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GEOGRAPHICAL INFORMATION SYSTEM

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Introduction : -

Geographic Information System (GIS) has been defined as a data handling and analysis system based on data distributed spatially in two dimensions. The data sets may be map oriented, when they comprise qualitative attributes of an area recognized as lines. points and areas (often in Vector format) or image oriented, when the data are quantitative attributes referring to cells in a rectangular grid (usually in raster format). It is also known as a geo based, or geocoded, information system. (Drury,1987).

GIS is a computer system which provides integrated data base and has become an essential tool in the Data management and Plan preparation process. Geographic Information Syustem is a system for handling spatial and non spatial data on land and water resources, land use and change patterns, land values, demographic and socio-economic attributes. GIS has also been defined as a set of tools for collecting, storing transforming and displaying geographically referenced spatial data with its corresponding attribute information to meet a specific requirement (Geeta Varadan Etal. 1992).

The GIS differs from other information, storage and retrieval systems in that it uses the location of features in a co-ordinate space as the fundamental referencing principle ,and as important variable in quantitative analysis. The matic maps in the form of overlaying transparent copies, on topography, geology, soil hydrogeology, geomorphology, forest, land cover, water resources etc are stored as layers in digital form in the computer (Fig. 1)

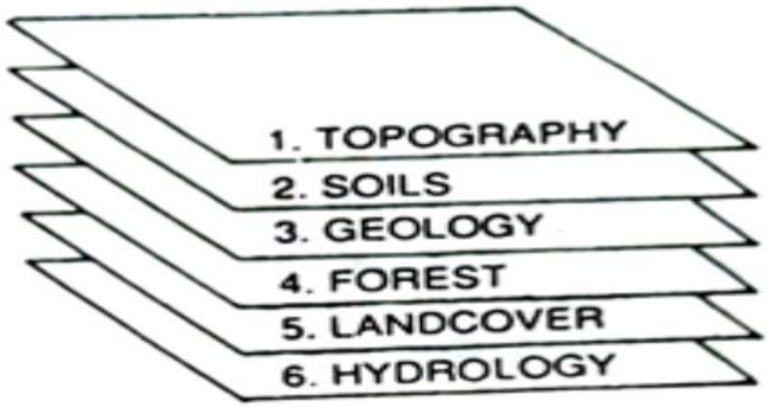

Fig. 1 : Data Organisation in GIS

Thus a GIS has a data base of multiple information layers that can be manipulated, to evaluate relationships among the desired elements, in a computer system. GIS is designed to handle large volume of spatial data, derived from different sources, including remote sensors,

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process them and transform into usable information. The basic needs to access, organize, update and analyze the host of data in an optional way led to the concept and development of Geographic Information System. It has come to the rescue of planners and decision makers who are often faced with the lack of timely, reliable information as the success of any plan would depend on the availability of effective, accurate and timely data base.

The term Geographic Information System is quite new in Indian context, but its origin can be traced back to 1960s in North America. Advancement in computer graphics and high speed and now low cost micro computers have dramatic impact on the development of GISs in 1980s (Taylor, 1991). Ultimate objective of GIS has been capturing, storing, checking, integrating, manipulating, analyzing and displaying data which are spatially referenced to the Earth. This is normally considered to include a spatially referenced computer data base and appropriate applications softwares. Major components of GIS are 6) data input system, (2) data storage system and (3) data analyzing system (Stenfanovia, 1989). Wiken (1992) however, considers GIS as a technology to integrate various social, economic, and environmental in formations for decision making process.

Geographically referenced data in the spatial form collected by space imagery are presented in the form of photographs as paper prints and digital images. Non- partial data, are soil properties, vegetation types, climate data, population, socio- economic data etc. It is possible to transform and integrate this information into thematic data and process in the GIS.

Geographical data describe objects in terms of (a) their position with respect to a co-ordinate system, (b) their attributes that are unrelated top position (such as colour. cost, pH, incidence of disease and crime) and (c) their spatial inter relations with each other. Three conceptual components of GIS are shown in Fig. 4. these data are stored and organized in the computer for which different types of data structure are adopted. The data structure basically refers to the way in which the data is organized in a structure and on which depends the efficiency in manipulation and analysis of the data. Most of the data are represented on two dimensional maps as points, lines, and areas. There are two ways of representing the information.

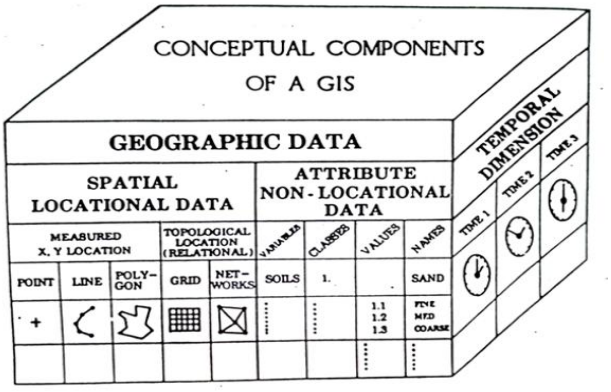

Figure 2 Three Conceptual Components of GIS

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The format of spatial data, where cartographic entities are translated line-for line and point-for-point into digital form. is known as Vector format (Fig. 1). The vector data structure is compatible with many standard cartographic formats developed for manual use. In vector format the fundamental blocks are co-ordinate pairs from which points, lines and areas (polygons) are constructed.

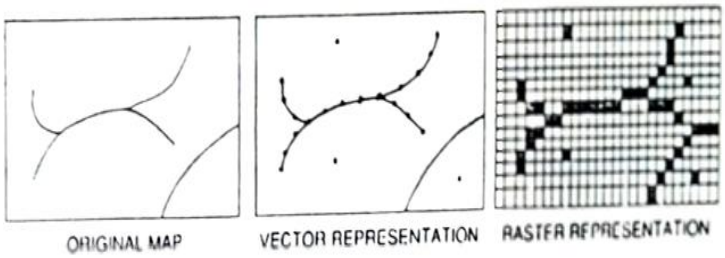

Fig. 3 Vector and Raster Structures

While points are represented by single x, y co-ordinate pair, lines and polygons are composed of straight line segments joining two co-ordinate pairs. Spatial relationships, are established through the use of topological are more representation and attribute values are stored independent of the spatial representation.

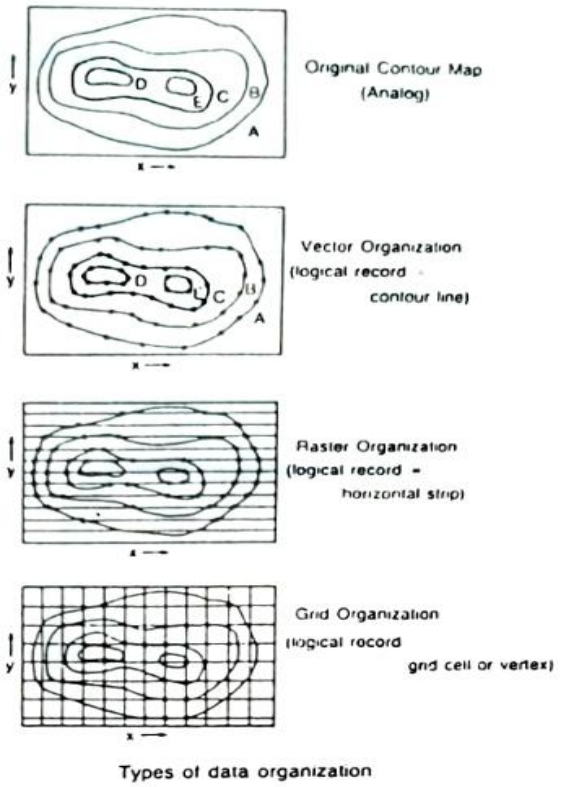

Fig. 4 : Vector/Raster Data Structures

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The other main type of representation for spatial data is known as raster format which has been largely driven by graphic input/output hardware technology. In a raster system, the geographical data is represented by a geometric array of rectangular or square cells or pixels in case of remotely sensed data. The resolution is determined by the size of the cell. The smaller the grid size, the greater the resolution and precision, as also the volume of data to be handled. In this structure the points are represented as individual cells, and lines and polygons as clusters of cells. (Fig. 4). The raster structures, besides being more compatible with modern input/output hardware technology, have the advantage that the order of the data elements, as stored in digital form, is dictated by their geographical positions.

Vector data structure are useful for

1) data archiving phenomenologically structured data such as soil areas, landuse units etc.

2) network analyses, such as drainage or transport network,

3) the highest quality line drawing,

4) digital terrain models, with attitude matrices,

Raster methods are more useful for

1) quick and cheap map overlay, map combination and map analysis,

2) simulation and modeling when it is necessary to work with surfaces

Raster and vector in combination, are useful for plotting high quality lines incombination with efficiency area filling in colour. The lines can be held in vectorformat and the Raster filling in compact RASTER structures such as run lengthcodes.

Any GIS or data information system should satisfy basic requirements to be auseful tool such as

1. Provide standardized format and a set of standards andprocedures for recording data

2. Allow efficient storage and retrieval for all the input data

3 Provide independence of the storage format of the data.

4. Ensure non-redundancy in the data.

5. Protect the data from accidental loss.

6 Provide easy use of the system : and provide economy ofsystem use.

Modern systems provide more than these basic requirements.

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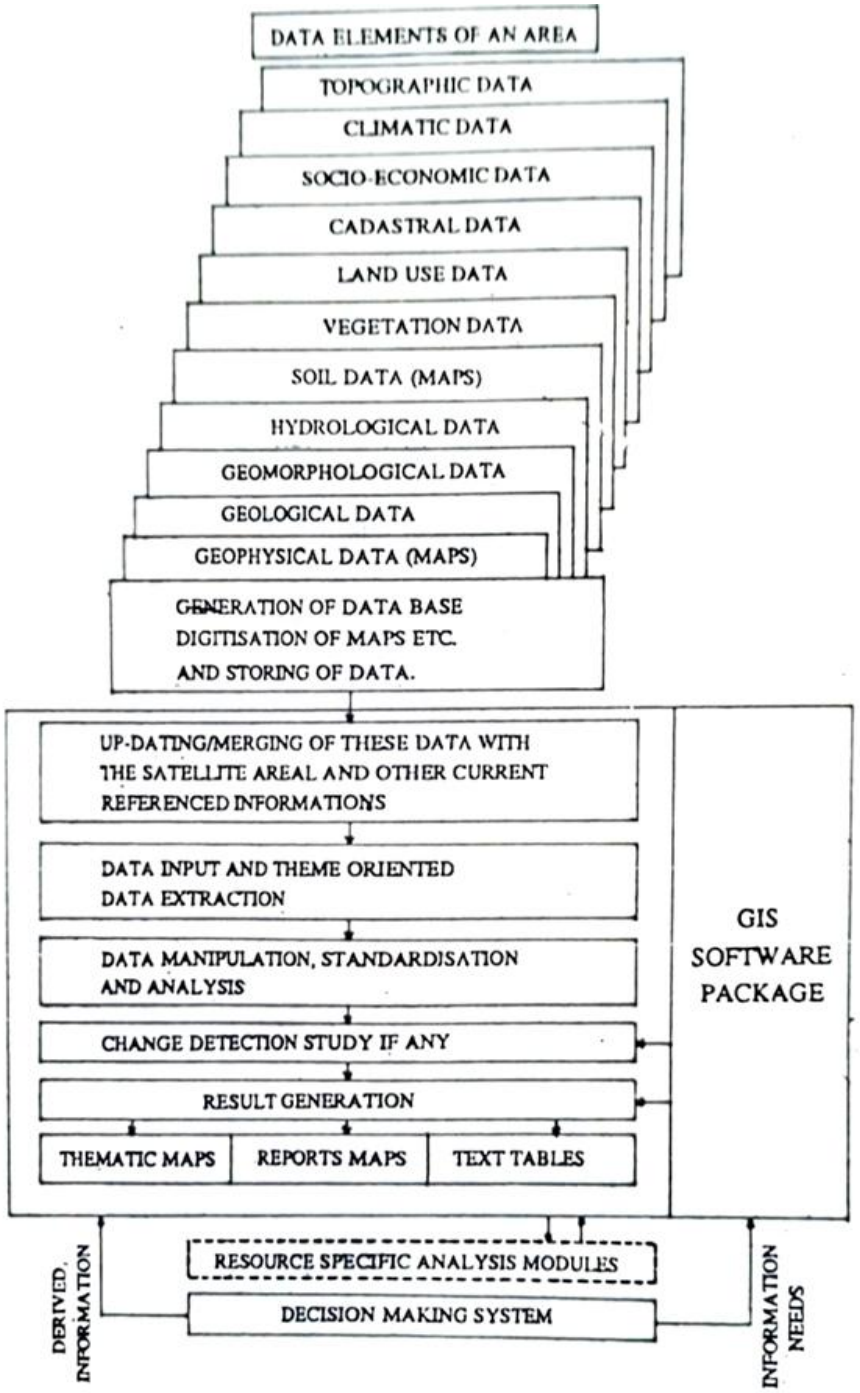

Fig. 5: GEOGRAPHICAL INFORMATION SYSTEMANDDATA BASE MANAGEMENT SYSTEM

monitoring environmental resources. One of the most important area of GIS applications is micro-level regional planning, for balanced regional development.

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GEOLOGY :

The operation of GIS for geological work is best illustrated by exploration (Drury, 1987). Exploration for minerals is guided by various factors, such as market trends, combinations of size, grade and type of deposit, political and logistic standpoints, profitability, chances of success etc. A variety of data have to be generated for exploration of mineral deposits, such as surface geological indications, geochemical, air and ground geophysical, chemical analyses, remote sensing engineering geology etc, which when plotted on a point, line or area, can best and chances of making find improve, more sophisticated and expensive methods, enumerated above, are brought into play. A geographic information system helps to assess objectively all the available data throughout the exploration phase even upto the stages of evaluation and operation.

Host of data generated by different agencies at different times are on different scales. Efficient synthesis and interpretation requires maps with a common scale. When the data of different atributes are expressed in diferent forms, it is difficult to assign meaningful weights to the different sets of data. When these data are reduced to the same scale using GIS they become more meaningful and interpretable. Computer assisted synthesis, of GIS based map data, can be manipulated using image-processing enhancement techniques to produce desired derivates of the raw data. These can, then, be correlated and compared to express various geological models to help in the exploration of the mineral resources.

Geological research often calls for combination, comparison, and correlation of different kinds of data. This is known as Synergetic analysis. Such data sets are best handled in the form of a GIS. Many parameters such as gravity and magnetic data, elements and their relation to vegetation etc are to be handled together to arrive at a geological model. This can at best be done by adopting GIS to plan and prepare exploration strategy.

LAND USE PLANNING

The key to useful computer based GIS tool for land use planning and environmental management is integration. (Nagraja et. al;. 1994). Land use planning requires information from different sources, for, national level data on 1:250,000 scale will suffice, on district level it should be on 1:50,000 scale and on micro level the data on 1:10.000 scale would be required.

Remotely sensed data from IRS, SPOT and Landsat have been extensively used and land categories are identified and delineated at various levels. For proper identification of land suitability and capability classes information on soils, ground water potential, slope etc. are required, Geographic Information System facilitates computerization of all the required data in different layers and the integration of these natural resources information for appropriate land use suitability analysis. Socio- economic data are also required to be analyzed to identify

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the local needs and suggest the development activity to meet their needs which can best be achieved by use of GIS.The details methodology being followed by NRSA for land development is given in Fig. 6.

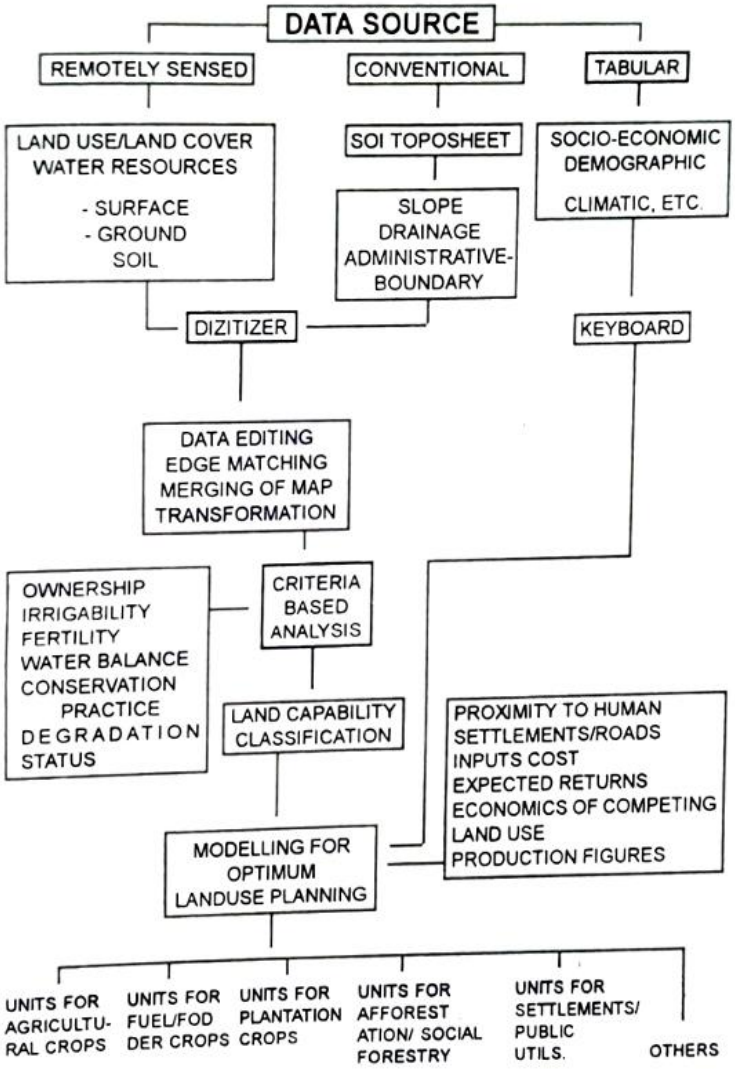

Fig.6 Framework of GIS for Land Development

Remotely sensed data and ancillary data are generated, compiled and composed for integration using GIS for preparation of action plan for development. In the absence of GIS as a tool integrating various layers of Spatial and non-Spatial data and their analysis, it is very difficult to achieve the objective with accuracy and speed, as only GIS package allows multi-manipulations for analysis.

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INFRASTRUCTURAL PLANNING

Integration of inherently geographical and non-geographical information is first task for the planning of infrastructural services. Initially, three types of geographical informations are required (1). Village locations, (2) transport and irrigation network and (3) topographical informations. Satellite data and so toposheets provide most of these informations. Geographical data can be captured in two types of coverages-point and line using digitizer or scanner point coverages for settlement locations and line coverages for transport and irrigation network. Village location data will be in vector format.

Non-geographical information's such as population size of a village, availability of facilities such as schools, hospitals, number of students, agricultural produce, marketing centres etc. are of vital significance for planning of infrastructural facilities. When all these and many other data are computerized, demand points can be identified. Once appropriate locations are identified and stored into the system, using GIS applications the final output in the form of map, monitor display, tabular form etc can be produced.

Thus integration of spatial and non-spatial informations in GIS may be of great help in better spatial planning of infrastructural services in rural, as well as urban areas. This is true that work for planning of infrastructural services can be done manually also. But, it will be time consuming process. Also, some transportation and irrigation networking analysis are not only diflicult manually but impossible if number of nodes are considerably large. Besides, for evaluation, up-gradation and modification again lot of work has to be done. While using GIS there is need to prepare geographical data base once only, attribute informations can be appended and manipulated as and when required. GIS, provide chronological data on demand which will further the scope for spatial planning of infrastructural services quickly and economically.

Utility of GIS in developing query base:

The selective display and retrieval of information from a data base area among the fundamental requirement of GIS. The ability to selective retrieve information is an important facility. There are two type of query

i) Query by attribute ii) Query by geometry.

Map functions/features can be retrieved on the basis of attributes. The attribute data base is stored in a table with a unique code linked to the geometric data. This data base can be searched with specific characteristics GIS can carryout number of geometric query. There are five primitive geometric query point; rectangle; circle; line; polygon.

More complex query is one that uses both geometric and attribute search criteria together.

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GIS provides both simple point and dick query capabilities and sophisticated analysis tools to provide timely information to mangers and analyst. GIS technology really comes into its own when used to analyze geographic data to look for pattern and trends and to undertake "what if" scenario.

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