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Development of Alluvial Fans and Associated Land Use Problems of Himalayan Foot Hills, West Bengal

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ABSTRACT: ***T****he present paper embodies some observations and distinct findings about the Development Of Alluvial Fans And Associated Land Use Problems Of Himalayan Foot Hills,Werst Bengal.The study area give an ample scope for studying the evaluation and developmental striates of alluvial fans being originated by fluvial action.The present worker have taken 1000km2 area, demarcated by Tista nd Jaldhaka including no. of rivers,streams. Actually a mountain stream debouching out onto a flat,gentle gradient deposits its load building the alluvial fans. Fan development is are result of complex interaction of climate and tectonism being influenced by open hydrological system.According to Bull(1964) fan materials are classified by Mud flow, Braided stream flow and stream channel flow among which stream channel flow is responsible for the development of alluvial fans over this area.This fan areas are also marked by variabilities of land use mainly agriculture is well developed over the fertile alluvial deposits on which soil layers have prominently developed. The gentle sloped cultivated plots are mainly suffered by proper irrigation, mainly in rabi season. The EW demarcating zone of 250m contour line between Bhabar and Khadar ,due to the presence of HFF water is percolated and in the downstream area they are come out as capillary action. side this reason the soil character is also responsible. So proper land use management and well irrigation system is needed for agriculture.*

KEY WORDS: *Alluvial fan development, problems of land use and related mitigation.*

I. PROLOGUE:

The present paper bespeak about the development of 'Alluvial Fans And Associated Land Use Problems Of Himalayan Foot Hills,West Bengal'.The detail study about the nature and development of alluvial fans is concerned with the morphological arrangements and mode of occurrences both in a quantitative as well as qualitative aspect with time and space .It is an ample scope for studying the evolution and developmental strategies of alluvial fans being originated by both endogenetic and exogenetic forces. There are several macro and micro fans have developed over the entire elongated Himalayan foothills of West Bengal with spectacular land use development being influenced by slope, water velocity, carried materials etc.The mountain streams debouching out on a flat plain, deposits its load, building up an alluvial fan. The geometry of fans are mainly controlled by the relating factors like relief, climate, lithology and the hydrographic characteristics of the streams. The study area is composed of mainly Tista and Jaldhaka fan being over taken by many micro fans like Chel-Mal fan, Mal-Neora fan, Neora-Murti fan etc. The alluvial fan deposits are coarse grained poorly sorted and immature sediments. Usually boulders and gravels predominate with subordinate amounts of sand, silt and sometime clay. The size of materials is large and process of soil formation is hampered by regular flood deposits. The development of fans are controlled by some integrated factors like- slope, climate ,parent material, decrease of velocity etc.The piedmont zone of the foothills are well marked by the development of alluvial fans.This fan areas are also marked by variabilities of land use mainly agriculture is well developed over the fertile alluvial deposits on which soil layers have prominently developed. The gentle sloped cultivated plots are mainly suffered by proper irrigation, particularly in rabi season.The EW demarcating zone of 250m contour line between Bhabar and Khadar ,due to the presence of HFF water is percolated and in the downstream area they are come out as capillary action. Beside this reason the soil character is also responsible. The entire fan area is dominated by sandy to loamy type having high infiltration rate and low water holding capacity. So in the middle parts of every rivers and streams, amount of water is low which effect the agriculture in the alluvial fan deposits areas. In order to solve the problem both GO and NGOs have taken steps to solve the irrigation problems through micro watershade management.

II. AREA AND LOCATION:

The study area is located under the lower Brahmaputra river basin bordered by the two perennial rivers,Tista in the west and Jaldhaka in the east covering 2000 km^2. From the administrative point of view the area covers three blocks of Jalpaiguri district i.e. Mal, Maynaguri and Matiali extending from 26º25´N-27ºN and 88º30´E-890º0´E. Geographically the area is well known as 'Duars'.(FIG-1)

III. METHODOLOGY:

To fulfill the aforesaid objectives this worker has adopted the modern methodology including the Remote Sensing and GIS, employing appropriately the relevant data, information and evidences and intensive field work with particular environmental and geomorphological interest. This dynamic interfluve area seismotectonically known as active zone of complex neotectonic framework. Most of the analysis of the study is based on intensive field work, data collection and empirical observations in terms of- (i) pre-field, (ii) field and (iii) post field methods with an application of advanced techniques of measurement and analysis. Due weightage has also been given on the level of socio-economic well being. The first phase includes the collection of data, preparation of maps like hydrological, pedological, drainage and data base maps concerning primary and secondary sources. This piece of study encompasses the data and information of primary (based on field measurements- using Dumpy level, Prismatic compass, G.P.S., Current meter, Ablese level, Clinometers, Questionnaire and some direct methods and secondary sources mainly both published and unpublished work (from G.O. and N.G.O.). These concern Memoirs, Records and Reports from G.S.I., the Topo maps (78 B/9, B/10, B/11, B/13, B/14) from S.O.I., Thematic maps from NATMO

IV. GENERAL GEOLOGY

The Tista-Jaldhaka interfluve area has a great diversity of landscape with different geological formation, lithology, neo-tectonic and morphological structure. This area manifests much notable structure and riverine features being developed by the interruptions with the progress of cycle of erosion. The Sub-Himalayan foothill zone consists almost entirely Siwalik and lesser Himalaya which are quite younger deposit in nature. These can be traced into Nepal upto about 20 km east of Tista river. Thereafter they disappear for 10 km. to appear again and after a short stretch disappear finally below the advanced spun of the lower Himalayas west of Bhutan at Jaldhaka river. Compared to the adjacent Nepal Himalaya Siwalik and lesser Himalaya are quite narrow. Moreover, the massive thickness of upper siwalik beds, conglomerate and sandstone as seen in the north, west, central and eastern Himalayas are absent here. This foot hill zones of Quaternary deposits are mainly fluvial origin and fluvial terraces, alluvium fans and cones of recent origin are also abundant along the river section. They contain unoxidized sediments ranging from boulder to sand. Depositions are of broadly two phases, older one is of black soil cover. Both phases are benched at levels. The piedmont deposits have been grouped into 5 units from south to north based on the oxidation index, color of sediments (weathering zone) and the top soil (soil zone) (Das and Chottopadhyay, 1988).

TABLE NO.1.MAJOR GEOLOGICAL FORMATIONS

FORMATIONS	WEATHERING ZONE	SOIL ZONE
Shaugaon Formation	Unoxidised	No soil cover
Baikunthapur Formation	Do	Black soil cover
Chalsa Formation	Yellow coloured sediments	Brown soil cover
Matiali formation	Oranged coloured sediments	Red soil cover
Sumsing Formation	Red coloured sediments	Chocolate soil cover

Source : Geological survey of India, Record Volume No. 121 Pt. 2-8, PP. 101-109

CLIMATE AND NATURAL VEGETATION

The interfluve area of Tista-Jaldhaka river from different types of physiographic sections extending towards the great plain of rest Jalpaiguri and Coocbehar area which is under the Ganga-Brahmaputra river system respectively. With little latitudinal variations (26^{o} 25′N – 27º) and landscape from south to north have brought about the meteorological diversity influencing the geomorphological landforms and land use evolution of the particular area. The importance of climate in the study of climatogenetic geomorphology has been put forward by the climatologists. The general climate of the study area is Modified Tropical Monsoonal climate. The topographic forms like Terraces, floodplain deposits, transacted river systems, scarp, relatively level plains of different attitude, land use variations flat alluvium fan areas appear to affirm the change of climatic conditions in the past. The climate is believed to have played an important role in punctuating the fluvial processes of the interfluve. The vegetation of the Himalayas can be classified into attitudinal zones by complex of environmental features including climate, soil, and geology and forest history. An attempt has been made to classify the natural vegetation of Tista-Jaldhaka interfluve.

(i) Tropical Evergreen Forest : These type of forests are found to be distributed in a very small patches in the southern part of the study area.(Plate No.III.5)

(ii) Mixed Deciduous Riverine Scrub : The most important forest type is observed in the entire part of Maynaguri and south of Mal Bazar with trees like Teak (Tectona Grandies), Sal (Shorea Rabusta), Siris (Albizza), Palash (Butea Frodnosa) and Axle Wood (Anogeissus Latifolia). But now the forests have degraded because of the unauthorized encroachment of settlements and agricultural lands.

(iii) Sub-tropical Deciduous (Semi Evergreen type) : The Sub-tropical Deciduous semi-evergreen forests are frequently distributed in the middle part of the study area covering Mal Bazar, Matiali block. The main species of the forests are Sal, teak and Rubber (Plantation).

SOIL CHARACTERISTICS :

Soils of the interfluvial area are dominated by zonal, azonal and interzonal group of soils developed on varied landscape and parent material. From the geological point of view the soils of Tista-Jaldhaka interfluve area is mainly the products of weathering of fluvial classifies. They have developed on the Quaternary deposits of the piedmont plains along with southern flank of the foothills, which is well within the subtropical climatic environment. Pedologically the deposits can be grouped into five units .

TABLE 2.CLASSIFICATION OF SOILS BASED ON WEATHERING ZONE

UNIT	NAME OF FORMATION	COLOUR OF WEATHERING ZONE	COLOUR OF TOP SOIL
UNIT-I	Shaugaon Formation	Unoxidised	No soil cover
UNIT-II	Baikunthapur Formation	Unoxidised	Black soil cover
UNIT-III	Chalsa Formation	Yellow, Oxidized	Brown soil cover
UNIT-IV	Matiali Formation	Orange, Oxidized	Reddish brown soil cover
UNIT-V	Samsing Formation	Red, Oxidized	Chocolate soil cover

Source : Geological survey of India, Record Volume No. 121 Pt. 2-8, PP. 101-109

V. DRAINAGE PATTERN

Unique in its complex and diverse drainage characteristics, the antecedent rivers like Tista and Jaldhaka offer a fascinating study for the evolution of landscape as well as land use pattern. Broadly speaking this interfluvial area belongs to the Brahmaputra Drainage System. Regionally the entire area is drained by no. of perennial, non perennial rivers and jhoras. The study area is well bounded by Tista in the west and Jaldhaka in the East and they have got no. of tributaries like Lish, Gish, Chel, Neora, mal, Kurti, Murti, Diana etc. The drainage system of the study area is controlled by the structure and neotectonic activity within the polygenetic activity. The drainage pattern includes mainly terraces, valleys, alluvial cones, trancated ridge-spurs, rectangular, braided, dendritic and radial drainage pattern being sculptured by both endogenetic- exogenetic forces. These are also supported by the peculiar modes of formation of the riverine topography primarily under fluvial environment. The fluvial landforms as well as drainage channel patterns have reflected several morphological characteristics being enabled with land use pattern. It should be mentioned that in the lower part of the rivers landforms like paleochannels have been developed and they are changing through human interference

VI. TERRAIN ANALYSIS:

The present worker has taken an attempt to discuss the landscape pattern with detail terrain analysis and many striking contrasts of morphogenetic conditions. As a potential control of farm, prevalent climatic variation is as important as the existing litho-tectonic structural variation. These are associated with strong relief and active morphogenesis which have been well indicated in the three tired and four tired terrace system of Tista-Jaldhaka interfluvial area. This chapter concerns a methodological approach to study the landforms development adopting advanced techniques both quantitative and qualitative. The interfluve is typified by the varied geomorphological processes of fluvial morphogenetic environment. In order to visualize the properties of the multi-faceted terrain of the Tista-Jaldhaka interfluve, Relative relief, Average slope, Relief map, Dissection index, Drainage density have been prepared.

VII. ALLUVIAL FAN DEPOSITS :

The Eastern Himalayan rivers including Tista-Jaldhaka interfluve, debouching on to the foothills of North Bengal is characterized by the occurrence of No. of series of alluvial fans ranging from 71m to 200m a.s.l. Such a wide extension of fans are mainly divided by River Tista whose Estern part is well known Duars and Western part as Tarai. The development of alluvial fans are mainly controlled by the river action. The geometry of fans are mainly controlled by the relating factors like relief, climate, lithology and the hydrographic

characteristics of the streams. The study area is composed of mainly Tista and Jaldhaka fan being over taken by many micro fans like Chel-Mal fan, Mal-Neora fan, Neora-Murti fan etc1qa. The alluvial fan deposits are coarse grained poorly sorted and immature sediments. Usually boulders and gravels predominate with subordinate amounts of sand, silt and sometime clay. The size of materials are large and process of soil formation is hampered by regular flood deposits.(FIG-2)

Controls of Fan Development**:** The development of fans are controlled by some integrated factors like-

(i) Climate : The climate of the region is characterized by the hot humid type of climate with strong seasonal (June-October) distribution of rainfall. When precipitation is high the slopes of the alluvial fan remain gentle as the flow of water shifts the sediments and decreases the gradient. Actually, heavy rainfall increases the flow of water with huge amount of sediments.

(ii) Lithology : The lithology of the rock character is another controlling factor for the deposition of fans. The entire study area contained comparatively less coarser materials are not so large, steep and imposing in relief (Dutta, 1984).

(iii) Slope : Slope is another influencing factor for deposition of fans. The sudden break of slope in the northern part mainly near Bagralote, Pathorjhora, Chalsa, Mal Bazar help to deposit the carried materials. But range of slope decreases.

TABLE 3. : CONTROL THE RATE OF DEPOSITION

Slope	Rate of deposition	Rate of Wash materials
Steep-slope (5^o - 10^0)	Slow	High
Moderate slope (5^o - 10^0)	Moderate	Moderate
Gentle slope (1^o - 5^o)	High	Slow
Very Gentle slope (> 1^o)	Very High	Very slow

Source : Field work,2007.

(iv) Hydrological Characteristics : A large amount of debris deposited on the alluvial fans which are widely expand over the Himalayan foothills. On the fan surface the trunk streams feds the distributary channels and water discharge diminishes along its course. Moreover, as the fans consist of more permeable sediments, additional discharge is lost because of downward water perculation (Mukhopadhyay, 1982). These discharge promotes the rate of deposition.(plate-2&3)

SELECTED CASE STUDIES OF MICRO ALLUVIAL FANS :

Chalsa Fan : The gently undulating terrain as viewed from Metiali and Chalsa uplands to the southern sectors which have been largely occupied by a series of almost parallel river valleys like Chel, Mal, Neora, Kurti, Murti. The total area is under Chalsa alluvial fan, largely extended into North Bengal alluvial fan. Most of these tributary rivers negotiating with Northern elevated tracts and the southern plains are largely controlled by the rain waters of south west monsoon winds and also exhibits the typical features of alluvial erosions specially the avulsion and corrations set in the wide valleys with smaller heights of the terrain beds. The combined types of landforms related to the fluvial and tectonic activities are covered by not only the river channels but also the adjacent gently undulating plains of North Bengal area. The Tista-Jaldhaka intertfluve are made by the collisions of series of alluvial fans originating from the foothill zones of the Himalaya under fluvial environment (Mukhopadhyay 1982). The Chalsa fan, a largest fan plain which is a unique fluvial morphological feature in the study area.

Chel-Mal Inter fan : This is an another important micro fan formed by the depositional activity of River Chel, mal and no. of small jhoras and nalas like Kumlai, Chaity, Sankhani, Sati, Gurjang Jhora etc. The expanded fan like depositions (Fig. No. VI.14) are governed by the slope, drainage, climate and vegetation cover of the area. Stratigraphically this micro fan is sub-divided into 4 parts.

[1] Upper fan - Close to the apex and characterized by steep slope, boulder beds
[2] Middle fan – Moderately developed between upper and lower margin fan and typified by moderate slope, smaller deposits and braided rivers.
[3] Lower fan - Zone of coalescence of lower part of the fans with minimum slope and fine Deposits.

[4] Base fan - Zone of most lower base on which fans starts to developed and has very
[5] minimum slope with very fine materials like clay and silt and it is under
[6] floodplain areas of braided course of river Chel and Mal.(FIF-3)

The braided channels with their reduced cross-sectional area incapable of containing the huge monsoonal discharge and often cause flood which leads to the deposition of silt materials with fine grain. Actually, from the Mal Nadi Tea Garden area, the junction of mountain and plain, fans have started to deposit forming flat like plains which is being sculptured by the human activities.

LAND USE DEVELOPMENT AND ASSOCIATED PROBLEMS:

The extreme flat alluvial fan areas are characterized by its land use verticality. The word 'Land utilization' shows a reciprocal relationship between the prevailing ecological conditions of a particular regional area and human being. In using the land, land resources should be managed in a appropriate manner to their nature and to the desired results to be obtained from the particular type of land utilization. The fertile land with huge sedimentation every year is responsible for agriculture development,speciaslly the dry pirated river courses as eg.Gurjongjhora(old Mal course) is vastly used for rice acutivation.The same formula is practiced in left bank of River Kurti.With paddy vegetabled,Maize and other crops are cultivated on the flat alluvial plains.Consedering the developmental divisions the upper fan area is mainly used as Tea gardens ;only some strop of land are used roe vegetables. The Middle fan areas are totally cultivated area where food crops are grown. The new layer of sediments are important for agriculture but these sediments are very permeable and some where soils are loamy to sandy specially the lower bank of the rivers because of which the incoming water from the upstream are percolated to the soil and discharge amount is decreased which affecte the agriculture and the cultivated lands suffer for proper irrigation during rabi period. This loss water is also caused for the presence of 250m contour which demarcate the HFF along the Chalsa fault and Borodighi fault. In field study if we conceder the discharge amount of river Chel, it should be better understood.(FIG 4A 74b)

TABLE NO.3 SHOWING DISCHARGE DATA WITH HEIGHT

Height (m)	Location	Discharge in cumec	Date : 30.10.2009
500	Ambeck Tea Garden	16.36 ms^{3-1}	8.00 A.M
250	Pathorjhora	15.60 ms^{3-1}	12.05 P.M.
160	Near NH 31, Odlabari	15.73 ms^{3-1}	2.00 P.M.
80	Confluence of Chel and Dharala	17.00 ms^{3-1}	4.45 P.M.

Source : Field Work,2007

This water scarcity affects the land as well as production also. Proper irrigation is required and both GO and NGOs are taken steps through micro water shade management.

Micro watershade management taken from the GO

Among the governmental schemes there are two main micro Watershade Managements which have been considered.

(A) Renovation of Kilkot and Indong Jhora Irrigation Scheme in P.S. Matially, Dist. Jalpaiguri.
(B) Sakam Hydral Power Project, P.S. Garubathan, Dist. Darjeeling.

(A) <u>Renovation of Kilkot and Indong Jhora Irrigation Scheme in P.S. Matiali, Dist. Jalpaiguri .</u>

Considering the above mentioned facts an irrigation scheme was constructed to provide irrigation to the local tribal people. As during the dry period amount of discharge is very minimum so only kharif season large area can be irrigated. Regarding these facts, construction of a weir with proposed height 0.74m and length 40m with gates to control water in canal has been taken as renovation scheme. Size and No. of gates will be kept same which was at original scheme, but pedestal and gear rod system will be introduced in stead of chain pulley system. There is no provision of D/S floor of weir. Only 45cm thick boulder pitching over 15cm thick shingles filter is provided in the scheme. The total construction was done under the Sub Divisional Officer, Mal Bazar irrigation sub-division. Mal, Jalpaiguri. The irrigated area during kharif period are given below.

TBLE NO.4 DISTRIBUTION OF IRRIGATED AREA (2003-2005)

Name of the Mouza	J.L. No.	Irrigated Command area (Acres)
Chalsa Mahabari	16	700
Mangalbari	17	300
Uttar Dhupjhora	27	200
Purba Batabari	26	250
Dakshin Dhupjora	28	100
Total		1550 acres

(B) Sakam hydral Power Project, P.S. Garubathan, Dist. Darjeeling

The Sakam hydral power project has been taken on River Neora at Garubathan Block of Darjeeling. A major portion of Neora valley in an around the hydral project and under the human interference, in terms of the occurrences of the human controlled, the river valley being made a concrete wall in both sides. The area where water flow are allowed to gushing out the depth and width vary between 4m (approx.) and 8m (maximum) respectively. The main water flow has been bifurcated both in its left and right canal (man made) of 8m and 6m in the edge and 5m in the middle.

2. Micro Watershade Management taken from NGO-

To solve the water scarcity problem NGO like IBRAD visited several villages and taken so many micro watershade management scheme since January 2000. Among the schemes three have been taken as a case study, one in Mal Bazar block and another two from Maynaguri block.

(A) Micro Water Management conducted in Mathachulka MRLI.
(B) Micro Water Management conducted in Babupara MRLI.
(C) Micro Water Management conducted in Bhatpara MRLI.

(A) Micro Water Management conducted in Mathachulka MRLI

It is a special study that was conducted on Micro water management on the 11th of January, 2000 by the staff of IBRAD. Unit at the Mathachulka MRLI in Jalpaiguri district. The scheme falls under Bidhannagar G.P. of Mal Bazar block, 60 km from Jalpaiguri. IBRAD has been working here to helping the capacity building of the cultivators in running and managing the scheme effectively. The scheme has been set up on the river Kurti.

(B) Micro Water Management Conducted in Babupara MRLI

It is another micro level study which was conducted on micro-level Water Management and introduced on the 5th of January, 2004 by the staff of IBRAD. The location is Babupara MRLI scheme in the Jalpaiguri district. The scheme falls under the Padamati II G.P. of Maynaguri C.D. Block, 35km from Jalpaiguri. The scheme falls under the NBTDP project and IBRAD is working to manage the local people.. In this scheme cultivators were asked about the different water resources both natural and man-made, which they had to access in the village.

(C) Micro Water shade Management conducted in Bhatpara MRLI

It is the last but not the least Micro Level Water Management was taken on the 8th of February, 2002 by the staff of IBRAD. The location of the unit is Bhatpara MRLI. Scheme which is also under Padamati II G.P. of Maynaguri CD Block, 40km from Jalpaiguri. The scheme has been set up on the river Cheniajan. The main objectives of the scheme is the same as above said i.e. identifying local sources of water and axis them in agricultural lands as well as domestic purposes. During field work it has been found to be observed that the village has 121 houses within the command area. The entire command area is bounded on three sides by a kancha road. The villagers have wells, tube wells, 4 ponds as a source of water. However, the lands were not fertile at that time, but a turn around in the fertility of the land was ushered in by the famous flood of the Tista river in 1968. The fertility has increased and depth of the Cheniajan river was decreased due to siltation. Vegetables began to be produced on a commercial scale about 15 years ago. But now boro is cultivated. There are several problems which are taken for solution in this project like,

(i) Electricity problem
(ii) Technical problem in agriculture
(iii) Lack of health centre facility
(iv) Schooling problem
(v) Sanitation
(vi) Problem of drinking water
(vii) Marketing problem

CHANGES IN LAND USE PATTERN :

The agricultural plots of chal- mal inter fan and Chalsa fan areas are not only suitable for paddy but seasonal vegetables and Boro rice are also cultivated specially in middle fan area.There foe, with the development of irrigation system ,the scarcity of water is moderately minimized. Near about 212 plots have been considered under the cultural command area of Kolkot Barrage project. The Mini River Lift Irrigation scheme which was taken from the NGO like IBRAT,2000 on Kurti river of BidhanNagar G.P.of Metiali block is running effectively. The extra water of monsoon period are preserved in a depressed lands or old channel of river Neora at Borodighi Mouza is considerably used for pisciculture . The duel purpose of use of water is a remarkable step towards the sustainable and optimum use in rabi season. This step and development have influenced the changing land use pattern of Mateali block from1980 – 2007 wher the amount of agricultural lands have changed.

TABLE NO.5CNANGING LAND USE PATTERN OF MALTEALI BLOCK

	1980		**2012**	
Land use pattern	Area in Km^2	In %	Area in Km^2	In %
Agricultural land	35.323	15.57	43.578	19.20
Rabi crop area	10.67	4.70	19.459	8.57
Natural forest	64.91	28.60	43.53	19.18
River	1.374	0.60	13.78	6.07
Sand deposits	9.562	4.213	6.84	3.01
Settlement	43.376	19.10	135.030	59.41
SociL forestry	0	0	4.29	1.89
Plantation G.ps	27.20	11.98	30.34	13.36
Waste land	35.40	15.59	7.927	3.48
Wasted tea garden	13.74	6.05	22.46	9.89
Waste lands/paleo channels	0	0	2.49	1.09

Source: topo sheet, satellite image and field study

VIII. CONCLUSION:

The effect of such wide and different features developed from Garubathan to Maynaguri area are found to be well manifested in the development of diverse land use in distinct geomorphic units of the study area. The large scale piedmont terraces with extensive flat alluvial fan deposits are formed by the result of progressive flattening of the gradient of the major rivers and their tributaries. From the applied geographical point of view that this area is a representative of a remarkable land productivity not only for agriculture but also for horticulture and plantation. The major conclusion emerges that although resources are present in abundance their management in area is for from optimal. So far the proper management of agriculture production needs sufficient irrigation system improving the methods The expansion of roads, railways i.e. the transport and communication with an ideal situations have helped the socio-economic growth in the Tista-Jaldhaka interfluve. This has to be done through local micro level water management planning since every year.

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