Image Rectification & Enhancement

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Outline

- Image pre-processing
- Geometric correction
- Image enhancement
  - Spectral ratioing & indices

Image pre-processing

- precedes image manipulation & analysis
  - Ie, precedes enhancement or classification
  - And typically involves some or all of:
    - Radiometric correction,
    - Noise removal, &
    - Geometric correction (rectification)

Image pre-processing, cont'd...

- Radiometric correction
  - accounts for variations in measured radiance at the remote sensing system due to changes in:
    - scene illumination
    - Atmospheric conditions
    - Viewing geometry &
    - Sensor response characteristics
- Noise removal (largely for early sensors)
  - Removes any unwanted disturbance in the image data resulting from
    - Limitations in the remote sensing
    - Signal digitisation, or
    - Data recording process
- The above 2 are usually done at image processing centres (or big research projects)
- For most remote sensing images in day-to-day applications, the bulk of image pre-processing work is in Geometric correction (rectification) and geo-referencing

Lillesand & Kiefer, 2000; and Mather, 1999

Geometric correction (rectification)

- Raw remote sensing images contain geometric distortions resulting from many factors that include:
  1. Variations in sensor parameters (altitude, velocity)
  2. Non-linearities in the sweep of a sensors Instantaneous Field of View (IFOV)
  3. Atmospheric refraction
  4. Panoramic distortion
  5. Earth curvature
  6. Relief displacement
- Geometric correction seeks to
  i. eliminate, or at least compensate, for these distortions
  ii. Transform, (resample) remote sensing image into a known map projection and datum for purposes of
    - Geo-referencing
    - Ease of access & manipulation just like any other raster map in GIS
- Distortions (1) - (3) are compensated for at image processing centres
- Distortions (4) and (5) are compensated for by transforming an image into a map projection (known sphere or spheroid for the shape of the earth and datum)
- Ground control points (GCPs) or DEM compensate for (6) through ortho-rectification

Image Enhancement

- Why the talk on image pre-processing then?
  - Because enhancement DOES NOT create any new information
    - If the image is distorted or has noise you will essentially be enhancing the distortion and/or noise
- Why enhance an image then, if its well pre-processed?
  - To make it more interpretable for a specific application
    - It makes important features of raw, remotely sensed images more interpretable to the human eye (feature extraction)

Image Enhancement, cont'd...

- Enhancement functions
  - Radiometric – based on individual pixels
    - Contrast, Default , No, Linear, Histogram Equalization & Special stretch etc
  - Spatial – based on values of individual and neighbouring pixels
    - Convolution filtering & resolution merge
  - Spectral – transforms the values of each pixel on a multiband basis (multispectral images)
    - Spectral ratioing and indices – performs band ratios (vegetation & mineral studies)
    - Principal components – compresses redundant data values into fewer bands
    - Tasselled cap – rotates the data structure axes to optimise data viewing (vegetation studies)

Image Enhancement, cont'd...

- choice of one over the other depends on
  - Application
  - Type & availability of images
  - Experience & preferences of the image analyst (or user), &
  - The particular algorithm

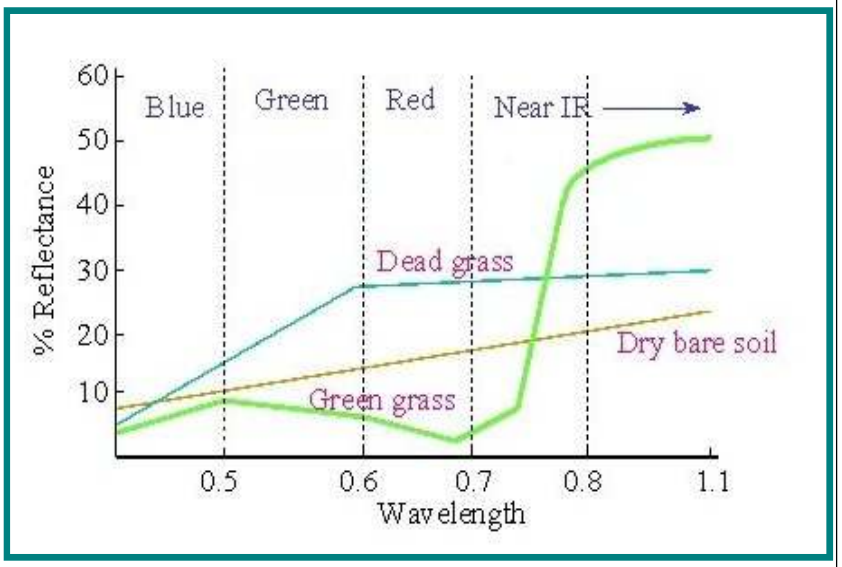
- We will look at Spectral Ratioing and indices – Spectral enhancement
  - Has wide applications in vegetation studies

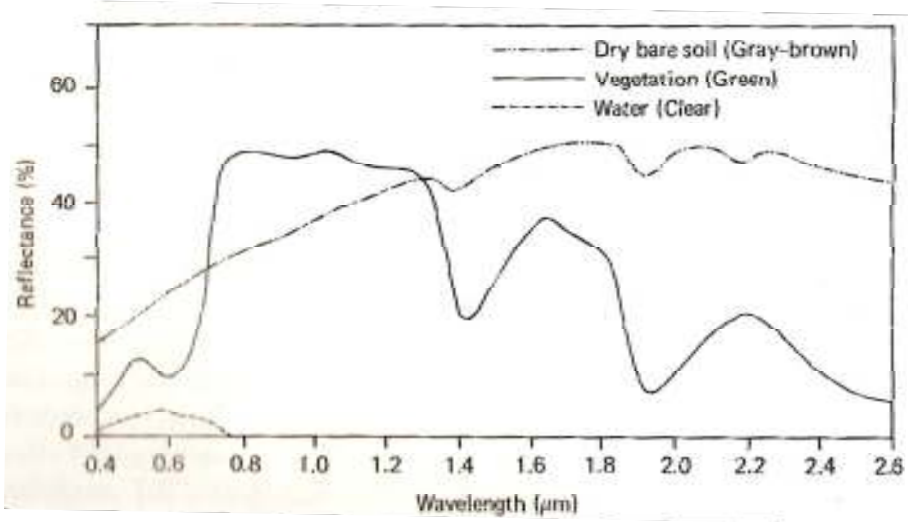
Spectral Ratioing and indices Practical – Model Maker

Click here for manual

Normalised Difference Vegetation Index

- **NDVI = (Band 4 - Band 3) / (Band 4 + Band 3)**
  - Negative values of NDVI (values approaching -1) correspond to water.
  - Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow.
  - Lastly, low, positive values represent shrub and grassland (approximately 0.2 to 0.4),
  - while high values indicate temperate and tropical rainforests (values approaching 1)





Normalised Difference Vegetation Index, cont'd...

- Advantages
  - Simplicity - distinguishes vegetated areas from other surface types (sea, bare soil)
  - Data compression (by a factor of 2 or more)

Normalised Difference Vegetation Index, cont'd...

- Disadvantages
  - NDVI utilises & carries only a fraction of the initial information
    - Relevance or value of the missing information is up to the user to judge
  - Scale issues: applications correlate NDVI & ground-measure values sampled from areas smaller than the sensor-covered areas
  - NDVI values are very sensitive to perturbations
    i. Atmospheric effects,
    ii. Clouds,
    iii. Soil effects (reflectance varies with wetness),
    iv. Anisotropic effects (surfaces reflect light differently in different directions),
    v. Spectral effects (each sensor, for each band measurement, has its own characteristics and performances)
- Therefore, use NDVI with great caution

Thank you!!