International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

Studies on Morphological Changes of Puducherry Coast - A Review

Anandabaskaran.V
Research Scholar ,
Department of Civil Engineering
Pondicherry engineering college
Pondicherry, India

Dr.G.Vijayakumar
Professor.
Department of Civil Engineering
Pondicherry engineering college
Pondicherry India

Abstract - **The coast is an area bordered by an ocean or a sea, dynamic and fragile. Traditionally, coastal areas have played an important role in the socio – economic development of the country, primarily because seaborne trade remains the cheapest method of transporting large quantities of goods over long distances. Pressure on the coast has been increasing ever since dawn of civilization by vigorous unorganized developmental activities. Due to this rapid development activities and settlement on the coast has created an imbalance situation on the geomorphology of the coast. For the study, the Puducherry coast was considered which pose the similar situation as discussed above. Phenomenal shoreline changes prevail along the puducherry coast due to rapid developments such as construction of harbours , jetties, breakwater, seawalls and groynes. Add on to the above problem , construction of new port is proposed by the government of Puducherry. This could cause an adverse impact on the coast if such structures are constructed without proper scientific understanding above the coast. Thus, there is a need to study the impact of such projects prior to construction and its consequence on the coastline. The objective of the present study is to develop a reliable model to predict the phenomenal morphological change due to impact of coastal structures..**

***Keywords—:* Beach erosion, offshore , Nearshore , wave currents, mike 21**

INTRODUCTION

The coastal morphological change in the near shore zone are induced by natural activities such as wind, wave, storm, tides etc., which abide to seasonal. Tsunami, sea level rise. construction of groin, breakwater ,seawall, dredging and beach nourishment which are the prime response for an unstable coastal zone . Therefore, understanding the beach morphological changes in this zone is necessary and important for coastal engineering projects, *e.g.*, constructing harbors, maintaining navigation channels, and protecting the beach against erosion.

ORGIN OF THE RESEARCH PROBLEM

The union territory of Pondicherry ,located on the south East Coast of India facing Bay of Bengal at latitude of 11º 56' N and Longitude of 79º 50' E. The region experiences an average of 2 to 3 cyclones annually. The wave height in the nearshore of this coast ranges between 1.0 m to 1.5 m with a wave period ranging between 7.0 sec to 9.0sec. The wave climate is very severe during monsoon with significant wave heights ranging from 4.0 to 6.0 m and wave period from 10.0 sec to 15.0 sec.

Acknowledging the elevation of the Puducherry shore line, settlement on this coast dates back to 18th century by the French .The French colony was established on a sand dune of 15 mts high, and 250 mts wide which spans along the eastern coastal stretch of South India till Cape Comarine . The coast has lost a sandy beach of nearly 1km in width two century back after the settlements and left out with 25 meters of beach opposite to the white town spanning around 3.7Km, which was evident till 1986. The construction of Groynes at the tidal inlet of the artificial fishing harbor at Veerampattinam as aggravated the situation and had led to severe erosion problem and the consequences are propagation of shore line towards in land. This phenomenon has lead to sweeping of houses which are constructed along the coast on the Northern side of the Groyne thereby affecting the coastal community.

Moreover, in order to protect the upland from severe erosion, the coast opposite to the white town of Puducherry was armored with random rubble mound seawall. Since the predominant movement of sediment is Northerly, this activity has extended the problem of erosion further in the Northern side of the coast thereby causing severe damages to coastal Hamlet villages. This study focus on the various technical aspects to safeguard the remaining beach and win back the lost beach by adopting a proper scientific approach , which could help the coastal engineers to understand and implement the coastal related activities .

SHORE LINE PROTECTION IN THE SELECTED AREA

Both hard solution and soft solution methods were followed in puducherry coastal region which to protect the coastal form of erosion. The hard solution are groyne, breakwater, seawall etc. Soft solution are artificial beach nourishment using river sand. The selection of suitable method depends on number of parameter like environmental condition like wave speed, wave height etc, cost of the project, availability of the material, and machinery for the construction of a structure , environmental impact of the proposed method. etc. The merits and demerits of the proposed methods are given below.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

Groyne
Groyne is a shore protection structure which is usually built perpendicular to the shore extending from landward of possible shoreline recession in to the water a sufficient distance which helps in stabilizing the shoreline at a desirable location. Groyne can be classified as based on material ,height, permeable.

Seawall
The structure which are constructed parallel to the shoreline to separate an eroding land area from water area and to protect the land and upland areas from further erosion by waves with an incidental function a retaining wall or a bulkhead. The limitation of these structure are that they can only protect the land behind them and none adjacent to the up coast or down coast. When built on a receding shoreline the recession on the adjacent shore will continue and may get accelerated.

Break water
The structure which is to dissipate the wave energy is known as breakwater. It can be constructed in offshore breakwater and onshore breakwater . Offshore breakwaters are usually shore parallel structures. It is a structure designed to provide protection from wave action to an area located on the leeside of the structure. It dissipates a significant part of incident wave energy and only the remaining energy is available at its lee side. Offshore breakwater is not only used for shore protection but also to provide Harbor protection, acting as a littoral barrier. It also serves as littoral barrier-sediment trap to some extent. The shore starts building up towards the breakwater and the formation is called 'salient' if the advanced shoreline does not reach the breakwater. If it reaches the breakwater, the formation is known as 'tombolo'. Detached breakwater works efficiently, when the waves are coming in the direction normal to the shore. But in Pondicherry coastal region waves are approaching at different angles to the shore depends upon the seasons over the year. Moreover this option will be expensive, since the quantity of rock required for the offshore breakwater construction is more when compared to Groyne, since it is constructed in relatively deeper waters (say 3 to 5 m water depth). It also needs sophisticated equipment like floating barges, cranes and a working harbor when compared to groin construction. Hence the offshore-detached breakwater option is also not well suited for the present problem

Models
Models can be classified according to the time and space (area) covered. They can be classified as short term small area models(S), medium term medium area models(M), long term large area models(L). Some typical definitions are: S-models cover a model durations of hours (or less) and areas of I to 100 m^2 Coastal applications are models of bed forms (ripples and dunes), breakwater cross-sections, local scour near structures, water intakes, sewerage outfalls and diffusers. M-models typically cover prototype areas of several km2 and durations of years.
Coastal applications are models of shore formation, port and harbour, inlets, estuaries or portions of estuaries, and shore protection with offshore and onshore structures. This category also includes fluid flow models (waves and currents) that cover medium areas, although they may only represent a short duration. L-models typically cover areas greater than 100 km2 over centuries. Coastal L-models extend in the cross-shore direction from behind the dunes to the continental shelf. To simulate long durations and the slow sediment transport, long-term erosion of coasts, they must account for the (very slow) sediment transport processes that exchange sediment between the active coastal zone, the continental shelf and the backshore.

TYPES OF MODELLING

Physical modeling
Physical model constructed and operated at reduced scale offer an alternate for examining Coastal phenomenon that are presently beyond our analytical skill. Using physical model replicate near shore process
Physical modeling has three attributes that commend it:

a) Integrate the appropriate equation governing the processes without simplifying assumptions that have to be made for analytical or numerical model.
b) The small size of model permits easier data collection throughout the regime at a reduced cost, whereas , field data collection is much more expensive and difficult, and simultaneously field measurements are hard to achieve
c) The degree of experimental control that allow simulation of varied or sometimes rare environmental condition at the convenience of the research.

Disadvantage of physical model

a) Scale effect occur in models that are smaller than the prototype if it is not possible to simulate all relevant variables in correct relationship to each other than in the prototype.
b) Laboratory effects can influence the process being simulate to the extent that suitable approximation of the prototype is not possible. Typical laboratory effects arise from the impact model boundaries have as the process being simulated.
c) All forcing function and boundary condition acting in nature are not included in the physical model, and the necessary functions and condition need to be assessed and accounted for its evaluation of model results.
d) Physical models are undeniably more expensive to operate than numerical models; and in situations where the numerical model gives reliable results with engineering accuracy, numerical models is the tool of choice.

Numerical modeling
With the advent of computers and with the incredible explosion of size and speed of computers, sophistication of software and development of information technology, numerical modeling would seem to be a natural choice. Laboratories for physical modeling need large real estate properties and must construct specialty equipped buildings and infrastructure. Numerical models and associated software must also be purchased or developed at substantial cost, but can be operated in standard office space. Physical models have high operating costs associated with them. The large laboratories

need to be maintained. Moreover, the costs of model construction, equipment, such as pumps and wave makers, measurement instrumentation, and provision of water and power also accounts to physical model study. Operating a physical model needs staff with technical backgrounds varying from backhoe operators to instrument makers. A numerical model needs computing equipment and a small, homogeneous group of people familiar with the computer programs. Both types of models needs expertise in the field of coastal engineering to evaluate and Justify the model. From the above discussion it is evident that, numerical modeling is more cost effective and lower operating cost than Physical model studies. Numerical models also has the following disadvantages

a) It gives spurious solutions that show little similarity to the prototype,

b) It do not add to the modeler's understanding; they essentially reflect the modeler's input,

c) A problem must be clearly understood before a model study is formulated.

Mike 21 software for numerical modeling

The MIKE 21 is more user friendly, reliable in specifying and editing input parameters with in-built mathematical options for like time series interpolation, spatial interpolation options for data interpolation and editing. The data can be entered in required time interval range namely in hours, minutes or seconds. The model option has automated validation for error correction and a separate log file is also furnished to denote the errors during modeling. Simulation and validation options are user specific and required key pollutant parameter can be modeled and validated separately. Moreover, the results are more technically sound enough for ease extraction, visualization, and usage of them for comparison with other mathematical models.

MIKE 21 is a professional engineering software package for the simulation of flows, water quality, waves and sediment transport in lakes, estuaries, bayso and coastal seas and other water bodies. MIKE 21 has four basic modules viz., Hydrodynamic (HD), Environmental, Waves and Sediment, among which Wave model is used for the present study. A range of wave modules are included in MIKE 21, each with a particular area of application. The models can be divided basically into two groups:

❖ Models based on wave action concept

- Offshore Spectral Wind-Wave Module (OSW)
- Nearshore Spectral Wind-Wave Module (NSW)

❖ Models based on the momentum concept

- Boussinesq Wave Module (BM)
- Elliptic Mild-Slope Wave Module (EMS)
- Parabolic Mild-Slope Wave Module (PMS)

This model is used to determine wave fields in coastal areas where diffraction can be neglected. MIKE 21 NSW can produce radiation stresses for the calculation of wave-induced currents, for instance as part of sediment studies. Varying water levels from tides and winds can be included. The HD Module simulates the water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal areas. The water levels and flows are resolved on a rectangular grid covering the area of interest when provided with the bathymetry, bed resistance coefficients, wind field, hydrographic boundary conditions, etc. The BW model is the most advanced wave model within the MIKE 21 package. The model can determine wave disturbance in harbours due to the penetration of irregular short-crested and long-crested waves and includes details such as wave grouping and the generation of bound long waves. This model is an ideal choice for studies of harbour resonance and seiching. It may also be used to calculate wave fields in smaller coastal areas where diffraction and wave breaking are important. In addition, it can be used in combination with the MIKE 21 HD Module to calculate wave-induced currents in the surf zone. The PMS model is a simplified version of the EMS model in the sense that it assumes a predominant wave direction and partly neglects diffraction and backscattering. The model is an efficient tool for the determination of wave fields in larger coastal areas where diffraction from obstacles and back-scattering can be neglected.

Survey on Puducherry coastal erosion

Limited research work has been established on the erosion protection of Puducherry coastal region

.

Neelamani,S. and Sundaravadivelu,R., 2006. In their investigation stated that, the Northern Pondicherry coast has subjected to severe erosion after the construction of Pondicherry fishing Harbor situated at Thengaithitu South of the coast .

Vijayakumar,G., and Govindarajulu,D., in their research stated that, transformation of the nearshore waves at the surf zone and the coastal front structures attribute the morphological changes of the coast

Sivaprakasam and Marimuthu in their investigation stated that, the sand dunes of the coastal stretch between Puducherry and Portnova has been reduced and nearly become flattened and the berm have been washed away after the Indian Ocean Tsunami 2004 causing a serious morphological changes of this coast thereby erasing the imprints of the Historical signature and their remain relics.

Aravind and salghuna in their research, stated that, shoreline changes were investigated from the Northern Coramandel coast for a stretch of 112km and observed the morphological changes using the concept of map overlay from 1972 to 2009.

Punithavathi and tamilenthi 'study of thane cyclone and its impact in Tamilnadu ,india using GIS' 2012, in their investigation study it was stated that, the impact of thane cyclone was severe along the coastal region of Puducherry and Cuddalore leading to sea water intrusion at places were berms are distrubed.

Vijayakumar,G., and Rajasekaran.,C 'studies on dynamic response of coastal sediments due to natural and manmade activities for the puducherry coast'2013 in their investigation

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

study it was stated that, response of coastal sediment are mainly due to the impact of waves and construction of manmade structure in the puducherry coastal region .

Rajalakshmi P.R. and Usha Natesan, ‘Dynamics of Pulicat mouth’, November 2006, in their investigation study, used simulated offshore waves characteristics (from NCEP August 2004 – July 2005) and nearshore bathymetry as input for MIKE 21 for predicting the transformation of the coastal stretch and the littoral drift at Pulicat tidal inlet. The results were also compared with field data with the aid of GIS.

Nam P.T., Larson,M. Hanson,H Hoan L.X, developed a numerical model of beach morphological evolution due to waves and currents in the vicinity of coastal structures 2010. The model was applied to simulate the beach evolution in the vicinity of coastal structures in a non tidal environment under wave current action. The developed model was validated against six high quality data sets from the experiments on the morphological impact of a T head groin and a detached breakwater in the LSTF basin at the coastal hydraulics laboratory Vicksburg miss .The simulation showed that the model could well produce the wave field compared to the measured data .A accurate wave induced current were also obtained with the model. Neglecting the cross current concept, this model can be applied in coastal engineering projects for predicting the beach evolution due to waves and currents in the vicinity of coastal structures for a rough estimate.

Hoan L.X , and Hanson et al, developed a model for shoreline evolution at hai hau beach Vietnam 2010. The model was very much compatible and stimulated the shore line evolution at hai hau beach including the dike seawall boundary condition offshore sediment losses the complex morphology around the ba lat mouth . The overall magnitude and trend of the stimulated shoreline evolution was in good agreement with the measurements both for the calibration and validation period .The calculated results used to establish the sediment budget showed that the net sediment transport is in the Southward direction and that of a large amount of fine sediment is transported offshore into deep water due to gradient in the LST and fine sediment lost into deep water are the major causes of the severe erosion at hai hau beach. The LST are induced by diffractive and refractive waves due to the effects of the headland of ba laut estuary .

Concluding remarks

Limited research work has been done in the Puducherry coastal addressing the severe erosion problem. From the literature reviewed on various aspects, following lacunae are observed. No single model had been used for offshore and nearshore wave transformation, and sediment transport. A holistic approach is missing; the studies attempted any one component only. Approach on integration of models to obtain offshore, nearshore and littoral transport had not been undertaken. Studies on modelling of nearshore wave climate along puducherry coast from the offshore wave transformation based on satellite data are absent. Hence the present study aims to hindcast waves in offshore and nearshore areas with NCEP wind components and numerical modelling. Predicted nearshore wave climate were used to compute the littoral transport using LITDRIFT and morphological changes of puducherry coastal region using MIKE 21.

REFERENCES

[1] Neelamani and sundarvadivelu 2006. Investigation on the reasons for erosion of Pondicherry Coast, South East Coast of India; Journal of Coastal Research, SI 39 (Proceedings of the 8th International Coastal Symposium), 880 - 883. Itajaí, SC, Brazil, ISSN 0749-0208.

[2] Nam, P.T., Larson, M., Hanson, H., Hoan, L.X., 2009. A numerical model of near shore waves, currents, and sediment transport In: *Coastal Engineering*, Vol. 56, 1084-1096.

[3] Nam, P.T., Larson, M., 2010. Model of near shore waves and wave induced current around a detached In: *Journal of Waterway, Port, Coastal, and Ocean Engineering*, Vol. 136, No. 3, 156-176.

[4] Larson, M., Camenen, B., Nam, P.T., 2010. A unified sediment transport model for inlet application Submitted to: *Journal of Coastal Research* (in press).

[5] Rajalakshmi P.R. and Usha Natesan, ‘Dynamics of Pulicat mouth’, November 2006, Accepted in the Journal of Engineering today