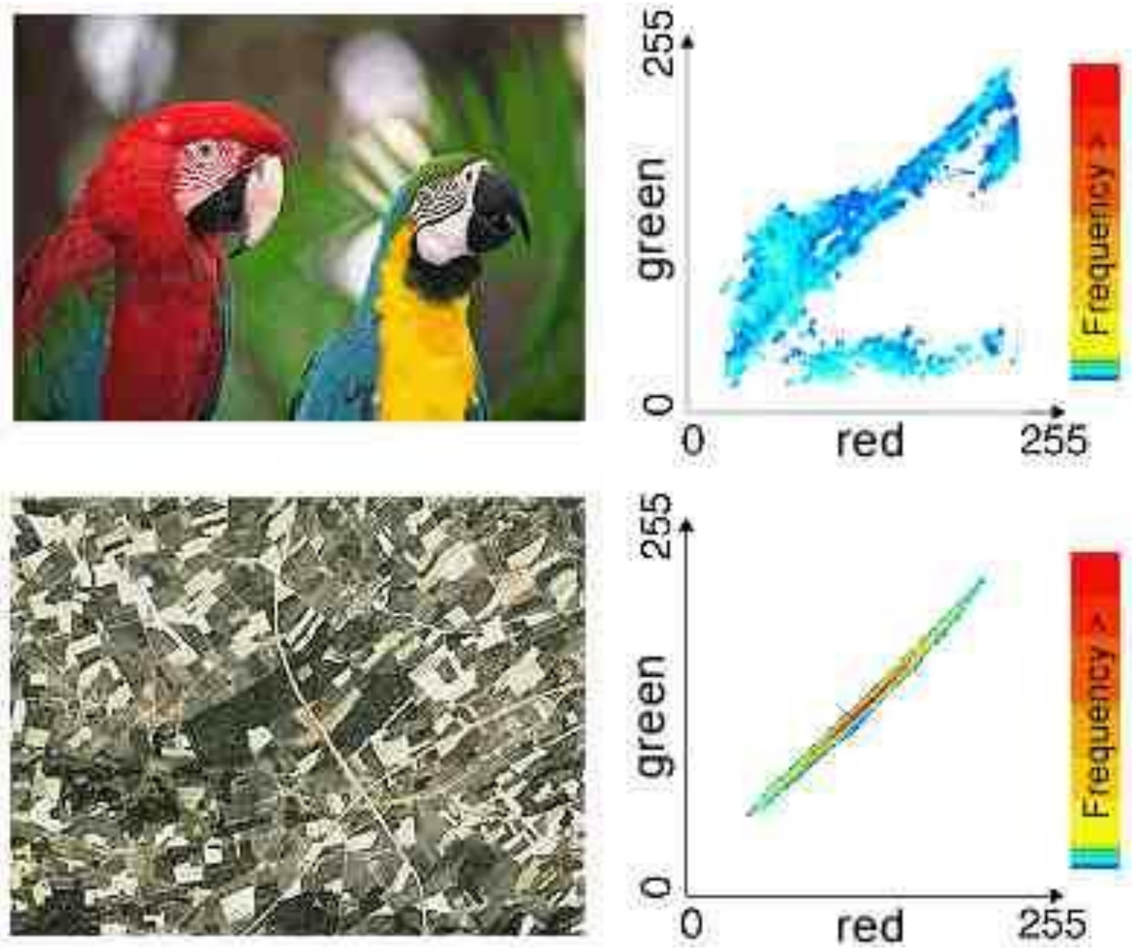
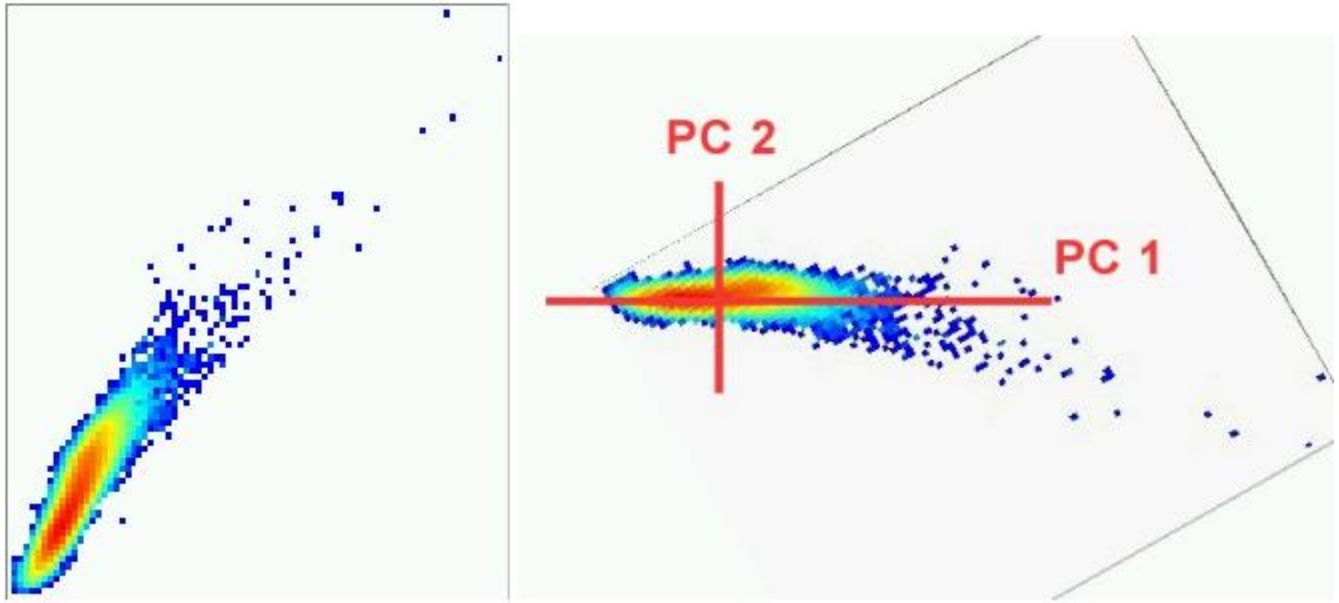
Principal Components Analysis (PCA)

PCA is a mathematical transformation that converts original data into new data channels that are uncorrelated and minimise data redundancy.

Like TCA, it can also: reduce shadows and spectral correlation between bands



http://eoedu.belspo.be/en/guide/compprin.asp



Now ! imagine this in 3d, or in 7 dimensions, which includes all of the bands.

The bands can be reduced to their respective 'components', by an 'axial rotation'

The main axis through the points is a 'component'; if all points were on it, correlation=1, the first component (PC1) would 'explain' all the variation.

The 2nd component (PC2) is normal to PC1, uncorrelated and hence two bands are converted to two components, but most variation is explained by the first (the 2nd is always smaller)

http://geology.wlu.edu/harbor/geol260/lecture_notes/Notes_rs_PC.html

Principal Components Analysis (PCA)

The new channels are defined by <u>eigenvectors</u> / <u>eigenvalues</u>.

In the statistics ‘matrix’:

Eigenvectors: define the contribution of each band

Eigenvalues: ‘explain’ the % variance of each PCA channel

PC1 and PC2 explain 95-99% and PC3 most of the rest

PCA channels

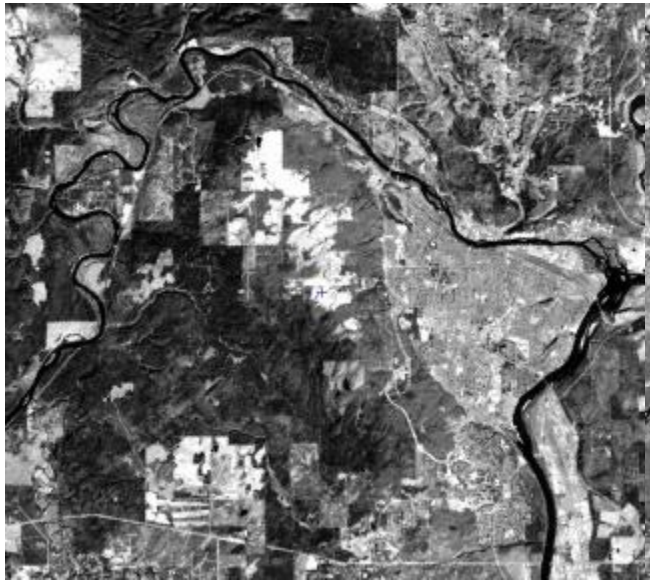
Eigenvectors of covariance matrix (arranged by rows):

	TM1	2	3	4	5	6	7
PC1	0.22	0.15	0.29	0.16	0.75	0.33	0.40
PC2	-0.28	-0.14	-0.29	**0.82**	0.23	-0.25	-0.16
PC3	**0.51**	**0.31**	**0.43**	**0.49**	-0.46	-0.05	-0.00
PC4	-0.09	-0.09	-0.19	0.19	-0.23	**0.91**	-0.18
PC5	0.31	0.13	0.05	-0.12	**0.35**	-0.00	-0.86
PC6	**0.69**	-0.16	-0.68	-0.01	0.01	-0.04	0.19
PC7	-0.19	**0.90**	-0.39	-0.04	0.00	0.00	0.06

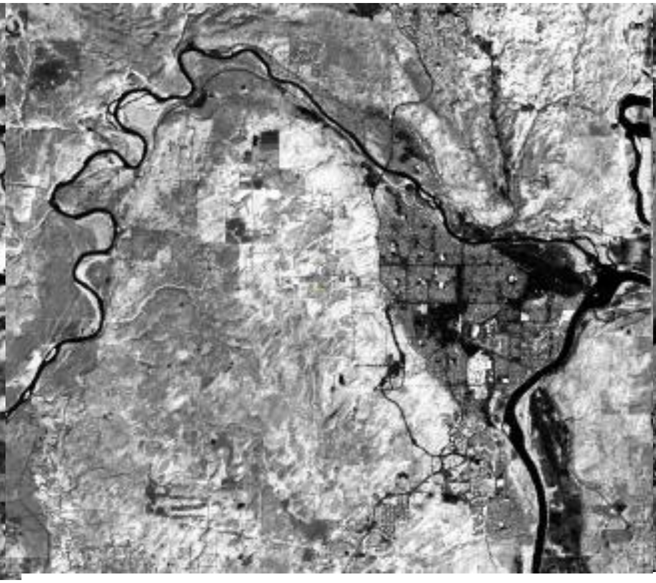
Component

71% Brightness
21% Greenness
3.8% Swirness / Wetness
2.3% Impact of TM6
1.6% Band 5 v 7 (MIR)
0.2% Band 1 v 3 (B v R)
0.1% Band 2 v 3 (Yellowness)

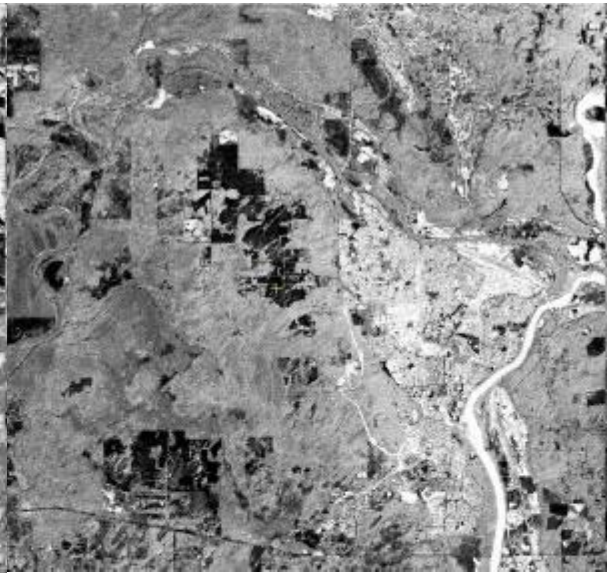
PC1: Brightness,



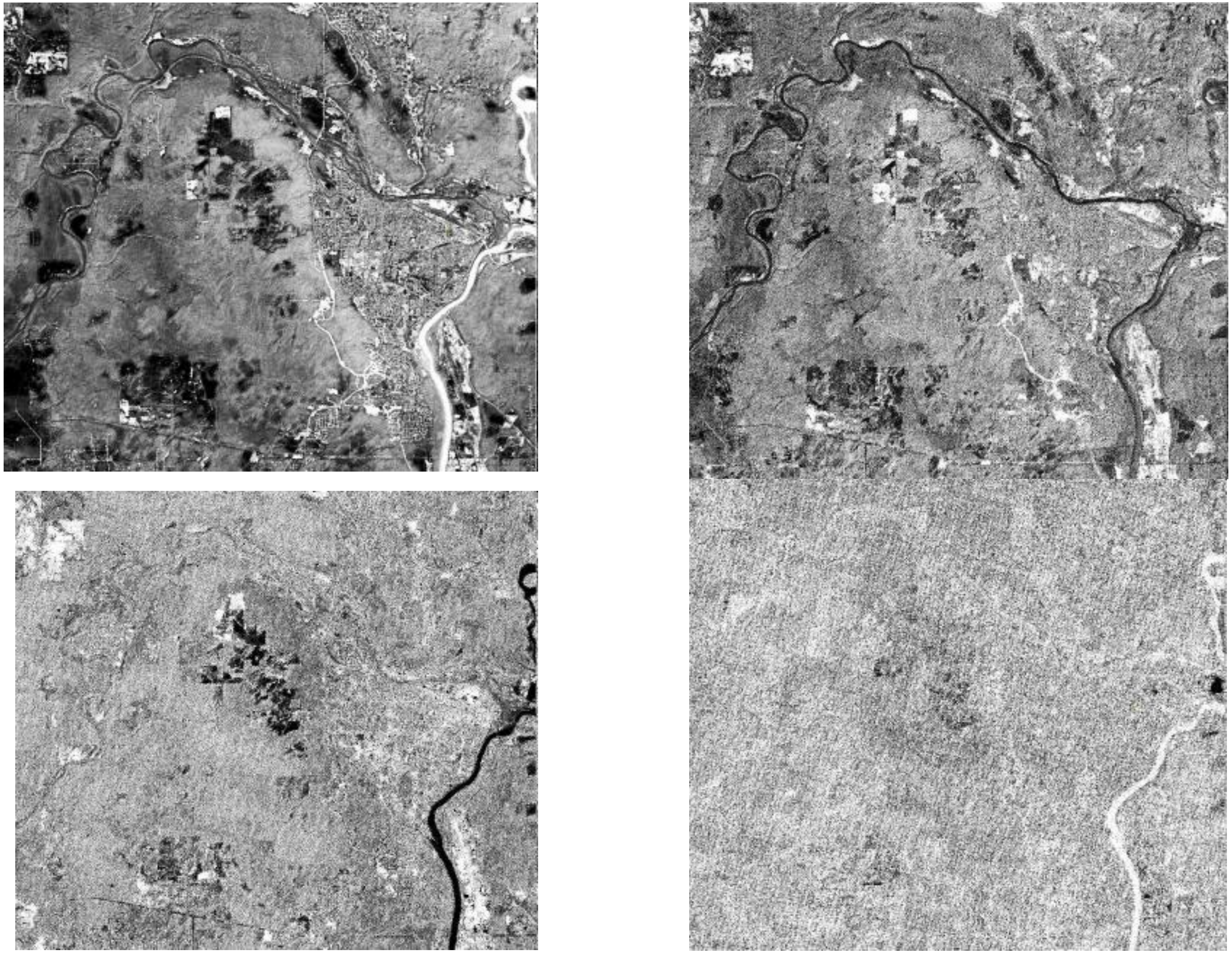
PC2: Greenness,



PC3: Swirness / Wetness



PC components PC4: ~TM6, PC5: ~5/7, PC6: ~1/3, PC7: ~2/3



Reasons to use PCA

1. It reduces a n-band dataset to a smaller number of ‘principal components’

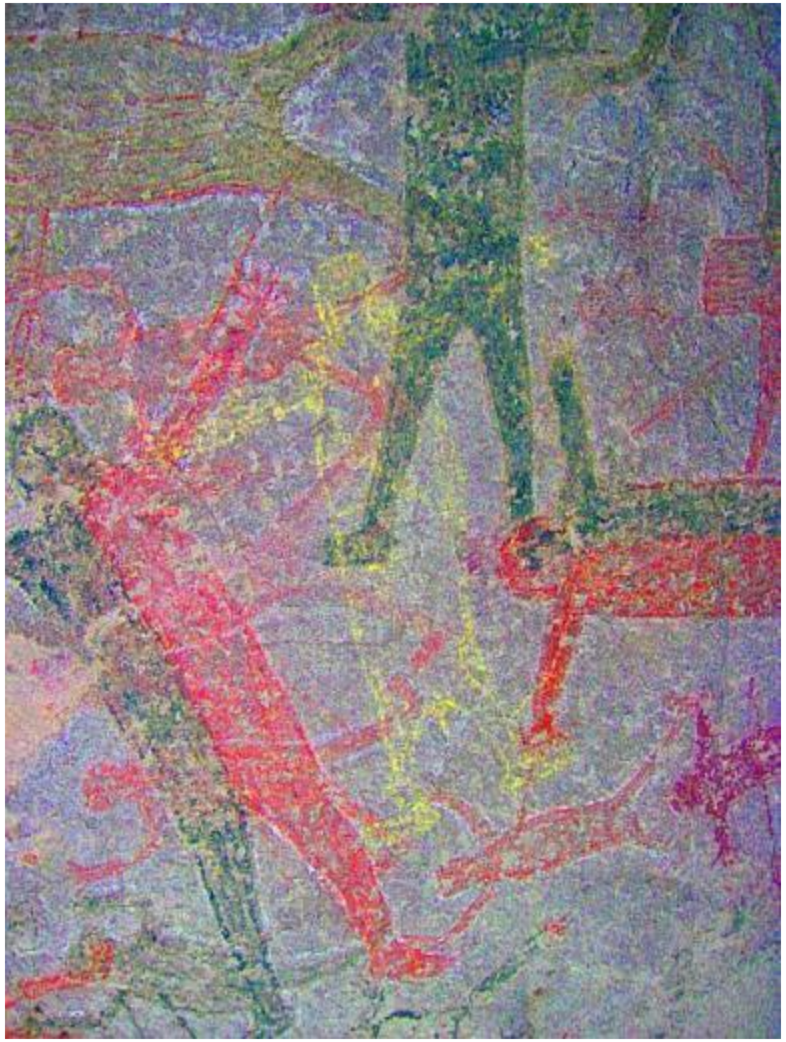
2. It can be applied to any dataset with any number of bands

3. A resulting PCA channel might reveal new features / information

Decorrelation Stretch: **Remote sensing technique to enhance images**

- **Based on Principal Components Analysis (PCA) to enhance RGB display**

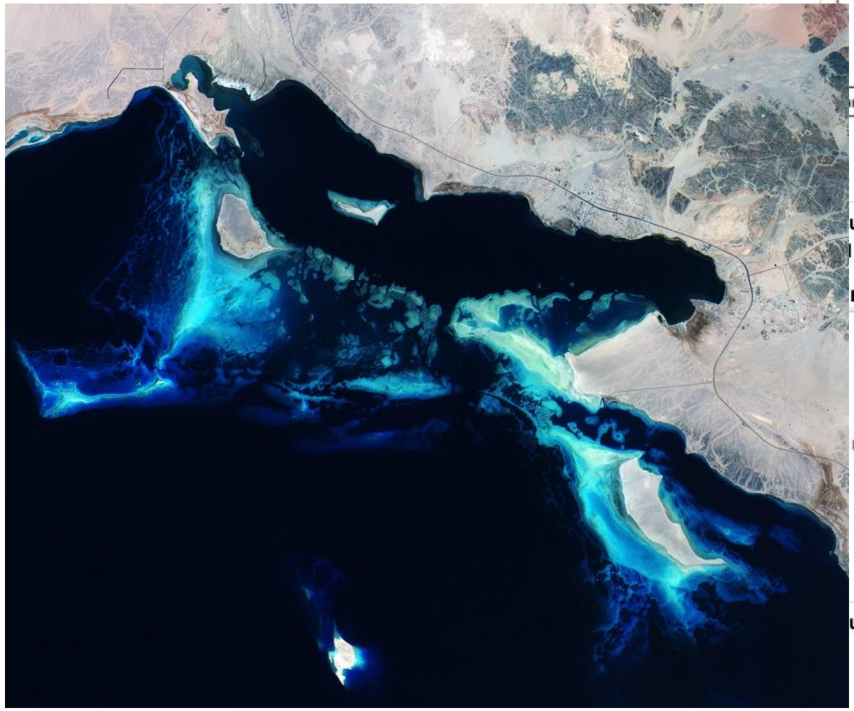
- **used to Enhance Rock Art Images** By Jon Harman, Ph.D.



Sentinel – Radar and Multispectral

European Commission (EU executive) and the European Space Agency

[ESA - Sentinel](#)



10 metre spatial resolution:

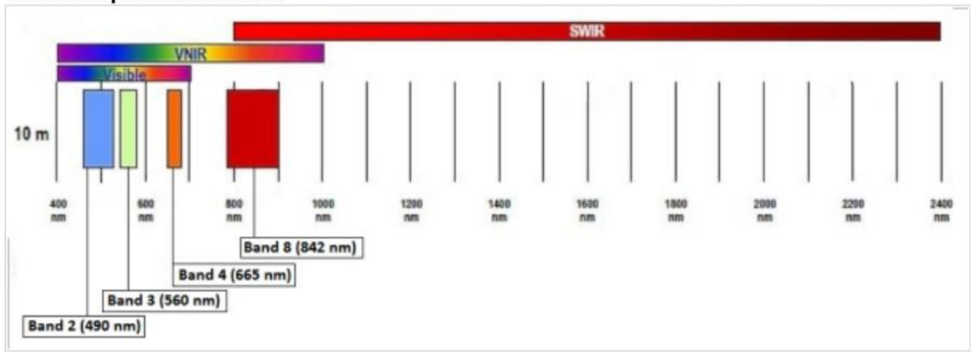
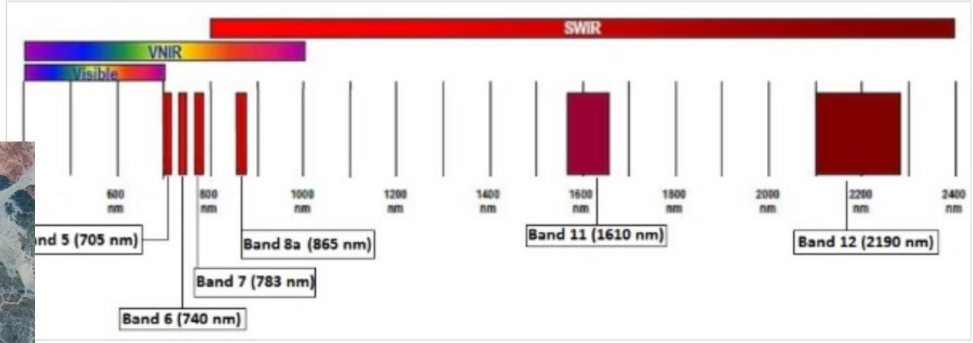


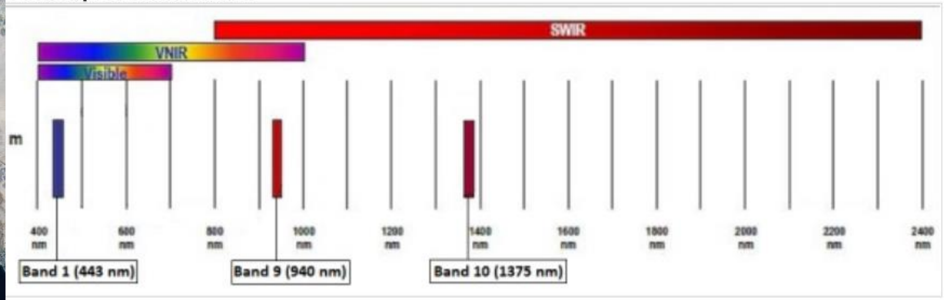
Figure 1: SENTINEL-2 10 m spatial resolution bands: B2 (490 nm), B3 (560 nm), B4 (665 nm) and B8 (842 nm)

20 metre spatial resolution:



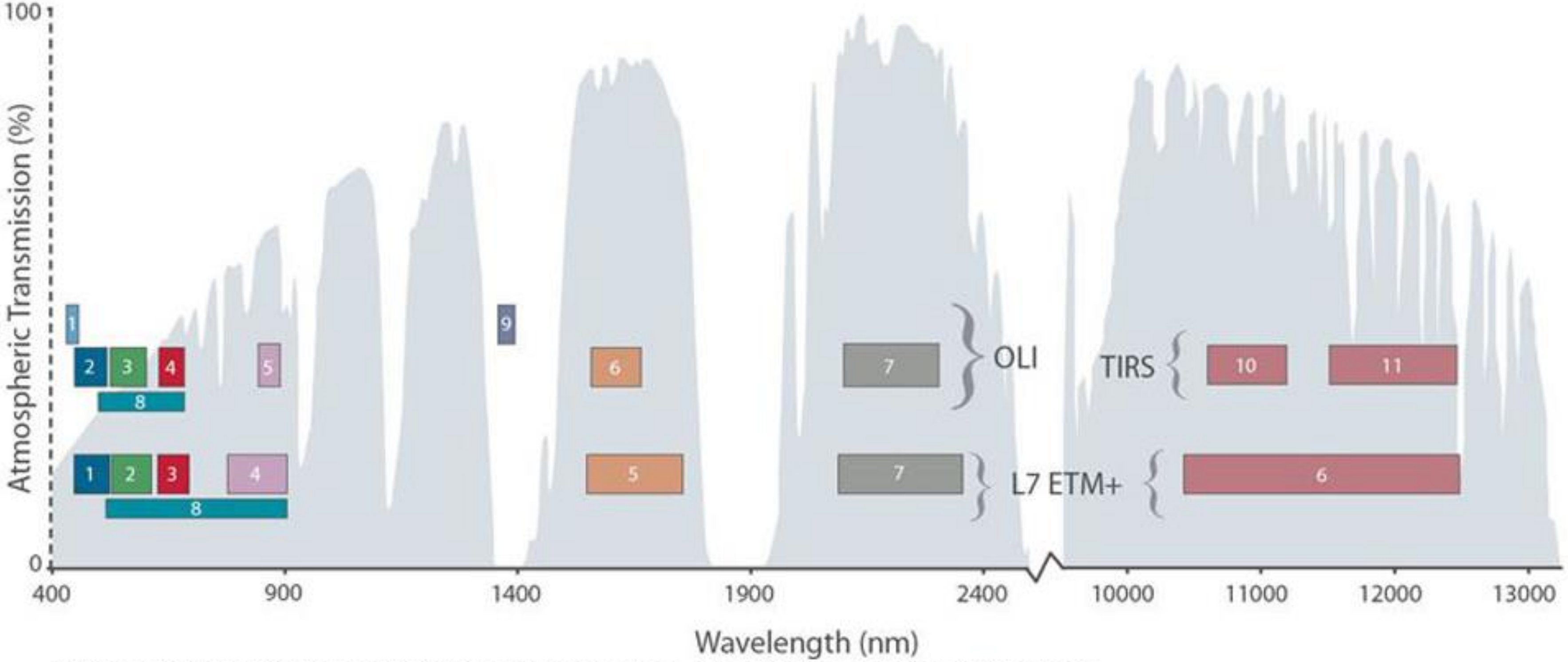
ure 2: SENTINEL-2 20 m spatial resolution bands: B5 (705 nm), B6 (740 nm), B7 (783 nm), B8a (865 nm), (1610 nm) and B12 (2190 nm)

metre spatial resolution:



ure 3: SENTINEL-2 60 m spatial resolution bands: B1 (443 nm), B9 (940 nm) and B10 (1375 nm)

Landsat 8 OLI versus Landsat 7 ETM+ bands



Bandpass wavelengths for Landsat 8 OLI and TIRS sensor, compared to Landsat 7 ETM+ sensor

Note: atmospheric transmission values for this graphic were calculated using MODTRAN for a summertime mid-latitude hazy atmosphere (circa 5 km visibility).

http://landsat.usgs.gov/best_spectral_bands_to_use.php

Comparison of Landsat 7 and 8 bands with Sentinel-2