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Case Study

Problem in drainage outlet and it's management: a case study on selected villages of *Laxmi Janardanpur* Gram Panchayat under Patharpratima CD Block (Sundarban Delta Region) in South 24 Pargana, West Bengal, India

Kartick Chandra Mandal[1*] and Utpal Bose[2]
[1]Department of Education, Netaji Subhas Open University, India
[2]Department of Geography, The University of Burdwan, India
kartickcmandalpged@gmail.com

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Abstract

The flow of water through well decorated channels is known as drainage and the network of the channels are called drainage systems. The drainage system of an area is dependent on topography, Slope, nature and structure of rocks etc components. Sometimes drainage related problems occur due to some known and unknown reasons. This Research paper concentrated on the problems of drainage outlets and its impact on physical and socioeconomically also how to do manage it, on selected Villages of Lakshmi Janardhan Gram Panchayat of Pathar Pratima CD block in South 24 Pargana. Premature land reclamation and unplanned land use practices play a major role in creating drainage base some environmental problems such as drainage outlets problem Salinity and impeded drainage. This problem affects soil, Surface and Groundwater, Agricultural land and also overall livelihood of the area. More than 70 % of people in the study area are dependent on agricultural activities. They are highly affected due to the poor drainage conditions basically in monsoon season and also in atmospheric depressions. The main objective of the study is to analyze the impact of drainage outlet problems on the physical and socio- economic phenomenon of the respective study area. The work of the study has done through field Survey base on qualitative research method and secondary data after collecting the data through randomly from authentic sources it has been analysis and interpretation through the proper way the result finds out that this area suffering from the problem of drainage outlet in day by day basically in monsoon season. In this work, beside highlighting the problem and its impact on the physical and man-made environment of the study area, some authentic Management strategies have been stated to get rid of this problem. The study concludes that the consciousness of the local people in the study area is the main power to solve this problem, otherwise application of this method will be uncatched to solve this problem.

Keywords: Drainage, Drainage Systems, Topography, Drainage Outlets, Affects, Salinity, Monsoon Season, Agricultural Management.

Introduction

Sundarbans is an estuarine deltaic region of lower Ganga Basin. This region is geotectonically dynamic, unstable, immature, geomorphologically plain land with very gentle climatological hazards with destructive tropical cyclones, lithologically riverine as well as marine deposited Sediment and biologically diverse and unique[1]. The Laxmijanardanpur Gram Panchayat is established through destruction of mangrove forest cover and destabilization of natural land building processes. This is an immature island with rich fertile soil where more than 75% people are engaged in agricultural activities. The rest population is engaged in fishing activities with very few are in other sectors of economy[2].

A temporal pattern may also be developed on the ways of land utilization into two periods: pre-independence period and post-independence period in the study area. Colonial economic order forced the local as well as encouraging of people from surrounding emigration of people from surrounding districts, states to deforestation as much as possible. Arresting the natural flow of tidal rivers, creeks, lifeline in the area, through haphazardly constructed earthen embankments as much extent as in the low tide level. In this unwise way, brackish wild virgin land converted into a cultural landscape for expansion of agricultural land, and establishment of human settlement. In recent times, the unchecked population growth through nature along with influx of people and without maintaining the slope unplanned land use practices dwindle the natural equilibrium of the landscape ecosystem which lead to the drainage outlet problem. This problem also exists in the hilly region[3].

Location of the study area: Laxmijanardanpur Gram Panchayat under the study is a deltaic region of Patharpratima Block of South 24 Pargana District in Sundarban of West Bengal. The J.L. No. of the mouzas of Laxmijanardanpur Gram

Panchayat are Laxmi Janardanpur-187, Purba Chintamanipur-188, Kumarpur-189, Maheshpur-190, Kedarpur-191, Purba Dwarkapuri-192, the study area situated in the North-East part of Patharpratima Block and near about 20 km South-West of from Raidighi town. The latitudinal extension of the study area from 48°13'25" N to 51°22'54" N and 86°46'35" E to 88°30'15" E. Three major rivers are flowing along three sides of the study area, at North and West Mrydangabhanga river, Eastern side Kumari river and in Southern side Atar Gachhiya river.

Objective: The main objectives of the present study may be stated as below – i. To state the physical structure of the present study area. ii. To investigate the land use pattern in the present study area, iii. To examine the drainage outlet problem in the present study area, iv. To propose a solution about drainage outlet problems in the study area.

Hypothesis: i. Unplanned land use practices dwindle the natural equilibrium of the landscape ecosystem, ii. Drainage outlet problem extremely affected the agriculture, iii. Drainage outlet problem widely affected the livelihood.

Methodology

Field work base qualitative research method has applied in this work and more traces has been given on primary data and information which are collected through personal interview and local sources. The secondary data has been collected from the Laxmi Janardanpur Gram, Patharpratima Block office in South 24 Pargana District of West Bengal and various books, articles and journals. After collecting all types of primary and secondary data and information it has been sorted and represented.

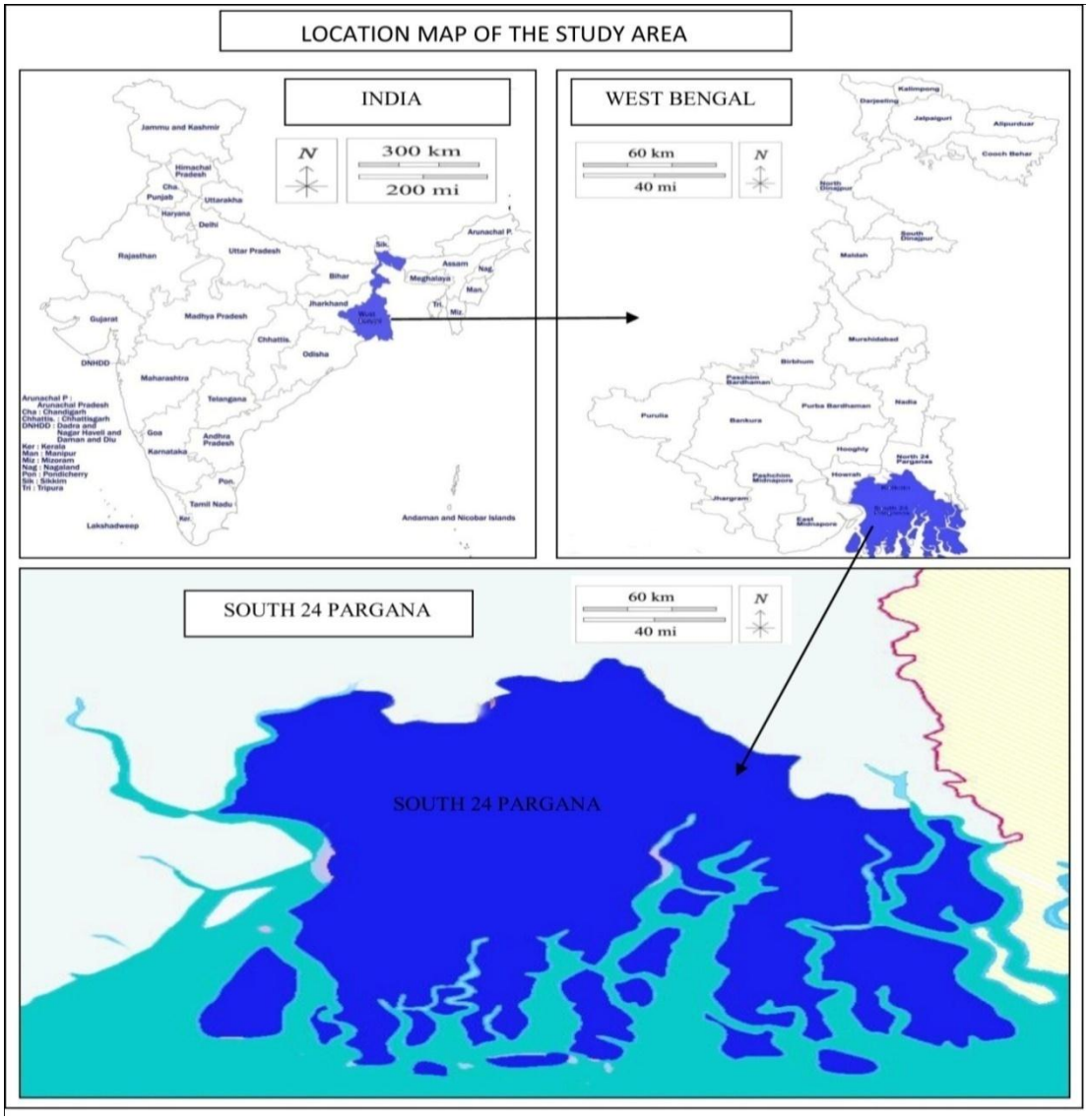

Figure-1: Location map of the study area.

Data sources: Data source plays a very important role for conducting any type of research work. Authentic Sources of primary and secondary data are stated below.

Sources of primary data: The major sources of primary data are as follows: i. Face to face interview and questionnaire survey with the victim of the selected area, ii. Questionnaire survey and face to face interview of the villagers, school teachers, member of local club and Gram Panchayat.

Sources of secondary data: i. The general information about natural as well as demographic and socio-economic set up of the district have been collected from the District Gazetteers, Census 2011, Google Earth Images and many other Websites, ii. Other information has been collected from different books, reports, e-journal and journals on the social structure and health issues on that study area.

Results and discussion

Physical profile of the study area

Geology: This study area is extremely sensitive due to subsidence trends, sea level fluctuations and basin tectonics which was formed by six phases of deposition[4]. This is solely by quaternary sediment carried and deposited by the rivers Ganges, Matla and Bidyadhari. The stratigraphic records from lithological logs and boreholes at many places from north to south and east to west portion, reveals that this is underlined by a thick aggregate of unconsolidated sediment comprising a succession of clay, silt, sand of various colour, grades and grave[5].

Topography: The study area belongs to the active deltaic plain land of Lower Ganga Basin. The general topography of the area is less varied. The average height of the study area is about 7 to 10 meter above mean sea level[4]. Several rivers, streams, channels are flowing in the area, the general slope of the study area from NW to SE. Topographically, being at the formative part of the Gangetic Delta the Sundarban as well as the study area is a naturally comparatively unstable landscape. The water courses are constantly shifting and ill-defined. Land formation in this area by transportation of sand, silt, clay, etc. materials through upland floods, occurring mostly in the monsoon months is supplemented by tidal activity[5].

Drainage: Sundarban region is land of rivers, numerous rivers are flowing in this region. There are three main rivers Mridanga Ganga river, Atargachhiya river, and Kuyemari river in the study area. Mridanga Ganga river is the major river of the area, which flows from North-East to South -West portion of the area. Kuyemari river is flowing along the eastern part and Atargachhiya river is flowing along the southern part of the present study area. Including Kakamari river and Kakmari khal, there are several streams, channels flowing over the study area[6].

Soil: The soil of the study area as well as Sundarbans is mainly derived from floodplain alluviums in nearest delta region and from tidal-marsh materials like organic matter. The soil is deep, poorly drained and has mineral compositions that are traceable to the bedrock parent material of the gneissic mountains of the Himalaya. The soils are silty clay to clay type in nature[7].

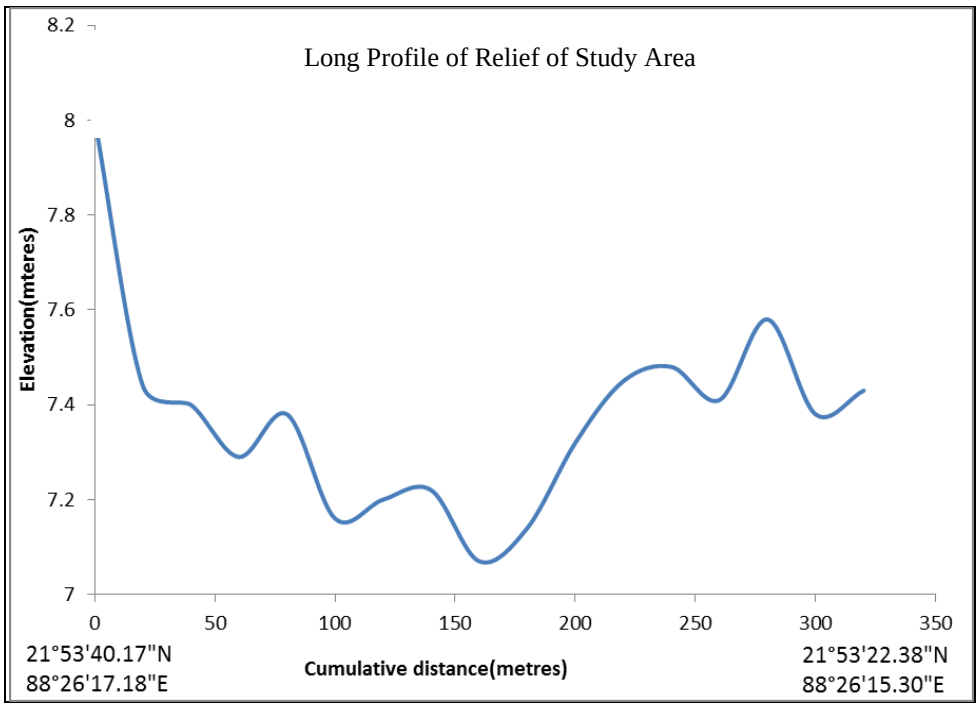

Figure-2: Long profile of relief of study area.

Climate: The general climatic characteristics of the study area is subtropical to tropical oceanic There are three main seasons viz. Winter (November to February), Summer (March to June), Monsoon (July to October) are easily recognizable in the study area. The annual rainfall range is between 1500 and 2400mm. The heavy rainfall happens during the monsoon season, which is 75% of the total rainfall of the year. The maximum and minimum temperature are respectively 36° in summer (March to June) and below 10° in winter (November to February) in the area. The maximum wind velocity is 16 to 50km/h (April to June) and minimum wind velocity is 10 to 15km/h (December to February) and frequently the area suffers from severe cyclonic storms like devastating Aila in 2009, Amphan in 2020 and Yash in 2021[8].

Natural vegetation: The natural vegetation or flora of the area today is confined only to the forest tracts, popularly known as halophytic conditions, Goran, Passur, Keora, Genwa, Bain, Tora, Baniia, Krippa etc. are the main plant species in the area.

Characteristics of the mangrove community: i. The stilt roots which both support the plants and their means of respiration. The Garjan (Rhizophora apiculata), Genwa (Excoecaria agallocha) and Jelegaren (Crisps decandra) are examples of such plants. ii. Another feature of this community is the presence of breathing roots. iii. Many plants have salt-excretory glands. iv. The cell sap develops high osmotic pressure which helps the plants to draw water from the concentrated soil solution. v. Many of these plants have viviparous germination[6].

A wide group of the grasses, climbers, shrubs etc. also found in the study area.

Drainage outlet problem of the study area

Geo-morphologically a drainage system is also known as a river system that is a pattern which is formed by the streams, rivers and lakes in the drainage basin. But in agriculture, a drainage system plays a role to control water logging aiming to improve soil for agricultural production. Drainage system is very much linked with land use.

Land use is a kind of permanent or cyclic human intervention to satisfy human needs, either material or spiritual or both from natural and artificial resources which together are called Land.

Land use is the application of human controls, in a relatively systematic manner, to the key elements within any ecosystem in order to derive benefit from it.

Land use is application of human control which is in systematic order in the ecosystem.

The study area is endowed with natural resources. In Spite of that, unplanned land use practices (Settlement area, Fisheries, and agricultural land) created some environmental problems such as drainage outlet problem, salinity and impeded drainage. Drainage outlet problem is a major problem in the study area.

Causes of drainage outlet problem

Premature land reclamation: Premature land reclamation has occurred for unplanned construction of agricultural fields and settlement areas which also creates drainage outlet problems as well as environmental degradation in the study area. This situation creates drainage outlet problems during monsoon season and at the time of atmospheric depression[9].

Land use change: Land use change is one of the most important factors of environmental change that breaks ecological balance of nature. The land use is changed due to over growth rate of population, upland patterns of land use, Settlements expansion, construction, industrialization and other human activities. It also impacts on living condition and threatens the vulnerability of people. Transformation of agricultural lands into fisheries is the most dominant aspect of land use change, a trend has been found to convert agricultural land into the fisheries, especially in the study area. Apart from these, unplanned construction of artificial banks embankment for expansion of agricultural fields which also creates the land use change[10,11].

Figure-3: Natural vegetation of study area.

Paddy cultivation transfers into Bheri culture: The scenario of agricultural land use is changing very firstly from simple subsistence economy to complex market driven commercial mono cropping and water cropping as bhericulture[10].

Construction of settlement area: Unplanned construction of settlement areas also creates drainage outlet problems in the study area during monsoon season and at the time of atmospheric depression[12,11].

Construction of embankments: The study area is surrounded by embankments which creates water logging problems during high tide and flood time. Due to premature reclamation, the land in the study area lies below on average 3 meter contour. This water logging becomes more prolonged because natural drainage systems are blocked due to unplanned land use practices and siltation on the river, which creates two vital environmental problems- i. decay of tidal river system. ii. growing pressure on earthen protective embankment during flood-time and high tides causing breaches at place followed by incursion of saline water into agricultural fields injurious for both standing crops[11,12].

Figure-4: Bhericulture.

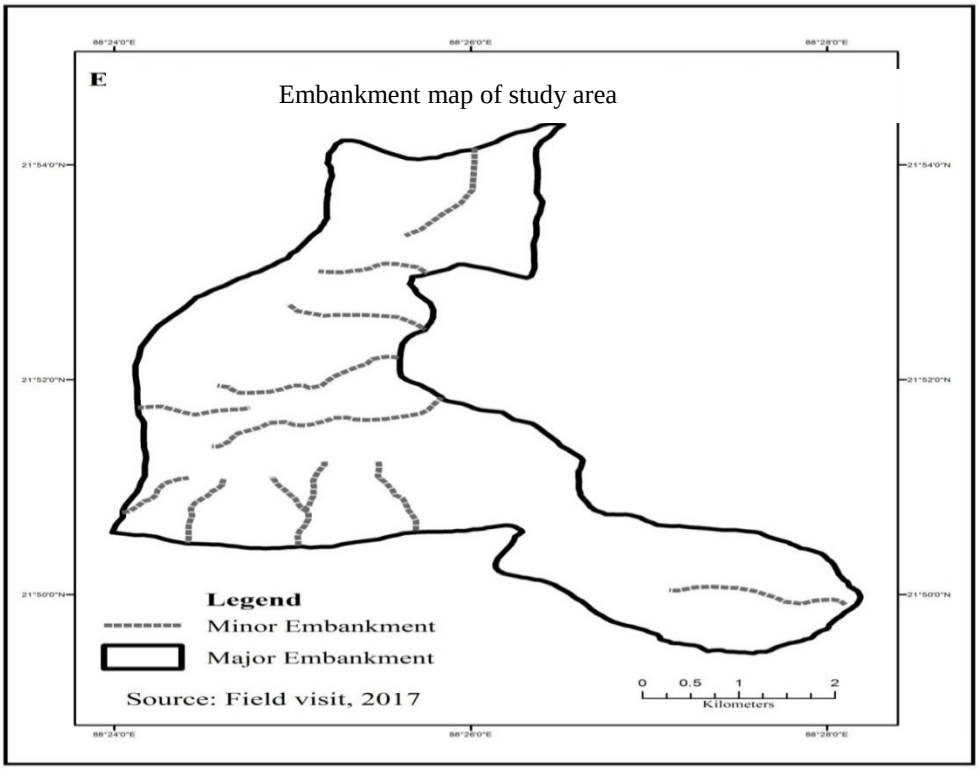

Figure-5: Embankment map of study area.

Construction of artificial banks: For the excessive expansion of settlement area and agricultural land, the agricultural fields were enclosed by embankments and the rivers were forced to remain within their channels through the artificial banks. Even that smallest water inlet was carefully confined between high embankments. As a result of this interference with the natural channels is the gradual rise of the river beds above the general level that creates the problems in maintenance of the embankments more and more difficults[11].

Tidal creek closure project: In recent times, tidal creeks are used as a playground and agricultural field which creates a lot of drainage outlet problems in the study area and may pose a strong potential threat in flood problems in agricultural land use[13]. These flood problems create the drainage congestion situation. This problem becomes more prolonged because natural drainage systems are blocked due to unplanned land use practices and siltation on rivers[14].

Impact of drainage outlet problem on physical-cultural set up

Agriculture: Agriculture is affected by the unplanned land use practices which create the water logging problems. Major agricultural problems in the study area are related to drainage congestion. Agricultural fields are very affected during monsoon season and at the time of atmospheric depression due to insufficient drainage condition[15].

Soil: Poor drainage facilities associated with presence of brackish water on the ground leads to leaching which makes sodium ions enter the exchange complex of the saline soil and produces saline-alkaline soils, which decreases the fertility and productivity of soil. Due to poor drainage conditions, flood water raises soil salinity as well as reducing productivity of the soil[16].

Surface water: Due to insufficient drainage conditions, surface water is generally saline, varying from 8ppt (moderate) during August to October and 20ppt (high) during march-July. For percolation of standing brackish water, ground water at lower depths is also more or less saline. Ground water with low salinity which is found only at a substantial depth ranging from 300 to 400 meters[4].

Livelihood: The economy of the study area is mainly dependent on agriculture including crop culture and fishery forest. This is an important Island with rich fertile soil where more than 90% people are engaged in the agriculture activity; very few are in other sectors of the economy or live as pseudo labor. Due to the unplanned land use practices drainage condition is not so good in the study area that's why agricultural is extremely affected by the drainage congestion situation in monsoon season and at the time of atmospheric depression due to this reason agricultural production is not very well which forces people to go outside Kolkata Delhi and Chennai for different kinds of work but the agricultural sector still continues the most important sector because it support the livelihood of large number of active population. Road Infrastructure is also affected by it[13].

Health Hazards: An obstruction of tidal flow and water logging not only bring the problem of agricultural deterioration but also enable the anopheles to breed and multiply which creates an issue of health hazard in this area. In this way Malaria became endemic and led to the debilitation of the population in the earlier time but now this situation is reduced. Cholera and diarrhea also becomes a periodic scourge during flood time as a result of not flushing or drainage. Poor drainage systems are also responsible for the deterioration of the health of the rural population[17].

Figure-6: Tidal creek closure project.

Management

Drainage outlet problems can be managed by some techniques such as land shaping techniques, three tier strategy, integrated water management, construction of sluice gates, proper cropping pattern and land leveling which are discussed below:

Land shaping techniques: Farm pond system: A dug out structure with proper shape and size and also having proper inlet and outlet structures for collecting the surface runoff that flows from farm area is called Farm pond. Farm pond is a important rain water harvesting practices that is constructed in lower part of the farm area. In this area 20% of the farm area is converted into a farm pond of about 3 meter depth to harvest excess rainwater. The soil which is dug out is used for raising the land from highland to medium land. Raised land and original low land are used for growing multiple and diversified crops in the year. High land is used for growing high value vegetable and fruit crops round the year. During kharif season high yielding varieties of rice are grown in medium land and low land is used for paddy-fish cultivation. The low water requires crops like sunflower, cotton are grown on the medium land and rice is grown on lowland during rabi/summer season.

Shallow furrow and medium ridge system: In the area around 40% of the farmland is shaped into shallow furrows of 0.50-0.75 meters deep at a distance of about 4-5 meters and medium ridges of 0.80- 1.00 meters high along the furrows. The furrows are used for rainwater harvesting and paddy- fish cultivation during kharif season [18].

Deep furrow and high ridge: In this area about 50% of total the farmland is shaped into alternate ridges (1.5m top width and1.0 m height) and furrows (3m top width and 1.0m depth). Dug out soil from furrows makes ridges which are used for cultivating vegetables and other crops or multi-purpose tree species (MPTs) which is a plant species that is purposefully grown and it also provides two or more services at a time around the year[18]. Rainwater is also used for the purposes of harvesting fish cultivation and other crops in the deep furrows.

Paddy cum fish cultivation System: A paddy fish cultivation is poly culture type practices that integrates paddy cultivation with aquaculture (Fish Cultivation). It is a beneficial symbol of the relationship between paddy and fish that is mutually developed into the same ecosystem. Deep trenches (3-5m width and 1.5m depth) are dug around the periphery of the farmland and the dugout soil is used for making dikes (1.5-4m width and 1.5m height) which is used to protect the flow of more rain water in the rainy season. In the trench a small ditch is dug out at one corner of the field as shelter for fishes in dry session. The dikes are used for harvesting vegetables, green manuring crops, fruit etc around the year. Remaining portion of the farmland including the trenches is used for kharif. The farm land excluding trench-and-dike area is used for harvesting low water requiring crops during the dry season[20].

Broad bed and furrow: Broad bed and furrow system intervenes shaping of land for broad beds (4-5m width and 1m height) and furrows (5-6m width and 1m deep) with a provision of (2mx4mx1m) fish shelter at the end of the furrow alternatively in near lands. Raised beds are used to cultivate vegetables around the year and fish is also cultivated in the furrows. This system provided the scope for *in-situ* rainwater harvesting which is used to cultivate second crops during dry season 7.

Paired bed techniques: In paired bed technique degraded low lying land is shaped into broad furrow of 9m width x2m depth and two beds of 6m width. In this technique a nursery pond of 5 mx9m size is also created at one end of the furrow for raising fingerlings while a broad furrow is used for brooders. Two dikes are created of 2-3m width at both ends. Broad furrow is used for harvesting rainwater. Vegetables and Other Crops are grown around the year in raised beds and dikes[20].

Three tier land configuration: In this technique of land shaping degraded low-lying land is shaped into three equal portions as raised land, medium or original land and pond which depth is 2.5-3 meters and dikes of 5metres wide and 1.5 meters height. Pond at the lower part of the land is used for harvesting of rainwater and poly-culture of fish. Paddy in medium (original) land along with vegetables on raised land and dikes are cultivated[18].

Three tier strategy for surface drainage: In areas with high rainfall during the rainy season, Surface drainage may be modified as quick removal of excess water from field to storage tank to drainage system. This not only reduces the drainage volume in the main drain but also provides the scope for second crop cultivation[19].

Integrated water management: By the integrated water management this drainage outlet problem can be reduced which are discussed below: In 2006 Geo-scientist Ambast and Sen has developed a computer simulation model and user-friendly software named 'RAINSIM' basically for Sundarbans region for small holdings, and the hydrological process, which has been the same tested duly for different agro-climatic regions in India. The software may be used for checking and computing soil water balance, optimal design of water storage in the On-farm reservoir (OFR)' by converting 20% of watershed, reducing water congestion in 75% of the area during water logging and optimal land allocation under various constraints of land and water to arrive at contingency plan for maximization of profit[14,15].

Construction of sluice – gates: Sluice-gates drained out excess rain water[12]. Construction of adequate no. of sluice – gates in study area which is reducing these drainage outlet problems. In this way, agricultural lands are free from drainage outlet problems and the livelihood of the people is also secure[14].

Proper cropping pattern: Proper cropping pattern indicates the traditional crops which were cultivated in carline time in this study are. Basically mugai, kalamota, marishal- different types of traditional paddy seeds were cultivated. But for high economic profit they used some hybrid types of paddy seeds, which have high productivity but when a drainage congestion situation occurred then those paddy plants never survived. Keeping in mind the environmental conditions of that area, suitable crops should be cultivated.

Land leveling: By the land leveling techniques, we can manage this drainage outlet problem. Those are some land leveling methods which are plan method and profit method which are also two types i. plan inspection method and ii. contour adjustment method.

Plane method: Plane method is a suitable method for the study area, to develop a good quality leveling Jobs. It is so called, because of it's result, the land surface has a uniform field slope and cross slope[21,19]. In this way true plane surface results and design some underground systems in rural areas which are technologically sound and suitable for that area to manage drainage conjunction problem[15.]

Conclusion

From the Overall study, it is stated in the Conclusions of the study that the area is suffering from the drainage outlet problem. Premature land reclamation and unplanned way of land use practices are the main causes of the drainage outlet problem. This situation hugely affected the agricultural land, soil, surface water, livelihood and health conditions. As more than 70% of the people are engaged in agricultural activities, they are hugely affected by this poor drainage condition basically in monsoon season and at the time of atmospheric depression. To manage this problem some management strategies of land shaping are to be taken which reduce this problem. Some management strategies of land shaping techniques are farm pond, shallow furrow and medium ridge, deep furrow and high ridge, paddy fish cultivation, broad bed and furrow, paired bed techniques, three tier land configuration, integrated water management, construction of sluice gates, proper cropping pattern etc. These manage mental strategies not only reduced the water logging problem in the study area but also enhancing the agricultural productivity which help to enrich the life and livelihood of the local people in the study area. It is seen that, if the proper application of these methods are possible then we can more or less reduce this problem.

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