Identification of Suitable Sites for Urban Solid Waste Disposal using Multicriteria Evaluation Method in Amravati -a Case Study

J. Netaji, P.J.Chandra Sekhar, G.Jai Shankar

Abstract: ***In the developing country like India, Urban Solid Waste Management is considered as one of the most vital and serious environmental problems for the municipal authorities.. There is a drastic increase in the residential, commercial and infrastructure development due to the growth of population which resulted in the generation of solid waste in huge amount. The increasing waste generation rates stress on all the infrastructural, economic and natural resources with adverse impacts on the environment and human health due to the unscientific and improper solid waste dumping. The improper storage, enormous generation of waste, the unscientific waste disposal site can affect the air and water quality, public health and land use. These impacts are caused due to the dumping site location in the unsuitable areas. So, this study tries to give an insight on evaluation of suitable sites for solid waste disposal in the Amaravati capital city of Andhra Pradesh, India. The suitable disposal site selection should adhere to the norms of the guidelines prescribed by Andhra Pradesh Pollution Control Board(APCB) to ensure there would be no risk involved with the environment and people. The Remote Sensing and GIS techniques connection with the satellite imagery can build a more accurate type of information based on several criteria's to take the right decision for the solid waste disposal sites. The thematic layers like geology, soil, slope, land use/land cover, etc., are generated to perform the analysis. The elements in each of these thematic map layers were assigned the weights according to the Analytical Hierarchy Process (AHP). The Multi Criteria Evaluation Method of Weighted overlay analysis was performed for determining an appropriate dumping site for the solid waste disposal in the Amaravati***

Index Terms: solid waste disposal site, GIS, weighted overlay analysis Amaravati.

I. INTRODUCTION

Amaravati The New Capital of Andhra Pradesh is envisioned to be world-class infrastructure, healthy environment and efficient resource management. The city is projected to reach a population of 3.5 million by 2050. There is a need of a potential solid waste Disposal site for healthy environment Urban solid waste management is one of the major problems that city planners face all over the world. The problem is particularly severe in most developing country cities where increased urbanization, poor planning and lack of adequate resources contribute to the poor state of municipal solid waste management (Obirih-Opareh & Post, 2002; Mato, 1999; Doan, 1998; Mwanthi et al., 1997) Landfill site selection is a complex process involving social, environmental and technical parameters as well as government regulations. There isa specific set of rules and regulations prescribed by Andhra Pradesh Pollution Control Board (APPCB)(Under the law of Solid waste management rules 2016) According to the Section 2(a) Environmental protection act , 1986 'Environment' includes Water ,Air and Land are having interrelationship among them, that includes

1) The location of solid waste disposal site should be at least 100 meters away from the river.
2) 200 meters away from the pond.
3) 200 meters away from Highways, habitation, Public Parks, and water supply wells.

The study area consists of River, water body, canal, road network, railway network. This constrains taken for the study for buffer analysis. Therefore this study is aimed to solve solid waste disposal site using GIS, multi-criteria evaluation technique,weighted overlay analysis techniques are used which output is used for locating of best site suit of disposal of solid waste.

II. RESEARCH SIGNIFICANCE

The main significance of this paper is to find best suitable solid waste disposal site for capital city where there will be increase of population in near future.

III. STUDY AREA

Amaravati is the new capital city of Andhra Pradesh, India. This city is planned to build on the southern banks of the Krishna river in Guntur district of area 233 sq km, by Andhra Pradesh Capital Region devlopment authority , It is designed to have green spaces of 51% and 10 % water bodies Amaravati capital city is comprised of 26 villages it is being constructed to serve as the new capital city of Andhra Pradesh.The study area location map is shown in Figure 1.

Revised Manuscript Received on April 09, 2019.

J. Netaji, Post Graduate student, Geo-Engineering, Department of GEO- Engineering, Andhra University, Andhra Pradesh, Vishakapatnam, India.

P J.Chandra Sekhar, GIS Data Manager, APCRDA, Andhra University, Andhra Pradesh, Vishakapatnam, India.

G. Jai Shankar, Professor, Department of Geo-Engineering, College of Engineering, Andhra University, Andhra Pradesh, Vishakapatnam, India.

IV. MATERIALS AND METHODS

A. Data used

The Landsat 8 TM+ satellite image of the year 2018 and the ASTER GLOBAL DEM image which covers the study area are downloaded from the USGS website.The Survey of India (SOI) toposheets (65D/6, 65D/7, 65D/10, 65D/11) at 1:50,000 scale are acquired from Survey of India website. Collateral data and field data are provided by APCRDA (Andhra Pradesh Capital Region Development Authority) and APSAC (Andhra Pradesh Space Application Center).

B. Methodology

The extraction of the study area from the satellite images is done by sub-setting the image using area of interest (AOI) tool in ERDAS IMAGINE 2014. The FCC(False Color Composite) of an image is done by using layer stacking tools and the images are enhanced by the convolution tool, as well as the image registration is also done for the image to prepare Land use/Land cover map using the combined classification technique.Thereafter the thematic maps, i.e., the base map and transportation map are being generated using ARCMAP 10.2. The other thematic maps like a slope map is developed by downloading the DEM image from the USGS and analysed in ARCMAP 10.2 using hydrology tool. From the field report and different organizations data Soil map, Geology map, Hydrogeomorphology map are been prepared in ARCMAP 10.2, this constitutes the spatial database.For selecting best Solid waste management site buffer analysis is carried out for thematic maps like road and railway and water bodies and analytical hierarchy process by saaty is carried out for the study area in the first part of the study . By grouping all the layers and by performing weighted overlay analysis the analysis is carried out and decisions are made. At the beginning of the process, the criteria for evaluating the solid waste disposal site were selected by considering and following the guidelines and rules of Andhra Pradesh Pollution Control Board (APPCB), and by referring research articles, books,. This chain of criteria was, in turn, reflect the level of suitability obtained in the study, The methodology used in this study for site selection of the disposal site is shown in Figure 2. An analytical hierarchy processes used in this study for different layers.

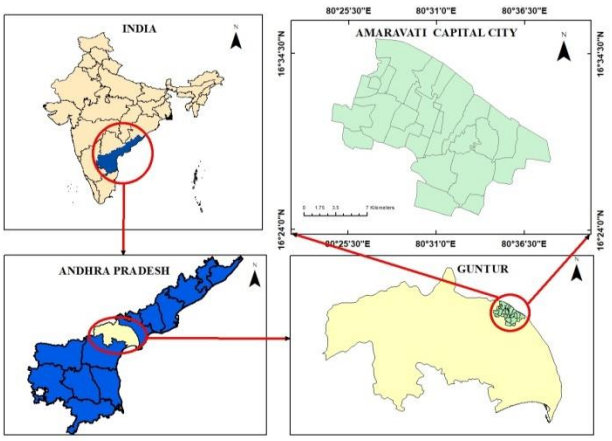

Figure 1 : Study area location map

V. RESULTS

A. Base Map

Basemaps contain reference information that will provide different geospatial information. .ABase map is delineated from the toposheet which depicts the basic information, i.e., the water bodies, canals, railway tracks, settlements, roads, forest etc. The Base Map of the study area is shown in Figure 3.

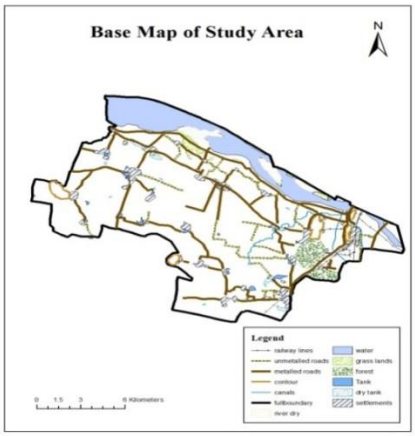

Figure 3: Base Map

B. Land use/Land cover Map

Land cover data comprises how much of an area is covered by different classes, and Land use shows how people utilizethe landscape. In this study different Lu/Lc classes derived from the Landsat 8 image using the combined classification technique isbuilt up-Rural, Built upUrban, Barren rocky, Agriculture-Crop land, AgricultureFallow, Agriculture-Plantation, Scrub forest, Scrub land, Water body-Pond, Water body-River. The level-2 classification is carried out for Land use/Land cover classification. The Land use/Land cover Map of the study area is shown in Figure 4.

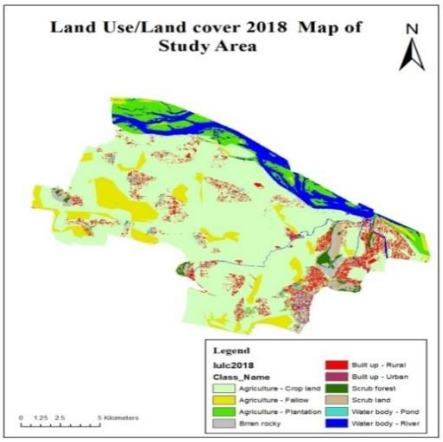

Figure 4: Land use/Land cover Map

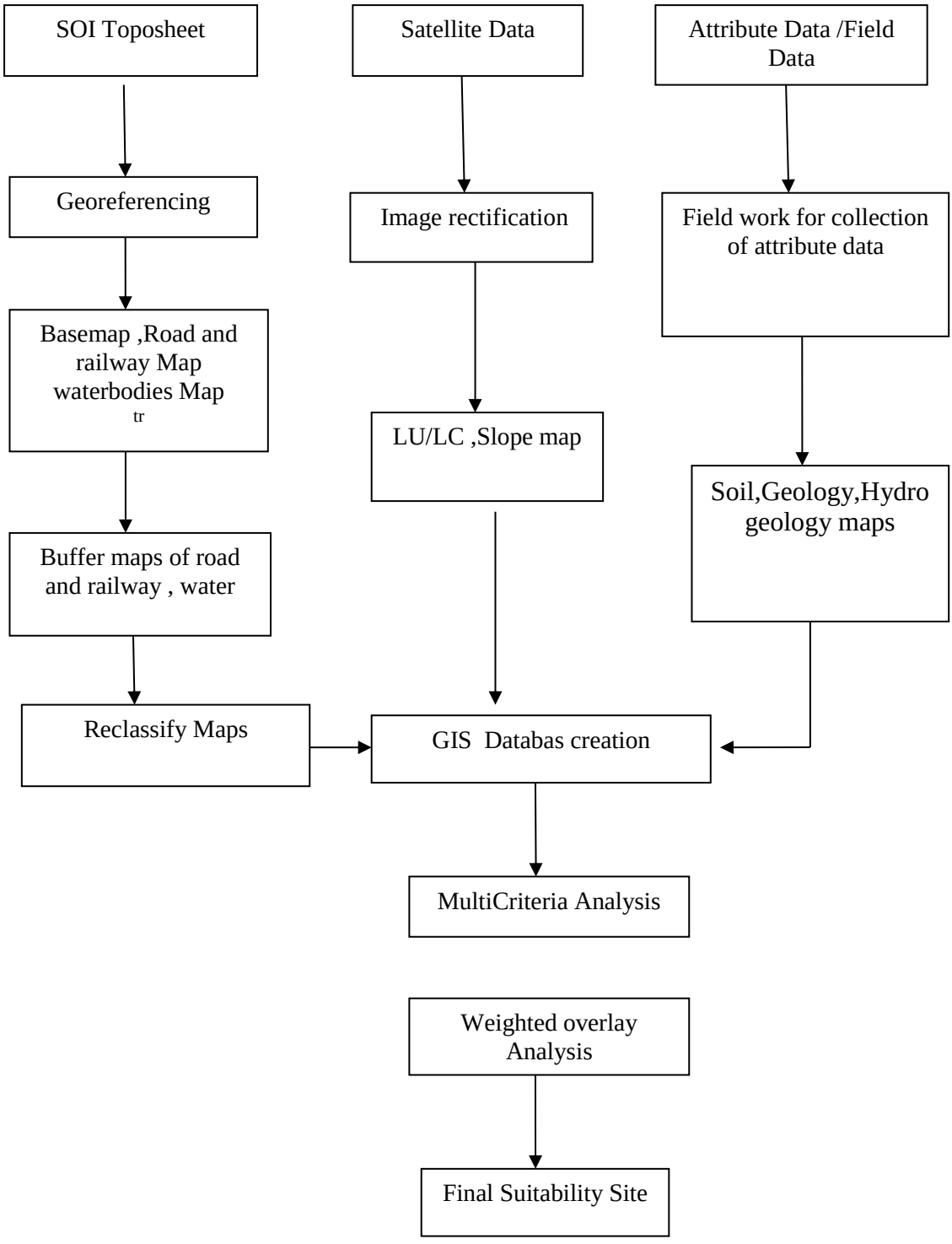

Figure 2: Methodology flowchart

C. Slope Map

For preparing the Slope Map the DEM image is used which is downloaded from the USGS. Using surface tool in ARCGIS 10.2 slope classification map is generated. The majority of the area in the study area is moderately sloping. The slope Map of the study area is shown in Figure 5.

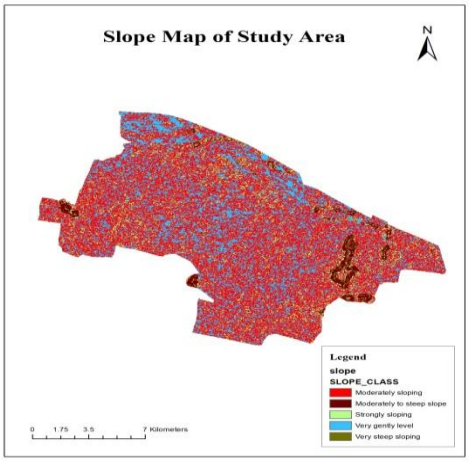

Figure 5: Slope Map

D. Soil Map

The soil map gives lucid information about the morphology of the soil strata, observed that there are majorly 3 types of soils in the study area they are Moderately deep black clayey soils, clayey to gravelly, clayey moderately deep dark brown soil and loamy to clayey skeletal deep reddish brown soil. Among the 3 types of soils in the study area clayey to gravelly clay moderately deep dark brown soils are taken highly suitable for solid waste disposal site. The soil map of the study area is shown in Figure 6.

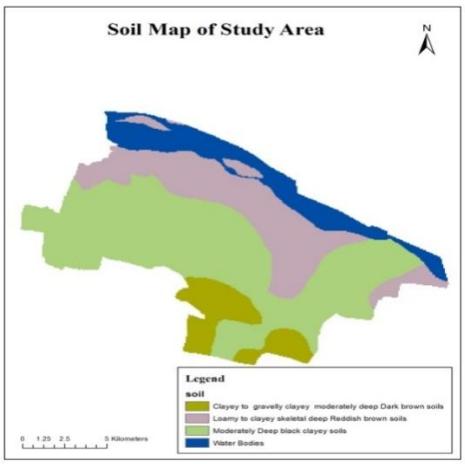

Figure 6: Soil Map

E. Geology Map

The less permeable Khondalite and Charnockite rocks which are mostly occurring in the study area and these rocks are of impermeable natured and most suitable for the disposal site and the remaining are considered as not suitable for solid in the level of suitability. The geology map of the study area is shown in Figure 7.

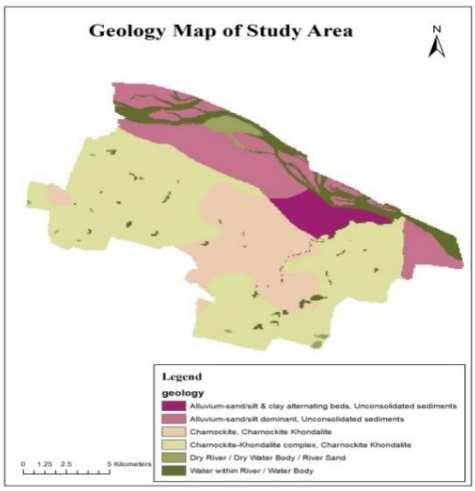

Figure 7: Geology Map

F. Hydrogeomorphology Map

The different hydrogeomorphological origins perceived in the study area are pediplain moderate weathered, channel bar, denudational hill, flood plain deep and moderate, inselberg, palaeochannel, pediment, structural hill, water body. At the level of suitability pedi plain moderately weathered and the pediment is considered as highly and moderately suitable . The remains are considered as not suitable. The hydrogeomorphology map of the study area is shown in Figure 8.

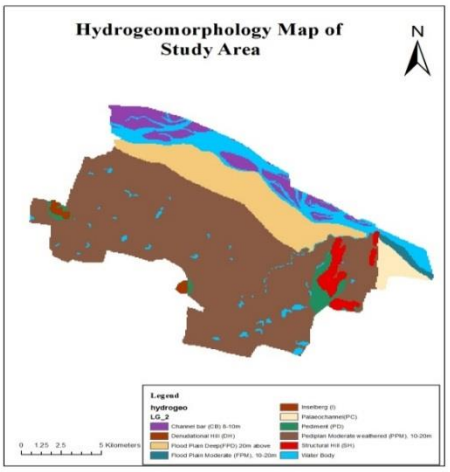

Figure 8: Hydrogeomorphology Map

G. Distance from roads and rail

Most of the study area is widely connected by Metal, Un-Metal roads and Cart-tracks. There is a railway track which passes through the some of the villages in the study area According to the norms of APPCB the disposal site should be atleast 200 meters away from the road and railways. By considering the buffer distance of 250 meters distance is taken as not suitable, 500 to 750 meters are taken as moderately suitable, greater than 750 meters is considered as highly suitable. The distance from roads and rail is shown in Figure 9.

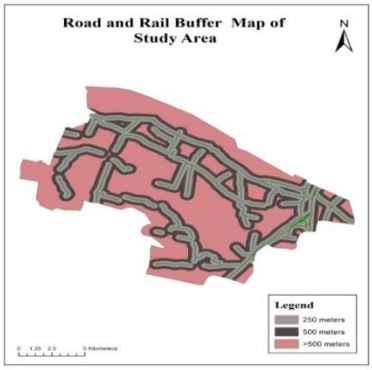

Figure 9: Road and Rail Buffer Map

H. Distance from water bodies

study area consists of river , canals , tanks According to the norms of APPCB the disposal site should be atleast 200 meters away from Waterbodies By considering the buffer distance of 250 meters distance is taken as not suitable in , 500 to 750 meters are taken as moderately suitable, greater than 750 meters is considered as highly suitable. The distance from water bodies is shown in Figure 10.

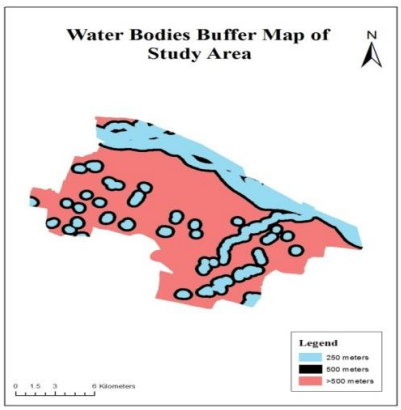

Figure 10: Water bodies Buffer Map

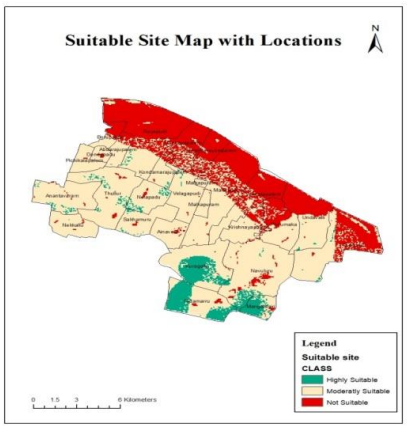

Figure 11: Suitability site Map

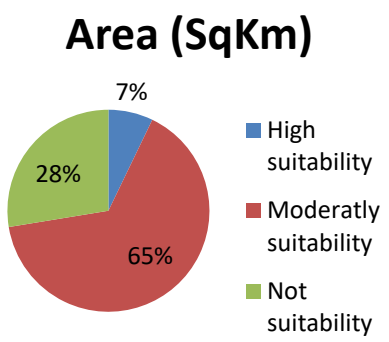

Figure 12: Suitability site area piechart

VI. CONCLUSION

The socioeconomic and environmental problems associated with the solid disposal site are multifaceted due to the quantity and diverse nature of the waste material. Remote Sensing and GIS techniques were most suitable tools to address the problems related to the spatial dimension. The foremost step in this process is Multi-Criteria Decision Analysis (MCDA) is used to classify different levels of suitability. The highly suitable areas in the given study area constitutes 16.679 square kilometers, moderately suitable areas gives about 152.069 square kilometers, not suitable areas is of about 64.267 square kilometers. Solid Waste should be managed by the modern techniques and methods which support long term sustainability of the environment and communities.Weighted Overlay tool in ARCMAP 10.2 is used for running of the model based on weightges what we have given according to the suitable conditions of the study area. Land use and land cover, geology, hydrogeomorphology, soil, slope, distance from water body, distance from road and railway line are 23%, 20%, 17%, 20%, 10%, 5% and 5% respectively. The final suitability map for the study area is shown in Figure 11.

REFERENCES

1. Olusina J. O and D.O Shyllon, “Suitability Analysis in Determining Optimal Landfill Location Using Multi-Criteria Evaluation (MCE), GIS & Remote Sensing”, *International Journal of Computational Engineering Research (IJCER),* Vol. 4, 2014, pp. 7 – 20.
2. Masood Ahsan Siddiqui et.al, “Municipal Solid Waste Management in Moradabad City, India”, *J Indian Soc Remote Sens*, Vol. 40, 2012, pp. 109 – 119
3. B. Feizizadehab and T. Blaschkeb, “Land suitability analysis for Tabriz County, Iran a multi-criteria evaluation approach using GIS”, *Journal of Environmental Planning and Management*, 2012, pp. 1 – 23
4. Abdelhakim El Maguiri et.al, “Land site selection using GIS, remote sensing and multicriteria decision analysis: a case of the city of Mohammedia”, *Morocco, Bull Eng Geol Environment*, 2016, pp. 1 – 9
5. “Management of Municipal Solid Waste. Ministry of Environment and Forests”, *Central Pollution Control Board (CPCB),* New Delhi, India, 2004.

6. Casares M.L et.al, "Solid industrial wastes and their management in Asegra (Granada, Spain)", *Waste Management*, Vol. 25, 2005, pp. 1075-1082.
7. Bovea M.D and Powell J.C, "Alternative scenarios to meet the demands of sustainable waste management" *Journal of Environmental Management*, Vol. 79, 2006, pp. 115-132
8. Hala A. Effat et.al, "Mapping Potential Landfill sites for North Sinai cities using spatial Multi- Criterion evaluation", *The Egyptian Journal of Remote Sensing and Space Sciences*, Vol. 15, 2012, pp. 125 – 133
9. Imtiaz Ahmed Chandio et.al, "GIS-based land suitability analysis of sustainable hillside development", *Science Direct*, 2014, pp. 87 – 94
10. Pan Qisheng and Zhai Dong et.al, "Optimized Selection of Landfill Sites in Houston Area Using Geographical Information System", *IEEE*, 2012.

AUTHORS PROFILE

J.Netaji Post Graduate student, Geo-Engineering, Department of GEO-Engineering,AndhraUniversity college of engineering Vishakapatnam, India
Email : netajigangulian@gmail.com

PJ. Chandrasekhara Rao working as a GIS Data Manager in Andhra Pradesh Capital Region Development Authority (APCRDA)
Email : chandrasekhar.pj@apcrda.org

Dr. G.Jai Shankar Professor, Department of GEO-Engineering, AndhraUniversity college of engineering Vishakapatnam,India
Email : jaisankar.gummapu@yahoo.com