Studies on Estuary of Thamirabarani River, Tamilnadu, India

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Abstract

The state of Tamilnadu is located along the south west of Indian peninsula. The state has nearly 40 river basin and most of them are seasonal. The river Thamirabarani is one of the perennial rivers covering 3 districts namely Tenkasi, Tirunelveli and Tuticorin. The river originates from the eastern side of the west coast and confluences with Bay of Bengal at a village called Punnakayal in Tuticorin district. The Thamirabarani river is known for its irrigation potential in the upper reaches. By the time it reaches the lower end, the flow is very low. The east coast is well known for its littoral drift which is dominantly towards the north direction. The village is famous for its fishing potential. The study area of Punnakayal is influenced by two monsoons namely south west and north east. Due to absence of high flow in the non-monsoon period, the estuaries are highly blocked by sand bar formation. Because of this sand bar formation, the fishermen find it difficult to go in to deep sea during low tide time. Hence studies were made and remedial measures were suggested and completed. The details of hydrologic analyses, hydraulic modelling, hydrodynamic studies, assessment of littoral drift remedial measures and post project performance are detailed in the paper.

Keywords: Drift, Estuaries, Hydraulic modelling, Thamirabarani river

1. Introduction

The river Thamirabarani flows along Tirunelveli district of Tamilnadu and confluences with Bay of Bengal at Punnakayal (8.6349° N, 78.1151° E) is shown in Figure-1. The estuary was mostly blocked with sand bar formation. This is mainly due to long-shore littoral drift which is predominantly towards north along the coast and absence of perennial flows in the river. The place has good potential for fishing operations. Due to the formation of sand bar the fishermen are not getting even minimum draft to take their boats for fishing operations during low tide time.

1.1 Issues

The estuary was always blocked with sand bar formation. The place has good potential for fishing operations. Due to the formation of sand bar the fishermen are not getting even minimum draft to take their boats for fishing operations. Hence to manage the sand bar formations, studies are made and suitable remedial measures are carried out.
2. Methodology

- Estimation of runoff
- Tidal details
- Hydraulic modelling
- Wave hydrodynamic studies
- Estimation of littoral drift
- Design of remedial measures

2.1 Estimation of runoff

The runoff estimation is made by delineating the catchment using GIS technique. The effects of catchment behavior on floods, prediction of catchment response to changes in the input conditions, modeling of river behavior, real-time flood forecasting, adjusting and evaluation of flood is assessed using geographic information systems (GIS). GIS can be defined as 'a computer system capable of capturing, storing, analyzing and displaying geographically referenced information that is, data identified according to location. The data for rainfall-runoff modeling ranges from a digital elevation model (DEM) to derive physical basin characteristics, soil characteristics. The advent of GIS, these data can be easily processed and analyzed to estimate hydrological modeling parameters from satellite images. The present location gets heavy rainfall only in north east monsoon. The Average annual rainfall 75cm with nearly 25 rainy days in a year. Usually, the location receives high rainfall of short duration. The Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic drainage basins. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems. This includes large river basin, water supply and flood hydrology, and small urban or natural watershed runoff. The maximum one-day rainfall received is 184mm. The discharge was estimated as 180 m$^3$/s adopting HEC-HMS (2016) tool.

2.2 Tide Details

Tidal levels play a major role in managing the ecosystem of an estuary. The tides observed at location are semi diurnal with ranging from 0.40 cm to 0.80cm is shown in Figure-2.
2.3 **Hydraulic Modeling**

The discharge carrying capacity of lower reach was estimated by hydraulic model studies. For the present study the U.S. Army Corps of Engineers’ River Analysis System (HEC-RAS) software is used. This software is developed by the Hydrologic Engineering Center (HEC), which is a division of the Institute for Water Resources (IWR), U.S. Army Corps of Engineers. HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. The basic computational procedure is based on solving the one-dimensional energy equation using the Manning’s equation in conjunction with the contraction and expansion coefficients using a procedure similar to the standard step method. The present analyses indicate no proper tidal exchange due to formation of sand bars during non-monsoon period from January to October. During heavy rains resulting more flow and thereby avoiding sand bar formations.

2.4 **Wave Hydro-Dynamic Studies**

A quantitative understanding of wave characteristics in the near shore is essential for the estimation of sediment transport and morphological changes along the coastal areas. Unfortunately measured or visually observed wave data is available only for locations of port. Hence, numerical models were resorted to for the simulation of wave climate. In the present study, two wave models of MIKE 21 (DHI, 2001), viz Offshore Spectral Wave (OSW) and Nearshore Spectral Wave (NSW) were used to derive the wave information in the near shore from the wind forcing. The physics and resolution of these models depend on the water depth for which the wave characteristics are derived (IITM 2010). The stretch of east coast of Punnakayal is found to be subjected to waves from south and south east directions can be seen in Figure 3.
2.5 Estimation of littoral Drift

The study reach is always dominated by waves from south, south-west, south-East and east directions. The study indicates alongshore transport is towards north during which accretion of beach materials are observed on the south side of the shore protruding structure. The littoral drift estimates are made using Van Rijn (2001) formulation which considers both particle size and nearshore slope. The annual drift works out to be 0.060 to 0.080 million m$^3$ towards north along east coast. The data was validated with published estimations (Sundar & Suresh 2011). In the absence of continuous flow, the sediment transfer due to waves dominates and hence resulting in blocking of river inlets and formations of sand bar. This is the reason for blocking of present estuary.

2.6 Design of Remedial Measures

The estuary entrance sand bar formation can be avoided by constructing a pair of straight groynes on both sides of estuary(190m and 260m). The training walls should be taken sufficiently more than breaker depth to avoid accumulation of sand. The river bed should be dredged to a depth of (-) 2.50m to accommodate more discharge and for further propagation of tides.

2.6.1 Project Completed

The fisheries department of government of Tamilnadu has constructed two groynes at the estuary location and carried out dredging of bed to about (-) 2.50m in order to facilitate tidal propagation (Figure 4). The length of southern and northern groynes are 260m and 190m . A connecting bridge is also constructed upstream.

2.6.2 Post Project observations

Prior to the remedial measures there was no proper tidal propagation inside the river. This is because of the sand bar formation which prevents the propagation. In the post project scenario, the effect of semi diurnal phenomenon is seen. At present the tides propagate in such a way that two high water and two low water effects are seen. The flow parameters were assessed based on the ground details provided by the clients. The slope of the river from near by Srivaikuntam anicut was estimated as about 1 in 2000. The study performed indicate that velocity was in the range of 1 to 1.5 m/s with average velocity of about 1.2m/s. After the remedial measures the velocity has increased. Near the bridge section it is around 5m/s which results in good flushing action during the flow. Prior to the project the depth available was less than 1m. Only during the high tide the boats can perform the operation. But after the dredging about 3m draft is available in channelized area. During high tide it can go up to about 4m which can easily facilitate the boat movements.

Figure-4 Training Groynes
3. Conclusions

The sand bar formation at estuary confluence point was controlled by constructing a pair of training walls in the form of groynes. The groynes are constructed after detailed studies and length was taken beyond breaker zone. At present there is good flushing action because channelizing by dredging and the high driving velocity near bridge section. The sedimentation is seen only on the south side of groyne located.

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References

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