11. Summary and Conclusion

The predictions of morphological changes have an immense application on the development of coastal infrastructure for the Coastal zone management. More relevantly, coastal erosion is a major problem faced by several sectors which need to develop a morphological model for the coast. Even though there are a number of free software’s available to the model and validate the coast, commercially available software such as, MIKE 21 coupled model are used in the present study. Hence, an investigation is done on numerical modeling of morphological changes by dynamic coupling of waves and currents using MIKE 21 Flexible mesh coupled model. The main objective of the research is to simulate hydrodynamic, spectral and sediment transport model and are compare with corresponding observed data for which field data collected for SW and NE monsoon 2009 and processed.

From the processed data, the tidal range of Kakinada coast with a maximum of 2.48 m normally was occurred at mouth bay in December (NE monsoon), and the minimum level 0.16 m was occurred in July. The observed surface elevation was 1.81m and 2.48m during SW and NE monsoon, respectively. The importance of semidiurnal constituents depended on geographical positions which could be calculated by form number. The obtained form number was 0.25 and 0.23 during SW and NE monsoon, indicating the study area was dominance of semidiurnal tidal constituents throughout the year. The highest current speed was about 0.88 (0.85) m/s at north of Godavari estuary (location 3), which was followed by the mouth of Kakinada bay about 0.72 (0.54) m/s during SW (NE) monsoon. The flood current reached maximum velocity which flows in a southerly direction near the Kakinada entrance channel and ebb current reached maximum velocity at Godavari point which flows in a general northerly direction along the
sand spit. The measured $U - V$ components were compared with the simulated model; the above results showed that the current in the upper layer increased significantly under the influence of monsoonal winds.

During the study period, the measured wave directions were predominantly from south-east to south for SW monsoon and north to north-east for NE monsoon. Model calculation revealed that the wave height of the offshore region varied as 1.02 m for SW and 1.04 m for NE monsoon. The waves approaching near the coast at a particular time step, at an average value of 0.75 m with a peak period of 9.24 seconds. The overall results indicated that near the mouth of Kakinada bay and north of Godavari estuary the waves had converging points, while at the interior of the bay region the waves got diverged. Because of the convergence of wave energy near the entrance of the bay, there was removal of sediments especially lighter materials. This was coincided with the presence of sandy materials up to 2km from the mouth. In the most interior part of the bay, the wave rays got diverged, which indicated the reduction of waves activity and consequently deposition of clay and silt materials. It could also be seen that the occurrence of deviation was more in SW monsoon than NE monsoon seasons. This might be the reason for changes in Wind Sea dominant during SW monsoon.

Further, simulation analysis of the results showed that the radiation stresses near the coast reached a maximum of $0.87m^3/s^2$ (SW) and $0.52m^3/s^2$ (NE) along the coast, while $0.62m^3/s^2$ (SW) and $0.52m^3/s^2$ (NE) were perpendicular to the coast. Shear radiation stresses were quietly less as the waves approached the coast almost perpendicularly and an average value of $S_{xy}$ was found to be as $0.06 \text{ (0.08)m}^3/s^2$ for southwest (northeast) monsoon. Thus, in this model the wave shear stress dominated near the bay entrance and current dominated further towards
offshore. At the bay entrance the total shear stress was maximum at low tide and minimum at high water. Moreover, the wave’s incidence angle affected directly the wave convergence and divergence around the coastal area and total shear stress depended on the wave and current angle; thus erosion and deposition were certainly modulated by wave ordination.

The calibration was made against three stations at Kakinada coast during southeast and northwest monsoon. In the calibration process scattering index was reduced to obtain best results, it was made through several runs by changing various tuning parameters. Overall comparisons and validation between modeled data with measured data showed that the models were in good correlation with similar quantities of the measured data.

Initial bed change plays a vital role in prediction of erosion and deposition. Simulated bed level change rate showed that the area north of Godavari estuary was getting eroded while near the mouth of Kakinada bay was getting deposited for both SW and NE monsoon. However, the rate of bed level change was lesser in NE monsoon than the SW monsoon near the mouth of Kakinada bay. Therefore, throughout the study period, bed level changes showed higher rate during the SW monsoon along the Kakinada coast. The simulation showed that the longshore transport was directed towards North for waves from the SSE and S, while towards south for waves from NE and ENE direction. This result showed a significant area of deposition which was noticed along the mouth of the Kakinada bay and around HOPE Island. The waves from the southern direction carried sediment along the shoreline from the south (north of Godavari estuary), which was deflected by offshore waves and refracted by the morphological features of HOPE Island and deposits in the mouth region of Kakinada bay. This result suggested that the
sediments in the nearshore region were transported from south of Kakinada spit toward north of the hope island, deflected towards the Uppada region and tended to erode in this region.

The net sediment transport study for Kakinada Coast was estimated $3.2 \times 10^3 \text{ m}^3/\text{year}$ for SW monsoon and $7.7 \times 10^3 \text{ m}^3/\text{year}$ for NE monsoon, both were present at mouth of Kakinada bay and north of Godavari estuary, respectively. It was understood that the quantity of longshore sediment transport rate was increased from Godavari estuary upto mouth of Kakinada bay and then gradually decreased in Uppada region which indicated maximum sediment transport within the mouth region. The results of numerical modeling of sediment transport based on the hydrodynamic data collected on Kakinada coast had shown that sediment transport was strongly controlled by wave direction, which significantly enhanced bed shear stress, resulting in increasing sediment remobilization. From the above simulation, large quantity of materials were carried by rivers and deposited along the mouth of estuary. These sediments were piled into barrier features by the influence of waves and development of spits along the shoreline was due to the strong longshore drift.

The present study shows that hydrodynamic processes respond instantaneously to morphological change which requires the redistribution of sediment. As sediment takes a finite time to move, there is a lag in the morphological response to hydrodynamic forcing. Sediment can therefore be considered to be a time-dependent coupling mechanism. Since the boundary conditions of hydrodynamic forcing change regularly, this may mean that the beach never attains equilibrium. Morphodynamic processes exhibit positive and
negative feedbacks towards shoreline region of Kakinada coast which results in the
design, construction and maintenance of coastal and maritime projects.