GLG4207: Photogeology & Remote Sensing

Lecture Presentation by:
I.M. Abdullahi
Department of Geology,
Faculty of Earths and Environmental Sciences,
Bayero University, Kano.

Spatial data acquisition

- All human beings, one way or another, deal with georeferenced data.
- They might be involved in the collection of data, processing of data, analysis of the data or actually using the data for decision making.
- In the end, data are acquired to yield information for management purposes: water management, land management, resources management, etc.
- By *data* we mean representations that can be operated upon by a computer;
- by *information* we mean data that has been interpreted by human beings.

The data need for spatial data is best illustrated by some examples

- An agronomist is interested in forecasting the overall agricultural production of a large area. This requires data on the area planted with different crops and data on biomass production to estimate the yield.
- An urban planner needs to identify areas in which dwellings have been built illegally. The different type of houses and their configuration needs to be determined. The information should be in a format that enables integration with other socio-economic information.
- An engineer is needs to determine the optimal configuration for sitting of relay station for Telecommunication Company. The optimal configuration primarily depends on the form of the terrain and on the location of obstacles such as buildings.

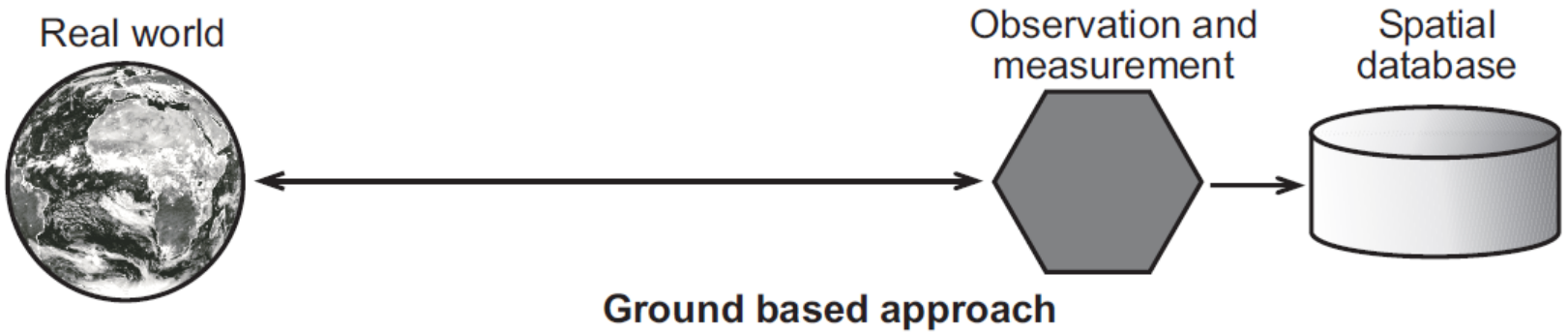
- A mining engineer is asked to explore an area and to provide a map of surface mineralogy. In addition he/she should start to give a first estimation of the effect of water pumping on the neighboring agricultural region.
- A climatologist would like to understand the causes of El Nino phenomenon. For, he/she would need data on many parameters including sea currents, sea surface temperature, sea level, meteorological parameters, energy interactions between the land and water surface, etc.

- Note that all of the above examples deal with spatial phenomena; in fact, with *spatio-temporal phenomena* since time is an important dimension too.
- To satisfy the information requirements of the above mentioned examples a wide variety of methods will be used: conducting interviews, land surveying, laboratory measurements of samples, interpretation of satellites images, measurements by *in situ* sensors, using aerial photographs, running numerical models, etc.
- For our purposes, it makes sense to distinguish between ground-based and remote sensing methods.

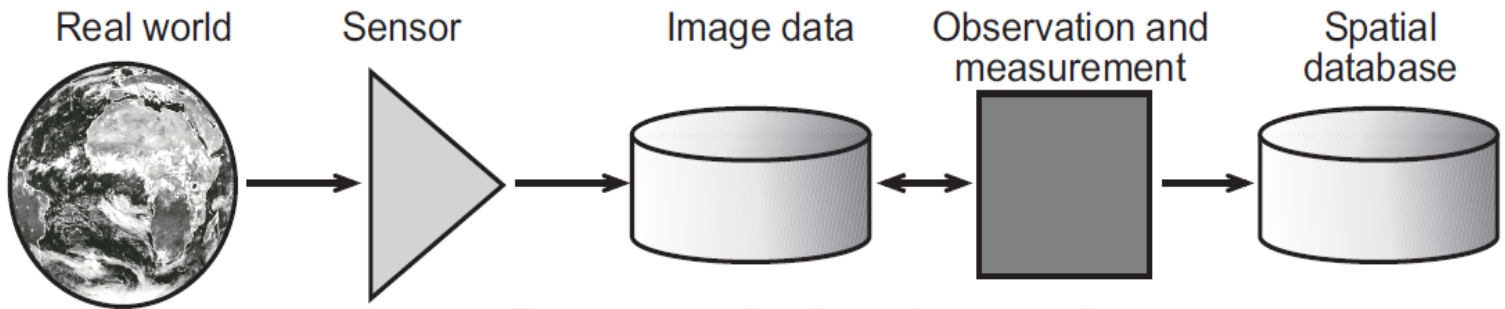
Ground-Based and Remote Sensing Methods

In principle, there are two main categories of spatial data acquisition:

- ***Ground-based methods*** – such as making field observations, taking *in situ* measurements and performing land surveying. Using ground-based methods, you operate in the real world environment.



- ***Remote sensing methods*** – which are based on the use of image data acquired by a sensor such as aerial cameras, scanners or radar. Taking a remote sensing approach means that information is derived from the image data, which form a (limited) representation of the real world.

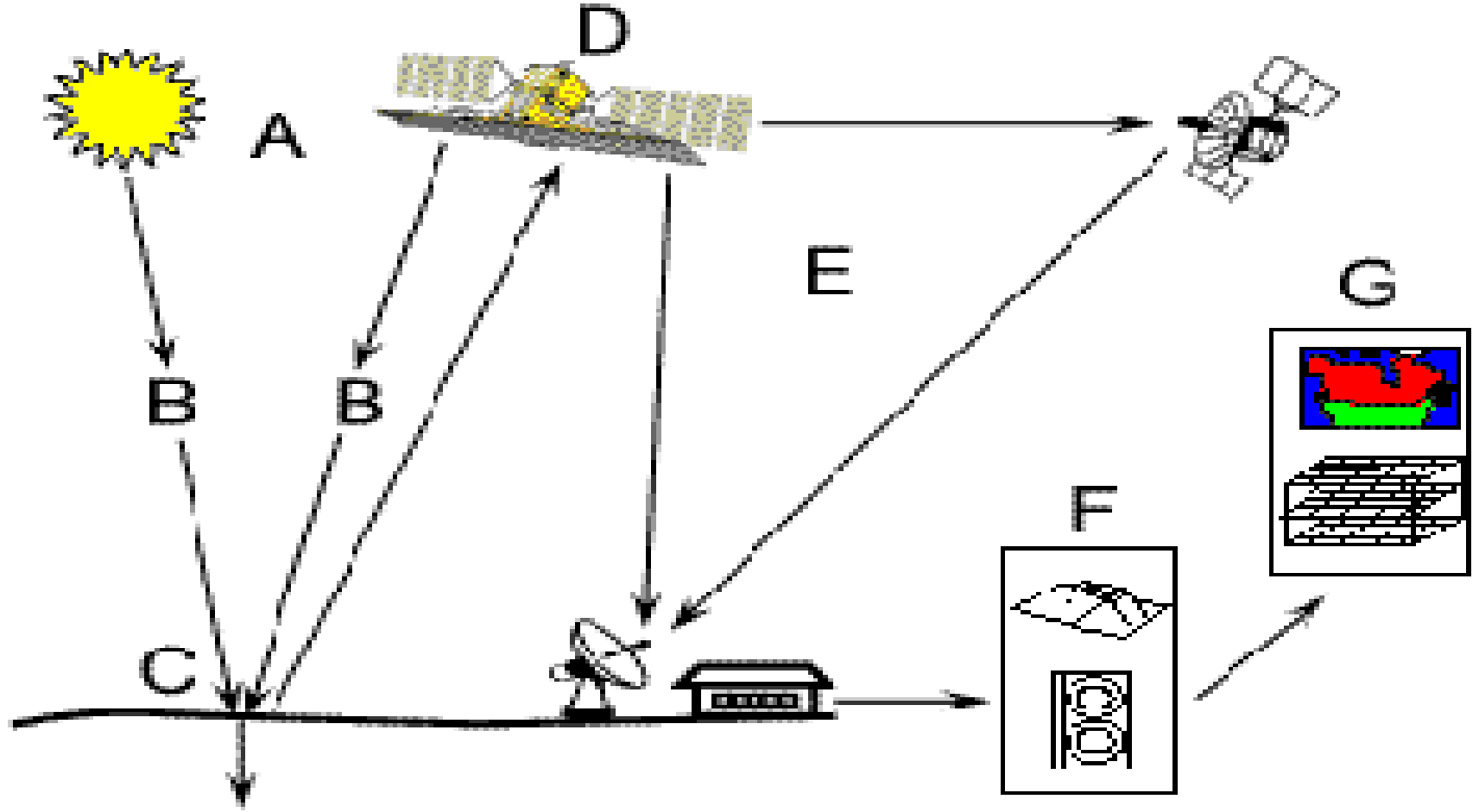


Remote sensing based approach

- **What is Remote Sensing?**

  "Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.“
- In much of remote sensing, **the process** involves an interaction between incident radiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved.
- Note, however that remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors.

Components of remote sensing



Components of remote sensing

- **1. Energy Source or Illumination (A)** – the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

- **2. Radiation and the Atmosphere (B)** – as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

- **3. Interaction with the Target (C)** - once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.

- **4. Recording of Energy by the Sensor (D)** - after the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.

Components of remote sensing

- **5. Transmission, Reception, and Processing (E)** - the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).

- **6. Interpretation and Analysis (F)** - the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.

- **7. Application (G)** - the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.
- These seven elements comprise the remote sensing process from beginning to end.

Passive and Active Remote Sensing Systems

- *Passive* remote sensing systems record electromagnetic energy that was reflected (e.g., blue, green, red, and near-infrared light) or emitted (e.g., thermal infrared energy) from the surface of the Earth. There are also active remote sensing systems that are not dependent on the Sun's electromagnetic energy or the thermal properties of the Earth.
- *Active* remote sensors create their own electromagnetic energy that

(1) is transmitted from the sensor toward the terrain
(2) is largely unaffected by the atmosphere),
(3) interacts with the terrain producing a backscatter of energy, and
(4) is recorded by the remote sensor's receiver.

Active Remote Sensing Systems

- The most widely used *active* remote sensing systems include:
- • *active microwave (RADAR),* which is based on the transmission of long-wavelength microwaves (e.g., 3 – 25 cm) through the atmosphere and then recording the amount of energy back-scattered from the terrain;
- • *LIDAR*, which is based on the transmission of relatively short-wavelength laser light (e.g., 0.90 μm) and then recording the amount of light back-scattered from the terrain; and
- • *SONAR*, which is based on the transmission of sound waves through a water column and then recording the amount of energy back-scattered from the bottom or from objects within the water column.
- • *SODAR*, which is based on the transmission of sound waves through air (atmosphere) and then recording the amount of energy back-scattered from atmospheric layers (typically within 1km).