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Coastal Disaster Damage and Neotectonic Subsidence Study Using 2D ERI Technique in Dhanushkodi, Rameshwaram Island, Tamilnadu, India

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Abstract: The coastal dip of southern part of Dhanushkodi was destroyed due to cyclone in the year 1964. The area was subsidence under the Neotechtonic activity in the mid of century. The submerged part was studied through the 2D electrical resistivity imaging study. The ancient part of the structural feature and subsurface coastal soil condition were studied up to depth of 20m or 60 feet. The coastal disaster affected area was identified using field works. The submerged pars of the palaeo structural features and tress, church and historical places were identified through the field work and scientific methods. The recent rents of 2D Electrical Resisivity Imaging (ERI) are a fast and cost effective technique, which covers both vertical and horizontal changes in the subsurface of the geological formation of the study area. The collected resistivity data prepared in the form of pseudosection or 2D pictorial form of the study area subsurface condition and Neotectonic studies.

Key words: Costal disaster · Cyclone · Dhanushkodi · Rameshwaram Island · 2D ERI · Coastal submerged · Subsidence

INTRODUCTION

The study is mainly focused to the environmental and ancient historical place of the Dhanushkodi Township. It was a part of the Rameshwaram Island in Tamilnadu. The 2D Electrical Resistivity Imaging (ERI) study Geophysical resistivity imaging studies is to be carried out in the study area, to characterize the subsidence, neotectonic submerging and marine environmental, coastal palaeoenvironmentals studies. The study area is a part of southern tip of Rameshwaram Island of Dhanushkodi coastal sector of 65 km length from Manapad to Vallinokam trending towards the southern part of Gulf of Mannar, India (Fig.1).

The ERI study involves measuring a series of constant separation traverse with increase of electrode spacing with each successive traverse. The increase of electrode spacing increases the depth of penetration, so that apparent resistivity measured at various depths is used to construct a vertical contoured section, displaying the variation of resistivity both laterally and vertically over the section. The 2D ERI study was used in different locations in order to characterize the geology of the subsurface lithological, structural and hydrological condition [1-4]. The investigation using the high resolution 2D ERI techniques to help determine the Neotectonic, palaeo environmental hydro stratigraphic frame work and the extent of sea water in the study area. The main aim of the study were conducted using topographical mapping (Geodetic survey) – Total station and 2D ERI survey along some profile in tip the Dhanushkodi, Rameshwaram Island.

Coastal Disaster Affected Area in Dhanushkodi Field Work: Coastal areas are the arrangements of complex, diverse and fragile ecosystems like Mangroves, tidal salt marsh, tidal mudflats, sand dunes, backwater area, lagoon, coral reef ecosystem affected by cyclone. They need special attention for their resources function and provide opportunity for economic development of the local people in Dhanushkodi (Fig. 2-9).

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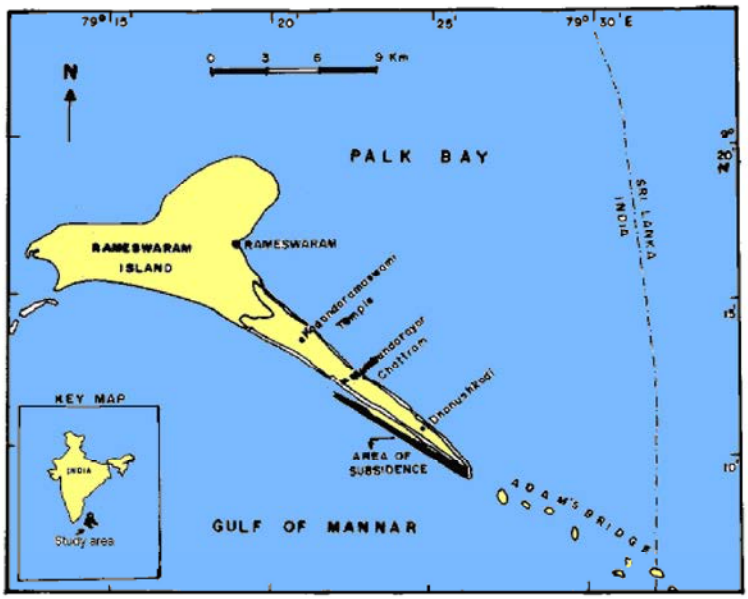

Fig. 1: Map showing area of study and subsidence (Modified G. G. Vaz, 2007).

Fig. 2: Photograph-Old railway station.

Fig. 3: Cyclone was affected in the church in the middle township of Dhanushkodi.

Fig. 4: The Church building was constructed using Corals from Island

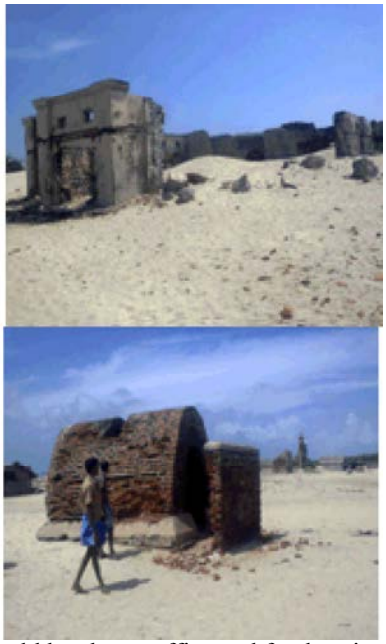

Fig. 5: The old head post office and food saving yard

Fig. 6: The Golden Jubliee function celeberated by Dhanushkodi Municipality Since, May, 1933

Fig. 7: The cyclone was affected in the trees are and dumped 3m thickness of sediments (sand and mud's)

Fig. 8: Shows the tree growth and rings of the tree was affected by salt water. intrusions and drowned temple developed in recent year

Instrumentation and Data Collection: The scanning of the 2D ERI starts from the high water line and move of perpendicular to the shoreline towards the landward side. In this technique forty (40) stainless steel electrodes are pierced 30cm to 40 cm into the beach surface with an interval of 3m each. These electrodes are connected through multicore cables to a switching panel which is placed in the middle of the profile. The current and

Fig. 9: The head lands are developed due to wave and tidal impact in Arabian and Indian Ocean near Pamban Bridge

Fig. 10: Electrical Resistivity imaging data collection

potential terminals from the switch panel are connected to the respective terminals of the CRM 500 Resistivity meter.The switching panel consist series of sockets connected to the electrodes through the multicore cable system. The current terminal pin and the potential terminal pin which are connected with the current source and the resistivity measuring instrument can be inserted in the appropriate sockets for measuring the resistivity between any two electrodes without actually changing the electrodes along the profile. The multiple sounding along the selected profile registered the horizontal and vertical resistivity changes. These resistivity values are used to create a 2D ERI of the cross section of the profile. The pseudo section contouring method is used to plot the data collected through the field experiments [3]. The pseudo-section reflects the true resistivity distribution along the profile and therefore can be used as a base for qualitative interpretation. To minimize the differences between the measured and the calculated apparent resistivity values, the inversion method is applied by Antony Ravindran [1]. The inversion method projects a 2D model of a subsurface by using the measured data and by using RES2DINV software program. The ERI with an aid of topographical variation helps in identifying the saltwater intrusion along the beaches perpendicular to the coastline 120m from the high waterline in the areas of tip of the Dhanushkodi. The resistivity of the rocks varies with porosity, fracture, fracture filling fluids and fluid saturation. In the tip of the Dhanushkodi sand projected dune area, three ERI surveys were carried out to a length of 120m respectively (Fig. 10).

RESULT AND DISCUSSION

The delineation of saltwater intrusion and beach sand dunes are done on the basis of the contour pattern of apparent resistivity values that is reflected in the 2D ERI. The Distribution pattern of saltwater and sand dunes in the area profiles are estimated through the ERI up to the depth of 11.9 m. The distribution pattern of saltwater intrusion, sandstone clearly reveals that the increase of the percentage of beach rock decreases the influence of the seawater intrusion [5-7]. The beach rock and rocky coast acts as dyke rock and disallows the infiltration of the seawater into the coastal aquifer [8-9]. The lower percentages of sandstone/rocky coast, in the areas of clearly depict the above conclusion as seawater intrusion into the coastal aquifer is evident from the field experiment.

The impact of the tidal and wave energy along the coastal zone is clearly articulated with the advent of the 2D ERI study in the study area. Through this 2D ERI study the variation of hydraulic conductivity from the high waterline of the beach to a distance of 120m perpendicular to the coastline in the study area clearly exhibits the saltwater intrusion zone low resistivity values of various profiles. At Dhanushkodi tip seawater occurrences are observed from 3m to a maximum depth of 8m. Saltwater zones are encountered from a depth of 7.5 m

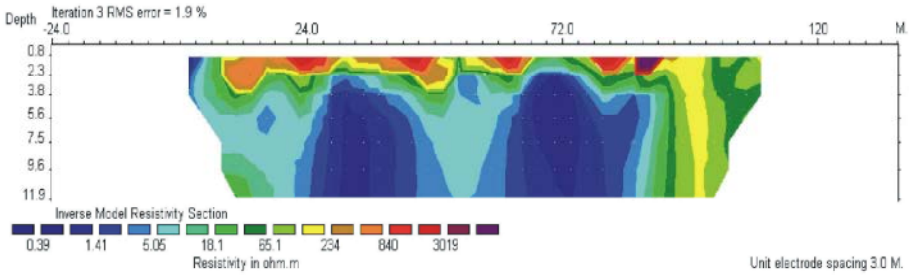

Fig. 11: 2D Electrical Resistivity imaging Pseudosection survey carried for the exploration of palaeo environment of Dhanushkodi

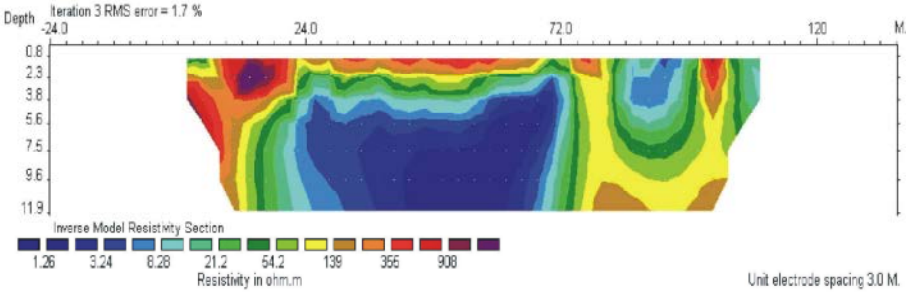

Fig. 12: 2D Electrical Resistivity imaging Pseudosection survey were carried for the exploration of palaeo environment of Dhanushkodi

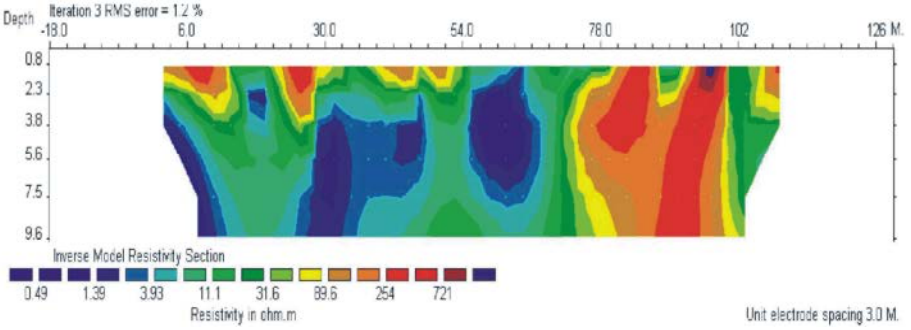

Fig. 13: 2D Electrical Resistivity imaging Pseudosection survey was carried for the exploration of palaeo environment tip of Dhanushkodi

onwards. The consolidated beach ridge or beach rock in the subsurface zone of the high water line of the beach prevents further intrusion of seawater. The detached patches of the sandstone/beach rock in these areas allow intrusion of seawater (Fig. 11-13). The low resistance is occurs between 1-5 ohm.m along the three profiles represent saltwater intrusion with high salinity [10]. The moderate resistive layer were identified between 10 to 20 Ohm.m indicates sand dunes in the study area. The high resistive value (100 Ohm.m) shell limestone with Neotectonic implications at the surface between horizontal distances indicates sand stone in the study area.

CONCLUSION

The 2D ERI gives image of the subsurface resistivity changes and relationship of seawater intrusion at Dhanushkodi, Rameshwaram Island, Tamilnadu. The electrical resistivity imaging pseudo section along the profiles in the study show different three types of resistivity zones such as sea water, brackish water and sand dunes. High resistivity material more than 1.2-10 Ohm.m is represents sand dune. The moderate resistive layer between 1-5 Ohm.m represents soil with brackish water. The low resistivity layer 0.1 – 1 Ohm.m along the profile represents sea water intrusion. The resistivity

changes randomly in both horizontal and vertical direction in the sea water intrusion of the study area due to Arabian Sea and Indian Ocean. The 2D ERI technique is a useful tool for the sea water intrusion study in the study area and to find out the palaeo envirionmetal study of coastal aquifers. In this study used to identify the Neotectonic uplifted coatal areas like, Dhanushkodi, Vallinockam, Manapd dunes are completely eroded due the wave action in the future.

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