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Locating Archaeological Sites in the Ajay River Basin, West Bengal

An Approach Employing the Remote Sensing and Geographical Information System

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INTRODUCTION

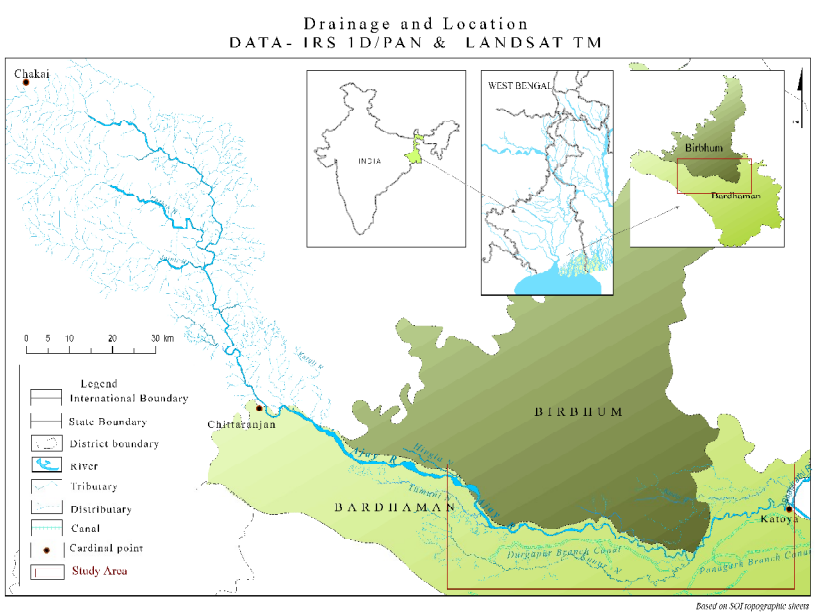
Technological progress over the years has influenced various disciplines of study and archaeology too is no exception. Application of Remote Sensing (RS) and Geographical Information System (GIS) in the domain of archaeology started in Europe about three decades back. The advent of the same in India took another twenty years. This technological boon is being selectively employed in archaeological explorations and excavations in our country.

In eastern India, a project to map archaeological sites of West Bengal is currently going on wherein the cartographical work involves RS and GIS programs. The present author herself is involved with the project. It is interesting to see how far these applications can help us in reading the past.

In this paper an integrated RS and GIS approach has been adopted for identification and mapping of archaeological sites in the Ajay river basin, West Bengal. The particular interest of the present author is to represent past archaeological settlements (i.e. Chalcolithic – Early-historic period/ c.2500 BCE – 300 CE) in present landscape from a scientific pictorial view. To map the distribution pattern of archaeological sites, field investigation has been undertaken and topographical sheets, GIS database; RS data have been made use of.

THE AJAY RIVER BASIN

The river Ajay originates from the Chakai hill tract (86°21'40″E, 24°25'N, at 346.3m above MSL) of the Chhotonagpur plateau in the district of Saran, Bihar, enters West Bengal near Chittaranjan (86°42'30″E, 23°55'N, at 233.8m MSL) and drains into the river Bhaghirathi at Katoya (88°08'E, 23°39'N, at 14m MSL) in Bardhaman district. It flows as the common boundary between Bardhaman and Birbhum districts of West Bengal (Map.i). This riverine route was an important one in ancient *rarh* Bengal (*Hunter, 1877: 317*).



Map.i

The southern bank of the basin is water-shed by the river Kunur, the main tributary of the river Ajay. It originates from the undulating land to the north of Kanksa police station, Bardhaman and drains into the river Ajay at Kogram. Other two rivers, Brahmani and Kopai also flow through this basin. The river Brahmani, tributary of Bhagirathi flows to the south-east of Mangalkot police station and falls into the Bhagirathi near Daihat. The river Kopai, a tributary of the river Bakreswar, drains the northern bank of the Ajay basin. The river bed of Ajay is sandy and banks are low.

STUDY REGION

The study region lies between 87°30'E and 88°00'E Longitude and between 23°30'N and 23°35'N Latitude (*SOI* Topographical sheets: 73M/10 and 73 M/14; scale 1:25000) (Map.i).

The Ajay river basin was one of the areas intensely inhabited by the past population. A number of Chalcolithic and Early-historic sites have been identified in this river basin. The three archaeological sites of Pandu Rajar Dhibi (Bardhaman district), Mangalkot (Bardhaman) and Bahiri (Birbhum) were excavated yielding sequential cultural horizons with rich deposits. The course of the river Ajay and its tributary Kunur are traceable using the RS data. Having originated from a hilly region, the river Ajay flows in an extraordinarily meandering course, resulting in oscillation of current through the deltaic silt.

Geomorphology

The river basin of Ajay bears features of both the Chhotonagpur plateau region and the Bengal River Basin. The region comprises three geomorphic units. The first, the Lateritic upland, called the Illambazar formation, has ferruginous lateritic soil with sand, gravel and pebble. The Illambazar formation ranges in elevation between 80m and 54m. The sediments of Illambazar formation exhibit more than two depositional cycles— each cycle starting with coarse sand/gravel at the base and ending in clay at the top.

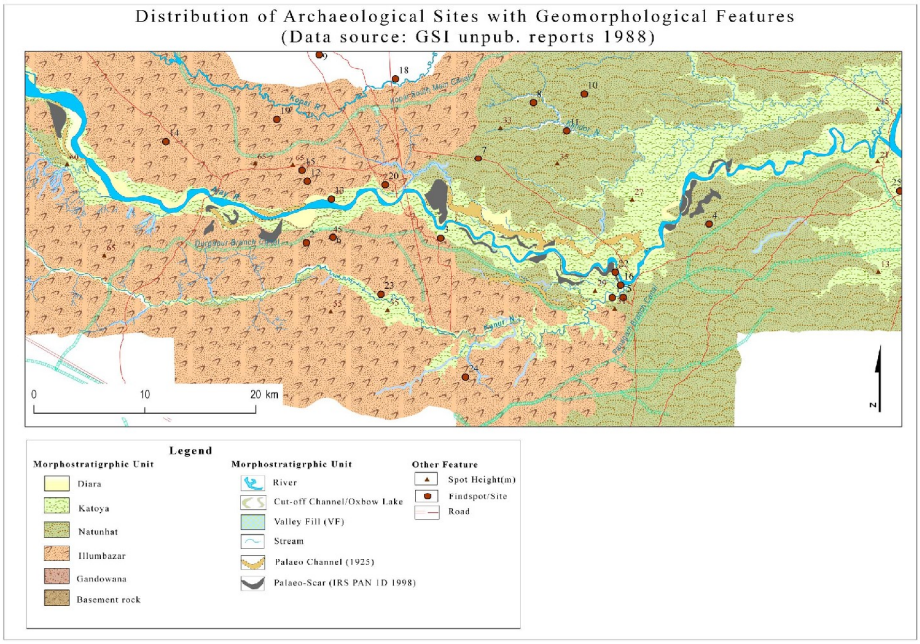
The succeeding Nutanhat formation, an eastwardly sloping upland, overlies the Illambazar formation and is encountered in the bore-hole located at Bamunia and Kandra in the easternmost part of the Ajay basin. The maximum thickness of this formation as revealed from bore-hole at Bamunia is 14m. The sediments are comprised of yellow, oxidized sand and clay. This unit constitutes the water-shed area of the Kunur sub-basin and has moderately dissected alluvial tract covering the highest grounds above the occasional and usual flood level in the alluvial landscape of the Ajay basin. The relief zone between 20m and 40m elevations has the pedocal soil (containing calcium carbonate and magnesium carbonate), the marker between the older and newer alluvium

zone with alluvium covering the maximum surface area. The alluvial terrace is dotted with a host of anthropogenic features like agricultural fields, low embankments, tanks (permanent and seasonal), road, canals etc.

The overlying Katoya formation has maximum thickness of 15 metres, comprising modern alluvial soil with unoxidized sand and clay (Map.ii). The entire landscape represents a depositional and erosional picture with a large number of lesser-order streams (locally known as kandors) present all over.

Archaeological Finds

Chalcolithic and Early-historic sites like Pandu Rajar Dhibi, Basantapur, Berenda are in the southeastern part of the Illambazar surface and on the right bank of the river Ajay. This zone, called the older alluvial terrace comprising thick compact brown sand and sandy loam is favourable for agrarian work and therefore the early people preferred this zone for settlement. Sites on the left bank of the river Ajay, in the same landform are Chella-kamarpara, Bergram, Kalyanpur, Supur etc. The Chalcolithic site of Basantapur and the Early-historic sites of Aral and Kogram belonging to the Katoya formation are on the left bank of the river Kunur whereas the Early-historic site of Deuli, belonging to the same formation is on the left bank of the river Ajay. The Early-historic site of Sagira of the same formation is on the right bank of the river (Map ii).



Map.ii

On the other hand Mangalkot is on the Natunhat surface, on the left bank of the river Ajay and is towards the downstream of the river. The site too is in the older alluvial terrace. Notably this terrace is wider than its counterpart in the context of Illambazar surface. This is because of the high meandering action of the river. The surface comprises sandy and silty loam favourable for cultivation. Settlements came up due to this favourable agrarian context. At the same time, as this particular zone is the confluence point of the river Ajay and its tributary Kunur, the scope for riverine trade also helped in the development of the Early-historic settlement (*Mukundaram`s Chandimangal*: *417*). On the same landform Bahiri, Beluti, Charkalgram, Nachansaha etc are on the right bank of the river Ajay. Artefacts have been found from the modern village settlements of the Ajay basin. They indicate that the Chalcolithic people lived on the flood plain even in the c.3000BP.

PROBLEMS

It is a common phenomenon of floodplain archaeology that sites are often found buried due to river channel shift and floodplain evolution usually renders them largely invisible to field survey. All archaeological sites are distributed from the upland zone (Lateritic upland) to the older alluvial terrace (Nutanhat formation) in the Ajay basin. The basin has preserved cut and fill terraces 3/4m above the present channel of the river Ajay. Most of the sites are found buried under the present habitational and flood deposits (at least 4/5m) and as such, buried cultural features are often marked by the presence of redeposited artefacts on the surface. For example, at the site of Deuli, artefacts found are held secondary in nature as indication of reworking has been observed (*Roychowdhury, 2002*). By using the RS data and GIS, the site location pattern can be assumed and in turn the site networking in the Ajay basin can be better understood.

METHODOLOGY

As the alluvial terrains are mostly formed through fluvial processes, growth and destruction of ancient human settlements in this plain are also attributed to such natural processes. In this case, the satellite data leads to the study of preservation and superimposition of landforms, and of palaeo-drainage pattern, abundance or paucity of particular land formation— of alluvial terrain and palaeo-environment. Such palaeo-channels have been identified with confidence using the Indian Remote Sensing (IRS) data. Different thematic layers related to the archaeological study have been prepared and juxtaposed in the GIS ambience through certain decisions and rules so that suggestions can be made about the potentiality of those archaeological sites.

Developing the GIS Database

The integration of advanced RS data within the context of the GIS is of immense significance in archaeological, cultural and environmental research strategies. The Image Processing System (Erdas Imagine 9.1) and GIS (ArcGIS 9.2) have been used for the analysis. Though very little information as regards the palaeo-environment of the Ajay river basin is currently available, it has been decided to use whatever limited data are available as variables for input in the GIS study. The GIS database covering the area in this paper is about 1,977.430sq.km (approx). The current basic raster and vector layers of the GIS include elevation, slope, palaeo-channels, drainage, roads, archaeological sites and other field data.

The Archaeological Database

In this paper, the present course of the river Ajay along with archaeological sites has not only been demonstrated, an attempt to show the work of the past history in the present landscape of the basin has also been made which in turn has provided a database capable of responding to considerable demands of GIS technique. Archaeological knowledge has been combined with the temporal data (both *spatial* and *non-spatial*) in a *Hermeneutic* diagram (*Rivett, 1997*) (Fig.i). It is an interpretative practice, an attempt to make sense of the past in its contextual embeddedness.

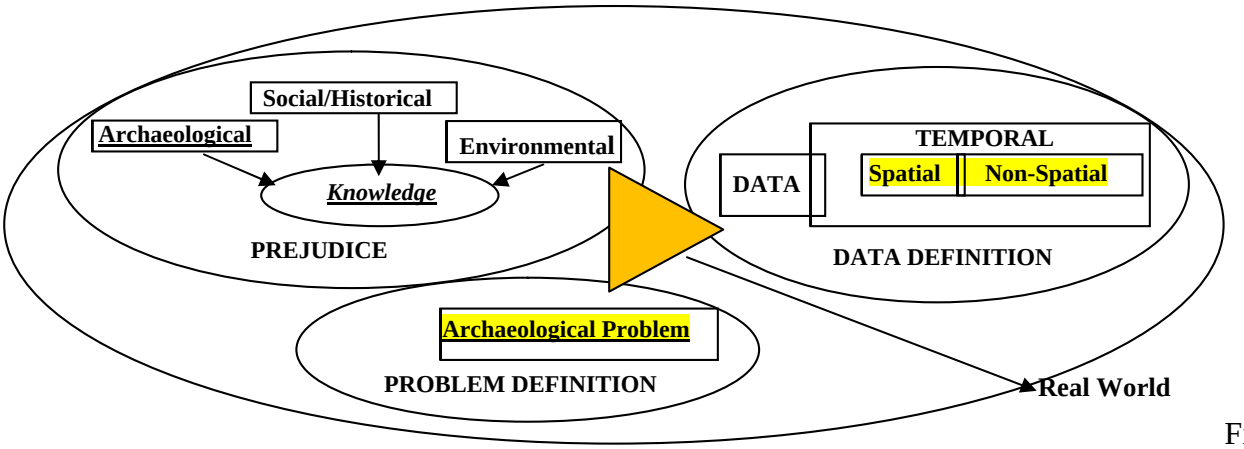


Fig.i

The basic chronology of archaeological remains in this basin is described and presented briefly:

Locational Chalcolithic and Early Historic Site Database Showing with a Geomorphic Unit

OBJECT ID	Archaeological Finds		Geomorphic Unit	Location	Cultural chronology	
	Site	Present Village	IF/NF/KF*	AFP/KFP/AKC# Right Bank (R)/Left Bank (L)	Chal/EH^	% of total Cuture
1	Aral	Aral	IF	KFP/L	EH	1
2	Goswamikhanda	Mallickpur	IF	AFP/R	Med	1
3	Kalyanpur	Kalyanpur	IF	AFP/R	CH/EH	2
4	Majhigram	Majhigram	NF	AFP/R	CH/EH	1
5	Mangalkot	Mangalkot	NF	KFP/R	CH/EH	3
6	Pandu Rjar Dhibi	Panduk	IF	AFP/R	CH/EH	2
7	Chandra Hazradanga	Bahiri	NF	AFP/L	CH/EH	3
8	Beluti	Beluti	NF	AFP/L	CH	2
9	Bergram	Bergram	?	Kopai	CH/EH	2
10	Chandidaser Bhita	Nanur	?	Kopai	EH	2
11	Kholamkuchir Math	Charkalgram	NF	AFP/L	CH/EH	2
12	Chella	Chella	IF	AFP/L	CH/EH	2
13	Deuli	Deuli	KF	AFP/L	EH	2
14	Ghurisha	Ghurisha	IF	AFP/L	CH/EH	3
15	Kamarpara	Kamarpara	IF	AFP/L	EH	1
16	Kogram	Kogram	IF	AKC/R	EH	1
17	Kirnahar	Kirnahar	?	Kopai	CH/EH	2
18	Mahishdal	Mahishdal	?	Kopai	CH/EH	3
19	Nachansaha	Nachansaha	IF	AFP/L	CH/EH	3
20	Surath Rajar Dhibi	Supur	IF	AFP/L	CH/EH	3
22	Sagira	Sagira	KF	AFP/R	EH	1
23	Hazradanga	Basantapur	IF	KFP/L	CH	1
24	Bulbuldanga	Orgram	IF	KFP/R	CH/EH	2
25	Indrani Pargana	Bekeihat	KF	AFP/R	CH/EH	2

* IF— Illumbazar Formation, NF— Natunhat Formation and KF— Katoya Formation. # AFP—Ajay Flood Plain, KFP— Kunur Flood Plain and AKC—Ajay Kunur Confluence. ^Chal & CH— Chalcolithic, EH— Ealy Historic

Table.1

Processing the Archaeological Database

Previous published documents of the study region only give an idea of the location of the sites. But, with the passage of time, new researches have been carried out on the basis of intensive and extensive scientific fieldwork. Such researches not only represent the location of sites but also give a holistic view of sites— locational criterion, nature of preservation, nature of distribution of sites across the given landscape and also formation processes involved in the evolution of these sites. Such data initiate a quantitative assessment of the nature of sites, environmental settings and

preservation in a separate thematic layer of visual representation. By making use of the *Spatially Extended Entity Relationship (SEER)* diagram (*Firns, 1994*)— line data (river, contour, road. etc), point data (site, bench-mark etc.) and polygon data (geological formation) are correlated and cross-referenced leading to formation of thematic layers (Fig.ii).

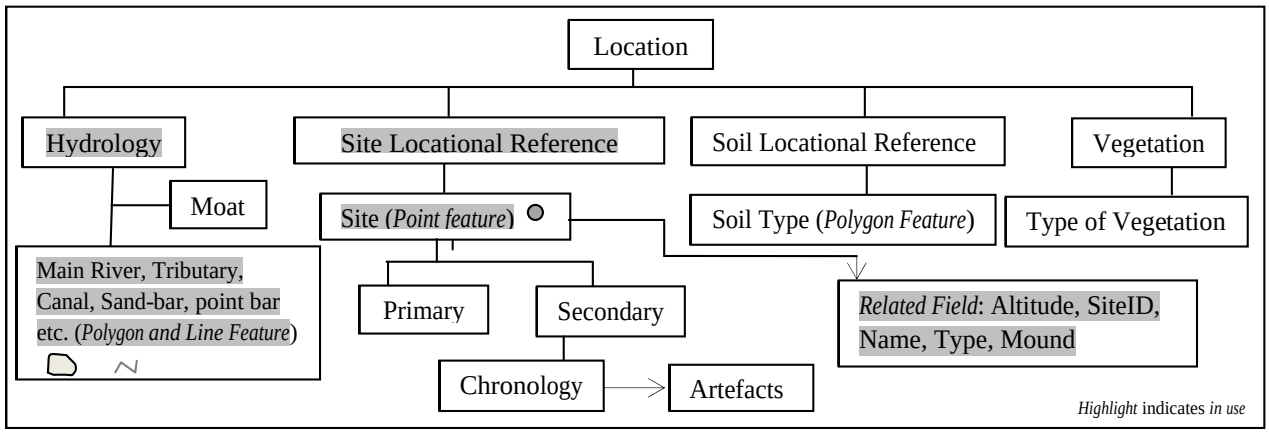


Fig.ii

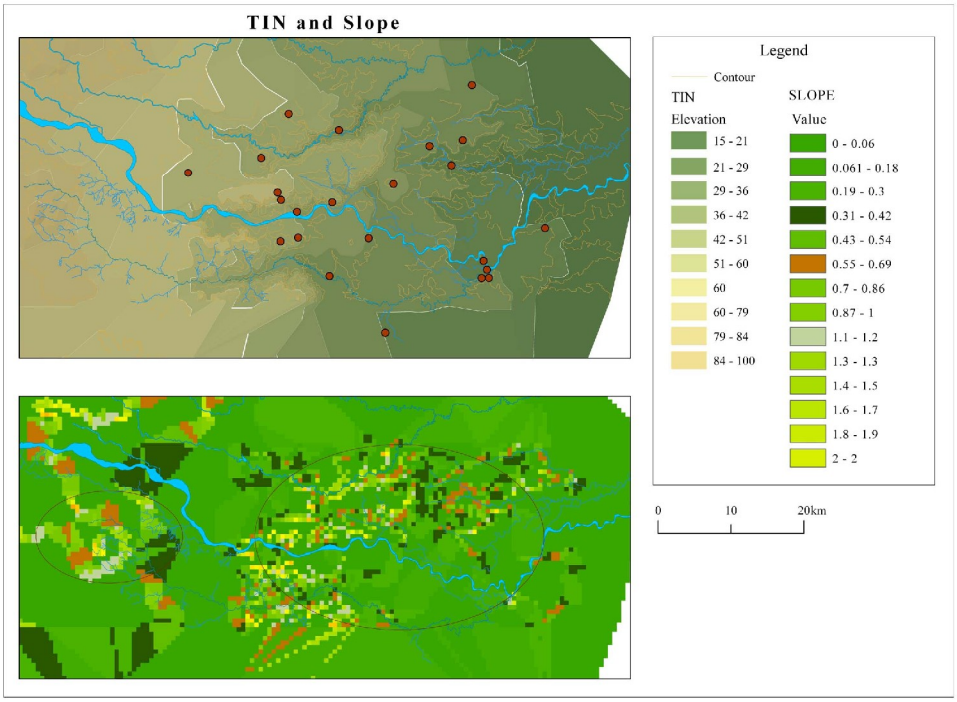
Map Preparation

At first, a set of georeferenced parameters (*factors*)—which are, or should be, related to site occurrence—have been collected, stored and manipulated on *SOI* Toposheets and LANDSAT TM, IRS ID PAN data at the scale 1:25000 in Erdas Imagine 9.0. All thematic layers have been prepared using ArcGIS 9.2 geo-database environment. Likewise, already known archaeological evidence has been acquired and classified chronologically and typologically. By correlating spatial and non-spatial data, scope to identify, analyse and interpret archaeological sites becomes wider. The integration of such techniques makes it possible to relate known sites with the environmental context. (Map.ii)

Triangular Irregular Networks (TIN)

The TIN of this basin has been developed on contour data from the *SOI* Topographic sheets at the scale of 1:25000. Contours have been manually digitized at an interval of 5m and some other characteristic features have been added, e.g. BM points, triangulation points etc. Altogether, more than 13,155 points have been taken. The light brown or yellowish grey areas (i.e. 65m) are the highest elevation points and sites like Pandu Rajar Dhibi (Panduk), Chella-kamarpara, Nachansaha, Bergram are situated between 60m and 45m altitude. The dark green area (40m-19m) of the TIN harbours other sites like Mangalkot, Deuli, Bahiri, Aral, Ausgram, Majhigram etc. There has been a significant landscape change in this basin since the Late-Holocene period. Still some sites are yet not disturbed and survive in the upper region of the Ajay flood-plain rather than those situated in the alluvial zone (Map.iii.).

From the field study as well as from the data available it has been understood that the Illumbazar and the Natunhat surfaces provided the most stable landscape for the Chalcolithic people. The Map iii is about the direction of the slope of the plain generated from the TIN. This also enables one to understand the rate of preservation of sites as most of the undisturbed sites (from the fluvial action) are situated at the point of merging of the two *slope directions* of the riverine plain. The Illambazar surface (Laterite Upland) has regional slope 1.28 m/Km. The regional slope of Nutanhat surface and Katoya surface (alluvial terraces) are 0.61 m/Km. & 0.34 m/Km respectively. The drainage channels of Ajay are at places interact the intensity of entrenchment and are higher in older land units. Sudden change in flow direction of Ajay river from an E-SE course to N-NE direction near Mangalkot is one of the most notable tectonic features of the area *(GSI unpub. Rept. 1988)*.



Map.iii

Interfacing Archaeological Problems

RS technique has been adopted to address certain archaeological questions in respect of at least two excavated sites, Pandu Rajar Dhibi and Mangalkot. Pandu Rajar Dhibi, rich in Chalcolithic cultural deposits does not represent the later periods, whereas, Mangalkot bears the chronological testimony of a period spanning from the Chalcolithic to the 18th century AD. Ambiguity pertaining to the question of abandonment of the site Pandu Rajar Dhibi can be addressed more aptly with the RS aid. Palaeo-channel of the river Ajay has been identified using the PAN (5m) data and it strengthens the proposition of nuisance flood as the cause of abandonment. *P.C.Dasgupta* too during the excavation in the 1960s found a yellowish layer in stratigraphy indicative of flooding. Though the river Ajay today flows 20km. away to the north of the site, the RS data beyond doubt proves its proximity to the site thereby contributing to the proposition of flooding. The 2005 survey, undertaken by the present author, found carbonaceous black soil on the exposed section of the *Sarkaridanga* mound at Mangalkot, thereby giving scope to conjecture the possibility of presence of the palaeo-riverine course of Kunur. The northeastward slope of the mound too helps in making the hypothesis. When the RS data (IRS ID PAN) has been taken into consideration, the hypothesis becomes a more confident claim (Fig. iii).

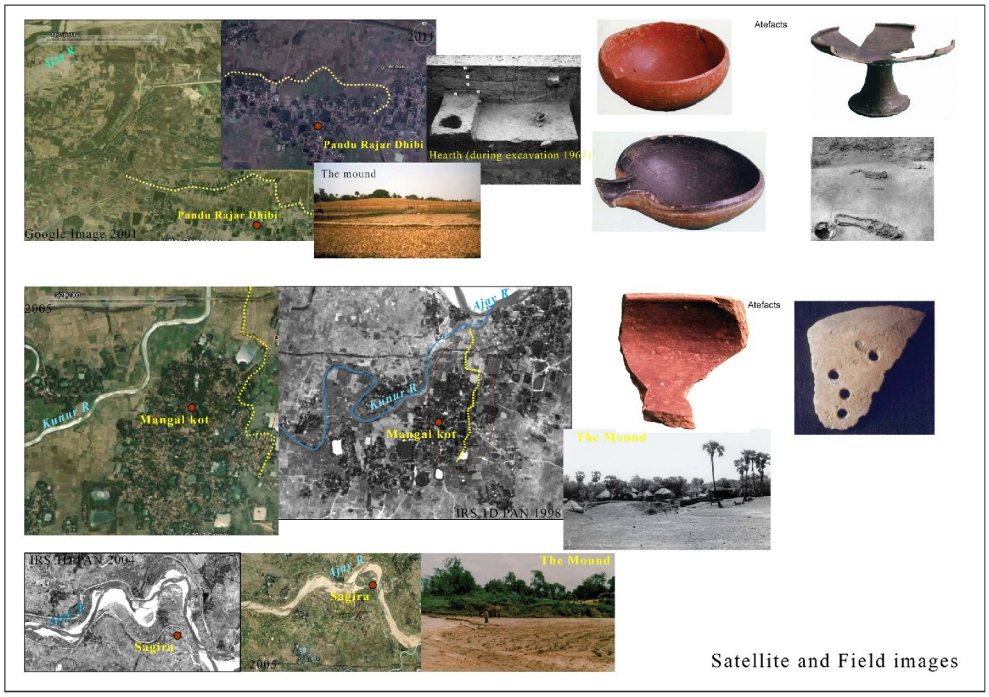


Fig. iii

Again in case of the Chalcolithic site Sagira, *S. Roychowdhury* in 2000 found it near the right bank of the river Ajay but the PAN (2004) and the Google Earth data (2005) as well as the survey data (2005) indicated huge deposition of sand at the site suggestive of flooding.

CONCLUSION

Though a single data (Satellite) is not sufficient, the present study shows that sites belonging to the older alluvial terrace are more stable than those in the zone influenced actively by the river. From the study of the palaeo-channels the growth, abandonment and resettlement features of sites are better comprehended.

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