Geog 4/581: Satellite Digital Image Analysis

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Course webpage:
http://web.pdx.edu/~jduh/courses/geog481w07/index.htm

Overview

- What is remote sensing?
- How can RS techniques be used?
- Why do you learn RS?

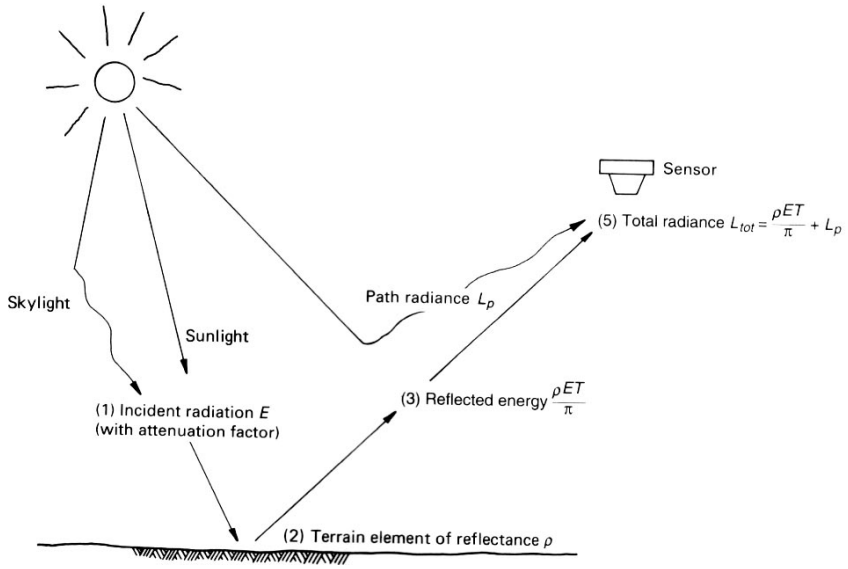
Definition

- The science of remote sensing comprises the analysis and interpretation of **measurements** of **electromagnetic radiation** that is **reflected** from or **emitted** by a target and observed or recorded from a vantage point by an observer or instrument that is not in contact with the target.

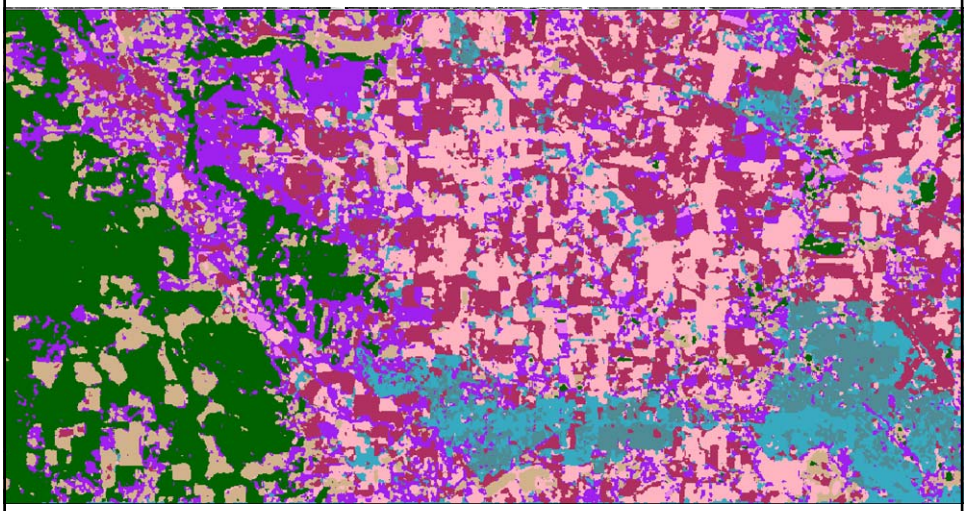
Image Interpretation Tasks

- Classification
  - Detection, recognition, identification
- Enumeration
  - Counting, statistics
- Measurement
  - Photogrammetry: geometry
  - Photometry: intensity
  - Radiometry (spectrometry): spectrum
- Delineation
  - Thematic mapping

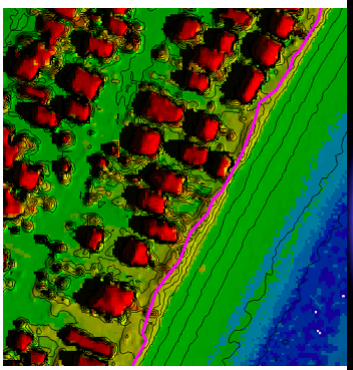
Remote Sensing Components



Remote Sensing Applications



Classification done by D. Fuhriman.



LIDAR data for Pawleys Island, SC.
(Source: NOAA Coastal Services Center)

The red areas show the logging disturbance in Brazil. (The logging region comes from the Carnegie Institution, which is overlaid on image from Google Earth.)

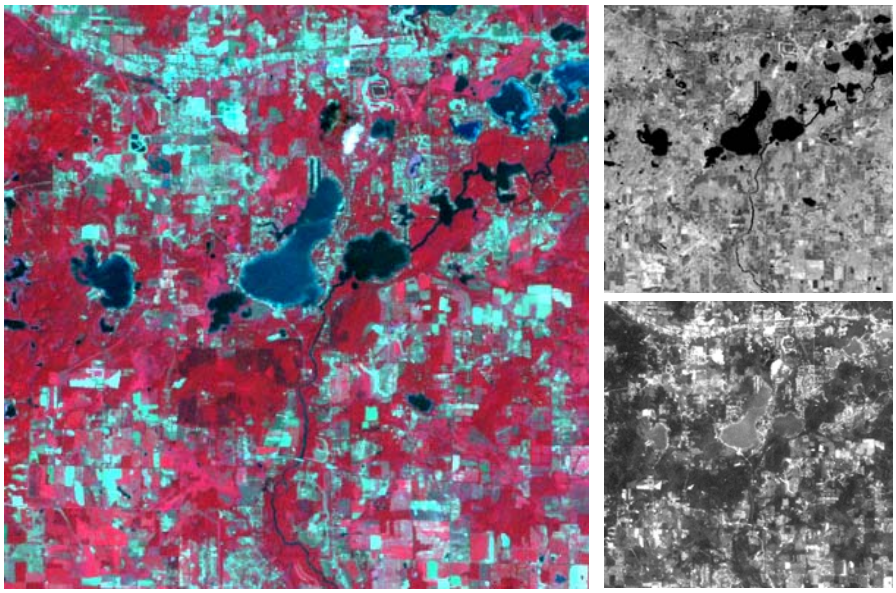
Elements of Image Interpretation

- Color (tone, hue)
- Texture
- Shadows
- Pattern
- Association
- Shape
- Size
- Site

Digital Image Analysis

- Digital vs. analog
- Digital number (DN), brightness value (BV)
- Pixels
- Bands (channels)
- Resolution
- Platform and sensors
- GIS

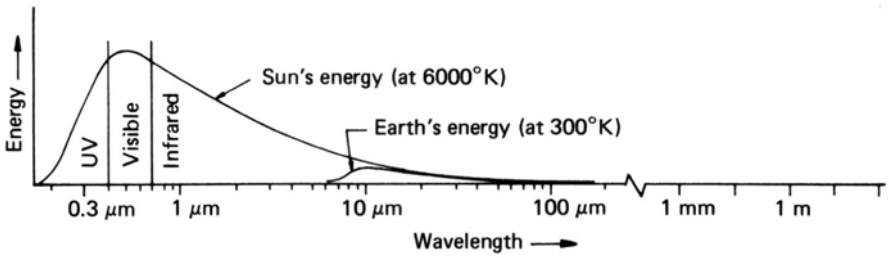
ETM+: CIR False Color Composite Image



Electromagnetic Radiation

What is EMR?

- EMR is generated by the change of energy levels of electron, decay of radioactive substances, the thermal dynamics of atoms and molecules, …



(a) Energy sources

Distance Unit

- Micron (μm): micrometer
- 1 mm = 1000 μm
- 1 μm = 1000 nm (nanometer)
- Blue wavelength: 0.4 ~ 0.5 μm or 400 ~ 500 nm

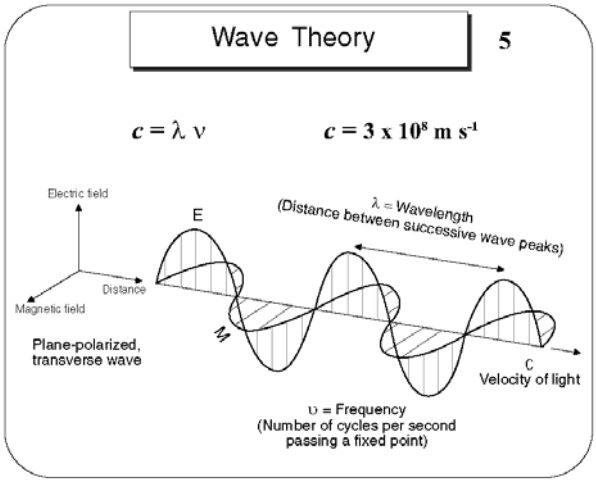
Table 1.1 Terms and symbols used in measurement

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{-18}	Atto	a			
10^{-15}	Femto	f			
10^{-12}	Pico	p	10^{12}	Tera	T
10^{-9}	Nano	n	10^{9}	Giga	G
10^{-6}	Micro	μ	10^{6}	Mega	M
10^{-3}	Milli	m	10^{3}	Kilo	K

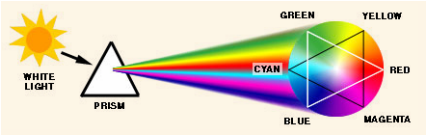
Properties of EMR

Wave Theory
- Wavelength
- Frequency
- Amplitude

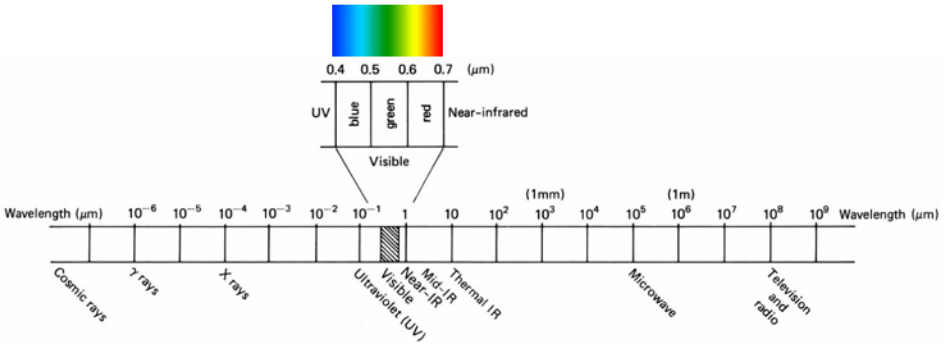
Photons



EMR Spectrum



Optical Spectrum: 0.3 – 15 μm
Reflective Spectrum: 0.38-3 μm

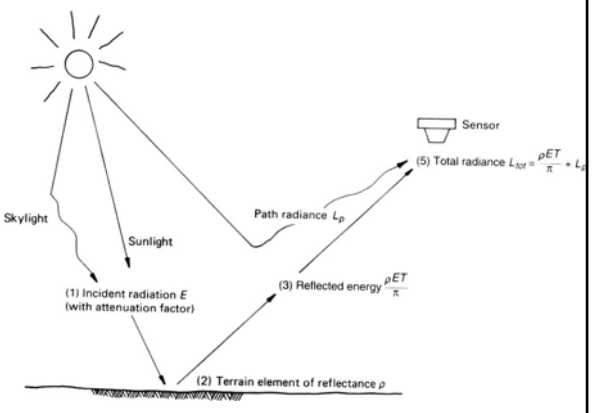


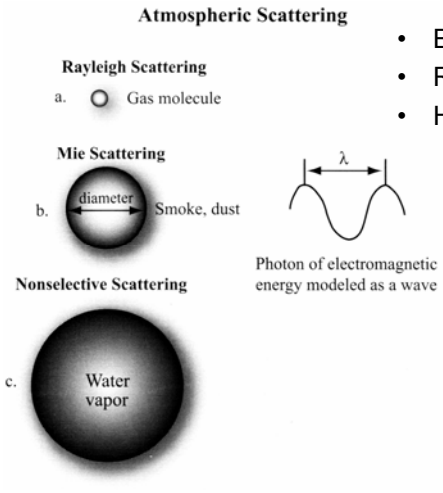
EMR Energy

- Radiant exitance (M_e): watts emitted from a surface
- Radiant flux: m-kg-sec (watts) delivered to a surface
- Irradiance (E_e): radiant flux per unit area
- Radiance: radiant flux in a specified direction (i.e., that reaches the sensor)

Interactions with the Atmosphere

- Scattering
- Refraction
- Absorption





- Blue sky (Rayleigh)
- Red-orange color at sunset (Mie)
- Haze

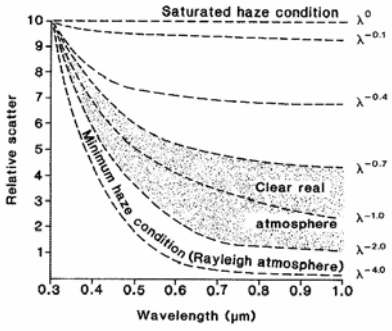
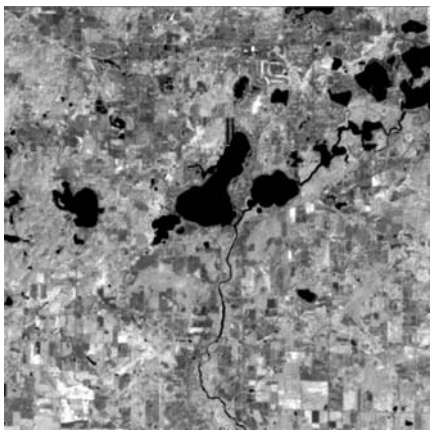


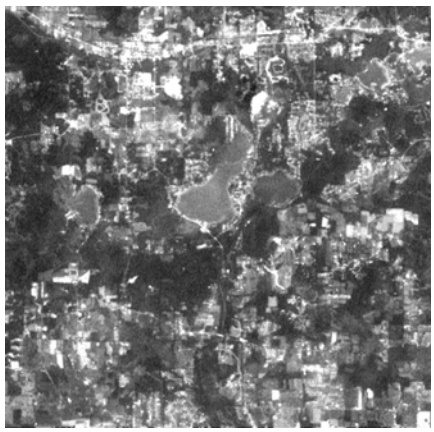
Figure 1.18 Relative scatter as a function of wavelength for a range of atmospheric haze conditions. Based on R.N. Colwell (ed.), 1983, Manual of Remote Sensing, 2nd edition, Figure 6.15. Reproduced by permission of the American Society for Photogrammetry and Remote Sensing.

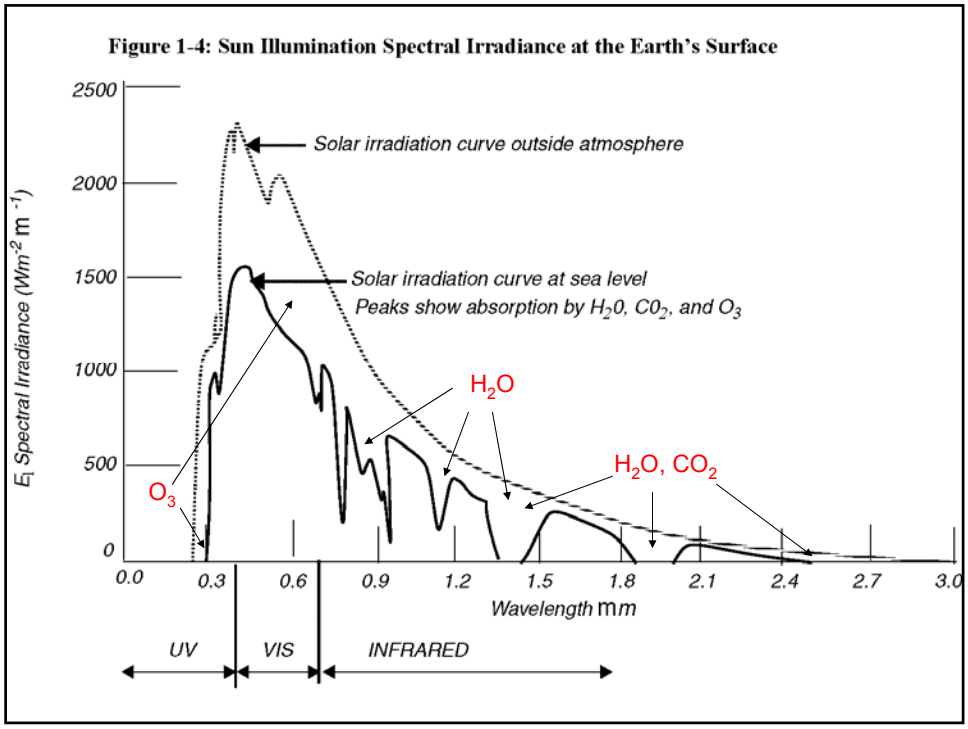
Atmospheric Scattering

ETM+ Band 4: NIR (0.75-0.9 μm)



ETM+ Band 1: Blue (0.45-0.51 μm)





Atmospheric Effects and Remote Sensing

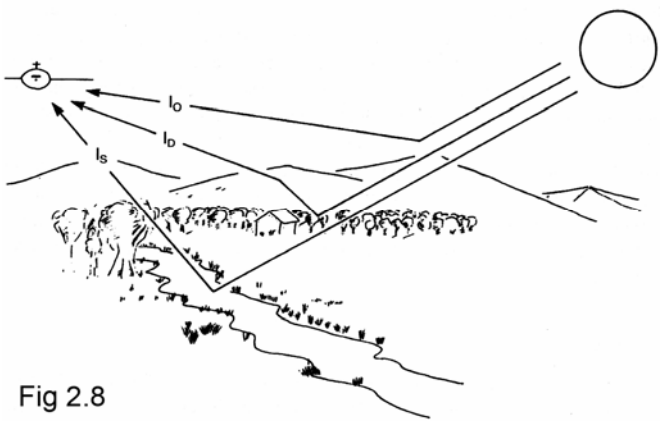
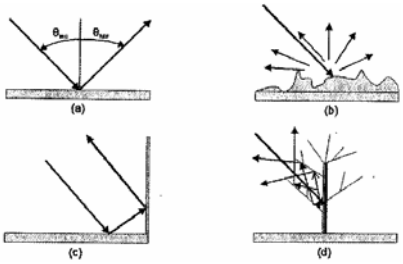


Fig 2.8

I_S: surface reflection, I_D: refracted, diffused light, I_O: scattered light

Interactions with Surfaces

- Reflection
  a) Specular
  b) Diffuse (e.g., Lambertian reflection)
  c) Corner reflectance
  d) Volume reflectance



- Absorption
- Transmission

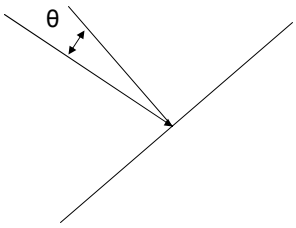
Transmitted = Incident radiation – Reflected – Absorbed

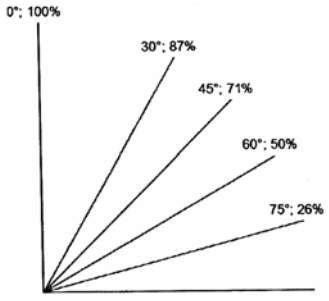
Sun Position/Slope Effects

- Lambert's Law of Illumination

$$I' = I / \cos \theta$$

I': observed irradiance
I: incident irradiance
θ: incidence angle





Spectral Properties of Objects

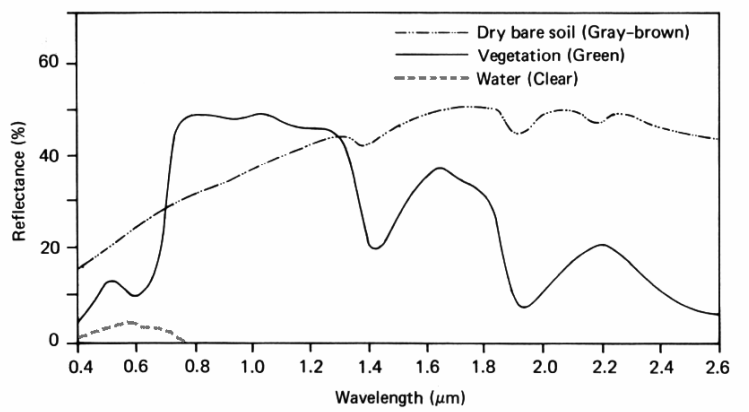


Figure 1.10 Typical spectral reflectance curves for vegetation, soil, and water.