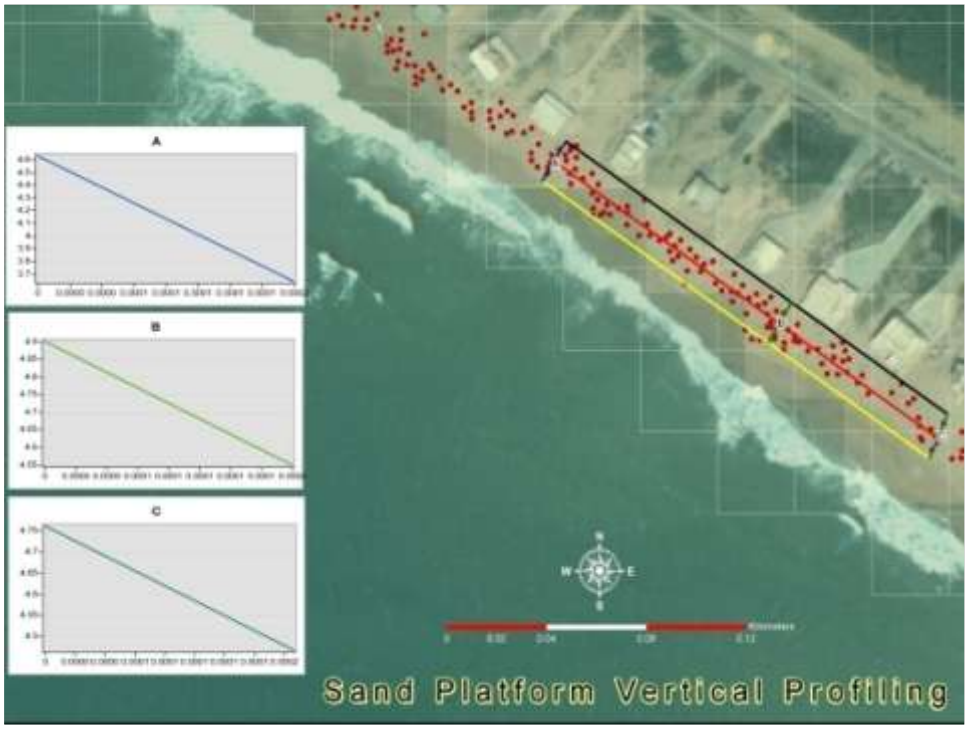
GIS Mapping of Karachi coast and GIS based analysis of marine turtle habitat: Sandspit/Hawksbay Eco-system

(FINAL REPORT)



Implementing Partner

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1. The Project

The project goal was to provide a credible and scientifically based planning, management and monitoring tool that establishes a knowledge base for effective and sustainable conservation of the Karachi coast in general (GIS based identification of species/habitats) and the turtle nesting habitat at the Hawksbay/Sandspit beaches in particular and to facilitate in creating the legislative and institutional space for implementation

Project Objectives

The following key objectives aimed at the long term and effective conservation of the turtle nesting habitat of the project area were identified:

- Establishment of a framework for the storage and retrieval of spatial data *(includes inventory of spatial features and map outputs) – the GIS Map*
- Preparation of a tool which provides the functions to do spatial analysis/geographic modeling on the spatial data thereby gaining an understanding of patterns and processes taking place over a period of time
- Lobby support and implementation of the project recommendations by targeting all the relevant stakeholders

Project Outcomes

The following project outcomes were indicated:

- General mapping of the Karachi coast from Rehri Goth, Korangi Creek to Cape Mounze – (identification of species and habitats)
- A major project output would be the identification and analysis of causes and locations of hindrances to turtle nesting and consequently identification of habitats suitable for turtle nesting.
- Based on the findings/recommendations of the GIS Mapping, the design of a comprehensive lobbying/awareness raising campaign aimed at creating the legislative and institutional space for implementation.

Project Implementing Strategy

The project was divided in two components:

1. The setting up of the GIS Data base/map by making combined use of hardware, software, skills and spatial data with provisions of analysis of spatial attributes and geographic modeling to recommend habitat conservation measures
2. Based on the GIS findings/recommendations, the design/conduct of a comprehensive lobbying/awareness raising campaign aimed at creating the legislative and institutional space for implementation and finalizing recommendations

Project Justification

A threatened coastal habitat

The coastal ecology is threatened form land based activities. However, updated and scientifically acquired data and updated information does not exist that is crucial in developing the appropriate policies, plans and conservation measures that can contribute to the sustained protection of the coastal habitat. This projects aims to contribute in filling this information gap through digitized GIS based mapping. While general mapping of the whole project area – Rehri Goth to Cape Mounze – **(that includes identification of the species/habitat based on the available data)** would be carried out through acquisition of satellite imagery, processing and incorporation of available data on the GIS map an extensive data collection and mapping exercise will be carried out in the Sandspit/Hawksbay area that can serve as a model for future such initiatives along the rest of the coast **(no primary data will be generated in project areas other than the Sandspit/Hawksbay turtle habitat).**

It is globally acknowledged that protection of sea turtle nesting sites is critical for ensuring survival of the specie for if nesting habitats are irreversibly damaged, there won't be any specie left to protect. Due to various human activities, the Sandspit/Hawsbay habitat is severely threatened. Beach front development is presently in the form of beach huts where land use violations have been observed and a number of huts exceed the limits of legally allowed land usage. Consequently, space for turtle nesting is severely restricted. In addition, more extensive development activities are being proposed for the area.

The beaches often contain large amounts of litter. Consumption may interfere in metabolism/gut function, and cause absorption of toxic by-products. Garbage also attracts predators like dogs, crows/gulls that then pose a direct threat to the turtle eggs/hatchlings. Construction debris on the beaches from newly constructed/unused huts can alter the sand characteristics, deter nesting attempts and interfere with the incubation of eggs/ emergence of hatchlings. Sand excavated during the process also damages the beach/sand habitat. All these activities may cause irreversible damage to the turtle nesting habitat if urgent corrective measures are not taken.

Towards conserving the habitat

The project has aimed to address these issues through the use of an emergent technology that has revolutionized sea turtle research. *Geographic Information System (GIS)* provides a tool with the potential to perform powerful spatial data analyses for long term monitoring of wildlife habitats including sea turtle nesting sites.

The project has used the GIS technology for mapping, processing and incorporation of available data for the whole project area while it has also undertaken base map preparation, retrieval and storage of field data and visualizing interactions between sea turtle nests and the physical/environmental attributes at the Sandspit/Hawksbay beaches. The successful/unsuccessful nesting sites have been marked and related with data on mean sand depth, beach access *(obstructions to nesting access such as huts)* and potential predation sources. This has helped in analyzing and identifying causes and locations of hindrances to turtle nesting and consequently describing habitats suitable for turtle nesting in addition to determining scientifically the *High Tidal Zone.* The product output would establish the scientific basis for properly describing project area's nesting habitats, monitoring changes over time, their impact on the nesting habitats and modeling geographic processes inferred from predicted changes, for implementing strategic management.

Project Area

Geographical Location: The project area is spread over a stretch of about 70 km (from Rehri Goth, Korangi to Cape Mounze) which is part of the Sindh coast. The Sindh coastal region is located in the South-eastern part of the country between the Indian border along Sir Creek on the east to Hub River along the Baluchistan coast on the west. The Sandspit/Hawksbay eco-system where extensive project activities will be located comprises of about 5 km long beach strip located 24 27 – 24 52 N, 66 50 – 66 59 E, on the coast southwest of Karachi City. The Hawksbay/Sandspit beaches are flanked to the northwest by the Arabian Sea and to the southwest by a dense mangrove forest cover in the coastal backwaters.

Environmental Profile: The area between Cape Mounze and Korangi is characterized by wide surf zones, cliff beaches, sea arch, sea notch and river silt. The prominent geomorphologic features of Karachi coast comprise shallow lagoons, sea cliff, sea stacks and terraces, wave cut platforms, sea caves and notches, which dot this part of the Sindh coast. The vegetation along the Sindh coast is dominated by mangrove forests. Again eight species have been documented with avicennia marina being the most abundant. This ecosystem provides habitat for wildlife of terrestrial and marine origin. Environmentally sensitive eco-systems in the project area include the Korangi Creek system, the Green Turtle habitat at the Hawksbay/Sandspit beaches.

The eastern part of the beach *(Sandspit)* is all sand; and the western part *(Hawksbay)* has some rocky areas. The area experiences an arid sub-tropical climate with temperatures remaining high throughout the year. The average annual rainfall is 125 mm, and the mean annual temperature is 32 C. The beaches are one of the most visited and important turtle nesting sites in the world for the *Green Sea Turtle (Chelonia mydas)* and Olive Ridley *(Lepidochelys olivacea)*. In addition, the sandy shores of Karachi have three to four main groups of macro marine organisms such as crabs, gastropods, macro-fauna, interstitial fauna and cast off sea weed along the high water zone as well as floating near the coastal waters. Further inland a large area of backwaters supports a dense mangrove vegetation comprising *Avicennia marina.* The backwaters contain a very rich and complex food web of algae, invertebrates living in the mud, such as worms, shrimps, crabs and juvenile fish. Many water birds are found in this area, especially herons, waders such as stints, sandpipers, redshanks, avocets and black winged stilts, and hawks such as ospreys, brahminny kites and marsh harriers.

Socio-economic Profile: The project area is unique within the context of the coast of Pakistan in that while most of the coastal habitation consists of small and scattered rural fishing communities, the Karachi coast is characterized by the port and the bustling industrial and commercial urban settlement of more than 12 million people. It is one of the largest city in the world and the largest in Pakistan. It supports 70% of the industrial activity in Pakistan, provides 25% of the federal revenue, 40% of the provincial revenue and 15% of the Gross Domestic Product *(GDP).* Fishing communities also reside along the coast of both indigenous and non-indigenous nature that includes large settlements like Ibrahim Haidery, Rehri, Machar Colony etc. In the Sandspit/Hawksbay area, two separate types of human settlements exist in and around the proposed project area:

- Permanent Human Settlements
- Non Permanent Human Settlements

The permanent human settlement exists in the form of the *Kakapir* coastal fishing village located at the meeting point of the Sandspit and Hawksbay beaches. Population, in excess of 1000, is 95% ethnic Sindhi with some clusters of Baloch and Seraiki speaking communities. Almost 90% of the households are dependent on fishing and related activities. Women are mostly involved in household chores, child rearing, livestock management and fuel and fodder collection.

Visitors to the beach huts represent non-permanent classification of human settlement. 201 huts are located in the *Karachi Port Trust (KPT)* owned stretch of the beach, while 282 huts are located in the jurisdiction of the *City District Government Karachi (CDGK)* owned stretch of the beach.

Project Beneficiaries

The project as focused in general on the GIS based documentation of the Karachi coast for facilitating future policy making, planning and conservation. However, indirectly the implementation of project recommendations would benefit:

The sensitive ecology along the Karachi coast: through scientific documentation of the eco-systems that can help in identifying pollution threats, document present status and assist in establishing trends in urban development and impact on the coastal ecology

The local community: the local fishing community can benefit tremendously as recognition of the ecological importance of the project area can lead to proper conservation measures and possibly controlled recreational and tourism activities in the area where they can benefit financially by being trained and utilized in the role of *Environmental Stewards.* This is important particularly as the fishing industry is facing a crisis and provision of alternative livelihood options for the fishing communities are urgently needed

The land owning agencies: the land owning agencies by recognizing the ecological importance of the project area and by initiating habitat management measures can gain global recognition for developing and implementing a pioneering and innovative conservation plans.

The public at large: the general public would benefit by having environment friendly development and clean beaches in addition to enjoying controlled access to a globally recognized ecological sites

2. Implementing the Project

For implementation purposes, the project area was divided into two parts:

- The turtle nesting habitat at Sandspit/Hawksbay beach eco-system
- The coastal eco-systems of Karachi

A. The turtle nesting habitat at Sandspit/Hawksbay beach eco-system

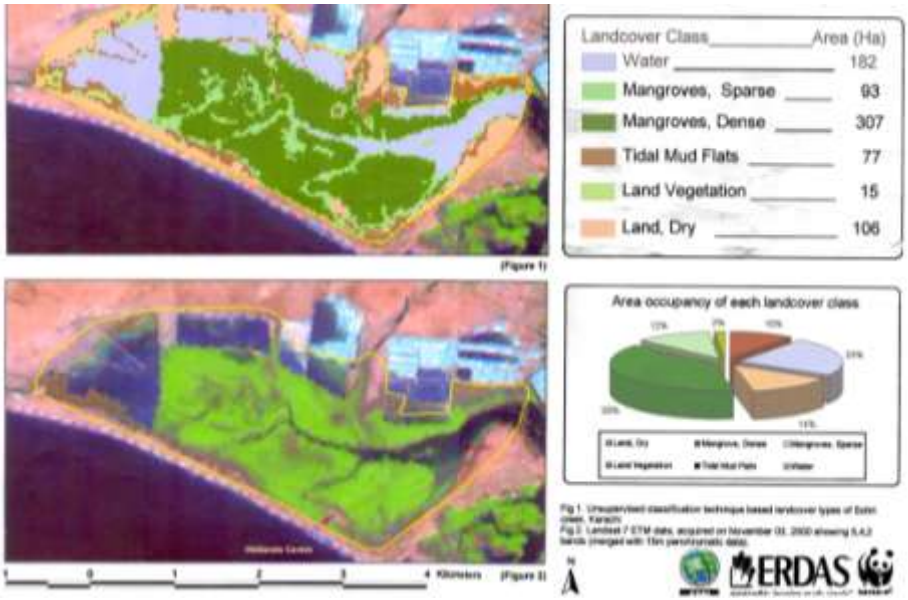
Location

Located 24º 47º – 24º 52º N, 66º 50º – 66º 59º E; on the coast southwest of Karachi City. This stretch of the coast lies in between the area west of Karachi Harbor entrance upto Buleji/Paradise Point consists of sandy beaches, which are separated from each other by rocky protruding points. The Hawksbay/Sandspit beaches lie about 15 km south west of Karachi City. They are flanked to the northwest by the Arabian Sea and to the southwest by a dense mangrove forest cover in the coastal backwaters.

Hawksbay / Sandspit beaches on the Karachi Coast

Description of site

A gently sloping sand beach with open sandy offshore approaches stretching for about 20 km along the Arabian Sea coast west from Manora Point at the mouth of the Karachi Harbor, and a complex of creeks and shallow tidal lagoons with extensive inter-tidal mud-flats and some mangrove swamp behind the beach. The eastern part of the beach *(Sandspit)* is all sand; the western part *(Hawksbay)* has some rocky areas. The beach platform is high enough to stay above the high tide mark at all times of the year except during the monsoon when it can be inundated by high tides.



(Courtesy: WWF Pakistan)

Climatic conditions

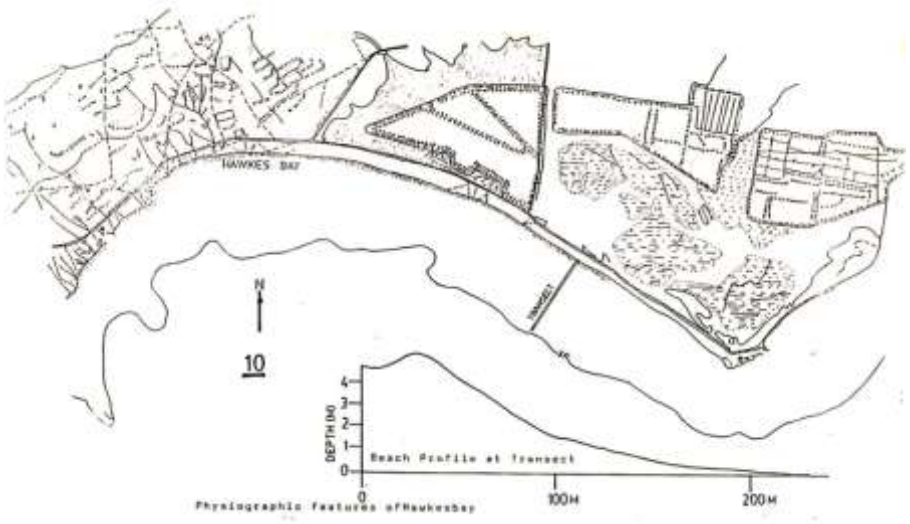
The area experiences an arid subtropical climate with temperatures remaining high throughout the year. The average annual rainfall is 125 mm, and the mean annual temperature is 32ºC.

Physical features

The significant shoreline features of both the Hawksbay and Sandspit beaches are discussed as follows:

Hawksbay beach

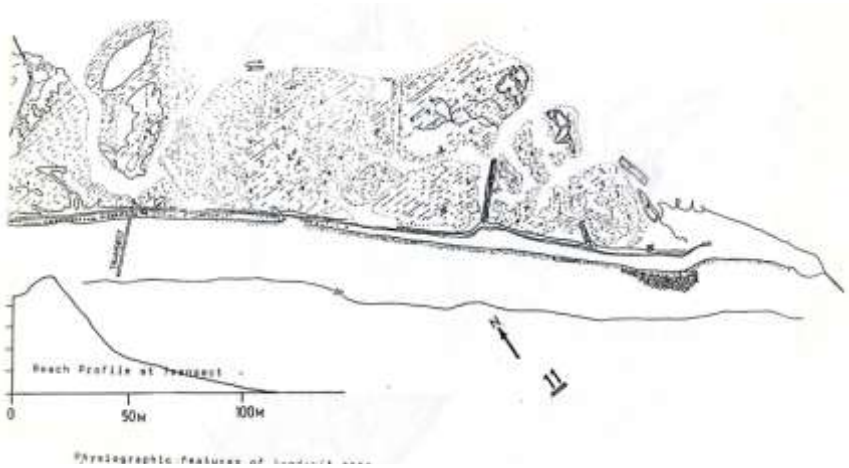
There is no cliff at the Hawksbay beach. The sand dunes are common all along the beach at high water zone. The beach slopes vary between 20-40 degrees from high water mark to the sub-tidal area and then slopes are very gentle up to a depth contour of 5 meters. There is a small rocky outcrop within the inter-tidal area between Hawksbay and Sandspit called Kakapir area. The rocky ledges have a very gentle slope and extend only up to the neap low water zone. There are sabellarian reefs along the edges of the rocky ledge near the neap low water zone. The rest of the basement of the rocky ledges is buried in the sand and extends up to the adjacent sub-tidal area.



Profile of Hawksbay Beach

Sandspit beach

No cliffs are present. Sand dunes at high water zone of this long sandy beach oriented at southwest direction. The beach slopes vary between 40-60 degrees from high water mark to the sub-tidal area and then slopes are very gentle up to a depth contour of 5 meters.



Profile of Sandspit Beach

The Ecosystems – Flora and fauna

Discussed below are the salient features of the nature of the prevailing ecosystems:

Seashore – beaches and cliffs

Green turtle nesting on the Hawksbay / Sandspit beaches

Stretching from Sandspit through Yunus Abad Goth, Hawksbay, Buleji and Paradise Point to Cape Monze, the coastal areas west of Karachi consists of some 20 km of mainly sandy beaches with small rocky areas, cliffs and raised mud plateaus. The beaches of Sandspit and Hawksbay are mostly lined with beach huts built between the road and the top of the sand dunes.

The sandy shores of Karachi coast have three to four main groups of macro marine organisms such as crabs, gastropods, macro-fauna, interstitial fauna and cast off sea weed along the high water zone as well as floating near the coastal waters. The beach is a very important nesting site for the Green Sea Turtle *(Chelonia mydas)* and Olive Ridly *(Lepidochelys olivacea).* The site is of international importance for *C.mydas* both in regional and in global terms.

The crabs *Ocytopoda rotundata* – the ghost crabs, are very common near the high water zone, and the moon crab *(Matuta lunaris)* are also found on some of the sandy shores. The common gastrpods of the sandy shores include *Nautica didyma, Terebra sp.* The star fishes *(massive star fishes - Asterina sp.)* are also common in the sandy

shores *(e.g. Clifton, Hawksbay etc.).* The gastropods are usually found more frequently on the sandy beaches at steep angle of the beach slope. Star fishes are more commonly found on sandy beaches with gentle angle of beach slope.

Backwaters, mangroves and mud flats

The backwaters extend into the area behind Sandspit beginning from Yunus Abad Goth and reaching the Naval Officers Housing Society at a couple of points. A large area of backwaters supports a dense mangrove vegetation comprising *Avicennia marina.* The mud flats are generally barren except for some very stunted bushes of mangroves. There is 400 hectares of mangrove forest in Sandspit area and it includes 307 hectares of dense forest and 93 hectares of sparse forest. There is only one species of mangroves in the backwaters at Sandspit called *Avicennia marina.*

Mangrove swamps in the coastal backwaters of Hawksbay / Sandspit

The backwaters contain a very rich and complex food web of algae, invertebrates living in the mud, such as worms, shrimps, crabs and juvenile fish. In this particular area the diversity of species may be somewhat curtailed by the extensive pollution which must be swept back by the tide from the sewage and industrial and industrial waste being discharged un-treated from the Lyari River.

Many water birds are to be found in this area, especially herons, waders such as stints, sandpipers, redshanks, avocets and black winged stilts, and hawks such as ospreys, brahminny kites and marsh harriers. At times, when they lose their way back to the seas, adult turtles and their hatchlings can also be found in the backwaters.

Saltpans and low-lying salt affected areas

The saltpans have been in the area for over half a century. These occupy the area between the backwaters and the Naval Officers Housing Society. Sea water is pumped into these pans for salt production. Neither these nor the adjoining low-lying salt affected areas support any vegetation due to high salinity and waterlogged soil. However, in some of the salt pans, containing water at the appropriate depth, thousands of migratory wading birds cab be seen in the winter time, particularly little and temminck stints *(Calidris minuta & C.temminckii)*, dunlin *(Calidiris alpinus),* sandpipers *(Numenius arquata, Tringa hypoleucos, Numenius phaeopus, Tringa terek, T. stagnatilis, T. tetanus etc.)* avocets *(Himantopus, Recurvirostra avosetta)*, godwits *(Limosa limosa, L. lapponica)* etc. Several hundred Flamingoes *(Phoenicopterus roseus)* are also seen regularly in this area. It is assumed that they are attracted by the food from small crustacean which can survive in highly saline conditions such as brine shrimp collection.

Factors affecting the areas ecological character

Sea Turtles enjoy a protected status in Pakistan. Virtually all the marine turtles nesting sites in Sindh occur on the Hawksbay/Sandspit beaches, concentrated along one 5 km stretch but extending in some degree along the entire beach strip of around 20 km. These two beaches represent the largest nesting habitat for marine turtles in Pakistan where the dominant resident turtle is the green turtle. Due to various human activities, this habitat is now threatened. In the absence of any effective and regular beach cleanup and garbage disposal system, beaches often contain large amounts of beach litter. Green turtles eat a wide variety of marine litter such as plastic bags, plastic styro-foam pieces, balloons and plastic pellets. Effects of consumption include interference in metabolism or gut function, even at low levels of ingestion as well as absorption of toxic by-products. In addition, garbage attracts predators like dogs and crows/gulls in large numbers that then pose a direct threat to the turtle eggs/hatchlings.

A green turtle caught in a wire net erected along a beach hut

Garbage on the beach which results in attracting predators such as crows and dogs.

Presently, beachfront development is limited to the construction of beach huts. However, land use violations have been observed with a number of huts exceeding the limits of land usage as described in the law. This is resulting in the reduction of available nesting habitat for turtles. Land previously used by turtles for nesting has been built upon *(Huts/roads)* and hence space for turtle nesting is now severely restricted. Night use of beach huts is common. Use of lightening in the night discourages females from nesting and causes hatchlings to become disoriented because they instinctively head towards the brightest horizon, which should be the moonlit ocean. Beachfront lighting instead causes them to disorient and wander inland, where they often die of dehydration or predation. They are also run over by offshore road traffic.

GIS mapping and assessment of turtle nesting – physical/environmental features linkages: A Field Study

For a detailed analysis of turtle nests large scale ground data is required. For this purpose, high resolution satellites imageries were procured which could identify turtle nesting pits (size ranging from 1-1.7 m). Hence recent imageries of QuickBird were acquired for September 2009 (acquired in October 2009). As it is evident from nesting pits are quite prominent and clearly visible on QuickBird data, showing the details of nests in various years. Through enhancement filters we further enhanced the image to make it more understandable and visible for a layman. Beside this other GIS based thematic layers were developed. Following are some important factors about building a GIS for turtle consumers (Figure-3).

Figure 1

Nesting Grounds From 2006 – 2009 (Sep)

Year	Nesting Grounds
2009	534
2008	551
2005	478

Table -1

Figure-

2

Figure-3

Figure-3(a)

Nesting ground data on Geo Eye imageries is totally absent though it is much finer resolution (50cm) the reason is the date of image which was acquired in May 2009 when we usually don't have single nest on the ground available Data has been verified by the field survey conducted by biologist (Figure-3(a)) on an interval on 100 m on the nesting beaches quite amazingly the nests which were identified on satellite imageries are a perfect match (100%) with in-situ field data.

Figure-4

Building a GIS

For the development of a comprehensive Vector-Based GIS, enhanced satellite raster data is converted into attribute-based raster data. The raster data first projcted onto UTM Coordinates (Zone-42 N) and setup on a scale of 1: 1000. By using ArcGIS, these are modeled as a collection of discrete features in vector format. The vector data are overlaid on raster images used as background. Tabular data are linked via SQL connection to the sea turtle nesting point data. This will allow users to continuing usage and update of data in more familiar office productivity software (*i.e.*, Excel or Access).The tables from these applications are linked to line feature that represent kilometers of nesting beach. Queries are then run on the linked tables. The resulting data are then overlaid as line features that represent the queried data (Figure-5).

Figure-5

Entire GIS data has been mapped on this scale to obtain the thematic layers through on-screen digitization techniques . The main featuers which have been digitized on priority bases are hut, hut boundary, hut corridor, hut encrochment, roads, garbage points, water line, moisture line, dry sand areas, and nesting sand bars (Figuer-6). This

is a lengthy and complicated process. There are certainly some collietral information for which need to be integrate for proper baseline studies. Most important of which was hut numbers. Unnfortunately, this was diffcult to mark as no continous spatial series of the houses were recorded. To cope this data defficency we hyperlinked the photograph of each hut with its polygon. This provided us with authentic information beside coordination and number of the hut. All data were than merged into one information system so that researchers or other end users can monitor, explore, analyze, and query data to determine possible impacts on the overall survival of the sea turtle choosing any of the different data sets used.

Figuer-6

Vector Data

Digitized land use plans topographical maps, bathymetric and the EM of the nesting beach was utilized by using GIS, these data can be modeled as a collection of discrete features in vector format.

Ancillary (tabular) Data

The coastal GIS was prepared (zoomed pixels) and digitally classified (classes being mangroves forests, water-covered areas, shallow water, vegetation, settlement areas) satellite images. Most important of all data layers are the themes which are affecting the turtle nests. Turtle nests from 2005 to 2009 were mapped with the help of HRS data. The extent is from Manora in the east to Cape Monze in west. For the year, 2005 mosaic of archived image was used to identify the spatial distribution of turtle nests with the help of visual interpretation, all the nests were marked in

appoint theme (Figure-3). A total of 478 nesting grounds were identified in 2005. This low number of nests may be due to the "Tasman oil spill, around in August 2003. Similarly, 2008 nesting datasets were plotted from Google-Earth imageries. Direct KMZ file developed in Google-Earth. This file was then exported into Arc GIS system through "Interportability Tool", which then transformed into a shape file and stored as a vector theme in the GIS database. With increase in nests, a total of 551 emerged. For the year 2009, recently procured image for this project was used to identify nests that were about 534. From the year 2005- 2009, there is a little Waxing and Waning of the nests, although Fehmida (1999) has identified 1660 nests during 1985 nesting seasons, This may be because of extensive beach nourishment activity, especially construction of huts. Though huts construction is legally bound to have an area of 30 x 30 meters. However, very few "hut owners" are following this. On ground, there seems to be no restriction on the size or orientation of "hut plot" (Figure-7).

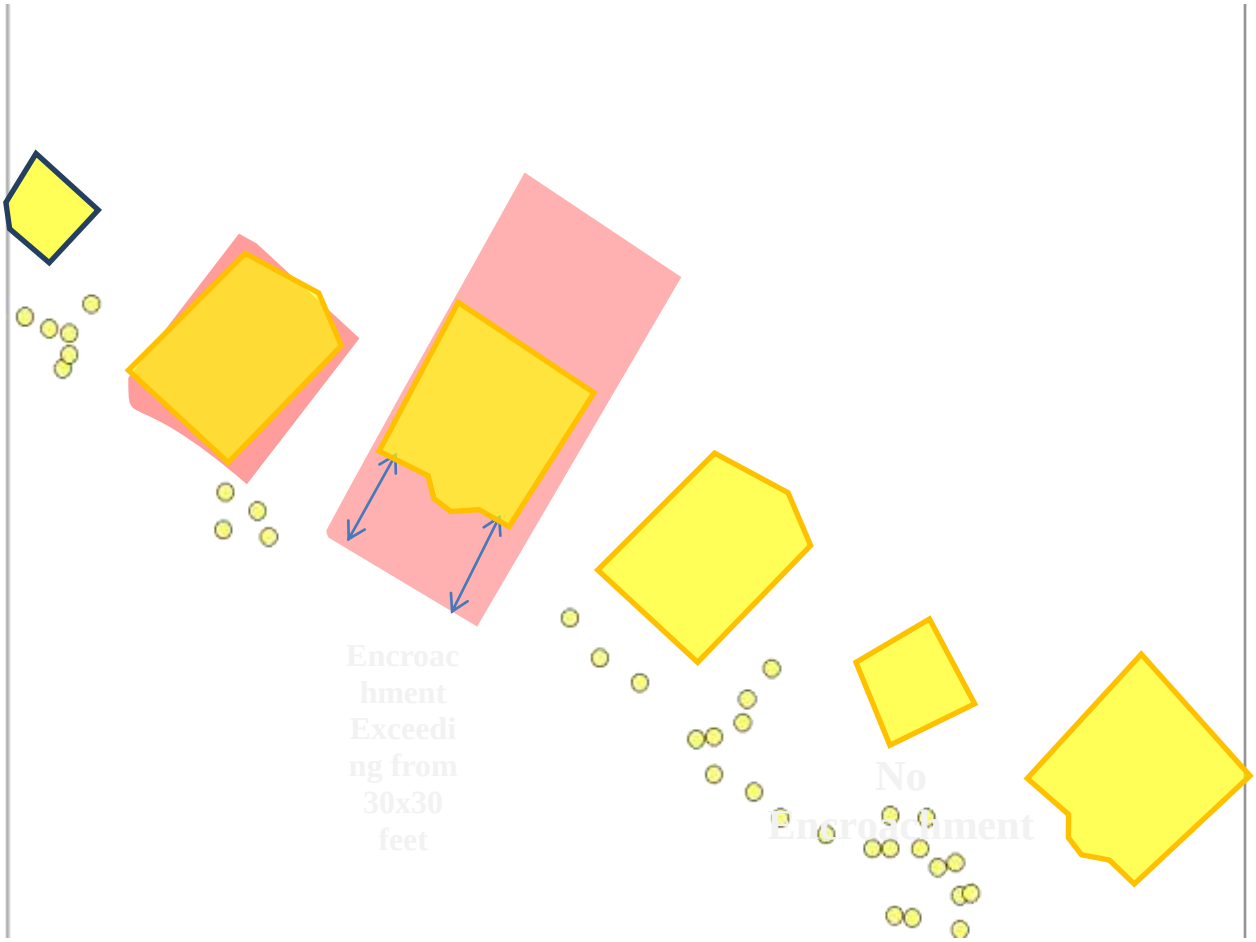


Figure-7

Having an area of 13120 sq.m – length of 780 m, the entire stretch of the beach is approximately 9 km. 52% of the entire documented nests along the 9 km beach strip were located on the 0.78 km sand bar. Legally covered area is 68813 sq.m while the area of actual constructed structure is 189148 sq.m. As such, the area of extended encroached space (car park/fencing) comes out to be 256689 sq.m. (Total beach huts are 823).

Contours Drawn at an interval of 1meter

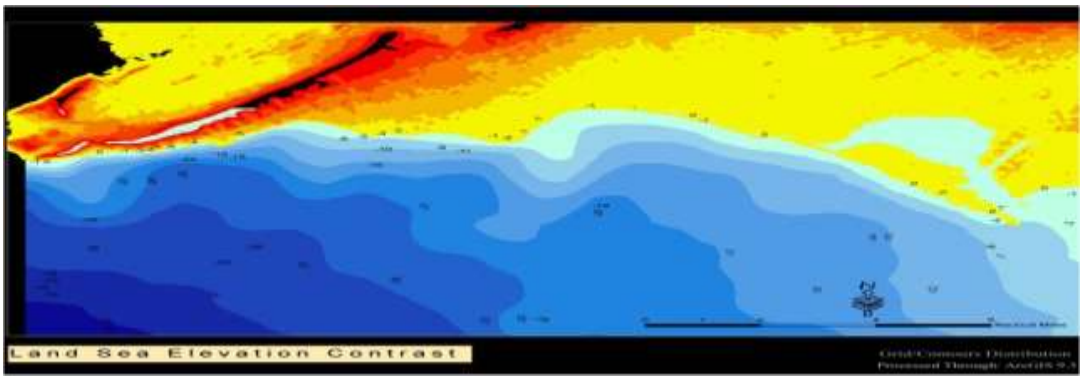


Figure-8

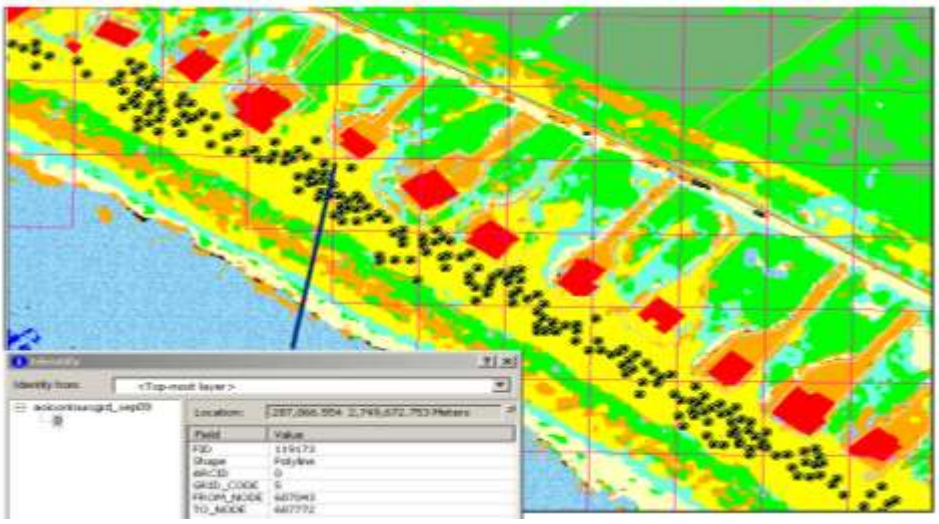


Figure-8(a)

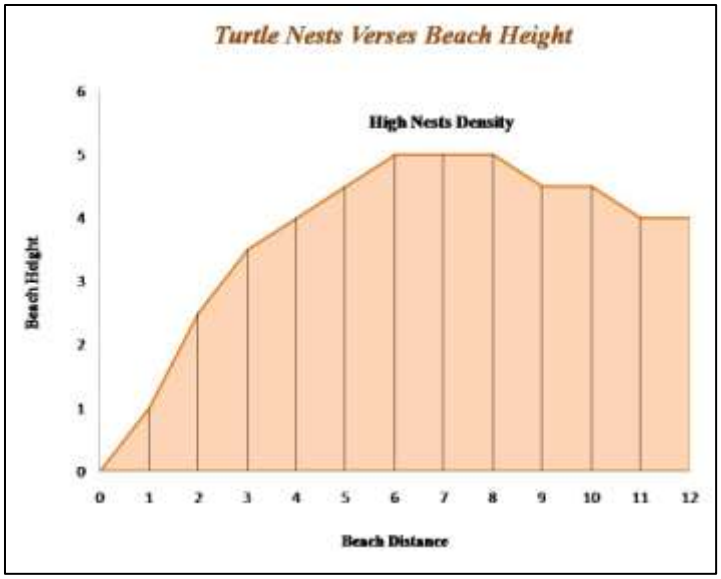
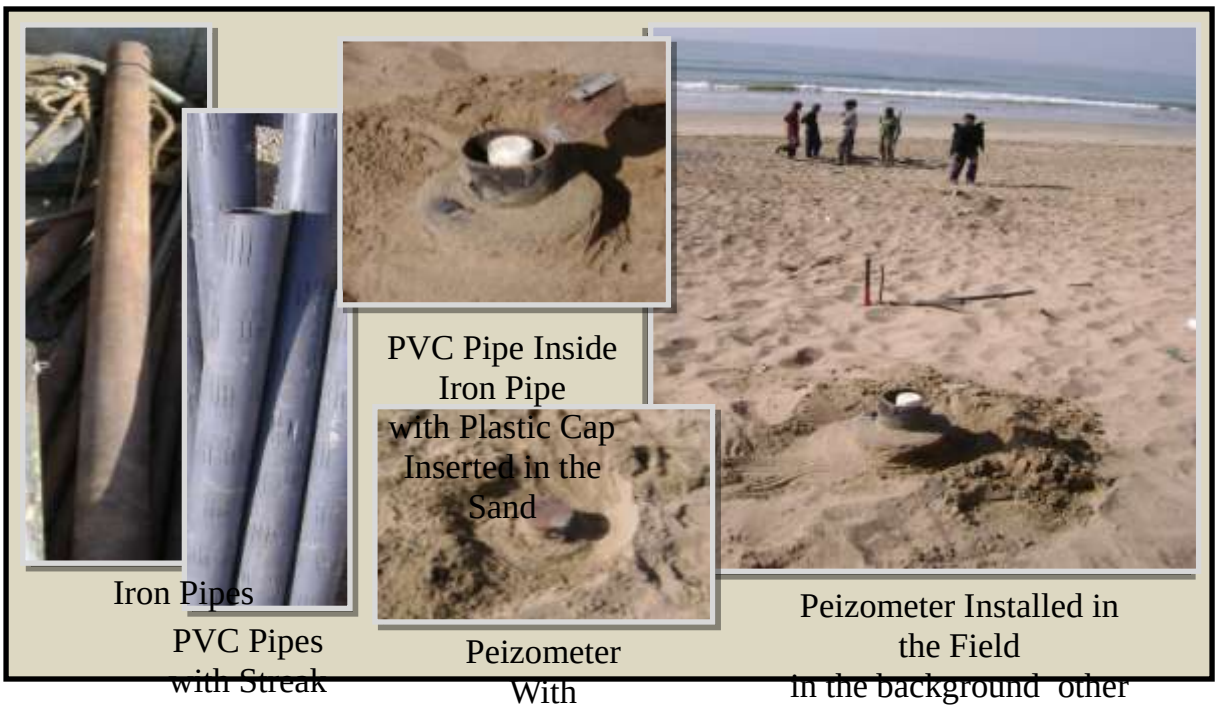


Figure-8(b)

This provided an extremely valuable information as we found that the turtles are nesting mostly in high sandbar area as they need more to safely dug in their nests as perfect depth. All the high nesting areas in the sand bar having an average height 3 – 5 meters, where the range of “no Nests zone” is only 1 – 1.5 meters. For the further evaluation of sand bar “Nesting Layers” of all the years, along with water and moisture line, were plotted. The polygons (Sand bar) are about 24, 447 sq. meters. Sand bar confirmation further strengthened with the help of “Soil and Grain analysis” and peizometer data (Table-2, Figure-9).



Iron Pipes

PVC Pipes with Streak Lines for water Percolation

PVC Pipe Inside Iron Pipe with Plastic Cap Inserted in the Sand

Peizometer With Locked Iron Cap

Peizometer Installed in the Field
In the background other Peizometer and Water line on the Beach Could be Noticed

Figure-9

GRAINSIZE ANALYSIS & NATURAL MOISTURE CONTENT TESTS

S. No	Peizometers	Coordinates			SAMPLE	DEPTH (FEET)	Per cent finer than sieve												NMC (%)
		X	Y	Hut No			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	
1	BH-1	287070	2749653	N 104	DS-1	1	-	-	-	-	-	100	99	96	82	43	8	2	16.8
2	BH-1	287070	2749653	N 104	DS-2	3	-	-	-	-	-	-	100	97	81	41	8	3	-
3	BH-1	287070	2749653	N 104	DS-3	5	-	100	88	70	64	63	61	58	50	25	4	1	14.8
4	BH-1	287070	2749653	N 104	DS-4	6	-	100	89	82	77	60	49	41	30	14	3	1	-
5	BH-2	287066	2749651	N 104	DS-1	1	-	-	-	-	100	90	86	73	44	21	12	10	-
6	BH-2	287066	2749651	N 104	DS-2	3	-	-	-	100	93	80	70	59	37	11	2	1	12.8
7	BH-2	287066	2749651	N 104	DS-3	5	-	-	-	-	100	99	97	87	63	18	3	1	-
8	BH-2	287066	2749651	N 104	DS-4	6	-	-	-	-	-	100	97	74	50	16	8	2	18.2
9	BH-3	287062	2749649	N 104	DS-1	1	-	-	100	77	66	63	61	54	50	24	9	7	-
10	BH-3	287062	2749649	N 104	DS-2	3	-	-	-	-	100	96	86	57	36	24	14	6	14.9
11	BH-3	287062	2749649	N 104	DS-3	4	-	100	80	76	73	70	67	51	24	8	2	1	-
12	BH-3	287062	2749649	N 104	DS-4	6	-	-	100	75	66	59	53	44	28	9	2	1	18.8
13	BH-4	286850	2749788	N 113	DS-1	1	-	-	-	-	-	-	100	99	95	86	34	3	17.1
14	BH-4	286850	2749788	N 113	DS-2	3	-	-	-	-	-	-	100	98	94	81	35	7	-
15	BH-4	286850	2749788	N 113	DS-3	4	-	-	-	100	81	79	76	73	65	46	16	4	18.2
16	BH-4	286850	2749788	N 113	DS-4	5	-	-	100	97	86	62	46	42	36	30	27	21	-
17	BH-4	286850	2749788	N 113	DS-5	6	-	-	100	88	75	51	32	22	15	9	4	1	16.1
18	BH-5	286840	2749775	N 113	DS-1	1	-	-	-	-	-	-	100	97	92	79	27	4	17.1
19	BH-5	286840	2749775	N 113	DS-2	2	-	-	-	-	-	100	98	94	88	76	32	4	-
20	BH-5	286840	2749775	N 113	DS-3	3	-	-	-	-	-	-	100	98	95	75	35	6	18.2
21	BH-5	286840	2749775	N 113	DS-4	4	-	-	100	88	73	53	38	32	25	22	18	12	-
22	BH-5	286840	2749775	N 113	DS-5	5	-	-	-	-	100	99	96	94	89	77	32	4	16.2

23	BH-5	286840	2749775	N 113	DS-6	6	-	-	-	100	81	76	67	65	59	47	22	3	-
24	BH-6	286515	2749955	N 125	DS-1	1	-	-	-	100	91	64	43	28	19	12	6	2	14.9
25	BH-6	286515	2749955	N 125	DS-2	2	-	-	-	100	87	64	45	33	23	14	6	2	-
26	BH-6	286515	2749955	N 125	DS-3	3	-	-	-	-	100	81	62	53	41	31	16	4	16.2
27	BH-6	286515	2749955	N 125	DS-4	45	-	-	-	100	94	73	55	44	35	28	15	1	-
28	BH-6	286515	2749955	N 125	DS-5	6	-	-	-	-	100	75	57	47	35	18	9	5	15.1
29	BH-7	286296	2750108	Between A-106 & A-107	DS-1	1	-	-	-	-	-	100	95	92	89	77	29	1	14
30	BH-7	286296	2750108	Between A-106 & A-107	DS-2	3	-	-	-	-	100	88	78	73	63	56	15	12	-
31	BH-7	286296	2750108	Between A-106 & A-107	DS-3	4	-	-	-	100	81	71	64	55	50	40	19	3	12.9
32	BH-7	286296	2750108	Between A-106 & A-107	DS-4	5	-	-	-	100	87	78	73	66	57	46	20	5	-
33	BH-7	286296	2750108	Between A-106 & A-107	DS-5	6	-	-	-	100	90	72	70	68	64	55	33	17	16.8
34	BH-8	285101	2750732	Between A-71 & A-73	DS-1	1	-	-	-	100	90	70	39	20	14	10	5	2	16.7
35	BH-8	285101	2750732	Between A-71 & A-73	DS-2	2	-	-	-	100	80	60	37	18	13	7	4	1	-
36	BH-8	285101	2750732	Between A-71 & A-73	DS-3	3	-	-	-	100	87	68	43	23	17	15	7	5	18.2
37	BH-8	285101	2750732	Between A-71 & A-73	DS-4	4	-	-	-	100	78	59	34	24	17	7	2	1	-
38	BH-8	285101	2750732	Between A-71 & A-73	DS-5	5	-	-	-	-	100	95	88	76	52	29	8	1	20.1
39	BH-9	287584	2749245	N 82 (KakaPir)	DS-1	1	-	-	-	-	100	98	94	87	72	41	8	2	16.1
40	BH-9	287584	2749245	N 82 (KakaPir)	DS-2	2	-	-	-	-	100	87	72	62	43	33	23	18	-
41	BH-9	287584	2749245	N 82 (KakaPir)	DS-3	3	-	-	-	-	100	78	59	49	44	41	31	27	14.8
42	BH-9	287584	2749245	N 82 (KakaPir)	DS-4	4	-	-	-	100	80	59	40	35	31	27	18	12	-
43	BH-9	287584	2749245	N 82 (KakaPir)	DS-5	5	-	-	100	81	65	46	38	32	27	20	13	3	19.2
44	BH-10	287579	2749264	N 82 (KakaPir)	DS-1	1	-	-	-	-	-	-	100	98	95	82	45	6	13.2
45	BH-10	287579	2749264	N 82 (KakaPir)	DS-2	2	-	-	-	-	-	-	100	97	91	75	48	4	-
46	BH-10	287579	2749264	N 82 (KakaPir)	DS-3	3	-	-	-	-	-	100	99	97	94	89	51	9	15.9
47	BH-10	287579	2749264	N 82 (KakaPir)	DS-4	4	-	-	-	-	100	87	78	68	58	50	45	37	17.2

Counting of Nests of Green Turtle in Sandspit /Hawksbay area during December, 2009 ()7/12/ 2009 to 23/12/2009)

Date	Hut No 1 _____ 800_____ Hut N 108								Total	Hut no 109 __400__ Hut No 119				Total	Hut No 120 ____ 300____ Hut No 128			Total	Grand Total
7/12/2009	3	4	4	1	3	3	6	3	**27**	-	3	1	1	**5**	1	1	-	**2**	**34**
8/12/2009	4	4	5	7	6	4	7	4	**41**	3	3	2	1	**9**	1	-	1	**2**	**52**
9/12/2009	3	7	5	6	4	3	5	4	**37**	3	4	4	3	**14**	2	4	-	**6**	**57**
10/12/2009	3	5	8	4	6	5	5	6	**42**	4	3	4	7	**18**	1	-	2	**3**	**63**
11/12/2009	1	7	3	3	2	2	2	6	**26**	3	3	1	1	**8**	2	3	1	**6**	**40**
12/12/2009	2	2	3	1	5	2	2	4	**21**	2	2	-	3	**7**	1	2	-	**3**	**31**
13-12- 09	1	4	1	3	3	3	2	3	**20**	-	1	1	3	**5**	1	2	1	**4**	**29**
14-12- 09	2	3	2	-	2	1	2	2	**14**	1	2	-	4	**7**	1	2	-	**3**	**24**
15 -12- 09	-	1	1	1	-	-	5	1	**9**	0	3	-	-	**3**	1	-	1	**2**	**14**
16 -12- 09	-	1	1	2	-	3	3	3	**13**	3	-	-	1	**4**	-	-	-	**-**	**17**
17 -12- 09	-	1	-	3	2	2	3	-	**11**	1	-	2	1	**4**	-	1	-	**1**	**16**
18 -12- 09	-	-	2	-	1	-	1	2	**6**	1	1	1	1	**4**	-	-	1	**1**	**11**
19 -12- 09	-	-	3	1	1	-	3	1	**10**	-	-	4	-	**4**	-	-	1	**1**	**15**
20 -12- 09	1	1	3	3	-	-	-	1	**9**	1	3	2	-	**6**	1	1	1	**3**	**18**
21 -12- 09	1	-	1	3	1	1	3	2	**12**	1	2	-	2	**5**	1	-	-	**1**	**18**
22 -12- 09	-	-	1	1	1	6	5	10	**24**	1	5	2	10	**18**	-	2	-	**2**	**44**
23 -12- 09	-	-	3	2	-	4	5	8	**22**	-	4	4	4	**12**	2	6	1	**9**	**43**

It has been found with the help of “Grain Analysis” that loosely bound fine sand horizon is preferred by the turtles as they quickly dig in the loose dry sand to build their nests and egg-chambers. As it is obvious from figure-10, high density turtles nests were found in the thick layers of sand.

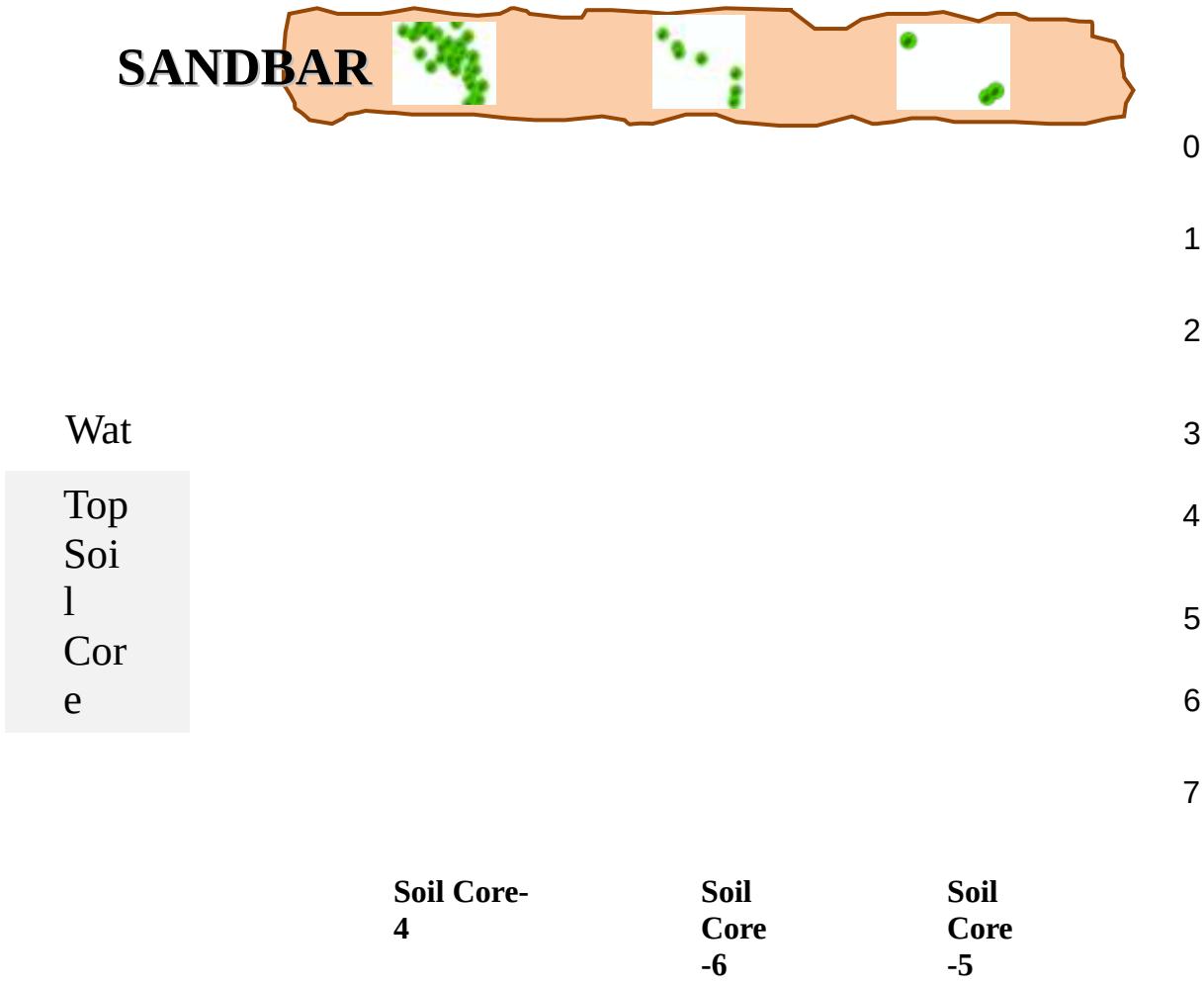


Figure 10

Soil Core

About 10 soil cores were collected from Sandspit (Kakapir to Sandspit) to see the composition of soil horizons detailed soil sampling/analysis report already submitted). These soils were analyzed in the “soil testing lab.” The soils with greater thickness of look fine sand having a very high density, whereas low density nests soils having a shallow thickness of loose sand (Figure-10). The composition of soil and groundwater depths played a significant role in determination of the appropriate “Sana bars”, which are the most precious resources of the context of turtle conservation.

Image Classification

Beside digitization, few thematic layers were extracted through classification techniques. A good example of utilizing satellite imagery to protect the sea turtles is the digital classification of QuickBird data to obtain information about nesting grounds. In addition, few features like mangrove vegetation, tidal backwater and dry sand bars were highly time consuming and expensive to digitize. It was therefore decided to extract these thematic layers through Supervised Image Cassification technique on recent raster imageries. Furthemore, this exercise also cross-verified the features which were digitized through on-screen digitization technique.

Comparing the classification results of the classified multidate satellite images for nesting conditions and beach nourishment simultaneously, it was very easy to evaluate the negative or positive impacts of the increased or decreased beach huts on sea turtle survival.

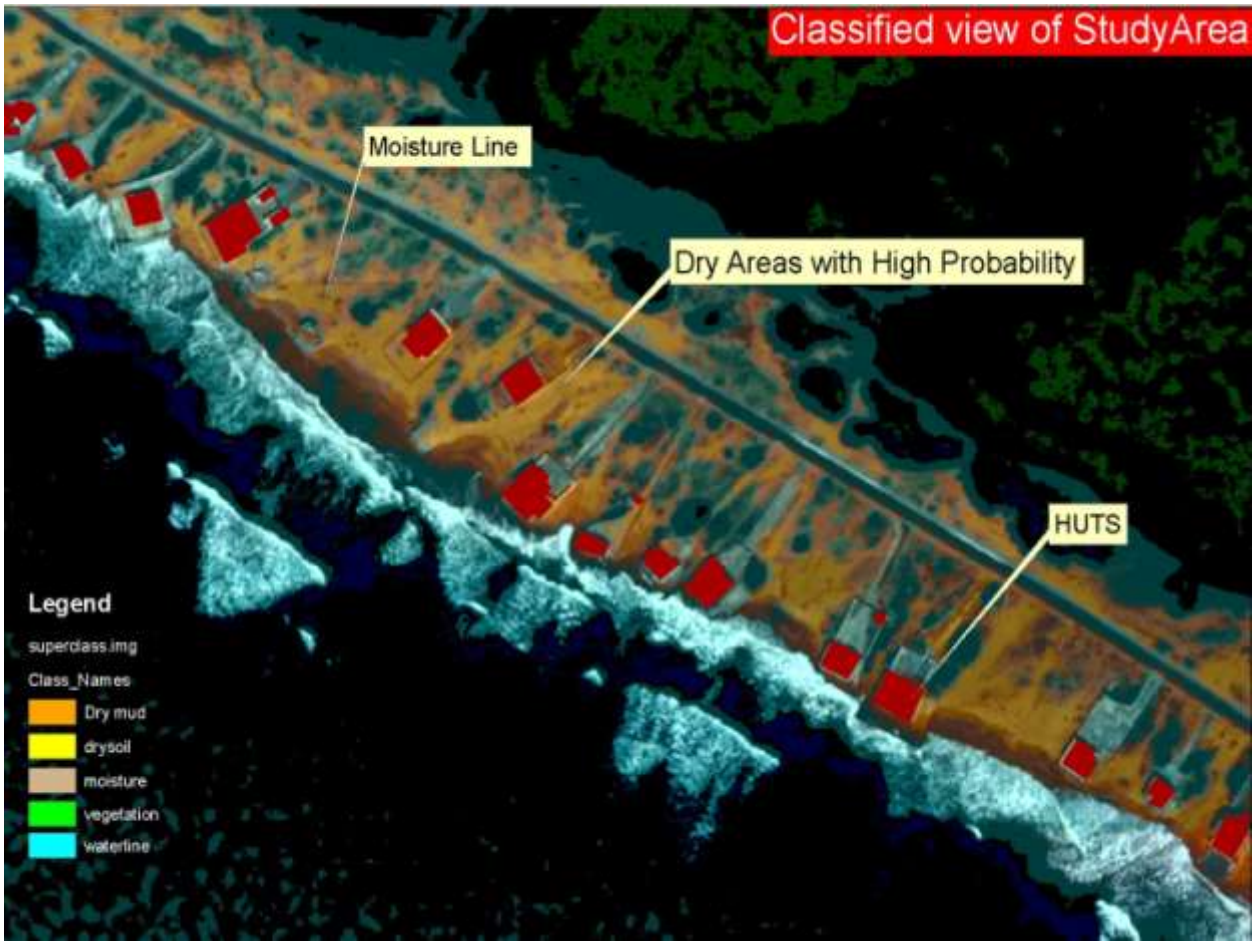


Figure 11

Field Survey

Field surveys were conducted mainly to analyze and verify to analyze and verifying following information:

GPS Survey

GPS survey was conducted to verify records of vectorization. With the ground data, especially coordinates of each hut boundary, construction debris, garbage site **(Table-3)**. GPS also used to mark the cores coordination's of piezometer and soil cores.

Ground Control Points through GPS

S. No.	Hut Add	Way Point	Y	X	Time	Elevation	Comments
1	N-120	wp008	2749866	286701	2:10 PM	10m	
2	N-122	wp009	2749913	286610	2:14 PM	8 m	
3	N-127	Wp0010	2749997	286355	2:18 PM	8m	
4	N-128	wp0011	2750079	286355	2:28 PM	8m	(Limits of Sandspit)
5	N-114	wp0012	2749796	286833	2:39PM	8m	Move Back
6	N-120	wp0012	2749796	286985	2:45 PM	-7	Opposite WWF
7	N-85- N86	wp0014	2749257	286985	3:28 PM	-4	Center Point
8	N-108	wp0015	2749758	286998	3:34 PM	-5	Hatching 2
9	N-80-81	wp0015a	2749318	287641	3:28 PM	-4	Last limit
10	N-87	wp0015b	2750505	285665	3:42 PM	12	
11	A-87	wp0015c	2750474	285633	3:45 PM	8	
12	A-71	wp 0016	2750803	285037	3:57 PM	18	Back Side
13	A-71	wp0017	2750793	285021	4:00 PM	16 m	

Table-3

Peizometer Survey

Peizometers were used to record groundwater depths at various both in low and high tides periods **(Table-2).** It was discovered that at high density turtle nesting points groundwater depths were found at greater depth (Figure-10).

Groyne Analysis

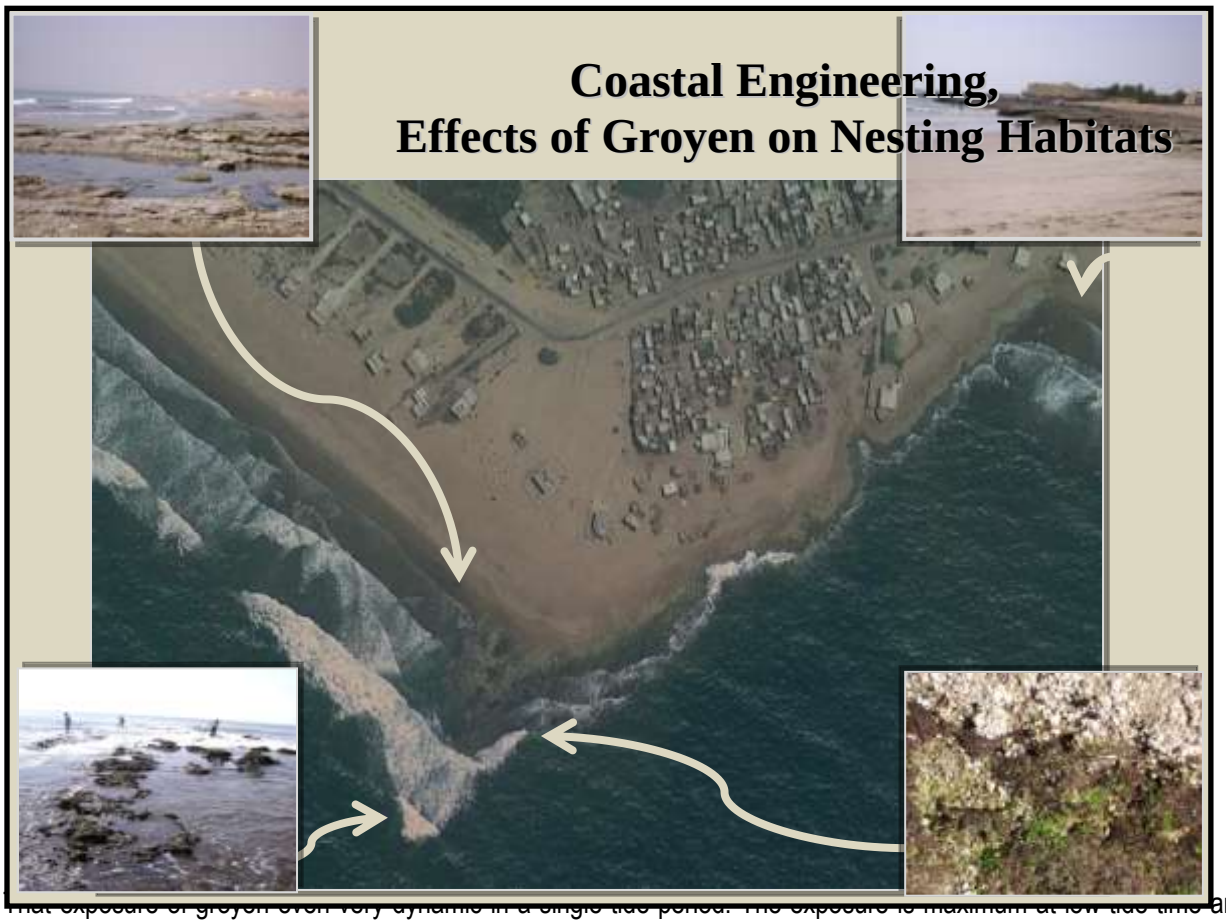
A *Groyne* is a protective structure of stone or concrete; extends from shore into the water to prevent a beach from washing away. This kind of structure is generally built perpendicular to the shoreline that traps the sediment that is being transported along the coastline. A *Groyne (Groin* in the United States) is a rigid hydraulic structure built from an ocean shore (in coastal engineering). In the ocean, groynes create beaches, or avoid having them washed away by long shore drift. Ocean groynes run generally perpendicular to the shore, extending from the upper foreshore or beach into the water. All of a groyne may be under water, in which case it is a **submerged groyne**. The areas between groups of groynes are **groyne fields.** A groyne's length and elevation, and the spacing between groynes is determined according to local wave energy and beach slope. Groynes that are too long or too high tend to accelerate down drift erosion because they trap too much sediment. Groynes that are too short, too low, or too permeable are ineffective because they trap too little sediment. Flanking may occur if a groyne does not extend far enough landward.

A groyne creates and maintains a wide area of beach or sediment on its up drift side, and reduces erosion on the other. It is a physical barrier to stop sediment transport in the direction of long shore transport (also called Long shore Drift). This causes a build-up, which is often accompanied by accelerated erosion of the down-drift beach, which receives little or no sand from long shore drift (this is known as terminal groyne syndrome, as it occurs after the **terminal groyne** in a group of groynes). Groynes do not add additional material to a beach, but merely retain some of the existing sediment on the up drift side of the groynes. If a groyne is correctly designed, then the amount of material it can hold will be limited, and excess sediment will be free to move on through the system. However, if a groyne is too large it may trap too much sediment, which can cause severe beach erosion on the down-drift side.

However, groynes could be a means of accretion along the coast if materials such as shell, sand and shingle are brought to the shore by currents or waves from deeper water and trapped between the groynes. If there are no (coarse) sediments moving along the coast, nothing is trapped by the groynes and their outstretched arms remain empty as sling mud is transported in suspension and no groyne of reasonable dimensions and construction could slow down their east to west travel and cause deposition to conjure stability of the substrate for mangroves to flourish.

Groyne Analysis at Kakapir

In the study area, there are about seven groynes naturally created as a result geomorphic process. Unfortunaly, most of these groynes are not supporting turtle nests becaue of the rock-outcrops and their angle with the coast. However, at Kakapir, highest concentration of turtles could be obvious (Figuer-12). This groyne is almost perpendicular to the coast and provide sand deposits on the winward side of the groyne. Nevertheless, with the help of image analysis, it has been found that there is a siginificant change in the size and shape of the groyne since 1955 (Figuer-13).



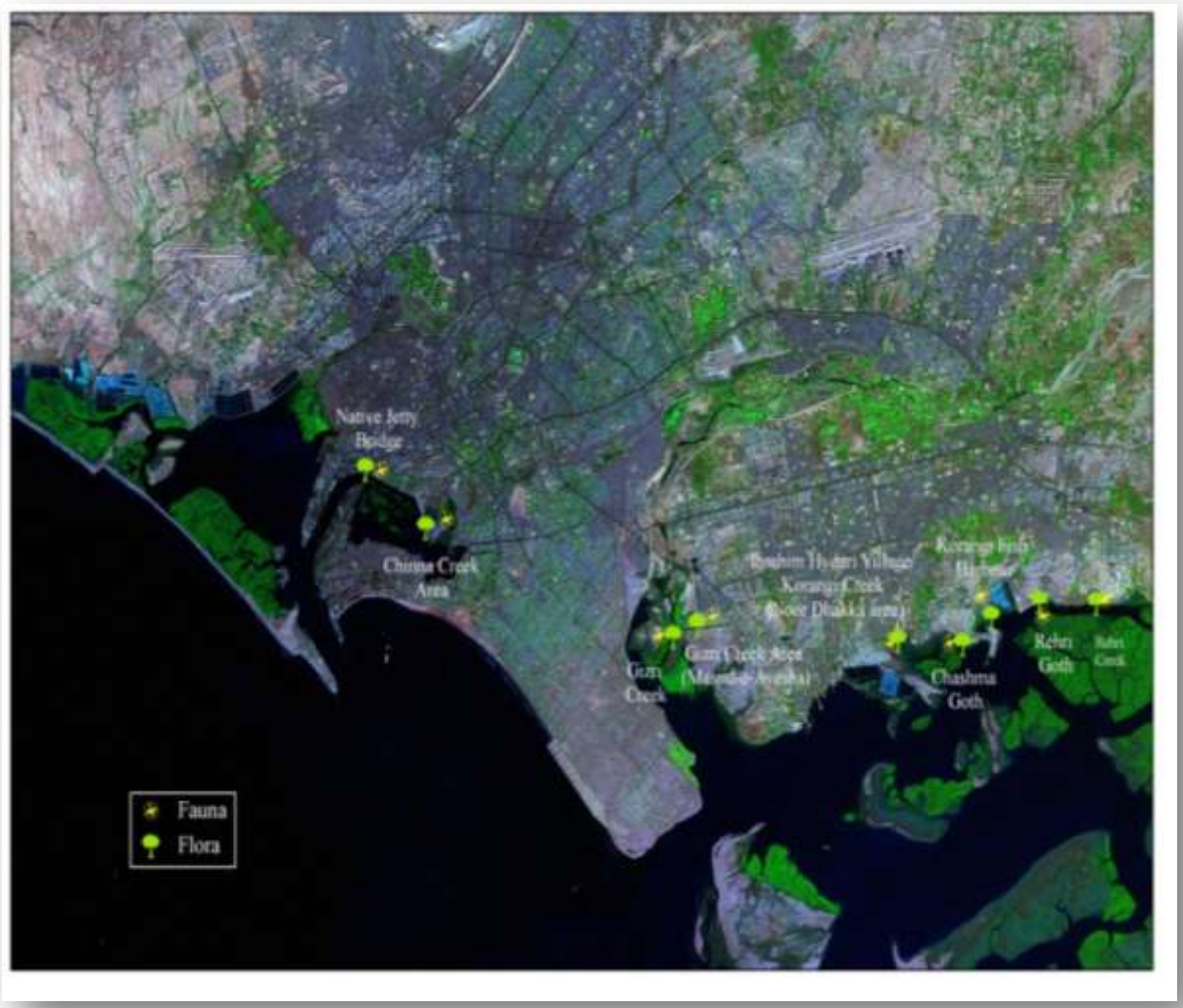
minimum at high tide time. As evident from (**Figure-13),** the groyne extent in 1992 is oriented westward and shorter in latitude extent.

Figure-13

The extent of groyne in 2009 has been submerged in west and eroded a little whereas it has been exposed in the south (keeping the fact of low tide in February). Hence, it is also showing the almost the same extent in September 2009. This means sea receding at this point. However, further studies are required to prove this important finding.

B. The coastal eco-systems of Karachi

Acquisition of satellite imagery and GIS mapping and incorporation of generated data - primary and secondary field data on coastal eco-system's flora and fauna has been done (detailed report already submitted). In this part of the project area mostly only secondary data was utilized and limited primary data was generated.



3. Concluding Remarks

The critical finding of the project is the revelation of the turtle nesting suitability of the Sand Bar Platform. Data generated during the project clearly indicates that the Sand Bar Platform because of its specific physical and natural characteristics provides the highest level of suitability for turtle nesting. Some key characteristics such as

soil composition, ground water level, slope and gradient and high water mark have been studied and linkages established with turtle nesting. Possible linkages with changing coastal and wave dynamics has also been considered and it is recommended that detailed field studies and analysis that are sustained over time are initiated to study this phenomenon with special focus on existing coastal features such as the Kakapir Groyne. Studies have been conducted in the past to determine the turtle nesting patterns and change in densities over time. However, this project for the first time tackles the extremely critical linkages that exist between the turtle habitat in terms of the physical, ecological and environmental features that determine its landscape and the changing trends and patterns in turtle nesting. The survival of the specie is linked to the protection and sustainable development of its habitat – that would require continued and detailed monitoring of the physical and natural landscape and human influences and appropriate planning to facilitate greater suitability of the habitat to, as is the case in our project area – nesting of green sea turtles.

With regards the documentation of the coastal eco-system other than the turtle habitat, this product – the GIS Map should help through digitized documentation in deterring future non-environment friendly activities such as un-planned land reclamation, land us change, waste dumping, deforestation etc. from happening in some critically sensitive and vulnerable ecosystems identified. The pioneering GIS map that has been prepared during the course of this project, serves as a useful information documentation, analytical and planning tool for policy and decision makers, planners and conservationists alike.

PROJECT PROGRESS DETAILS

In the **first quarter**, the following activities were identified to be undertaken in the *Project Work Plan:*

- Meetings/consultations with stakeholders (collection of secondary data)
- Collection/generation of field data (partial) including procurement of satellite imagery

Several fruitful meetings and consultations with the relevant government/civil society stakeholders were been initiated to introduce and discuss the project and seek cooperation and input. In addition, important secondary field data was generated on the environmental, social and physical attributes of the project area.

A detailed *Work Plan and Methodology* for field data generation was prepared, the outputs of which were identified as follows:

- Procurements of satellite Imageries
- Field monitoring and observation of turtle nesting sites with reference to tidal conditions through GPS measurements to be interactive on the GIS. The following physical and environmental parameters were to be marked for further assessment:
    - Locations of the dug sites / nesting chambers (with specific ecological features)
    - Soil characteristics
    - Beach topographic contours of the study area
    - Demarcation of High / Low tidal water lines
    - Water level in the Piezometers
    -

In the **second quarter**, the following activities were undertaken as per the requirements of the *Project Work Plan:*

- Technical interface, guidance, environmental supervision and conduct of the field/GIS work for determining high bio-diversity zones in project area and organization of the field data (determining of bio-diversity criteria/planning and conservation guidelines) based on the following work that has been carried out:

    - Static GPS Observation carried out for geo-referencing of satellite imagery
    - Survey to collect spot elevation data to demark high tidal zone
    - Survey data used to delineate the high and low water line
- Satellite imagery enhancement and geo-referencing

- Digitized prominent features outlines from satellite imagery

- Technical interface, supervision and conduct of the soil sampling work and linking of soil grain size/chemical analysis with nesting patterns and related nesting site data. Details of field work as follows:

- *Sand profiling of 10 No. turtle nesting pits in the project area (Soil Core – 6 ft from Ground Level) for determining:*

  - *Moisture content*
  - *Soil classification & Grain size*
  - *Organic/inorganic content*

- *Water level determination using piezometer at 6 No. monitoring points in the project area*

- Initiation of work of linking External Data to GIS for analysis and preparation of **Final Report** that would include:

  - Background information – Documentation & Tabulation
  - Organization of all the ecological/GIS field data – primary and secondary
  - Determination of criteria and bio-diversity grading of project area eco-systems

  - Use of GIS/field data for analysis of impacts of physical/ecological characteristics and attributes of the Sandspit/Hawksbay ecosystem on the turtle nesting process
  - Assessment of possible impact of climate change (temperature and sea level rise) on the turtle nesting habitat/process

- Collection of primary/secondary data of birds, mammals, reptiles, invertebrates, plant species, both migratory and resident found in the following project areas/ecological zones:

  - Korangi Creek
  - Rehri Creek
  - Gizri Creek
  - Clifton Beach
  - Mai Kolachi/Boating Basin
  - Chinna Creek
  - Sandspit/Hawksbay
  - Cape Monze

- Topographic Survey of the prime turtle nesting area using GPS to delineate the contours (about 6 km stretch)

PROJECT FIELD WORK