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National Highway Alignment Using Gis

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ABSTRACT

Planning a new road or highway can be expensive and time consuming process. There are numerous environmental issues that need to be addressed. The problem is exacerbated where the alignment is influenced by the location of services, existing roads and buildings, and the financial, social and political costs of land resumption. GIS, a powerful tool for the compilation, management and display data associated with geographic space, is used for the preparation of digital maps and analysis purposes. The conventional manual methods were difficult, time consuming and expensive.

In this project the shortest and the economical path is identified using GIS software. The factors considered are mainly related to the land use, geology, land value and soil. The weights and ranks are assigned to each of the above themes, according to expert opinions, for GIS analysis. After assigning weights and ranks these themes are overlaid to get an overlaid map. The final overlaid map has the most suitable area to align the highway

KEYWORDS: National Highway, Remote sensing, Alignment Using Gis, Shortest route

1. INTRODUCTION

Determining the best route through an area is one of the oldest spatial problems. This problem has recently been solved effectively using GIS and Remote Sensing technologies. During the last decade, a few attempts have been made to automate the route-planning process using GIS technology. Constructing a new road or railway, or aligning an old one can be very expensive, with costs depending on the alignment selected. Costs are increased by long structures, by large volumes of cut and fill, and by unbalanced cut and fill were discrepancy has to be dumped or borrowed. There are numerous environmental issues that need to be addressed to ensure that the alignment does not reduce bio-diversity or degrade the environment. The first step in producing high quality alignments depends on obtaining suitable data on geology, land use, slope, soil and drainage. In addition, there are issues such as land value and ownership, social and economic impact, and identifying environmentally sensitive areas.

1.1 GENERAL

Remote sensing can be defined as the collection of data about an object from a distance. Human and many other types of animals accomplish this task with aid of eyes or by the sense of smell or hearing. Geographers use the technique of remote sensing to monitor or measure of phenomena found in the Earth's lithosphere, biosphere, hydrosphere, and atmosphere. Remote of the environment by the geographers is usually done with the help of mechanical devices known as remote sensors. These gadgets have a greatly improved ability to receive and record information about an object without any physical contact. Often, these sensors are positioned away from the object of interest by using helicopters, planes and satellites. Most sensing devices record information about an object by measuring an object's transmission of electromagnetic energy from reflecting and radiating surfaces.

"Remote sensing is the science of making inference about from measurements, made at a distance, without coming into physical contact with the object under study". That is, remote sensing refers to any method, which can be used to gather information about an object without actually coming in contact with it.

1.2 CONCEPT OF SIGNATURES

Electromagnetic radiation when incident on a surface, gets reflected, absorbed, re-emitted or transmitted through the material depending upon the nature of the object and the wavelength of the incidence radiation.

1.3 MULTI-SPECTRAL CONCEPTS

Spectral variation is the most often used signature, especially in the optical-IR region. The spectral variation of some of the natural objects in the 0.4 to 2 µm range. However, it is not easy to generate continuous spectral for identification objects. Therefore a practical solution is to make observance in a number of discrete spectral regions, usually referred as spectral bands.

1.4 REMOTE SENSING SYSTEM

With the background treatise on remote sensing we have made so far, it would now be easier to make an analysis of the different stages in remote sensing.

- Origin of electromagnetic energy (sun, transmitted carries by the sensor)
- Transmission of energy

- Intervening of energy or self emission
- Detection of energy
- Transmission or coding of the sensor output
- Collection of ground truth
- Data analysis and interpretation
- Integration of interpretation images

We shall now briefly describe the various components of a remote sensing system.

1.5 REMOTE SENSORS

The instrument used to measure the electromagnetic radiation reflected or emitted by the target under study are usually referred to as remote sensors. Sensors which sense natural radiation either emitted or reflected from the earth is called passive sensors, sensors, which are, carry electromagnetic radiation of a specific wavelength or band of wavelength to illuminates the earth's surface are called active sensors.

The major parameters of a sensing system which can be considered as indicators of the quality of data and which have bearing on optimum utilization for specific end users include spatial resolution, spectral resolution, radiometric resolution and temporal resolution, these are four resolution are the most basis requirement of any sensor system.

1.6 PLATFORMS

Sensor system needs to be placed on suitable observation platforms and lifted to a pre-defined altitude. Platforms can be stationary or mobile depending upon the needs of the observation mission and the constraints. Some of platforms such as aircraft, balloons, etc. are used. For the satellite their two types of platforms are considered such as, geostationary, which are about 36000 km above earth. Second is sun-synchronous satellite, this type of satellites are nearer to earth like few km above.

1.7 DATA PRODUCT

Acquired data has number of errors due to

- Imaging characteristics of the sensors
- Stability and orbit characteristic of the platforms
- Scene/surface characteristic
- Motion of the earth
- Atmospheric effect

Data product are generated after correcting these error so that the inherent quality of the original information of the scene. The data product is generated in standardization formats either in photographic or digital form to allow further analysis.

1.8 DATA ANALYSIS

Visual interpretation and digital image processing are two important techniques of data analysis needed to extent resources related information either independently or in combination with other data.

1.9 VISUAL INTERPRETATIONS

Visual interpretation has been the traditional method for extracting information from a photograph based on the characteristic such as tone, texture, shadow, shape, size, association etc. Though the number of colour tones recognized by human brain is large, it is still limited. When photographic products are generated from digital data, the contrast is further degraded. Visual interpretation poses serious limitation when we want to combine data from various sources. Above all, when a large volume of data has to be analysed, it cannot meet the throughput requirement.

1.10 DIGITAL PROCESSING TECHNIQUES

Digital techniques facilities quantitative analysis, make use of full spectral information and avoid individual bias. Simultaneous analysis of multi-temporal and multi-sensor facilitated in digital methods. In digital classification, the computer analysis the signature, so as to associates each pixel with particular features of imagery. The digital classification technique essentially partitions this features space in some fashion so that each pixel in the feature space can be uniquely associated with one of the classes.

2. AIM AND SCOPE OF THE INVESTIGATION

- To establish shortest path for road network from palani to erode.
- To provide a better and comfortable base for updating the traffic and other related information in road administration.
- To identify the short route for the vehicles traveling from palani to erode. And to reduce the time travel for the vehicles.
- Our main scope is to reduce the traffic and travelling time in the roads.
- To prepare various thematic maps for analyzing the environmental status.
- To find possible paths/routes/places for laying eco-friendly highway.

3. STUDY AREA

3.1 ERODE

Erode is a city, a municipal corporation and the headquarters of Erode district in the South Indian state of Tamil Nadu. It is situated at the centre of the South Indian Peninsula, about 400 kilometres (249 mi) southwest from the state capital Chennai and on the banks of the rivers Cauvery and Bhavani, between 11° 19.5" and 11° 81.05" North latitude and 77° 42.5" and 77° 44.5" East longitude. As per Census 2011 alignments. It has population around 156,953.Erode Local planning Area extends up to 54sq.km. Within the city, and will be extended to 109 km^2. The roadway connects all the parts of the state and nearby states such as Kerala, Karnataka and Andhra Pradesh with the city. The City has both local (City) and mofussil (city-to-city) bus services with connections to nearby towns and villages. Plenty of city buses are ply to connect all parts of the city. One can get buses from Erode to almost any part of the state. NH connecting Salem – Coimbatore – Cochin passes through Erode and Bypasses the city via Bhavani (Lakshminagar by-pass), Chithode, Perundurai, which is the major National Highway connectivity for the city.SH 79 connecting Rasipuram - Tiruchengode - Pallipalayam - ErodeSH-15 connecting Erode – Gobi – Sathy – Ooty .NH-67A connecting Karur – Erode – Sathy – MysoreAnother planned from Erode (Bhavani) – Anthiyur – Bangalore.

3.2 KANGEYAM

Kangeyam is a Municipality in Tirupur district in the Indian state of Tamil Nadu. Kangeyam was the capital of Kongu Nadu for many centuries. Kangeyam is situated in the heart of the Tirupur district. Kangeyam has a population of 38,862. Kangeyam is situated in the meeting point of NH 67, SH 37 and SH 205.Kangeyamis located at 11°00′19″N 77°33′43″E/11.0054°N coordinates77.5620°ECoordinates 11°00′19″N.77°33′43″E/11.0054°N77.5620°E. Access to all main cities of Tamil Nadu like Coimbatore, Tirupur, Tiruchy, Erode, Palani, Dharapuram, Tanjore, Karur, Dindigul, Madurai, Chennai, Ooty, Theni, Kodaikanal, etc. are available frequently.Kangeyam comes under Tirupur District and Dharapuram revenue division.The town of Kangayam is well connected by NH 67,which runs between Mysore Viz. Gudalur, Ooty, Mettupalayam, Coimbatore and Nagapattinam Via Thiruchirapalli, Thanjavore. A major State Highway connecting Erode and Palani runs through Kangeyam. The highways through Kangeyam are NH67, SH37, SH81, SH96, SH172 and SH189.

3.3 DHARAPURAM

Dharapuram also known as **Rajarajapuram** and a municipality in the Tirupur district of the South Indian state of Tamil Nadu. Dharapuram is one of the Oldest Town in Tirupur District. It has a population of 78,137.Dharapuram is located at 10°44′N77°31′E / 10.73°N 77.52°E. It has an average elevation of 245 metres (803 feet). It is strategically located in the line of Palakkad pass from where it gets lot of wind for its numerous windmills. Water scarcity is high here. One side of it is bordered by the Kodaikkanal mountain ranges. It stands on the banks of the holy Amaravathi River, a tributary of the Kaveri River. Dharapuram is the major junction point of Roadways connecting major cities Coimbatore-Madurai, Trichy-Cochin, Tirupur- Madurai, Palani - Salem (Via Erode), Coimbatore - Theni, Dindigul-Tiruppur and Karur -Pollachi, via road connects.Every 5 minutes once buses available for Coimbatore, Tirupur, Erode, Palani and Madurai, midnight time every 15 minutes once buses available.78 km from Erode,34 km from Palani, 80 km from Coimbatore,48 km from Tirupur, 150 km from Trichy, 72 km from Karur, 243 km from Neyveli, 118 km from Madurai. Buses are available to all these cities 24 hours.

3.4 PALANI

Palani is a city and a municipality in the Dindigul district of the South Indian state of Tamil Nadu, located about 100 km South-east of Coimbatore City and 60 km west of Dindigul. It is the location of the far-famed temple of the god Kartikeya, resorted to by more than 7 million devotees each year. It is situated at the South Indian Peninsula.Its coordinates are 10°27′01″N 77°30′38″E 10.45037°N77.510429°ECoordinates:10°27′01″N77°30′38″E / 10.45037°N 77.510429°E.Palani had a population of 67,175. Males constitute 51% of the population and females 49%. A Roadway NH209 connects Palani to Coimbatore and Mysore. There are frequent buses to Dindigul, Coimbatore, Madurai, Erode, Tirupur, Pollachi, Karur, Trichy. Many Omni buses are available to Chennai, Bangalore and Kodaikanal. Railways there was a meter gauge line between Coimbatore and Dindigul via Palani, which is presently under gauge conversion. After the gauge conversion a Coimbatore-Madurai Intercity Express and Coimbatore-Rameshwaram Express are expected to ply the route. Airways Palani is located equidistant from Coimbatore, Trichy and Madurai Airports.

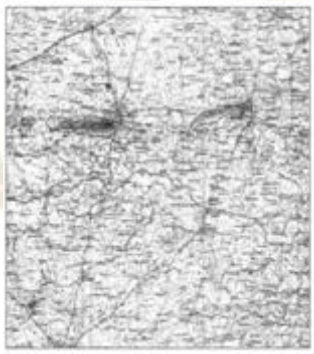

FIGURE.1 STUDY AREA TOPOSHEET

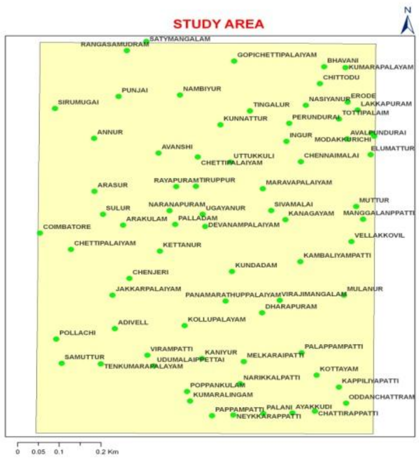

FIGURE.2 STUDY AREA MAP

TABLE.1 PROPOSED ROAD AREAS OF LONGITUDINAL AND LATITUDE

S.No.	Location	Longitude (E)	Latitude (N)
1.	Erode	11° 19.5"	11° 81.05"
2.	Kangeyam	77°33'43?	11°00'19?
3.	Dharapuram	77.52°	10°44'
4.	Palani	77°30'38?	10°27'01?

3.5 DATA COLLECTION

Survey of India Toposheet No. 58E/11, 58E/12, 58F/9, 58F/11 & 58F/10 on 1:50,000

LAN SAT (MSS) DATA 2007

Maps, field work and remote sensing techniques are necessary for proposed road design and construction. Topographic maps, geomorphology, Land use/Land Cover, Drainage, DEM, road, Slope and Contour maps were used for this proposed route. The favourable path analysis, using various data and GIS analysis, was intended to confirm the best transport route within this site.

3.6 DATA PROCESS AND ANALYSIS

In this implementation, the best route is found for a new road. The steps to find possible path are outlined below. Path is identified by using ArcGIS 9. Spatial Analysis Module.

Create Source, Destination and Datasets
Generate different Thematic Maps (Classify and Weight age)
Perform Weighted Distance
Create Direction Datasets
Identified Shortest Path with Distance and Direction Datasets

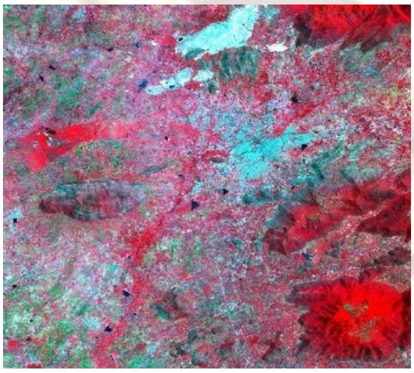

FIGURE.3 SATELLITE IMAGE FOR ERODE

4. DESIGN GUIDELINES

4.1 PLANNING OF ROAD IN PLAIN AREAS

Planning of roads in plain area is somewhat different from hill areas. In hill areas alignment of roads has to be circuitous and is primarily governed by the topography. In the plain area we should find the elevation and depression by the surveying. The elevation areas should be levelled by removing the upper surface of the earth and this soil can be used for the filling up the low lying areas.

The roads in our country in plain areas, they have been classified as National Highways, state Highways, Major District Roads, and Other District Roads and Village Roads according to specification, traffic needs, and socio economic, administrative or strategic consideration. Some National Highways are point to point which will connect the state boundaries. State Highways will connect all the National Highways. Major District Roads will connect all the state Highways. Other District Roads and Village Roads will connect the major district Roads however from topographical considerations; these can be broadly being divided into arterial Roads and link roads. Arterial roads will include national/state highways and major district roads. Link roads take off from arterial roads to link villages/production areas in small/sub-valleys. These will comprise other district roads and village roads.

4.2 WIDTH OF ROAD LAND, ROADWAY, CARRIAGEWAY AND SHOULDERS.

Desirable widths of road land (right of way) for various categories of roads are given in Table.2.

4.3 HIGHWAY ALIGNMENT

"The position or the layout of the centre line of the highway on the ground is called alignment."In general alignment is of two types,

- Horizontal alignment
- Vertical alignment

FIGURE. 4 EXISTING ROAD NETWORK

4.3.1 Requirements

The basic requirements of ideal alignment between two terminal stations are

- ❖ Short- A straight line alignment would be the shortest, though there may be several practical considerations which would cause the deviation from the shortest path.
- ❖ Easy - The alignment should be such that it is easy to construct and maintain with minimum problems.
- ❖ Safe – The alignment should be safe enough for construction and maintenance from the view

point of stability of natural hill slopes, embankments, cut slopes.

- ❖ Economical – The alignment is considered economical only if the local cost including the initial cost, maintenance cost.

TABLE.2 DESIRABLE WIDTHS OF ROAD LAND (RIGHT OF WAY) FOR VARIOUS CATEGORIES OF ROADS

	HIGHWAY CLASSIFICATION	CARRIAGEWAY WIDTH (M)	SHOULDER WIDTH (M)	ROADWAY WIDTH (M)
A	National highway and state highway 1.single lane 2.double lane	3.75 7.00	2.25 2.9	6.25 8.8
B	Major district roads and Other district roads	3.75	2.5	4.75
C	Village roads	3.09	2.5	4.00

4.3.2 Factors Controlling Alignment

For an alignment to be shortlisted, it would be straight between two terminals which are not always possible due to practical difficulties such as intermediate obstructions and topography. A shortest route may have very steep gradients and hence not easy for operations. Similarly, there will be construction and maintenance problems along the route which may be otherwise short and easy. Canals are often deviated from the shortest route in order to cater for intermediate places of importance or obligatory points.

A highway which is economical in its initial construction cost need not be necessarily economically maintenance or operation cost. It may also happen that at the shortest and the easiest route may work to be the costliest of different alternatives from construction point of view. Thus it may be seen that an alignment can seldom fulfill all requirements simultaneously; hence a judicial choice is made considering all factors.

The various factor which control the canal alignment in general may be listed as,

4.3.3 Obligatory Points

These are control points governing the alignment the canal. These control points may be broadly divided into two categories,

- ➢ Points through which alignment is to pass.
- ➢ Points through which alignment should not pass.

'Obligatory points through which alignment has to pass may cause alignment to often deviate from the shortest or easiest path'

4.3.4 Geometric Design

Geometric design factors gradient, radius of curvature governs the final alignment. As far as possible while aligning a canal the gradient should be gradually increasing. It may be necessary to make adjustments in horizontal alignment of canal keeping in view the minimum radius of curvature and the gradient.

4.3.5 Economic Considerations

The alignment finalized based on the above factors should also be economical. In working out economics, the initial cost, operation cost, maintenance cost is taken into account. The initial construction cost could be minimized by avoiding embankments and deep cuttings and alignment is chosen in a manner to balance cutting and filling.

4.3.6 Slope Stability

While aligning canal, special care should be taken to align along the side of the hill which is stable. A problem in doing this is that of the landslides. The cutting and filling to construct the canal on the hill side causes steepening of existing slopes and affect its stability.

4.3.7 Engineering Surveys for Highway Alignment

Before canal alignment, engineering surveys are to be carried out. The surveys may be completed in four stages; first three stages consider all possible alternate alignment keeping in view the various requirements.

Four stages of engineering surveys are,

- ➢ Map study
- ➢ Reconnaissance
- ➢ Preliminary survey
- ➢ Final location and detailed survey

4.4 Horizontal Alignment

The horizontal alignment should be fluent and blend well with the surrounding topography. The horizontal alignment should be coordinate carefully with the longitudinal profile. Breaks in horizontal alignments at cross drainage structure and sharp curves at the end of long tangents/straight section should be avoided.

Short curves give appearance of kinks, particularly for small deflections angles, and should be avoided. The curves should be sufficiently long and have suitable transitions to provide pleasing appearances. Curve length should be at least 150 m for a deflection angle of 5 degrees and this should be increased by 30 m for each degree deflection angle. For deflection angle less than one degree, no curve is required to be designed.

Reverse curves may be needed in difficult terrain by very sparingly used. It should be ensured that there is sufficient length between the two curves for introduction of requisite transition curves. Curves in the same direction separated by short tangents, known as broken back curves, should be avoided as far as possible in the interest of aesthetics and safety and replaced by a single curve.

Compound curves may be used in difficult topography but only when it is impossible to fit in a single circular curve. To ensure safe and smooth transition from on e curve to the other, the radius of the flatter curve should not be disproportional to the radius of the sharper curve. A ratio of 1:5:1 should be considered the limiting value. Horizontal curves should consist of circular portion of the curve followed by the spiral transitions on both sides. Design speed, super elevation and coefficient of friction affect the design of curves.

Length of transition curve is determined on the basis of change of centrifugal acceleration or the rate of the change of super elevation.

4.4.1 Minimum Curve Radii.

On a horizontal, the centrifugal force is balanced b y the combined effect of super elevation and side friction. Basic equation for this condition equilibrium is as follows:

$$v^2/gR = e+f$$

$$R = V^2/127(e+f)$$

Where v = vehicle speed in metre/second
V = vehicle speed in km/hr
g = acceleration due to gravity in metre/s^2
e = super election in meter
f = coefficient of side friction between vehicles tyre and
Pavements (taken as 0.15)
r = radius in meter

based on the equation and maximum permissible value of super elevation, radii for horizontal curves corresponding to ruling minimum and absolute minimum design speeds are given in hill road manual IRC.

4.5 VERTICAL ALIGNMENT

Broken back grade lines, i.e. two vertical curves in the same direction separated by a short tangent should be avoided due to poor appearance, and preferably replaced by a single curve. Decks of small cross drainage structures should follow the same profile as the flanking road section, with no break in the grade line.

4.6 CO-ORDINATION OF HORIZONTAL AND VERTICAL ALIGNMENT

The overall appearance of a highway can be enhanced by judicious combination of the horizontal and vertical alignment. Plan and profile of the road should not be designed interpedently but in unison so as to produce an appropriate three dimensional effect. Proper co-ordination in this respect will ensure safety, improve utility of the highway and contribute to overall aesthetics. Vertical curvature superimposed upon horizontal curvature gives a pleasing effect. As such the vertical and horizontal curves should coincide as possible and their length should be more or less equal. It is difficult for any reason; the horizontal curve should be somewhat longer than the vertical curve.

5. METHEDOLOGY

The base (study area) map, Drainage, Slope and Contour maps were repared with the help of SOI Toposheet (on 1:50,000 scale). High resolution LANSAT satellite data of 2009 was used and by using Digital Image Processing techniques the following thematic maps such as geomorphology, Land use/ Land Cover were generated. The Digital Elevation Model (DEM) was generated using various GIS based analysis, such as overlay, raster network analysis. The DEM is used in order to

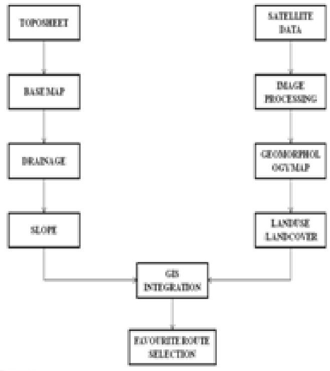

FIGURE.5. DATA INTERPRETATION

understand the terrain condition, environmental factors and social economic status in this study area. Finally, possible/feasible route was identified based on various physical and cultural parameters and their inherent properties. The cost reduction analysis was also done for substantiating the formation of national highway. Figure.5.shows data interpretation

5.1 TOPOGRAPHY

Topographic and geologic data of the proposed road network area were prepares in a GIS ready format and used as input to the GIS data base. The location of roads, railways, wetland, forest and drainage features are derived from the topographic map layer. The map that produced by SOI is the base for national topographic database and has a number of features for instance location of roads, railways, wetland, forest and drainage features. In this proposed project, digital elevation model was prepared from elevation data. It was used as input to the least cost and shortest pathway analysis.(Figure.6)

FIGURE.6 TOPOSHEET 58 E/12

5.2 GEOMORPHOLOGY

Different landforms present in the area are depicted in this geomorphic unit were extracted data from the satellite image by digital interpretation and incorporated into the GIS database. These geomorphic units were classified into Plateau, Scarp face, Debris slope, bazada, residual hill and pediments (deep, shallow & moderate).(Figure.7)

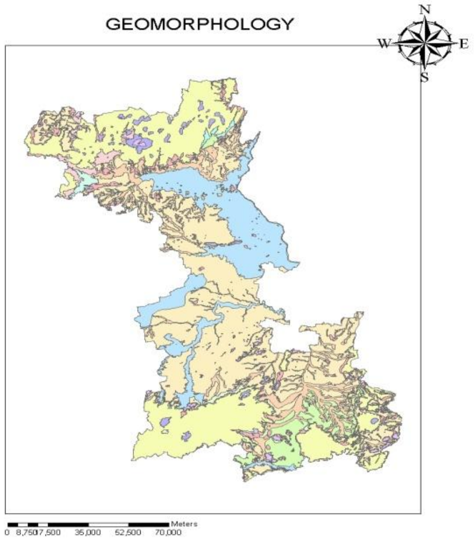

FIGURE.7 GEOMORPHOLOGY MAP

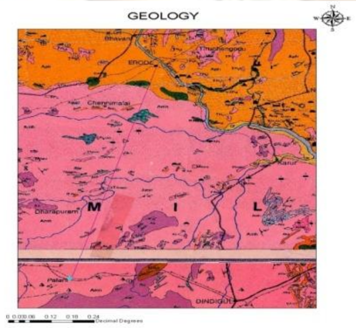

FIGURE.8 GEOLOGY MAP

Figure.8. Shows the geology map of study area. Figure.9. Shows the watersheds map of study area. . Figure.10. Shows the drainage map of study area.Figure.11 Shows the waterbodies map of study area.

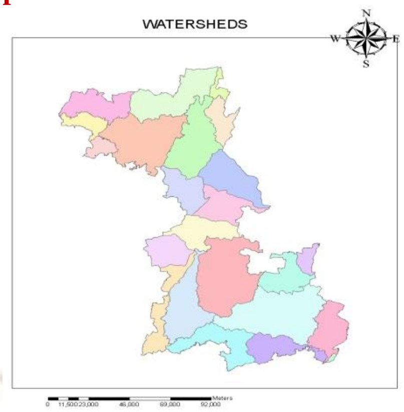

FIGURE.9 WATERSHEDS MAP

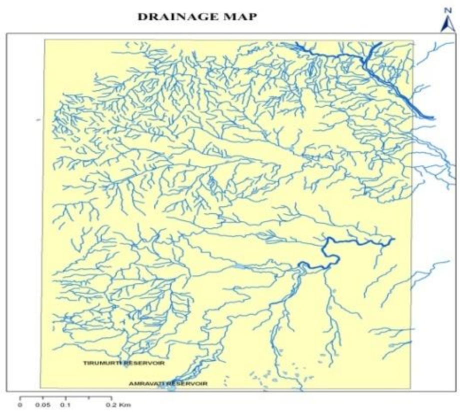

FIGURE.10 DRAINAGE MAP

FIGURE.11 WATERBODIES MAP

5.3 Geographical Information System

Visualization is a form of communication, which is universal and which has the ability to form an abstraction of the real world into graphical representation. Once a project proposal is developed, it is necessary to communicate the effect of proposed changes to other agencies and public review groups to facilitate decision making. Some of the changes in the environment can be modelled and visualized using GIS.

6. OVERVIEW OF SOFTWARE

6.1 INTRODUCTION TO ARCGIS

Arc GIS 9.2 is a product of ESRI. IT adds topology for the geo database. You can choose which feature classes in a feature dataset participate in a spatial relationship with other feature classes in that feature dataset or within themselves. Certain rules can be applied, such as polygons cannot overlap one another, lines cannot have dangling nodes, and points must be completely inside the bounds of a polygon. The number of spatial integrity rules offered for the geo database far exceeds those used in the Arc Info workstation coverage model, and are much more flexible.

The editing abilities of Arc Map have been improved to leverage these spatial integrity rules and to help find and fix topological errors more easily and quickly. Arc Map is the premier application for desktop GIS and mapping. Arc Map gives you the power to:

6.1.1 Visualize:

In no time you'll be working with your data geographically; seeing patterns you couldn't see before, revealing hidden trends and distributions, and gaining new insights.

6.1.2 Create:

It's easy to create maps to convey your message. ArcMap provides all the tools you need to put your data on a map and display it in a effective manner.

6.1.3 Solve:

Working geographically lets you answer questions such as " Where is ...?," " How much...?," and " What if...?," Understanding these relationships will help you make better decisions.

6.1.4 Present:

Showing the results of your work is easy. You can make great-looking publication-quality maps and create interactive displace that link reports, graphs, tables, drawings, photographs and other elements to your data. You'll find that communicating geographically is a powerful way to inform and motivate others.

6.1.5 Develop:

The Arc Map customization environment lets you tailor the interface to suit your needs or the needs of your organization, build new tools to automate your work, and develop standalone applications based on aroma mapping components. See about customizing Arc Map and Arc Catalog for more information.

6.1.6 Modelling:

Statistical models allow life phenomena to be represented in a mathematical or statistical way. The advantage of modelling real life phenomena include:

- The determination of factors or variables which most influence the behaviours of the phenomena;
- The ability to predict or forecast the long term behaviour of the phenomena.

Once a statistical model has been developed, simulations of the real life phenomena can be performed. The modeller can construct a wide range of scenarios by changing the influential factors. The key advantage of conducting simulations is that the phenomenon's predicted behaviour can be observed without placing the phenomena.

6.2 THE VECTOR MODEL

The vector model, the spatial locations of features is defined on the basis of coordinate pairs. These can be discrete, taking the form of points linked together to form discrete sections of line; linked together to form closed boundaries encompassing an area Attribute data pertaining the individual spatial features is maintained in an external database. In dealing with vector data any important concept is that Topology. Topology derived from geometrical mathematics, is concerned with order, contiguity and relative position rather than with actual linear dimensions. Topology is useful in GIS because many spatial modelling operations do not require coordinate locations, only topological information-for example to find an optimal path between two points requires a list of the arcs or lines that connect to each other and the cost to transverse them in each direction. It is also possible to perform the same spatial modelling and interrogation processes without using stored topology, by processing the geometrical data directly by generating topology on the fly or using vector object model as and when it is required.

6.3 THE RASTER MODEL

The spatial representation of an object of and its related non-spatial attribute are merged into a unified data file. In practice the area under study is covered by a fine mesh or matrix of grid cells and particular ground surface attribute value of interest occurring at the centre of each cell point is recorded as the value for that cell. It should be noted that while some raster models support the assignment of values to multiple attribute per discrete cell, other strictly to a single attribute per cell structure.

Within this model spatial data is not continuous but is divided into discrete units. In terms of regarding where individual cells are located in space, each is referenced according to its row and column position within the overall grid. To fix the relative spatial according to its row and column position within the overall grid. To fix the relative spatial position of the overall grid i.e. to georeferance it, the four comers are assigned planer co-ordinates. An important concept concerns the size of the component grid cell and referred to as grid-resolution.

The following information should always be recorded when assembling, compiling and utilizing raster data.

- Grid size (Number of rows and columns)
- Grid resolution
- Geo referencing information e.g. comer co-ordinates, source projection
- Data collection

Topographic maps are collected to generate multi-layered, geo-referenced digital maps on a GIS platform, with the basic inputs of available information. These comprehensive maps shall cover the following aspects:

- Slope map
- Land use and land cover pattern
- Population and settlement pattern
- Study area

This done using SOI toposheet (58E/11, 58E/12, 58F/9, 58F/11, 58F/10 NW) in the scale of 1:50,000. The boundary is traced over a tracing sheet. Traced boundary is converted to digital format using digitization in ArcGIS'9.2

6.4 RASTER CALCULATOR

Build expressions in the Raster Calculator by using Map Algebra to weight raster and combine them as part of a suitability model, to make selections on your data in the form of queries, to apply mathematical operators and functions, or to type Spatial Analyst functions. Multiline expressions can be typed into the raster calculator. It is useful to build multiline expressions for complex functions, such as cost path, or to chain processes together. For example:

[Cost]= ([rlanduse] + [slope])

[Dist] = costdistance ([source], [cost], back link)

Path = costpath ([destination], [dist], back link)

The output dataset shows how suitable the each location is for highway alignment, according to the criteria set in the suitable model. A higher value indicates the locations that are more suitable.

6.5 PERFORMING SHORTEST PATH

It is almost ready to find the shortest path from the source. We have already performed cost weighted distance, creating a distance dataset and a direction dataset using the source point. However it is necessary to decide on, and then create, the destination point for the road. Hence this requires the creation of destination point on the Erode to Palani which is used in the calculation of shortest path to the highway.The shortest path is calculated using the function 'shortest path' in the Spatial Analyst. Specifying the destination point as input along with the distance and direction theme, calculates the optimal path through which Highway has to run. It represents the least cost path-least cost meaning avoiding steep slopes and on land use types considered to be least costly for constructing the Highway-from source to destination.

7. DISCUSSION

In general the results of the project can be discussed under two aspects,

1. Geotechnical aspects
2. Ecological aspects

Geotechnical Aspects:

Case 1: The alignment of highway was done based on the following criteria (Table.3)

TABLE.3 SLOPE WEIGHTAGE

Slope (degrees)	Rank
0-5	1
05-Oct	2
Oct-15	3
15-20	4
20-25	5
25-30	6
30-40	7
40-50	8
50-70	9
No data	No data

TABLE 4 LAND USE WEIGHTAGE

LANDUSE TYPE	RANK	LANDUSE TYPE	RANK
Barren land	2	Sheet rocky	3
settlement	4	Waste land	1
Non agri-use	7	Cultivable land	5

In this case, both the layers have an equal influence on the alignment of the highway(Table.4). This is done using theformula,(reclass_slope)*0.4+(reclass_landuse)*0.6

9. CONCLUSION

The purpose of this study was to develop a tool to locate a suitable less route between two points. The GIS approach using ground parameters and spatial analysis provided to achieve this goal. Raster based map analysis provide a wealth of capabilities for incorporating terrain information surrounding linear infrastructure .Costs resulting from terrain, geomorphology, land use, drainage and elevation resulting the shortest routes for the study area. The existing road path was 90 km long from Erode to Palani (via Kangeyam, Dharapuram). Results indicate that the route which was designed applying GIS method is more environmentally effective and cheaper.This proposed shortest route (Figure.12) provides traffic free, pollution free, risk free, operating for movement of vehicle passing from Erode to Palani. Time and consumption of fuel will also be reduced considerably. A important tourist spot cum pilgrimage, Palani will approached without traffic problems. This has shown a potential savings which can be obtained by automating the route selection process. GIS method can also be used for route determination for irrigation, drainage channels, power lines and railways.

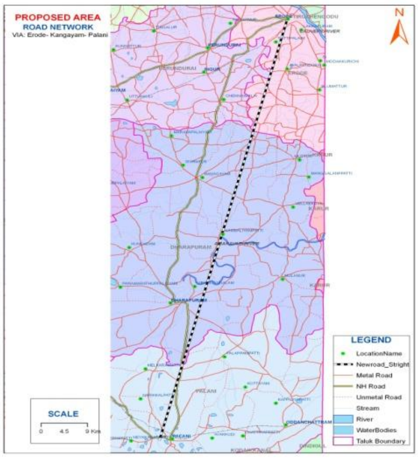

FIGURE.12 PROPOSED SHORTEST ROUTE

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