5. Materials and Methods

5.1 Bathymetry

The bathymetry survey was carried out in the Kakinada coast from north of Godavari to Uppada including bay region, during July 2009 using single beam echo-sounder (ODOM Hydrotrac) (fig. 5.1) interfaced to a differential global positioning system (DGPS-Trimble) and laptop computer in a water resistant case mounted on a fishing trawler boat along with heave sensor (HS-50, Heave sensor allows for the correction of the boat's roll, pitch and yaw on the estuary surface, and a gyro compass provides accurate heading information to correct for vessel yaw). The variable frequency transducer provided water depth soundings and the horizontal positions of the measured points were obtained from a DGPS, which was connected to the transducer through a serial cable and to an antenna. The antenna was situated on a 3 m pole to prevent loss of signal in areas adjacent to levee edges. The entire electronics were powered by 12 volt batteries. We calibrated the echo-sounder system before the survey by conducting a bar check. The echo-sounder device had a transducer (sender-receiver unit) that converts electrical energy into simultaneous sound waves and an echograph (control-record unit). In this system, sound waves sent from the transducer spread within a conical volumetric surface towards the sea floor and the sound waves reflected from the sea floor were detected by the receiver unit. As a result of the comparison within the control unit, the return time (t) of the sound waves was determined electronically. Since the control unit was adjusted to a certain sound speed (V), depth (D) was calculated based on the formula:

\[ D = \frac{1}{2} Vt \]
Before commencing the survey, the information about latitude, longitude and grid had been given as inputs to HYPACK data collection software. The planned track lines were displayed on the monitor at wheel for navigation. Watch guards were positioned at the bow, transducer/antenna, heave sensor and at the rear end. The data were continuously collected at on-board PC along each transect. After completing a day of data collection, entire data was downloaded to an external hard disc and stored. The recorded data included: date, time, and latitude, longitude, X coordinates, Y coordinates, heave and depth. The survey sounding were incorporated to Hypac software to produce the survey chart. The data was recorded digitally and stored on Laptop for further processing. Although, the echo-sounder provided essential hydrographic information during survey operations, tidal corrections were made in the observed depths and reduced to chart datum. Transects were established; the system was calibrated with the bar-check plate; time, echo sounder water depth, and DGPS position was recorded in a text file on the laptop; and data records was converted to latitude, longitude, and average elevation. The elevation and boundary data was used to create bathymetric grid maps using MIKE21 software.
5.2 Waves, Tides and Currents:

Wave and tide parameters were measured using the MIDAS Wave Recorder (Valeport tide gauges - Valeport Limited, U.K) and current data was measured using Recording Current Meters (Aanderaa RCM9) for two monsoons (northeast (NE) and southwest (SW) monsoon) from 14 to 28 July and 14 to 30 December during 2009 at Kakinada coast, respectively (Table 1). The instrument was deployed in I mooring method with wave recorder settled at the sea floor and the current meter floats 2m above wave recorder with the help of double buoys. The Wave (Tide) sensors were set up to record a wave (Tide) burst once in every one hour (10 minutes) and current sensors at every 10 minutes. Each wave (Tide) burst consisted of 1024 samples of subsurface pressure at regular 60 (10) minute intervals at a frequency of 4 Hz through Fourier transform, giving wave burst duration of approximately 4 minutes 16 seconds. The measured sea level data was subjected to harmonic analysis to determine the amplitudes and phases of the tidal constituents (Emery and Thomson, 1998). Tidal analysis was carried out using standard harmonic method, where a finite set of cosine functions with frequencies
at the known astronomical forcing frequencies was fitted to the data using the least square method. Removal of a tidal component of the sea level data leaves residuals of sea level that include contributions from direct wind forcing, indirect wind forcing and surface waves.

![Image](image_url)

**Figure 5.2 Directional wave recorder and Recording Current meter**

### 5.3 Numerical model

Numerical models are effectively used for modeling the different coastal engineering problems all over the world. There are number of numerical models available ranging from open source (DELFt 3D, TELEMAC, ROMS, POMS, FVCOM etc.) to commercial (DHI MIKE, SMS, MOHID etc). In this thesis, MIKE 21/3 Coupled FM module (integration of Mike 21 HD, SW and ST modules) developed by DHI by combined wave/current/sediment transport for the study area. The reason for selection of MIKE 21/3 Coupled FM models is they suit for the provision of flexible mesh, which enable much more accurate representation and easy user interface to handle the problems with better real-time
scenario. The flexible mesh also allows reduction of grid size locally at areas of special interest. Coupled FM model simulates three models in parallel while interchanging the input of one model to simulate the output of another model. Wave radiation stress obtained as the SW model output is fed input to the hydrodynamic model. Water level flow and current variation from HD model is provides input to the ST model.