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RESEARCH ARTICLE

SAND QUARRY LOCATIONS ON THE SEGMENT OF KOLLIDAM RIVER AND ITS IMPACT ON RURAL ENVIRONMENT USING SPATIAL INFORMATION TECHNOLOGY

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ABSTRACT

The Kollidam basin mostly serves the ever-increasing sand needs for builders in and around the towns and therefore is the most exploited resources of the river basins in the State. The background note says that mining operations, both legal and illegal, have been noticed in a number of places and the norm regarding the depth of the mine is often flouted. Irrigation and drinking water supply are the major casualties. Besides lorries, that are overloaded with sand damages village roads. In some places, houses are found to have developed cracks. The Kollidam River, with its banks eroded as a result of illegal sand mining. The basin is one of the most affected river basins in Tamil Nadu. Deposed that the extensive illegal mining for silicon sand had resulted in depletion of groundwater and consequently affected agriculture in the village. With drain canals blocked, agricultural lands were getting flooded in several places. The degradation of river ecosystems is directly linked to development process. Indeed, no one can remain aloof from the issues related to environmental degradation of rivers. Among the various kinds of human interventions, indiscriminate mining for construction grade sand from the active channels and floodplains is the major cause for the degradation of rivers. Although the sand extraction is a destructive activity as far as river ecosystem is encamped, a proper assessment of its impact on various environmental components of the system is often difficult as many of the adverse effects are surfaced only after a long period of time.

INTRODUCTION

Problems associated with riverbed erosion, sand quarry, encroachment, movement and deposition of sediment in rivers, lakes and estuaries persist through the geologic ages in almost all parts of the earth. The worst affected region is the Kaveri delta region wherein several breaches were noticed along the distributaries and irrigation canals. The river beds, which could not resist the excess flow along the Kollidam river has been breached and ultimately the water was allowed to flow in the low-lying areas, affecting many villages in the Kollidam river region. The several breaches due to Kollidam River surrounding areas mostly affected. Particularly human and millions of property were losses. This necessitates a systematic study on the detrimental indicators for the floods that had caused human life and property, the river breaches, affected agricultural properties by using optical remote sensing technology. The GPS has also been used to map the river course and mark the breaches through field survey methods. The study would suggest a plan to strengthen the natural/ artificial levees that control the river course and also suggest the village that would be affected. Using the optical Remote sensing data and field data to create a Geographical Information System Model for disaster reduction in future would generate a geo-spatial data. But the situation is aggravated in recent times with man's increasing interventions with the environment. At present, the quality of available data is extremely uneven. Land use planning based on unreliable data can lead to costly and gross errors. Soil erosion research is a capital-intensive and time-consuming exercise. Global extrapolation on the basis of few data collected by diverse and non-standardized methods can lead to gross errors and it can also lead to costly mistakes and misjudgments on critical policy issues. The riverbed erosion for this problem further, voluminous data gathered with the help of utilized with the help of Geographical Information Systems (GIS). In this case study, GIS inventory and their analysis for assessing soil erosion and soil conservation planning. Scientific management of soil, water and vegetation resources on watershed basis is, very important to arrest erosion and rapid siltation in rivers, lakes and estuaries. The proposed research would study the November floods that devastated several districts in Tamil Nadu due to cyclonic disruptions. The worst affected region is the Kaveri delta region wherein several breaches were noticed along the distributaries and irrigation canals. The flood situation in the river Kaveri and its distributaries were due to heavy rainfall at the catchments of Western Ghats and the consequent cyclone formations in the Bay of Bengal. This had caused to fill the dams, tanks and let out of excess water on the one hand, and heavy downpour due to cyclone in Tamil Nadu parts, on the other. Overflow in the river Kaveri had caused to

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rise in water level from Srirengam and in subsequent river canals. The riverbeds, which could not resist the excess flow along the river Kaveri, had been breached and ultimately the water was allowed to flow in the low-lying areas, affecting many villages in the Kaveri Delta.

Study Area Descriptions

Papanasam is a rural area located along the river Kollidam in Thanjavur district taken for a sample study. It has latitudinal extension from 10° 43' N to 11° 0' N and longitudinally 79°8' E to 79°22' E. It is bounded on the North by Colleroon River that separates it from Trichy, Perambalur and Cuddalore districts on the Eastern side in Kumbakonam and Thiruvidaimarudur taluks in southern side by Orathanadu, the western side by Thanjavur and Thiruvaiyaru taluks. Papanasam taluk extends over an areas of about 377521 ha (2001) has been divided into 120 revenue villages. Papanasam taluk is a plain region in Kaveri delta region. The terrain dips towards the direction of the flow of Kaveri and its distributaries .The entire land area lies well below the 48 meters on the western side and 36 meters on the eastern side in Papanasam taluk.The alluvial soil deposits found along the riverside of the Papanasm taluk. Such as Kaveri River, Coleroon River, Vennar River, Vettar River. Arasalar River, Thirumalairajan River. Black soil covered in the land area suitable for the paddy, sugarcane, and plantation crops. Classify the three types of the soils. Such as Alluvial, Regur, clay soil. Kaveri is the main river in Papanasam taluk. It drains towards eastern side with its distributaries branches in all direction. Kaveri, Coleroon, Vennar, Vettar are the chief river systems of the taluk. The numerous distributions of these two system are draining the entire taluk there by promoting agriculture activities with increased irrigation facilities There are four major river in Papanasam taluk , such as Coleroon , Kaveri, Vennar , Vettar .Minor river Kudamuruttiyar , Arasalar, Maniyar, Thirumalairajan, Vadavar are the minor rivers. The distributaries of river Kaveri, Coleroon, Arasalar from October to January the river system get water from northeast monsoon occurring in the taluk. The monsoon rainfall occurs during October and November help in regulating the supply in the canals and this conserving the water for the use during the end of the samba paddy season.

Problem statement

The Kollidam River, with its banks eroded as a result of legal and illegal sand mining for quite a long time and since the rise in prices of sand for construction industries. A field investigation reveals that the Kollidam basin is one of the most affected river basins in Tamil Nadu by overexploitation of sand. Removal of sand for the extensive illegal mining for silicon sand had resulted in depletion of groundwater and consequently affects agriculture activities in the nearby villages. With drain canals blocked, agricultural lands were getting flooded in several places due to Sand mining and riverbed encroachment, Breeches and the activities of the brick kilns work. This necessitates a field level investigation and information gathering using GPS technology and maps the variables to derive a possible solution. Papanasam is one of the worst flood affected taluk in Thanjavur district. Although floods are not new to the people of Papanasam taluk, monsoon during November 2005, brought great misery. After three years of drought, the monsoon rain last year disappointed the farmers by washing away their crops in many places. The taluk received 237.80 mm of rainfall in October against the normal 181.25 mm. In November the rainfall recorded was 517 mm, more than double the normal 222.65 mm. For December, the normal rainfall of 127.43 mm was almost reached in the first five days. After a gap of 40 years the Coleroon, the major flood carrier, was in spate. Not once but twice. In October it reached a flow of 2.35 lakh cusecs and in November 37 lakh cusecs, this time water flowing one foot above the bank. A major breach occurred at Karuppur in Papanasam Taluk in Thanjavur District to a length of 50 metres and water entered the village. At Karuppur, water was flowing one foot above the Top Level Bund (TBL-maximum water can flow) and sand bags heaped to arrest the flow proved ineffective. The bund breached and water seeped in to the village. Breaches were noticed at Kudikadu village in Papanasam taluk, Vasudevamangalam near Ukkadai at the border of Thanjavur district. There are three main breaches in Vennar – two at Mahimalai village at Vennar and Vettar head at Kalaperambur near Thanjavur and the one at Vasudevamangalam. The municipal authorities have take steps to augment drinking water supply by enhancing the capacity of Vennar pumping station as the flood in the Coleroon had disrupted water pumping in this taluk. The Vennar pumping station is more than 100 years old. In Vennar about 17,257 cusecs of water was discharges, which was over and above the maximum discharge of 16,863 cusecs discharged in Vennar during 1983. Due to this abnormal discharge breaches occurred in Right bank and the maximum discharge realized at the place where last breach occurred was about 22,010 cusecs against the mean sea level of 7,238 cusecs. The unprecedented rain in the Kaveri delta districts and the floods that followed emphasis the need for modernization of the irrigation system in the delta. When the Coleroon River carried 2.35 lakh cusecs in the first flood and 3.37 lakh cusecs during the second instance – in November and December called for measures to strengthen the system to meet such eventualities in the future. In the delta, rivers, canals, drains run to a total length of 34,864 km. agriculture crops were submerged of several hectares. Of the total damages of 5,438 huts, partly damaged huts in this taluk was about 4417 and fully damaged huts about 1017.

Objectives

- To locate the legal and illegal sand quarry locations and demarcate them on the parts of river Kollidam,
- To highlight the problems of sand quarrying on the river beds and focus upon them with the social problems,

MATERIALS AND METHODS

To study the above problem of arising out of legal and illegal sand quarrying in the riverbeds of Papanasam taluks topographical maps were initially selected to prepare a base map. To assess the flood disaster in Papanasam taluk during November 2005 floods. using Indian Remote Sensing Digital

P6 LISS-III data was used to map the flood affected areas. A base map for Papanasam taluk was initially prepared using 5 Survey of India topographical maps for the study area such as 58 N/6, 58 N/2, 58 M/8, 58 N/1 and 58 N/5, in the scale of 1:50,000 and it is converted into digital data by scanning with the help HP Scanjet scanner. Scanned topographical maps are then georeferenced using the software tool, ArcGIS 9.0. Spatial features needed for the study are digitized in the Georeferenced topographical maps using ArcMap and it is converted into shape files. Digitized spatial feature layers such as major rivers, minor rivers, tanks, settlements, transportation network, agricultural lands, etc are stored in shape files(*.shp) and the files are maintained in Arc Catalog. Flood related damages such as hut damages, agriculture loss and breaches are collected from the Taluk Administrative Office of Papanasam. Collected details about the damages of every village have been surveyed primarily using GPS (Global Positioning System) instrument – GS 20. Sample points for breaches, damages and agricultural loss has been taken under GPS survey. GPS field survey has made the awareness about the present condition of the affected area and it also made the requirements to improve the affected area in the future. Secondary data of Digital Satellite image, Indian Remote Sensing IRS – P6 LISS-III data dated December 8, 2005 for Papanasam taluk has been collected from National Remote Sensing Agency (NRSA, Hyderabad). Digital image is then cropped using the taluk boundary and digital image processing methods were adopted using ENVI image analysis software. Using the sample points collected from GPS survey, Classification methods were adopted for the agricultural losses, major breaches, and water stagnant area in ENVI image analysis software. Flood impact in Papanasam taluk for November, 2005 has been classified in the Digital satellite image of IRS – P6 multispectral data and it is processed using ENVI image processing software. The classication adopted in the study area is major breaches, river and tank water, flood water intrusion areas and unaffected area. Using the Benchmark sample points collected from GPS survey using Spor Trak Map instrument, local slope map has been derived. Flood Vulnerability map is performed by classifying the digital image of the flood affected area into 5 classes such as Very High, High, Medium, Low, and Very Low. Agricultural losses has been performed by dividing into 9 major classes such as Acacia, Banana, Coconut, Eucalyptus, Paddy, flood water features, sugar cane, teakwood and bricklins using Digital IRS – P6, LISS – III data. Vulnerability map is overlayed with the study area using overlay technique in ArcGIS 9.0. Global Positioning System (GPS) was used to track the breaches and breaches points and the affected tank is located.

RESULTS AND DISCUSSION

Papanasam taluk study area map was prepared using Survey of India topographical sheet. The sheets were scanned and then digitized using ArcGIS to convert them in the form of digital maps. The map was traced from the village to taluk to trace all the minute details for the flood disaster assessment in the study area. Figure-1 shows the Papanasam taluk boundaries along with the flood related features of river, streams, tank, road, railway and major villages. These features have been traced using ArcGIS 9.0. Figure - 2 shows the locations of bricklin, legal and illegal sand mining areas surveyed by using GPS in the study area, Kollidam river. Legal sand mining areas are those under the direct collection and distribution of sand to the users by the government agencies. The vendors are provided with gate passes towards the collection and further distribution to the users. Illegal sand mining areas are those does not have any control over the sand mining areas and they are illegally collected and transporting the sand. In the study area as per the survey there are 4 legal and 14 illegal sand mining areas in the river. The illegal miners will normally operate after hours and they collect and transport heavy load, which will affect the rural connecting roads and also they create unnecessary noise during night time. The legal land mining areas are well defined with proper intermittent gaps over the river bed, where as the illegal has no binding on this. They are the sole responsible for the ground water depletion in that area and also when they dig out the sand large number of river beds also dug and hence the water is being let out from these gaps and affects the rural population, like this area. Alongside the river bed there are large numbers of bricklin small scale household industries are set up based on the river clay soil which is available. The GPS survey map indicates that there are 23 such industries, some time affects the free flow of water or redirects to the villages during seasonal rainfall. Figure 3 exhibits the contour map showing the lines connecting places having equal elevation. This was prepared taking sample points with the hand held GPS. The GPS would give the latitude and longitude positions along with the corresponding height of a particular point. The collected information of latitude and longitude and the height parameters were then computed using the SURFER package and finally the contour map was derived. The map shows the general relief is from west to east of the study area and there is an elevated area having the height of 46 meters. There has been an increase in height in the western part than the eastern part of the Papanasam taluk. The general slope can be inferred that from moderate steep to gentle is towards the low lying areas of this taluk. Figure-4 displays the flood level mapping derived from the GPS field data. This map reveals the major river breaches of Kudikadu, Pudukudusai and Vazhkkai affected due to floods around vast stretches of these areas. Northeastern part of this taluk was worst affected due to recent floods. Displays the general flood impact map derived from the IRS P6 digital data as well as the GPS field data. Analysis and integration of these two spatial information data reveals the areas affected due to floods in the following categories: they are water bodies (river and tank) 9.513979 sq.km, flood water intrusion areas (20.56413 sq.km), unaffected area (286.1042 sq.km) in the study area apart from major breaches. Agriculture and horticulture crops were severely affected due to floods, which causes major environmental concern in the long run. Small and marginal farmers affected in Papanasam, Kabistalam, Ayyampettai, Milattur, Saliyamangalam and Ammapettai are about 1119 (5.33 per cent), 3932 (18.74 per cent), 2174 (10.36 per cent), 4872 (23.22 per cent), 5186 (24.72 per cent) and 3695 (17.61 per cent) respectively. The total affected areas in the above firkas accounts for 8,248.81 ha. Maximum area affected in the above firkas is Milattur (26.52 per cent). Next to Milattur, Saliyamangalam (26.36 per cent) , Ammapettai (18.23 per cent), Ayyampettai (9.32 per cent), Kabistalam (13.84 per cent) and Papanasam (5.6 per cent). Total affected area of large farmers accounts for 3115.18 ha. Of this total affected area, 851 large farmers of Ammapettai 1127.62ha (36.19 per cent) area

Table-1 Small and Marginal farmers affected and crop loss during November 2005
Both agricultural crops and horticultural crops

Sl. No	Firkas	No. of farmers affected	In %	Total Extent of area affected (in ha.)	In %
1	Papanasam	1119	5.33	470.13.5	5.69
2	Kabistalam	3932	18.74	1142.08.5	13.84
3	Ayyampettai	2174	10.36	769.05.5	9.32
4	Milattur	4872	23.22	2188.22.0	26.52
5	Saliyamangalam	5186	24.72	2174.68.0	26.36
6	Ammapettai	3695	17.61	1504.53.5	18.23
	Total	20978		8248.81	
		Total No. of villages affected			110
		Total extent of area affected			8248.81.0

Source: Taluk Administrative Office, Papanasam

Table2 Large farmers affected and crop loss during November 2005 both agricultural crops and horticultural crops

Sl.No	Firkas	No. of farmers affected	In %	Total Extent of area affected (in ha.)	In %
1.	Papanasam	83	3.13	107.97	3.46
2.	Kabistalam	222	8.38	244.53	7.84
3.	Ayyampettai	213	8.04	280.43	9.00
4.	Milattur	524	19.79	417.84	13.41
5.	Saliyamangalam	754	28.48	936.78	30.07
6.	Ammapettai	851	32.14	1127.62	36.19
	Total	2647		3115.18	
		Total No. of villages affected			110
		Total extent of area affected			3115.185

Source: Taluk Administrative Office, Papanasam

Table3 Papanasam Taluk: Loss in Agricultural Statistics

Sl.No	Name	Area in Sq. meters	Area in Sq. kms
1.	Paddy	2804509.58	2.80
2.	Banana	482114.25	0.48
3.	Sugarcane	3394496.66	3.39
4.	Coconut	2561519.58	2.56
5.	Eucalyptus	105479.75	0.10
6.	Teak wood	353624.08	0.35
7.	Acacia	827086.41	0.82
8.	Brick kilns	2209	0.002
9.	Settlement with water	57249.916	0.05
10.	Barren land with water	73449.25	0.07
11.	River and Tank with water	6890975.5	6.89

Source: ENVI Image Processing Results

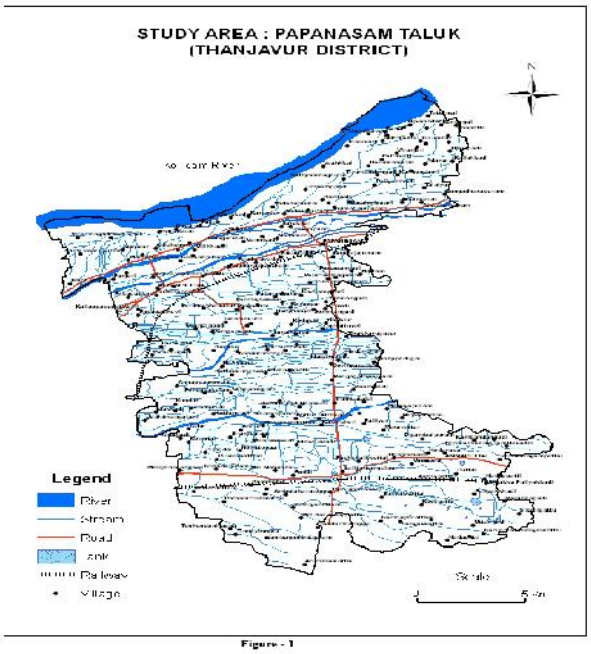


Figure - 1

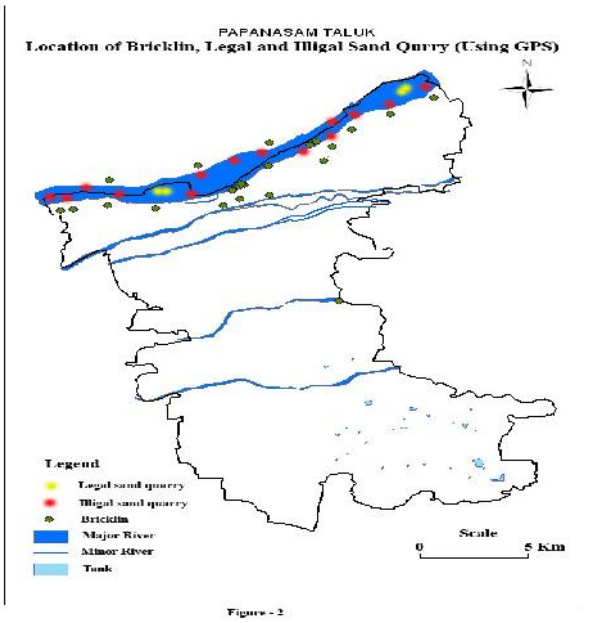
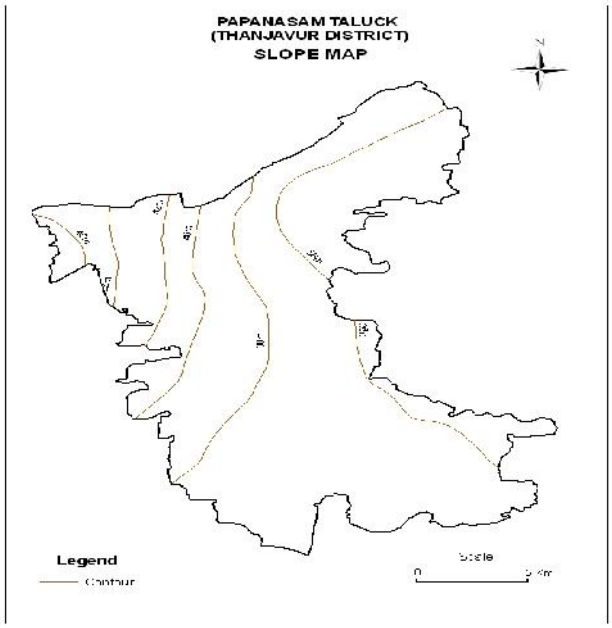


Figure - 2



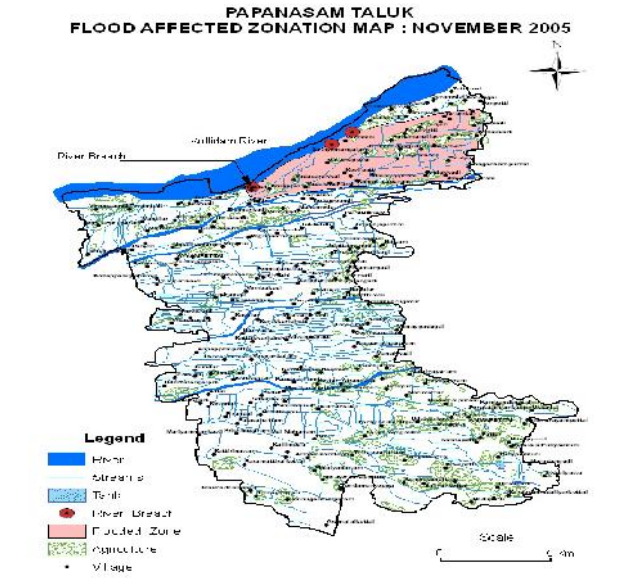
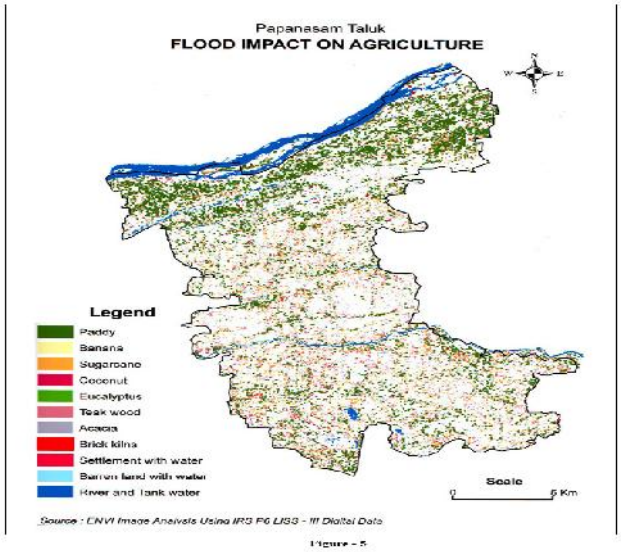


Figure 4



Source : ENVI Image Analysis Using IRS P6 LISS - III Digital Data

Figure - 5

has been highly affected. Next to Ammapettai, Saliyamangalam, Milattur, Ayyampettai, Kabistalam and Papanasam were affected of about 30.07 per cent, 13.41, 9.00, 7.84 and 3.46 per cent respectively. Total numbers of large farmers have also been affected in this order. These affected details are given in (Table –1) and (Table-2)

Figure-5 shows the flood impact on agriculture crops in Papanasam taluk. This map was derived using IRS P6 LISS III digital data through ENVI image analysis methods. Field samples of individual agriculture crops were also taken using GPS to differentiate the crops that were in the flood affected region as well as in the unaffected region because of the changing nature of the spectral reflectivity.

The following table-3 gives the results of the pixel-by-pixel analysis for the study area through supervised classification done by creating training sites and the areas of the affected agriculture crops were estimated through the digital image processing technique. Loss in Agricultural productivity due to November 2005 floods indicate that there has been heavy loss to Paddy (2.80sq.km), Banana (0.48 sq.km), Sugarcane (3.39 sq.km), Coconut (2.56 sq.km), Eucalyptus (0.10 sq.km), Teakwood (0.35 sq.km), and Acacia (0.82 sq.km).

CONCLUSION

The study concluded with the problems associated with the uncontrolled sand mining for construction industries brings other social problems along the river beds. The study also indicate from the GPS maps about the legal and illegal land quarrying, the illegal quarrying is in the abnormal limit due to higher black market prices. During high flood season the villages in the nearby area is worst affected along the Kollidam river places like Anaikarai, Vadapathi, Kudithangi, Vazhkkai, Puthur, Pattugudi, Devangudi, Anaigudi, Tenkatchiperumalnattum, Annakaranpettai and Karuppur. Other obstructing activities along the Kollidam riverbank such as backline industries encroachments like permanent and semi permanent settlements and leased agriculture lands, this resulting several breaches along the river during seasonal rainfall and heavy flooding several villages are inundated and affecting rural population. To overcome this type of problem a proper management of sand quarrying and elimination of encroachments along the river banks to reduce pressure of water along the riverbanks. In the meantime the Government of Tamil Nadu has allotted Rs. 30 crores of rupees to the Public Works Department for the repair works, damaged during the recent floods. The work relating to strengthening bunds, removal of encroachments and monitoring the illegal sand mining had been in progress. Although Sand is required for development of Human being, but at the same time the threats posed due to sand mining can't be ignored. Hence decisive steps are to be taken & alternate solution to be found out for sand mining, without disturbing the environment.

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