free entry in the local market are comparatively cheaper due to high agricultural subsidy that the farmers receive from the government. Although, no visible consequences of higher rates of groundwater pumping is evident as yet, this could become a problem in future as urbanization along the roads and highways converts agricultural lands into built up and paved areas. Shallow aquifers in Tarai are recharged locally, through rainfall and accumulated runoff as it flows through local water bodies. Unregulated urbanization would mean impeded recharge, depletion in groundwater and increased constraints for locals to access the groundwater for irrigation and drinking water uses.

Another consequence is high arsenic concentration in groundwater in region of Nawalaprasi District south of East-West Highway. The GoN and other organizations have promoted the use of arsenic filters as mitigation measure for drinking water. No viable mitigation measure is available to remove high arsenic from groundwater used for irrigation. Thus, the risk of arsenic reaching the food chain through water routes remains. This problem is also common in plains of Eastern Uttar Pradesh, Bihar, West Bengal and Bangladesh.

Operation and Maintenance: The operation, management and maintenance of the canals and barrage are inadequate. Sediment deposits in canals and siphons reduce their capacity to convey water. When water ceases to flow below the blocked and section, it spills over the sides of the canals causing more damage to the banks. The sluice gates, which are built in the embankments to allow tributaries to flow into the main river, are not regularly cleaned either. Their metal gates have rusted and cannot be opened and closed easily to regulate flow. Thus, water ends up inundating the land outside the embankments and causing waterlogging. Low performance and unintended consequences have eroded the confidence of the people in the capacity of the state agencies to deliver service.

Roads and Transportation: The tops of the canals along the banks are used as service roads over which the residents of villages travel. Though these roads have increased connectivity, they are poorly maintained and in some places, people have built homes along the service roads without permission. Many settlements within the command area still wait to be connected by roads. The demand for new roads has increased. The construction of roads is perceived as a prerequisite to other forms of development. Roads increase people's connectivity to markets, schools, health posts and hospitals. They also allow local people to commute from where they live to where they work.

The prevailing approach is to design, construct, and operate new roads, bridges and culverts without considering their implications for flood peaks or, for that matter, the impact of floods on roads. In 1998, 2002, 2007, 2013, 2014 and 2017 Parasi faced widespread flooding due to excessive rainfall and also due to constrained local drainage systems. The building of highways, embankments and the afflux bunds of barrages on small streams across the border in India has caused widespread inundation in the Nepal's southern Tarai. However, this issue remains largely unaddressed despite the fact that inundation decreases local well-being and degrades water sources.

Compensation: Many people that were involuntarily displaced many years ago when the barrage and related structures were constructed have still not been compensated. At the same time, losses due to inundation, sand-deposition and bank-erosion have been increasing in frequency. The involuntary displacement of local communities is treated as a bureaucratic problem rather than social challenge. Local civil society actors highlight the issue of unpaid compensation but their voices remain largely unheard.

Compliance: The head regulator of the NWGC is 11 feet higher than that of the WGC. Thus, water from the river can enter the NWGC only when the level upstream of the barrage reaches this threshold. Even when water does flow into the canals, only the main canal receives it; distributaries and tertiary canals remain without water due to poor maintenance. The capacity of local institutions to deliver the designed services to the targeted beneficiaries is low.

Community Activism: The affected communities have persisted and raised voices. They have demanded improvements in service delivery, the sharing of legitimate benefits, and new livelihood opportunities. Affected families have established the Gandak River Control Struggle committee and demanded compensation and rehabilitation. This step has helped their voices to be heard at the local, national and even transnational levels. Earlier, their demands for compensation did not receive a fair hearing. The alignment of powerful forces means that top-down solutions that cast aside grassroots issues and concerns are the norm. Only when local communities were organized with support from intermediaries with a built-in knowledge base and some sort of evidence, were they able to engage the government agencies and political leaders and paid compensation. Civic activism may appear "adversarial" in a polity unused to it, but it is actually a fundamental aspect of a society's progression towards a participatory democratic path. The space for civic activism therefore must be nurtured; social activists need to highlight disjunctions between promises and delivery. Such activism can play the role of a power balancing local institution and help maintain quality of local fresh water ecosystem.

Way Forward

The Gandak Agreement accomplished what it had set out to do: construct the Gandak barrage and its appurtenances. On other counts GIPP's performance however is low and less than satisfactory even when conventional metrics are used. The management of the allocated water, production increase, and security from floods, alleviation of poverty, reduction of vulnerability and promotion of overall well-being of the households in Nepal's specific geographic region fall short of expectations.

The preamble of Gandak Agreement says, "…Government of Nepal and Government of India consider that it is in the common interests of both Nepal and India to construct a barrage, canal head regulator and other appurtenant works about 1,000 feet below existing Tribeni Canal head regulator and of taking out canal systems for purpose of irrigation and development of power for Nepal and India …. And where as in the view of common benefits …… His Majesty's Government have agreed to construction of said barrage, head regulators and other connected works as shown in the plan……" The two key words in the preamble, 'common interest' and 'benefit', set the premise of the Agreement.

How has the "regulated" flow produced incremental benefits in Nepal and India? Do these benefits serve the interests of the two governments, and more specifically, that of the common people living in GIPP service area? are some key questions. The agreement may have met the objectives of the two governments when it was concluded in 1959, but the GIPP neither produced benefits as promised nor served the interests of the people in the area as anticipated. Till 1976, the GIPP was being developed and there were high expectations among the local people for a better future. Benefits were yet to come while the State power had been marshaled to deploy technology changing the stock and flow of the Gandak River at Bhaisalotan. Some benefits accrued immediately but have largely remained elusive even four decades after the GIPP's construction is completed. People remain unsure as local livelihoods have not been built and hardships have not been minimized.

Inequitable benefit sharing is an issue of debate in all trans-boundary water treaties between Nepal and India. While the issue of dissatisfaction is played out at political levels in Nepal and India, the question of benefits and burden that technological deployment brought to the people living in the vicinity of the projects remains localized. Statistics shows that inhabitants of the 22 VDCs in Parasi, 27,523 households identified as beneficiaries of the project have shared the burden more than the benefits from the GIPP. Dependable and year-round irrigation allocated to NWGC has been inadequate and unreliable. The responsibility of delivery of irrigation water rests with the barrage operators under the GoI and the GoB. They neither coordinate nor communicate the schedule of barrage and canal operation with irrigation agencies and farmers in Nepal.

The unreliability of delivery despite availability of infrastructure means that cropping diversification have not taken place and agricultural practices have remained at subsistence level, crop productivity has been low and value addition to agriculture deficient. Unreliable irrigation supply has forced the farmers to invest in developing tube wells and pumps either independently or conjunctively with surface water. But local farmers face continued threat of inundation and flooding due to inadequate maintenance of natural drainage. Constrained waterways and uncleared debris below aqueducts further lead to upstream inundation. The hydropower plant, designed to benefit Nepal, faces technical and operational hurdles. The electricity generated is much lower than envisaged in the design. Much of the problems emerging from operation of the barrage and canal can be addressed by improving consultation between Indian and Nepali officials. No institutional mechanism for such consultation, however, is in place.

The socio-economic indicators of the households in NWGC command, who are the direct beneficiaries of the GIPP in Nepal, are low compared to those of Nawalparasi District and adjoining districts of Rupandehi and Chitwan (Table 6) though the area had seen though construction of irrigation canal, hydropower plant, service roads and bridges over crossings as early as mid 1970s under GIPP. The socio-economic indicators are indicative of low level of value addition by GIPP in achieving socio-economic well-being.

Irrigation is one among many inputs for supporting agriculture. Quality seeds, fertilizer, crop protection, market infrastructure, connectivity and agro-industrialization must support access to reliable water for enhancing agricultural productivity. The assumption that construction of irrigation infrastructure itself would increase agricultural productivity and provide returns on land and labor is misplaced. Without continued innovation in technological support and access to knowledge, agricultural production cannot be increased. In the GIPP-dependent area in Nepal, this support has been grossly inadequate and farmers still follow conventional farming practices. The opportunities for diversification are low. This limitation points towards the need for updated access to knowledge on farming issues, technological support and strengthened extension mechanism. This latter support is necessary if irrigation is to produce a multiplier effect on agricultural productivity, household's income and local economy.

The NWGC was identified as a sugarcane growing area. Theoretically tropical climate, sandy loam soil and availability of irrigation water create ideal agro-ecology for sugarcane production. The NWGC does have these attributes. Initially, the acreage under sugarcane increased but started to decline because farmers did not get right prices for their produces. The delayed payments by sugar factories to farmers created disincentives for continuing cultivation. If government support is synchronized with incentives of sugarcane farmers and sugar factory operators, these limitations could be addressed. Thus value addition to agriculture would require a different institutional mechanism that incentivizes farmers through support of knowledge, technology and assurance of correct price for the produces at right time.


@Dixit, A.
Aqueduct in canal

The issues identified above are local, dynamic and context specific. The burdens faced by the farmers also emanate from use of embankments for flood mitigation and canals interfering with local hydrology that produces unintended consequences. In NWGC and around. The rivers and streams flow from north to south while the canals are aligned east to west and have caused local hydrological disruption. Few cross drainage structures are provided. The structures are provided with smaller waterways and are poorly maintained. Thus water accumulates on the land on both sides of the canals, inundating the area that was a prime agricultural area earlier.

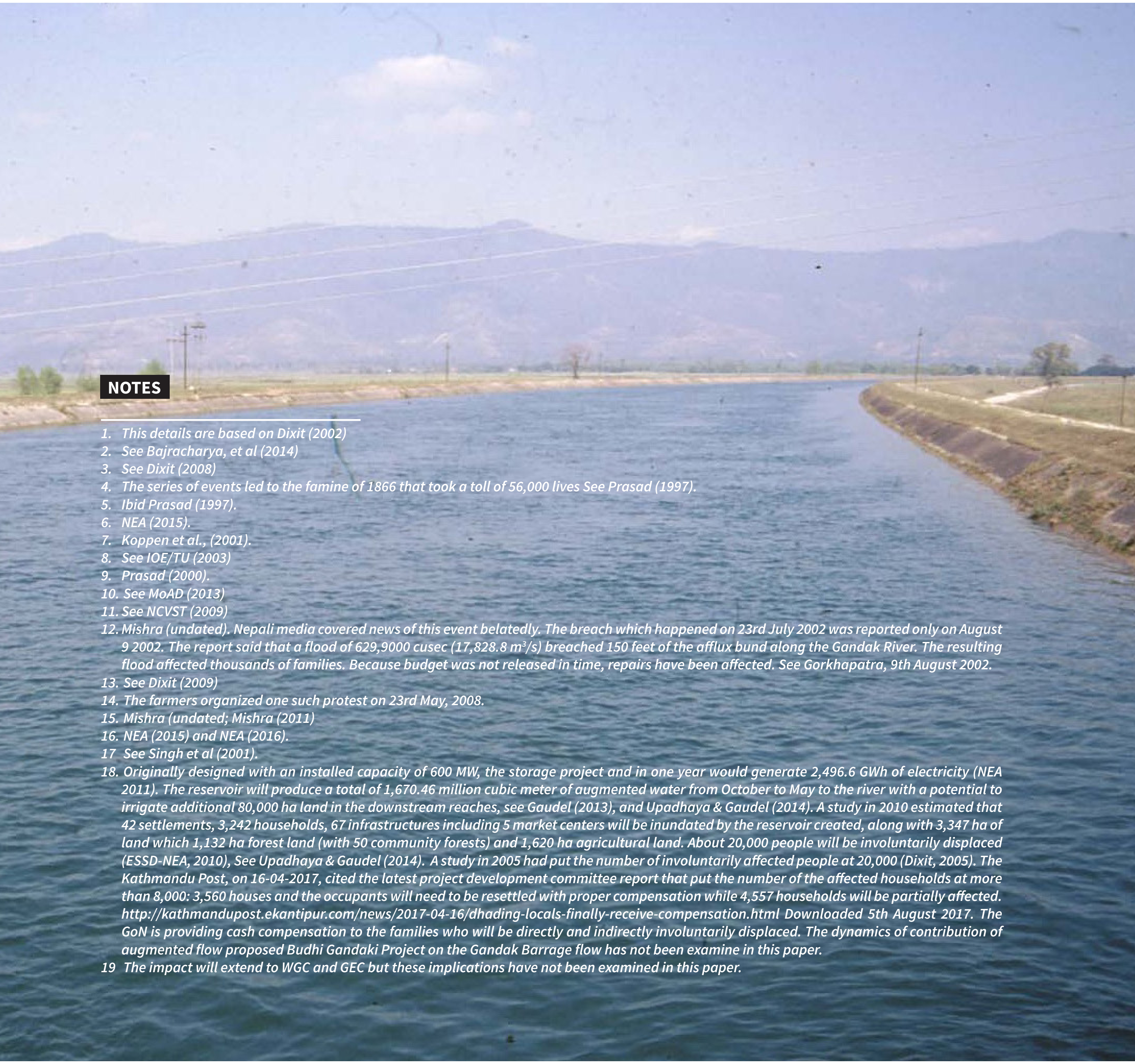
The local challenges have remained outside the attention of the national governments and have come to the surface only when civic activists have highlighted them. Activism has enabled the local population to be more concerned about the problems they face and organize themselves to address them. In fact, these local dynamics need to be seriously examined as climate change and other change drivers stress the local ecosystems and communities that are dependent on them.

Climate change presents serious challenges as floods in the Gandak and other rivers are likely to be more intense. In the monsoon season, high flows may exceed the capacity of the built infrastructure increasing risk of flood-induced disasters. Intense, high-magnitude flood events could change the sedimentation behavior of rivers further increasing flood risks. In a drought year, on the other hand, low flows could further go down, thereby decreasing the availability of water for irrigation, household uses and for the riverine ecosystems. This variability will impinge upon operation of the barrage making availability of water for irrigation in NWGC more uncertain[19]. Climate change will also induce impacts on irrigation water demand, mineralization and cause losses of soil nutrients, and increases in crop disease and insect dynamics. These impacts will further lower agricultural production in NWGC and adjoining areas, thus undermining water productivity and its role in supporting the local socio-economic well-being.

It is perhaps time to redefine the notion of 'interest' and 'benefit' mentioned in the preamble of the Gandak Agreement to resonate with changing times. The socio-political-economic context in India and Nepal are not that of 1959 when the agreement was signed. The pace of socio-political changes in Nepal has been rather rapid after 1990, though the country has not done well on economic fronts. Without entering into the debate of revising the provisions of the agreement or benefit sharing, which requires entirely different sets of discussions, this paper suggests that the management of infrastructure in the GIPP should be improvised and burden on local communities minimized. It would require simple tasks such as timely release of water regular maintenance, preparedness and building on initiatives that local farmers have taken to improve their lives and maintain livelihoods. India and Nepal must work together to develop mutually agreed standard operating procedure, for example, of the GIPP to minimize burden on local people. Without such actions, burden will increase.

This paper's lessons are counterfactual: the development indicators of the families in NWGC command are lower than the adjoining districts of Nepal. Why is this so despite the fact that the area had major investment in infrastructure development? Answers to this question need much deeper examination of the local dynamics as well as the functioning of the government agencies in Nepal and India that have primary responsibility for water. Yet the outcome is undesirable and perhaps has resulted from the consistent inundation of land and lack of improvisation of agriculture.

A new beginning must be made and this must start with recognition of fresh water bodies as living entities fundamental for healthy ecosystems as well as human welfare. This premise should help identify new starting point for more inclusive and deliberative processes that will promote stewardship of fresh water at all scales from local to trans-boundary. Starting points matter because response strategies to water stewardship as well as development evolve in path dependent ways.



NOTES

1. *This details are based on Dixit (2002)*
2. *See Bajracharya, et al (2014)*
3. *See Dixit (2008)*
4. *The series of events led to the famine of 1866 that took a toll of 56,000 lives See Prasad (1997).*
5. *Ibid Prasad (1997).*
6. *NEA (2015).*
7. *Koppen et al., (2001).*
8. *See IOE/TU (2003)*
9. *Prasad (2000).*
10. *See MoAD (2013)*
11. *See NCVST (2009)*
12. *Mishra (undated). Nepali media covered news of this event belatedly. The breach which happened on 23rd July 2002 was reported only on August 9 2002. The report said that a flood of 629,9000 cusec (17,828.8 m^3/s) breached 150 feet of the afflux bund along the Gandak River. The resulting flood affected thousands of families. Because budget was not released in time, repairs have been affected. See Gorkhapatra, 9th August 2002.*
13. *See Dixit (2009)*
14. *The farmers organized one such protest on 23rd May, 2008.*
15. *Mishra (undated; Mishra (2011)*
16. *NEA (2015) and NEA (2016).*
17. *See Singh et al (2001).*
18. *Originally designed with an installed capacity of 600 MW, the storage project and in one year would generate 2,496.6 GWh of electricity (NEA 2011). The reservoir will produce a total of 1,670.46 million cubic meter of augmented water from October to May to the river with a potential to irrigate additional 80,000 ha land in the downstream reaches, see Gaudel (2013), and Upadhaya & Gaudel (2014). A study in 2010 estimated that 42 settlements, 3,242 households, 67 infrastructures including 5 market centers will be inundated by the reservoir created, along with 3,347 ha of land which 1,132 ha forest land (with 50 community forests) and 1,620 ha agricultural land. About 20,000 people will be involuntarily displaced (ESSD-NEA, 2010), See Upadhaya & Gaudel (2014). A study in 2005 had put the number of involuntarily affected people at 20,000 (Dixit, 2005). The Kathmandu Post, on 16-04-2017, cited the latest project development committee report that put the number of the affected households at more than 8,000: 3,560 houses and the occupants will need to be resettled with proper compensation while 4,557 households will be partially affected. http://kathmandupost.ekantipur.com/news/2017-04-16/dhading-locals-finally-receive-compensation.html Downloaded 5th August 2017. The GoN is providing cash compensation to the families who will be directly and indirectly involuntarily displaced. The dynamics of contribution of augmented flow proposed Budhi Gandaki Project on the Gandak Barrage flow has not been examine in this paper.*
19. *The impact will extend to WGC and GEC but these implications have not been examined in this paper.*

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ActionAid-Nepal

ActionAid is a global federation working to end poverty and injustice with thousands of communities and millions of people across the planet. With 45 national members and country programs worldwide, ActionAid focuses the majority of its resources on working with the poorest and most excluded women, men and children. ActionAid International Nepal (AAIN) is a member of ActionAid International Federation, working in Nepal since 1982.

Vision
"A Nepal without poverty and injustice in which every person enjoys their right to a life of dignity."

Mission
"To work with people living in poverty and excluded people to eradicate poverty and injustice in Nepal"

Strategic Objectives

- Ensure improved livelihoods and build disaster resilient communities by enabling people living in poverty and marginalised people to claim productive resources.
- Facilitate political advancement of people living in poverty and marginalised people to hold duty bearers to account, develop propositions for national development strategies and deepen democracy.
- Engage with women and girls to build their active agency to challenge and take actions against all forms of discrimination and injustice against their body, sexuality and unequal burden of work.
- Support all children to attain quality education in a safe and equitable environment.

ISET-Nepal

ISET-Nepal is a research organization that conducts interdisciplinary research and engages in policy dialogues. The organization was established in 2001. ISET-Nepal examines social and environmental challenges with the aim of contributing to building a society capable of addressing such challenges through improved knowledge and capacities. ISET-Nepal collaborates and partner with diverse national and international academicians, researchers and organizations. ISET-Nepal conducts interdisciplinary research and holds interactions on crosscutting issues involving the environment, water, technology, politics, and society with a wide spectrum of the Nepali society as well as with global actors. It generates evidence for policies on the five themes: Disaster Risk Reduction; the changing rural-urban continuum; climate, water, ecosystem, food, and livelihood interdependence; energy system and management and public-sector governance.