

EGM702 – Photogrammetry and Advanced Image Analysis

Week 3, Part 4: Spectral Indices

Normalized Difference Indices

- Difficult to compare band differences ($B_2 - B_1$) between seasons, locations
 - Environmental factors (slope/aspect, shadow)
 - Differences in seasonal illumination
- Band ratio (B_2/B_1):
 - Limits seasonal/environmental factors
 - Effectively unbounded: $[0, \infty)$
 - Values between $[0, 1]$ are compressed (harder to visualize differences)
- Normalized Difference Index:
 - Limits seasonal/environmental factors
 - Bounded values: $[-1, 1]$
 - Centered on 0

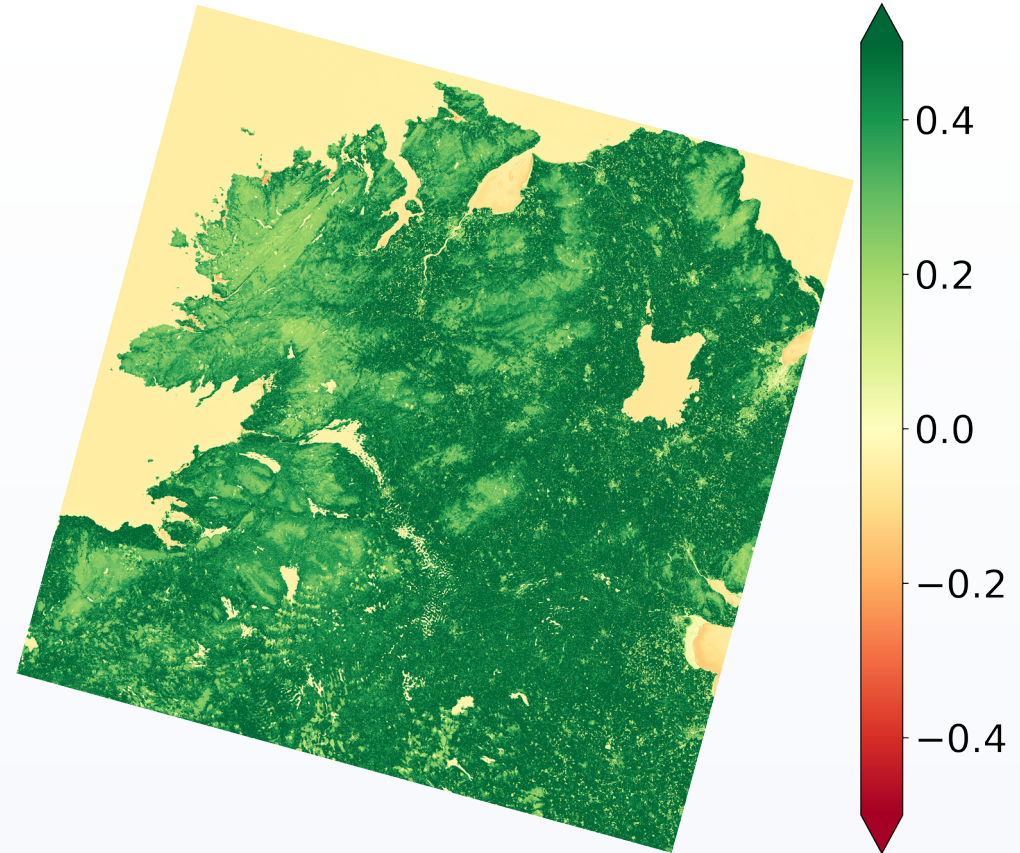
$$NDI = \frac{B_2 - B_1}{B_2 + B_1}$$

Normalized Difference Vegetation Index (NDVI)

- Formula:

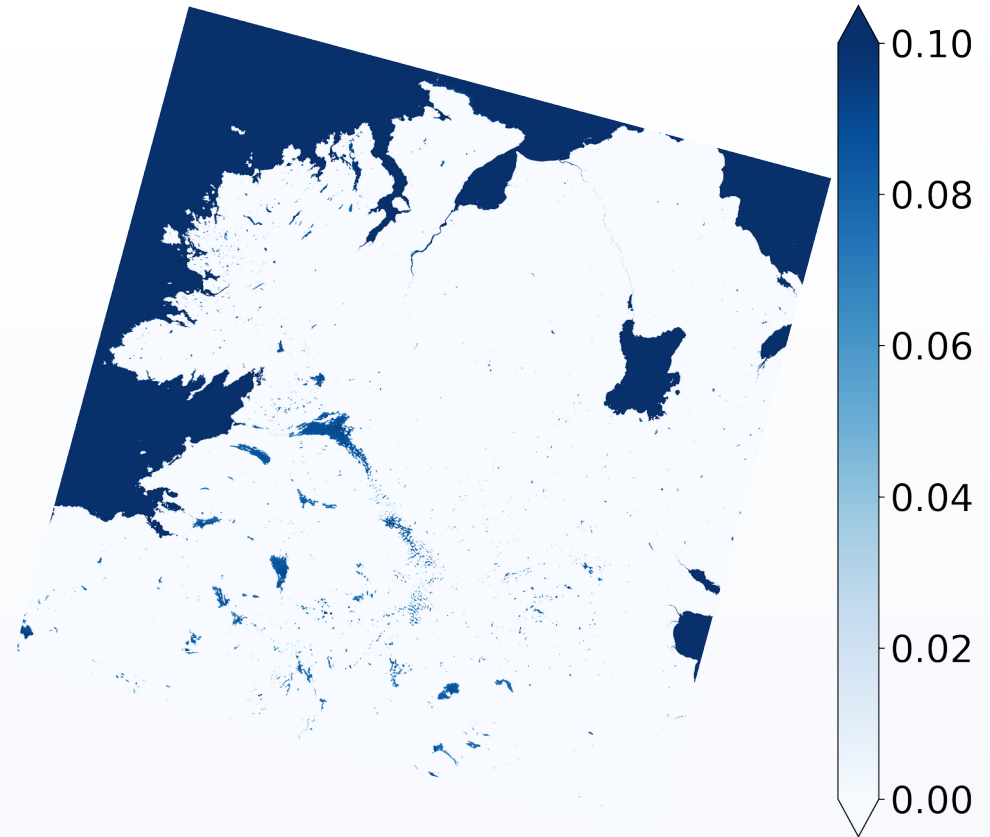
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

- NDVI > 0: healthy vegetation (usually)
- NDVI < 0: something else
 - Clouds, snow/ice
 - Soils
- Uses:
 - Mapping healthy vegetation
 - Deriving information about vegetation



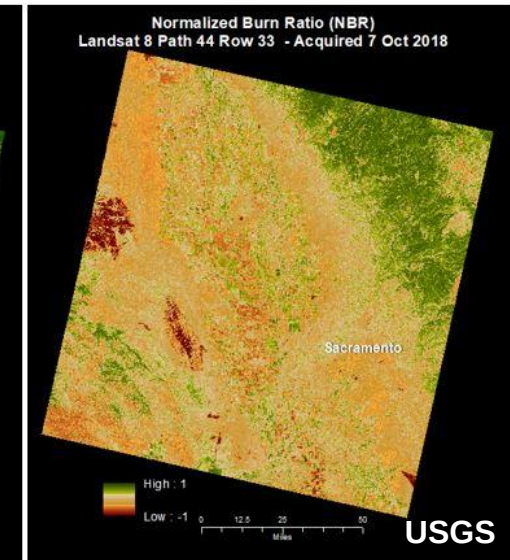
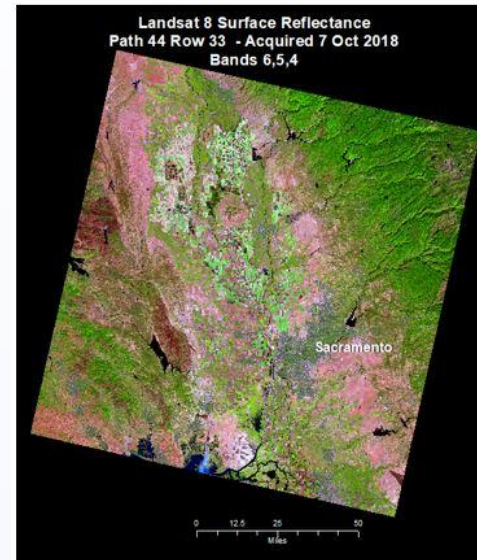
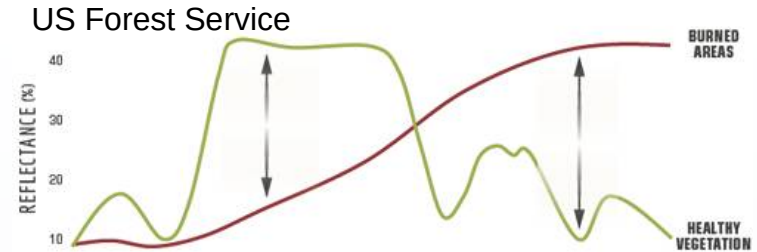
Normalized Difference Water Index (NDWI)

- For water, $\rho(\text{green}) \gg \rho(\text{NIR})$
- Formula:
$$\text{NDWI} = \frac{\text{Green} - \text{NIR}}{\text{Green} + \text{NIR}}$$
- Used for:
 - Automatically mapping water bodies
 - Flood detection
- Using NIR, SWIR: leaf water content (Gao, 1996)



Normalized Burn Ratio

- Used to estimate burn severity
 - Difference between NIR, SWIR:
- $$NBR = \frac{NIR - SWIR}{NIR + SWIR}$$
- Normally difference pre, post-fire images (dNBR)
 - Field assessment helps with interpretation



Normalized Difference Built-up Index

- For built-up spaces,
 $\rho(\text{SWIR}) > \rho(\text{NIR})$
- ND Built-up Index:

$$\text{NDBI} = \frac{\text{SWIR} - \text{NIR}}{\text{SWIR} + \text{NIR}}$$

- To ensure that
vegetation is removed:

$$\text{NDBI} = \frac{\text{SWIR} - \text{NIR}}{\text{SWIR} + \text{NIR}} - \text{NDVI}$$

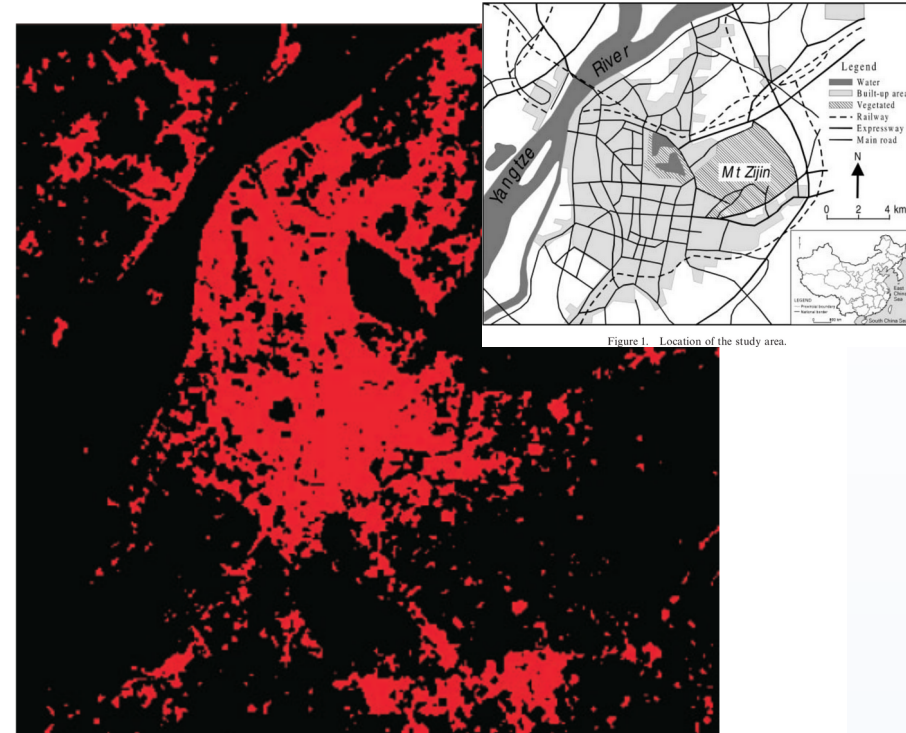


Figure 4. Results of automatically mapped urban land use after spatial filtering with a window size of 5 pixels by 5 pixels.

Zha et al., 2003

- Normalized difference indices combined advantages of band differencing, ratios
- Many, many applications have been derived
- Can also combine them (e.g., $\text{NDBI} - \text{NDVI}$) to further aid interpretation/classification

- Lillesand, Kiefer & Chipman – Chapter 7
- McFeeters, 1996 [[Int J Remote Sensing](#)]
- Gao, 1996 [Remote Sensing of Env]
- Epting et al., 2005 [[Remote Sensing of Env](#)]
- Zha et al., 2003 [[Int J Remote Sensing](#)]