

## Slide 1 – Title Slide

Hello and welcome to the final part of EGM310: Terrestrial Remote Sensing. In this part of the module, we'll cover the fundamentals of terrestrial remote sensing and how we can apply remote sensing techniques to complement or enrich our research.

## Slide 2 – Week 1 Introduction

To make things a bit easier to digest this semester, I've broken the lecture this week into five smaller pieces, each of which has its own video and slides. The theme for this week is "Fundamentals of Remote Sensing." In this first video, we'll cover what "terrestrial" remote sensing is and why we're learning about it. Just as a note, I will most likely drop the "terrestrial" portion of the name, and just use "remote sensing" as a shorthand. In the next videos, we'll cover the basics of electromagnetic radiation, how it interacts with both the Earth's atmosphere and objects on the Earth's surface, and finally we'll cover the spectral properties of objects.

For each of these "mini" lectures, I've also included some links to additional resources, including youtube videos that cover some of the different topics, as well as the chapters in a few textbooks that cover the same material. If you download the lecture slides from blackboard, you should be able to get the links to the different videos or websites, but I've also included these links in the description below each of the videos.

With that out of the way, let's get started with the first topic – what is (terrestrial) remote sensing, and why are we studying it?

## Slide 3 – Acquiring data

To begin with, think about some of the ways that we acquire data or information about the topics that we study. We might work in a laboratory, conducting experiments or analyzing data; we might go out and conduct surveys, interviewing people to learn about different aspects of our topic; or, we might go out and conduct field work, taking measurements and acquiring data.

## Slide 4 – Acquiring data

Each of these different methods give us detailed, accurate, fine-grained information. They allow us to study small-scale processes, but they can be very difficult to scale from the small scale to the regional or global scales. For example, measurements we make in one river catchment, or one lake, don't necessarily tell us anything about another river catchment just a few kilometers away.

In addition, field work can be dangerous, difficult, or expensive – and if we want to make the same measurements in another area, we might have to buy duplicate equipment, we need to make multiple trips to service equipment, and so on. Sometimes, **cough cough**, travel isn't feasible or even possible.

So, if we can't travel to the thing we're studying, how can we study it?

## **Slide 5 – What is remote sensing?**

On this slide, I've put a few different textbook definitions of remote sensing, and I've highlighted some of the important words. You can see from the different definitions that the basic meaning of remote sensing is, as the name might suggest: studying something without having to touch it or travel to it directly.

## **Slide 6 – What is remote sensing?**

Are we new to remote sensing? Not at all! In a sense, this is something we've all been doing for years. Aside from touch or taste, our other senses all involve collecting information about the world without directly touching it directly.

## **Slide 7 – Advantages of remote sensing**

Remote sensing gives us a unique perspective of the Earth and environment. Rather than seeing things at ground level, remote sensing gives us an overhead, "bird's-eye" perspective. This can enable us to see patterns or relationships that aren't immediately clear at ground level. It also allows us to observe or study areas that are too dangerous or difficult to travel to – for example, we can use remote sensing to study active, erupting volcanoes, study hurricanes and other storms and their impacts; or map wildfires on a global scale.

With multiple images, we can analyze changes over time, mapping large areas quickly and cheaply. Finally, remote sensing allows us to map the Earth system on a global scale.

## **Slide 8 – Example – glacier mapping**

As a first example, let's say we want to map the extent of Vatnajökull, the second-largest glacier in Europe by area. Now, we could take a GPS, throw it in a backpack, and walk around the perimeter. If we're feeling a bit lazy, we could try driving instead. Of course, this is a huge distance we'd have to walk, and it's not easy ground to cover. There are large rivers to cross, and it's steep, rocky terrain in areas. It would probably take several days to cover the whole thing – and what happens when we want to map the whole thing again later? To say nothing of the other glaciers on Iceland, some of which you can see in this image here. From this direct method, we also can't make any measurements back in time.

The good news is, we can map the glacier extent of Vatnajökull and other glaciers in a few hours (or faster) using satellite images. With some of the datasets we'll talk about in this part of the module, we can even map the glacier extents back to the early 1970s from satellite images.

## **Slide 9 – Example – Archaeology**

Another example of the power of remote sensing is from Archaeology. As you might imagine, mapping the full extent of ancient monuments or cities can be difficult, painstaking work if it's done in the field.

This is especially true in tropical regions, such as the example shown here – over hundreds or thousands of years, forests can cover over human activity. In this satellite image, we can clearly see some modern developments – roads, a canal, some agricultural fields, but it’s hard to see much of anything else.

Using a technique called LiDAR – more on that later – scientists have recently discovered the ruins of a number of large monuments and cities in the rainforests of Central America. This example, a site called Aguada Fénix in southern Mexico, was built between 1000 and 800 BC, and abandoned around 750 BC. The main plateau here is ~1400 m long and 10-15 m high – think about how much work it would be to excavate and study this site without the benefit of remote sensing. In week 12, we’ll look at a number of different studies that apply remote sensing techniques to a wide array of topics.

## **Slide 10 – Remote Sensing**

So remote sensing is any way of capturing information at a distance. It lets us quickly and easily monitor changes at large scales, including across the globe. The sensors that we use for remote sensing can be almost anything: cameras, laser scanners, radar, other instrumentation – anything that lets us acquire data from a distance. In this module, we’ll mostly focus on imaging from optical or visible + infrared sensors, although we’ll touch on some of the other examples.

## **Slide 11 – The remote sensing process/system**

Remote sensing depends on a number of things, all of which make up a part of the “process” or “system” of remote sensing. These include a radiation source – often the sun, but it can also be the sensor itself; the sensor, the Earth’s atmosphere, the properties of features or surfaces on the ground, as well as the different interactions between these things. The system also includes the transfer and storage of the data, as well as the actual analysis of the data.

## **Slide 12 – Additional resources**

In two of the textbooks recommended for this course – Lillesand, Kiefer & Chipman and Campbell & Wynne, more information about remote sensing and the remote sensing process is in Chapter 1. There’s also a link here to the Remote Sensing Tutorials provided by Natural Resources Canada, which have some good introductory information and quiz questions you can use as you study. Finally, there are two different youtube videos, from ClimaByte and CIRES, which try to answer the question “what is remote sensing?” That’s all for this lesson – I hope you found it interesting, and if you have any questions, please don’t hesitate to e-mail me or post in the discussion forum on blackboard. Bye!