**2.2** **Fundamentals of Remote Sensing**

**Reading material**

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| In the first session, you will get familiar to the fundamentals of remote sensing and the definitions of key concepts. After that you’ll be presented with two types of remote sensing: active and passive. |
| **Remote sensing** is the art, science, and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representation of energy patterns derived from noncontact sensor systems (adopted by the ASPRS in 1988; in Colwell, 1997).   * A remote sensing instrument collects information about an object or phenomenon within the instantaneous field- of-view (IFOV) * The remote sensing instrument may be located just a few meters above the ground and/or onboard an aircraft or satellite platform |
| In remote sensing, many different instruments that detect and record electromagnetic radiation (EM)exist. Those instruments are called **sensors**. Sensors differ one from another in terms of their sensitivity to radiation at different wavelengths but also in terms of how they register electromagnetic radiation. Two main categories of Earth Observation systems can be differentiated – **passive and active**.    Source: John R. Jensen (2014): Remote Sensing of the Environment: An Earth Resource Perspective |
| **Passive Remote Sensing**  Sensors that use external sources of electromagnetic radiation to “observe” an object, so usually rely on the Sun but also the Earth or atmosphere radiation are called passive sensors.  Passive sensors record electromagnetic energy that is reflected (e.g., blue, green, red, and infrared light) or emitted (e.g., thermal infrared radiation) from the surface of the Earth.  What is important to remember is that this kind of Earth Observation will not work at night when no reflected energy coming from the Sun. Only energy that is naturally emitted (for example thermal infrared) can be detected both at night and during the day, only if the amount of energy to register is large enough to be recorded. So, briefly speaking the passive sensors can detect naturally occurring radiation only. |
| Passive Earth Observation employs multispectral or hyperspectral sensors. They can measure the acquired quantity of radiation with multiple band combinations. These band combinations differ by the number of channels, they consist of more than two wavelengths. These bands register spectra which are not visible bands only, but also the ones beyond human vision (IR, NIR, TIR, microwave).    Credits: NASA Applied Sciences Remote Sensing Training Program. Remote Sensors | Earthdata (nasa.gov) |
| **Active Remote Sensing**  On the other hand, active remote sensing is based on the sensor’s own energy of light (illumination). The sensor itself emits radiation which is directed toward the target and then reflected back to the sensor to be recorded. So, this type of sensing and observing the Earth does not require the sunlight to measure and detect the radiation. Lidar and radar technologies are example of active sensors.    Credits: NASA Applied Sciences Remote Sensing Training Program. Remote Sensors | Earthdata (nasa.gov) |
| Active or Passive Remote Sensing - what does it mean?  To get a grasp on how satellite data collection works, watch this video  What is Active and Passive Remote Sensing? - YouTube (time duration 2:51)  <https://www.youtube.com/watch?v=vzfGMMEEz5w> |
| **Remote sensing process**  On the image below, you can see the process of remote sensing. Below you will find the explanation of what the different points correspond to.    Source of picture: Canada Centre for Remote Sensing (CCRS)   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. In case of passive satellites that is the Sun, in case of a actives satellites that is the satellites itself. 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. 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. |

**Exercise materials and tasks**

**Quiz questions**

Instructions: As a recap and deepening of this session’s content, we have prepared the following quiz Have fun!

1. Which satellites are daytime dependent?

1. Active satellites
2. **Passive satellites**

2. When considering our eyes to be remote sensors, which of the following statements are false?

1. Our eyes detect radiation from the sun
2. Our eyes detect energy in the form of visible light from the sun allowing us to see
3. **Light energy occupies a wide portion of the electromagnetic spectrum**
4. Other types of light energy are invisible to our eyes

3. Which of the following satellites are active satellites?

1. **LiDAR**
2. **Radar**
3. Optical