Application of Remote Sensing in Large Scale Irrigation System Management: A Case Study of Teesta Irrigation Project

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Abstract

Agricultural areas in the north region of Bangladesh suffer from water shortages during the dry season as well as dry spells in the monsoon period. The Teesta Barrage was constructed in 1990 to provide supplemental irrigation water during the monsoon period. After completion of the project high yielding variety of crops were introduced more in the project area. Due to this reason unforeseen needs of irrigation water during the dry season has emerged. This study reviews the current irrigation status and related constraints to a full development of the project and provides suggestions for future improvement of the project. Also suggested is to apply remote sensing technique for the management of the system as a whole. Use of remote sensing technique for the management of irrigation water resources is a new approach in Bangladesh. Application of such a powerful tool will provide better management options for large-scale irrigation projects in the country.

Keyword: Bengladesh, Teesta, Large irrigation project, Remote sensing technique, Landsat 7

Introduction

Teesta Irrigation Project is one of the largest gravity canal irrigation systems in Bangladesh. It comprises a barrage on Teesta River at Doani, canal head works, a silt trap to supply sediment free water to canals and an extensive network of canals and regulating structures for delivering water to crop fields. Constructed physical infrastructure also includes flood control dykes and drainage channels. Major physical components consists of a 615 m long barrage fitted with 44 radial gates, a 110 m long canal head regulator fitted with 8 gates, 708 km of canal network, 380 km of drainage channels, 80 km of flood embankment, 11,300 canal regulating structures, 120 drainage control structures, and 2000 field turnouts or outlets. The project is intended to provide irrigation water and flood control as well as drainage facilities to a gross area of 749,000 ha of which the net irrigable area is 541,000 ha. Construction of phase I of the project having a gross area of 154, 000 ha and net irrigable area 111,000 ha was completed in June 1998. Phase-II work is yet to start depending upon the experience and performance of phase I irrigation system. The Project area including canal network is described in fig.1.

Project Concept and Changing of Irrigation Needs

Teesta Barrage Project is located in the northwest Bangladesh where rice-based agriculture is intensive, but hampered by drought. The project was originally developed to provide supplementary irrigation from Teesta River for growing Aman variety of rice in post-monsoon season. With changing cropping practices people became interested in irrigation during winter and summer months to grow Boro variety of rice. The project is intended to contribute agricultural production and enhance rural development: Agriculture, Employment, Communication, Fisheries and poultry, Plantation, Environment, Recreation and tourism. With the progress of the project, the above scenarios are conceivable. It is necessary to monitor this area in detail to control these factors and it is considered that application of high resolution satellite image data of the latest performance is most suitable.

Command Area Development and Irrigation Coverage

The Command Area Development (CAD) is targeted for acceleration of agricultural production upto full potential by expanding irrigation coverage to arable lands removing all the infrastructural

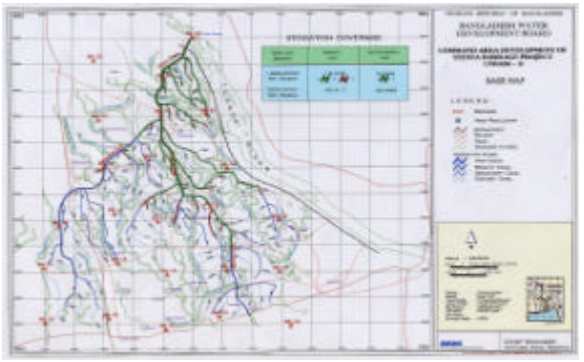

Fig.1 Teesta Barrage Project Area

bottlenecks/shortfalls for adequate supply of irrigation water (2). It also helps in environmental management as well as socio-economic enhancement by introducing multiple development programmes, viz. fisheries, duck culture, grass cultivation, afforestation etc. establishing adequate water user groups and associations to permit efficient and equitable irrigation practices. This promotes people's participation in the project works including participatory cost recovery programme as another fundamental goal of the project.

So far CAD activities have been expanded into the sub-districts (Upazilla) Dimla, Jaldhaka, Saidpur, Taraganj, Gangachara and Rangpur Sadar during 1999-2002 (3). Progress of work during this time period is described below.

Progress of CAD Activities

Agriculture: While command area development activities were in progress irrigation supplies started in 1993 to the areas adjacent to main canal. Gradually the irrigation coverage has been increased. Although irrigation coverage is being gradually improved, the achievement has not yet met the technical development and investment made in the construction of infrastructure.

In the CAD project both Directorate of Agricultural Extension and Agricultural Extension wing of BWDB are working for agricultural development work. During 1999-2000 Directorate of Agricultural Extension demonstrated improved agricultural practices through 69 demonstration plots. Training was provided to 2320 beneficiary farmers and 217 block supervisors in improved crop production system and modern and sustainable agricultural technology. Agricultural Extension wing of BWDB set up 62-demonstration plots and provided training for 1998 beneficiary farmers.

Fishery: Directorate of Fisheries had demonstrated fish breeding and growing in 85 demonstration sites and training was provided to about 1,270 beneficiaries for improved fish culture in Rangpur, Nilphamari and Dinazpur districts.

Livestock: During this time Directorate of Livestock was provided training to 550 beneficiaries and they had set up 19 demonstration plots. In 2000-2001, they have organized about 118 groups of duck and 4 grass demonstration plots in the project area.

Afforestation: The Department of Forestry had planted 74000 trees along the existing dykes and about 250 beneficiaries were trained in plantation.

Constraints to achieving target

Although the Phase I of the project was completed by 1998 the achievements were not as projected during planning stage of the project. The reasons behind the shortfall can be identified as follows.

- There were some bottlenecks/shortcomings in the structural part of the Teesta Barrage project. Some of the structures were not completed in due time. As a result, the projected targets were difficult to achieve.
- There is a lack of awareness among the farmers regarding modern irrigation systems and sustainability through proper water distribution resulting in inequitable supply of irrigation water in the head, middle and tail reaches of the canal.
- There is a lack of modern communication system for proper dissemination of information, which is essential for the operation of the barrage and canal head regulators and structures. The information regarding irrigation water demand at different areas within the project area are not conveyed in time.

The Teesta Barrage was constructed with the aim of supplying supplemental irrigation water during the rainy season. But after the completion of the project and the introduction of high yielding variety crops, unexpected needs of irrigation water during the dry season has emerged. The dry season flow of the Teesta at upstream is regulated by a barrage at Gajoldoba in India and hence the flow has to be shared with India during the dry season. However, there exists no water sharing agreement between the two countries. Hence, the irrigation during the dry season is somewhat uncertain. But now negotiation between Bangladesh and India is taking place for sharing rhe dry season flow of Teesta.

Suggestions for Future Improvement

The following were identified for future improvement of the project to better serve the farmers.

Crop Diversification: Proper planning for ensuring optimum cropping pattern is needed to take full advantage of the existing irrigation facilities. For example crop diversification with introduction of less water-consuming crops can increase irrigation coverage. It also deals with problems like preservation of the soil fertility and round the year availability of agricultural production.

Table 1: Season-wise irrigation coverage during 1993-2003 period

Year	Kharif-II season (ha)		Kharif-I season (ha)		Total Irrigated Area (ha)	
	Target	Achieve-ment	Target	Achieve-ment	Target	Achieve-ment
Before CAD Project						
1993-1994	8000	6000	7000	5400	15000	11400
1994-1995	8000	6271	7000	2405	15000	8676
1995-1996	6000	4400	6000	4490	12000	8890
1996-1997	6000	4317	6000	4000	12000	36000
1997-1998	20000	16000	20000	20000	40000	36000
1998-1999	20000	4225	20000	8005	40000	8005
During the CAD Project						
1999-2000	20000	4225	20000	9345	40000	13570
2000-2001	45417	35960	28332	8693	73749	44653
2001-2002	53824	57626	10450	18008	64274	75634
2002-2003	85045	61044	20000	In progress	105045	In progress

Augmentation of Dry Season Flow: At present due to flow regulation at upstream without any water sharing agreement the dry season flow is more uncertain than natural uncertainty causing difficulties in proper planning of dry season irrigation. Possibility of augmenting dry season flow should be explored and considered in the Indo-Bangladesh negotiation.

Adequate Monitoring: Proper monitoring of the existing distribution network is needed to ensure the best operational performance throughout the project area. More manpower and/or introduction of modern communication system are essential for this.

Beneficiary Participation: Participation of the stakeholders at every stage is essential for a sustainable irrigation system. By strengthening the participation of the beneficiaries through proper training on modern irrigation systems, irrigation development rate can be substantially speeded up.

Future Prospect

The land use and cropping pattern of the project area needs continuous updating which can be conveniently done using remote sensing imagery. Monitoring of irrigation coverage, crop growth and operation of canal system with related regulating structures requires automated data collection, processing and decision support system.

In this study, Landsat 7 etm+ data (138-042) observed on November 17, 2000 has been used, as the basic image data though use of satellite image data obtained by MOS-1 and JERS-1 in Japan was also possible. Fig. 2 shows this satellite image after geometric correction overlapped with the project area. In Figure 3 it has been tried to locate the Teesta River, the barrage, main canal and major cities and to grasp populations in the cities. Fig. 3 shows the image overlayed with the actual canal networks and this figure has been used as the basic analytical tool.

In future, it may be useful to accumulate information from satellite images by dividing the area into each water distribution system and analyzing the actual state of water use, crop planting, land use change and environmental assessment in each section to extract monitoring factors that are important for fruitful results expected by the implementation of the project, and to improve the living standard of the regional inhabitants from the aspect of appropriate agricultural management.

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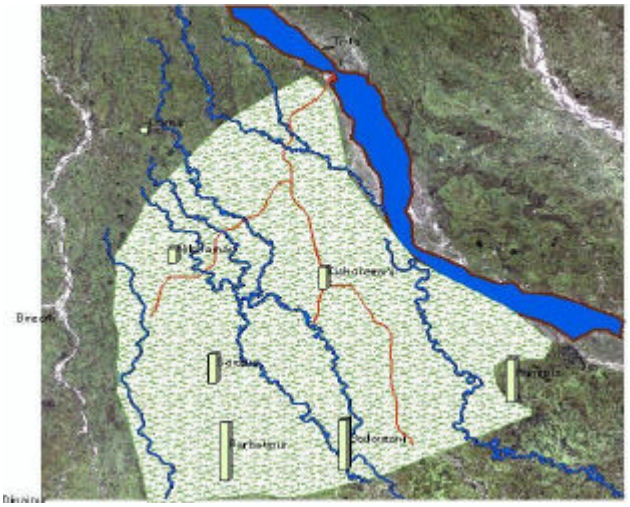

Fig.2 Satellite image of study area extracted from Landsat 7 etm+(observed 17Nov.2000, 138-042) and overlapped project area map including main cities and its population

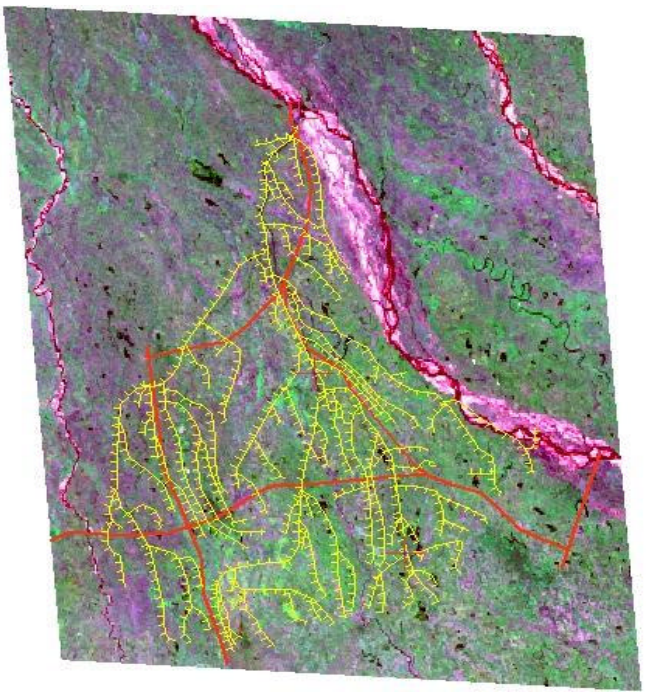

Fig.3 Geo_corrected Landsat 7 etm+ image of Teesta Barrage project(Bangladesh) overlapped irrigation canal system and main road