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Issues of climate change and the Ganges Kobadak irrigation project

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ABSTRACT

The Ganges Kobadak (G-K) Irrigation Project is the largest irrigation initiative in South Asia, which has historically met the water demands of this region with minimal electricity consumption. However, its effectiveness has declined in recent years due to both technical and climate-related challenges. This study follows a qualitative approach to explore the project's inception, historical performance, and the impact of climate change on its current issues. Data were collected through in-depth interviews using a semi-structured interview guide, involving a total of 11 respondents, including seven farmers, two residents, and two project officials. The thematic analysis technique was followed to present the findings. This study found that after the construction of the Farakka Barrage, the G-K project has experienced a loss in efficiency, with severe droughts, flash floods, and declining groundwater levels complicating water availability. Increased salinity in soil and water, excessive heat, and mechanical issues have further undermined agricultural production, threatened food security, and prompted migration. The study concludes that urgent intervention is needed to address these issues. Recommendations include revising the water distribution treaty with India, rehabilitating technical infrastructure, modernizing equipment, increasing manpower, and ensuring equitable water distribution. Climate-driven challenges such as extreme weather conditions, water salinity, and inconsistent rainfall require immediate, comprehensive action to restore the project's effectiveness and safeguard the livelihoods of millions of farmers. A fair water-sharing agreement and comprehensive project rehabilitation are vital to ensuring food security and reducing climate change issues in the project.

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1. Introduction

The Ganges Kobadak Irrigation Project is the largest irrigation project to distribute surface water to the locations where lack of water is affecting agricultural activities. This project is on the southern bank of the Ganges River, just downstream of the Hardinge Bridge. The project area is enclosed by the Ganges River to the north, the Gorai-Madhumati River to the east, the Naboganga River to the south, and the Mathabhanga River to the west. It spans across several upazilas, including Kushtia Sadar, Kumarkhali, Khoksha, Mirpur, Daulatpur, and Bheramara in Kushtia district; Chuadanga and Alamdanga in Chuadanga district; Jhenaidah, Harinakunda, and Shailakupa in Jhenaidah district; and Magura and Sreepur in Magura district (Ministry of Planning, 2014). The primary objectives of the project were to provide flood protection, drainage, water supply, and internal road connectivity along canal banks for an area spanning 1.7 million acres. In the initial phase, 120,000 acres were developed as a pilot project. Water is pumped from the Ganges River using massive pumps with a capacity of 5,400 cubic feet per second and distributed through a 496-mile irrigation canal network, which was planned and funded by the government. However, to effectively irrigate their crops,

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farmers needed to dig 1,722 miles of field channels, known as quaternary canals, along with several small plot channels or watercourses (Andreou, 1979).

This project was initiated and implemented for the betterment of the regions across four districts in Bangladesh. Construction began in 1954, and the project became operational between 1962 and 1963 (Banglapedia, 2021). Shortly after the project commenced operations, the Government of India commissioned the Farakka Barrage on the Ganges River in 1962, with the barrage becoming fully operational in 1975. Once operational, the barrage began to produce significant negative effects on the Ganges Basin and also on the project area (Hossain, 2024). Since its inception, the Farakka Barrage has had a very negative impact on Bangladesh's rivers and river systems. In 1971, Bangladesh had approximately 1,274 rivers, but since then, nearly 507 rivers have disappeared, largely due to unequal water distribution caused by the Farakka and other Barrages. Numerous dams constructed in India have frequently had negative consequences on Bangladesh's river systems (RDRC, 2024).

The project has been affected by several negative impacts, including droughts during the summer due to water retention in India, flooding during the monsoon season (also caused by the dams in India), increased water salinity, rising temperatures, reduced underground water moisture, and elevated arsenic levels. Collectively, these challenges have made life more difficult for the beneficiaries in the G-K irrigation project areas (Mirza and Hossain, 2004). Moreover, technical issues have caused two of the three main pumps as well as 12 subsidiary pumps to malfunction, further complicating the situation. As a result, farmers at the tail ends of the project's canals frequently struggle to receive sufficient water for cultivation. The situation is likely to worsen if the remaining pumps also experience technical failures (Mustafa, 2024). Although modernization efforts were undertaken by the Asian Development Bank, the outcomes did not meet expectations (ADB, 2022). The beneficiaries situated at the head of the project are regularly receiving water in time, and the water flow in that region is robust during the irrigation season. Even when water is available, the flow is significantly slower (The Daily Star, 2021; Mustafa, 2024; Hasenbeck et al., 2025). Several issues have arisen within this project, most of which are directly connected to the impacts of climate change. The Farakka Barrage and the Teesta Electricity Project in India are among the most significant issues to the project's negative impacts. Major challenges include drought due to water shortages, flooding caused by water overflow, disparities in water distribution, reduced water flow, inadequate maintenance, corruption among officials, technical malfunctions, increased water salinity, and the presence of arsenic. Exploring these challenges is essential for understanding the full impact of climate change on the G-K irrigation project. Properly addressing these issues may also provide some ways into how to prevent or mitigate these issues. Bangladesh experiences an abundance of surface water during the summer monsoon months but faces significant shortages in the dry winter season. The country's flat topography complicates the development of dam facilities, making it difficult to regulate water flow across the year. Groundwater serves as the only natural water storage, though its availability differs with the seasons. Despite these seasonal shortages, water management remains inefficient. The Bangladesh Water Development Board (BWDB) has shown limited effort in improving irrigation water to ensure efficiency and equitable distribution. Of the approximately 550,000 hectares covered by large irrigation schemes, only 253,000 hectares, or 46%, are irrigated during the dry season. The modernization program of this project was also not effective and less successful (ADB, 2022).

Impact of climate change on the GKIP project: Several challenges restrict the success of this project, including the impact of the creation of Farakka Barrage over the river, summer droughts, monsoon flooding, declining soil moisture, decreasing underground water levels, insufficient rainfall, rising temperatures, arsenic contamination, increasing salinity, and several technical difficulties. These issues are complicating the project's operations, with many of them being closely linked to climate change. To fully understand the impact of climate change on the G-K irrigation project, these issues must be thoroughly addressed.

Impact of Farakka Barrage, drought, and flood: One of the primary reasons for the complications in the G-K Irrigation Project (GKIP) is the construction of the Farakka

Barrage in the Ganges River system. This project began its operations before the Farakka Barrage was built. If the Farakka Barrage had been established earlier, the government might have reconsidered initiating the project, given its potential limitations. The Farakka Barrage is creating a chain reaction of problems, including disrupting the ecological balance of the surrounding areas (Hossain, 2024; Mustafa, 2024). The West Bengal government keeps the barrage's gates fully closed during the dry season, resulting in drought, and opens them during the rainy season, causing severe floods. These droughts and floods not only affect regions in Bangladesh but also impact parts of India, including Bihar, West Bengal, Odisha, and Tripura (Chari, 2016; Kawser and Samad, 2016; Halder and Yaseen, 2024). The GKIP project is entirely dependent on water from the Ganges River. However, the presence of the Farakka Barrage on this river has resulted in a significant reduction of water flow to the Bangladeshi portion of the Ganges, particularly during the summer and dry seasons when water is critically needed for the project. Conversely, during the rainy season, when all the gates of the barrage are opened, the project area is subjected to severe flooding. Overall, the situation continues to deteriorate each year (Mirza and Hossain, 2004; Gain and Giupponi, 2014). In the pre-diversion period, agricultural droughts were largely mitigated through irrigation from various surface water sources, such as the Ganges and its distributaries, ponds, and other water bodies. This form of drought arises when insufficient rainfall and inadequate soil moisture hinder healthy crop growth during the growing season, resulting in significant drop crop production (Venkateswarlu, 1987).

Increasing salinity in water and soil: Following the construction of the coastal embankment project in the 1960s, there was an expectation of a steady increase in double cropping practices. However, the reduced flow of the Ganges in Bangladesh has ultimately ended this hope. The cultivation of *B. aus* rice has been steadily declining, as broad areas are increasingly affected by salinity (Mirza and Hossain, 2004). The significantly reduced water flow downstream of the Farakka Barrage during the dry season has led to a severe water crisis and exacerbated salinity levels in the southwestern region of Bangladesh. This saline intrusion has degraded soil quality and disrupted the local ecosystem, resulting in reduced agricultural productivity and an increase in poverty levels (Ahmad and Hasanuzzaman, 1998). The increasing soil salinity observed in the greater Khulna and Jessore Districts, especially during the dry season, due to the intrusion of tidal water from the sea and the capillary rise of saline water from the underground water table. The use of saline water for irrigation exacerbates soil salinity by causing the accumulation of salts within the soil profiles. Research has indicated increased soil salinity levels in the districts of Khustia, Meherpur, Jhenidah, Faridpur, Gopalgonj, Narail, Magura, Satkhira, and Bagerhat since the pre-diversion period (BWDB, 1993; EGIS, 2001).

Insufficient rainfall: The Ganges basin area in Bangladesh experiences the lowest mean annual rainfall in the country, ranging from approximately 1,270 mm in the western part of Rajshahi District to around 3,000 mm along the southern coastal belt. This contrasts with the national average, which varies from 1,270 mm to 5,000 mm. In some areas, there are extended periods with no rainfall at all. The country regularly faces flooding during the monsoon season due to heavy rainfall within Bangladesh and incoming floodwaters from neighboring countries. However, the situation reverses during the dry season, when the country suffers from a severe shortage of freshwater. This shortage is exacerbated by the reduced flow in the Ganges River and its distributaries, caused by upstream diversion of the Ganges waters at the Farakka Barrage and beyond (BWBD, 1993).

Temperature rising: Adel (2002) conducted a comparative study of pre- and post-Farakka annual and summer maximum and minimum temperatures in the Ganges basin, encompassing parts of the districts of Nawabgonj, Naogaon, Rajshahi, and Natore. The analysis revealed a noticeable rise in the annual maximum temperature after 1981, as well as a decline in the annual minimum temperature after 1982. It was found that the maximum temperature, which had previously been 37°C, surged to 43°C within just four years following 1981, during the post-diversion period. Similarly, the minimum temperature, which had been around 8°C, dropped below 5°C in some years after 1982. The average temperature during the decade from 1971 to 1980 had remained stable above 8 °C. This temperature rise can be attributed to factors

such as reduced rainfall and diminished water flow from upstream sources. This situation is also negatively impacting the GKIP Project, as rising temperatures led to drought and less crop production.

Dropping of groundwater levels: During the post-diversion period, the reduced flow in the Ganges River system has led to most occurrences of hydrological drought. Hydrological drought is characterized by insufficient stream flows to meet the established demands of a given water management system (Linseley et al., 1975). These demands include the water required for flora, fauna, fisheries, navigation, domestic and industrial uses, and surface water irrigation. Increased water demand in drought-prone areas is further intensified by reduced water availability due to upstream usage and regulation, saltwater intrusion, and salinization of aquifers. Also, a significant amount of groundwater flows back into the Ganges due to the river's low level and the dryness of its branches during the dry season. All these factors ultimately result in the overuse of groundwater resources, leading to a dropping of groundwater levels (EGIS, 2001).

Dropping of soil moisture: The extent and duration of seasonal flooding influence soil moisture conditions. Typically, higher-ridge soils do not benefit from floodwaters; however, capillary rise can significantly increase the water table and get back the soil moisture. In contrast, soils in medium and lower topographical positions experience various depths and durations of flooding. Water diversion has altered the region's hydrological system, causing a considerable amount of groundwater to flow back into the Ganges due to the river's low levels and the dryness of its tributaries during the dry season. This situation impacts the topsoil and subsurface moisture regime of the surrounding area. Rapid moisture dropping constrains the productivity of *rabi* crops and delays the sowing of *B. aus*, *B. aman*, and jute. Additionally, delays in the transplantation of *aman* paddy further contribute to reduced yields (Mirza and Hossain, 2004).

Arsenic poisoning: A significant portion of Bangladesh's groundwater resources are tainted with arsenic. Dropping the water table beneath organic matter deposits carrying reactive arsenic pyrites causes arsenic pollution. As the arsenic dissolves on the iron hydroxide, these arsenic pyrites oxidize, releasing the arsenic. The water table repeatedly dropped and rose as a result of greater underground water irrigation brought on by the reduction in surface water flow created by several barrages and dams constructed in India on streams that crossed into Bangladesh. Furthermore, the frequent depletion and replenishment of the area surrounding the well was caused by the construction of countless tube wells to meet home needs and avoid using contaminating surface water. According to a study, the number of shallow tube wells in Bangladesh's Ganges basin's old Khulna and Rajshahi regions increased by 400% and 160%, respectively. Organic-rich sediment containing arsenic-bearing sulfides was repeatedly wet and dried as a result of the construction of barrages and dams and the digging of tube wells. Because of a reduced water table, arsenic is released into groundwater as a result of the oxidation of minerals containing arsenic. This way, the quantity of arsenic in both water and soil is increasing in the GKIP project area (Swain, 1996; Bridge and Husain, 2002).

Challenges and technical issues: The main elements that determine the success of any irrigation project include the reliability of the water supply, an optimal pumping schedule, the ability to reuse drainage water, potential interruptions in pumping, the capacity to pump water efficiently, adjustments to rice production schedules, and effective utilization of soil moisture. However, research has revealed several challenges, such as a lack of financial autonomy, poor service quality, inefficiencies in the collection system, factionalism, limited participation from all irrigators, inadequate protection of farmers' interests, water wastage, ineffective water management, inefficient land use, interactions between fertilizers and drainage, issues with maintenance service fees, and difficulties in handling credit, labor, and risk constraints to diversification. To address these challenges, a comprehensive and coordinated approach to land and water management is necessary (Miranda and Maglinao, 1993).

Effect on crop production and fisheries and food safety: Approximately 407 million people across Bangladesh, India, Nepal, and China rely on the Ganges River for their livelihoods, either directly or indirectly. The river also supports important wildlife, including the endangered Ganges River dolphin (Platanista gangetica),

and sustains economically valuable fisheries, which contribute significantly to the region's economy. Moreover, the riparian zone is home to a diverse range of plant species that play a crucial role in preventing soil erosion and conserving water and nutrients. As a result, the Ganges River is an essential component of the social-ecological systems in these four countries (Gain and Giupponi, 2014). In 1992-1993, approximately 0.36 million hectares of agricultural land were impacted by water shortages, moisture depletion, delayed planting, and salinity, resulting in a crop production loss of around 0.34 million tons. This included a significant loss of food crops, particularly clean rice and wheat, valued at Tk. 2,299.2 million (US$ 56.9 million). According to the BBS (1991) census, the study area's population of 24.8 million required 4.2 million tons of clean rice, but the actual production fell short by 0.2 million tons. Without the agro-ecological constraints caused by the diversion of the Ganges waters, the region could have been self-sufficient in food production. The reduced flow in the Ganges has also caused a decline in the Hilsa fishery, once thriving at the Goalundo Ghat landing station. Fish production in the Ganges basin has dropped significantly, leading to nutritional challenges in Bangladesh, where fish is a major source of animal protein (Miranda and Maglinao, 1993).

A Way forward: The primary cause of these problems is the diversion of water at the Farakka Barrage, which has significantly disrupted the ecological balance in the Ganges basin in Bangladesh. Collectively, these issues lead to damage to crops due to water shortages, moisture depletion, delayed planting, heightened exposure to drought, and increased salinity (Mirza and Hossain, 2004). Command area development, efficient water distribution, and effective crop-water management practices are being promoted, and active participation of local communities in drainage and irrigation programs are needed to properly mitigate the challenges. Proper and consistent maintenance of irrigation facilities is crucial for the success of these initiatives. According to Ali (2001), addressing the issues in this project requires several key actions, which include continuous training for irrigation staff and water users to enhance their ability to manage irrigation systems, regular monitoring, and the implementation of a well-structured management information system to support effective operations and maintenance. Moreover, adopting labor-intensive practices, when well-managed, can provide a sustainable approach to system rehabilitation and improvement. Creating an appropriate environment management is also essential for significantly enhancing system performance.

Research gap and significance of this study: The Ganges Kobadak Irrigation Project (GKIP) is the largest irrigation initiative in Bangladesh, serving farmers across 13 upazilas in four districts in southern Bangladesh. This project was not only established to provide irrigation for agricultural lands but also to mitigate the effects of various natural calamities. However, over time, the project has contributed to further complications related to climate issues and has itself been impacted by climate change, reducing its overall effectiveness. While several studies have assessed the project's effectiveness, no research till now has specifically examined the climate challenges associated with it. Yet, these climate-related challenges are increasing over time and require immediate attention. This study aims to investigate the underlying factors and root causes of climate change issues affecting the Ganges Kobadak Irrigation Project. By exploring these issues, the research seeks to raise awareness among stakeholders and the public about the connection between climate change and the project's inefficiencies, providing insights that will help them understand why the project cannot function effectively in its current state. The primary objective of this study is to examine the context and challenges associated with the Ganges-Kobadak Irrigation Project, with particular attention to its historical and contemporary dimensions. Specifically, the study seeks to explore the motivations behind the initiation of the project, uncover the climate change issues linked to both its inception and current activities, and examine the impact of climate change on agriculture within the framework of the project. Through these objectives, the research aims to provide a comprehensive understanding of the project’s significance, its vulnerabilities, and its implications for sustainable agricultural development.

2. Material and methods

This research has been conducted with a qualitative approach to explore the cause of the

starting of the Ganges-Kobadak irrigation project and the broader impact of climate issues on both the project area and its implementation, with a particular focus on agriculture and irrigation. The study areas were Bheramara, Kushtia, and Alamdanga, Chuadanga, as these areas are respectively the head and tail parts of this project. The population of this study were the beneficiaries and officials of this project. To select the sample, non-probability convenience sampling was used to select farmers, locals, and project officials as the respondents in this study. The population in this study includes stakeholders of the GKIP project, particularly farmers, livestock owners, members of local communities, and project officials. A non-probability convenience sampling method was employed to select the samples from this population. The researchers conducted on-site observations within the project area to obtain a comprehensive overview as well. Data were collected using a semi-structured interview guide that included twelve questions addressing the interconnections between climate change and the GKIP project. Several follow-up questions were also asked during the interviews to seek further clarification. To collect valuable insights and comparisons regarding the project's inception and its relationship to climate change, in-depth interviews were conducted through a semi-structured interview guide with a total of 11 respondents. Which includes 7 farmers from three different areas within this project in Kushtia and Chuadanga, along with 1 local cattle owner and 1 local resident. Additionally, interviews with 2 officials of the Ganges-Kobadak irrigation project were conducted to provide a thorough understanding of the underlying causes and motivations for initiating the project, as well as its connection to climate-related concerns. Following the data collection process, the data were systematically coded and categorized following open and axial coding methods. After that, several sub-themes were derived from the data, ultimately leading to some core themes. At last, the findings were presented thematically.

The limitations of this study include the absence of any laboratory-based experimentation and quantitative data, as the research solely relies on the opinions, insights and experiences of respondents concerning the interconnections between climate change issues and the GKIP project, as well as the project's impacts on agriculture and the overall livelihoods of the affected communities.

3. Results and discussion

This research is set to explore the origins and underlying factors that led to the initiation of the Ganges-Kobadak Irrigation Project while also examining the impacts of climate change on this project. Data was mainly gathered from farmers, local residents, and project officials through in-depth interviews, guided by a semi-structured interview guide. Finally, the data is thematically organized and presented as follows:

3.1. Initiation of Ganges-Kobadak irrigation project

This project traces its origins back six decades, when the government of the time initiated a pilot project to provide irrigation support to local farmers. Following the positive outcomes and desired responses from the pilot project, the government expanded the project's support in a larger area. As an official said:

> *"This project, originally planned around 1957 with the welfare of the people in mind, reached completion between 1960 and 1962 during the Pakistan period. Initially launched on a small scale as a pilot project in Kushtia, it generated phenomenal responses, prompting its expansion to four districts. The project now features numerous secondary and tertiary canals branching off from the main canal." (Md. Masud Rana, Official)*

Many years ago, a powerhouse was located within the present project office area, and its maintenance required large quantities of water. After using the necessary amount for the powerhouse, the remaining water was supplied to nearby farmers. This practice motivated the idea of developing a comprehensive project aimed at providing irrigation water throughout the entire area. As one of the farmers stated:

> *"There used to be a powerhouse that generated 20 megawatts of electricity, and water was needed for that. The same water that went to the powerhouse was also used for irrigation in the surrounding areas. Eventually, the project was expanded into a larger initiative benefiting everyone." (Md. Atiar Rahman Khan, Farmer)*

Another significant reason for initiating the project was addressing food shortages in the region. In 1952, low crop production led to widespread food shortages, creating the system for increased food production. Ensuring sufficient food supply became one of the root factors behind the project's inception. As one farmer affirmed:

> *"Around 1952, there was a severe food shortage, and the idea for this project existed since the time of A.K. Fazlul Haque, though it was implemented by the Pakistan government." (Md. Moazzem Malitha, Farmer)*

In the Chuadanga region, this project was expanded around the 1980s. Farmers in this area also needed irrigation water badly, as the region, like Kushtia, is situated at a higher ground level. In response to this need, the government extended the project to include Chuadanga, Jhenidah, and Magura. As one farmer stated:

> *"The canal in other areas was completed before 1971, but this side of the canal was finished after '71. This was originally a river, and when people came to dig the canal, they cut through what I referred to as the Morgang, merging it with the river to form the main canal of the G-K project." (Md. Shahidul Islam, Farmer)*

3.2. Positive impact of Ganges-Kobadak irrigation project

This project has provided farmers with the opportunity to consider cultivating multiple crops and vegetables on their land. The government is also striving to maximize the benefits for the people. As the project official stated:

> *"However, following the excavation of the canal, the region has seen a dramatic shift, allowing the cultivation of rice and other crops up to three times a year in some areas. The network of canals under the G-K project is designed like a spider web, spanning across 13 upazilas within four districts." (Md. Masud Rana, Official)*

This project has significantly benefited the residents of the project area. In some regions, it now facilitates the production of paddy three times a year, giving new agricultural possibilities. Farmers are now able to cultivate multiple vegetables and crops, including rice, corn, wheat, tobacco, and onions. As one farmer affirmed:

> *"Before the country gained independence, when we cultivated under this project, we planted only Ropa paddy and 76 paddies during the month of Chaitra. The yields back then were quite low, around 1 to 10 or 20 bushels per harvest, but now the yields have doubled." (Md. Atiar Rahman Khan, Farmer)*

During the rainy season, surface water is also preserved in the project's canals. This stored water can then be utilized as needed, allowing farmers to access and use it in their fields with ease. As one of the farmers stated:

> *"During the rainy season, the presence of water is abundant, and often, just a small amount of additional water can suffice. Even without any supplementation, the water does not dry up during the monsoon. We have a field on the other side of the Kumar River and another field across from it. In the field on the opposite side, there are some boring machines that extract water, which is then used for irrigation. As a result, the entire field is utilized for the cultivation of paddy." (Md. Jakir Hosen Malitha, Farmer)*

3.3. Impact of climate change on the GKIP project

3.3.1. Direct impact through Farakka Barrage

This project encounters several challenges, primarily due to the Farakka Barrage, located in India on the shared river, the Ganga. The Indian authorities retain water when it is needed and release more than usual when they face excess water pressure. As stated by the official:

> *"Compounding these issues is India's Farakka Dam, which holds back Ganges water during the summer and releases it during the monsoon season, creating water shortages during the dry months and flash floods in some higher areas, such as parts of Chuadanga." (Md. Masud Rana, Official)*

There is a mutual agreement between India and Bangladesh regarding the distribution of water between the two countries. However, the Indian

authorities disregard the agreement and control the water flow from the Farakka Barrage at their discretion. As one of the officials of the GKIP project affirmed:

> *"The climate of the Ganges Basin and the project area has been substantially altered due to the improper implementation of the water-sharing agreement between India and Bangladesh. India doesn't care about any laws and treaties in the case of distributing common water." (Md. Moshfikur Rahman, Official)*

The discretionary control of water flow by the Farakka Barrage significantly impacts the general farmers of the Ganges Basin in Bangladesh. Also, several areas in India are also affected by this issue. A local resident remarked:

> *"When farmers need it most, water is blocked by the Farakka Barrage, and when India is flooded, Bangladesh suffers as well from the excess water released from Farakka. We are also experiencing extreme heat and cold during certain seasons, which further adds to the struggles faced by farmers." (Md. Robiul Islam, Local)*

3.3.2. Drought and flood

Drought is a common issue in the high-lying areas of Bangladesh. Kushtia, Chuadanga, Magura, and Jhenidah, being comparatively higher in elevation than other regions, severely experience drought, which leads to several challenges in cultivation. As one of the farmers stated:

> *"Droughts have become a frequent problem. When water is not supplied, people here are unable to cultivate." (Md. Atiar Rahman Khan, Farmer)*

Although drought is a common issue during the summer, flooding was not a concern until the canal was constructed. However, in recent years, these areas have also been experiencing floods during the monsoon season. As one of the farmers agreed:

> *"That said, after the construction of the canal, we have experienced floods in our area several times during the monsoon season. We've seen these floods with our own eyes. Yet, before this project began, I had never seen a flood until I was about 14 or 15 years old. The water even rose around my house." (Md. Jalaluddin, Farmer)*

As a previously dead river has been reused as the main canal for the G-K project in Chuadanga, during the monsoon season, when excess water is discharged through the Farakka barrage, it causes flooding in the downstream areas of this project canal. Millions of people in Alamdanga, Chuadanga, face the consequences. As one of the farmers acknowledged:

> *"As you can see, this river serves as the main irrigation canal for the G-K project. Water flows from the Ganga through this direction. During this time of year (moonsoon), floodwater enters through this route. There have been floods in this area before, twice that I recall before the war, prior to the G-K project. After that, we didn't see floods for a long time. However, the river has begun flooding again, and water is rising on the fields and houses." (Md. Shahidul Islam, Farmer)*

3.3.3. Increasing salinity in water and soil

In the summer season, extreme drought sometimes occurs when no water can be found. During such times, saline water occasionally surfaces through the tube wells. As one of the officials of the project stated:

> *"During the summer, when irrigation is interrupted and water levels drop in some areas, saline water begins to emerge through tubewells, despite water levels rising in other locations." (Md. Moshfikur Rahman, Official)*

3.3.4. Less water in the tail

When the water is released initially, the areas situated at the head of the project receive the water for irrigation. However, there are times when the water cannot reach the tail part of the project. Occasionally, farmers make necessary preparations, but despite expecting water, they fail to achieve the desired production. As a farmer said:

> *"The crops aren't growing in here. Last time, they cultivated the land and applied fertilizer; however, later the water supply stopped, and that's it—everything was ruined. They provided water once a year but then stopped, leaving the whole land to dry out."*

(Md. Jakir Hosen Malitha, Farmer)

The farmers in the tail part experience several challenges in getting water for irrigation. When the farmers in the head part of the project use the water for cultivation, those in the tail part don't receive even a drop. As a farmer agreed:

> *"After water reaches Kushtia, it is then provided to our region in Alamdanga. We notice that water is already flowing in Kushtia, and farmers there are receiving it, but we do not get it in our area. It usually takes about 10–15 days after the farmers of Kushtia receive their water for it to reach us. We only receive water after the needs of the farmers in those areas have been met." (Md. Jasim Uddin, Farmer)*

3.3.5. Insufficient rainfall

The project areas are primarily situated in the Tropic of Cancer region. It is well known that in such regions, the weather is extreme and the rainfall is significantly less compared to other areas. As an official stated:

> *"Rainfall in the Tropic of Cancer region is already minimal, and most of the project areas fall within this zone, further contributing to the low rainfall." (Md. Moshfikur Rahman, Official)*

The project fully relies on surface water, so rainfall plays a crucial role in increasing the water flow in these areas. However, during the summer cultivation period, the lack of rainfall leads to a significant decrease in surface water levels. As one of the officials stated:

> *"Additionally, declining rainfall in the region is contributing to a steady reduction in surface water availability." (Md. Masud Rana, Official)*

In these areas, insufficient rainfall has become a major issue, contributing to severe drought conditions. Over the past 5-7 years, the region has experienced significantly less rainfall. According to a farmer:

> *"The climate here is harsh; it's very hot, with little rainfall, and extremely cold in winter. Rainfall has been scarce or nonexistent over the past few years, especially for the last 5-7 years. This lack of rain has contributed to severe droughts." (Md. Moazzem Malitha, Farmer)*

3.3.6. Migration

The current conditions of the project have led to several problems, one of the most significant being migration. Many people have been forced to leave the area as they are unable to sustain a livelihood in such extreme weather conditions. As the official agreed:

> *"With the current weather and climate conditions, the project is struggling to operate effectively. As a result, families from this region are migrating elsewhere in search of better opportunities. In sum, climate change, driven in large part by the Farakka Dam and declining rainfall, has had a profound impact on this area." (Md. Moshfikur Rahman, Official)*

Many individuals have tragically committed suicide, while many others have migrated to new locations in search of a better life. A significant number of farmers, who relied on borrowed funds to cultivate their land, have suffered severe losses, leaving them unable to repay their creditors. As a result, they have relocated to other areas in an attempt to grow crops and repay their debts. In the words of one farmer:

> *"Many even committed suicide; those who had taken loans became debt-ridden, leased land, and paid money. Many of them took out loans, but later they did not get the water, and then, being helpless, they had to leave their house. Many left their homes and moved away; where they went, where they're living now—there's no certainty. They left with their families." (Md. Jakir Hosen Malitha, Farmer)*

3.3.7. Temperature rising

The rising temperature is one of the most common issues in today's world. In Bangladesh, the weather is becoming increasingly extreme with each passing day, which can be said as the severe consequences of climate change. As the official agreed:

> *"In our equatorial or Tropic of Cancer region, temperatures always rise during the summer and drop significantly during the winter." (Md. Moshfikur Rahman, Official)*

During the spring, the project areas experience extreme heat. Although spring is typically the ideal season for cultivating paddy, farmers are unable to grow crops despite having access to water. As one farmer stated:

> *"During the month of Chaitra, we don't receive enough water for irrigation. I didn't get water this time, and I didn't get it last time either—what can I do about it? The lack of water during Chaitra creates significant problems for agriculture." (Md. Enamul Munshi, Farmer)*

3.3.8. Dropping of groundwater levels

The extreme heat and insufficient rainfall not only result in a reduction of surface water but also contribute to a declining groundwater level. This directly affects the cultivation and irrigation processes in the project areas. As the official remarked:

> *"The declining water levels, insufficient river water flow, and decreasing rainfall are undermining the project's effectiveness." (Md. Masud Rana, Official)*

In the years 2017 and 2024, there was extreme heat that led to severe drought, and the level of groundwater also dropped. That even complicated the other means of irrigation as well. According to an official:

> *"Groundwater levels are declining day by day, and we are unable to receive sufficient water to counteract the effects of the Farakka Dam in time. Notably, in both 2017 and 2024, the Ganges water level hit record lows. This year alone, the water level dropped by 3.66 cm, reaching the lowest point I have ever seen." (Md. Moshfikur Rahman, Official)*

3.3.9. Dropping of soil moisture

The combined effects of insufficient rainfall, severe drought, and declining groundwater levels ultimately lead to a reduction in soil moisture. During such times, if the project's water supply cannot be provided, it further complicates access to drinking water. As an official stated:

> *"This has led to reduced soil moisture. In some areas, if water from the project does not reach, tubewell water levels drop, and the water table declines." (Md. Moshfikur Rahman, Official)*

Although water cannot be supplied in a timely manner, in some areas of the project, even a small amount of water could make a difference. However, obtaining water in these areas feels like an impossible task, leading to a continuous decrease in soil moisture. As a farmer affirmed:

> *"The soil in our area requires less water—if water is applied for one day, it lasts for five or six days, making it more efficient. However, our fields are still prone to flooding. Sticky soil needs more water, but my land in Dauki Union, near the Kumar River, is alluvial and requires less water." (Md. Enamul Munshi, Farmer)*

3.4. Challenges and technical issues

All the technical machinery and equipment supporting this project are becoming outdated. The authorities are doing their best to repair the pumps repeatedly in order to keep the project operational. However, it is becoming increasingly challenging, as two out of the three pumps are now inoperable. According to an official:

> *"We provide irrigation water through an extensive canal system, with the main canal stretching approximately 193 kilometers. However, of the three pumps that service the canal, one is broken and another is not operational, leaving only one pump to meet the region's growing irrigation needs. The population has significantly increased, and with it, the demand for food. This has necessitated the cultivation of more land, which in turn requires more water." (Md. Masud Rana, Official)*

Some pumps and machinery were repaired during the rehabilitation of this project between 2005 and 2009. However, in the years that followed, after 12 years of use, the pumps are now in poor condition. As a result, the project cannot operate at full capacity. As an official stated:

> *"Between 2005 and 2009, Japan undertook mechanical and technical renovations of the entire project, providing a warranty until 2019 to address any issues within that 10-year period. However, following the expiration of this warranty around 2021, two main pumps became*

inoperable, severely limiting our ability to supply water to all areas during the summer." (Md. Moshfikur Rahman, Official)

At one time, the project's canals and other infrastructure were properly maintained by the authorities. However, due to manpower cuts, the neglect of regional offices, and several technical challenges, the project is now losing its credibility and effectiveness. As a farmer remarked:

"In the past, many people worked on maintaining the canals, digging them out and clearing the bushes, but now that work has stopped. The machinery is broken, the water doesn't come, and various problems keep arising. The old machines often fail to start, and we only get water for five days before it stops for ten days." (Md. Atiar Rahman Khan, Farmer)

3.5. Effect on crop production and fisheries and food safety

Due to the lack of timely irrigation, farmers are experiencing reduced crop yields in their fields. This decline in production poses a significant threat to food security in the region. As one farmer noted:

"After the Aush paddy is harvested, Chaitri paddy is planted, followed by Aman paddy, which is then replaced by Paushi paddy in the month of Paush. Unfortunately, this year we couldn't follow this cycle. If we receive sufficient water from the project, it is possible to harvest paddy 2-3 times a year. However, when the project fails to provide water, we are forced to rely on boring to irrigate the fields." (Md. Emarot Ali, Farmer)

Also, people are now using pesticides when irrigating with groundwater extracted through boring. However, utilizing water from the project guarantees higher production, eliminating the need for fertilizers. The absence of project water, however, forces farmers to rely on both fertilizers and pesticides. As one farmer explained:

"In the past, crops were of better quality, but now farmers use as much pesticide as necessary to improve the appearance of their yield. Everything has changed for the better in terms of production, but at a cost." (Md. Moazzem Malitha, Farmer)

3.6. A way forward

The combined impact of both climate change and technical issues has resulted in devastating challenges for farmers in these areas. Many respondents attributed this situation to the Farakka Barrage. As one local expressed:

"Overall, the farming community here is not doing well. If the water distribution from Farakka were managed properly and if the water was not blocked during the summer, many of these issues could be resolved. This blockage is one of the main reasons for the difficulties faced by many in this area." (Md. Robiul Islam, Local)

In the downstream section of this project, farmers do not receive water when needed, forcing them to rely on the boring irrigation system. This method requires the use of groundwater, which is both costly and demands greater maintenance. As one farmer commented:

"In our village, we use boring for irrigation. I have three bighas of land, which I cultivate using boring water, while my brothers irrigate their fields with canal water. Boring is costly—it requires oil and comes with an electricity bill." (Md. Enamul Munshi, Farmer)

People in the downstream region are now focusing on cultivating crops that require less water and are also sustainable, such as corn and mustard. As one farmer remarked:

"We also plant mustard after paddy. Some people plant corn as well, but there isn't a suitable situation for corn cultivation because the water supply is unreliable." (Md. Emarot Ali, Farmer)

Even many farmers plan to disconnect their land from the G-K irrigation project canel and independently irrigate their land with boring and cultivate the crops that require less water. As a farmer stated:

"We plan to fill all the pipes of the G-K canal, dry out the fields, and cultivate crops suited for dry conditions, such as corn. We no longer wish to rely on canal water for our fields, and we are also unable to use

project water as the canal authorities will not supply it to us." (Md. Jasim Uddin, Farmer)

This project was initially a great success, but the Farakka Barrage has had a highly negative impact on its performance, significantly reducing its effectiveness. Also, certain climate change factors have further complicated these challenges. A repair proposal has already been submitted to the relevant authorities. It is now crucial to rehabilitate this project and restore its effectiveness for the farmers. As an official stated:

"Despite its early success, the project is currently losing its capacity due to various climate-related factors. It is imperative that we take a comprehensive look at the project and work to restore it to full capacity. A summary budget has been submitted for the repair and activation of all pumps, and once approved by various departments and ECNEC, the project can proceed with renewed energy." (Md. Masud Rana, Official)

3.7. Discussion

The Ganges Kobadak (G-K) Irrigation Project is the largest irrigation initiative in South Asia. Historically, it required less electricity than any other irrigation project and effectively met the region's water demands, even as recently as 10 years ago. However, its effectiveness has been now declining for several issues of climate change. The objectives of this study are to explore the reasons behind the inception of this project and to assess whether the challenges, both past and present, are linked to climate change.

The G-K project began in 1954 and became operational in 1962. This is the time when the Farakka Barrage was not started. However, following the initiation of the operation of Farakka Barrage, the project has experienced a gradual loss of efficiency. The barrage has contributed to severe droughts and extreme flash floods in the region which complicated the functionality of this project. Climate change further compounded these issues. Insufficient rainfall and extreme heat have led to a decline in surface water and groundwater levels, which has caused a reduction in soil moisture that is essential for cultivation. The drop in groundwater and soil moisture has resulted in increased salinity in both water and soil, and this restricts the effectiveness of the project.

The project's area situated along the Tropic of Cancer. For which, this experiences extreme weather conditions during summer, winter, and spring. These extreme temperatures have negatively impacted crop yields, as both excessive heat and cold hamper optimal growth. All of these factors have contributed to reduced agricultural production, leading to migration as people seek better livelihoods elsewhere and posing a serious threat to food security in the region.

On top of these, technical challenges have worsened the situation. The pumps and machinery of this project have become less efficient over time. The cause of starting the G-K project was to ensure regional food self-sufficiency, but due to various climate-related and technical issues, it is now complicating the lives of farmers and losing its effectiveness.

At the national level, Bangladesh can take proper steps to improve the effectiveness of this project. More investment in efficient irrigation systems, upgrading infrastructure, and supporting farmers through training on climate tolerant agricultural practices can make a big difference. Also, regional cooperation through joint data sharing, coordinated water management, and shared early warning systems for emergencies could help both countries to adapt with climate pressures. Aligning these strategies with national adaptation plans and the Sustainable Development Goals (SDGs) can help save the G-K Project and strengthen food security and regional stability in coming years.

4. Conclusion

The Ganges Kobadak (G-K) Irrigation Project is losing its effectiveness and efficiency. Despite this, the desired response from relevant authorities has been lacking. This project requires urgent attention, as millions of farmers depend on it for their livelihoods. Without water from the project, farmers across 13 upazilas are unable to carry out essential irrigation, which poses a serious threat to food security. With proper water distribution, higher agricultural production can be ensured. All stakeholders must raise their voices to revitalize this critical project.

This study has put forward several suggestions and recommendations, particularly focusing on water distribution, technical support, and

project rehabilitation. According to respondents, the key recommendations are as follows:

- ➢ Revise the water distribution treaty with India to ensure fair access to water. The Ganges flows through both Bangladesh and India, so Bangladesh has an equal right to equitable water distribution. Even if diplomatic interference may cause inconvenience in this regard, international water-sharing guidelines can serve as a framework for this process. Moreover, complex diplomatic negotiations needed to make this work.
- ➢ Repair the technical infrastructure including pumps and machinery, so that the project can function efficiently. Reviving and repairing the outdated structures are critical as most of the machineries are out of date.
- ➢ Replace outdated machinery with new, modern equipment to ensure farmers receive irrigation water in a timely manner. Negotiating with Indian authority for making a fair deal regarding the opening a closing of Farakka Barrage can be instrumental in this regard.
- ➢ Most of the infrastructure of this project are not maintained properly as there is not enough skilled manpower which has brought such losses over the years. Increase manpower dedicated to the project to ensure proper maintenance and protection of its infrastructure.
- ➢ This is crucial to distribute water evenly across all regions within the project area, ensuring that farmers at the tail end of the project receive sufficient water for irrigation and cultivation.

The climate-related challenges in this region are severe and worsening. Extreme heat and cold, insufficient rainfall, declining groundwater levels, increased water salinity, droughts, and flash floods are all having a devastating impact on the project. Immediate action is required to address these issues and restore the project's effectiveness for farmers. The government must take the lead in renegotiating a fair water-sharing agreement with India to address the distribution issues of the Ganges. This step is crucial in mitigating several climate-driven issues. Moreover, comprehensive technical rehabilitation of the project is urgently needed. All stakeholders must collaborate to develop long-term solutions that will ensure food security and reduce the climate-related issues that are affecting this project.

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