Open Educational Resources
The Open University of Sri Lanka

Unit 1
Basics of Remote Sensing

Session1
Elements of Remote Sensing

Department of Civil Engineering
The Open University of Sri Lanka

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Session 1- Elements of Remote Sensing

Introduction

Remote sensing is a means of obtaining images suitable for identification of data, with no contact of the objects in question. It is important to obtain data through such means in order to reduce expensive ground verification surveys at the initial stages of projects. Land use patterns can be observed and considerable information gathered by remote sensing. Then it is required to perform ground tracking only to verify the data as a final stage. Remote sensing data required for observing the land can be obtained through airborne systems and through satellite systems. Civil Engineering projects are carried out in undeveloped areas where at times access is difficult. Feasibility studies for the construction of reservoirs, dams, highways and other such facilities require detailed study of the existing land area. Environmental issues and the results of natural disasters need to be studied for prevention and remedial action. Natural habitats need to be observed for the preservation of nature. Agricultural areas need to be observed for growth patterns and impending disasters to the crops. The ocean needs to be monitored for adverse effects. Remote sensing technology is fast becoming the initial source of obtaining information and data both in spatial and temporal form, prior to developing a plan for more detailed ground study. Hence it is important to investigate the means of obtaining digital images of areas on our planet, both on ground and in the oceans, and study the methods analyzing the data on the images. An introduction to the basic elements of remote sensing is given in this session with the aim of creating an interest in the reader regarding this reliable means of obtaining initial data at least cost.

Aim:

- The aim of this session is to give the basic knowledge of remote sensing, to be able to start interpreting satellite images.

1.1 What is Remote Sensing?

It is a method of collecting information about an object without the instrument being used to collect the data, coming in direct contact with the object. Eyesight is a form of remote sensing. When the eye sees an object, the electromagnetic radiation, which is the reflected light, from the surface of the object, gets registered in the eye and information is sent to the brain. When you take a photograph of an object, the electromagnetic radiation is recorded on the film. A scanner in a satellite also records electromagnetic radiation. The picture taken from a satellite is referred to as an 'image'.

1.1.1 What is Earth Observation using Satellite Remote Sensing?

There are many satellites in orbit around the Earth. They have been designed, built and launched to relay images of our planet back to Earth. In fact, Earth observing satellites gather data which have valuable application in areas such as scientific research, industry, environment, engineering, urban planning, agriculture, meteorology, education, business, other areas of people related activities and in policies adopted by governments. The most familiar use we see, is in meteorological information which is used widely by people whose business interests are influenced by changing weather. The construction industry can plan their operations in keeping with the weather pattern.

This is really the Science of Earth Observation from space. The satellites carry instruments, which send back a wide variety of data about the planet and its processes, on land, sea and air.

Remotely sensed information is most widely used in the application of urban planning, agriculture, disaster monitoring, oil spill monitoring etc. Earth observation by remote sensing also gives us a practical way to keep an eye on the inaccessible areas where volcanoes are erupting, ice sheets are breaking up and forests are burning.
What is most important is that with remotely sensed information we can do a better job of managing our scarce resources and try to preserve our environment for the future generations.

When we talk of remote sensing in a scientific sense, it is an attempt to measure the properties of objects present on the Earths' surface, from a distance. It is a means of observing and discovering what is happening on the surface of the Earth or vice versa.

1.2 Introduction to the basic elements in Remote Sensing

There are four essential elements in obtaining remotely sensed information.
They are;

- The **object** to be observed
- The instrument or **sensor** to observe the target
- The form of the '**information**' obtained from remote sensing, and the method of storage
- A **platform** to hold the instrument.

‘Remote sensing’ in a scientific manner, means ‘observing the Earths features’. So, what will the above elements be?

- The **object** will be the Earth.
- The **sensors** are the instruments used to observe the Earth, such as cameras, scanners, radars etc.
- The **platforms** will be the planes and satellites.

We shall proceed to see read a little bit about the ‘object’, the ‘sensors’ and the ‘platforms’. We can read all about the ‘**information**’ contained in an image, in section 1.3.

1.2.1 The Observed Objects

The observed object is the one on which the sensor’s field of view is directed when obtaining an image. In Remote Sensing, the observed object is the Earth.
How does the satellite cover the entire Earth when taking images?
How do we view the various parts of the Earth on images taken from the satellites?
The Earth is a spheroid. There are many different orbits possible around the Earth. If an image of the Earth ‘as a whole’, is needed, it has to be taken from a satellite situated at a suitable distance away from the Earth. The image of the Earth taken in this manner will be in the form of a disk. If images with much detail are required, they need to be taken at a closer range and covering smaller areas. If scientists want to have a picture of a larger part of the Earths’ surface, with much detail, the sensor on board the satellite is programmed to take overlapping images. By creating a mosaic of the images, it is possible to obtain a view of a larger area on the ground and even of the whole planet in detail. A ‘mosaic’ if formed when several images are joined to each other (overlapping each other) to form a bigger image. But you must note that in such a case the amount of data is huge and perhaps excessive to be handled with small computers. Depending on the image required and the satellites orbit, there are these two main types of images, which are possible (of course, this is apart from the many other image types possible, which depend on other factors such as the satellite orbit etc.).

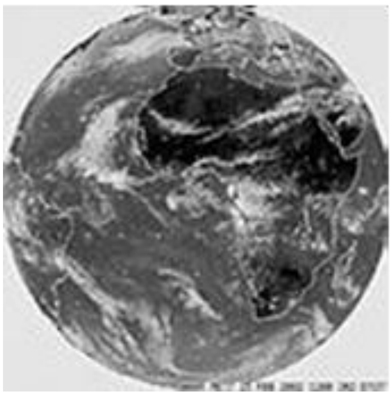

Figure 1.1: An image taken from a satellite at 36,000 km from the Earth. It is possible to see the whole planet as a disc.
(Source: EOLI Catalogue Access - Earth Online – ESA)

How is it possible to see features in more detail, in small parts of the Earths' surface once the image is displayed on a computer screen?
This is done by 'zooming' in to an image. If scientists want to study some phenomena on the Earths' surface, they will 'zoom' in and track a feature rather than the whole region.

1.2.2 The Sensors

A sensor is a device used to acquire a photograph or an image. What a sensor will do is, it will 'sense' and measure the amount of radiated energy reflected from an object and record it (see radiation in session 2). Although the camera is a type of sensor, the word 'sensor' is normally used for the device used to acquire images in remote sensing.
The amount and range of the radiation that the sensor is capable of sensing, is specific to each type of sensor. When it is required to study and monitor some phenomena, first, scientists must decide what type of pictures need to be taken of the area. The sensor used for the purpose will be depend on the type of picture that requires to be taken.

A camera is a sensor used in aerial photography. Black and white aerial photographs are generally made with panchromatic film or infrared-sensitive film.

In satellite remote sensing, the types of sensors used can capture radiation from many parts of the electromagnetic spectrum, which are not visible to the human eye (see session 2 for radiation and electromagnetic spectrum).

Passive sensors and Active sensors

We have been speaking of radiation and measuring it by means of sensors. How does this radiation come about? There is the radiation from the sun, which once it hits the Earths objects, gets reflected and we can measure this quantity. There is also radiation, which is emitted by certain elements. A sensor will record information reflected from Earth surface features. A sensor, which measures wavelengths reflected or emitted by the objects under observation, is called a 'passive sensor'.

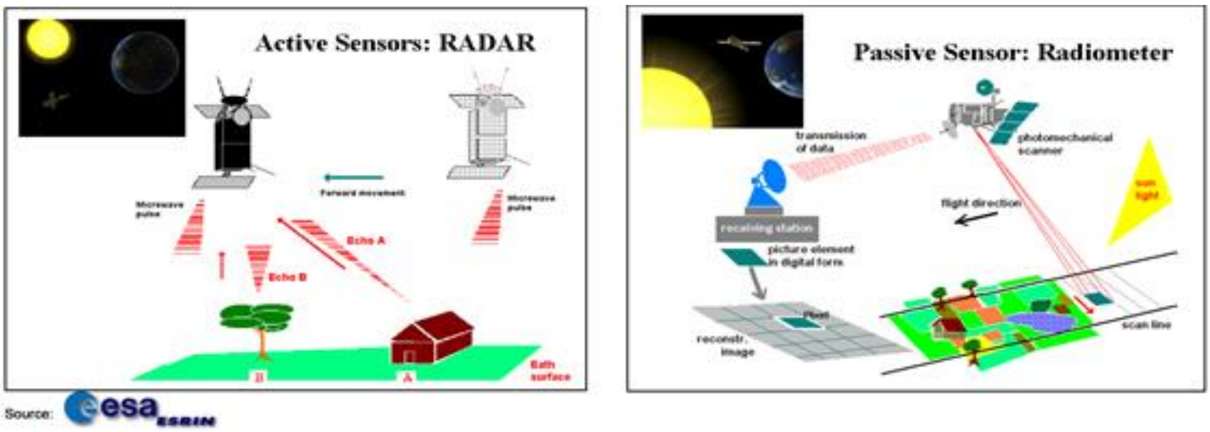

Figure 1.2: The basic principle of active & passive sensors at a glance

(Source:
http://www.esa.int/var/esa/storage/images/esamultimedia/images/2010/02/active_sensors_radar/10183122-2-eng-GB/Active_sensors_radar_large.gif)

Active sensors 'emit' radiation that reflects off objects and only the little energy returned to the sensor is measured. The most common active sensor used in remote sensing is 'radar'.

1.2.3 The Platforms

To get a good overview of the Earths' surface, you need to be at a reasonable distance away from it. Hence you need to leave the Earths' surface. The earliest method of taking off from the surface of the earth was on air balloons and at a later stage on airplane. This afforded an opportunity of taking photographs and images of the Earth, from vertically above. The latest method of obtaining a view of the Earths' surface is from artificial satellites. The platforms are hence aircraft and satellites.

Aircraft

Aircraft equipped with cameras can fly at a low altitude and take photographs with many details. Such detail cannot be obtained from afar. But obtaining this amount of detail of an entire area can be uneconomical. The procedure adopted is as seen in the following diagram. The aircraft must cover the given area strip by strip in a consecutive manner in order not to miss any detail.

You need to plan the 'flight' of the aircraft to obtain the most economic coverage for an area, with images. For surveying aircraft to fly, the weather must be good. Often, it may not be possible to obtain a photograph at the time that it needs to be taken, due to severe weather.

Also, it would be a huge undertaking for an aircraft to survey an entire ocean to spot oil slicks. But, as we shall see below, with a satellite, the task is much easier. The sensor on board a satellite takes regular images of the ocean and someone just needs to look at the satellite images to determine if the ocean is clean.

Satellites
A satellite is a celestial body orbiting around a planet. The moon is a natural satellite moving around the Earth. The first artificial satellite (Sputnik) was launched by the Soviet Union and since then many artificial satellites have been launched mostly for communication but also for observing the Earth and taking images.
Today, satellites are the main platforms used in remote sensing. They carry several types of 'sensors' to study various areas such as, the weather, landscape, natural disasters, vegetation. Some sensors are capable of 'seeing' in the night or through clouds and dry snow or sand.

Once a satellite is launched and has reached its orbit, it may replace aerial photos taken from an airplane. There is no need to plan a flight as in the case of the airplane. The satellite can be programmed to continuously take images at various intervals. Satellite images can cover a much larger area than aerial photographs but in general with less detail. Depending on the application images are required at a certain time interval and in certain ranges of the electromagnetic spectrum, which we shall discuss about in the sessions to follow. One satellite alone cannot cover all the possible Earth Observation tasks.

1.3 Information contained in an image

When you sense an object with your eye, what is the information contained?
It is the exact object as it is real, with its natural colours in the visible range. The rays of visible light will enter your eye and you perceive the object.

If you use a camera to sense an object, what is the information contained?
In this case the camera will act as the eye and you will obtain on the film an exact image of the objects you photograph. A camera can however record in a broader range of radiation than is possible with the eye. The color will be either 'black and white' or 'coloured' depending on the film used for recording the image.

When using a sensor on a satellite, the sensor will record data pertaining to a much wider range of radiation, and what is invisible to the human eye can be identified on a satellite image.

1.3.1 Analogue vs Digital

Sensors will provide information pertaining to all features in an area of interest, in different forms, depending on the sensor. In remote sensing, it is very important to understand the different data provided by sensors to interpret the data. A camera is a sensor, which provides a photograph. A photograph has an analogue format and is usually printed on paper before being interpreted. The sensors on board satellites provide images, which have a digital format. A computer is generally used to display, to manipulate, to analyze and interpret it. However digital images can well be permitted on paper or film.

An analogue format saves all the data **continuously**. For example, when you take a photograph of your house, which will be in analogue format, all the information is continuously spread over the photograph. There is an underlying photochemical process to store the information of the scene as a photograph.

But the digital format saves each element of information **discretely**. This effect can be compared to the eye of an insect, which is in effect the same as the human eye. The scene is split into many picture points building up the image. If you zoom far enough in to a satellite image, you will see lots of squares of different color. If you zoom too far you will see only the squares. Hence, we can see that the image is not continuous but is formed by a matrix of squares, which are called pixels or picture elements.

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Figure 1.3: zoomed image

(Source:http://www.esa.int/var/esa/storage/images/esa_multimedia/images/2017/05/amsterdam_netherlands/16924334-1-eng-GB/Amsterdam_Netherlands_node_full_image_2.jpg)

1.3.2 The digital format

The binary system

The digital format is based on a mathematical procedure called the '**binary system**'. This enables computers to register data, calculate and save data, and to display an image. Thus, the image will consist of a set of data.

The computer can understand only 'electric pulses'. There is a pulse or no pulse, where a pulse could be; which can be 'yes' or 'no' or in the form 1 or 0.

There is no decimal system in computers. Computer memory comprises small elements that may only be in two states off/on that are associated with digits 0 and 1. There are just zeros and ones, put into series with 0 when there is no electric pulse, and 1 when there is one. In other words, 1 indicates high voltage and 0 indicates low voltage. What the computer does is to manipulate numbers that have been converted to the binary system and are represented by voltages. Computers are based on the binary system, which means that only two digits 0 and 1 may appear in the representation of any number. Such an element is said to represent one bit or binary digit.

Most information is stored in eight-bit words or bytes.

So, in computer language we have;

0 = 00000000	**4 = 00000100**	**8 = 00001000**
1 = 00000001	**5 = 00000101**	**9 = 00001001**
2 = 00000010	**6 = 00000110**	**10 = 00001010**
3 = 00000011	**7 = 00000111**	**100 = 01100100**
		255 = 11111111

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Let us see how we obtain the number 255 in the decimal and the binary system.

The decimal system uses the powers of 10 to represent numbers.

(255)10 = 2 * 102 + 5 * 101 + 5* 100

The binary system uses the powers of 2 in a comparable manner.

(255)10 = 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1

(255)10 = 1 * 27 + 1* 26 + 1* 25 + 1 * 24 + 1 * 23 1 * 22 + 1 * 21 + 1 * 20

= (11111111) 2

Use of algorithms in transformations

The computer performs the conversion from decimal to binary using an appropriate algorithm. An algorithm is a programmable mathematical function, which is used whenever you need to transform a digital number of a pixel to another representative number.

Note about the binary system

0 or 1 representation (also called 'digit') is called a 'bit' or an electric pulse.

A group of 8 bits is called a 'byte' (A byte contains values ranging from 0 to 255. Hence there are 256 possible values)

A file or data set can contain many bytes.

1 Kb is equal to 1000 bytes

1 Mb is equal to 1* 106 bytes

1 Gb is equal to 1* 109 bytes

1 Terabyte is equal to 1* 1012 bytes.

1.3.3 The pixel

A given data set or image, can be represented by a vast number of pixels. A pixel is the smallest unit on a satellite image. A pixel is generally equivalent to one word or byte (sometimes to 2 bytes).

When the pixels are displayed in the correct order a meaningful image is created. The intensity of radiation is reflected by the value of the pixel. This value is referred to as the Digital Number (DN).

Let us consider a green plant with the sensor made to detect green the intensity will be very high. If we use the same sensor to observe a red object, the intensity will be very low.

The value of the pixel varies from 0 to 255 displayed on a screen as gray levels ranging from black (0) to white (255).

There are 256 possibilities, all contained in 1 byte.

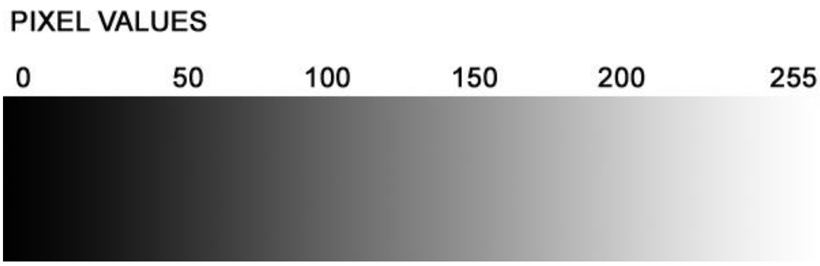

Figure 1.4: The range of pixel values depicted in a black and white image

Let us read on to find out more about these intensity values.

Coding and pixel values

Black and white digital images will provide information on the intensity of visible light only. To understand how the pixels, represent the respective digital values, let us consider an example of a black and white digital image where each pixel has, for the purpose of explanation, a conventional value of 1 or 10. The data may be represented as a grid of values, but if we assign an intensity of grey to the numerical values such as 1 = black and 10 = white, the grid numbers will turn into a picture with just two levels of gray.

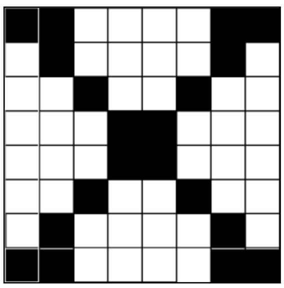

Figure 1.5: Figure represented by just two different digital values, 1 for black and 10 for white.

Figure 1.6: Figure with 256 levels of grey

(Source: http://www.tonmeistes.ca/seening dither/bit8 quant.png)

Let us see what the computer does with a black and white digital image. A computer can display 256 levels of gray! The above picture for instance, might contain anything up to 256 levels of grey.

Computers are designed for processing digital data coded in 8-bit groups or bytes. These bytes can take on values ranging 0 to 255. That is why digital images are often coded in 256 levels of brightness, going from black (0) to white (255). Each tone of gray will an intermediate value. A 'middle grey' will thus have a value of 127.
So, a computer can identify 256 levels of grey!

Actually, the human eye cannot pick out more than a few different shades of grey. Hence there will be no discontinuity in an image that has been coded using 256 levels of grey. As we said earlier, a given image can be represented by a different number of pixels. An image containing 2300×1760 pixels will be clearer than the same image with 320×240. That is, when we increase the number of pixels composing an image, we reduce the size of each pixel. This will increase the spatial resolution of the image. The image resolution of a digital image is given by pixels per inch. A quality image displayed on a computer screen has a resolution of about 75 pips or 3 pixels per millimeter. A gray scale digital image could be produced by having a very large number of radiometers, projecting a scene on a photo array as it is done in a digital camera.

1.3.4 Colors

We have seen that raw pixel values are grayscale. i.e. between 0-255.

Then how are colorful images obtained through processing?

Let us see how Post-Processed (finished) color satellite images are produced.
The raw pixel values are only greyscale, with the digital numbers 0 to 255 corresponding to levels of grey. Resulting images are black and white. They are called 'panchromatic' and the pixel digital numbers are the same for each band in the visible part of the electromagnetic spectrum.

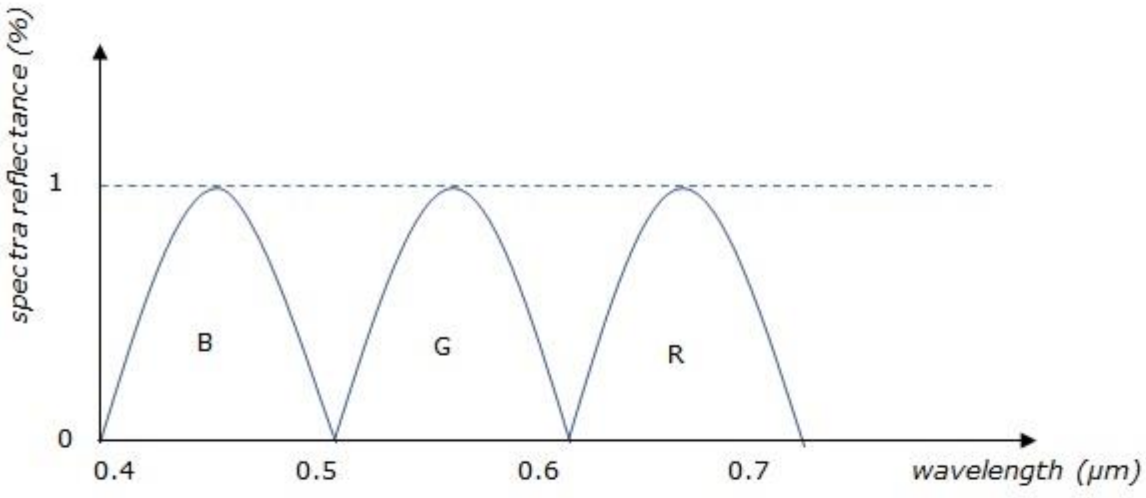

Figure 1.7: Graph of RGB wavelength vs spectral intensity (spectra reflectance) for black and white output

How will the intensity of radiation reflected by the object, be specified by value?
To produce color images, you must allow for spectral separation (see under electromagnetic spectrum in session 2) of the object's reflected light. In other word, the reflected part of the incident energy on a surface feature will decide the color of the feature. Each color is associated with a specific frequency and hence a specific wavelength. So, the color 'blue' has a shorter wavelength than the color 'red'.
It is convenient to obtain any color in the visible spectrum by combining the primary colors red, green and blue (RGB primary colors), in various proportions.

So now, how can we produce a color digital image?
A color digital image will be created by acquiring data of an object in separate parts of the electromagnetic spectrum, corresponding to the colors red, green and blue (red-green-blue glasses).

What you must do is, to create three digital images corresponding to red, green and blue. When these are laid over each other, on a computer screen, to the nearest pixel, they make it possible to create a color image. If each of the primary images is coded using a 256-level scale, it is then possible to obtain 16 million different colors!


How does this take place?

When you consider any pixel on the three separate images, the red, green and blue tones can be so adjusted to obtain a color in between. This is how the system works on all the pixels in the image and a complete color image with 16 million possibilities is the result.

So, in remote sensing what we do is, we use a unique instrument with three sensors to take three images, in three different bands (i.e. three different wavelengths ranges). These are then combined or put together to create a colorful image. To produce a color image on the screen, red, green or blue sensed images, must be attributed to the corresponding color guns in the computer screen.

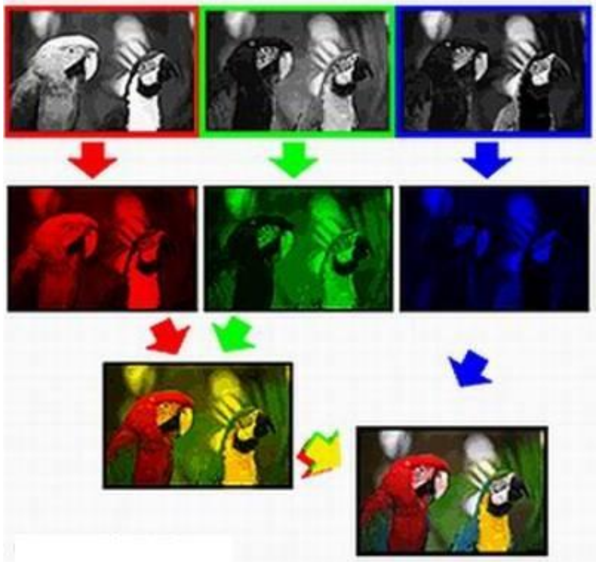

Figure 1.8: Combination of colors

(Source: https://www.esa.int/images/pappegai_large,0.jpg)

red + green = yellow

yellow + blue = natural color image

1.3.5 True or Natural color image and False color image

A true/natural color image is obtained when the red color is attributed to the red band (sensing is in the visible red of the electromagnetic spectrum), the green color is attributed to the green band (sensing in the visible green of the spectrum), and the blue color is attributed to the blue band (sensing in the blue of the spectrum). Read about the electromagnetic spectrum and spectral bands in session 2. In a natural color composite, the blue sensitive data will appear as blue, green sensitive data as green, and the red sensitive data as red. A false color composite is obtained when in general bands other than visible bands are used.

For example, the red color on the screen is attributed to the near-infrared band, green color is attributed to the red band, and the blue color is attributed to the green band. In the given example of color combinations, the blue band will not be used, the green band will appear as blue, red band as green and near infrared as red. This combination is ideal for vegetation mapping as you will see later.

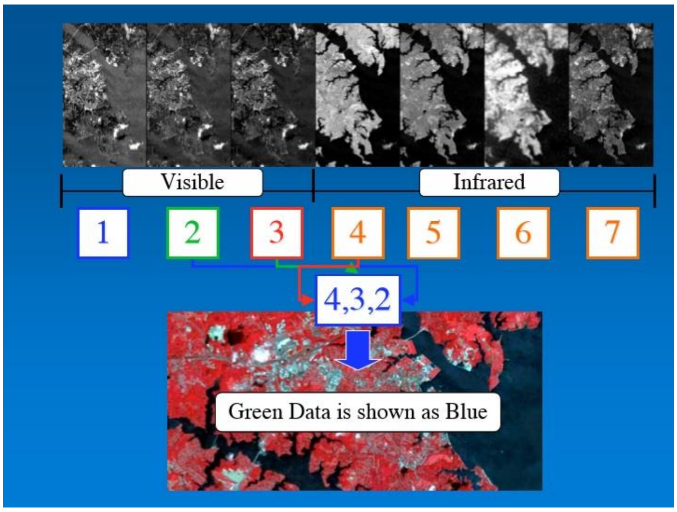

Figure 1.9: A false colour composite

(Source: https://landsat.gsfc.nasa.gov/wp-content/uploads/2012/12/How2make.pdf)

You will learn about these color combinations in detail under 'color mixing processes' in the sub section 'Color Film'.

1.3.6 Spatial Resolution

The spatial resolution or ground resolution of an image is the smallest size of a feature that the sensor can identify. Consider a satellite image with an 80 m by 80 m car park on it. If the ground resolution, i.e. the size of a pixel with respect to the image area, is 80 m, then the entire park can possibly be covered by just one whole pixel. This is of course to give you an idea of the concept of ground resolution. But what is more likely is that the park will be covered by parts of two or more pixels. The form of the car park cannot be assessed.

What happens if the resolution is, say 20m?

If the sensor can identify a smallest distance of 20m, each pixel on the image will depict a distance of 20m and such an image will indicate the picture more clearly. It will be possible to cover the car park entirely with 16 whole pixels and hence show its form (but of course, it is more likely to be covered by parts of a greater number of pixels).
If the ground resolution is 1m, then each pixel will show a distance of 1m on the image and the car park is well outlined and one can also count the number of cars! Hence it is clear, that a set of digital data, covering a relatively large area in low resolution, will be much smaller than a set covering the same area in high resolution.

1.4 Applications of image interpretation

Satellites can have different applications depending on their capabilities. The range of electromagnetic waves that can be detected and recorded by the sensors on board the satellites, will determine the capability. By using the appropriate sensor instruments we can use satellite imagery in many applications. Given below are some of them.

Activity 1.1

Try to think of some instances, where remote sensing information can be used in civil engineering and related areas.

- **Dam and reservoir construction –** An environmental impact assessment. Satellite and other information can be used within a land information system, to assess the impact of the construction of a dam and the resulting reservoir on the local population, especially in respect to the loss of agricultural land.

- **Revising maps -** High resolution satellite imagery can be used to update maps.

- **Siting studies for small hydro-electric power stations -** The potential for generating hydro-electric power can be assessed using Digital Elevation Models and land cover classification information derived from satellites. The resulting maps can indicate the most favorable site for the station.

- **Rapid landslide hazard mapping -** Satellite data can be used to assist in the prediction of landslides. Information can be used for contingency planning to mitigate against the effects of landslides on the local population and the infrastructure in areas of risk.

- **Coast monitoring coastal sediment transport -** Techniques are being developed to support a coastal monitoring service, which will provide maps on suspended sediment transport and water quality on a frequent and regular basis.

- **Offshore vessel traffic monitoring system -** An information service can be developed using satellite derived data to provide the location, heading, speed, length, width and type of vessels using a stretch of water close to a country.

- **Surveying mining related subsidence** - Innovative contour maps can be generated using Synthetic Aperture Radar Interferometry. The technique can detect change, in this case subsidence, of only a few centimeters over a short period of time and continue the process on a regular basis.

- **Pipeline mapping** - New high-resolution satellite images can help to map and monitor gas carrying pipelines. Not only is this more cost effective and quicker than walking or flying the lines, but it is also safer than low level maneuvers in helicopters.

- **SAR interferometry for monitoring earthquakes** - Interferometry measurements from ERS SAR data are used to assess the potential of damage caused by an earthquake. GIS is used to incorporate various data sources and so enable the information to be delivered to decision makers in a clear and easily understandable form.

- **Keeping an eye on the weather** - Being able to predict the weather can help to minimize risks and optimize construction planning.

- **Monitoring oil spills in the seas** - The location and movement of both illegal and accidental pollution events can be identified and monitored within two hours of a satellite overpass of the area. This means that remedial action can be initiated very rapidly.

- **Wild life habitat monitoring and evaluation** - Remote sensing techniques can be used to protect bio-diversity and maintain natural habitats at favorable conservation status.

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- **Energy conservation** - Heat loss to the atmosphere results in substantial amounts of wasted energy. Using airborne thermal imaging systems, it is now possible to pinpoint individual buildings losing heat through lack of insulation.

- **Temperate forest monitoring** - SPOT, Landsat TM and ERS SAR data can be used for temperate forest mapping, so providing information for monitoring forest area change.

- **Bathymetric surveying** - An innovative method has been developed using radar satellite images, hydro-dynamic models and in-situ depth measurements to survey a bottom depth chart. The SAR imagery is used to map the bottom topography of shallow seas (up to 30m depth).

- **Monitoring large river flooding** - Using EO data, planners can identify high flood risk areas and reduce flood damage.

- **A procedure for creating a database of land cover** - Satellite data and traditional field survey data can be integrated for creating such a database, and can be updated to integrate vector and ancillary data, including statistics, web cam-links etc.

- **Estimating and monitoring atmospheric emissions** - Software has been developed that incorporates satellite data in a system that can estimate natural and polluting emissions.

- **Climate research** - Key inputs to Global Climatic modelling are contributing to the scientific understanding of Global Climate Change.

- **Modelling air quality** - The potential spread of pollutant emissions can be modelled, to assess the impact of new plant, to predict events or to assess their causes.

- **Boundary changes and Land classification using aerial photography** - The level of accuracy obtained from aerial photography or latest technology satellites, with a 0.5 m pixel resolution makes it an ideal data source for surveyors and planners. It also provides a view of what future satellite data may look like where the resolutions will be even better.

- **Updating urban maps** - This project looks at the potential for using high resolution data to update a cartographic vector database used for car navigation systems.

- **Defining urban areas – Future high-resolution systems** - Simulated SPOT 5 imagery can be compared with current SPOT 3 data to quantify and qualify any improved accuracy in land use classification and delineation of urban morphological zones.

Note – Any abbreviations used, for satellites etc. That you cannot understand will be discussed in the sessions to follow.

List of Abbreviations used in 1.4

SAR – Synthetic Aperture Radar
ERS – European Remote Sensing Satellites
GIS – Geographical Information Systems
SPOT – System Pour observation de la Terre (A series of satellites launched by France)
Landsat TM – Landsat Thematic Mapper (An American satellite equipped with a special sensor).

Review Questions

Please try to answer the questions below.

1. What are the reasons for considering the science of Earth Observation as being very important for us?
2. Explain what the four important elements for applying remote sensing are, with regard to taking photographs of your house. Can you think of another example combining these four important elements?
3. What are the two main types of images, which could be taken by satellites, as explained in this session?
4. Explain what ‘active’ and ‘passive’ sensors are.
5. What are the ‘platforms’ used in remote sensing? What is the advantage of using these platforms, over airplanes?
6. Explain, giving reasons, two instances where it would be preferable to use a satellite rather than a plane to observe phenomena on the Earth.
7. Explain the difference between the analogue and digital format for obtaining data, giving their advantages and limitations.

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8. What is meant by the resolution of an image? What is the ground resolution?
9. Can you explain how images are combined to obtain a color image?
10. Can you identify the areas where remote sensing could be used in regard to the kind of work handled by your work organization?

Summary

The use of satellite imagery for earth observation, the means of obtaining data and the basics of the image content have been discussed in this session.

Learning Outcomes

At the end of this session you will be able to briefly explain:

- how satellite remote sensing is used for Earth Observation
- the essential elements in remote sensing, that is, the sensor used for sensing and recording the information about the object, the object under observation, the platform used for supporting the instrument
- about some of the information contained in images, such as, the format in which the data is recorded, Analogue vs Digital, briefly about the digital format
- the pixel and the 'resolution of an image' and 'ground resolution', briefly on color
- the difference between a natural color image and a false color image.

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