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Prediction of Sediment Transport Along the Puducherry Coastal Region: South East India

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Abstract:- **A comprehensive treatise of related topic for understanding the essentials required for all the activities along the coast has been presented. Apart from these, activities encompass the development of systems to protect from natural and manmade hazards like coastal erosion, severe cyclonic storms. The rate of sediment transport along the shore is related to long shore currents and the evaluation of the above is of significance importance before embarking on any activities pertaining to the coast .As a result of this sediment movement the coastal region experiences erosion and deposition creating problems, not only to the people living in the coastal areas but also for the maintenance of coastal structures. This study focuses on the determination of the rate of sediment transport along the coastal zone of Pondicherry using sand trap setup for actual measurements . The prediction sediment transport using mike 21 sediment transport module along the puducherry coastal region for calculation of sediment transport and related bed level changes for non cohesive sediment transport due to currents or combined waves and currents in different monsoon periods in the puducherry region.**

Keywords: (Cyclone, storms, erosion, deposition, mike 21 ,sediment transport)

1. INTRODUCTION

Coastal zone is the most dynamic zone since it experiences by erosion, accretion and sea level rise etc. One of the main factors that govern the beach erosion is the long shore sediment transport, which is mainly controlled by wave characteristics and near shore topography. Waves propagating from deep sea into the near shore expend their energy causing lifting of sediments, generating long- shore currents and producing littoral sediment transport. Onshore–Offshore transport is initiated by the high and short period waves resulting from a storm removing the sand from the beach and transporting it into the sea to form offshore sandbar. Long- shore sediment transport is more dominant than onshore – offshore transport and of greater significance to coastal engineers who are interested in annual changes rather than seasonal variation. Due to some obliquity of the crests of the breaking waves with the shoreline, there is a net component of momentum and energy in the direction along the beach. This causes a net alongshore transport of beach sand. Littoral drift(i.e., along – shore transport) rates and distribution are functions of wave and beach parameters. These littoral currents also get influenced by beach forms, and rip currents. From the earlier studies, the longshore sediment transport is dominant in the east coast of India. The net transport varies all along the coastal stretch because of the natural and manmade activities. The estimation of the sediment transport rate in the Puducherry coast has been carried. A specially fabricated sand trap has been employed in the measurement of the sediment transport. Two prominent methods of estimating the sediment transport has been taken for the present study in order to observe the response of the sediment transport.

Fig 1. Coastal region of south east India

2. MATERIAL AND METHODS

A sand trap was developed and fabricated for measuring the sediment transport rate in the surf zone. The trap was designed in such a way that it is very easy to handle; durable to with- stand maximum current and also capable of measuring transport rates of sand - sized particles moving in any unidirectional fluid flow. The jetty structure was selected for hoisting the sediment trap (Fig. 2). Sampling was taken at five meters interval across the surf zone. The samplers were arranged in such a way that the mouth of the sampler faces the longshore current. After a few initial trails,

it was found that an inclination of 45^0 was best suited for collection of sediment samples. After a sample run was complete, the sampler bottle was detached from the instrument and carried to the laboratory for analysis. The trap was deployed across the surf zone for one hour and three samples were collected each day, during the sampling period. The samples were taken directly without disturbing the sampler bottle and taken to the laboratory for analysis. Every time a new sampler was attached to the system for the collection of samples. The sediment collected was weighed and the sediment transport rate achieved per unit width of surf zone per unit time was calculated and tabulated. Soil samples were also collected along the study area at 20 m intervals on the surf zone, each week of the month during the year 2012. Based on the above, *K* values were estimated for this coastal stretch for each month for the above year.

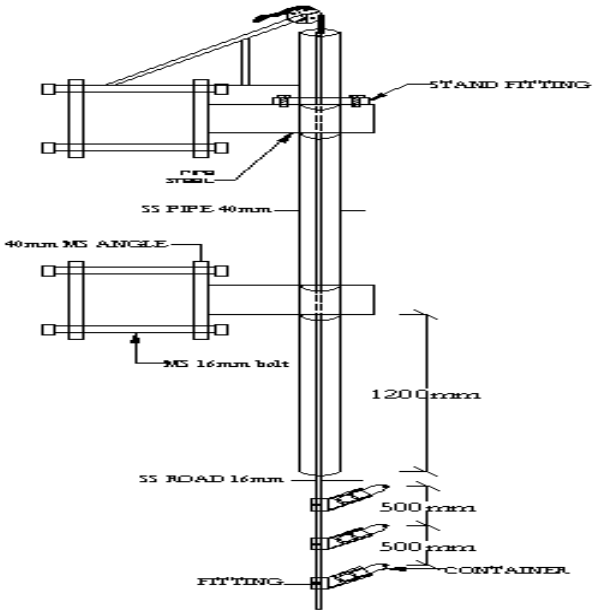

Fig 2 :Sand trap setup

MIKE 21 ST MODULE

The present study is an application of the dhi group.

MIKE 21 is a computer program that simulates flows, waves, sediments and ecology in rivers, lakes, estuaries, bays, coastal areas and seas in two dimensions. It was developed by DHI Water. Environment. Health.

MIKE 21 ST is a module in the MIKE 21 application suite for calculating non-cohesive sediment (sand) transport rates. Also to calculate sand transport based on pure current information, or take both current and waves. In addition to sand transport rates, a simulation will give the initial rates of bed level changes. This is sufficient to identify potential areas of erosion or deposition. MIKE 21 ST can simulate sand transport rates in a wide array of settings, including natural environments like tidal inlets, estuaries, and man-made structures like harbours, breakwaters and groin. Tide, wind, wave and current can all be taken into consideration for optimum precision in the simulations.

SEDIMENT TRANSPORT MECHANISIM

The following are the primary responsible for initiating sediment transport. They are changes in sea level rise , tides, waves, currents, stream flow etc. Sediment transport model can be obtained in two condition are only current and the other one is waves and current. Based on this two condition there have five theories for pure current condition and two theories for waves and current . For pure currents Engelund and Hansen theory, Engelund and Fredsoe theory, Zyserman and Fredose theory, Meyer peter and Muller bed load transport theory, Auckers and white total load transport. Two stimulation methods available in combined current and wave conditions are intra wave sediment transport model , Bijkers total load transport method. In these above theories Engelund and Hansen, Engelund and Fredose theory was adopted for pure current condition. Bijker total load transport was adopted for combine waves and current condition. These theories which was adopted and apply in different monsoon periods like south west monsoon, Non monsoon and north east monsoon.

DATA REQUIREMENTS

The following are some of the datas which are required for Mik21ST module they are bathymetry data of the nearshore which are very parallel to the coastline upto 15m water depth . tide level ,current data, wave height wave direction ,wave period, wind direction etc. These data which have been listed as below in the table 1 .

Table 1
Data requirements[a]

	Contents
Bathy metry data	4,6,10,12,15m_s
Tides	MHWS + 1.30 m, MHWN + 1.00 m MLWN + 0.70 m MLWS + 0.49 m
Currents	0.26 (max)
Wave height	0.9 m
Time period	8s

RESULTS AND DISCUSSION

The present study has been made to the analysis of the total sediment transport in the puducherry coastal region . The sediment transport has been estimated under two forcing conditions are pure current and combination of current and waves . Out of five theories three theories are to be considering as current and out of two theories one theory are to be considered as combination of waves and currents. Using these theories total sediment transport has been calculated by using mike 21ST module along the puducherry coastal region. Using these mike21ST module simulation were carried out on southwest monsoon, non monsoon, northeast monsoon. In the southwest monsoon the average sediment transport and bed level changes in the nearshore area of Pondicherry using current only condition and combination of waves and current are given in the figure 3.Using pure current the sediment transport is less than $1m^3$ /yr/m width over most of the coastal region of Pondicherry. The seabed shows the negligible change of the order of less than 1mm/day at most of the place, since the seabed nearly stable at some places and the sediment transported towards the direction of north. Using the combined current and waves condition stimulation has been carried out the total sediment transport has increased to $500m^3$ /yr/metre width over the Pondicherry coastal region. Sediment deposition along the coastal region are around 10mm/day.

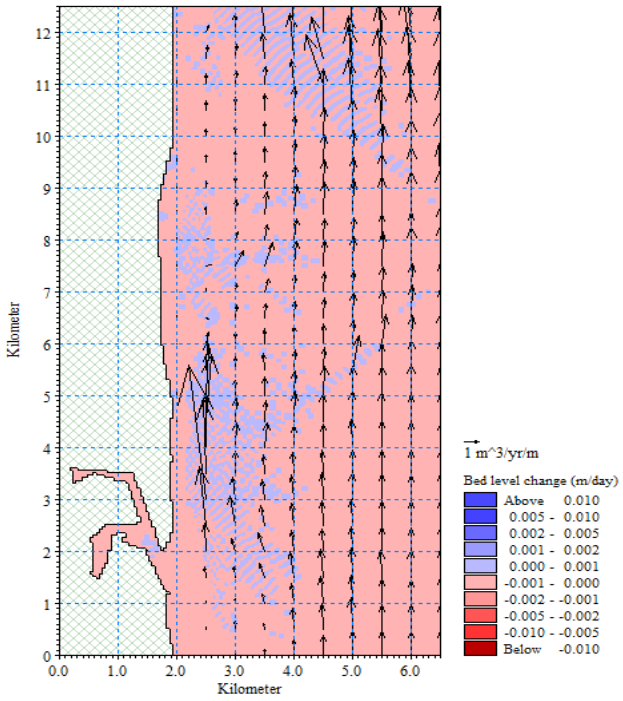

Fig 3 Engelund Hansen theory

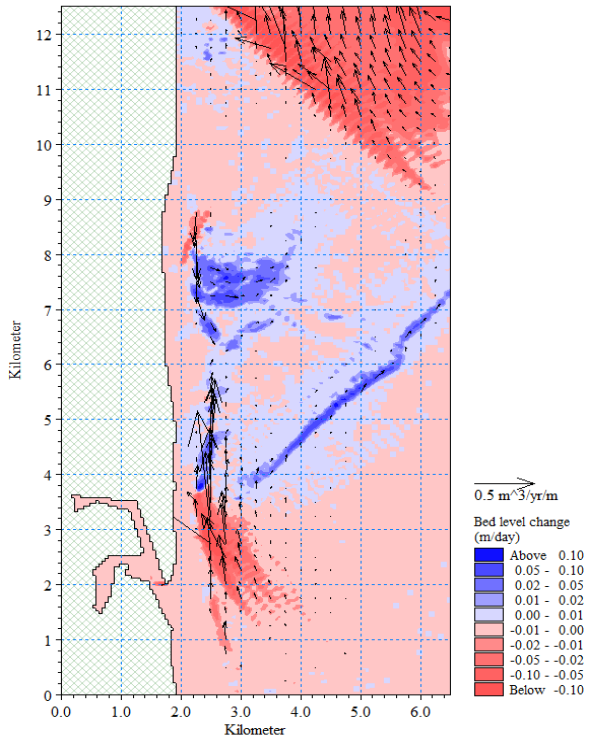

Fig 4 Englund and fredose theroy

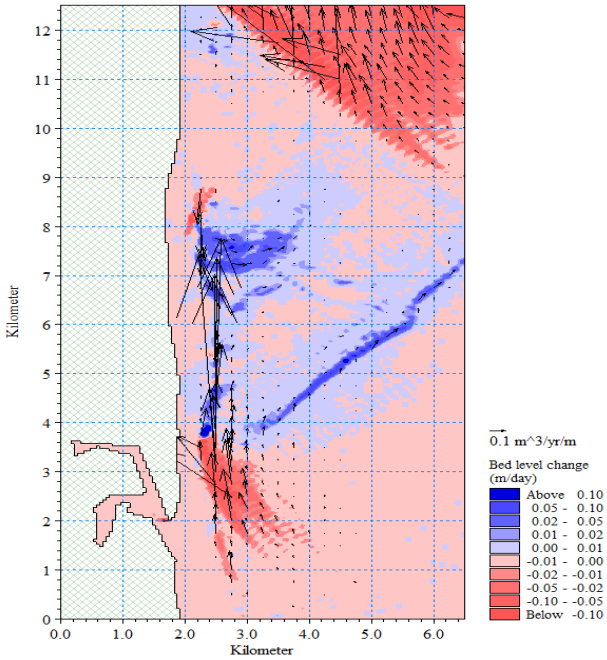

Fig 5 Zyserman and Fredose Theory

In the non monsoon period simulation were carried out using current or combined waves and current condition with bikers theory. In this simulation average sediment transport on the coastal region as given as below figure . in this average sediment transport rate and bed level changes after the harbour development during non monsoon period should be less than 5m3/yr/meters with of the puducherry coastal region. In this seabed level changes should be very low and the rate of sediment moved towards the south direction.

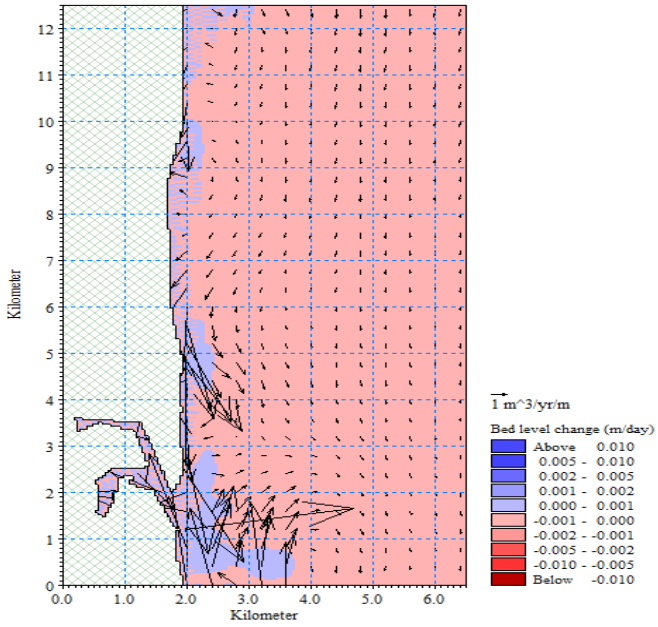

Fig 5 bijkers method

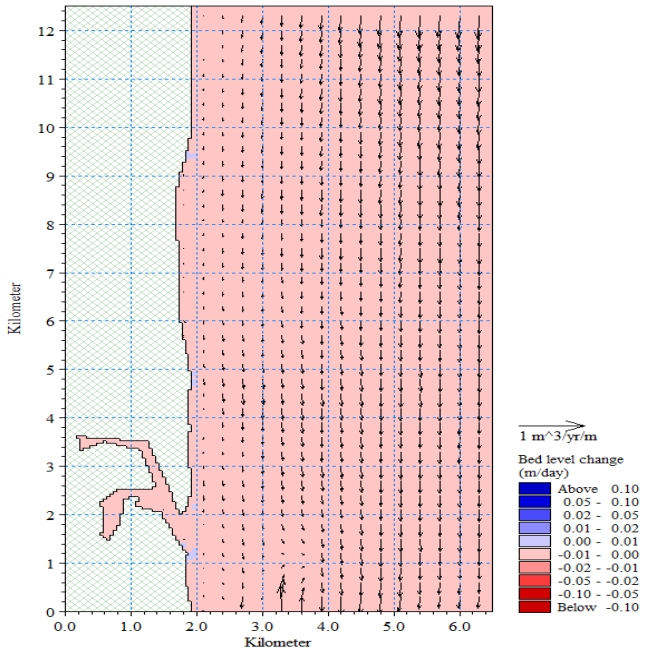

Fig 6 Englund Hansen theory

In the northeast monsoon simulation can be carried out using current and combined current and waves using bijkers methods .the sediment transport rate increase to 50m3/year/meter width over most of the region of Pondicherry in the northeast monsoon. The deposition of the seabed of the order of 10mm/day and the sediment moved towards the south direction. The average sediment transport flux and the bed level changes should shown on the given fig 7 below.

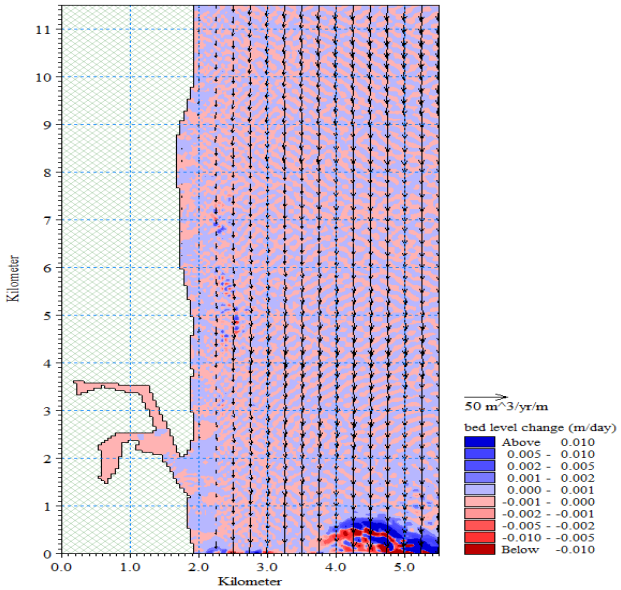

Fig 7 Bijkers Methods

SUMMARY AND CONCLUSION

The study reports on the application of mike21 ST Module to stimulate the total sediment transport on the puducherry coastal region on different monsoon periods using the above said theories were estimated under two condition, as current and combined waves and current . The stimulation shows that the bed level changes 1mm/day and sediment transport could be 2 m^3/yr/m. on the non monsoon period. In the combined waves and current bed level changes 10mm/day and the sediment transport 5m^3/yr and the sediment transport towards north in the southwest monsoon and in the north east monsoon bed level changes 10mm/day movement of sediment transport towards south direction. Stimulation shows that the movement of sediment transport direction, erosion ,deposition, etc were clearly differentiated in different colours. It is recommended that based on the sediment movement in different direction in different monsoon period should be considered before to proceed the construction activities like harbour construction shore protection structures like groyne, offshore breakwater etc should be carried out to avoid coastal erosion problem in the coastal region.

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