Advantages of Remote sensing:

1. Relatively cheap and rapid method of acquiring up-to-date information over a large geographical area.

2. It is only practical way to obtain data from inaccessible regions, e.g. Antarctica, Amezonia.

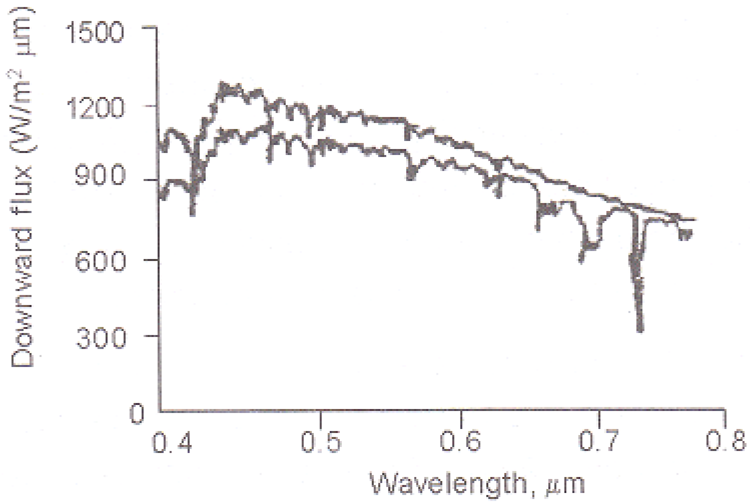
3. At small scales, regional phenomena which are invisible from the ground are clearly visible. A classic example of seeing the forest instead of the trees.

4. cheap and rapid method of constructing base maps in the absence of detailed land surveys.

5. Easy to manipulate with the computer, and combine with other geographic coverages in the GIS.

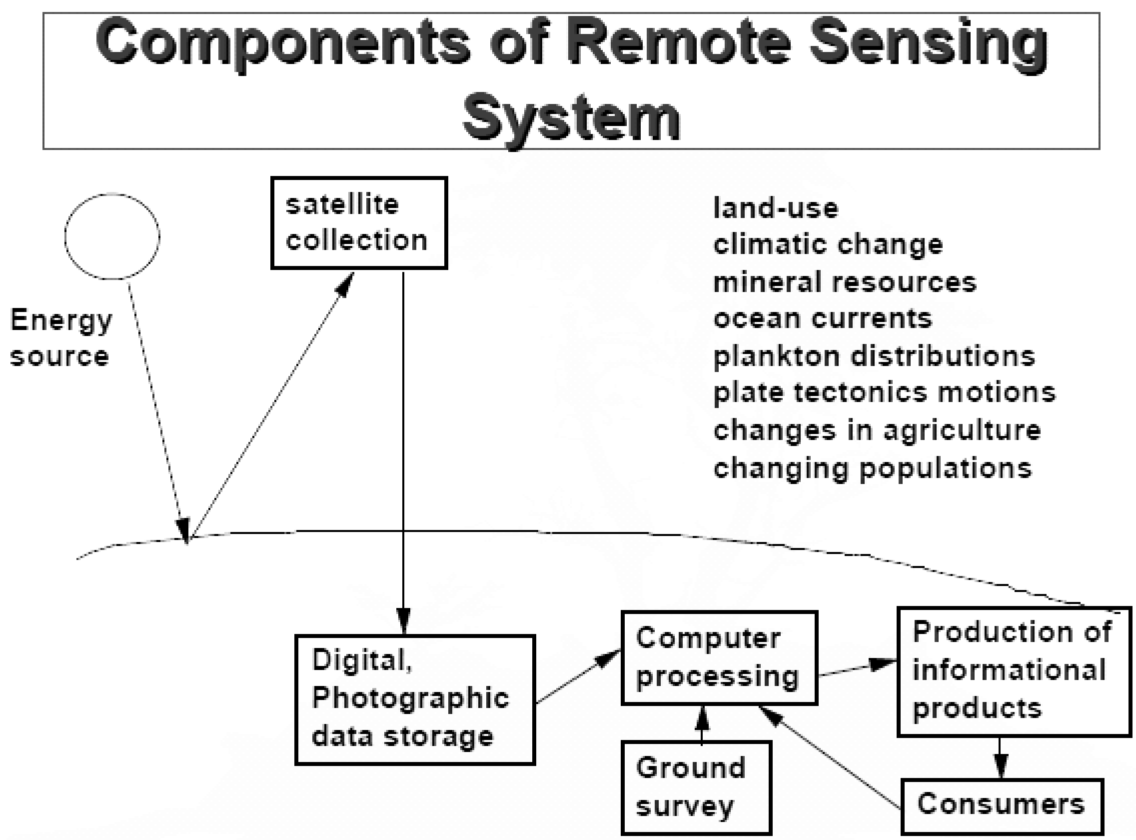
8. a. Explain the significance of atmospheric properties in remote sensing.
b. Write the basic components in remote sensing. (10+6)

Answer:
(a): The main part of the radiance measured from high flying aircraft or satellite stems from multiple scattering in the atmosphere. There fore, the remaining signal can be interpreted in terms of suspensions only after a careful correction for the atmospheric contribution. For this reason the varying optical parameters of atmosphere must enter the radioactive transfer calculations. Before we study the effects of solar radiation and atmospheric properties, we shall consider the mass quantities which determine the spectral upward radiance. The source of the shortwave radiation field in atmosphere is the sun emitting in a board spectral range. The extraterrestrial irradiance at the top of the atmosphere, the solar constant, depends on the black body emission of the sun's photosphere and on the scattering and absorption process in the Sun's chromosphere. Important Fraunhofer lines caused by the strong absorption in the sun's chromosphere show some prominent drops in the spectral distribution of the solar radiation. Fig shows the solar irradiance at the top of the earth's atmosphere to be between 0.4 to 0.8 μm as determined by Necked and Labs.



Solar irradiance at the top of the atmosphere illuminating the Earth between 0.4 µm – 0.8 µm.

(b):



1. Explain in detail basic elements of image interpretation.

Answer:
Basic elements of image interpretation:

(i) Tone: Ground objects of different color reflect the incident radiation differently depending upon the incident wave length, physical and chemical constituents of the objects. The imagery as recorded in remote sensing is in different shades or tones.

(ii) Texture: Texture is an expression of roughness or smoothness as exhibited by the imagery. It is the rate of change of tonal values. Texture can qualitatively be expressed as course, medium and fine. The texture is a combination of several image characteristics such as tone, shadow size, shape and pattern etc., and is produced by a mixture of features too small to be seen individually because the texture by definition is the frequency of tonal changes.

(iii) Association: The relation of a particular feature to its surroundings is an important key to interpretation. Some times a single featured by itself may not be distinctive enough to permit its identification.

(iv) Shape: Some ground features have typical shapes due to the structure or topography. For example air fields and football stadium easily can be interpreted because of their finite ground shapes and geometry whereas volcanic covers, sand, river terraces, cliffs, gullies can be identified because of their characteristic shape controlled by geology and topography.

(v) Size: The size of an image also helps for its identification whether it is relative or absolute. Sometimes the measurements of height (as by using parallax bar) also gives clues to the nature of the object.

(vi) Shadows: shadows cast by objects are sometimes important clues to their identification and interpretation. For example, shadow of a suspension bridge can easily be discriminated from that of cantilever bridge. Similarly circular shadows are indicative of coniferous trees.

(vii) Size factor or topographic location: Relative elevation or specific location of objects can be helpful to identify certain features. For example, sudden appearance or disappearance of vegetation is a good clue to the underlying soil type or drainage conditions.

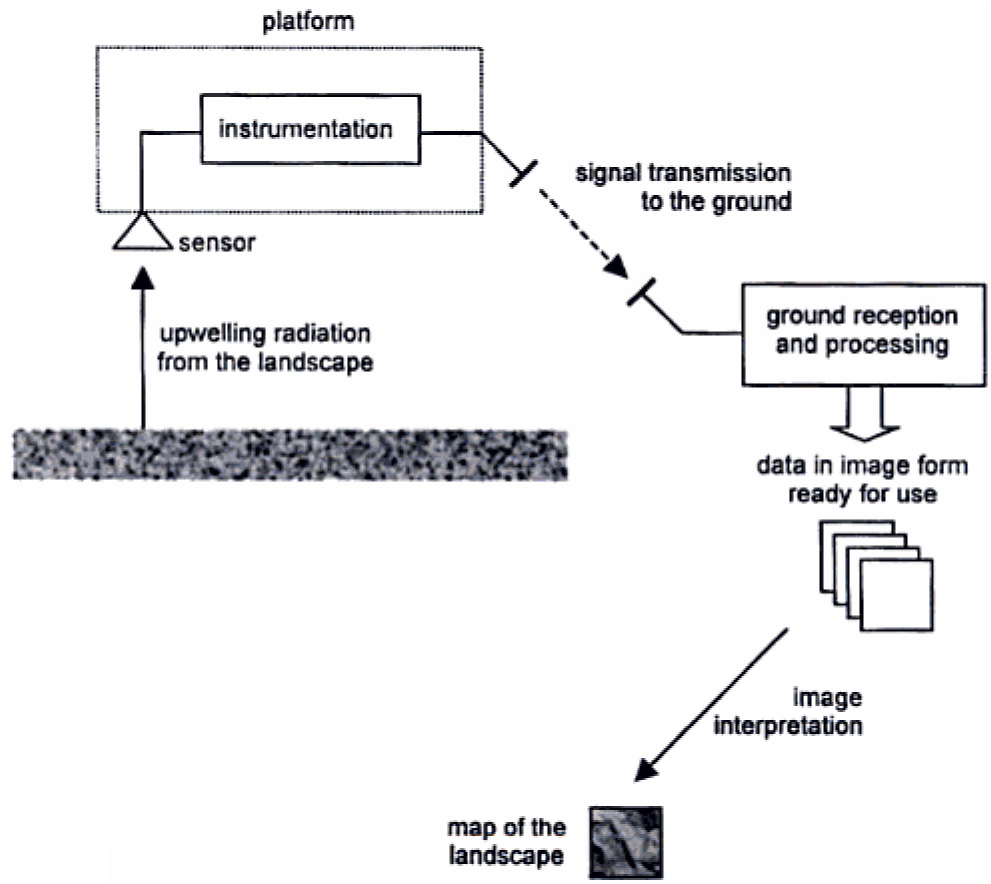
(viii) Pattern: Pattern is the orderly special arrangement of geological topographic or vegetation features. This special arrangement may be two-dimensional or 3-dimensional.

2. (a) Explain the basic character of digital image
(b) What do you mean by image registration

Answer:
(a):
In remote sensing energy emanating from the earth's surface is measured using a sensor mounted on an aircraft or spacecraft platform. That measurement is used to construct an image of the landscape beneath the platform, as depicted in Fig.

The energy can be reflected sunlight so that the image recorded is, in many ways. similar to the view we would have of the earth's surface from an aeroplane, although the wavelengths used in remote sensing are often outside the range of human vision. As an alternative, the upwelling energy can be from the earth itself acting as a radiator because of its own temperature. Finally, the energy detected could be scattered from the earth as the result of some illumination by an artificial energy source such as a laser or radar carried on the platform.

Each of these will be outlined in more detail in the following; it is important here to note that the overall system is a complex one involving the scattering or emission of energy from the earth's surface, followed by transmission through the atmosphere to instruments mounted on the remote sensing platform, transmission or carriage of data back to the earth's surface after which it is then processed into image products ready for application by the user. It is really from this point onwards that the material of this book is concerned, viz. we wish to understand how the data, once available in image format, can be used to build maps of features on the landscape.



(b):

1. Preprocessing: This involves preparing the images for feature selection and correspondence. Using methods such as scale adjustment, noise removal, and segmentation. When pixel sites in the images to he registered are different hut known, one image is resampled to the scale of the other image. This scale adjustment facilitates feature correspondence. II the given images arc known to be noisy, they are smoothed to reduce the noise. Image segmentation is the processor partitioning an image into regions so that features can be extracted.

2. Feature Selection: To register two images, a number of features are selected from the images and correspondence is established between them. Knowing the correspondences, a transformation function is then found to resample the sensed image lo the geometry of the reference image. The features used in image registration arc corners, lines, curves, templates, regions, and patches. The type of features selected in an image depends on the type of image provided. An image of a man-made scene often contains line segments, while a satellite image often contains contours and regions. In a 3-D image, surface patches and regions are often present. Templates ore abundant in both 2-D and 3-D images and can he used as; features to register images.

3. Feature Correspondence: This can be achieved cither by selecting features in the reference linage and searching for them in the sensed image or by selecting features in both images independently and then determining the correspondence between them. The former method is chosen when the features contain considerable information, such as image regions or templates. The latter method is used when individual features, such as points and lines, do not contain sufficient information. If the features are not points, it is important that from each pair of corresponding features at least one pair of corresponding points is determined. The coordinates of corresponding points are used to determine the transformation parameters. For instance, if templates arc used, centers of corresponding templates represent corresponding points; if regions arc used, centers of gravity of corresponding regions represent corresponding points; if lines are used, intersections of corresponding line pairs represent corresponding points; and if curves are used. locally maximum curvature points on corresponding curves represent corresponding points.

4. Determination of a Transformation Function: Knowing the coordinates of a set of corresponding points in the images, a transformation function is determined lo resample the sensed image to the geometry of the reference image. The type of transformation function used should depend on the type of geometric difference between the images. If geometric difference between the inures Is nut known, a transformation that can easily adapt to the geometric difference between the images should he used.

5. Resampling: Knowing the transformation function, the sensed image is resampled to the geometry of the reference image. This enables fusion of information in the images or detection of changes in the scene.

3. Write a note on:
(i) Geometric Correction Methods
(ii) Radiometric correction methods

Answer:
(i) Radiometric Corrections
Since detector output changes gradually over time, it is necessary to calibrate the data they produce. The detectors are calibrated by (a) viewing an electrically illuminated step-wedge filter during each mirror sweep and (b) viewing the sun during each orbit to provide absolute calibration. These calibrated values are used to develop radiometric correction functions for each detector. The correction functions yield digital numbers that correspond linearly with radiance and are applied to all data prior to dissemination. The radiant values contain an added component due to 'air light' reflected from the atmosphere. The removal of this component is described as 'haze removal.' Occasional problems due to transmission cause a 'striping' effect, which is corrected by a normalizing procedure.

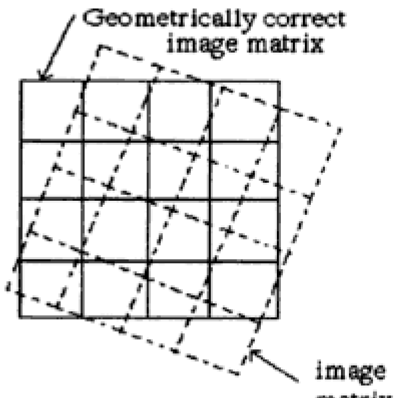
(ii)Geometric Corrections
These corrections are needed due to variations in altitude, attitude, and velocity of the aircraft and eastward rotation of the Earth. The eastward rotation of the Earth causes the mirror sweep to view an area slightly to the west of the previous sweep. Geometric corrections, which are random and complex distortions, are made by analyzing ground

control points and developing the following functions to transform image coordinates (x, y) to ground coordinates (X.Y):

$X = f_1(x, y)$ ……………………….(1)

$Y = f_2(x, y)$ ………………………….(2)

The process by which geometric transformations are applied to the original data is called re sampling. Using f_1 and f_2, the appropriate pixel value (x, y) is transferred from the image dataset to the geometrically correct matrix (Figure).

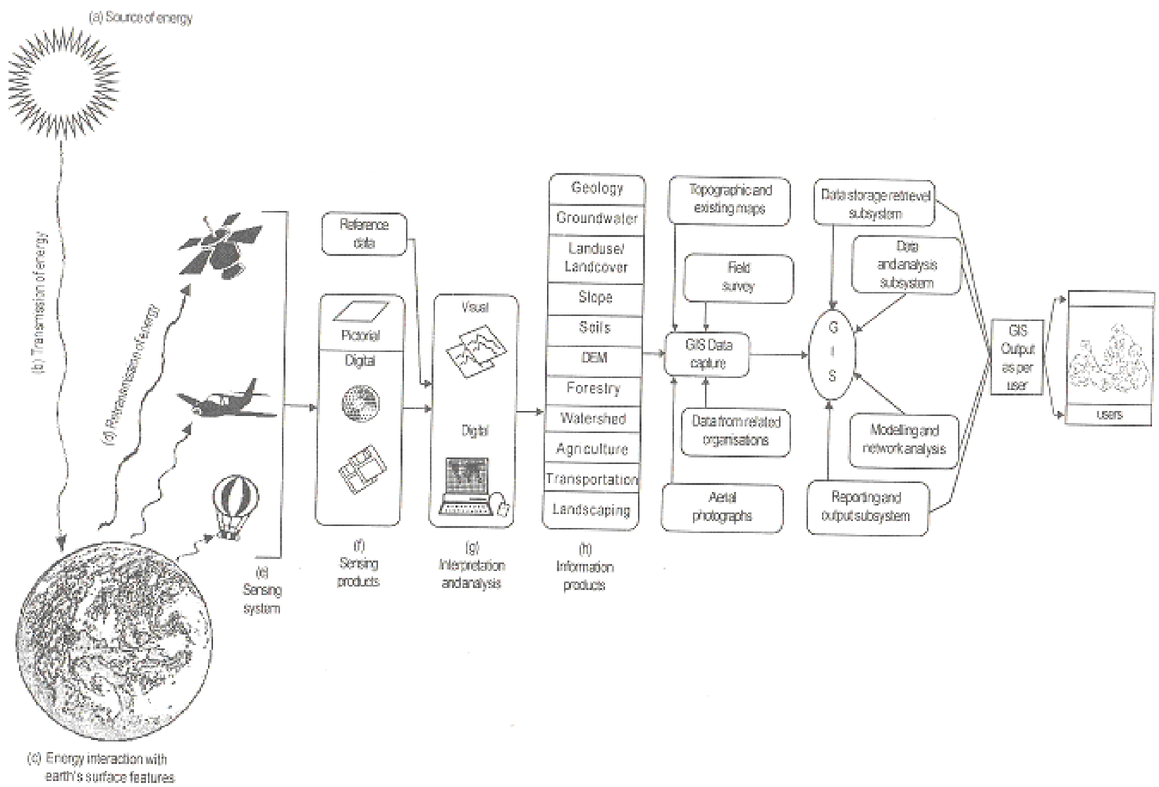


Geometric correction

4. a. Explain the electromagnetic process in integration with GIS.
b. Explain the electromagnetic energy interactions with earth surface materials. (8+8)

Answer:

(a):

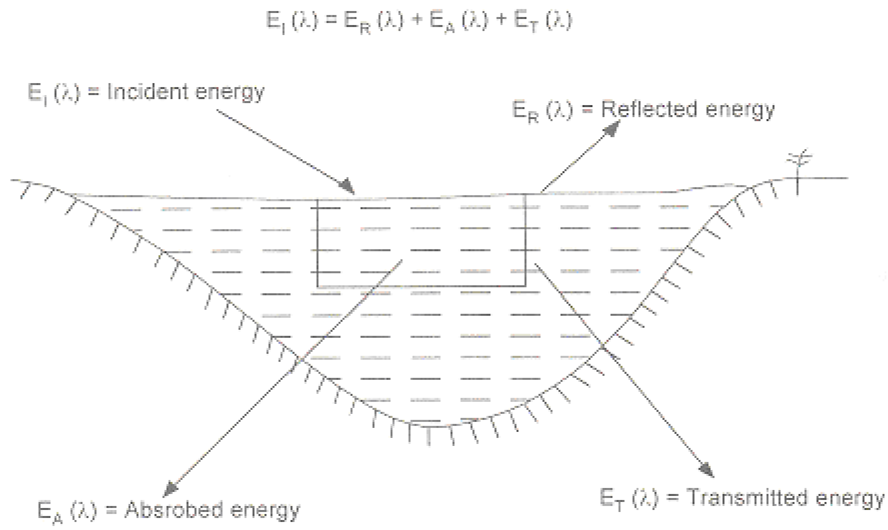


The generalised processes involved in electromagnetic remote sensing system or passive remote sensing system, namely, data acquisition and data analysis are outlined below and a schematic diagram of electro-magnetic remote sensing process is shown in fig. The data acquisition process comprises distinct elements, namely, (i) energy sources, (ii) propagation of energy through the atmosphere, (iii) energy interactions with earth's surface features (iv) airborne sensors to record the reflected energy and (v) generation of sensor data in the form of pictures or digital information. These elements are described in detail further in this chapter.

The data analysis process involves examining the data using various viewing instruments to analysis pictorial data which is called the 'visual image interpretation techniques'. Use of computers to analyse digital data through a process is known as digital image processing techniques. The analysis of a data utilizing visual image interpretation involves use of the fundamental picture elements, namely tone, texture pattern, size and shape in order to detect and identify various objects. Areal or satellite imagery are seen through stereoscopic instruments today for visual interpretation and for transferring the details on to base maps. If the data is available in digital form, it can be analysed on interactive computer systems for extracting statistical data or classified to obtain thematic information about resources. The scene is interactively analysed using computers by comparing with the actual "signature" of the object collected through field visits. This system of classification of objects is quite accurate and depends on the dispersion of training data sets over the area of the scene.

(b): Electromagnetic energy interactions with earth surface materials:

When electro magnetic energy is incident on any feature of earth's surface, such as a water body, various fractions of energy get reflected, absorbed, and transmitted as shown in fig. Applying the principle of conversation of energy,



Basic interactions between Electromagnetic Energy and a water body.

$E_I(\lambda) = E_R(\lambda)+E_A(\lambda)+E_T(\lambda)$.

Where, E_I = Incident energy
E_R = Reflected energy
E_A= Absorbed energy
And, E_T = Transmitted energy

All energy components are functions of wavelength, (l). In remote sensing, the amount of reflected energy $E_R(\lambda)$ is more important than the absorbed and transmitted energies. There fore, it is more convenient to rearrange these terms like

$E_R(\lambda) = E_I(\lambda) - [E_A(\lambda)+E_T(\lambda)]$ . . . . (i)

Eq^n (i) is called balance equation. From this mathematical equation, two important points can be drawn. Firstly,

$[E_R(\lambda)/E_I(\lambda)] = [E_I(\lambda)/E_I(\lambda)] - \{[E_A(\lambda)/E_I(\lambda) + [E_T(\lambda)/E_I(\lambda)]\}$ . . . . (ii)

According to principles of physics, it is known that

$(E_R(\lambda)/E_I(\lambda))$; $E_A(\lambda)/E_I(\lambda)$ and $E_T(\lambda)/E_I(\lambda)$ are called reflectance, absorbance and transmittance and can be denoted as $\rho(\lambda)$, $\alpha(\lambda)$, and $\gamma(\lambda)$.

Simply, it can be understood that, the measure of how much electromagnetic radiation is reflected off a surface is called its reflectance. The reflectance range lies between 1 and 1. A measure of 1.0 means that 100% of the incident radiation is reflected off the surface, and a measure ‘0’ means that 0% is reflected. The reflectance characteristics are quantified by “spectral reflectance, $\rho(\lambda)$ which is expressed as the following ratio:

$\rho(\lambda) = E_R(\lambda)/E_I(\lambda)$

= (energy of wavelent ‘λ’ reflected from the object)/(energy of wavelength ‘λ’ incident upon the object)…………………(iii)

Eq^n (ii) can be written as

$\rho(\lambda) = 1-[\alpha(\lambda)+\gamma(\lambda)]$ . . . . (iv)

Since, almost all earth surface features are very opaque in nature, the transmittance $\gamma(\lambda)$ can be neglected. According to kirchoff’s law of physics, the absorbance is taken as emissivity(ξ). There fore equation (iv) becomes

$P(\lambda) = 1- \xi(\lambda)$ . . . .(v)

The fundamental equation by which the conceptual design of remote sensing technology is built. If $\xi(\lambda)$ is a zero, then $\rho(\lambda)$, that is, the reflectance is one, which means, the total energy incident on the object is reflected and recorded by sensing systems. The classical example of this of the type of object is snow. If $\xi(\lambda)$ is one, then (λ) is a zero indicating that whatever the energy incident on the object, is completely absorbed by that object.

5. a. Describe the spectral bands of Landsat and Thematic mapper.
b. Write the details of Indian remote sensing satellites (IRS Series) and their sensor capabilities (8+8)

Answer:
(a): Landsats 4 and 5, launched in 1982 and 1984, respectively, were augmented with an advanced version of an Earth observation sensor known as the Thematic Mapper (TM). The TM provides a significant increase in data acquisition capability over the MSS in a number of ways, as shown in the Figure of Observation Characteristics. The TM sensor has seven spectral bands: Six acquire Earth reflectance data, and one acquires Earth temperature data. The spatial resolution of bands in the visible and reflective infrared regions is 30 m, some 2 1/2 times better than the Multi spectral Scanner (MSS). The TM sensor also has greater overall radiometric sensitivity than the MSS.

Currently, the TM sensor on Landsat 5 is still collecting data. EOSAT's construction of a Landsat 6 satellite was intended to continue acquisition of TM data with a so-called "enhanced Thematic Mapper" (ETM). The ETM included the addition of a 15-m panchromatic band to obtain higher spatial resolution. Landsat 6 was lost during launch, however, when it failed to reach orbit in October 1993.

(b): Indian Remote Sensing satellites (IRS) are a series of Earth Observation satellites, built, launched and maintained by Indian Space Research Organisation. The IRS series provides many remote sensing services to India.
Data from Indian Remote Sensing satellites are used for various applications of resources survey and management under the National Natural Resources Management System (NNRMS).

Following is the list of those applications:

1. Preharvest crop area and production estimation of major crops.

2. Drought monitoring and assessment based on vegetation condition.

3. Flood risk zone mapping and flood damage assessment.

4. Hydro-geomorphological maps for locating underground water resources for drilling well.

5. Irrigation command area status monitoring

6. Snow-melt run-off estimates for planning water use in down stream projects

7. Land use and land cover mapping

8. Urban planning

9. Forest survey

10. Wetland mapping

11. Environmental impact analysis

12. Mineral Prospecting

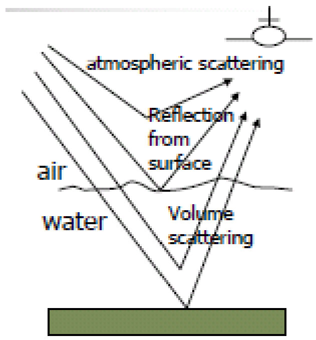
13. Coastal studies

14. Integrated Mission for Sustainable Development (initiated in 1992) for generating locale-specific prescriptions for integrated land and water resources development in 174 districts.

6. a. Describe the spectral characteristics of water bodies.
b. Write notes on spatial and spectral resolution. (10+6)

Answer:
(a): Spectral characteristics of water bodies:

1. radiation incident to the water surface



2. optical properties of water

3. rough ness of the surface

4. Angles of observation & illumination

5. Reflection of light from bottom.

As the sediment concentration increases spectral properties change

i. Overall brightness in visible region increases- no more "dark" object, becomes more of a "bright" object.

ii. Wave length of peak reflectance shifts from the blue to the green region.

Due to presence of large particles

i. wavelength of maximum scattering shifts towards the blue-green regions.

(b): In various applications of remote sensing, when high spatial resolution is required in addition with classification results, sensor fusion is a solution. From a set of images with different spatial and spectral resolutions, the aim is to synthesize images with the highest spatial resolution available in the set and with an appropriate spectral content. Several sensor fusion methods exist; most of them improve the spatial resolution but with a poor quality of the spectral content of the resulting image. Based on a multi resolution modeling of the information, the ARSIS concept (from its French name "Amelioration de la Resolution Spatial par Injection de Structures") was designed in the aim of improving the spatial resolution together with a high-quality in the spectral content of the synthesized images. The general case of application of this concept is described. A quantitative comparison of all presented methods is achieved for a SPOT image. Another example of the fusion of SPOT XS (20 m) and KVR-1000 (2 m) images