Band ratio review – in a nutshell

Band ratioing = Divide the DNs in one band by the DNs in another band for each pixel to create a new data channel

Purposes:
a. Spectral slope enhancement – highlight the difference between two adjacent bands (cancel out what is similar)
b. Suppress / reduce topographic effect – shadow
c. Include as channel input for classifications
d. Use for thematic analysis / display

Related image arithmetic:
- Band addition, subtraction and multiplication

Banff Focus tools and algorithms:
Raster calculator, or RTR, ARI algorithms

Indices

Ratios

… enhance albedo contrasts by reducing inter-band similarities

e.g. Near-IR / Red … to identify vegetation

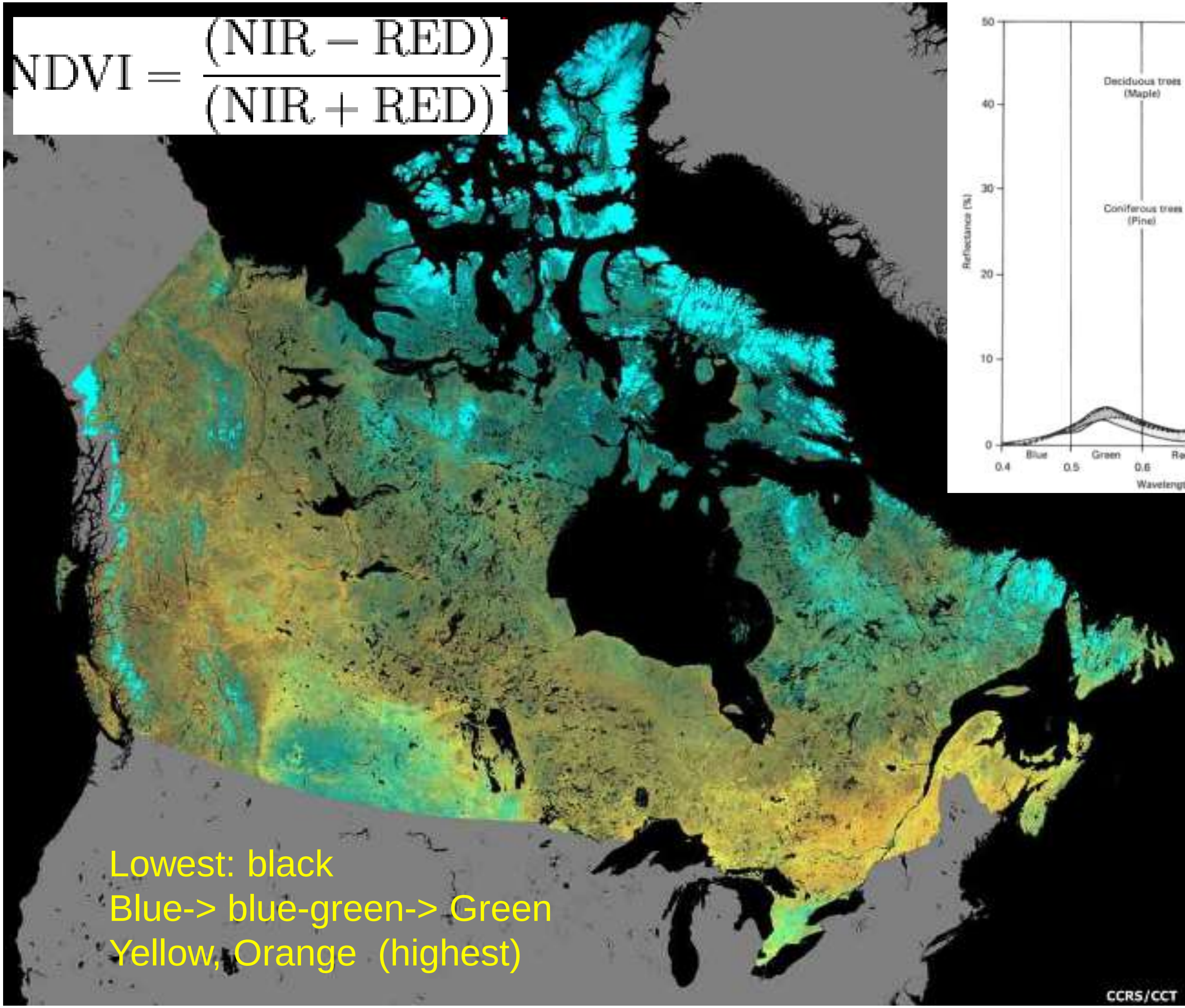
Ratio Vegetation Index (RVI) = **NIR / Red** > 1 = vegetated
* RVI can create infinite values (if Red Band DN is low)

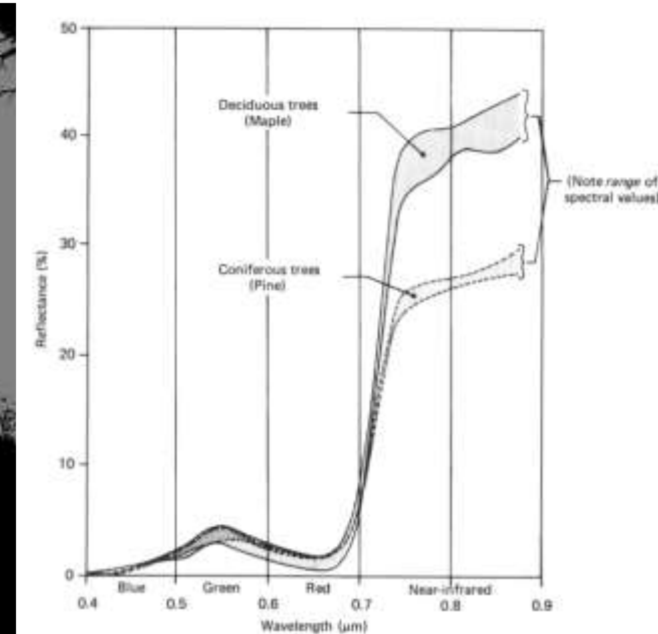
Difference Vegetation Index (DVI) = **NIR-Red** > 0 = vegetated
* DVI is heavily influenced by different lighting

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

Normalised Difference Vegetation Index: NDVI

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$





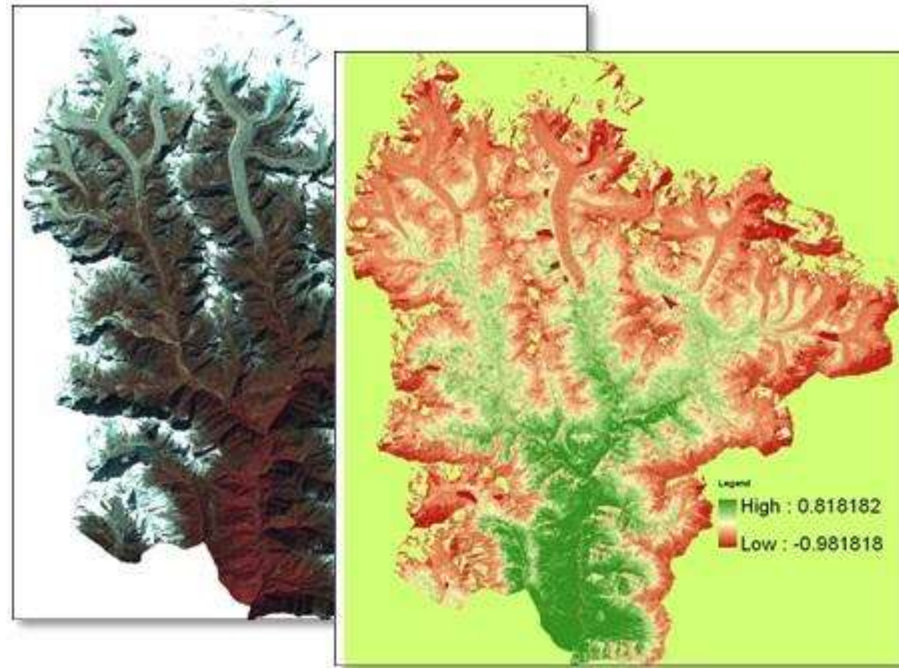
Max= 1.0

Min= -1.0

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**



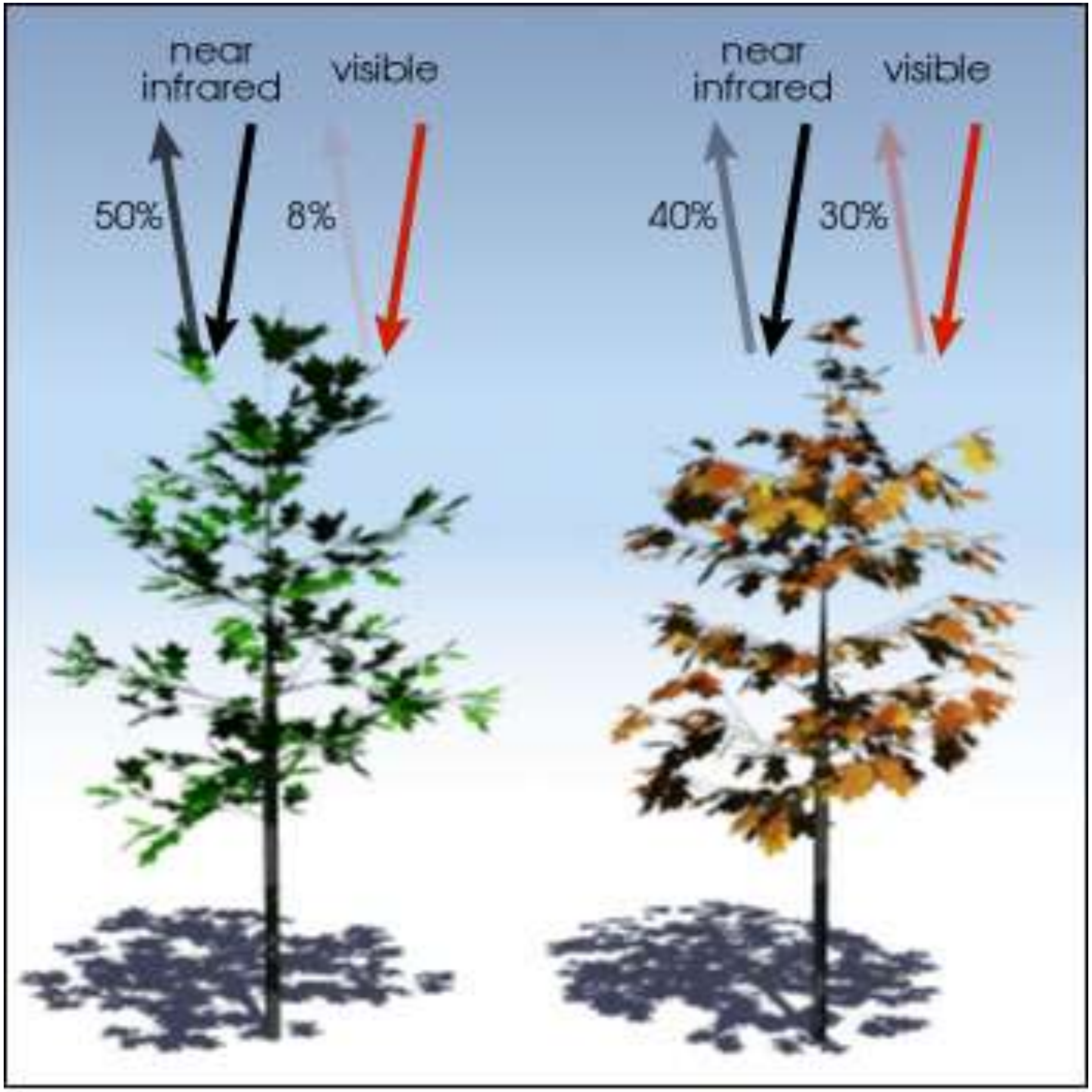
- Negative values of NDVI (values approaching -1) correspond to water.
- Values close to zero (0 to 0.1) = barren areas of rock, sand, or snow.
- low, positive values represent shrub and grassland (~ 0.2 to 0.5),
- high values indicate temperate and tropical rainforests (0.6 to 0.9)

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

Annual and interannual changes in NDVI



$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72$$

$$\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

Canada

NDVI values increase with 'green-up' in spring

Hit peak in mid-late July

Start to drop in August, and into the fall

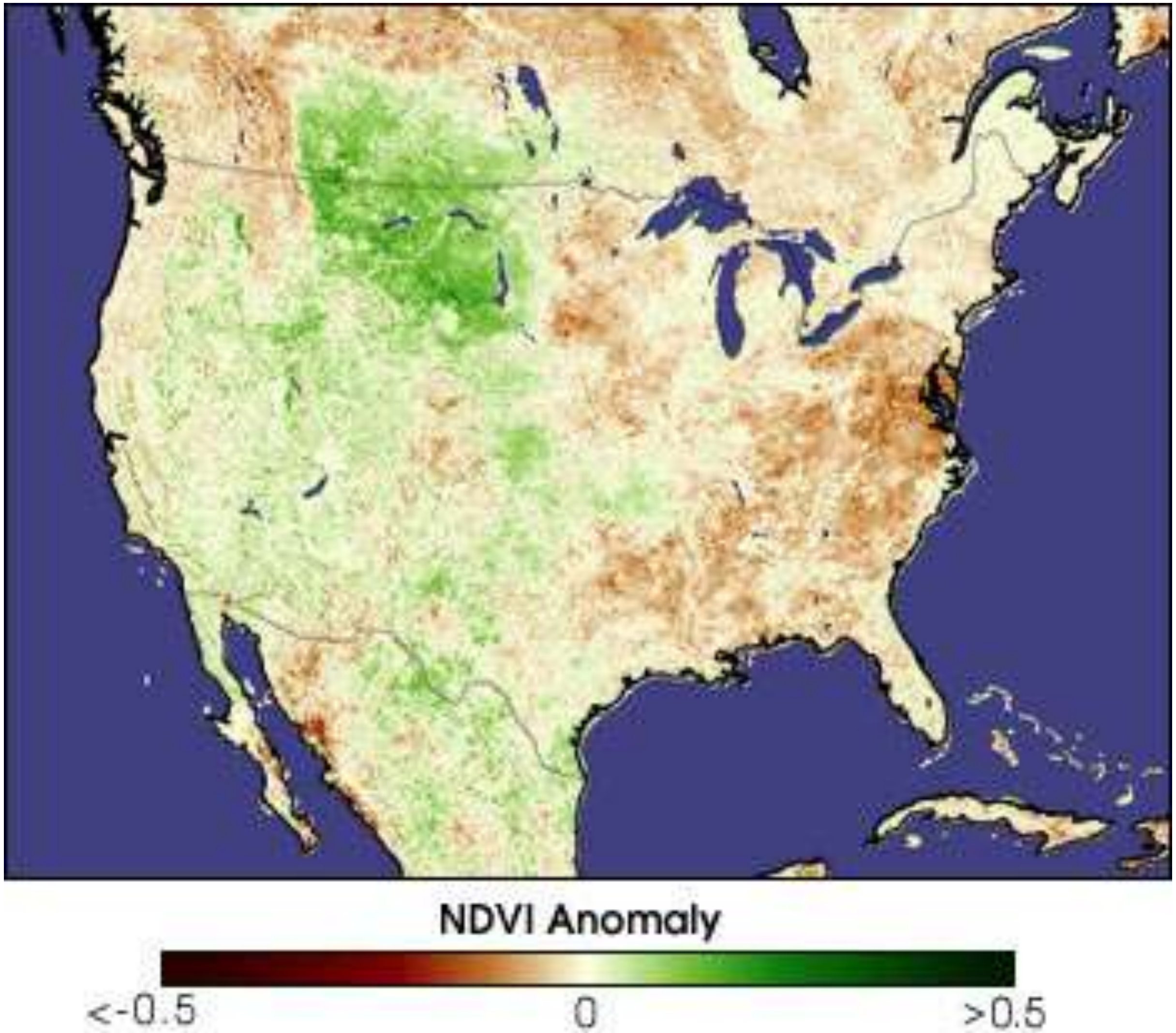
From mid-summer

-> Near-IR decreases

-> Red increases

(until leaf fall)

->Implications for wildlife habitat and movement



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).

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]

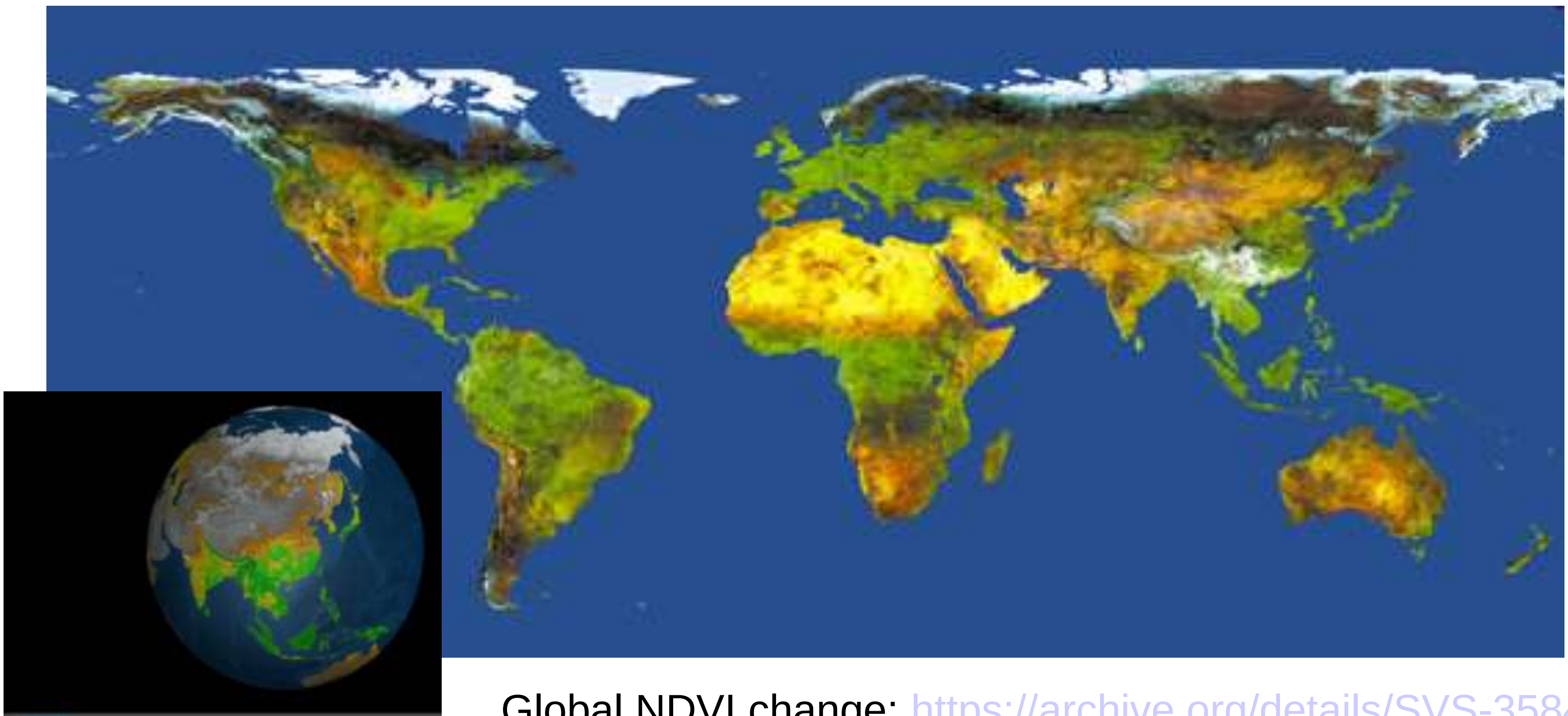
Sensor	Satellite	Overpass/ Orbit Frequency	Data Source (terrestrial data)	Data Record (years)	Spatial Resolution(s)	Processed Time Step	Latency
AVHRR	NOAA series	Daily	USGS/EROS[2]	1989-present	1 km	1-week, 2-week	~24 hours
AVHRR	NOAA series	Daily	NASA Ecocast[3]	1982-2013	8 km	Twice monthly	N/A
MSS	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

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"



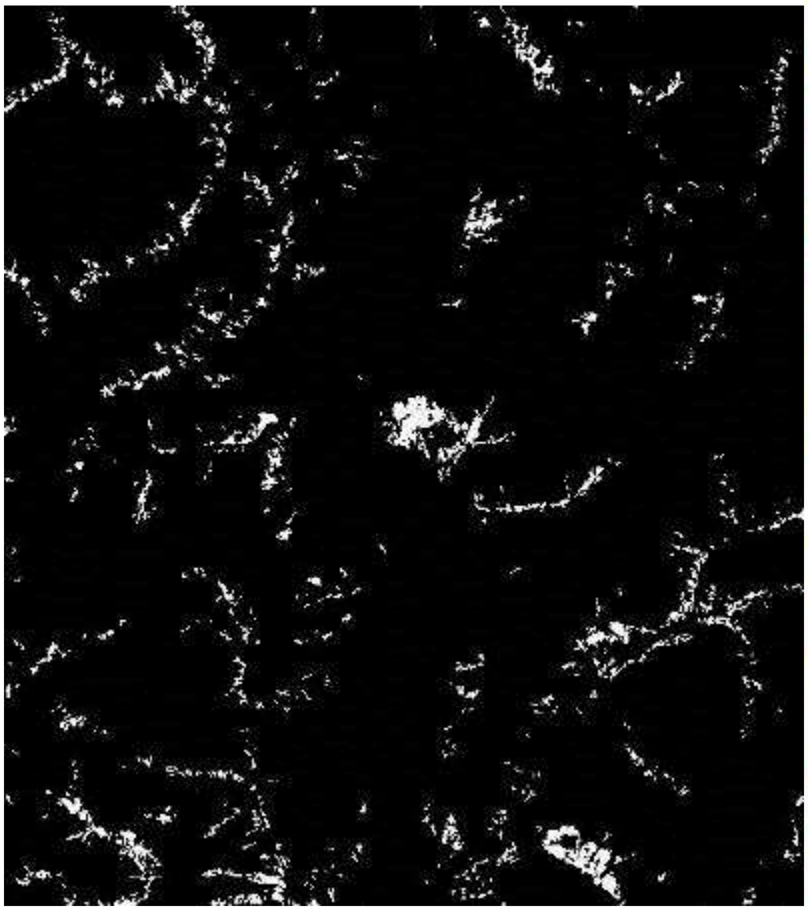
Global NDVI change: https://archive.org/details/SVS-3584

Delineation of Grizzly Bear Habitat in Bute Inlet

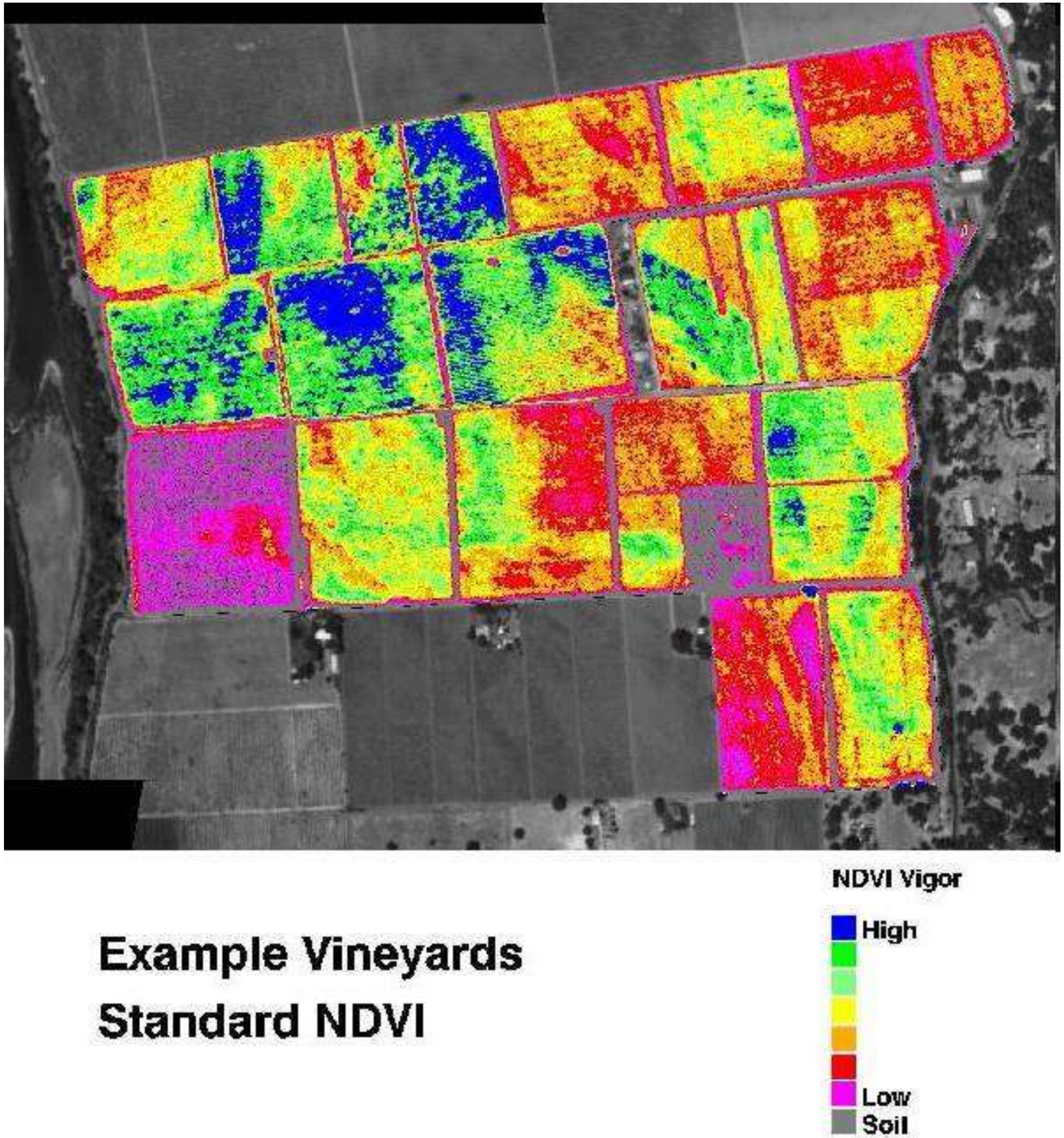
GEOG357 project

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

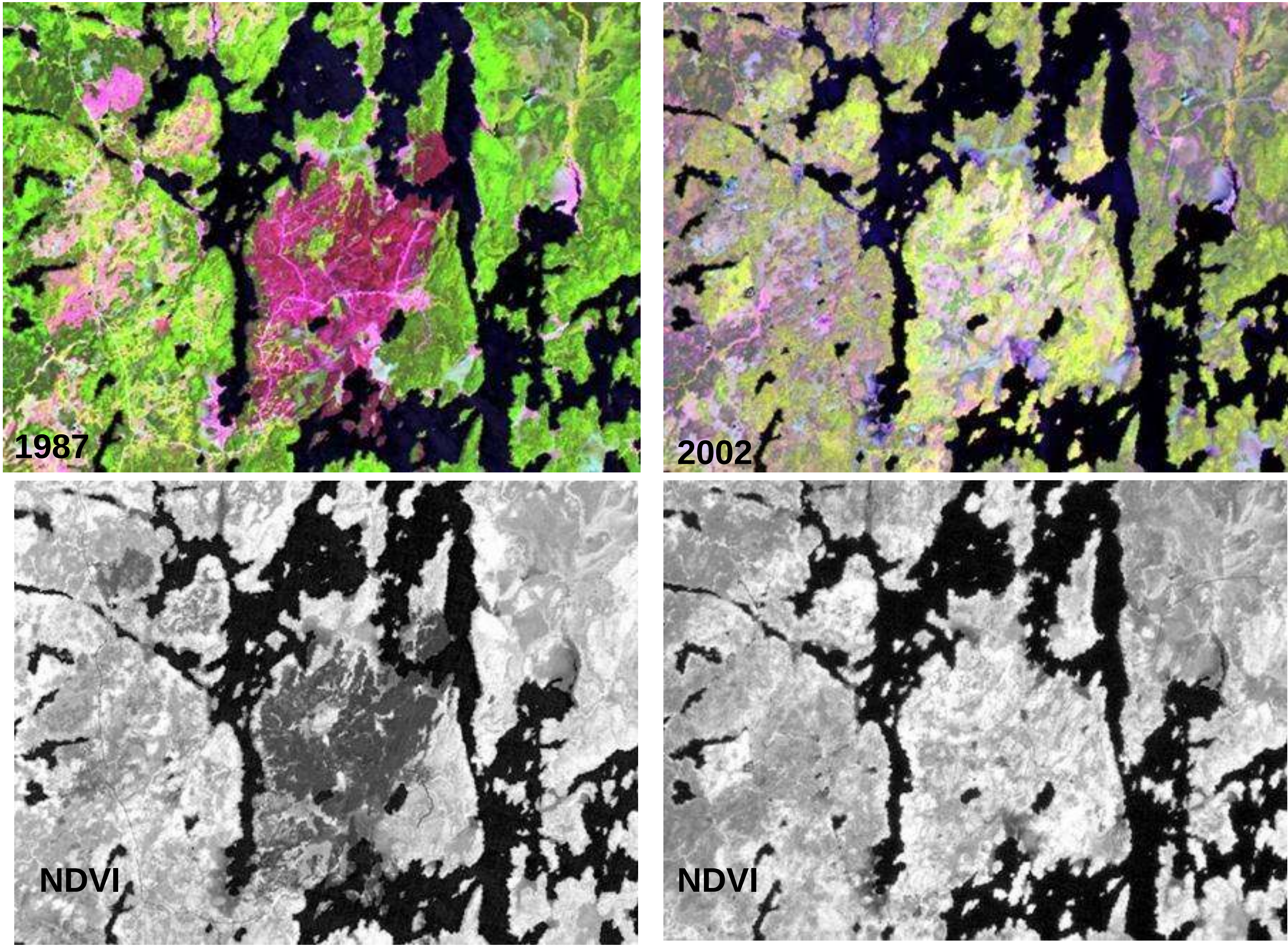
Sieved maximum NDVI result



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

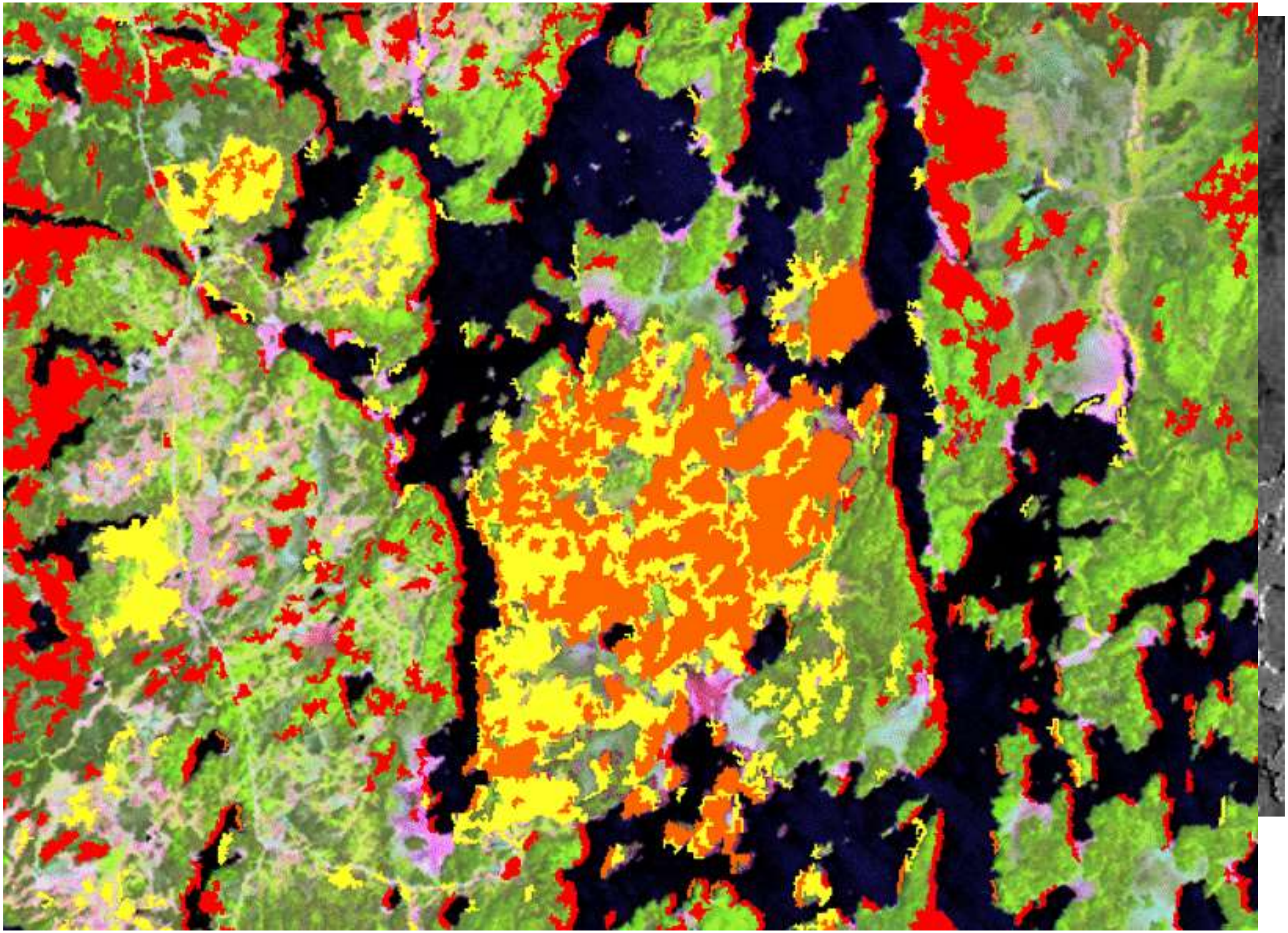


The use of NDVI to determine vegetative green-up after a forest fire Geog357



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

NDVI difference – 1987-2002

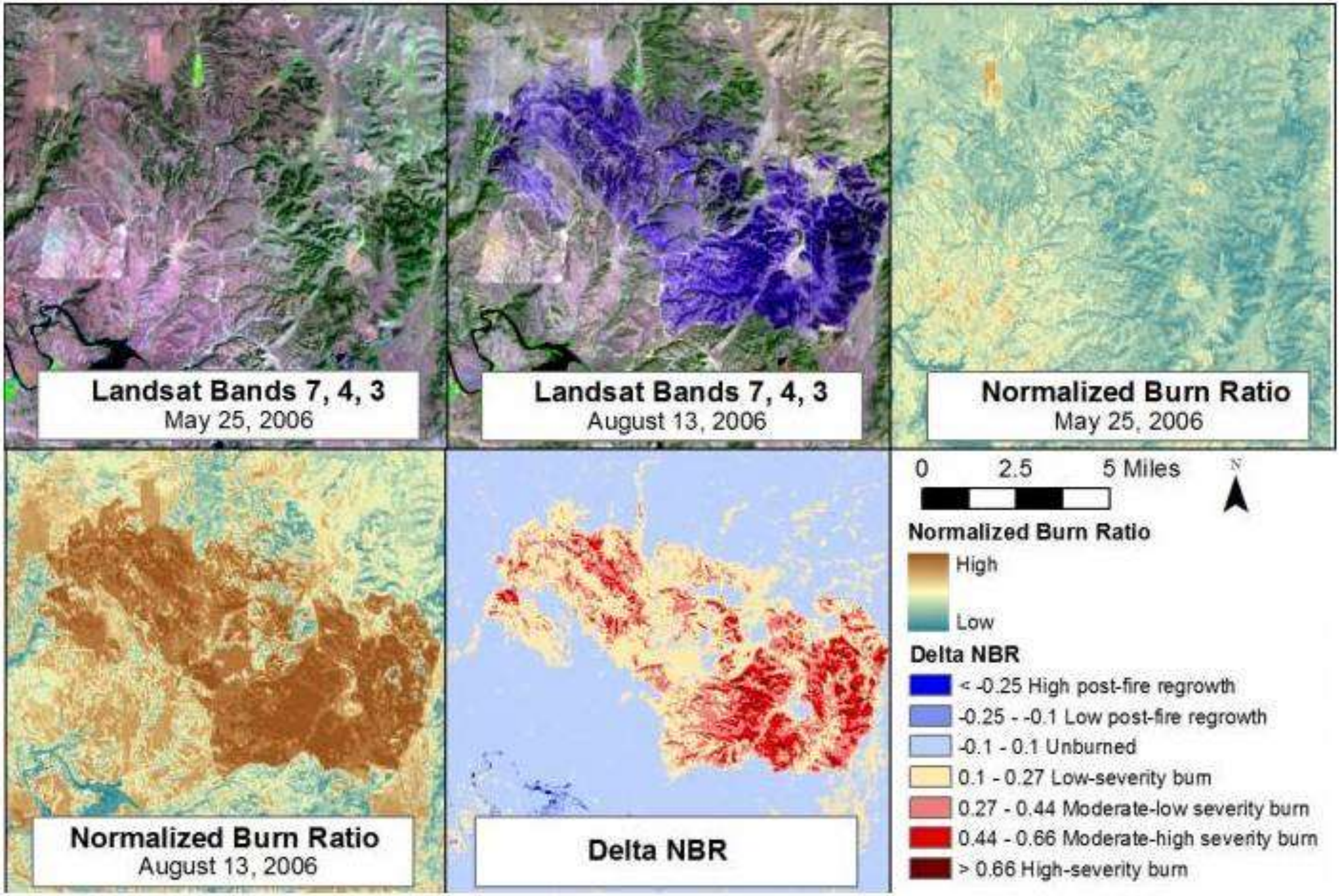


Red - Negative Growth Range **Clear -** Neutral Growth Range

Yellow - Minimal Positive Growth **Orange** - Maximum Positive Growth

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

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

GEOG357, Fall 2020: Article review 10%

due **November 15** (email to wheate@unbc.ca)

Goal: to ensure you visit at least one material resource for GEOG357 beyond the course lecture and lab notes - there's a world of remote sensing on the internet.

Select a scholarly journal article involving remote sensing and an application of interest in your studies; include an online link to your article (if available)

Some information sources: (library and online) ... many others

- Canadian Journal of Remote Sensing
- Int. Journal of Remote Sensing
- Journal of Applied RS; Science of RS; Remote Sensing
- Remote Sensing of Environment
- Photogrammetric Engineering & Remote Sensing (monthly)
- IEEE Transactions on Geoscience and Remote Sensing

Also see application journals: Journal of Forestry, J of Wildlife Biology etc..
www: gazillions of references .. beware of non-refereed articles

Article review (continued)

Articles should generally be 4-20 pages long
They should be relatively current (since 2010) – RS changes quickly !
You can include a graphic or two if you wish

Review sections should include: (~ 3-4 pages, 1.5 spacing):

1. Introductory summary / rationale
2. Imagery used – type, resolution, wavelengths
3. Digital Image Processing techniques employed
4. Summary of results and success relative to goals
5. Limitations, and indications of continued work (if any)

Do not copy and paste sections of the authors' text – use your own words
You should properly reference your article at the bottom of your review

Suggested total word length: ~ 500-750 words

Env. Change assignment 10% (Oct 19)

The (free) Landsat image archive covers 1984 – 2020

Select before/after images to show some selected change

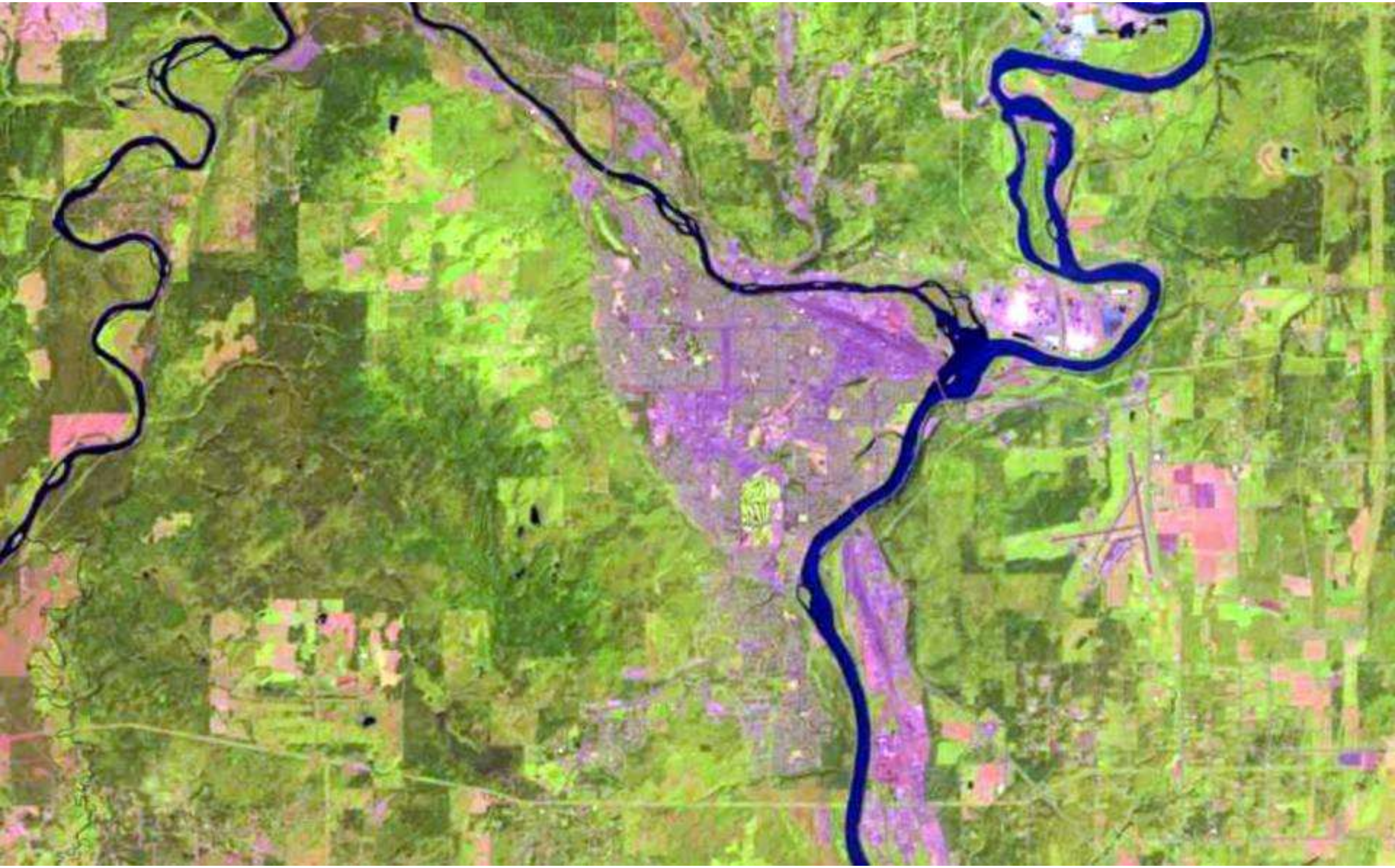
* This should be in an **area of interest** to you, both the location and topic / feature -   e.g. deforestation, urban expansion, glacier retreat, fire, volcanic eruption etc..

* Hence it could show a **gradual** or **catastrophic** change – it might be one event - just before and after

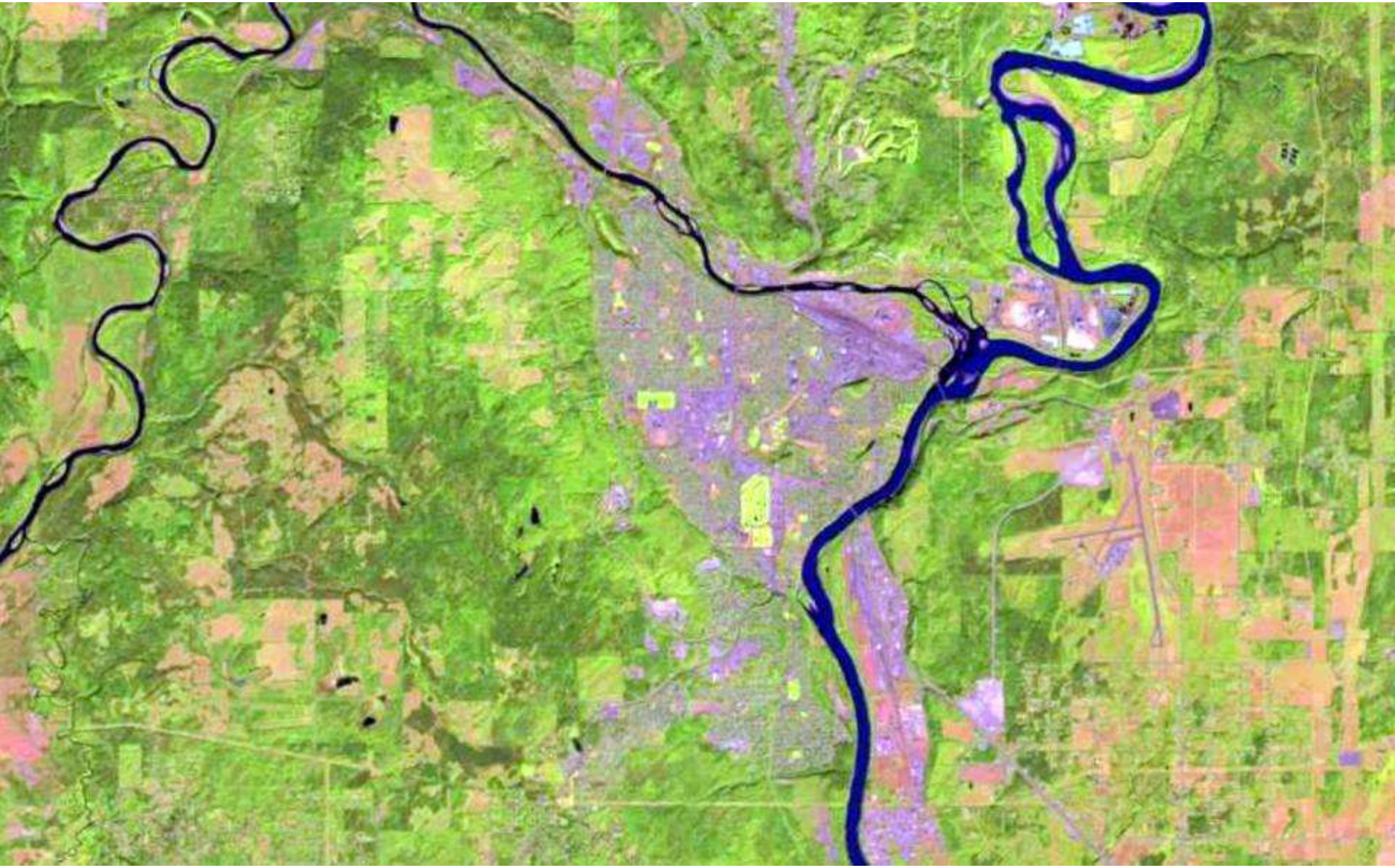
Please send me
The before / after images
~ one page of descriptive text (word doc)

- why you chose this pair
- where is it – country/region
- what has changed (and why)

Prince George, 25 July 1990



Prince George, 17 August 2016



Match the scene date as far as possible – ‘anniversary date’ is ideal

Env. Change assignment 10%

Fri Oct 2 today: start thinking about it …

Fri Oct 9 lecture: more details plus midterm tips

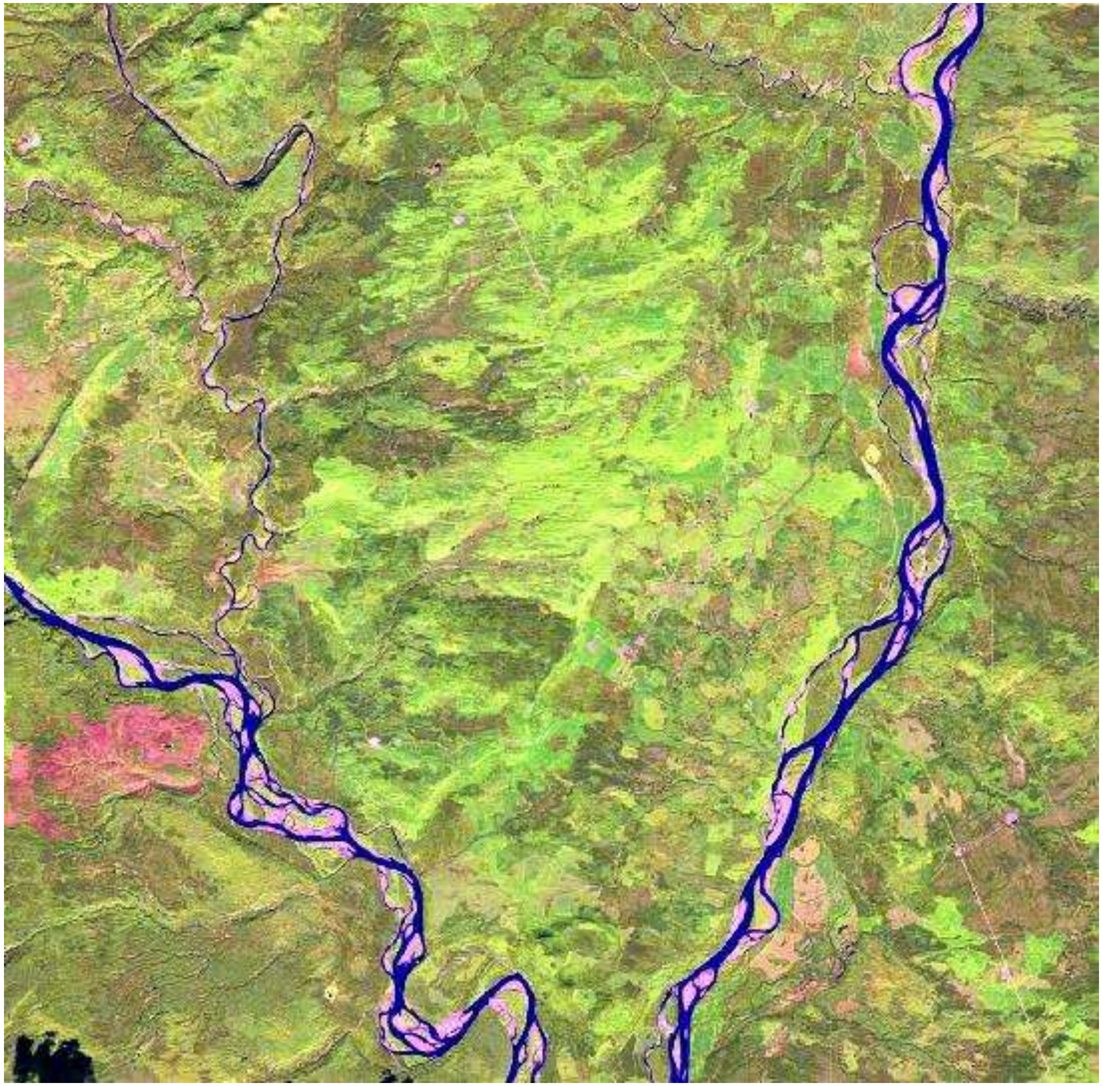
Thurs Oct 15 lab: download and clip/format the two images

Mon Oct 19:   send slides and text to wheate@unbc.ca

Wed Oct 21:   lecture: 3 minutes each – demo your example

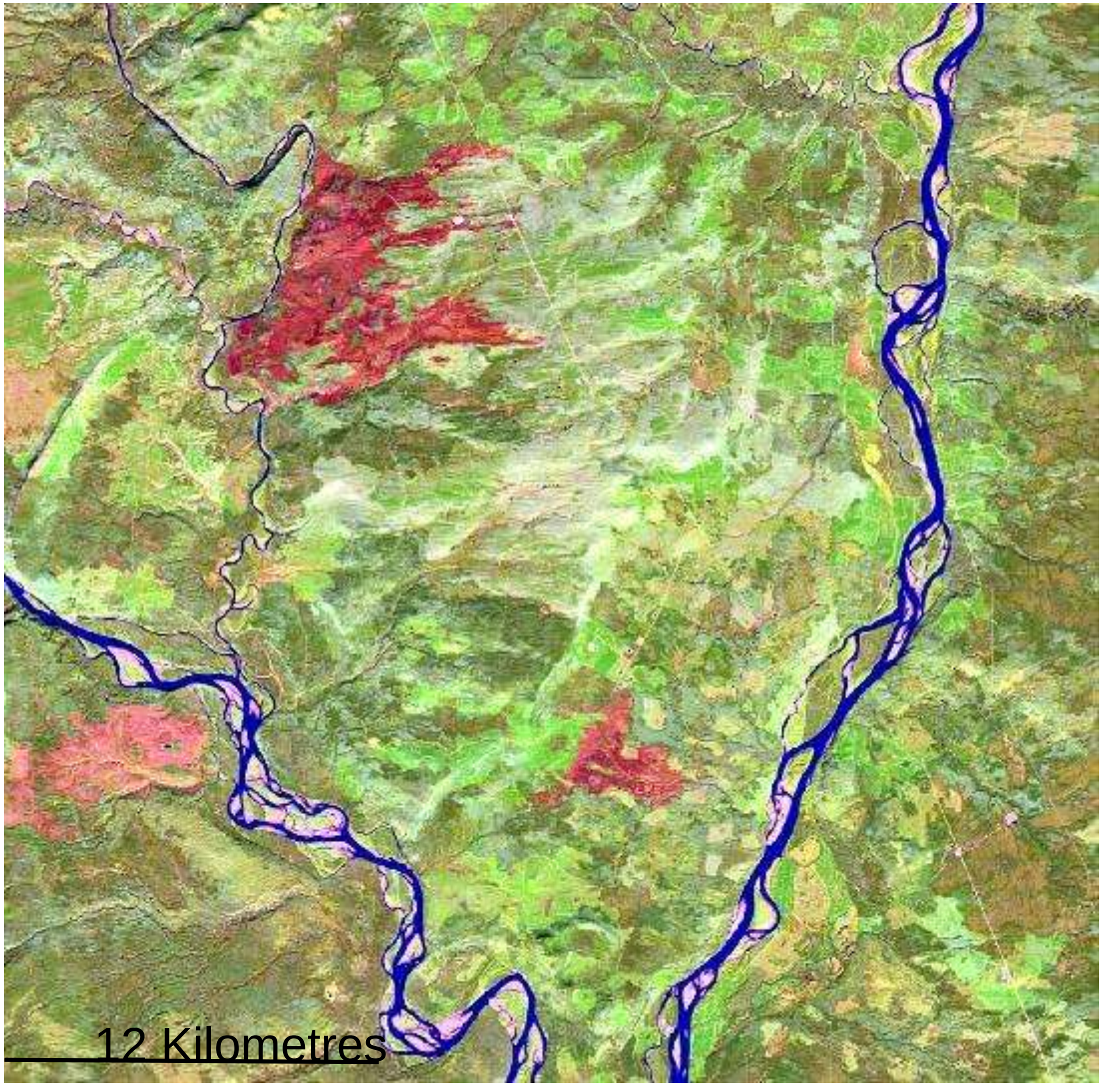
GEOG357 assignment example- before / after

Nelson
Forks
September
3rd 2017



The first non-lab graded assignment – select/download two images showing change

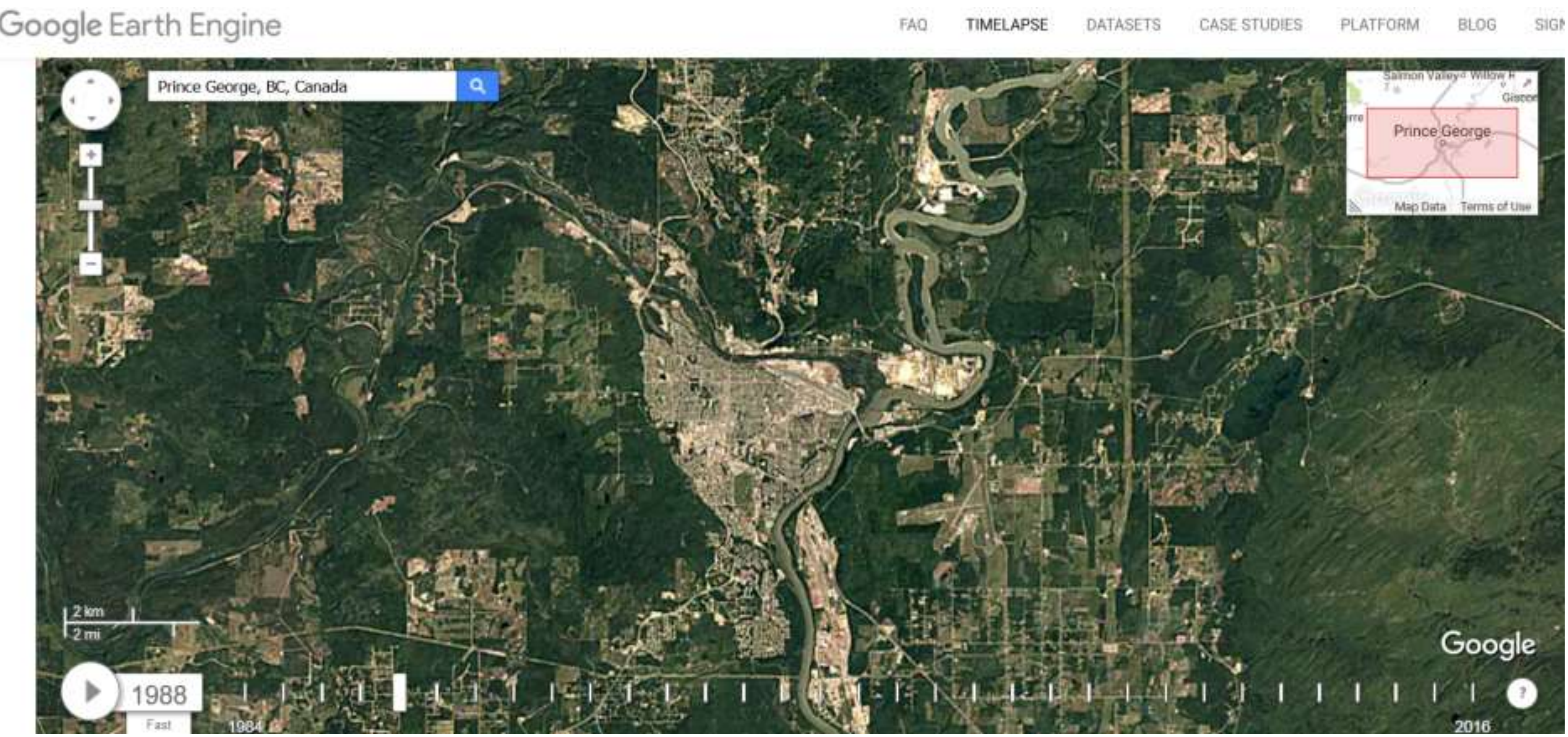
Nelson
Forks
September
9th, 2019



This was one of the student's last year, showing an area close to his home
Your sample area could cover an area and topic of interest to you and your studies

Mapping and showing change
Landsat images 1984 - 2019 (30m res.)

https://earthengine.google.com/timelapse/



The google earth engine now shows 35 years of change around the world, though the images chosen are not always the best – they will be in your work !.. You can use the link above to review where they might be interesting changes (quite subtle in Prince George)