GEOG 357

LECTURE 8

1

- Everything we have covered
- Multiple choice questions
- Short answer questions

40 Minutes

Midterm

October 19th

2

Band Ratios

These are quotients between measurements of reflectance in separate portions of the spectrum.

Effective when there is an inverse relationship between two spectral responses from the same surface

- Ratioing strategy commonly used because of the inverse relationship between vegetation brightness in the red and infrared regions.
- The absorption of red light and strong reflection of infrared radiation ensures that the red and near infrared values will be quite different and that the IR/R ratio of actively growing plants will be high.
- The NIR/R ratio is one of many measures of vegetation vigor

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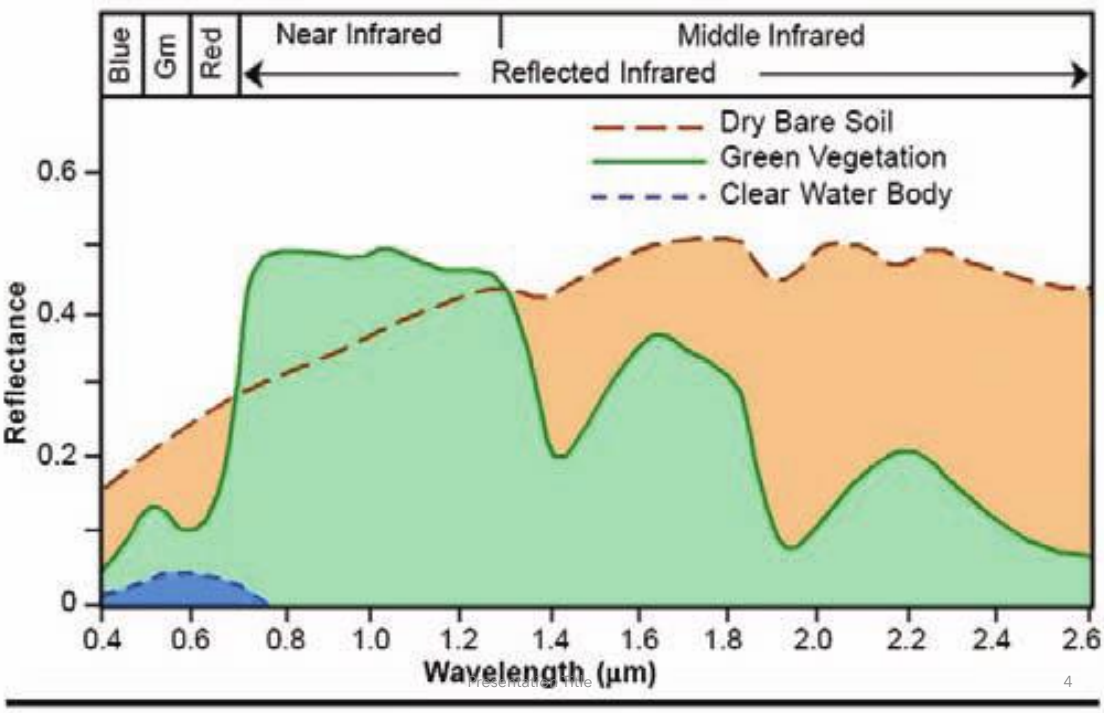

Govender, Chetty and Bulcock, 2007. A review of hyperspectral remote sensing and its application in vegetation and water resource studies. Water S.A. 33(2)

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Band Ratios

RVI = NIR/Red

- Higher values for vegetation
- Lower values for soil, ice, water, *etc*.
- Indicates amount of vegetation
- Reduces the effects of atmosphere and topography

Soil and Vegetation Reflectance

- Soil reflectance is usually high in NIR region (like vegetation),
  - dry soil has higher reflectance than wet soil
- Usually, soil has a low red reflectance (like vegetation)
  - Note that the difference between NIR & Red reflectance for soil is much less than for live vegetation
- Soil reflectance is affected by colour, roughness & water content

Vegetation Indices

- Like Band Ratios:
  - they are based on digital numbers
  - attempt to measure biomass or vegetative vigor
- Formed from combinations of several spectral values that are added, divided, or multiplied
- Designed to yield a single value that indicates the amount or vigor of vegetation within a pixel
- High values identify pixels covered by substantial proportions of healthy vegetation

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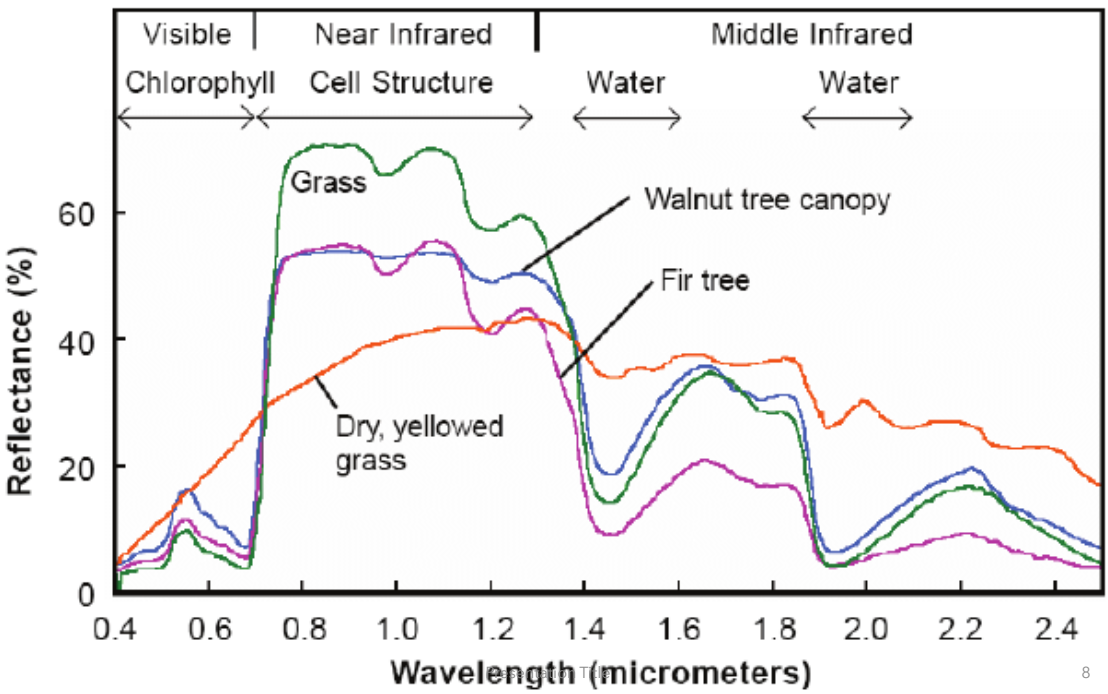

Govender, Chetty and Bulcock, 2007. A review of hyperspectral remote sensing and its application in vegetation and water resource studies. Water S.A 33(2)

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Vegetation Indices

- Ratio Vegetation Index (RVI)
  - **NIR / Red** > 1 = vegetated
    - * RVI can create infinite values (if Red Band DN is low)

- Difference Vegetation Index (DVI)
  - **NIR-Red** > 0 = vegetated
    - * DVI is heavily influenced by different lighting

- 'Combining' these two creates the most common vegetation index:

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Difference Vegetation Index

- Indices based on accentuating the difference between red and NIR reflectance
  - Difference Vegetation Index (DVI)
    - DVI = NIR – Red
    - Sensitive to the amount of vegetation
    - Distinguishes between soil and vegetation
    - Does it deal with the effects caused by the angle of illumination?

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Normalized Difference Vegetation Index

- NDVI = (NIR – Red)/(NIR + Red)
  - Ranges from -1 to 1
  - Indicates amount of vegetation,
  - distinguishes veg from soil,
  - minimizes topographic effects

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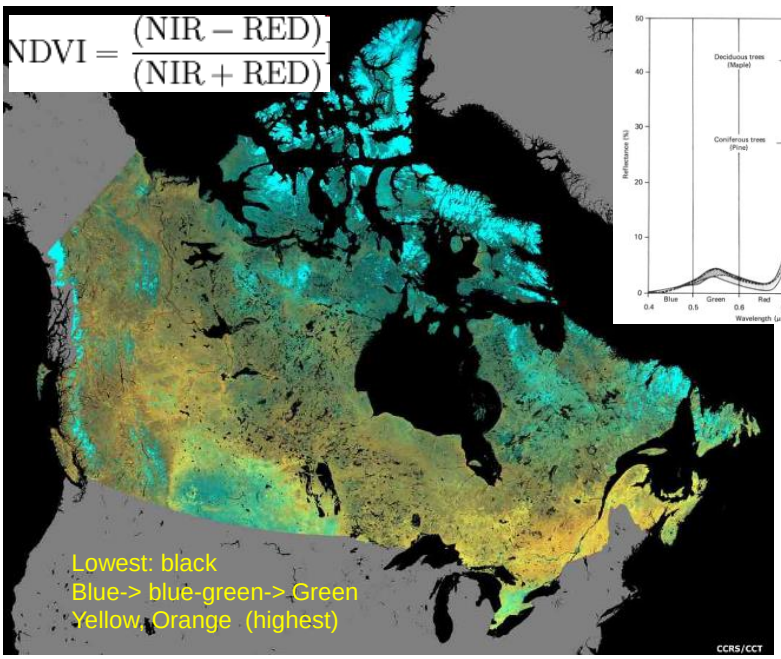
Normalised Difference Vegetation Index: NDVI



Max= 1.0

Min= -1.0

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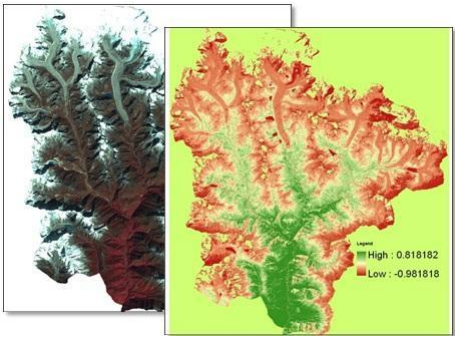
Normalised Difference Vegetation Index NDVI

Division compensates for differential illumination and yields values between -1 and 1, … in a 32 bit channel

= a close estimate of **biomass** also referred to as **greenness**



- Negative values of NDVI (values approaching -1) correspond to water.
- Values close to zero (0 to 0.1) = barren areas of rock, sand, or snow.
- low, positive values represent shrub and grassland (~ 0.2 to 0.5),
- high values indicate temperate and tropical rainforests (0.6 to 0.9)

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Ecosystem	Typical NDVI values	Location	References
Boreal forest	0.6-0.8	Alaska	Parent and Verbyla, 2010
Temperate forest	0.3-0.7	France	Pettorelli et al., 2006
Coastal rainforest	0.88-0.92	Solomon Islands	Garonna et al., 2009
Alpine pastures	0-0.35	Italy	Pettorelli et al., 2007
Annual grassland	0.15-0.45	California	Gamon et al., 1995
Desert	0.06-0.12	Sinai, Egypt	Dall'Olmo and Karnieli, 2002

Table 1 - Typical NDVI values for different ecosystems (Pettorelli, 2013)

https://medium.com/regen-network/remote-sensing-indices-389153e3d947

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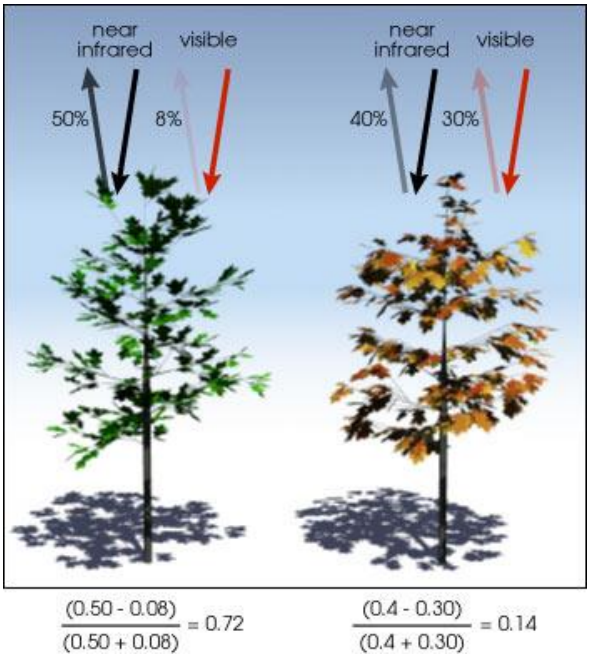
Annual and interannual changes in NDVI



Canada

NDVI values increase with 'green-up' in spring
Hit peak in mid-late July
Start to drop in August, and into the fall

From mid-summer
-> Near-IR decreases
-> Red increases
(until leaf fall)
->Implications for wildlife habitat and movement

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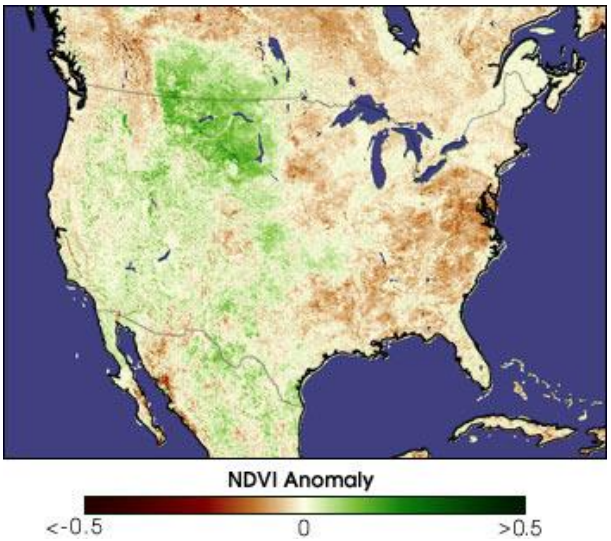

Monitoring monthly and yearly changes and anomalies in NDVI

Long term changes: may represent global impacts e.g. large scale forest change - clearance / regrowth

The difference between the average NDVI for a particular month of a given year (such as August 1993, above) and the average NDVI for the same month over the last 20 years is the NDVI anomaly. In 1993, heavy rain in the Northern Great Plains led to flooding in the Missouri River. The resulting exceptionally lush vegetation appears as a positive anomaly (green).

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Many satellite sensors have red and Near IR bands to assess global vegetation

Table 1. Low or no-cost satellite sensors and data streams utilized for land surface phenology studies[1]

Sensor	Satellite	Overpass/ Orbit Frequency	Data Source (terrestrial data)	Data Record (years)	Spatial Resolution(s)	Processed Time Step	Latency
AVHRR	NOAA series	Daily	USGS/EROS[2]	1989-present	1 km	1-week, 2-week	~24 hours
AVHRR	NOAA series	Daily	NASA Ecocast[3]	1982-2013	8 km	Twice monthly	N/A
MSS	Landsat 1-5	18 days	USGS/EROS[2]	1972-1992	79 m	Distributed by scene	N/A
TM	Landsat 4-5	16 days	USGS/EROS[2]	1982-2011	30 m	Distributed by scene	N/A
ETM+	Landsat 7	16 days	USGS/EROS[2]	1999-present	30 m	Distributed by scene	~1-3 days
Vegetation	SPOT	1-2 days	VITO[4]	1999-present	1.15 km	10-day	~3 months
MODIS	Terra	1-2 days	LPDAAC[5]	2000-present	250 m, 500 m, 1 km	8-day, 16-day	~7-30 days
MODIS	Aqua	1-2 days	LPDAAC[5]	2002-present	250 m, 500 m, 1 km	8-day, 16-day	~7-30 days

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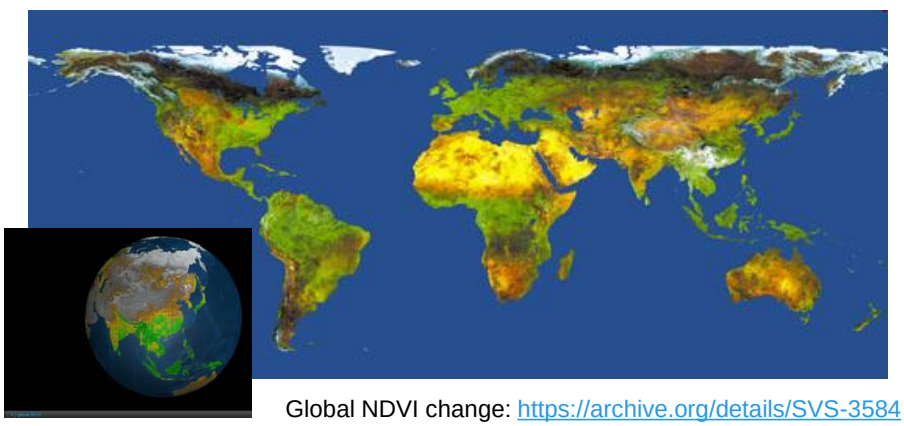
Special sensors for NDVI

SPOT 5 has extra bands / wide sensor in visible/NIR with 1 km resolution to capture a repeat 2400 km swath for global coverage

MODIS and NOAA-AVHRR have 250m/1000m red /near-IR bands for NDVI

NDVI is used to measure vegetation amount or biomass, in regional and global estimates.
"NDVI is directly related to photosynthesis and thus energy absorption of plant canopies"



Global NDVI change: https://archive.org/details/SVS-3584

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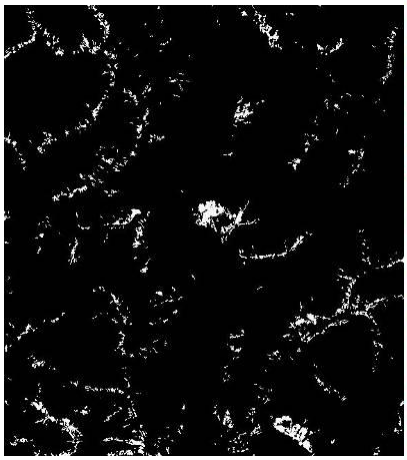
Delineation of Grizzly Bear Habitat in Bute Inlet

GEOG357 project

- Assumes bears are attracted to highest biomass areas e.g. avalanche slopes

Sieved maximum NDVI result



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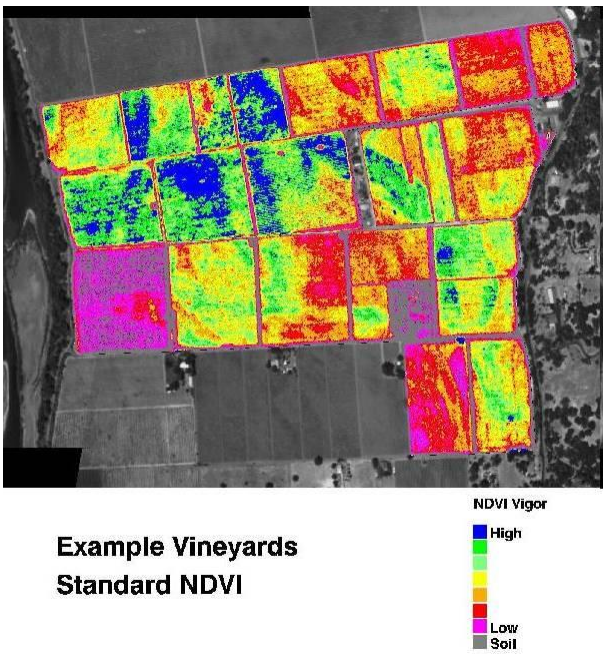
http://grayhawk-imaging.com/use-of-ndvi/



Example Vineyards
Standard NDVI

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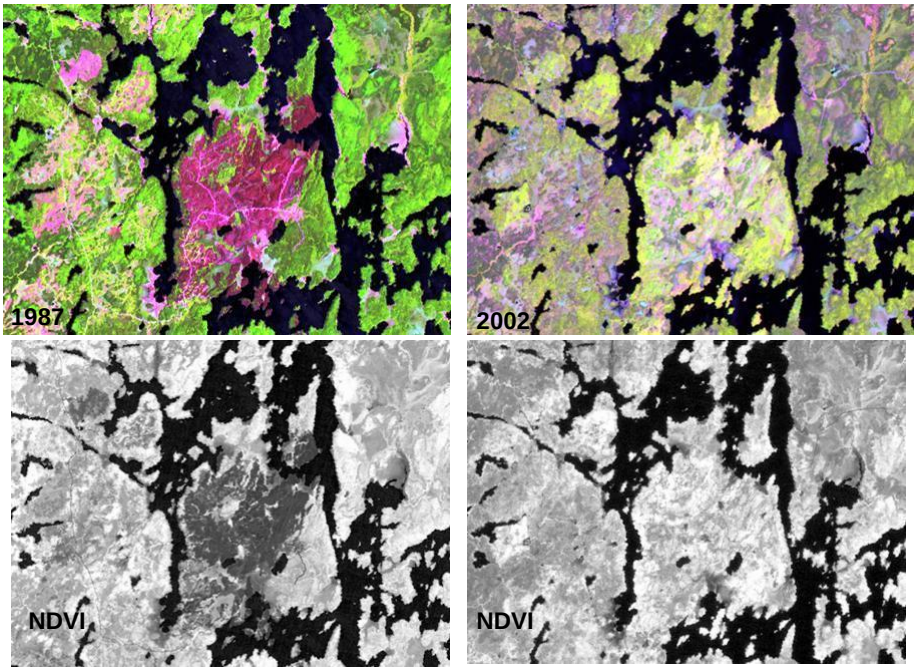
The use of NDVI to determine vegetative green-up after a forest fire Geog357



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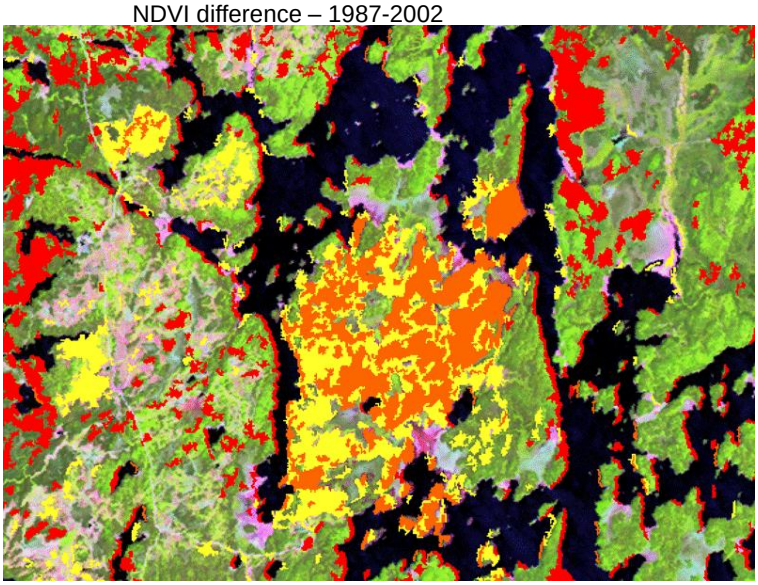
The use of NDVI to determine vegetative green-up after a forest fire

NDVI difference – 1987-2002



Red - Negative Growth Range **Clear -** Neutral Growth Range
Yellow - Minimal Positive Growth **Orange** - Maximum Positive Growth

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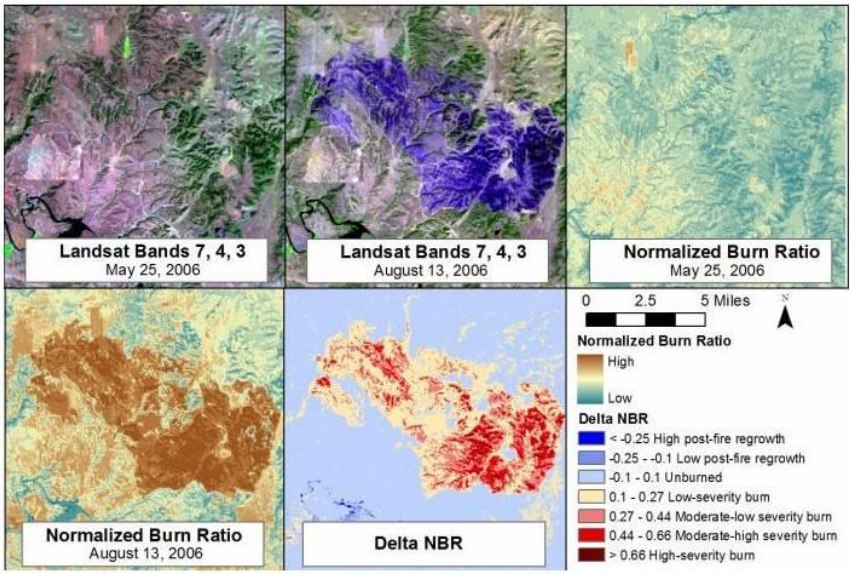
Similar indices: **Normalised** Difference **Burn Ratio (Index)**
(Near IR – Mid-IR2) / (Near IR + Mid-IR2) Landsat TM: NBR = (4-7)/(4+ 7)



http://abstracts.rangelandmethods.org/doku.php/remote_sensing_methods:normalized_burn_ratio

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Other indices include:

Soil-adjusted Vegetation Index **(SAVI)** = 1.5 * (NIR - R) / (NIR + R + 0.5)

Optimised Soil-adjusted Vegetation Index **(OSAVI)** = (NIR - R) / (NIR + R + 0.16)

Green: **NDGI** = (NIR-G) / (NIR+G) TM = (4-2)/ (4+2)

Snow: **NDSI** = (Green-MIR) / (Green+MIR) TM = (2-5) / (2+5)

Water: **NDWI** = (NIR – MIR)/ (NIR + MIR) TM = (4-5) / (4+5)

Burn: NDBR = (NIR – MIR2) / (NIR + MIR2) TM = (4-7) / (4+7)

Many more…
https://medium.com/regen-network/remote-sensing-indices-389153e3d947
https://www.l3harrisgeospatial.com/docs/vegetationindices.html

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