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Beach Profiling studies at Yarada Beach, Visakhapatnam,
East Coast of India.

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July 2010.



राष्ट्रीय समुद्र विज्ञान संस्थान



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ABSTRACT

Seasonal morphological variations and effect of oceanographic processes such as erosion or accretion along beaches are important to understand the nature of the beach and the cyclic changes occurring during different seasons. Detailed investigations were taken up to analyze volumetric and morphologic variations at Yarada beach (Lat:17° 39.4 N. and Long.:83° 16.3 E.), which lies 8.5 kms south of Visakhapatnam port, in Andhra Pradesh, Central East Coast of India. Yarada beach is one of the most important areas, which has appreciable rate of erosion and deposition through out the study period. Five locations were selected at Yarada for beach profiling. The collected data clearly shows the specific zones of erosion and sand accretion during various periods. This study is based on the results of topographic profiles carried out on monthly basis, between May 2009 and May 2010. The volume variations of the sediments i.e. an account of accretion and erosion was estimated keeping the May 2009 profile as the base reference, over which the values of other seasons are compared and is presented in Table 9(iii). “A program to compute the volume of sand along beach profiles” (Ganesan, P., 2006) was used for computation of volumes for the entire field data collected. The results of beach profiling at Yarada indicate that the beach was found to be accreting throughout the observation period at stations 2 and 5. But the comparison of beach profiles at stations 1 and 3 clearly shows the dominance of erosion, which probably could be because of the oceanographic processes. However at

station 4, it is observed that 60 percent of the study period, the beach is accreting and the remaining 40 percent, the beach is eroding, probably because of dredging activities by Gangavaram Port Trust, just north of station 4, for their proposed new Jetty.

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1. Introduction

Beach profile studies of beaches give ample information on cyclic/seasonal changes of the area. These studies are essential to understand the erosional and depositional features, which in turn helps in understanding changes in oceanographic processes in the coastal areas. As part of a R & D work, a location namely Yarada beach was selected to carry out such studies at monthly intervals. Yarada beach is located around 8.5 kms south of Visakhapatnam port, which is in Andhra Pradesh along central east coast of India, whose geographical location is Lat:17° 39.4 N. and Long.83° 16.3 E. Yarada beach is one of the most important area, which has appreciable rate of erosion and deposition through various seasons. However, so far no detailed investigations were taken up to understand the seasonal morphological variations of Yarada beach. The objective of this present work is to analyse volumetric and morphologic variations of Yarada beach of North Andhra Pradesh, Central East Coast of India. This study is based on the results of topographic profiles carried out at Yarada beach between May 2009 and May 2010, at monthly intervals. The data was collected using an automatic level instrument (Accuracy ± 5 mm.) for vertical control along the beach profiles and Differential Global Positioning System (Accuracy ± 1 m.) for horizontal control over the five benchmark pillars established along the survey area.

2. Methodology

Five topographic profiles across the study area were established and the beach profiling studies were conducted along these five profiles from May 2009 onwards at monthly intervals till May 2010. Bench mark pillars were set up at all the five places (STN:1 to STN: 5). Ceeducer DGPS (Differential Global Positioning System) was used for obtaining the horizontal location (Geographical co-ordinates) of these benchmarks. The values were recorded initially in WGS – 1984 (World Geodetic System) datum and later was converted to Indian datum (India-Nepal). The vertical control of these benchmarks was done by observing the tidal observations of that particular day (two high waters and two low waters) and later reduced to mean sea level. Visakhapatnam tide, from Indian predicted tide table (2009 & 2010) was also used for comparison of high and low waters. Vertical spot heights during the profiling were determined using an

automatic level instrument (Carl Zeiss make), a graduated staff of 4 metres length with leveling shoes and marker lines were used. The calculations of the beach sediment volume variations were performed using a software developed by Ganesan (2006).

3. Morphology of the area

The area under investigation forms a part of the northern Andhra Pradesh coast line. This NE-SW oriented coast line is represented by a narrow coastal plain lying between Dolphin's Nose in the north and Gangavaram port in the south (Fig.1).. The coastal strip is about 65 - 150 m wide, has a gentle to moderate foreshore backed by a narrow berm and sand dune ridges of variable dimensions. Oceanographic properties of the near shore waters along this region are subject to seasonal variability with the reversing south west (June to September) and northeast monsoons (October to January). From February to June, the winds are predominantly from S and SW; from July to September, it is from SW and W and from October to January, the winds are predominantly from NE and E (KUMAR, V.S. *et.al.* 2001) The Highest high water recorded in this area is +2.38 m and lowest low water recorded is -0.55 m with respect to chart datum. The mean high water spring value is +1.50 m and mean low water spring value is +0.10 m with respect to chart datum. The chart datum at Visakhapatnam is 0.8 m below mean sea level. The wet season at Visakhapatnam persists mainly during the south-west monsoon and slightly before and after this period. September and October are the wettest months of the year with the average rain fall of about 170 mm. and 260 mm. respectively. The average annual rainfall is around 975 mm. The average number of rainy days per annum is 50. The north east monsoon period is from end of November to end of February with predominantly north easterly winds. The pre-monsoon period is from the month of March to May, the period of the year when the winds shift towards south westerly direction. The south-west monsoon is from middle of May up to middle of October with predominantly south-westerly winds and cloudy weather. From February to June, off shore current flows towards north east. From August to December, currents flow towards south-westerly direction with the velocity of the currents ranging from 0.5 to 1.0 knot. At Visakhapatnam coast, currents are neither related to wind or to tides in any appreciable way. The determining factor for the direction of nearshore current is the direction of predominant wave. The direction of shallow water waves during March to October is

predominantly from south-south-east. During the remainder of the year, wave direction is principally from the east and practically all wave directions are confined to the sector between east-north-east and south-east .

4. Equipment used

i) Differential Global Positioning System : A “Hemisphere” make Differential Global Positioning System (DGPS) was used for collecting geographical location of the bench mark pillars from where the profiles start. The accuracy of the system is ± 1 m. All the geographical positions were collected in WGS – 1984 datum first and then later converted into Indian datum.

ii) Automatic Level instrument: A “Carl Zeiss” make automatic level instrument (Accuracy ± 5 mm.) was used for collection of elevation of every point (with respect to mean sea level) along the profiles, at specified distance intervals, while carrying out beach profiling surveys. The other accessories used along with this instrument are one 4 metre long millimeter graduated staff with leveling shoes and one marker line having length of about 50 m.

5. Results and Discussions

The first month observation (May 2009) was fixed as the base line data and the remaining month's data was compared to it. Volume computations were done for, per square meter area along the concerned profiles. At stn: 1, during June, an increase in deposition of sand of 0.15m^3 was observed. But then a significant trend was noticed between July and February, showing a decrease in volume of sand due to erosion, the highest being during the month of September, by about 0.95 m^3 . The loss of volume of sand during October to November was between 0.5 to 0.8 m^3 and during December to May, it was between 0.1 to 0.5 m^3 , except March, during which the erosion was the highest by about 0.96 m^3 . Overall, the beach was eroding by 0.19 m^3 during May 2010

(last month of observation) when compared with May 2009 (first month of observation). (Ref:10. Bar Chart & Table:11 (iii))

A significant trend was noticed at Stn: 2, which shows an increase in volume of sand throughout the periods of observation (from May 2009 to May 2010). The volume of sand deposit was between 0.6 to 0.8 m³ during June to September, 0.9 to 1.25 m³ during October to November, 0.6 to 0.8 m³ during December to March and 0.9 to 1.10 m³ during April to May 2010. (Table:11 (iii))

At Stn: 3, the loss of sand due to erosion was highest during June, which was about 1.06 m³. During July to September, 0.1 to 0.4 m³ of loss of sand was noticed. But during October to November, there was a rise in volume of sand due to deposits, which was between 0.05 to 0.2 m³. But during Dec to March, again loss of sand was noticed, which was between 0.2 to 0.72 m³. During the last two months of observation (April and May 2010), there was slight rise in volume of sand, which was about 0.10 to 0.12 m³. (Table:11 (iii))

At Stn: 4, a significant trend was noticed. Sand deposit was regular between June and October. The rate of sand deposit during June to September was between 0.05 and 0.4 m³ and 0.2 m³ during October. But from November till February, there was loss of sand due to erosion; the quantity was between 0.1 to 0.65 m³. During March, the erosion was the highest by about 1.37 m³ but then the rate of erosion has gradually reduced to 0.13 m³ during April and 0.02 m³ by May 2010. (Table:11 (iii))

At Stn: 5, there was increase in volume of sand during the entire period of observation. The rate of sand deposits, however vary by substantial margin. During June, the deposit was 0.76 m³, but in July it was only 0.3 m³. During Aug to October, the sand deposits vary from 0.5 to 0.7 m³. The sand deposit was found highest during November, which was 1.33 m³. During December to February, the sand deposit was between 0.5 to 0.55 m³, but in January, the sand deposit was only 0.03 m³, being the lowest. Even though there was slight erosion during March by 0.05 m³, there was huge rise in volume of sand deposit between April and May 2010, which was about 0.8 to 1.0 m³. Overall, Stations 1 and 3 were found to be eroding and stations 2 and 5 were accreting almost the entire observation period. But at station 4, during May 2009 to October the beach was accreting and then Nov to May 2010 the beach was eroding.

This phenomenon could probably be because of the dredging activities near the Gangavaram proposed Jetty site, which is south of station 4. (Table:11 (iii))

6. Acknowledgement

The authora are very thankful to the Director Dr. Shetye, of National Institute of Oceanography, Goa and the Scientist in Charge, Dr. V.S.N. Murty, of National Institute of Oceanography, regional centre, Visakhapatnam for their kind permission to publish this report. This task was funded from several sponsored projects taken up by NIO regional centre, Visakhapatnam and is duly acknowledged here. We extend our sincere thanks to Dr. A.S. Subramanian for reviewing the manuscript and making valuable suggestions for improving this report. We are thankful to Dr. Mohan Rao for his encouragement and guidance throughout the field trips. The help rendered by Mr. Suri babu and Mr.Vasu during the field observations is greatly acknowledged.

7. References

1. Kumar,V,S.; Kumar,K.A. and Raju,N.S.N. 2001. Nearshore processes along Tikkavanipalem beach, Visakhapatnam, India. ***Journal of Coastal Research, 17(2).***
2. Ganesan, P. 2006. Programs to obtain vertical heights from mean sea level and for computing volume of sand/mineral along beaches: A case study with Kalbadevi beach profiling data and results.; ***NIO/TR-01/2006.***

8. Graphs showing beach profiles

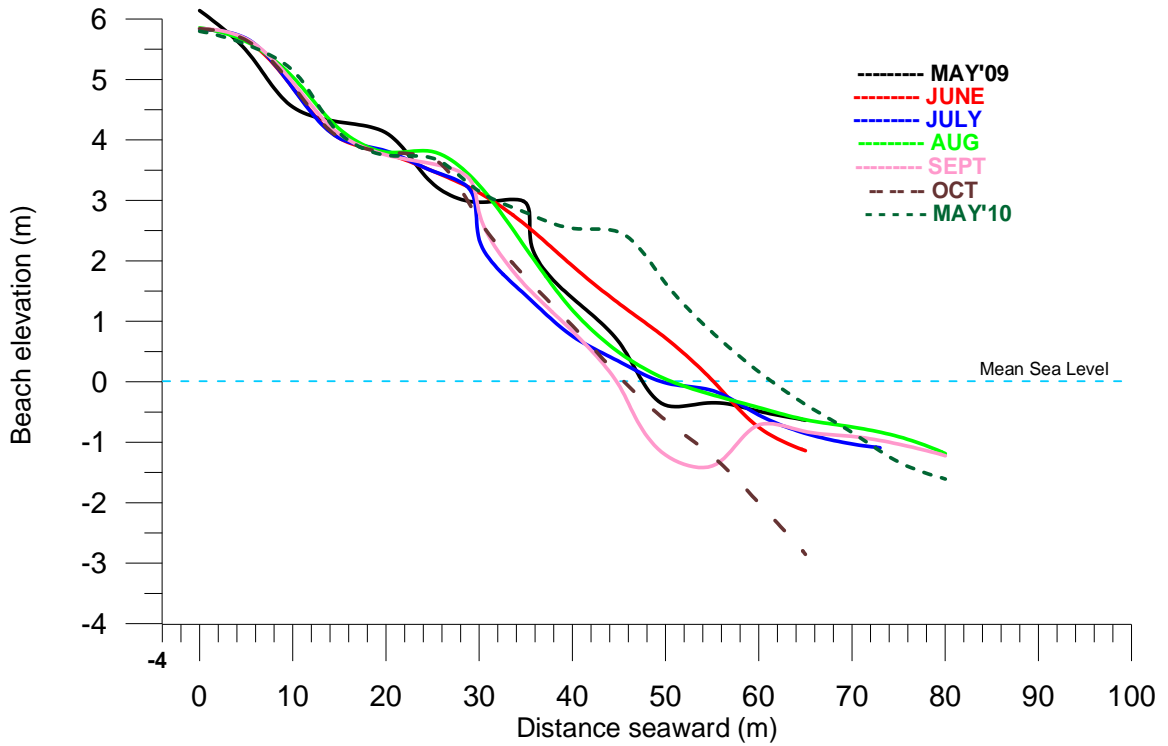


FIG:1. MONTHLY BEACH PROFILES AT STN : 1
(May 2009 to Oct 2009 and May 2010)

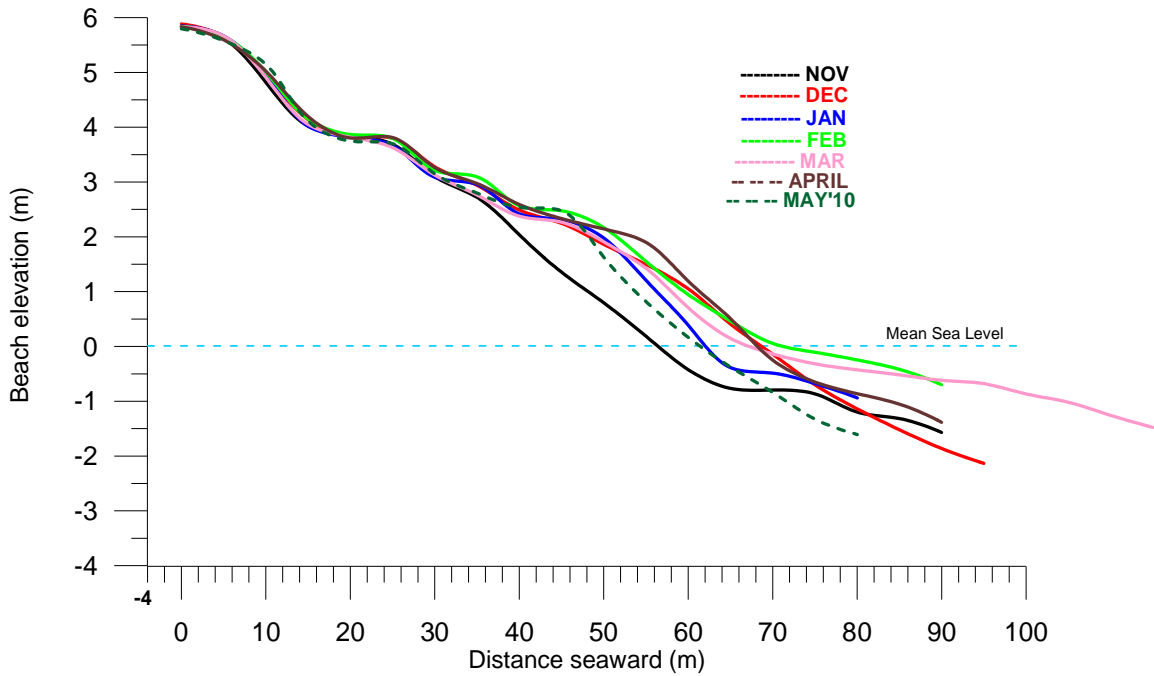


FIG:2. MONTHLY BEACH PROFILES AT STN : 1
(Nov 2009 to May 2010)

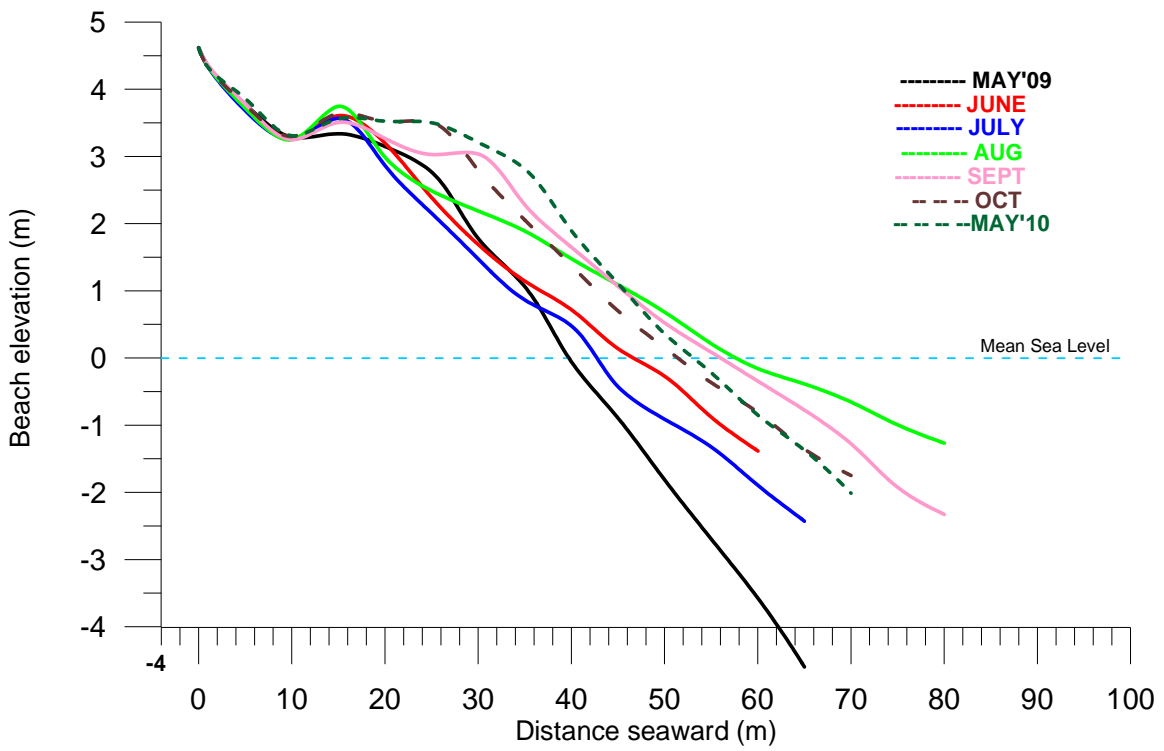


FIG:3. MONTHLY BEACH PROFILES AT STN : 2
(May 2009 to Oct 2009 AND MAY 2010)

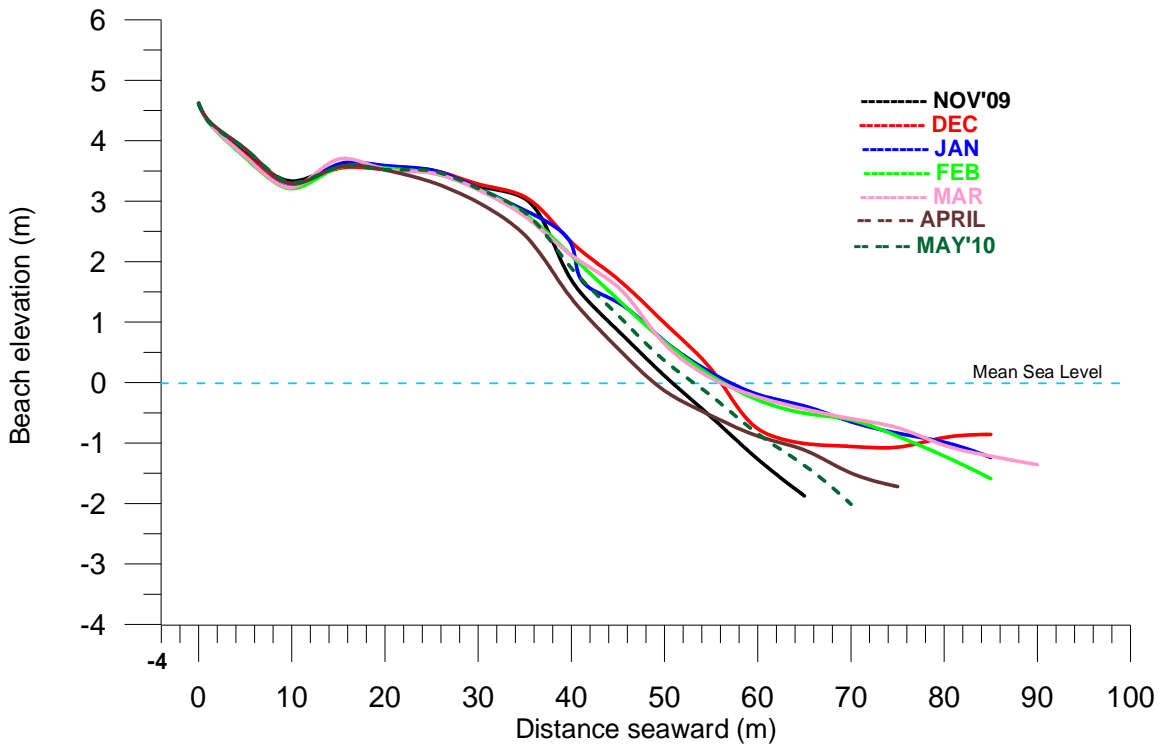


FIG:4. MONTHLY BEACH PROFILES AT STN : 2
(Nov 2009 to May 2010)

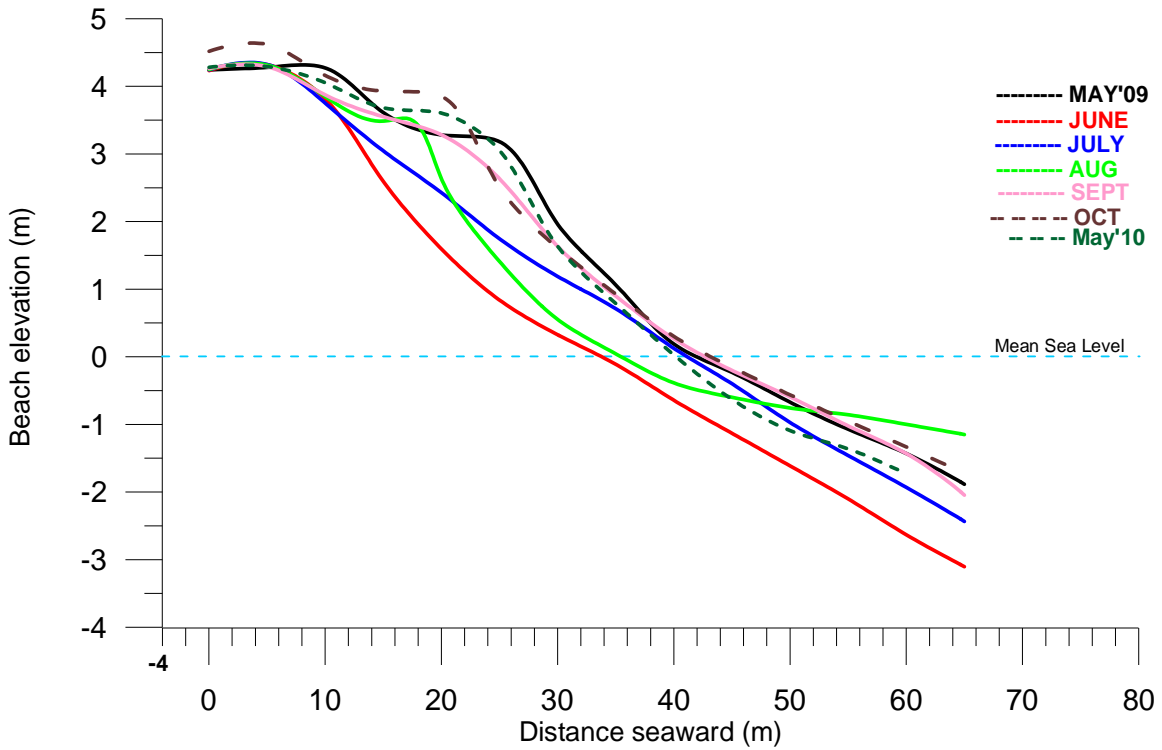


FIG:5. MONTHLY BEACH PROFILES AT STN : 3
(May 2009 to Oct. 2009 and May 2010)

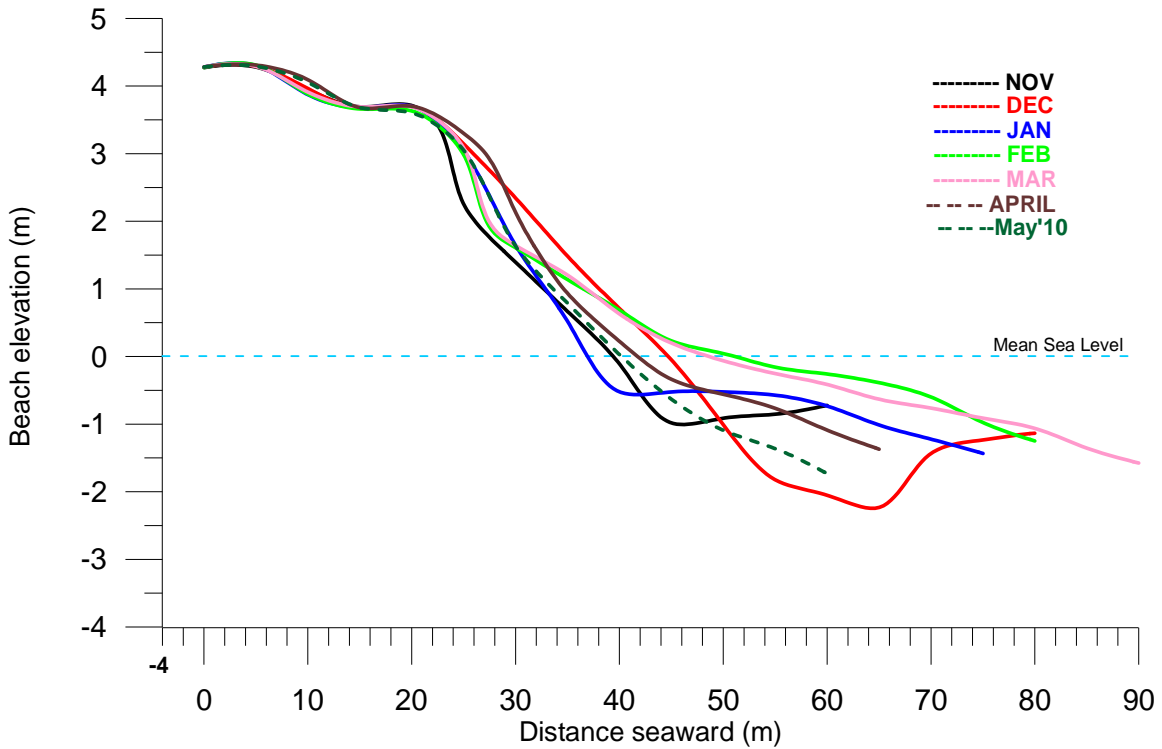


FIG:6. MONTHLY BEACH PROFILES AT STN : 3
(Nov 2009 to May 2010)

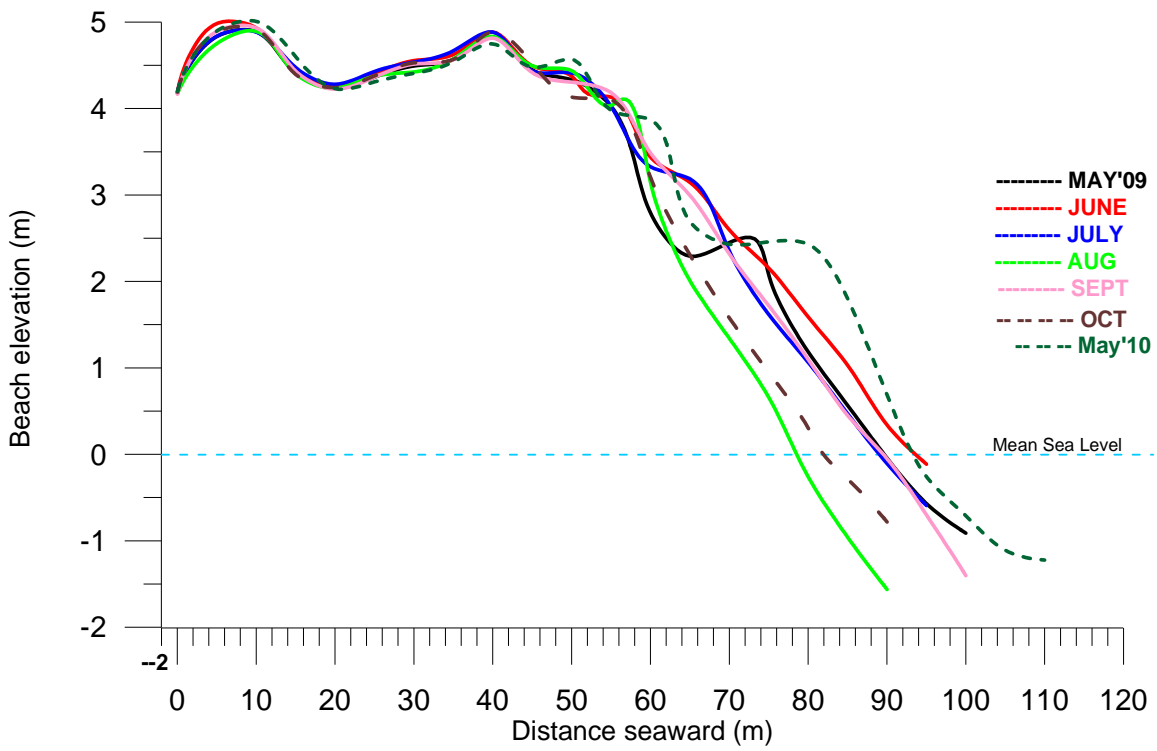


FIG:7. MONTHLY BEACH PROFILES AT STN : 4
 (May 2009 to Oct. 2009 and May 2010)

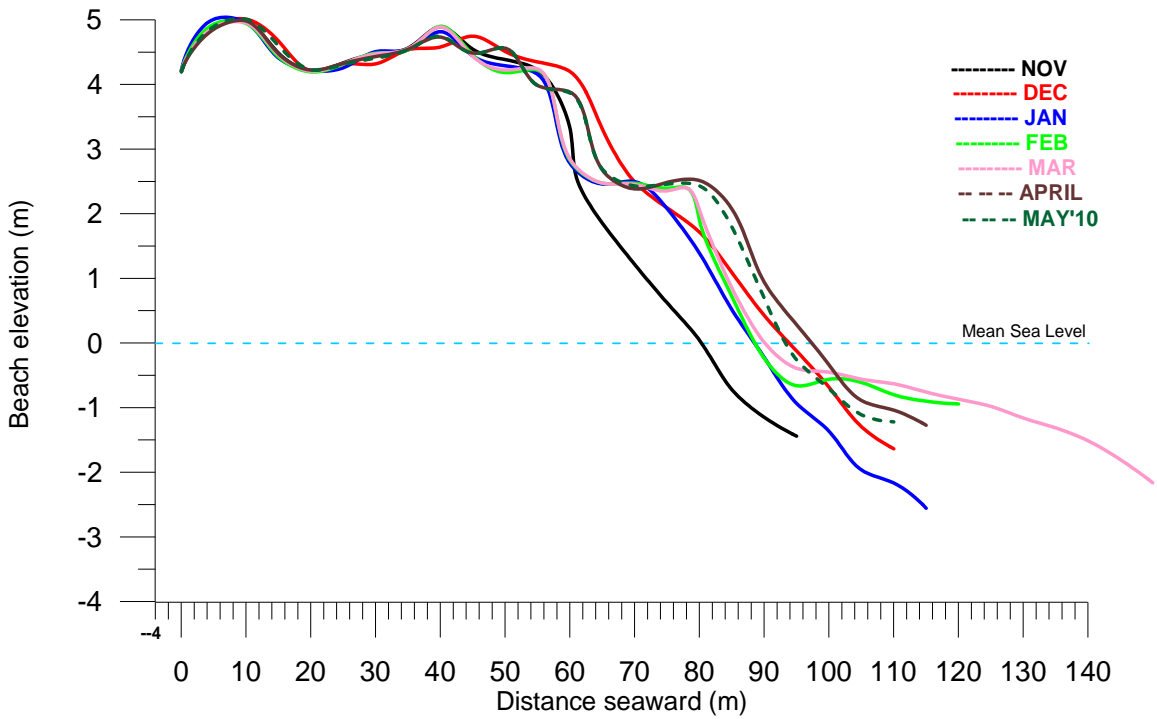


FIG:8. MONTHLY BEACH PROFILES AT STN : 4
 (Nov 2009 to May 2010)

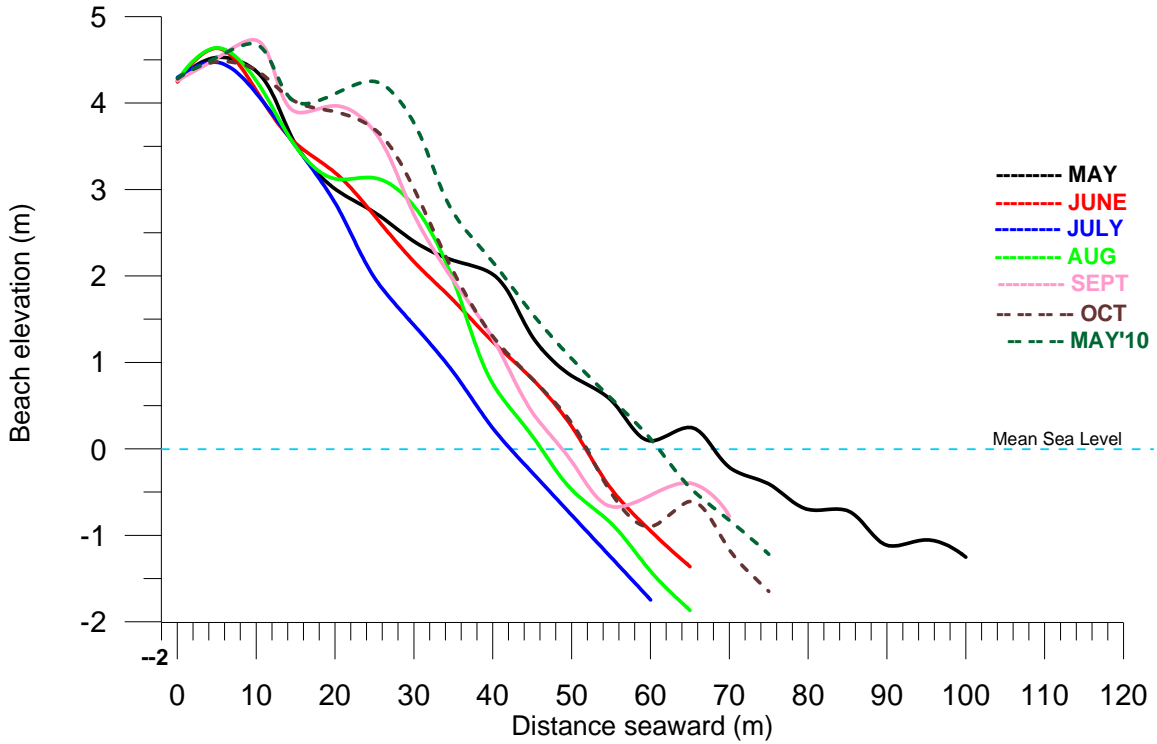


FIG:9. MONTHLY BEACH PROFILES AT STN : 5
(May 2009 to Oct. 2009 and May 2010)

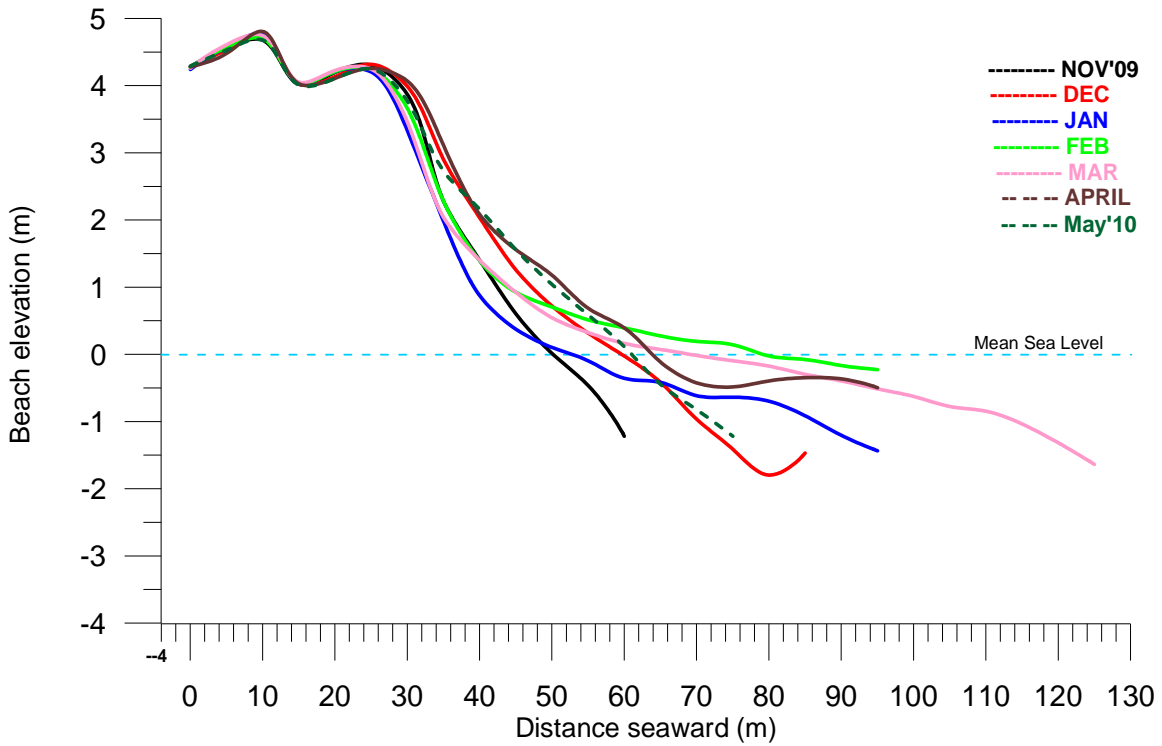
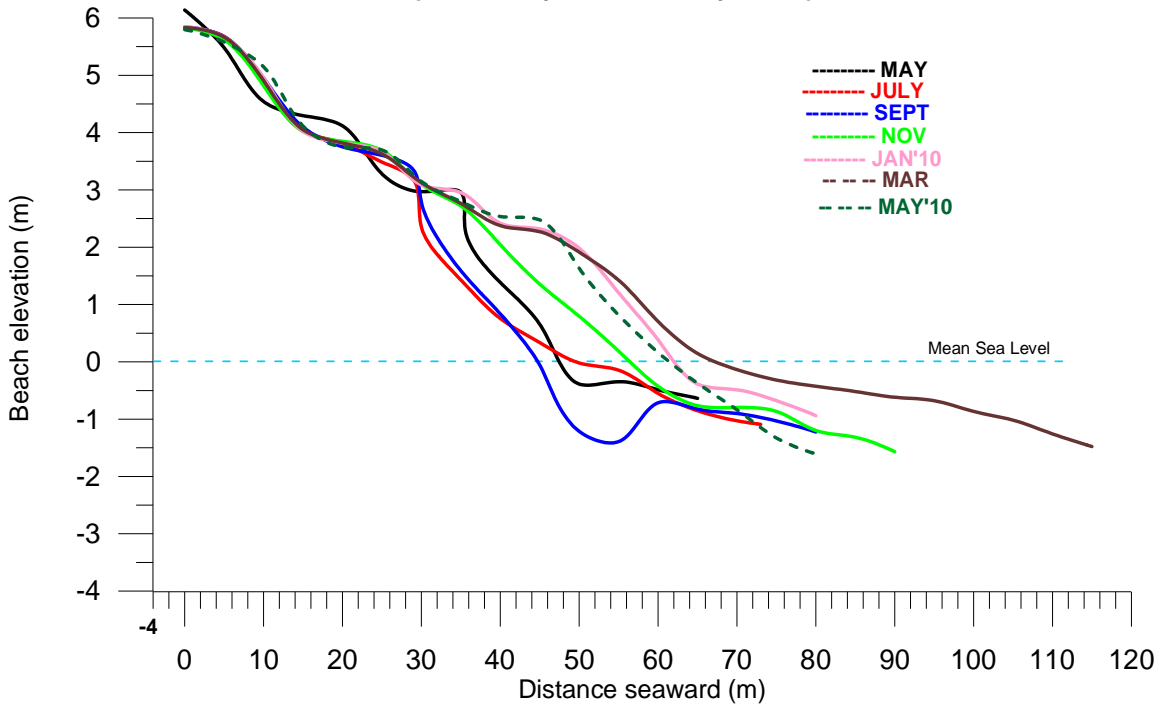


FIG:10. MONTHLY BEACH PROFILES AT STN : 5
(Nov 2009 to May 2010)

Beach profiling at Yarada beach (Visakhapatnam).

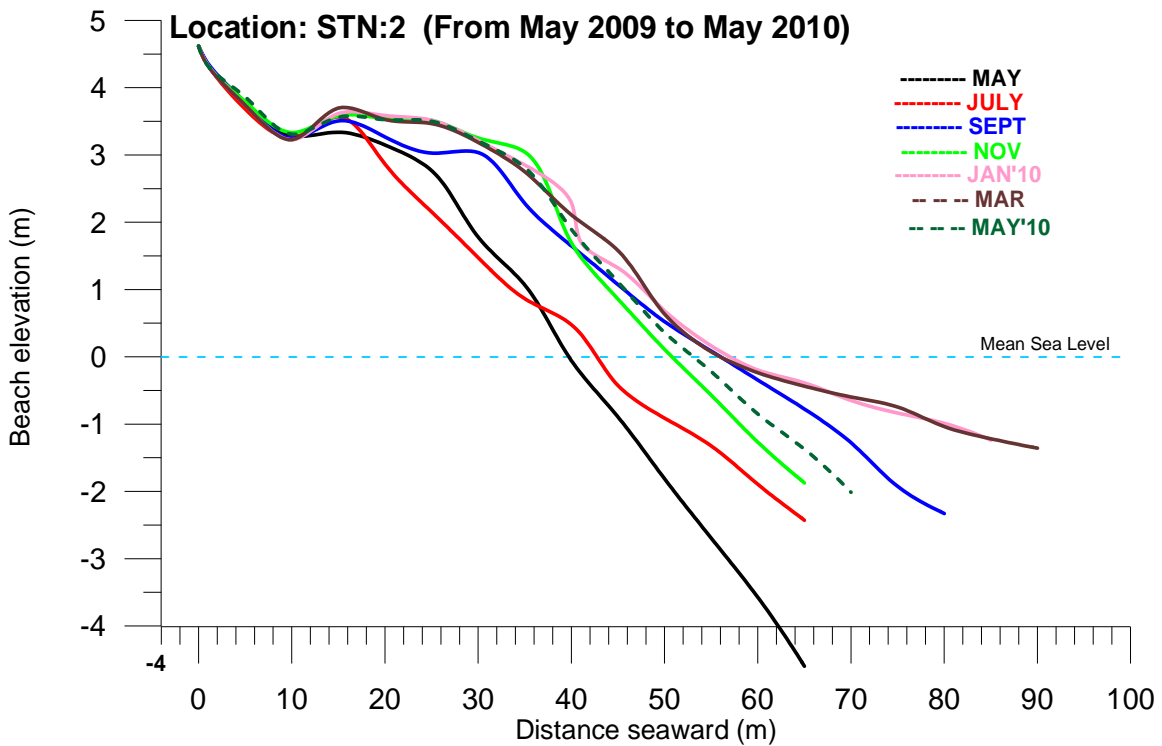
Location: STN:1 (From May 2009 to May 2010)



**FIG:11. BI-MONTHLY BEACH PROFILES AT STN : 1
(May 2009 to May 2010)**

Beach profiling at Yarada beach (Visakhapatnam).

Location: STN:2 (From May 2009 to May 2010)



**FIG:12. BI-MONTHLY BEACH PROFILES AT STN : 2
(May 2009 to May 2010)**

Beach profiling at Yarada beach (Visakhapatnam)

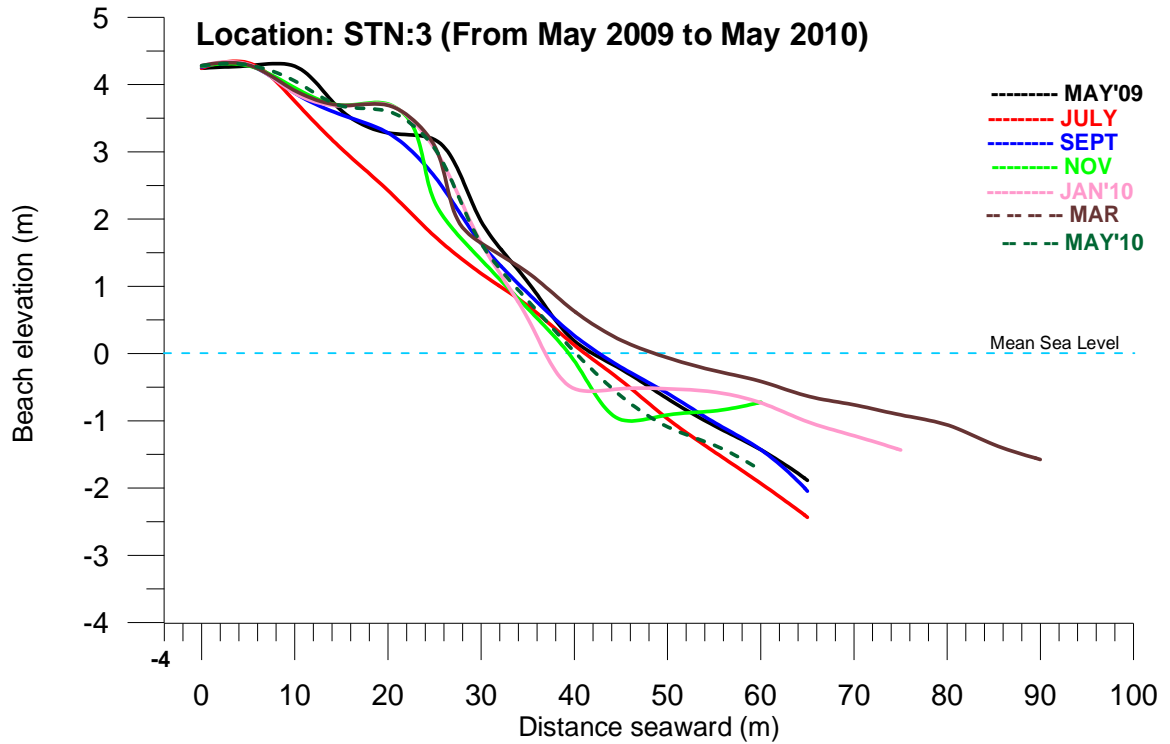


FIG:13. BI-MONTHLY BEACH PROFILES AT STN : 3 (May 2009 to May 2010)

Beach profiling at Yarada beach (Visakhapatnam)

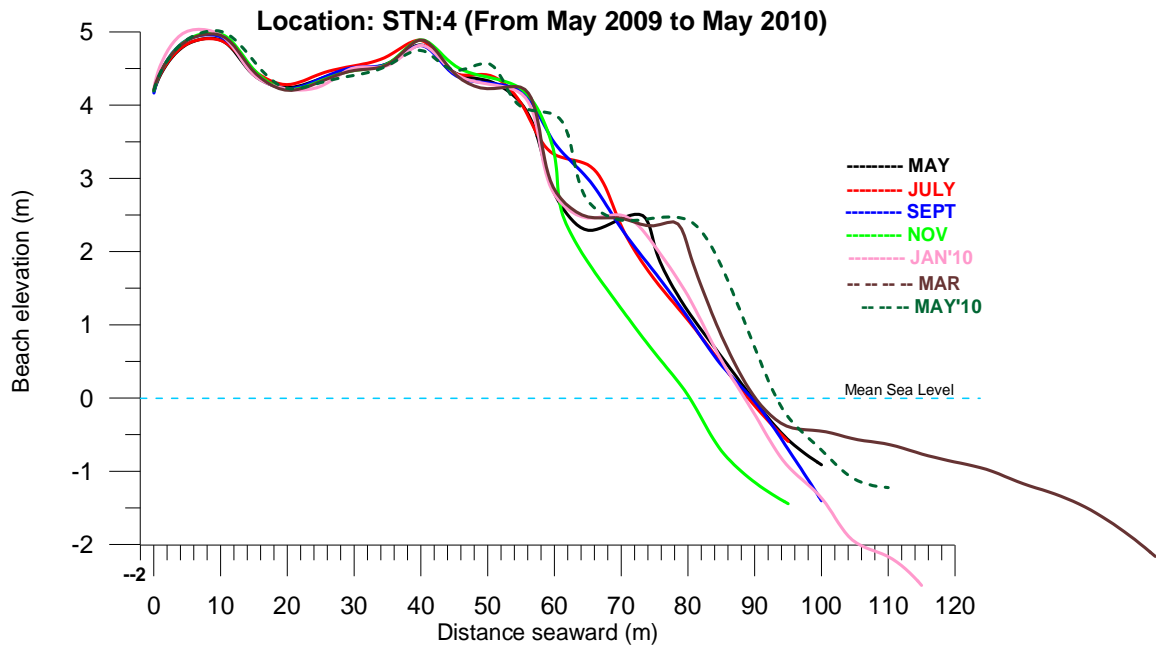


FIG:14. BI-MONTHLY BEACH PROFILES AT STN : 4 (May 2009 to May 2010)

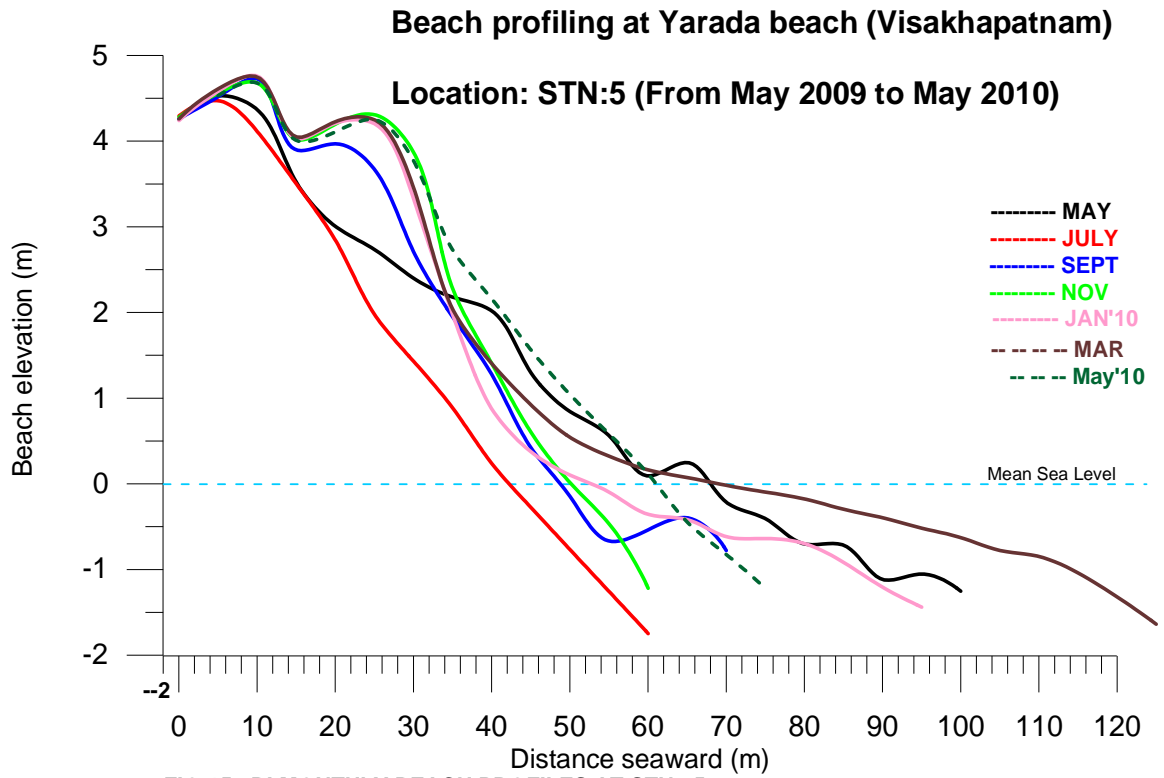
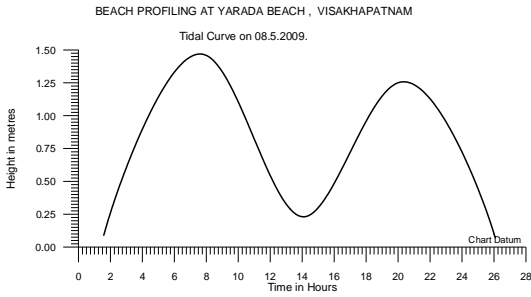


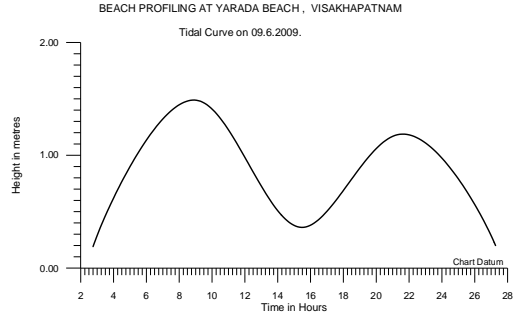
FIG:15. BI-MONTHLY BEACH PROFILES AT STN : 5
 (May 2009 to May 2010)

9. Graphs showing tidal variations during survey period

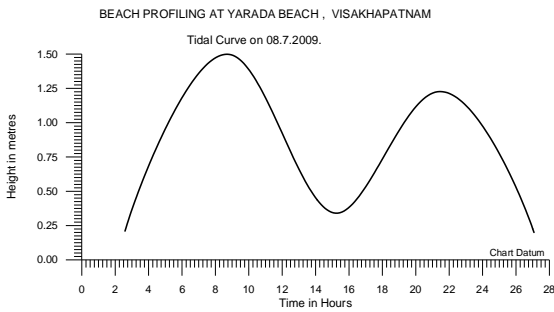
Tidal graphs (May 2009 to May 2010)



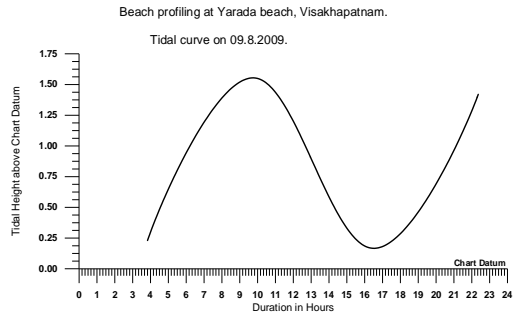
May 2009



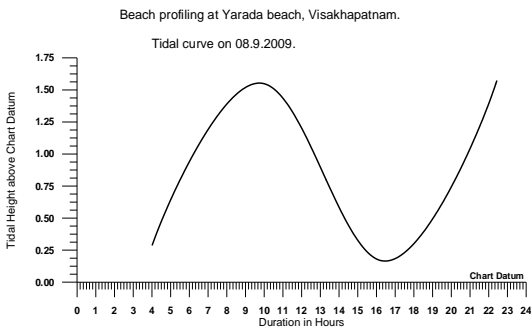
June 2009



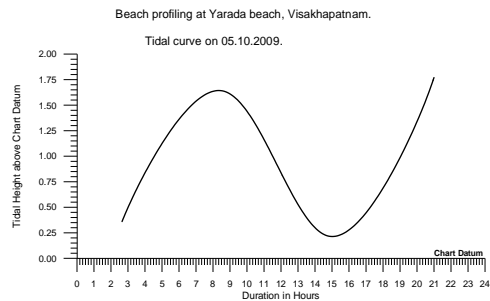
July 2009



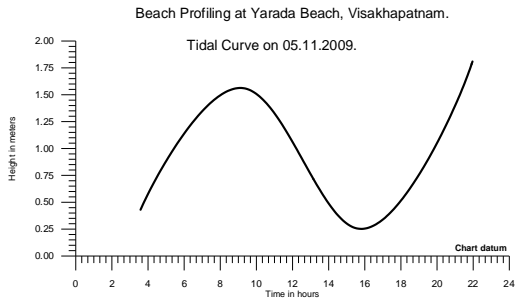
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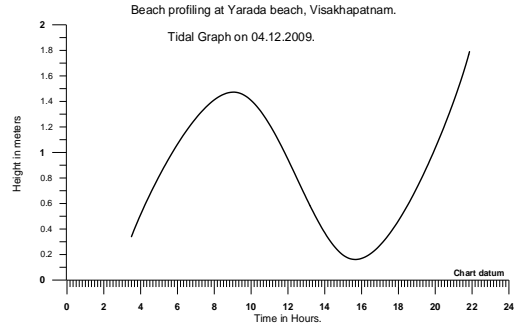
Sept. 2009



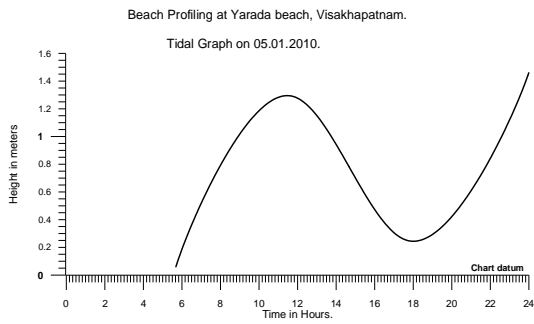
Oct. 2009



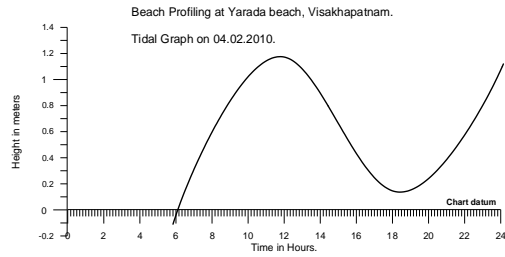
Nov. 2009



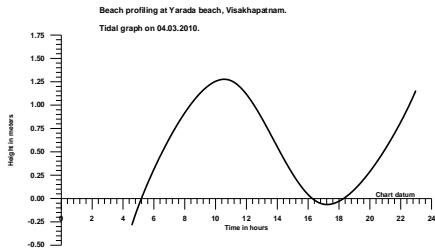
Dec. 2009



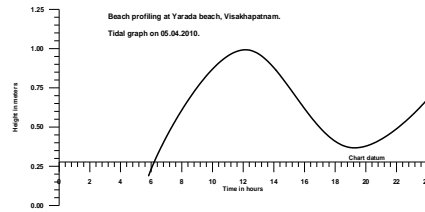
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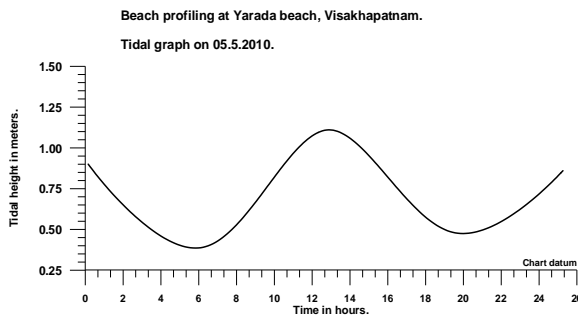
Feb. 2010



Mar. 2010

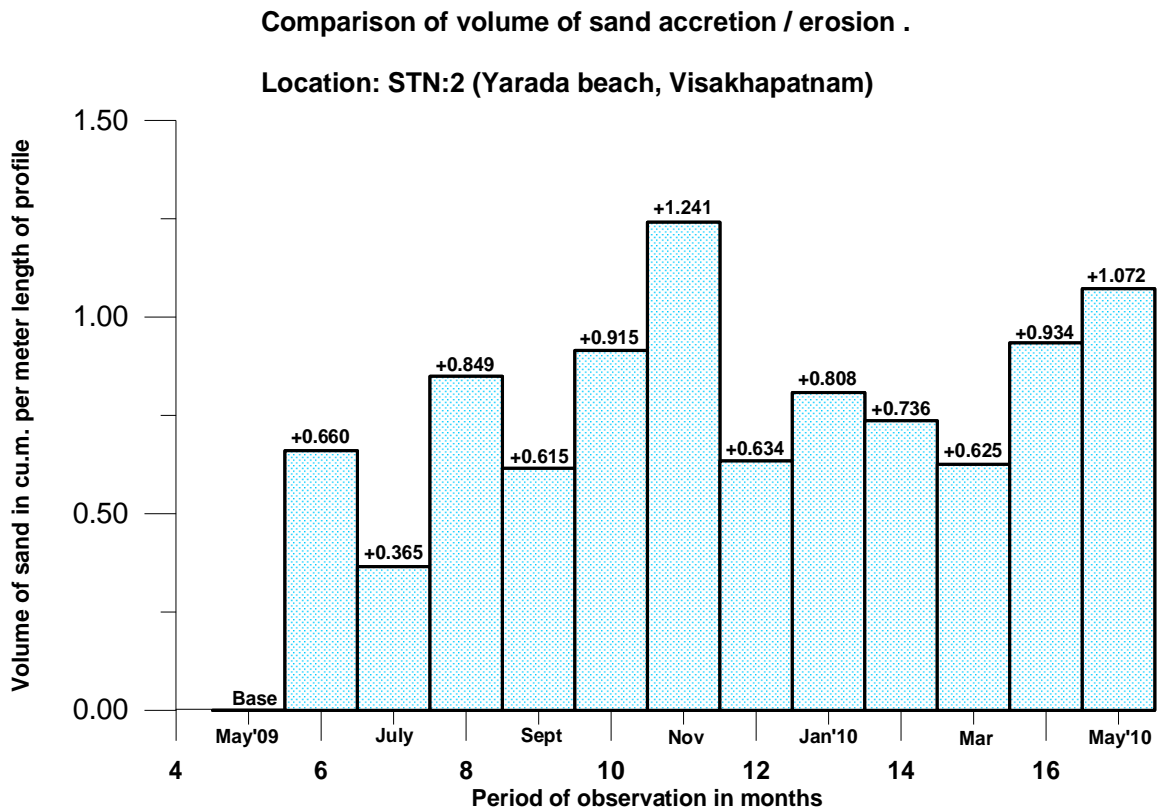
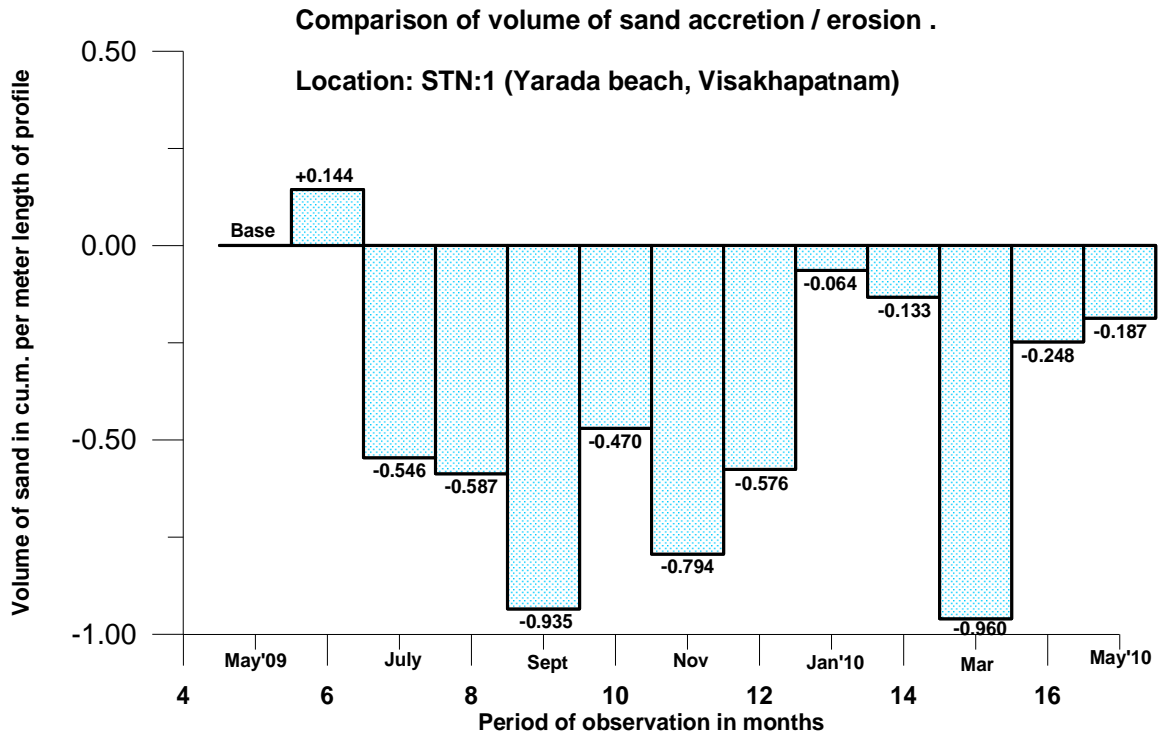


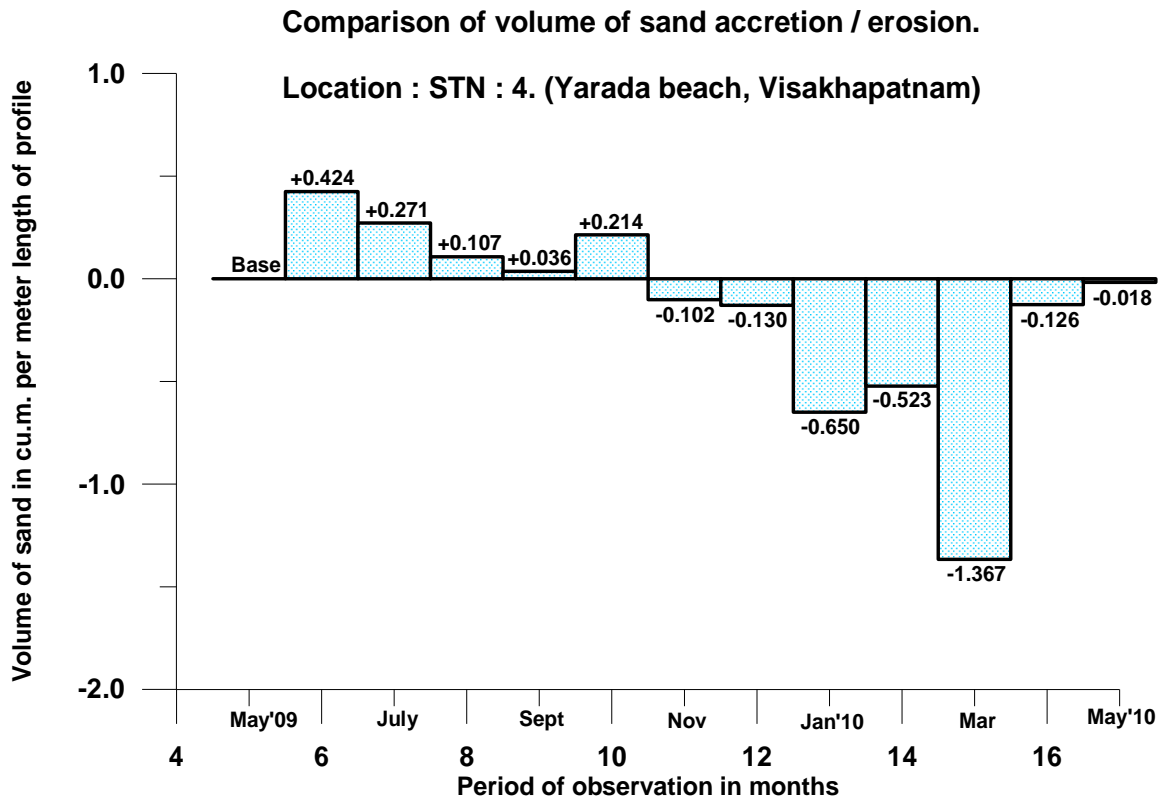
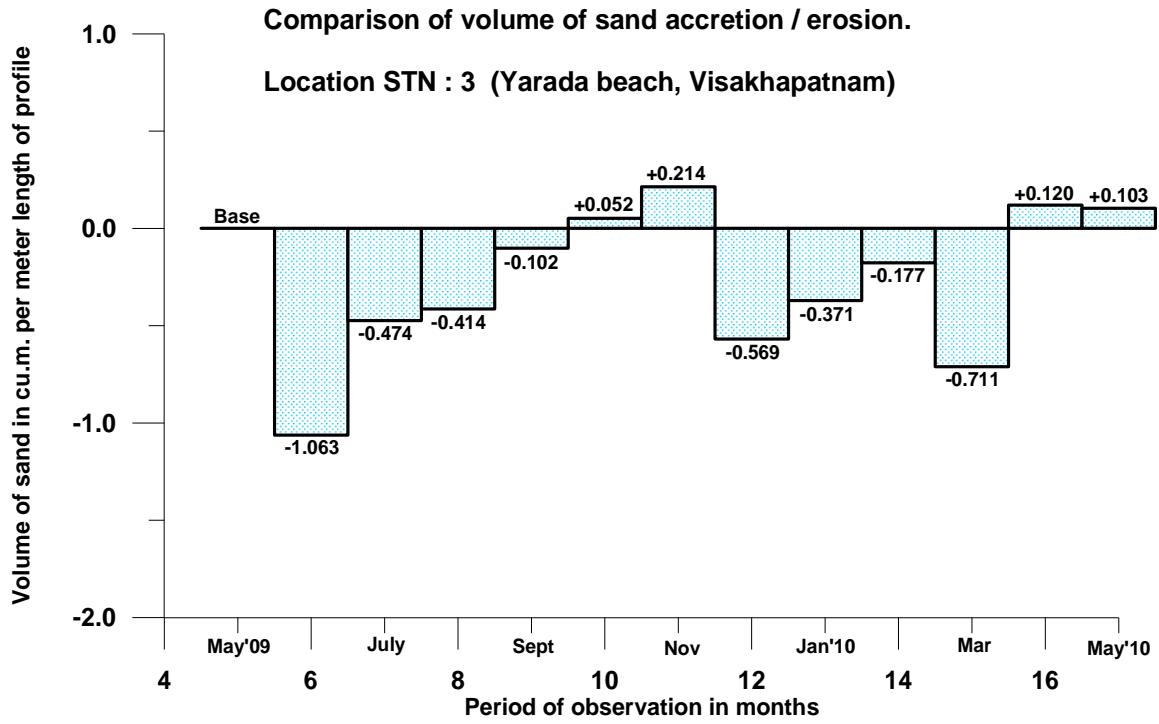
April 2010



May 2010

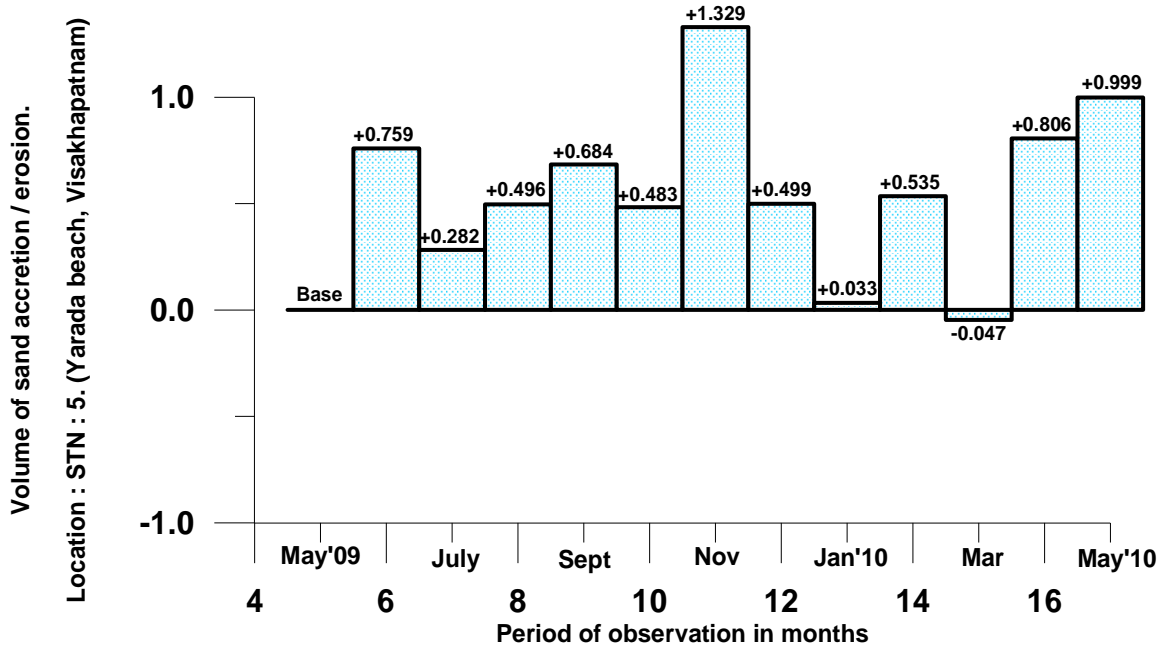
10. Bar charts showing comparison of volumes of sand accretion & erosion





Comparison of volume of sand accretion / erosion.

Location : STN : 5. (Yarada beach, Visakhapatnam)



11. Tables

i) Vertical control of bench mark pillars established

Five benchmark pillars were established along the shore of the study area. The values of the benchmark stations and the geographical locations are given below:

Station name	Value of bench mark pillars (above M.S.L.)	Geog. locations in	Everest spheroid
		Latitude (N)	Longitude (E)
STN:1	6.290 mts.	17° 39' 49".697	83° 18' 03".795
STN:2	4.620 mts.	17° 39' 27".255	83° 16' 39".424
STN:3	4.914 mts.	17° 39' 19".455	83° 16' 28".862
STN:4	5.286 mts.	17° 39' 10".154	83° 16' 03".358
STN:5	5.571 mts.	17° 39' 00".313	83° 15' 48".236

The chart datum lies **0.84 meter below mean sea level** and this value is taken for computation of all the 5 bench mark pillars with respect to M.S.L.

ii) Volume of sand computed at all 5 stations per square meter area of each profile :

	At STN:1	At STN:2	At STN:3	At STN:4	At STN:5
Period	Volume of sand in m ³	Volume of sand in m ³	Volume of sand in m ³	Volume of sand in m ³	Volume of sand in m ³
May 2009	2.400	0.778	1.508	2.998	1.254
June	2.544	1.438	0.445	3.422	2.013
July	1.854	1.143	1.034	3.269	1.536
August	1.813	1.627	1.094	3.105	1.750
September	1.465	1.393	1.406	3.034	1.938
October	1.930	1.693	1.560	3.212	1.737
November	1.606	2.019	1.722	2.896	2.583
December	1.824	1.412	0.939	2.868	1.753
January 2010	2.336	1.586	1.137	2.348	1.287
February	2.267	1.514	1.331	2.475	1.789
March	1.44	1.403	0.797	1.631	1.207
April 2010	2.152	1.712	1.628	2.872	2.060
May 2010	2.213	1.850	1.611	2.980	2.253

iii) Comparison of volume of sand computed at all 5 stations (per square meter area of each Profile) keeping May month observation as the base:

Loca-tion	May 2009	Jun in m ³	Jul in m ³	Aug in m ³	Sept in m ³	Oct in m ³	Nov in m ³	Dec in m ³	Jan' 10 in m ³	Feb in m ³
Stn:1	Base	+ 0.144	-- 0.546	-- 0.587	-- 0.935	-- 0.47	-- 0.794	+ 0.576	-- 0.064	-- 0.133
Stn:2	Base	+ 0.660	+ 0.365	+ 0.849	+ 0.615	+ 0.915	+ 1.241	+ 0.634	+ 0.808	+ 0.736
Stn:3	Base	-- 1.063	-- 0.474	-- 0.414	-- 0.102	+ 0.052	+ 0.214	-- 0.569	-- 0.371	-- 0.177
Stn:4	Base	+ 0.424	+ 0.271	+ 0.107	+ 0.036	+ 0.214	-- 0.102	-- 0.130	-- 0.650	-- 0.523
Stn:5	Base	+ 0.759	+ 0.282	+ 0.496	+ 0.684	+ 0.483	+ 1.329	+ 0.499	+ 0.033	+ 0.535

Loca-tion	May 2009	Mar 2010 in m ³	April 2010 in m ³	May 2010 in m ³
Stn:1	Base	-- 0.96	-- 0.248	-- 0.187
Stn:2	Base	+ 0.625	+ 0.934	+ 1.072
Stn:3	Base	-- 0.711	+ 0.120	+ 0.103
Stn:4	Base	-- 1.367	--0.126	-- 0.018
Stn:5	Base	-- 0.047	+ 0.806	+ 0.999

iv) Final processed elevations of every point on the profile. All values are in meters with respect to mean sea level. Location: STN : 1.

May 2009		June 2009		July 2009		Aug. 2009		Sept. 2009		Oct. 2009	
0	6.14	0	5.84	0	5.823	0	5.855	0	5.845	0	5.84
5	5.48	5	5.65	5	5.68	5	5.63	5	5.675	5	5.65
10	4.545	10	4.86	10	4.855	10	5.04	10	4.955	10	4.895
15	4.3	15	4.03	15	4.03	15	4.18	15	4.095	15	4.035
20	4.12	20	3.78	20	3.82	20	3.8	20	3.755	20	3.8
25	3.28	25	3.49	25	3.49	25	3.81	25	3.605	25	3.695
30	2.97	30	3.13	29	3.18	30	3.25	29	3.345	30	2.673
35	2.96	35	2.59	30	2.347	35	2.21	30	2.785	35	1.723
35.5	2.33	40	1.92	35	1.422	40	1.18	35	1.585	40	0.923
40	1.38	45	1.29	40	0.752	45	0.48	40	0.835	45	0.088
45	0.65	50	0.72	45	0.332	50	0.04	45	-0.065	50	-0.642
50	-0.39	55	0.02	50	-0.023	55	-0.22	47	-0.665	55	-1.231
55	-0.35	60	-0.76	55	-0.148	60	-0.43	50	-1.215	60	-2.011
60	-0.49	65	-1.14	60	-0.553	65	-0.63	55	-1.395	65	-2.854
65	-0.64			65	-0.858	70	-0.75	60	-0.715		
				70	-1.033	75	-0.91	65	-0.825		
				73	-1.093	80	-1.19	70	-0.905		
								75	-1.035		
								80	-1.225		(cont....

Nov. 2009		Dec. 2009		Jan. 2010		Feb. 2010		Mar.2010		Apr. 2010	
0	5.83	0	5.885	0	5.85	0	5.84	0	5.835	0	5.835
5	5.62	5	5.66	5	5.67	5	5.66	5	5.670	5	5.595
10	4.82	10	4.96	10	4.96	10	5.01	10	4.910	10	5.025
15	4.02	15	4.14	15	4.02	15	4.15	15	4.050	15	4.195
20	3.85	20	3.83	20	3.82	20	3.87	20	3.820	20	3.805
25	3.69	25	3.8	25	3.67	25	3.8	25	3.630	25	3.815
30	3.1	30	3.28	30	3.09	30	3.21	30	3.130	30	3.265
35	2.72	35	2.94	35	2.955	35	3.1	35	2.765	35	2.975
40	2.04	40	2.49	40	2.42	40	2.57	40	2.380	40	2.595
45	1.35	45	2.25	45	2.32	45	2.48	45	2.270	45	2.335
50	0.79	50	1.865	50	1.98	50	2.17	50	1.910	50	2.145
55	0.18	55	1.495	55	1.2	55	1.55	55	1.420	55	1.900
60	-0.43	60	1.045	60	0.38	60	0.94	60	0.700	60	1.185
65	-0.77	65	0.405	65	-0.39	65	0.46	65	0.140	65	0.505
70	-0.8	70	-0.145	70	-0.49	70	0.05	70	-0.140	70	-0.255
75	-0.87	75	-0.705	75	-0.68	75	-0.11	75	-0.320	75	-0.655
80	-1.2	80	-1.145	80	-0.94	80	-0.25	80	-0.430	80	-0.655
85	-1.32	85	-1.525			85	-0.42	85	-0.520	85	-0.655
90	-1.57	90	-1.865			90	-0.7	90	-0.620	90	-0.655
		95	-2.135					95	-0.680	95	-0.865
								100	-0.870		
								105	-1.020	85	-1.055
								110	-1.260		
								115	-1.480	90	-1.385

v) Final processed elevations of every point on the profile. All values are in meters with respect to mean sea level. Location: STN : 2.

May 2009		June 2009		July 2009		Aug. 2009		Sept. 2009		Oct. 2009	
0	4.62	0	4.62	0	4.62	0	4.62	0	4.62	0	4.62
0.5	4.45	0.5	4.46	0.5	4.46	0.5	4.46	0.5	4.47	0.5	4.45
5	3.78	5	3.76	5	3.685	5	3.72	5	3.78	5	3.77
10	3.29	10	3.27	10	3.26	10	3.25	10	3.25	10	3.3
15	3.34	15	3.61	15	3.57	15	3.75	15	3.51	15	3.645
20	3.15	20	3.2	20	2.865	20	2.99	20	3.27	20	3.52
25	2.77	25	2.39	25	2.155	25	2.49	25	3.03	25	3.515
30	1.78	30	1.69	30	1.475	30	2.19	30	3.04	30	2.795
35	1.06	35	1.145	35	0.86	35	1.89	35	2.28	35	2.055
40	-0.06	40	0.715	40	0.475	40	1.48	40	1.65	40	1.38
45	-0.9	45	0.135	45	-0.43	45	1.09	45	1.07	45	0.695
50	-1.82	50	-0.275	50	-0.915	50	0.68	50	0.52	50	0.145
55	-2.7	55	-0.885	55	-1.33	55	0.21	55	0.08	55	-0.37
60	-3.58	60	-1.385	60	-1.90	60	-0.16	60	-0.35	60	-0.815
65	-4.6	65	-1.956	65	-2.43	65	-0.39	65	-0.78	65	-1.36
						70	-0.66	70	-1.28	70	-1.75
						75	-1.00	75	-1.93		
						80	-1.27	80	-2.33		

(cont....

Nov. 2009		Dec. 2009		Jan. 2010		Feb. 2010		Mar. 2010		Apr. 2010	
0	4.445	0	4.450	0	4.450	0	4.440	0	4.440	0	4.450
5	3.795	5	3.77	5	3.74	5	3.72	5	3.740	5	3.870
10	3.335	10	3.295	10	3.23	10	3.21	10	3.230	10	3.290
15	3.585	15	3.545	15	3.62	15	3.56	15	3.700	15	3.570
20	3.545	20	3.53	20	3.59	20	3.55	20	3.530	20	3.570
25	3.515	25	3.515	25	3.52	25	3.47	25	3.470	25	3.520
30	3.255	30	3.285	30	3.22	30	3.2	30	3.190	30	3.320
35	3.045	35	3.075	35	2.85	35	2.79	35	2.750	35	2.980
40	1.695	40	2.325	40	2.29	40	2.1	40	2.110	40	2.440
45	0.855	45	1.71	41	1.71	45	1.37	45	1.580	45	1.390
50	0.105	50	0.98	45	1.32	50	0.67	50	0.630	50	0.560
55	-0.575	55	0.215	50	0.68	55	0.11	55	0.070	55	-0.140
60	-1.275	60	-0.77	55	0.16	60	-0.29	60	-0.240	60	-0.550
65	-1.875	65	-1.01	60	-0.2	65	-0.51	65	-0.440	65	-0.890
		70	-1.06	65	-0.39	70	-0.62	70	-0.600	70	-1.120
		75	-1.07	70	-0.65	75	-0.89	75	-0.750	75	-1.500
		80	-0.91	75	-0.84	80	-1.22	80	-1.040	80	-1.720
		85	-0.86	80	-0.99	85	-1.59	85	-1.220		
		90	-0.91	85	-1.24			90	-1.360		

vi) **Final processed elevations of every point on the profile. All values are
In meters with respect to mean sea level. Location: STN : 3.**

May 2009		June 2009		July 2009		Aug. 2009		Sept. 2009		Oct. 2009	
0	4.244	0	4.234	0	4.244	0	4.249	0	4.264	0	4.519
5	4.284	5	4.324	5	4.327	5	4.319	5	4.294	5	4.619
10	4.274	10	3.814	10	3.752	10	3.849	10	3.874	10	4.164
15	3.614	15	2.594	15	3.047	15	3.489	15	3.554	15	3.929
20	3.284	20	1.594	20	2.427	17	3.529	20	3.284	20	3.854
25	3.184	25	0.834	25	1.747	20	2.629	25	2.634	25	2.509
30	1.964	30	0.324	30	1.19	25	1.409	30	1.634	30	1.609
35	1.064	35	-0.116	35	0.707	30	0.549	35	0.894	35	0.924
40	0.184	40	-0.646	40	0.122	35	0.039	40	0.264	40	0.299
45	-0.236	45	-1.136	45	-0.403	40	-0.391	45	-0.206	45	-0.161
50	-0.676	50	-1.616	50	-0.976	45	-0.601	50	-0.596	50	-0.566
55	-1.076	55	-2.106	55	-1.466	50	-0.761	55	-1.026	55	-0.956
60	-1.436	60	-2.636	60	-1.936	55	-0.861	60	-1.436	60	-1.336
65	-1.886	65	-3.106	65	-2.436	60	-1.001	65	-2.046	65	-1.726
						65	-1.151				

(cont....

Nov. 2009		Dec. 2009		Jan. 2010		Feb. 2010		Mar. 2010		Apr. 2010	
0	4.274	0	4.284	0	4.284	0	4.274	0	4.284	0	4.284
5	4.284	5	4.294	5	4.304	5	4.314	5	4.294	5	4.314
10	3.954	10	3.964	10	3.874	10	3.884	10	3.914	10	4.094
15	3.694	15	3.674	15	3.684	15	3.664	15	3.694	15	3.684
20	3.714	20	3.704	20	3.704	20	3.634	20	3.694	20	3.704
22	3.524	25	3.144	25	3.044	25	2.984	25	3.084	25	3.304
25	2.254	30	2.344	30	1.644	28	1.819	28	1.874	27	3.019
30	1.394	35	1.484	35	0.514	30	1.609	30	1.644	30	2.129
35	0.664	40	0.704	40	-0.526	35	1.139	35	1.204	35	0.929
40	-0.116	45	-0.056	45	-0.526	40	0.679	40	0.624	40	0.219
45	-0.986	50	-1.016	50	-0.526	45	0.229	45	0.194	45	-0.341
50	-0.916	55	-1.826	55	-0.576	50	0.039	50	-0.066	50	-0.561
55	-0.856	60	-2.056	60	-0.736	55	-0.161	55	-0.256	55	-0.771
60	-0.726	65	-2.236	65	-1.016	60	-0.261	60	-0.416	60	-1.091
		70	-1.436	70	-1.226	65	-0.391	65	-0.636	65	-1.371
		75	-1.236	75	-1.436	70	-0.601	70	-0.766		
								75	-0.916		
		80	-1.136			70	-0.601	80	-1.066		
						75	-0.981	85	-1.356		
						80	-1.251	90	-1.576		

vii) Final processed elevations of every point on the profile. All values are in meters with respect to mean sea level. Location: STN : 4.

May 2009		June 2009		July 2009		Aug. 2009		Sept. 2009		Oct. 2009	
0	4.186	0	4.176	0	4.196	0	4.176	0	4.166	0	4.191
5	4.836	5	4.986	5	4.841	5	4.756	5	4.896	5	4.886
10	4.891	10	4.936	10	4.886	10	4.896	10	4.936	10	4.921
15	4.411	15	4.426	15	4.476	15	4.406	15	4.436	15	4.396
20	4.241	20	4.266	20	4.283	20	4.236	20	4.226	20	4.246
25	4.366	25	4.406	25	4.431	25	4.376	25	4.366	25	4.381
30	4.496	30	4.556	30	4.539	30	4.426	30	4.516	30	4.531
35	4.571	35	4.626	35	4.671	35	4.576	35	4.566	35	4.571
40	4.826	40	4.886	40	4.886	40	4.836	40	4.816	40	4.891
45	4.446	45	4.496	45	4.436	45	4.496	45	4.416	45	4.521
50	4.336	50	4.376	50	4.414	50	4.441	50	4.306	50	4.136
55	4.028	52	4.176	55	4.026	52	4.246	55	4.186	55	4.101
57	3.688	55	4.136	60	3.326	55	4.036	60	3.486	60	3.201
60	2.788	60	3.436	65	3.186	56	4.096	65	2.996	65	2.306
65	2.293	65	3.146	70	2.351	60	3.136	70	2.316	70	1.576
70	2.453	70	2.596	75	1.614	65	2.006	75	1.716	75	0.946
73	2.503	75	2.156	80	1.062	70	1.336	80	1.096	80	0.301
75	2.073	80	1.586	85	0.465	75	0.656	85	0.446	82	-0.014
80	1.183	85	1.026	90	-0.111	80	-0.264	90	-0.054	85	-0.289
85	0.563	90	0.336	95	-0.593	85	-0.964	95	-0.704	90	-0.784
90	-0.047	95	-0.114			90	-1.564	100	-1.404		(cont....

95	-0.572					
100	-0.912					

Nov. 2009		Dec. 2009		Jan. 2010		Feb. 2010		Mar. 2010		Apr. 2010	
0	4.196	0	4.211	0	4.221	0	4.206	0	4.216	0	4.216
5	4.896	5	4.911	5	5.011	5	4.936	5	4.886	5	4.856
10	4.976	10	5.011	10	4.961	10	4.946	10	4.956	10	4.986
15	4.486	15	4.671	15	4.411	15	4.426	15	4.456	15	4.476
20	4.216	20	4.211	20	4.221	20	4.196	20	4.206	20	4.226
25	4.336	25	4.321	25	4.261	25	4.316	25	4.326	25	4.326
30	4.476	30	4.321	30	4.511	30	4.486	30	4.476	30	4.436
35	4.566	35	4.541	35	4.541	35	4.536	35	4.556	35	4.546
40	4.896	40	4.581	40	4.821	40	4.906	40	4.896	40	4.736
45	4.546	45	4.751	45	4.441	45	4.456	45	4.436	45	4.486
50	4.386	50	4.511	50	4.291	50	4.186	50	4.226	50	4.566
55	4.226	55	4.351	55	4.161	55	4.226	55	4.246	55	3.986
60	3.316	60	4.201	60	2.781	60	2.826	60	2.846	60	3.886
61	2.566	65	3.311	65	2.461	65	2.476	65	2.476	65	2.676
65	1.856	70	2.491	70	2.501	70	2.476	70	2.456	70	2.386
70	1.216	75	2.091	75	2.081	75	2.396	75	2.356	75	2.486
75	0.616	80	1.716	80	1.391	78	2.406	78	2.406	80	2.516
80	0.036	85	1.091	85	0.511	80	1.896	80	2.056	85	2.076
85	-0.724	90	0.421	90	-0.229	85	0.716	85	0.846	90	0.936
(cont....											

90	-1.154	95	-0.129	95	-0.939	90	-0.244	90	0.006	95	0.276
95	-1.444	100	-0.689	100	-1.369	95	-0.664	95	-0.394	100	-0.344
		105	-1.299	105	-1.969	100	-0.564	100	-0.454	105	-0.894
		110	-1.639	110	-2.169	105	-0.614	105	-0.564	110	-1.044
				115	-2.559	110	-0.804	110	-0.634	115	-1.274
						115	-0.904	115	-0.764		
						120	-0.944	120	-0.874		
								125	-0.984		
								130	-1.164		
								135	-1.314		
								140	-1.514		
								145	-1.804		
								150	-2.164		

viii) Final processed elevations of every point on the profile. All values are in meters with respect to mean sea level. Location: STN : 5.

May 2009		June 2009		July 2009		Aug. 2009		Sept. 2009		Oct. 2009	
0	4.251	0	4.246	0	4.296	0	4.261	0	4.261	0	4.281
5	4.531	5	4.636	5	4.474	5	4.641	5	4.521	5	4.481
10	4.371	10	4.146	10	4.117	10	4.261	10	4.731	10	4.38
15	3.523	15	3.536	15	3.504	15	3.501	15	3.901	15	4.016
20	3.006	20	3.196	20	2.844	20	3.126	20	3.971	20	3.9
25	2.736	25	2.696	25	1.979	25	3.136	25	3.671	25	3.7
30	2.401	30	2.166	30	1.429	30	2.81	30	2.711	30	3.01
35	2.181	35	1.716	35	0.884	35	1.95	35	1.951	35	2.05
40	2.021	40	1.236	40	0.234	40	0.746	40	1.271	40	1.296
45	1.296	45	0.806	45	-0.279	45	0.146	45	0.421	45	0.806
50	0.841	47	0.256	50	-0.769	50	-0.474	50	-0.149	50	0.296
55	0.561	50	-0.464	55	-1.259	55	-0.864	55	-0.669	55	-0.51
60	0.091	55	-0.954	60	-1.749	60	-1.419	60	-0.539	60	-0.9
65	0.246	60	-1.364			65	-1.869	65	-0.399	65	-0.61
70	-0.216							70	-0.779	70	-1.169
75	-0.409									75	-1.649
80	-0.704										
85	-0.719										
90	-1.119										
95	-1.054										(cont....

100 -1.254					
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Nov. 2009		Dec. 2009		Jan. 2010		Feb. 2010		Mar. 2010		Apr. 2010	
0	4.281	0	4.291	0	4.241	0	4.281	0	4.261	0	4.281
5	4.561	5	4.541	5	4.581	5	4.571	5	4.611	5	4.481
10	4.681	10	4.771	10	4.331	10	4.701	10	4.301	10	4.811
15	4.021	15	4.041	15	4.031	15	4.041	15	4.051	15	4.031
20	4.201	20	4.136	20	4.211	20	4.211	20	4.231	20	4.111
25	4.311	25	4.321	25	4.206	25	4.251	25	4.251	25	4.261
30	3.871	30	3.991	30	3.331	30	3.661	30	3.461	30	4.071
35	2.281	35	2.901	35	1.981	35	2.281	35	2.041	35	3.111
40	1.401	40	2.031	40	0.871	40	1.391	40	1.401	40	2.081
45	0.601	45	1.261	45	0.371	45	0.921	45	0.921	45	1.561
50	0.011	50	0.716	50	0.101	50	0.701	50	0.541	50	1.181
55	-0.469	55	0.311	55	-0.099	55	0.511	55	0.321	55	0.681
60	-1.219	60	-0.029	60	-0.359	60	0.391	60	0.161	60	0.391
		65	-0.419	65	-0.419	65	0.271	65	0.071	65	-0.119
		70	-0.969	70	-0.619	70	0.191	70	-0.099	70	-0.429
		75	-1.419	75	-0.639	75	0.141	75	-0.179	75	-0.489
		80	-1.799	80	-0.699	80	-0.029	80	-0.299	80	-0.399
		85	-1.469	85	-0.919	85	-0.079	85	-0.399	85	-0.399
				90	-1.209	90	-0.169	90	-0.519	90	-0.369
				95	-1.439	95	-0.229	95	-0.629	95	-0.499
								100	-0.779	100	-0.349
								105	-0.849	105	-0.369
								110	-1.039	110	-0.369
								115	-1.319	115	-0.499
								120	-1.639	120	-0.499
								125	-1.639	125	-0.499

Final processed elevations of every point on the profile. All values are in meters with respect to mean sea level

Observation period: May 2010 (Last month).

STN:1	STN:2	STN:3	STN:4	STN:5
0 5.80	0 4.430	0 4.284	0 4.201	0 4.291
5 5.58	5 3.865	5 4.294	5 4.901	5 4.531
10 5.15	10 3.310	10 4.054	10 5.011	10 4.681
15 4.11	15 3.565	15 3.684	15 4.601	15 4.011
20 3.75	20 3.525	20 3.604	20 4.231	20 4.111
25 3.70	25 3.505	25 3.054	25 4.311	25 4.251
30 3.15	30 3.210	26 2.814	30 4.411	30 3.771
35 2.80	35 2.815	30 1.634	35 4.541	35 2.731
40 2.54	40 1.895	35 0.784	40 4.751	40 2.161
45 2.48	45 1.110	40 0.024	45 4.481	45 1.561
50 1.63	50 0.355	45 -0.636	50 4.571	50 1.041
55 0.81	55 -0.225	50 -1.096	55 3.981	55 0.581
60 0.16	60 -0.855	55 -1.366	60 3.871	60 0.111
65 -0.38	65 -1.375	60 -1.736	65 2.691	65 -0.449
70 -0.84	70 -2.015		70 2.431	70 -0.829
75 -1.33			75 2.461	
80 -1.61			80 2.431	
			85 1.796	
			90 0.686	
			95 -0.264	
			100 -0.714	75 -1.219
			105 -1.114	
			110 -1.224	

End of processed data.

12. List of figures.

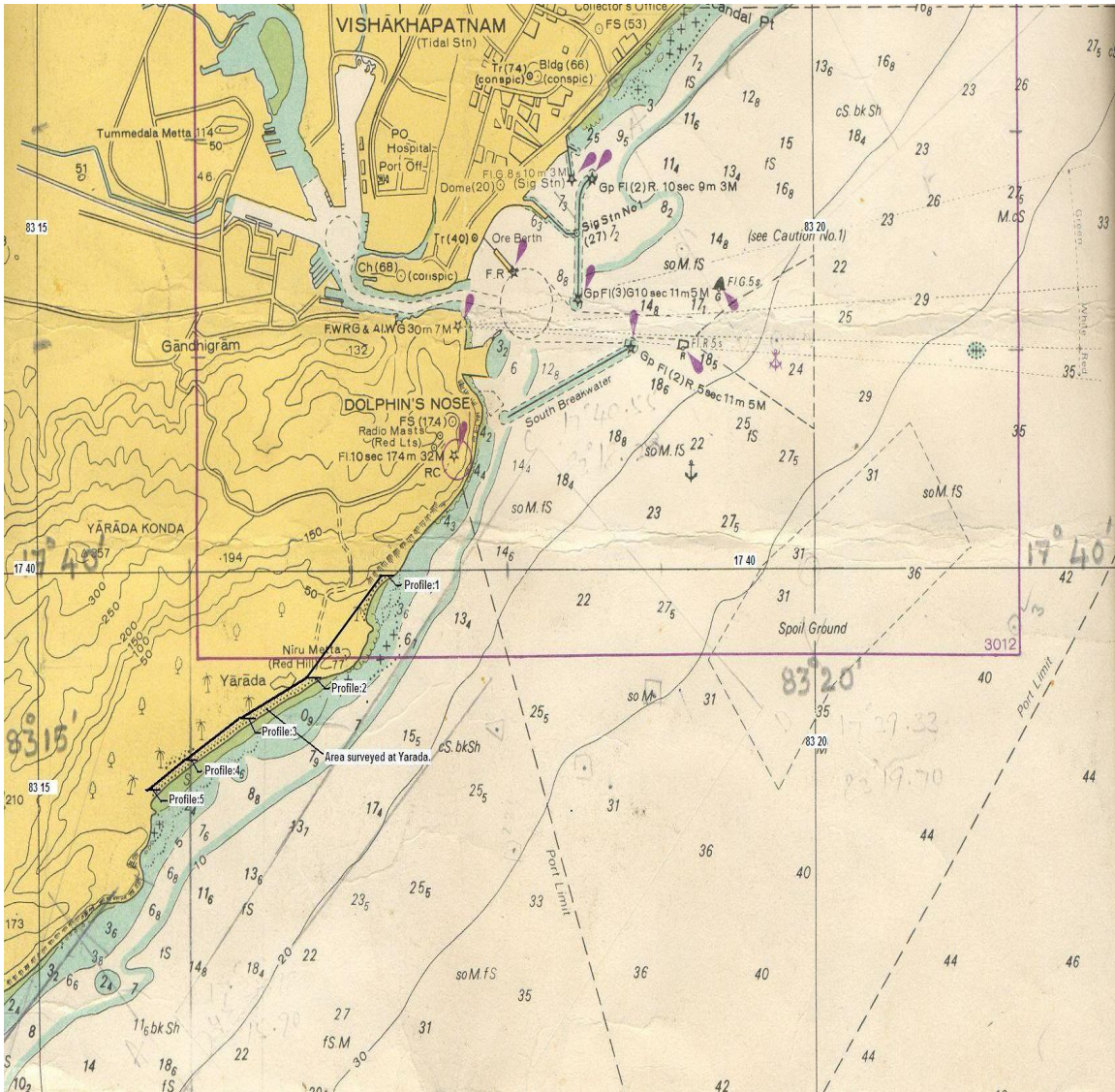


Fig: 1. Map showing the area surveyed at Yarada beach.

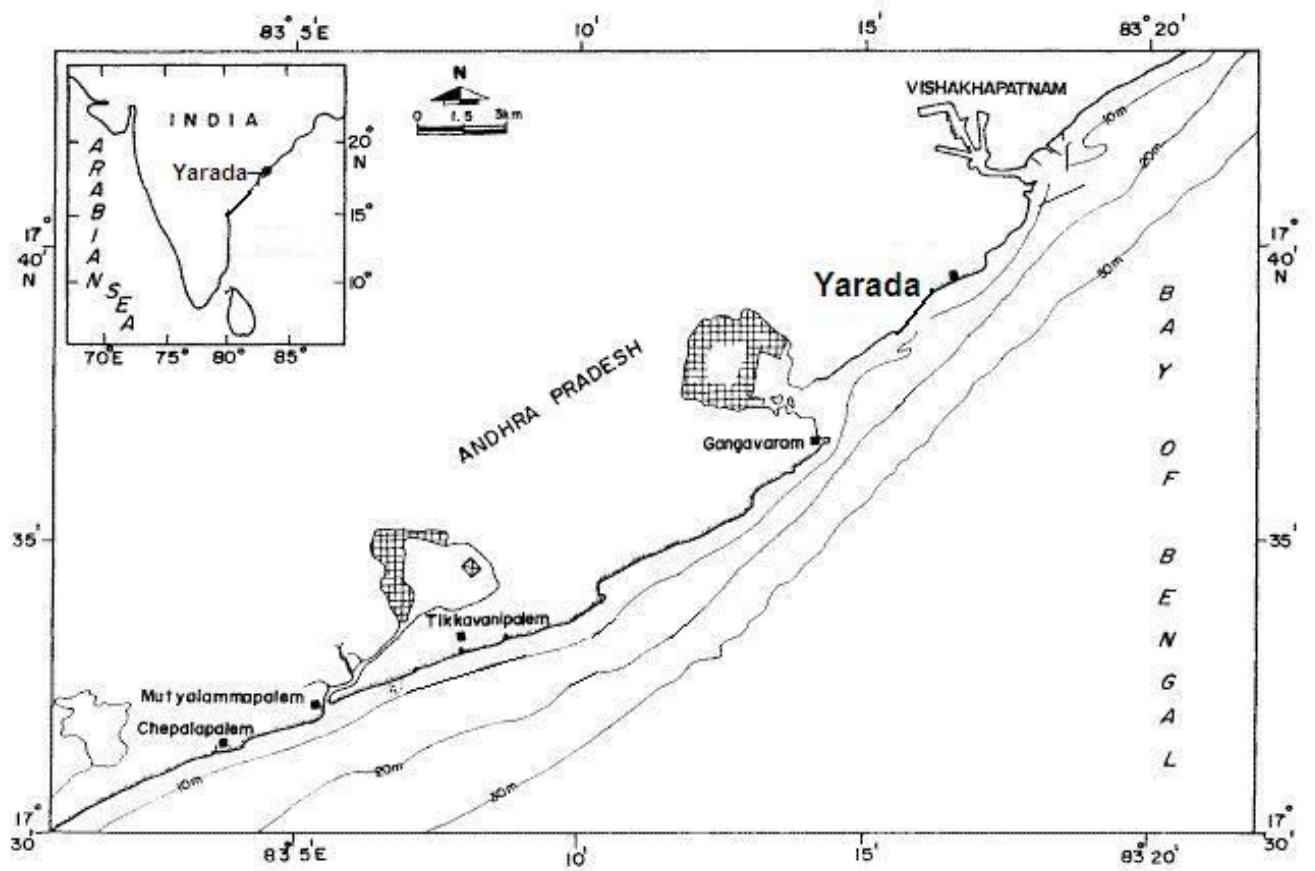


Fig: 2. Map showing the location of Yarada along the East Coast of India.



Fig:3. Location of a benchmark pillar from where beach profiling starts at station:1. (Northern most profile)



Fig:4. Huge sand hills observed at station:1. (Northern most profile)



Fig:5. Cross sectional view of the sandy beach at station:1. (Northern most profile)



Fig.6. Beach erosion (viewed from north to south) observed during September at station:1. (Northern most profile)



Fig.7. Beach erosion (viewed from south to north) observed during September at station:1. (Northern most profile)



Fig.8. Sand accretion (viewed from south to north) observed at station:2. (Just below Northern most profile)



**Fig:9. Sand accretion (viewed from south to north) observed at station:2.
(Just below Northern most profile)**



Fig:10. Vegetation line along the high water line at station:3. (Middle profile)



**Fig:11. Sand erosion observed during June (viewed from north to south) at station:3.
(Middle profile)**



**Fig: 12. Beach profiling in progress from the benchmark pillar at station: 4.
(Just above southern most profile)**



**Fig:13. Cross section of the beach (viewed from north to south) observed at station:5.
(Southern most profile)**



**Fig:14. Beach profiling observations under progress near low water line at station:5.
(Southern most profile)**