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Assessment of Prolonged Unsafe Conditions through Tidal Flood and Rain water Flood at Lower Bengal Basin, India

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Abstract

Khejuri police station is located at the lower Bengal Basin near the Hugli river mouth under Midnapore (east). It is considered as a littoral tract region having monsoon climatic character. Naturally this area is known for its agricultural potential. Rice, Betel leaves, Lemons and various types of vegetables like potato, Brinzal, Chilli, Sugarcane stick etc. are the main crops produced which are sent to local and national markets which is important in the context of national trade. The present paper seeks to analyze the problems of land degradation due to recurring water logging that has been instrumental in losing the earlier glory of the area as an agriculturally potential tract.

Keywords: Water logging; Bengal basin; Littoral tract; Agricultural potential

Introduction

Khejuri a part of Kanthi coastal tract (regionally extended from Rupnarayan River to Subarnarekha delta around Hugli estuary) is associated with several beach ridges and sand dunes and intervening tidal flats at the south west of this area [1]. The area is also formed under deltaic floodplain environment of Hugli estuary. Later the area was modified by tidal process. This coastal low land tract lies at a height about 2-3 m above mean sea level. The beach ridges and sand dunes of this area are partly obliterated, segmented and cut by tidal waves, anthropogenic activities and weathered in sub aerial environment [2]. These coastal features suggest that the area was once lying under older coastal control and estuarine environment. Belong a low land area, Khejuri is also prone to water logging, flood risk and storm hazards due to estuarine location [3]. The entire area is protected by earthen embankment to avoid water logging during storm and high tide episodes [4,5].

Water logging is one of the major problems of land degradation in India. Unscientific management of soil, water and crops in irrigated lands and obstruction of natural drainage systems by various developmental activities are the main factors responsible for disrupting the balance of inflow and outflow of water, leading to water logging [6]. While irrigation has increased by leaps and bounds, its attendant problem of water logging is now plaguing substantial area of agricultural lands.

The Study Area

Khejuri Police Station is formed of two blocks namely, Khejuri- I and Khejuri- II, extending between 21°47'4" N to 22°4' N latitudes and 87°45'4" E to 88°18' E longitudes covering an area of 267.97 Sq.km. (Table 1).

Block	Area (Km^2)	% of Area to total district area	Physical Boundary
Khejuri-I	130.51	3.04	Talpati channel in the North. Rasulpur in the South. Khejuri – II in East. Thakurnagar Khal and Bhagwanpur-II Block in West.
Khejuri–II	137.46	3.20	Talpati channel in the North. Hugli river in the East. Rasulpur in the South-West. Khejuri – I in the West.

Table 1: The physical properties of the study area according to block.

Khejuri is a part of coastal plain of west Bengal by the western bank of giant funnel shaped Hugli estuary, lying just to north of Bay of Bengal (Figure 1). Hence this area is frequently attracted by cyclones that take of course along the Hugli estuary. At the event of a cyclone amplification of storm surges causes inland flooding of vast area [7]. Some devastating cyclones like Calcutta cyclone (1737) Midnapore cyclone (1864, 1942) Sundarban cyclone (1988 and 1989) many other cyclones occurred during October and November and even 'Aila' of 2009 struck Khejuri due to its estuarine location [8]. The south-west monsoon (June- September) appears in the lower Bengal with a series of depressions developed at the head of the Bay Bengal and also recedes from west Bengal (Oct. Nov.) by forming depression over Bay of Bengal [9]. Among these depressions at least 80% (Table 5) turn into storms and lash on the coastal area of Bengal Basin. Usually, high monsoon rainfall over Bengal coastal plain, downstream discharge of

Bengal Rivers and the seasonal high seas of the Bay of Bengal modify tide and surges during cyclonic episodes.

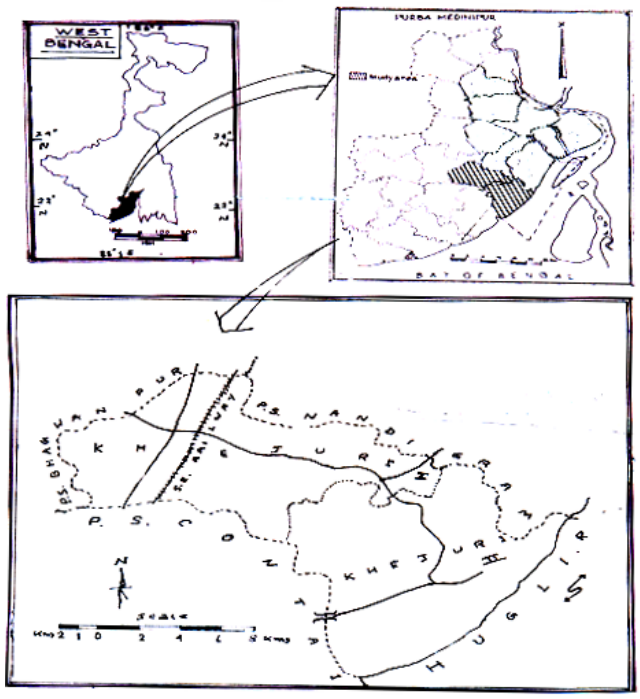

Figure 1: Location Map of the Study Area extending between 21°47'4" N to 22°4' N latitudes and 87°45'4" E to 88°18' E longitudes.

Identification of Water Logging Conditions

An irrigated area is said to be waterlogged when the surplus water stagnates due to poor drainage or when the shallow water table rises to an extent that soil pores in the root zone of a crop become saturated, resulting in restriction to the normal circulation of the air, decline in the level of oxygen and increase in the level of carbon dioxide [7]. The actual depth of water table, when it starts affecting the yield of the crops adversely, may vary over a wide range from zero for rice to about 1.5 meters for other crops. A Working Group constituted in 1991 by the Ministry of Water Resources to identify the problem areas affected by water logging/ salinity/ alkalinity in existing irrigation projects in the country and to suggest suitable remedial measures for their reclamation adopted the following norms for identification of waterlogged areas (Table 2): Some States, however, have adopted different norms for defining waterlogged areas according to their own conditions and perceptions.

Major causes of water logging condition over the study area

The prime causes of water logging condition of this geomorphic part have been identified by the present researchers as well as the Administrative Department of East Medinipore. These causes are very frequent in nature in this part of lower coastal littoral tract. The causes are as follows:

a) The earthen embankment of the river Rasulpur and Hugli are in very poor condition.

b) The excess water of the river Subarnarekha from Orissa over flown and becomes stagnant during the rainy season which inundates the coastal part of Khejuri.

Water logged Areas (Due to rise in water Table)	Water table within 2 meters of the land surface
Potential Areas for water logging	Water table between 2 to 3 meters below land surface
Safe Areas	Water table below 3 meters of land surface

Table 2: The norms for identification of waterlogged areas according to their own conditions and perceptions.

C) Sea coast saving embankment is in weak condition. Some time it is broken by the lashing of wave water and allows the tidal water to enter into the low lands of the area.

d) In some parts, the old embankments are very so weak that after heavy rain that are unable to withstand the water pressure and thence undergo wreckage.

e) Over flow of the river Rasulpur, Hugli and the water surges of Bay of Bengal frequently inundate the three sides (Excluding western) of Khejuri even in pre and post- monsoon period.

District administration have also declared Khejuri- I, as light flood zone and Khejuri- II, block as the cyclonic and flood prone zone (Disaster Management Plan of Purba Medinipur, 2002, Office of district Magistrate). In course of time the tidal canals of the study area have fallen victim of decay and causes water logging.

Man-made causes

i) The entire southern part of Khejuri belt adjoining the Hugli and Rasulpur River is known as "JALPAI" which means an area from where huge fuel-wood was collected for making salt from brine [10]. Once one a time Khejuri was noted for making this type of salt. So it paved the way for massive deforestation causing enormous soil erosion in this area. Naturally this erosion helped silting in the river bed.

ii) The density of population here demands varieties of trees and plants in place of mangrove swamps seemingly less valuable in the eyes of the people of this place. But its saline environment, only suitable for mangrove swamps, cannot stand the indiscriminate felling of these trees and so it causes quick erosion of soil and silting.

iii) The natural flow of the tidal channels here is mostly impeded for fishing purpose by way of casting nets and making petty cross earthen embankments in these channels. For example Hijili Tidal Canal (H.T.C.), once an important waterway for trade and commerce, is now mostly obstructed for fishing purposes.

iv) As per need of human habitation here many 'khals' (narrow tidal channels linked with the big tidal channels) have been occupied forcibly by way of filling mud into the beds of these. Secondly, culverts and foot-bridges have been constructed for communication and transport. All these cause obstruction in the natural flow of water in these channels.

v) In the past, up to mid-19th century brine was allowed to enter into the channels for making salt. But now salt making is totally stopped and brine is not allowed to enter as was previously done. So there is dearth of easy flow of water.

vi) More over brine is not helpful for agriculture. So it is not allowed to enter through channels. It can be referred that, in 1832 an earthen embankment was constructed by the then British government around the river side for the purpose of restraining brine for agriculture.

Natural causes

i) This area is recognized by National Atlas and Thematic Mapping Organization, Govt. of India as recent alluvial zone. Consequently, it facilitated the quick erosion of soil.

ii) Actually Khejuri is situated to the north part of the Digha-Kanthi coastal sand dune belt. Once there were also many sand dunes over the area. Due to repeated cyclones, storm surges and some man-made activities, these sand dunes were destroyed prompting future siltation in channel beds.

iii) For its geographical location by the side of Hugli mouth, sea wind and waves are strong enough to cause erosion and silting simultaneously.

Water logging scenario in the study area

Water logging may be a result of both natural and man-made factors. Natural factors may include poor natural drainage as a consequence of unfavorable sub-soil geology like existence of hardpan at shallow depths; spilling of rivers resulting in submergence of agricultural lands; heavy storm rainfall event etc. [11]. Water logging is, however, caused mainly because of man-made factors like deforestation. Developmental activities such as construction of roads, bridges and dwelling houses lead to the choking of natural drainage.

Even a rain having duration of few hours causes water-logging for few days. All the Gram Panchyayets (G.P.) of Khejuri-I block except the Kamarda and Kalagachia G.P of the study area water logging is very common. Inadequacy of outlets for drainage of rain water; entry of high tide water along the channels hindering passage of excess water of rain and flooding due to embankment breaching are the causes behind water logging in this area. Not only in 1942, had most of the area under study remained under the water of height about 5 feet by only one day cyclonic rain of 5 hours duration on 25th May, 2009 kept the entire of Khejuri block especially the river side low lands, under water of considerable depth. On the year 2005, the one day rain of 3 hours duration kept the water standing up to two feet height in the central part of Khejuri II block along the river side low lands.

The following Tables 3 and 4 gives an idea of severity of the problem in the area by representing the effects of a 7 days rainfall event in 2004. So far as the month wise distribution of storms and depressions originating in Bay of Bengal is considered. There is a remarkable concentration of such events in October and November. During this post monsoon phase of hydrologically saturated regime, occurrence of cyclones with high rainfall leads the area to be affected severity by flooding.

The tropical storms and depressions for the period 1971-1990, except for a small number that formed over land during the south west monsoon months, June to September, all the remaining disturbances were of sea origin. The monthly frequencies of occurrence of a period for the last 20 years are given below (Table 5).

Khejuri-II Block	
Causes of calamity	Continuous Rain fall
Occurrence period of rain	3rd to 7th October, 2004
Affected area	116 sq.km. out of 133.96 sq.km
No. of mouzas affected	95 out of 99
No. of people affected	1,13,940 out of 1,17,409
No.of house affected	368
Damage of crops in hectares	2417 out of 4616
Pan boroj (Beetle leaf Garden) affected in hectare	122
Relief measures	Tarpaulins sheets, cloths, ice, medicines, water pouches distributed from different sectors.
Source: Block Development Office, Khejuri-II D.R.Cell,Memo No. 1165 /14.10.2004.	

Table 3: The Prime Causes of Water Logging Condition During the October 3rd to 7th in 2004 at Khejuri-II Block.

In effect of the Cyclone 'Aila' a large section of backward and marginal people of the area became homeless and their suffering knew no bounds. Mainly sea facing villages like Pachuria under Khejuri –II block submerged after bursting of sea dyke [9-11]. 6 rescue camps at Khejuri-II were set by the Government to provide immediate relief and support to about 20,000 affected people.

Sl	Names of the G.P.	Types of the Crops						
		Beetle vine yards in hectare			Summer vegetables in hec.		Orchard in hec.	
		Area Covered	Affected /Damaged	No. of Boroj	Area Covered	Affected/ Damaged	Area Covered	Affected / Damaged
1	Heria	3	2	30	23	10	12	4
2	Lakshi	4	2.4	65	25	15	10	5
3	Tikashi	5	5	50	15	10	10	5
4	Birbandar	5	5	60	10	5	5	3
5	Kamarda	10.5	5	150	5	3.5	4	3
6	Kalagachia	7.5	5	120	5	3.5	5	3
	Total	35	24.4	475	83	47	46	23
Source: Agricultural Development Office, Khejuri –I Block, (30/5/2009).								

Table 4: Statement Showing the Damage Due to Water-Logging by Heavy Rain Fall on 2004, Khejuri Police Station, West Bengal.

Type of Calamities	Jan	Feb	Mar	Apr	May	Jan	July	Aug	Sep	Oct	Nov	Dec	Total
Storms	1	0	0	2	11	3	3	4	7	16	27	8	82
Depressions	2	0	0	0	1	13	11	29	10	15	7	8	96
Total	3	0	0	2	12	16	14	33	17	31	34	16	178
Source: An addendum to the storm track atlas 1877-1970. Indian Meteorological dept.-1996, Mousom Bhaban New Delhi, Page i.													

Table 5: Monthly Frequencies of Storms and Depressions in Bay of Bengal Region (1971-1990).

Due to breaching of embankment along Rupnarayan River area in its western part of Khejuri –I Block got inundated. Following table (Table 6) has given the detail of damage impacts of 'Aila' 2009 in Purba Medinipore District.

Name of District	Name of Sub-Division	Name of Block	No. of Affected Village	No. of House Fully Destroyed	No. of House Partly Destroyed	Population Affected	Sector of Population Most affected
Purba Medinipur	Contai	Contai-I	50	60	1000	25000	Fishermen and Marginalized Families, Children, and women
		Contai-II	40	75	500	20000	
		Bhagwanpur-II	25	7	400	15000	
		Ramnagar-I	75	15	750	30000	
		Ramnagar-II	65	10	500	25000	
		Khejuri-I	20	10	500	20000	
		Khejuri-II	30	215	350	12000	
Source: Cyclone Aila report of W.B.Govt. 2009.							

Table 6: Damage Impacts of 'Aila', 2009 in Purba Medinipur District in Terms of House and Population.

A few low lying pockets in the area faces water logging during kharif season due to poor drainage system resulting from deposition of silt along the drainage channels. The total drainage length is sufficient for the area but the problem may be solved properly. Most of the channels are virtually connected to the two rivers-Hugli and Rasulpur river. Hence, there happens ingress of saline tidal water dominantly during summer months, which increases the salinity of the area. This may be prevented by constructing sluice gates on selected drainage points.

The inherent salinity being at considerably lower level is not a problem for the area. Some areas which are very frequently flooded by saline tidal water during high tide become highly saline. This problem gets minimized on repeated washing by the rain water during Kharif

season. In some Entisol area sub-soil salinity increases during Rabi season if faulty irrigation practice is followed. The growing of salt tolerant crops with a limited irrigation is suggested. In the pre-monsoon summer months, the unsaturated coastal soil of the area may be encrusted with salt by saline water when large cyclone passes over the area with high tidal waves [12].

Logging of saline water has not only worsened the agricultural practices but also it prompted the spread of some tropical disease like Malaria, Blood dysentery, Small Pox and Cholera. The saline ocean water is stored in the ditch like low lands for the salt preparation in this coastal region. Salt is manufactured during the months from January to May. After that, in the rainy season rain water mixes with the saline water disabling the process of making salt. This stored water creates an unhygienic environment offers an ideal place for mosquito breeding and Malaria spreads. So the people of this area are used to be attacked by a native proverb goes as -'It is one thing to go to Hijli but quite another to come back alive'. When Job Charnok took shelter over here in 1687, Khejuri was then attacked with a severe Malaria episode [13].

Characteristically Khejuri is an alluvial tract, similar to most districts of the Gangetic plain in lower Bengal. So the environment had always been conducive for living. Just 500 years ago people from Western side of this tract came over to here for living and were mostly engaged in salt manufacturing, agriculture and collection of sea fish. The anthropogenic modifications of the landscape upon increasing population pressure have added much fuel to the water logging problem (Table 7) [14].

Population density Classes	1951	1961	1971	1981	1991	2001	Average growth rate/ year 1951-1961	Average growth rate/ year 1961-1971	Average growth rate/ year 1971-1981	Average growth rate/ year 1981-1991	Average growth rate/ year 1991-2001
Below 401	79	55	34	21	14	7	-3.04	-3.82	-3.82	-3.33	-5
401-800	44	62	74	77	54	45	4.09	1.94	0.41	-2.99	-1.67
801-1200	7	14	18	24	44	50	10	2.86	3.33	8.33	1.36
1201-1600	3	1	8	8	17	18	-6.67	70	0	11.25	0.59
Above 1600	0	2	1	4	8	17	0	-5	30	10	11.25
Depopulation	7	7	6	7	4	4	0	-1.43	1.67	-4.29	0
Total	140	141	141	141	141	141					

Source: District Census Hand Book, Govt. of India, 1951, 1961, 1971, 1981, 1991, 2001. N.B.: After 1951 AMouza Named Kamdebnagar (J.L. No. 142) was formed.

Table 7: Temporal Change in Number of Mouzas of the Study Area under Different Population Density Classes (1951-2001).

Long term problems produced by water logging conditions

The study area, a part of the Gangetic alluvial plain in lower Bengal, receives medium-high rainfall (average 175.26 cm/y) and the soils have developed from sand and clay brought down by the river Ganga from the country above. Moreover, the area is situated near the sea coast and low-lying areas are traversed by tidal river and creeks. All these factors collectively play and increased the soil salinity and set negative impacts on agricultural crops [8-11] (Table 8). Other rivers being incapable of holding excess water during monsoon are apt to overflow and cause serious damage to standing crops. In the events the period of inundation, large section of the area covered by deposits of sands. To keep the area out of these floods, many embankments have been constructed around flood prone areas, called 'circuits'. As such much of the alluvial tract is consequently crisscrossed with a network of embankments. Transverse embankments are constructed across the channels which prohibit ingress of tidal saline water but accelerate the silting process causing decline in the capacity of channels to hold water.

Name of Block	Saline			Alkaline			Acidic			Micro Nutrient Deficiency			Soil Erosion			Water Logged			Total
	Mild	Severe	Area (Hec.)	Mild	Severe	Area (Hec.)	Mild	Severe	Area (Hec.)	Mild	Severe	Area (Hec.)	Mild	Severe	Area (Hec.)	Mild	Severe	Area (Hec.)	
Khejuri - I	725	0	725	0	0	0	0	0	0	300	0	300	0	0	0	300	200	0	1525
Khejuri - II	545	0	545	0	0	0	0	0	0	0	0	0	0	0	0	250	150	0	945
District Total	8640	0	8640	425	0	425	2420	0	2420	5585	0	5585	2660	75	2585	10415	5635	2175	37405

Source: S.R.E.Plan PurbaMedinipur, 2006, page-III/2.

Table 8: Soil Problems in Terms of Salinity, Alkalinity and Acidity in Khejuri Block.

In the coastal area, embankments of extensive length are required for protecting the coast line from the invasion of river, for preventing the inrush of salt water along tidal creeks and for avoiding the submersion of low lands by the rivers overflowing their banks. In most cases, the river have ceased to be a drainage channel and water holding capacity diminishes as its approaches towards mouth, while its bed rises in elevation.

Embankments are thus urgently required in the tidal areas for protection of the lands in the interior, which slope away from the rivers and form saucer-shaped hollows between them. It is said in Hijili, that a single overflow of salt water is fatal to crops for the next three years [15]. Poorly managed embankment of river system and utterly neglected drainage systems are instrumental for water logging in the area which not only causes serious agricultural damages but also various infectious diseases to spread. Cholera took an epidemic form in 1901, 1902, 1906 and 1907. A death density of 25.8 people per square mile and 3.8 people per square mile were recorded in 1906 and 1907 respectively due to blood dysentery. A special investigation about the disease was made in 1906-07 by captain W.E.H. Forster, I.M.S. by whom a method of vaccine therapy was introduced. After that the death rate was checked. About 17841 lives were lost by smallpox in 1902, and in the coastal area the death density was 6.39 people per square mile [15].

Conclusions

Storm, tidal waves, flood, water-logging conditions etc. play jointly as natural causes of the degradation of agricultural lands. This has significantly reduced the agricultural field of the blocks under study. In addition to the natural factors, the anthropogenic factors have contributed much to the situation. Deforestation has emerged as a serious problem in the area that has naturally worsened the water logging problem more serious by weakening and exposing the embankments to the hazards. Hence there is a need for increasing safety of the area against water logging.

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