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Teesta Barrage Project – A Brief Review of Unattained Goals and Associated Changes

Baishali Mukherjee[1], Ujwal Deep Saha[2]

[1, 2]University of Calcutta, Department of Geography, 35, Ballygunge Circular Road, Ballygunge, Kolkata – 700019, India

Abstract: ***The Teesta Barrage Project that has been conceived in the year 1975-76 had a grand plan for the revival of agricultural economy of six districts of North Bengal- Cooch Behar, Jalpaiguri, Darjeeling, North Dinajpur, South Dinajpur and Malda which did not have any strong industrial base. The project is still incomplete and there is a very little chance for the completion of the entire project as executed. The dam constructed aimed to control flood, bring lands under irrigation, generate hydro electricity, navigation, fishing and tourism which after the completion of the first phase is still unachieved and far from fulfilment. This paper is attempted to study the objectives behind the construction of the project along with its achievements and unachieved goals. Changing natural habitat with emphasis on the impact of the project over human life in the catchment area have been tried to determine through selected study of respondents and using Remote Sensing techniques. The changes of LULC attributes within the catchment area in due course of time have few striking characteristics along with increasing sufferings for the locals due to some changes in geo- economic environment.***

Keywords: Teesta barrage, flood, irrigation, LULC, geo-economic environment

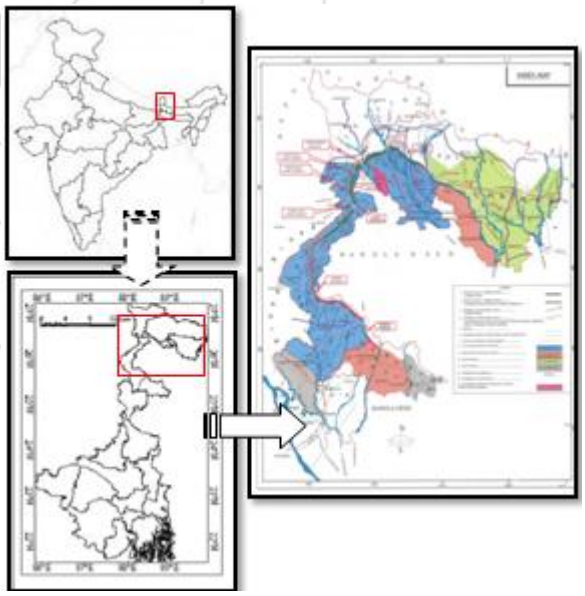
1. Introduction

Any part of the world dependent on agricultural practices require ample amount of water for crop production and if the concerned area is associated with rainfall variability then demand of irrigated water will be higher. North Bengal is endowed with 60% of total water resource in West Bengal [7]. To exploit such huge resource base and to supply irrigated water a barrage was constructed on the mightiest river of North Bengal, Teesta in 1975-76, in 6 districts of north Bengal which had no such industrial base and required a strong irrigation related infrastructure to meet its demand mainly for agriculture during the dry months. The North Bengal plains are associated with high rainfall variability and it gets rainfall accounting for lower than average rainfall frequently. 90% of total annual rainfall in concentrated in 4 summer months followed by a long spell of time with rainfall averaging 0-50 mm [8]. Often monsoon gets delayed and the agricultural fields suffer from acute shortage of water. Such gap between required water and available water in this region has to be met through the supply of irrigated water. Until the Teesta Barrage Project (TBP) there were literally no such large irrigation schemes in North Bengal.

Amount of Teesta's water received by Bangladesh gets reduced, due to TBP, raised a conflict between 2 neighbouring states and the circumstances became more complex as 5 more dams were constructed upstream. Environmental condition during post dam period below the TBP raised so much concern among the researcher presently. Application of Remote sensing and GIS for evaluation of environmental condition of the area lying below the TBP is undertaken by many researchers [1]. This research work is aimed at the evaluation of changing environmental condition in terms of vegetation, ground moisture and land use pattern of a certain part of TBP command area through applying RS-GIS techniques along with the scenario of gaps present between proposed aims and its implementation has been done.

2. Geographical settings of the study area

To evaluate the environmental condition a certain extent of TBP lying closest to Teesta River has been taken into consideration. The flat low lying plain land in Jalpaiguri and Coochbehar districts of West Bengal is lying on the fringe of Teesta mega fan. Teesta followed a straight course with numerous wandering channels below the barrage constructed at Gajoldoba in Jalpaiguri with an average width of 2.3 kms approximately. Such low lying plain areas, considered as one of



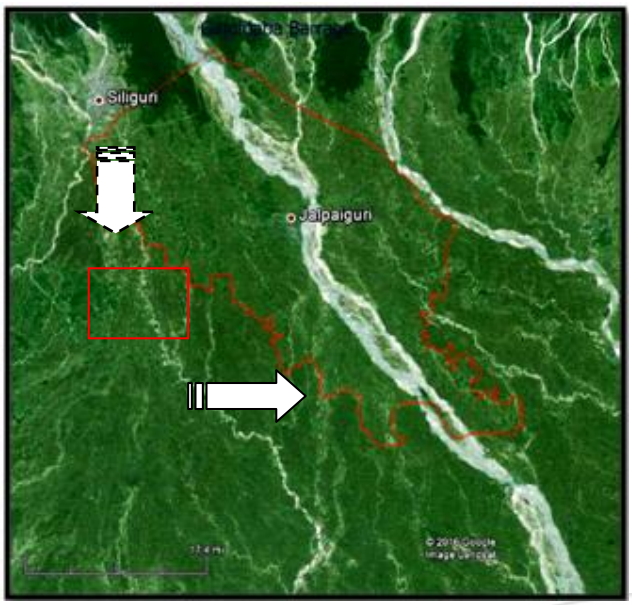


Figure 1: Location of Study area, (a) studied part for evaluation of environmental characteristics.

(a)

most security seeking border areas in India. With minimum changes in Relief character and annual average rainfall fluctuates between 3000-3500mm [5] aided with sediments brought down by Teesta this area is dominated by paddy cultivation.

3. Materials and Methods

A digital database dated 1991, 2001 and 2014 of Land sat satellites has been used to evaluate the environmental characteristics in terms of certain selected aspects. Mosaic operation has been done to subset the studied part after environmental correction is completed for all the images of concerned years to reduce the environmental noises for better accuracy in EDRAS Imagine and Arc-Gis 10.2 environment. A comparison is also done between the proposed goals and project achievements based on previous literatures, published reports and problems oriented survey among the locals of the concerned area.

Vegetation characteristics have been evaluated on a particular temporal interval with the help of following equation for obtaining NDVI, (NIR-RED) / (NIR+RED). A method is used where the band ratio between SWIR (TM/ ETM+ band 5 and OLI band 6) and Green has been done that water and land can be separated directly because among all the spectral bands of Land sat satellites mid-infra red has the maximum potential of separating water from land [9]. This mentioned method has been used to capture the ground wetness condition and its change over time. To obtain land use description from analysing digital data sets nearest neighbour method, considered as most efficient for Land sat images, has been applied.

4. Hydrological Characteristics

The operation of TBP and water diversion through Teesta-Mahananda Irrigation canal has made some serious changes in the hydrological character of Teesta below Gajoldoba barrage. During the dry months of a year the discharges are found to be decreasing during post dam period. A decrease of about 88% is found after the operation of this Barrage. After the construction of Gajoldoba Barrage a decrease is observed in case of lowest annual discharge about 85% [1]. This alteration within the fluvial regime has opened up a greater scope of human intervention on the drier part within the floodplain. With due course of time water demand in Teesta basin has been increased but the available water in the stream decreased by 32% from 1995 to 2010 (69 billion m^3 to 47 billion m^3) in the downstream of TBP has transformed the area into such a region where the word water scarcity can be tagged in.

Table 1: Discharge characteristics of Teesta during pre and post barrage operation period. (Source- Fakrul and Higano, 2003)

YEAR	Discharge in Cumec (m^3/S)			YEAR	Discharge in Cumec (m3/S)		
	MAX	MEAN	MIN		MAX	MEAN	MIN
1978-79	721	541	361	1988-89	667	397	127
1979-80	670	432	195	1989-90	645	409	173
1980-81	522	330	137	1990-91	729	427	125
1981-82	666	400	135	1991-92	653	391	135
1982-83	652	415	177	1993-94	453	296	138
1983-84	883	523	164	1994-95	633	412	190
1984-85	795	488	182	1995-96	459	252	44
1985-86	760	487	214	1996-97	478	259	39
1986-87	660	425	190	1997-98	672	353	34
1987-88	527	301	76	1998-99	364	200	36

5. Components of TBP

The Teesta Barrage project is a large multipurpose water resources project in the state of West Bengal. The Project has three different phases and the Project envisages utilisation of potential of the Teesta River in the field of irrigation, hydropower generation, navigation and flood moderation. It planned to irrigate 922 thousand hectare land under the 1st phase, generation of 650 MW electricity in the 2nd phase and it schemed navigational plan by envisaging link between Ganga and Brahmaputra under the 3rd phase. The 1st phase was again divided into three stages which aimed to irrigate 546 thousand hectare land under the 1st stage, 223 thousand hectare under the 2nd stage and 153 thousand hectare under the 3rd stage. The 1st phase of the project started in the year 1976 and is proposed to be completed by March'2015 which is still under progress [8]
The 1st sub stage of Stage-I of Teesta Barrage Project envisages the following works:

a) Construction of a barrage across river Teesta at Gajoldoba in the Jalpaiguri district.
b) Construction of distributaries, minors, sub-minors and water courses covering a length of 2450.00 km (approx.) for sub-stage-1 of stage-I.
c) Construction of 27 Nos. of Regulator and fall structures, including 3 Nos. of Power Falls.
d) Construction of 166 Nos. of bridges on main canals including crossings of Railway Lines, National Highway, State Highway and Major District Roads.
e) Construction of residential and non-residential buildings, stack-yards, stores and go downs throughout the Project Area.
f) Construction of Inspection paths, approach roads and other allied works.
g) Two pick-up barrages, one across the Mahananda River at Fulbari in Jalpaiguri district and other across river Dauk at Chopra in Uttar Dinajpur district.
h) Construction of five main canals namely:
   i. Teesta- Mahananda Link Canal for the length of 25.75 km.
   ii. Mahananda Main Canal for the length of 32.33 km.
   iii. Dauk Nagar Main Canal for the length of 80.20 km.
   iv. Nagar Tangon Main Canal for the length of 42.20 km.
   v. Teesta- Jaldhaka Main Canal for the length of 30.31 km.

6. Project Achievements

After the completion of the 1st sub stage, the Teesta Barrage project has been able to achieve the following:

6.1. Irrigation

Work on the project started 35 years ago for irrigating the fields of North Bengal. The 210-km canal network, a crucial part of Teesta Barrage Project, would have helped to irrigate 9.22 lakh hectares, now it is managed to water 66,000 hectares which is less than 10% of the proposed plan. Work on the three barrages of the project that were to have been built along with the canals to take the river water to the interiors of North Bengal is under developed.

6.2. Hydro Power Generation

The 1st Sub-stage was to generate 650 M.W. of hydropower from three canal falls in the Mahananda main canal. The reservoir that was planned to be constructed during the second phase of the Teesta irrigation project cannot be now undertaken since the NHPC has already started working towards the implementation of the 'low dam' just 400 m. upstream of the Coronation bridge. So the plan to generate an additional 600 MW power under the TBP will probably never take off.

6.3. Flood Mitigation

There has been record of the shifting courses of the Tista in recent history. Now there are cut-offs from the flow of Tista and appear to be derelict channels where the beds are risen with deposition of sand-silt .As a result of these have become perennial source of water logging and flood over the North Bengal plains. Construction of 12 Nos. of Major Cross Drainage structures on main canals including major aqueducts on crossings of rivers and Construction of 27 Nos. of regulator will decrease the intensity of floods in this region, but the construction is incomplete and has failed to reduce flood.

6.4. Communication and Construction

The project was to develop transportation as well as communication in this region .It is stated that 166 Nos. of bridges on main canals including crossings of Railway Lines, National Highway, State Highway and Major District Roads will be constructed. Not only that Construction of distributaries, minors, sub-minors and water courses up to 8 ha. Blocks covering a length of 4200 km.(approx.) in an area of 3.42 lakh ha. C.C.A. in the six districts of North Bengal. Apart from this Construction of residential and non-residential buildings, stack-yards, stores and Go downs throughout the Project Area will change the social environment. Still around the barrages local village population is residing in 'Kuccha' houses mainly. Constructions of transport arteries through the embankments and Barrage road have reduced the distance with Kolkata and other districts.

6.5. Recreation and Tourism Development

The region is based on three T, such as Tea-Timber-Tourism. This place has high eco tourism potential. The project has encouraged things of attraction. Around the gigantic, magnificent beautiful Barrage and its head works there are green parks, flower gardens, course of the Teesta and the Silt Trap. These barrages have become famous picnic spots in Darjeeling and Jalpaiguri district. The implementation of project has change the economic condition of people a bit. Small restaurants and shops are ran by local people near the barrages. Recently a 'Eco Tourism Park' is under construction which is in the catchment area of Gajoldoba Barrage and it has promising future for the development of the economy of the local area.

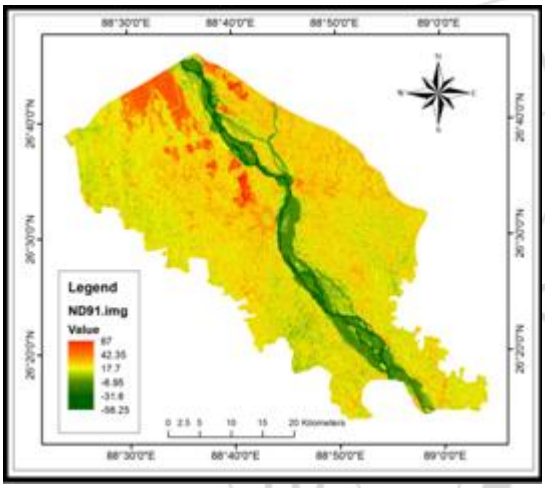
7. Changing Environmental Condition

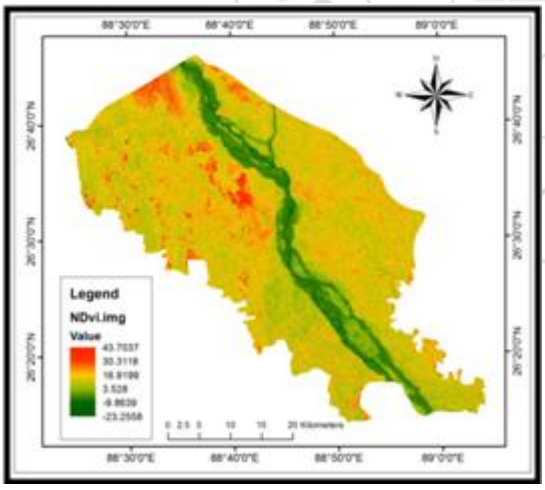
Construction of barrage is a way of river impoundments where changes in the fluvial regime of downstream portion of the barrage will undoubtedly change and the environmental setup in terms of ground condition as well as land use characteristics will also experience changes. In case of dependence for economic utilisation of land on the river is quite significant then the change could be immense depending upon the nature of the project in action. In the study area of this research work NDVI and Tasselled-cap transformation has been applied to detect the changes in green coverage and ground wetness characteristics with associated quantification to analyse the changes.

7.1. NDVI study

NDVI on TM and OLI data has been done to showcase the nature of vegetation richness based on RED and NIR bands. Recent and ancillary data are used to capture the overall change of vegetation coverage and its nature over time on the area under study (see Fig 3). It's evident here that due to

human encroachment and establishing the barrage and its associated structures dense forest cover has been cleared in due course of time. Whereas sparsely distributed forest cover has been seen gaining its areal distribution may be with the effect of social forestry and remaining fragments of previous dense forests. Low NDVI values signifies barren land [1] and within the braiding plain it seems to be decreasing which is because of ever increasing human pressure that transforms fresh depositions into crop lands. Overall dense vegetation cover has been decreased in a striking manner and alongside croplands has been gaining its areal coverage with comparatively increased irrigation facilities day by day. Here in this case irrigation projects has partial relationship to increase or decrease vegetation within the project boundary [1]. Northern part of west Bengal receives quite high, just less than 1000mm [5] but average trend of getting rainfall is has been reduced except those years experienced extreme events [6] which may have partial relationship with decreasing vegetation cover.





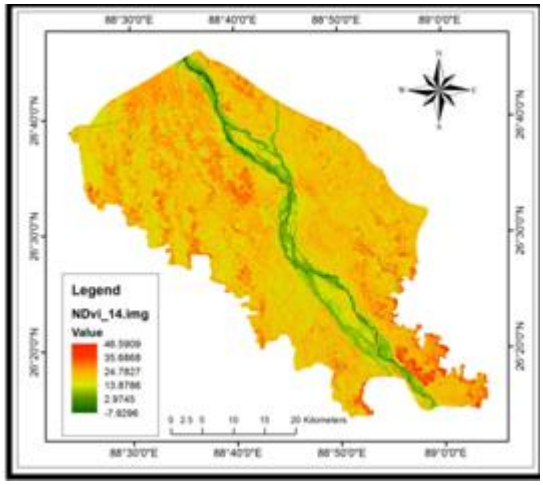


Figure 3: NDVI map of study area during 1991, 2001, 2014 (respectively from top) and graphical distribution of NDVI values

7.2. Ground wetness characteristics

In due course of time wetness characteristics within the fluvial regime has been decreased. Due to spilling of water from the irrigation sub canal human induced wetlands emerged in Jalpaiguri district with in the study area (see Fig 3). The over ground wetness excluding the braid plain has increased. Such increased ground wetness did not help the crop cultivation as these wet grounds are used to grow low quality jute during July to September and from November to April vegetables like tomato, chilli is cultivated. On the other hand these human induced wetlands have actually reduced the areal extent of crop lands in this region.

7.3 Changes in Land use and Land cover

Decreasing ground moisture content [1] and inability of providing irrigation facilities result in increase of barren surface in certain parts. Eventually increasing wet surface along the irrigation sub canals is also responsible for decreased agricultural land as well in the northern part. Due to decreasing river discharge during lean period river 'chars' are used as agricultural fields. Thus, agricultural fields get increased along the main channel as well as in the active braidplain. Area occupied by active river had been decreased by 54.22% from 1991 to 2014. Settlements had been grew in with passage of time as Jalpaiguri town attracts more population and rural settlements emerged into this region in search of better livelihood around the multipurpose project. It was increased by 15% by 2014 from 1991. Wetlands had shown a decreasing trend from 2001 to 2014 probably due to the transformation of such land into agricultural fields to some extent for vegetables and fibre crops. Thus there is an overall transformation of land use as well land cover characteristics which is clearly guided by human intervention and has also shown the significant failure of TBP within its command area. Although cultivation of Rabi crops like Sunflower has been increased due to better availability of water through the irrigation canals compared to before. This results in decreased amount of cultivable fallow.

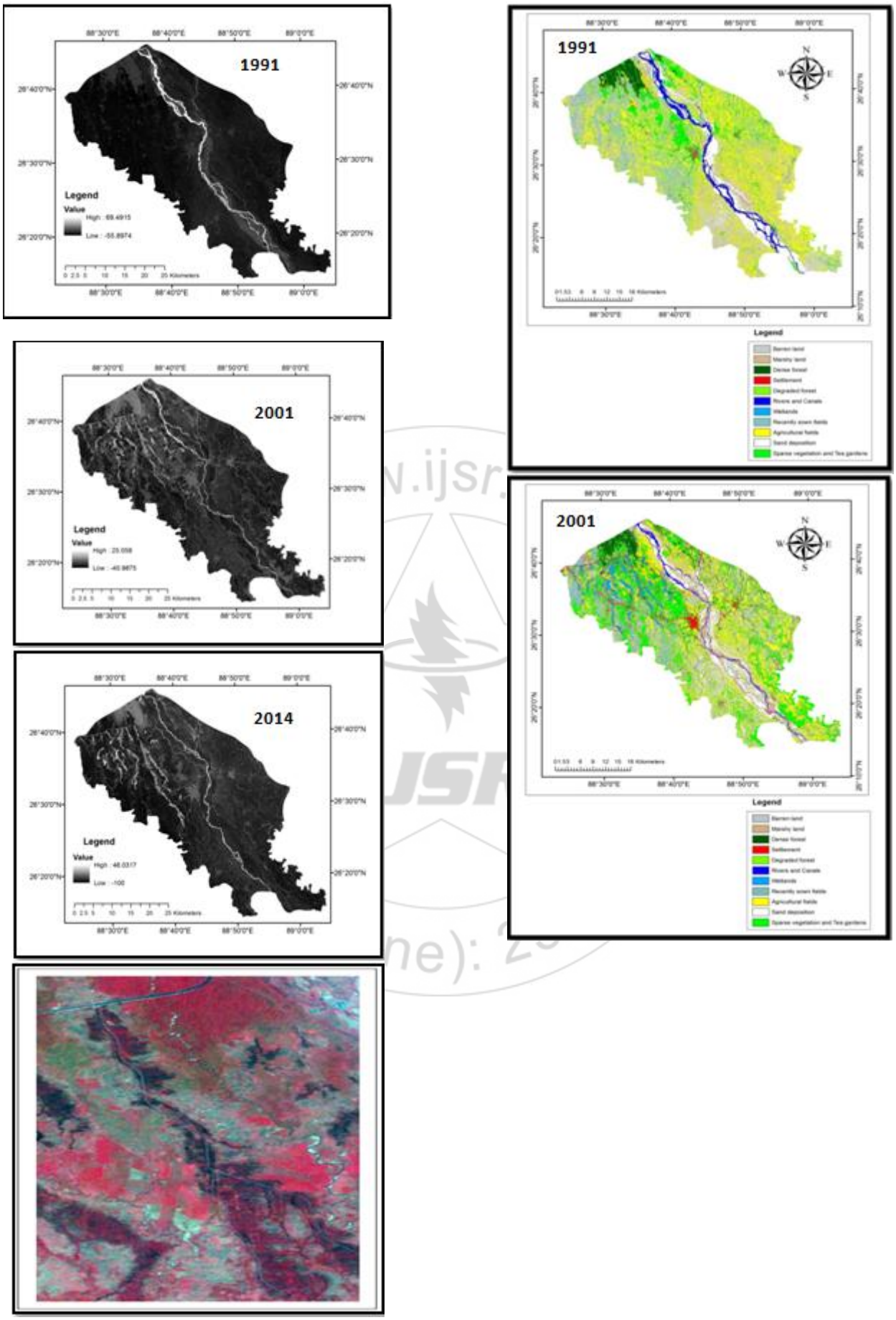


Figure 4: Ground wetness map during 1991, 2001 and 2014. Wetlands present beside irrigation sub canals.

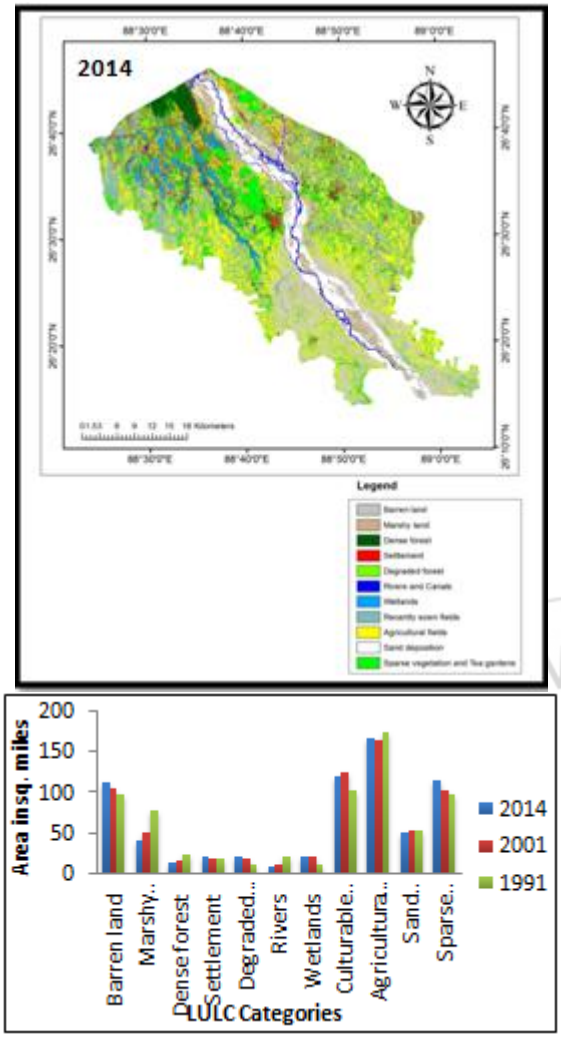


Figure 5: LULC maps and areal occupation by different LULC attributes during 1991, 2001 and 2014.

8. Conclusion

Teesta Barrage has been declared as National Project. The total expenditure of the project up to March'09 was 1236.01 Crores. The Planning has been done as per the guide lines of the National Project. Besides, Irrigation & Waterways department, being the nodal department has taken necessary initiations for other activities as laid down in the guide line of the National Project. As a whole the over ambitious project is still far from reaching its real objectives. And negative impacts on the associated environment are of great concern from socio-economic perspective.

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Author Profile

Baishali Mukherjee has received her B.Sc and M.Sc Degree in Geography from University of Calcutta (CU) and she stays in Sakherbajar, Kolkata. She is presently a research scholar at CU.

Ujwal Deep Saha has received his B.Sc and M.Sc Degree in Geography from University of Calcutta (CU) and he stays in Baruipur, Kolkata. He is presently a Junior Research Fellow at CU.