Climatic Impact Assessment: A Case Study of Teesta Barrage Irrigation Project in Bangladesh

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***Abstract*-- Increasing water demand due to faced over population, overexploitation of natural resources and environmental degradation have notable tainted the world's freshwater resources. Since the dawn of civilization, the means of water storage are explored and transferred by human to the area those suffer from a paucity of water. The ultimate goal of the agricultural development projects is to ensure a better living for the local people, but climatic issues are generated by this project in practice. The Teesta Barrage Project was also implemented to increase the agricultural production in the vast area of northern Bangladesh suffering from acute shortage of water every year. The aim of this study is to find out the change of climatic parameters due to construction of Teesta Barage Irrigation Project on its catchment area. After all, the project has succeeded in increased production of crops; improved lifestyle of rural people and conservation of community resources. Change in climate is noticed in surrounding project area, has some positive and negative impacts on the ecosystem.**

***Index Term*-- Teesta Barrage, Climatic Change, Paucity of Water, Development.**

1. INTRODUCTION

Food production is always a crying need and it directly depends on irrigation systems, irrigated lands and other associated factors. However, surface water is the best option to produce more food which would enable the farmers to use cheaper irrigation water that would also be environment-friendly. Moreover, water is becoming an increasingly scarce commodity because most region of Bangladesh is located in semi-arid regions with a high population growth. Groundwater has played an important role in irrigated agriculture in Bangladesh. For many cases, supply of irrigation water for their crops is a matter of life and death. However, water increases productivity in the agricultural sector and the cost-effectiveness of irrigation infrastructure are increasingly necessary to enhance the reliability of the water supply to the farmers. In fact, difficulties of having access to water frequently determine the position of the poor on the poverty scale (ADB, 2005; Islam and Akmam, 2007).

Northern Bangladesh is a plain land area and 90% of its population rely on agricultural production, depending on nature. Due to lack of water they cannot cultivate the land in the dry season. Every year they used to face drought and lose a huge amount of crop and hence be hit by mass poverty. But the Teesta Barrage Irrigation Project (TBIP) is a blessing to the distressed people with supplying irrigation water through a network of canal system and a Barrage across the river Teesta at Doani in Lalmonirhat District mainly for supplementary irrigation during Monsoon. It also caters to the requirements as possible during lean period by crop diversification and irrigation rotation. Moreover, it is also likely to create better job opportunities, leading to economic emancipation of the poverty stricken people.

India constructed a Barrage at Gazoldoba over the Teesta river which is around 100 km upstream of Teesta Barrage (Bangladesh). In the rainy season they depart excessive water through the Gazoldoba Barrage to the Bangladesh area causing floods. But in the dry season India retraces water from the Teesta River for using in agricultural fields and navigation purposes in their land. So, lacking in sufficient flow of water in the Teesta River, irrigation system is likely to be hampered and climatic conditions of the surrounding region has been dampened day by day.

The agricultural development projects have to ensure a better living for the local people, but most often climatic issues are generated by the projects in practice. Variation in agro-climatic parameters e.g. rainfall, temperature, humidity, evaporation, evapo-transpiration etc. during the year has led to the division of the year into distinct crop seasons. Therefore, the main objective of the TBP is to increase agricultural production through irrigation and thereby create employment opportunities in the vast area of northern Bangladesh by supplying sufficient water during Monsoon season when there might have irrigation water scarcity. Keeping in mind the objective of the TBIP, this study focuses to evaluate climatic changes in the catchment of Teesta basin due to construction of TBIP.

2. PROJECT BACKGROUND

Most of the rivers in Bangladesh which have their upstream in India, flow to the south towards the Bay of Bengal, which not only bring misery for the people but also every year they bring alluvial sediments and make the land more fertile, help to produce more crops. In spite of expansion of population and predominant agrarian economy, such lands can produce

sufficient food to feed the population of Bangladesh, if proper modernization policy and planning can be implemented. The economy of Bangladesh depends on agriculture and Bangladesh is continuing her effort for economic development by increasing agricultural production. As an effort, the Government of Bangladesh undertook and completed the TBIP for irrigation purposes to boost agricultural production by bringing more land under cultivation during the dry season. The idea of irrigation from the Teesta River was conceived since British time (1935).

The Teesta Barrage has been completed in 1990 to provide irrigation water in three crop seasons from the river through canal networks in the TBIP catchment area. It is a concrete structure of 615 m long fitted with 44 radial gates having a discharge capacity at 12,750 cumec. Water is diverted by the Barrage through a canal head regulator at 110 m long with a discharge capacity of 280 cumec. There is 4,500 km long network of canal system for supply of irrigation water to the field. In order to exclude silt from entering into canal system, silt trap covering an area of 45.0 hectares has been constructed just below the head regulator. Moreover, improvement of the internal drainage system (about 5,000 km) has been removed drainage congestions from the project area. Beside, the flood affected area along the Teesta river is protected from flood by an earthen flood embankment. The construction of 80 km flood embankment with nearly 10 km bank protection (sand cement block & c.c. block revetment) has been completed and the major portion of the project is being protected from flood. The project was planned to be completed in two phases. The phase 1 has been completed in 1998. The phase I (restructured) has a command area of 154,250 hectares with a net irrigable area of 111,406 hectares. It comprises construction of Barrage, flood, embankment, flood bypass, silt trap, main canal, and part of canal system with improvement of drainage. The remaining area will be developed under phase-II that is under construction.

2.1 Boundary and Area of the Project

The TBIP is the largest irrigation project of Bangladesh. It stands across the Teesta river at Dalia-Doani point in Lalmonirhat district. The project is bounded by the Teesta river on the North, the Atrai river on the West, Shantahar-Bogra railway line on the south and Bogra-Kaunia railway line on the East. It is being implemented for irrigation, flood control and drainage for a command area of 750,000 hectares of which 540,000 hectares are irrigable. The project covers seven districts of northern Bangladesh. However, the TBIP command area covers parts of the administrative districts of Nilphamari, Rangpur, Dinajpur, Bogra, Gaibandha and Joypurhat though the barrage itself is situated at Doani in the district of Lalmonirhat.

2.2 Data Collection

This study is based on analyses of secondary data sources. Secondary data have been collected from various agencies as: Bangladesh Water Development Board (BWDB); Teesta Barrage Monitoring Office, Dalia, Lalmonirhat; Water Supply Authority, Bangladesh; Ministry of Agriculture, Bangladesh and Bangladesh Bureau of Statistics (BBS).

3. Climate Change and Impacts in the Project Area

Global climate change may have serious impacts on water resources and agriculture in future. Variation in agro-climatic parameters during the year has led to the division of the year into crop seasons. Temperature in Bangladesh is suitable for cultivation and growth of crops throughout the year. Moreover, rainfall and flooding are the natural sources of soil moisture; these are supplemented by irrigation. Amount of evaporation, evapo-transpiration, humidity, wind load, wind pressure has a bit effect to crop production. Crop production is governed by moisture supply from rainfall and soil storage. Unreliable rainfall and droughty soils are the limitations to the crop production. The crop damage from drought is many times higher than the damage from flood (MPO, 1987). In this study, the changes of climatic parameters temperature, rainfall, humidity and evaporation due to construction of TBIP are discussed. The TBIP was constructed and implemented in 1990. There data sets of before and after 1990 are collected and analysed to assess the climatic impacts on the catchment area.

3.1 Variation of Temperatures

Temperature is an independent variable among the climatic elements whose variation causes corresponding changes in the pressure distribution and consequently in the direction of wind as well as its velocity which controls atmospheric humidity, condensation formation of cloud and their drafting in the sky, precipitation and storms. Nevertheless, temperature increases can have both positive and negative impacts on crop yields. Higher temperature also affects the rate of plant development (vegetative growth) and hence speeds annual crops through the developmental process.

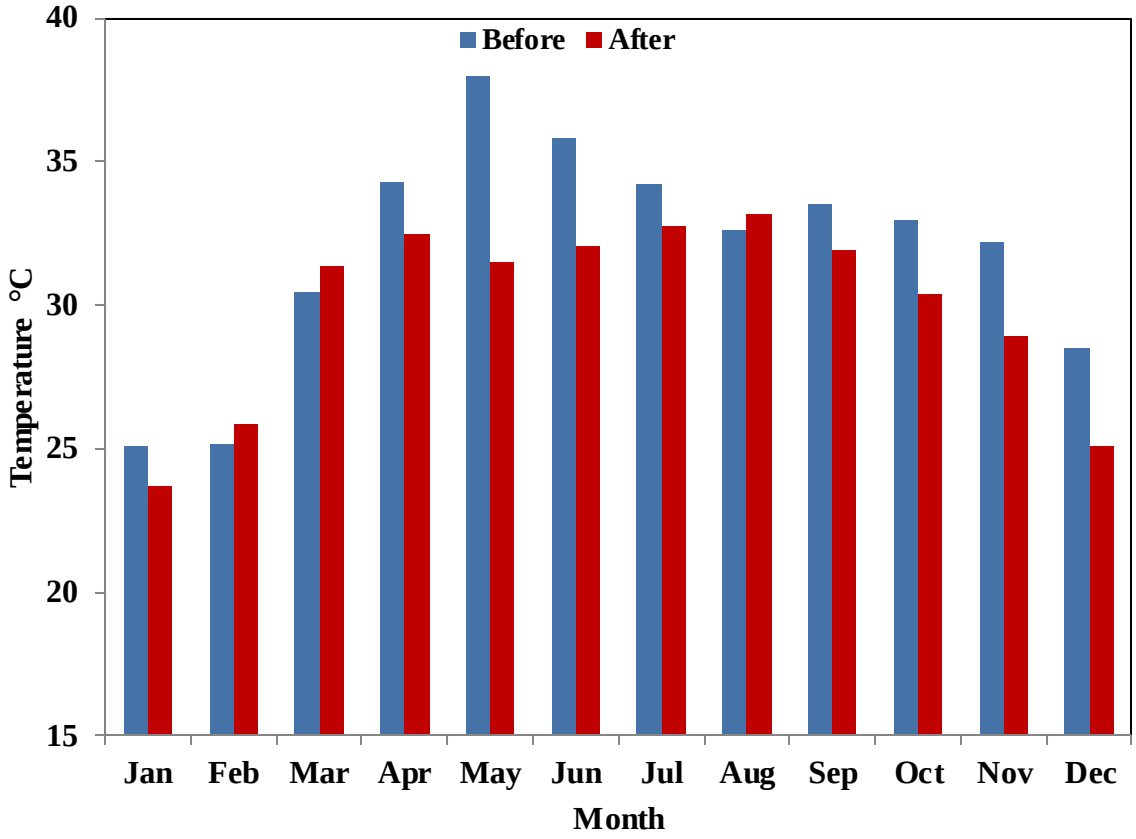

Fig. 1. Yearly variation of maximum temperature at Rangpur

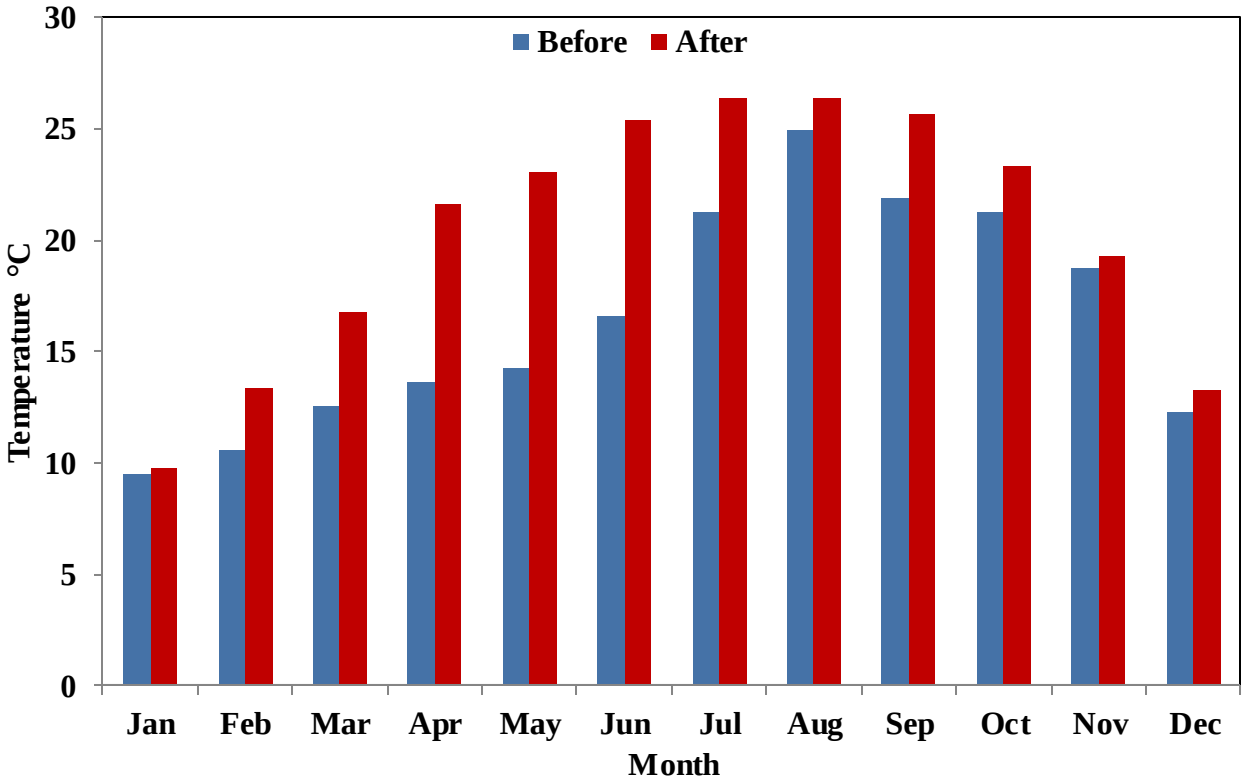

Fig. 2. Yearly variation of minimum temperature at Rangpur

However, yearly variation of maximum and minimum temperature at Rangpur before (1977) and after (2001) TBIP started is shown in Fig. 1 and Fig. 2 respectively. From the Fig. 1, it is observed that the maximum temperature varies from 25.1 to 35.8°C and 25.1 to 33.2°C before and after the TBIP commencement respectively, whereas the respective highest values are observed in month of September (before) and July (after). On the other hand the minimum temperature varies from 9.5 to 21.3°C and 9.8 to 26.4°C before and after the TBIP commencement respectively. Therefore it can be said that there is no abrupt change of temperature between before and after construction period. During the winter (especially January and February), there is usually little rain or snow in the valley as well as hot periods (April-October) occur during the growing season when temperatures can rise.

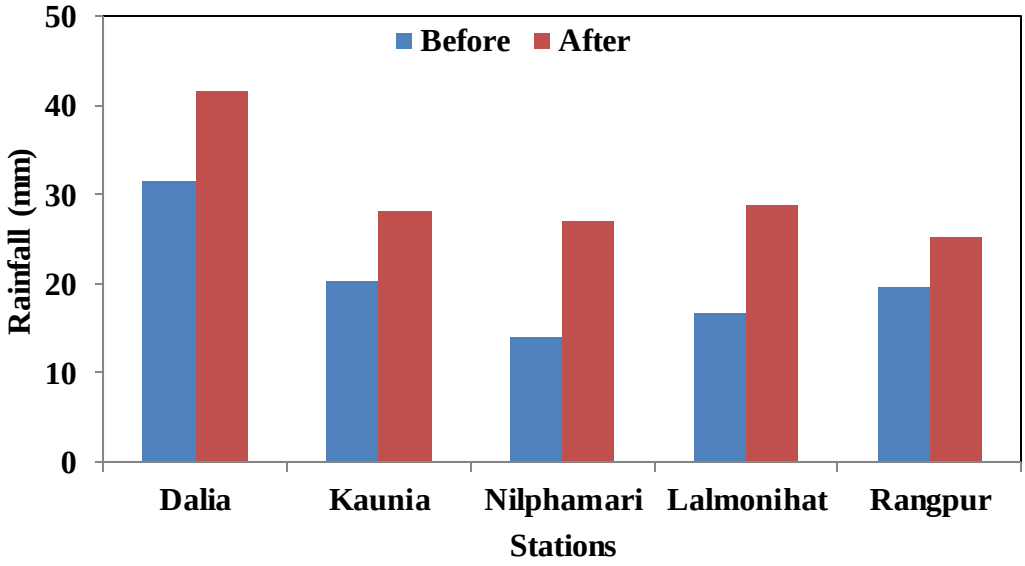

Fig. 3. Increment of mean annual rainfall in different stations in TBIP catchment area

3.2 Rainfall variation at before and after the TBIP construction

Rainfall is a product of some phenomena as evaporation, condensation, vapour pressure and formation of cloud etc. It is one of the dominant factors in the assessment of climatic water balance region. Moreover, agricultural growth largely depends on water, which is the prime input. The primary source of water for agricultural production for most of the world is rainfall. But, rainfall is not quite dependable or helpful to agricultural development in Bangladesh. The Bangladesh monsoon is known for its vagaries. So, the study was compared the rainfall distribution among these catchments areas. Fig. 3 shows the rainfall amount on before and after at different adjacent station of TBIP catchment area. It is seen that the percentage increases of mean annual rainfall is 24.35, 27.65, 48.36, 41.84 and 22.49 in Dalia, Kaunia, Nilphamari, Lalmonirhat and Rangpur stations. The reason behind the increasing rainfall could be tree plantation on the bank of the canals.

3.3 Change in Humidity at TBIP catchment area

Analysis of relative humidity, which is a major important for human comfort and plant growth, shows in Fig. 4. Humidity varies from season to season in this part of the country (Fig. 4), being highest during the high rainfall season from July to September. During the dry season, December to January, relative humidity drops, small streams dry up, and the volume of water in big streams and rivers is reduced in some parts. The maximum humidity was found in September with the value of 85% and 87% for both year of 1982 and 2001 respectively. The humidity was increased all over the month in 2001 than 1982, except in July.

However, Temperature humidity index (THI) is often placed into classes to indicate the degree of heat stress (Armstrong, 1994; Mader et al., 2006; Dikmen and Hansen, 2009) and its value is also lower than the actual temperature. THI is calculated by using the following equation

$$THI = 0.8 * T + ((\frac{RH}{100}) * (T - 14.3)) + 46.4$$

where, T = Ambient temperature (°C)

RH = Relative humidity (%)

In this study, THI shows that humidity was increased all over the year after construction of Teesta irrigation project, except in January (Fig. 5). However, people feel uncomfortable at the month of July, August and September for both of year due to high value of humidity.

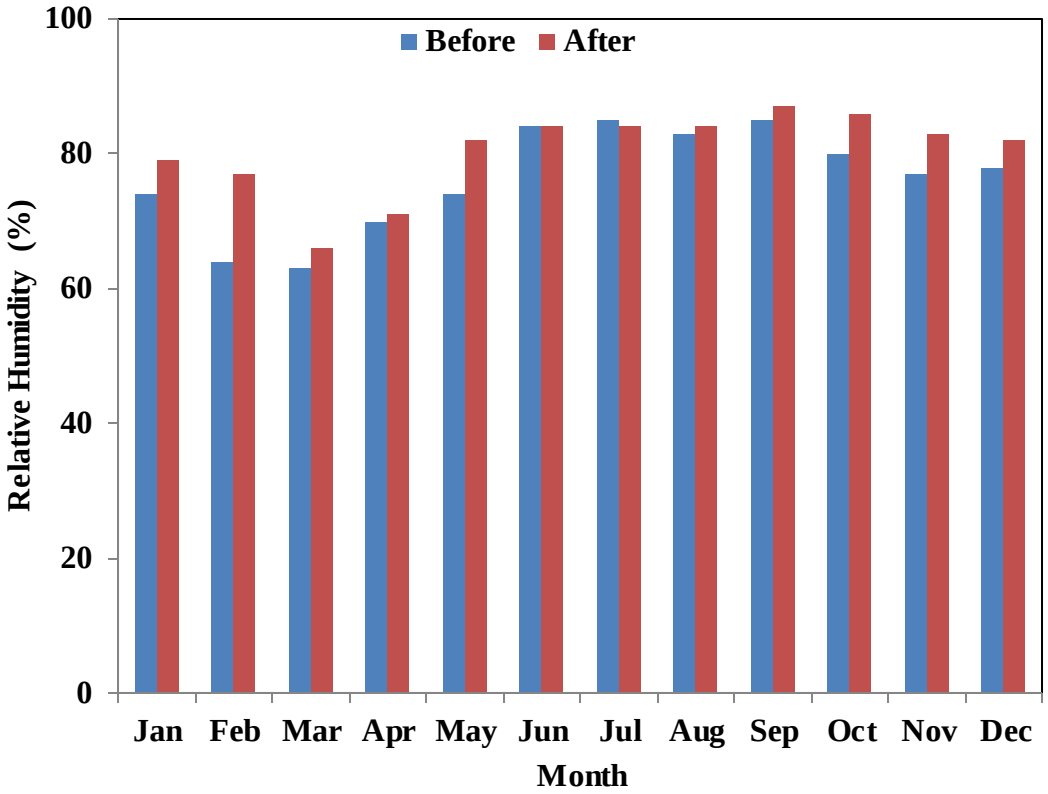

Fig. 4. Mean monthly relative humidity (%) at Rangpur

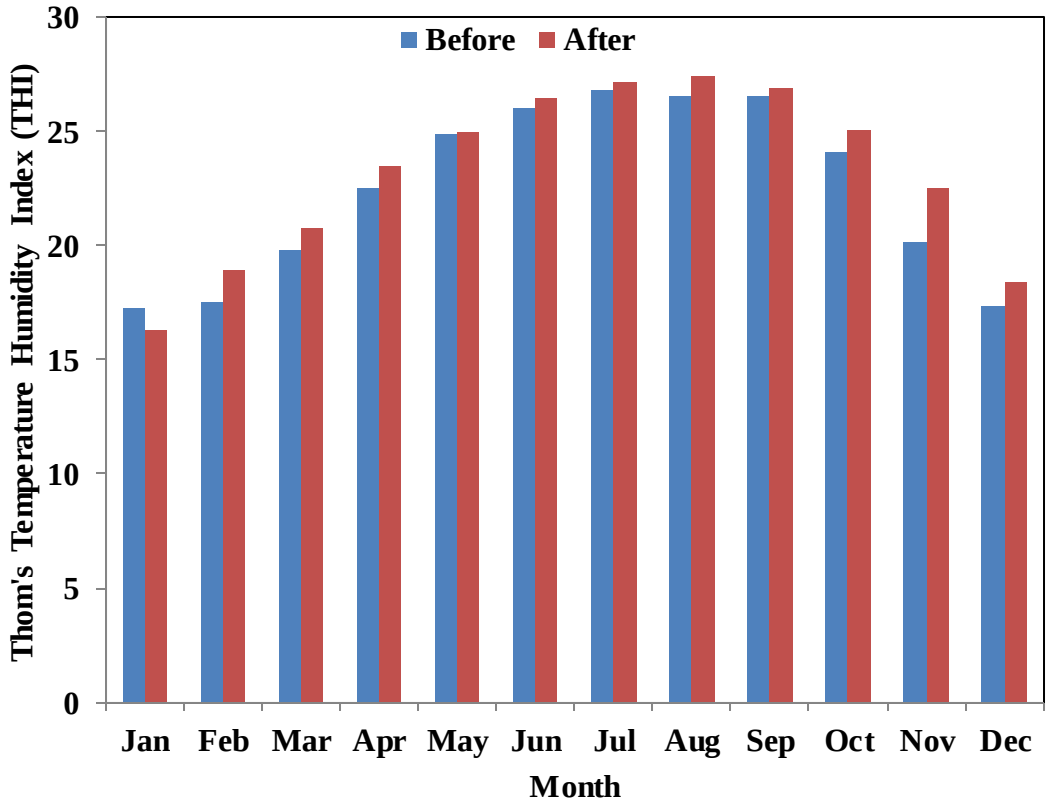

Fig. 5. Thom's temperature humidity index (THI) for pre and post project situation at Rangpur

3.4 Evaporation

Evaporation is a change of a solid or liquid in to vapor. Evaporation is subject to less variation than rainfall. However, the study was investigated the amount of evaporation at Rangpur district in both time of before and after the implementation of the project. The amount of evaporation was significantly increased after implementation of the project (Fig. 6). Except in April, the maximum mean monthly evaporation was 3.25 inch and 4.82 inch for the year of 1980 and 2000 respectively, which indicate that the evaporation after implementation of the project have increased by 32.57%. But evaporation was slightly decreased in April by 6%.

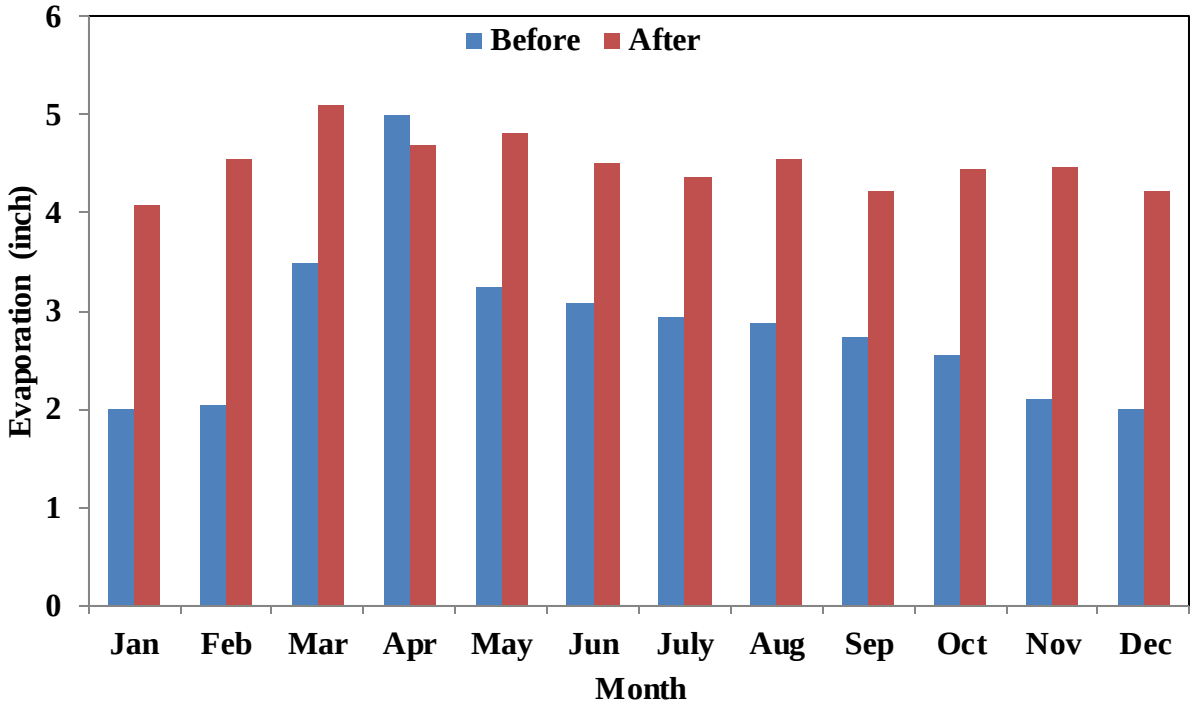

Fig. 6. Mean monthly variation of evaporation for the year 1980 and 2000 at Rangpur

4. CONCLUSION

In recent years, the use of water for agricultural and industrial purposes has increased tremendously. It has recognized that water resources project like Teesta Barrage Project is necessary for the development of a nation. The successful implementation of the Teesta Barrage Irrigation Project was a dream comes true for them. The poverty stricken people could now hope for a better future. Based on the above discussion, the major findings of the study can be summarised as below:

(i) There is no significant change of temperature due to implementation of the project, whereas a significant change in rainfall pattern was observed.

(ii) There is a minor change in humidity but remarkable change is observed in evaporation.

(iii) Proper use surface water available in Teesta Barrage catchment area is the best option, which would enable the farmers to use cheaper irrigation water that would also be environment-friendly.

ACKNOWLEDGEMENTS

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