Lecture 1 – Introduction to Remote Sensing

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Bldg Purple 12.2.27
Lecture Outline

• Introductions
• Unit admin
  – Learning outcomes
  – Unit outline
  – Practicals
  – Assessment
  – Learnline
• The what, why, and how of remote sensing
• Common applications
• History of remote sensing
Learning Outcomes

1. Explain the interaction of electromagnetic radiation with atmospheric, oceanic, and terrestrial features;

2. Identify a range of commercial airborne and satellite imaging sensor systems;

3. Critically examine the trade offs between spatial, spectral, radiometric and temporal resolution of remotely sensed data;

4. Apply the underlying principals of interpreting image data;

5. Perform basic operations associated with digital image processing; and

6. Evaluate applications of remotely sensed data for monitoring and managing marine and terrestrial resources.
Unit Outline

• Introduction to remote sensing
• Understanding electromagnetic radiation interactions
• Radiation transfer theory
• Image characteristics and dimensions

• Aerial photography and image analysis
• Digital image processing (3 weeks)

• Applications and operational projects
• Effective ways to communicate information from remotely sensed products

• Unit summary
Resources


• Remote Sensing Computer Aided Learning

• Remote Sensing Virtual Lab
Practicals

- All held in Purple 12.1.17
- Designed to expand on lecture materials and provide ‘hands on’ learning
- Software in use will be ENVI
- All practicals are assessed

- After hours swipe access to 12.1.28
Assessment

• All assessment items are compulsory
• Due by 11.59pm on the given date
• To be submitted via Learnline
  – No cover letter required
• Advise lecturer well in advance if you are having difficulties
• Penalty of 5% per day for late submissions
Assessment Items

• Practical exercises
  – 8 practical exercises
  – 3 assessment items
  – Short / paragraph answers
  – 20% ea

• Application project
  – Select an environmental problem of interest and design a remote sensing mapping and monitoring solution
  – 3000 words for ENV202, 5000 words for ENV502
  – Grading criteria different for ENV202 and ENV502
  – 40%
Related Units

- ENV101 – Earth Systems
- ENV203 – Environmental survey and monitoring skills
- ENV208/508 – Applied Geographic Information Systems
- ENV318/518 – Advanced Spatial Analysis
- ENV306/506 – Environmental monitoring and modelling
- SID300 – Professional practice in applied science
- SID301 – Research Project
Learnline Demo
What is Remote Sensing?

• The science and art of obtaining information about an object, area, or phenomenon, without being in direct contact with the feature under investigation…
Your Job…

• Make a list of the benefits of remote sensing
• Brainstorm a range of different possible applications and link them to the different benefits. For example:

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large area coverage</td>
<td>Continental scale vegetation mapping for Kyoto protocol compliance</td>
</tr>
</tbody>
</table>
Weather Forecasting
Sea Surface Temperature

NOAA12 SST 13 Dec 2002 0630Z–0619Z
Copyright 2002, CSIRO Marine Research, Hobart
Ocean Colour and Vegetative Cover
Coral Cover

2nd Derivative - 529nm

Live Coral Cover

High

Low

0 250 500m

>50%

25-50%

<25%
Dust – SW Queensland

Source: Graeme McIntosh, Mungo Nat. Park, 050201_1815
Vegetation Monitoring
Digital Elevation / Bathymetry Models
Volcanic Eruptions – Gas Emissions
Volcanic Eruptions – Hunga Tonga

14 Nov 06

25 Mar 09

Photos: NZAID
Volcano Monitoring – Temperature

ASTER Thermal Imagery of Mt Ruapehu

Mt Ruapehu Crater Lake

ASTER derived

In-situ measured

3 Sep 07 26 Sep 07 28 Oct 07 22 Nov 07 24 Dec 07 31 Dec 07 26 Feb 08 5 Apr 08 16 May 08 20 Aug 08 5 Sep 08

Sample Date
Volcano Monitoring – Lahar Mapping

ASTER Imagery of Mt Ruapehu
Earthquakes and Deformations

Source: S. Samsonov
Minerals and Geology
Counting Landslides

Number of landslides:
- 1 - 2
- 3 - 5
- 6 - 10
- 11 - 19
- 20 - 31

BEFORE

AFTER

Number of landslides:
- 1 - 2
- 3 - 5
- 6 - 10
- 11 - 19
- 20 - 31

BEFORE

AFTER
Other Applications

- National Security
- Landcover / land use
- Infrastructure mapping
- Oil and gas
- Telecommunications
- Online mapping
- Personal navigation
- Construction, survey
- Agriculture
- Forestry
- Water resources
- Insurance
- Disaster relief
- Environmental monitoring
History of Remote Sensing

- Birth of photography (1839)
- Photography from Balloons (1850-1900)
- Photography from aircraft (1909)
- First World War (1914 – 1918)
  - Aerial scouting and reconnaissance
- The discipline of photogrammetry was established (1920’s)

US Army Balloon Corps, early 1860s
History of Remote Sensing

- Radar developed (1930’s)
- Second World War (1939 – 45)
  - Colour infra-red film used to detect camouflage
- The Cold War (1945 -91)
- Colour infra-red photography used to detect crop disease
- The term ‘remote sensing’ was first used (early 1960’s)
- Space Race - Rockets & Satellites (60’s and 70’s)
- Commercial (i.e. civilian) Satellites (July 72 to date)
- Digital image processing
History of Remote Sensing

- Landsat 5 (1984) 29 years of operation - original intended mission only 3yrs!
- Landsat 7 (1999) SLC failure 2003
- Landsat 8 (2013 - )
- High spatial resolution satellite imagery IKONOS (1999) & Quickbird (2001)
- First satellite hyper-spectral sensor EO-1 (2001)
- LiDAR
- Google Earth brings remote sensing to everyone with internet access (2005)
- Landsat archive freely available (2009)
How Does Remote Sensing Work?

- Any object with a temperature > 0° Kelvin emits electromagnetic radiation (EMR)
- Sunlight is a form of EMR
- Thermal energy (heat) is a form of EMR
- EMR from the sun is
  - Reflected
  - Transmitted
  - Absorbed
- Reflected and/or emitted energy is recorded by a sensor
How Does Remote Sensing Work?
EMR Interactions

- Types of interactions observed in images are controlled by:
  - Physical, Chemical and Biological characteristics of object; and
  - Type of sensor
From Images to Information

- Understanding EMR interactions with features of interest allows qualitative and quantitative analysis of images.
- Maps are created by developing relationships between EMR (as recorded in an image) and features of interest (as measured on the ground).

Water
Grasses etc
Dense Veg
Artificial Surfaces
The Remote Sensing Process

Figure 1.1  Electromagnetic remote sensing of earth resources.

Source: Lillesand, Kiefer & Chipman (2008)
Satellites

In Google Earth just go to "Add"->"Network Link" and paste link into the "Link:" field.
Why Use Remote Sensing?

- Large area coverage
- Synoptic view, continuous spatial coverage
- Information about hard to access areas
- Use sensors to ‘see’ in wavelengths not visible to human eye
- Make quantitative measurements about biogeophysical properties of earth’s surface
- Digital record of features and processes
- Repeat coverage
- Cost (field vs. image)
Who uses remote sensing?

- Military
- Many Government Departments
- Commonwealth Agencies (CSIRO, ERISS, etc)
- City Councils
- NGOs
- United Nations
- Private industry (SKM, EWL, ERA etc)
- Universities and research agencies
Coming Up

• No prac this week
• Week 2 lecture: Understanding electromagnetic radiation (EMR) interactions
• Week 2 – first practical

Source: C.Roelfsema/S.Phinn