



Remote Sensing Vegetation Indices

A Biogeography & Landscape Dynamics Reference Guide
2020

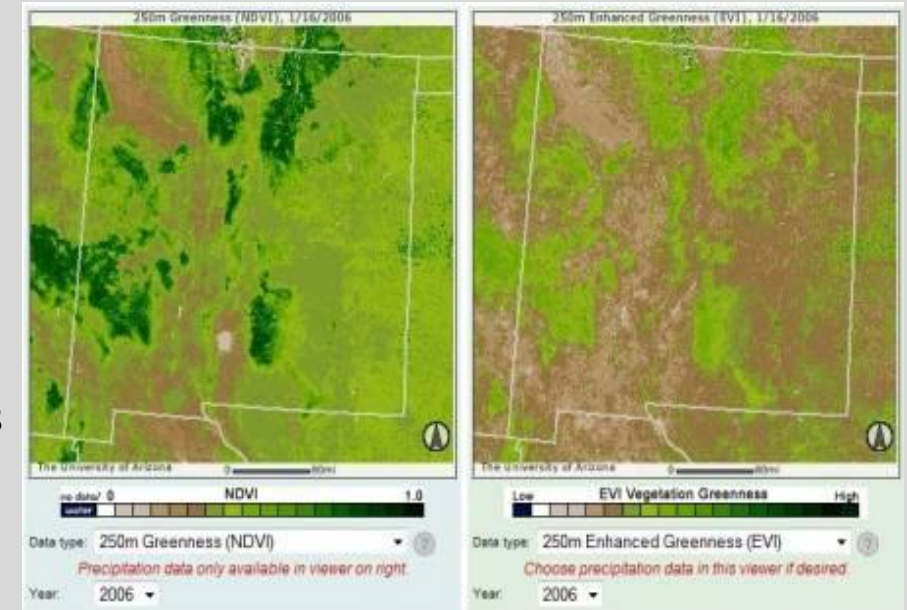
NDVI (normalized difference vegetation index):

- Formula: $NDVI = (NIR - Red) / (NIR + Red)$
 - Landsat 8 (L8): NIR = Band 5 & Red = Band 4
 - Landsat 7 (L7): NIR = Band 4 & Red = Band 3
 - ***CALCULATE AFTER MASKING***
- Theory: plants absorb visible light (400-700 nm range) for photosynthesis, reflect NIR (700-1100 nm)
 - More absorption = healthier vegetation = more NIR reflection = peak in the NIR range
- General Purpose: determine whether or not the image has live green vegetation
 - normalize impact of varying solar zeniths (images taken during different times of the day)
 - Precision Agriculture
 - Time averages for drought detection
- Shortcomings:
 - Atmospheric effects: aerosols and water vapor (always calculate NDVI after masking)
 - Clouds: not just thick clouds, thinner clouds that may not be masked impact NDVI
 - Potential solution: composite daily images together (MODIS)
 - Saturation: too much dense vegetation in one area saturates the signal
- Other Notes:
 - Net Photosynthesis is directly related to the amount of visible light absorbed/reflected;
 - more visible light reflected □ redder/browner plants □ less healthy vegetation

NDVI Value	Interpretation
-1.0	Water
-0.1 to 0.1	Barren/Rock
0.2 to 0.4	Shrubs/Grass
.4 to 1.0	Forests

EVI (enhanced vegetation index):

- Formula*: $EVI = G * ((NIR - Red) / (NIR - C_1 * Red - C_2 * Blue + L))$
 - $C_{1\&2}$: aerosol resistance coefficients; in L8&7, $C_1 = 6$, $C_2 = 7.5$
 - G = Gain Factor; in L8 = 2.5
 - L = Canopy background adjustment; in L8 = 1.0
- Theory: Use the blue band to correct for atmospheric influences in red band
 - Use atmospherically corrected Surface Reflectance values
- General Purpose: Vegetative index that is more receptive to high biomass areas
 - Decouples canopy background & reduces atmospheric influences
 - Makes up for areas where NDVI can become over-saturated
- Shortcomings: Uses three bands, sometimes the blue band can cause disturbance if there is high reflectance in blue areas (rooftops, etc.)
- Other Notes:
 - with snow; NDVI decreases, EVI increases
 - *Apply a scale factor to bands when calculating. Scale factor for L8 is 0.0001
 - Ex: $NIR = \text{Band 5 Value} * 0.0001$



NDVI (left) vs. EVI (right)

Dense biomass saturates NDVI signal


Source:

https://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:enhanced_vegetation_index

EVI2 (two-band enhanced vegetation index):

- Formula*: $EVI2 = 2.5 * (NIR - Red) / (NIR + 2.4 * Red + 1)$
 - L8: NIR = B5, Red = B4
 - L7: NIR = B4, Red = B3
- Theory: The signal to noise ratio on the blue band is poor, and the AVHRR satellites do not have a blue band, so a two-band EVI was created
- General Purpose: Use when *atmospheric effects are insignificant and data quality is good*
- Shortcomings: Not a popular index, usually used as a second resort if three bands aren't available
- Other Notes:
 - * Apply a scaling factor to band values during calculation. In L8, scaling factor = 0.0001

NDM(or W)I (normalized difference moisture (or water) index):

- Formula: $NDMI = (NIR - SWIR) / (NIR + SWIR)$
- Theory: Amount of water in leaf mesophyll determines reflectance/absorbance of SWIR light
 - SWIR Reflectance \uparrow then leaf water content \downarrow ;
Inversely correlated
- General Purpose: describes crop's water stress level
 - Immediately recognize areas with water stress problems
- Shortcomings:
 - Index is not a 1:1 interpretation, value can have many different interpretations (see graph )
- Other Notes:
 - Ranges from -1 to +1

NDMI	INTERPRETATION
-1 - -0.8	Bare soil
-0.8 - -0.6	Almost absent canopy cover
-0.6 - -0.4	Very low canopy cover
-0.4 - -0.2	Low canopy cover, dry or very low canopy cover, wet
-0.2 - 0	Mid-low canopy cover, high water stress or low canopy cover, low water stress
0 - 0.2	Average canopy cover, high water stress or mid-low canopy cover, low water stress
0.2 - 0.4	Mid-high canopy cover, high water stress or average canopy cover, low water stress
0.4 - 0.6	High canopy cover, no water stress
0.6 - 0.8	Very high canopy cover, no water stress
0.8 - 1	Total canopy cover, no water stress/ waterlogging

Table 2: Agricolus NDMI index

Source: <https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/>

SAVI (Soil Adjusted Vegetation Index):

- Formula: $(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red}) * (1.0 + L)$
 - L commonly = 0.5; L=0 in areas with high vegetation, L=1.0 in areas with no vegetation
- Theory: Exposed soil surface can reflect light in the red and NIR wavelengths, changing NDVI values
- General Purpose: Areas with <40% vegetative cover
 - Used as NDVI when veg cover is low
- Shortcomings:
 - Only necessary when vegetative cover is low
- Other Notes:
 - Outputs a range of -1 to 1; lower value = lower amount of green vegetation

Continued Reading / Sources / Relevant Sites

◦ NDVI:

- https://www.usgs.gov/land-resources/nli/landsat/landsat-normalized-difference-vegetation-index?qt-science_support_page_related_con=0#qt-science_support_page_related_con
- <https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/>
- <https://earthobservatory.nasa.gov/features/MeasuringVegetation>

◦ EVI:

- https://www.usgs.gov/land-resources/nli/landsat/landsat-enhanced-vegetation-index?qt-science_support_page_related_con=0#qt-science_support_page_related_con
- <https://earthobservatory.nasa.gov/features/MeasuringVegetation>
- https://en.wikipedia.org/wiki/Enhanced_vegetation_index

◦ NDMI:

- <https://rdr.io/cran/LSRS/man/NDMI.html>
- <https://www.agricolus.com/en/indici-vegetazione-ndvi-ndmi-istruzioni-luso/>

◦ EVI2:

- [https://vip.arizona.edu/documents/review/materials/Quantifying%20surfacegradientswitha2-bandEnhancedVegetationIndex\(EVI2\).pdf](https://vip.arizona.edu/documents/review/materials/Quantifying%20surfacegradientswitha2-bandEnhancedVegetationIndex(EVI2).pdf)
- https://en.wikipedia.org/wiki/Enhanced_vegetation_index#Two-band_EVI

◦ SAVI:

- <https://www.sciencedirect.com/science/article/abs/pii/S003442578890106X>
- https://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:soil-adjusted_vegetation_index