A STUDY ON THE IMPACT OF NATURAL HAZARD DRIVEN ENVIRONMENTAL CHANGE ON THE FEW SELECTED COASTAL COMMUNITIES OF ORISSA, INDIA.

Natural hazards are becoming one of the major environmental change drivers around the globe, impeding both sustainable development and poverty-reduction initiatives. There is a close correlation between the trends of increased demographic pressure especially in developing countries that escalates environmental degradation, increased human vulnerability and the intensity of the impact of disasters. Adapted, sustainable and integrated management of natural resources like reforestation schemes, proper land use and good management of rivers and coastal areas will increase the resilience of the communities to disasters by reversing current trends of environmental degradation.

Major objectives of the study is to document the coastline changes along the villages and identify the major drivers for such changes; to analyze the consequences of the environmental change on the community, livelihood, lifestyle and mobility and to suggest management plans for more disaster resilient communities.

The study was conducted in the coastal communities of Satabhaya gram Panchayat in the state of Orissa, on the East coast of India. The communities were selected based on the immediate threat to the communities from flood; cyclone and saline surges Also the natural hazards occurring in the past have obliterated the existence of these villages that only 4 remain out of initial 7 villages, within a period of 40 years.

Remote sensing and GIS tools were used to detect the coastline change. The research paper is based on the field work conducted in the communities in 3 successive stages between December 2007 and June, 2009. The data collected participatory rural appraisal, focus group discussions and semi structured questionnaire. Random sampling was adopted for data collection.

Coastline change was observed to have changed along all the villages more than the global average. The natural disasters in the past along with development policy of the government were found to be the major drivers. Adaptation by the community included both technical and

non-technical strategies. This study will help assess the vulnerability of the community as well as help policy makers develop a disaster risk reduction strategy with sustainable development goals.

KEY WORDS disaster, environmental change, disaster risk, coastline change, resilience

1. INTRODUCTION

Natural hazards are happening since the time immemorial and have taken part in shaping any community, both its existence and perish. In the years that are passing by we are getting increasingly subjected to the natural hazards culminating into disasters, claiming a large portion of life and property (Cutter, 2007). If we look into the recent trend of natural disasters, it can be strongly argued that in the coming years the number, frequency and impact of natural disasters are increasing. This compels us to think that physical event is equally responsible as is the social construct of the given community which is exposed to it (Benson and clay, 2004; Schipper and Pelling, 2006; Tomkins,2002;). In this scenario, a disaster free world can only be a valid argument when disaster warning/prediction, preparedness, and management are priority concerns in disaster prone regions (Diley et al, 2005; Kapoor, 2005; Moss et al, 2003; Oxfam, 2007,).

A natural hazard is any natural event which possesses any threat to the natural environment and human population. While disaster can be a serious disruption of the functioning of the community or a society, it essentially involves widespread human, material, economic or environmental losses and impacts that exceeds the ability of the affected community or society to cope using its own resources. Disasters are often described as a result of the combination of exposure to natural hazards, vulnerability of the resident human population and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well being, together with damage to property, destruction of assets, loss of services social and economic disruption and environmental degradation(Oxfam, 2007). UNISDR defines *disaster risk reduction* as “the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development Disaster risk management includes both disaster risk reduction (prevention, preparedness and mitigation) and humanitarian and development action (emergency response, relief and reconstruction). Major aim of any disaster risk reduction

programme is to reduce vulnerability and creating more resilient indivisuals and communities. Understanding the reasons for vulnerability of a community to natural disasters can help us fill the gap between vulnerability to resilience. Assessing the economic, social, political, cultural, institutional, psychological factors along with natural hazards perceptions of the exposed population, could lead to more effective interventions and practical adaptation strategies to enhance the ways people deal with natural hazards (Davis and Hall, 1999; Wisner et. al., 2004; Smit and Wandel, 2006;Lopez 2008).

2. CONCEPT AND NEED INTEGRATION OF DRR INTO MAINSTREAM DEVELOPMENT POLICY IN DEVELOPING COUNTRIES

UNISDR defines *disaster risk reduction* as "the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development Though disasters have a global occurrence the amount of suffrage caused is more in countries with low development index, more among vulnerability groups like women and children. Underlying social conditions and structures determine who is most vulnerable to the impact of natural hazards such as extreme weather events, and disasters consequently follow. Need for mainstreaming disaster risk reduction into the developing countries is based on the argument that disasters not only cause immediate suffering but hold back long-term development (Oxfam, 2007). Hence integrating the DRR concepts into development policy can help improve social conditions as well as cut on the cost incurred on the post- disaster relief activities. Although on average the 50 poorest countries are exposed to only 11 per cent of the world's natural hazards, they suffer 53 per cent of deaths from disasters each year. In contrast, countries with high levels of human development, despite their exposure to 15 per cent of all hazards, account for only 1.5 per cent of the death toll (UNDP, 2004). Poverty forces people to live in dangerous locations and unsafe shelters. The options open to people depend on their wealth. Better-off families are more likely to obtain shelter with friends or relatives, and also to recover at least part of their incomes and assets

(Oxfam, 2007). Every time a natural disaster strikes in South Asia, invariably more women die than men. In Nagapattinam and Cuddalore, the districts of the Indian state of Tamil Nadu that were worst affected by the tsunami, twice as many women died as men. They are expected to take more responsibility of family, perform domestic scores as well as provide as an extra hand. Studies show that women are more likely to volunteer for projects in their communities for activities related to emergency management. When disasters strike, socially excluded groups are at the greatest risk. Minorities and low caste people suffer more and find it harder to recover from disasters. Poor economic development practices can contribute to 'natural' disasters through flawed implementation, over-emphasis on badly designed large projects, and environmental degradation.

3. STUDY AREA

The study was conducted in the coastal communities of Satabhaya gram Panchayat in the state of Orissa, East coast of India namely- Magarkanda, Balisahi,Satabhaya, Barahipur and Kahnapur. The communities were selected based on the immediate threat to the communities from flood; cyclone and saline surges. This region is the most cyclone prone region of India and the annual cyclone probability of this area is nearly 1, implying that it faces at least one cyclone (of different intensity) every year on an average (Das, 2007). Every cyclone that originates in the Bay of Bengal during the monsoon months(June, July, August), passes through this part of the Indian coast, although the tracks of cyclones during the other periods follow no such fixed pattern (IMD, 2000). The cyclone record of the state of Orissa reveals the frequency of very severe cyclones (very severe cyclonic storms and super cyclones) to have increased in recent decades, the annual probability being 0.00 for 1900 – 1920, 0.1 for 1921 – 1940, 0.05 for 1941 – 1960, 0.15 for 1961 – 1980 and 0.15 for 1981 – 2000 (Chittibabu et al., 2004). The Orissa coastal zone enjoys a tropical monsoon climate. The region receives rainfall from the southwest, retreating and northeast monsoon. The heavy torrential rain downpour with raging cyclonic storms and depression from the Bay of Bengal are the climatic characteristics of the coastal zone. About of the annual rainfall occurs over the region during the southwest monsoon season with two peaks i.e July-August and October. In the coastal region the normal rainfall ranges between 130-165 cm indicating a sub-humid zone. The rainy days in a year ranges from 55-80

days. The May is the hottest month and the maximum temperature varies from 38^0C to 45^0C. The December is the coldest month and the average temperature comes down to 10^0C to 15^0C. Relative humidity remains high throughout the year ranging from 90% in the South West to 65% in the winter months.

The study area is located in a mangrove ecosystem. Mangroves are salt tolerant, complex and dynamic eco-system that occur in tropical and subtropical inter-tidal regions. Bhitarkanika is one such location of rich, lush green vibrant eco-system lying in the estuarine region of Brahmani- Baitarani in the North-Eastern corner of Kendrapara district of Orissa. The area is intersected by a network of creeks with Bay of Bengal on the East. The alley between the meandering creeks and rivers, houses the second largest viable mangrove eco-system of India. Its 672 sq.kms. of mangrove forest & wetland, provides home to well over 215 species of birds including winter migrants from central-Asia and Europe. Giant salt water crocodiles and variety of other Wildlife inhabit in this eco-system which form Asia's one of the most spectacular Wildlife area. An area of 145 Sq.kms. has been notified as Bhiterkanika National Park vide Notification No.19686/F & E dated 16.9.1998 of Forests & Environment Department, Govt. of Orissa. It has much significance with regard to ecological geomorphological and biological background which includes mangrove forests, rivers, creeks, estuaries, back water, accreted land and mud flats. Bhiterkanika National Park is the core area of Bhiterkanika Sanctuary.

Total population of the villages is 2200 with 347 households. The communities depend mostly on the rainfed subsistence agriculture. Few communities based on their caste may do fishing but is not an encouraged livelihood as the communities are part of Bhiterkanika national park and as a result cannot sell their yields outside. Few are engaged in providing services like petty shops, boat operator, potter, carpenters, and cycle repair shop. Off -Sea fishing was not reported among the community. The houses are mostly thatched roof with straw and mud walls. They increase their vulnerability to natural hazards especially high velocity cyclones.

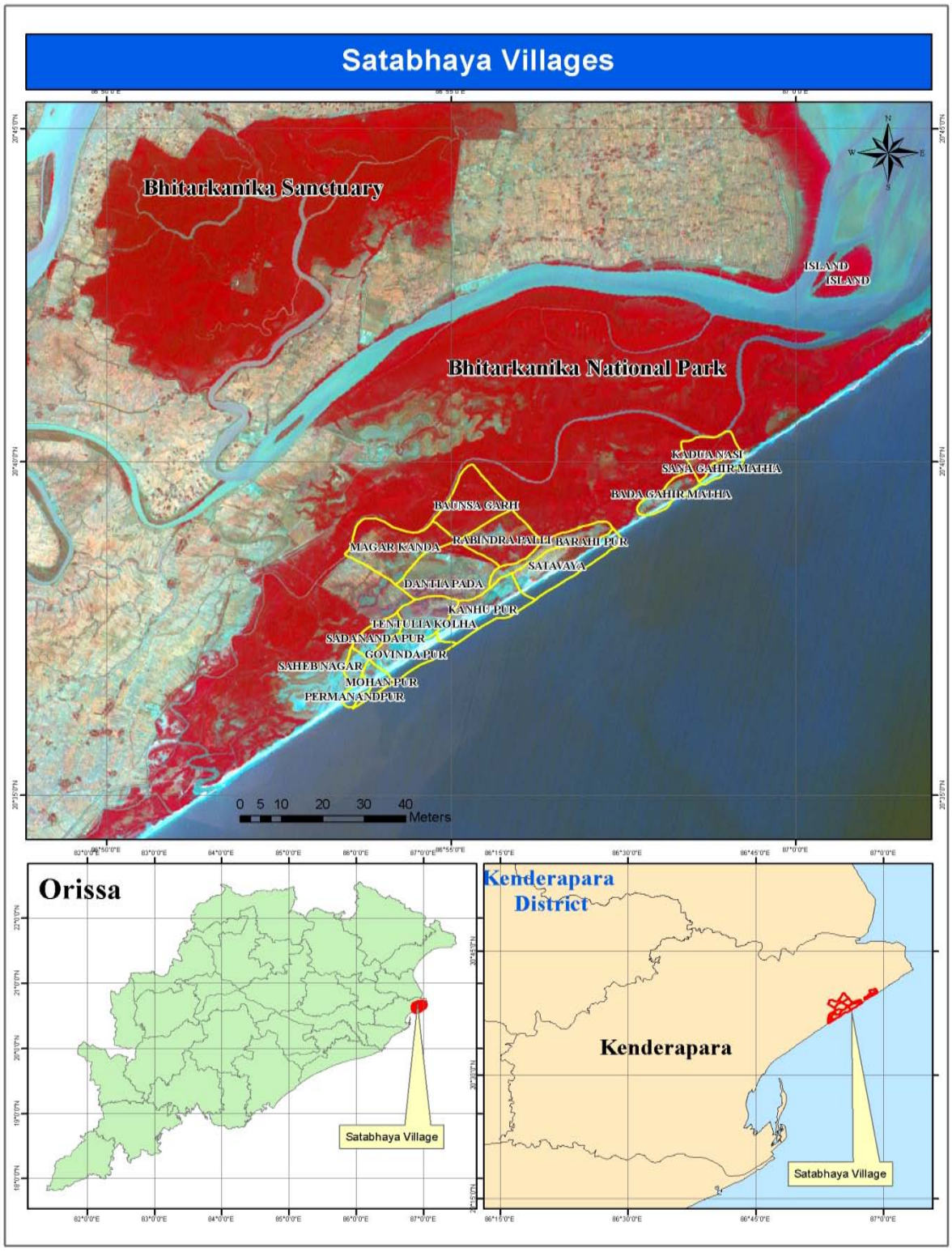

Figure 1 STUDY AREA

4. METHODOLOGY

The study is based on the field work conducted in the communities in 3 successive stages between December 2007 and June, 2009. The first phase of exploratory field survey was conducted in December, 2007 in which primarily interviews with the key informants were carried out in 20 villages in the coastal area. Based on these interviews, the communities which faced an immediate threat and which had faced the most severe consequences were chosen for the second phase of intensive interviews and focus group discussions. From April 2008 to May 2008, mostly PRA's were conducted to get more information on the resource use, major livelihood of the community as well as to acquaint oneself with people in four villages namely Magarkanda, Balisahi, Satabhaya, Barahipur and Kahnapur. Questionnaire based data collection was carried out between March to May 2009. One of the reasons for choosing this region is basically that all the families are of Oriya origin and have lived for at least 3 generations in the study area, hence when it comes to past disasters that struck these villages they are able to reconstruct the past better. A household census was done using systematic random sampling to ensure that the selected households were spread throughout selected settlements. Every Nth house was sampled, after a randomly chosen starting point .N was calculated by dividing the total number of households in the sampling frame (usually in all the villages) by the sample size required.

In order to detect the shoreline change, the SOI toposheets were georeferenced mentioning with a common projection system as of the Satellite images being WGS 84 in 1:50,000 scale. The designated village boundaries were traced out. The cadastral sheets were geo-referenced with the same projection system as for the SOI toposheets. Finally the cadastral sheets were mosaiced and vectorisation was done and the boundaries for the selected villages nearing the coast were done. Similarly the digitization for coastline was done from the SOI toposheets, which gives a solid baseline date of 1970's.Superimposition of the boundary was done independently for toposheets, IRS P6 LISS III and IRS P6 PAN.

The present study was carried out between April 2008(pre-monsoon) and September 2008(post monsoon). The soil sample was collected from 3 sampling sites from each of the 4 villages 60 cm x 60 cm x 30 cm quadrate was laid according to Lee; 1985.The soil was mixed well and sent for analysis of chemical parameters. Following parameters that is pH, salinity, organic carbon, phosphorous, and potash were analyzed. The ground water is basically used for drinking and domestic use. The water samples were collected by using wide mouth sterile transparent plastic jar of 5litre capacity. For the analysis of dissolved water samples were collected in BOD bottles of 300ml capacity. Also microbial counts were done for each water sample. Following variables were studied pH, Temperature, Nitrate, phosphate, Chloride, Calcium, Iron and microbial counts. Not much change was observed in post and pre-monsoon samples. Maximum temperature was found to be 33ºC and minimum 26ºC. All the parameters tested were found to meet the Indian standard prescribed for each variable in drinking water as well as WHO standards. The major impact of the shoreline change is also felt on the drinking water. Many of the tube wells located near shore have become non-functional owing to the saline surge and salination of aquifer. The Depth of getting fresh water has also increased from previous years increasing the cost of putting a new tube well. The loss of functional tube wells has led to increase in number of people depending on a single tube well. Change in mangrove was basically studied by using secondary data and PRA exercises.

5. RESULTS AND DISCUSSION

5.1. SOCIO-ECONOMIC PROFILE

The villages are mixed communities with heterogeneous social groups with schedule caste (SC) 36%, scheduled tribe (ST) 7 %, General caste 26% and other backward classes (OBC) 31%. Majority of household are below the poverty line. Out of the total 341 houses in the Panchayat, 334 are thatched houses and 7 houses are of pucca. There is not a single house which is made up of brick wall having thatched roof. The Panchayat has 10 single women- headed households.

Out of 341 households in the Panchayat, 153 households belong to SC community, 36 households are ST community, 82 households are from OBC community and other 70 households are general category. Total population of the Panchayat is 2286 out of which 1182 are male and 1104 are female.

The Panchayat infrastructure is not adequate, except two upper primary school, one minor school and 2 Anganwadi centres. The road to villages is generally kutcha and is difficult to travel during rainy days. Most of the villager's viewed proper road connectivity as one of the main requirement. Besides there are 2 public distribution systems. There is also a post office in the Panchayat but it is defunct. On an average 23 families share a tube well that meets the drinking as well domestic requirements.

Education and literacy the Panchayat has an education facility up to class 7^{th} known as ME. The Panchayat has two anganwadi centres that are located in low lying area often getting flooded at the time of flood. High school that is till 10^{th} standard the children have to depend on a high school located at hatina, 20kms away from the Panchayat. Lack of transportation makes the access to school even more acute especially in case of girls. But with repeated crop failures the boys migrate out for jobs outside the village, hence there is increased number of dropouts among boys also.

5.2. RECONSTRUCTING HISTORY OF PANCHAYAT

The Gram Panchayat of Satabhaya derives its name from 'sata' meaning seven and 'bhaya' meaning brother in Oriya language. The villagers associate themselves to the story of mythical "Tapoi" a young girl who had 7 brothers, all sailors and her true faith in Goddess Mangala. Being tortured by her sister-in-laws in the absence of her brothers she prays to goddess Mangala for their safe return. Her prayers are answered and brothers return safely. In that faith, even today unmarried girls still pray for safety of their families. The villages were established when few families settled by clearing the mangrove forests by the help of Kanika king around the early 19^{th} century. The people prospered by the agriculture because of the fertile land of the mangroves. The Port was opened to Traffic on 12th March 1966. Government of India declared Paradip as the Eighth Major Port of India on 18th April 1966 making it the first major port in the East Coast commissioned after independence. Displacement of the communities started in 1966 due to the Paradip port, and a large scale displacement started from Gobindhpur village to surrounding villages of Baghpatia, Okilapala, and Mahakalapada in 1966 due to coastline erosion.

Gobindhpur village was totally washed away by the saline surges of 1971 cyclone. Out of the initial 7 villages only 4 are left to the present day. Due to the cyclone induced saline flood in 1982, the land became uncultivable for the subsequent 4 years. As a result large-scale internal migration started with people moving to Southern states of India in search of jobs. After super cyclone, most of the families of Satabhaya shifted to Balisahi and Barahipur and people from Kanhapur shifted to Okilapal and Magarkanda. Most of the agricultural lands have lost their fertility due to salinasation. The cyclone Aila which affected west Bengal, India, also kept these people landlocked inside without any communication from the outside for 72 hours. Thus, the natural hazards have shaped both the population as well as local environment of the given community.

Figure 2 Number PRA map drawn by the community showing the major events of past and present day village.

The area being exposed to these factors has remained well behind the required economic development. Repeated natural disasters have led to loss of fertile land leading to loss of livelihood. Loss of fertile land exerts a strain on food self sufficiency of the region. The area is far from meeting the millennium development goals. Basic human needs like sanitation, education, primary health care services still remain a distant dream.

5.3. NATURAL DISASTERS: MAJOR DRIVER OF CHANGE

Overall There had been 125 disasters in Orissa during the last 107 years (1900 to 2007) (New Indian Express, 2009).Natural disasters kill about 1,300 people every year in Orissa (OSDMA, 2009). According to the report by OSDMA , natural disasters have taken the lives of over 50,000 people in a span of 38 years (1970-2007). The major natural disasters include cyclones, floods, lightning, heat wave, fire, epidemics and droughts. Among the natural disasters, the worst killers are floods, tropical cyclones and health hazards. They claim about 88 percent of the total lives lost due to disasters. Natural disasters kill about 1,300 people every year in Orissa (OSDMA, 2009).Studying the magnitude and frequency of cyclonic disturbances is an indispensible, when u needs to study the component of understanding the relative vulnerability of the coastal areas towards the cyclone. The present study analyses the cyclonic disturbances of the last century (1900-2008) chronologically which had a landfall and affected Orissa coast. Natural disasters have taken the lives of over 50,000 people in a span of 38 years (1970-2007). The disasters include cyclones, floods, lightning, heat wave, fire, epidemics and droughts. Among the natural disasters, the worst killers are floods, tropical cyclones and health hazards. They claim about 88 percent of the total lives lost to disasters. The report uses Disaster Risk Index (DRI) to measure the risk and vulnerability to disasters. As per the about 10 percent of the state's total population is exposed to these disasters every year (OSDMA, 2009).

The average financial loss of the State of Orissa per annum due to different disasters has been estimated at Rs 1,241.82 crore. In its memorandum submitted to the Thirteenth Finance Commission (TFC), the State Government maintained that the financial loss due to disasters during the last 14 years stood at Rs 17,385.61 crore. (OSDMA, 2009).

In the Orissa coastal zone on an average 5000sq km of the area per year is affected by the floods. The highest flood recorded in the last century in 1982 inundated 33,790 sq km of area. The flood damage of the coastal zone constitutes nearly 85% of the total flood affected area and 80% of the total flood damage (OSDMA, 2009).

In the last century the Indian subcontinent has experienced 1019 cyclonic disturbances of which 890 were along the Coromondal coast and 129 on the western coast. Orissa had a major share of 260 disturbances, out of which 180 depressions(69%), 57 storms(22%), and 23 severe storms(9%).out of the total severe storms in the Bay of Bengal region 15% of them i.e., one in every six affect Orissa coast(Chittababu et al, 2002).

The study area was mainly affected by three natural disasters severely, 1971 flood, 1986 saline flood and 1999 super cyclone. These natural disasters profoundly affected the natural environment, local livelihood and the community.

5.4. NATURAL HAZARD DRIVEN ENVIRONMENTAL CHANGES

In the focus group discussion, majority of participants pointed out four main changes to their natural environment caused by recurrent natural hazards precisely coastline erosion, salinisation of soil, loss of drinking water source and reduction in mangrove cover. Hence we limited our study to these four main parameters to prove that there has been change in environment due to natural hazards.

5.4.1. COASTLINE CHANGE

From Figures-2, Figure-3, and Figure-4, it is evident there is a shore line change. There are two schools of thoughts regarding the erosion of shoreline change. First being the climate change all around the globe has an effect on the Satabhaya coast also and hence has resulted in the shoreline change. The average rate of sea-level change obtained from tide gauges over the last 50 years is +1.8 ± 0.3mm/year **(**Nerem et. al., 2006). As per a book named 'Global Environmental Negotiation', if sea level rises 1 m from the current level, 1,70,000 Ha of cultivable land in Orissa will be submerged. The second school of thought claims that the commissioning of Paradeep port is leading to erosion on the North side reducing Satabhaya coast. By the analysis of the image, the average coastline change was found to be 3.7 m in Gobindhpur between 1966 to 2008 and similarly sea had intruded 3m in the coast of satabhaya (Table-1). The intrusion of sea has increased the vulnerability of the villagers to the storm surges often leading to loss of lives and livelihoods during the natural disasters.

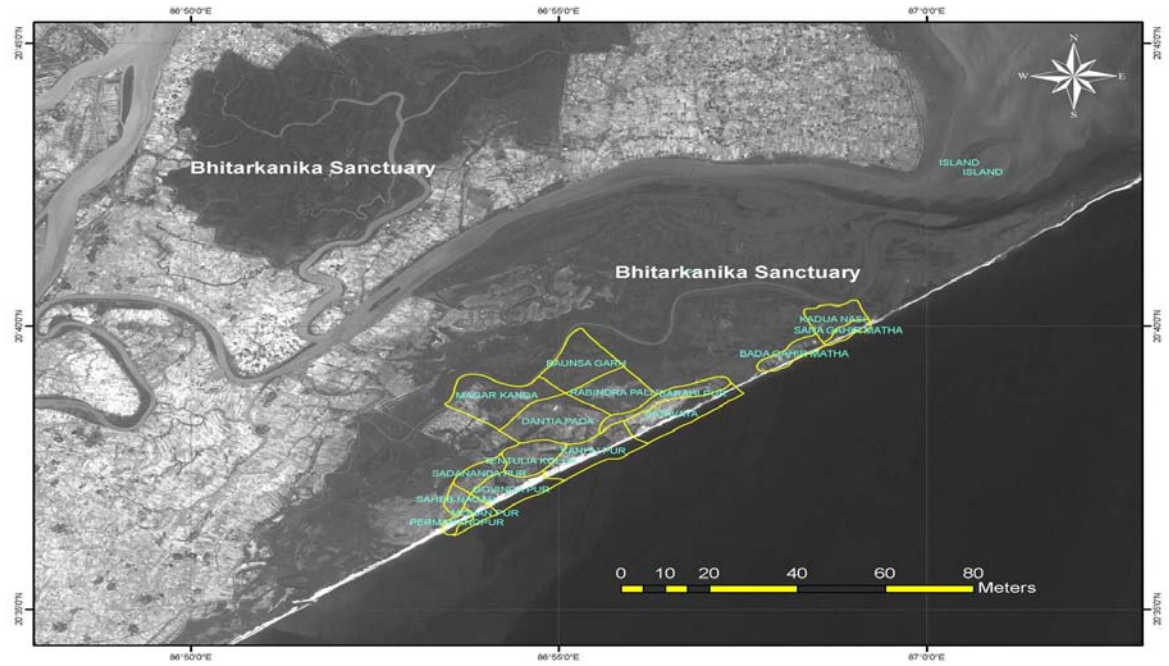

Figure 3 IRS P6 LISS III

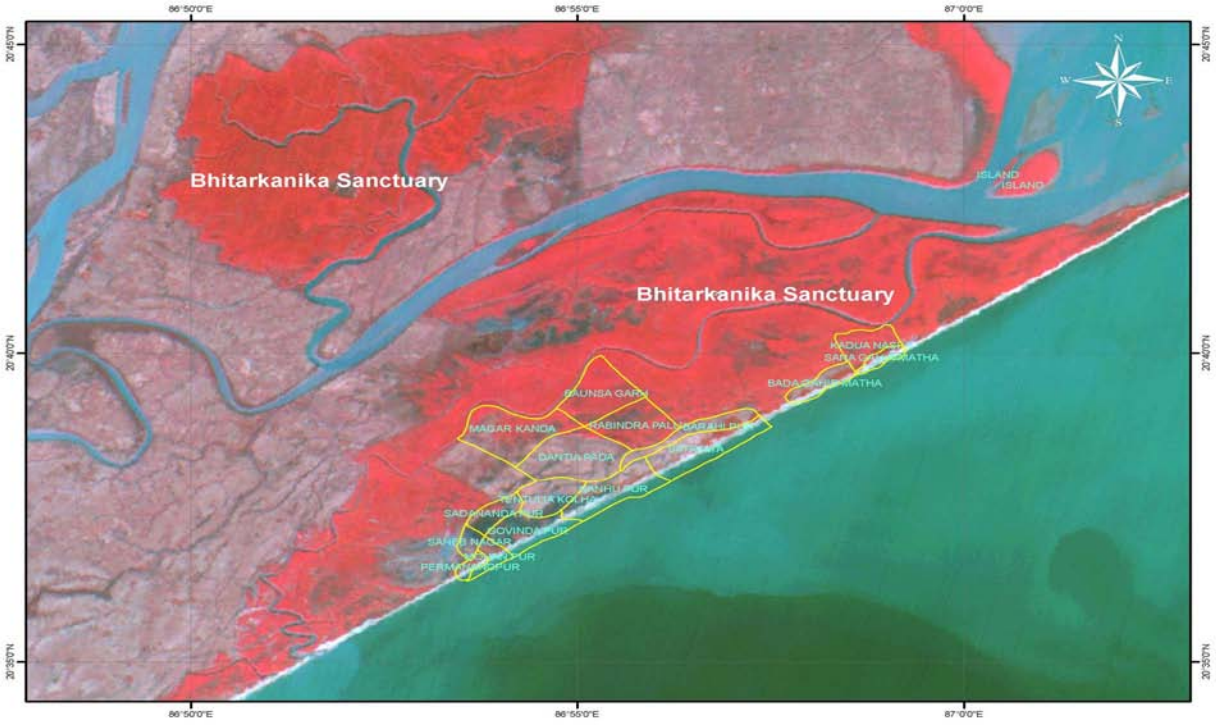

Figure 4: IRS P6 PAN

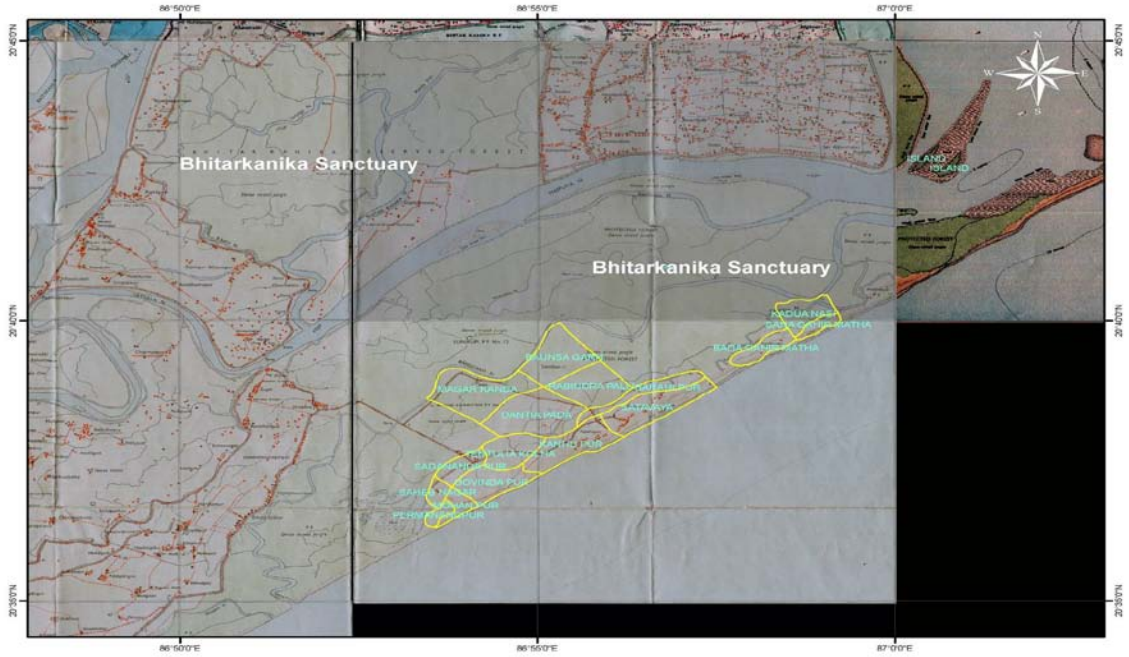

Figure 4 TOPOSHEET IMAGE

TABLE 1- Coastline line change(M)	
Name of the village	**Coast line (m)**
Premanandapur	2.5
Govindpur	3.7
Mahanpur	3
Kahnapur	4
Satabhaya	3
Sana Gahirmatha	1
Bada Gahirmatha	1

5.4.2. SOIL QUALITY

In the Indian context, the continental shelf of 0-50 m depth spreads over 1,91,972 km2 and that of 0-200 m depth over 4,52,060 km2 area. The continental shelf is more stable than the coast and is wider (50-340 m) along the East coast. Notable among the past works was that of Yadav *et al*. (1983) who suggested 3.1 million hectare (M ha) area (including mangrove forests), while Szabolcs (1979) suggested 23.8 M ha under coastal salinity in India. Salinity in soil has a dual effect on plant growth via osmotic effect on plant water uptake and specific ion toxicities (Sheldon *et al*., 2004). Several factors, such as temperature, humidity, stage of plant growth, moisture, soil texture, soil fertility, etc., as well as their interactions influence plant response to soil salinity, which are not uniform and therefore present a complex mechanism. In the study sites the salinity increased after the monsoon season. The reason can be due to saline flooding of the coast. Organic carbon is an indicator of soil fertility. Soil organic carbon is important for the function of ecosystems and agro-ecosystems having a major influence on the physical structure of the soil, the soil's ability to store water (water holding capacity), and the soil's ability to form complexes with metal ions and supply nutrients. Organic carbon of the soil increased post monsoon.

Table 1 SOIL QUALITY ANALYSIS

		pH	SALINITY	ORGANIC CARBON(%)	PHOSPHATE	POTASH	BACTERIAL COUNT
PRE-MONSOON	SITE 1	6.03	0.45	0.10	54.00	108.60	2.05
	SITE 2	6.37	0.80	0.12	18.00	327.60	2.17
	SITE3	6.58	0.15	0.15	27.00	487.20	2.38
	SITE4	6.74	0.71	0.25	24.0	103.30	2.64
POST-MONSOON	SITE 1	6.13	0.36	0.20	50.45	100.56	2.15
	SITE 2	6.25	0.95	0.20	20.90	320.85	2.24
	SITE3	6.60	0.10	0.30	25.89	450.75	2.37
	SITE4	6.81	0.62	0.32	22.90	100.00	2.92

From the results it's clear that bacterial counts are more in post than pre monsoon in the soil samples. This means that some favorable conditions such as suitable moisture, ambient temperature have contributed to this increase in bacterial load. The increase in load can be well correlated with high values of pH, salinity, which also shows similar trend of higher value in post than pre monsoon season irrespective of the samples (place from where water collected). The amount of organic carbon (%) and phosphorus (kg/ha) is higher in site 4 and lowest in site 1 in both pre and post monsoon. This higher value of organic carbon and phosphorus and pH range between 6.05-6.8 and lowering values of salinity is very well reflected in more loads of bacteria in soil. So it can be concluded that site 4 is more microbiologically active and fertile than the rest and site 1 is least favorable as compared to all site under study. And post monsoon season is most suitable for microbial growth as evident from higher bacterial load. The reason may be attribute to proper moisture content in post monsoon (dry conditions in pre monsoon) and proper aeration, O_2 availability. For proper activity and growth of microbes pH and moisture is a must requirement. And this has supplemented with higher soil macronutrients of organic carbon and phosphorus.

5.4.3. GROUNDWATER QUALITY ANALYSIS

The ground water is basically used for drinking and domestic use. The water samples were collected by using wide mouth sterile transparent plastic jar of 5litre capacity. For the analysis of dissolved water samples were collected in BOD bottles of 300ml capacity. Also microbial counts were done for each water sample. Following variables were studied pH, Temperature, Nitrate, phosphate, Chloride, Calcium, Iron and microbial counts. Not much change was observed in post and pre-monsoon samples. Maximum temperature was found to be 33ºC and minimum 26ºC. All the parameters tested were found to meet the Indian standard prescribed for each variable in drinking water as well as WHO standards. The major impact of the shoreline change is also felt on the drinking water. Many of the tube wells located near shore have become non-functional owing to the saline surge and salination of aquifer. The Depth of getting fresh water has also increased from previous years increasing the cost of putting a new tube

well. The loss of functional tube wells has led to increase in number of people depending on a single tube well.

Table 2 GROUND WATER ANALYSIS

		pH	TOTAL HARDNESS	CALCIUM HARDNESS	MAGNESIUM HARDNESS	CHLORIDE	IRON	NITRATE
PRE-MONSOON	SITE 1	7.5	248	86	158	190	5.0	3.4
	SITE 2	7. 3	280	108	162	208	4.5	3.7
	SITE3	7.4	290	90	172	218	3.7	5.0
	SITE4	7.4	250	95	170	220	4.0	4.5
POST-MONSOON	SITE 1	7.5	255	90	163	195	6.0	3.8
	SITE 2	7.4	285	110	169	210	5.0	4.1
	SITE3	7.6	300	95	175	223	4.1	5.3
	SITE4	7. 7	260	98	172	228	4.2	4.8

5.4.4. CHANGE IN MANGROVE

Mangrove forests are a unique (Wilson, 2006), and one of the most productive ecosystems of the world (Qamar, 2009). Furthermore, they provide shelter and feeding sites in coastal environments (Kon *et al.*, 2010). Mangroves are one of the most biodiverse wetlands on earth due to their rich nutrient content (Ahmed, 2008; Jusoff, 2008). Mangroves also provide a physical habitat and nursery grounds for a wide variety of marine animals such as birds, reptiles, fish and mammals (Nagelkerken *et al.*, 2008; Wilson, 2006). In addition, the branches and leaves of mangrove plants are important forage for nourishment of domestic animals such as camel and cow in Iran. Materials such as Saponin, Flavonoid and Tannins which have remedial effects, are obtained from mangrove leaves. Mangrove wood is used in construction of buildings, as firewood and in the manufacture of charcoal and applied in local wooden industries for construction (Zahed *et al.*, 2010).

Bhitarkanika was part of Kanika Zamindari till 1952.When the Zamindari system was abolished and the area were vested with the State Government of Orissa, mangroves were considered as unwanted weed and were cleared for growing agricultural crop and settlement of colonies till 1970s. Thus, pristine mangrove areas were clear felled to rehabilitate settlers both local and Bengalis from neighboring states and even from Bangladesh during early 1950s. Realizing the importance of mangroves and concerns expressed by intellectuals over depletion of mangrove forest in Bhiterkanika, the State Government of Orissa declared it as Sanctuary in 1975 under Wildlife (Protection) Act, 1972. Subsequently, considering the zoolological, geographical, geomorphological and ecological importance of Bhitarkanika, the core area of the Sanctuary over an area of 145 Sq Km having the mangrove forests has been declared as a national Park in 1998.

In the year 1971 the coastal belt of Orissa experienced a serious cyclonic storm, which almost wiped out two coastal villages of Bhiterkanika facing Bay of Bengal i.e. Kanpur and Satbhaya, claiming lot of human life and livestock. However, the villages protected by mangrove forests were saved. Super cyclone that hit Orissa coast in Oct 28, 1999 has caused havoc with loss of human and cattle population apart from loss of vegetation and properties worth millions of rupees in Paradip and Erasama area in Jagatsinghpur. But no significant damage was done to Bhitarkanika area there by highlighting the role played by mangroves in protecting the hinterland. The winds speed and tidal wave invasion has been minimum to areas close to mangrove forest. (Hatoi et al, 1999)

Table 4 :Specific Uses Of Various Mangrove And Non-Mangrove* Species Of Bhitarkanika Conservation Area, East Coast Of India (Badola And Hussain, 2010)

Specific use	Species			
	Poles	Rafters and supports	Beams/Bars	Connectors
Timber	Heritiera fomes H. littoralis Cynometra ramiflora Avicennia spp	Phoenix paludosa	Avicennia spp. Bruguiera gymnorrhiza	Ceriops tagal P. paludosa Heritiera spp.

Fuel wood	C. tagal Bruguiera gymnorrhiza Heritiera spp *Tamarix dioica *Hibiscus tiliacea			
Thatching	*Phoenix paludosa			
Fodder	Avicennia spp. Myriostachya wighitiana			
Weaving materials	M. wighitiana			
Medicinal properties		Medicinal values		
	Heritiera fomes	Cuts/Bruises		
	Xylocarpus granatum	Oil (anti diarrhoeal)		
	*Pongamia pinnata	Oil (cure for skin diseases in human & cattle)		
	*Diospyros melanoxylon	For neutralizing the poisonous latex of Excoecaria spp.		
	*T. dioica	Stomach ailments		
	* Strychnos nux-vomica	Multiple uses		
Honey	C. tagal Sonneratia apetala Aegiceras corniculatum Amoora cucullata			

We did a matrix scoring as to understand the dependency of local people on the mangroves. Matrix ranking is a grid which represents relative value or preferences, by creating hierarchies of activities or items. We asked people to rank the usage of each component according to order to importance to them. The most important component was rated as five and least as one.

Table 5 Matrix scoring

Resource	Ranking
Fuel wood	****
Fish/ crab	***
Timber/construction material	*****
Honey	***

Mangroves as a source for timber, construction material was ranked most important usage this also included the thatching material, which is replaced every year before the rains. Also the main cause of this might be the constant movement of people due to coastal erosion. Fuel wood ranked second in terms of importance as a product from mangroves as most of the energy needs of the house is fulfilled by fuel wood collected from the mangroves. Bruguiera gymnorrhiza and Heritiera spp are most important fuel wood species. According to Badola and Hussain, 2010, 14.2% of the fuel need of each of the household was being met by the forests with a mean consumption of 312 kg wood annum-1 in Bhiterkanika conservation area. In this study area very few families reported of going for fishing, those who did worked with other village fishermen who had boats and ships. Of the 25 species of fish reported from BCA (Chadha and Kar 1999), 12 species were caught during the sampling. Of these Estuarine catfish (Mystus gulio), Gangetic koi (Anabas cobojius), Yellowtail catfish (Pangasius pangasius) and Giant catfish (Arius thalassinus) were the most common species (Badola and hussain, 2010). Families reported to be dependent on mud crab (Scylla serrata) and fish for their own during the lean months of food and money shortage. Honey harvested was generally sold to traders who came and collected. The direct harvest of mangrove products is rarely a full-time occupation for them, but many rely on these products to meet subsistence needs. For others, the harvest and sale of mangrove products is an important income supplement (Christensen 1982; Kunstadter et al. 1986; Diop 1993; Spalding et al. 1997; Lacerda 2002; Glaser 2003; Walters 2005). For the poor rural families, mangrove products have an emergency food provision function and constitute the main source of protein in their diet (Magalhaes et al. 2007). The social welfare of the traditional sector depends heavily on nonmonetary income or in-kind services provided by the undeveloped mangrove areas (Nickerson 1999).

The change in mangrove cover occurs both due impacts of natural hazards as well as over dependence of local people on the mangroves. People tend to rely on local resources for post – disaster reconstruction. Especially the frequent change in place of place of stay has led to increased dependency on the mangroves. Hence over the years there has been a change in mangrove cover. The mangrove cover once 23400 ha in 1975 was reduced to 22700 ha in 1980-82. The mangroves have increased from 1980-1982 status due to government initiatives. The increasing dependency on the mangroves can prove deterrent for further increase of mangrove cover.

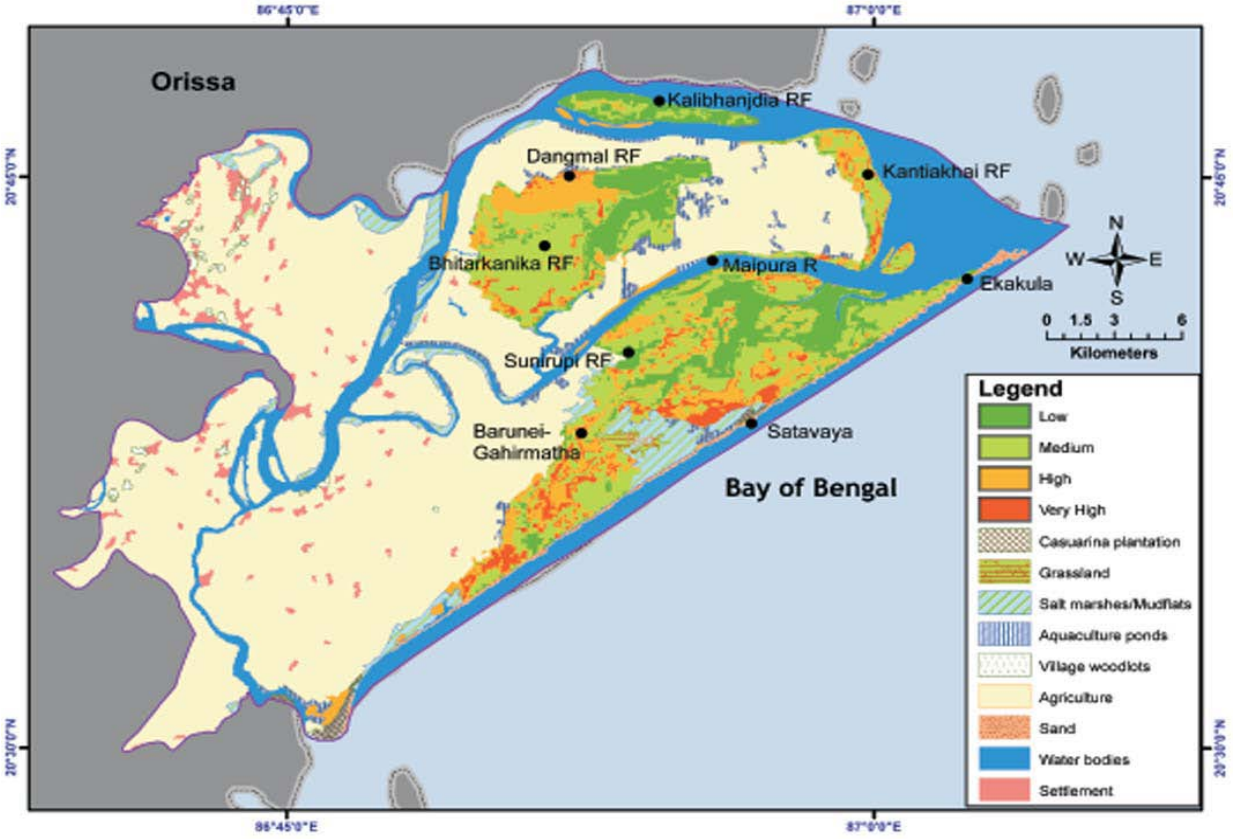

FIGURE 5 MAGROVE DEPENDENCY IN BHITERKANIKA CONSERVATION AREA(Ambasta et al, 2010)

TABLE 6 MANGROVE CHANGE

Mangrove Area Statistics Of Orissa			
period	area in ha		Source
March,1975	23400		NRSA
Nov,1975	22575		ORSAC
1980-82	22700		NRSA
APRIL,1984	21458		ORSAC
2005-06	20383.27	DENSE	ORSAC/NRSC
2008-09	3131.54	OPEN	ORSAC/NRSC

5.5. IMPACT ON COMMUNITY

People's ability to face hazards and disasters often conversely relies on strong and sustainable livelihoods, traditional knowledge, social capital and institutional support. Ways to reduce people's vulnerability and enhance their capacity to face natural hazards emphasize community participation and underline local contexts and everyday life (Anderson and Woodrow 1989; Maskrey 1989; Delica-Willison and Willison 2004). The concept of livelihood emerged in the late 1980s as an alternative to the technocratic concept of 'employment' to better describe how people struggle to make a living (Scoones 2009). Livelihoods thus refer to the means and capacities required to sustain durably people's basic needs. Basic needs are vitally linked to food, but also include shelter, clothing and social relations. Chambers and Conway (1991) define sustainable livelihoods as follow: 'A livelihood comprises people, their capabilities and their means of living, including food, income and assets. Tangible assets are resources and stores, and intangible assets are claims and access. A livelihood is environmentally sustainable when it maintains and enhances the local and global assets on which livelihoods depend, and has net beneficial effects on other livelihoods. A livelihood is socially sustainable which can cope with and recover from stress and shocks, and provide for future generations. In 1970, a cyclone engulfed Govindpur; 1971 cyclone and 1989 tidal surge submerged Bada kanhapur and a part of Sana kanhapur; 1999 super cyclone(with the wind speed >222 KMPH) has reduced Satabahya to almost a small group of hamlets.

Table 7: TREND ANALYSIS OF IMPACT ON THE COMMUNITY

SL NO.	FACTOR	1970	2009
1	**Condition of villages**	• 7 villages • Sea 2kms away from the temple	• 4 villages • sea 100m away from temple • salt embankment made 1979 • village reduced to 1/3rd of its earlier population
2	**Livelihood**	• People were engaged in agriculture only • Yield/ Ha from agriculture was satisfactory, enough to sustain families all through the year • Vegetables were also cultivated • Animal husbandry was profitable • Village was self sufficient	• After saline flood due to increased salination, migration has started. • Yield/Ha has reduced • No vegetables as fresh water level decreased. • Number of animals have decreased. • Large-scale migration
3.	**Vulnerability**	• Sea was 2kms away • No warning system • No evacuation • Dense mangroves	• Sea now 100mts away. • Warning from authorities • Decrease in mangroves
4.	**Govt Policy**	• Less information regarding govt policies • No relief after natural hazards	• More information and better implementation. • Better relief and post disaster mitigation.

5.6. ADAPTATION BY THE COMMUNITY

Adaptation by the community to natural disasters can be through technical strategies or non technical strategies. Technical strategies include combining materials for house construction, raising height of the floor, making the house thatch before the rains. Non technical strategies might include ensuring food security, livelihood security, community networks etc. The demand for rehabilitation from the state as well as the change of coastline keeps the community moving from one one site to other. Structural adaptation by the community was observed to be minimum. The constant shifting of house and less number of helping hands(most of the youth are working outside) can be the major reason behind it. Majority of respondents reported that they re-thatch the houses before the rains and also make the walls thicker. Currently, the predominant occupation is agriculture. They are involved in growing only paddy during the monsoon season from mid June to November. Thus it leaves them free for almost half of the year. Only 4% of the farmers have their own cultivable lands where as 31% are agricultural laborers' in the Panchayat. Some landless families also work as share croppers (accounting for 12%), while 32% work as laborers in the Southern states basically in industries or construction companies.

A trend analysis (Table-7) on the livelihood options and avaibility to the present day asserts the fact that they are on brink of annihilation as a sources of livelihoods have shrunk. With no other acquired skills they are forced to migrate to different parts of the country in search of work. 90% of respondents reported their family members working in Kerala. The impact of migration is well known. Migration, whether permanent or temporary, has always been a traditional response or survival strategy of people confronting the prospect, impact or aftermath of disasters (Hugo 1996). Disasters serve as indices of the success or failure of a society to adapt, for whatever reasons, to certain features of its natural and socially constructed environment in a sustained fashion (Oliver-Smith 2002). In 1998, for the first time since records have been kept, natural disasters accounted for the displacement of more persons worldwide than wars or other conflicts (http://findarticles.com/p/articles/mi_qa3970/is_200401/ai_n9353848/).

First major coping strategy that almost all respondents reported was diet rationing i.e. people ate less so as to save on the food they have for those days. 45% families reported depending upon non-cooked food items like beaten rice or similar things that are stored before the rains start. Petty shops store the stocks like food items, battery and recharge coupons before the rains. All the households store firewood before the rainy season. 86% of all the respondents' reported postponement of celebrations or avoidance during rainy season.

Wedding if held in rainy season is always held outside the village in a temple. 92% of families reported of running deficit on the financial resources. 24% reported of taking loans or pawning their assets such as gold, land etc. 26% reported not able to refund the loan installments. The paddy is often sold during the financial crisis. The physical isolation of some coastal communities makes them highly resource-dependent and reduces access to alternative livelihoods; this can make them especially vulnerable to any disruptions.

In the absence of any doctor in the village they have to rely on quacks and ASHA (Govt trained midwife) for any medical eventuality. When asked if they experienced any medical ailment during the rainy season, 66% reported of having them. According to them, the children and the aged had reported most cases of fever and diarrhea.

Though ladies are not directly involved in agricultural activities in the field, they help in post harvest operations. From paddy, rice is made and different products of rice like beaten rice and puffed rice is made and saved for the whole next year. They also work as agricultural labours if family needs an extra income. Besides, they collect crabs and firewood from the adjacent forests. Capacity to cope is dependent on the opportunities for alternative livelihood. Since, no feasible alternative exists, they are forced to migrate in search of jobs. This may be attributed to demand of easy labour in the unskilled sector.

Migration of people as a coping strategy still remains highly debatable. The dominant perception of migration among policy makers, academics and officials in India continues to be that migration is more for survival and the migrants remain poor. The image of the migrant

continues to be that of a powerless, impoverished and emaciated person who is trapped in poverty (Deshingkar and Start, 2003). Environmental disruption is recognized as both a cause and a consequence of population movements (Black 1998). It is a cause when people can no longer gain a secure livelihood in their homelands and are obliged to flee, having no other alternative. It is a consequence when environmental degradation results from the mass movement of people, both in the departure and the receiving areas (Gemenne et al, 2006). In Western Sudan, for example, studies have shown that one adaptive response to drought is to send an older male family member to Khartoum to find paid work to tide the family over (McLeman and Smit, 2004).Thus, migration has been characterized as both successful adaptation as well as adaptation failure.

6. SUGGESTED DRR STRATEGIES

6.1. Community/ social level

Policy interventions need to be addressed at social/community level, improving infrastructure level and economic level. Level of preparedness plays a major role in reducing the impact of the disaster on the community. For a community to be prepared for any natural hazard, they need to realize that they are at risk. In the study area the community though is aware of the risk it faces it is not totally prepared. The main reason as claimed by the people is they have little resources to spare for other than meeting their daily needs. Also the number of helping hands has decreased as the majority of people are migrating out of village for work. These factors must be taken into account while designing any DRR programme and the whole community should be brought together to understand the risks they face and also their vulnerabilities. Local people are the first responders to any disaster, so disaster risk reduction programmes must work to strengthen self reliance and resilience (Oxfam, 2007). Community based DRR have been very successful in many countries. Early level preparedness like among school children and women who are general the worst sufferers can be an effective way of reducing disaster risk. Better warning systems can go a long way in helping people avoid disasters. Every community has indigenous way of predicting natural disasters; these practices should be recorded and used. With the increased use of mass communication both in print media as well

as televisions, media needs to play a proactive role in advocating preparedness for disaster. Better infrastructure like pucca houses can help reduce high velocity cyclonic winds. The red cross made cyclone shelters in the coastal Orissa helped save thousands of life during supercyclone of 1999. Similarly better roads aid the evacuation process. Infrastructure must be built to withstand local conditions and hazards, and a careful analysis of the risks is vital before construction starts. For example, in sandy areas experiencing cyclones, buildings need to be built with deeper foundations. In India, traditional houses of wood and stone survived the Uttarkashi earthquake in 2000, while modern buildings collapsed. Similarly, during the Kutch earthquake, Bhunga circular houses with thatched roofs suffered from minimal damage. Important way of increasing community resilience to disasters is to enhance the financial safety nets. Better insurance policies and available of credit locally can help them tide over the immediate crisis. Helping communities diversify livelihoods has been known to increase the community resilience.

6.2. ECOSYSTEM AND NATURAL RESOURCES MANAGEMENT

Ecosystem based disaster management refers to decision-making activities that take into consideration current and future human livelihood needs and biophysical requirements of ecosystems, and recognize the role of ecosystems in supporting communities to prepare for, cope with, and recover from disaster situations. Healthy ecosystems both reduce vulnerability to hazards by supporting livelihoods, while acting as physical buffers to reduce the impact of hazard events. Developing and protecting wetlands for instance can help reduce the onset of flood. Similarly mangroves have been debated as having storm protection values.

6.3. LEGISLATIVE

India has many legislative acts that are aimed at disaster risk reduction. Coastal zone regulations, 1991 help limit the development in the coastal zone. Similarly Disaster management Act 2005 lays down provision The Act provides for establishment of National Disaster Management Authority. Major functions are to lay down policies on Disaster Management, approve the National plan, approve plans prepared by Ministries/Departments of

GOI, lay down guidelines to be followed by State Authorities in drawing up state plans, coordinate enforcement and implementation of policies and plans, recommend provision of funds for mitigation and take measures for prevention, mitigation, preparedness and capacity building for dealing with threatening disaster situation or disasters.

7. CONCLUSION

From the above discussion it is evident that the natural hazards have induced environmental change in the given study area. The environmental change has increased the vulnerability of the residents. It also has shaped the people in terms of their livelihood, lifestyle etc. The community has tried to adapt with short term strategies. But if there has to be included in the mainstream, better long standing measures needs to be planned and implemented. A holistic approach from economics, ecology, natural sciences is needed to address the present problem along with disaster risk reduction strategies.

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