RESOURCE INVENTORY AND WATER MANAGEMENT THROUGH REMOTE SENSING TECHNOLOGY

Remote Sensing:

Remote Sensing means getting information regarding any place located at a distance using artificial satellites and space skills.This is an advanced technique, which gives information regarding changes occurring on the earth from time to time.Electro-Magnetic energy obtained from sun or auto-abandonment is used as a source in it.

Transmission of this energy into the atmosphere is caused on the ground as a source through absorption or expansion. Reflection and abandonment of electro-magnetic energy from the ground is important for getting information from the earth. They cause interaction, which transmits energy from the earth to remote sensors.

The remote sensors located in satellites, collect different types of information and send it to receiving stations on the earth, which is used after digital image processing. The resolution of remote sensors is the most important fact in this technique. For example, the resolution of remote sensors LISS III of Indian Satellite IRSIC is 23.5 metre whereas the resolution of Panchromatic (pan) is 5.8 metre. There are three types of platforms in the remote sensing technique. Platform is a rectangular position of the camera which obtains information regarding the target.

According to height, they are of three types. These are:

1. Ground Borne

2. Air Borne

3. Space Borne

Ground-borne remote sensing system is used for study of land resources for which detailed information is received with the help of space technology and satellites. Airborne technique is normally used for getting air photo pictures for photo interpretation and detailed description can be obtained at any time through them. Space borne platforms are generally not affected by the environment of the earth and they move independently in their orbit. Vast statistics can be obtained from them though they depend on the extension of the sphere of the satellite.

For the last 30 years, many geographers had been thinking about a system by which spatial information could be organized and stored using computer. During the last decade, this growing

technique came to be known as ‘Geographical Information System’. Geographical Information System is mainly a system of computer hardware and software that organizes and stores geographical data for counting, analysis and individual planning. In other words, it is an information technology which analyzes spatial and non-spatial data after its collection. Many areas have been included in this Information Management Technology.

They include mainly computer science, cartography, information management, telecommunication, geology, photo-geometry, remote sensing etc. Geographical Information System has developed in many forms. The first publication of the word ‘Geographical Information System’ was made in 1965 by Michael Decy and Deven Marbel of Northwest University in a paper written by them.

This name is related with the following techniques:

1. Automated Mapping

2. Computer-Aided Mapping

3. Computer-Aided Design

4. Computer-Aided Drafting

5. Geographical Information System

6. Geo-processing and Network Analysis

7. Land Information System

Elements of Geographical Information System:

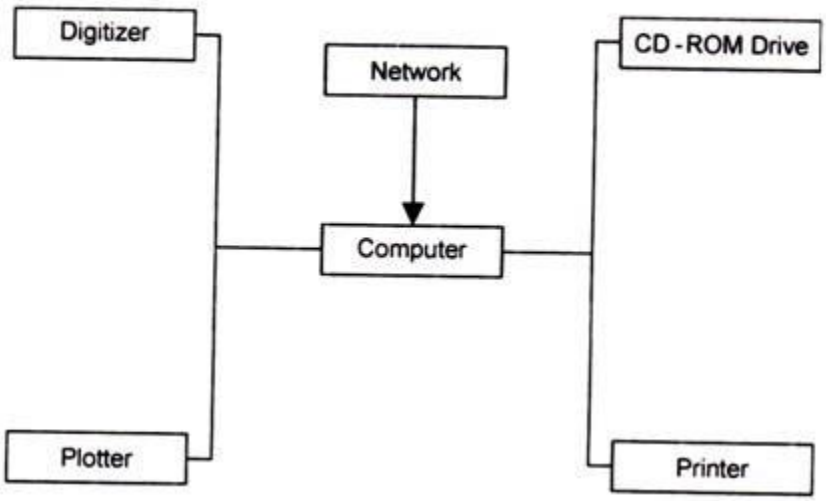
The main elements of Geographical Information Systems (CIS) include hardware, software, scanners, digitizers, C.D., key board, graphics, monitor, plotter and printer.

Computer Hardware:

The computer hardware has a hard disc for collection of data and programs. Digital tape cassette, C.D. Rom etc., are also its pans.

Scanner digitizer is used for converting maps and data in digital form. Plotter or printer is used for demonstrating the result.

Figure 20.1
Important Hardware Constituents of Hardware of GIS



GIS Software:

Geographical Information System is divided in five functional classes. They are:

1. Presentation and Verification of data

2. Storage and Management of data

3. Exit and Presentation of data

4. Transfer of data

5. Interaction with user

Utility of Geographical Information System and Remote Sensing:

Use of Geographical Information System and Remote Sensing is possible in the following areas:

1. Agricultural development

2. Land valuation analysis

3. Study of changed reflection capacity of vegetative regions

4. Analysis of deforestation and environmental crisis

5. Supervision of vegetative health

6. Management of land degradation

7. Estimation of area of crops and production

8. Mapping of waste lands

9. Soil Resource Mapping

10. Groundwater Probability Mapping

11. Discovery of geological minerals

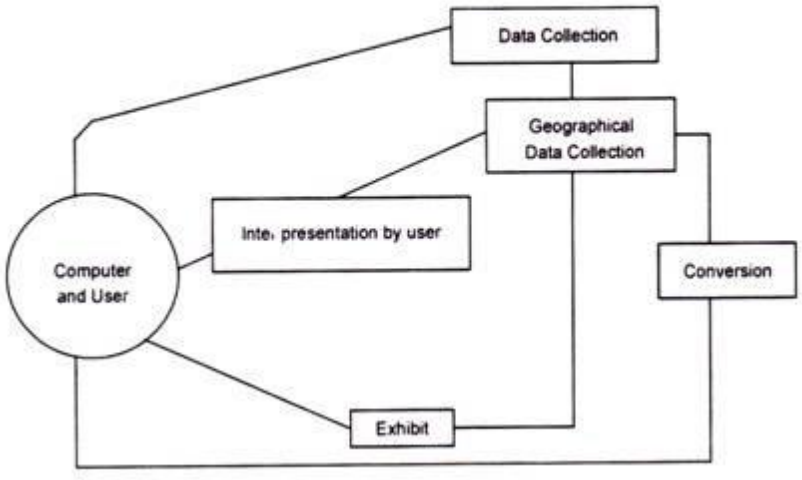
12. Supervision of forest fire

13. Supervision of Oceanic products

14. Water Resources Management etc.

Picture 20.2

Important Constituents of GIS Software



Geographical Information System and Remote Sensing technique has performed an important role in water resources management since suitable and sufficient quantity of information can be obtained from satellites.

The following aspects of water resources management can be studied with the help of Geographical Information System and Remote Sensing:

1. Survey and search of surface water
2. Hydrological studies
3. Watershed conservation, planning and management
4. Management of flood affected areas
5. Water management in irrigated areas
6. Groundwater management

Surface Water Inventory and Surveying:

Satellite capacity is important for surface water management because information regarding hydrological regions of large geographical states can be obtained very quickly. Occasional rays of infra-red electromagnetic wavelength are absorbed by water, whereas they are reflected by the earth and vegetation. Hence, this view appears as black in the imagery.

Management of surface water is made under the following spheres:

i. Location
ii. Numbers
iii. Periodic Fluctuation
iv. Turbid v/s clear water
v. Water quantity status: shallow v/s deep water

The Above study is helpful in planning the following things:

1. Supply of water for agriculture
2. Supply of drinking water
3. Development of probable sources for recharging of groundwater

Thus, constant use of surface water would be possible in these spheres.

Hydrological Studies:

Study of different aspects of hydrology can be done easily with the help of Geographical Information System and Remote Sensing technique. Modeling of rain water, study of water balance, flow forecast and estimate etc. are important among them. In modeling of rain water flow first of all, contour map is prepared. After that an elevation map is prepared.

This is superimposed on the land utilization map and a soil map is then prepared. Knowledge of rainfall, evaporation, evapotranspiration, infiltration etc. is essential for study of water balance. Hydrological balance is important in certain conditions when hydrological cycle is affected. Hydrological cycle affects climatic changes. Forecast regarding flow of water and its estimate can also be easily done with the help of Geographical Information System and Remote Sensing technique.

Watershed Conservation, Planning and Management:

Work plan of watershed management can be prepared with the help of Geographical Information System and Remote Sensing technique. After scanning the toposheet, drainage system maps and contour maps can be prepared through digitization. A digital elevation model can then be prepared after counting from the contour bund map.

Slope map and three dimensional view are prepared thereafter. Soil map, classified slope map and land utilization maps are superimposed on the basis of facts collected during topographical survey. Soil map is cross checked from the conservation work plan. Water management has become the necessity of the day. Optimum utilization of land and water resources is possible only through this technique.

Watershed management is resorted to with the following objectives:

1. Control over degradation of flow water.
2. Management and use of flowing water for useful purposes.
3. Control on soil erosion and reduction in quantity of silting.
4. Diversion of water towards suitable direction in flood affected areas.
5. Making provision for groundwater recharging wherever possible.
6. Suitable use of land resource.

For meeting the above objectives, Geographical Information System and Remote Sensing technique is used and prioritization of methods is done for watershed development. Land utilization maps are prepared from statistics of remote sensing. Micro watershed area maps are drawn from contour maps and drainage basin maps are prepared from toposheets.

The map obtained by cross tallying of watershed priority map, soil map, slope map, and land utilization map, is cross tallied with the micro watershed maps to obtain the final micro watershed map.

Work plan of watershed management is affected by the following features of watershed area:

1. Size and shape of watershed
2. Morphology of the site
3. Soil and its specialties
4. Rainfall
5. Land utilization
6. Vegetative cover

Essential statistics required for watershed planning can be divided in three categories:

1. Hydrological Information
2. Soil and land use data
3. Economic and social data

Hydrological information includes information regarding rainfall, requirement of water for crops on climatic basis, and data regarding flow of river and silting. Soil and land use data include data regarding existing land, data related to soil, morphological data, geological map and types of vegetation.

Economic and social data includes calculation of investment on the project. Thus, the process of planning, conservation and management of watershed can be completed easily by Remote Sensing and Geographical Information System and a suitable conservation plan can be implemented.

Management of Flood-Prone Areas:

Survey of flood-prone areas is essential for economic assessment of measures to be adopted for flood control and to assess intensity as well as extension of floods. Remote sensing technique has provided praiseworthy methods, with the help of which maps of flood affected areas can be prepared through Remote Sensing and Geographical Information System for managing floods.

Maps of flood affected areas are special types of morphological maps indicating special features of floods by graphs prepared from an imaginative point of view. Trends of previous floods are also indicated in it. This map is a type of basic instrument on the basis of which a strong future strategy is chalked out.

These maps are prepared for fulfilling the following objectives:

a. Basic primary information regarding land utilization plans are provided by them.

b. They provide permission for correct development of new urban areas
c. Assessment of loss due to floods can be done with the help of such maps.
d. They provide help in controlling unstructured floods.
e. Public awareness is spread by them.
Indian remote sensing satellites are now collecting information regarding various peculiarities of floods. In the G.I.S. series, micro sensors LISS-I and LISS-II located in IRS-IA, IRS-2B and IRS-P2 satellites having resolutions of 36 metres and 72 metres are collecting information every 24 days.
IRS-IC is the latest modern satellite in which three sensors, PEN, LISS-III and WIFS, possessing local resolution capacity of 5.8 metre, 23.5 metre and 188 metre respectively are located. WIFS sensor is established in IRS-P3, which reaches the ground again after five days.

The regional coverage of WIFS sensor is 810 km NOAA (AVHRR) and Land-sat (TM) satellites, established by Indian National Remote Sensing Agency (NRSA) which are in the space for climatic study, have local resolution capacity of 30 metres and repetition duration of 16 days. European Remote Sensing Satellites (ERS) are also collecting data about flood affected areas.

Effective use of such data generated by remote sensing system are being made in the following forms:
a. Obtaining information about duration, extension and size of flood
b. Getting information regarding construction of dams etc. to control floods
c. Obtaining knowledge about areas preventing drainage
d. Making assessment about losses on account of floods
e. Studying morphology found in flood affected areas
f. Studying erosion of banks and migration of rivers
Geographical information system provides description of vast areas affected by floods and gives estimate about future data. A digital elevation model is prepared by using local data of flood affected areas. It can provide suitable direction for construction of structures in the context of water received, height of water and slope of the area, so that the adverse effects of flood are prevented.

Water Management in Irrigation Command Areas:
Up-to-date pictures of irrigated areas and crops grown on them can be taken by remote sensing satellites, and assessment regarding requirement of water for irrigation can be made after

analysis through Geographical Information System. Sensors like LISS-III and thematic Mupper (TM) in the latest satellites IRS-IC and Landsat, have proved very effective.

Their inverse colour combination (ICC) provides correct and timely analysis of crops. ICC is a technique involving little time and nominal expenditure for management of irrigation in command areas through Geographical Information System.

The following data is required for it:

1. Crop Areas
2. Crop Calendar
3. Soil Map
4. Transpiration
5. Crop Coefficient
6. Canal Network
7. Rainfall Data
8. Discharge
9. Other Sources of Irrigation

For water management in irrigated areas, first of all the cropped area is assessed through Geographical Information System. This information is received from visual interpretation of imageries of satellites. Thereafter, polygons are digitized and a supervised classification is done.

Optimum utilization of irrigation water is essential for proper water management. Some crops require less water, whereas other crops need more water. Computation of water requirement is done on the basis of the above data through Geographical Information System. Soil map is required for this purpose to calculate loss from percolation.

This map is digitized and converted into the polygon mode. Information about crop calendar is also required. This information is important for assessment of requirement of water. These figures are kept in the form of a table. Study of sources of irrigation is also very important because quantity of water is decided on this basis, for example, to decide how much quantity of water is lost if it is carried through the canal system.

Hence, computation of the following morph metric elements is important:

a. Calculation of cropped area
b. Transpiration
c. Stage of crops
d. Percolation loss

e. Conveyance loss

During present times, water management is being done by analyzing data regarding timely agricultural crops furnished by Sensors LISS-III and Thematic Mupper (TM) in latest satellites IRS-IC and Land-sat through remote sensing by Geographical Information System.

Management of Groundwater:

In India, more than 90 per cent rural population and more than 30 per cent population in urban areas is dependent on groundwater for drinking water and other domestic requirements. 60 per cent irrigation in the country is done by groundwater.

Demand for water is 3-4 times more than its availability, hence by proper management, this gap between demand and availability can be balanced. Different countries of the world have been making use of satellite imageries for management of groundwater since the last two decades. In the beginning, regional maps were developed on a 1:250,000 scale from imageries received from Land-sat and IRS series satellites having lesser resolution. Now, the National Drinking Water Technical Mission, Space Department, has developed maps on 1:2, 50,000 scale regarding probable availability of groundwater in 446 districts of India during 1987 to 1992, with the help of some non-governmental organizations.

More information is now possible through IRS-IC that has a high resolution capacity. Recently, Rajiv Gandhi National Drinking Water Mission in the National Remote Sensing Agency, has prepared groundwater probability maps on 1:50,000 scale for the states of Rajasthan, Madhya Pradesh, Andhra Pradesh, Karnataka and Kerala.

Companion places are being developed as sources for drinking water and a scheme for artificial recharging of groundwater is also being resorted to at places wherever it is feasible. Maps regarding surface sources and groundwater in highly irrigated and canal areas are being prepared on 1:15,000 scale with the help of LISS-III and PAN data in IRS IC/ID satellites.

The following integrated information can be obtained regarding groundwater management from Remote Sensing technique and Geographical Information System that is directly or indirectly related to geology, morphology and hydrology:

1. Assessment of groundwater resources.
2. Assessment of surface water flow.
3. Computation of available groundwater balancing for macro use.
4. Identification of underground areas based on groundwater development.

5. Identification of overexploited groundwater areas.
6. Delineating areas having increased groundwater resource.
7. Identifying problems created in the context of water conservation.
8. Planning for combined use of surface water and groundwater resources.
9. Making optimum management and use of groundwater.
10. Maintaining constant vigil on development and use of groundwater.

Thus, a detailed outline for constant use of groundwater in future is being prepared on the basis of imageries received from satellites through remote sensing and analysis through geographical information system.

Indian remote sensing agency is performing a very important task in the direction of water resources management in the country.

IRS P4 (Oceansat) was launched in May 1999 for management of the area of oceans. Its sensor is Ocean Colour Monitor (OCM). On the basis of information received from it, suitable management of oceanic resources like fish, quality of oceanic water and management of coastal areas would be possible. Its repetition is once in two days.

India is constantly progressing in the direction of launching satellites with higher resolution and improving quantity and quality of data. The following satellites are important from this point of oceanic resources like fish, quality of oceanic water and management of coastal areas would be possible. Its repetition is once in two days.

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The following satellites are important from this point of view:

Cartosat-U Irs-P 5:

It is a mission of cartographic methods in which there are two panchromatic cameras. One camera is in the front side and other is in the back side. They draw three-dimensional pictures daily. Its resolution capacity is 2.5 metres. Its main features are: planet route is 618 km, local time is 10.30 A.M., weight is 1450 kg, mission duration is five years and time of re-visit is five days.

India launched METSAT stationary satellite on the earth in September, 2001. It was renamed as KALPNA-1. This satellite has a very fast resolution and has been sending pictures of water vapour and clouds in three bands of radio metre.

Resourcesat, Irs-P 5:

This satellite is in the continuous series of IRS – IC/ID. Its sensor is LISS-III having resolution of 23.5 metre with three bands (Green, Red, Near IR). Pan camera of IRS – IC/ID will soon be converted into multi-spectral camera which will also have 3-bands, resolution capacity 5.8 metre and WIFS sensor having resolution capacity of 70 metre.

Its height is 817 km, equator crossing time is 10.30 A.M., weight is 1250 kg, mission duration is five years. Data received from PSLV -1 RESOURCESAT is very important for soil agriculture, water resources etc.

RESOURCESAT-1 was launched on 17 October 2003 from PSLV. Its next series CARTOSAT-1 and CARTOSAT-2 would be launched very soon.

Climatsat:

Knowledge about water vapour, snow, clouds etc. in tropical regions is being sent by this satellite.

Thus, in the programmes pertaining to space. India has made revolutionary changes from the point of view of resources management and climatic data during the last two decades. It has developed the most modern techniques and the information obtained through them can be analyzed using Geographical Information System. Thereby quantitative availability and use of resources can be balanced.