BEFORE THE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONE, CHENNAI
(Under Section 18 (1)) read with Section 14 of National Green Tribunal Act, 2010)
Application No.153/2016 (SZ)

In the matter of

1. PARYAVARANA PARIRAKSHANA SANGHAM
   Through its President Mr.Y.Krishnamurthy,
   Sompeta, Srikakulam District,
   Andhra Pradesh.
2. E.A.S.Sarma
   14-40-4/1, Gokhale Road,
   Maharanipeta,
   Visakhapatnam – 530002.

... Applicants

Versus

1. UNION OF INDIA
   Through Secretary
   Ministry of Environment & Forest
   ParyavaranBhawan, CGO Complex,
   Lodhi Road,
   New Delhi – 110 003.

2. CENTRAL WETLANDS REGULATORY AUTHORITY,
   Through its Chairman
   Ministry of Environment and Forests
   And Climate Change,
   Indira ParayavaranBhawan,
   Jorbagh Road, Aliguni,
   New Delhi.

3. STATE OF ANDHRA PRADESH,
   Through its Chief Secretary,
   Government of Andhra Pradesh,
   Secretariat, Hyderabad – 500 022.

4. M/s NCC Ltd.
   (formerly known asNagarjuna Construction Company Ltd).
   Nagarjuna Hills, Punjagutta,
   Hyderabad, Andhra Pradesh.

   (Now at NCC House,
   Madhapur,
   Hyderabad)

   Also at:-

   M/S NAGARJUNA CONSTRUCTION COMPANY LTD.
   Project office at: - Sompeta Town,
   Sompeta Mandal, District, Srikakulam,
   Andhra Pradesh
   Rep by its G.M-Admin & Co-ordination,
   Sri.Badari Narayana N.

... Respondents

TYPED SET OF DOCUMENTS

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2		**A study on Bio-diversity and water quality in regard to these lands and downstream drainage up to sea by Prof.Seshagiri Rao (University of Hyderabad) and Prof. V S Raju (Kakatiya University Warangal)**	32
3	02.03.2009	**Study by Survey of India on the Topo survey of the entire project site and identification of the physiographic units which shows that the site is waste land with grass.**	51
4	16.02.2009	**National Hydrographic Map published by Chief Hydrographer to the Govt. of India showing that the project site is not a mudflat, not a marshy land and not connected to sea.**	53
5		**Land use/ Land cover obtained from remote sensing studies carried out by Andhra Pradesh State Remote Sensing Applications Centre, Hyderabad**	55
6	11.02.2009	**Assessment of soil type and quality of water from the Regional Agriculture Research Station (Acharya N G Ranga Agricultural university, Bapatla) Andhra Pradesh**	74
7	10.02.2009	**Studies on Regional Geology of site environs by Prof M Jagannadha Rao, Principal Investigator, Department of Geology, Andhra University, Visakhapatnam**	104
8	05.02.2009	**Certification by Dist. Collector, Srikakulam, Andhra Pradesh about the classification of land as per revenue records as Poramboaku (waste) land.**	156

9	24.08.2009	**Certification from DFO, Srikakulam District, Andhra Pradesh – The animal species reported in 10 Km radius from the plant site are common in nature to the region and there are no endangered, protected, threatened animal and plant species in the study area.**	158
10	03.11.2009	**Studies of WAPCOS (public sector undertaking under the Ministry of Jal Shakti of the Government of India) on area drainage system in consultation with the Department of Irrigation, Govt of Andhra Pradesh.**	159
11		**A detailed report submitted by the Collector, Srikakulam submitted to the Human Rights Commission**	164
12	16.08.2011	**Counter Affidavit filed by the District Collector in W.P. No. 174482011**	171

The above documents are certified to be true copy of the originals

Dated at Chennai on this the 15th day of April 2021.

COUNSEL FOR RESPONDENT -4

DEMARCATION OF HTL, LTL AND CRZ BOUNDARIES

BY

NATIONAL INSTITUTE OF OCEANOGRAPHY, GOA

2

DISTRIBUTION RESTRICTED

NIO/SP-03/2008

DEMARCATION OF HTL , LTL AND CRZ BOUNDARIES NEAR SOMPETA IN SRIKAKULAM DISTRICT, ANDHRA PRADESH.

SPONSORED BY:

NCC (NAGARJUNA CONSTRUCTION COMPANY) INFRASTRUCTURE HOLDINGS LIMITED, HYDERABAD.

JANUARY 2009

राष्ट्रीय समुद्र विज्ञान संस्थान
NATIONAL INSTITUTE OF OCEANOGRAPHY
Dona Paula, Goa - 403 004

DELINEATION OF HTL, LTL AND CRZ BOUNDARIES AT GOLLAGANDI VILLAGE NEAR SOMPETA, SRIKAKULAM Dt., A.P

SPONSORED BY
NCC (NAGARJUNA CONSTRUCTION COMPANY)
INFRASTRUCTURE HOLDINGS LIMITED,
HYDERABAD.

Scientist-In-Charge: ***Dr. V.S.N. Murty*** Project Leader: ***Dr. B. Prabhakara Rao***

NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific & Industrial Research)
Regional Centre, Visakhapatnam – 530 017
INDIA

JANUARY 2009

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PROLOGUE

Nagarjuna Construction Company is developing a 4 x660 MW Thermal Power Project at Sompeta, Dist. Srikkulam, Andhra Pradesh. As an input to the EIA/EMP study NCC approached National Institute of Oceanography, Goa to demarcate the CRZ area with HTL and LTL lines from the coast and to if there exists any ecologically sensitive the site in the area.

HTL and CRZ mapping revealed the following

- The surroundings of this land are undeveloped rural area. The proposed land for development meets the CRZ-III criteria.
- On either side of proposed plant area, habitation with vegetation was noticed.
- The water and soil at the project site also proves to be fresh water only. The region inland of the project area is waste and barren vacant land and rain fed single crop agriculture lands. The soil is silt in nature and is not marshy.
- The project site is away from the marine environment and the main plant activities are far away from the CRZ area.
- The proposed pipeline corridor area is sandy in nature and barren land with Casuarinas.
- Beyond the HTL, 10 to 12m height of sand dunes with sparse casuarinas trees exists in the northern side and all other type of trees in the southern side of the study area were noticed. The sandy area around 200 m wide is spreading all along the coastal front. The proposed pipe line has to cross these sand dunes.
- This coastal region comprises of fairly wide beaches with well defined foreshore and elevated backshore.

- The buried pipeline route for intake of the sea water and discharge of the treated waste water, Jetty and coal conveying system cross sand deposition area, 200m, 500m set back lines of the open coast from HTL and the inter tidal zone.
- Buried pipelines, Jetty and transportation of raw materials fall in CRZ-I (LTL to HTL), which is a permitted acitivity between LTL and HTL for taking of cooling water and discharge of treated water.
- The main land use of the area, where the power plants are proposed to be set up comprises of either barren or waste land, where as the main land use of the suggested pipe line routes consists of grass vegetation or barren lands.
- The development area does not fall or contain in its vicinity, any environmentally sensitive and important ecosystem.

PREFACE

M/s. Nagarjuna Construction Company (NCC) Infrastructure Holdings Limited has proposed to establish 4X660 MW Coal based Thermal Power Plant near Gollagandi village, Sompeta Mandal, Srikakulam District, Andhra Pradesh. For this thermal plant, it is proposed to locate intake point and outfall points to draw the sea water and discharge the treated waste water into the sea through buried pipelines and to construct a jetty for imported coal handling, coal conveying system from the jetty to the plant. To set up the power plant, jetty with coal conveying system and to lay the buried pipe lines for treated wastewater conveyance, CRZ surveys are required to be carried out to obtain necessary permission from Ministry of Environment and Forests (MoEF) on CRZ regulations. In this connection, NCC Infrastructure Holdings Limited, Hyderabad had approached National Institute of Oceanography, Regional Centre, Visakhapatnam, one of the authorized agencies by **MoEF** for carrying out the CRZ demarcation, to take up the CRZ surveys along coastal front of the proposed power plant area vide their letter dated 18-08-2008.

Regional Centre of National Institute of Oceanography, Visakhapatnam has carried out the required surveys and field measurements for the demarcation of CRZ from 10th to 11th September 2008. The details of these investigations and the CRZ maps are presented in this report.

Date: 3-2-09

B Prabhakara Rao

(Dr. B. Prabhakara Rao)
Principal Investigator

LIST OF PARTICIPANTS

Dr. V.S.N. Murty

Dr. B. Prabhakara Rao

Shri. A.S. Subrahmanyam

Shri. A. Suribabu

Shri. D. Rama Rao

Mr. G. Sridhar

Miss K. Sai Sandhya

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Plates 5 to 7	Area showing the waste land and agriculture lands.
Plates 8 to 10	Area showing the existing thunga grass and waste lands.

1.0 INTRODUCTION

1.1 Project

The recent enactment of legislation like Coastal Zone Regulation Act is indicative of both National and State policies, concern for the effect of regulating the development in environmentally sensitive coastal zones. This legislative promulgation has been mainly intended for regulating various uses of terrestrial and aquatic resources in the coastal areas restricting to a distance of 500 m from HTL in the open coast and 100 m in cases of estuaries and creeks. For strict compliance of the Coastal Regulation Zone (CRZ) act, these areas are expected to remain qualitatively unchanged in respect of their fauna and flora.

Utilizing the opportunities offered by the current policies and regulations, NCC Infrastructure Holdings Limited has proposed to establish 4X660 MW Coal based power project near Gollagandi village. For this thermal plant, it is proposed to locate intake and outfall point to draw the sea water and discharge the treated waste water into the sea through buried pipelines, jetty and coal conveying system from jetty to the plant. To set up the power plant and to lay the buried pipe lines for treated waste water conveyance, jetty and coal conveyance system from jetty to plant, CRZ surveys are required to be carried out to obtain necessary permission from Ministry of Environment and Forests (MoEF) on CRZ regulations. In this connection, NCC Infrastructure Holdings Limited, Hyderabad had approached National Institute of Oceanography, Regional Centre, Visakhapatnam, one of the authorized agencies by **MoEF** for carrying out the CRZ demarcation, to take up the CRZ surveys along coastal front of the proposed power plant area.

Regional Centre of National Institute of Oceanography, Visakhapatnam has carried out the required surveys and field measurements for the demarcation of CRZ from 10th to 11th September 2008. The details of these investigations and the CRZ maps are presented in this report.

Keeping in view the requirement of Coastal Regulation Zone legislation, National Institute of Oceanography has undertaken the project with the following scope of work.

- To demarcate HTL and LTL along the open coast along the open coast near Gollagandi village near thermal power plant area as per the prescribed policy, practice and procedure of MoEF.
- To delineate the set back lines of 500 m and 200 m from the HTL boundary.
- To conclude if the proposed site for the power project is out of CRZ area and is free from any eco-sensitive area

Based on the above objectives, studies have been made about land use pattern, morphological features and environmentally sensitive areas to predict the response of the proposed development within CRZ. The results are presented in the form of this report and the physical demarcation of HTL and restricted development boundaries are presented in the form of a CRZ map annexed to this report (Figs. 2 and 3).

1.2 Coastal Geology

Andhra Pradesh has a long coast line forming about 40% of the East cost of India. The coastal tract of the Srikakulam, Vizianagaram and Visakhapatnam districts is narrow with interspersed estuarine rivers such as Vamsadhara, Nagavali, Champavati, Gosthani, Sarada, Tandava, Varaha etc, with their narrow flood plains. The coast in this part is highly rocky in nature with scraps and rocky promontories of khondalite exposed right on the beach. A number of wave erosionl features like rock-cut terraces, benches, cliffs etc are present. This stretch may be termed as an erosionl coast.

The structural landforms, mainly hogbacks of khondalite, denudational landforms of khondalite, pediments and pediplain composed by yellowish brown silts, rock fragments and kankar are common features. The active channels invariably contain coarse-medium sand. Brown and black salty clay are to be met within flood plains. Channel bars are seen in the rivers. Gray to White sand with black sand concentration berm crests compose the active beach ridges with 2 to 3 rows of dunes as part of the coastal marine landforms. The black sands consist of minerals like Ilmenite, Garnet, Magnenite, Monazite, Rutile, Zircon etc.

In the northern segment for instance, the heavy mineral suite consists of Siullimanite, monazite, zircon, Ilmenite, rulite etc are characteristic of the khondalite provenance.

Several patches of black sands with Ilmenite, magnetite, garnet, tourmaline, rulite, zircon and Monazite as heavy mineral concentrations occur along the beach and in river beds in this segment.

1.3 Tidal ranges in the study area

The spring and neap tidal ranges in this region are about 1.43 m and 0.54 m respectively. The tide values at Visakhapatnam were referred from Tide Table 2008 and are given below.

Tide Levels at Visakhapatnam Height (m) above Chart Datum (CD)	
Mean Lower Water Springs	0.09
Mean Lower Water Neaps	0.54
Mean Sea Level	0.84
Mean High Water Neaps	1.08
Mean High Water Springs	1.52

1.4 Objective

The objective of the study is 1) to delineate the HTL, LTL and Coastal Regulation Zone boundaries in nearest cadastral scale delineated on an appropriate scale map inclusive of superposition of different zones of Coastal Regulation Zone as notified by the Ministry of Environment and Forest (MoEF), Government of India, along the open coast area near proposed power plant area. 2) to report on the eco-sensitive areas like mangroves , wetlands and other eco sensitive physiographic features in the site.

1.5 Approach

Based on the above objectives, studies have been made about land use pattern, morphological features and environmentally sensitive areas to predict the response of the proposed development with in CRZ. The key elements of general approach are as follows:

1. To delineate the HTL, LTL and CRZ boundaries along open coast near Thermal power plant area.
2. To conduct the primary field inventory on large scale base map.
3. To gather information on status of eco-system (such as mangroves, tidal flats, mud flats , saltpans etc) prevalent in the project area.
4. To identify the project boundary on the CRZ map ascertaining the compliance to CRZ regulation stipulated by MoEF
5. To compile and conclude genesis of the project area
6. To compile the CRZ map delineating the HTL, LTL and the CRZ.
7. To interpret and demarcate CRZ setbacks using Auto CAD which can be used by the proponent for earmarking the project boundary including the main plant area from CRZ.
8. To identify and categorize the project area into CRZ and non CRZ area and measure the project area which is coming under the different CRZ areas.

1.6 Data Source

The following data sources were used for compilation of the final map and preparation of the CRZ report.

1. Hydrographic chart of NHO (356) and land use map of the study area.
2. Route maps and charts of the project area provided by the NCC Infrastructure Holding Private Limited, Hyderabad
3. Field mapping.

2.0 MATERIALS AND METHODS

2.1 Equipment and methods used for surveys

For the purpose of meeting the requirement of the CRZ notification, the high tide line means the line on the land up to which the highest water line reaches during the spring tide. Here the word "highest water line reaches during the spring tide" refers to the mean high water spring (19 years average of spring water) that is the regular water level fluctuations caused by changes in relative position of Sun, Moon and the Earth.

Coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action (on land ward side) are included in Coastal Regulation Zone (CRZ). Highest range of spring tide and its horizontal run up on the land was identified by way of morphological features, permanent vegetation line and flotsam along the open sea as per the existing guideline of MOEF. Delineation of HTL was carried out by using the Differential Global Positioning System techniques (Hemisphere, Australia) and the data were collected by following the established principles in survey of this nature. For demarcation of Low Tide Line (LTL), surf zone bathymetry was carried out along the study area. From the surf zone bathymetry, LTL position, was demarcated corresponding to Chart datum (0.00 m) which lies (-) 0.84 m below the MSL for the project area was identified and recorded.

The Everest Datum and Transverse Mercator Projection have been used for presenting the HTL, LTL on the map and also for preparing the CRZ classification map. Finally the positions of HTL, LTL and CRZ boundary lines were marked on the local CZM maps in 1: 25000 & 1: 8000 scales.

2.2 Differential Global Positioning System (DGPS)

The horizontal positioning of the mobile unit was carried out using Hemisphere R100 Series DGPS Beacon Receiver. It combines high-performance GPS reception with a DGPS-capable receiver in a lightweight, durable housing and comes with a separate antenna. It gives the horizontal position to an accuracy of close to 1 m. The GPS receiver also contains technology enabling *WAAS/EGNOS*, *OmniSTAR* or *Beacon* real time differential capabilities. When used with a Real- time Kinematic (RTK) Base station, the GPS receiver provides RTK positioning for high-accuracy, centimeter-level applications. A standard GPS receiver provides the following features: •10 Hz (10 positions per second) output rate •12 GPS (C/A-code L1, C/A code L2 (for the OmniSTAR XP/HP and RTK models)) tracking channels, code carrier channels •Sub meter differential accuracy (RMS), assuming at least five satellites and a PDOP (Position Dilution of Precision) of less than four (when used with Satellite Based Augmentation Systems (SBAS) correction).

The system configuration is enabled with:

- LED display and keypad
- Outputs a 1 PPS (pulse per second) strobe signal on both ports. This signal enables an external instrument to synchronize its internal time with a time derived from the very accurate GPS system time.
- SBAS such as WAAS (Wide Area Augmentation System) differential correction 1
- Beacon differential correction
- Omni STAR VBS capability

- Omni STAR XP/HP capability in the XP/HP and RTK models (also available as an upgrade)
- RTK positioning capability, In the RTK model only (also available as an upgrade)
- EVEREST ™ multipath rejection technology
- Two connectors that support both CAN 2.0B and RS-232:
- –CAN: J1939 and NMEA 2000 messages
- –RS-232:
- NMEA-0183 output: GGA, GLL, GRS, GST, GSA, GSV, MSS, RMC, VTG, ZDA (the default NMEA messages are GGA, GSA, VTG, and RMC).

3.0 RESULTS

3.1 CRZ Components

MoEF has declared the stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 m, in case of the open sea and minimum 100 m in the estuaries, rivers, creeks and back waters from High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the High Tide Line as Coastal Regulation Zone, and imposes with effect from the date of the notification, the restrictions on setting up and expansion of industries, operations or processes etc; in the said Coastal Regulation Zone (CRZ). A key component of the coastal regulation zone are the setback lines measured from the high tide line through which coastal development is regulated in a protected zone contiguous to HTL. These setback lines are with reference to the HTL and act as buffer zones between the ocean and the upland property. Thus precision is required in delineating the High Tide Line which forms the base to define the setback.

3.2 Survey Details

The HTL and LTL were demarcated by physical survey in the study area as per the MoEF guidelines. The horizontal position of HTL, associated with wave run up at preceding high tides and forming geomorphic features and the features such as boundary of perennial natural terrestrial vegetation, flotsam, and drift wood have been considered. The identification of these markings enabled a reasonably accurate assessment of High Tide Line. On demarcation of High Tide Line, the plan annexed to this report was prepared in the scale of 1: 25000 and 1: 8000. For demarcation of Low Tide line, the surf zone bathymetry with reference to the Chart Datum was carried out at fixed places along study area. Physical demarcation of HTL, LTL and the delineation of CRZ boundaries relevant to the project site were carried out.

3.3 Presentation of maps

The observations in respect of HTL, LTL and other setback lines are presented in maps in the scale of 1: 25000 and 1:8000 (Figs. 2 and 3). The legend for different demarcations like HTL, LTL, and Thermal Power Plant facilities are also given in the CRZ map. Along the open coast, the set back lines of 200 m and 500 m from the HTL are drawn in the map as per CZMP of Andhra Pradesh.

3.4 Salient observations from the CRZ map

Physical demarcation of HTL, LTL and the delineation of CRZ boundaries relevant to the project site was carried out (Fig.1). Along the whole area beyond the HTL towards landward side, wide patches of sand deposition with casuarinas trees and wide vegetation (Plates 1 to 4) are noticed all along the coast in the study area. Beyond this sandy area, the area comprises of manmade vegetation, waste land, and agricultural lands (Plates 5 to 7). The proposed power plant area exists on waste land with Thunga grass and barren vacant lands (Plates 8 to 10). The vegetation in the proposed project land is of fresh water origin. Part of the area in the proposed power plant is low lying with the growth of Thunga grass. This area is completely devoid of any indications related to marine environment, but experiences a stabilized fresh water environment as it has no connection from the sea as observed from the "Biodiversity Assessment studies" (November 2008) . Approved CZMP of Government of Andhra Pradesh was referred for the preparation of this report.

4.0 SUMMARY AND CONCLUSIONS

Based on the précised policy, practice and procedure of MoEF, the following conclusions have been drawn.

- HTL and CRZ mapping was carried out for the proposed Thermal power plant near Gollagandi during the period 10th and 11th September 2008.
- The position of HTL, LTL and CRZ boundaries are demarcated on 1:25000 and 1:8000 scale maps.
- The whole stretch of the relevant High Tide Line along the coast is demarcated by taking into consideration the geomorphic signatures that were discernible in the field.
- The surroundings of this land are undeveloped rural area. The proposed land for development meets the CRZ – III criteria.
- On either side of proposed plant area, habitation with vegetation was noticed.
- As per the report of Biodiversity Assessment of Sompeta Bella and Its environs by Dr. K. Seshagiri Rao, Department of Life sciences, University of Hyderabad, it is noticed that the project site collects slope wash from upper regions of the drainage basin and also receives irrigation waste waters from paddy fields and drains out to the beela at Manikyapuram. From there, it drains into sea through other channels. The water and soil at the project site also proves to be fresh water only. The region inland of the project area is waste and barren vacant land and rain fed single crop agriculture lands. The soil is silt in nature and is not marshy.
- The project site is away from the marine environment and the main plant activities are far away from the CRZ area.
- The proposed pipeline corridor area is sandy in nature and barren land with Casuarinas.

- Beyond the HTL, 10 to 12 m height of sand dunes with sparse casuarinas trees exists in the northern side and all other type of trees in the southern side of the study area were noticed. The sandy area around 200 m wide is spreading all along the coastal front. The proposed pipe line has to cross these sand dunes.
- This coastal region comprises of fairly wide beaches with well defined foreshore and elevated backshore.
- The buried pipeline route for intake of the sea water and discharge of the treated waste water, Jetty and coal conveying system cross sand deposition area, 200 m, 500 m set back lines of the open coast from HTL and the inter tidal zone.
- Buried pipelines, Jetty and transportation of raw materials fall in CRZ –I (LTL to HTL), which is a permitted activity between LTL and HTL for taking of cooling water and discharge of treated water.
- The main land use of the area, where the power plants are proposed to be set up comprises of either barren or waste land, where as the main land use of the suggested pipe line routes consists of grass vegetation and barren lands.
- The development area does not fall or contain in its vicinity, any environmentally sensitive and important ecosystem.
- As per the Coastal Regulation Notification, 1991 Consolidated version Annexure 2 (incorporating amendments up to 24th July 2003, the following activities are permissible activities for laying of buried pipe lines of Thermal power plants:

(a) any construction activity between the Low Tide Line and High Tide Line for carrying treated effluents and waste water discharges into the sea, facilities for carrying sea water for cooling purposes, oil, gas and similar pipelines and facilities essential for activities permitted under this Notification.

(b) Clearance shall be given for any activity within the Coastal Regulation Zone only if it requires water front and foreshore facilities.

(c) Facilities for power by non conventional energy sources, Thermal power plants and weather radars.

(d) Thermal power plants (only foreshore facilities for transport of raw materials facilities for in-take of cooling water and outfall for discharge of treated waste water / cooling water).

(e) Extraction of sand, leveling or digging of sandy stretches, except for the structural foundation will not be permitted within 500m of the HTL

(f) No new construction shall be permitted in CRZ I except Pipelines, conveying systems including transmission lines

ACKNOWLEDGEMENTS

We express our grateful thanks to the Director, NIO, and Goa for his permission to take up this work and to Shri. K. Mohana Rao for reviewing the report.

Fig.1: Location Map

PLATE 1

PLATE 2

PLATE 3

PLATE 4

PLATE 5

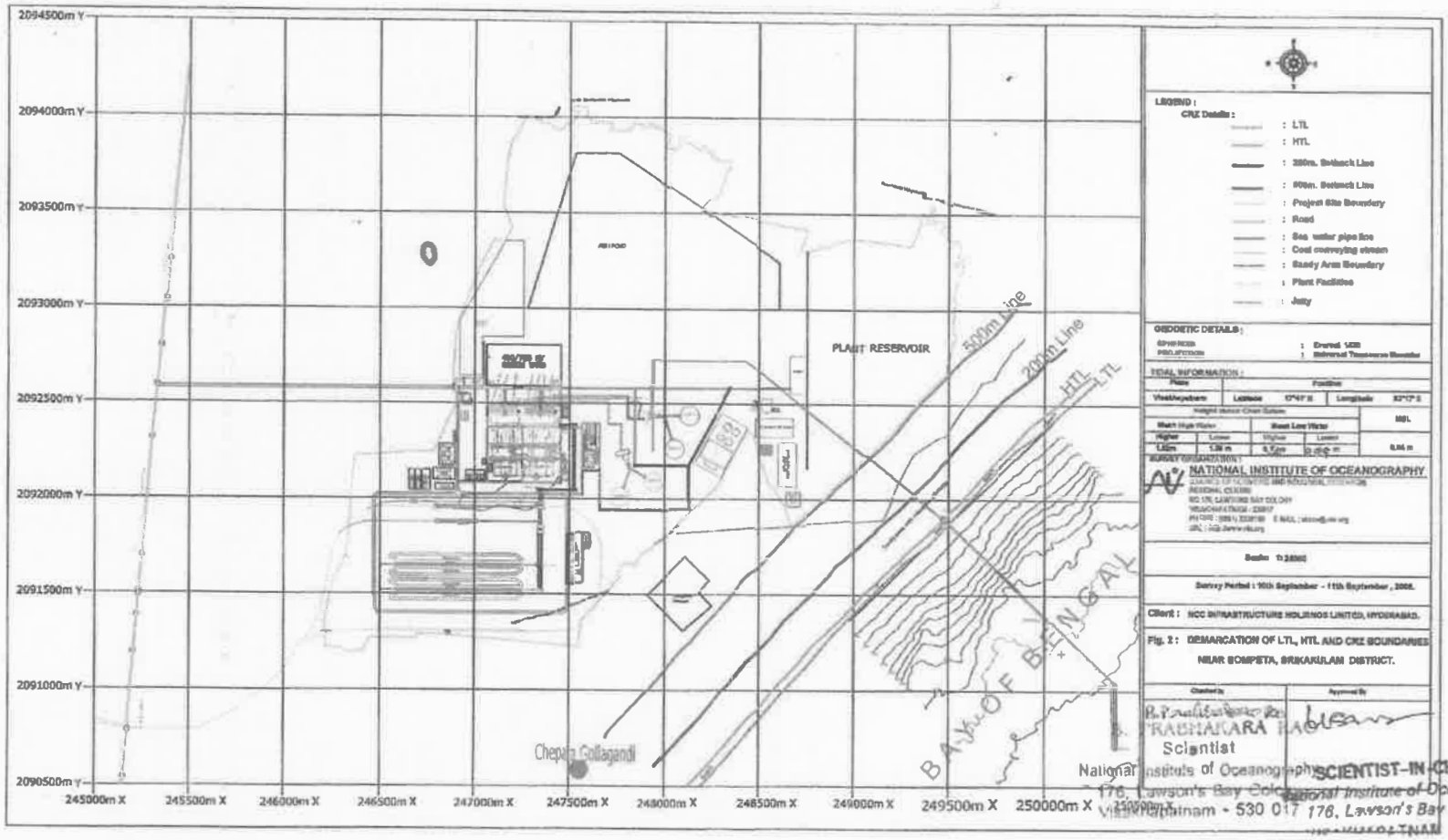
PLATE 6

PLATE 7

PLATE 8

PLATE 9

PLATE 10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2094000m Y
2093500m Y
2093000m Y
2092500m Y
2092000m Y
2091500m Y
2091000m Y
2090500m Y
245000m X
245500m X
246000m X
246500m X
247000m X
247500m X
248000m X
248500m X
249000m X
249500m X
250000m X
PLANT RESERVOIR
500m Line
200m Line
HTL
LTL
BAY OF BENGAL
Chepala Collagandi
LEGEND :
CRZ Details :
: LTL
: HTL
: 200m. Setback Line
: 500m. Setback Line
: Project Site Boundary
: Road
: Sea water pipe line
: Coal conveying stream
: Sandy Arm Boundary
: Plant Facilities
: Jetty
GEODETIC DETAILS :
: Everest 1830
: Universal Transverse Mercator
TIDAL INFORMATION :
Place
Position
Visakhapatnam
Latitude 17°41' N
Longitude 83°17' E
MSL
Mean High Water
Mean Low Water
Higher
Lower
Higher
Lower
1.39 m
0.44 m
SURVEY ORGANISATION :
NATIONAL INSTITUTE OF OCEANOGRAPHY
Survey Period : 10th September - 11th September , 2008.
Client : NCC INFRASTRUCTURE HOLDINGS LIMITED, HYDERABAD.
Fig. 2 : DEMARCATION OF LTL, HTL AND CRZ BOUNDARIES
NEAR BOMPETA, SRIKAKULAM DISTRICT.
Checked By
Approved By
B. PRABHAKARA RAO
Scientist
National Institute of Oceanography
176, Lawson's Bay Colony
Visakhapatnam - 530 017
SCIENTIST-IN-CHARGE
National Institute of Oceanography
176, Lawson's Bay Colony
VISAKHAPATNAM 530 017

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BIODIVERSITY ASSESSMENT OF THE PROJECT SITE AND ITS ENVIRONS

BY

UNIVERSITY OF HYDERABAD, A.P. / KAKATIYA UNIVERSITY WARANGAL, A.P/ MEMBER A.P BIO-DIVERSITY BOARD

BIODIVERSITY ASSESSMENT OF SOMPETA BEELA AND ITS ENVIRONS, SRIKAKULAM DISTRICT, ANDHRA PRADESH

Report prepared by

DR. K. SESHAGIRIRAO
ASSOCIATE PROFESSOR IN LIFE SCIENCES
UNIVERSITY OF HYDERABAD, HYDERABAD
MEMBER
ANDHRA PRADESH BIODIVERSITY BOARD

AND

DR. VATSAVAYA S. RAJU
PROFESSOR & BOS IN BOTANY
KAKATIYA UNIVERSITY
WARANGAL

NOVEMBER 2008

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Executive Summary

NCC is developing a 4 x 660 MW Thermal Power project at Sompeta and approached Hyderabad University to do a "Bio Diversity Assessment Of Sompeta Site And Its Environs" for its input to EIA/EMP studies.

Study Conducted by

DR. K. SESHAGIRIRAO
ASSOCIATE PROFESSOR IN LIFE SCIENCES
UNIVERSITY OF HYDERABAD, HYDERABAD
MEMBER
ANDHRA PRADESH BIODIVERSITY BOARD

AND

DR. VATSAVAYA S. RAJU
PROFESSOR & BOS IN BOTANY
KAKATIYA UNIVERSITY
WARANGAL

The professors along with a small team from the project went to the site. The samples were collected for soil and water. The flora and fauna species information was collected and photographed.

The study indicated that variation in chemical quality of water in the Beelas signify that the Sompeta Beela has no influence of sea water invasion, whereas, the other two Beelas have connectivity and circulation of saline water. They represent a definite gradation and transition zone between the sea and Sompeta Beela. The aquatic species in Sompeta Beela are exclusively of fresh water environment, the middle Manikyapuram Beela has combination of both fresh and marine environments, whereas, the sea side Beela supports mainly marine species.

(i) The Chemical analysis indicated that the lagoon is a freshwater body and has no indication for any salinity interference.

(ii) The species diversity analysis indicated by Lagoon and Species indices disclose that the highly populated aquatic species are inhabitants of freshwaters and many of them are weeds of no major economic value.

The diversity indices also reveal the diversity is minimum, while there is more equitability of species and there are also biological invasions.

Based on the evidences gathered during the present scientific study, the following conclusions are drawn:

The proposed site has no Ecologically Sensitive Areas (ESA) or factors (cf. Annexure II of CRZ - Indicative List of ESA) like: (1) Mangroves. (2) Coral reefs. (3) Sand dunes. (4) Mud flats. (5) Protected Marine Wildlife Parks and Sanctuaries. (6) Coastal Forests and Wildlife, (7) Coastal Freshwater lakes. (8) Salt Marshes. (9) Turtle nesting grounds. (10) Horse-shoe Crab's habitats. (11) Sea weed beds (12) Sea grass beds, and (13) Nesting grounds for migratory birds.

(a) Sompet Beela area has no connection from the sea. It is completely devoid of marine environment. It experiences a stabilized freshwater environment.

(b) Sompet Beela is natural sink which receives spillover waters from Mahendra Thanaya and Paidigon irrigation anicuts. Waters are neither wholesome nor fresh for human consumption.

(c) The soil deposited at the bottom of Sompet Beela essentially comprises silt, organic matter, clay and of very less granular material.

(d) There are no threatened categories of plant and animals species in the Red Data Lists (**IUCN Categories**) which occur as natural inhabitants.

(e) The Shannon – Weaver index which underscores the species richness reveals the diversity to be minimum, while there is more equitability of species and there are biological invasions

(f) The quality of water, nature and composition of soil, and the associated biota preponderate conclusively prove that the area (proposed site) enjoys only of lacustrine environment while occasionally becoming water-logged.

BIODIVERSITY ASSESSMENT OF SOMPETA BEELA AND ITS ENVIRONS SRIKAKULAM DISTRICT, ANDHRA PRADESH

1. INTRODUCTION

Nagarjuna Infrastructure Holdings Limited, Hyderabad, Andhra Pradesh is planning to build a coal-based Thermal Power Plant between Sompeta and Baruva villages in Srikakulam district of Andhra Pradesh. The proponent company has requested to undertake Biodiversity Assessment Study of the proposed site and its environs.

Coastal environment plays a pivotal role in India's economy by virtue of the resources, productive habitats and rich biodiversity. India has a coastline of about 7,500 km. About 250 million people live within a distance of 50 km from the coast. The coastal zone is also endowed with a very wide range of coastal ecosystems like mangroves, coral reefs, sea grasses, salt marshes, sand dunes, estuaries, lagoons, etc., which are characterized by distinct biotic and abiotic processes (CRZ, Report 2005).

The coastal areas are assuming greater importance in recent years, owing to the ever increasing human population and accelerated developmental activities. These anthropogenic activities have put tremendous pressure on the fragile coastal environment. Therefore, there is an urgent need assess critically the possible impacts of any proposed anthropogenic activity, like the one contemplated between Sompeta and Baruva villages, right from the site selection.

2. GEOGRAPHCAL SETUP

The proposed site extends from western peripheral areas of Sompeta Beela and right up to the asphalt road connecting the Baruva village and Sompeta town.. The site falls in a natural topographic depression with its eastern margin extending into a water body known as *Sompeta Beela.* Sompeta Beela is a sink and collects slope wash from upper regions of the drainage basin and also receives irrigation waste waters from paddy fields of a net work of chain-tank system of *Mahendra Tanaya* and Paidigaon anicuts.

The Sompeta site area drains the water to the middle Manikyapuram Beela whose overflow in turn joins the third Edduvanipalem Beela. It has its outlet to debouch into *Bay of Bengal* when all the Beelas in series are completely full to their capacity by the surface storm water inflows.

Fig: Proposed Site Location

A major continuous beach ridge of width of about 300 meters and having a height of about 10-15 meters extends from Baruva to Edduvanipalem, acts as a natural barrier to both Sompeta Beela and Manikyapuram Beela. Thus, they enjoy a stabilized back barrier environment. There is no irrigated ayacut under all the Beelas. However, all along western inland margins of Edduvanipalem and Manikyapuram Beelas, have extensive paddy cultivation under shallow bore-wells constructed in the potential alluvial sand aquifers

3. OBJECTIVE AND SCOPE

The scope of the present investigation includes:

(1) A detailed monitoring and identification of Biota thriving in the Sompeta Beela Area.

(2) Monitoring the quality of surface waters stored in Beela and groundwater in wells located in its Immediate neighborhood.

(3) Soil salinity characteristics study in the Beela bed.

(4) A general comparison in species, including their variation if any, between the Sompeta Beela

and other two down-stream Beelas, and

(5) Estimation of Biodiversity indices such as Shannon-Weaver index (H') which underscores the species richness [oft-used used in community ecology] for the purpose of determination of eco-sensitivity of the Beela area

4. APPROACH TO THE STUDY

Floristic and faunistic diversity of a region is determined by the environmental factors of abiotic and biotic in nature. Abiotic factors include the climatic conditions such as precipitation, light, temperature, atmospheric humidity and wind and also, equally important physiographic conditions such as topography, underlying rock formations and soil characteristics. Biotic factors include all living things comprising plants and animals, their inter related actions and reactions, all imposing on each other directly or indirectly, still exist as a closed knit and inter dependent community

The entire stretch of land covering all the three Beelas and their neighborhood, more or less, enjoy similar climatic conditions. However, site specific conditions comprising the nature of under lying soil cover and the quality of water present on the surface are likely to have greater influence on the prevalence, preponderance and diversity of fauna and flora. Considering these three aspects are the most important that can be easily and immediately assessed, the study is programmed to monitor all the living species including plants and animals, to determine the quality of water, to find out the nature of surface soil on the floor of Sompeta Beela and finally, relate these attributes to the two down stream Beelas characteristic features

5. METHODOLOGY ADOPTED

The Sompeta Beela is accessible to reach to the point of interest for the recording the section. Initially an inventory of approaches and possible locations were identified with the help of local knowledgeable persons. The routes selected are from southern Palli-Gollagandi village, Western Kamba - a major drain of *Mahendra Tanaya* irrigation canal, northern Jinkabadra-Benkili villages and from east, following the Beela drainage outlet which is an unregulated drainage course occurring towards Isukalapalem village.

The incidence of plant and animal species in 10m grids and also their occurrence at random along the approach paths have been carefully studied and identified on the water tank area .

Fig: Biota quadrate analysis

The chemical quality of water has been assessed using a pocket type conductivity meter by recording Specific Electrical Conductance of the sample on the spot. In addition, the representative samples from the Beelas (Sompeta, Middle Manikyapuram and Edduvanipalem) and also from the adjoining wells were analyzed for water and soil quality at Pragathi Labs & Consultants Pvt. Ltd., a recognized Analytical Laboratory at Hyderabad.

Fig: Electrical Conductance measurement

Eleocharis atropurpurea
Eleocharis dulcis
Eleocharis spiralis
Hydrilla verticillata
Impatiens balsamina
Ipomoea fistula
Ipomoea reptans
Juncellus alopecuroides
Jussieua adscendens
Kyllinga brevifolia
Limnophytum obtusifolium
Lymnophyton
Mariscus compactus
Nelumbo nucifera
Nitella sp.
Nymphaea nouchali
Nymphaea pubescens
Nymphaea rubra
Oryza rufipogon
Oryza sativa
Ottelia alsimoides
Oxystelma exculentum
Panicum miliaceum
Paspalum canarae
Pentapetis phoenicea
Poloygonum glabrum
Polygogum hydropier
Schoenoplectiella articulatus
Schoenoplectiella lateriflora
Sesbania sesban
Typha angustata
Utricularia stallaris
Streblus asper
Strychnos
Synstemmon bacciformis
Thespesia populenea
Tinospora cordifolia

Eclipta alba
Ficus religiosa
Ficus tincotoria
Ichnocarpus frutescens
Indigofera trita
Ipomoea aquatica
Ipomoea fistulosa
Ipomoea sp.
Jasminum
Killinga nemoralis
Killinga triceps
Ludwigia parviflora
Lufffa acutangula
Melochia corchorifolia
Morinda tinctoria
Nitella sp.
Nyphaea stellata
Pandanus odoratissima
Panicum miliaceum
Pantapetes phoenecia
Pedalium murex
Pentapheta phoenecia
Perotis indica
Phoenix sylvestris
Phyla nodiflora
Phyllanthus pinnatus
Pouzolzia
Pseudarthria visida
Rothia trifoliata
Sanseveria roxburghii
Sida cordata
Solanum trilobatum
Triumphetta rhomboideae
Typha angustata
Urena lobata
Vernonia cinera
Wedelia chinensis

(ii) Exotics:

(a) Crops/Planted

Achras zapota
Annacardium occidentale
Annona muricata
Annona reticulata
Annona sqamosa
Artacarpus integrifolia
Borassus flabellifer
Citrus aurantiacum
Citrus lemon
Cocos nucifera
Mangifera indica
Musa x paradisica
Sapindus emarginatus

(b) Planted for fruits/flowers/fence/shelterbelt

Almanda chathartica
Casuarina equisitifolia
Jatropha curcas
Nerium indicum

***(iii)* Invasive Shrubs/Herbs**

Chromolaena odorata
Crotalaria pallida
Croton bonplandianum
Jatropha gossypiifolia var. elegans
Lantana camera
Mimosa pudica
Parthenium hysterophorus
Waltheria indaca (americana)

B. CHEMICAL QUALITY OF WATER

Water takes into solution all soluble minerals. Dissolved salt content can be estimated by its electrical conductivity value. The specific electrical conductance value (E.C.) is expressed in micro Siemens / cm at 25 C. As per the Indian drinking water standards, the total dissolved salt content of 500 parts per million (ppm) is the desirable limit (E.C.750) and 1500 ppm is permissible limit (E.C.2250). As per irrigation classification of waters E.C of less than 750 is excellent, 750-2000 is permissible, 2000-3000 is doubtful and beyond 3000 is unsuitable category.

E.C. values of water samples of Sompeta Beela are determined using pocket type conductivity metre and they range from 480 to 1270 micro Siemens .It is more fresh at the western inlet (E.C 480) and has slightly higher E.C. in outlet drain at Isukalapalem road bridge (E.C 890). Analytical results of different chemical constituents are given in the Annexure I. Quality of Beela water is falling in the Excellent to Good Irrigation water standards. Quality of ground water from the adjoining Dug/Bore wells is slightly brackish and is unsuitable for drinking purposes

C. BEELA FURFACE SOIL QUALITY

Results of soil samples analysis are given Annexure II. The top root zone of 0.30 m depth is slightly acidic with pH value of 5.76. It has a low value of E.C.205 with organic matter content of 3.6 percent. The bottom layer at one metre depth the organic matter is 1.9 percent, slightly alkaline with pH of 7.82 and a slightly higher E.C. of 1270. The salinity in soil is less than 0.66 gm/kg indicating that the soil is normal with no salinity hazard.

7. INDICATOR SPECIES – SOMPET BEELA AREA

The study revealed that it has a fresh water habitat. The following are the clear ecological indicators for the freshwater ecosystem.

(i) *Plant Indicators* (from the middle of the Beela to its margins): **Freshwater Aquatics:**

Ceratophyllum demursum
Cyperus articulatus
Cyperus corymbosus
Cyperus platystylis
Eleocharis acutangula
Eleocharis spiralis
Hydrilla verticillata
Impatiens balsamina
Jussieua adscendens
Kyllinga brevifolia
Limnophytum obtusifolium
Nelumbo nucifera
Nitella sp.
Nymphaea nouchali
Nymphaea pubescens
Nymphaea rubra
Nymphoides hydrophyllacea
Nymphoides indica
Oryza rufipogon
Ottelia alsimoides
Paspalum canarae
Pentapetis phoenicea
Poloygonum glabrum
Polygogum hydropier
Schoenoplectiella articulatus
Schoenoplectiella lateriflora
Sesbania sesban
Utricularia stellaris

(ii) Animal Indicators of Freshwater Habitat:

Freshwater catfish
Freshwater Heron
Freshwater snails
Leaches
Murrel
Tealapia
Water duck

The photographs of the fresh water species are given in the following Figures

Two soil samples, one from root zone extending up to 30 cm and the other at one meter depth have been collected at the lake bed, located towards Benkili–Jinkabadra area. The soil samples were also analyzed for their characteristics at Pragathi Labs & Consultants Pvt. Ltd., Hyderabad.

Fig: Soil sample collection

6. OBSERVATIONS ON SOMPETA BEELA & ITS NEIGHBORHOOD

A. BIOTA—PLANT SPECIES

The following plant species are encoutered in the Beela and surrounding locations:

(i) Natural species

Aesynomeneindica
Alternanther sessilis
Astercantha longifolia
Bolboschoenus maritimus
Ceratophyllum demursum
Cyperus articulatus
Cyperus corymbosus
Cyperus difformis
Cyperus iria
Cyperus platyphyllus
Cyperus platystylis
Cyperus rotundus
Eleocharis acutangula
Abrus precatorius
Abutilon indicum
Alangium lamarkii
Ammania baccifera
Atylsia gangetica
Barleria prionotis
Boerhavia repanda
Cassia occidentalis
Chloris barbata
Cissua quadrangularis
Clerodendrum
Combretum ovalifolium
Desmodium triflorum

Fig: ***Oryza rufipogon***

Fig: ***Ipomea fistulosa, Oryza rufiogon***

Fig: *Cyperus corymbosus*

Fig: ***Polygogum hydropier***

8. OBSERVATIONS ON TWO DOWN STREAM BEELAS & NEIGHBOURHOOD

The middle Manikyapuram Beela receives overflows from Sompeta Beela connected by an irregular drainage channel. Along the inland margins of Manikyapuram Beela and Edduvani Palem Beela in west, ground water is fresh with E.C value of 470 in the shallow sand zone aquifer being extracted by means of borewells for irrigating paddy crop.

Fig : Rice fields in the western inland margins of Manikyapuram Beela

Manikyapuram Beela water is brackish with E.C value of 5480 micro Siemens. Water entering into sea from Edduvani Palem Beela is highly brackish with E.C value of 8430 micro Siemens.

Fig: Cat-tail in Manikyapuram Beela

Manikyapuram and Edduvanipalem Beelas are receiving seepage from the upper regions and also getting irrigated waste waters from the adjoining paddy fields.Their courses are wide and their discharges are considerably high.

Fig : Edduvanipalem Beela entry into sea

The predominant Biota in the Manikyapuram Beela are :

(A) Plants:
Reed (*Phragmitis karka*)
Cat-tail (*Typha angustata*)

(B) Animals:
Eeel (*Anguilla bengalensis*)
Fiddler-crab (*Uca stylifera*)

The redominant Biota in the Edduvanipalem Beela are:

(A) Plants
Saltwater-Acanthus (*Acanthus ilicifolius*)
Brackish-rice (*Zizania latifolia*)

(B) Animals:
Sand-crab (*Ocypoda* sp.)
Satl-water Gastropod (*Cerithium* sp.)
Mud-skiper (*Boleopthalmus dussumierei*)

9. INTERPRETATION OF OBSERVATIONS

Away from the proposed site, the village Baruva has a typical sandy beach with the costal dunes covered by sand-binders like *Spinifix littoreus, Impomoea per-caprae, Hydrophyllax maritime, Launea procumbens, Cyperus arenarius*, etc. with the backdrop provided by a mix of exotic and indigenous woodlands. There is shelter belt of *Casuarina equisetifolia* abutted by private and government lands planted with *Cocos nucifera, Mangifera indica, Anacardium occidentale, Sapindus emarginatus, Tamarindus indicus, Borassus flabellifer, Musa* x *paradisica, Artacarpus integrifolia*, clumps of *Pandanus odoratissima* and scattered trees of wild species like *Morinda corea, Cordia oblique*, and planted hedges *Annona muricata, A. reticulata* and *A. squamosa, Jatropha curcas,* etc. A larger part of the area is under paddy cultivation between the habitations (villages), roads, canals and water bodies.

Sompeta Beela inlet water collected towards western periphery has very low Specific Electrical Conductance value of 480 micro siemens / cm at 25°C and its outlet water in the drain near Isukalapalem Road Bridge has 890 Micro Siemens. The Manikyapuram Beela has brackish water of 5480 Micro siemens and the outlet water in the last Beela at Edduvaripalem before entering into sea is highly brackish and has E.C value of 8430 Micro siemens. Thus, the quality of Sompata Beela water is fresh and is useful for irrigation and many other purposes, where as, the water stored in other two Beelas are not suitable for irrigation and other purposes

The variation in chemical quality of water in the Beelas signify that the sompeta Beela has no influence of sea water invasion, whereas, the other two Beelas have connectivity and circulation of saline water. They represent a definite gradation and transition zone between the sea and Sompeta Beela. The aquatic species in Sompeta Beela are exclusively of fresh water environment, the middle Manikyapuram Beela has combination of both fresh and marine environments, whereas, the sea side Beela supports mainly marine species.

(i) The Chemical analysis indicated that the lagoon is a freshwater body and has no indication for any salinity interference.

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The diversity indices also reveal the diversity is minimum, while there is more equitability of species and there are also biological invasions.

10. CONCLUSIONS

Based on the evidences gathered during the present scientific study, the following conclusions are drawn:

The proposed site has no Ecologically Sensitive Areas (ESA) or factors (cf. Annexure II of CRZ - Indicative List of ESA) like: (1) Mangroves, (2) Coral reefs, (3) Sand dunes, (4) Mud flats, (5) Protected Marine Wildlife Parks and Sanctuaries, (6) Coastal Forests and Wildlife, (7) Coastal Freshwater lakes, (8) Salt Marshes, (9) Turtle nesting grounds, (10) Horse-shoe Crab's habitats, (11) Sea weed beds, (12) Sea grass beds, and (13) Nesting grounds for migratory birds.

(a) Sompeta Beela area has no connection from the sea. It is a completely devoid of marine environment. It experiences a stabilized freshwater environment.

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(c) The soil deposited at the bottom of Sompeta Beela essentially comprises silt, organic matter, clay and of very less granular material.

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(f) The quality of water, nature and composition of soil, and the associated biota preponderate conclusively prove that the area (proposed site) enjoys only of lacustrine environment while occasionally becoming water-logged.

Dr VATSAVAYA S. RAJU
Professor & BOS in Botany
KAKATIYA UNIVERSITY
WARANGAL, A.P.

Prof. VATSAVAYA S. RAJU
Department of Botany
Kakatiya University
Warangal - 506 009 A.P.

Dr K. SESHAGIRIRAO
Associate Professor in Life Sciences
UNIVERSITY OF HYDERABAD
&
Member
Andhra Pradesh Biodiversity Board

Dr. K. Seshagirirao
Reader (Associate Professor)
School of Life Sciences
University of Hyderabad
HYDERABAD - 500 046

TOPOGRAPHIC SURVEY

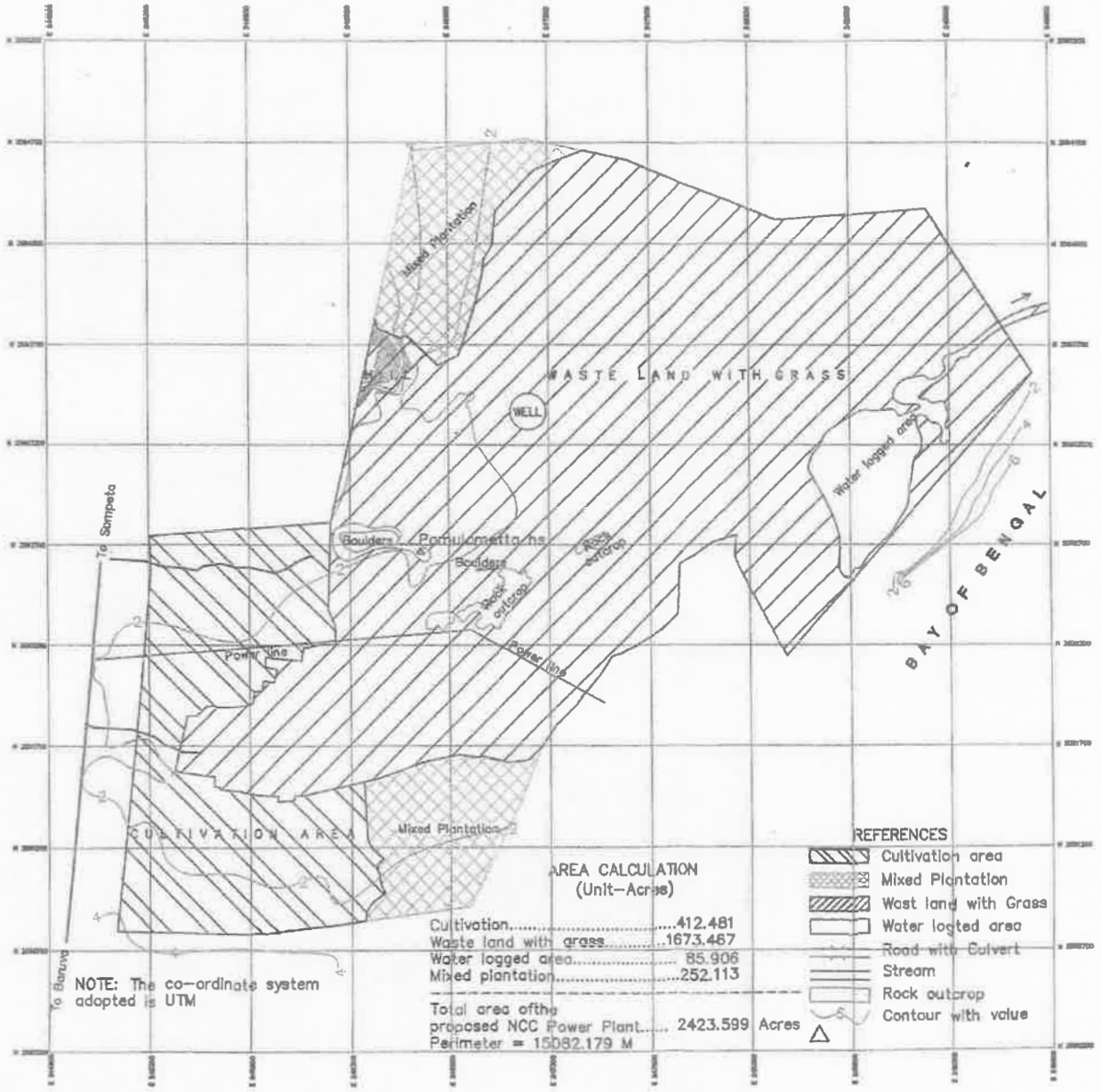
BY

SURVEY OF INDIA GOVT. OF INDIA

SURVEY OF INDIA

AP. GEO SPATIAL DATA CENTER

UPPAL HYDERABAD



NOTE: The co-ordinate system adopted is UTM

AREA CALCULATION
(Unit–Acres)

Cultivation	412.481
Waste land with grass	1673.467
Water logged area	85.906
Mixed plantation	252.113
Total area ofthe proposed NCC Power Plant	2423.599 Acres
Perimeter = 15082.179 M	

REFERENCES

- Cultivation area
- Mixed Plantation
- Wast land with Grass
- Water logged area
- Road with Culvert
- Stream
- Rock outcrop
- Contour with value

(P.S.S. BABU)
SURVEY ASSISTANT
Survey of India
AP Geo-Spatical Data Centre
Uppal, Hyderabad-500 039.

TOPOGRAPHIC SURVEY OF NCC VAMSADHARA POWER PROJECT AT SOMPETA DIST SRIKAKULAM ANDHRA PRADESH	
2X660 MW VAMSADHARA POWER PROJECT AT SOMPETA	
NAGARJUNA CONSTRUCTION COMPANY LTD.	
SCALE - 1 : 5000	
CONTOUR INTERVAL - 2M	

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NATIONAL HYDROGRAPIC MAP
(KALINGAPATNAM TO GOPALPUR)

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KALINGAPATNAM to GOPALPUR

TENTATIVE BOUNDARY

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LAND USE STUDY

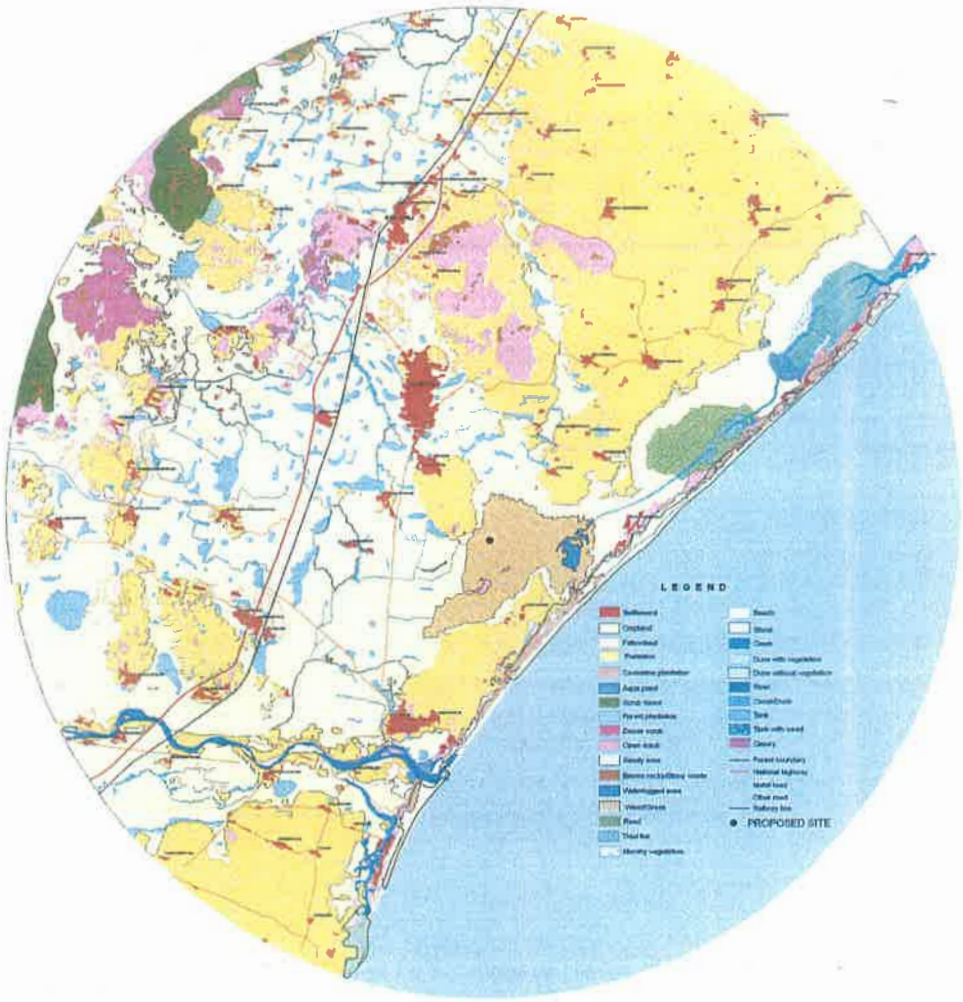
BY

ANDHRA PRADESH STATE REMOTE SENSING APPLICATION CENTER (APSRAC)

56

PROJECT REPORT

LAND USE / LAND COVER AROUND PROPOSED THERMAL POWER PLANT SOMPETA MANDAL, SRIKAKULAM DISTRICT, ANDHRA PRADESH



ANDHRA PRADESH STATE REMOTE SENSING APPLICATIONS CENTRE

(APSRAC)

2nd FLOOR, DES CAMPUS, KHAIRATABAD, HYDERABAD-500 004

February 2009

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PREFACE

M/s Nagarjuna Construction Company (NCC) Infrastructure Holdings Limited, Hyderabad requested A.P. State Remote Sensing Applications Centre (APSRAC) to prepare a Land use / Land cover around proposed Thermal Power Plant, Sompeta Mandal, Srikakulam District, Andhra Pradesh.

APSRAC has prepared Land use / Land cover map of the ~~10 km~~ radius of proposed thermal power plant using remote sensing techniques with limited field verification. The work has been carried out in the month of January and February 2009. The details of the study are given in this report along with map.

Date: 16th February 2009
Hyderabad

K.MRUTHYUNJAYA REDDY
DIRECTOR GENERAL

K. MRUTHYUNJAYA REDDY
DIRECTOR GENERAL
A.P. STATE REMOTE SENSING
APPLICATIONS CENTRE
JNTU CAMPUS
KHAIRATABAD, HYDERABAD-500 004

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LAND USE / LAND COVER AROUND PROPOSED THERMAL POWER PLANT SOMPETA MANDAL, SRIKAKULAM DISTRICT, ANDHRA PRADESH

INTRODUCTION:

M/s Nagarjuna Construction Company (NCC) Infrastructure Holding Limited has proposed to establish 4 X 660 MW coal based thermal power plant near Gollagondi Village, Sompeta Mandal, Srikakulam District, Andhra Pradesh. They requested APSRAC to prepare a Land Use / Land Cover map around the proposed plant.

STUDY AREA:

The area is located at 18° 53' N and 84° 36' E situated in Sompeta Mandal, (between Sompeta & Baruva), Srikakulam District, Andhra Pradesh. The study area covers 10 km radius around the proposed site. The total geographical area is about 23,114 ha., which doesn't include the area of the sea (9556 ha).

OBJECTIVE:

The main objective of the project is to prepare the Land use/ land cover map around the proposed thermal power plant, near Sompeta based on interpretation of recent satellite data with limited field checks.

DATA USED:

Indian Remote Sensing (IRS) Satellite P6 LISS – IV data of 16.4.2008, 7.11.2007 & 13.12.2007, and LISS III data of 26.9.2008 & 24.1.2009 images have been used to prepare the land use/ land cover map.

SALIENT FEATURES OF THE AREA:

The coastal tract of Srikakulam is interspersed with estuarine rivers like Vamsadhara, Nagavalli with their narrow flood plains. Mahendra Tanaya, a small rivulet joins Bay of Bengal in between Kotturu and Battegalluru, which is in the southern part of the study area. Beach ridges and sand dunes act as a natural barrier along the coast.

The western and south eastern parts of the study area are dominant with coconut plantation. The prominent villages in the study area are Sompeta, Kanchili and Baruva. A number of tanks are chain linked in the rolling plains, which supports the tank irrigation. There are three natural depressions present in the eastern part of the study area i.e., Sompeta, Manikyapuram and Iduvanipalem. These depressions, which constitute water and vegetation, are locally known as "Bela".

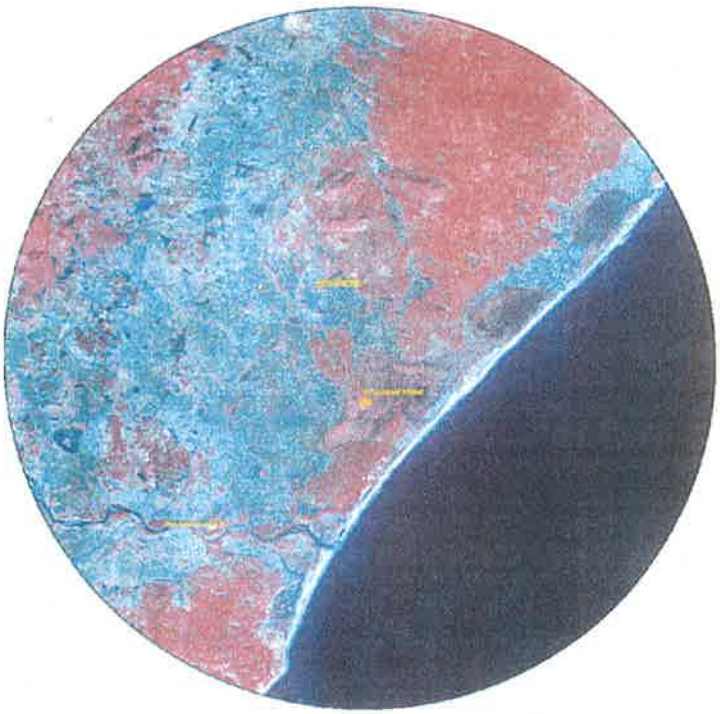
LAND USE/ LAND COVER CATEGORIES

The land use/ land cover mapping of the study has been carried out based on the on screen digitization of the satellite imagery. Various land use/ land cover includes built-up land, agricultural land, forest land, wasteland, water bodies and other categories. Each of the above units is sub-divided. The spatial extent of each land use/ land cover category and their percentage to the total geographical area is shown in table-1 along with map.

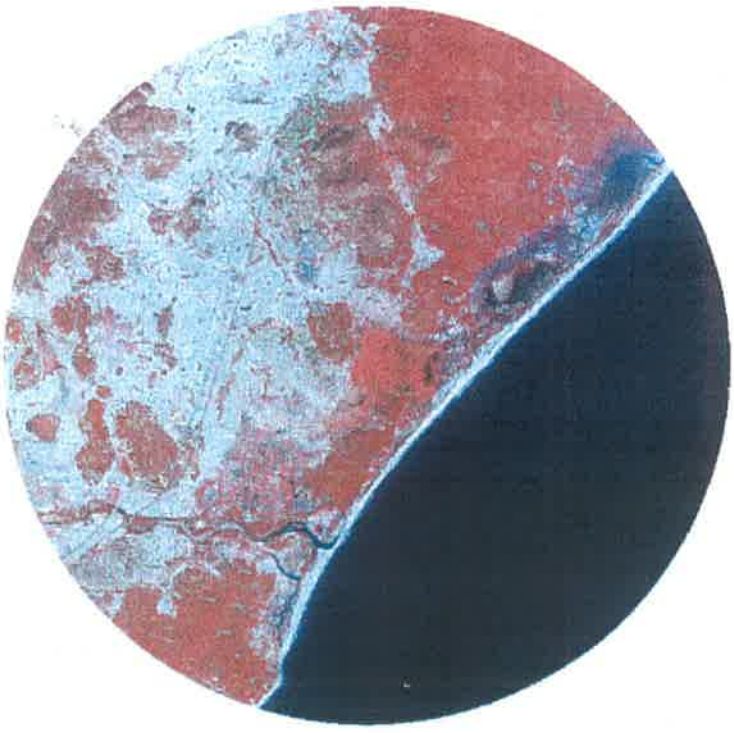
BUILT-UP LAND (Settlement): It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands. The major settlements identified include Somperta, Kanchili, Baruva, Manikyapuram, etc. The total area of all the settlements is about 572 ha., which forms 2.48% of the study area.

AGRICULTURE LAND: These are the lands primary used for farming and for production of food, fiber, and other commercial crops. It includes land under crops (irrigated and un-irrigated, fallow, plantations etc.). Various sub categories of agriculture land include cropland, fallow land, and plantation.

Cropland: These are the areas with standing crop as on the date of satellite overpass. They are widely distributed in different terrains; prominently appear in the irrigated areas irrespective of the sources of irrigation. The predominant crop grown in the study

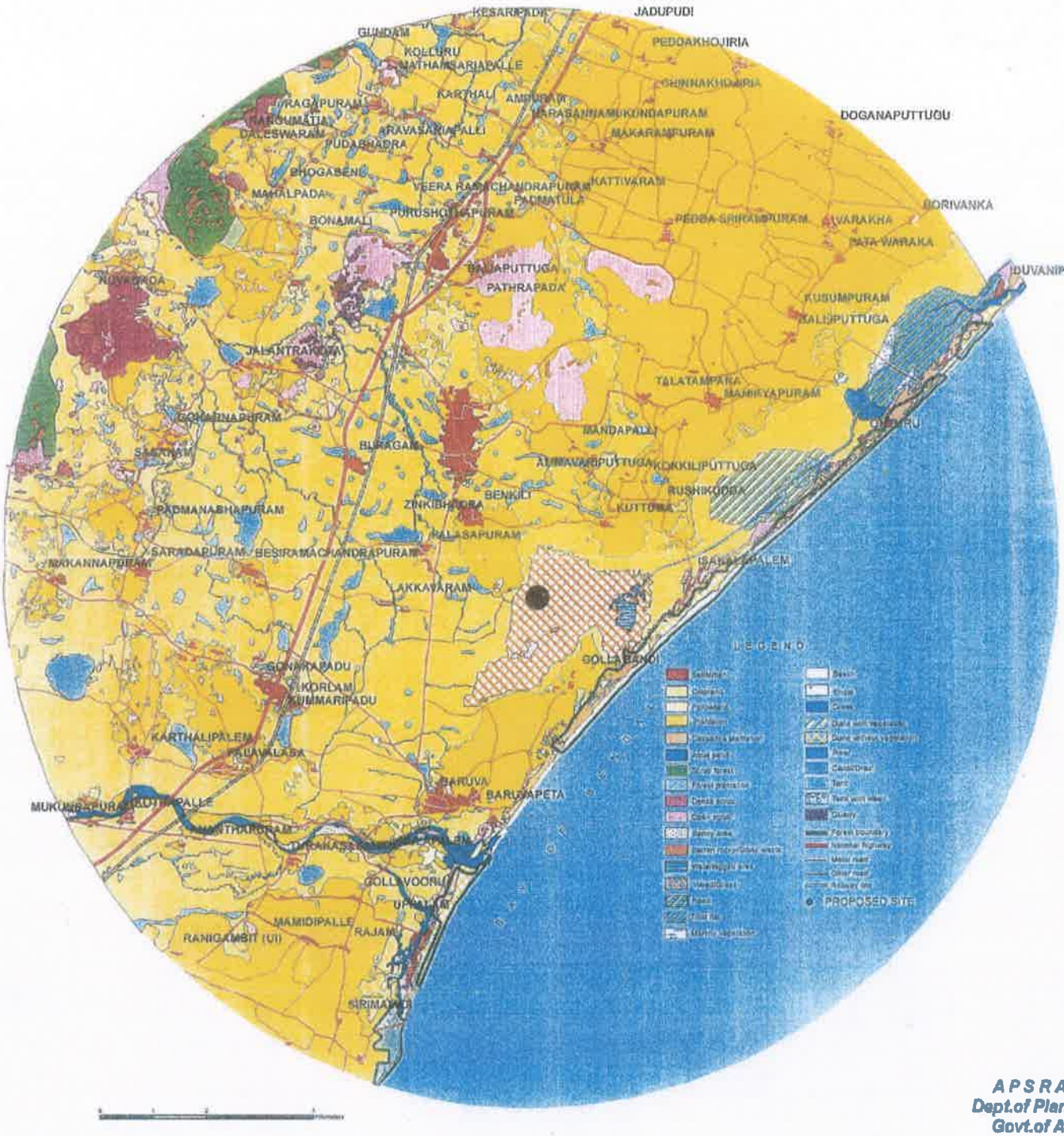


IRS P6 LISS-IV Image of 7th Nov. and 13th Dec. 2007



IRS P6 LISS-III Image of 24th Jan. 2009

LAND USE / LAND COVER AROUND PROPOSED THERMAL POWER PLANT SOMPETA MANDAL, SRIKAKULAM DISTRICT, A.P.



APSRAC
Dept.of Planning
Govt.of A.P.

DATA USED: IRS-P6-LISS IV-07NOV-2007 & 13DEC-2007; IRS-P6-LISS III-21SEP-2008 & 24JAN-2009

A.P. STATE REMOTE SENSING APPLICATIONS CENTRE
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area is paddy where as the minor crops grown include pulses, vegetables, etc. The total area of crop land is about 9800 ha., which forms 42.65% of the study area.

Table 1: LAND USE/LAND COVER STATISTICS OF PROPOSED THERMAL POWER PLANT, SOMPETA MANDAL, SRIKAKULAM DISTRICT

S.No	Description	Area in Ha	Percent to total study area
1	Settlement	572.89	2.48
2	Cropland	9800.06	42.65
3	Fallow	676.16	2.93
4	Plantation	7621.08	33.12
5	Casuarina plantation	151.61	0.66
6	Aqua ponds	46.97	0.20
7	Scrub forest	352.56	1.12
8	Forest plantation	46.91	0.20
9	Dense scrub	247.93	1.07
10	Open scrub	848.73	3.67
11	Sandy area	36.00	0.16
12	Barren rocky/Stony waste	112.85	0.49
13	Waterlogged area	19.57	0.08
14	Weed/Grass	473.24	2.05
15	Reed	182.50	0.79
16	Tidal flat	227.84	0.99
17	Marshy vegetation	26.54	0.11
18	Beach	147.99	0.64
19	Shoals	0.44	0.00
20	Creek	65.63	0.28
21	Dunes with vegetation	17.02	0.07
22	Dunes without vegetation	183.36	0.79
23	River	129.83	0.56
24	Canal/Drain	229.18	0.99
25	Tank	833.30	3.61
26	Tank with weed	11.37	0.05
27	Quarry	52.56	0.23
	Total	**23114.11**	**100.00**

* An area of the sea which constitutes 9556.63 ha. is not taken into consideration

Fallow Land: These are the lands, which are taken up for cultivation but are temporarily allowed to rest, un-cropped for one or more seasons, but not less than one year. The area under this category has been estimated as 676 ha. (2.93%).

Plantation: These areas are separable from cropland, especially with the data acquired during rabi/ zaid season. Plantation appear in dark-red to red tone of different sizes with regular and sharp edges indicating the presence of a fence around it. Depending on the location, they exhibit a dispersed or contiguous pattern. Use of multi-season data will enable their separation in a better way. Vast stretches of cashew and coconut plantation has been observed around Sompeta, Kanchili and south of Mahendra Tanaya river. The total area of agricultural plantation is about 7621 ha., which forms 33.12% of the study area. The casuarina plantation is delineated separately which is present along the coast. Part of the casuarina plantation is present in the protected forest land. The total area of casuarina plantation is about 151 ha., which forms 0.66% of the study area.

Aqua ponds: These are the areas where fish / Prawn are reared for commercial purposes. Abounded aquaculture ponds are located south of Iduvanipalem bela.

FOREST: These are the areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundaries) capable of producing timber and other forest produce. There is no dense forest / open forest in the study area. The total forest area is classified as scrub forest.

Scrub Forest: These are the forest areas where the crown density is less than 10% of the canopy cover, generally seen at the fringes of dense forest cover and settlement, where there is biotic and abiotic interference. They appear in light red to dark brown depending on the canopy cover and soil background. Their size will vary from small to big, irregular to discontinuous in shape, contiguous to non-contiguous in appearance.

Most of these are located on hill/mountains slopes within notified forest areas, at times closer to habitations. The area under this category has been estimated as 352.56 ha.

Forest Plantation: These are the areas of tree species of forestry importance, raised and managed especially in notified forest areas. The species mainly constitute teak, Sal, eucalyptus, casuarina, bamboo etc. They appear in light red to red in color of varying sizes mostly in contiguous pattern and at times non-contiguous. Most of these are located in uplands, coastal areas within notified areas. Many of these can be identified based on the sharp boundary exhibited by them. The forest plantation is about 47 ha. (0.20%).

WASTE LANDS: Wasteland is described as degraded land which can be brought under vegetative cover with reasonable effort and which is currently underutilized and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as by location, environment, chemical and physical properties of the soil or financial or management constraints. Different waste land categories include scrub land (dense scrub and open scrub), sandy area, barren rocky/ stony waste, and waterlogged area.

Scrub Land. This is a land, which is generally prone to deterioration due to erosion. Such lands generally occupy topographically high locations, excluding hill/mountainous terrain. They appear in light yellow to brown to greenish blue depending on the surface moisture cover and vary in size from small to large having either contiguous or dispersed pattern. Scrublands are associated with moderate slopes in plains and foot hills and are generally surrounded by agricultural lands. The scrub lands are categorized into dense scrub and open scrub. The area of the dense scrub has been estimated as 248 ha. (1.07%) and the open scrub is 848 ha. (3.67%).

Sandy Area: These are the areas that have stabilized accumulation of sand, in coastal, Riverine or inland areas, that can be either desertic or coastal. They appear as white to

light yellow/bluish depending on moisture content and at times light red when vegetation is associated with this class, vary in size, with regular to irregular shape with contiguous to linear pattern mostly they are located in deserts, riverbeds and along the shores. The sandy areas are demarcated in riverbed, along the shore in the study area. Dunes with vegetation and dunes without vegetation are delineated separately which are present along the coast. The extent of the sandy area is about 36 ha., (0.16%) and the area of dunes without vegetation is about 183 ha. (0.79%).

Barren Rocky/Stony Waste: These are the rock exposures of varying lithology often barren and devoid of soil and vegetation cover. They occur amidst hill-forests as opening or as isolated exposures on plateau and plains. Such lands can be easily discriminated from other categories of wastelands because of their characteristic spectral response. They appear in greenish blue to yellow to brownish in color depending on the rock type. They vary in size with irregular to discontinuous shape with a linear to contiguous or dispersed pattern. They are located in steep isolated hillocks/hill slopes, crests, plateau and erode plains associated with barren and exposed rocky/stony wastes, lateritic out-crops, mining and quarrying sites. The area under this category has been estimated as 113 ha. (0.49%).

Waterlogged Area: The waterlogged land is that low lying land where the water is at or near the surface and the water stands for most part of the year. The total area of this category is about 19 ha. (0.08%).

WATER BODIES: This category comprises areas with surface water, either impounded in the form of ponds, lake and reservoirs or flowing as streams, rivers, canals etc. These are sub divided and delineated as river/stream, canal/drain, and tanks

River/Stream: River/Stream is natural course of water flowing on the land surface along a definite channel/slope regularly or intermittently towards a sea in most cases or

a lake or an inland basin in desert areas or a marsh or another river. Mahendra Tanaya is present in the southern part of study area.

Canal/Drain: Canals and drains are artificial water course constructed for irrigation, navigation or to drain out excess water from agricultural lands. A major drain is connecting all the three belas.

Tanks: Tanks are small lakes of impounded water-ways constructed on land surface for irrigation. They appear in light blue to dark blue depending on the depth from small to large sizes. They possess regular to irregular shape dispersed to linear, occupying lowlands, plains. They are associated with cropland. This category has been estimated as 833 ha. (3.61%).

OTHER LAND USE / LAND COVER CATEGORIES:

Other land use/ land cover categories includes Weed /Grass, Reed, Tidal Flat, Marshy Vegetation, beach, Shoals, Creek, and Quarry.

Weed /Grass: Weed are typically considered as unwanted and economically useless where as Grass lands are the areas of natural grass present along with other vegetation dominated by grass like plants. They include Typha angustata (popularly known as elephant grass/ cats tail), Ipomea sp. (popularly known as water hyacinth), Cypres sp., etc. The above vegetative cover usually exists in fresh water environment. This unit is extensively observed in the Sompeta bela. This category (Weed /Grass) has been estimated as 473 ha. (2.05%).

Reed: Common reed grass is tall, invasive perennial wetland prevalent in open habitats. These areas include drier borders and elevated areas of brackish and fresh water marshes, along river banks and lake shores and almost anywhere there are slight depressions that hold moisture. Common reed variety present include Phragmitis sp. This is present in the Manikyapuram bela. The extent of reeds in the study area is about 182 ha. (0.79%).

Tidal Flat: Tidal flat constitutes the region between the highest-high and lowest-low tide. The aerial extent of these tidal flats depends on the topography and connectivity to tidal creek. This is predominantly present in the Iduvanipalem bela which is connected to the sea by the creek. The total area of the tidal flat is about 220 ha. (0.99%).

Marshy Vegetation: Marsh is a land which is permanently or periodically inundated by water and is charecterised by hydrophytic vegetation, which includes water hyacinth and reeds. This unit is present in the southwestern and southeastern periphery of Iduvanipalem bela.

Creek: A small tidal channel through tidal swamps or a shallow intermittent stream in the coastal areas is called a creek. The Iduvanipalem bela is connected to the sea by the tidal creek.

Shoal: Shoal are either submerged ridge, bank or bar producing a shoal, consisting of or covered by sand, mud, gravel or other consolidated material.

Beach: Beach is defined as a shore consisting at least partly of unconsolidated material. Most often the material is of sand grade. This is present in the eastern margins adjoining the Bay of Bengal.

Quarrying: Quarrying for road metal is extracted from barren rocky/ stony waste areas. The total area has been estimated as 52 ha.

OBSERVATIONS:

- There are three natural depressions present in the eastern part of the study area i.e., Sompeta, Manikyapuram and Iduvanipalem belas. A drain connects Sompeta Bela & Manikyapuram bela and another channel connects Manikyapuram bela & Iduvanipalem bela.

- The proposed site is situated in the southeast of Sompeta village which forms part of Sompeta Bela.

- The Sompeta bela collects water from the basin through drains from the adjoining agricultural fields. The water is accumulated in the eastern part of the Sompeta bela, which forms waterlogged area.

- The vegetative cover present in Sompeta bela is dominated by weed/grass which includes Typha angustata (popularly known as elephant grass/ cats tail), Ipomea sp. (popularly known as water hyacinth), Cypres sp. This vegetative cover usually exists in fresh water environment.

- An anicut built across the drain which connects Sompet bela and Manikyapuram bela is supporting irrigation in the surrounding areas.

- There is no indication of marine environment in the Sompeta bela based on the observations made by remote sensing data.

- The Manikyapuram bela in between Onturu and Manikyapuram is dominated by reed with a limited extent of tidal flat. Common reed variety present include Phragmitis sp.

- The northeast bela near Iduvanipalem is connected to sea through creek. This bela is dominated by tidal flat with a limited extent of marshy vegetation.

- Sompeta, Kanchili and Baruva are the main settlement locations of which the first two are mandal head quarters.

- The study area is dominated by coconut and cashew plantation in the northeastern and southeastern parts.

- There are large numbers of tanks which are inter connected.

- Paddy is the main crop grown in the study area.

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Fig. 1: Coconut Plantation near Kaviti

Fig. 2: Cashew plantation near Gollavuru

Fig. 3: Casuarina plantation near Gollagondi village

Fig. 4: Weed in Sompeta bela

Fig. 5: Ipomoea species in Sompeta bela

Fig. 6: Creek connecting the Iduvanipalem bela and Sea

Fig. 7: Anicut on the drain connecting Sompeta bela and Manikyapuram bela

Fig. 8: Paddy grown near Rushikuddu village.

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ASSESSMENT OF SOIL TYPE AND QUALITY OF WATER

BY

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY,
BAPATLA, A.P

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REPORT ON THE ASSESSMENT OF SOIL TYPE AND QUALITY OF WATER AT THE PROPOSED PROJECT SITE FOR NCC POWER PROJECTS LIMITED, SOMPETA MANDAL, SRIKAKULAM DISTRICT, A.P.

A report prepared by

Dr B. Bapuji Rao

Principal Scientist (Agronomy) & Head

Agricultural Research Station

YELAMANCHILI- 531 055

&

Dr T. Sreelatha

Senior Scientist (Soil Science)

Regional Agricultural Research Station

ANAKAPALLE – 531 001

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Acharya N.G. Ranga Agricultural University

Agricultural Research Station

Kokkirapalli, Yellamanchili
Visakhapatnam District-531055
Ph. No. 08931 – 232441
Email : arsylm@yahoo.co.in

जय हिन्द

Date.....11-02-2009.

CERTIFICATE

Certified that the Investigation "**REPORT ON THE ASSESSMENT OF SOIL TYPE AND QUALITY OF WATER AT THE PROPOSED PROJECT SITE FOR NCC POWER PROJECTS LIMITED, SOMPETA MANDAL, SRIKAKULAM DISTRICT, A.P.** " is a bonafide scientific evaluation. These results are not reported elsewhere and are exclusive for M/s. Nagarjuna Construction Company Limited, Hyderabad. This is carried out at their request.

11/2/09

(Dr B. Bapuji Rao)
Principal Scientist (Agronomy) &
Head
Agricultural Research Station
YELAMANCHILI- 531 055

11/02/09

(Dr T. Sreelatha)
Senior Scientist (Soil Science)
Regional Agricultural Research
Station
ANAKAPALLE – 531 001

PROLOGUE

NCC is developing 4 x 660 MW Thermal Power Project at Sompeta, Dist. Srikakulam, Andhra Pradesh. As a input to EIA/EMP studies NCC approached Regional Agricultural Research station,(Acharya N G Ranga Agricultural University) Anakapalli to do an "Assessment Of Soil Type And Quality Of Water ".

A team consisting of Dr B. Bapuji Rao (Principal Scientist (Agronomy) & Head, Agricultural Research Station, YELAMANCHILI) & Dr T. Sreelatha (Senior Scientist -Soil Science, Regional Agricultural Research Station, Anakapalle) along with a team from the project went to the site and collected the water and soil for analysis. The study revealed that

- The site proposed for the construction the thermal plant is a waste and barren land without any cultivation and habitation.
- Analysis of soil and water from the site indicated that both are near neutral in majority of the area and suitable for many of the field and orchard crops.
- There are no signs of any tidal features like mudflats or marshy lands in and around the site.
- The vegetation found in the site and grown around indicated that these are of fresh water origin and commonly found in the north coastal districts.
- Cultivation of saline sensitive crops like tomato and cabbage during rabi 2008-09 around the site, utilizing water drawn from the *site*, clearly indicates that the *land* has no interaction and effect of sea or saline environment.
- A comparison of water collected from site with sea water clearly indicated that the water is of fresh water origin and suitable for cultivation. There is no sea water incursion into the site.
- Presence of high water table and poor drainage has led to the formation of saline patches due to evapo-transpiration of fresh water in certain part of the site. The extent of such an area is very limited (less than 50 acres). However,

these patches can be reclaimed by providing good drainage through installation of surface/ sub-surface drains.

- There are no eco-sensitive vegetation found at site.

As per the finding the conclusion was

1. The area is away from the coastal regulatory zone and separated from the sea by well developed dunal complex.
2. The demarcation of this study area as "Mud" in the survey of India topo-sheet could not be established during the ground check.
3. **Based on this accepted scientific explanation the area cannot be called as a mud flat because of the following reasons:**
   - The area has **no physical connectivity** with tidal zone and it is not influenced by tidal oscillations.
   - The area is **disconnected with sea water by a complex dunal belt** which separates the land with the sea.
   - The water quality in the area of the study in fact is **characterized by the fresh water** supplied by rivulets draining into the area from nearby high lands.
4. The rivulets from Mukundasagaram reservoir and Mahendrathanaya are seasonal and drain the area, thus support the agricultural activity. The traditional lift irrigation methods have being practiced in some locations.
5. The geological evidence indicate that the area is characterized by rocks such as Khondalites, Charnockites and Coastal dunes which is tune with the regular generalized pattern and no abnormality is observed. The rockbed lies underneath about 10m deep silty sand deposits.

INTRODUCTION

Nagarjuna Construction CompanyLimited, Hyderabad has requested the Associate Director of Research, Regional Agricultural Research Station, Anakapalle to examine the site proposed for construction of 2640 MW coal based thermal power plant near Gollagondi village, Sompeta Mandal, Srikakulam district to assess the type of soil, type of vegetation and quality of surface and sub surface waters. The Associate Director of Research, Regional Agricultural Research Station, Anakapalle has constituted a team to accomplish the task with the following members:

- Dr B. Bapuji Rao, Principal Scientist (Agronomy) & Head, Agricultural Research Station, Yelamanchili.
- Dr T. Sreelatha, Senior Scientist (Soil Science), Regional Agricultural Research Station, Anakapalle.

The team has visited the site on 5.1.2009. The team has conducted field survey of project site & surrounding area (s) and collected soil and water samples for analysis.

OBJECTIVES OF THE STUDY

- To study the type of soil in the proposed site and surrounding area.
- To assess the quality and characteristics of water.
- Find the nature, physical and chemical characteristics of surface and sub surface soil.
- Determine the quality of the surface and subsurface water available in the project area.
- To study the nature and type of plants and vegetation with in the site.
- To study the soil microbial population and its activity.
- Recommendations on suitability of site for development of power project.

The analysis of collected samples, methodology adopted, results obtained and the findings/ conclusions are reported here under. The analysis on the microbial activity and their population is being carried out at the Microbiology Laboratory, Directorate of Rice Research

(ICAR), Rajendra Nagar, Hyderabad. The results of these studies are awaited and shall be submitted in due course separately.

GEOGRAPHICAL FEATURES OF THE REGION AND SITE:

The overall region of (Sompeta mandal) spread over 14330 ha receives an annual rainfall of 1130 mm. Of the total geographical area, 3.3 % (480 ha) is under forests and 2.2% (316 ha) area is barren and uncultivable. About 30.6% (4400 ha) of the land is put to non-agricultural use and 3840 ha (26.8) is under current fallows. About 36.7% area (5260 ha) is net area sown with 700 ha of land sown more than once in a year and about 573 ha (0.04%) is cultivable waste.

The site for the proposed thermal station is near Gollagondi, Baruvapeta and Rushikudda villages, of Sompeta Mandal, Srikakulam district. The average site elevation is about 5 m above MSL. The area of the project site is about 500 ha and is of mainly barren and waste lands with different grasses and weeds. Adjacent to the site on three sides are agricultural lands mainly monocropped and in few occasions double-cropped.

The topography map of the Sompeta region prepared by "The Survey general of India" indicated that the the area is on the 8m contour above AMSL. To the west of the region is 'Padma Konda' hill ranges with embedded Jalantrakota Reserve Forest at an elevation of 300 m AMSL. The general orientation and angle of the slope of the region is from West to East. During monsoon season, the rain water from the hill ranges partially flows on the north side of the project site. This water further travels about 1 KM North East direction and enters *"Manikyapuram bela"* and flows for about 6 km Eastwards reaching *"Edduvanipalem bela"* and finally discharges into the sea. Except during rainy seasons, there is no water inflows in to the site and the site remains generally dry with a few pockets of shallow water on the north-east parts of the site. To the east of the site (1.5 Km away) on the shore there are sand dunes of about 5 m high and width ranging between 250-350 m. This is acting as a natural barrier against the sea water incursion and exposure to the site. The site has no physical appearance of exposure to sea and does not represent any kind of marine environment.

Water resources of the Region:

It is observed that there are about 62 minor irrigation projects in the region mainly in the upper reaches. Majority of the project surrounding area receives water from Mahendratanaya Open Head Channel. Using the natural slope/ gradient, farmers on the down stream raise the crops with water that is let out as drainage or seepage or flood from the upper reaches. There is also a small lift irrigation scheme by the name "Benkili lift irrigation project" installed by the A.P. State Irrigation Development Corporation.

During the rainy season, water flows to sea through the some portion of the project site on the north-eastern parts. Some part of water remains stagnated due to natural shallow slopes over an area of less than 50 acres. These waters bring eroded soil (silt and clay particles) with them and deposit on the site over a longer duration.

The existence of an Anicut near to the project site, prevents sea water or salinity reaching the site which is about 7 km distance down-stream. Hence there are no chances of backwaters entering the proposed site. The saline patches noticed in small extents are due to the evaporation of surface waters. There are no coastal ecosystems like mangroves, coral reefs, sea grasses, salt marshes, estuaries, lagoons, etc noted in and in the vicinity of the project site.

Agricultural scenario of the site & region:

In Project Site:

Basically the project site of about 1000 acres is barren land covered with perennial/ seasonal weeds and grasses. There is no agricultural activity in the site and there is no special and organized vegetation grown in the site. There is also no habitation at the site.

In the Region :

The agro ecological situation of the region can be classified as sandy loam and sandy soils under rain fed conditions. Surrounding the site, some agricultural activities are noticed. These are primarily seasonal and less intensive. The agricultural and plantation crops grown in the surrounding region during rainy and post-rainy season are as follows:

a. Agricultural crops: Paddy (*Oryza sativa*)

Groundnut (*Arachis hypogaea*) in rice fallows

b. Horticultural crops: Cabbage (*Brassica oleracea var. capitata*)

Cauliflower (*Brassica oleracea var. bortrytis*)

Chillies (*Capsicum annum*)

Tomato (*Lycopersicon esculentum*)

c. Plantation crops: Coconut (*Cocos nucifera*)

d. Social forestry: Toddy (*Borassus flabellifera*)

The major cropping systems of the region are as follows.

1. Single crop paddy
2. Paddy – Paddy
3. Paddy – Groundnut
4. Paddy – Vegetables like Cabbage / cauliflower / chillies / tomato

The weed population observed in the region include the following species

S. No	Name of the weed	Family
1.	*Asteralantha longifolia*	Acanthaceae
2.	*Cyperus iria*	Cyperaceae
3.	*Cyperus rotundus*	Cyperaceae
4.	*Ipomea aquatica*	Convolvulaceae
5.	*Ecilipta alba*	Asteraceae
6.	*Nelumbo nucifera*	Nelumbonaceae
7.	*Nymphaea pubescens*	Nymphaceae
8.	*Typha angustata*	Typhaceae
9.	*Hydrilla verticillata*	Hydrocharitaceae
10.	*Ottelia alismoides*	Hydrocharitaceae
11.	*Fimbristylis miliacea*	Cyperaceae
12.	*Cynodon doctylon*	Poaceae
13.	*Echinochloa crusgalli*	Poaceae

14.	*Cressa cretica*	Convolvulaceae
15.	*Chrozophora rottleri*	Euphorbiaceae

These agricultural crops are cultivated in almost all types of soils and agro-ecological situations of the region and not specific to a particular situation like saline / saline-alkaline/ alkaline or water logged conditions. The entire weed population is of fresh water habitat with a lone exception of *Cressa cretica,* a weed commonly found in saline patches. This weed is wide apread in Krishna and Godavari delta lands in rice fallows wherever there is a slight saline patch..

The existing vegetation observed at site and the crops being cultivated in the surrounding region existing at the time of site inspection are depicted in figures 1 to 7.

Fig 1 Rock outcrops & weed grass found in project site

Fig 2: Larger view of barren site with weed grass

Fig 3 Another view of site with weed grass

Fig 4Flat grounds form part of the project site.

Fig 5 The secondary agricultural activity near site.

Fig. 6 – Paddy Nursery raised with water lifted with *Tenda in the vicinity*

Fig. 7 – Cultivation of tomato beyond site

These crops are being cultivated in a small scale during post rainy season. The crops are being irrigated with water drawn from the surface and sub surface by a sort of surface / sub-surface water harvesting technology. The water is being drawn into a sump by lateral

underground pipes and then pumped from the sump by lift irrigation into a well and then finally to the fields. The water from these sumps is also used for irrigation by pot watering.

Fig. 8 – Water being collected into the sump

Fig. 9 – Lift irrigation system in operation

Farmers raise paddy crop in the post rainy season once the water level recedes and irrigate the paddy crop with water lifted by *Tenda*, an indigenous water lifting device works on the principle of the see-saw. Each *Tenda* has a capacity to command an extent of two acres (Fig. 6).

Sample collection:

The analysis of the soil samples provides the knowledge on the type of the soil and quality of soil water. Based on the topography, soil surface characteristics and type of crops existing the field the area to be surveyed is sub divided into four blocks. Soil samples were collected from surface (0-30 cm) and sub-surface (30-60 cm) soil layers. Since the objective here is to obtain a general evaluation of the quality of soil and water, the average of quality parameters of a number of samples provides an index for the overall appraisal. To avoid the sampling error, a minimum of 10 soil samples were drawn in each soil layer in each of the four sub divisions to arrive at the average conditions for that sub division.

Fig. 10 – Soil samples collection in the surface layer in block 2

Fig.11 – Sub- soil sample collection in block 3

Fig. 14 – Water sample collection at the inlet of a field

Water samples were collected from the upper reaches i.e., at Benkili village at several points of field water inlets and finally at the outlet of the site i.e., at Isukallipalem,

a hamlet of Rushikudda village. The purpose behind the selection of sites is to determine whether the water undergoes qualitative changes after traversing the site or not.

Water samples were also drawn at two locations from the sea to assess whether there is any sea water incursion into the site, by a comparison with that of water collected from site itself.

ANALYTICAL METHODS

The methods adopted in the analysis of the soil and water samples parameter-wise are presented in table 1:

Table 1: Details of methods adopted for quality analysis

S.No	Parameter	Method adopted
A) Soil samples		
1.	EC	Conductivity bridge
2.	pH	pH meter
3.	Nitrogen	Kel-plus N- analyser
4.	Available phosphorous	Spectrophotometer
5.	Available potassium	Flame photometer
6.	Na	Flame photometer
7.	Organic carbon	Walkly method
B) Water samples		
9.	Chlorides, Sulphates	Titration method
10.	Carbonates and bi-carbonates	Titration method

THEORETICAL CONSIDERATIONS

In irrigated agriculture, the quality of water used for irrigation has a significant role. Water quality not only affects the crop growth during a particular irrigation cycle but also influence the soil productivity for subsequent crop production. If the irrigation supplies are drawn from surface reservoirs, the water could be generally satisfactory for irrigation through wells and tube-wells, the quality of water used may not always be satisfactory. Even if the salt content of the irrigation water is very small, its repeated application could cause salt

build up and deteriorate soil properties creating condition unfavourable for plant growth. In irrigated agriculture a knowledge of the quality of the water used for irrigation as well as its possible effects on the soils and the crops is essential (Bapuji Rao and Raghubabu, 2002).

Water quality should be evaluated on the basis of its suitability for the intended use. Specific user will have different quality needs. For example, most river waters are of good quality for irrigation but may be unacceptable for municipal use without treatment. After chlorination, low salinity water may be acceptable for municipal use but may be too corrosive for industrial use without further treatment. Such a low salinity water may also cause soil permeability problems in irrigated agriculture (Murthy *et al.*,1990).

Estimation of absolute concentration of soluble salts of various ions is not sufficient for determining the potential hazards of irrigation water to soil and crop growth. The presence of the amount of sodium relative to calcium and magnesium has considerable effect on soil physical properties (such as infiltration rate) and nutrient availability due to high pH. An index of sodium hazard is the sodium adsorption ratio (SAR), The sodium adsorption ratio is defined as

$$SAR = (Na^{+}/ ((Ca^{2+} + Mg^{2+})/2)^{0.5}$$

where, Na^{+}, Ca^{2+} and Mg^{2+} represent the concentrations in milli equivalents per litre (m.eq. / 1) of the respective cations.

Concentration of carbonate and bicarbonate

Presence of carbonate and bicarbonate in irrigation water results in the precipitation of calcium and magnesium present in the soil. This increases the sodium hazard of the water. To assess the sodium hazard due to carbonate and bicarbonate of irrigation water, Eaton (1950) assumed that all the calcium and magnesium would precipitate as carbonates and proposed the concept of residual sodium carbonate (RSC). The residual sodium carbonate (RSC) is expressed as

$$RSC = (CO_3^{2-} + HCO^{-}_3) - (Ca^{2+} + Mg^{2+})$$

where, the concentration of ions is expressed as m.eq. /1. Eaton (1950) based on the limited data available concluded that waters with more than 2.5 m.eq. / 1 residual sodium carbonate are not suitable for irrigation purpose. Waters containing 1.25 to 2.5

m.eq. / l are marginal, and those containing less than 1.25 m.eq. / 1 RSC are probably safe. In practice it has been seen that waters having RSC grater than 2.5 m.eq. / 1 can also be used for irrigation, however, gypsum will have to be applied to soil occasionally.

The SAR and RSC values are being used independently of each other to evaluate the sodium hazard. However, considerable interaction between the calcium, magnesium, carbonate and bicarbonate ions occur affecting the relative concentration of sodium.

Classification of water

Based upon the total concentration of soluble salts and SAR of the water, irrigation waters are classified for their suitability in crop production.

General guidelines for characterizing irrigation water quality for crop production are given in Table 2.

Table 2: General guidelines on water quality

S.No	Characterization parameter	Extent of problem		Severe
		No problem	Increasing problem	
1.	Electrical conductivity EC, dS/m at 25°C	< 2	2 - 4	> 4
2.	Sodium adsorption ratio, SAR (m. eq. / 1)$^{1/2}$	< 8	8-18	> 18
3.	Residual sodium carbonate, RSC, m. eq. / 1	< 2.5	2.5-5.0	> 5.0
4.	Boron, mg / 1 (ppm)	< 1.0	1-2	> 2.0

SOIL SALINITY/ ALAKLINITY vis-à-vis AGRICULTURE

Irrigation water contains dissolved salts in varying amounts. Most of the applied water soil is lost to atmosphere in the form of evapotranspiration and only small fraction percolates into soil below the crop root zone. The former process results in an increase in the concentration of soluble salts in the soil while the later helps in reducing accumulation of excessive amounts of soluble salts in the crop root zone. The concentration of soluble salts in the crop root zone is, therefore, governed by the rate of evapotranspiration and the leaching fraction. Leaching fraction (LF) is the fraction of irrigation water applied that is drained below the crop root zone depth.

Continuous application of saline irrigation water results in the excessive accumulation of soluble salts in the sol profile and create soil salinity problem. Even if the total salinity of irrigation water is not high but contains high concentration of sodium or bicarbonate ions it

results in the accumulation of sodium in the soil and create soil alkalinity problem. The composition of irrigation water changes once it enters the soil profile. There could be precipitation of soluble salts or dissolution of soil minerals and of sparingly soluble salts such as calcium carbonate and gypsum. Thus, a soil being irrigated with saline water will have to be characterized with regard to the salinity or alkalinity problem.

A soil is said to be saline or cause salinity problems if the electrical conductivity of saturation extract is greater than 4 dS/m at 25°C. Such soils usually have pH of saturation paste (pH_s) less than 8.5 or a pH of the 1:2 soil water suspension (pH_2) less than 9.3.

On the contrary, sodic soils (or alkaline soils) contain predominantly sodium salts which are capable of causing alkaline hydrolysis of soil due to high pH and exchangeable sodium percentage (ESP). A soil is said to be sodic or suffers from sodicity or alkalinity problems if the pH of saturation paste and ESP of soil is more than 8.5 and 15, respectively.

Soil salinity and crop growth

Soluble salts present in the soil are integral component of soil solution. As water is transported to the plant root from the soil due to transpiration pull created at plant leaves the soluble salts also come along with it. But only a fraction of dissolved salts in the soil solution is absorbed by the plant roots, and most of salts accumulate near the plant roots. As the process of evapotranspiration continues, the concentration of soil solution near the plant roots rises up to 2 to 5 times than that in the irrigation water. Consequently the water potential decreases due to osmotic effect of soluble salts and thus, availability of water decreases. Such an effect when reduces plant growth, it is termed as osmotic effect. Sometimes the concentration of some specific ion in soil solution increases to such an extent that it interferes with the plant growth mechanism. Such an effect on plant growth is called specific ion effect. The plant growth in saline conditions may be limited because either osmotic effect, or specific ion effect or combination effect of both these factors (Bapuji Rao *et al*., 1990).

Osmotic effect

Plant growth is greatly affected by the soil water potential or water availability. Total soil water potential is sum total of matric potential and osmotic potential. Matric

potential is due to soil matrix and osmotic potential is due to osmotic effect of soluble salts present in the soil solution. Osmotic potential (OP) is expressed as atmospheres and can be measured by its relationship to the salinity of solution using the following equation.

$$OP = - 0.36 \times EC$$

Where, EC is the electrical conductivity of soil solution in dS/m at 25°C.

An increase in soluble salt concentration in the soil will decrease water potential i.e. water availability and thus, uptake of water and transpiration are reduced when the osmotic potential of the rooting media decreases. Transpiration rate per unit surface area decreases with an increase in soil salinity level (Hira and Singh, 1973).

Plant roots growing in saline media try to accumulate more amounts of inorganic or organic solutes in the plant cell sap. This is the mechanism through which plant tries to thrive in saline media by decreasing the osmotic potential inside the plant cell sap, so that the water uptake gradient at root soil interface is not reduced. This mechanism is called osmotic adjustment. Osmotic adjustment is the primary mechanism affecting the plant growth in saline soil (Bernstein, 1975). Absorption of excess of inorganic salts from soil solution or synthesis of organic solutes to effect osmotic adjustment may result in reduced dry matter production. Higher levels of respiration may also be needed to maintain increased solute concentration. Higher levels of solute within the cells may also alter the hormonal balance of plant and may damage the cytoplasmic bodies (Meiri and Shalhevet, 1973).

Specific ion effect

Plant growth reduction due to specific ion effect is because of toxicity of particular element that occurs within the plant itself as a result of the uptake and accumulation of certain ions from the irrigation water. This may occur even though salinity level is low enough to have any significant osmotic effect. The toxic ions of concern are sodium, chloride, boron and fluoride. Specific ion effect is not normally associated with annual crops, but most of trees and woody-type plants are sensitive to the specific ion effect. However, some annual crops are sensitive to chloride or sodium may also develop symptoms of leaf burn when sprinkled with brackish waters containing 10-20 m.eq. / litre of sodium or chloride.

Such damage has been observed in tomatoes (Gornet et al., 1973) and cotton (Busch and Turner, 1965).

Mass and Hoffman (1977) concluded from an extensive review of crop tolerance data that there is some minimum level of salinity up to which no reduction in yield is experienced. To this they referred as 'threshold' salinity level. An increase in all salinity beyond the threshold level, linearly decreases the crop yields. They have proposed following equation to express crop response to soil salinity.

$$Y = 100 - b\,(EC_e - a)$$

Where Y = relative crop yield in per cent

EC_e = Electrical conductivity of saturation extract (dS/m at 25°C)

a = Electrical conductivity threshold value for the crop representing the maximum EC_e at which no yield reduction takes place.

b = Yield decrement per unit of salinity between the threshold value (a) and the EC_e value representing 100 per cent yield decrement.

The crop tolerance value for various crops are given in table 3 that are calculated using the above equation.

Table 3:Yield reduction to be expected for certain crops due to salinity of irrigation water when common surface irrigation methods are used

Crops	Expected yield reduction at EC_e or EC_{iw} indicated									Maximum EC_{iw}
	0 %			10 %			25 %			
	Ec_e	EC_{iw}	LR	Ec_e	EC_{iw}	LR	Ec_e	EC_{iw}	LR	
Cotton	7.7	5.1	10	9.6	6.4	12	12	8.3	16	54
Soybean	5.0	3.3	17	5.5	3.7	18	6	4.2	21	20
Groundnut	3.2	2.1	16	3.5	2.4	18	4	2.7	21	13
Rice	3.0	2.0	9	3.8	2.6	11	5	3.4	15	23
Maize	1.7	1.1	6	2.5	1.7	8	4	2.5	13	20
Sugarcane	1.7	1.1	3	3.4	2.3	6	6	4.0	11	37
Tomato	2.5	1.7	7	3.5	2.3	9	5	3.4	13	25
Cabbage	1.8	1.2	5	2.8	1.9	8	4	2.9	12	24
Sweet corn	1.7	1.1	6	2.5	1.7	8	4	2.5	13	20
Onion	1.2	9.8	5	1.8	1.2	8	3	1.8	12	15

1. Ec_e is the electrical conductivity of the saturation extract (dS/m) in the root zone where about two-third of the water uptake occurs. For 0 yield reduction,

Ec_e is the threshold salinity at which yield is expected to being to decline.

2. EC_{iw} is the electrical conductivity of the irrigation water, in dS/m at 25°C. This assumes about a 20 % leaching fraction and an average salinity of soil water taken up by crop about three times that of irrigation water applied (EC_{sw} = $3EC_{iw}$) and about two times that of the soil saturation extract ($EC_{sw} = 2EC_e$). Thus, $EC_e = 3/2\ EC_{iw}$.
3. LR is the leaching requirement or the minimum leaching fraction that can be relied upon to control salts within the tolerance of the particular crop. LR is determined from equation $LR = EC_{iw} / EC_{dw} = D_{dw} / D_{iw}$ and is given as a percentage.
4. EC_{dw} is the maximum electrical conductivity that can develop in percolating water draining from the root zone due to water uptake by crop. At this maximum EC_{dw} yield reduction would be 100 %.

Crop tolerance to alkalinity

Evaluation criteria

For correlating the sodicity or alkalinity levels of soils with the plant growth generally the exchangeable sodium percentage (ESP) of soil is measured. Exchangeable sodium percentage is calculated as:

$$ESP = \frac{\text{Exchangeable sodium}}{\text{Cation exchange capacity}} \times 100$$

where, exchangeable sodium and cation exchange capacity are expressed as m.eq. / 100 g soil. Exchangeable sodium is usually measured by extracting the exchangeable sodium with 1N ammonium acetate solution after washing the soil with alcohol. Crops suitable for different classes of ESP and alkalinity are presented in tables 4 and 5.

Table 4: Tolerance of various crops to exchangeable sodium percentage (ESP) under non-saline conditions

Classes	ESP	Crops
Very sensitive	2-10	Citrus
Sensitive	10-20	Beans, maize
Moderately tolerant	20-40	Rice
Tolerant	40-60	Tomato

Table 5: Relative tolerance of crops to alkalinity

Tolerant	Semi-tolerant	Sensitive
Rice	Sugarcane	Cotton (at germination)
Dhaincha (Sesbania)	Cotton	Maize
	Bajra	Groundnut
		Greengram
		Sunflower

Rice is very suitable crop in alkali soils in monsoon season. Pearl millet can be grown where enough where is not available. Sugarcane can do well on mild alkali soils. Blackgram, Bengal gram, pigeon pea and cowpea are very sensitive to soil sodicity. Maize and groundnut are the other sensitive crops (Subbaiah *et al.*, 1992).

ANALYTICAL RESULTS

The results of the analysis carried out for water collected from site, sea water and soil samples, as per the techniques discussed earlier, are presented in tables 6 to 8.

Table 6: Quality Analysis of water collected from the site and around

Parameter	Units	Sample codes					
		1	2	3	4	Optimum	Threshold values
pH	--	6.8	7.1	7.2	6.9	6.5-8.5	6.5-8.5
Electrical conductivity	dS/m	1.5	1.	1.8	2.4	<2	>4
SAR	$(m.\ eq./1)^{1/2}$	7.3	7.7	8.2	8.0	<8	8-18
RSC	m.eq./l	1.9	2.2	2.4	2.1	<2.5	<5.0
Chlorides as Cl	m.eq./l	10.0	11.2	12.0	11.5		
Sulphates as SO_4	m.eq./l	5.72	5.9	6.0	5.9		
Carbonates as CO_3	m.eq./l	1.7	1.9	1.8	1.7		
Bi Carbonates as HCO_3	m.eq./l	2.0	2.8	3.0	2.6		
Ca	m.eq./l	8.5	8.2	7.9	8.3		
Mg	m.eq./l	3.5	3.3	2.4	3.0		
Na	m.eq./l	7.0	10.5	12.0	11.4		
K	m.eq./l	0.37	0.25	0.19	0.28		

B) Quality of sea water

Sea water is a solution of salts – a brine – whose ingredients are approximately in fixed proportions. The results of the analysis of two sea water samples are presented in table 8. The high EC values are an indication of huge quantities of total dissolved salts and very high value of Na indicate the high Na salt content, which makes the sea water unsuitable for irrigation.

Table 8: Chemical analysis of sea water samples

S.No.	Parameter	Sample 1	Sample 2	Average
1.	EC (Electrical conductivity) (dS/m at 25°C)	38	37	37.5
2.	pH	7.3	7.5	7.4
3.	Na^+ (m.eq/l)	423.8	431.0	427.4
4.	K^+ (m.eq./l)	7.4	7.7	7.5

Table 8: Chemical analysis of soil samples collected from the site

Parameters	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
pH	6.1	5.7	7.8	6.9	7.2	7.0
Electrical Conductivity (dS/m)	1.2	1.4	1.5	2.2	2.6	1.9
Texture	Loamy	Clayloam	Clayloam	Sandy loam	Loamy	Loamy
Organic Matter (%)	1.8	2.6	2.2	1.5	1.7	1.2
ESP	10.3	11.2	10.9	11.1	10.6	10.4

Soil health:

The parameters, like pH and EC, considered to assess the soil health of the project site suggest that the soil is almost neutral in majority of the area and suitable for many of the field and orchard crops. In certain patches the soil is slightly saline due to evapo-transpiration of stagnated fresh water leaving dissolved salts behind (EC ranging from 1.2 to 2.6) wherein certain management practices like selection of crops or lowering the water table or addition of organic matter are to be adopted to realize normal yields.

Organic matter is an index of the productivity of the soil since it is a store- house of essential nutrients for plant growth. It is also a source of cation exchange capacity besides

promoting desirable soil structure and influencing moisture retention and aeration of soils. A soil is said to be low in organic matter when the OC value is < 0.5, moderate between 0.5 and 0.75 and high when OC is > 0.75. The organic content of the soil is very high in certain locations, primarily due to the decomposition of weed flora, and in majority of the area the organic matter content is quite satisfactory (> 0.75) for crop production.

,The pH of the soil is the measure for its acidity or alkalinity. The pH of a soil is an important physico-chemical characteristic because it influences:

a) suitability of soil for crop production,

b) availability of soil nutrients to plants,

c) microbial activity in the soil,

d) lime and gypsum requirement of the soil,

e) physical properties of the soil like structure, permeability, etc.

The pH data of the soil samples collected from the site (Table 8) indicate that the soil on average is neutral as it is in the range of 5.7 to 7.8.

The electrical conductivity (EC) data of the soil presented in table 8 indicate that the soil normal in majority of the sampling sites but at one location the EC value exceeded 2 dS/m, which may be not conducive for the growth of saline sensitive crops. A saline become saline because of one or a combination of the following factors:

a) high water table with a high salt content

b) high temperature promoting rapid loss of water from soil surface

c) low rainfall and high evaporation rates

d) excessive application of irrigation.water

e) seepage from canals and lateral channels

f) irrigation with saline waters

g) poor drainage

h) use of salt producing fertilizers.

In the present context, high water table and poor drainage has led to the formation of saline patches in certain fields. For the reclamation of these patches, proper

drainage facilities have be created. Addition of decomposed organic residues or bulk organic manures is suggested.

FINDINGS OF THE INVESTIGATION

Soil suitability

It is evident from the soil textural analysis that the soil type is sandy loam to loamy in the site and in certain pockets it is clayloam. This confirms the fact that the soil is not marine origin but formed from parent material due to weathering of rocks over centuries and due to sedimentation of slope wash. These soil types are common in the north-coastal districts of Andhra Pradesh. This is not a mud flat terrain as mud flats are barren expanses of silt and clay exposed at low tide and covered at high tide. The soil type does not indicate any interference of sea water. The soil analysis and composition conclude that there no features related costal marshy or mudflats present at site. The vegetation is mainly of fresh water habitat and the soil physical and chemical characteristics indicate that the soil is suitable for field crops and quite different from saline or sea environment.

Water quality

The results of the analysis of the water samples (Table 6), collected from different points of the site, clearly indicates that the water is normal water and as good as that of water used for irrigation in north-coastal region. The EC values suggest that the water is quite suitable for irrigation for most of the crops grown in the Srikakulam district. A comparison made between the sea water and water from the site (Table 8) clearly demonstrate that the water is fresh and there is no sea water incursion into the site. The analysis of water samples clearly indicated that the water present at site is of fresh water origin. This is due to the fresh water flows into the site during heavy rainfall and collected from the upper reaches. There are no indication of saline water intrusion into the site. This is due to the presence of sand dunes on the eastern side and the anicut at the confluence point. All the vegetation found at the site is fresh water origin only and that are commonly found in the north coastal districts. The water samples analysis also corroborates that the land and soil are not mudflats and no eco-sensitive features and life present in the site.

SUMMARY & CONCLUSIONS

The results of the present investigation can be summarized as:

- The site proposed for the construction the thermal plant is a waste and barren land without any cultivation and habitation.
- Analysis of soil and water from the site indicated that both are near neutral in majority of the area and suitable for many of the field and orchard crops.
- There are no signs of any tidal features like mudflats or marshy lands in and around the site.
- The vegetation found in the site and grown around indicated that these are of fresh water origin and commonly found in the north coastal districts.
- Cultivation of saline sensitive crops like tomato and cabbage during rabi 2008-09 around the site, utilizing water drawn from the *site*, clearly indicates that the *land* has no interaction and effect of sea or saline environment.
- A comparison of water collected from site with sea water clearly indicated that the water is of fresh water origin and suitable for cultivation. There is no sea water incursion into the site.
- Presence of high water table and poor drainage has led to the formation of saline patches due to evapotranspiration of fresh water in certain part of the site. The extent of such an area is very limited (less than 50 acres). However, these patches can be reclaimed by providing good drainage through installation of surface/ sub-surface drains.
- There are no eco-sensitive vegetation found at site.

Bibliography:

Bapuji Rao, B. and Raghubabu, M. 2002. Agro-hydrological modeling for dry land water management. (In) Dhopte, A.M. (Ed.) Agrotechnology for dryland farming, (Pb.) Scientific Publishers, Jodhpur, pp 387-408.

Bapuji Rao, B., Prasad, P.R.K., Mahalakshmi, B.K., Durga, N.K. and Subbaiah, G.V. 1990. Response of maize to different levels of nitrogen and salinity of irrigation water and irrigation intensities. Current Agric., 14: 53-55.

Bernstein, I. 1975. Effects of salinity and sodicity on plant growth. Ann. Rev. of Phytopathology, 13: 295-311.

Busch, C.D. and Turner, F. Jr. 1965. Sprinkiling cotton with saline water. Prog. Agric. Ariz., 17: 27-28.

Eaton, F.M. 1950. Significance of carbonates in irrigation waters. Soil Sci., 69:123-133.

Gornet, B., Goldberg, D., Rimon, D. and Ben-Ahher, J. 1973. The physiological effect of water quality and method of application on tomato, cucumber and pepper. J. Am. Soc. Hort. Sci., 98: 202-205.

Hira, G.S. and Singh, N.T. 1973. Effect of soil salinity and water table depth on yield, salt uptake and transpiration rate in wheat. Indian J. Agric. Sci., 43 (2): 126-128.

Mass, E.V. and Hoffman, G.J. 1977. Crop salt tolerance- current assessment. J. Irrig. and Drainage Div. ASCE.,103 (IR2): 115-134.

Meiri, A. and Shalhevet, J. 1973. Irrigation with saline water. Chapter VI. (In) Yaron, B., Danfors, E. and Vaadia, R. (Eds.) Arid Zone Irrigation, Springer Verlag (Berlin), 433 pp.

Murthy, K.S., **Bapuji Rao, B.** and Rao, Y.N. 1990. Water quality for irrigation. (In) Rao, K.S. and Pitchaiah, P.S. (Eds.) Water ecology, pollution and management. (Pb.) Chugh Publications, Allahabad, pp 212-231.

Raghubabu, M., **Bapuji Rao, B.** and Subbaiah, G.V. 1998. Sub-surface water harvesting technology: A feasibility study. J. India Soc. Coastal Agric. Res., 16 (2) : 116-121.

Subbaiah, G.V., Veeraiah, K. and **Bapuji Rao, B.** 1992. Effect of graded levels of salinity, SAR and Mg/ Ca ratios in irrigation water on pod yield of groundnut. J. India

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STUDY ON THE ESTABLISHMENT OF GEOLOGICAL SUB-ENVIRONMENT

BY

DEPT. OF GEOLOGY ANDHRA UNIVERSITY, VISAKHAPATNAM

105

"Studies on the Establishment of Geological Sub-Environment at Gollagandi Village, Sompeta Mandal, Srikakulam District, Andhra Pradesh"

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By

Prof. M. Jagannadha Rao
M.Sc. (Tech.), M.S. Engg. (USA), Ph.D. GGS (Ind.), SME (USA)
Principal Investigator, Department of Geology
Andhra University
Visakhapatnam – 530 003

PRINCIPAL INVESTIGATOR

Prof. M. Jagannadha Rao

M.Sc. (Tech.), M.S.Engg.(USA), Ph.D, GGS (Ind), SME (USA)

Professor and Research Director

Department of Geology,

Andhra University,

VISAKHAPATNAM-530003.

INDIA.

Place: Visakhapatnam,

Date: 10-02-2009,

Signature of the Principal Investigator.

Prof. M. Jagannadha Rao
M.Sc (Tech)., M.S. Engg (USA)., Ph.D., GGS (Ind)., SME (USA)
Professor and Principal Investigator,
Dept. of Geology,
Andhra University
Visakhapatnam - 530 003. (A.P) INDIA

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PROLOGUE

NCC is developing a 4 x 660 MW Thermal Power Project at Sompeta, Dist. Srikakulam, Andhra Pradesh. As an input to the EIA/EMP study NCC approached the Andhra University to do a study the Geology, Environment, Environmental sensitivity and other aspects.

The study was done by Prof. M. Jagannadha Rao, M.Sc. (Tech.), M.S. Engg. (USA), Ph.D. GGS (Ind.), SME (USA), Principal Investigator, Department of Geology, Andhra University. The study revealed as below

1. The area is away from the coastal regulatory zone and separated from the sea by well developed dunal complex.
2. The demarcation of this study area as "Mud" in the survey of India topo-sheet could not be established during the ground check.
3. The entire area can be named as **"Normal coastal area drained by small seasonal rivulets causing water logging during monsoon periods, which is a natural phenomena along this part of this coast"**
4. An attempt has been made to have a comparison with a possible **mudflat environment**, basing on the scientific definitions (which are mentioned in the report) the established scientific literature clearly indicate that the "Mud flat" is a sensitive ecological coastal terrain formed in an **"inter tidal zone"** where by the brackish water will submerge the area during **high tide** and water will retreat during **low tide**. **Based on this accepted scientific explanation the area cannot be called as a mud flat because of the following reasons:**

    - The area has **no physical connectivity** with tidal zone and it is not influenced by tidal oscillations.
    - The area is **disconnected with sea water by a complex dunal belt** which separates the land with the sea.

- The water quality in the area of the study in fact is **characterized by the fresh water** supplied by rivulets draining into the area from nearby high lands.

5. The area is marked by stray grass vegetation and seasonal agricultural activity. The surrounding land is fertile and supports agricultural activity on physical observation the agricultural activity indicate the small scale cultivation of paddy, coconut plantation, cultivation of vegetable etc,. Thus the land could be established as an environment of fresh water rather than brackish water.

6. The rivulets from Mukundasagaram reservoir and Mahendrathanaya are seasonal and drain the area, thus support the agricultural activity. The traditional lift irrigation methods have being practiced in some locations.

7. The geological evidence indicate that the area is characterized by rocks such as Khondalites, Charnockites and Coastal dunes which is tune with the regular generalized pattern and no abnormality is observed. The rockbed lies underneath about 10m deep silty sand deposits.
8. The generalized geological section suggests that the regional slope is from west to east where by certain places of low lying areas could be expected a situation of manmade and natural causes for accumulation of water. In this case also such low lying area resulted the present study area.
9. Geomorphologically, this part of the coast at places characterized by coastal environments influenced by influx of coastal waters. These environments are Salt marshes, Mud flats, Estuaries, Tidal Creeks, etc.,

However, the study area doesn't belong to this group of environments and **it is entirely formed due to sedimentation & stagnation of surplus waters** due to accumulation of water seasonally.

PREAMBLE

Nagarjuna Construction Company Limited has proposed to establish 4X660 MW Coal based Thermal power project near Gollagandi village, Sompeta Mandal, Srikakulam District, Andhra Pradesh. For this thermal plant, it is proposed to locate intake point, and outfall point to draw the sea water and discharge the treated waste water into the sea through buried pipelines, a jetty for imported coal handling, coal conveying system from the jetty to the project coal handling system and other related facilities.

In this connection the study area near the village Gollagandi (Beela) village, Sompeta Mandal, Srikakulam District has been investigated to understand its **Geology, Environment, Environmental sensitivity and other aspects**. The main aim of this study is **to establish the factual scientific data on its sub environments**. By consulting **the available literature and comparing the same with the investigated area** some of the scientific conclusions were drawn. Besides this information the Regional geology and the Regional geomorphology of the area are presented.

1.0 Introduction:

Understanding the coastal environments will be complete, only when we have the knowledge of geological processes that are responsible for the coastal evolution time to time. The coastal system is a dynamic process and continuous throughout the course of geological time. The coastal environments will under go changes resulting new environments over the older systems. The dynamic coastal system will be influenced by geological processes like sea level oscillations, neo-tectonism, drainage pattern and other similar processes. The Natural system is so complex and some times it may be difficult to fully comprehend. However, with the strong scientific data on the geology, geomorphology and tectonics, one can understand the formation and geological sensitivity of a particular given area.

With this context the area in which the **Nagarjuna Construction Company Limited** has proposed to establishment of 4X660 MW power project near Gollagandi village, has been investigated. With the experience and expertise on the coastal systems, the author has investigated that the area with a sole objective of determining the geological nature of the site of the proposed thermal Power station. Using the data on regional geology, local geology, geomorphology and tectonics from the earlier investigations of different workers, the environment could be realistically established. The study could establish that the proposed area for thermal power station is not environmentally sensitive and it could also be scientifically proved that the proposed area is neither a mud flat nor any such similar environment.

From the available geological data, the study area is underlain by rocks such as Khondalites and charnockites, which are of general geological nature and in tune with the Regional geology. Geologically there are no abnormalities are found and in fact the area represent an environment which is more influenced by the inland process rather than coastal processes. The area typically bordered by well formed dunal systems disconnecting the area with the inter tidal zone.

This scientific document presents the relevant information on Geology, geomorphology and Neotectonics of the area in general and basing on this the scientific nature of the area under study is established and conclusions are drawn.

2.0 Objectives:

- To Understand the Geological nature of the study area using the regional geological, geomorphological and neotectonic controls of the coast
- To establish the factual scientific nature of its geological sub environment.
- To investigate whether the study area is influenced by sensitive coastal environments like mud flats or alike.

2.1 Location and Accessibility

The study area lies in the survey of India Toposheet no 74B/9. The area is accessible from Srikakulam District Head Quarters. In between, the area is well connected by all weather motorable NH-5 road. The National Highway NH-5 connecting Chennai ñ Kolkata passes through Visakhapatnam, Srikakulam and Palasa. The broad gauge railway line from Chennai to Howrah runs parallel to the Coast. The nearest air port is Visakhapatnam.

2.2 Physiography

Physiographically, the area may be classified into three units, as (i) high topographic relief represented by the hill ranges, (ii) narrow and steep valleys between hill ranges, and (iii) plains with isolated hillocks or inselbergs. The hilly terrain showing high topographic relief is characterized by Eastern Ghat rocks and exhibit NE- SW trend, and a few hills show EW to NW ñ SW trend. Intermediate valleys are narrow and steep. Plains are about 15 km wide constitute in situ weathered mantly and washed of materials from hills and valleys, which essentially composed of coarse to medium sands, gravels and clayey material. The general elevation of plains varies from 60 to 120m above mean sea level. The coastal land comprised of sand dunes having heights 10 to 15m are common.

2.3 Rainfall

The coast of Andhra Pradesh receives a normal annual rain fall of about 98.8cm. It varies form 75 cm to 150 cm in the southern part. The southwest and northeast monsoons bring rainfall to this region. Mostly south ñ west monsoon during June to September brings heavy rain fall (60%). North-East monsoon during October to December gives rainfall of about 30%. Intermittent rain, showers are common during winter (January) to hot weather period (May), which constitutes 10% of total annual rain fall.

2.4 Temperature and Humidity

Temperature in this region rises from middle of February till May and the mean maximum temperature recorded is about 42^0C in May. With the onset of SW monsoon the temperature decreases by about 2-3^0C. In winter season, the area enjoys modest temperature of about 18^0C. Humidity in this region is more (nearly 80%) in early hours of a day and by evenings, decreases relatively low up to 70%. Humidity is more during rainy season and less in winter season.

2.5 Winds and Currents

Winds of moderate speeds are common during summer and early part of the south-west monsoon seasons, winds with all directions and some strengthening winds are common. During October to December, winds are northerly or north westerly in the mornings and north-easterly and south-easterly in the afternoons. In January and February, the morning winds have directions from west and north. The afternoon winds are from east and south in. January and from south-east and south-west in February. Storms and depressions originating in Bay of Bengal cause widespread rains and high speed winds. Thunderstorms occur mostly during April to September. Fog or mist occurs in the coastal areas occasionally during December to February months.

2.6 Drainage

The study area is drained by five main rivers namely Gosthani, Panchavati, Kandivalasa, Nagavali and Vamsadhara rivers. All the rivers originate in the Eastern Ghats traversing NW-SE direction over 100 to 250 km and join the

Bay to Bengal. During the rain seasons, water flows through a number of small rivulets along the hill slopes. The general drainage pattern is dendritic to subdendritic and parallel at some places. On hilly terrain the drainage is dendritic and central part of the area shows parallel to sub dendritic. Among the rivers flow in this region, Nagavali River is perennial and other respond to seasonal rains.

2.7 Coastal Studies:

Several workers have studied particle size characteristics and sedimentary environments. Along east coast, the first occurrence of heavy minerals was reported by **Mahadevan** et al. (1948) from Viksakhapatnam beach. **Borreswara Rao** (1957) has carried out work on erosional aspects, along the river confluences between Nagavali ñ Vamsadhara Rivers and explained the reasons for grain size distribution and heavy mineral concentration along the northern and southern river confluences. **Krishna Rao and Murthy (1964)** have studied the petrography of leptynites, khondalites, charnockites, quartzites and pegmatites.. **Dhana Raju** and **Krishana Rao** (1967) have indicated the effects of artificial barriers on the beach sands of Visakhapatnam as the storms help in high concentration of opaques. The coast of Andhra Pradesh was studied in detail by many workers, notable among them are **Rao** et al. (1980, 1985) reported cheralite a thorium rich mineral from Visakhapatnam ñ Bhimunipatam coast. They have dealt the origin of white sands of Prakasam district, Andhra Pradesh. **Raman** (1980) and **Srihari** (1980) gave a complete account of the origin of red beds around Bhimunipatnam. **Ramamohana Rao** (1982), **Jagannadha Rao** et al. (1984) and **Sastry et al. (1987)** have studied the heavy mineral concentration and mineralogy of ilmenites of Visakhapatnam- Bhimunipatnam coast. **Prudhvi Raju** et al. (1978) have described the geomorphology of Visakhapatnam , along East coast. **Dhanunjaya Rao** et al. (1989) have broadly covered heavy mineral control and textural characteristics of coastal sands of vast stretch from Krishana River to Champavati River along Andhra Pradesh coast.

Rajasekhara Reddy et al. (1997, 1998, and 1999) have worked on beach sands of northern Andhra Pradesh coast, between Kalingapatnam and Baruva. Their studies were confined to grain size environment and heavy mineral concentration pattern on fore shore and back shore along Bhavanapadu coast, Pudimadaka and Pentakota. A rare variety monazite analyzing ThO_2 of 30.81% indicating cheralite has been reported from north of Kalingapatnam coast.

Ali et al. (1989) have studied the textural characteristics of heavy minerals at Ratnagiri coast of Maharastra. Reconnoitary exploration work along East coast in the part of Andhra Pradesh by **Dhanunjaya Rao** (1989) has indicated potential heavy mineral resources between the coastal tracts of Nellore in south of Champavati River in north. He has described the mineralogical assemblage and their distribution in sand. The coast off- Andhra Pradesh, Orissa has been studied in detail by several workers. **Mallik** (1981) has discussed about the distribution of heavy minerals ilmenite, rutile and pyroxenes of Kakinada offshore sediments (east coast). **Nagamalleswara Rao** et al. (1998) have conducted studies on textural studies of beach and dune placer deposits of Andhra Pradesh coast. **Mallikharjuna Rao** (1999) studied the trace and rate earth element composition of garnets from Eastern Ghat rocks. There is a substantial variation in trace elements and REE content. **Dikshitulu** et al. (1999) have briefly described about mineralogical, textural and chemical variation in heavy mineral beach sand deposits of Andhra Pradesh.

The coast of Tamil Nadu has also been studied by several workers. **Chandrasekar** and **Rajamanickam** (1999) have focused on mineralogy and geochemistry of opaque minerals from the garnet beach sands of central Tamil Nadu coast.

On the west coast, number of workers have studied the sedimentary environments and the controls of heavy mineral concentration and their distribution in sands. **Prabhakara Rao** (1962) described the heavy mineral concentration along Chavara coast between Neendkara- Kayamkulam (Kerala coast) is a result of slow wave action and enrichment of heavy minerals due to

natural panning in the barrier beach. **Mallik** (1987) has studied the sea erosion and sediment pattern along the Kerala coast. Atomic mineral Division under Department of Atomic Energy, Government of India has estimated the heavy mineral reserves of chatrapur in Orissa, Manavalurchi in Tamil Nadu, Chavara in Kerala, Ratnagiri in Maharastra and several new heavy mineral beach deposits are recently identified in India. All the placer deposits of India, their reserves, chemical quality of minerals, mining activities in India, flow sheet operation etc were reviewed.

Jagannadha Rao and others (1984, 1987, 1993, 2007, 2007a, 2007b,) studied the beach placer deposited associated environments. The studies on geochemistry and genesis of Ilemnite from the Beach Placer deposits of East Coast of India were extensively carried out. Similarly studies on environmental aspects including the establishments of coastal environments to delineate areas for mining and set of industries were carried out. The study on Paleo sea levels along this coast were also undertaken. These studies resulted the establishment of intertidal deposits like beach rocks and other lithologies. **Jagannadha Rao** (2006) studied the coastal environments along the Srikakulam Coast.

3.0 Regional Geology and Geomorphology:

3.1 Regional Geology

It is very well known that the geological setting is the prime responsible factor for the evolution of any coast. The suite of heavy minerals of any area is the reflection of lithology of hinterland, the geology of Andhra Pradesh Eastern Ghats is presented to show the various geological feature to some extent, where the present area studies forms a part of it. Secondly the local geology of north coastal Andhra Pradesh (present area of study) is presented in detail with reference to geological formations, and lithological units

3.2 Regional Geology of Eastern Ghats

Geology of Eastern Ghats is very complex and interesting. They consist a series of hill ranges along the East Coast of India representing dendudational rocks ranging in age from Achaean to Mio-Pliocene. Pioneering work was

carried out by Oldham, Blanford, Ball, King, Holland, Walker, Fermor, Crookshank, Krishnan and Ghosh. The recent work include Rerraju, Venkatesh, Sriramsas, Murthy, Krishna Rao, Narayana Swamym, Banerjee, Ranganathan, Viswanathan and Reddy, Nanda and Natarajan, Ray and Bose, Sarkar et al., Subramanian, Aswathanarayana, Vibogradow, Geological Survey of India and many Indian Universities. Only the latest references are presented in the bibliography (Workshop on the Eastern Ghats Mobile Belt, 1994; Proceedings of the workshop published in 1998). Krishnan (1943) defined the Eastern Ghats as a Series of Rather detached hill ranges of heterogeneous composition which stretch intermittently along the northern borders of Orissa through the coastal regions of Andhra Pradesh to join Nilgiris in the western part of Chennai. The Eastern Ghats constitute a major Precambrian belt of Peninsular India and is characterized by the distinctive association of khondalite (quartzo-feldspathi-garnetiferous-graphite-sillimanite gneisses and schists) and are well developed in the Eastern Ghats of Orissa and Andhra Pradesh, which is taken as the type area for the purpose of composition and correlation (Murthy et al. 1971). These two rocky types were intruded and migmatised by quartzo-feldspathic intrusive, resulting varied assemblages of migmatite rocks the Younger intrusions include granite, anorthosite, carbonatite, pegmatite and nepheline syenite.

Ramakrishnan et al. (1998) presented a tentative stratigraphic column of Eastern Ghats in geochronological order of 3000 Ma to 800 Ma. The hinterland geology of the coastal area mainly consists of Eastern Ghats Mobile Belt (EGMB) encompassing an area of over 50,000 sq km extending over a distance of 900 km in a direction NE-SW, extends from Brahmani river in Orissa to Ongole in Andhra Pradesh. This belt runs almost parallel to the coast and has 100 km width for 600 km length, encompassing the pats of Krishna, Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts. This tapers down to less than 20 km down to south. The geological formations encountered along the eastern margin of the coast are covered with Gondwana, Tertiary and Quaternary formations. The mobile belt is largely divided into three zones via the Western Charnockite Zone, the Central Khondalite Zone and the Eastern Migmatite Zone, which constitute major

lithological proportions of 30%, 25% and 45% respectively (Raman and Murthy, 1997). The three zones have variable widths western charnockite zone is 20-30km wide and central khondalite zone and eastern migmatite zone are 40-100km wide.

The succession of Eastern Ghats super group is as follows: (Raman and Murthy, 1997)

Instrusives	Layered anorthosite and associated mafic and
Charnockite Group	charnockite with magma crystic K-feldspar
Khondalite Group	Calc Silicates granulites

Ramakrishnan et al. (1998) have described that the EGMB has four zones with characteristic lithological association viz., Western Charnockite Zone, Western Khondalite Zone, Central Migmatite Zone and Eastern Khondalite Zone. **Krishna Rao et al (1996)** have studied the mineralogy of gneisses and granulites for opaque minerals and estimated the opaque minerals by modal composition. They have derived the conclusion that leptynites are K-rich consists of hypersthene and suggested granitic composition. The diopside-garnet-plagioclase-hypersthene assemblage suffests impure calc rich rocks. Greenshchists poor in quartz consist of hornblende, garnet with or without chlorite, biotite and magnetite. Retrograde metamorphism results garnet of granulites breaking into biotite and magnetite. High grade metamorphic and igneous (plutonic and Volconic) rocks are considered to be most suitable host rocks which contain ilmenite, rutile, zircon, monazite, garnet and sillimanite among accessories or essential minerals.

3.3 Local Geology of the Area:

Andhra Pradesh has a long coastline forming about 40% of the East coast of India. The Quaternary formations are underlain by diverse rock types along different sections of the coast via precambrians along the northern coast represented by the litho units of the Eastern Ghats super group.

The coastal tract of the Srikakulam, Vizianagaram and Visakhapatnam districts is narrow with interspersed estuarine rivers such as Vamsadhara, Nagavali, Champavati, Gosthani, Sarada, Tandava, Varaha etc. with their narrow floods plains. The coast in this part is highly rocky in nature with scraps and rocky promontories of khondalite exposed right on the beach. A number of wave erosional features like rock-cut terraces, benches, cliffs etc are present. This stretch may be termed as an erosional coast.

The structural landforms, mainly hogbacks of khondalite, denudational landforms of khondalite, pediments and pediplain composed by yellowish brown silts, rock fragments and kankar are common features. The active channels invariably contain coarse, medium sand. Brown and black salty clay are to be met within flood plains. Gray to white sand with black sand concentration berm crests ***compose the active beach ridges with 2 to 3 rows of dunes as part of the coastal marine landforms***. The black sands consist of ilmenite, garnet, magnenite, monazite, rulite and zircon.

In the northern segment for instance, the heavy mineral suit consists of Sillimanite, Monazite, Zircon, Ilmenite, Rulite etc, characteristic of khondalite provenance. Several patches of black sands with Ilmenite, Magnetite, Garnet, Tourmaline, Rulite, Zircon and Monazite as heavy mineral concentrations occur along the beach and in river beds in Srikakulam, Vizianagaram, and Visakhapatnam.

Beach and dune sands in the northern segment extend for 352 km and are best developed in the embayment-headland combination that has abetted and helped in the formation of palcer deposits. Most of the bedrock headlands

have acted as traps for sediment build-up. Ventral khondalite zone and eastern migmatitic zone of the Eastern Ghat Mobile Belt and coastal Gondwanas are the important litho-units in this segment. Important deposits identified are Bhavanapadu, Kalingapatnam and Srikurmam of high-tonnage and Donkuru-Barua, Koyyam, Bhimilipatnam and Pentakota of medium-tonnage. These are characterized by heavy mineral (THM) concentration of 10% to 25% (average), with ilmenite, garnet and sillimanite, together accounting over 90% of THM. Generally of shallow depths (8m to 10m), the deposits have width ranging from 150m to 1500m. Reserves of 49.75 million tones (mt) of ilmenite (48.30% of AP reserve), 38.87 mt of garnet, 37.46 mt of sillimanite, 1.65 mt of zircon, 2.55 mt of rulite and 0.87 mt of monazite have been estimated. Gangue minerals and magnetite form 5.60% and 0.40% of THM. TiO_2 content of ilmenite ranges from 50 to 52%.

3.4 Geology of Eastern Ghats of Andhra Pradesh

It is considered as a classic example of a Precambrian mobile belt in the Peninsular Indian shield. In recent times, it is categorized as Eastern Ghats Mobile Belt (EGMB) and also as Middle protrusion Mobile Belt (MPMB); as they are younger, linear, metamorphic belt which surround ancient cratonic nuclei of shield area and are characterized by high grade metamorphic granitisation and intense shearing. The EGMB has been found along Khammam, Prakasam, Guntoor, Krishna, East Godavari, West Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh for more that 600km in length and with variable width of less that 20 km to 100 km. The district Visakhapatnam, Vizianagaram and Srikakulam form the present area of study.

3.5 Description of Rock Types

3.5 .1 Khondalite Group

This is a metasedimentary group consisting of and interbeded sequence of garnetiferous Sillimanite Schists/Gneisses (Khondalites), quartzites, diopside

granulites and gneisses, and represent respectively the argillaceous, arenaceous land calcareous members. The khondalites are grayish, purple or dirty in colour and are essentially composed of quartz, rusty brown garnet in discret grains/aggregates, needles of Sillimanite and minor amounts of brownish decomposed feldspar. The typical khondalites are analysed for whole rock composition (Murthy et al. 1999). Diopside granulites, crystalline limestones and marbles represent the calcareous members of the metasedimentary group and are closely associated with garnetiferous Sillimanite gneisses and quartzite. Diopside, scapolite, wollastonite, plagioclases and garnets are important constituents.

3.5.2 Charnockite Group

The occurrence of hypersthene bearing granulite and gneisses, referred to as charnockite. They have intimate association with the metasedimentary rocks of khondalite group. The origin of charnockites is a debate in the recent years. The genisis is believed to be igneous to sedimentary metamorphic and metasomatic origin. They are dark in colour, hard massive having there varieties acid, intermediate and basic, the first two varieties are more abundant in the area under review. The basic charnockites occur as bands and dykes in gneissic rocks. The western charnockite zone shows interbands of orthopyroxenes bearing granites to tonalities in gneissic rocks. The composition of granodioritic predominates, whilegranites and tonalities are subordinate. Charnockites in shear zone show porphyroblastic nature with feldspars as mega crysts. The rock composed of quartz, orthoclase, plagioclase, hypersthene and garnet. Some charnockites are migmatitic and contain hronbledne, biotite and garnet besides ortho, clinopyroxenes.

Two pyroxene granulites with garnet and amphibole occur as narrow layers in charnockites as well as ortho para geneisses. Petrological studies on sapphirine granulites of Eastern Ghats of some areas have revealed that khondalites, charnockites, pyroxenites and khondalites -charnockite contact contain rutile 1-2%, zircon 1-2%, monazite 1-5%, ilmenite 1-2%, garnet 10-

25% (khondalites), Sillimanite 10-25% (khondalite-charnockite contact), pyroxenes 1-2% charnockite **(kamineni and Rao, 1988).** This gives fair idea about chemical characteristics of accessory minerals.

3.5.3 Quartzo- Feldspathic Granulites

In the Eastern Ghat terrain, garnetiferous quartzofledspathic granulites are of wide spread occurrence constituting leptynites (garnetferous types) and leptites (non-garnetiferous types). These rocks occur mainly as narrow bands along the foliation planes of khondalites.

The quartzo-feldspathic granulites also as veins traversing the pyroxene granulites. The rocks are migmatitie in nature as most of the outcrops of these rocks contain bands, streaks and patches of either khondalites or pyroxene granulites. The modal composition of leptynites indicates quartz 20%-30%, plagioclase 14-45%, K-feldspar 16-42%, garnet 7%-20%, biotite 1%-7%, zircon 0.2%-1.2%, apatite 0.2%-0.8% and opaques 0.5%-2.5%. Garnet is important consitituent mineral shows euhedral to rounded shape. Divakara Rao and Murthy (1999) have studied the whole rock composition and trace element content.

The quartzites are highly weathered and garnets are leached and removed, leaving the pitted surface, showing a wide colour variation from white to pink. They occur more abundant to north of Mahanadi lineament and occur within the politic gneisses as layers in Srikakulam and Vizianagaram areas. Sillimanite quartzite, hypersthene quartzite and diopsite quartzite (rare) are seen in central migmatitic zone. They are also associated with manganiferous horizons of Srikakulam and Vizianagaram areas.

3.5.4 Calc Silicate Rocks

Calc Silicate rocks, rich in diopside and garnet and local marble bands are commonly occurring with quartzite and politic gneisses.

3.5.5 Granites and Gneisses

The porphyritic feldspar gneisses occur as small mounds and hills with a height about 500ml MSL. The central migmatic zone shows the abundance of migmatitic gneisses of two compositions, hornblende-biotite-gneisses with garnet and hypersthene and garnetiferous quartzo feldspathic gneisses with biotite and Sillimanite. Younger granite intruded into gneisses exposed in some parts of interior Srikakulam district.

3.5.6 Sandstones and Clay

They are of Gondwanas, which occur in some parts of northern Andhra Pradesh coast. They form moderately buried pediplain deposits.

3.5.7 Laterites

A period in which these host rocks undergo weathering, and there by a deep soil mantle zone formed, from which all soluble silicate minerals were leached by organic and mineral acids, leaving the quartz and other resistant minerals including titaniferous minerals like ilmenite, rutile and insoluble silicates like zircon and phosphates like monazites.

In brief, the coastal area of Andhra Pradesh expose rock types mainly of Dharwar insouthern part and khondalite and charnockite rocks in northern part. The Proterozoic sediments of Cuddapah basin and Kurnools are exposed in the western part of interior parts of Andhra Pradesh. Gondwana sediments and laterites adjoining coastal plains are seen along northern coastal parts of Andhra Pradesh. The

geological studies indicate that the area is characterized by Khondalites, Charnockites and their variants. The geology and structure is more or less similar along the East Coast and structurally we did not find much difference in the study area. As shown in the geological section the rocks are Precambrian age in which Khondalite is a metasediment and the Charnockite is an igneous emplacement into metasediments. These two rock types have undergone a deformation during Eastern Ghats evolution. During that evolution trends in the direction NE-SW and E-W have been formed along these trends it is believed that the East Coast is structurally disturbed resulting a number of regional blocks along the Coast. Movement of these blocks relative to the rest of the land mass resulted the subsidence or up throwing of the blocks. This is well established by studies carried out on Neotectonics.

4.0 GEOMORPHOLOGY

Coastal Geomorphology plays a vital role in the evolution of the Coast. Features like bays, caves, creeks, flat beaches with low angle slopes, backwater systems etc are common in the coastal tracts of AP. Studies based on Remote sensing techniques by Gaitan vaz et al (1998) have revealed geomorphic features of North Andhra coast which are mainly pediplain, denudational hills, badlands, flood plains, lagoons, dunes and beach. Bays protected by headlands like at Lawsonís Bay ñVisakhapatnam, Kalingapatnam coast, the wave energy is reduced by refraction and in such cases, instead of erosion, and sand deposition takes place. Hence, wide areas of coasts near Nagamayyapalem-Annavaram, Nagavali-Vamsadhara coastal stretches contain more of sediment deposition than sea erosion. The berm zones are better developed on the northern areas of Gosthani, Kandivalasa, Nagavali and Vamsadhara rivers. ***They extend about 30-50 m wide and extend landward side. They are followed by frontal sand***

dunes raising to the heights of about 8m. Some isolated dunes are formed along the coastal stretches where the movement of sand is obstructed by plantation. Sometimes they completely separate the marine environment from the inland environment. The coastal plains consist of certain denudational and depositional landforms such as dissected topography, sea cliffs and the depositional forms include narrow flood plains, terraces, dunes of various sizes, tidal flats and spits. The width of the coastal plains also depends on certain geomorphological controls like rocky coast and configuration of the coast. The coast along the north of Visakhapatnam containing narrow beaches having width up to 200m and extends up to 600m near the river confluences.

The geomorphology of the Eastern Ghats represents a lithostructurally controlled denudational morphology under humid tropical climate and tectonic stability since the Mid Jurassic times (Mahalik, 1998). The rivers Nagavali and Vamsadhara are controlled by tectonic lineaments. The sediment cover 0-20m of coastal plain is of Holocene age. The Eastern Ghats form a major part of hinter land geology and expose along the coastal plains. The geology indicates the rivers flow along distinct NW-SE lineaments. Hill ranges of Eastern Ghats forming as NE-SW direction exhibiting number of rock promontories and bay features between headlands. The erosional features of red beds attaining at higher elevations and forming as bad land topography are clearly demarcated south of Gosthani River. The coast near Visakhapatnam, the presence of laterite and kankar at -20 and -23m below ground level close to the coast indicated that the sea level must have 23m below the present mean sea level. A few rock cut marine terraces at the elevations 2.6 and 10m above MSL near Bhimunipatnam were observed **Vaidyanathan (1981).**

4.1 COASTAL EVOLUTION:

The coastal geomorphology of Andhra Pradesh coast is unique and present a wide variety of land forms both of erosional and structurally controlled. It is quite long inquisitive in the minds of coastal scientists on the changes and

differences noticed along the coast within the short distances. While other parameters are constant, it is questioned how the changes are influencing the distribution of minerals. Of late, neo-tectonism and the sea level variation studies have drawn the attention of environmentalists and geologists in general; a slight variation in one spot has been taken into consideration for a broad generalization. The coastal geomorphological study has clearly shown the existence of different east-west blocks. Along the East and West coasts, the prevalence of such blocks have been confirmed from geomorphic as well as seismic studies. It is expected that the Indian coast has been subjected to great stress and given way to the formation of such east-west blocks. Recent study along the east coast by some workers have clearly established the existence of such blocks having divided by the strike slip hinge fault system. Probably, the tilt and the throw vary from block to block. The clear distinct distribution of vegetation, soil, crop pattern, sediment and rocks have established the necessity of studying the geomorphology in close grid.

The establishment of such blocks explain the coastal evolution. With this background one can understand that the coastal system is influence by either an up thrown block or a subsided block. The subsidence sometimes may result a low lying area, resulting an environment of water logging.

The neotectonic events reactivated the prominent lineaments and are responsible for the shaping of the present coast. In the make of continuing the neotectonic movements along with the existing trends, it is expected that East Coast line would undergo further modifications. The geomorphological and recent coastal landform studies revealed that their role is significant in shaping the present day coastline. Most of landforms are stabilized during the lowered sea level at Pleistocene period. The prominent lineaments trending NE- SW represents the tectonic episode of the Eastern Ghats. These lineaments are younger in age. The various geomorphological processes have accentuated the coastal lineaments. The geophysical data on the lineaments of the coast indicate that they are extended to the offshore. The lineaments in the coastal areas have played a significant role in shaping of the coasts.

The lineaments are extended to offshore areas of the East Coast the seismic records of Visakhapatnam-Gopalpur shelf, east coast of India reveal prominent morphological features suggest a possible neo-tectonic activity. The lowest sea level at Pleistocene down to about 130m below the present sea level also helped the accumulation of huge sediments in the coastal and near shore areas. Thus fluctuations of sea level during Pleistocene and Holocene periods have left their imprints on the present geomorphological features on the coast. The relict sediments on the coastal areas deposited in sub-aerial, lacustrine and paludal environments. The presence of oolites, foraminifer corals, and erosional features on the coast indicate the fluctuations of sea levels and may also represent the presence of neotectonic activity. The micro-paleontological studies indicate the fluctuations of the shorelines during Quaternary period. The topographic linear hights is between Kalingapatnam-Pentakota, East Coast in the near shore areas gives evidence of the neotectonic activity along the East Coast.

4.2 Fractures/Fracture traces along the coast:

Fractures (also known as lineaments) have been defined (Lattman and Matze, 1961) as natural linear features that have more than one mile of continuous expression as viewed on aerial photographs. To these linear features that have less than one mile of continuous expression are fracture traces. These fractures/fracture traces which are, usually straight and occasionally arcuate are considered by many workers as the surface expression of joints or joint concentration/faults in rocks. Emphasized by topography drainage and vegetation (Blanchet, 1957, Lattman 1958, Henderson 1960 and Boyer and Mcqueen 1964). In the Precambrian craton majority of these lineaments are fractures and faults.

Raghavaswamy (1980) has identified a number of fracture zones in this area. Prudhiviraju and **vaidyanadhan (1981)** reported fracture pattern from Eastern Ghats by land sat imagery.

A majority of fractures/fracture traces in this area have ENE-WSW to E-W orientation (Raghavaswamy 1980). The length of fracture/fracture traces varies between 2 to 6 km in aerial photos.

4.3 Shelf off the Visakhapatnam-Bhimunipatnam

The shelf off the Visakhapatnam may be said to be generally steep. The steepness increases towards the north of Visakhapatnam. The width is 24-25 miles. Kukkuteswara Rao and Lafond (1954) gave the shelf profile characteristics of this area.

Magnetic surveys over the continental shelf off Visakhapatnam were conducted by Rao and **Murthy (1980)** revealed the existence of a fault zone in the near shore region and a possible zone of heavy mineral concentration off Bhimunipatnam.

Bathymetry conducted by. Rao etal (1980) revealed karst type structures over the shelf off Visakhapatnam ñBhimunipatnam coast, which is characteristic feature of limestone terrain. These features are structurally controlled.

4.4 Influence of Tectonics

Indian coast is known to be controlled by different sets of lineaments. Prominent among them are NW-SE, ENE-WSW and NE-SW trends. Studies on coastal landform carried out with emphasis on linear trend signify their contribution in shaping the present day coastline (Varadarajan and Ganju, 1989). While NW-SE and NNW-SSE faults have shaped the west coast, NE-SW to N-S lineaments have shaped the east coast. The studies also show recent movements along these prominent lineaments as evident from deflection of river courses, off setting of sandbars etc.

Their orientation and nature show imprint of different episodes of tectonic events from Precambrian to Recent. The three tectonic lineaments that represent major tectonic episodes are Dharwarian (NW-SE), Eastern Ghats (NE-SW) and Satpura (ENE-WSW). NW-SE lineament corresponding to the Dharwarian structural trend is considered oldest and is one of the more

pronounced lineament directions along the Andhra coast. Most of these extend into offshore region and dissect the coast into various segment. NE-SW lineament corresponds to Eastern Ghat regional trend. Recent coast, apart from being restricted and shaped by its presence, seem to have affected by the movements along it. ENE-WSW lineament of Satpura trend affect both NW-SE and NE-SW lineaments and is considered as the youngest.

Study of the regional lineament map and synthesis of lineament/fracture and geophysical data (Varadarajan and Ganju, 1989) show a remarkable feature along the Andhra coast. The NW-SE Dharwarian trends have dissected the coast at a number of places and their trends coincide with erosion or deposition of sand The study shows that divergence pair of lineaments result in formation of a good and large deposit, e.g, Bhimunipatnam, Kalingapatnam, Bhavanapadu and Kakinada. However, where they converge it has been found to carry low-grade occurrences with thickness of less than 5m. Further, they are found to be erosional in nature as near Koyyam and Pentakota. The parallel occurring lineament carries medium sized deposits. This observation needs, however, further refinement by studying the effect of minor lineaments. The angle of convergence is found to have a great bearing on the formation of sand body. The greater the convergence, the lesser are the chances of mineralisation. The large angle divergence has helped in the formation of large bays with an enclosed lineament and helped in large accumulation of sand body.

4.5 Special Geomorphic features of the study Area

4.5.1 Back Water/Estuaries

The estuaries are submerged river mouths. The river debouching into the sea alohg the coastal sections with broadening nature of river before they enter into the sea water. Consequent on the development of wide estuarine mouths near the sea, a lot of sea water encroaches through them during high tide.

The best developed estuarine environment is noticed along the Coast. Nearly up to 1 km landward, sea water surges forward to form the back water zone in the study area.

4.5.2 Tidal Creeks

Tidal creeks are inlets, through which water flows to and from backwater during high and low tides respectively. Tidal creeks are found in the Tekkali, and Bendi region. The width of the tidal creeks also gets enlarged and reduced during high and low tides, respectively. It consists of fine sand, silt and black mud and clay with shell fragments.

4.5.3 Mudflats and Tidal Flats

Consequent on the development of wide estuarine mouth near the sea, a lot of sea water encroaches through them during high tide and submerges low lying flat areas adjacent to the rivers forming tidal flats.

The mud flats that were developed during the last inter glacial and Holocene transgressions are designated as palaeo tidal flats. They are found to occur underlying the palaeo barriers, but they are wider than the palaeo barriers, the exposures are found encircling the palaeo barrier at 1 or 2m below the surface. They have a width in the east west direction up to 4m length in the north south direction up to 35 km. These palaeo tidal flats are being actively utilized for the cultivation of the wet crops.

The southwest monsoon winds help to raise the level of sea during rains and cause a battle of supremacy between the landward rushing of sea water and seaward rushing of flood water of the rivers. This results in oscillation of mass of mud near mouths of estuaries and it responsible for the formation of mud flats. It is observed that the mud flats are of local nature extending up to 2km in the east west and up to 4km in the north south. The thickness of the clay and silt goes up to 5m. The developments of tidal flats and mud flats are common in the Srikakulam coast.

4.5.4 Salt marshes

Salt marshes are defined as marshy lands that are periodically flooded by water. In other words, salt marshes are vegetated mudflats. While the mud flat regions are completely submerged under sea water during high tide, the salt march area gets water only through tide **(John Petnick, 1984).**

4.5.5 Salt Pan

There are very common in the study area. During dry seasons, hyper salinity is achieved leading to the development of evaporates. The saltpans are composed of clayey silt with minor amount of sand size grains. The sources of silty sediments are from the. The sediments are well bedded and laminated. Mud cracks are very common.

4.5.6 Dunal Belts:

Dunal belts formation of extensive dune belts along this coast is very common. These are windblown sand mounts characterized by well sorted fine sand. Sometimes these mounts raise up to 40 to 60 feetís and form like a barrier between coast environment and inland environment. In the present study area also this phenomena could be observed.

The geomorphological features along the this Coast mentioned above indicate the features are mainly resulted by influx of sea water into the land wards side, these includes Salt marshes, Tidal Creeks, Mud flats, etc., these features are invariably have connection with the sea and the environments are resulted due to the influence of sea water.

5.0 GEOLOGICAL ENVIRONMENT THE STUDY AREA:

5.1 STANDARD DEFINITIONS AND DESCRIPTIONS OF MUDFLAT ENVIRONMENT

5.1.1 Mud flat

Low-lying muddy land that is covered at high tide and exposed at low tide. Mud flat is a low-lying land consisting of silt or sand that is covered at high tide and exposed at low tide.

5.1.2 Mud·flat (Webster's Dict)

A level tract lying at little depth below the surface of water or alternately covered and left bare by the tide

Mudflats (also tidal flats, tide flats, etc.) are coastal wetlands that form when mud is deposited by the tides, sea and oceans. They are found in sheltered areas such as bays, bayous, lagoons, and estuaries. Mudflats may be viewed geologically as exposed layers of mud Bay mud resulting from deposition of estuarine silt Silts, clay Clays and marine animal detritus.

Mudflats are typically important regions for wildlife, supporting a large population, although levels of biodiversity are not particularly high. They are often of particular importance to migratory birds.

5.2.1 Mudflats (EU Definition and Garner, A Text book of Geomorphology)

Mudflats are **sedimentary intertidal habitats** found in estuaries and other sheltered areas. The sediments generally consist of silts and clays with a high organic content. Mudflats frequently occur as part of the natural sequence of habitats between the **sublittoral zone and vegetated saltmarshes**. Like most

other intertidal areas they **dissipate wave energy** and thus have an important role to play in reducing the risk of erosion damage to saltmarshes and coastal defences, and of tidal flooding in low-lying coastal areas. Mudflats are typically highly productive habitats supporting a high biomass but relatively low species diversity with few rare species. The precise nature of the biota reflects both the prevalent physico-chemical conditions and the degree of enrichment by, for example, sewage pollution. Mudflats are very important habitats that support huge numbers of birds and fish. They provide both feeding and resting areas for internationally important populations of waders and waterfowl and also act as nursery areas for flatfish. The main importance of the mudflats to wildfowl and waders derives from their high productivity and consequent high biomass of prey items. They are also important as resting areas, a function that is enhanced by their relative inaccessibility and freedom from disturbance.

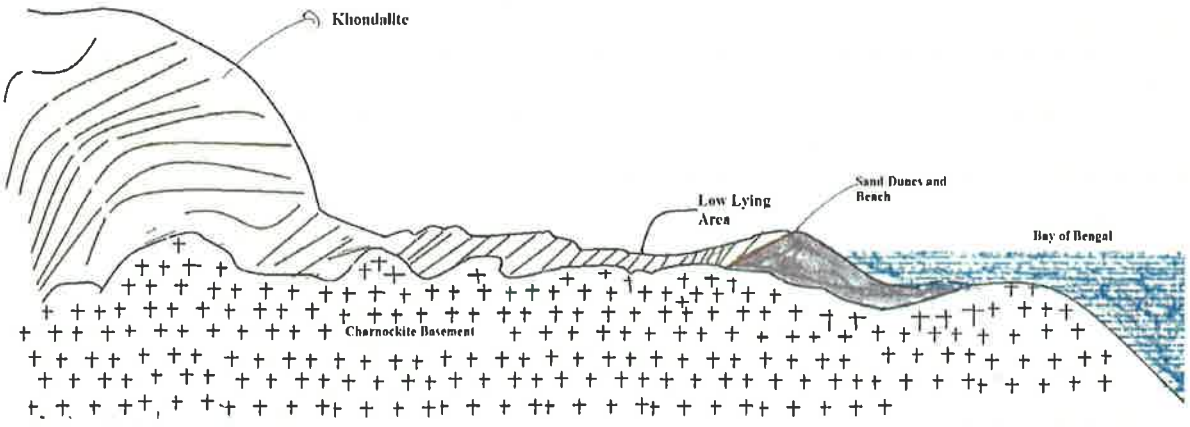
5.2.2 Physical and biological status of Mudflat (Govt of Ireland document, Standard Def)

Mudflats are intertidal habitats created by sedimentary deposition in low energy coastal environments, particularly in estuaries and other sheltered areas such as sea loughs. The substrate is formed mainly from silts and clays and has a high organic content. In higher energy environments, such as the mouths of estuaries, the proportion of sand in the substrate increases. Physical processes link mudflats to many other coastal habitats such as soft cliffs and saltmarshes. They often form the transitional habitat between subtidal channels and vegetated saltmarshes. In larger estuaries they can reach several kilometres in width and are commonly the most extensive part of the estuarine intertidal area. Mudflats play an important role in dissipating wave energy, thus reducing the risk of erosion of salt marshes, damaging coastal defences and flooding low-lying land. The surface of mudflats plays an important role in intertidal nutrient chemistry

5.2.3 The Scientific Explanation:

As mentioned earlier, though certain areas of the Srikakulam coast are characterized by geologically sensitive environments like mud flats, tidal flats, creeks, salt marshes, etc., this area after the detailed investigation is scientifically proved that it does not belong any of this category. To clarify the apprehension that this area is a possible mudflat environment, standard scientific definitions of the environment "Mud Flats" are given below and successfully established the actual geological nature of the study area in the following paragraphs.

Fig.1 Generalized section of the Coast at the study area:

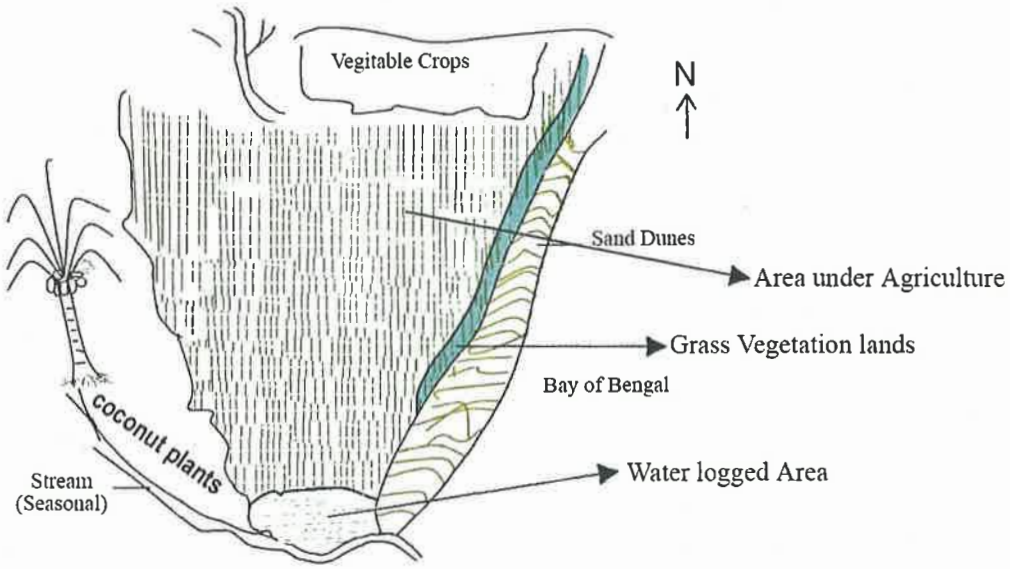


Generalized Geological Section of the Coast

The above figure1 presents the generalized section of the coast. As one can see from West to East the geological slope is maintained towards the East. This generally result the flow of drainage towards the Eastern side. The drainage includes major rivers, minor rivers, streams and seasonal rivulets. Naturally the drainage water some times will tend to accumulate along the coastal tracts resulting a situation of water logging. . The lifting of water using age old method can be seen in the area. "It is to be noted that this area is nothing but a normal area with the occurrence of water seasonally". It is found that , 80% the land is dry, only small patch of the land towards the south is wet. The occurrence of this special condition perhaps explained to be due to the natural depression formed by the basement rock as shown in the schematic diagram. This depression allows the rain water, the drainage water to stagnate little longer during rainy season than usual. This explains the present environment.

From the available geological data, the study area is underlain by rocks such as Khondalites and charnockites, which are of general geological nature and in tune with the Regional geology. Geologically there are no abnormalities are found and in fact the area represent an environment which is more influenced by the inland process rather than coastal processes. The area typically bordered by well formed dunal systems disconnecting the area with the inter tidal zone.

Fig. 2 Schematic Diagram of the Study Area:



Schematic Diagram of the Study Area

The above figure 2 shows the schematic diagram of the study area. As shown in the figure the entire area is characterized by extensive agricultural activity. During the field work it is observed that the area is more or less dry except in the southern part where a small patch of land is wet geologically the area is composed by Khondalites with a Charnockites basement which is in accordance with the general geology setup of east coast geologically or structurally the area present very normal geology and no abnormalities found.

6.0 Surface Hydrology of the Study area:

1. Inflow of water to shallow pockets

The water received from Mukunda sagaram under Pydigam reservoir and Mahendra thanaya River groin, and flood water during the rainy season from the villages lying in western side of low lying shallow water pockets.

2. Out Flow of water from shallow waters goes to

The excess stagnated water will flow through ìIsakalapalemî channel (Bridge) to china Beela of Sompeta Mandal there to Bay of Bengal at ìIdduvanipalem villageî near Borivanka village of Kavitiì Mandal.

7.0 Conclusions

1. The area is away from the coastal regulatory zone and separated from the sea by well developed dunal complex.
2. The demarcation of this study area as ìMudî in the survey of India topo-sheet could not be established during the ground check.
3. The entire area can be named as **"Normal coastal area drained by small seasonal rivulets causing water logging during monsoon periods, which is a natural phenomena along this part of this coast"**
4. An attempt has been made to have a comparison with a possible **mudflat environment**, basing on the scientific definitions (which are mentioned in the report) the established scientific literature clearly indicate that the ìMud flatî is a sensitive ecological coastal terrain formed in an **"inter tidal zone"** where by the brackish water will submerge the area during **high tide** and water will retreat during **low tide. Based on this accepted scientific explanation the area cannot be called as a mud flat because of the following reasons:**

   - The area has **no physical connectivity** with tidal zone and it is not influenced by tidal oscillations.
   - The area is **disconnected with sea water by a complex dunal belt** which separates the land with the sea.
   - The water quality in the area of the study in fact is **characterized by the fresh water** supplied by rivulets draining into the area from nearby high lands.

5. The area is marked by stray grass vegetation and seasonal agricultural activity. The surrounding land is fertile and supports agricultural activity on physical observation the agricultural activity indicate the small scale cultivation of paddy, coconut plantation, cultivation of vegetable etc,. Thus the land could be established as an environment of fresh water rather than brackish water.

6. The rivulets from Mukundasagaram reservoir and Mahendrathanaya are seasonal and drain the area, thus support the agricultural activity. The traditional lift irrigation methods have being practiced in some locations.

7. The geological evidence indicate that the area is characterized by rocks such as Khondalites, Charnockites and Coastal dunes which is tune with the regular generalized pattern and no abnormality is observed. The rockbed lies underneath about 10m deep silty sand deposits.
8. The generalized geological section suggests that the regional slope is from west to east where by certain places of low lying areas could be expected a situation of manmade and natural causes for accumulation of water. In this case also such low lying area resulted the present study area.
9. Geomorphologically, this part of the coast at places characterized by coastal environments influenced by influx of coastal waters. These environments are Salt marshes, Mud flats, Estuaries, Tidal Creeks, etc.,

However, the study area doesnít belong to this group of environments and **it is entirely formed due to sedimentation & stagnation of surplus waters.** due to accumulation of water seasonally.

9.0 Bibliography

Ali, M.A., Naidu, P.S., Manjunath, Y.S., (1989). Studies on the beach placers of Ratnagiri district, Maharastra India. Exploration and Research for Atomic Minerals Vol. 2, pp 167-178.

Blanchet, P.H., 1957. Development of fracture analysis as exploration method. A.A.P.G. Bull. Vol.41 No. 8 p 1748-1759.

Borreswara Rao, C. (1957). Beach erosion and sorting of sand on East Coast Beaches, Current Science, Vol. 26, pp 27-28.

Boyer, E. Robert and Mcqueen, E., 1964, Gomparision of mapped rock fractues and airphoto linear fratures photogrammetric Engineering,. Vol 30, No.4 p630-635.

Chandrasekar, N. and Rajamanickam, (1999). Mineralogy and geochemistry of opaque minerals from the beach sands of Central Tamil Nadu coast. Abst. International Seminar on placer deposits, 14-20 December, 1999, Abst. Vol. p. 89.

Dhana Raju, R. and Krishna Rao, J.S.R. (1967). Effects of artificial barriers on the beach sands at Visakhapatnam, India. J. India Geophysical union, Vol. IV, No. 3&4.

Dhanunjaya Rao, G. (1989). Nature distribution and evaluation of heavy minerals in the beach sand deposits between Mangalore and Cochin, West Coast of India, Exploration and Research for Atomic Mineral, Vol. 2, pp 157-166.

Dhanunjaya Rao, G., Krishna Setty, B. and Raminaidu Ch. (1989). Heavy mineral contol and textutal characteristics of coastal sands in the Krishna Godavari, Gosthani-Champavati and Penna river deltas of Andhra Pradesh, India; A Comparative study. Exploration and Research for Atomic Minerls Vol.2 pp.147-155.

Dikshitulu, G.R., Yugandhrara Rao, Krishnan Banerjee, D.C and Jagmer Sing (1999). Mineralogical ñ textural- chemical variations in heave mineral beach sand deposits of Andhra Pradesh State, east coast of India. Abstract Vol. International Seminar on Placer Deposits. Abstract paper, pp. 90-91.

Gaitan Vaz, G., Mahapatra G.P., and Hariprasad, M (1998). Geomorphology and evolution of barrier-lagoon coast of North Andhra Pradesh in relation to late Quaternary sea level change. Abstract, National symposium Late uaternary, geology and sea level changes and Annual Convention Geol. Soc. India, Cochin p 12.

H.F.Garner, The Origin of Landscapes, New York, Oxford University Press, London, 1974 Toronto.

Henderson,, G., 1960. Airphot lineaments in Mpanda area western province tanganyika, Africa. Bull Amer Soc Petro Geol V44(1), p53-71.

Jagannadha Rao and J.S.R. Krishna Rao. ìTextural and mineralogical studies on red sediments of Visakhapatnam ñ Bhimunipatnam coastî. *Geo views, Vol.XII*, No.2, 1984. Pp.57-64.

Jagannadha Rao, ìBeach Rock from Visakhapatnam coastî. *Current Science,* 1987, 2, pp.26-27.

Jagannadha Rao and J. Syam Kumar. ìRadiometric prospecting in placer sands and associated sediments along Visakhapatnam ñ Bhimunipatnam, East Coast of Indiaî. IM & EJ Jour. Special Volume on *Mining and Environment*, June 1993.

Jagannadha Rao, J.Venkata Ramana, R.Venugopal and M.C.Rao ìGeochemistry and Ore Mineralogy of Ilmenite from Beach placers of the Visakhapatnam-Bhimunipatnam Deposit, Andhra Pradesh, î Journal-Geological Society of India , Vol 66. Aug 2007.

Jagannadha Rao' J. Venkataramana, R. Venugopal and M.Chandra Rao ìCharacterization and paleoclimatic significance of beach rock formation from Visakhapatnam coastî, Andhra Pradesh. Journal of Geological Society of India, Banglore. Vol.70, December 2007, pp.975-980.

Jagannadha Rao and others ìZincian Ilmenite from beach sands of Sreekurmam, Andhra Pradesh, Indiaî Current Science, Vol, 95, No. 9, 10 November 2008..

Kukkutesware Rao, B. and Lafond, E.C., 1954. The profile of the continental shelf off Visakhapatnam coast. A.U. Memoirs in Oceanography, Vol. I.

Lattman, L.H. and Matzke, R.H., 1961. Geological significance of fracture traces. Photogrammetric Engg. V27 No. 3 p435-438.

Lattman, L.H., 1958. Technique of mapping geologic fractue traces and lineaments on aerial photographs. Photogrammetric Engg V24 No. 4 p568-576.

Loveson V., Angusamy N and Rajamnickam. (2000). Usefulness of identifying different geomprphic blocks along the coast of southern Tamil Nadu, Lecture Notes, Short term Training Course 3rd ñ 17th Oct 2000, OSTC, Tanjore.

Mahadevan, C., and Sathapathi, N. (1948). The home of Monazite in Vizianagaram area Current Science, Vol. 17, p 297.

Mahadevan, C., and Sriramadas A. (1948). Monazite with the beach sands of Visakhapatnam district. Proceedings India Academic Science V 27, Sec A, p 275-278.

Mallik, T.K. (1981). Distribution patterns of heavy minerals from the northern part of the Godavari Delta off Kakinada. Ind. Jour. Mar. Sci, Vol. 10, pp 51-56.

Mallik, T.K., Vasudevan, V, Abby Verghese, and Machado T, (1987). The black sand placer deposits of Kerala beach, South West India. Marine Geology, Vol. 77, pp 129-150.

Mallikharjuna Rao, J. (1999). Trace and Re Composition of garnets from Eastern Ghat Granulite Belt. The Indian Mineralogist, Vol. 33, No. 2, pp 47-54.

Murthy, N.N. and Divakara Rao, V. (1999). Geochemistry, provenance and depositioned environment of the Khondalites from the Eastern Ghats Mobile Belt. Gondwana Mem., pp. 16-30.

Nagamalleswara Rao, B., Deva Varma, D. and Varma, K.V. (1998). Textural studies of beach and dune placer deposits of Andhra Pradesh Coast. J. Indian Acad. Geosci., Vol. 41, No.1.

Prudhvi Raju, K.V.N and Vaidyanadhan, R., 1981. Fracture pattern study from land sat imagery and aerial photos of a part of the eastern ghats in India Peninsula, J Geo Soc. of India V22 p17-21.

Prudvi Raju, K.N. and Vaidyanathan, R. (1978). Geomorphology of Visakhapatnam, Andhra Pradesh. J. Geol. Soc. India, Vol. 19, pp 26-34.

Raghavaswamy, V. and Vaidyanadhan, R., 1980. Morphology and land systems of a part of Visakhapatnam district, Andhra Predesh from air photo

studies. Photonirvachak, J Ind Soc Photo Int and Remote sensing V8 No1p 9-21.

Rajasekhara Reddy D., Malathi, V,. Prasad, V.S.S., Reddy, K.S.N. and Varma, D.D. (1999). Beach studies between Bavanapadu and Kalingapatnam, East Coast of India. Paper presented in international Seminar on Placer Deposits, 14-20 December 1999, p 57.

Rajasekhara Reddy D., Vemuri Malathi, Reddy, K.S.N. and Varma, D.D. (1998). Heavy minerals in different environment of beaches between Pudimadaka and Pentakota east coast of India. Jour. Indian Acad. Geoscience, Vol. 41, No.2, pp. 47-54.

Rajasekhara Reddy, D. and Siva Sankara Prasad, V. (1997). Grain size characteristics of beach sediments of north coastal Andhra Pradesh. Ind. Jour. Mar. Sci., Vol. 26, pp 283-286.

Ramamohana Rao, T., Shanmukha Rao, ch. And Sanysi Rao, K. (1982). Textural analysis and mineralogy of the black sand deposits of Visakhapatnam-Bhimunipatnam Coast, Andhra Pradesh, India. J. Geo. Soc. India, Vol 23, pp. 284-289.

Raman, C.V., and Rao, A. T., (1980). Textural analysis of red sediments from Visakhapatnam district, Andhra Pradesh. J. Geol. Soc. India. Vol.21(1), pp.48-53.

Rao, A.T. and Prakasa Rao Ch. S. (1980). Cheralite from Beach Placers of Visakhapatnam-Bhimunipatnam Coast. Ind. Jour. Mar. Sci., Vol.9, No.8, pp.214-216.

Rao, A.T. and Sankar Pitchaih, P. (1985). Origin of white sands from Prakasak district, Andhra Pradesh. J. Geo. Soc. India, Vol. 26, No.4, pp 275-280.

Rao, T.C.S. and Murthy, K.S.R., 1980. Magnetic surveys of the continental shelf of

Visakhapatnam. Mahasagar: Bull of National Institute of Oceanography V13 No.2 p83-90.

Rao, T.C.S., Terry Machado and Murthy, K.S.R., 1980. Topographic features over the continental shelf off Visakhapatnam. Mahasagar: Bull of the National Institute of Oceanography, V13 No.1 p23-28.

Srihari, Y. (1980). Origin of Visakhapatnam red sands, east coast of India. Unpublished thesis submitted to Andhra University, Visakhapatnam.

Varadarajan, K and Ganju, J.L. (1989). Lineament Analysis of Coastal belt of Peninsula India. Memoirs Geological Society of India, No.12, p 49-58.

Sastry, A.V.R., Swamy, A.S.R. and Vasudev, K. (1987). Heavy minerals of beach sands along Visakhapatnam ñBhimunipatnam, East coast of India. Indian J. Mar. Sci., Vol.16, pp.39-42.

Ramam, P.K. and Murthy, V.N. (1997). Geology of Andhra Pradesh. Geological Society of India, p.245.

Murthy, M.S., 1961, Mineralogy and petrology of the charnockite series and associated rocks of Visakhapatnam. Ph.D. Thesis, Andhra University, Waltair.

Prabhakara Rao, G., 1962. Some aspects of the placer deposits of south kerala in relation to geomorphic evolution of the west coast of India. Ph.D. Thesis, Andhra University, Waltair.

Ramakrishnan, M., Nanda, J.K and Augustine, P.F. (1994). Geological Evolution of the Eastern Ghat Mobile Belt. Workshop on éEastern Ghats Mobile Beltí Visakhapatnam, India, 15-16 June 1994, Abstract Vol, pp.1-3.

Rao, A.T., Nageswara Rao, K. and Nath, C.S.R. (1995). Aluminous clino-pyroxene from Eastern Ghats Granulite Belt. Geol. Soc. India. Spl. Pubg., Vol. 44, pp.86-89.

Prudhvi Raju, K.V.N. and Vaidyanadhan, R., 1981. Fracture pattern study from land sat imagery and aerial photos of a part of the eastern ghats in Indian Peninsula, J Geol Soc. Of India V22 P17-21.

Rao, T.C.S. and Murthy, K.S.R., 1980. Magnetic surveys of the continental shelf off Visakhapatnam, Mahasagar: Bull of the National Institute of Oceanography V13 No.2 P83-90.

PROFILE OF PRICIPAL INVESTIGATOR
Dr. MOKKA JAGANNADHA RAO

Name and Designation : **Dr. Mokka Jagannadha Rao**
Professor, Dept of Geology,
Adviser, International Student Affairs,
Andhra University, Visakhapatnam-530 003.

Address (Residential) with Telephone No. : F3, Doctors' Arcade,
Official Colony, Near KGH,
VISAKHAPATNAM- 530 003
☎ 0891-2729268(R), 0891-2501519, 2844718(O)
Cell: 9849798978
E-mail: mjrao_isa@yahoo.co.in

Specialization : Coastal Geology, Environmental geology, Coal Science and Technology, Mineral Beneficiation, Mineral Resources and Computer applications in Geology with research topics of relevance to Environmental Applications

Date of joining University: 06.11.1986
Service

Academic qualifications:

Degree/ Diploma	University/ Institution	Year	Class	Subjects
B.Sc.	Andhra University	1975	**First**	Geology, Physics and Chemistry
M.Sc. (Tech.)	Andhra University	1981	**First class .with Distinction II RANK**	Applied Geology
M.S. (Engg.)	University of Alaska, USA	1995	**3.75 GPA, On 4.0 Scale**	Mineral Preparation and Geological Engineering
Ph.D.	Andhra University	1985	-	Coastal Geology
P.G. Diploma	Andhra University	1989	**First**	Applied Statistics

Professional Experience:

a) Teaching : 20 years
b) Research : 24 years

Additional information:

Specialized training:

a) Coastal Resources –Research experience
b) Coal Preparation, Coal Petrology, Coal Chemistry, Mineral Beneficiation from Mineral Industry Research Lab, University of Alaska, Fairbanks, USA.
c) Spectrochemical Analyses (AAS, ICP-MS, Spectrograph) at MIRL, UAF, USA, Grad Courses.
d) Electron Probe Micro Analysis (EPMA), University of Washington, Pullman, USA.
e) Geostatistics, National Mineral Development Corporation, Hyderabad, India.
f) Computer Applications - Operating systems, Database, Multimedia, *Diploma in Advanced Computing, Multisoft, Visakhapatnam*
g) Neutron Activation Analysis, (INAA), Kalpakkam, BARC, India.
h) PG Diploma, Applied Statistics, Andhra University, India.
i) Statistical computing packages, MINITAB, SPSS (Grad Courses), UAF, USA.

b) International exposure:

I have visited the University of Alaska, Fairbanks, USA and spent nearly two and half years and worked with Prof. Daniel E. Walsh at the Mineral Industry research mainly to develop Environmentally friendly Mineral and Coal Processing Techniques including "Hot water drying of low rank coals and development of Coal Water Fuels (CWF's)". and also worked on the project "Process mineralogy of ferric Chloride leaching of complex Sulphide ores" and other projects of Coal science and Technology.

a) Collaborative ties: (National/International)

International:

1. **Mineral Industry Research Labs. U.A.F Alaska, U.S.A. – Prof. D.E. Walsh**
   The main objective of this project is to upgrade the low rank coals of tertiary age with special emphasis on moisture reduction using hot water drying (HWD) technique. Also emphasis is given to develop **coal water fuels** from HWD product.
2. **CSIRO, Petroleum, Astralia, Prof.N.Sherwood, Fluorescence Alteration of Multiple Macerals, (FAMM) Studies**

National:

Regional Research Laboratories, Bhubaneswar – Dr. R.B. Rao
Indian School of Mines, Dhanbad – Prof. R. Venugopal,
Nuclear Chemistry Division, BARC, Mumbai- Dr A.V.Reddy
Within the Campus:
Dept Mechanical Engg- Prof A.Rama Krishna, Material Science,
Dept of Nuclear Physics-Dr S.Lakshmi Narayana

Dept of Geo-Engineering- Prof K.S.Prakasa Rao

Research Outcome:

(a) *No. of Ph.D's awarded under the guidance:* **8**

(b) *No. of research projects carried out with titles, grant received, source:* **2**

1. "Genetic Evaluation of Magnetites and Chromites from parts of Eastern Ghats India." Funded by UGC, Rs. 6.50 lakhs Co-PI
2. "Studies on Characterization and Localization of placer mineral deposits from parts of coastal tracts of AP and Orissa with special reference to the development of processing strategies". Funded by DOD, Rs. 10.66 lakhs, Principal Investigator

(c) *No. of research projects on hand:* **4**

1. "Studies on exploration and reserve estimation for new and hidden Bauxite deposits from EGMB of A.P." funded by APMDC-DMRTUF, Govt of AP, Hyderabad. The project is of two years duration. (Rs.13.0 Lakhs)
2. "Studies on exsolved phase mineralogy and chemical finger printing of placer ilmenites from North coastal Andhra Pradesh to establish from North Coastal Andhra Pradesh to establish genetic affinities and to evolve economic implications" funded by DST, New Delhi. The project is of three years duration. (Rs.12.0 Lakhs)
3. "A study on process chemistry and product characterization of zeolite synthesis from coal flyash and its applicability in soil remediation and conditioning" funded by UGC, New Delhi. (Rs.5.5 Lakhs).
4. "A Study on coastal geomorphological and neo-tectonic controls on the localization of placer mineral deposits along Bhimunipatnam - Itchapuram, North Coastal, Andhra Pradesh" funded by MoES, Govt of India, New Delhi. (Rs.12.0 Lakhs)

(d) *No. of papers published – National and International:* **39(Published in Journals), 14 papers presented in National and International Seminars.**

(e) *BOOKS PUBLISHED:* ONE, COMPUTER APPLICATIONS IN GEOSCIENCE

Memberships of Scientific societies:

1. Member, Gondwana Geological Society, Nagpur, India.
2. Member, Society for Metallurgical Engineers, (SME), USA.
3. Life member Indian Geological Congress.(IGC)
4. Associate Fellow, A.P Akademi of Sciences, Hyderabad.
5. Life Member and Executive secretary (Visakhapatnam Regional Chapter), SAAG,

Title and year of the Ph.D. thesis awarded under the guidance:

Name	Year	Title
1.U.P.N. Raju	1990	Genetic Evaluation of Manganese Ores from parts of Eastern Ghats, India.
2. K.S. Peter	1992	Geochemistry and Mineralogy of Magnetites and Associated rocks of Polavaram, E.G. District, India.
3. J. Shyam Kumar	1995	Environmental Geology and Impact Assessment of two Geological sub-Environments from Visakhapatnam Urban-Industrial area. A.P.

4. G. Jai Sankar	1997	Environmental Hydrogeology and Impact Assessment of Groundwater regime from Agnigundala Sulphide Deposit, A.P., India.
5. P.L.V. Prasada Rao	1998	Studies on Mineralogical and Geochemical Transformations of Coal ash in relation to Coal Combustion from Kothagudem Coal field, AP, India.
6. P. Jagadeswara Rao	1999	Hydrogeology, Morphometry and Remote Sensing Studies on Champavathi River basin, Vizianagaram District, A.P.
7. J. Venkataramana	2007	"Studies on Geology, Ore Mineralogy and Geochemistry of Ilmenite from beach placers of Kakinada, Bhimunipatnam and Srikurmam deposits, Andhra Pradesh, India"
8. M. Swarna Latha	2008	A Study on land use, land cover and environmental impacts on various sub-environments of Greater Visakha Muncipal Corporation area, A.P, India, using remote sensing and GIS tools.
9. K. Mehar Ganesh	2008	A Study on Geology, Hydrogeology and quality of fluoride bearing groundwater regime, from parts of Nalgonda District, Andhra Pradesh, India, Using Remote sensing and G.I.S. Tools" (Submitted – to be awarded)
10. G. Venkateswara Rao	2009	Studies on development of Network based Global Emission Monitoring System using spatial database software systems. (Thesis to be submitted, soon)

Highlights of Scientific Achievements,

1. Coastal Environments along the east Coast.

2. Collaborative research works with University of Alaska Fairbanks, U.S.A. (Development of environmental friendly coal water fuels)
3. Initiation of Research work on Indian Coals in Collaboration with Labs like RRL, Indian School of Mines etc with emphasis on environmental aspects of coal combustion.
4. Conducted Refresher Courses to ONGC officials on Applied Coal Petrology in Oil Exploration, which was rated as "Excellent" in ONGC's internal circular.
5. Undertaken research work on groundwater pollution due to mining, urbanization and Industrialization.

Industry Interaction:

1. Conducted two Refresher Courses to ONGC Officials on **"Organic Geochemistry and Applied Coal Petrology in Oil Exploration"**
2. Number of cement Industries (L&T, ACC and are showing keen interest in my research work leading to the process development for zeolite synthesis from Coal Fly ash which will be of **Environmental friendly technology in fly ash management.**

Future plans of Research:

Wish to work on the aspects of, Coastal Environments, Coal Processing, Environmental geology and Mineral Resources on the research topics of Industrial applications like material science of natural materials, synthesis of zeolites from fly ash, new and

innovative Environmental friendly, mineral beneficiation techniques and computer simulation and modeling of Geo environmental Problems.

Honor's, Appointments etc.

1. **Editor, Journal of disaster Advaces**

2. **Associate Editor, Indian Journal of Environment and Ecoplanning.**
3. **Member, International Geological Correlation Group, National Working Group Environmental Catastrophes.**

2. Fellowships:

1. **Federal Graduate Research fellow, University of Alaska, USA (1990,1992-95)**
2. JRF, SRF, CSIR, New Delhi (1982-86)

Earlier Selections:

1. **Civil Services Group B Service, UPSC Exam 1985.**
2. **UPSC, Geologists Exam, All India 11th Rank, 1983.**

Consultancy:

Undertaken consultancy projects in the following fields;

1. Environmental Geology and Coastal geology
2. Coal Science and Technology (Coal Petrology, Coal processing and CBM)
3. Mineral beneficiation, Mining and Mineral resource evaluation,
4. Natural materials and industrial applications,
5. Instrumental analysis (AAS, ICP, INAA) of Geological materials.
6. Interdisciplinary investigations with Civil, environmental, Metallurgical and chemical Engineering.

ADMINISTRATIVE EXPERIENCE:

Dean, International Students' Affairs, Andhra University.

Activities carried out in 2007-08

As the Adviser of International Students' office I co-ordinate all the affairs related to International programs and events at Andhra University. These include International Students admissions including NRI's and PIO's, student exchange programs, MOU's with foreign Universities, design and implementation of joint and Twinning programs with International Universities of repute, faculty exchange, International joint research programs etc. Some of the achievements are given below.

Number of Foreign, NRI and International Students given Admission during the year 2007-08.

Country	Number of Students Admitted
Ethiopia	50
Iran	2
Afghanistan	2
Nepal	1
NRI's from various countries	45
TOTAL	100

Some of the most important MOUs' signed during 2006-09

- Asia Theological Association, Bangalore on Religious Studies.
- Kansas State University, USA for Research and Development.
- Indian Institute of Human Rights, New Delhi.
- Indian Navy, for establishing a center for Maritime Studies.
- The National Geophysical Research Institute (N.G.R.I).
- Alcorn State University, Mississippi, USA.
- NATCO Institute of Pharmaceutical Sciences & Research, Hyderabad.
- Blekinge Institute of Technology, Sweden.
- Defense Research and Development Organisation.
- Soonchunhyang University, Republic of Korea.
- Steel City Securities Limited, Visakhapatnam.
- UND Life Sciences, USA.
- Indian Institute of Remote Sensing (IIRS), Dehradun.
- Florida State University, USA.
- Globus Education, Hyderabad.
- University Hospitals of Geneva, Switzerland.
- University of Delware, USA.
- University of Alaska, Fairbanks, USA.
- Jackson State University, USA.
- University of Alaska, Fair Banks, USA.
- Educational Consultants India Ltd., Govt. of India.

International Students Hostel

A full fledged International Students Hostel with a capacity of 100 rooms has been completed and International Students were given accommodation. The Hostel is of International Standards with facilities for cooking, dining, entertainment, games room, internet facility etc.

Dual Degree and Twinning Programs Initiated

1) **Dual Degree Program with Blekinge Institute of Technology, Sweden.**
   a) M.S. Software Engineering
   b) M.S. Signal Processing
   c) M.S. Telecommunication Systems

2) **Twinning Program with Kansas State University, USA.**
   - M.S. Molecular Biology & Biotechnology

3) Twinning Programme with Perth College, UK.
   - B.Eng Aircraft Engineering

LIST OF PUBLICATIONS

1. M. Jagannadha Rao and J.S.R. Krishna Rao. "Textural and mineralogical studies on red sediments of Visakhapatnam – Bhimunipatnam coast". *Geo views, Vol.XII*, No.2, 1984. Pp.57-64.

2. M.J. Rao, U.P.N. Raju and J.S.R. Krishna Rao. Textural analysis of beach sands from south Andaman". Mahasagar, Bulletin of the NIO, Vol.18 (1), 63-66.

3. M. Jagannadha Rao, "Beach Rock from Visakhapatnam coast". *Current Science,* 1987, 2, pp.26-27.

4. M. Jagannadha Rao and J.S.R. Krishna Rao. "Ore mineralogy of Black Sand concentrates from Visakhapatnam" presented at the National seminar on the Ore Mineralogy and its impact on resource evaluation" held at Andhra University.

5. M.J. Rao and G.B. Naidu "A note on the erosional tendency at the Visakhapatnam Beach Environment". *IJEP* 9(11): pp.813-814, 1989.

6. A.V. Subrahmanyam and M. Jaganadha Rao. "Genesis of Panchpatmali Bauxite Deposit, Orissa, India" Presented at International Geological congress held in Washington 1989.

7. J.R. Mokka, H.K. Lin and P.D. Rao. "Process mineralogy of Ferric chloride leaching, Delta District Complex Sulphide Ores, Alaska". *Journal of minerals and Metallurgical processing*, Nov. 1991, pp.205-209.

8. A.V. Subrahmanyam, M.J. Rao and J.S.R. Krishna Rao. "Nodular Laterite from Panchapatmali, Koraput District, Orissa". *IMEJ* January, 1992.

9. U.P.N. Raju, M.J. Rao and G.B. Naidu. "Geological Exploration and processing of Manganese in parts of Eastern Ghats". *IM & EJ*, June and July 1992, pp 3-7.

10. M. Jagannadha Rao and K.K.V.S. Raju. "A comment on the paper entitled Sapphirine – bearing assemblages from Perumalmalai, palani hills, Tamilnadu". *Jour. Geol. Soc. India.* Vol.40, Sept. 1992, pp.287-290.

11. Jagannadha Rao Mokka. "A study on phosphorus distribution and its possible applicability in seam correlations – A case study from Matunuska coal field". Presented at the International conference Focus on Alaska's coal, 1993 held at Anchorage U.S.A.

12. Jagannadha Rao Mokka. "Physical stability of hydrothermally treated Alaskan low-rank coal". Presented at the International conference" Focus on Alaskans coal, 1993 held at Anchorage, U.S.A.

13. M. Jagannadha Rao and J. Syam Kumar. "Radiometric prospecting in placer sands and associated sediments along Visakhapatnam – Bhimunipatnam, East Coast of India". IM & EJ Jour. Special Volume on *Mining and Environment*, June 1993.

14. Daniel E. Walsh, Jagannadha Rao Mokka and P.D. Rao. "A study of Non-evaporative Hot-water drying of Three Alaskan Low-rank coals". Proceedings the Focus on Alaska's coal 1993 conference, *MIRL Report No. 94,* University of Alaska, Fairbanks,USA

15. A.V. Subrahmanyam, M. Jagannadha Rao and J.S.R. Krishna Rao "Nodular laetrile from Panchpatmali Bauxite deposit, Koraput Dist, Orissa Evidence for New Tectonism from East coast Bauxite province".*Indian Jour. of Earth Sciences*, No 2-3, Vol.23, p.147-160, 1996

16. M. Jagannadha Rao, P.L.V. Prasada Rao and Ch. Hanuman Prasad – "A study on non-evaporative hot water drying of low rank coal and its possible applicability in upgrading Indian lignites". Solid-liquid separation in mineral and Metallurgical Industries, published by *Indian Institute of Mineral Engineers,* Vol 3, p.219-237, 1996.

17. P.L.V. Prasada Rao and M. Jagannadha Rao – "Scanning electron microscopy of Quartz grain surface features of sandstones from Godavari Valley coal fields, Andhra Pradesh". *Jour. of the Indian Academy of Geoscience.* Vol.40, No.2, 1997, pp.33-37.

18. P.L.V. Prasada Rao and M. Jagannadha Rao – "A study of Mineralogical transformations in coal ash during combustion of coals from Godavari Valley, Andhra Pradesh". Presented at National Conference on Pollution Control and Management in Coal Mining and Thermal Power Plants held in Sambalpur University, December 1996.

19. J.Syam Kumar, Mokka Jaggannadha Rao and KKVS Raju "A study on Impact of Industrial effluents on Ground water quality of Visakhapatnam Urban area using parametric Ratio correlation" *Journal of the Indian Academy of geo-science*, vol. 40, No.2, 1997, PP. 11-16.

20. Daniel E Walsh, J.R.mokka and O. Noirot "Characterization of Hydrothermally treated Low rank Coals from Beluga Coal fields, Alaska, MIRL Publication, Vol 11, 45-49, 1998..

21. Daniel E Walsh, J.R.mokka and O. Noirot "Petrological and Chemical Characterization of Hydrothermally treated Low rank Coals from Beluga Coal fields, Alaska, MIRL Publication, Vol 12, 56-61, 1998.

22. M.Jagannadha Rao, S.Radha Krishna and K.Prasad Kumar "A Study on Environmental Characterisation of Flyash and its response to Zeolite Synthesis" *IJEP*, Vol 20(4) 290-296, 1999.

23. D.E. Walsh, P.D. Rao, H. Owens, J.R. Mokka and O. Noirot "Characterization of hydrotheromally dried low – rank coals"
Minerals and Metallurgical processing, Vol 16, No.1, Feb 1999.

24. Mokka Jagannadha Rao, J.Shyam Kumar, and K.Vasudev " A Study on Erosional pattern along Visakhapatnam Coast of Andhra Pradesh" *Indian J Environment & Ecoplanning* 3(3) 521-526, 2000.

25. P.D.Rao, J.R.Mokka and D.E.Walsh "A study on Phosphorous accumulation in a high latitude Coal Seam" Journal of Coal Science and Technology, Vol 20(2000) 261-284

26. G.Jaisankar, M. Jagannadha Rao, B.S. Prakasa Rao, and D.K. Jugaran "Hydromorphogeology and Remote sensing applications for Ground water exploration in Agnigundala Mineralized Belt, Andhra Pradesh, India" *Photonirvachak, Journal of the Indian Society of Remote sensing,* vol 29, No. 3, 2001.

27. M. Jagannadha Rao, G. Jaisankar, B.S.P. Rao and M. Chandra Rao "A study on spatial variability of Ground water Chemistry from Agnigundala mining district, Andhra Pradesh, India using statistical Tool ANOVA". *Environmental geochemistry,* vol 5, No. 1 & 2, pp 17-21, 2002.

28. P. Jagadeswara Rao, M. Jagannadha Rao and P. Harikrishna "Geo - Electrical data analysis to demarcate ground water pockets and recharge zones in Champavathi River Basin, Vizianagaram District, Andhra Pradesh "*J. Ind. Geophys Union* (2003), vol 7, No. 2, pp. 105-113.

29. P. Jagadeswara Rao, S. Jhansi, M. Jagannadha Rao "A study on Morphometric Analysis water shed in Visakhapatnam Districtsm, Andhra Pradesh" *Landscapes systems*, No. 2, vol XXIV, pp 18-26, 2002.

30. M. Jagannadha Rao, J.Syam Kumar, B. Surya prakasa Rao and P. Srinivasa Rao "Geomorphology and land use pattern of Visakhapatnam Urban – Industrial Area" *Photo nirvachak journal of Indian Society of Remote sensing*, vol 31, No2, 2003

31. S.Lakshminarayana, M.Jagannadha Rao, J.Venkataramana and Others " A study on trace element geochemistry of Kothagudem coal deposit, Godavari Valley, Andhra Pradesh" *Environmental Geochemistry Vol 6, No 1&2, pp21-25, 2003*

32. .Ch. Venkateswara Rao, M. Jagannadha Rao, C. Kasipathi, K.V. Satyanarayana and J. Venkata Ramana "A study on the factors controlling the spatial and Temporal variability in Ground water quality in and Around Rajahmundry, East Godavari District, Andhra Pradesh Environmental geochemistry, Vol 7 no 1&2 pp27-32, 2004, *Association of Environmental Geo-chemists."*

33. M. Jagannadha Rao, J.Venkataramana, N.Avataram and B.S Ganga Rao " Zeolite Synthesis from Coal Fly Ash Process Chemistry and Product Characterization" Jour Min Met and Fuels, Vol Dec, 2004 pp 410-414

34. M.Jagannadha Rao, J.Venkata Ramana, R.Venugopal and M.C.Rao Geochemistry and Ore Mineralogy of Ilmenite from Beach placers of the Visakhapatnam-Bhimunipatnam Deposit, Andhra Pradesh, Vol 66. Aug 2007.

35. M.Jagannadha Rao, P.I.V.Prasada Rao, N.Avataram, J.Venkataramana and M.C.Rao " Mineralogy and Trace Element Geochemistry of inorganic matter from Kothagudem coal Deposit, Godavari valley, AP Gondwana Geol Magz Vol 20 Dec 2007 pp 89-98

36. M. Jagannadha Rao, B. Durgaiah, B. Vijay Saradhi, G. Jaisankar, D. Pundarika Rao and K. M. Ganesh " Spatial Variability of Groundwater Chemical Quality in Part of Nalgonda

District, Andhra Pradesh" Journal-Geological Society of India. Vol.69, May 2007, pp.983-988.

37. M.Jagannadha Rao' J. Venkataramana, R. Venugopal and M.Chandra Rao "Characterization and paleoclimatic significance of beach rock formation from Visakhapatnam coast", Andhra Pradesh. Journal of Geological Society of India, Banglore. Vol.70, December 2007, pp.975-980.

38. M. Jagannadha Rao, J, Venkataramana and Ch.Rama Krishna "Mining initiatives for placer deposits along the East Coast of India – A preliminary assessment of possible impact on coastal environment.." Journal of the Indian Academy of Geoscience, Vol. 50. No.2. pp.11-18, 2007

39. M. Jagannadha Rao and others "Zincian Ilmenite from beach sands of Sreekurmam, Andhra Pradesh, India" Current Science, Vol. 95, No, 9, 10 November 2008.

Papers presented in Seminars

1. M. Jagannadha Rao and J.S.R. Krishna Rao, "Ore Mineralogy of Black Sand Concentrates from Visakhapatnam".

   Presented at the National Seminar on the "Ore Mineralogy and its Impact on Resource Evaluation" held at Andhra University, 1987.

2. Chandra Rao. M and Jagannadha Rao. M, "Genetic Evaluation of Magnetite Ore Bodies from Addatigala area, East Godavari District, Andhra Pradesh, South India – A tecteno – magmatic model".

   Presented at International Voloconology Congress, Ankara, Turkey, January 1994.

3. Jagannadha Rao.M and Chandra Rao.M, "Groundwater Assessment in Agnigundala Mineralized Belt, Andhra Pradesh, Using Remote Sensing techniques."

   Published in Proceedings on National Conference on Nellore Schist belt, Andhra University, Visakhapatnam, December 1997.

4. Jagannadhra Rao.M, Chandra Rao.M and Jai Sankar. G, "Groundwater Resources Evaluation and Pollution Targeting in Agnigundala area – using Remote Sensing and G.I.S tools".

   Presented at National Seminar on Environmental Geology and Waste Management held in September 2000 at Department of Geology, Andhra University.

5. Jagannadhra Rao.M and Chandra Rao.M, "Synthesis of Zeolites from Coal Flyash – An Experimental Study".

   Presented at National Seminar on Environmental Geology and Water Management held in September 2000 at Department of Geology, Andhra University.

6. Jai Sankar.G, Jagannadha Rao.M and Chandra Rao.M, "Hydrogeology- Hydrogeochemistry of Groundwater from Agnigundala Mineralized Belt, Andhra Pradesh, India."

Presented at International Seminar on "Challenges of Water Resources Management in the Developing Countries" held in May 2001, Department of Geology, Andhra University.

7. Jagadeswara Rao.G, Jagannadhra Rao.M and Chandra Rao.M, "Groundwater Evaluation in Chamapavathi River Basin, Vizianagaram district, using Governmental norms".

   Presented at International Seminar on Challenges in Water Resources Management in the Developing Countries held in May 2001, Department of Geology, Andhra University.

8. J.Venkata Ramana and M.Jagannadha Rao, "Mineralogical Characterization of Placer Sands for better processing strategies".

   Paper Presented at National Seminar on "Mineral Based Industries Present Status and Future Prospects" held from 5-7 December 2001, Department of Geology, Andhra University, Visakhapatnam – 530 003.

9. "Studies on Characterization of Placer Ilmenite from parts of East Coast using Ore Microscopy and Ore Chemistry".

   [1]M.Jgannadha Rao, [1]J.Venkata Ramana, [2]R.Venu Gopal and [1]M.C.Rao.

   1. Dept. of Geology, Andhra University, Visakhapatnam.
   2. Dept. of Mineral Engineering, ISM, Dhanbad.

   Paper Presented at International Seminar on Sedimentation and Tectonics in space and time, 16-18th April 2002.

   Organized by: Dept. of Civil Engineering, S.D.M. College of Engg & Tech, Dharwad-3 & Dept. of Geology, Karnataka University, Dharwad – 580 003.

10. M. Jagannadha Rao, "Studies on Coal Bed Methane Exploration and Exploitation".

    Presented at National Seminar on Non-conventional Energy Resources held at Department of Geophysics, Andhra University, Visakhapatnam, August 2002.

11. M. Jagannadha Rao, "Some Concepts of Computer Applications in Geology".

    Presented at National Seminar on Computer Applications in Earth Sciences held at Department of Geology, Andhra University, Visakhapatnam, August 25-27, 2003.

12. M. Jagannadha Rao, J. Venkata Ramana and B.S. Ganga Rao, "Process Chemistry and Product Characterization of Synthesized Zeolites from Coal Flyash". Presented at National Seminar on Mineral Process Technology held at Regional Research laboratory, Bhubaneswar, March, 2004.

CERTIFICATE ISSUED BY DISTRICT COLLECTOR
SRIKAKULAM , A.P

157

Rc.No.272/08-E3 Dt. 05.2.09. Collector's Office, Srikakulam.

CERTIFICATE

Certified that the Government in G.O.Ms.No. 1107 Rev.(Assn.I) Dept., Dated 15.09.2008 has issued orders that an extent of Ac.972.69 cents of Government land located in (1) Rushikudda (2) Gollagandi (3) Baruvapeta and (4) Benkili Villages of Sompeta Mandal of Srikakulam District has been alienated to APIIC for onward transfer to M/s. Nagarjuna Construction Company Limited (NCC Power Projects Limited) for setting up of 1980 MW Thermal Power Plant. These lands are Government waste lands.

JOINT COLLECTOR * SRIKAKULAM.

Sd/-Nagulapalli Srikant,
Collector and
District Magistrate, Srikakulam.

//t.c.f.b.o//

Joint Collector, Srikakulam

6/2/09 E3 6/2/09

To:-

The Vice President (Projects),
Nagarjuna Construction Company Ltd.,
Banjara Hills,
Road No.12,
HYDERABAD.

Government of Andhra Pradesh
Forest Department

Rc.No.2412/2009/A4
Dated 27.08.2009.

Office of the Divisional Forest Officer
Srikakulam

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From
Sri B.Sree Rama Murty, S.F.S.,
Divisional Forest Officer (FAC)
Srikakulam.

To
The Director,
NCC Power Projects Limited,
4th Floor, MJ Towers,
Road No.12, Banjar Hills,
HYDERABAD – 34.

Sir,

Sub:- Certification of National Parks, Wild life sanctuaries etc,. and Authentication of Flora & Fauna in the study area of 10 km from the project site of the proposed NCC Power projects limited at Sompeta Mandal – Regarding.

Ref:- Your letters No.NCCPPL/DFO/01/2009 dated 20.07.2009.

** ** **

With reference to your letter cited, this is to certify that there are no Tiger reserves, Elephant reserves, National Park, Wild life Sanctuaries, community reserves and conservation reserves, within 10 km radius from boundary of proposed Power project site of 2640 MW coal based NCC Power Projects Limited at Gollagandi and Baruva villages, Sompeta Mandal, Srikakulam District.

The area proposed for the said Projects is mainly Government waste land which was alienated to the Project the following villages by Government G.O.Ms.No.1107 Revenue (Assignment A-1) Dept dated 15.09.2008 and partly private agriculture land in the same villages.

Village	Sy.No	Extent in Acres
Rushikudda	152/2	395.36
Gollagandi	23/9	208.75
Baruvapeta	247	169.78
Benkili	231	198.80
	Total:-	**972.69**

Regarding Flora & Fauna existing in the study are, it is to certify that about 356 plant species, the predominant plant species of Mangifera indica, Borassus flabellifera, Phoenix Sylvestris, Dlionix regia, Acacia nilotiica, Tamarindus indica, Borassus flabellifera, Cocos nucifera, Cassia tora, Cassia occidentlis, Abution indicum, Achyranthes aspera, Parthenium hysterophorus, Tephrosis purpurea species, were identified within 10-km radius of the Project site. Similarly, the animal species reported in the 10 Km study area are common in nature to region and there are no endangered, protected, threatened animal and plant species in study area.

The observed plan species and animal species from study area are presented in Annexure – I and Annexure – II respectively.

Therefore, there is no objection for setting up of 2640 MW coal based Thermal Power Plant at Gollagandi and Baruva villages, Sompeta Mandal, Srikakulam District.

Yours faithfully,

27/8/09

Divisional Forest Officer (FAC)
Srikakulam

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Rc.No.1926/2009 E3 dt.3.11.2009 Collector's Office, Srikakulam

From
Sri.Nagulapalli Srikant, I.A.S.,
Collector, Srikakulam

To
The Secretary,
A.P. State Human Rights Commission
Gruhakalpa Complex,
M.J Road,
Hyderabad.

Sir,

Sub:- Andhra Pradesh Human Rights Commission – H.R Case No.6251 /2009 filed by Sri Beena Dillirao of Palasapuram Village of Sompeta Mandal against the establishment of Thermal Power Project in Sompeta Mandal M/s Nagarjuna Construction Company Limited – Report submitted – Reg.

Ref:- 1.H.R.C. No.6251/2009 dt.08.09.2009 of the Secretary A.P State Human Rights Commission, Hyderabad.
2. This office Rc.No.1926/2009 E3 dt.03.10.2009 addressed to the Revenue Divisional Officer, Tekkali.
3. Rc.No.1240/2009 H dt.31.10.2009 of the Revenue Divisional Officer, Tekkali.

****

I invite kind attention to the references cited.

I submit that the Secretary A.P State Human Rights Commission, Hyderabad, in the reference 1st cited, while forwarding a petition filed by Sri Beena Dillirao and 7 others of Palasapuram village, Sompeta Mandal directed to enquiry into the matter and submit a report in induplicate as the case stand posted on 04.11.2009.

The matter has been referred to Revenue Divisional Officer, Tekkali for enquiry and to report vide this office reference 2nd cited.

In reference 3rd cited, Revenue Divisional Officer, Tekkali submitted a report stating that Sri Beena Dillirao and 7 Others of Palasapuram village of Sompeta Mandal filed petition against the proposed establishment of 2640 mw Thermal Power Project, in Sompeta Mandal and requested the Hon'ble Commission to drop the proposed Thermal Power Project. According to the report of the Revenue Divisional Officer, Tekkali the following is the brief history of the case.

The Vice President (Projects) M/s Nagarjuna Construction Company (Infra) Holdings Limited,Hyderabad has sent the requisition in the prescribed Proforma Appendix XXIX of B.S.O 24 to the Collector, Srikakulam for alienation of Government land for an extent of Ac.1046.21 cents in Sompeta Mandal for establishment of Thermal Power Plant with a capacity of 2640 MW.

As per the report of the Tahsildar, Sompeta and extent of Ac 1125.08 Cts of Swamp lands available in Sompeta Mandal and locally called it as "Beela" and all the lands are Government lands situated in low lying area

--2--

and receiving excess water from Mukunda Sagaram in Kachili Mandal, Pydigam Reservoir, Mahendratanaya river and flood water during the rainy season and Due to stagnation of the excess water in the Swamp lands, the paddy fields of nearby areas are submerged and adversely affected. After completion of Survey of the entire extent of Ac.1125.89 in Baruvapeta, Benkilli, Gollagandi, Rushikudda Village of Sompeta Mandal, an extent of Ac.972.69 cents was proposed for alienation of establishment of Thermal Power Plant in Sompeta Mandal as show below.

Sl.No	Name of the Revenue Village	Survey No.	Classification	Total Extent (Ac.Cts)	Extent of land excluded for the reasons mentioned	Net extent of land available for alienation
1	2	3	4	5	6	7
1	Baruvapeta	247	Beela Gayalu	277.00	75.87 BDR 31.35 Encroachments	169.78
2	Benkilli	231	Beela Tampara	198.80	----	198.80
3	Gollagandi	23/9	Tampara Poramboke	249.43	40.68 CRZ	208.75
4	Rushikudda	152/2	Kaluva Poramboke	399.85	3.03 BDR 1.46 Channel	395.36
			TOTAL	**1125.08**		**972.69**

Accordingly Revenue Divisional Officer, Tekkali submitted alienation proposals for an extent of Ac.972.69 Cts to the Collector, Srikakulam and inturn proposals were submitted to the Government through the CCLA, A.P Hyderabad recommending market value at Rs.80,000/- per acre.

Government of Andhra Pradesh, after careful examination have issued orders for alienation of land for an extent of Ac 972.69 cents in favour of Andhra Pradesh Industrial Infrastructural Corporation, Hyderabad for onward transfer to M/s Nagarjuna Construction Company (Infra) Holdings Limited. Hyderabad for establishment of Thermal Power Plant on payment of market value at Rs.80,000/- per acre vide G.O.MS.No.1107 Revenue (Assignment-I) Dept dt.15.09.2008. The land was handed over to the Zonal Officer, APIIC, Visakhapatnam on 28.05.2009 duly showing the boundaries of the lands.

The following are the remarks on the petition affidavit.

It is submitted that the proposed swamp lands are locally called as "Beela" According to Revenue Records there is no ayacut l under the "Beela". The said lands are not useful for agricultural purpose. Total extent of "Beela" land is Ac 1125.00 Cts only, but not Ac 4000.00 cents of Wet land as alleged by the petitioner, in their petition. Water of Beela

land is not notified as any irrigation sources of Government and the water is not applicable for the double crop. If the Beela is useful for Agriculture purpose, the land would have been distributed to the landless poor in Massive Assignment programme of four phases. Beela is almost waste land, as the land is not fit for agriculture purpose except little extent. If it is actually Agricultural land, it could have been occupied by the people and They would have claimed D Pattas But this was not done since several years, showing that the land is not fit for cultivation. Hence, the contention of the petitioners is not correct.

It is submitted that a hill nearly an extent of Ac 25.00 cents is located in the midst of the Beela locally called as "Pamulamett" and is nearer to Gollagandi and Benkilli villages. According to the information from the villagers of Benkilli and Zinkibhadra, some snakes are living in that hill, so that people of the two villages call it as pamulametta, except this, no birds are residing in the Beela and no birds come from Australia and Siberia visiting to Beela.

It is submitted that regarding the flora and Fauna, the Divisional Forest Officer, Srikakulam reported that about 356 plant species, the predominant plant species of Mangifera indica, Borassus flabellifera, Phonix sylvestires, Dlionix regia, Acacia nilotica, Tamarindus Indica, Borassus flabellifera, cocos nucifera, cassia toa, cassia occidentis, Abution indicum Achyranthes aspera, Parthenium hysterophours, Tephoris purpures species, were identified within 10 km study area are common in nature to region and there are no endangered, protected, threatened animal and plant species in the study area and that there are no objections to Forest Department if Power Plant is proposed to establish in the above land.

It is submitted that the Sompeta Mandal consisting of 76 habitations with a population of 74.047 as per 2001 census, out of which agriculturists are 5151 cultivators + 10,422 agriculture laborers and fishermen families 3,690 in 76 habitations. No second crop under the beela water and even single paddy crop is not used under the Beela water. The Government has set up 3 lift Irrigation schemes in Benkilli Rushikudda of Sompeta mandal and Kuttuma in Kanchili from the Beela water, but the schemes have not been functioning due to lack of sufficient water in the Beela. During the rainy season the entire lands abutting Beela are being submerged.

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It is submitted that regarding fishermen belonging to Manikyapuram village, Deputy Director, Fisheries Department, reported that that In Land Fishermen Cooperative Society (I.F.C.S) consists of 158 members and their area of operations is Manikypuram, Rushikudda and Gollagandhi villages and according to the norms one hector of water spread area is to be provided each family. The total water spread area required for the society is Ac 390.26 cents which is available at Manikyapuram village in Kaviti mandal and Gollagnadi and Rushikudda in Sompeta Mandal i.e., (China Beela land). The water spread area under the possession of the said society comes to be Ac 584.44 Cents. Hence, the depriving of the livelihood of the fishermen is baseless and not at all convincing. Further to improve livelihood of the above fishermen families, the company provided following assistance.

1) Pucca houses to each eligible fishermen family at Rs.50,000/- from NCC in addition to indiramma funds.
2) To deepening the existing Chinna Beela lands of Ac 247.00 cents in Rushikudda village by converting into fish tanks for which the company has already deposited Rs.62.00 Lakhs with Collector (Fisheries) account.
3) To import training to the educated un-employees of fishermen youth with NCC funds at NAC/SIFT, hence their livelihood is not deprived.

It is fact that the alienated of Beela land is not at all useful for Agricultural purpose and nobody applied for assignment of the said Beela land for agriculture prupose. During the enquiry it reveals that no grass in Beela land is used for making mats. Similarly no damage is causing to the vegetable crops in Benkili and Zinkibhadra villages.

It is fact, the environment public hearing for the NCC Thermal Power Plant held at Gollagandi village on 18.08.2009 in the presence of the Collector and District Magistrate and minutes were recorded by the A.P Pollution Control Board, Vizianagaram. About 4000 people attended public hearing from various villages of that area out of which around 200 people agitated raising "Slogans" against establishment of power plant.

It submitted that a minor group of people including the petitioners started the agitation in month of August'2009, and put their represented their grievances at all levels, without any proper

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reason and proof Actually the ryots around of the Beela came forward to sale their lands to the company and supporting for the establishment of the power plant.

At present there are no industries in Sompeta Mandal. The educated youth of this area are going round to other places for employment in this connection, it is submitted that putting of this representation is far of truth in the interest of development of the area and employment generation.

It is submitted that the establishment of Thermal Power Plant by M/s Nagarjuna Construction Company (Infra) Holding Limited, Hyderabad may create more employment directly and indirectly in that area. Similarly this are may develop in the regard of infrastructural like sanitation education health, roads electricity telephone etc.,

In the circumstances submitted above, it is submit that the petition filed by Sri Beena Dillirao and seven others of Palasapuram village of Sompeta Mandal is baseless, far of truth and it deserves no consideration and is liable for dismissal.

I submit that basing of the report submitted by the Revenue Divisional Officer, Tekkali, I request that the case deserves no consideration and is liable for dismissed. I submit herewith copies of report of the Revenue Divisional Officer, Tekkali along with its enclosures.

Yours faithfully,

Encl:- As above

(Sd) N. SRIKANTH,

COLLECTOR, SRIKAKULAM.

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AREA DRAINAGE STUDY STRATEGY

BY

WAPCOS LIMITED

AREA DRAINAGE STUDY AND HYDROLOGICAL STUDY
FOR NCC POWER PROJECTS LIMITED
SRIKAKULAM DISTRICT, ANDHRA PRADESH

NCC Power Projects Limited is setting up 2440MW Coal Fired Thermal Power Plant in Sompeta Mandal, Srikakulam District Andhra Pradesh. The Power project would be developed in two phases. The capacity of the first phase is 1320 MW.

NCCPPL has appointed WAPCOS, New Delhi, to carry out the Area Drainage Study (surface & sub-surface) and Hydrological Study of various Nallas & Drains present in & around the proposed project site and prepare feasible diversion plan for the same considering the catchment area. The study will include

- Land use mapping of required area using satellite data by preparing and integrating different thematic layers on geomorphology, drainage, geology and lineaments, land use, un-irrigated and irrigated land, forest cover etc.
- Preparation of report on the drainage of the plant and buffer zone, impact of plant on drainage, surface hydrology, delineation of water sheds, its catchments and catchment yields, impact on water regime, estimation of storm and floods and designing of drainage plan.
- Designing rain water harvesting system/program of the plant by estimating the availability of rain water, its recharge by different cost effective recharge structures and its hydrological net work system to quantify the recharged water.
- Study of various nallas & drains present in & around the project site for developing feasible diversion plan which will cover
    - a) Review and analysis of rainfall data to arrive at design storm scenarios of various return periods including Standard Project Storm/ Probable Maximum Precipitation as may be applicable.
    - b) Preparation of digital elevation model for the study area for delineation of catchment and delineation of drainage network for comparison with drains on the topo sheet. Registration of Satellite image.

c) Estimation and routing of flood hydrograph, by hydraulic modeling for routing the flood waters calculated from the hydrologic study using one dimensional mathematical model, through the drainage system of concerned catchments considering appropriate boundary conditions including pre – project scenario as well as post – project scenario.

e) Designing of drainage plan.

f) Rainwater Harvesting Plan – Designing rainwater harvesting program of the plant by estimating the availability of rain water, its recharge by different cost effective recharge structures, its hydrological network system to quantify the recharged water.

METHODOLOGY OF AREA DRIANAGE STUDY

(i) Data Collection and Review of Reports

Available reports, literature, satellite images etc. having a bearing on the area drainage plan shall be collected from different agencies as well as from project authorities and analyzed. Topographical feature of the proposed site for the power project and its surroundings shall also be studied.

(ii) Design Storm Studies

Generalized studies for determining storm rainfall for specified return period and thereupon estimating the design flood of the corresponding frequency render great assistance in quickly arriving at the design flood values of project where detailed studies are not warranted or can not be taken up due to paucity of data. Such regional studies have been carried out jointly by Indian Metrological Department (IMD), Research Design and Standards Organisation (RDSO), Ministry of Railways, Ministry of Surface Transport (MOST) and Central Water Commission (CWC). For this purpose the country has been divided into 7 zones and 26 hydrometerologically homogenous subzones. Detailed rainfall studies for each of the regions has been carried out, covering the depth duration frequency analysis and the design storm components such as conversion factors from point to areal

rainfall, short duration ratios and time distribution factors have been derived. Flood estimation report of the subzone in which project area falls shall be used to estimate the design storm of 50 year and 100 year return period and the respective return period flood as well as SPF/PMF as admissible depending upon the various flood estimation scenarios.

(iii) Design Flood Studies

The decisive factor in the determination of a design flood is that feature or parameter of the flood that can be identified as the major cause of potential damage. Even though several factors are relevant when deciding about the method to be used for design flood estimation, data availability and the purpose of study are the most important factors. The following two methods are commonly adopted for estimation of design flood:

(i) Statistical approach commonly known as Flood Frequency Approach

(ii) Hydrometeorological approach, commonly known as the Unit Hydrograph Approach

In both these approaches, adequate data inputs are required for processing and obtaining the design flood outputs. The inputs are generally the long term and short term rainfall and run-off records, annual flood peak series, catchment or physiographic characteristics etc. Rational approach shall be utilized for compution of design flood of the drains. The detailed methodology to be adopted in a particular case depends upon the data availability. The return period flood studies will be carried out using appropriate method depending upon the data available.

(iv) Digital Elevation Model (DEM)

Digital Elevation Model is a 3-D representation of the terrain or ground elevation in graphical form. Purpose of creating a DEM in the project is (i) to ideally locate the plant and its appurtance structures spread over the plant campus requiring minimum cut and fill (ii) To estimate the volume of earthwork required to level the undulating topography of the plant site. DEM is proposed to be generated by using topographic grid survey data of the plant area recently conducted by NPCIL

transposed into a topo contour map in DXF format. Other helps needed to generate the DEM will be SOI topographic maps on 1:30,000 scale in digital mode and common geo-reference points from the grid survey map and the topographic map. ERDAS Imagine 8.5 software is proposed to be used for generation of DEM using appropriate software module by interpolating digital elevations into equally sized grid cells. Graphical representation of DEM will be depicted through different gray shades or colors representing numerical variation in elevation. (iii) To locate drainage disposal points and transit storage pond/reservoir and (iv) to depict the extent of flooding and vulnerable areas resultant to flood of 50 and 100 years return period.

Area drainage depends much on landuse-land cover, soils, drainage, geomorphology and slope of the terrain which help in initial rainfall absorption and run-off excess. These spatial varaiations of the contributing catchment to the plant site will be studied by computer processing of Indian Remote Sensing Satellite Resourcesat-1 Liss-IV (ground resolution 6.0 metre) digital data using appropriate modules in ERDAS Imagine 8.5 software ArcGIS. The resultant outputs will be several GIS maps as stated above useful for computing rainfall excess using an appropriate hydrological method like Rational Method or SCS Model.

(v) Ground Water Study

For ground water study well data shall be collected from CGWB/State Water Centre. Aquifier conditions shall be identified based on aquifer performance tests carried out by NCC Ltd. Ground water modeling using suitable software shall also be carried out.

(vi) Water Budget

Water budget reflects the relationship between input and output of water through a region. Water budget, in its elementary form, can be represented by the equation:

Total rainfall input = Surface water flows + Groundwater recharge + Evapotranspiration

Water Budget shall be developed based on the surface water, ground water, evapotranspiration, infiltartion data collected/obtained form field studies.

(vii) Geophysical Investigation & Sea Ingress

Sea ingress in the reservoir proposed for water storage in the vicinity of plant will be studied using geophysical investigation. Geophysical methods measure physical properties of the earth that can be related to hydrologic or geologic aspects of an aquifer, such as pore-water conductivity. Although there are a variety of geophysical techniques that commonly are applied in groundwater investigations, two types of techniques - electrical methods and seismic methods are particularly useful in coastal environments. In the present study, Electrical methods shall be used because of their ability to detect increases in the conductivity of an aquifer that result from increases in pore-water conductivity.

METHODOLOGY OF WATER AVAILABILITY AND HYDROLOGICAL STUDY

10-daily/monthly Rainfall data and monthly G & D data within the catchment/ near by sites of river Mahendra Tanya shall be collected from agencies such as CWC and State Govt. to carry out the water availability study for River Mahendra Tanya. Depending upon the data available, rainfall-runoff regression analysis or runoff-runoff correlation methods shall be adopted to arrive at 90% dependable flows of Mahendra Tanya. Simulation studies shall also be carried out to establish the supply demand matching. Assessment of peak and lean season water availability based on the recently observed G & D data collected by NCC Ltd. shall also be carried out.

METHODOLOGY OF STORM WATER DRAINAGE STUDY

Available data in terms of L-sections and cross-section of existing drains shall be collected and analysed to derive at the carrying capacity of drains. This shall also be checked during high flood season by site verification. Details of existing cross-drainage works, outlets, outlet structures, outfall channel etc. shall also be reviewed and alternatives for storm water disposal shall be worked out to arrive at the best feasible alternative for the same. Hydraulic design of internal drainage within plant, colony and ash pond & training of excess discharge into sea shall be carried out. Based on the above design layout of storm water drainage inside and outside the power plant will be developed.

Hydraulic design of storage reservoir within the plant shall also be carried out. Cost Estimation storm water drainage works shall be carried out.

Study of history and effect of cyclones and tsunamis at the proposed site will be carried out based on the available data and measures for prevention of siltation and erosion shall be suggested accordingly.

IN THE HIGH COURT OF JUDICATURE OF ANDHRA PRADESH
AT HYDERABAD

W.P.No. 17448 of 2011

Between:

A.Jagannayalu Achari
And 2 others

Petitioners

And

Government of Andhra Pradesh
Rep.by its Principal Secretary to Government
Revenue (Assn.I) Department
Secretariat Buildings, Hyderabad
And 8 others.

Respondents

COUNTER AFFIDAVIT FILED BY THE RESPONDENT No. 7

I, G.Venkatram Reddy, Son of Sri Subba Reddy, Aged about 54 Years, Resident of Srikakulam, do hereby solemnly affirm and sincerely state on oath as follows:

1. I am working as Collector and District Magistrate, Srikakulam and the Respondent No. 7 herein and as such I am well acquainted with all the facts of the case. I have read the affidavit filed in support of the writ petition and I deny all those allegations made in the affidavit except those that are specifically admitted by me herein.

2. It is submitted that On receipt of an application made by M/s NCC Private Limited necessary proposals were submitted to Government for alienation of lands in Sompeta Mandal of Srikakulam District. The details are furnished below:

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Sl. No.	Name of the Village	Sy.No.	Extent in acres	Classification	Remarks
1.	Rushikudda	152/2	395.36	Kaluva poramboke	Out of total Ac.399.85, only Ac.395.36 was ordered for alienation duly deducting Ac.03.03 cents under D-patta Ac.1.46 cents for channel.
2.	Gollagandi	23/9	208.75	Tampara Poramboke	Out of total Ac.249.43, only Ac.208.75 was allotted for alienation duly deducting Ac.40.68 cents under CRZ.
3.	Baruvapeta	247	169.78	Beela Gayalu	Out of total Ac.277.00, D-patta for Ac.75.87, land under encroachment Ac.31.35 was deducted from alienation.
4.	Benkili	231	198.80	Beela Tampara	-
	Total		**972.69**		The total extent is Ac.1125.08 without deductions.

Government in GO.Ms.No.1107 Revenue (Assn.I) Dept., Dt.15-09-2008 accorded permission to the District Collector to alienate the above Government land to an extent of Ac.972-69 cents in favour of APIIC for onward transfer to M/s NCC limited, Hyderabad for setting up of 1980MW Thermal Power Project on payment of market value @ Rs.80,000/- per acre subject to the conditions stipulated in BSO – 24.

3. It is submitted that prior to this, public hearing was conducted on 18-08-2009 under the Chairmanship of District Collector, Srikakulam in the locality. During the public hearing no objections were received against the

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anticipated alienation proposal. The public hearing was attended by almost all levels of peoples representatives like Surpanches, Mandal territorial constituency members, Lift Irrigation scheme beneficiaries and other village elders and other different sections of the society. Further, the proceedings were got recorded, video-graphed and submitted to the Ministry of Environment & Forests, Govt. of India, New Delhi. In this connection, the sarpanches of the four villages who participated in the public enquiry did not express any objections orally or in writing for the said plant to be set up in the lands under alienation proposals.

4. I submit that normally, at the time of settlement of village, the land parcels in the entire village are usually divided into different classifications keeping in view of their probable utilization for raising crops etc., on the lands. As such, the land parcels would be put into different classes like Wet, Dry and Poramboke lands etc., Further, the wet land was classified into single crop or double crop wet depending upon the availability of the source of irrigable water and crop pattern raised on the land. If the land is so fertile, but dependent upon the rains for want of assured water source for raising crops it will be classified as Dry land. If the land is not fit for either cultivation or for assessment, such land was earlier classified as poramboke land. All such poramboke lands are Government lands. For these types of lands, if assessment is done, then the land would be categorized as assessed waste dry popularly known as Gayalu (AWD) which may be made available for assignment. Several categories of poramboke lands like Donka, Road, Drain, Canal, Forest, Grazing land, trashing ground, cattle shed, village site, river, burial grounds, swamp lands etc., could be seen from the village

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permanent Register like Diglot, Settlement Register, Re-settlement Register/Fair Adangal, Khasra pahani etc., Though this is not an exhaustive list, several land parcels would be called as Beela / Tampara etc., which are synonyms to swamp lands. Most part of the year, water would be stagnated in these lands with little drain facility, suitable for growing of mass, weed and water grass. The lands are not fit for any type of cultivation. Hence, the classification of the land is the sole business of the Settlement Officer at the time of taking up survey operations in the village. This classification would be recorded in the village permanent register. There is a prescribed procedure in Revenue Department for change of classification of one type of land to the other.

5. I submit that the lands covered in the alienation are Government lands with different names which shows their classification like kaluva, tampara, beela, gayalu etc., The classification could not be changed if any one calls a piece of land as wet land and it does not attain any status other than the recorded classification unless due procedure as prescribed in the BSOs/Government instructions issued from time to time, is followed for change of classification. The entire extent of Ac.972.69 covering four villages is Government land and locally called as "Beela". It is waste swamp land, not useful for agricultural purpose and it is not a source of Irrigation except for storing, excess drain water, before draining in to the sea, these lands are inundated for a part of the year.

6. I submit that the Divisional Forest Officer vide his letter No.2412/2009/A4, dt.27.08.2009 submitted a report to the Principal Chief Conservator of Forest (WL) & Chief Wild Warden, Andhra Pradesh,

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Hyderabad stating that there are no tiger reserves, Elephant reserves, National Park, Wild life Sanctuaries, community reserves and conservation reserves, within 10 KM radium from boundary of proposed site for alienation to M/s NCC Limited. Regarding Flora & Fauna, he reported that about 356 plant species, the predominant plant species of Mangifera indica, Borassus flabelifera etc., were identified within 10KM radius of the site. He further opined that there are no endangered, protected, threatened animal and plant species in the site.

In this connection, the Executive Engineer, APSIDC, Srikakulam has submitted a report stating that three LI Schemes namely,

1.Rushikudda LIS – 10/93,

2.Benkili LIS – 8/95,

3. Kuttuma LIS - yet to be commissioned (as on the date of reporting) are located in the area. Since there was no irrigation source and abundant stagnated water available in the Beela lands these lift irrigation schemes have been planned for Ac.750.00 in total for an estimated consumption of Ac.42.09mc.ft for using this stagnated water. The first two Lift Irrigation Schemes were commissioned and handed over to lift irrigation beneficiaries committee constituted with the water users for maintenance. The poor maintenance of these Lift Irrigation Schemes resulted in cultivation of Ac.230.00 during Khariff 2009 and much reduced extent during 2010 was reported. The lands under Lift Irrigation Schemes are very far away from the subject lands. The Commission of Lift Irrigation Schemes itself speaks that there was no permanent water source exists in the locality, the fact which rebuts the claim that these lands are classified as wet lands. The

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apprehension of the locals that establishing the Thermal Plant would hamper their peaceful living in the vicinity that led to several agitations and finally resulted in filing of a series of WP Nos.12220/2008, 8326/2010 and this present Writ Petition. Apart from filing these Writ Petitions, 6 appeals were also filed before the National Environment Appellate Authority, New Delhi by some people of Sompeta Mandal and few residents of Visakhapatnam and Hyderabad. They obtained orders quashing the environmental clearance accorded earlier by the Union Ministry of Environment. Consequently, there is no activity at field level by M/s NCC Limited, Hyderabad.

7. It is humbly submitted that the first petitioner in this case Sri A. Jagannadharao, S/o Apparao resident of Kuttuma Village possesses a pink card in his village. He owns Ac.11.62 of land, out of which Ac.6.55 cents is wet land and Ac.5.07 cents is dry land. As such, his claim that he is a small scale farmer is not correct. Similarly, Sanapala Kamesh, S/o Ramanna petitioner No. 2 also possesses Ac.3.79 of wet and irrigated dry lands in Benkili Village. These petitioners do not come under the category of small scale farmers.

8. It is humbly submitted that the Benkili, Rushikudda and Kuttuma Lift Irrigation Schemes are located in the surrounding area of the subject lands alienated, and the schemes should supply irrigable water for 750 acres. Actually, the schemes are facing lot of maintenance problems since farmers are not showing proper interest for maintenance of the schemes. As such, during the Khariff season 2009 an area of 230 acres was irrigated under

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these schemes. The EE,APSIDC, Srikakulam has reported that the schemes have been working partially owing to poor maintenance. In view of the above fact, as reported by the EE, the averment made by the petitioner that the setting up of coal based Thermal Power Project would cause hindrance to the free supply of water is not correct and that they would loose water supply source is not correct because only part of the swamp land has been alienated to the Respondent-9 leaving ample land for the purpose of storage. If the balance land (approximately 150 acres) is properly developed into a tank with sufficient depth, it could serve the purpose of water source for the Lift Irrigation Schemes.

9. It is humbly submitted that there was no stoppage of water flow by the authorities as averred in the petition. The water supply schemes were handed over to the concerned lift irrigation beneficiary committees, constituted with the local farmers. No other Irrigation Authority or drainage authority is there to stop the water as averred by the petitioners. It is only a misrepresentation of the fact. Further, it is submitted that averments stating that people were misled during the public enquiry is also not based on facts. Because, the public hearing was conducted in open arena after duly publishing the date, time and venue amidst effected people, villagers, peoples representatives and other notable personalities from the locality. The proceedings of the open enquiry were got recorded and video graphed. It is utterly false to state that the alienated land is wet land. Sanction of a lift irrigation scheme or mere mentioning of kaluva poramboke does not make a swampy land as a wet land. The classification of the subject land in revenue records is poramboke land for

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which assessment was not done and left it as un-assessed waste land. Even measurements were not done in this land as in the case of ordinary survey numbers which may measure to an extent of about Ac.5.00 in the case of wet land or Ac.10.00 in the case of dry lands. Whereas in the present context the alienated lands are huge extents. These are minor circuit blocks surveyed with the help of Theodolite machine. The classification of these lands was made in the village permanent register as poramboke lands specifically kaluva poramboke, tampara poramboke, beela gayalu, beela tampara. These classifications cannot be changed automatically if part of the land is provided with lift irrigation facility etc., Even the District Collector is not authorized to change the classification of a particular piece of land without following the due procedure as prescribed in Board Standing Orders and instructions issued by the Government from time to time. Hence, if any lay man or any other farmer or villagers calls a piece of land as a wet land it is not sufficient to consider its change of classification in to wet land. As such, the averment of the petitioners that though the subject lands are wet lands, Kaluva poramboke and source of lift irrigation scheme are sought to be destroyed was suppressed before the Ministry of Environments and Forests is untenable and far from truth. Actually these are waste lands where water stagnates for about 10 months in a year, weeds and grass is over-grown in the stagnated water. Even the farmers who were earlier granted D-pattas for the land in the periphery of these lands could not bring their lands into cultivation. Instead they came forward to hand over their lands on payment of the rate as fixed by the Government. All these facts

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corroborate that the subject lands are purely lands unfit for any cultivation. It is further submitted that the subject site is not part of any notified wet land system much less as per the criteria of Ministry of Environment and Forests for wet land system. With regard to irreparable loss and injury to the environment, it is humbly submitted that the then Divisional Forest Officer, Srikakulam reported that the animal species within the 10 KM area were common in nature to the region and there were no endangered protected threatened animal and plant species in the area. As such, there was no threat or loss and injury to the environment as claimed by the petitioners. The contents of the inspection report of the MOEF may be put to strict proof for establishing the fact that the subject lands ought not to have been alienated.

10. It is humbly submitted that the claim of the petitioner that the lands shall not be used for any other purpose except as a source of water is not at all fair on the part of the petitioners. If the prayer of the writ petitioner is accepted then it would in effect means that the land measuring 1125 acres should not be used for any other purpose except to irrigate 230 acres by utilizing the water. It is further submitted that the orders passed in Appeal Nos.1 to 6 of 2010 by the National Environment Appellate Authority to the effect that the environment clearance accorded by the Ministry was quashed does not convey the subject lands automatically conferred to the community since the R-9 obtained the alienated land on payment of the market value as fixed by the Competent Authorities subject to the conditions as stipulated in BSO-24. It is further submitted that it is not correct to say that local police are harassing the villagers.

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11. It is humbly submitted that an extent of Ac.972.69 in Government poramboke lands was alienated to M/s Nagarjuna Construction Company Limited through G.O.Ms.No.1107, Revenue (Assn.I) Department, dt.15.09.2008 for setting up of 1980MW Thermal Power Project in the villages of Rushikudda, Gollagandi, Baruvapeta and Benkili villages of Sompeta Mandal in Srikakulam District. The said land was alienated to the Respondent – 9 subject to the conditions stipulated in BSO-24, by duly fixing the market value. There may be little inconveniences to the public in the locality which can be worked out and redressed in a coordinated manner by setting up of a team of local villagers, representatives from the Firm and Government Officials. But, it serves public at large by producing 1980 MW power thereby strengthening the regional grid, providing employment in general and to the locals in specific.

For the reasons stated above, it is, therefore, prayed that this Hon'ble Court may be pleased to vacate the interim order granted in WPMP.NO.20972 of 2011 in WP.No.17448 of 2011 dated 23.6.2011 and consequently to dismiss the writ petition in the interest of justice.

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Deponent

COLLECTOR
SRIKAKULAM

Solemnly and sincerely affirmed
This the 16th day of August, 2011
and signed his name in my presence
at Srikakulam

Before me

Attestor

Administrative Officer
Collector's Office
SRIKAKULAM

BEFORE THE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONE, CHENNAI
(Under Section 18 (1)) read with Section 14 of National Green Tribunal Act, 2010)
Application No.153/2016 (SZ)

In the matter of

1. PARYAVARANA PARIRAKSHANA SANGHAM
   Through its President Mr.Y.Krishnamurthy,
   Sompeta, Srikakulam District,
   Andhra Pradesh.
2. E.A.S.Sarma
   14-40-4/1, Gokhale Road,
   Maharanipeta,
   Visakhapatnam – 530002.

... Applicants

Versus

1. UNION OF INDIA
   Through Secretary
   Ministry of Environment & Forest
   ParyavaranBhawan, CGO Complex,
   Lodhi Road,
   New Delhi – 110 003 and 4 others

TYPED SET OF DOCUMENTS

M/s L.G.SAHADEVAN1102/93
T-8, 4th FLOOR, SINGAPORE PLAZA,
164/337, LINGHI CHETTY STREET,
CHENNAI- 600 001: PH: 9841016152
COUNSEL FOR RESPONDENT-4