# Spectral Reflectance Curve

**Course :** CC1 Remote Sensing

Unit: 1

**Programme:** M.Tech., Geoinformatics

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**Professor and Head**

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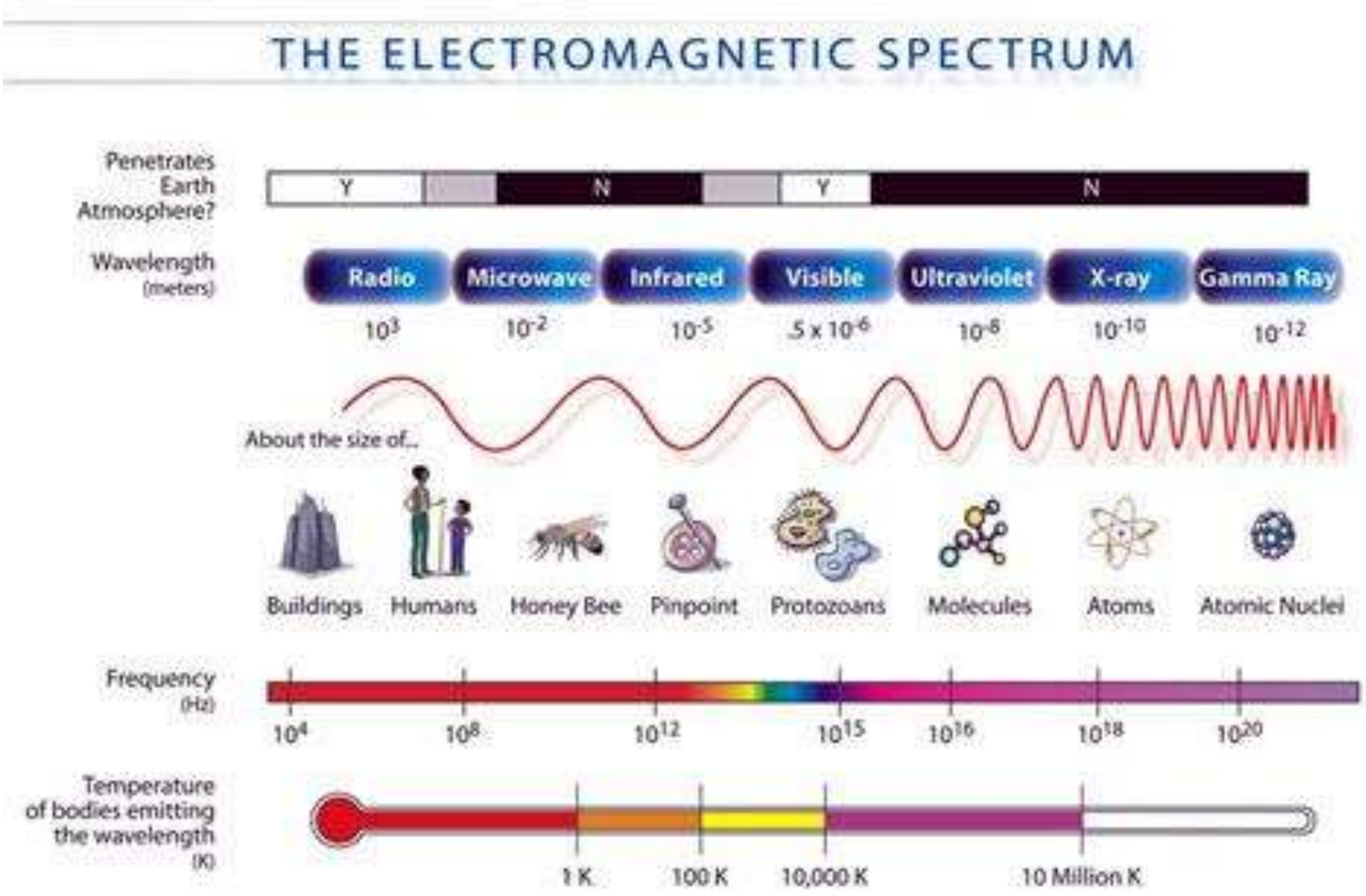
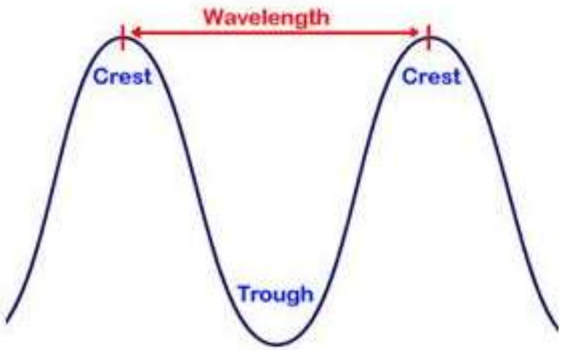
# Electromagnetic Spectrum



# Spectral reflectance curve

**The graphical representation of the spectral response of an object over different wavelengths of the electromagnetic spectrum is termed as spectral reflectance curve**. The reflectance characteristics of the surface features are represented using these curves.

These curves give an insight into the spectral characteristics of different objects, hence used in the selection of a particular wavelength band for remote sensing data acquisition.

The graph is drawn between various wavelengths (μm) of EM spectrum on x-axis & the amount of reflectance (%) recorded by the R.S. system on the y-axis.

Spectral reflectance curve exhibits the "**peak-and-valley**" configuration. ***High amount of reflectance a wavelength from a particular feature may result in peaks in the graph & low reflectance results in a dip or valley in the curve***. In other words, the peaks indicate strong reflection of incident energy and the valleys indicate predominant absorption of the energy in the corresponding wavelength bands

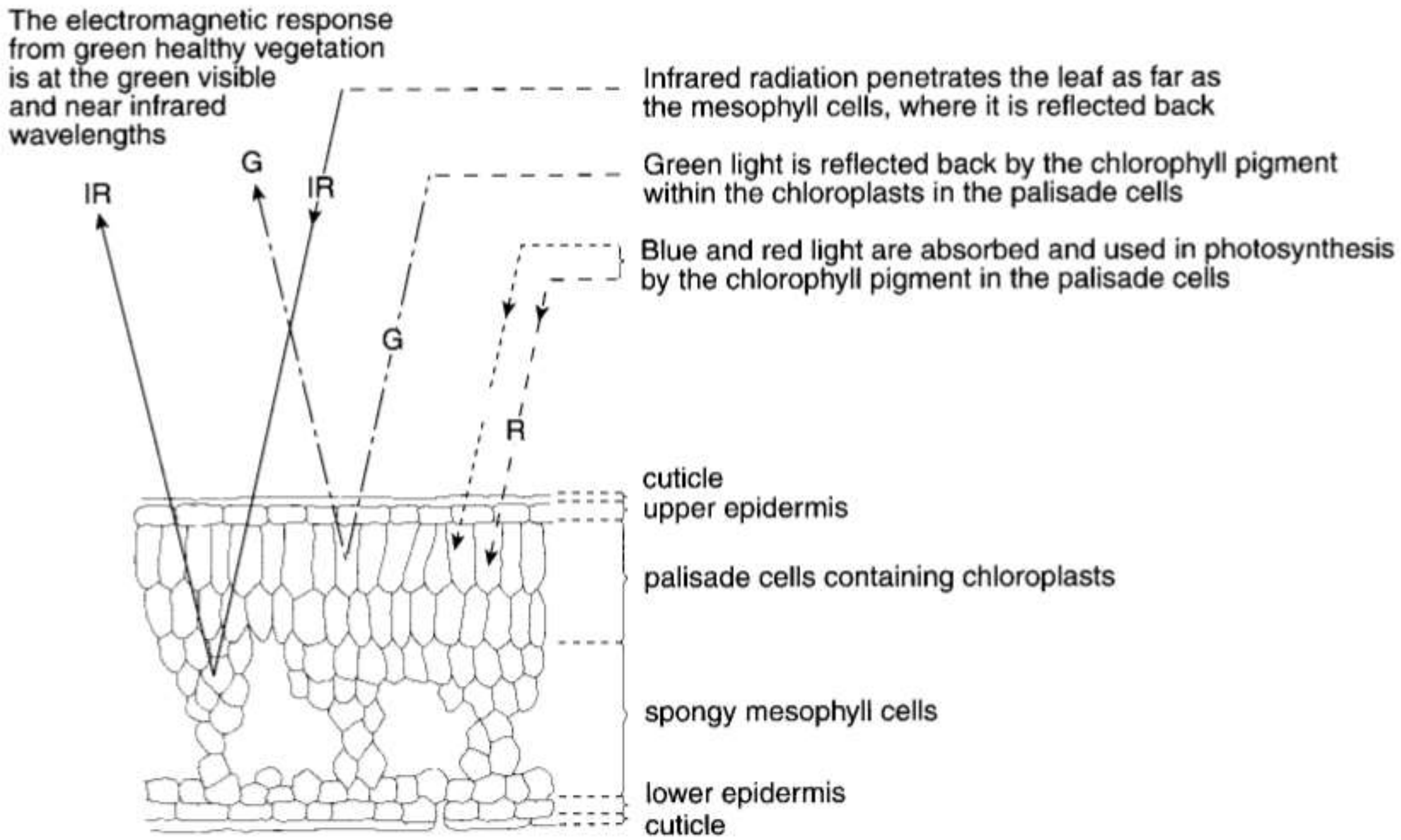
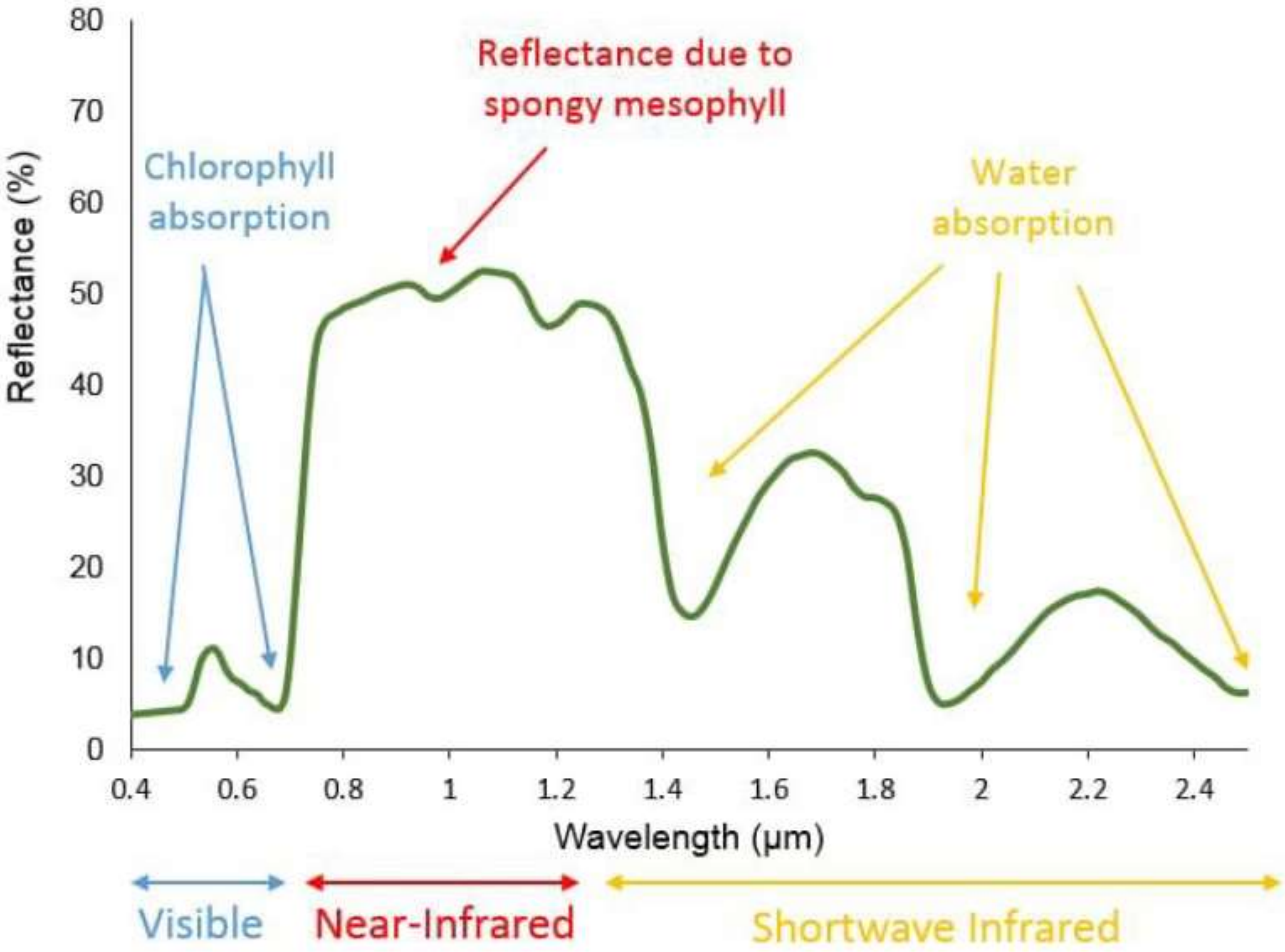



Fig.2. Cell structure of a green leaf and interactions with the electromagnetic radiation (Gibson, 2000)




## Wavelength Region

(0.4-0.7μm)

(0.7-1.3μm)

beyond 1.3μm

**The valleys in the visible region (0.4 to 0.7 μm) of the spectrum are due to the pigments in plant leaves.**

**The palisade cells containing sacs of green pigment (chlorophyll) strongly absorb energy in the wavelength bands centered at 0.45 and 0.67 μm within visible region (corresponds to blue and red),**

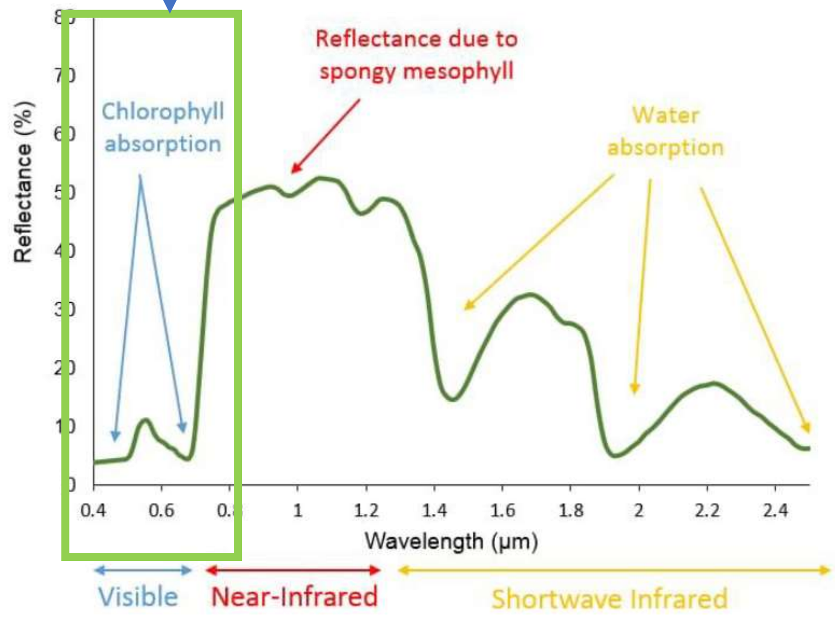
**On the other hand, reflection peaks for the green colour in the visible region, which makes our eyes perceive healthy vegetation as green in colour. However, only 10-15% of the incident energy is reflected in the green band.**

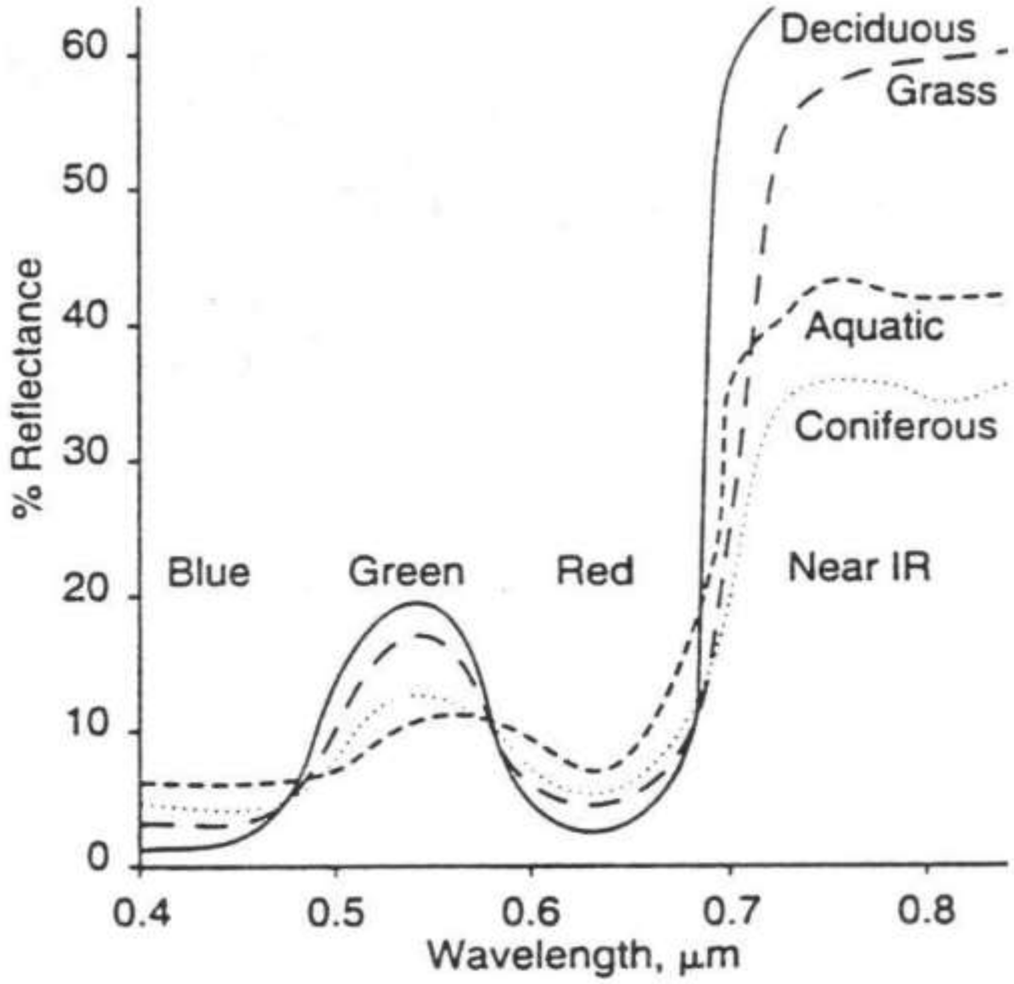
**The near infrared (NIR) region (0.7 to 1.3 µm) of the spectrum, at 0.7 µm, the reflectance of healthy vegetation increases dramatically. In the range from 0.7 to 1.3 µm, a plant leaf reflects about 50 percent of the energy incident upon it.**

**The infrared radiation penetrates the palisade cells and reaches the irregularly packed mesophyll cells which make up the body of the leaf. Mesophyll cells reflect almost 60% of the NIR radiation reaching this layer.**

**Most of the remaining energy is transmitted, since absorption in this spectral region is minimal. Healthy vegetation therefore shows brighter response in the NIR region compared to the green region.**

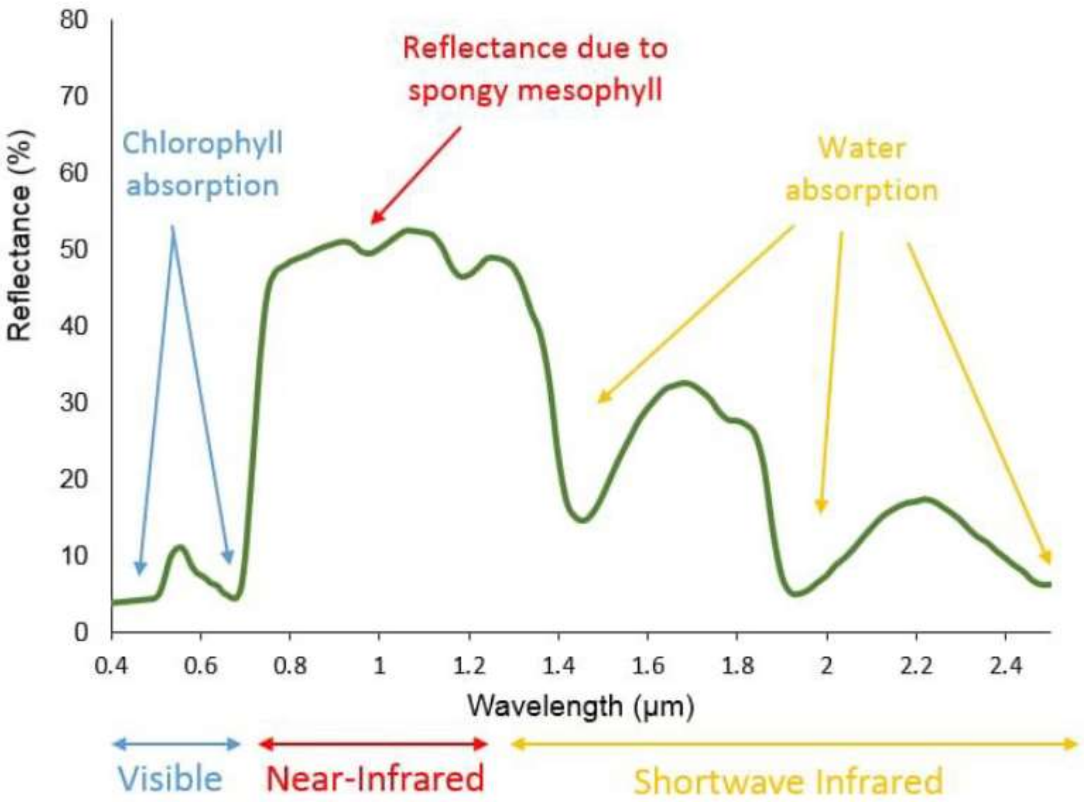
**As the leaf structure is highly variable between plant species, reflectance measurements in this (NIR) range often permit discrimination between species,**


Reflectance due to spongy mesophyll
Chlorophyll absorption
Water absorption
Reflectance (%)
Wavelength (µm)
Visible
Near-Infrared
Shortwave Infrared


Deciduous
Grass
Aquatic
Coniferous
Blue
Green
Red
Near IR
% Reflectance
Wavelength, µm

In the region **beyond 1.3 μm,** leaf reflectance is approximately **inversely related to the total water present in a leaf as water absorbs the energy**. This total water is a function of both the moisture content and the thickness of the leaf

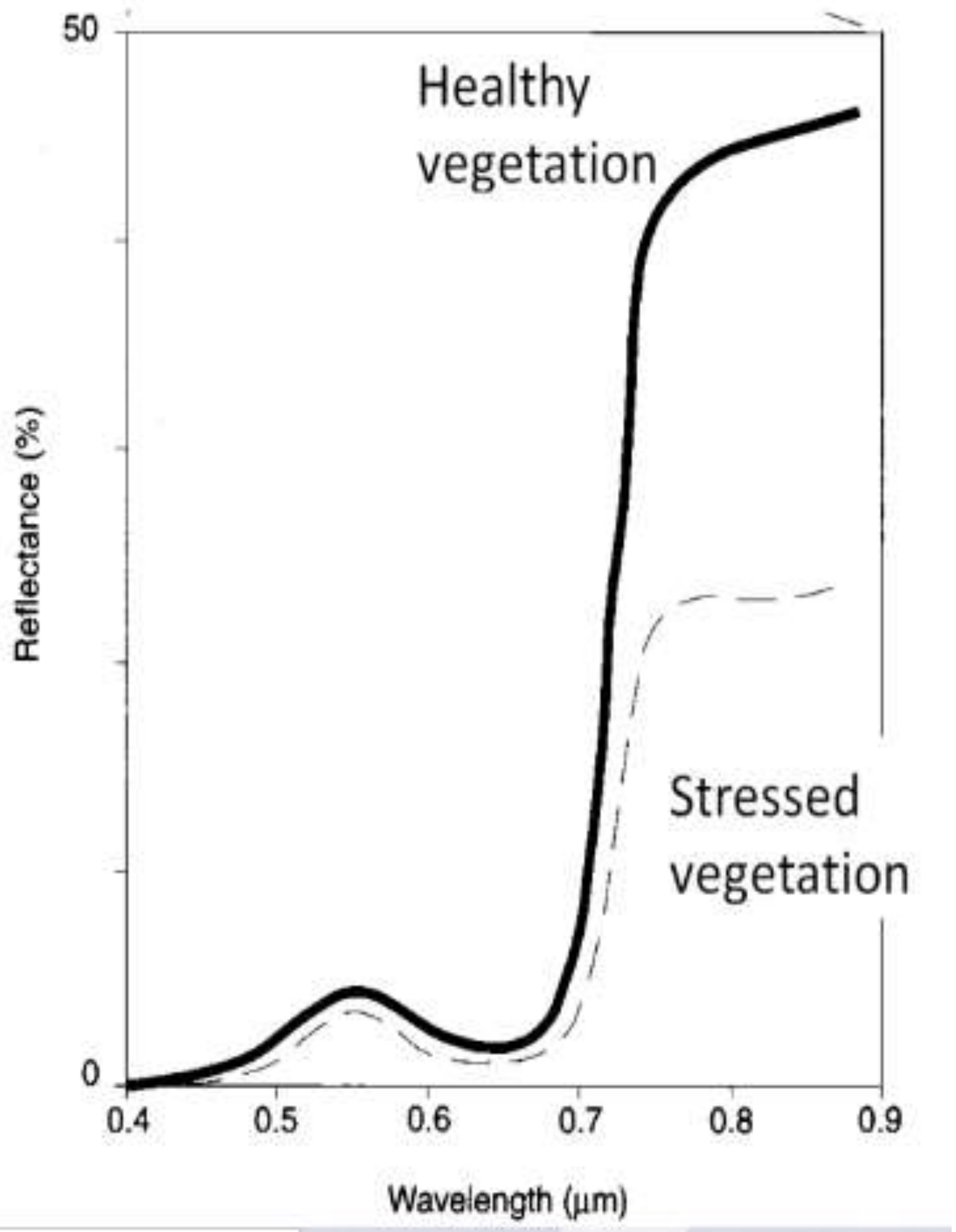
Dips in reflectance curve occur at **1.4, 1.9,** and **2.7μm** as water in the leaf strongly absorbs the energy at these wavelengths. So, wavelengths in these spectral regions are referred to as water absorption bands. Reflectance peaks occur at **1.6** and **2.2μm** between the absorption bands



If a plant is subjected to some form of stress that interrupts its normal growth and productivity, it may decrease or cease chlorophyll production. The result is less absorption in the blue and red bands in the palisade.

Hence, **red and blue bands also get reflected along with the green band, giving yellow or brown colour to the stressed vegetation.**

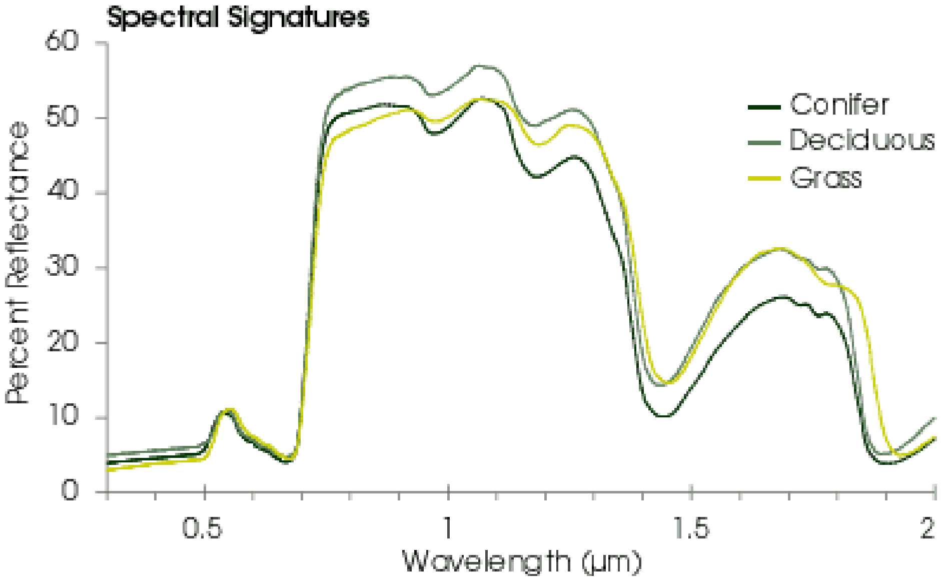
Also in stressed vegetation, the **NIR bands are no longer reflected** by the mesophyll cells, instead they are absorbed by the stressed or dead cells causing dark ones in the image

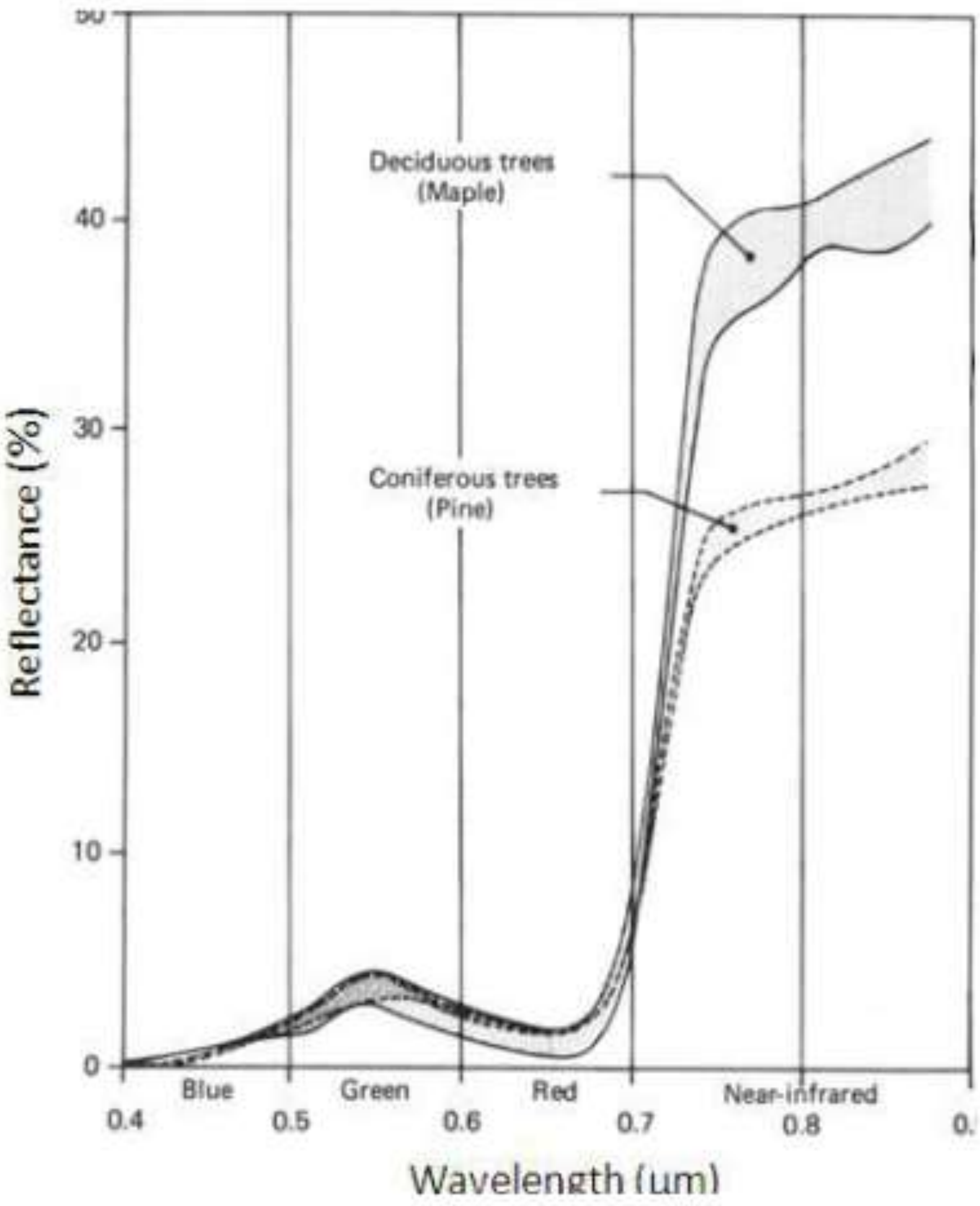


As the reflectance in the IR bands of the EMR spectrum varies with the leaf structure and the canopy density, measurements in the IR region can be used to discriminate the tree or vegetation species.

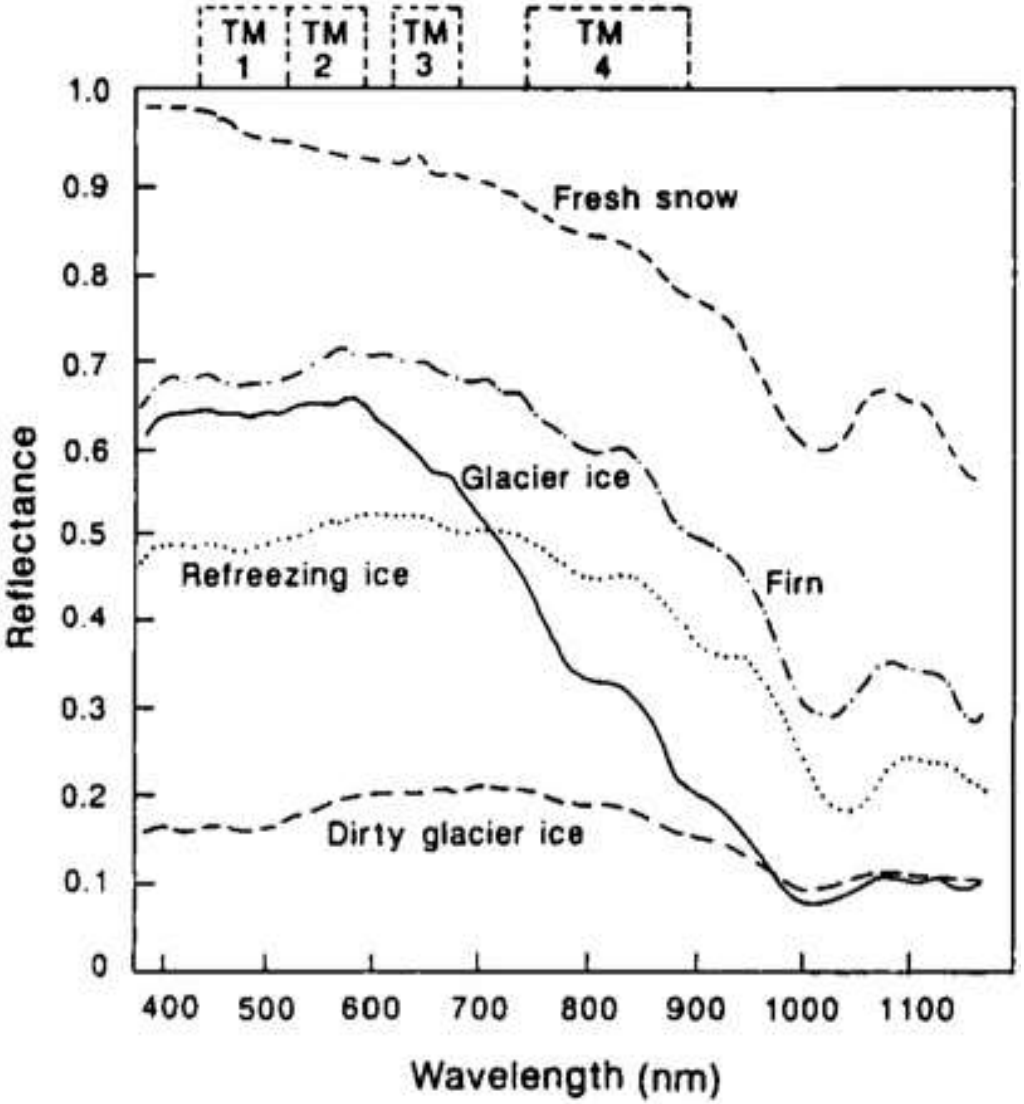
For example, **spectral reflectance of deciduous and coniferous trees may be similar in the green band**. However, **the coniferous trees show higher reflection in the NIR band,** and can be easily differentiated

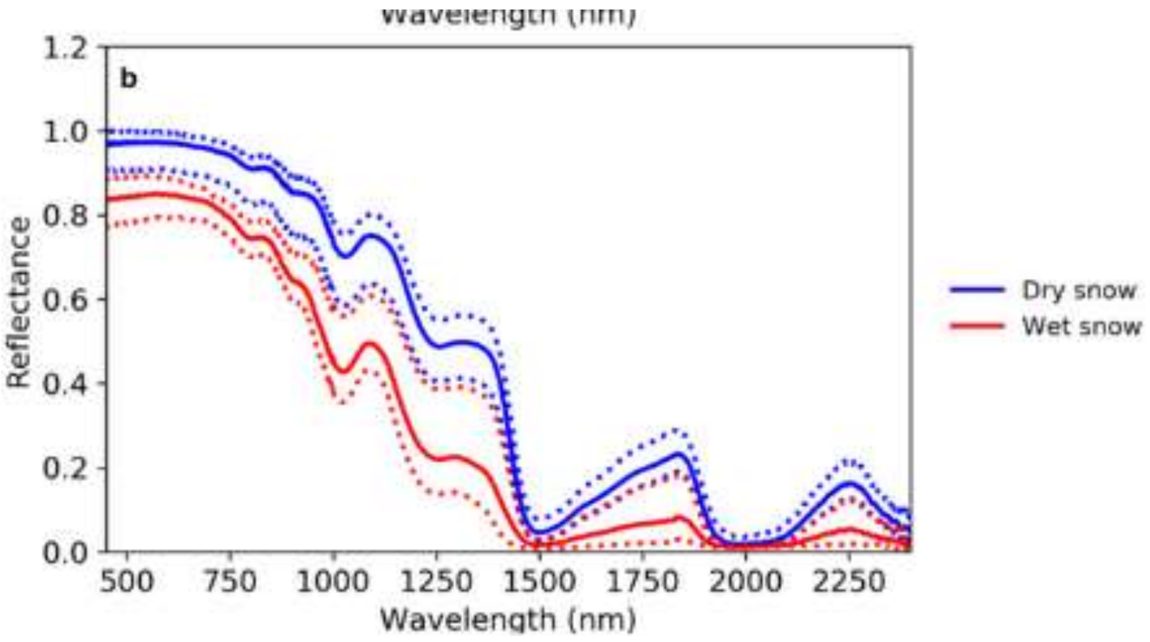
**densely grown agricultural area, the NIR signature will be more.**



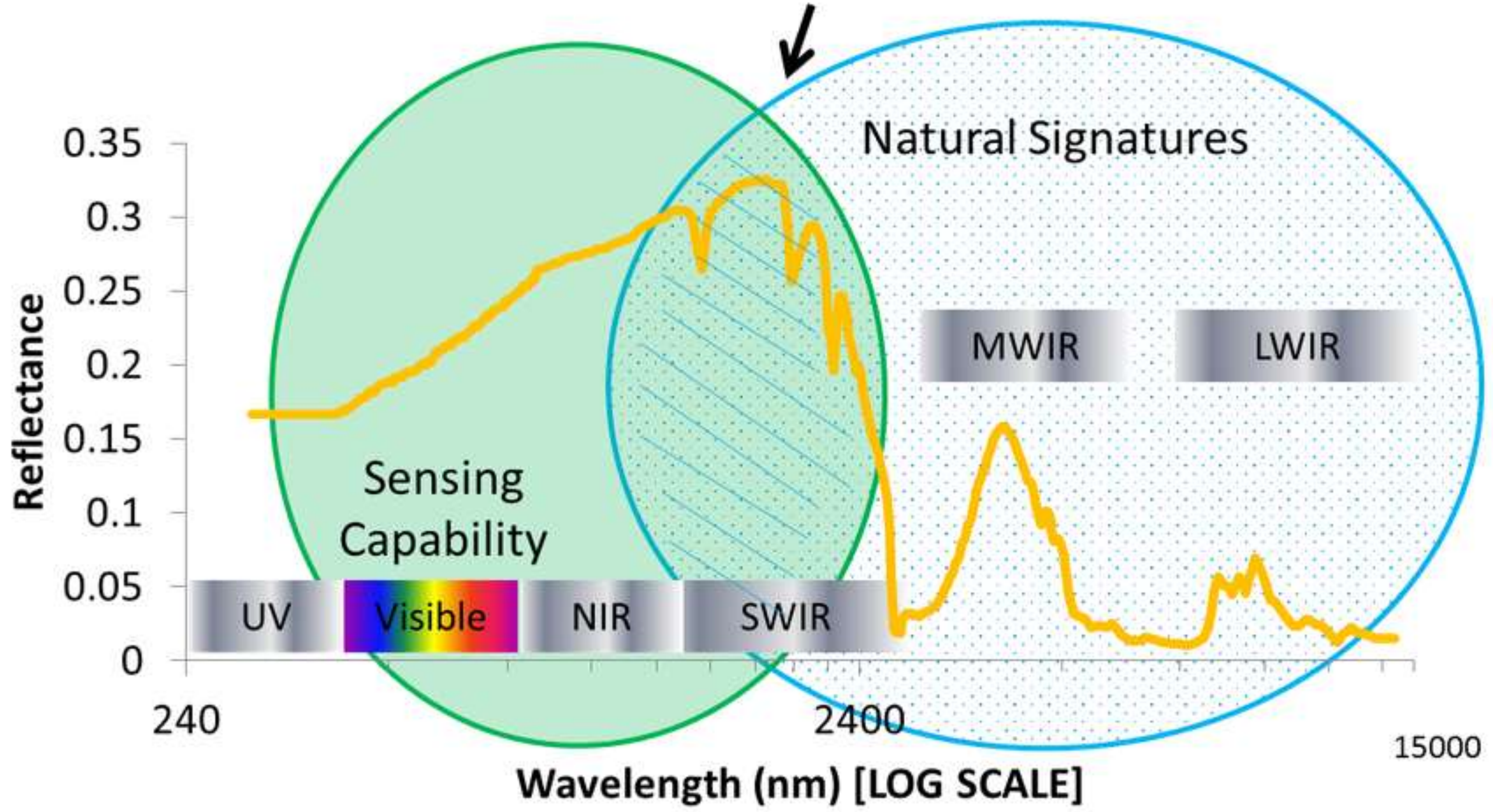
# Spectral Reflectance Curve: Ice, Snow and Glacier



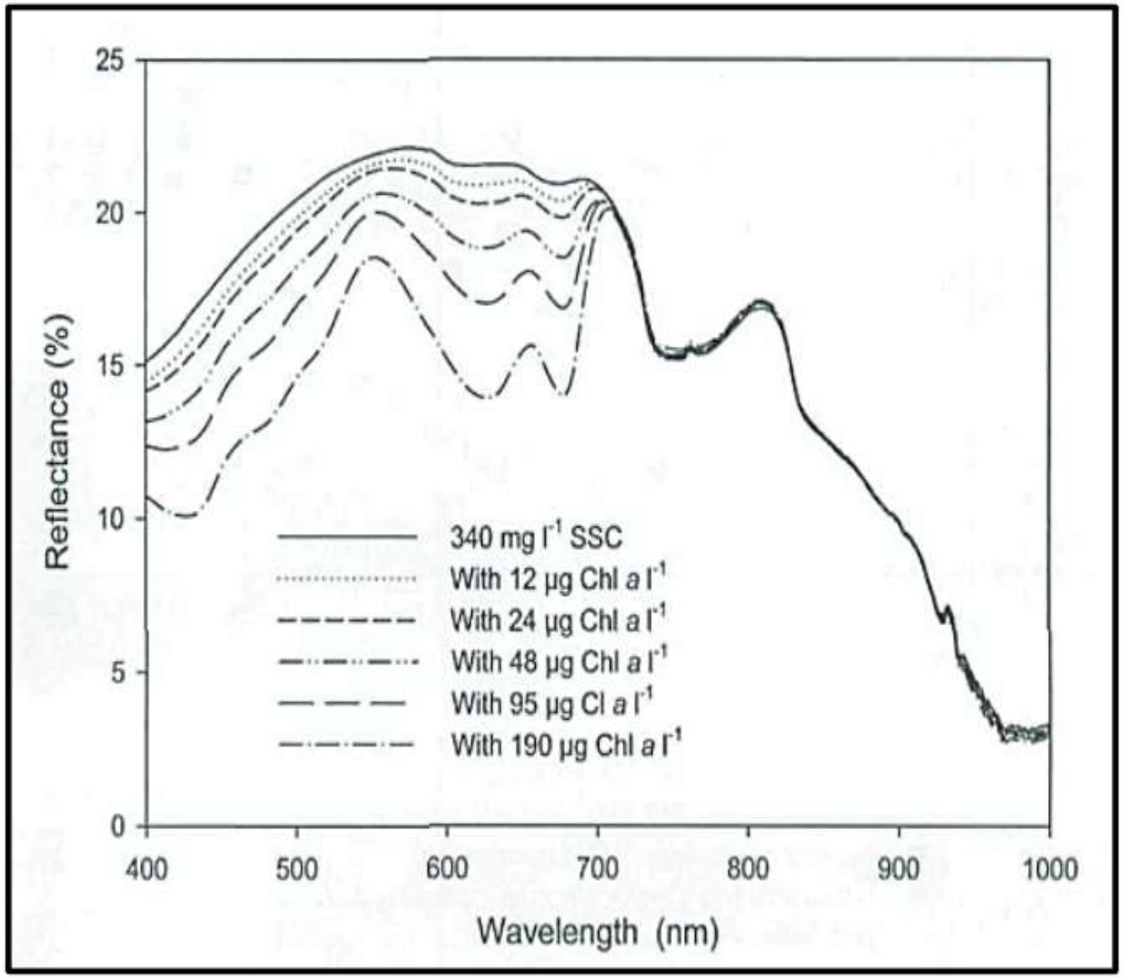



| Band | Applications |
| --- | --- |
| Coastal | coastal applications, water penetration, deep water masks<br>materials differentiation, shadow-tree-water differentiation |
| Blue | coastal applications, water body penetration, discrimination of soil/vegetation, forest types, reef cover features |
| Green | crop types, sea grass and reefs, bathymetry |
| Yellow | leaf coloration, plant stress, $CO_2$ concentration, algal blooms, sea grass and reefs, separability of iron formations, "true color" |
| Red | chlorophyll absorption, vegetation analysis, plant species and stress |
| Red Edge | vegetation health, stress, type and age, sea grass and reefs<br>land/no land, impervious from vegetated, turbidity, camouflage |
| NIR1 | biomass surveys, plant stress<br>delineation of water bodies, soil moisture discrimination |
| NIR2 | biomass surveys, plant stress<br>materials differentiation |

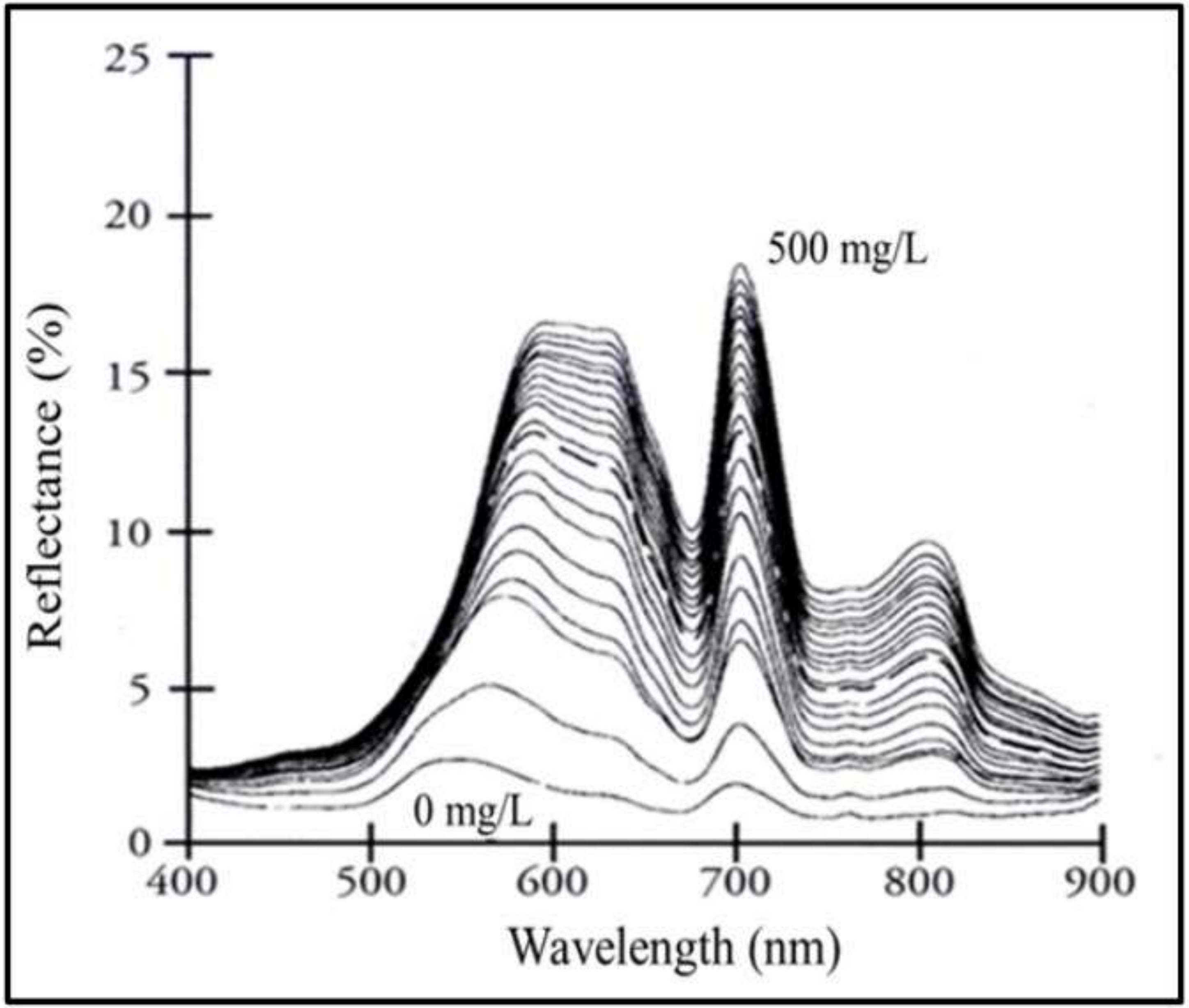
SWIR is the Spot!



# Water rich in **Suspended Solids** with variations of **Chlorophyll** concentrations




http://spectralevolution.s3.amazonaws.com/assets/Chlorophyll_detection_water.pdf




## Water rich in chlorophyll with variations of suspended solids concentrations

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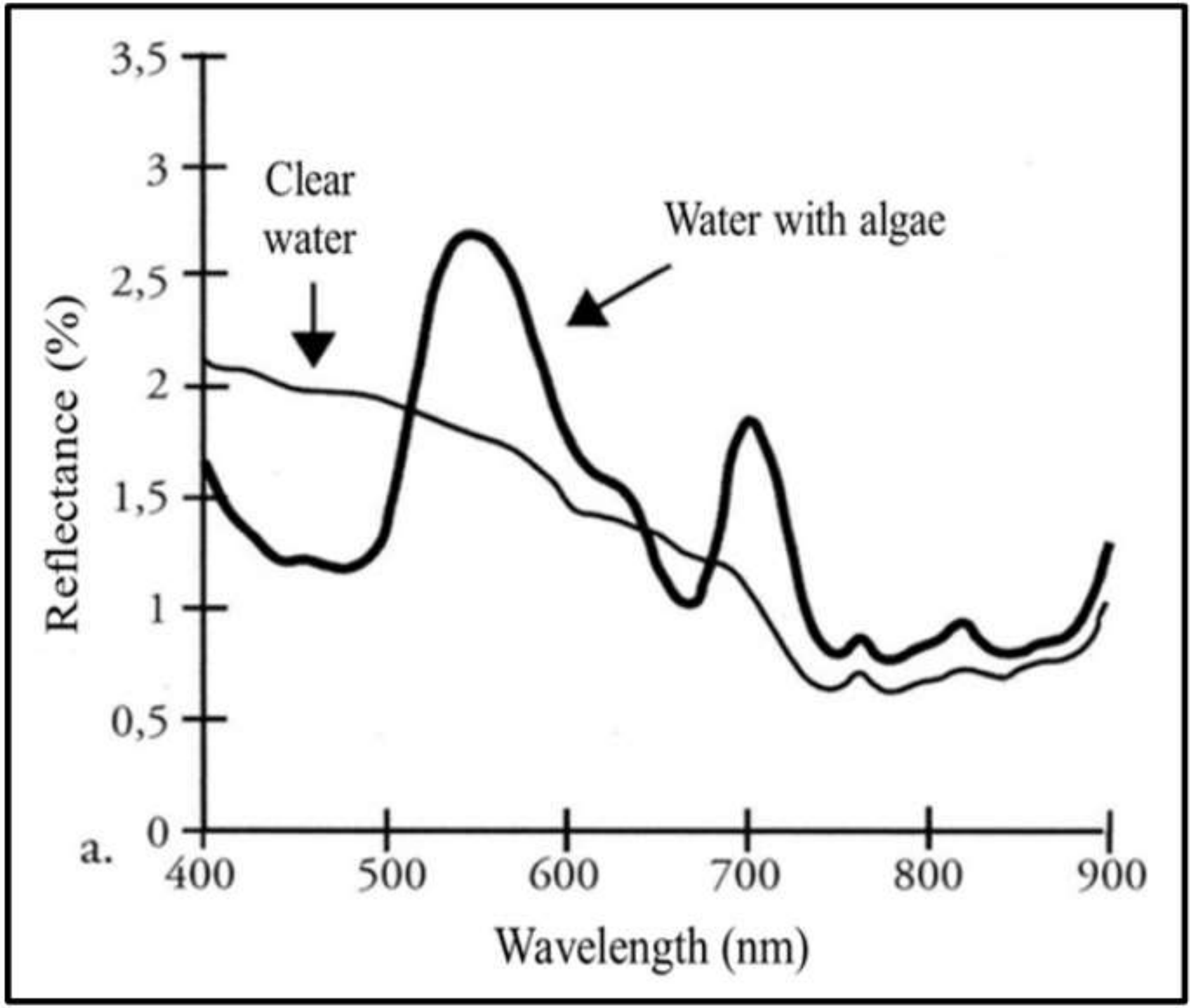
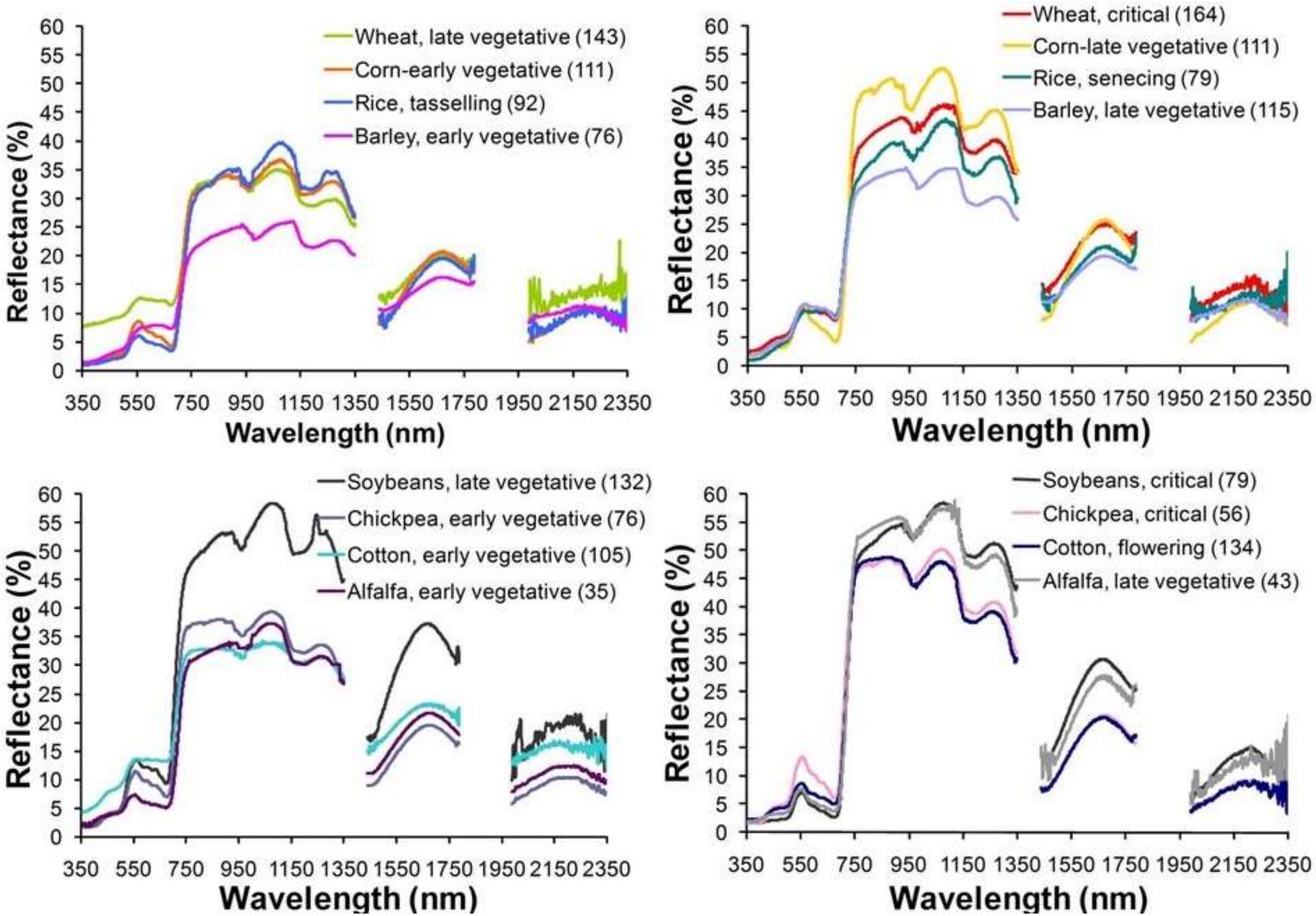



# Comparison between Clear Water & Water With Algae

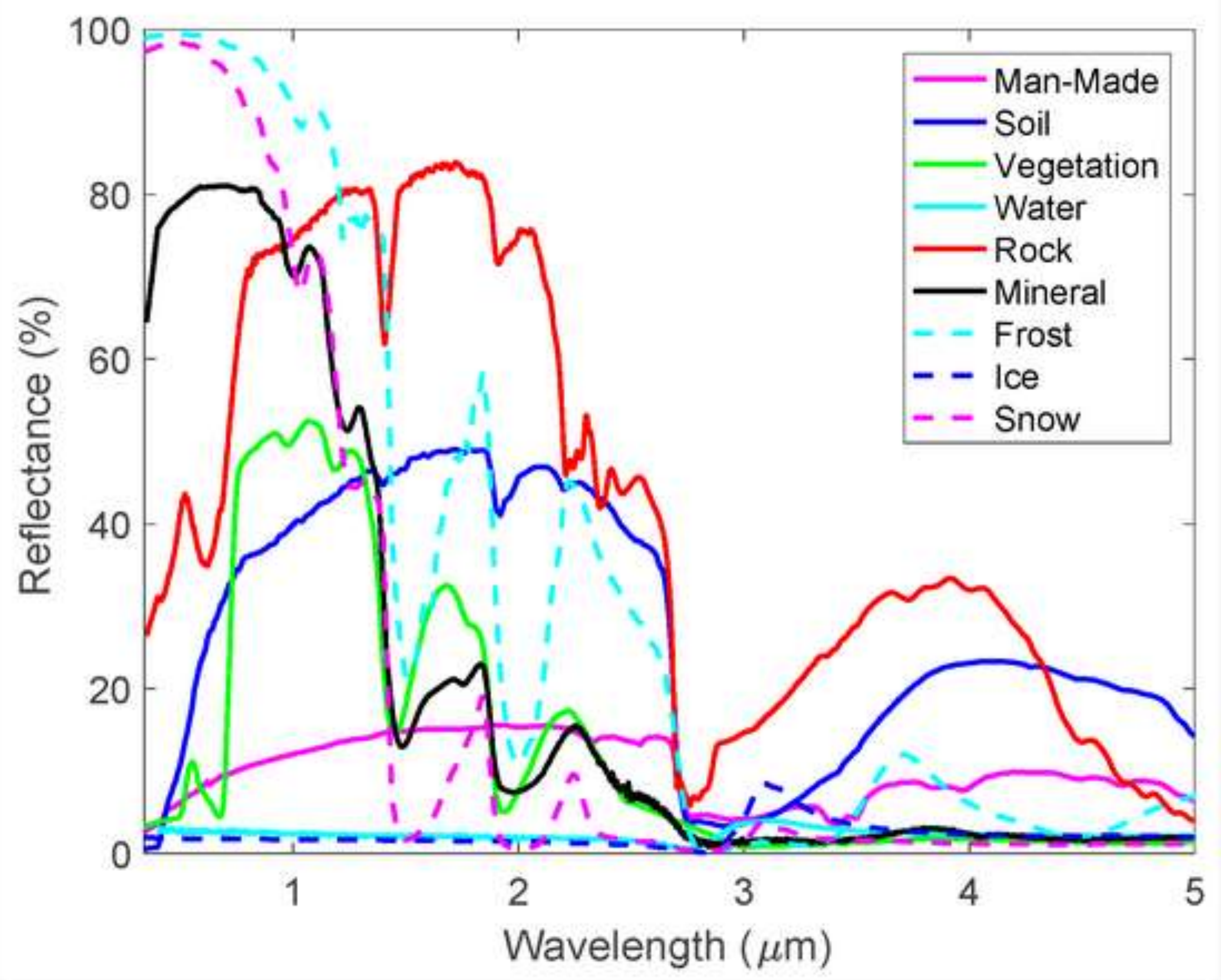
http://spectralevolution.s3.amazonaws.com/assets/Chlorophyll_detection_water.pdf

# Spectral Reflectance Curve: **Crops**




https://www.usgs.gov/media/images/hyperspectral-signatures

**Figure 1.** The typical reflective spectra for various land surface materials from the ASTER Spectral Library. They were used to build the land surface bidirectional reflectance distribution functions (BRDFs).




https://www.mdpi.com/1424-8220/20/16/4456/htm

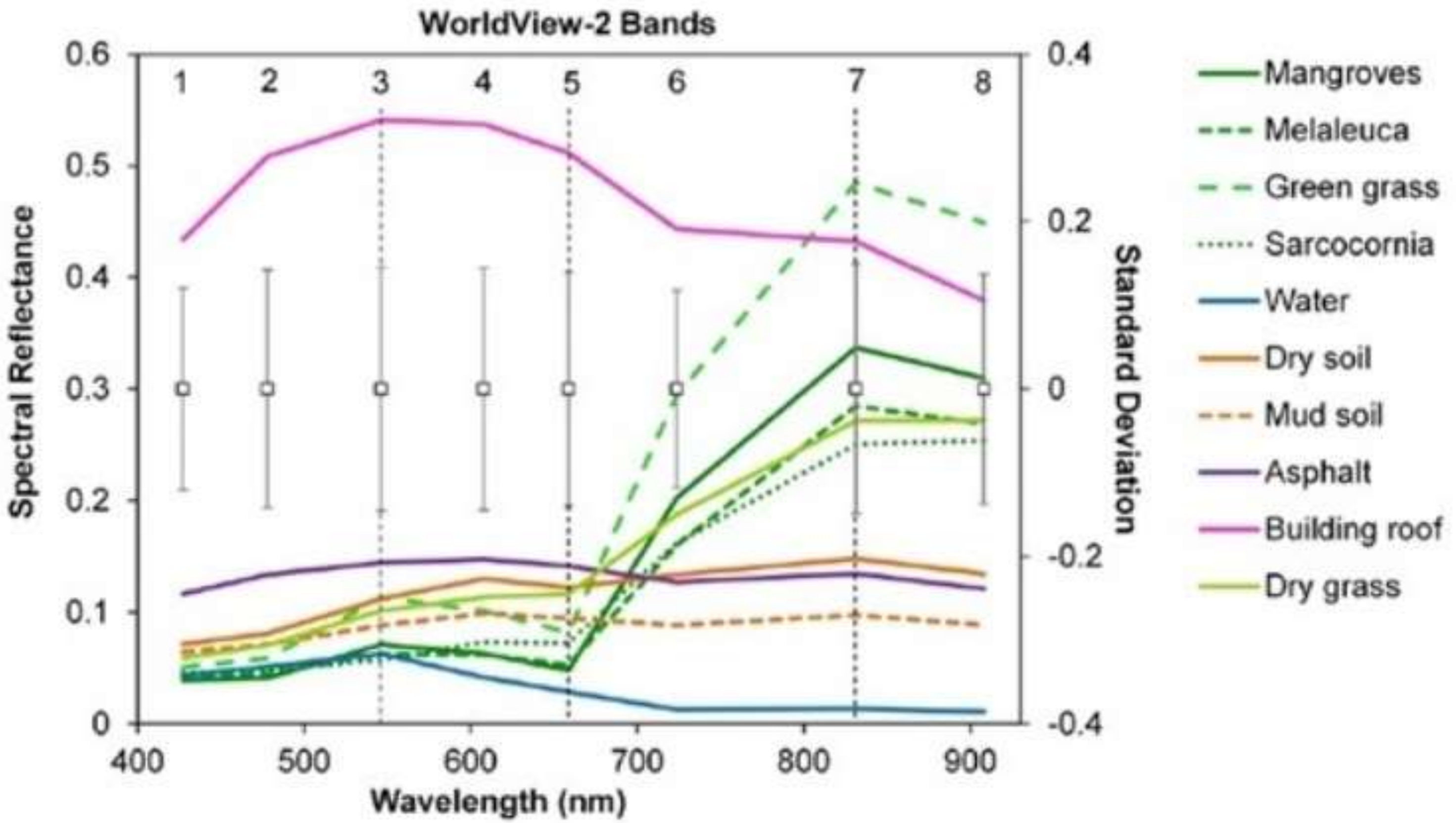
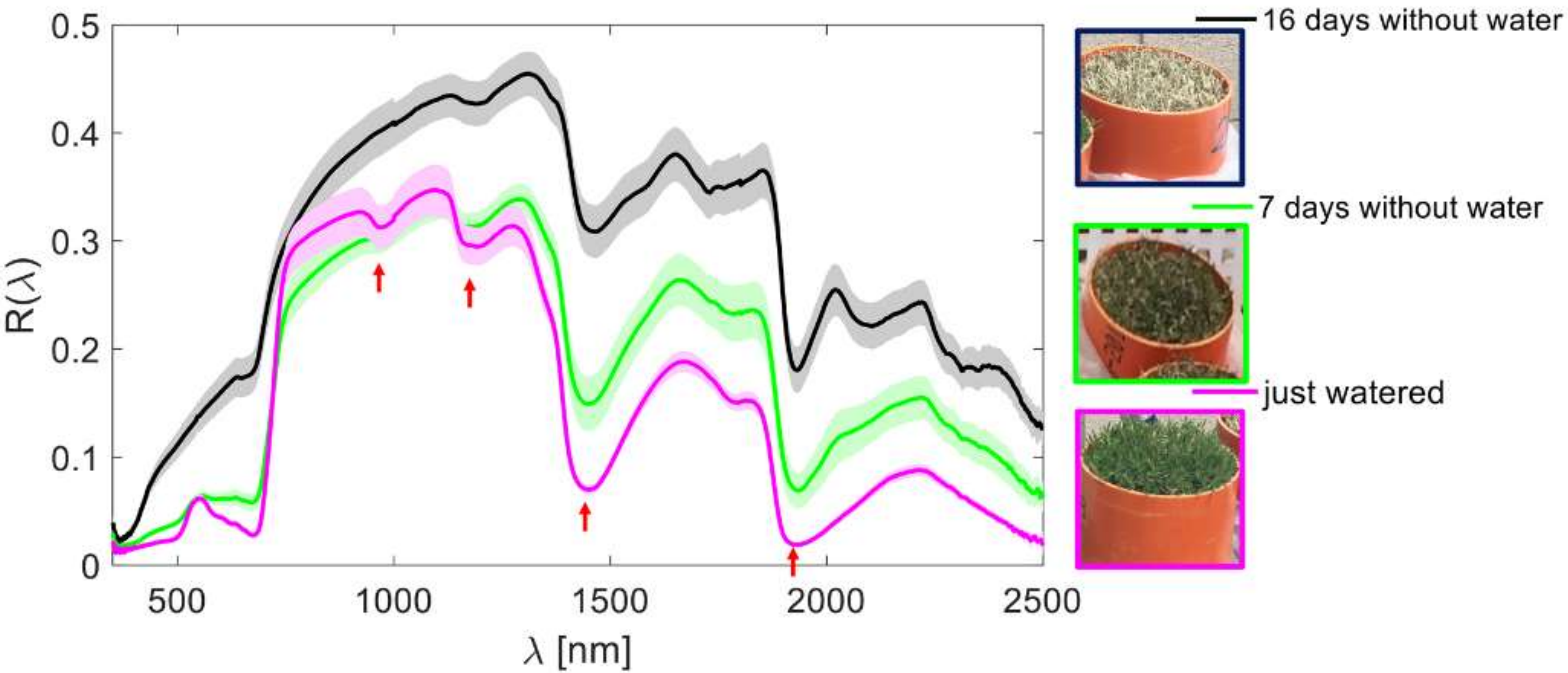
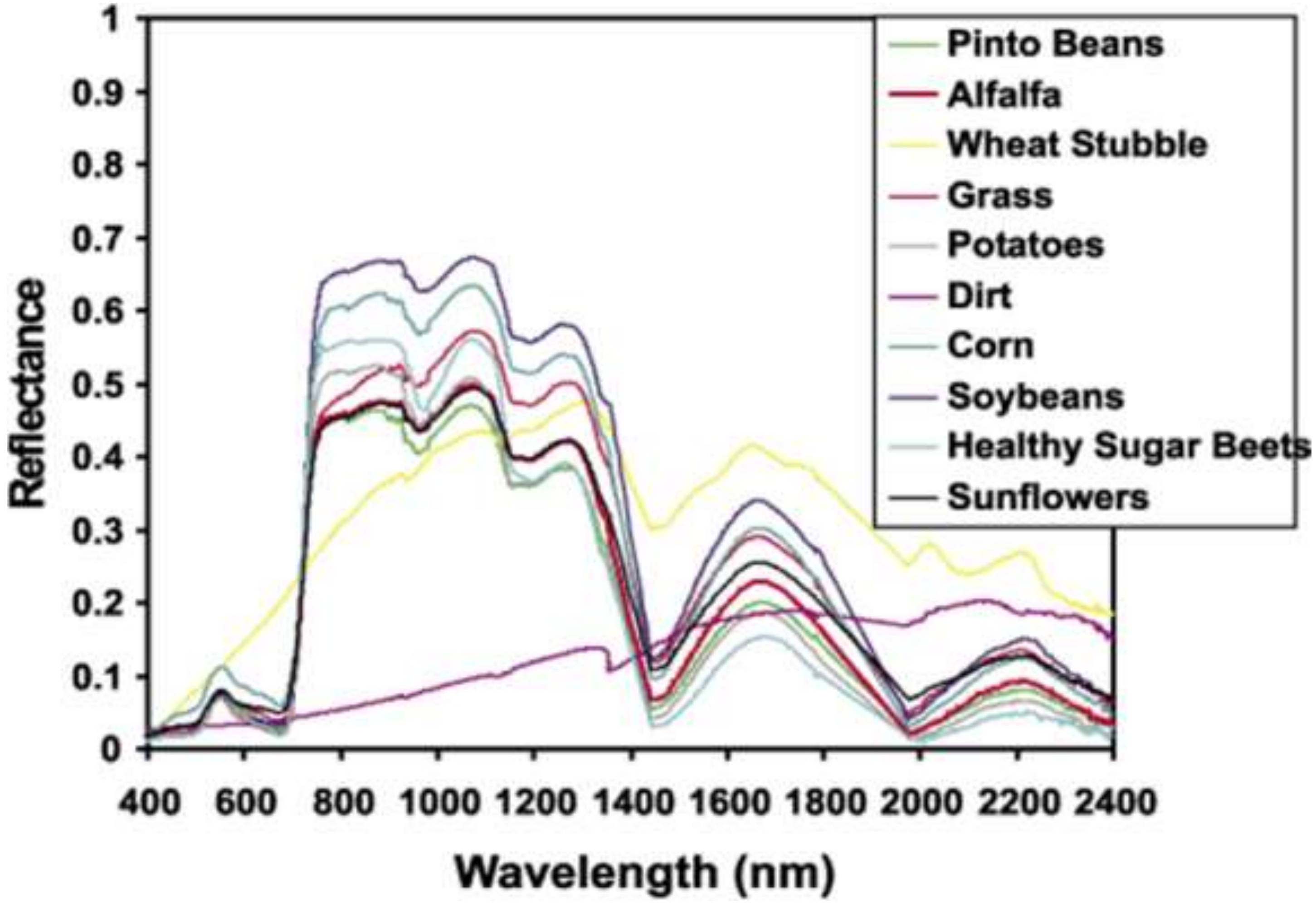



**Figure 1.** Spectral reflectance profiles of a range of landcover types

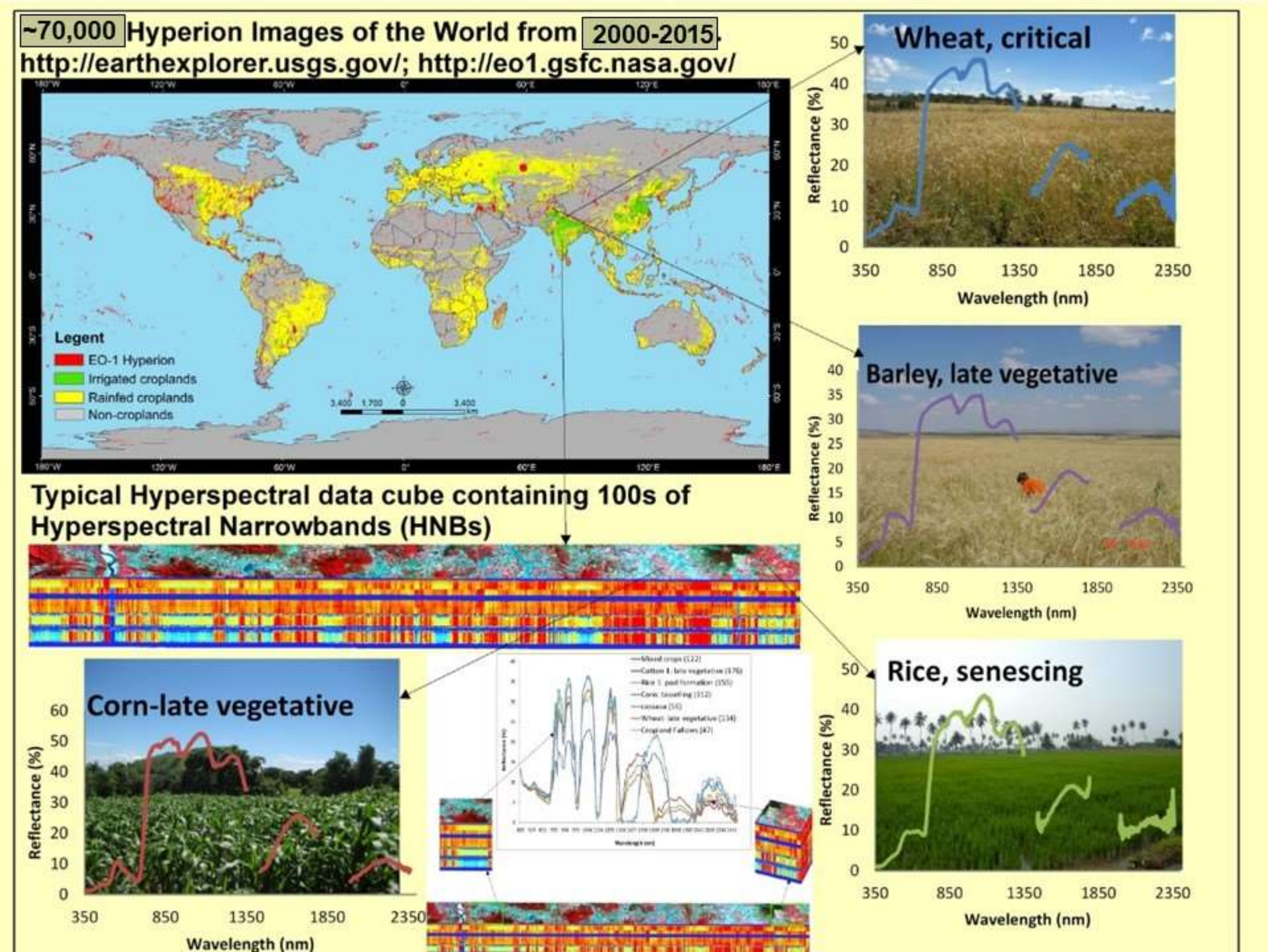
Kamal, M., Phinn, S. and Johansen, K. (2015). Object-Based Approach for Multi-Scale Mangrove Composition Mapping Using Multi-Resolution Image Datasets. Remote Sensing, 7(4), pp.4753-4783.



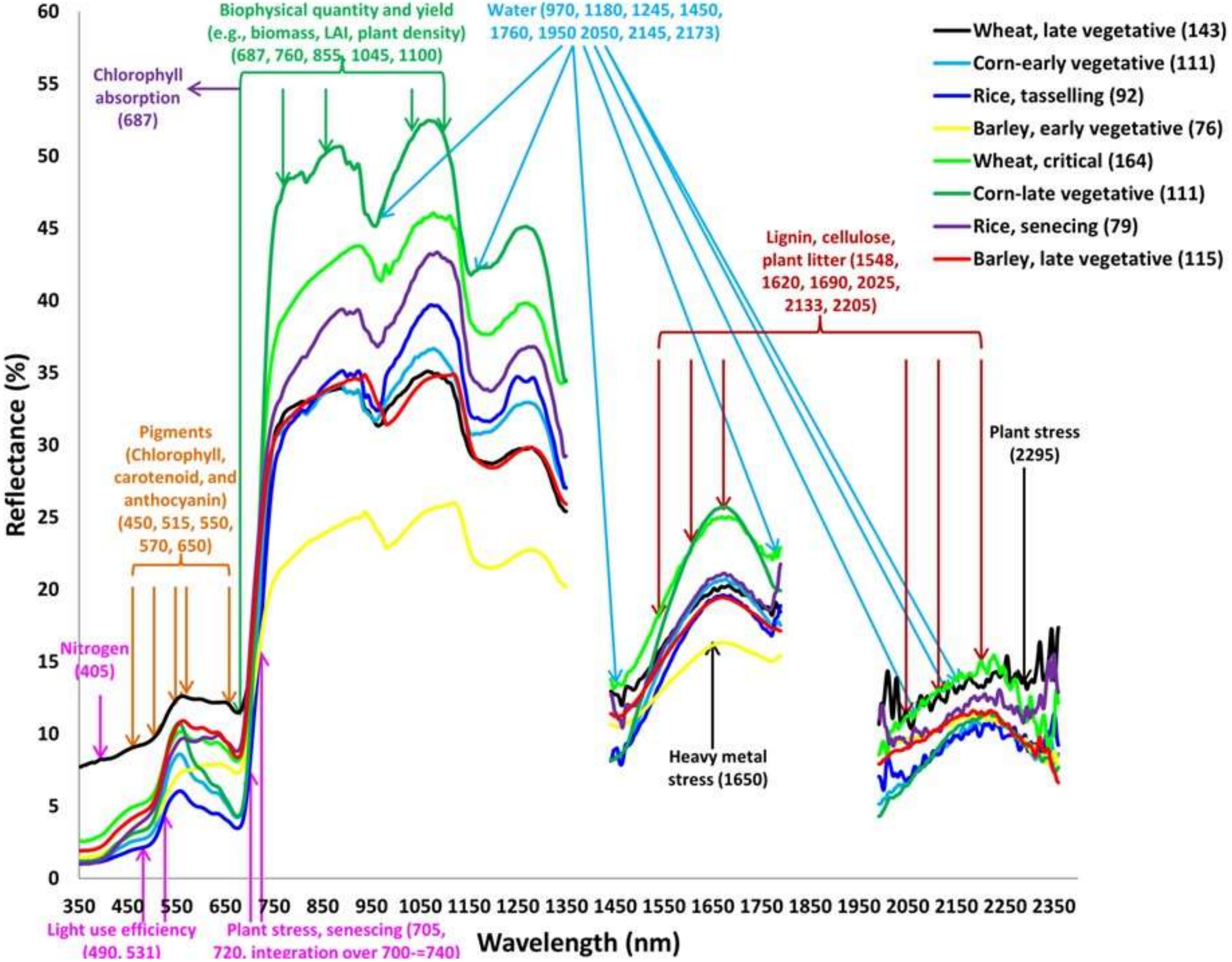

https://www.nature.com/articles/s41598-020-72006-6




https://www.intechopen.com/chapters/19222

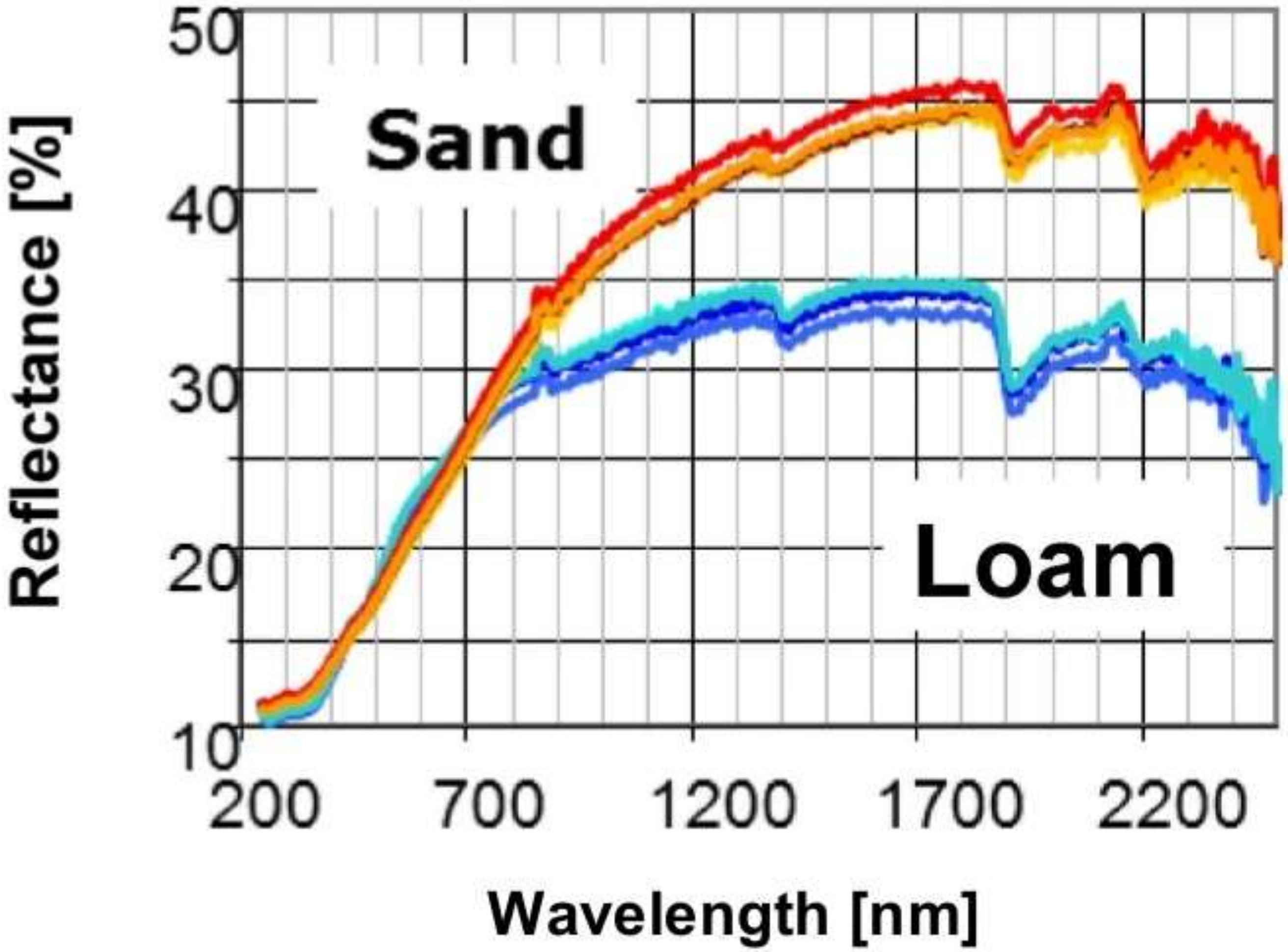



https://www.usgs.gov/centers/western-geographic-science-center/science/global-hyperspectral-imaging-spectral-library



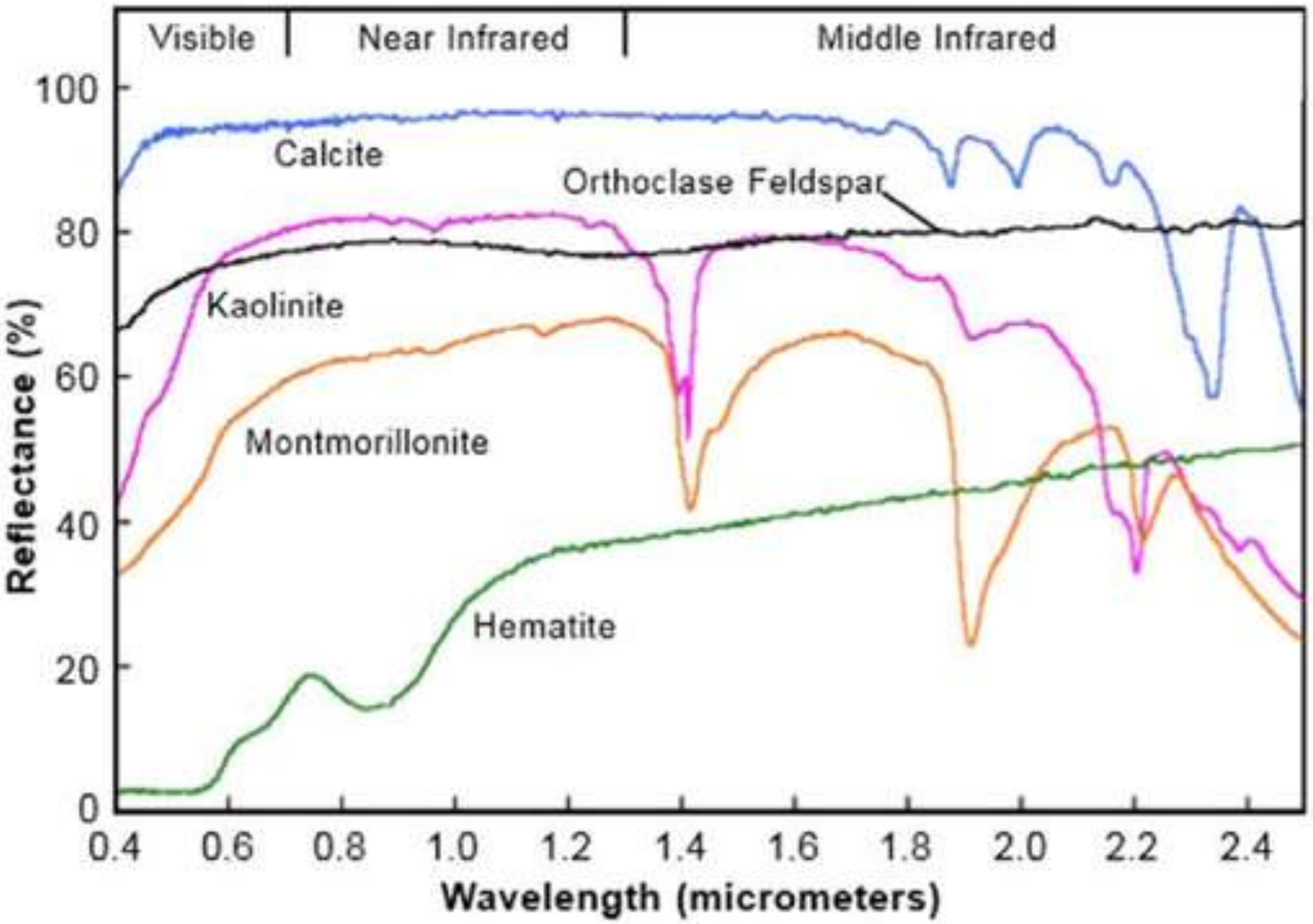

https://www.usgs.gov/media/images/hyperspectral-signatures-0

# Spectral reflectance of Soil

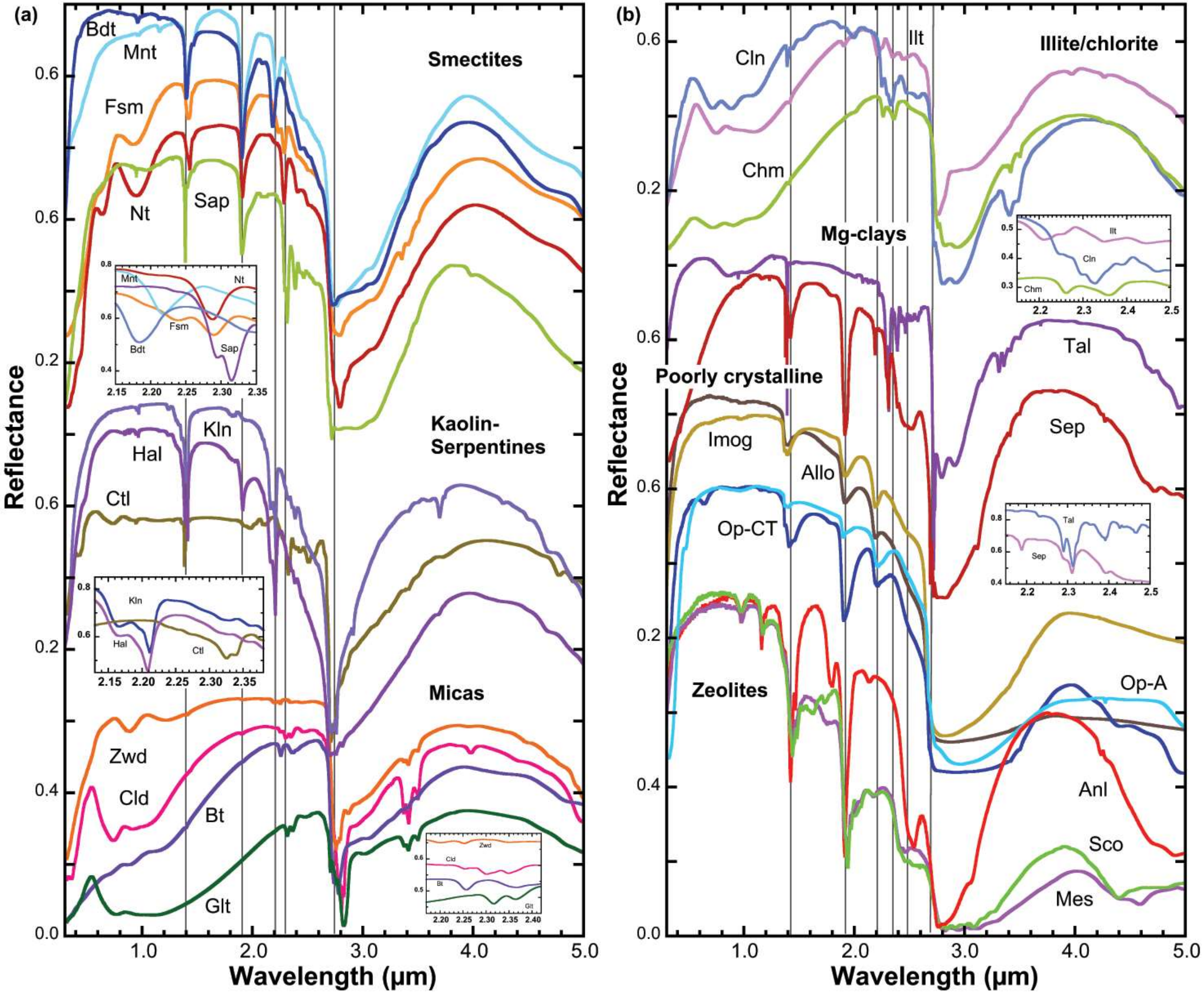



*Gebbers, 2012*

# Spectral Reflectance Curve: Minerals




Spectral reflectance of different clay minerals. (Source: Clark, 1999).




https://www.cambridge.org/core/books/abs/remote-compositional-analysis/visible-and-nearinfrared-reflectance-spectroscopy/82C806F534AFFD6192C9303FEEAD177D https://www.slideshare.net/harihariharasudhan/application-of-spectral-remote-sensing-in-agronomic-decision-by-drvhariharasudhan-tnau-coimbatore3