

COLLECTION AND PROCESSING OF PRIMARY DATA IN CONNECTION WITH REGIONAL COASTAL PROCESS STUDY

Executive Summary

Coastal Zones due to high population densities, linked with urban growth, expanding tourism, port activities and industrialisation, posed major threats to natural resources and resulted in extensive destruction and degradation of coastal ecosystem in the recent past. The effects of unplanned development are destabilizing the coastal ecosystems, adversely affecting the livelihood of the coastal communities due to resource depletion. Since most development activities are sectoral and highly competitive, there is often conflict for space and resources. In order to achieve sustainable development of the coast, Integrated Coastal Zone Management (ICZM) has been recommended as a great tool for which scientific field data on the dynamics of coastal process is essential. Coastal process study (RCPS) helps for better understanding of spatial and temporal changes and dynamics of shoreline process, movement of sediments, area of accretion, erosion and bathymetry of coastal zone. In view of this, the consultancy was awarded to Indomer Coastal Hydraulics (P) Ltd. to take up the collection and processing of primary data in connection with the Regional Coastal Process Study.

Measurement Plan : . Regional Coastal Process Study (RCPS) which is a unique path breaking study has been carried out first time in India. It includes extensive time series data collection on coastal energy, coastal sediments and coastal morphology covering entire 480 km coastal stretch of Odisha. In order to take up the Collection and Processing of Primary data in connection with RCPS the consultancy was awarded to INDOMER Coastal Hydraulics (P) Ltd, Chennai. The consultant deployed the Oceanographic equipments like Wave Rider Buoy, Tide gauge, Current meter etc. and commissioned the in-situ measurements from May, 2012 to April, 2013 based on Sediment Cells and sub-cells delineated by the NCSCM, Chennai following the guidelines of Prof. John Pethick, an international expert on Coastal Geo-morphologist. A wealth of coastal information on energy (waves, winds, tides, currents), morphology (*Inter* - tidal, Super- tidal and supra- tidal), sediment (Classic & nonclastic), beach profile, river discharge and surf zone measurements were generated for 12 months (May, 2012 to April, 2013) on time series basis.

(i) Coastal Energy: The details of data collection on coastal energy inputs (wave, wind, tide current) are depicted at Table- 1.

- **Wave:-**The directional Wave Rider Buoys were deployed at two locations such as off Paradeep (at 7.2km offshore, 20 m water depth) and off Balosore (at 15km offshore, 10m water depth) and wave data were collected continuously for one year. The wave data collected were processed using Waves21 software for obtaining various wave parameters such as significant wave height, zero crossing wave period, wave direction, wave period etc.

- **Wind:** - Weather stations (Wind Anemometer) were installed on the shore at two locations such as Paradeep and Balasore and the wind parameters such as wind speed, wind direction were recorded.
 - **Tide:** - In case of tide measurements, three self Recorders have been installed at three locations one each at Gopalpur, near the mouth of Chilika Lake and Budhabalanga River (Balasore) and the data were collected completely for one year. Tide data for Paradeep were collected from INCOIS, Hyderabad and the Dhamra Port provided the tide data for one year. The measured tides have been subjected to Harmonic Analysis in order to derive the tidal constituents at each station.
 - **Current** :-Current meters were deployed at 10 locations, comprising of one near shore location and offshore location at 5 places, i.e Off Gopalpur (One at 2 km & 15m water depth and other at 5.5 km & 25m water depth), Off Chilika (One at 1.8 km & 15m water depth and other at 7.5km & 20m water depth), Off Paradeep (One at 1.8km & 9m water depth and other at 7.2km &20m water depth), Off Dhamra (One at 6km & 5m water depth and other at 10km &12m water depth), and Off Balasore (One at 5km &5m water depth and other at 14km & 10m water depth) and the variations of current speed and current direction were measured.
- (ii) **Coastal Sediments:** The frequency of water and sediment sampling from rivers and sea, beach profile measurement are shown at Table- 2.
- **SSC and Sediment:** Sediment samples were collected from rivers, sea and beaches for different seasons and subjected to sieve analysis for sand fractions and hydrometer analysis was carried out for fine fractions. Water samples from eight rivers and from sea in the surf zone and 250m off shore at 10 km interval were collected for the estimation of SSC.
 - **Nutrients:** Water samples were also collected from surface and mid-depth at the mouth and upstream of eight rivers and analysed for nutrient parameters such as nitrite, nitrate, ammonia, phosphate and silicate.
 - **Beach Profile:** Beach profile surveys were carried out in four seasons at 5 km interval along the entire stretch of the Odisha coast.
 - **LEO:** Daily LEO measurements were carried out at three locations namely Gopalpur, Puri and Paradip.
 - **Discharge measurements:** River flow and discharge measurements were carried out for three seasons in six rivers such as Budhabalanga, Subarnarekha, Dhamra, Mahanadi, Devi and Rushikulya.
- (iii) **Coastal Morphology:** The spatial and temporal studies of coastal morphology such as bench mark establishment, terrain survey, bathymetry in rivers & sea, and Remote Sensing data are given at Table- 3.
- **Bathymetric Surveys:** Bathymetric surveys were conducted in eight rivers up to 5ppt Salinity and in the sea up to 25m water depth or 15km offshore whichever is closer using Echo-sounder. The survey was conducted along the planned lines perpendicular to the shore and the line spacing was maintained at 250m interval.
 - **Bench Mark:** The permanent Bench Mark Blocks have been erected at 46 locations at 10 km interval. The locations for the erection of concrete blocks were arrived as per the suggestion of NCSCM, Chennai based on Sediment Cell delineation. Using the available

Bench Mark levels at Gopalpur Port, Dhamra Port and DRDO, the MSL for 46 ICZM Bench Mark Blocks were transferred using the Leica RTK system. The validation of the ICZM bench marks was carried out with the bench mark value of Dhamra Port.

- **Terrain Survey:** Terrain survey was conducted for two seasons i.e during monsoon and fair weather seasons. The survey was done at 250m interval covering entire the Odisha coast. The terrain survey data were processed using Leica Geo Office and HYPACK MAX software. Charts were prepared using AUTOCAD.
- **Thematic mapping:** The thematic mapping on Land use, Wetland and Geomorphology of Odisha coast for Pre-monsoon and Post-monsoon seasons were carried out using high resolution Resources at LISS IV data with a special resolution of 5.8m procured from NRSC, Hyderabad. The entire coastline of Odisha state is covered in 37 topo maps with 1:50000 scale. The area taken for the study is 20km buffer from the coastline towards inland and covers an area of 12098.98sq.km. Ground truth verification study was conducted and the total 530 maps were prepared for land use, wetland and geomorphology.

Salient findings: The salient observation and findings of RCPS carried out during 2012-13 are given below:

1. Wave heights were higher at Paradeep than Balasore. The maximum wave height at Paradeep was 5.53 m in July. The wave direction was predominantly from SE - S off Paradeep and Balasore.
2. In general, wind speed was higher at Paradeep than the Balasore. Wind direction was predominantly between S and SW.
3. No much variation of tidal range along the coastal stretch between Gopalpur and Paradeep was noticed. However, the tidal range gets amplified from Paradeep towards north.
4. Surface currents are generally stronger than sub-surface currents. Current speed was generally stronger during September to November. Currents of Dhamra and Balasore are mainly tide dominant.
5. Long-shore sediment transport is comparatively high on southern Odisha coast and the net long shore sediment transport is towards north.
6. Bathymetry charts indicate that the seabed in the southern part is generally steeper than the northern part.
7. The stretches of beach near Gopalpur port, Paradeep port, Chilika Lake, Puri, Satabhaya, Penth under go erosion.
8. The riverbed is predominantly composed of sand in all eight rivers (Subarnarekha, Budhabalanga, Dhamra, Baitarani, Brahmani, Mahanadi, Devi and Rushikulya). The seabed sediment is primarily composed of sand followed by silt and clay. Considerable proportion of clay fractions are observed in offshore region.
9. In general, the southern beach of Odisha coast is mainly composed of medium sand where as the middle and northern parts of the Odisha coast, the beach is mostly composed of fine sands/silts.
10. The highest value of SSC (596 mg/l) was recorded in Budhabalanga river .The SSC values were higher at mid-depth than the surface. The salinity values in coastal sea

water were higher in south Odisha and showed a decreasing trend towards the north which is primarily dependent on the magnitude of river run-ruff.

Table: 1- MEASUREMENT OF COASTAL ENERGY INPUTS

No.	Activity	2012										2013				Details showing area & frequency of measurement
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		
		PR		MO				PO				FW			PR	
1	Wave Measurements															2 locations (Paradeep, Balasore) continuously for 12 months
2	Wind Measurements															2 locations (Paradeep, Balasore) continuously for 12 months
3	Tide Measurements															3 locations, (Gopalpur jetty, Chilika lake near Sipakuda village, and Budhabalanga river) continuously for 12 months
4	Current Measurements															10 locations, (Nearshore and offshore stations of Gopalpur, Chilika, Paradeep, Dhamara and Balasore) continuously for 12 months
5	Wave Transformation															-----
6	Long shore sediment transport															-----



:-Measurement period

Table: 2 – COASTAL SEDIMENTS

Activity	2012									2013				Details showing area & frequency of measurement
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
	PR		MO			PO			FW		PR			
SEDIMENT SAMPLING														
RIVERS														8 Rivers. 1 km interval. 150m on either side. (Upto 5 ppt salinity). 2 seasons.
SEABED														10 km interval along coast (Benchmark) Stns - surf zone, 250 m, 1000 m, 2500 m and 5000 m.,(2 seasons)
BEACH SEDIMENTS														5 km interval along coast. Bench mark stations – a) Foreshore, b) Backshore, c) Dune/ +5 m MSL (four seasons)
BEACH PROFILES														5 km interval, (-) 2m CD to (+)5 m MSL or 200 m whichever is nearer(four seasons)
WATER SAMPLING														
RIVERS														8 Rivers. 2 depths. (Surface and mid depth) 1 km interval. Up to 5 ppt salinity. (Four season)
SEA														2 locations. (Surf zone and 250 m distance). 10 km interval. Surface. (two seasons)
NUTRIENTS														8 Rivers, 2 locations (5 ppt and mouth)
WQ PROBE IN RIVERS														8 Rivers. 2 locations (5 ppt and mouth). 24 hours.

PR: Pre-monsoon, MO: Monsoon, PO: Post-monsoon, FW: Fair weather



: - Measurement period

Table: 3 – COASTAL MORPHOLOGY

Activity	2012									2013					Details showing area & frequency of measurement
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
	PR		MO			PO				FW			PR		
BENCH MARK ESTABLISHMENT															10 km interval
TERRAIN SURVEY															At 250m interval (2 seasons)
BATHYMETRY IN RIVERS															8 rivers up to 5 ppt (once)
BATHEMETRY IN SEA															250m spacing, up to 25m depth or 15km distance whichever is nearer to shore (Once)
LEO- BEACH PROFILE STATIONS															10 km interval. (also daily LEO at 3 stations)
DAILY LEO															At Gopalpur, Puri and Paradeep
REMOTE SENSING DATA ANALYSIS															LTL and (+) 5m MSL or 15 km inland whichever is close to the sea.

PR: Pre-monsoon, MO: Monsoon, PO: Post-monsoon, FW: Fair weather

: - Measurement period