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STUDIES ON LONGSHORE SEDIMENT TRANSPORT ALONG COAST OF NAGAPATTINAM, INDIA

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***Abstract**: The study region of 40km length is located along the coast of Nagapattinam the south east coast of India. The coast is known to have mild littoral drift. It was one of severely affected coast during the Tsunami of 2004. Since then a number of protection measures were planned along the coast. Apart from this the minor port located is also witnessing lot of expansion activities.. This calls for a detailed monitoring program of the coastal process. Accordingly the shoreline monitoring program was done in 2008. The study consists of collection of field data, study of shoreline changes and prediction of littoral drift. Initially field observations like beach width changes, beach profile surveys and sediment samplings were made. The wave climate has been generated using WAM model. The estimation of littoral drift was made with transport coefficients arrived from the expressions CERC (1984) and Van Rijn (2001) after calibrating with the field measurements. The details of field measurements, studies using imageries, and methodology for estimation of littoral drift and protection measurements adopted are detailed in the paper*

***Keywords**: breakwater; shoreline; imageriws..*

INTRODUCTION

There have been a number of studies on the estimation of the alongshore sediment transport along the Indian coast., it has been established that the net littoral drift along the east coast of India towards the north,. But the quantity varies along the coast. The littoral drift is minimum near Nagapattinam (10^0 17''N, 79^0 53"E) and along Chennai (13^0 13'N, 80^0 20'E) it is maximum of about varies between (0.8 and 1.2) x10^6 m^3 per year through notable contributions of Ananth and Sundar(1990) and Sundar and Raju(1997) and the net drift is towards north. The climatic conditions along this region are influenced by two seasons namely, the south west (SW) monsoon from May to September and north east (NE) from October to December and the coastline is almost normal to the geometric north. In the present study the offshore wave climate has been simulated from National Centre for Environmental Prediction (NCEP) wind data for the year 2008 using the WAM model, of Komen et al (1994) whereas, the near shore wave climate was derived by adopting MIKE21 PMS module. Observtions on shoreline

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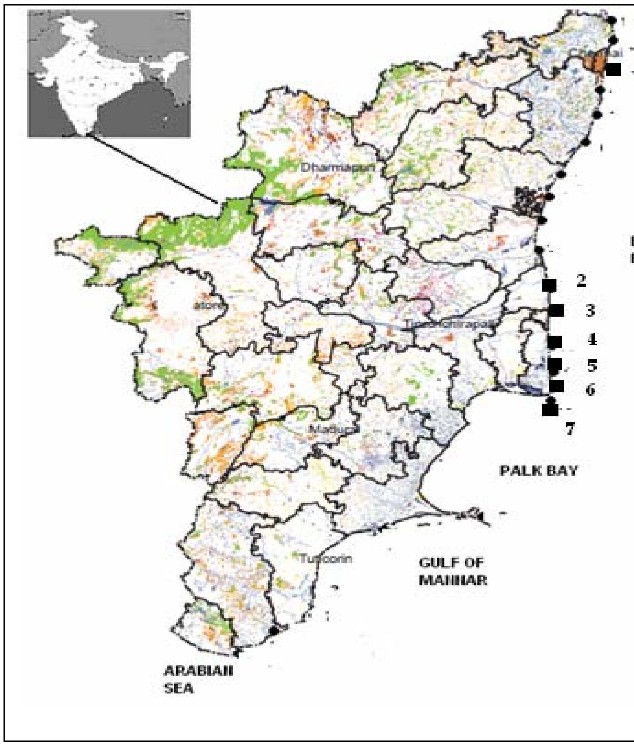
movement was carried out near river mouths and protruding structures along the coast. Apart from this data from satellite imageries were used. . Then the alongshore sediment transport rates were arrived using the approach of Van Rijn (2001). The details of the measurements, numerical and physical model studies and analysis of results are presented and discussed in this paper.

STUDY AREA

The study area is the stretch of coast of about 3km. The coastline is oriented in SE-NW direction.. The study area is shown in Fig.1. The coastline is oriented almost parallal to geographic north (N)**.** The rivers Cauvery and Vellar meet the Bay of Bengal coast at Poompuhar and Velankanni. Apart from that there is an ancient shore temple existing at Tranquebar and a pair of breakwater of minor port of Nagapattinam is projecting in to the sea.



Sl no	Site
1	Chennai
2	Poompuhar
3	Tranquebar
4	Nagapattinam
5	Velankanni
6	Vedaranyam
7	Point Calimere

Fig 1 Index map

OBJECTIVES

It is proposed to study the alongshore sediment movement pattern along this coast based on the field data and satellite imagery informations.

METHODOLOGY

Based on the observations on the shoreline movements in the vicinity of river mouths and estuaries it is possible to estimate the alongshore sediment transport. Hence for the present study the shoreline changes in the vicinity of estuaries at Poompuhar, Velankanni and shoreline movement in the vicinity of protruding structures at Tranquebar and Nagapattinam were monitored in the year 2007. Monthly measurements of shoreline along the Poompuhar, Tranquebar, Nagapattinam and Velankanni were observed. The foreshore slope and orientations of the coast were also observed.

FIELD MEASUREMENTS AND SALIENT OBSERVATIONS

Shoreline oscillations for a distance of 1km north and south of estuaries at Poompuhar and Velankanni were observed. Apart from this the data on shoreline variations for a distance covering north and south of structures at Tranquebar and Nagapattinam were collected for the year 2008. The observations were grouped in to Non Monsoon (NM) from January to May, South West (SW) from June to September and North East (NE) monsoon from October to December. The details of observations are detailed below..

Poompuhar

The place is historically important. The beaches north of Cauvery estuary have undergone accretion to the tune of 41m in SW monsoon. The estuary mouth was migrating towards north. During NE monsoon erosion of about 30m has taken place on both sides of estuary. The average wave height and periods were 1.25m and 8 sec. In NE season average wave height of about 2m with period of 6 sec was prevailing. The beach slope up to (-) 8m was 1/100 with effective sediment size of 0.2mm.

Tranquebar

There is a famous shore temple existing in this place. Apart from this there is an ancient 16^{th} century Danish fort is also located here. Half of the temple is almost eroded and at present the temple is like a protruding structure in the sea. The observations were made on the north and south side of the temple. On the south side about 40m of beach formations were observed in SW monsoon and it was 11m in NE monsoon. On the northern side no significant beach formations were seen. The average wave height and periods during SW season were 1.0 m and 9 sec. In NE season average wave height and period were in the range oft 2m and 7 sec respectively. The foreshore slope and effective size of sediments were 1/120 and 0.26mm.

Nagapattinam

This coast is characterized by the formation of a minor port. The two breakwaters of the port are projecting in to the sea. The shoreline observations were taken on north and south side of the port. In Sw monsoon 15 to 20m of beach was observed on north and south side of the port. About 25m of beach was seen on the north side of port at the end of NE monsoon. The foreshore slope and effective sediment size are 1.470 and 0.3mm respectively.

Velankanni

This is a famous piligrimage centr and river Vellaiyar meets the Bay of Bengal in this stretch. Shoreline observations were carried out on north and south side of estuary. About 75 to 90m of beach was seen on both sides of estuary. It gets eroded in October – November and reforms in January. During SW season the average wave height and period was about 1m and 10 sec respectively. In NE season the average wave height and period are 1.5m and 8 sec respectively. The foreshore slope up to (-) 8m was 1/980 and effective sediment size was 0.41mm.

SATELLITE IMAGERIES

The available satellite imageries were collected and analysed for evaluating the shoreline changes. The migration of river mouths of Cauvery in Poompuhar and Vellaiyar in Velankanni were analysed. The estuary of Cauvery was migrating towards north and that of Vellaiyar was found to move southwards. Apart from this the shoreline changes in the vicinity of protruding temple at Tranquebar and breakwater in Nagapattinam were also assessed with the satellite imageries. Accretion of beach was seen on the north side of temple at Tranquebar . In case of Nagapattinam more beach width was seen on the north side compared to the south side of breakwater as shown in Fig 2 to 5.

Fig 2 Poompuhar-Cauvery-July 2008

Fig 3 Velankanni-Vellayar-Sep-2008

Fig 4 Tranquebar-July-2008

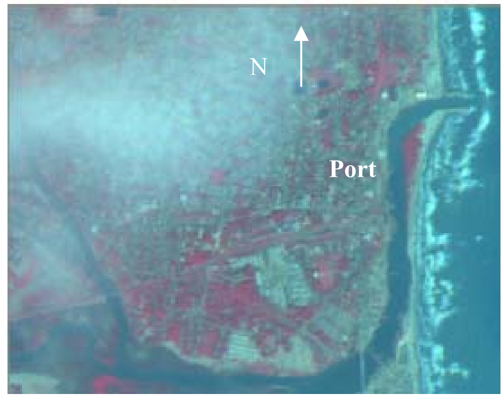


Fig 5 Nagapattianm-Feb 2006

GENERATION OF WAVE CLIMATE

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 numerical models were employed to derive monthly near shore wave climate. The two wave models that were adopted are Offshore Spectral Wave (OSW) or WAM model and Near Spectral Wave (NSW) models of MIKE21 developed by Danish Hydraulic Institute (DHI), Demark using the National Centre for Environmental Prediction (NCEP) wind data. The bathymetry data for the model was derived from Earth TOPOgraphy 2 minute (ETOPO2) grid data base and discretized into a spatial square grid of size 77 km .The coast is influenced by two monsoons namely south west and north east monsoons as stated in earlier chapter. Waves are predominantly from southeast (100–160^o) during the Southwest monsoon (June–September) and Northeast (80–90^o) during northeast monsoon (October–December). The basic equations of OSW are based on the 3rd generation model, WAM Cycle 4 model of (Komen et al 1994) developed for deep-water applications on global and regional scales. NSW is a wind-wave model, which describes the growth, decay and transformation of wind-generated waves and swells in near shore areas. It takes into account the effects of refraction and shoaling due to varying depth, local wind generation and energy dissipation due to bottom friction and wave breaking. The model also takes into account the effect of wave-current interaction. It is a stationary, directionally de coupled parametric model. For details of the model physics and equations Holthuijsen et al (2000) and DHI, 2001 can be referred. The near shore bathymetry from the Naval Hydrographic Office (NHO) chart was digitized and discretized into a 100 m by 100m grid and adopted for generating the nearshore wave climate. The nearshore wave climate was adopted for the estimation of alongshore sediment transport using Van Rijn (2001) approach. The season wise rose diagrams are furnished in Fig 6 to 8.

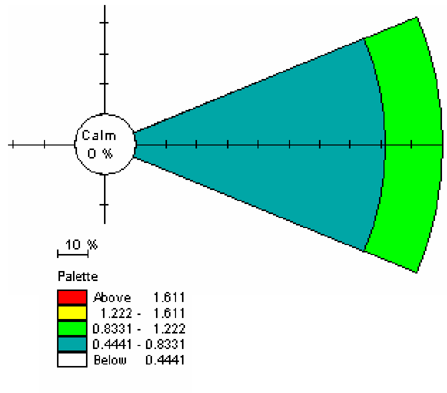


Fig 6 Wave rose for non monsoon (Jan-May)

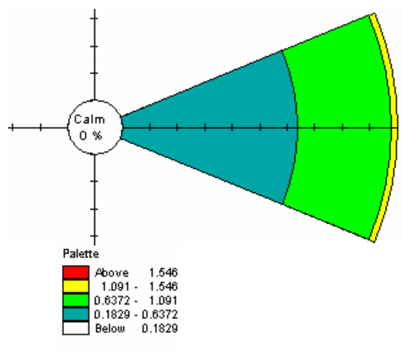


Fig 7 Wave rose for south west monsoon (Jun-Sep)

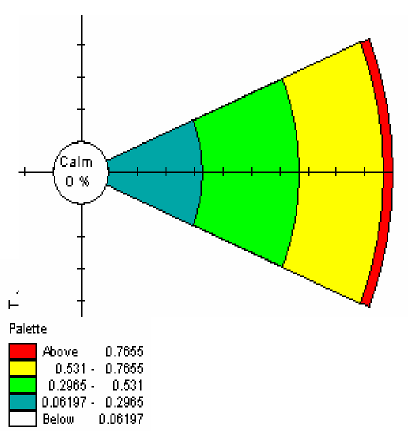


Fig 8 Wave rose for north east monsoon (Oct-Dec)

ESTIMATION OF ALONGSHORE DRIFT

The sediment size and foreshore slope of the coast is varying along the coast from Poompuhar to Velankanni. These variations play a major role in the estimation of alongshore sediment transport. However the CERC (1984) expression does not consider these expressions. Hence the expression of Van Rijn (2001) was used and is described below and detailed in table

$$Q = 40\, K_{swell}\, K_{grain} K_{slope} (H_{sb})^{3} \sin(2\alpha_{b})$$

Q = alongshore sediment transport (kg/s), T_P= Peak period, Swell correction factor,

K_{swell} = $T_P/6$, D_{50} = Particle size (mm), K_{grain}= Particle size correction factor = $0.20 / D_{50}$,

K_{slope}= Slope correction factor = $(\tan\beta/0.01)^{0.5}$

Table 1

Sl no	Site	Gross Alongshore sediment transport m^3/year	Net Alongshore sediment transport m^3/year	Comments
1	Poompuhar	223000	2500	Net drift towards north
2	Tranquebar	143000	1600	Net drift towards north
3	Nagapattinam	65000	2300	Net drift towards south
4	Velankanni	33000	1200	Net drift towards south

RESULTS AND DISCUSSIONS

The analysis of field data along Poompuhar to Velankanni indicates large variations in coastal process. The coast being a straight one, it is subjected to waves from all directions. Hence the littoral drift is not dominantly directed towards a particular direction. The visual observations of the wave climate indicate that the coast is prone to cyclone waves during north east monsoon. The short period waves are more in NE season.

CONCLUSION

The study of the coast with field observations and satellite imageries indicate change in the direction of sediment transport from Velankanni to Poompuhar. The foreshore slope also decrease from Velankanni to Poompuhar and this results in increase in the magnitude of the alongshore sediment transport. The direction of net sediment transport is in agreement with the finding of Sanil Kumar et al (2002). The net sediment transport varies from 1200m^3 to 2500 m^3 and it changes from south to north.

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