Site selection for solid waste management in Krishna district, Andhra Pradesh using GIS

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Abstract. Solid waste management involves collecting and processing garbage. It also recycles products. Solid waste management helps determine the best ways to use industrialised garbage. Industrialization produces chemicals and other waste products that harm human health. Solid waste management reduces this impact. Waste management has several ways. This study examined Krishna district in Andhra Pradesh. This study collects soil and geological data. This study shows how GIS may be utilised for waste management planning. The result shows the solid waste management area. So, garbage management should be simplified.

1 Introduction

Solid waste is trash produced by humans in home, commercial, and industrial contexts. Three main solid waste categories are:

1. Residential, commercial, or institutional rubbish can be the source.
2. Glass, metal, plastic, paper, and organic stuff are present.
3. Dangers can be lethal, non-lethal, flammable, radioactive, infectious, and other types.

Environmental and health effects are lessened or eliminated via solid waste management. Municipal trash management requires a few steps. Monitor, gather, transport, process, recycle, and dispose of evidence. The key factor influencing waste variances in metropolitan areas is lifestyle, which is closely tied to socioeconomic level. In India's main cities, 0.8 kilogramme of trash is produced everyday per person. Municipal solid waste (MSW), or 68.8 million tonnes, or 0.573 MMT/d, was generated in metropolitan India in 2008. MSW collection effectiveness ranges from 22% to 60%.

2 Objectives

- Find a suitable solid waste disposal site.
- Locating landfills away from populations and natural resources.

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3 Review of the literature:

3.1 Surendra Kumar Yadav et al., (2013):

Strategic models are needed to pinpoint regions with development potential and constraints in long-term management strategies. The analytical hierarchy process (AHP) was used to weight numerous aspects for the selection of the primary dump site. The appropriateness index (S) was computed using the weighted linear combination (WLC) method in a GIS setting after the criteria were combined. The appropriateness index (0-10) values are divided into four groups and used to determine where the landfill will be best suited [1].

3.2 K. Rasappan et al., (2013):

This study will assess how much rubbish is produced in the urban area surrounding Coimbatore and propose realistic and transparent administrative solutions to garbage collection. Coimbatore is in western Tamil Nadu. 105.6 square km house 102,219 people. The research area created 749 tonnes of garbage. Geographic information systems were used to collect demographic and solid trash data from Coimbatore's 72 wards for the city's urban map (GIS). Map study revealed which places generated more solid trash than the surrounding population [2].

3.3 Gautam Dadhich et al., (2016):

This study uses geomatics and MCDM to find economically viable Jaipur rubbish disposal sites. Several factors were considered when assessing solid waste disposal sites. Socioeconomics, geology, and geomorphology were considered. The study's geospatial analysis yielded a map ranking Jaipur's solid waste dump sites from best to worst. This study showed how GIS and MCDM may help make solid waste management decisions [3].

3.4 L. Yeshodha et., (2016):

This study uses GIS and remote sensing to find Krishna Giri's most environmentally friendly garbage disposal site. Before choosing solid waste dump sites, this study examined the current site. The IRS P6 LISS-IV satellite pictures were interpreted on-screen to map land use, land cover, geology, geomorphology, soil, road network, and drainage. Q-spatial GIS's analyst tool was used to analyse all themed vector layers to evaluate if each theme was suitable for the research area's classes and to find waste disposal sites [4].

3.5 Samiullah1 et al., (2016):

This page seeks out Peshawar City District municipal garbage and solid waste disposal places. This ensures garbage disposal. GIS and remote sensing can locate rubbish faster and cheaper than traditional methods. Choose a spot carefully to dispose of solid waste responsibly. A 2010 SPOT satellite photo and topography information were used to find a safe dumping site in Peshawar. It started here. We gathered primary and secondary sources from many sources. The parameters' surfaces were generated using ArcGIS 9.3's multicriteria analysis and spatial analysis [5].

3.6 U Kiran et al., (2017):

This work uses GIS and multi-criteria analysis to build a model based on past research on solid waste disposal sites. This study's data and suitability model were utilised to rank Andhra Pradesh state capital region areas. This research's appropriateness analysis methodology used classified raster layers. Land use classification, slope, road and railway distance, and constraint layers were incorporated. Then, the eligible zones were polygonised to assess their size and land use. India's high population limits usable land. This study used several methods to discover rare solid waste disposal land [6].

3.7 Sachin K. Kamble1 et al., (2019):

This essay examines SWM GIS use. GIS improves system performance, saves time and money, and aids solid waste management decision-making (SWM). GIS-based waste collection optimisation in several countries with different socioeconomic and technology histories shows that large cost savings are often possible. Route optimisation reduces urban noise, greenhouse gas emissions, and financial costs, which benefits the environment (reduction of fuel consumption and maintenance expenses) [7].

3.8 P.J. Chandra Sekhar., (2019):

Amaravati was covered by this study. Solid waste disposal facilities were found using a number of criteria. The research area has a river, a river system, a rail system, and another body of water. The study of buffers was constrained by this rule. Therefore, the goal of this study is to find the optimal location for disposing of solid waste. This is made possible with the aid of GIS, multi-criteria evaluation, and weighted overlay analytical approaches. For the model to function successfully, the weights they offered must correspond to the conditions of the study region. Considerations included geology, hydrogeomorphology, slope, closeness to water, soil, distance from railway tracks and highways, land use, and land cover. ARCMAP 10.2's Weighted Overlay was applied. They are 23%, 20%, 17%, 20%, 10%, 5%, and 5% in terms of quality [8].

3.9 Sandra L. Cobos-Mora1,2 et al., (2022):

The ideal TS installation locations in Azuay, Ecuador, are identified by this study. Multi-criteria decision analysis for geographic information systems examines subjective and unprofitable data. Analytical hierarchical process methodology is heuristic and scalable. Authors handle the issue holistically. To organise information, the viewpoint has three levels of categories, criteria, and sub-criteria. Technology, environment, economics, and society are the components. Rivers, protected areas, populous regions, land usage, educational and medical institutions, tourist attractions, basic services, highways, gravity centres, geology, energy grids, and slopes must be satisfied [9].

4 Methodology

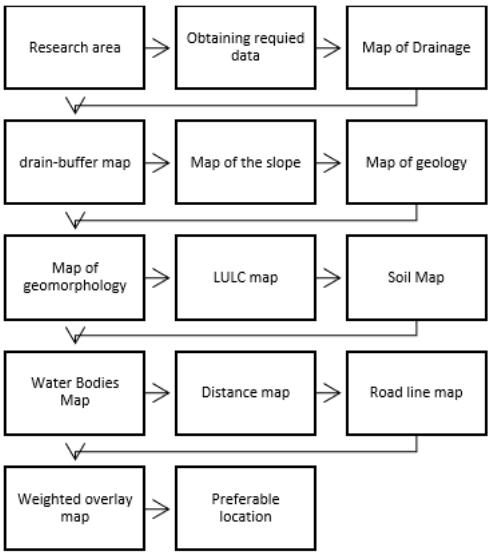

Fig. 1. Site suitability Analysis process

5 Research area

Bay of Bengal borders Eluru, NTR, Guntur, Bapatla, NTR, and Krishna districts. Krishna has 3,754 square km. Working on Krishna's topography was decided. Cities and towns are growing rapidly, making solid waste disposal problematic. Cities urbanise faster than towns. The exact Krishna district borders were published by the official government website of Andhra Pradesh. The Krishna district border is digitalized using the generate feature command once the map has been acquired and georeferenced. The raw data for the research area is collected from the USGS Earth explorer. The Digital Elevation Model Data has been obtained and from then the raster form the data has been added to the contents as the data obtained is not a single image, the entire obtained data tiles should be converted into a single raster format. The tool named as “mosaic” from the data management tools such that the raster is obtained. And later in order to clip the raster to the research area use the “clip raster” tool from the data management tools. Fig 2 represents Krishna's administrative divisions & DEM data.

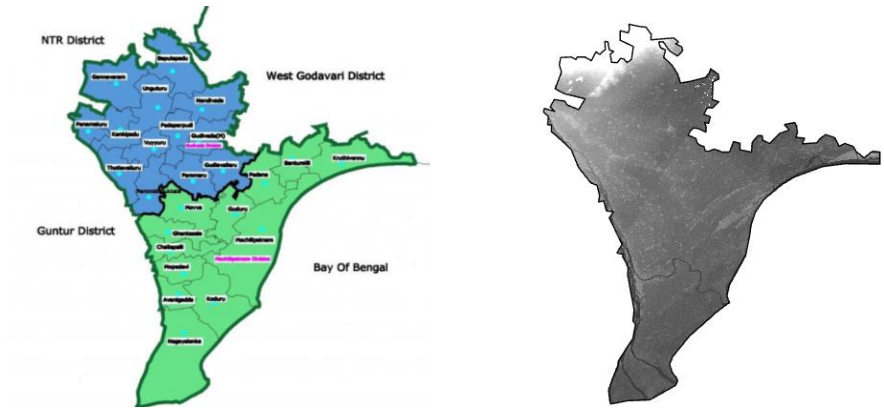

Fig. 2. Krishna district's administrative boundaries and DEM data.

6 Maps obtained

6.1 Drainage Buffer Map

While using the buffer tool, drainage buffer analysis is done using the drainage pattern map. There shouldn't be any trash placed there because doing so will contaminate all nearby waterbodies via the drainage system, making a buffer space necessary. There should be no rubbish disposal area within the drainage system. Hence To prevent pollution, the drainage system now includes a 100-meter barrier. Choose the drainage buffer from the geoprocessing menu, then launch it using the necessary parameters. The north arrow, scale, legend, title, and grids should all be added to the drainage buffer map to create a new layout. Fig 3 represents Map of Krishna District's drainage buffers, Andhra Pradesh.

Fig. 3. Map of Krishna District's drainage buffers, Andhra Pradesh.

6.2 Slope Map

The slope map is produced using USGS DEM data. A slope classification map is made using a surface tool from ARCGIS Online. A slope map is a two-dimensional representation of the gradient of a surface. The slope's current gradient is shown, along with how steep or gentle it is. You can pick a better spot for disposing of the waste from various sources by being

aware of the area's slope. The raster data obtained from USGS will be added. The slope tool from geo processing tools is taken and 100m slope is created. Furtherly the Slope map is obtained by adding a layout and inserting legend, North Arrow, Scale. Fig 4 represents Krishna District, Andhra Pradesh, Slope Map Layout.

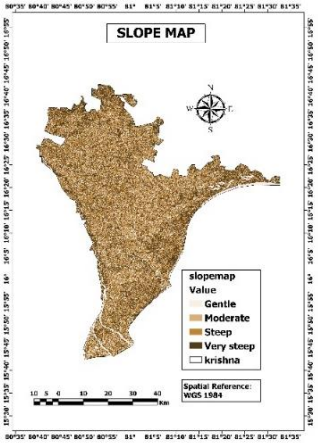

Fig. 4. Krishna District, Andhra Pradesh, Slope Map Layout.

6.3 Map of the soil

A soil map is a diagram that shows the various types and or features of soil. Soil maps are most frequently used for tasks like land evaluation, spatial planning, agricultural extension, and other related ones. It is essential to understand the details of the soil being used for trash disposal because it could cause rubbish to leak or decompose, poisoning ground water. Download the soil map from the FAO right away. Go to geoprocessing and trim the data for the study area. Ensure the symbology is correct, then enter DOMSOI in the Field. Fig 5 represents Krishna District, Andhra Pradesh, soil map layout.

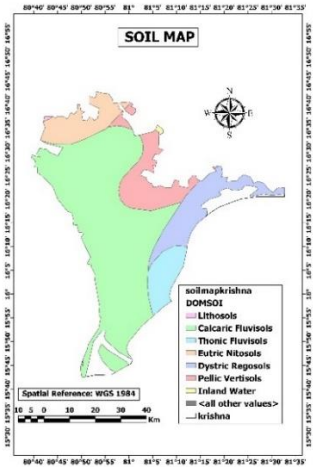

Fig. 5. Krishna District, Andhra Pradesh, soil map layout.

6.4 Map of Geology

The location and arrangement of the region's geologic features are shown on geology maps. These characteristics may include different rock types, faults, minerals, and groundwater. Geologic maps show a variety of geological features. Geologic layers or rock units are coloured or symbolically represented. The official BHUKOSH website has provided the Geology map shape file for download. Using the clip tool from the geo processing tools, the map has been cropped to the appropriate study region. Later, the symbology was modified to depict classes. Furtherly the Geology map is obtained by adding a layout and inserting legend, North Arrow, Scale. Fig 6 represents Krishna District, Andhra Pradesh, Geology Map Layout.

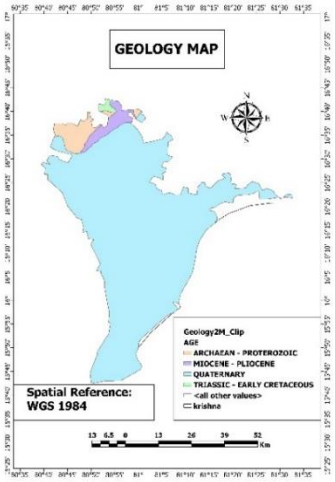

Fig. 6. Krishna District, Andhra Pradesh, Geology Map Layout.

6.5 Map of Geomorphology

Geomorphology studies landforms' genesis, development, structure, and distribution over the landscape. Thus, comprehending one of geography's most famous subfields requires geomorphology. In the current study the geomorphology map for the research area has been downloaded from the “Bhukosh” website. And later the geomorphology data required for the research area has been clipped by using the “clip” tool from the geo processing tools. Furtherly the Geomorphology map is obtained by adding a layout and inserting legend, North Arrow, Scale. Fig 7 represents Krishna District, Andhra Pradesh, Geomorphology Map Layout.

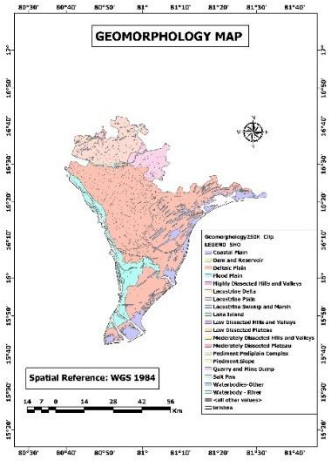

Fig. 7. Krishna District, Andhra Pradesh, Geomorphology Map Layout.

6.6 Map of Land Use Land Cover

"Land cover" refers to the earth's surface. This could be water, vegetation, urban infrastructure, or barren dirt. Resource planning, worldwide monitoring, and resource management need land cover identification, delineation, and mapping. Change detection starts with land cover determination. The baseline thematic maps use this step's ground cover data. Land usage includes agriculture, wildlife habitat, and recreation. Baseline mapping and continuing monitoring are needed for land use applications. This data will help establish strategies that balance conservation, development, and conflicting uses. Land use studies are prompted by agricultural land loss, urban development, and forest thinning. The google earth engine has been used to obtain the LULC map. A code is written by using the chat GPT to obtain the LULC map. The shape file has been provided to get the result for the required area and later the LULC map for the march 2022 is obtained. The LULC map contains of 8 classes such as water bodies, trees, shrubs, grass, flooded vegetation, built up, barren and crops. The map obtained is in the raster format in order to get the perfect outline for the required research area the tool named as “extract by mask” has been used from the geoprocessing tools. And the required map layout has been created. Fig. 8 represents LULC Flow Chart & Fig 9 represents Krishna District, Andhra Pradesh, Land Use and Land Cover Map Layout.

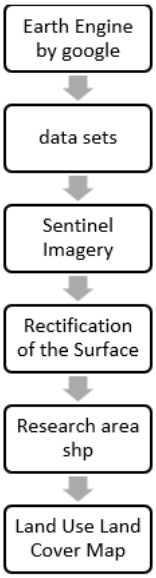

Fig. 8. LULC Process

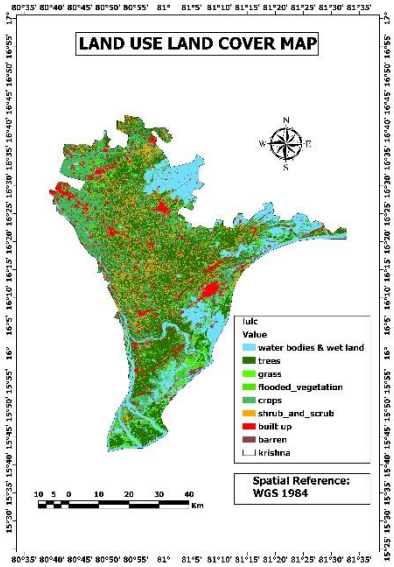

Fig. 9. Krishna District, Andhra Pradesh, Land Use and Land Cover Map Layout.

6.7 Water Bodies map

A map of the water bodies in the study region should be taken into consideration even if disposal sites cannot be placed where there are bodies of water. All living things should be concerned about surface water contamination and the suffocation that results from waste disposal close to water sources and drains. A single layer was made using the data for the water bodies that was created using USGS Earth Explorer. The data is then clipped with the clip tool to the required research region. The title, north arrow, scale bar, legend, and grids

were used to build the layout. Fig 10 shows Map of Krishna District's Water Bodies in Andhra Pradesh.

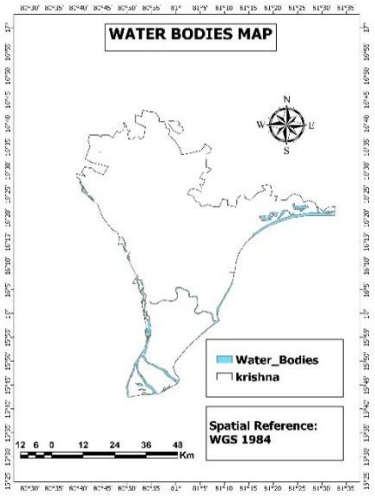

Fig. 10. Map of Krishna District's Water Bodies in Andhra Pradesh.

6.8 Distance from Road Line Map

A road map shows the layout of streets and roads in a certain area using a network of connected points and lines. Finding the quickest paths to all garbage sources is made easier with its help. It makes it easier to get waste to the perfect location from a variety of sources. The selection of the distance range was determined to make transportation easier and to increase accessibility to and cost effectiveness at the disposal site. Moreover, garbage disposal facilities shouldn't be situated too close to transportation infrastructure. Map of the road network is consequently considered. The network map has been clipped using the clip tool to match the needed research region after the road map data was downloaded from the GEOFABRIK website.

Later, the symbology was modified to depict classes. The addition of the north arrow, legend, title, scale bar, and grids has resulted in a new map layout. The road layout map is created as a result. Fig 11 represents Map of Krishna District's Road Network in Andhra Pradesh.

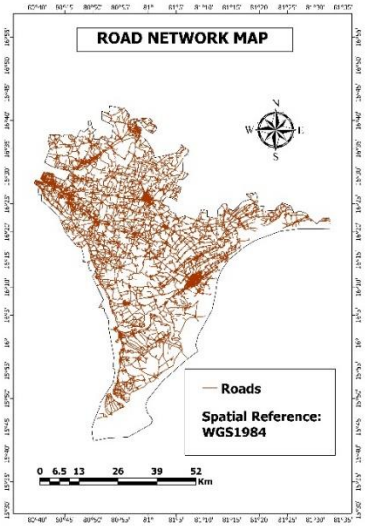

Fig. 11. Map of Krishna District's Road Network in Andhra Pradesh.

6.9 Distance Maps

From GEOFABRIK, data for the roads and railways have been downloaded. Information about water bodies can be downloaded using the USGS Earth Explorer. Fig 12,13,14 represents the Krishna District, Andhra Pradesh, Distance from Road Line, Railway line & Waterbodies Map Layouts.

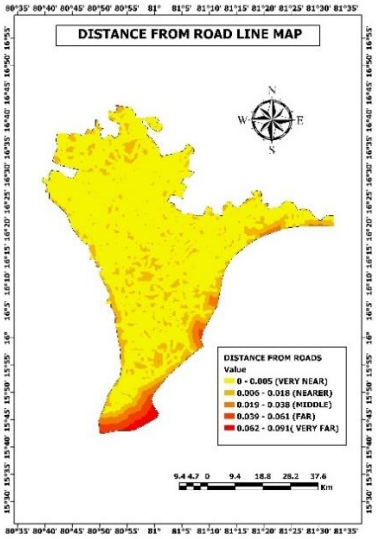

Fig. 12. Distance from Road Line Map, Krishna District, Andhra Pradesh.

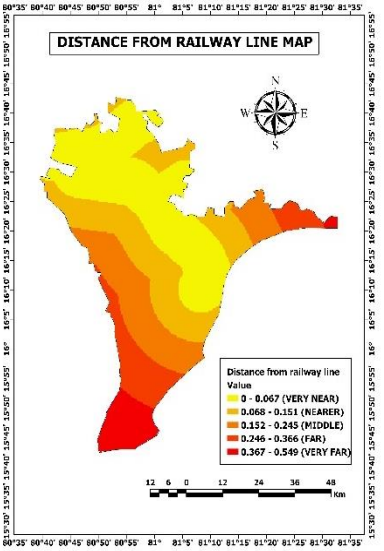

Fig. 13. Distance from Railway Line Map, Krishna District, Andhra Pradesh.

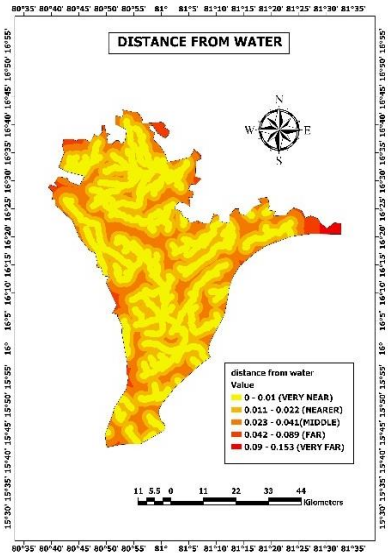

Fig. 14. Distance from water bodies Map, Krishna District, Andhra Pradesh.

To calculate distance between roads, bodies of water, and railway lines, the "Euclidean distance" tool from geoprocessing tools is utilised. Change the symbology to change how many classes there are. The regions that are nearby and far away are noted. Furtherly the distance from roads, railway and water bodies maps are obtained by adding a layout and inserting legend, North Arrow, Scale.

6.10 Weighted Overlay Analysis Map

Generally, there are two tools that can be used for the analysis. In the current study the tool called “weighted overlay analysis” tool has been used from the geo processing tools. A weighted overlay analysis is used to complete each of the conventional overlay analysis phases. The first requirement for this weighted overlay analysis tool is that all layers must only be in raster format. Use the "feature to raster" tool in geoprocessing to convert any remaining vector layers to raster files so that all of the maps may be kept together in a single folder. After doing this, each map's classes must match exactly; else, errors may occur. Use the "re categorise" tool in the geoprocessing for the maps to give them the same number of classes. After the geoprocessing tools have been fully configured, choose "Weighted Overlay" and enter the raster data. Drag and drop is another method of entering raster’s. There should be a percentage influence given for each layer. The raster's overall impact should be 100.

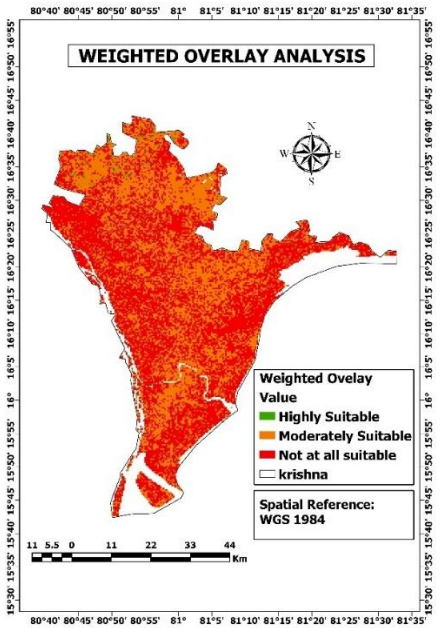

Fig. 15. Weighted Overlay Analysis map layout of Krishna district, Andhra Pradesh.

7 Results

Each of the following maps receives a percentage effect of 36%, 9%, 11%, 10%, 19%, 5%, 5%, and 5%, respectively.

Table. 1. Thematic maps utilised in the weighted overlay study had a % of influence.

MAPS	INFLUENCE PERCENTAGE
Land Use Land Cover	36%
Geology map	9%

Soil	11%
Geomorphology	10%
Slope	19%
Road Network Distance	5%
Railway lines Distance	5%
Water Bodies Distance	5%

Table. 2. Area where the suitability of solid waste management for each category is determined.

Category	Area
Highly Suitable	13.02 Km^2
Moderately Suitable	1483.16 Km^2
Not at all Suitable	1857.02 Km^2

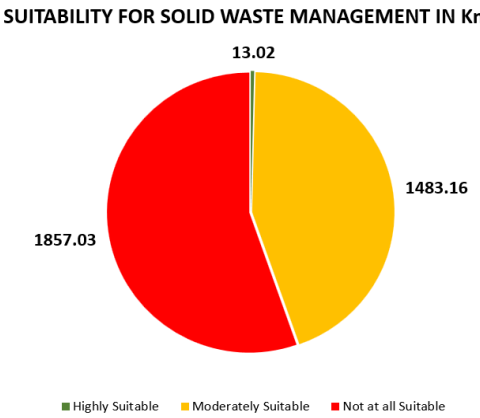

Fig. 16. Depicting the suitability for solid waste management in Km^2

Fig. 17. Location as shown on Google Earth after Weighted Overlay Analysis.

8 Conclusions

- To determine the location of the site to dispose of the garbage, all of the thematic maps from this study were converted to raster format and subjected to a weighted overlay analysis.
- The significance of each and every thematic map varies according to its suitability, therefore the location of the solid waste management site should not be close to any bodies of water or inhabited residential areas since those places may become polluted and dangerous to humans and animals.
- Fig.17 depicts the final suitable location for the handling of solid waste.
- While not all of the places determined by the weighted analysis are accurate to a 100%, we may get a general notion of where solid waste management might be carried out.
- Following thorough investigation, it is obvious that there are far fewer highly acceptable areas than moderately and poorly suited areas for the disposal of solid waste. So, it is evident that the Krishna district lacks a suitable location for a solid waste management site.
- The salvaging process, in which some items can be recovered, repurposed, and reused, is a different way to deal with solid waste. To lessen the number of solid wastes, waste can also be burned into ashes through incineration.

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