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CONTENTS

Agriculture : Past, Present and Future

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Abstract

Agriculture in this century is going through a paradigm shift in true sense of the term. Family farms and smaller farmers are being rapidly replaced by giant multi-national agri-products supplier. More and more farming communities across the world are showing a consistent trend of leaving the farming profession and looking for other available alternatives (Basu, 2008). Farming as a business and enterprise has started failing to attract those that have been so closely associated for several decades and even through generations. Why is this happening around the world? There are several factors that have deep socio-economic roots that are resulting in such strong impact on the agricultural sector.

Key words : Agriculture : Food security; Bio energy; Environment.

1.0 Agriculture: Global Crisis

Among these factors that are most significant are the rising expenditures for successful farming that has been showing an alarming trend in its upward growth over past few decades almost hitting the roof now! The cost of necessary agricultural tools and machineries and chemicals such as fertilizers, pesticides, herbicides, plant growth hormones etc is going up at such an accelerated rates that it is getting increasingly difficult for farmers to barely continue sustenance in their agri-business. On top of that seed royalties, farming labor cost, harvesting and shipping costs are also on rise making extensive agricultural practices difficult too (WFP Report, 2006). On top of that, the financial returns brought back by the agricultural produce to the farmers and the farming families are falling behind to what they expect to cover even their basic agri-business operational cost (WFP Report, 2007). The recent global economic recession is also another factor that has intensified the pain even more in agricultural sector. Several large exporting countries are holding their exports of major and essential food grains, fruits and vegetables and other essential food

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crop products for securing food safety in their respective countries, indicating a possibility of global food crisis in the coming years (Basu, 2008; WFP Report, 2007).

Food riots have been reported in several corners of the globe in the immediate past few years showing that the situation in the agricultural sector can soon spin way out of control. In addition, the entry of high end profit making giant food chain incorporations, and multinational companies into the food market in both developed and developing world is another sign of deterioration of the old farming business and the exit of the old school farming practices. The family farms so common in the North American Prairies have started vanishing and being replaced by land owned by giant corporations. In poorer countries through the middle men and their other trading counterparts are consuming the biggest share of the agri-business profits returning very little to the original producers and carrying forward higher expenses for the final end consumers (Basu, 2009).

2.0 Agriculture and Environment: Intertwined together

Not just economics, but environment also has significant impact on the agri-business. The threat and increasing effect of global warming has been consistent with the down trends in yields of several crops across the planet made worse with sporadic outbreaks of crop diseases due to increased insect and microbial pests at regional levels as result of longer and warmer growing seasons (IAASTD, 2008). High yielding cultivars are turning useless at a much faster scale than it has been a few decades back. There has been an increasing global demand on plant breeders and agronomists to come up with newer varieties, lines and cultivars to cope up with the impending environmental challenges. Making the situation worst, the incidence of natural disasters such as hail storm, cycles, hurricanes, tsunamis and rising level of mean sea level have been regularly contributing to crop loss and crop failures in different parts of the world (IAASTD, 2008).

Consistent environment pollution and crop overproduction has impacted soil qualities in several corners of the globe with rampant mineral deficiencies, soil erosion, loss of top soil, inundation of agricultural lands in the coastal belts with sea water resulting in hyper salinity of soil and long periods of draught due to inadequate rain (Basu, 2008,2009). Crop failures in the poorer parts of the world has been devastating to the local economies as there are negligible amount of government support for failing crops in marginal and non-productive agricultural land, lack of crop insurance opportunities and also lack of training, skills, knowledge and financial and technical resources to address these challenges. The result is looming food crisis and food shortage, malnutrition, famine and death. Several poor African, Asian and Latin American countries are becoming victim of this vicious cycle. Even farmers representing richer economies such as European Union, Canada, USA, Australia, New Zealand, Japan and giant agricultural countries such as China, India, Russia,

East Europe are also not doing very good under the present conditions (Basu, 2008,2009).

Between 1000 and 700 BC, true peasant culture began to diffuse into Bengal from the Ganga plains and it featured the plow and the whole bundle of north Indian village cultural attributes and it brought with it Indo-Aryan speech. All these were greatly modified by the underlying 'Munda' type culture in Bengal and Eastern India. Bengali peasant culture is suffused with a pro-fertility ethos which evolved over 3000 years of adaptation and symbolic relationship between man and the land. The culture has become highly successful in its ecological setting. Food in cultural context means food in ethnicity or specific to a group, a region or a state, consisting language, religion and social groups like caste, clan or gotra etc. In a nation like India or a state like Bengal, having multiethnic groups and a plural society, the cultural diversity and multiculturalism affects food habits or dietary pattern and food ideology. Human fertility and land fertility are analogous. A woman is the field and the seed is nourished by her juices before birth and by her milk after birth. Each person's food is preallocated before his birth - this Muslim profertility belief is based on the conception that land can indefinitely support those souls to be born (Datta Banik, 2006).

3.0 Environment and Bioenergy

Another disturbing trend has been the shift of interest to biofuel all over the globe (Basu, 2008). High oil prices have drawn attention to bioenergy generated from plant sources and hence of keen interest worldwide. The escalating price of fossil fuel coupled with increase in prices of essential commodities requires alternative fuel, either as a substitute or for blending with non-renewable fossil fuel to reduce oil imports (Maheshwari, 2008). Using biomass has many advantages over conventional energy sources, as well as over other renewable energies. Biomass includes a wide range of products and by-products from forestry and agriculture as well as municipal and industrial waste streams. Biomass energy or "bioenergy" includes any solid, liquid or gaseous fuel, or any electric power or useful chemical product derived from organic matter, whether directly from plants or indirectly from plant-derived industrial, commercial, or urban wastes, or agricultural and forestry residues (EEA Report, 2006). After a conversion process, the biomass can be used as a fuel to provide heat, electricity or as transport fuel, depending on the conversion technology and the type of primary biomass (EC, 2005).

In the market, there are two main types of liquid fuels, bio-ethanol and bio-diesel, made from crops such as cereals, corn, soybean, rape seed oil, sugar cane, switch grass and palm oil. Bio-ethanol which is made from crops that are high in carbohydrates such as corn or sugarcane is used as an additive to petroleum in cars and is a way of reducing the production of carbon monoxide and greenhouse gases. The other type of liquid fuel is bio-diesel, which is made from vegetable or animal oils and fats, can solely be used for fuel or

it can be used as an additive having the effect of reducing harmful emissions. However, burning conventional fossil fuels such as gasoline, oil, coal or natural gas results in an increase in carbon dioxide in the atmosphere, the major greenhouse gas which is thought to be responsible for global climate change. Burning biomass efficiently results in little or no net emission of carbon dioxide to the atmosphere, since the bio-energy crop plants actually took up an equal amount of carbon dioxide from the air when they grew. A substantial number of researchers have asserted that plant biomass generated energy is close to "carbon neutral" as the CO_2 released in processing is equal to that captured by the plant by photosynthesis (Sims *et al.*, 2006).

As a renewable energy source, bioenergy has great economic growth potential. The use of crop waste and animal manures could provide more income for farmers and the growing of bio-energy feed stocks would be another source of revenue. The biomass sector is a major employer in many developing countries, especially in Germany, Brazil and the US. Moreover, production of bio-diesel also has derivatives such as phenol which has already been used to make products like some forms of plastics, adhesives and foam insulation. It is assumed, in the future, the technology could be developed to a wider range manufacture industries of a group of products of completely biodegradability to replace those currently made from petroleum. Biofuels could also mitigate some of other environmental risks of the fossil fuel industry such as drilling and burning oil, and the exploitation of wilderness areas by mining companies. Another big advantage for biofuel crops has been the fact that transgenic approach could be applied to generate new high yielding cultivars for production under minimal agricultural input or for under developed parts of the world to generate additional income for poor farmers. Since biofuel crops would be used in an industrial platform and will not be a part of food or feed chain; the resistance or negative feelings as is prevalent for Genetically Modified (GM) crops is not expected against brand transgenic fuel crops of the future. This could certainly act as a grand economic boost to several developing countries.

Crops dedicated to bioenergy production differ from conventional food and fodder crops as they are optimised for their energy content rather than for food production. The growing demand for bioenergy crops may create further competition for land and water between existing agricultural activities, energy production and the use of agricultural land for nature conservation and urbanisation needs. This could result in additional negative environmental pressures from cultivating bioenergy crops (EEA Report, 2006).

Brazil has been manufacturing ethanol from sugarcane for more than 30 years for blending with petrol and sold the product "gasohol" as automobile fuel (Nass *et al.*, 2007). Currently, USA uses about 20% of the corn for manufacturing biofuel by converting grain

starch into alcohol via glucose. The E85 fuel containing 85% ethanol and 15% gasoline is becoming increasingly common in the mid-west United States where corn is a major crop, (Dhugga, 2007). Diverting 17% of the US corn crop to biofuel, corn prices have been driven to higher which has rippled throughout the economy and have passively raised animal feed costs and prices for soft drinks and other products that use corn syrup (Maheshwari, 2008). The decision to divert arable land with high agriculture productivity for biofuels is being criticized. Pimentel (1991) and Giampietro *et al.* (1997) with many other investigators have raised major ethical and environmental points such as 'energy crops compete on fertile soil with food and feed production'.

Pimentel (2003) has concluded that increased pollution from fertilizers and pesticides, increased soil erosion, and decreased biodiversity can result when natural land is converted into arable land for energy crops. For raising concerns about the take-over of agricultural lands for food and feed crops by energy crops, bioenergy crops have switched on taking marginal or fallow lands under cultivation. As these marginal and fallow lands are usually less fertile and less productive, these lands needs a huge amount of chemical fertilizers, pesticides, insecticides input to give the yield of near expectance level. Since chemical fertilizers, pesticides, insecticides etc. and pumping irrigation are got on the cost of fossil fuel; converting marginal and fallow lands to energy crop cultivated lands has more disadvantages than advantages as the input energy is much higher than its output (Ceotto, 2008).

Nitrogen oxides (NOx), a mixture of nitric oxide (NO), and nitrogen dioxide, (NO_2), are released when biomass is burned to generate energy. NO_2, itself a greenhouse gas, promotes further warming and forms ozone which is a substantial absorber of infrared radiation, in a warm atmosphere (Moomaw, 2002). Nitrogen oxides, released during the combustion of fossil fuels and biomass, have a detrimental effect on global warming (Moomaw, 2002). Although nitrogen, along with carbon, is one of the most essential elements for life. However, Keeney and Hatfield (2001) stated that many ecological problems arise when nitrogen is separated from its common partner carbon. Regardless of whether biomass was co-fired with coal to generate electricity, converted into ethanol and electricity, the critical point is that all nitrogen contained in harvested dry matter returned quickly to the atmosphere via combustion involving a dramatic reduction of the residence time of the biologically-fixed nitrogen (Ceotto, 2008).

Another major concern about cultivation of bio-energy crops is that bio-fuel derived from grasslands and prairies might cause losses of biodiversity (Ceotto, 2008; Tilman *et al.* 2006). The prairies and grasslands are the natural habitat of a range of crop species that are not cultivated for economic benefit but a source of living of different wildlife. These grasslands and prairies are so diversified and need to be undisturbed. But clearing of these

grasslands and prairies to convert into cultivated land for new energy crops might hamper both the environment and wildlife diversity. Environmental guidelines need to become an integral part of planning processes of the development of bioenergy production in an environmentally-friendly way at the local, national and global level to further explore co-benefits with nature conservation, Furthermore, an appropriate policy framework, combined with advice and guidance to bioenergy planners, researchers, business persons, farmers and forest owners on environmental considerations, could help to enable bioenergy production to fulfill its 'green potential' (EEA Report, 2006).

4.0 What then for the future?

The demand and need for food is projected to be growing even upwards in not so distant future. The total acreage of agricultural land is not going to increase in near future but the demand for food is. Hence the only option will be to increase the productivity of already available agricultural land resources. With transgenic and genetically modified crops still not being accepted by customers in a major part of the globe, the cry of hunger is going to span across continents. If proper planning and care is not taken at this right moment the future of agriculture could be extremely detrimental. It is not always easy to realistically project the trends in future; however, one thing is for certain that it is not going to be easier. Famines, death due to starvation and food riots all have high probability to be more common in the approaching future. Who is responsible for this? To my most sincere and humble faith we all are! Shocking it may sound, but we are all collectively responsible for this. Unrestricted population growth, depletion of natural resources, fluctuating global economy, our selfishness, greed and crave for unethical profits, short-sightedness and attempts to change everything for our small personal gains we have certainly impacted the global agriculture economics BIG TIME!

It is very important for us to realize that the water is flowing over our nostrils now and if we do not adapt and include necessary corrections to our habits it is soon going to flow over our head. We need to think and work collectively to address these challenging issues at a global forum. Our actions now will be our response for tomorrow. We still have the time to make the necessary rectifications and change our farming practices and priorities. We need to get back to our older system approach of *sustainable farming* rather than *aggressive farming*. It will be important for First World Nations to transfer the low cost technologies developed by them to poorer Third World Nations to sustain and thrive in the lean period. In return, the developing and under developed countries also need to work on restricting the growth of population, introduce better family and health care practices, restrict unchecked population growth beyond the carrying capacity of regional and local economies, improve infrastructure and distribute wealth equally and promote better education for the younger generations to face the challenges posed on them more effectively. It will be also

important to curb the growing power and monitor the aggressive business policies of giant multi-national agri-business initiatives by unbiased international monitoring agencies. We all need to hold our hands together to look for a brighter future and a better agricultural platform to sustain thrive and nourish our future generations.

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Geoinformatics in Environmental Cost Assessment of Purulia Pumped Storage Project-West Bengal.

Abhisek Chakrabarty[1] and **Soumendu Chatterjee**[2]

Abstract

The Purulia Pumped Storage Project (PPSP) on Kistobazar River of Ajodhya Hills is developed to improve the peak power scenario of West Bengal, but during the gestation period of this project (2000-2007) a huge amount of forest and agricultural lands are destroyed. Stream impoundment for filling the reservoirs created water scarcity in the downstream villages. Air, water and noise pollutions are prevalent near the project site. Social environment of Ajodhya also deteriorated somewhere drastically. This study attempts to find out the spatial extent and magnitude of these environmental impacts with their monetary values and compare it with the benefit of the project.

To accomplish these targets a multi-temporal image analysis with an IRS-LISS-III data (GCR-23.5m) of 1999 and an IRS-LISS-IV MX data (GCR-5.8m) of 2005 is done and a change detection map is prepared to demarcate the aerial extent of land degradation. Cadastral map overlay on the change detection map clearly shows – which forestlands and private ownership lands are acquired by this project and which are simply damaged. Overlaid GIS layers of different impact buffer zones on population density map reveal the actual number of population directly affected by this project. Once the spatial measurements of environmental impacts are over, monetary valuations of all those impacts and cost benefit analysis of the total project are done. The result shows considering only the tangible costs, this project appears to be economically viable; but with huge amount of intangible costs, the total annual cost of the project becomes seven times higher than the claimed annual benefit.

Key word : Geoinformatics : PPSP; Environmental Impacts; Monetrary Valuation; Cost Benefit Anslysis.

1.0 Introduction:

Satellite remote sensing provides a reliable, accurate and updated database on land and water resources, which is a prerequisite for change detection and environmental impact

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study, where as huge database handling capacity of GIS has proven these a successful means of information extraction and optimal management of resources of a geographical area. As a demonstration of this concept the newly built Purulia Pumped Storage Project (PPSP) of Ajodhya Hills and its surrounding area of Baghmundi and Balarampur Blocks of Purulia, has been chosen as the study area for assessment of the environmental cost of the project. The study area consists of fourteen (14) micro-watersheds of the southern slope of Ajodhya hills and foothill plains, and altogether forms the physical boundary of the area of interest. As physical boundary does not coincide with the administrative boundary, mauza boundaries of Baghmundi and Balarampur Blocks covering the physical boundary presumed as the administrative boundary of the study area. Thus Seventy-nine Mauzas (villages) and four protected forest patches consisting of fourteen micro-watersheds are considered as the ultimate study area (23°05′58′′N-23°15′01′′N, 85°58′11²E-86°12′22′′E) of this assignment.

2.0 Objectives and methodology of the study :

There are four basic objectives of this study. First one is the measurement of aerial extent of land use alteration, and its consequent land degradation, that took place throughout the gestation period (2000-2007) of the project. Change detection map was prepared by *"Post Classification Comparison Change Detection"* (ref[7]), which shows changes in land use class for individual pixel and also the no change pixels. This process needs two classified layers of same Ground Cell Resolution (GCR). Therefore the LISS-IV data (5.8m) were degraded to match the resolution of LISS-III data (23.5m). The "Degrade" command in ERDAS Imagine-8.6 is used to reduce the resolution of an image by an integer factor in the X and Y directions. "Degrade" averages all of the original "small" pixels that make up the new "big" pixels. These two classified layers of same resolution are then compared pixel-by-pixel basis using RSI ENVI–4.3 software. A change detection matrix also prepared with "To?From" row and column, showing the aerial exchange between major classes.

The second objective is the assessment of number of population affected by different project actions. From field observation it is recorded that air pollution (Respirable suspended particles PM_{10} >600 ig/m^3) and noise pollution (>65 decibel) are noteworthy up to 3.5 km and 2.0 km radial distances respectively from the rock blasting-crushing grounds. Impact of water scarcity and water pollution are observed up to 0.5 km on either side of Kestobazar River and its Canals. These distances are used as buffer distances for respective layers and overlaid on land use and population density map to get affected area and population (eq.-1). Arc GIS-8.3 software is used to perform these operations.

Affected Population = Area inside buffer × Population density.....[eq.-1]

In the third stage, monetary values of tangible impacts were obtained by questionnaire survey in households, markets and offices. Where as valuation of intangible impacts were done by taking instances from other literatures or by using "Contingent valuation method" (CVM) where people are asked what they are willing to pay for keeping 'X' or preventing 'Y', or what they are willing to accept for losing 'A' or tolerating 'B' (ref[5]). Monetary

values of each environmental impact are multiplied by their quantity or magnitude that were assessed earlier.

3.0 Results and Discussion :

From the raster attributes of the classified images and change detection map (Fig-2A), areas under the six main categories of land use classes for 1999 and 2005, shows that before the commencement of major project work (forest clearance and dam construction started in the year 2000) there were 93.8 sq.km of dense forest which is reduced to 85.8 sq.km. by Jan, 2005. Forest clearance in the project site is primarily responsible for this, where forestlands are altered to dry fallow (1.112487 sqkm), wet fallow (0.41sqkm) and in some cases built-up area (0.1999 sqkm). Conversion of forest to agricultural land (6.268 sqkm) is also responsible for forest cover contraction, and it has taken place all over the study area.

From USDA Forest Service Greg McPherson and David J. Nowak (ref[10]) assessed the monetary value of the role of Colorado's urban forest in providing environmental benefits to the community. According to them the annual benefit from a mature tree in terms of Oxygen (O_2) production is US$625, Carbon dioxide ($CO_2$) sequester US$1000, Rain water interception US$750, Surface temperature balance US$23, airborne pollutants absorption US$240, Soil loss protection US$600. Though the exchange value of US$1 = Rs.40/- (2007), but standard price or wage ratio is 1($) : 4(Rs), e.g. The federal minimum wage in the United States has been US$5.85 per hour since July-2007, and in India it is Rs. 20/hr or Rs.100/day, therefore dollar value is multiplied by four (4) to get the rupee value. From the forest density study (43 trees / 100 sqm) we have calculated that total 3,436,246 trees were cleared from 7.99127 sqkm of land and the annual cost of habitat loss for forest animals and birds (*Wild Pig, Barking Deer, Hare, Langur, Squirrel, Jungle fowl, Gray Partridge* etc.) estimated to be 10 million rupees. Thus the total cost of deforestation is found to be 47859.41 million rupees per year. Natural corridor of migratory animals from Saranda (Jharkhand) to Ajodhya hills is blocked by the construction of dams. Without having access to forest resources, migratory elephants are destroying nearby villages and agricultural resources, costing 2 million rupees per year (Table-2).

Deforestation and forestland acquisition resulted in area contraction for fuel wood (dry branches of Sal, Pial, Kusum, Ashon, Palash etc.) collection and total 898 households of 16 villages are loosing 12.57 million rupees annually. Minor forest products (Mahua - flower, honey, fruits, Lac, Wild Yams, Seeds of Sal, Kendu leaf and Sal leaf) collection also affected. The total annual loss is estimated to be 9.88 million rupees. Area for pasture (128.11hec) and number of cattle (Cow, Goat, Buffalo, Sheep etc.) per household also lowered down. Total 543 households are loosing 0.815 million rupees per year.

We can observe another significant change that is the alteration of agricultural land to dry fallow and built-up area at the project site. In down stream areas, agricultural lands are altered to fallow because of stream impoundment and water pollution. At present Kestobazar River is draining its entire water to fill-up the upper reservoir of PPSP. No

water is released to the irrigation dam of Kestobazar Irrigation Project (KIP) and the nearby cement-mixing plant is also polluting the existing water of KIP, and 0.84 sq km contaminated agricultural lands converted to wet valleys. Intense use of surface water in the construction site caused the alteration of 2.34 sq.km agricultural land to dry fallow.

Agricultural productivity of additional 11.73 sqkm (Table-1) of multi-crop land is also declined because of the above impacts. 2250 households in the downstream agricultural lands are affected by the scarcity of irrigation water in *Rabi* season. Annual production loss is 3 Quintal / Hec, the total cost of which is 1.85 million rupees. On the other hand Rs.2200 / Hec will be needed to pump up ground water for irrigation. Cement mixing plant near KIP reservoir polluting irrigation water, as a result despite of sufficient water supply in *Kharif* season, those people dependent on the same agricultural land are loosing rice production of 1.0 Quintal/Hec/Year, which in total costs 600,000 rupees (Table-2).

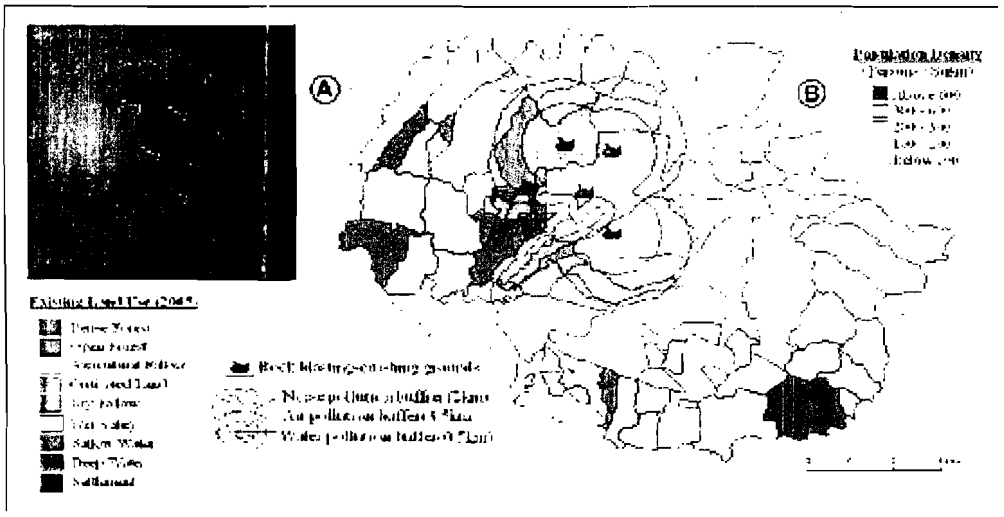

Fig-1. Secondary analysis of buffer layers (air, noise and water pollution buffer) and land use map of 2005. B) Secondary analysis of buffer layers and population density map of 2005

JL. No.	Mauza	Pop/sqkm.	Total area sqkm	Area inside buffer	Population affected
106	AJODHYA	86.23063	15.62	3.4	293
105	ANDHRA	173.6067	3.95	3.95	685
103	BAGHMUNDI	316.3399	11.09	10.1	3195
101	BARERIYA	192.0297	17.09	17.09	3281
78	BHUNIGHRA	120.9218	3.42	1.9	229
87	CHORDA	214.0754	9.75	1.6	342
122	EKRA	232.138	5.48	5.2	1207
94	GOBINDAPUR	2411.027	1.08	0.68	1639
102	GSAIDI	465.12	0.34	0.34	160
77	KALHA	95.93119	3.02	1.48	141
107	KUCHRIREKHA	47.65975	3.86	0.4	19
100	KUDLUNG	338.8514	2.06	0.5	169
119	KUDNA	93.2236	9.61	9.11	849

99	MATIYALA	66.67974	2.04	0.88	58
93	PATHARDIH	1192.739	1.05	1.05	1252
92	PRATAPPUR	521.2962	0.92	0.92	479
104	RANGA	199.084	2.71	2.71	539
90	SARAKDIH	1198.886	0.57	0.02	23
121	SUKRIDOBHA	15.6599	4.34	4.34	67
79	TELIYABHASA	75.23788	4.07	1.8	135
123	TIKARTANR	117.9389	2.14	0.16	18
		Total	**67.29**	**14630**	

Population affected by noise pollution

JL. No.	Mauza	Pop/SqKm.	Total area	Area inside buffer	Population affected
105	ANDHRA	173.6067	3.95	2.88	499
103	BAGHMUNDI	316.3399	11.09	7.03	2223
101	BARERIYA	192.0297	17.09	15.96	3064
102	GSAIDI	465.12	0.34	0.18	81
119	KUDNA	93.2236	9.61	7.05	657
104	RANGA	199.084	2.71	1.2	238
121	SUKRIDOBHA	15.6599	4.34	1.98	31
			Total	**36.1**	**6715**

Area affected by water pollution

JL. No.	Mauza	Total area	Area inside buffer	Agricultural land inside buffer
101	BARERIYA	17.09	5.8	5.1
98	BASUDI	0.8337	0.17	0.13
91	CHANO	0.82	0.55	0.55
94	GOBINDAPUR	1.08	0.14	0.14
100	KUDLUNG	2.06	1.94	1.14
119	KUDNA	9.61	0.06	0.06
95	MADLA	4.1	1.64	1.64
99	MATIYALA	2.04	1.81	1.21
93	PATHARDIH	1.05	0.61	0.61
92	PRATAPPUR	0.92	0.82	0.82
90	SARAKDIH	0.57	0.33	0.33
			Total	**11.73**

Table-1. Area and population inside the buffer zones (Fig-1) of PPSP generated pollutions.

	Environmental impacts of the project	Description of the resources affected	Total area affected (spkm)	Annual production / restoration by one mature tree	Cost/ mature tree	Monetary value (in million rupees)
1.	Doforestation (43 trees/ 100 sqm	Oxygen (O_2) production	7.99127 Total No. of tree 3,436,246	260 pounds of oxygen	$625	8590.54
		Carbon dioxide (CO_2) sequestration		130 pounds of carbon dioxide	$1000	13745
		Rain water interception		760 gallons of rainfall	$750	3641.1
		Surface temperature balance.		Reduce temperature by 30%-40%	$23	10308.8
		Airborne pollutants absorption		10 pounds of airborne pollutants	$240	3298.67
		Soil loos protection		110 pounds of top soil	$600	8247
		Habitat loss for forest Animals & birds	Total No. of birds & animals 743 approx (93/sq km) wild pig, Barking deer, hare, Langur, Squirrel, Jungle fowl, Gray Partridge (titir) etc.			28.3
	Barrier in natural corridor of migratory animals from Saranda to Ajodhya hills (due to dam construction)					2.0

	Environmental impacts of the project	Description of the resources affected	Total area affected /(spkm)	Population affected	Name of the diseases	Annual cost of treatment	Monetary value (in million rupees
8.	Air pollution (Dust from rock crushing & blasting and emission from heavy vehicles).	Human health,	67.29	14630	Respiratory Illness, Asthma, Heart disease, Cataract	$3,517	205.8
					Pulmonary Tuberculosis, Lung Cancer, Stroke,	$30,046	1758.3
					Adverse Pregnancy Outcome,	$600	35.1
		Plants & lac (Lakhha)cultivation	67.29	2500	5 Kg./ House hold/ year (Rs. 1500/-)		0.75
9.	Sound pollution (Rock rock crushing & noise heavy vehicles and	Human health, animals & birds.	36.10	6715	Hypertension, hiht blood pressure, Sleep depravity, Ulcers	$364	9.8

Environmental impacts of the project	Description of the resources affected	Total area affected /(spkm)	Populati on affected	Name of the diseases	Annual cost of treatm ent	Mone tary value (in million rupees
				Hearing loos, Heart disease,	$23,245	624.4
				Stroke, Low birth weights,	$600	16.1
Environmental impacts of the project	Description of the resources affected	Total area affected /(spkm)	Househ old affected	Loss of Daily/ Annual Collection/ production	Total working days/ year	Mone tary value (in million rupees)
3. Agricultural productivity loss (due to impoun-dment of river water)	Paddy (Boro), Wheat, Potato, Pulses, Oilseeds	11.73 (Rabi Season)	2250	3.0 Quintal/ Hec/Year (Rs. 1575/-)	90	1.85
10. Water pollution (cement mixing plant)	Irrigation water season)	11.73 (Kharif	2250 (Rs. 525/-)	1.0 Quintal /Hec/Year	90	0.6
6. Disturbance in river ecosystem due to water recycling, impoundment and Water pollution	Puntius ticto, P. chola, P. conch-onius Nemacheilus Lepidocephalus	0.2	18 fishermen families	3Kg./ House hold/day (Rs. 50/-)	30	0.027+ 0.5
14. Deterioration of moral values.	Increase in alco-addiction & socia crime.	Baghmundi &Balaramp urblock	3,000	Rs. 35/-per hold / day	36×35 ×3000	38.325
15. Loss of cultural purity	Cultural tradition		20,000			0.5
				Total		Σ50553.46

Table - 2 Environmental impacts of PPSP and their monetary values.

Though two surface water bodies (upper and lower dam) have been created in the plateau hills but stream impoundment and excessive use of surface water in project works have reduced the number of water bodies in down stream areas. Hence there were no significant changes found in areas of surface water bodies 1.1 - 1.0 sqkm. Obstruction in fishing (e.g. *Puntius Ticto, P. Chola, P. Conchonius, Nemacheilus Jonatus, Lepidocephalus Guntea* etc.) in Kestobazar River and KIP reservoir causing an annual loss of 27000 rupees for 18 fisherman families (Table-2). Aquatic species of KIP reservoir and down stream Kestobazar River are becoming extinct because of paucity of water as well as water contamination. Impoundment and recycling of river water for power generation will also disturb the Kestobazar River Ecosystem. The cost is estimated to be Rs. 0.5 million per year.

Dry dusts of the roads, dust from crushing stones and emission from heavy vehicles are creating air pollution. Almost 14630 people of 21 mauzas (Table-1) are under its impact and could suffer from Respiratory Illness, Asthma, Heart disease, Cataract, Pulmonary Tuberculosis, Lung Cancer and Adverse Pregnancy Outcome in future. Lambur et al. (ref[9]) made a Cost Benefit Analysis of Virginia Expanded Food and Nutrition Education Program (EFNEP), where the cost of each and every appropriate disease / condition treatment is documented from relevant scientific literature. Taking instances from that paper treatment costs of air pollution by PPSP is estimated to be 1999.2 million rupees annually (Table-2).

Air pollution also affecting Lac cultivation. *Sal, Pial, Kusum, Ashon, Palash* trees (67.29 sqkm) near the lower dam of PPSP were the breeding zone of *Lac* (Lakhha). Dust particles in the air causing the death of Lac larva and Lac (Lakhha) production is adversely affected. Though the extent of pollution is not very widespread still at least 2500 people who used to collect 1 kg of Lac/person/year costing 300 rupees/kg, altogether loosing 75,000 rupees per year (Table-2). The project site, are the victim of sound pollution, which could cause Hypertension, High blood pressure, Sleep depravity, Headaches, Ulcers, Heart disease and Low birth weights, and the treatment cost may be another 650.3 million rupees/year (Table-2).

Estimating the social cost of this project it is found that deterioration of moral values and consequent increase in alcohol addiction (Rs.20/day), and Rs.15/day for theft and other social crime cost 38.325 million rupees per year for 3000 households of Baghmundi and Balarampur Blocks. Influx of outsiders is responsible for the loss of cultural purity of these two Blocks and to restore their cultural tradition (e.g. Chhou Dance) Government should spend 0.5 million rupees every year for arranging local festivals like "Hul Uthsav" (Table-2).

Other than these environmental costs, total cost of development and annual running cost (including fixed cost and depreciation cost) of the project are also calculated. The total investment is 29520 million rupees and taken as ODA (Official Development Assistance) loan from Japan Bank for International Cooperation (JBIC). If we divide the total investment by the 70 years life span of the project, it would be Rs.421.7 million / year. The annual interest rate of this soft loan is 1.3% and will be 383.76 million rupees per year. Total compensation for land acquisition given by the State Government is 25.61 million. To pump up the water, PPSP will consume 1000 MW of electricity for 10 hours per day at the rate of Rs. 1.8 / unit. Thus 6570 million will be spent on electricity per year (ref[1]). Taking instances from other pumped storage projects of India e.g. Nagarjunsagar (810 MW), Srisailam (770 MW), Kadamparai (Cauvery basin in Tamil Nadu, 400 MW), the annual maintenance cost (including wages of the employees) of PPSP is estimated to be 170 million rupees.

5.0 Conclusion :

From the above analysis it may be concluded that if we consider only the tangible annual cost (Rs.7642.3367 million) and claimed benefit (Rs.8371.12 million) of the project, the project appears to be economically viable and profit making too. An annual profit of Rs. 728.8 million is observed. But when we add the environmental costs and benefits with the tangible one, the total annual cost of the project goes to 58195.8 million rupees, where as total annual benefit remains 8727.12 million rupees with a deficit of 49468.7 million rupees per year. Thus in an economist's point of view this project is viable but to an environmentalist it is a destructive one. Still considering the ever-growing need of electricity instead of only criticizing the project we must try to find out the mitigation measures to reduce these adverse environmental impacts.

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Land Reclamation, Drainage Decay and Embankment Breaching – A Case Study along the Raimangal.

Tapan Kumar Das[1] and Ramkrishna Maiti [2]

Abstract

In Sundarbans, the premature reclamation of islands through erection of embankments closer to the tidal channels excludes the intertidal areas on either sides and thus tide is forced to concentrate within the constricted channels. This reclamation makes the channels hydraulically 'unfit' and those are gradually narrowed down. It provokes in complete closure of the interior channels through construction of series of longitudinal and transverse embankment and complete occupying of the channel areas for fishing, cultivation and habitation. The interior channels of Boalia and Pairatuni once accommodating huge tidal water of 8526420m^3, are presently bouncing back into the parent channel, the Raimangal, causing concentration of energy by increase in the magnitude of tide by 0.43m considering the spread of concentration effect over a distance of 14.5 Km for an average width of 1366m, leading to the breaching in embankments along parent channel. The condition is further deteriorated by mid-channel siltation and development of shoals. The increasing hydraulic head allows an additional 167309 m^3 more flood water to enter into the reclaimed area through the breach having 7.65m plan length of curved breach crest, 4.32m height of the tide level from the base of embankment and 4.86m hydraulic head on breach crest at breach channel centerline.

Key Words : Reclamation, Embankment, Water logging, Breaching.

1. Introduction:

The improper understanding of the inter working of the processes or lower level of technology and capital available for ambitious and unscientific control over nature may cause potential threat for destruction of civilization.

The process of coastal wetland reclamation has a long history for at least 2000 years usually by enclosing mashes with earthen embankment for providing extra land for agriculture, industry, residences, transport links and recreation (Carter 1995). There is evidence of Ramano British land claim in the Wash and Severn estuary in the UK, where the Dutch perhaps

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regarded as the world leaders in land claim, have extensive tracks of coastal, formerly inter tidal, protected by sea walls which date back several centuries (Goudie 1990). Pye & French (1993b) attempted in assessing the reclamation of estuarine lands in UK. In Sundarban out of 102 islands 52 are reclaimed by construction of embankment surrounding the islands since 1770 following Henckell's scheme of Sundarban reclamation. The permanent settlement was offered since 1870 following Grants Rules (Ascoli,1921). The extraction of land areas from both sides of the tidal creek makes the channels hydraulically 'unfit' and thus leads to drainage decay (Shigemura,1980,81 and Fitzgerald et.al.,1984). This is accentuated by the construction of the series of transverse and longitudinal embankments in order to occupy the drainage area for fishing, cultivation, habitation and other purposes that restricts tidal water to enter into the island and hinders easy drainage of rain water causing water logging as well as making the embankment breach prone as a bouncing effects on the major channels like the Raimangal.

2. The Problem

The reclamation of the islands sets some serious impacts on the hydrological systems of Sudarbans. The exclusion of the intertidal areas turns the minor and interior streams hydraulically unfit and are gradually narrowed down inviting further land claim from the creek beds leading to ultimate choking. This causes the bouncing effects along the main channels with increasing tidal amplitude and thus the possibility of embankment breaching and overtopping is increased. The flood discharge through a breach also increases to engulf more and more reclaimed areas by saline water.

3. Objectives:

The aim of the present work is to investigate into the mechanism of encroachment into the creek beds and its effects on embankment along the Raimangal.

4. The Methods:

The mechanism of the gradual encroachment is revealed from detailed survey with structured questionnaire. The year of establishment of the cross embankments are identified both from direct responses and from the average duration of stay of inhabitants lying at the upper reach of respective embankments. The year of construction of longitudinal embankments are realized through the responses about starting of fisheries *(Jalkar)* and gradual shifting of land uses to cultivation and ultimately to homestead and gardening. The stages of occupancy are identified and mechanism is constructed through the combination of both transverse and longitudinal embankment and related shifting of land use. The length and width of the earlier inter tidal areas of Boalia Gang is calculated from both S.O.I. topographical map and map of Irrigation

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and Waterways Dept., Govt. of W.B. The depth of previous channel is calculated by measuring the depth of present natural water bodies along the thalweg line from the base of embankment. Ultimately the volume of live storage, previously occupied by the concerned channel is calculated after Morisawa,(1985). The additional tidal height due to further concentration of water by choking of Boalia and Pairatuni Gang was calculated considering the distribution of concentration effect of a tracer i.e. dilution gauging for a distance of 14.375km with an average width of 1366m following Davie (2007).

The Study Area

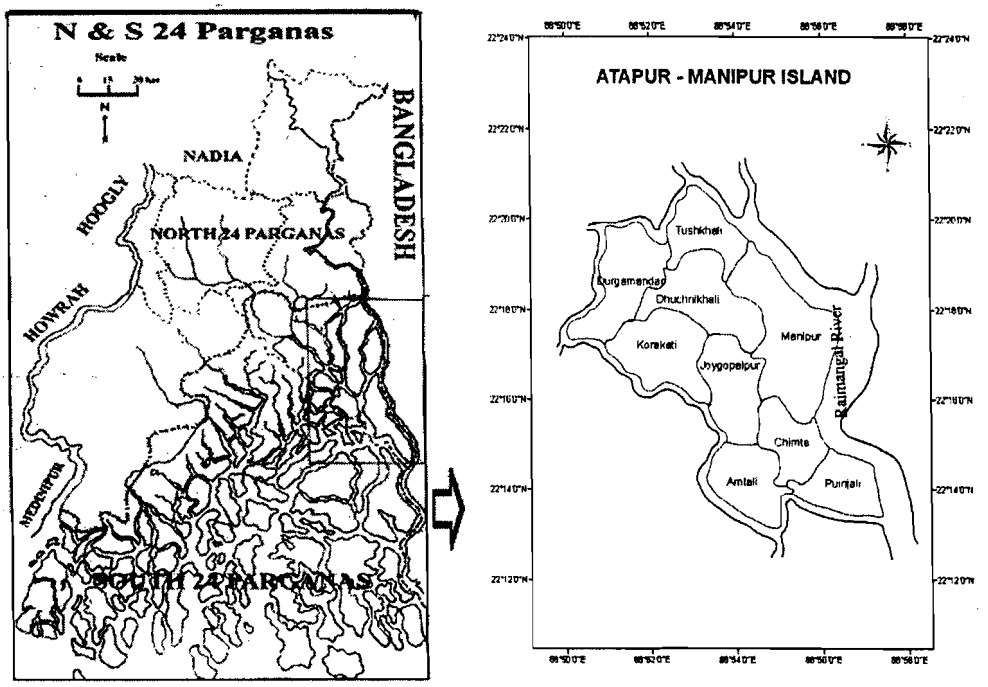

Fig. - 1

The study area includes the Boalia and Pairatuni Gang, the tidal creeks , once serving the mighty Raimangal and covers the north eastern part of Indian part of Sundarbans along The mighty Raimangal within North 24 Parganas District of West Bengal (Fig -1)

5. The Study

Prior to 1921(1st Stage) the then Boalia Gang was an important creek meeting the Raimangal River and experienced the temporary longitudinal embankment (LE) made on natural levee

to restrict the tidal inundation. Perennial course of the Boalia Gang was, then, constricted between long embankments and yet, the tidal water of Raimangal River could easily move into Boalia Gang. It was of 9.173 km length and 301m. width and its existence was exhibited in SOI Topographical map of 1920-21 edition as well as in the map prepared by Irrigation and Waterways Dept. , Govt. of West Bengal. The revised SOI Topographical map of 1968-69 shows its partial existence and thus revealing the fact of its almost choked situation during the period of 1920 to 1968. The thorough field survey with necessary measurements and that with structured questionnaire revealed the actual sequence of events and actions leading ultimately to the encroachment and chocking. The series of both longitudinal and cross embankments are constructed in order to restrict tidal entry and thus reclaiming more and more land from the river bed (Fig.-2). The objectives of the survey are to understand such sequences and identify the phases of embankment construction and sequential changes in land uses. Almost all the inhabitants living inside the channel (charland) are questioned for this purpose.

The first set of longitudinal embankment on either side of Boalia Gang was constructed to keep the island free form tidal inundation and to make the island hospitable and inhabitable (Ascoli, 1921 and Pergiter, 1934). The first complete cross embankment was constructed nearly 3050m inside the mouth of Boalia Gang during1921-1937 to restrict the tidal entry completely. The land from the channel bed was reclaimed with the construction of 2nd set of longitudinal embankment. The area between 1st and 2nd longitudinal embankment is divided into small compartments among the beneficiaries and transformed to fisheries for the first phase and gradually switched over to other land uses like agriculture etc. Ultimately these low-lying areas are filled with silt-clay to achieve required elevation above average flood level for making homestead. The gradual encroachment into the river bed was accomplished by the construction of series of longitudinal and cross embankments in association with those of land use changes (Fig.-2). During 2nd Stage (1932-37), the 1st cross -embankment (CE) was completed and two successive (2nd and 3rd at 2290m and 735m from mouth respectively) incomplete cross-embankment with wooden or bamboo made bridge was established. Fisheries were developed by erecting 2nd longitudinal embankment and thus constriction of channel hinders the free movement of tidal water. Temporary 1st long embankments were strengthened and became permanent un-metal road. During 1938-56 (3rdStage), the 2nd cross-embankment was completely constructed and it shortened the length of river course and 4th (424 m from mouth) incomplete cross-embankment with bamboo bridge was developed. Agricultural land started to be developed as an improvement over

previous fisheries. Fresh fisheries were developed between 2nd and 3rd long embankment and this 3rd long embankment made the river more constricted. The duration between 1957-70 is identified as the next (4th) stage. The survey reveals that during this period 3rd cross embankment was completed and the river course became more shortened. 5th incomplete cross-embankment was found at the month of Boalia Gang. Settlement was developed within the channel by filling the lowland with earth-mass and a cross un-metal road was constructed to make the newly developed settlement accessible to the already developed transport system passing through the midway between 2nd and 3rd cross embankment forming another segment. Most of the fisheries at the upper margin of the creek turned to agricultural land and a series of water bodies remains as remnant of the Boalia Gang along its central portion. Final stage(1971-2006) of encroachment identified through the survey revealed that 4th & 5th (at the mouth) cross-embankment were completed and Boalia Gang was completely detached from Raimangal River. A series of water bodies still remains as a remnant of Boalia Gang. One brick pitch road was developed along the 1st Longitudinal Embankment (Fig.-2).

5.1 Calculation of additional water-pressure on the embankment along the Raimangal River

The length, width and average depth of completely closed Boalia Gang are measured and the total volume of water that could be accommodated by Boalia Gang is 8526420 m^3 .This huge amount of tidal water concentrates into the Raimangal River to increase the additional magnitude of 0.43m. The silts carried by the Raimangal River can not be deposited within the low char land of Boalia Gang due to final detachment of Boalia Gang by cross embankment, and so, most of these silts are being settled at the base of the channel forming a large shoal reducing water holding capacity of Raimangal. Thus combined effects of shoal formation and additional water concentration sharply increase the tidal amplitude which causes embankment breaching along both sides of Raimangal River .So the height of water during high tide exceeds the height of embankment crest (Hs) initiating overtopping of water and subsequent breaching of embankment. The overtopped water , first, have the sub critical flow (Froude Number (F)<1) and over the embankment the flow becomes critical (F= 1) and ultimately transformed to supercritical (F>1) on the outward slope of embankment as it passes from a static head to a combined static-dynamic head Chanson,2004,and Coleman *et. al.*, 2004). The overtopped water at first develops outflow channel at the outward slope of the embankment, which gradually extend head ward and reaches the crest and thus causes complete breaching of embankment. The study of potentiality in embankment breaching,

the possible flood discharge and time of flood water to travel to settlement area have to be made with acceptable accuracy for developing emergency action plan (Wahl, 1997). The breaching may also be possible in the inward slope of the embankment by continuous scouring and formation of near circular scars. The probability of breach failure can be well assessed through the analysis of slope-stability criteria (Safety Factor) , soil mechanics , sediment transport or deposition mechanism etc. (Mohammed et. al.,2004).

5.2 Calculation for Additional Discharge of Flood Water Through a Breach

The height of the tidal water from embankment base (H), height of the embankment crest (Hs) from base (Fig.-3) play their role in increased frequency and magnitude of breaching. Although, most of the experiments are made on noncohesive embankments, the clayey embankments obeys some of the hypothesis which are not the function of embankment sediments (Coleman et.al.,2002). The flood discharge through the breach depends on the length and hydraulic head at the central streamline of the breach (Coleman et.al.,2004). The flood discharge through the breach is a function of gravitational acceleration, plan length of curved breach crest and hydraulic head on breach crest at breach channel centerline.

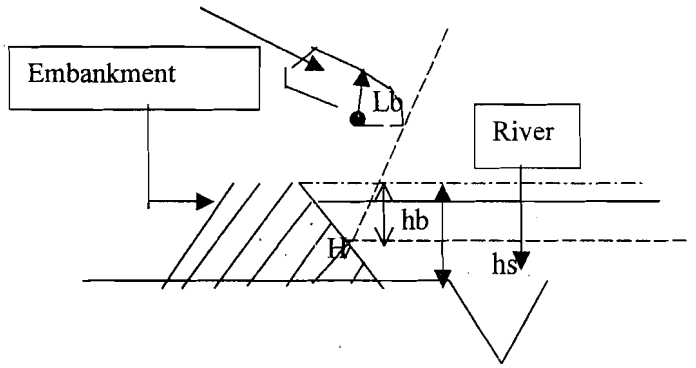

Fig.-3; Schematic Diagram to show the effect of increased tidal magnitude and consequent over-topping

Through a breach having 7.65m plan length of curved breach crest, 4.32m height of the tide level from the base of embankment and 4.86m hydraulic head on breach crest at breach channel centerline, an additional flood volume is estimated to be of 167309 m3 or 167,309,000L during entire high tide period of almost 6hrs

Th

6. Discussion:

As the high tide water can not be distributed through the interior distributary channels, the

concentration of water during high tide into the parent river is obvious and thus the level of water(H) increases (Table-1). Changes such as these have been noted in secular tide gauge records and confirmed by general observation ; for example Saeijs (1982) remarks that reclamation along the eastern Scheldt has led to higher tides and increased flood hazards. The tide on the lower River Thames in Eastern England has rises by over 1m since 1970, almost twice the rise recorded on near by coast. This phenomenon is believed by Bowen (1972) and Prandle and Wolft (1978) to be associated with reduction in cubature (volume) of the estuary brought about by dredging and reclamation. Similar problems have occurred in the Venice lagoon (Passino and Todisco,1984; Pirazzoli 1987) where reclamation of low marginal wetlands has drastically reduced tidal friction , causing asymmetrical tides which are more in phase with those in the adjoining Adriatic sea. In all these example the tide has risen. Coastal land reclamation also leads to tidal passes becoming hydraulically "underfit", so that in time they tend to narrow or even close completely. Shigemura (1980,1981) has developed an empirical model of this closing tendency , passed on example from Japan. Corroboration of shigemura's model has been provided by Fitzgerald et al.(1984) using historical changes on the East Fresian coast of the North Sea. Here reclamation of the Wadden sea over the last 300 years has led most of the barrier passes becoming narrower (Carter 1995).

After being claimed ,the new land previously covered by water twice a day will start to dry out and dewater, which will itself cause the land to compact and shrink, thus causing the land surface level to fall. After a period of years, the level will fall sufficiently to cause the new land surface level to fall. As an example ,work done for the UK national River Authority (now part of the UK Environment Agency) has indicated that the sea defences in the Wash was failed due to subsidence of reclaimed part. Surveying across sea defences in the Severn Estuary (Allen,1991) has indicated that this variation in height either side of the sea defences can show a relative drop on the land ward side by as much as 1.7 m over a period of 1700 years, or 0.88 m over the past 650 years. As a consequence of this with relative sea level rise, the increased depth of water will eventually allow greater wave activity and increased threat of over topping of defences and subsequent flooding (French 1997). The silts carried by tidal water cannot enter into the interior of the island, are thus deposited inside the parent channel, the Raimangal causing partial filling of it and 'one natural occurrence is the inevitable bar at the mouth of an alluvial channel (Mckay,1970). The formation of the large shoal at the mouth of the Boalia is due to this choking and restriction of water and silt inside the Raimangal. The water logging is the inevitable out come of such destruction of drainage system. The Boalia Gang not only carries the tidal water into the interior part of

island but also drains water from inland part during monsoon. The choking of the drainage lines means the obstruction in both the inward and outward movement of water as no sluice is there to allow minimum space for water movement and so the immediate acute problem of water logging affects the life and damages the properties, crops, inland fisheries and mud-built houses. The stored water remain unmoved for a long time till it dries in post-monsoon period.

7. Findings

The decay of hydraulically underfit streams are facilitated by human encroachment into the creek beds by making the channels completely detached from the main streams. The cross embankments were constructed with an initial stage with bamboo made bridge *(shanko)* above the alive water course and finally were completed afterwards without leaving any space to allow water to move to and fro. Construction of single embankment reclaims its upper portion allowing complete utilization of land for different purposes. Five of such stages of occupancy are identified viz prior to 1920, 1921-37, 1938-56, 1957 to 1970, 1971 to 2006. The construction of longitudinal embankment leads to constriction of the channel and initially reclaimed land is used for fisheries *(jalkar)* and gradually the process proceeds towards the river reclaiming maximum possible land, leaving minimum areas for the river to play. Ultimately the complete detachment of channel from Raimangal system was made by construction of latest cross embankment in 1972 compelling the main river to carry additional water and to store additional silt within the channel leading to the formation of large shoal. Increased depth of water in the Raimangal is 0.43m, considering the spread of concentrated water over a distance of 14.375km with an average width of 1366m. Additional height of tide water may increase the possibility of overtopping and Embankment Breaching and thus increases instability and vulnerability in the system.Discharge through the breach of 7.65m length and 4.86m depth is at present 69.84 m^3/sec but it could be 62.094m^3/sec if the height of high tide level become less by 0.43m. The Embankment materials may get stability at an angle near to 2 degree but it is now near vertical due to basal erosion at high tide. Additional water load in the Raimangal sets more velocity of tidal current for draining of more water during a fixed interval which causes more basal erosion (Wahl,T.L.(1997). This basal erosion makes the embankment steeper than the angle of repose that indicates absolute instability and potentiality of breaching.

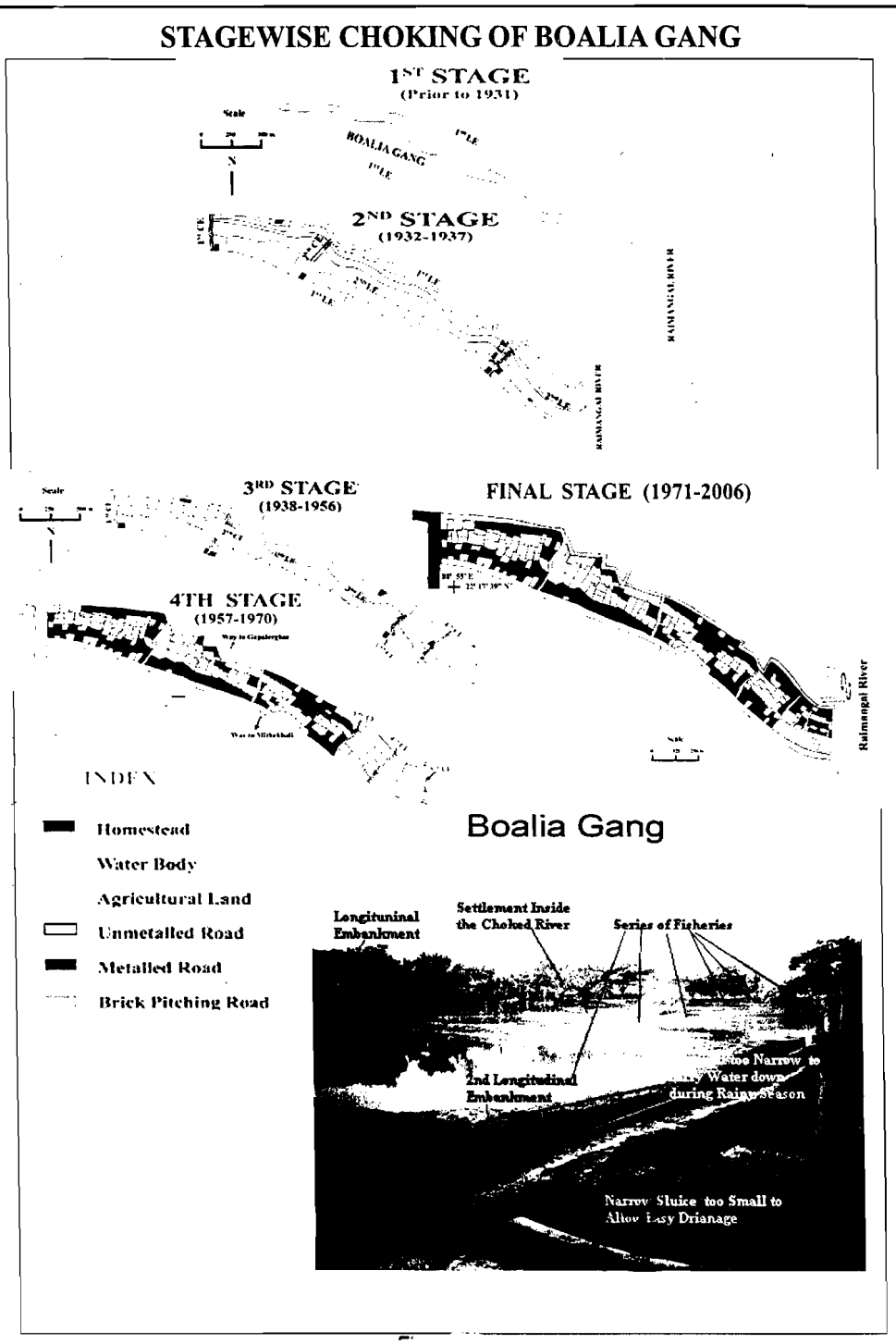

Fig. - 2; Mechaning of Choking of intericr creeks (Boalia gang)

8. Conclusion

The understanding of complex inter-working of the series of natural, economic and social processes are earnestly needed for the existence and development of human society. In a way to tame the nature, to make it more hospitable, man invests labour and capital with available technology. The negative effects of reclamation are seriously realized on hydrodynamics of this estuarine environment. The complete closure of the interior creeks like Boalia and Pairatuni increased stress on embankment leading to frequent breaching and subsequent flooding. The complete closure of interior drainage results in water logging in such a low gradient area. The embankment which was the 'lifeline' of Sundarbans, became the cause for sufferings of the local habitants due to irrational and unscientific construction and ill-management. This ultimately brings the property and land resources to a vulnerable situation of continuous deterioration and complete destruction. The reclamation of land for human habitation and other economic uses are welcomed only when the char (shoals and bars) gets its maturity and is naturally offered for human use with an elevation above the average high tide level. The present experience suggest for revival and excavation of the earlier interior drainage system in order to make room for tidal water to play and for easy drainage of rain water away from the reclaimed islands.

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Environmental Interpretation of Dash avatar, Changing Use of Dash avatar Cards and its Impact on Society and Space.

Nilanjana Das

Abstract

Dash avatar is a Hindu mythological concept. This concept in many ways related to physical environment. The religious concept of dash avatar is adopted by a group of artisans, engaged in making playing cards to glorify the negative concepts attached with the game of playing cards. Thus on the one hand a religious concept used as a resource base and it was personified as it was played by the royal families on the other. But in the changing socio-cultural environment these cards lost its religious significance and now are used as decorative materials and exist in a different cultural environment to serve different purpose.

Key words: Dash avatar, *gangifa*, *naksa* play card, concept as resource and changing concept of resource.

1. Objective

Objective of this article is to find out why and how a mythological concept like Dash avatar enters into the socio-cultural process. In what ways the process creates job opportunities among a group. Does the mythological concept ultimately participate in resourcisation process? One of the objectives is also to trace the changes in the concept and in the utilization of resource products as well.

2. Methods and technique

Present paper explores the strength of concepts and ideas on resource processes. Zimmerman's statement 'resource is not resource becomes' is a kind of model can be applied in the transformation of fundamental components into functional entities. In geography there is no such model which can be followed to establish the problem. Conclusion is tentative and based on empiricism. Data mainly collected from field survey, different books, journals and websites have been used.

3. Dash avatar as a concept

Dashavatar concept is related to the ten incarnated form of lord Vishnu. Lord Vishnu was little personified in the Vedic age but Hinduism adds a large number of fantastic developments. '*Vich*' means the whole universe and he holds the supreme position in Hindu mythology.

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Vishnu and his many forms are attached to many environmental concepts. Different names of Vishnu as '*Ananta*' means the infinite, '*Mukunda*' the liberator, '*Kesava*' the hairy whose hairs are solar rays and '*Narayana*', the source and refuse of beings. In this paper the ten incarnated forms of Vishnu are interpreted from environmental point of view. In the intervals of successive creation Vishnu sleeps on the cosmic waters, lying on the snake '*Shesha*' whose seven heads spreads like a fan makes a canopy for him. This slumber is not death but a state in which the gods virtually slowly ripens to uphold again in another universe. This alteration of rest and activity are as regular and certain as organic rhythm-Hindu talks of themes the gods in breathing and out breathing. Each cycle of creation is related to an Avatar or a descent of lord Vishnu. These avatars are *matsya* (the fish),*Kurma* (the turtle), *Varaha* (The wild boar), *Narasimha*(the half man half lion), *Vamana*(the dwarf man), *Rama, Parasurama, Balarama, Krishna* and *Kalki*(the destroyer). Mythological explanation attached to each avatar are- *matsya* avatar saved the universe from the cosmic deluge in the form of a hues one horned fish with golden scales. When the earth submerged by the deluge it was captured by the demons, Vishnu in the form of a wild boar dashed a crossed the heaven divided into the waters, where he tracked down the earth by his sense of smell and killed the demons then he lifted the earth from the abyss on his tusks. During the churning of the sea of milk (*Khirod sagar*), Vishnu in form of large turtle (invoked) got beneath the mountain *Mandar* and became its pivot. Narasimha or the half man half lion avatar was incarnated towards to kill Hiranykasipu father of Prahlad. Vamana avatar appeared in the story of Bali. The popular Ram avatar killed demon Ravan. Parasuram or the Ram with axe, created to break the power of warrior caste. The Balarama avatar (who is also the elder brother of Krishna) killed demon Pralamba. Krishna is the god of humanity, philosophical teachings and the tenth avatar who will eventually destroy the present stage of degeneration. Krishna in many mythological stories is replaced by Buddha or Jagannatha.

4. Environmental interpretation of Dash avatar

In Rig Veda (translated by Dutta, 1895) it was depicted that the meaning of Vishnu is the Sun. Vishnu in form of Sun formulates rain and moving the air. The stepping of Vishnu is emblematic of the rising it's Zenith and the setting of the sun. in other version it was stated that the three steps of Vishnu represented earth air and heaven, the first two steps were visible to human being where as the third is hidden from them(Bhattacharya.H,1984).

The avatars of Vishnu in the same way environmentally interpreted. The vamana or the dwarf avatar of Vishnu depicted as the supreme power as the sun rises in the east at dawn and touches the highest point firmament at mid day and sets in the west at dusk, again rises

in the east next morning. Thus three strides of the sun traverse the whole universe. This natural phenomenon interpreted as the conquering of the three worlds with three strides of Vamana avatar. In the Atharva veda lord Vishnu imagined as Sun and Sun's movement between the two solstices explained mythologically as the movement of Lord Vishnu. Incarnated form of Vishnu also resembles with the evolution of life forms on earth and Dashavatar also symbolize the five vital elements namely earth, water, heat, air, and atmosphere or space. Every avatar is related to a particular happening or phase or stage in the process of man-nature relationship. The first five incarnated form resembles with the evolution of life are shown in the following table.

Incarnation	Gross symbols	Purpose	Nature symbol	Body symbol
Matsya	Water	Saving organic life seeds from great cosmic flood	Origin of life in water	Blood
Kurma	Air	Providing base for creator from water	Life in water and earth	Breath
Baraha	Earth	Getting submerged earth out of the cosmic flood	Life in forest and land	Proper Substance
Narasinha	Fire	Getting established human power over demons	Phase of cooling earth	Warmth
Vaman	Sky	Getting control over the three realms of world	Origin of man primitive	Mind

Table - 1; Incarnated forms of Avatars, symbolic meaning and its relation with the evolution of man [Source: Singh. Rana. P. B. & Singh. R.L., 1987]

This order suggests the development of life on earth to its more evolved form. The science of evolution suggests that life first appeared in the water. Then the amphibians came and from there evolved the more advanced forms like mammals and human Parasuram symbolizes the prehistoric man as axe is his weapon. Ram is the man in the hunting stage as he holds the bow and arrow. Balaram holding the plough symbolizes agriculture. Krishna is depicted as a philosopher or scientist and Kalki holding a sword symbolizes the destroyer.

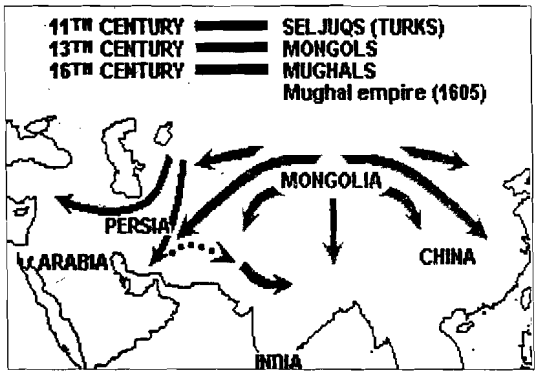
5. Religious ascribe of Dash avatar

In the Rig Veda Vishnu occupies a subordinate position (Das, 1925). He was not the sole god. His inferiority to lord Indra appears in the hymns of Rig-Veda. In the later Vedic Literature

Vishnu occupied the supreme position. He manifests the solar energy. From that period people deify Vishnu as supreme god and different religious beliefs were ascribed to him as Dash avatar. In the present days also Vishnu is worshipped before starting any religious rituals in Hindu religion.

6. Dash avatar as cards

Dash avatar, a Hindu mythological concept entered into cultural process and has been used in playing cards. Playing card is an indoor game. It is believed that this game is popular among lazy, jobless people simply for time passing. It is associated with gambling, conjuring and fortune telling. It is used to be played by the Royal families, kings, Nawab and Zamindar. Most of the concepts associated with this game are negative. By adopting the figure of different deities or pictures of idol people, the artisans make an effort to remove 'gambling' tag attached to playing cards which misleads its educative value as an art form. '*naksa*' card or designed cards are symbols of mass culture and a way of life for the artisans. Dash avatar play cards are one of the important *naksa* cards in India.



Not to Scale

Fig -1; Origin and distribution of 'naksa' card in India

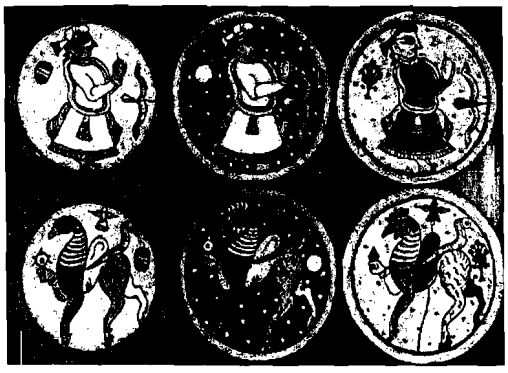


Plate -1; Play card in Mughal era

In the year1398 Timur Lenk invaded India. This game came to India from Persia with the Mughals. Babur the succerror established the Mughal Dynasty in India and Akbar(1556-1605) extended his empire to the gulf of Bengal . The game of playing cards started under the patronization of Akbar in India including Bengal.

The playing cards of Akbar era represent the then Mughal miniature culture. There were 144 cards in a set which was divided into 12 suits and each suit consists of 12 cards. . The highest card represents the king(of Delhi)on the horseback with umbrella, the standard and

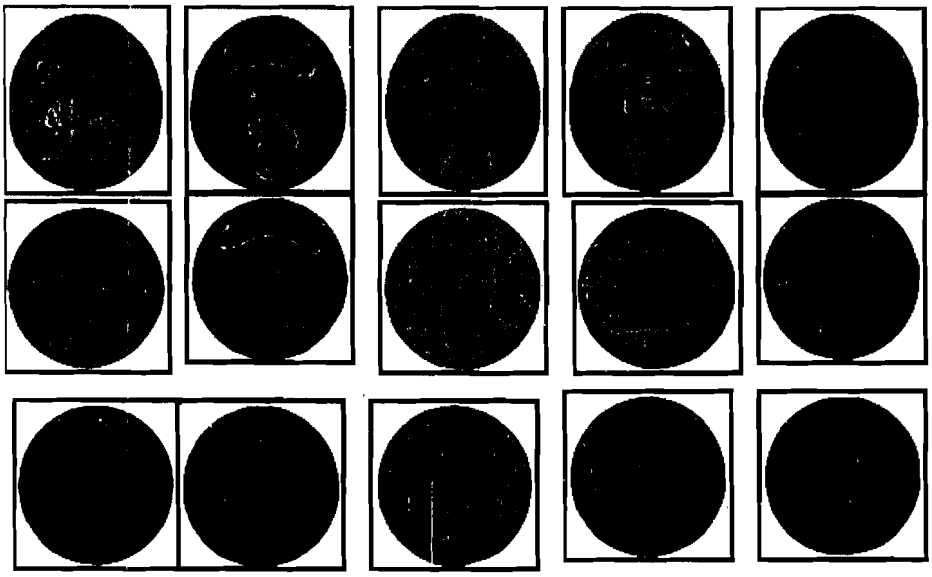


Plate -2 ; Ganjifa card of Orissa

Plate -3 ; Bishnupur Dasharatar Play card

behind this is night shows the darkness through Matsya avatar and day shows with Rama the divine God, which symbolizes that an enlightened morning comes after a dark night.

7.1 Making process

The artisans make dash avatar card collecting materials from physical environment .The base is formed by 3 or 4 layers of cloth one upon another and it is colored by coating white kaolin first. The radius of the circular card is 4''. A special adhesive made from tamarind seed is used to harden the cloth. For drying they collect natural goods from physical environment directly. The materials are Hingul red –Red color , Hingul hartal or yellow, stone of white clay, girimati, mottled clay for brown color ,leaves of sim(kidney bean) for green, carrot for orange color. To increase glaze and longevity they use *tentul* (tamarind) and *bel* (wood apple) gum. Here we may refer Jamini Roy who used these earthen colors in his paintings.

7.2 Changing concept

Only one family of Bishnupur is engaged in this work. In this era of globalization the significance of playing card exists in a poor form. Once these cards were made for kings and Nawabs simply for time pass. Dashavatar cards are no longer used for playing. Recent trend is ethnic. People started tom collect ethnic goods like Dashavatar playing cards for interior decoration or for pendal decoration during festivals. Dash avatar playing cards were likely to be extinct but recent trend or craze about ethnic goods help the artisans to survive.

8. Conclusion

Dash avatar is a mythological concept. This concept was transferred on playing cards. Therefore a cultural concept becomes a resource base. Within West Bengal it is extremely place specific. It was introduced in Bishnupur by Malla kings. By introducing incarnated figures of gods, the kings were tried to ascribe religious sanctity. It is a caste and group specific occupation and this specificity is still observable. Through the materials used in making of cards, these cards are related to the physical environment. The use of these cards was restricted to the royal families of Bishnupur. With the abolition of *raj* system the use has become defunct in Bishnupur. British colonial system makes a change in the cultural and social environment. Introduction of new play cards with king queen and servant become popular in India. Due to rejuvenation of ethnic concept these cards are used in interior decoration by urban population. The cards are widely used in *pandal* decoration. They are also exported as crafts.

Thus we may conclude that a Hindu mythological concept become a resource base for Dash avatar play cards. With changing cultural and behavioral environment it no longer used as

play cards but it exists in a different cultural environment to serve different people.

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Developing Municipal Information System To Assist Decision Making Processes : The Case of Jalpaiguri, West Bengal

Utpal Roy, Soumendu Chatterjee & Nilanjana Das

Abstract

Municipal organizations govern various types of activities each of which requires multitude of specific geo-referenced information for their execution in organized way. In the present context of tremendous urban expansion, particularly in the developing courtiers like India, policy making has assumed apex priority. All the facets of planning and development activities can not be harmonized unless high quality precise information of municipal interest is available at the largest possible scale. Insufficiency of such database in the process of policy making and implementation of those plans have resulted haphazard development works in most of the urban areas of our country without being able to satisfactorily solve the urban problems. The present paper deals with the methodology for developing and designing a *Municipal Information System* (MIS) and this has been tried in case of *Jalpaiguri Municipality*, West Bengal.

1. Introduction

The system of urban governance in the towns and cities of India is operated by the municipal organizations at the local level. Such autonomous bodies have been established in socially approved procedure to achieve the goals of popular participation in government, enhance the efficiency in governance by allowing them to function in small areas of higher population density, and to ensure sensitive delivery of public services. Diverse activities of municipal organizations include providing public amenities, making information available to the public, acting as an authority to enforce state legislation, formulating plans and policies for urban development, seeking and generating funds for local development, regulating private sector activities etc. But in the present juncture, urbanization and urban growth at an unprecedented scale has posed fundamental question on the sustainability of urban development. The urban functioning has assumed greater complexities owing to increasing demand for urban services, rise in urban expenditure, mismanagement of urban resources,

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inefficiency in tapping the economic resources etc. As such, some thrust areas in urban development have been identified during Rio Earth Summit and they have been categorically included in Agenda-21. These are- provision of shelter for all; ensure integrated provision for environmental infrastructure associated with water, sanitation, drainage, solid waste management etc.; development of sustainable energy efficient urban transport system; human settlement planning; special planning for disaster prone areas; and meeting the urban health challenges. Well integrated information base in regard to all the above spheres of municipal activities and responsibilities is priori need for their disposal. Municipal Information System (MIS) is just a modern approach in that direction.

The challenge area for the municipal authorities is to propagate a smart information system among the various stakeholders, service providers and the departmental heads in the municipal government structure. It should also be ensured that data are acquired and shared by all the relevant offices in such a way so that data can easily be exported to the Geographical Information System (GIS) system in a usable format. It requires developing a sharable computer environment and common file format structure to facilitate seamless sharing of information, updating information, developing metadata structure etc.

2. Municipal Information System :

A municipal information system consists of technology, personnel and other resources to create, maintain, search and share geospatial information and services. Usually it provides a structured common framework for collaboration and communication that allows the stakeholders to share information about locations for their efficient and effective use. A major goal of municipal information system is to generate map products to assist planning activities. With the advent of GIS technology, the usage and applicability of municipal information have been extended to a great extent involving integration of spatial or non-spatial data and their analysis and visualization. These have enabled to use those information in performing more sophisticated jobs like rendering permissions, work order processing, providing customer care services etc. which were not included in traditional systems of municipal management.

Municipal information systems are developed considering three basic concepts. Firstly, a municipal authority is to develop and sustain its service providing systems e.g. regulation of land use and sub-divisions, water distribution, rendering other civic facilities and public safety etc. Creation and management of GIS data by the individual municipal departments is a pre-condition to run those systems. Secondly, MIS should be capable of developing structured information base that can allow intra- and inter-department sharing of

raw and processed data for their multipurpose uses. More important is that, the database should be available to the public by means of networking. Thirdly, MIS should be equipped with facilities for integration and interoperation of data and other GIS resources with confidence to support individual and departmental efforts for maintenance and development of municipal business.

3. Data Types :

Municipalities are required to handle versatile nature of data that include not only the spatial data layers such as land parcels, streets, institutions etc. but also the aspatial information stored in attribute tables that describes many layered features such as street names, and also the events associated with them such as data related to repairing works last done. Most important in this regard is to develop a simple object based data model that ensures vertical stacking or integration of data/map layers. Some of the important municipal data/information required for developing MIS are- (i) administrative boundaries; (ii) Survey of India Toposheet base map; (iii) digital images; (iv) neighbourhoods; (v) water supply network; (vi) network of drains; (vii) flood/water logging zones; (viii) land units and their uses; (ix) address of the important sites; (x) landuse zoning; (xi) demographics; (xii) water resource potentiality; (xiii) biodiversity database; (xiv) service providing centres etc.

Land-based information necessary for administering municipal area can be categorized into two groups[7]. Firstly, the information that refers to a geographic unit is known as *topographic information*. Secondly, the information that can be added to a geographical unit is known as *thematic information*. For example- plot number, name of the owner, elevation etc. are the information about a geographical unit i.e. a plot in consideration. They can be designated as topographic information. On the contrary, legal situation, value, landuse etc. are the information that can be attached to any plot of land. Therefore, they are the thematic information. The topographic information may be derived at both *large* and *small scales*. Information for smaller geographic units like house, neighbourhood etc. are large scale topographic information while information for larger geographical unit e.g. ward, segment of a street etc. are small scale information. Attribution of thematic information may be accomplished in two formats. *Statistical information* are usually expressed in numerical terms and are collected through questionnaire survey while *registrative information* are non-numerical in nature. It is evident from the above that, any data/information- be it topographic or thematic, large scale or small scale and statistical or registrative- is always associated with a location and such locational element allows to use it as a reference for any exchange of related attribute data.

4. Data Models :

The entire task of data management virtually concerns the way in which information about position, linkages (topology) and other geographical attributes can be best represented [6]. Database is structured and organized with respect to the fashion they will be handled and the mode they will be used for municipal purposes. The data formats play significant roles in this respect. But it should be borne in mind that, when information are required to be exchanged between the municipal departments, it is necessary to formalize the data model in a manner so that they can be interpreted without ambiguity and communicated effectively. Several fundamentally distinguished designs can be adopted to describe the objects of municipal interests occupying an urban landscape [2]. The two extremes are- (a) to conceive space as being occupied by entities which are described by their attributes or properties and whose location on space can be mapped using convenient geographic co-ordinate system. Visualization of such objects (e.g. house, street, institution etc.) requires defining and recognizing them first and then their attributes are to be listed and their area and location to be defined specifically; (b) to imagine space as being occupied by attributes that varies over space according to some continuous mathematical function or field. In this framework of conceptual data model, geographical space is represented in terms of continuous Cartesian Coordinates in two or three or even four (time) dimensions. The attributes are assumed to vary continuously and regularly over space. Elevation, soil texture, population density etc. are the examples of such attributes. In visualization of such an attribute, its spatial variations are considered first, and then few clusters or ranges of its values are defined to prepare maps. In a MIS environment, both types of data models are used for specific purposes.

5. Components of Municipal Information System :

Municipal organizations are to perform at least three categories of tasks each of which requires specialized databases organized in spatial frameworks and specific categories of application software to handle those data[7]. These are- technical, administrative and planning. The technical tasks include designing, building and installation of planned projects along with their control and maintenance. High precision large scale maps visualizing buildings, road networks, service centres, distribution networks etc. are needed in performing the technical jobs. These information are mostly topographic in nature and number of statistical themes attached to them is relatively less. As such, these types of information are more graphical than numerical in character. Therefore, technical departments usually require design oriented systems e.g. CAD (Computer Aided Designing) to handle data for graphical designing in an automated environment. On the other hand, administrative jobs involve statistical database in

numerical formats to manage legal and financial responsibilities. Registrative information regarding land ownership, population, real estate, business, volume of different services rendered to urban dwellers, flow of traffic, public institutions etc. are the fundamental database needed to municipal organizations for their administrative functioning. Most important in managing and handling such data is that they are to be linked with each other and also with other types of information used by municipal departments. Administrative departments are required to handle information which are mostly numeric in nature and therefore, need Relational Database Management Systems (RDBMS) for updating, manipulation and analysis of such data. CAD systems are often integrated with RDBMS to enable cost effective production of technical maps automatically. The planning and policy making department of a municipality is responsible for making out planning zones, preparing master plans and plans for urban renewal, housing, providing facilities/utilities, traffic management, environmental protection etc. All these activities need highly generalized but largely integrated data generated through research based complex analysis of data collected by statistical and other departments of the municipality. Planning department is virtually engaged in handling the analyzed data and maps produced by the other departments (Fig. No.-1). Hence, it occupies the highest level of sophistication in utilizing database collected, manipulated and analyzed in other levels of a municipal organization. Introduction of GIS in the planning activities is an urgent need for qualitative improvement in decision making process. Most of the GIS packages are now interfaced with the popular DBMS packages and are adopted to operate in client-server network environment based on modern multi-user operating systems. As such, a MIS is basically an integrated system comprising CAD, RDBMS and GIS systems that offers facilities of sharing information across the municipal departments [5]

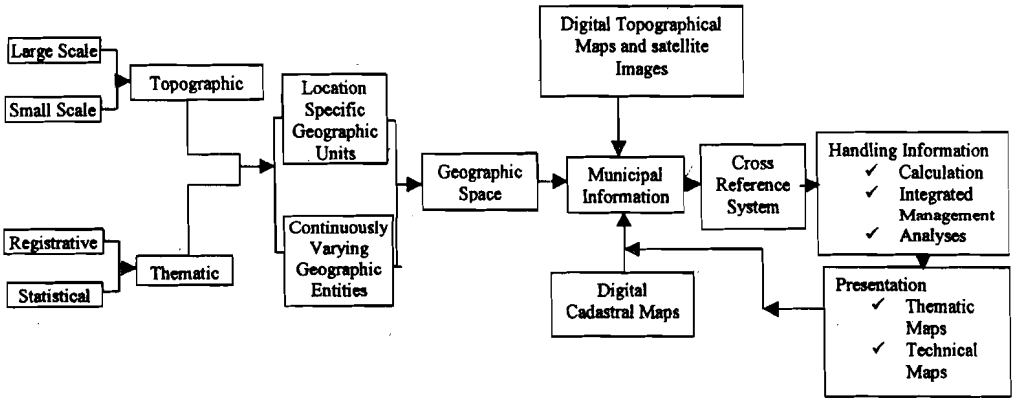


Fig. No.1- Concept Diagram of MIS

6. Case Study-Jalapaiguri Municipality :

Jalpaiguri town, one of the important urban centres of North Bengal, is situated on the west bank of River Tista. It has a long urban history since 1869 when it was developed as headquarter of the district. Jalpaiguri municipality, established in 1885, covers an area of 12.50 sq. km. distributed among 25 wards accommodating a population of slightly more than one lakh (2001). Processing of tea, timber, tobacco, jute etc.; manufacturing plywood chests; trade and commerce etc. form the economic foundation of this urban centre. Economic growth based on above activities led this town to assume regional importance. As such, peoples from other districts of West Bengal, also from other states and even from Bangladesh have migrated to this small town since long ago. Thus population of the town increased at phenomenal rate leading the population density to reach 5,394 persons/ km^2 (2001). But the figure does not actually reflect the congestion that actually exists at the central part of the town. Because many poorly populated marginal areas, mostly still under agriculture, have been brought within municipal jurisdiction. Haphazard urban growth, particularly in the heart of the town has given rise to many problems that have drawn attention of the municipal authority and few actions have been taken to redress them. But lack of information and incapability to generate updated database and to handle the already existing information could not yield fruitful results in tackling the problems up to a desired level. Hence, Jalpaiguri municipal authority urgently needs a modern MIS not only to cope with the problems but also for efficient management of service providing networks.

6.1 Problems Identified :

In developing MIS, identification of major problems is the primary task to be carried out first. Jalpaiguri municipal area suffers from number of inconveniences among which

water logging and drainage congestion, unscientific and improper sanitation, unplanned disposal of solid wastes, increasing traffic congestion due to bad condition and narrowness of the roads, increasing gaps between demand and supply of drinking water, expansion of built up areas at the cost of vegetal cover, poverty, illiteracy, crime etc. are more important and require urgent solution [4].

Principal causes behind water logging are- uneven topography; high intensity rainfall during monsoon; constriction of major drainage channels, particularly in case of River Karala (a tributary to Tista River that flows through the heart of the town), by dumping solid wastes and occupancy of channel bed by settlements etc. Four drainage problem zones have been identified under a project handled by the University of North Bengal, on the basis of topographic survey and field observations [10]. Indiscriminate disposal of solid wastes without any separate collection system for the biodegradable and non-biodegradable, or recyclable and non-recyclable wastes; not having any treatment plant for the solid wastes; lack of proper collection and transport system; scarcity of scientific know-how and equipments etc. have put restrictions to the management of urban solid wastes in Jalpaiguri municipal area. Furthermore, the authority should pay immediate attention to the problem of untreated sewage water flow into Karala river that turns into a mere drain during summer months causing serious health hazards to the nearby dwellers. Prevalence of vector-borne diseases in this town may be attributed to this nuisance. Public places like market, bus depot, schools etc. are not sufficiently equipped with safe urinal and toilet facilities. Traffic congestion is another major problem in Jalpaiguri town. Poor conditions of major roads added with their narrow width have made the situation critical for implementation of any traffic control plan. Only 17.70% of the total length of roads is in good condition and about 60% of the roads have width below 15 M. But the traffic flow along these roads is very high (18,700 PCU per day) making congestion problem severe, particularly during the peak flow hours. Occurrence of road accidents is also reasonably high in this town. As the population of the town is gradually increasing, it has been estimated that, the present arrangement of drinking water supply from deep tube well sources (12 in number) will not be able to meet the demand in near future. Many of the existing deep tube wells are prone to high iron content and further installation of such tube wells may cause water table to recede. Moreover, as a consequence of rapid urbanization, landuse and land cover of the municipal area have undergone dramatic changes particularly during the last couple of decades. Most damaging among such changes is conversion of vegetated areas into built up areas which has increased the volume of surface

runoff of rain water and thus act as an additive factor for water logging during rainy season. Besides the above problems, Jalpaiguri town also suffers from various types of pollution. Air pollution from vehicular sources has attained alarming level in the major congested roads, bus stands, taxi stands etc. Hospital road, Collectory road and Barabazar areas are much prone to air pollution in comparison to marginal areas of the town. Contamination of underground water by underground untreated effluents from sewer is another threat to the urban life in Jalpaiguri town. Violation of recommended spacing between soak pit and well and stagnation of rain water during monsoon season, open defecation by slum dwellers, discharge of untreated household and industrial waste water into the main drainage channel etc. have widened the scope of ground water pollution. Noise pollution in the town is not significant, sound level along the major roads have been observed to vary between 75 and 85 dB, where as in residential areas it remains well below 65 dB. Visual pollution in this urban area has miserably declined the aesthetic quality of its once spectacular landscape that attracted many tourists. Narrow roads guarded on the both sides by densely built high-rise structures, congested markets, unorganized overhead lines, hoardings, bill boards etc. have obscured the green pastures, agricultural lands, forests, meandering rivers and lofty Himalaya which could once be seen from this town.

In addition to all the above shortcomings, few socio-economic problems have also been encountered in Jalpaiguri town and crime has assumed considerable dominance among them. Burglary, motor accidents, rioting, theft, woman related crimes etc. are the major types of crimes within the town. A comprehensive database is given below that denotes the areas prone to particular type(s) of crime. It is possible to prepare thematic map on the basis of this information that can help police department in security management.

Crime Types	No. of Crime (during 2006)	Ward Nos.
Burglary	1	20
Crime related to women	11	7,9,12,21
Motor accidents	4	18,20,24
Rioting	1	6
Theft	31	1-25
Others	69	1-25

Source: Kotawali Police Station, Jalpaiguri; 2007

Among the other socio-economic problems, poverty, illiteracy, unemployment etc. are mostly prevalent in slum areas. There are at least 152 slums within the municipal area where standard of living is very poor, and people suffer much from most of the problems mentioned above. In comparison to other areas, slums have been found to be more vulnerable to water logging, water pollution, and health hazards. Slum dwellers have poor understanding about the environmental concerns.

6.2 Need for MIS:

The above discussion clearly reveals that, in spite of its substantial potentiality, further growth of Jalpaiguri town as an urban centre may not be sustainable unless management plans are taken up to ameliorate those troubles. But management decisions can not be designed without a sound database and information regarding the causes and consequences of each of those problems. Such data available with the municipal authority itself, are very few; some of them kept by the other government departments are not usually accessed by the municipal authority; many such information have not been updated for a long; and above all, the databases kept and maintained by a municipal department are seldom shared by other departments. But it is fact that, a particular data/information may become useful to many departments for analysis and framing management strategies. As such, the municipality urgently needs a system that allows the authority to analyze the database collected from various sources for generating maps on the themes which can immensely help in identification of the nature, spatial variation, causes and consequences of the problems along with their prioritization. Moreover, the system should allow sharing of the information and maps through networking. Introduction of MIS may help the authority to develop those facilities which will, in turn, help the decision making processes in an integrated way so that implementation of one project to solve a particular problem may not create any inconveniences in other sectors. Efficient monitoring of municipal functioning can only be attained through introduction of MIS.

6.3 Methodology:

Employment of computer based automation in database management and map production in place of age-old manual system of record keeping and making hand-drawn maps does involve major financial and organizational liabilities for any municipality. But effective management of urban businesses has now become very difficult without such systems. Hence, in developing MIS, cost effectiveness of the method to be employed for the above transformation should be given reasonable importance. Optimum utilization of the existing resources and easy incorporation of already collected information into the computer

system are the basic approaches that should guide the methods of developing integrated, effective and efficient computer support system for all activities governed by the municipal organization as a whole [7].

In the first phase, an existing cadastral map (1: 4,000) of Jalpaiguri municipal area with ward boundaries was scanned and geo-referenced with respect to SOI topographical sheet (1:50,000) using sizeable number of Ground Control Points (GCPs). This was further substantiated by GPS (Global Positioning System) readings taken on the field in differential mode. The second phase involved capturing Wikimapia (www.wikimapia.org) true colour images for the entire AOI (Area of Interest) at the largest possible scale and mosaicking all the separate scenes. The image was also geo-rectified on the basis of the earlier geo-corrected map. All the above operations were carried out in ERDAS IMAGINE 8.5 software using suitable projection system and datum. Municipal boundaries (including ward boundaries) were redrawn along with the road networks to prepare a base map having accuracy to the practicable extent. In the third phase, series of maps were generated through on screen digitization (in shapefile and Arc coverage file formats) and creation of vector layers using the above geo-referenced maps. Those maps were prepared on the basis of identification marks put on a hard copy of the true colour image during field work and a landuse map obtained from the municipality office. Thus geospatial data could be visualized keeping links between the points, parallelism of the lines, relative and absolute locations, association, intersections etc. The map files were basically combinations of points, line segments and polygon files derived from digitized vector layers [2]. Available and collected statistical databases were linked, wherever possible, to the vector layers by means of creating attribute tables. At this stage few new fields were incorporated to link them with databases of other layers. All these tasks resulted in a planning information system for the municipality which is useful for many queries and thematic mapping applications. Though the information collected and pulled together through questionnaire survey and field survey were insufficient to build up a full-fledged information system, but still the effort was fruitful to generate considerable database towards developing MIS for the municipality in question (Fig. No.-2).

The digital map had non-closed polygons, interrupted lines etc. due to manual error in digitization. Those errors were removed and topology was rebuilt in ERDAS IMAGINE environment. This enabled the operation of transformation into topological digital maps. Finally, the maps were composed using Arcmap software and themes were labeled according to the associated database. Some maps have thus been developed that can serve as bases for developing information system of the Jalpaiguri Municipality. Few of them are given here

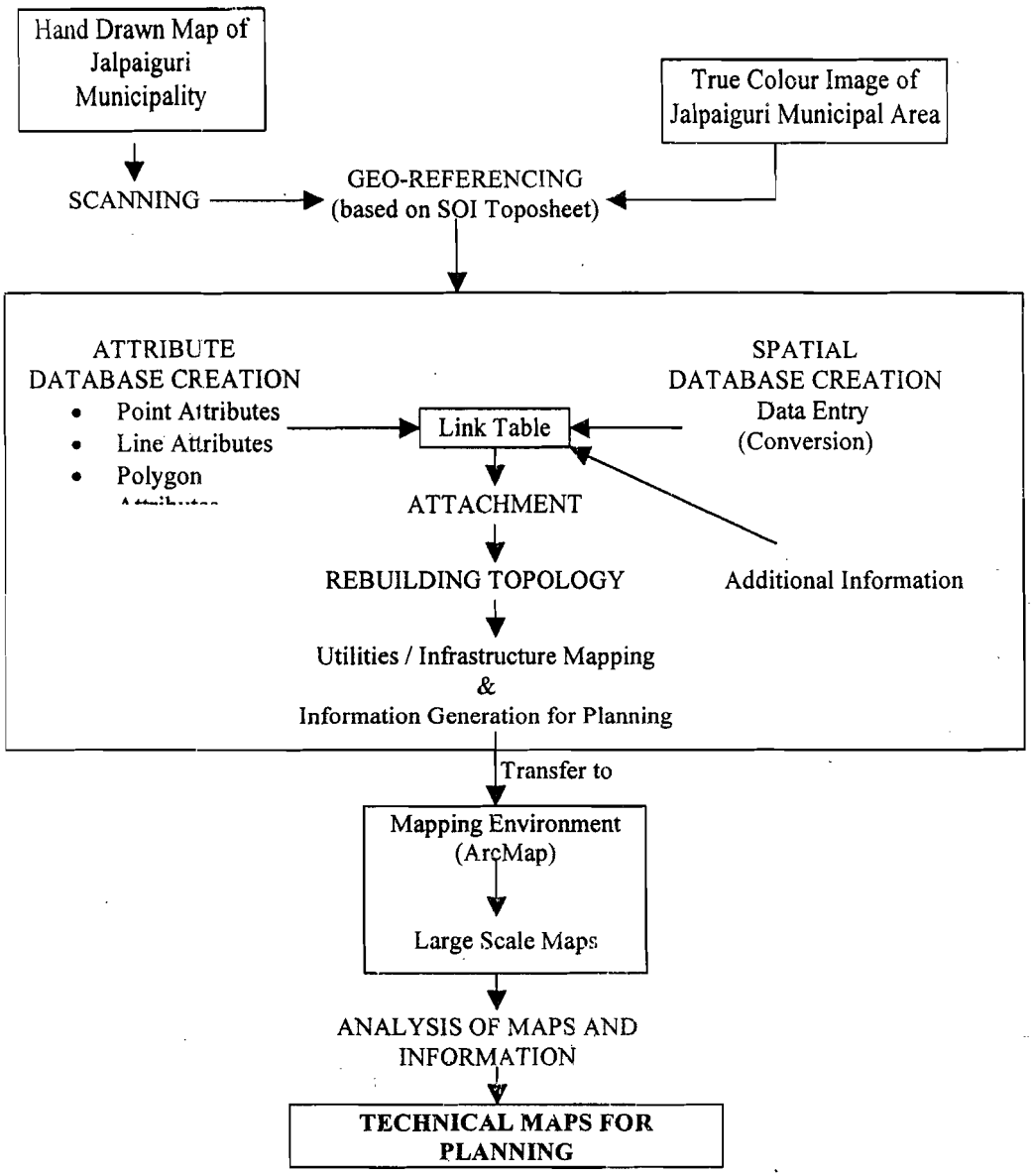
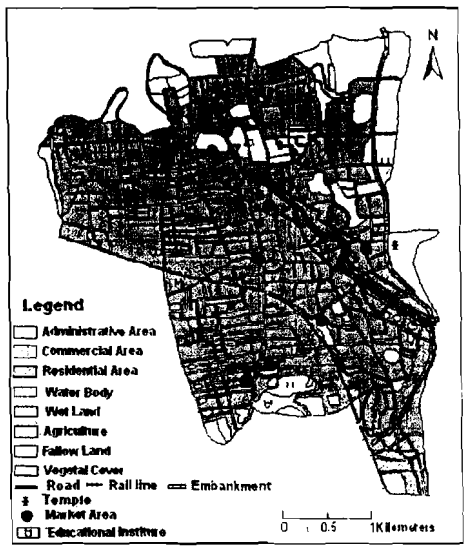


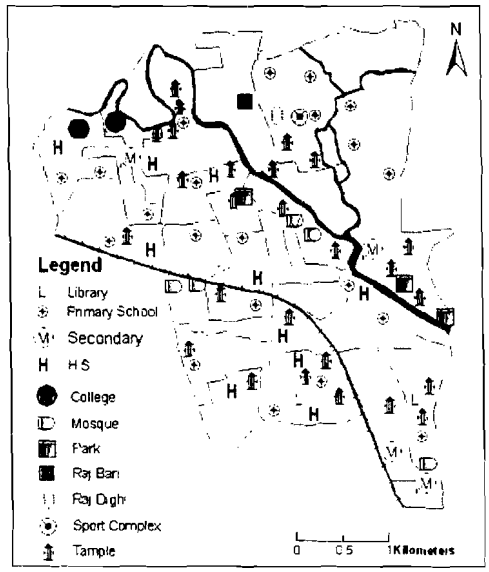
Fig. No.- 2: Flow Diagram of Methodology Followed

with (Map Nos. 1,2,3,4, 5 and 6).

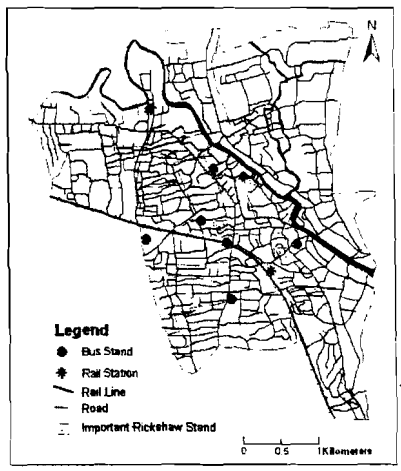
Lastly, upon establishment of linkages among the databases, it became possible to manipulate (selection, combination etc.) and analyze (overlaying, mosaicking, buffering etc.) the database [3]. The results of such manipulations and analyses can be used to compose highly technical maps that are essential for decision making and implementation of plans. Few examples of such maps are given here with (Map Nos. 7, 8, 9 and 10).



Map No. 1



Map No. 2



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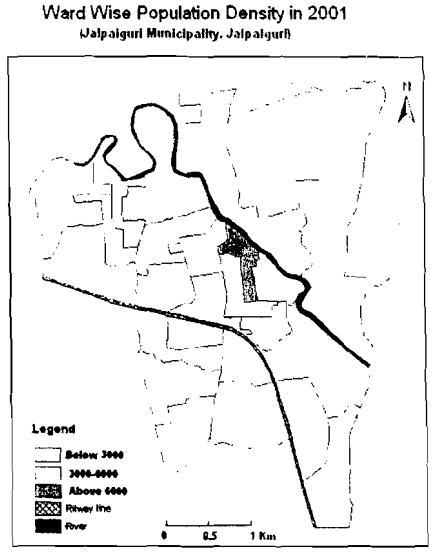
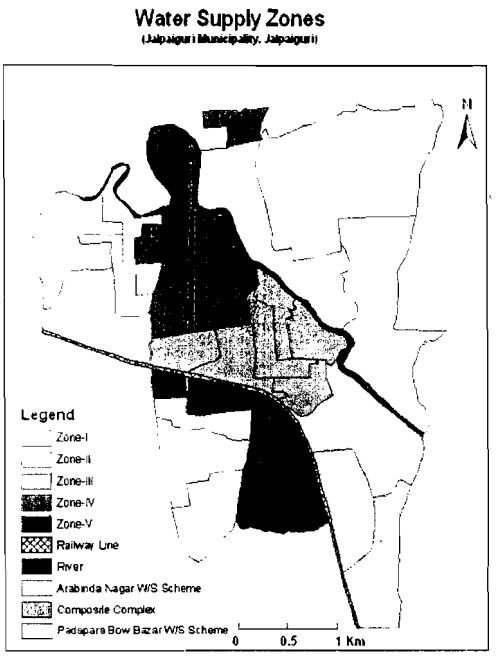
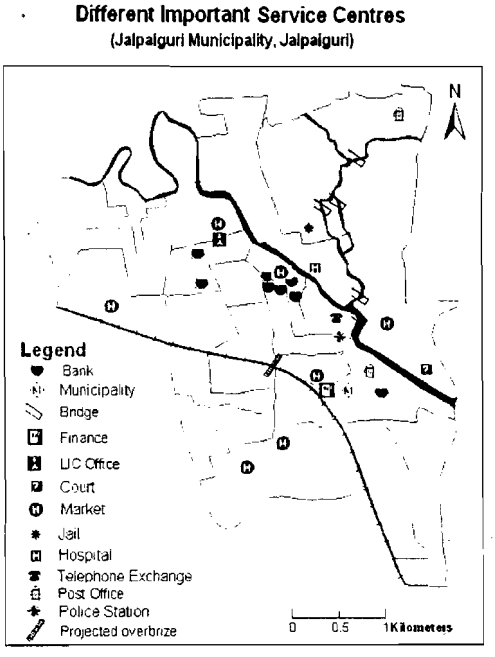


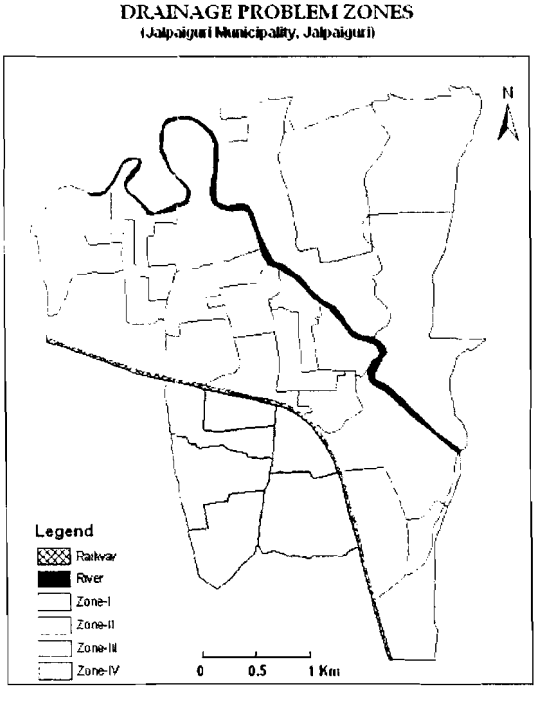
Map No. 4



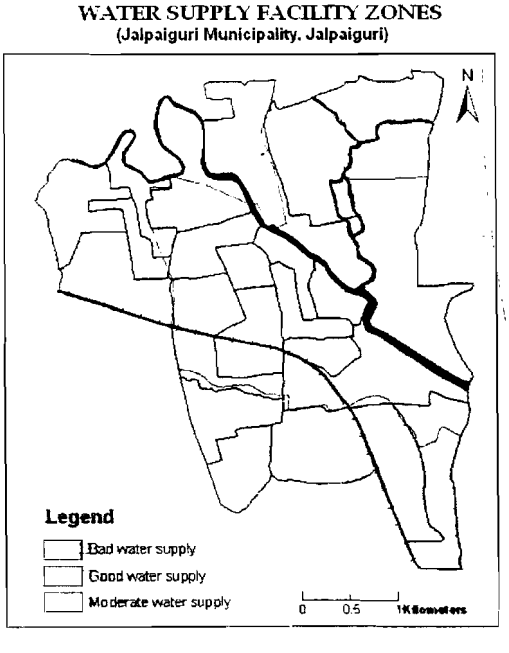
Map No. 5



Map No. 6

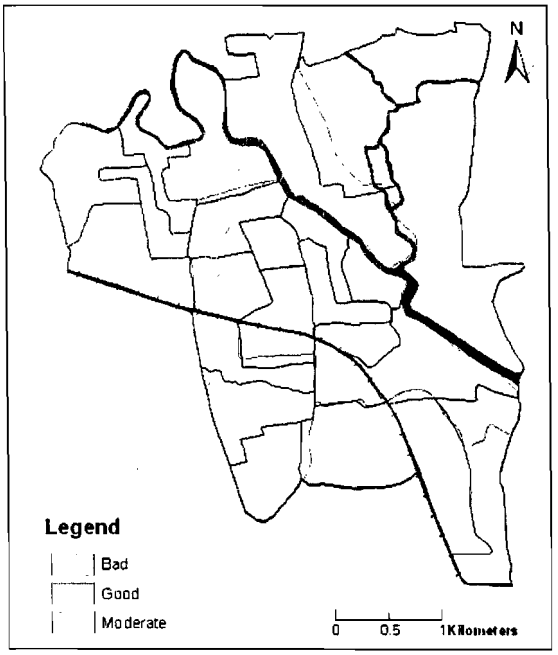


Map No. 7

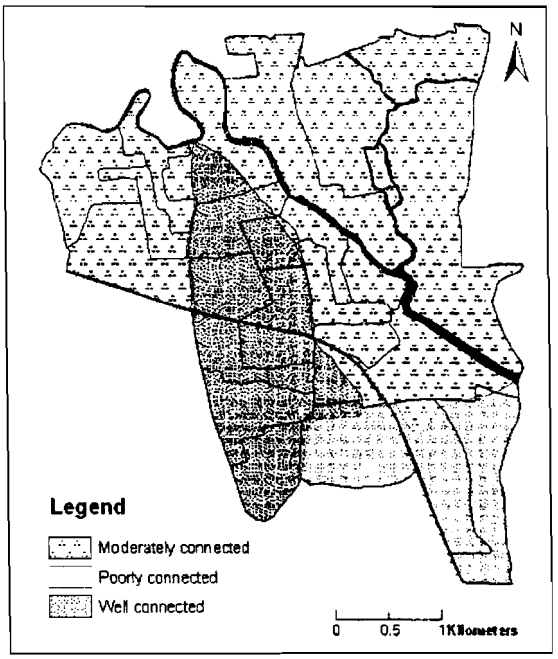


Map No. 8

Map No. 9



Map No. 10



6.4 Recommendations:

Analysis of database and maps has led to recommend the following steps to be taken for mitigating the identified problems of Jalpaiguri town.

- Embankments are to be elevated (at least up to 1 m) and strengthened and more embankments are to be constructed.
- Dredging along Karala and Panga is an urgent need.
- Diversion of Karala flood discharge.
- Protection of wet lands and water bodies.
- Construction of wide and deep drains.
- Karala river water to be used for drinking water supply that requires diverting water flow into Karala behind Tista barrage and convey it through water pipes to treatment plants before distribution
- Network of underground sewer lines to convey household effluents up to swage treatment plants before discharging them into Karala.
- Traffic flow management through planning and signaling system.
- Restriction to be brought in licensing para-transits.
- Restrict parking to terminals or specified locations.
- Development of bus terminus at Beguntari more, Post Office more, Ghoomti no-3, Merchant Road etc.
- Public facility centres to be installed at the fringe areas.

7. Conclusion :

Rapid rate of urbanization has emerged as a serious concern in the developing countries like India. Urban problems are gradually becoming more grave and multi-dimensional even in the small village towns like Jalpaiguri. Unprecedented growth of urban population along with inclusion of marginal areas under the municipal command in the form of urban sprawl and large scale congestion in the heart of urban centres without leaving vacant space have many folded the complexities of municipal activities. Therefore, need for largely automated systems and advanced MIS applications on PCs are expected to become unavoidable in near future. The shift from the existing manual mode of record keeping to MIS-based automated system should be executed in a cost effective approach without considerable loss of data. But if the desired conversion can be accomplished once, it will help the municipal authorities in four different ways viz. monitoring of major spatial developments within the

urban area by the use of geo-statistical methods; extrapolation and evaluation of alternative planning options; taking decision on the best option considering all its impacts and production of planning maps; and building capacity to store and analyze proposals submitted by developers or service providers. Therefore, municipal organizations, irrespective of their scale of activities, should immediately develop and adopt Municipal Information System because they should realize that *information is capital and future is digital.*

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Critical Analysis of the Causes for Flood at Lower Silabati Watershed, Paschim Medinipur , West Bengal

Suparna Choudhury[1] and Ramkrishna Maiti[2]

Abstract

Flood can be visualized as a result of breaking in systematic relation between input and output of both sediment and water in a drainage basin. The temporary storage of water and sediment at favorable parts of the basin is possible where input-outweighs the output and thus by incapacitating the streams flood happens. The heavy rain concentrated to few monsoon troughs and hydro-geomorphic as well as landuse conditions leading to almost same time of concentration from all the tributaries along radial routes to the central section at Ghatal , Paschim Medinipur , West Bengal cause flood almost at every year.

Keywords : Flood; Rainfall; Discharge; Time of Concentration

1. Introduction

Fluvial process, the most important geo-morphological system operating on the earth surface, is involved in transferring the water and sediment on slope through the channel network. Flowing water into rivers lay more imprints on the watershed or floodplain from geological past to recent time (Morisawa,1985). Flood, the inescapable hydrological phenomena, leads to inundation or submergence of land or strip of surface which is adjacent to the river channel and occupied by the inhabitants, the floodplain. So the occupants had always to cope with floods(Bedinent et al.,2008 and Benedict et al.,2008). In the fluvial hydro-system, the river basins , river channel and floodplain are the three main elements which are bound together by three dimensional , time dependent exchange of matter and energy which determine the ecological system with its interactions and successions (Benedict et al.,2008; Chattopadhya,2007; Mukhopadhya,2007). So the main channel and the floodplain are inseparable. The present work concentrates on the Silabati catchment, extending from the

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Hurra of Purulia district at north to Bandar at eastern part of Hooghly district at in West Bengal, where the river Rupnarayan emerges from the combined flow of Darakeshwar and Shilai. The flood plain area is stretched from 22°30′N –22°55′N and 87°15′ E- 87°47′E covering seven blocks viz. Garbeta-I, Chandrakona-I, Chandrakona-II, Ghatal, Daspur-I, Daspur-11 and a considerable parts of Keshpur. The present work aims to analyse the morphometric, hydro-geometric as well as landuse characteristics of the concerned drainage basin in relation to the climatic phenomena responsible for occurrence of extreme floods of certain recurrence interval.

2. Materials and Methods

Hydrographic survey is made to measure velocity and cross sectional area as well as wetted perimeter following Charlton,2008. Water samples are analysed to assess density and volume of suspended load. Gauge heights are recorded and analysed in relation to rainfall intensity. Rainfall analysis is done following Thiessen polygon method (Raghuath,1995). Land use analysis is done by supervised classification of LISS-III Imagery taking sufficient training sites for ground truth verification. Secondary data have been collected from Paschim Medinipur Irrigation Office, Sub-Divisional Irrigation and Water Way Office, District and Sub divisional Agricultural Office, District Collectorate Office, Bureau of Applied Statistics, Census book of India, Medinipur District Gazetteers, and related research farms and block offices. Maps and Imageries, used in the study are collected from Survey of India, N.A.T.M.O. and Block Offices, N.R.S.A. Balanagar-Hyderabad. The runoff efficiency as well as time of concentration of water in the channel are estimated following Runoff Curve Number Method of USDA, 1972 (Hand Book of Hydrology, 1972, Tiwary et al.,1991, Slack ad Welch, 1980).

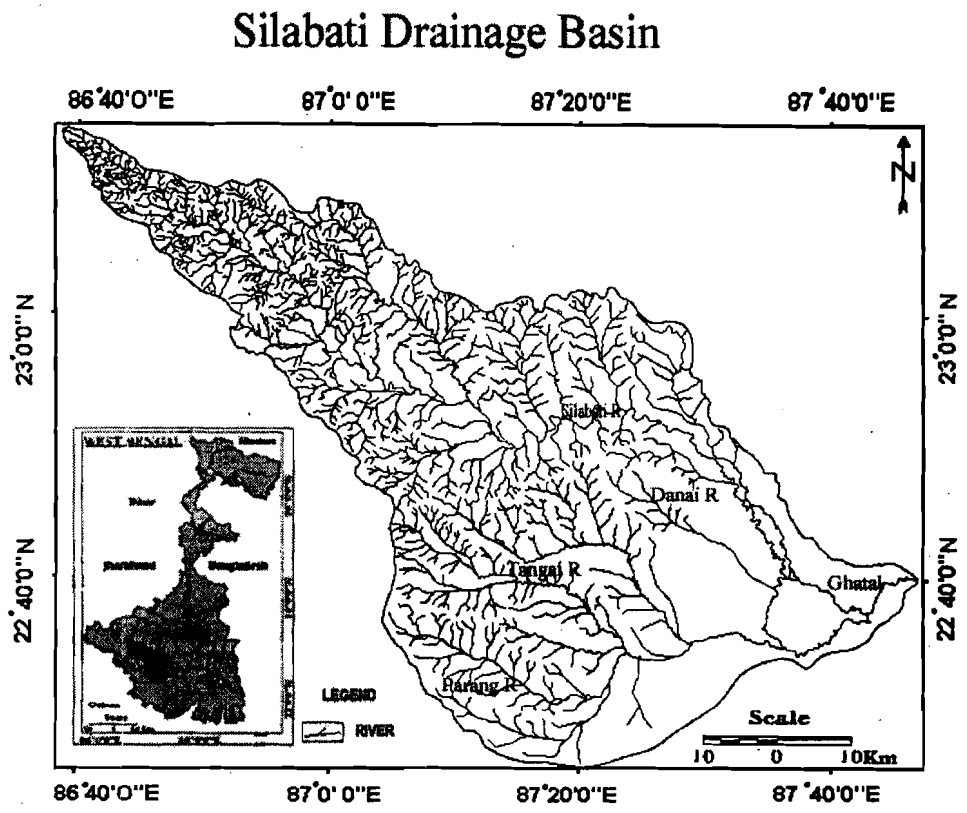

Fig. - 1

3. **Result and Discussion**

Daily rainfall records are of paramount importance, when performing hydrological investigations at a daily or monthly time scale. Theissen polygon is well documented interpolation technique to determine the spatial distribution of daily rainfall from rain guage positions by identifying areal significance to point rainfall values. In the Silabati river basin , we get non –uniform distribution of rainfall at various rain guage station from purulia district to district of paschim medinipur over the basin area, the stations are plotted on the map and are connected by straight lines to its nearest neighbor point. Perpendicular bisectors are drawn to form polygons. Mean areal depth of precipitation is 23.99cm (Table-1).

SL NO	Name of the station	Rainfall record in cm (P1)	Area of influential polygon (A1) .Km^2	Product A1P1	Mean area-depth of rainfall(cm)
A	Medinipur	15.45	198.5	3066.83	
B	Jhargram	25.2	274.3	6912.36	
C	Pingla	28.45	127.5	3627.38	
D	Khirpai	27.52	220.75	6075.04	MADR=ΣA1 *P1/ΣA1
E	Sabang	21.96	70.5	1548.18	=81862.16/ 3412.30
F	Keshiary	29.82	57.5	1714.65	=23.99
G	Garhbeta -I	20.11	492.75	9909.20	
H	Garhbeta -II	19.54	227.5	4445.35	
I	Keshpore	23.48	185.5	4355.54	
J	Ghatal	33.33	238.0	7932.54	
K	Tuswama	30.36	122.25	3711.51	
L	Bankura	21.85	387.75	8472.33	
M	Fulberia	29.18	242.50	7076.15	
N	Rangagora	32.48	176.75	5740.84	
O	Kharidiha	18.64	390.25	7274.26	
	TOTAL	ΣP1=377.37CM	ΣA1=3412.3	ΣA1P1=81862.16	

Table-1; Mean Area-Depth of Rainfall

Rain Frequency is the percentage of years during which the given magnitude of rainfall may be equaled or exceeded. From the analysis it is found that mean and median rainfall values of the available past 38 years' rainfall are 1450 mm and 1100mm respectively. The probability of the rainfall frequency shows that with F=20%, at 5 years recurrence interval, the magnitude of rainfall may be 1475mm, with F=5%, at 20 years recurrence interval rainfall magnitude may be 2050mm and with F =2%, at 50 years recurrence interval, rainfall magnitude will be 2400mm(Fig.-2).

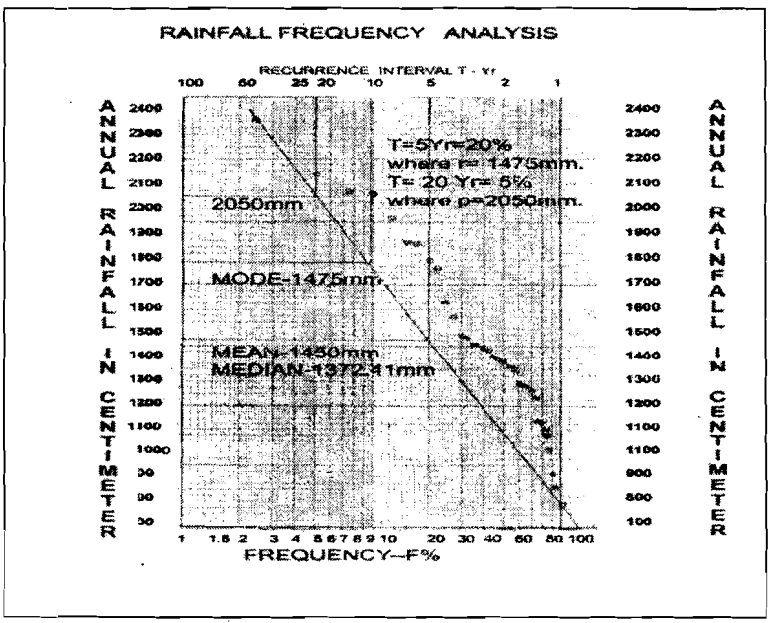

Fig.-2; Rainfall Analysis

Apart from the huge rain input in the concerned basin, it has to accommodate huge discharge from the neighbours like that of the Damodar and Kangsabati during heavy down pour. Sudden discharge, released from the reservoirs constructed on Damodar and Kangsabati, flows over a wide downstream section of adjacent basin crossing less elevated and gentle divide at lower catchment. The heavily silted reservoirs have to release a huge amount frequently (Table-2) and the incapacitated stream cannot bear this overburden that results in over spilling.

Year	Kangsabati in cusec	Damodar valley corporation in cusec	Others in cusec
1993	60000	95000	135000
1994	65000	45000	22000
1995	305000	622000	123600
1996	45000	179175	70000
1997	4366863	97000	
1998	128441	202300	
1999	436552	5914300	
2000	45000	636908	
2001	29681	155000	
2002	33000	100000	
2003	20000	50000	
2004	108400	30000	
2005	19000	65000	
2006	926700	1155417	

Table-2; Contribution of discharge from other basins.(Source:-Central Water Commission, Branch Office at Paschim Medinipur)

The calculated time of concentration after USDA (1972); Hand Book of Hydrology, 1972 and Schwab et al.,2002 shows some important results. The concentration time for the Silabati is less due to greater slope than that of the other tributaries. The discharge, collected at the parent stream, takes some time to reach the lower course when contributions from the tributaries are available there. Interestingly due to lower gradient the tributaries at the lower course experience more time of concentration (Table-3) indicating the possibility of concentration of runoff from all the tributaries during convey through the parent stream. The giant tributaries like Parang(9.1%), Danai(7.71%) and Tangai(21.87%) together carries the runoff from a major share(38.68%) of catchment to the incapacitated course of the Silabati simultaneously within a stretch of 5 km. The lag time is almost same for the said tributaries and that shows the potential simultaneous accumulation of peak runoff in the parent stream contributed from major part of the total contributing area. This may be responsible for further concentration and so flood becomes obvious and frequent.

Factor	Rivers				
D= Effective rainfall	Silabati		Parang	Danai	Tangai
	10hr		10hr	10hr	10hr
Length of the river in meter	7500		6000	5000	8750
Run off curve number(N) [SCS-CN(1972,1990)]	90.2		69.5	70	68
Topographic Characters	Length in kilometer	162.5	62.5	27.5	62.5
	Height of source point in m	213	80	100	35
	Height of mouth point in m	10	20	20	20
	Average Watershed Gradient(Sg in m/m)	203/162500	60/62500	80/27500	15/62500
Tc (Time of concentration) (Schwab et al. 2002)		13hr29m	24hr3m	28hr23m	30hr
T_L (Lag time) (Schwab et al. 2002)		8hr5m	15hr2m	17hr2m	18hr19m
Tp (Time of peak runoff) (Schwab et al. 2002)		13hr5m	20hr2m	22hr2m	23hr19m

Table 3; Time of Concentration of Discharge after Schwab et al. 2002.

4. Conclusion

Better functioning of hydro-geomorphic systems in a flood plain is ensured by optimum interaction between the physical and human factors. The high rain input, coupled with gradual lower gradient at the lower reach, favours concentration of discharge in water and sediment sink zone. The tributaries, contributing water from major catchment at the incapacitated section, aggravate the situation. Time of concentration at Parang, Danai and Tangai catchment increases downstream which indicates the possibility of concentrating upslope contribution to that of down stream and this is supposed to be the main cause of frequent flood at lower Silabati catchment. The contribution from neighbours like the Kangsabati and that from the Damodar are also responsible to aggravate the situation. The

wet cultivation is also responsible for high curve number as almost 100 % of the additional rain input drains as the runoff from paddy field. This high and similar runoff potentiality of the tributary catchment due to similar landuse practice is also responsible for heavy discharge being collected to the tributary channels at same duration after rain. The efficient diversion of the tributary contribution, and effective management to differentiate time of concentration may be fruitful for reduction of flood intensity and frequency.

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Assessment of Plant Potential with Relation to Soil Properties in Different Forest Zones of Midnapur and Jhargram Sub-divisions, West Bengal

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Abstract

Forest resources in Midnapur and Jhargram Sub-divisions of West Bengal, India are not only vital to the environment as a whole but also the paramount to large section of rural masses that eke out their subsistence from forests. The district is forest dominant and most of the rural people living inside the forest or near the forest are dependent on forest to maintain their daily needs. In the present study, a critical assessment of the plant growth of a few selected species is done in terms of some reliable physiological and biochemical indices by taking three selected forest zones of the Midnapur and Jhargram Sub-divisions *viz.* Deer Park ; Chandra Park and Gurguripal. The soil characters of the selected forest zones were also analyzed with regard to some reliable physio-biochemical parameters of the soil. Results of the investigation clearly indicates that the better growth of the plant species of a forest zone is related to the properties of soil of the same forest zone at per. The growth of the plants related to the soil properties as well as the geographical location of the area is apparent in this investigation.

Key words: Plant potential; Soil properties; Chlorophyll; Protein; Catalase.

1. Introduction:

Forests are important resources of the Paschim Medinipur district (Midnapur and Jhargram Sub-divisions) in the state of West Bengal, India. The district is covered with about 18.39% of the forest (Anoymous 1974-75, Pari, 2002, Mukherjee, 2003, Upriti, 2003). It is located between 21° 46'N to 22° 57'N and 86° 33'E to 87° 44'E (Fig. 1). The

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district is endowed with the distribution of wide range of different soil. Soil in the eastern segments can be termed under the taxonomic group of Paleustalfs and Haplaquents (known as alluvial soil). Bulk of the western segment soil is regarded Ochnaquelts, Rhodustults and Haplustults (known as red and yellow soil). Plinthustults and Plinthudults (laterite soil) occur in the central zone extending north-south. However, there are scattered occurrences of Haplustalfs, Paleustalfs and Rhodustalfs (red sandy soil and red gravelly soils) throughout the district in considerable proportions (Anonymous, 1984-85, Mukherje, 1995, Whitemore, 1999, West Bengal Magazine, 2006).

The natural vegetation of the forest area comprises mixed forest trees, grasses and shrubs. The most commonly growing and economically important plant species of the forest zones are kendu (*Diaspyrus kaki*; family: Ebenaceae), sal (*Shoria robusta*; family: Dipterocarpaceae) and teak (*Tectona grandis*; family: Verbenaceae) due to their inexpensive utility in commercial purposes. However, over the last hundred years or so, forests are being destroyed by several natural and anthropogenic factors. Damaging of the forests depends on the physio-chemical nature of soil. Depletion of the forest has appreciably impaired the ecosystem of the area which leads to the worst casualty in human life and economy (Shahbuddin and Pasad,2002, West Bengal Magazine,2006). In order to keep the economic benefit of the forest plant species like *kendu, sal* and *teak* along with the damaging or ill developed of the plants in the forest, an attempt has been made to study the nature of soil in the selected forest zones *viz.* Deer park, Chandra and Gurguripal of Midnapur and Jhargram Sub-divisions with related to plant growth and development.

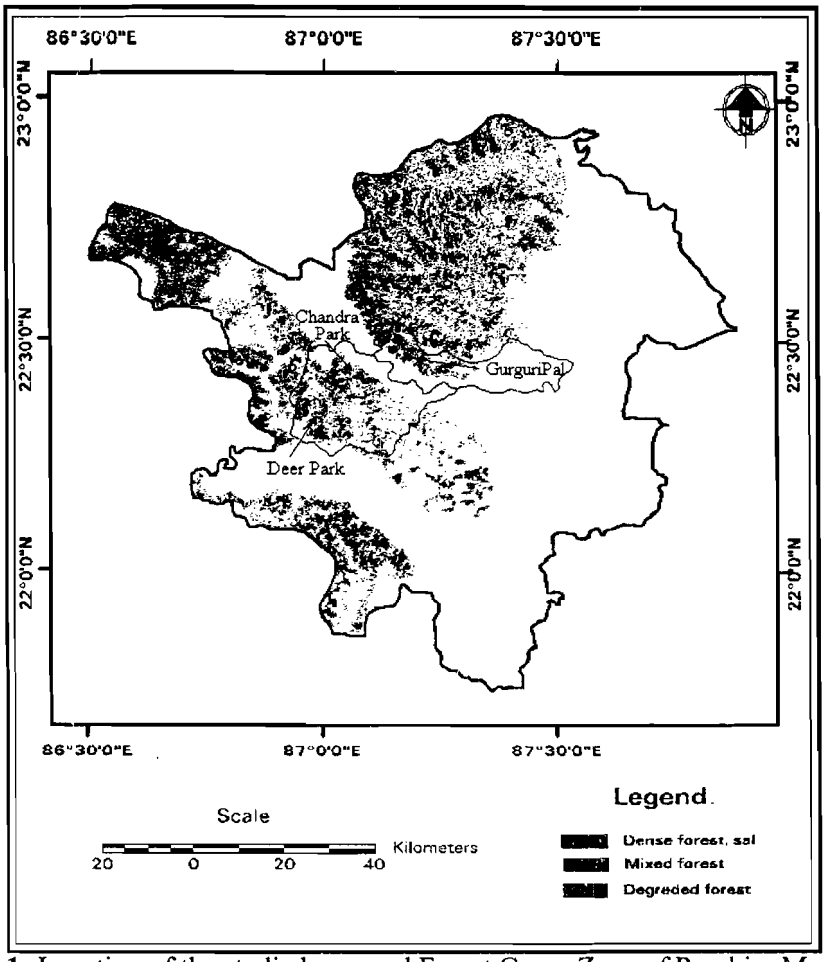

Figure 1: Location of the studied area and Forest Cover Zone of Paschim Medinipur District, 2008.

2. Materials and Method:

The forest zones *viz.* Deer park, Chandra and Gurguripal of Midnapur and Jhargram Sub-divisions were selected as study area (Fig.1).The plant species of the forest *viz.* kendu (*Diaspyrus kaki*), sal (*Shoria robusta*) and teak (*Tectona grandis*) were taken as study materials. To study the nature of soil, parameters like soil texture, color of soil, soil consistence, erodability of soil and soil pH, NPK, EC (Electrical Conductivity), OC (Organic carbon) were analyzed. Soil was collected by avoiding top soil of 20 cm depth from the four different places of each forest zones and the collected soils were mixed well to get an accurate and uniform result. The collected soil samples were dried and 100 g from each sample were mechanically sieved in the laboratory to sort the sediment into different size groups. The sieve sizes used for the analysis were 2mm (upper plate), 1mm,

$5x^{10-1}$ mm, $7.5x^{10-1}$ mm, $0.75x^{10-1}$ mm (bottom plate). The weight of each size groups was calculated in terms of percentage. Statistical analysis was done using Phi (Ø) values. For the present analysis, the weight of the sediment samples less than the 0.075mm sieve size was taken for the silt plus clay group as per Indian standard classification for engineering purpose. Soil color was analyzed using Munsell color Chart and pH and EC of soil was measured using the digital pH meter and digital EC meter. Soil fertility was also analyzed by NPK and OC using Kjeldahl distrilation for Nitrogen (N); Flame photometer for Potassium (K_2O) and UV-VIS Spectrophotometer for Phosphorous (P_2O_5) respectively.

The plant growth was analyzed by taking the leaves of each plant collected from different forest zones. The metabolic changes of plants were analyzed in terms of some reliable biochemical parameters like content of total chlorophyll and protein as well as activity of enzyme catalase by using the digital Spectrophotocolorimeter. Quantification of chlorophyll and protein was done by taking 0.1g of plant materials and as per the method of Arnon, 1949 and Lowry *et al.*, 1951 respectively. Extraction and estimation of enzyme catalase was done by taking 1.0g of plant materials following the method of Snell and Snell, 1971. For assaying the enzyme, the blank was taken zero time control and the activity was expressed as (ÄOD×T/txv), where ÄOD is the difference of OD of the blank and sample. Tv is the total volume of the filtrate t is the time (minutes) of incubation with the substrate and v is the volume taken for reaction (Fick and Qualset, 1975). Data recorded in this investigation were statistically analyzed (Panse and Sukhatme, 1967). In tables, LSD (least significance difference) values at 5% level was incorporated.

Forest Zone	Location	Soil Properties											
		Color	Consistence	Slope	Erodibility	N Kg/hect	P Kg/hect	K Kg hect	OC (%)	pH	EC (Mili mho/cm)	Texture (%)	
												Sand	Silt +Clay
Deer Park	22° 26'53.7"N 87° 00'56.8"E	Grey - brown	Slightly friable	5-7 degree	Slight	965	93	8.9	0.93	4.21	0.022	67.57	32.43
	22° 26'55.4"N 87° 00'52.1"E					876	86	6.4	0.87	4.64	0.023	66.84	33.16
	22° 26'50.3"N 87° 00'57.5"E					820	88	6.9	0.78	5.08	0.028	68.42	31.58
	22° 26' 54.9"N 87° 00'55.8"E					746	89	7.4	0.74	4.80	0.032	67.63	32.37
	Average					**851.75**	**89**	**7.4**	**0.83**	**4.6825**	**0.02625**	**67.61**	**32.39**
Chandra Park	22° 28'10.4"N 87° 08'59.3"E	Grey	Stickly	2-3 degree	Moderate	728	83	5.6	0.78	4.79	0.027	65.77	34.23
	22° 28'16.6"N 87° 08'52.2"E					735	110	3.4	0.71	5.10	0.028	64.12	35.88
	22° 28'11.8"N 87° 08'49.9"E					784	91	6.5	0.76	5.6	0.037	67.48	32.52
	22° 28'19.6"N 87° 08'57.1"E					805	95	7.8	0.81	4.81	0.035	69.85	30.15
	Average					**762.75**	**94.75**	**5.825**	**0.765**	**5.075**	**0.03175**	**66.81**	**33.19**
Gurguripal	22° 25'58.8"N 87° 12'50.8"E	White-grey	Plastic	1-3 degree	Moderate	842	98	3.9	0.83	5.47	0.035	77.03	22.97
	22° 25'51.1"N 87° 12'41.9"E					710	116	21.9	0.69	5.16	0.063	78.08	21.92
	22° 25'53.6"N 87° 12' 48.3"E					825	91	7.2	0.89	5.10	0.034	79.21	20.79
	22° 25'59.7"N 87° 12'48.4"E					789	84	7.8	0.75	5.07	0.031	78.56	21.44
	Average					**791.50**	**97.25**	**10.20**	**0.79**	**5.20**	**0.04075**	**78.22**	**21.78**

Table: 1. Characteristics of Soil Properties in the studied area.

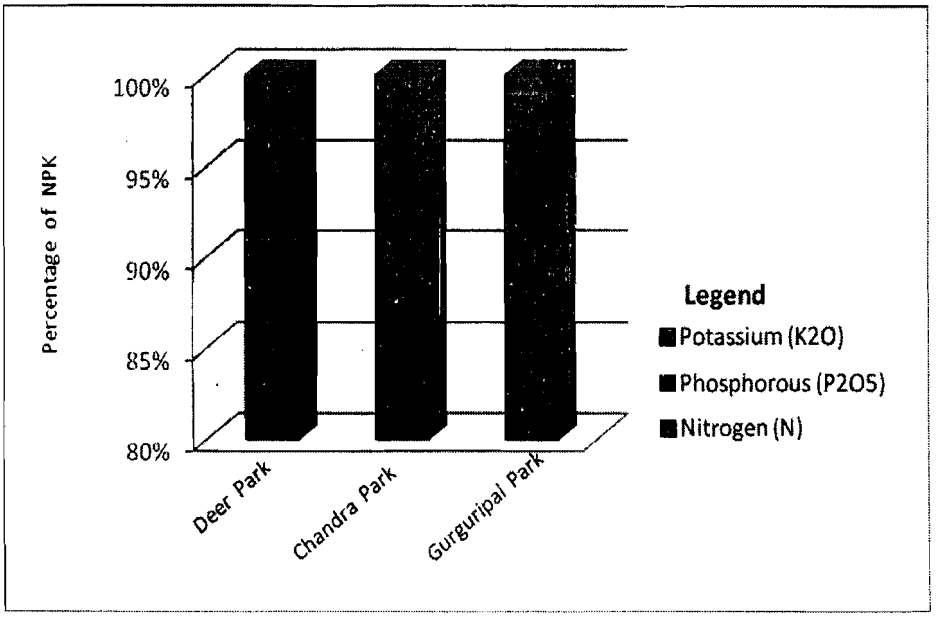

Figure 2: Percentage of NPK ratio of the studied

3. Results and Discussion:

Results of this investigation clearly showed that among three forest zones *viz.* Deer Park, Chandra Park and Gurguripal the former zone is having better soil quality in comparison to other two zones, determined in terms of different parameters of soil analyses (Table 1). Data on soil pH clearly reveals that the soil of Deer Park is less acidic than the forest zones of chandra park and gurguripal. The dear Park zone is also characterized by the contents of much higher percentage of soil organic carbon, soil nitrogen and silt-clay which are the reliable indices to certify the soil fertility (Fig.2). Results on grain size of soil reveal that among three forest zones the former one is having smaller grain size of soil (Table 1). Smaller soil particle indicates the higher water holding capacity which reflects the availability of soil water for better plant growth (Anonymous, 1984-85, Pettijohn *et al.*, 1972, West Bengal Magazine, 2006). Growth status of selected plants in this investigation was also analyzed in terms of some biochemical parameters like total chlorophyll content, protein and the activity of enzyme catalase (Table 2). Results revealed that the plant species growing in different forest zones of the district differ in their contents of total chlorophyll and protein. The remarkable variations in the activity of enzyme catalase in the same plant species under different forest zones are found. Differential result on the activity of catalase indicates the variation of the defense mechanism of the plants under different forest zones.

Different forest zones	Kendu			Sal			Teak		
	Chl.	Pro.	Cat.	Chl.	Pro.	Cat.	Chl.	Pro.	Cat.
Deer Park	12.13	78.19	58.00	13.10	82.15	73.198	12.90	84.00	64.17
Chandra Park	11.98	74.01	57.03	12.23	81.40	71.03	11.39	82.28	61.92
Gurguripal	11.01	73.95	56.18	12.00	80.01	68.95	10.98	80.93	60.97
LSD (p=0.05)	1.01	2.18	2.04	1.02	1.13	2.75	1.08	1.93	1.38

Table 2: Result on analyses of total chlorophyll (Chl., mg/fresh weight) and protein (Pro., mg/fresh weight) contents as well as activity of enzyme catalase (Cat., ÄOD× TV/txv) in leaves of the experimental plants.

Numerous reports exist in the literatures which indicate that chlorophyll and protein maintain normal functional life of plants. Optimum level of these vital macromolecules of a particular plant species indicate the vigour status of plants (Basignano *et al.*, 2002; Pati, 2007). Catalase is regarded as scavenger enzyme and higher activity of this enzyme is

indicative of plant vigour (Fridovich, 1976). Considering all the biochemical parameters of plants analyzed it may be concluded that the better soil quality of a particular area indicates the better growth of plants as well as better vegetation of that area. The potential status of the experimental plant species in relation to soil characteristics of the studied forest zones are apparent in this investigation.

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Water Resources of the District of Bankura and their Utilization

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Abstract

Hydro-meteorologically the district of Bankura is said to be a water deficit (i.e. annual total precipitation is less than that of evapo-transpiration) district of West Bengal. Being situated in the southwestern part of the state, the district of Bankura is, in general, designated as drought-prone (Jana and Das, 1987). This is because the nature of rainfall and other factors of water resources development of the district is such that it experiences severe water scarcity during the summer months when rainfall is almost absent, although average annual total rainfall of the district is 1364 mm which is more than that of a semi-arid region. But the seasonal and annual actual rainfall totals are very erratic that results in sever water crisis in some years causing hardships to agriculture and other activities of the district.

Keyword : Precititation; Drought; Water Potential; Irrigation.

1. Introduction

Life without water is unthinkable, and therefore water is considered as a precious natural resource. Water is essential for origin and sustenance of all organisms, and for human beings it has no other alternative. The main use of water to the people at large is quite diverse including agriculture, rearing of birds and animals, industrial, municipal, power generation, cooling, domestic activities, drinking, cooking, cleaning, washing, bathing, fire fighting, etc. But in our country, which is still dominated by rural population, the principal use of water is in agriculture and domestic sectors. With the increase of population and consequent rapid increase of consumption pattern, demand for water is also increasing at an alarming rate. Scarcity of water is felt in many countries over the world, including ours. Although most of the areas of West Bengal lie under humid type of climate, and the state is bestowed with many large rivers, parts of it especially the plateau margins of Purulia, Bankura, Birbhum, Barddhaman, and Paschim Medinipur use to experience drought-like

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situation during the summer months.

2. General information of the study area: the district of Bankura

An isosceles triangular shaped the district of Bankura covers an area of 6882 square kilometers and a population of 3 191 822 (Census of India, 2001) with a moderate density of 464 persons per square kilometer second lowest (after Purulia) in the state of West Bengal. The district has diverse geo-environmental characteristics in respect of its land, climate, soil, land use/ land cover, and population. Being located almost at the center, Bankura town is the head quarter of the district. More than 92 percent of the district population lives in the villages. About 49 percent area of it is under net cultivation, and another 6 percent is cultivable if there is assured supply of water (District Statistical Hand Book: 2006). Most of the people depend on agriculture (of 66 percent of the total workers 31 percent are cultivators and 35 percent are agricultural labourers) the key sector of employment, and rice is cultivated as the principal crop. However, the share of main workers to total population is very low, only 30 percent; and industries employ only 6 percent of the main work force. But the productivity of principal crops like rice, wheat, gram, potato etc. is quite well and the district has ample opportunity in rearing of poultry birds and animal husbandry, cultivation of flowers, fruits and vegetables given suitable infrastructure including water supply is adequately provided, as rain-fed agriculture still dominates a large area of the district. The uncertainty of rainfall very often jeopardizes the fate of the people.

3. The physical set up controlling water resources

Availability of water resources and water potential of a region depend on various physical factors including character and configuration of land, both surface as well as sub-surface, and climate, drainage, soils, vegetation etc. A brief account of these environmental features is outlined as follows:

3.1 *Geology and landforms*: The district of Bankura lies between the Chhotonagpur Plateau in the west and the great Bengal Plains in the east. Low-lying plains consisting of alluvium occupy the eastern part of the district. In the western part the land is undulating interspersed with rocky hillocks, broken up into low ridges and valleys. In many places the terrain is highly denuded exposing extensive areas of hard rocks, some of which stand as rocky mounds and isolated peaks of granite, gneiss, quartz, phyllite etc. The consolidated rocky formations of the west have very low yield of ground water, while the unconsolidated alluvial formations of the east have relatively more ground water resources.

3.2 *Climate*: Water potential as well as its utilization highly depends on the climatic condition of an area. Climate of the district has resemblance with that of the Chhotonagpur Plateau. By the end of February temperature rises over 33 °C and by March there is prevalence of hot westerly winds. May is usually the hottest month with the maximum temperature around 46 °C. Some afternoons of March to May get showers from Nor'westers associated with thunder and lighting. Monsoon rains occur during mid-June to mid-September with a drop of temperature by about 7-10°C. Winter prevails from the end of October to February. The minimum temperature is usually recorded in the month of January with an average of about 5°C. The range of annual temperature is quite high, the mean being 26°C.

The seasonal normal rainfall is less than 10 centimetres from November to January, and between 15-20 centimetres during February to May, after which there is a rapid increase of rainfall owing to occasional incursion of cyclonic storms with the monsoon winds. During the monsoon period of June to September the average rainfall is about 110 centimetres. July is the rainiest month with a rainfall of about 32 centimetres, while December records the minimum with about 1.5 centimetres. However, there are significant variations of this general pattern in different places within the district. The maximum relative humidity is recorded in the rainy season with an average more than 80 percent, and the minimum is recorded in the summer months with the average of about 50 percent, when many places of the district experience scorching heat waves. The winter is excessively cold and mostly dry due to incursion of western cold winds from the north and northwest.

3.3 *Drainage systems*: The district of Bankura is drained by the river Damodar (19.7 percent area) on the north and is intersected by the rivers along with the tributaries of Dwarakeshwar (35.6 percent area), Silabati (26.52 percent area) and Kangsabati (18.18 percent area) from northwest to southeast roughly parallel to each other. The typical climatic conditions and character of terrain are responsible for their non-perennial character. During the rainy season these rivers use to carry huge water and silt, sometimes quite rapidly due to greater slope and low infiltration, causing sudden floods, locally called *hoorpa ban*. During the non-rainy months most of the rivers and their tributaries remain dry because of almost no supply of water from sub-surface areas. Besides, the river systems the district is dotted with many man-made ponds and dug wells, tube wells etc that contributes a lot in maintaining the water balance of the district. Some natural pools or swampy areas along the river Damodar

and Silabati have been formed due to overflowing of the rivers during high floods, and are locally known as *asur panj* (foot prints of demon, e.g. *Bakasur*). Springs are also common in the upland plateau fringe areas (e.g. Susunia Hill). Occurrence of artesian well is another important feature of water resources of the district, especially found along the river Silabati and Joypanda, caused by considerable rising of water table in locally existing shallow aquifers (Chakladar, 1991).

3.4 *Land, Soils and vegetation*: Traditionally the land of Bankura district is classified into the following four groups, in order of their increasing trend of agricultural suitability, namely *tanr* or *danga*, *baid*, *kanali* and *bahal* or *soal* according to their elevation, moisture conditions, character of soil, soil productivity etc. The western highlands of the district are composed of well-drained lateritic, sandy and sandy loam. The soils of the eastern part are relatively more fertile having more moisture in them for cultivation of crops at least twice a year. Mixed forest vegetation dominated by sal trees (*Shorea robusta*) perhaps once densely covered the entire lateritic belt of the district (O'Malley, 1908), but today they are reduced to coppice. Since the western part of the district is vulnerable with deforestation, extension of agricultural practices and intensive grazing on a greater slope of land, there are the risks of low infiltration, reduction of ground water, soil erosion and degradation under heavy monsoon showers followed by drying up of the soil surface during the summer months resulting in desiccation of plants. The eastern part, of course, a comparatively small area experiences siltation, choking up of the drainage channels and flood.

4. Water resource systems and their potential in the district of Bankura

Estimation of water potential of surface, underground and re-usable, in terms of both quantity and quality is essential for the purpose of management of this scarce resource. Water potential is defined as the availability of water at a time for various human usages. More specifically, water potential is the actual amount of water that can be developed with the help of contemporary technical know-how to meet human demand for it (Water Forum, 1992). The term gross water potential is sometimes used to denote all water that fall in any form of precipitation; whereas net water potential is a part of it that is actually available for human requirements. The latter one comprises both surface and sub-surface water of a geographic area.

4.1 *Precipitation characteristics:* A rainfall record of about fifty years (1950-2001) shows that the average rainfall of the district if about 1360 mm, and co-efficient of variation of annual rainfall is about 15 percent; but the range of annual total rainfall is

quite high as in 1980 it was only 778 mm, while in 1995 it was 1616mm. Seasonally, July is usually the rainiest month with an average rainfall of 314 mm, while December is the month of least rainfall being only 3 mm. The co-efficient of variation of spatial rainfall in different areas of the district is about 8.07 percent. However, this average pattern is disturbed due to the presence/ absence of storms and local atmospheric circulation systems, e.g. Nor'westers, Tropical Cyclones, Western Disturbances etc in a particular year or season.

4.2 *Soil-atmospheric water balance*: An estimation of consumptive water use (Subramanium and Uma Devi, 1979) for the agro-meteorological station at Bankura shows that there is an annual soil moisture deficit of about 500 mm although the pluvial deficit (Potential Evapotranspiration minus Precipitation) is only 40 mm. However, due to the nature of concerned land and land-use/ land-cover 465 mm water is drained away as surplus.

4.3 *General land use and status of irrigation*: In all three sub-divisions, namely Bankura Sadar, Khatra and Bishnupur of the district of Bankura, net cultivated area accounts for the maximum percentage of area, the average of which is about 42 percent. This is followed by forests; settlements, roads and other non-agricultural use; fallow and barren lands, grazing lands and culturable wastes. Every year a sizeable area is left as current fallow for the dearth of water, otherwise that could be cultivated. Rice is the principal crop followed by wheat, potato, pulses and oilseeds. The cropping intensity is quite high in the eastern part of the district especially in Bishnupur sub-division because of availability of irrigation from surface as well as underground sources. In the western part of the district i.e. in Khatra and Bankura Sadar sub-divisions cropping intensity is low due to dominance of rain-fed cultivation. The present land use pattern requires about 500 thousand hectare metre of water. To bring all cultivable areas of the district for at least two crops requires more water.

A look into the crop calendar in reference to the seasonal soil-atmospheric water balance reveals that almost all of the soil moisture is utilized for the cultivation of rabi crops, which are highly irrigated. Thus the following crops like boro and aus paddy, jute, sugarcane, oilseeds etc are very much affected not being provided with required irrigation. Chances of failure of these crops are very high. The uncertainty of monsoon becomes detrimental to the kharif crops too.

5. Water potential and its development:

With the development of various irrigation projects the district of Bankura has got substantial

water resources potential both surface and underground. A physiographic zone wise water potential estimate (table-1) shows that the district has a total water potential of about 524 thousand hectare metre from surface and 270 thousand hectare metre from underground sources. It is found that with the decrease of elevation water potential increases towards the eastern part of the district.

Physiographic Zone	Area in '000 hectare	Mean rainfall in m	Mean fluctuation of water table in m	Net water potential in '000 hectare metre			Water Potential Index hectare metre per Sq. Km.
				Surface water	Ground water	Total	
Consolidated rocks: elevation >150 m	124	1.30	7	103	26	129	104
Semi-consolidated: elevation 100-150 m	259	1.35	6	207	63	270	104
Unconsolidated Laterite & Alluvium: elevation 50-100m	247	1.40	7	170	139	309	125
Unconsolidated recent Alluvium: elevation <50m	58	1.45	10.5	44	42	86	148
Total	688	-	-	524	270	794	115

Source: Calculated by the author based on Goswami, A. B. (1997) using various methods

In terms of utilization water resources it is found that agriculture is the principal sector of water consumption. Canal irrigation accounts for the largest coverage followed by tank and lift irrigation, and wells and tube wells. However, it is to be noted that the western part of the district do not get all these facilities, and surface irrigation systems have seasonal limitation of availability of assured water. Therefore, the farmers rely more on wells and tube wells especially in those areas where intensity of cropping is more as in Bishnupur sub-division of the district. During the last two-three decades there has been significant increase of tube well, both shallow and deep, to harness under ground water of the eastern plains of the district. This has created lowering of the ground water table more than 15 metre in areas during the summer months, causing drying up of the shallow tube wells supplying drinking water in the villages. A statistical analysis (Satpati, 2004) based on correlation co-efficient study of different parameters, e.g. population, intensity of cropping, irrigation, fluctuation of water table, precipitation, etc. related to water resources development, shows that the Community development Blocks like Joypur, Kotulpur, Sonamukhi, Indus etc. have already

scored very high in this respect leaving behind other parts of the district. Contrarily, development of water resources is very poor in northwestern and southwestern parts of the district.

6. Domestic and personal use of water

According to the recommendation of the World Health Organization (WHO) a minimum of 100 litres per capita per day water is required for various domestic and personal use of water, and in this count a total of about 11680 hectare metre of water should go to the domestic sector in the district. However, from the field experience it has been observed that most of this personal water used in a recycling manner. Since washing, cleaning, bathing including of domestic animals is mostly done in the stagnant water bodies like ponds or similar reservoirs and sometimes on flowing water of rivers and streams the quality of water is very often degraded. Excreta of human beings and of animals pollute water with high concentration of coliform bacteria, especially during the dry periods when the volume of surface water is low, and also in the early rainy seasons when the pollutants are washed out into the overland storages. Industrial pollutions are rather low because of low industrial development in the district, but water is contaminated through excessive use of chemical fertilizers and pesticides. All of these are ultimately responsible for various water-borne diseases like enteric, diarrhea, typhoid etc.

7. Conclusion

Given the environmental setup, Bankura is one of the water deficit districts of West Bengal, but the deficiency is not a direct consequence of low rainfall, rather improper management of water resources is responsible for the situation. However, it is to be remembered that in the district the uncertainty of rainfall is quite high that makes development of water resources difficult. Change of emphasis in development of ground water from surface water has created the problems of lowering of ground water table and a general drying up of water sources. It is advisable that rainwater harvesting through various storages should be encouraged in the relatively dry western part of the district, as this will enhance the water potential of the lower plains in the eastern part of it. Cultivation of crops requiring less amount of water like vegetables, corns, fodder may be practiced instead of growing three rice crops to reduce demand for water in agriculture. Development of surface water resources should get priority in agriculture and related sector, and utilization of ground water should be restricted in domestic sector only. This conjunctive use will definitely augment water resource potentiality of the district with a

future water security under hygienic water environment.

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Types, Nomenclatures, and Socio-Economic Signaficances of Pre-British and Britsh Period Coastal Embankments in Purba Medinipur District, West Bengal

Abhay Sankar Sahu

Abstract

Since time immemorial coastal embankments are very significant. They are constructed along the rivers, canals, creeks, estuaries, and seas to protect the coastal lands against the saline tidal and floodwater intrusion. In the district of Purba Medinipur of West Bengal in India different types of embankments are found from the historic past. In this paper an attempt is being made to evaluate the types, nomenclatures, and socio-economic significances of pre-British and British period coastal embankments in Purba Medinipur district. Classification and recording of embankments were started at first in the British period in a regular way. Hunter ([1876] 1997), Inglis ([1909] 2002), Harrison ([1909] 2002), O'Malley ([1911] 1995) and others observed and classified the embankments based on their location and purposes behind their construction. But unfortunately they did not follow the same nomenclature. Nomenclatures are very significant to understand the scale and dimension of their chorological distribution, and sometimes interrelationship with the environment. From their description it is clearly observed that the water-front coastal embankments were significant from the socio-economic perspectives. In the pre-British period they were constructed in a haphazard manner to protect the agricultural lands. Local landlords had constructed those embankments usually for the benefit of their subjects. Thereafter, in the British period coastal embankments were constructed and maintained in a regular way where the basic aim was to collect more revenue from the people. A field survey has been undertaken to observe the embankments and to assess how they were significant in the pre-British and British periods. Government reports and records helped the present author substantially to reach the conclusions presented in this paper.

Keywords: Coastal embankment, Pre-British period, British period, Embankment types, Coast, Flood, Socio-economic environment, Agriculture protection

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1. Introduction

Simply coast is considered as the intermediate zone of land and water. An embankment is conventionally defined as an artificial earthen and/or concrete mound built to support a road and to control movement of water. Constructions of embankments help the settlers in the coastal areas for their livelihood. With the growth and development of settlements and socio-economic activities like agriculture, fishing, industry, tourism etc. in the coastal areas coastal embankments become significant.

In West Bengal with changing politico-economic systems over *longue duree* the aim and objective behind construction and maintenance of embankments have been being changed continuously. In the pre-British period, environmental set up of the sea-front areas was extremely uncomfortable. With the retreating sea-front towards the south, new *char* lands were grown therein. The present day manifestation of the coastal portion of Purba Medinipur district is the outcome of fluvio-tidal and coastal processes. From the historical records it appears that once the Medinipur coast extended further inland. Tamluk was once located on an island near ocean. There are geological evidences that the sea had constructed Moyna basin, Pingla basin etc. by retreating towards south. Saline water prone rivers, creeks, and the Bay of Bengal had regularly flooded the adjoining low-lands. There maximum areas were depopulated. Hundreds of rivers and creeks made the south Medinipur coast poorly communicated with the other parts. In the pre-British and British period, low-lying Purba Medinipur coastal areas were characterised by shifting channels and avulsion of the rivers and tidal creeks. Inundation by tidal water was a normal process in the physical environmental system therein. These areas also fell in the path of tropical cyclones originated in Bay of Bengal. Intrusion of tidal water and saline floods got intensified during these tropical cyclones. Procreation of coast on the one hand, and coastal erosion on the other, were significant coastal processes there. Now this environmentally fragile tract is an agriculturally prosperous area since the pre-British period. Therefore, coastal rivers, creeks, and canals overlooking Bay of Bengal had to be embanked to protect riparian lands from the saline tidal water intrusion and flood occurrences.

2. Objective

The present paper attempts to review the types, nomenclatures, and socio-economic significances of pre-British and British period coastal embankments in Purba Medinipur district of the state of West Bengal in India.

3. Study Area

Here the Purba Medinipur district has been considered as the problem area. At present the latitudinal and longitudinal references of Purba Medinipur district are as follows: 21° 36′ N to 22° 30′ N and 87° 30′ E to 88° 12′ E. For our convenient study on coastal embankments we have considered a long stretch of coastal areas in the south and eastern portion of the district of Purba Medinipur as the study area (Figure 1). It is delineated by the West Bengal state border on the west. On the south, there is Bay of Bengal. Hugli and Rupnarayan estuaries have formed the eastern boundary of the study area. Orissa coast canal form the north-west of the study area continues toward east forms part of the northern boundary. Hijili tidal canal and Haldi river form the central north boundary. Moyna and Tamluk with their block boundary form the north-eastern boundary. There are 17 blocks. These are Moyna, Tamluk, Nandakumar, Mahisadal, Sutahata, Haldia, Nandigram I, Nandigram II, Khejuri I, Khejuri II, Kanthi I, Kanthi II, Kanthi III, Ramnagar I, Ramnagar II, Egra I, and Egra II. All these blocks are characterised by different types of coastal embankments with considerable lengths. There are sea-front, river-front, estuary-front, tidal creek-front, and canal-front embankments.

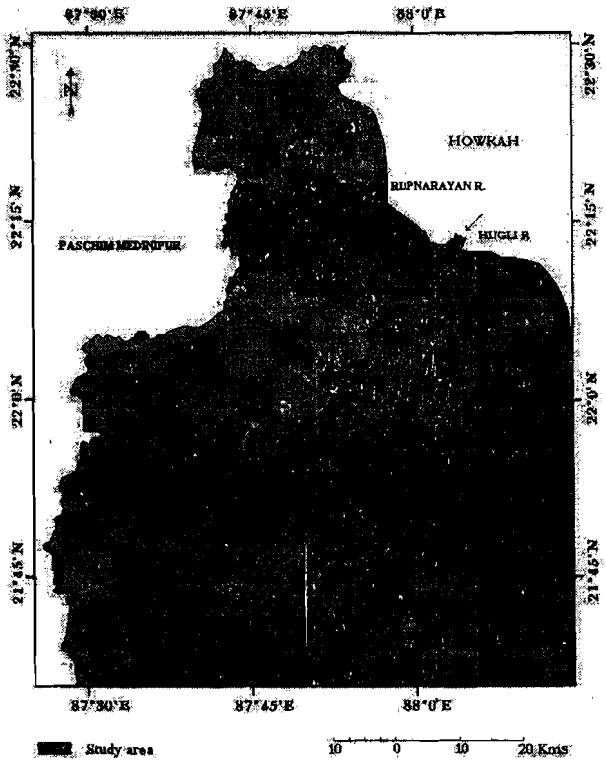


Figure 1: District Purba Medinipur and the study area

4. Database and Methodology

It is a study primarily based on secondary information from the government reports and records. Thereafter, a field survey was followed to examine the collected information. Some local people and academicians of different fields were interviewed also. Along with the government reports and records different books, souvenirs, and maps are also taken into consideration for the current study. One figure is prepared to corroborate the observations. Considering the uniqueness of the study area it is an attempt to develop generalisations on the types, nomenclatures, and socio-economic significances of the pre-British and British period coastal embankments. In a social science study it is difficult to sever social issues from the economic issues to evaluate socio-economic significances. Therefore, parameters to examine socio-economic significances of the coastal embankments are taken together as follows: agriculture protection, protection from coastal floods and tidal effects, irrigation, transport and communication, and revenue collection.

In this paper significant Bengali terms are used with their English meaning to corroborate the original sense of the term in the pre-British and British period. Some of the British scholars used the original contemporary Bengali terms in their description as they had collected. The term *Bundth* refers to the embankment. In Bengali b*undth* is often loosely used also for cross-dams, reservoirs etc. *Khal* refers to the canal. *Zamindar* means local landlord.

5. Classification of 1839-40

In the *Embankment Committee's Report* of 1839-40 (No. - 155, dated - 31.01.1839 and No. - 402, dated - 07.08.1839) of the British government embankments of Tamluk, Mahishadal, and Hijili were classified and designated by the local Bengali nomenclature. Here the term *Gungoorea bundee or Buheberee* is referred to as those embankments which are situated along the banks of the rivers like Rupnarayan, Hugli, Haldi etc. *Gangoor* means large body of water like river, estuary, sea etc. In the pre-British era these coastal embankments were very significant to protect the riparian lands from intrusion of saline tidal and floodwater. At present also, they are equally significant. *Hasua bundee* are the extension of *Gungoorea* or outer embankments. Such coastal embankments were used to drain rain and tidewater to the large water bodies like rivers. *Khal bundee* embankments were constructed to close the canals on their mouth at the point of their confluence with the large rivers. These were to protect the freshwater within the canals and also to defend neighbouring agricultural fields from the riverine tidal saline water intrusion. That water also is used to irrigate agricultural lands. There is also a term *Khalkundee*. It is made in the period of excavation of a canal.

Kundee refers to highlands i.e. embankments. Lastly, the term *Jalnikasee* embankment refers to those embankments which were engaged to drain the water in the canals and also in the cultivated fields. Thus this classification and nomenclatures of the embankments give a detail to understand their socio-economic significances in that socio-politico-economic environment.

5.1 Hunter's Description on Principal Embankments, 1876

A spatial embankment system of Medinipur (undivided) was estimated by W.W.Hunter ([1876] 1997). His aim was to prepare the *Bengal Embankment Bill* in order to make some provisions for the management of costs of construction and maintenance of embankments. It was published in the Calcutta Gazette on 17.09.1873. These coastal embankments were constructed and maintained mainly to protect riparian lands of rivers and tide prone canals from invasion of saline tidal and floodwater. According to him, nomenclatures of coastal embankments were made by the name of adjoining water bodies and/or places on which the embankments were constructed. In the study area these are Right Embankment on the Rupnarayan river, Right embankment on the Pairatungi *Khal*, Left embankment on the Pairatungi *Khal*, Right embankment on the Gangakhali *Khal*, Birkul Embankment, Keoramal and Majnamuta Embankment, Sanbaria Embankment, Majnamuta and Bhograi Embankment, Peechaboni Embankment, Sujamuta and Jalamuta Embankment, Kasba Hijili Embankment, Kasai and Haldi Embankment, and Keleghai and Kasai Embankment.

5.2 Description of Embankments by Harrison, 1909

H.L. Harrison in the *Bengal Embankment Manual* (1909) emphasised on spatial alignment of different embankments under schedule A, B, C, D, and E. These are right embankment on the Rupnarayan river, right embankment on the Pairatungi *khal*, left embankment on the Pairatungi *khal*, right embankment on the Gangakhali *khal*, great sea dyke, right embankment on the Rasulpur river, circuit embankment on the right bank of the Rasulpur river, left embankment on the Peechaboni *khal*, circuit embankment of Khejuri, left embankment of Kasai river, left embankment of Haldi river, right embankment of Hugli river and right embankment of Rupnarayan river, circuit embankment between the Keleghai and Kasai rivers, right embankment of Kholakhalee *khal*, left embankment of Kholakhalee *khal*, right embankment of Srirampur *khal*, and left embankment of Srirampur *khal*.

There are many similarities between these two classifications of coastal embankments by W.W.Hunter ([1876] 1997) and H.L. Harrison (1909). But the nomenclature by the latter

is not similar to the one by the former. Spatial dimension is more pronounced in Harrison's classification. There the alignments of embankments are clearly understood by position of the rivers, tidal creeks, *khals* (canals), and sea. But, both the classifications are signing to fault in the nomenclatures of the embankments considering socio-economic significances.

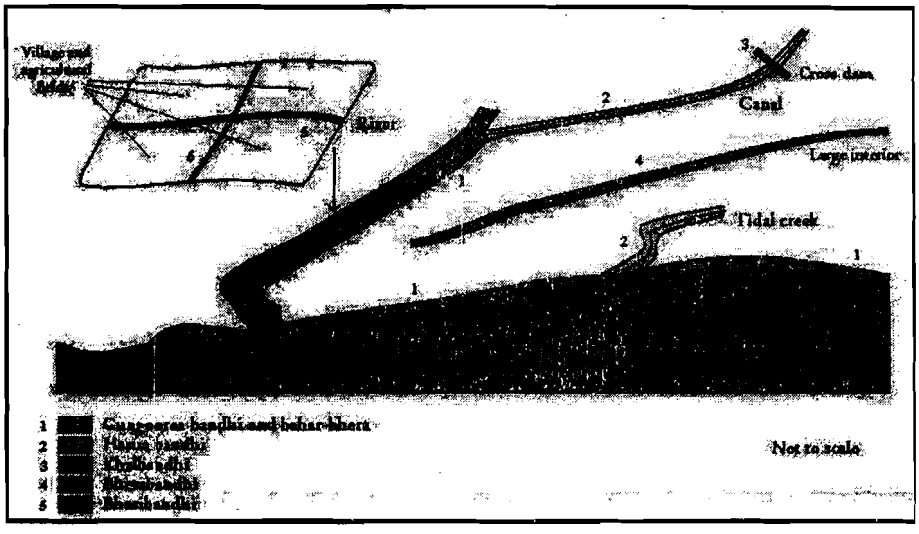
5.3 Description of embankments by Inglis, 1909

Again from the description of W.A.Inglis ([1909] 2002) the spatial characteristics of the coastal embankments can be estimated. According to him, from the Rupnarayan river to the Subarnarekha river within this district there was a complicated system of embankments. He considered two kinds of coastal embankments: one, to protect an area from the saline water inundation due to high tides and storm waves; two, embankments to exclude tidal water from the low-lands which were away from the sea-face and main estuary. Again he classified coastal embankments into four types. They are those on the Silai and Kasai river, those on the face of the Hugli estuary, those on the smaller estuaries, and those on the Subarnarekha river. According to him, in the district of Purba Medinipur there were embankments on the Hugli estuary and on the smaller estuaries. Hugli estuary embankments refer to those embankments between Subarnarekha and Rasulpur rivers, between Rasulpur and Haldi rivers, and lastly between Haldi and Rupnarayan rivers. According to him in the region of South Hijili i.e. presently in the coastal areas of Ramnagar I, II and Kanthi I and II blocks, Hugli estuary contains the great sea dyke. Then Hijili embankment, Khejuri circuit embankment, and Goomgarh embankment are situated in the North Hijili i.e. at present in the boundary of Khejuri I, II and Nandigram I and II blocks. The last part is known as the *Dorodumnan* embankment in the *Doro-Dumnan pergunnah.* At present this is found in the blocks of Haldia, Sutahata, Mahisadal, Nandakumar, and Tamluk.

5.4 Descriptions and Classification of Embankments by O'Malley, 1911

L.S.S. O'Malley ([1911] 1995) made a detailed description of embankments mentioning that the embankment system of Medinipur was like that of the Holland to prevent the intrusion of saline water into the low-lands. Coastal embankments were thus along the rivers, creeks, and sea. In his study embankments at Hijili had been emphasised and he noticed that there were sea dykes and subordinate embankments which ran along the tidal creeks. According to him, the whole system of embankments named as *pulbandhi* was to protect the agricultural lands from invasion of saline water. He also used different terms to describe embankments of different orders on the basis of the purposes they served. These are as follows: (i)

Gungoorea bundee and *bahar-bhera* — the largest and very important embankments along the tidal rivers, estuaries, and sea coast; (ii) *Hasua bundee* — continuous embankments along the canals, again sub-divided into outer-embankments and inner-embankments; (iii) *Khalbandhi* i.e. cross-dam; (iv) *Bherabandhi* i.e. large interior embankments; (v) *Bheribandhi* i.e. small interior embankments, again sub-divided into (a) *Jalnikasi hasias* — parallel embankments to protect water in the drainage channels, (b) *Gramsharahadbheris* embankments on the village boundaries, and (c) *Grambheris* — smaller inner-embankments to drain the rainwater.



Based on Embankment committee's report of 1839-40, L.S.S. O'Malley ([1911] 1995)

Figure 2: Diagrammatic sketch of different types of embankments mentioned in government reports and records

Here only *Gungoorea bundee* or *bahar-bhera* and *Hasua bundee* are water-front coastal embankments in the true sense. Embankments were basically classified on the basis of scale and place of construction. These bases finally lead to the aims of construction of the coastal embankments. There from socio-economic significances of those embankments can be understood. Figure 2 shows a diagrammatic sketch of different types of embankments which has followed the nomenclature given by O'Malley ([1911] 1995). He had also projected coastal embankments spatially in the following manner: (i) sea dyke; (ii) other embankments i.e. the right bank of Hugli river from Rasulpur river at Khejuri, *Dorodumnan* embankment, west bank of Rupnarayan, and both sides of Haldi and Rasulpur rivers.

6. Critical Review toward Socio-economic Significances

All these reports and records give a detailed description of spatial dimension of coastal embankments *vis-a-vis* their socio-economic significances. As people had started to settle in the coastal areas and prepared agricultural lands, embankments were constructed haphazardly by behest of the local landlords i.e. *zamindars* to protect from the saline tidal and floodwater intrusion. In the British period these coastal embankments were being regularised. New coastal embankments were found to construct for serving several purposes along the rivers like Rupnarayan, Hugli, Kasai, Haldi, Rasulpur, and Chandia; creeks like Ramnagar, Peechaboni etc.; canals like Orissa coast canal and Hijili tidal canal; and the Bay of Bengal. Thus a mesh of the embankments was developed in the Purba Medinipur district. Thus there the coastal environmental system was modified by human interference. According to W.A.Inglis ([1909] 2002) there was not a single system of embankments; rather there was a maze of embankments.

Pre-British embankments are referred to as *zamindari* embankments or embankments constructed by local landlords. In the pre-British era the socio-economic environment was used to be controlled by the local landlords. Embankments were constructed to meet the local demands. In most cases the embankments were unplanned and discontinuous and the main purpose behind construction of these embankments was the protection of riparian lands from saline water intrusion. Other aims and goals were to keep drainage channels in perennial condition. Some landlords were sympathetic towards the plight of their subjects due to breaching of coastal embankments. British government took the charge of maintenance of the embankments. The main purpose was to collect higher revenue from lands protected from saline water intrusion. It is difficult to distinguish between coastal embankments constructed by the landlords and embankment constructed by the British government since in many cases pre-British embankments were raised or repaired by the colonial government subsequently.

In the historic past, on the coast of Bay of Bengal in the Hijili-Kanthi portion, there was a very high sand dune from the mouth of river Rasulpur to Piplipattan. It was nearly 43 km. in length with the width of 2.4 km., and a height of 18 m. Roy Saheb Jogeshchandra Bidyanidhi in *Prabasi* (1910) had mentioned that this wall was known as *kanth* in Oriya language. It was used to protect the entire riparian lands and thence follows the name of the present block town, Kanthi (Pradhan, 2003). In the British period many tidal embankments on the smaller estuaries were constructed and *zamindari* embankments were connected to a regular chain shape. After the cyclone of 1864 the British government reconstructed several

coastal embankments by joint collaboration with the local landlords where the basic question was to collect more revenue for the interest of the British rulers. Most of the embankments were there before the invasion by the British (O'Malley, [1911] 1995). It is also very interesting to note that sometimes the Hijili embankment was known as Hijili sea-embankment. Therefore, it may be said that the boundary of sea and estuary was not systematically followed in nomenclatures of embankments. Orissa coast canal and Hijili tidal canal embankments were constructed also in the British period for the purpose of navigation. The Orissa coast canal embankment was constructed in the British period during 1880-1886. The Hijili tidal canal came into existence in-between 1868-1873 for Kalinagar section and 1872-1886, for Geonkhali section.

7. Conclusion

From the above discussion we come to the following major findings. (1) Embankments were named and classified by various scholars on the basis of place with special reference to spatial scale. Some of the scholars also paid their attention toward socio-economic significances in their classification and nomenclatures. But the nomenclature is often confusing. However, to understand the historical environment of that time some of these nomenclatures are excellent. (2) The study area was used to be governed by *zamindars* i.e. local landlords for a long time in the historical past. In that *zamindari* economic system, land constitutes the main economic basis. Therefore, it is the landlords who constructed water-front coastal embankments to protect the riparian lands from floods and saline tidal water intrusion. As a whole pre-British period embankments are referred as *zamindari* embankments. Alignments of these coastal embankments were often discontinuous and sometimes precarious. (3) Then the British came and made alterations in the embankment systems. The production relations were changed. The colonial government had started recording of coastal embankments and demanded higher revenue from lands protected by these embankments. This procedure of higher revenue collection necessitated the proper maintenance of old *zamindari* embankments and construction of newer ones. (4) Embankments were often destroyed by the tropical cyclones. They were reconstructed, however, for the public interest. The great sea dyke and Hugli estuarine embankments were damaged and reconstructed for the several times. (5) Orissa coast canal was constructed for navigation purpose. Embanking the canal was therefore necessary. With the extension of surface transport facility the canal itself has lost its significance. These embankments are no longer significant now. (6) Briefly in the pre-British and British period, there were two types of coastal embankments based on their socio-

economic significances. (i) Embankments for the very purpose of protection to the riparian lands from the flood and tidal hazards. These are sea-front, river-front, estuary-front, and tidal creek-front embankments. (ii) Embankments for irrigation to the agricultural fields, to eradicate drainage congestion, and for navigation. These are canal-front embankments. (7) Finally, within a space-time framework propensity of construction of coastal embankments was highest in the pre-British era. In the British period they were regularised and recorded to satisfy politico-economic aims and goals. In this context it is important to corroborate that the post- colonial governments are maintaining the pre-existing ones. Propensity of construction of new coastal embankments is lowest in this era.

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Study of Village Tourism in Sikkim: Aspects and Prospects

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Abstract

Ecotourims in Sikkim, the queen of the Himalayas, has attracted tourists from over the world. About 45% of the respondent were from India and 55% were from other countries that included France, Britain, Holland, Japan, USA, Switzerland, Germany, Sweden, Australia, Belgium and Canada. Visitors' survey was carried out over the year and recorded 75% tourists like to visit in the month of October – November. The respondents' age more or less evenly spread (31 to 40 years – 27%; 41 to 50 years – 22%; and above 50 years – 31%) of which 69% male and 31% were female. 29% of the tourist visited once a year are mostly foreigners. 60% of the respondents traveling in groups and 11% were traveling alone. In this survey it was also found that about 61% were willing to pay Eco – Tax while 20% could not understand this concept and 9% disagree to pay for Environmental conservation. The average WTP came up to Rs. 1700. on an average 87% have shown their eagerness to take up 'Always' or 'At – Times' basis the cultural tourism activities like Holy sites, Cooking, Local Handicrafts, Festivals, Local Lifestyle of the rural people etc, The above findings on Ecotourism and Cultural tourism supports its immense scope for development and improving livelihoods of the people of 'Sikkim'.

Key words Ecotourism; Village; Sikkim; Socio-Economics

1. Introduction

Sikkim, the 'queen of the Himalayas' over the years, has attracted thousands of tourists from all over the world. Geographical variations in terms of altitude and terrain, biodiversity and variety of tourism products based on natural beauty, adventure, religious sites, health resorts and culture has prompted Sikkim to be a prominent point in the international tourism

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map. Tourist inflow has grown at the rate of 12% to 15% annually during the last 10 years. The contribution of tourism towards improving and sustaining the livelihoods of concerned people varies depending on the type of the tourism and the capabilities of the local people to take advantage of the employment and income opportunities offered by tourism. It contributes to the livelihood of the people in the form of direct employment and related activities, better realization of income from production of items of tourist use and final benefit is the infrastructure development for tourism. Among the various kinds of tourism, the city based holiday tourism has minimum impact on income and livelihood generation, specially for the rural people.

Ecotourism offers vast potential in Sikkim both as a livelihood option and a conservation strategy. It is an instrument through which the state's natural and cultural capital can be used to augment incomes and livelihood without damaging the natural heritage. To attain this it is utmost important that there is participation and involvement of the local community.

Village tourism combines the duality of ecotourism, and cultural tourism can have maximum direct impact on their livelihoods of the village communities. The household providing lodge and boarding earn from this facility, others also derive benefit from working as guides, porters, and performers of cultural shows and through sale of local vegetables in the village. Tourism particularly based on demographic nature and culture has immense scope for development and improving livelihoods of the people.

2. Methodology

It becomes very important to do a market research to understand what exactly the tourists want, what is the perception of the tourists about village tourism, whether they are willing to experience the uniqueness of village tourism. For this purpose a visitors' survey was carried out in Gangtok. The objective of the survey was to have an idea about the visitor's perception. The respondent size of this survey was about 650.

The survey area was divided into four segments where most of the hotels in Gangtok were located. They were PS Road, Tibet Road, Deorali and Secretariat Road. A small questionnaire was prepared for doing this survey. Since this was qualitative research, numbers of questions were rated in Liker Scale to get a feel of the perception of the tourists. This questionnaire was circulated in about 14 hotels in Gangtok. The hotel in each of the four destinations was again subdivided into premium and economy category. The information in the filled questionnaire were then processed in computerized format and made ready for further analysis. Then using Excel software this data was analyzed.

3. Results and discussion

The respondents of this survey were from twelve countries including India. About 45% of the respondent were from India and 55% were from other countries that included France, Britain, Holland, Japan, USA, Switzerland, Germany, Sweden, Australia, Belgium and Canada. (Fig. 1).

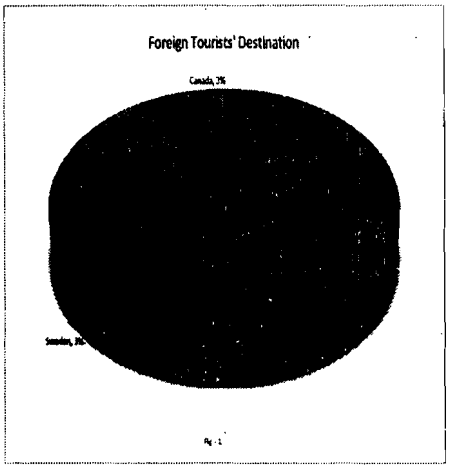

Fig.1

The respondents' age was more or less evenly spread among the intervals 31-40 years (27%), 41-50 years (22%) and above 50 years (31%). It can be said safely that most of the feedbacks represent the people of these three aged classes. About 69% of the respondents were male and 31% were female. Among the respondents about 62% mentioned that they visit Sikkim seldom whereas 29% confirmed that they visit Sikkim once a year and only 9% responded that they visit Sikkim more than once. The last type comprises mainly of the domestic tourists especially from the neighboring Indian state of West Bengal. It can be confirmed that 29% of the tourist who visit Sikkim once a year are mostly foreigners.

This is one of the assets of Sikkim that it attracts quite a large volume of tourists to make repeated visit (38%) and they play an important role in spreading through the word of mouth about the attractiveness of Sikkim. If at least few percent of these repeat visitors can be attracted to rural tourism lot of promotional activity will take up it's own course. Another aspect which is often quoted while talking about the benefits from tourism to local community is the duration of stay of the tourists. In community-based tourism like village tourism this is of paramount importance. This is because an increase in the duration of the stay of tourist will have a positive externality not only to the direct tourism service providers like homestays, porters, guides but also to those who are indirectly linked to the village economy like the local farmers, local craftsmen and handicraft owner who will have increased benefit.

In this survey it was found that 64% of the respondents reported to stay for one week or more. This means that a package can definitely be devised for 3-5 days exclusively for village tourism to give a unique experience to the tourists in the village as well as this will have a positive spill over effect to the entire village economy. However the visit to Sikkim is highly seasonal. Most of the tourists (75%) like to visit Sikkim in the month of October-November. These are the busiest months in Sikkim. It was also found in this survey that most of the foreigners prefer to visit Sikkim during the months of October-November while the domestic tourists come in the month of April-May. This can be a definite area of improvement. If activities can be designed that can be enjoyed by both types of tourists throughout the year then perhaps this pattern can be changed. Also special seasonal activities can be designed for the month of October-November.

It was also found that about 60% of the respondents were traveling in groups either family or friends and only 11% were traveling alone. This is a positive finding because person traveling in groups will have greater spill over benefits than single tourist who is traveling alone. This is because often a particular service is used for only one person; it becomes uneconomical comparing to when the same service can cater to an entire group. (Fig.2).

An important aspect of eco-tourism is encouraging the use of renewable source of energy and discourages the nonrenewable source of energy. Often such use of energy sources will lead to increase in the cost of operation of tourism enterprises. Now the most important question is that are the tourists ready to pay an increased price for the sake of environment.

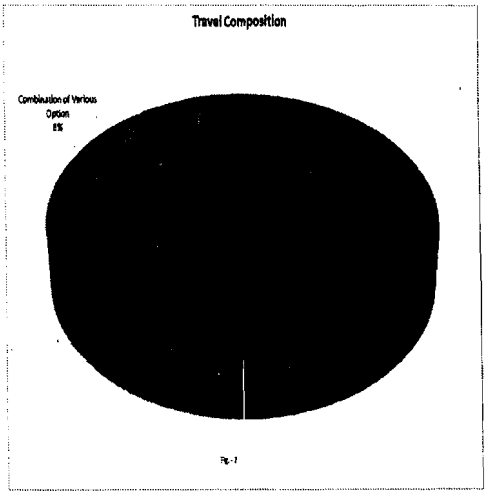

Fig.2

This is often termed as Eco-Tax. In this survey it was found that about 61% of the respondents were willing to pay Eco-Tax while 20% could not understand this concept and 9% disagreed to pay.

It was found that most of the tourists used to stay in Hotel or Lodges and used to take food from restaurant in Gangtok. However given options the respondents showed their willingness to taste the local food and local culture. About 98% of the respondents showed their willingness regarding this. This is perhaps a most important and promising indicator when a product like rural tourism is planned, as both these components are integral part of village tourism.

Another important aspect of this market research was to find out the Willingness to Pay (WTP) of the tourists. For this reason WTP per person per day was also researched. Any currency other than Rupee was later converted into Rupees and a frequency distribution was prepared. Also the average amount was calculated. The average came up to Rs 1700. The following table shows the WTP break-up. (Table 1.).

Table-1

Willingness to Pay (Per person per day)

Amount (in Rs)	No.of Respondents
0-500	2
500-1000	14
1000-1500	8
1500-2000	8
2000-3000	6
3000-4000	0
400-5000	5
Above 5000	2

When a product like village tourism is developed that is solely a destination based product the role of infrastructures comes into play. When a tourist comes to experience the uniqueness of village tourism what are the basic infrastructure that he/she will look for. For this the respondents were given with a list of infrastructures and they were asked to rate in a Liker scale from most important to least important. The main objective of researching this was to define clearly that when a destination is developed as village tourism destination what basic infrastructure needs to be developed to make the tourists' stay comfortable.

It was found from the survey that the most important attribute of developing a tourist destination is to choose a site that provides a great view of the surrounding scenery. Infact

91% of the respondents agreed that this is the most important factor of promoting a place as a tourist destination. The site should definitely have a basic provision for medical infrastructure and about 86% of the respondents perceived this as an important infrastructure.

A tourist coming for village tourism cannot be expected to just stay in a homestead and have food. In fact when it is said that the stay of the tourist needs to be increased then certain activities need to be designed and developed to make his/her tour interesting and refreshing. Now the big question is what kind of activities needs to be promoted? This is largely a demand-determined market where it is the tourist's preference that will determine what kind of activities needs to be designed and developed for promotion of village tourism.

In this survey there were number of activities that could be served to the tourist were written down and it was asked to the tourist whether they are willing to take up this activity at times, always or never. The activities were clustered into three major groups. They were adventure sports like trekking, rock climbing, paragliding, mountain biking, water sports and paragliding. There were bird watching, animal sighting, butterfly sighting, guided nature walk, flora/ medicinal plants, landscape and scenery which could be majored under nature tourism. The last category was more of cultural tourism where tourists were asked whether they are willing to visit holy sites, watch and enjoy various Sikkimese festivals, enjoy and taste the local form of life, local handicrafts, listen to village folk tales and move into a past which is still engulfed in mysticism and if they want to taste and learn preparing traditional dishes.

Type	Activities	Percentage of respondent		
		Always	Never	At times
Adventure Sports	Trekking Activity	23	29	48
	Rock Climbing Activity	24	58	18
	Water Sports	13	58	29
	Mountain Biking	14	59	27
Nature tourism activities	Bird Watching	27	12	61
	Butter Fly Watching	24	16	60
	Guided nature work	37	13	50
	Animal sighting	30	14	56
	Flora medicinal plant	27	13	60
Cultural Tourism	Visit holy sites	49	9	42
	Local handicrafts	68	4	28
	Sikkimese festivals	41	14	45
	Way of local life	53	7	40
	Listening of local folk tales	44	15	41
	Traditional cooking demonstration	27	33	40

Table -2: Percentage distribution of the opinion of the respondents.

It is quite clear that among the various adventure activities listed above it is only the trekking that the respondents have agreed to take up. About 71% of the respondents are willing to do trekking either always or at times. (Table-2). But for other activities like water sports, paragliding, mountain biking and rock climbing more than 50% of the respondents have confirmed that they will never take up those activities.The mean responses for different adventure activities are: Always 17.4%, At Times 29.4% and Never 53.2%. (Table-2).

However, the scenario changes in the case of nature tourism activities. Here for most of the activities the respondents have shown substantial interest. On an average for all the activities like Bird watching, Animal sighting, Landscape and Scenery, Butterfly Watching, Guided Nature walk and Flora & Medicinal Plant about 87% of the respondent have confirmed that they are willing to take up such activities either Always or At-times.

Most of the tourists have shown keen interest to take up activities like Landscape and Scenery (98%), Bird Watching (88%), Guided Nature Walk (87%) and Flora Watching (87%). (Table-2). The mean response for nature tourism activities are: Always 36.83%, At-times 51.5% and for Never 11.67%.

The situation further develops in the case of various cultural tourism activities that can also be designed for Village Tourism. For most of these activities like Holy Sites, Cooking, Local Handicrafts, Festivals, Local Life style of the rural people and Listening Folk Tales. It was found that on an average 87% have shown their eagerness to take up these activities on a more 'Always' or 'At-Times' basis (Table-2).

The average responses for various cultural tourism activities show a very high response rate on the 'Always' scale and on 'At Time' scale and very low response on 'Never' scale compared to the other set of activities.

4. Conclusion

The trend that has been seen in relation to various activities is very interesting. Most of the activities that can be promoted in village tourism like to show the tourist by the way of local life in the village, the local festivals, small guided nature walk, bird watching or animal sighting, small treks to nearby villages, local folk tales shows a very positive trend from the feedback of the respondents. This implies that, there is sufficient demand for these activities from the tourists and care needs to be taken to develop such activities while designing a village tourism package. Conclusion

The tourist visit to Sikkim is highly seasonal. Most of the tourists (75%) like to visit Sikkim in the early winter month. It was also found in this survey that most of the foreigners prefer to

visit Sikkim during the months of October-November while the domestic tourists come in the month of April-May. If activities can be designed that can be enjoyed by both types of tourists throughout the year then perhaps this pattern can be changed. Also special seasonal activities in rural areas of Sikkim can be designed during round the year by Government of Sikkim so that, rural villagers will be able to generate their livelihood from village tourism.

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BOOK REVIEW

Environment Education: Global Issues and Policies (Volumes I & II). Edited by Basu, S. K. and Datta Banik, S. Publisher: A. P. H. Publishing Corporation, New Delhi, India, 2009. ISBN: 9788131304921. Total pages: 662. Price (Hardbound): Indian Rs. 2195.00 & US $ 48.78.

This two volume series has been an exciting reading for an environmental enthusiast like me. The foremost joy has been to note that the two editors did a grand job of bringing diverse schools of thoughts under one roof. To my mind that is indeed a commendable job on the part of the editors. Another important aspect of this peer-reviewed edited volume is the diverse disciplines that have been covered, starting from Environmental Chemistry to Ecosystem Studies, and from different branches Social Sciences (including Anthropology, Demographics, Archaeology, Health Sciences, Environmental Management, Law and Policy Studies, Economics and Ethics) to Agricultural Studies and Natural Sciences; these broad range of disciplines have been captured in over 600 pages. Third and last strength observed in this seminal work has been the fact that contributors came from different countries and continents, giving it an additional international dimension in highlighting major environmental issues from their own perspectives. The contributors include well respected, internationally recognized, distinguished scholars, researchers, academics and reviewers from the related fields. This work is divided into 2 volumes with 3 different sections containing 25 chapters in total, an impressive peer-reviewed collection of diverse range of information, data, views, opinions and review of existing available literature.

This hard covered two volume set with an attractive cover has been divided into three broad sections to accommodate a wide diversity of thoughts in print. The three broad sections are: I. Environmental Pollution and Conservation; II. Environmental Policy Issues in Global Perspective; and III. Human Population Health, Environmental Conscience and Management Strategies. The first section represented in volume one highlights predominantly in and around environmental pollution and conservation with varied perspectives. It includes articles on polyaromatic hydrocarbons (Chapter 1), green house gas emission (Chapter 2), arsenic pollution (chapter 3), toxic heavy metal pollution (chapter 5), trace metal pollution (chapter 6), economic importance of wheat rusts (chapter 7), biological control of pests (chapter 8), plant aquaporins (chapter 9), gene technology for cold hardiness (chapter 10), socioeconomic and environmental aspects of sacred grooves (chapter 11) and native plant revegetation and reclamation (chapter 12). Section II and III represents volume 2 of the current series, with section II comprising of articles highlighting broadly on environmental issues and policies. The chapters included are environmental problems of Taiwan (chapter 13), environmental degradation (chapter 14) and sustainable development (chapter 15) both from

Nigeria, water management in western Canada (chapter 16) and lastly aspects of environmental sovereignty (chapter 17). The third and last section consists of 8 chapters focussing on health issues, demographics, ethics, economics and other facets of Social Sciences. These are environmental carrying capacity (chapter 18), nutritional stress (chapter 19), genetic diseases at molecular level (chapter 20), socio-cultural aspects of ecocide (chapter 21), ecological ethics (chapter 22), environmental education (chapter 23), green finance (chapter 24) and environmental archaeology (chapter 25).

The preface highlights on the strengths of such a multi-disciplinary approach, while the preface by Honourable Vice Chancellor of Vidyasagar University commemorates the incredible hard work and dedication demonstrated by the two editors in bringing out this volume. Both volumes are accompanied by a lofty introduction by the editors which deserves special mention since they included the fundamental aspect of environmental issues and linked them to history, society, academia, technological innovations and global politics in the delicate network of socialism, market economy and broad based environmental philosophy. The introduction indeed touches the deep sense of the commitment of the editors and the contributors for coming together a long way and generate a common platform for highlighting divergent environmental issues across the planet.

A few printing errors have been traced through the volumes. The overall quality of the bound hard cover volumes, papers used in printing and general gate up of the volume deserves special appreciation. The greatest criticism that could be raised against this work is its divergent nature. Too many topics have been included under one roof, which may turn overwhelmingly broad and diverse for some readers. However, as the editors have rightly pointed out that this is the strength of this seminal work while being looked at with a different perspective. Although the cost of the production does not seem to be too much reader friendly; however, I would strongly recommend this a prized library collection. In addition to scholars, researchers and academics in the field, this will also cater to the delights of general readers.

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