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Experimental Analysis of Waves Energy Spectrum Interaction on Sea wall Structures along Puducherry Coast

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ABSTRACT: The study of dynamic interaction between waves and coastal protection structure play a vital role in the establishment of coastal structures. It also plays a key role for the coastal environment and its management. The present study is focused on the analysis of waves and its energy spectrum at the location or near to the interacted sea walls along the coastal regions of Puducherry. Numerical modeling study is very essential to understand the wave characteristics along the coastal regions. In the present study numerical SWAN model is used to understand the local effects and large scale effects on the Puducherry coast. For this a detailed study has been conducted for the period 2013 using ECMWF wind in SWAN model. The model derived results shows the wave height is maximum during North East monsoon season compared to all other seasons. The variation of wave spectrum is observed that during Northeast monsoon season, the energy density reaches maximum of 1200 kg/s to 2400 kg/s at 0.2 to 0.3 Hz of frequency. The Energy transport during North East monsoon season is 1000 m^3 kg/s^2 and during South West monsoon season is 200 m^3 kg/s^2 and 500 m^3 kg/s^2 in rest of the year. Wave energy interaction along the seawall structure during North east monsoon season is observed to be higher compared to other seasons. So the seawall is more prone to damages during this season.

KEYWORDS: Wave spectrum, ECMWF, SWAN model, Stimulated waves, Energy density.

I. INTRODUCTION

India has a coast stretches of about 6000 kms, including islands the total coastline is about 7500 km. Indian coastline faces lot of problems due to waves along the coast. Interaction among the coastal process parameters like waves, tides, currents etc are very complicated and embrace abroad spectrum of near shore dynamics. Port developments and associated marine structures like seawalls, groins, breakwater, jetties etc. Puducherry is situated on the east coast of India about 160 kms from south of Madras (Chennai). It has been witnessing problems on its coastline. Especially due to certain developmental activities carried out recently like construction of a fishing harbour etc. Further being classified as a minor port it has the potential for development in the near future. Hence in this study, Puducherry coast is considered for acquiring and studying the waves interaction and variation in waves spectrum of this region. The main objectives of the present work is to analyze the wave characteristics along Puducherry Coast; to understand and examine the effects of waves on coastal protection structure; to investigate the seasonal variation of energy spectrum due to interaction between waves and the sea walls, Some specific studies and works are done in the present study are as follows

1.Configured SWAN model for the Puducherry region.

2. Variation of Energy spectrum along the region.

II. Location of the Study Area

Puducherry is located on the East Coast of South India facing Bay of Bengal having latitude of 11°56'N and longitude of 79°50'E. The coastal length of the Puducherry is about 22 kms. Due to its geographical location it experiences an average of two to three cyclones per year. The normal wave climate in Bay of Bengal is mild with significant wave height of 1.0 m to 1.5 m approximately, but the wave climate is very severe during cyclones with wave height ranging from 4.0 m to 6.0 m. The coast of Puducherry coast is facing severe erosion for past several years. After construction of the Puducherry port and the breakwaters in the Southern part of the coast, more significant erosion is on the Northern side and accretion on the Southern side of the coast. And because of this increased erosion the entire beach area of Puducherry is lost.

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Figure 1. Locations of the Study Area

III. Model Description

The SWAN model is a numerical wave model which is used to obtained realistic estimate of wave parameter in coastal areas, lakes and estuaries from given wind, bottom, and current conditions. SWAN model is the graphical user software that allows the user to set up, run and post-process the built-in depth- averaged shallow flow model. It describes free-surface, subcritical flow field by calculating the evolution of the water surface and horizontal depth-integrated velocities

IV. Model Simulation

The essential data for Swan model run are:

1. Bathymetry for a sufficient large area
2. Incoming wave fields.
3. wind field
4. current
5. water level
6. Bottom friction

V. Input Data

The Input Data Source files are downloaded from various research official sites for different parameter. Bathymetry data is extracted from GEBCO (GEneral Bathymetry Chart of Ocean) with the resolution of 30 arc seconds. Wind data is taken from ECMWF (European Centre for Medium Weather Forecasts) with the resolution of 0.125 X 0.125 degrees.

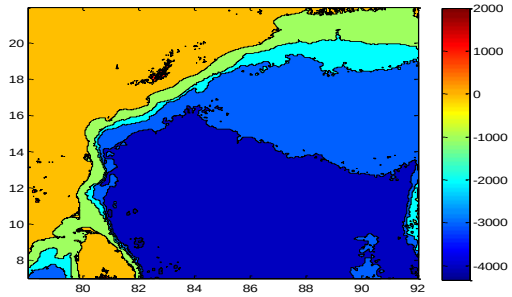

Figure 2. Bathymetry of East coast of India

For the present study bathymetry data is one of the inputs for the SWAN model. For the study area Puducherry bathymetry data is taken from GEneral Bathymetry Chart of Ocean. GEBCO bathymetry data is used to obtain the bathymetry values for the smaller domain. The extracted bathymetry is processed in MATLAB to get the bathymetry of the Puducherry regions. The figure shows the bathymetry data for the entire East coast of India.

VI. Wind Data

Wind data is one of the inputs for SWAN model. For the study initially, ECMWF (European Centre for Medium for Weather Forecasting) wind data is taken and is processed with MATLAB scripts in order to get wind speed for the year 2013

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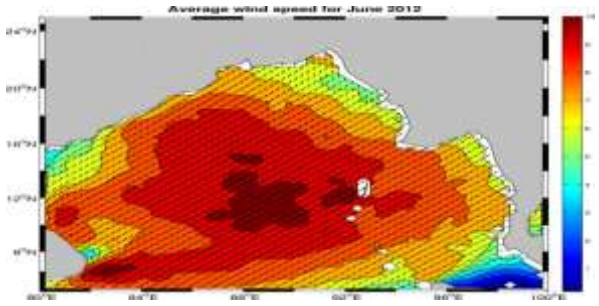

Figure 3: Wind speed direction

VII. Model Simulation

SWAN Model is initially simulated using constant wind for the year 2013 which is actually the average wind speed of every month of 2013. The wind direction is given manually like 30°, 45°, 90°, 180°, 270° and 360°. Its magnitude is given as 5 m/s.

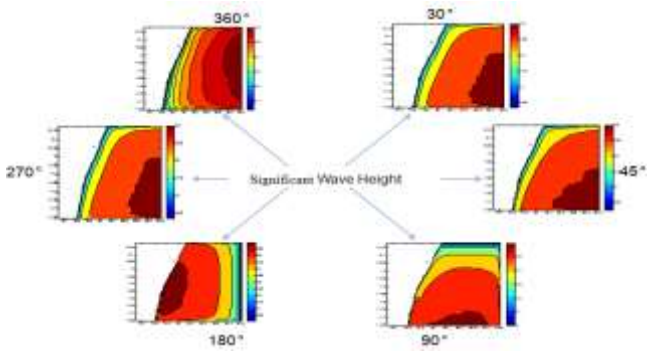

Figure 4: Significant Wave height

Swan Model is simulated for the year 2013 and it is displayed for all months and has shown in below.

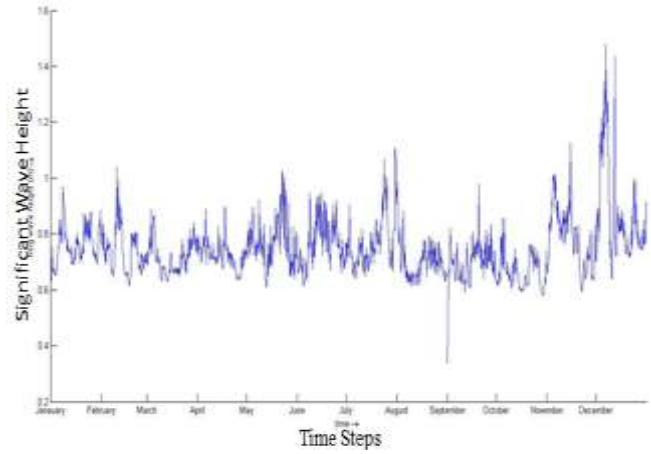

Figure 5: Variation of Significant Wave Height for 2013

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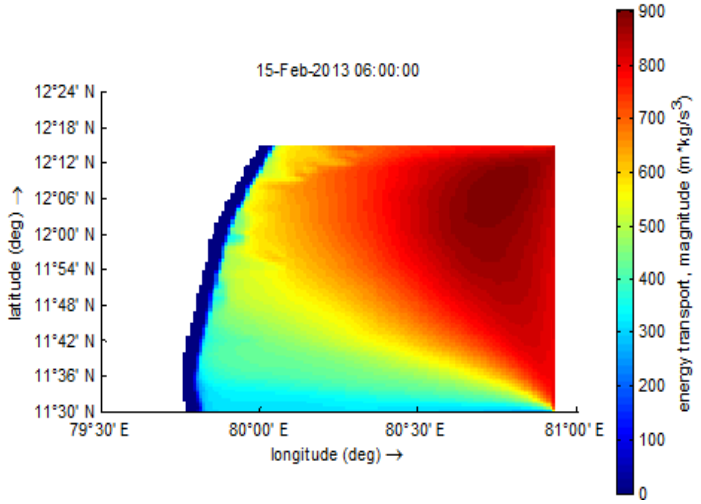

Figure 6: Energy Transport variation in February

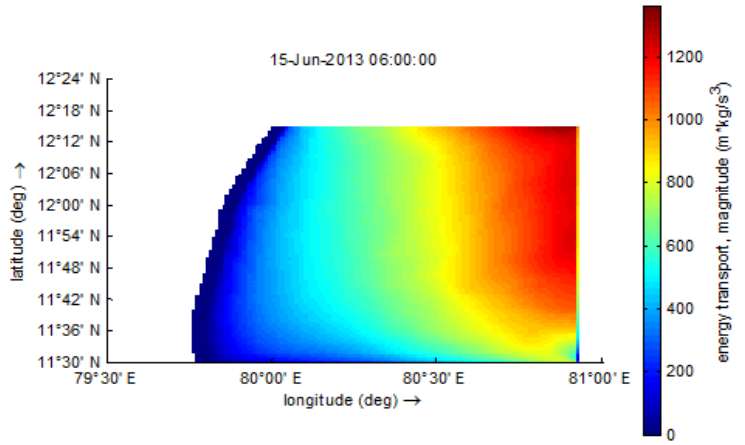

Figure 7: Energy Transport variation in June

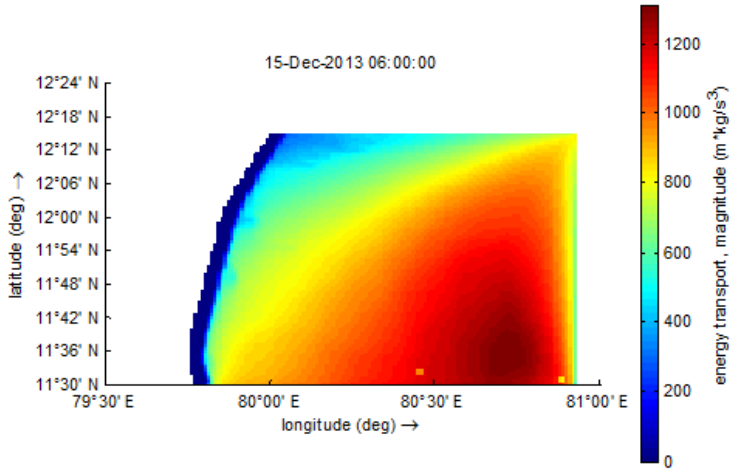

Figure 8: Energy Transport in December

VIII. Conclusion

The model derived results shows that wave height during the Northeast monsoon season is maximum of about 0.8 m to 1.4 m during November and December. During all other periods the maximum wave height ranges between 0.7 m to 1 m. The variations of wave spectrum is observed to be maximum of 1200 kg/s to 2400 kg/s at 0.2 to 0.3 Hz of frequency during Northeast monsoon season (November and December), and during South West monsoon

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(June - Sept) low energy density of range 250 kg/s to 900 kg/s at 0.2 Hz to 0.4 Hz frequency is observed. All other seasons remains the same. Wave carries considerable amount of energy along the coast. The Energy transport during North East monsoon is at maximum of the order of 1000 m^3 kg/s^2 in month of December. During South West monsoon minimum energyin the range of about 200 m^3 kg/s^2has been observed. Wave interaction along the seawall during the North East monsoon periods have significant amount of energy densities and energy transport compared to other periods. Since the seawall is more prone to damages during this seasons.

IX. REFERENCES

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