A Review on the Decadal Irrigation System of Shali Water Reservoir

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Abstract. Irrigation is a prime factor for agriculture, fishing and afforestation in two water scarce districts namely Bankura and Purulia of West Bengal province in India. To fulfill such purposes, Shali reservoir was erected on the Shali River near Bhairabpur village of Gangajalghati block at Bankura district in 1978. After the four decades of construction it was found that only a few studies were conducted by previous researchers on Shali reservoir. In these four decades many things like population, climate, soil type, reservoir life, hydro-meteorological parameters like rainfall pattern, evaporation rates etc., people’s behavior on water utilizations, river morphology –have been changed over periods. Therefore it is most needed to bring together all those previous researches for finding out the new need of any further detail research on Shali reservoir. This paper aims to coalesce all those researches in a succinct manner for the benefit of the people of Gangajalghati block in Bankura.

1. Introduction
Irrigation is a key component of agricultural development of an economy. Indian economy even after years of independence is still an agrarian economy. Still, the share of agriculture in GDP is about 20% more than 50% of people in India are still very much depended on agriculture for their livelihood. Irrigation in India helps to increase food security, reduce dependency on monsoons, improve agricultural productivity and generate rural job prospects. Irrigation in India is divided into four categories: canal irrigation, tank irrigation, river lift irrigation and tube well irrigation. On the basis of cultivable-command area (CCA) irrigation is divided into three categories in India: major (CCA above 10000 ha), medium (CCA within 2000 and 10000 ha), minor (below 2000 hectares).

2. Irrigation in West Bengal
West Bengal is an agricultural state. The agriculture of this state is mostly depended on irrigation water and the availability of irrigation water is depends on rainfall in many places (Table 1). The yearly rainfall captivatingly varies in the different parts of the state. North Bengal receives the highest rainfall, 200 cm to 400 cm. In the coastal areas rainfall is about 200 cm, in the Ganga plain and in the central part of the state rainfall is about 150 - 200 cm and the western plateau region the amount of rainfall is about 100 cm to 125 cm. Drought is common phenomenon in the Bankura - Purulia districts. According to rainfall statistics (Figure 1) of West Bengal that the annual rainfall in Southwest monsoon period is almost normal in all the districts which are good for agriculture in Kharif season (July to October). On the contrary, in winter and post-monsoon season the amount of rainfall is very...
low in Bankura (Figure 2), Birbhum, Howrah, Hooghly, East Midnapore West Midnapore districts. So, it can be said that these regions are required irrigation for crop production during Rabi season (October to March).

Table 1. Requirement of irrigation based on rainfall availability.

| Annual Rainfall (mm) | Irrigation Requirement                      |
|----------------------|--------------------------------------------|
| About 1000           | Rainfall needs to be supplemented by irrigation |
| 1000 – 500           | Rainfall is insufficient, so irrigation is essential |
| 500 – 250            | Only inferior crops can be grown. So irrigation is essential. |
| Less than 250        | No crop can be grown without irrigation    |

Figure 1. District wise annual rainfall of West Bengal (Source: Rainfall Statistics India 2017, IMD).

3. Irrigation in Bankura District
Bankura region is encircled by Midnapore and Hooghly districts in East, Purulia in West, Burdwan in North and over Purulia – Midnapore in south. It is fairly triangular like shape and located within 23°38’ to 22°38’ North latitude and 86°36’ to 87°46’ East longitude. The major fraction of Bankura district is exemplified by undulate topography. The average land slope, herein, varies from 0.4 % to 10 %. The soil is primarily of light texture, lateritic and in acidic nature.

Figure 2. Year wise rainfall of Bankura district.
The fertility grade is also exceptionally low. The soil nature is porous and light with low organic-matter and low water-holding capacity. However both east and south segments are more productive comparing to west segment. The river Dwarekeswar and Kangsabati are major rivers of the district. Others notable ones are Silabati, Gandheswari, Shali, Joyponda, Birai, Amoda etc. The average annual rainfall is very low here than other districts in West Bengal. During monsoon season Bankura district gets plenty amount of rainfall but in pre monsoon and post monsoon season the amount of rainfall is very low. So, irrigation is very much needed for Bankura district during winter. The major sources of irrigation of Bankura districts are tanks and shallow tube wells which help to irrigate major portions of Bankura district (Figure 3), because the topography of Bankura district is very undulating and the soil type is hard so during monsoon season water cannot percolate through soil. To store rain water -tank irrigation is very much popular here.

![Figure 3. Area irrigated by different sources& sources of irrigation in Bankura (Source: District Statistical Handbook Bankura, 2015.](image)

**Figure 3.** Area irrigated by different sources\& sources of irrigation in Bankura (Source: District Statistical Handbook Bankura, 2015.)

- HDTW= High Capacity Deep Tube well; MDTW= Middle Capacity Deep Tube well
- LDTW= Low Capacity Deep Tube well; STW=Shallow Tube well
- RLI= River lift Irrigation; ODW=Open Dug Well

### 4. Irrigation in Gangajalghati block

Gangajalghati block (Figure 4) is situated in the north western part of Bankura district. The total area of this block is about 366.47 sq. km. It has 10 Gram Panchayets i.e. Ban Ashuria, Barasal, Bhaktabandh, Gangajalghati, Gobindadham, Kapistha, Lachmanpur, Latiabani, Nityanandapur and Pirraboni. Gangajalghati block is surrounded by Mejia block on the north, Barjora block on the east, Bankura II block on south and Chhatna and Saltora blocks on the west. The area is considered as undulating terrain with many hills and ridges. The soil is laterite and hard beds are covered with scrubs and sal woods. According to district statistical handbook, in 2013- 14, the total irrigated area in Gangajalghati was 7268 ha, out of which 443 ha was by canal-water, 6095 ha by tank-water, 480 ha by river lift-irrigation, and 5 ha by shallow tube-wells and 245 ha by open dug-wells. In 2013- 14, Gangajalghati block yielded 5781 tonnes of Aman paddy, the main winter crop, from 2.109 ha, 12 tonnes of wheat from 12 hectares and 2953 tonnes of potatoes from 101 ha. It also produced pulses and mustard.
5. **Shali Water Reservoir**: Shali reservoir (Figure 5) known as Gangdua dam has been selected as a study area. The dam is situated at the origin of river Shali near Bhairabpur village of Gangajalghati Gram Panchayet under Gangajalghati block in Bankura district. It is a man-made reservoir and fed by Shali River. In 1978 it was built for irrigation purpose. The topography of the area is plain. The soil texture is quartzite. Shali dam is in Zone III (Moderate) of seismic zones of India. The district experiences tropical climate with hottest summer and coldest winter. The four distinct seasons are summer, March to June, may is the peak summer season with the highest temperature of 43°C. Monsoon June to September, annual rainfall varies between 766 to 1607 mm. Post monsoon September to October. Winter November to February, minimum temperature 4°C. Three types of irrigation are provided by the dam: a) Irrigation through canal system, b) lift irrigation from the reservoir and c) river lift scheme.
These images (Figure 5) of Shali reservoir and Shali reservoir canal were captured during field survey. Shali reservoir canal helps to distribute reservoir water to the villages of Gangajalghati Gram Panchayat for irrigation. The Shali reservoir therefore has immense importance on Gangajalghati. Due to undulating topography - runoff is very high, so to store monsoonal rainfall Shali reservoir was made (Figure 6). The elevation of this area ranges between 100 to 140 meters. Slope direction is north to south.

According to irrigation-and-waterways (I&W) department under Government-of-West-Bengal, it can irrigate about 1585 hectares during the normal monsoon season. More than 15 villages are getting water from this reservoir for irrigation purpose. The Shali reservoir has great impact on Gangajalghati block. Due to undulating topography - runoff is very high, so to store monsoonal rainfall shali reservoir was made (Figure 6). The elevation of this area ranges between 100 to 140 meters. Slope direction is north to south. According to irrigation-and-waterways (I&W) dept. under Government-of-West-Bengal it can irrigate about 1585 hectares during the normal monsoon season. More than 15 villages are getting water from this reservoir for irrigation purpose.

Both Kharif and Rabi crops are harvested with the help of this shali water reservoir. The major crops are rice, potato, wheat, vegetables, mustard etc. The water level of this reservoir totally depends on rainfall, it fluctuates season to season (Figure 7). Here a comparison of monthly reservoir water level
has been made between the years 2017 and 2018 to describe water level variation of Shali reservoir. This Figure 8 is confirming that during the monsoon period - water level is swelling up.

![Slope map of Shali reservoir.](image)

**Figure 6.** Slope map of Shali reservoir.

![Water level variation in Shali reservoir.](image)

**Figure 7.** Water level variation in Shali reservoir (Source: Irrigation department of West Bengal).

A few researches were done on Shali reservoir and Shali river basin. According to literature surveys, Shali reservoir was made on the mouth of Shali River for irrigation purpose, so it can be said that Shali reservoir has great importance on agricultural productivity of Gangajalghati block in Bankura district.
But no research so far has been done about seasonal variation of irrigation water of Shali reservoir and its impact on agricultural production. In the proposed research an attempt has been made to explore the seasonal variation of irrigation water of Shali reservoir with special emphasis on water management in Rabi period.

6. Inferences from previous researches on Shali River and Shali River Basin

First Koley (1993) [1] in his thesis discussed about Shali river basin and Shali reservoir and their importance on agriculture. In Bankura district, agriculture depends on monsoonal rainfall. Due to undulating topography - surface runoff is higher than any other districts of West Bengal. So it is necessary to store rainfall water for agricultural activities. In the Gangajalghati block the soil type is very hard so the rainwater cannot percolate through soils. It remains in upper layers which help to dry up all the water in the summer months. During the monsoon season water level increases in Shali river which is not sufficient for agriculture. For this purpose Shali reservoir project was implemented in 1978 at the mouth of Shali River to store monsoonal rainfall. In 1989-90, it could irrigate only 2475 hectares. The reservoir dries during the summer time when the need of water is maximum. According to him the main source of surface water of Shali basin is rainfall. In the Kharif season due to undulating topography great amount of water resource is lost due to high run off in the Shali river basin. During the retreating monsoon tropical cyclone helps to increase water level. About 35% of Shali River is covered by coarse grained sandy soils having very poor water holding capacity and 8% of the area is not cultivated every year due to the shortage of water.

Pan (2013) [2] applied remote sensing and GIS techniques to identify river course changing pattern of Shali River. For this study Landsat image series has been used to identify river course pattern. Shali River is main tributary of Damodar River which is directly flowing from north-west of Bankura. Sinuosity index (SI) was calculated by considering continuous points down the entire river length using formula RL/VL where RL is river length between two consecutive points on river and VL is valley length - shortest distance between same two spots. Sinuosity index analysis showed that the channel pattern is straight and SI value was 1.15 which is weak type. From the satellite images it is clear that in the last 30 years from 1972 to 2001, Shali River shifted about 2.18 meters.

Das and Gupta (2014) [3] did morphometric analysis on Shali river basin. The main objective of the study was to analyze morphometric characteristics of Shali river basin to identify stages of erosion of Shali River. The Shali river basin developed over polygenetic surface. Stream ordering is the first step of the basin morphometry. The study reveals that Shali basin is fifth order drainage basin. The total stream length is maximum in the first order and it decreases as the stream order increases. The drainage density value of Shali river basin is 0.74 sq.km specifying low drainage density. The drainage frequency value is 0.43 per sq.km is exhibiting positive correlation with drainage density. The drainage texture of Shali river basin is 1.93 and classified as very coarse drainage structure. Due to undulating terrain the amount of infiltration is very low. The elongation ratio of Shali river basin is 0.47 which is signifying moderately low relief with elongated shape of the drainage pattern.

Mukherjee (2015) [4] stated that Shali water reservoir is also known as Gangdua dam which is situated on the Shali River. It was made for irrigation purpose. Nowadays the dam is famous as a picnic spot. This paper reveals that the reservoir has a major role in fish production. Annual fish production is about six ton per hectare. Various types of migratory birds are also found here during the winter season. It plays a major role to maintain groundwater level of this region. A major portion of this area is depended on this reservoir for drinking water. About 70 families are engaged in fishing activities from Shali reservoir. During the peak season (October to March) more than 2500 people’s livelihood depends on the tourism. More over the reservoir has an important value for its existence and attractive sceneries.

Das and Gupta (2018) [5] delineated ground water potential zones in Shali river basin only with the help of GIS and remote sensing techniques. The ground water potential zones are delineated through different maps i.e. geology, hydro-geomorphology, slope, drainage, land use and land cover map, lineament using remote sensing and GIS techniques. The delineation of ground water potential zones has been made by overlaying of the thematic layers through weighted multi influencing factor. From this process five groundwater potential zones i.e. excellent, very good, good, moderate and poor have
been classified in the Shali river basin area. The study displays that about 28.70% of the total area falls under poor ground water potentiality, 15.65% falls under moderate ground water potentiality, 19.45% area falls under good ground water potentiality, 11.20% falls under very good ground water potentiality and 25% have excellent ground water potentiality. This study will help planners and decision makers to find appropriate places for extraction of water.

Malik et al. (2019) [6] analyzed intra annual variation of vegetation status of Shali watershed by using geospatial approach. To discover intra annual vegetation dynamics NDVI (normalized differential vegetation index) and statistical investigations has been done here. In this study NDVI has been calculated of different months of 2014. In the month of January high degree of NDVI found along Shali River due to river base flow is occurring and with the help of localized irrigation techniques peoples are used to cultivate their lands. The water body showed very low NDVI in the winter season. During April NDVI showed medium due to high concentrate of vegetation. After the month of April the forest cover area started to show higher NDVI and during the monsoon time (august) highest NDVI is found all over the area. Vegetation status for the months from Jan to May is more or less similar in nature. June month is considered as transition month. August to October months represent higher concentration. Novembers and December months comparatively does equal to pre-monsoons. There are two different patterns of NDVI reflection i.e. during the monsoon season single peak represents natural vegetation and multiple peak represents agricultural field. The study signifies that vegetation status is not uniform all over time. NDVI has been calculated following Rouse et al. (1974),

\[ NDVI = \frac{(NIR - RED)}{(NIR + RED)} \]

where RED is wavelengths surface reflectance in visible (\( \lambda \approx 0.6 \) micrometer) and NIR is wavelengths surface reflectance of (\( \lambda \approx 0.8 \) micrometer) of spectrum, respectively.

7. Conclusion

The major portion of Bankura is distinguished by undulate topography. Bankura soil is typically lateritic, light texture with acidic nature which has very low fertility status. The soil has low water-holding capacity. Agricultural productivity is totally depends on monsoonal rainfall. For this purpose a few irrigation projects are running in Bankura district. Shali water reservoir is a medium irrigation project which was built up in 1978. It is located in Gangajalghati block in the North West portion of Bankura district. After fifteen years from construction date, in 1993 first research was done on Shali river basin by giving importance on agriculture based on monsoonal rainfall although Shali reservoir was mainly made to store monsoonal rainfall for irrigation purpose. After 10 years, in 2013 another work was done on Shali River which identified the changing pattern of Shali River through remote sensing and GIS. There was no mention about Shali reservoir in that study. Next year some morphometric analyses on Shali river basin have been done. In 2015, a research was done on Shali reservoir’s role on fishing. Groundwater potentiality estimated using only GIS and remote sensing techniques on Shali river basin was published in 2018 and recently a work also using only GIS technique on vegetation cover in Shali river basin. So, it can be said that there is no such field based work has been done on Shali reservoir, Shali River and its impact on irrigation. More emphasis should be given on Shali water reservoir and its importance.

The study on surface water usage for irrigation purpose is immediately needed and required to analyze how irrigational practices have changed over the years and its impact on the depth of the water body and the life of the people around. Remote Sensing plays key role in such places like hill sides which are inaccessible. Satellite images of last 40 years may be minutely studied i.e. the pixel variation for determining the depth of the reservoir and hence the surface water availability. This data is needed to validate with the field data to predict the reservoir depths accurately for future. Over years there has been a change in irrigational practices, urbanization, population growth which has in a way impacted the depth of the water bodies, a negative impact or the lowering surface level is of immense concern and hence its monitoring is vital. Surface water change is also noticeable seasonally.

Though it has great impact on Gangajalghati block, about 20 villages are seriously dependent on this four decade old reservoir for irrigation. The most important thing is that, this reservoir also supplies drinking water to surrounding villages because the groundwater of Gangajalghati block is contaminated with fluoride which is very bad for human being. At present days this reservoir is
becoming a place of tourist attraction. Shali reservoir is a saviour for Gangajalghati block but it remains out of focus for many years. A research should be done on Shali reservoir to highlight its importance and its influence on agriculture.

8. References
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