

Spectral reflectance characteristics (Plants, Soil, Water)

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http://bioval.jrc.ec.europa.eu/





Optical spectrum 0.3 to 14 µm



Spectral reflectance curve for fresh green vegetation



Lillesand, Kiefer & Chipman, Remote Sensing and Image Interpretation, 6th Edition May 2008 (Wiley & Sons)

Leaf structure





http://harvardforest.fas.harvard.edu/research/leaves/science.html



http://www.microscopy-uk.org.uk/



'Senescence' of a Ficus benjamina L. leaf



Each time step is 10 mins., total duration 8 hrs Measurement is *reflectance plus reflected transmittance* Schaepman, M. (2007) Spectrodirectional Remote Sensing: From Pixels to Processes. *International Journal of Applied Earth Observation and Geoinformation*, **9**, 204-223. Remote Sensing and Geographical Information Systems for Resource Management in Developing Countries edited by A. S. Belward and C. R. Valenzuela (Kluwer Academic: Dordrecht) 1991

Effect of multiple leaf layers on NIR reflectance



Soil



Soil moisture / organic matter



Remote Sensing and Geographical Information Systems for Resource Management in Developing Countries edited by A. S. Belward and C. R. Valenzuela (Kluwer Academic: Dordrecht) 1991

Spectral response – spectral reflectance curves



Spectral characteristics of water



Water

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chlorophyll climatological annual mean from SeaWiFS (1998-2003)





Ocean colour

- Cyanobacterial bloom
- Baltic sea 8th July 2005
- SeaWifs





Source A. Stips, F. Melin (JRC) http://ioc.unesco.org/gpsbulletin/GPS1&2/Vol2ar1.jpg Rio Negro Dissolved Organic Matter

Rio Solimões Rich with Andean sediments

MISR Manaus (NASA)

http://img527.imageshack.us/img527/6031/encotrenosrq4.pn

http://www.satimagingcorp.com/satellite-sensors/spot-5.html Landsat

- Sensors capture the EMR incident with them and convert this into a permanent record
- The Sensor is mounted on a platform, in this case a satellite



Spatial characteristics

- Spatial resolution defines the level of spatial detail in an image. Indicative of the size of objects on the ground that can be seen as separate entities in the image
- Instantaneous Field of View (IFOV) the cone angle within which incident energy is focused on the detector
- Pixel size in part a function of the IFOV, but also determined by the way in which the radiometric signal is sampled
- Scene size determined by the number of detectors and the viewing angle of the instrument in the across track dimension...arbitrary along track





Structure of a digital image



A. GRAY-SCALE IMAGE.



B. LOCATION MAP.



D. HISTOGRAM AND GRAY SCALE.



http://www.satimagingcorp.com/media/images/spatial-resolution.jpg

https://zulu.ssc.nasa.gov/mrsid/tutorial/Landsat%20Tutorial-V1.html



https://zulu.ssc.nasa.gov/mrsid/tutorial/Landsat%20Tutorial-V1.html





http://upload.wikimedia.org/wikipedia/commons/3/33/Beyoglu_4671_tricolor.png http://www.colormatters.com/color-and-design/basic-color-theory

Band combinations – and display



B1 (Visible blue) = B



B2 (Visible green) = B

True-Color Composite (321)



RGB

RGB

Near Infrared Composite (432)



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TM bands overlaying spectral "signature" curves





Band 2 0.525 – 0.605 μm



Band 4 0.750 – 0.900 μm

Band 5 1.55 – 1.75 μm

The thermal portion 3 to 14 µm



Options from space

- "low resolution"
 "meteorological" satellites

 Typically in the order of 1 km measurements
- Sea Surface Temperature, Land Surface Temperature Cloud top temperature, evapotranspiration and fire monitoring are among key applications

AATSR LST image of Southern UK and Northern France obtained on 16 July 2005 (night-time) Source ESA



https://zulu.ssc.nasa.gov/mrsid/tutorial/Landsat%20Tutorial-V1.html http://asterweb.jpl.nasa.gov/gallerymap.asp

Options from space

- "moderate to high resolution" environmental satellites
 - Typically less than 100 m
 - Landsat Thermal, Advanced Spaceborne Thermal Emission and

Reflection Radiometer (ASTER) on the Terra satelline



Joliet 29, a coal-burning power plant in Illinois: ASTER Thermal Infrared band was color-coded to represent heat emitted from the surface. The progression from warmest to coolest is shown with the following colors: white, red, orange, yellow, green, blue, and black. (Image courtesy NASA/GSFC/MITI/ERSDAC/JAROS, and U.S./Japan Aster Science Team



Landsat's thermal channel cf False Colour Composite



Relationship between M_{λ} and λ for objects at different temperatures



Active fire detection, burnt area measurement



SPOT-VGT 1 km resolution – RCA Sudan border - ~ 500 km x 500 km

Source J-M. Gregoire

Another perspective, new rules...

Tobacco smoke particles are typically 0.1 to 1 micron

- A totally different scale to optical up to a million times bigger
- Interactions at the "structural" scale, rather than cellular/molecular scale

0.02 mm



0.02 mm = 20 μm 2 mm = 2000 μm



Active microwave remote sensing

RAdio Detection And Ranging (RADAR)



 Detects objects, determines distance away from EMR source, and the angular position

Radar

- Antenna slung below the platform and pointing to one side
 - Side Looking "airborne" Radar (SLAR) and Synthetic Aperture Radar (SAR) are the common systems
 - It transmits microwave EMR towards the earth's surface
 - It receives that portion of the transmitted energy which is reflected – backscattered from the surface to the antenna
 - It records the strength –amplitude- of the returned signal and the time...(because c is constant this can then be translated into distance from the antenna)
- As the platform progresses it accumulates observations...i.e. a strip is 'illuminated" to one side of the platform



http://www.stanford.edu/group/radar/group.html

Volume scattering

Radar remote sensing tutorial from the Canada Centre for Remote Sensing http://www.ccrs.nrcan.gc.ca/resource/tutor/ gsarcd/index_e.php



Geometric characteristics

- Leaves, stems, branches, trunks, canopies, gaps in canopies
- Soil clods, plough furrows, terraces, land form and topography
- Water body waves and surfaces, snow fields, ice sheets...
- Man-made structures (smooth roads, sharp angles of buildings, metal objects)



Summary

- The fate of a photon depends on its energy level, what it interacts with and when
- Spectral reflectance properties of objects can be used to differentiate between objects and to monitor changes in the state and condition of an object over time
- Understanding spectral properties is the key to interpreting remotely sensed data

