Remotely sensing senescent vegetation: Sensor requirements

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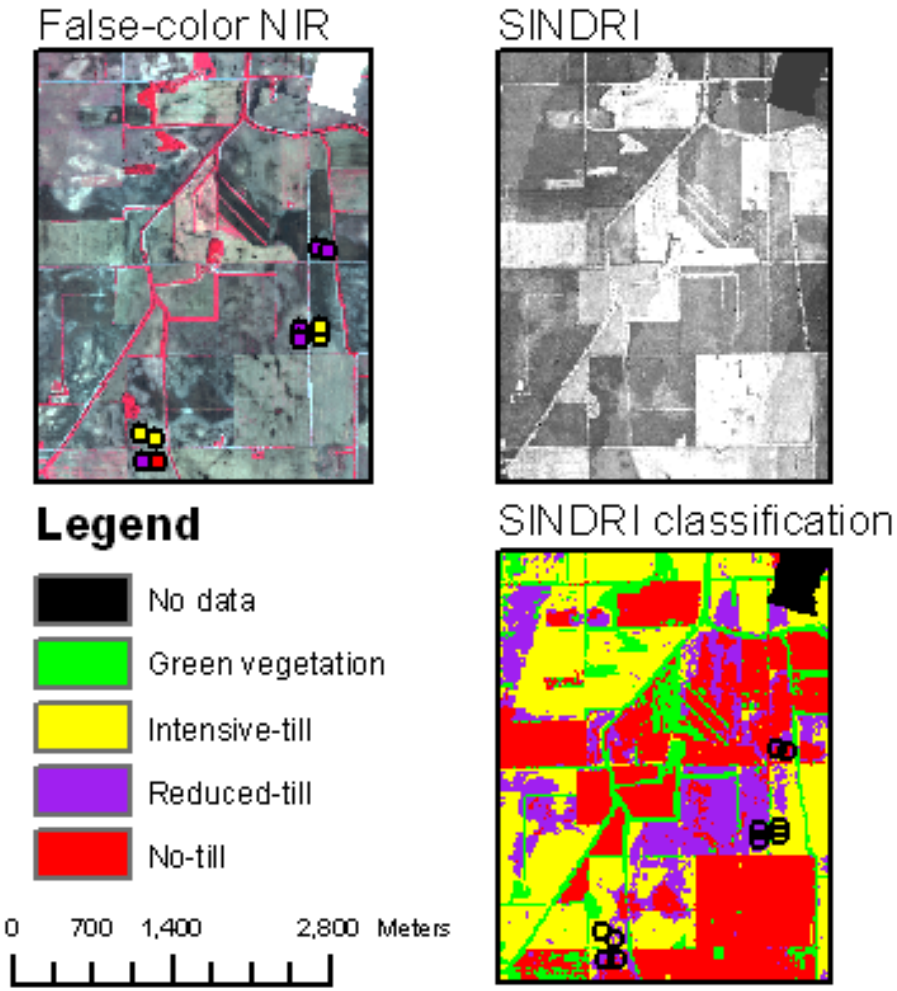

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Importance of Senescent Vegetation

A. Intensively tilled field

B. Conservation tilled (No-tilled) field

C. Rangeland burn
Wyoming Wildlife and Natural Resource Trust

D. Simi Valley, CA, Oct. 14, 2008.
(Associated Press)

- Also referred to as:
  - Nonphotosynthetic vegetation (NPV)
  - Crop residues in tillage farming
  - Leaf litter
- NPV important for grazing and fire fuel load applications.
- Data are important for environmental and agricultural analysis and policy.
- Remote sensing allows for rapid data acquisition NPV cover.
- Hyperspectral data are ideal, but cannot currently produce the required data stream.

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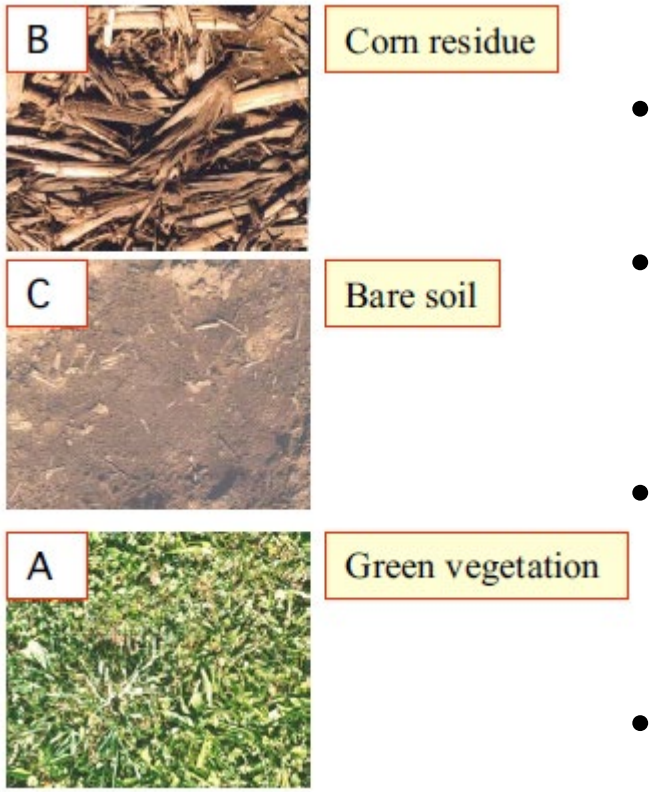
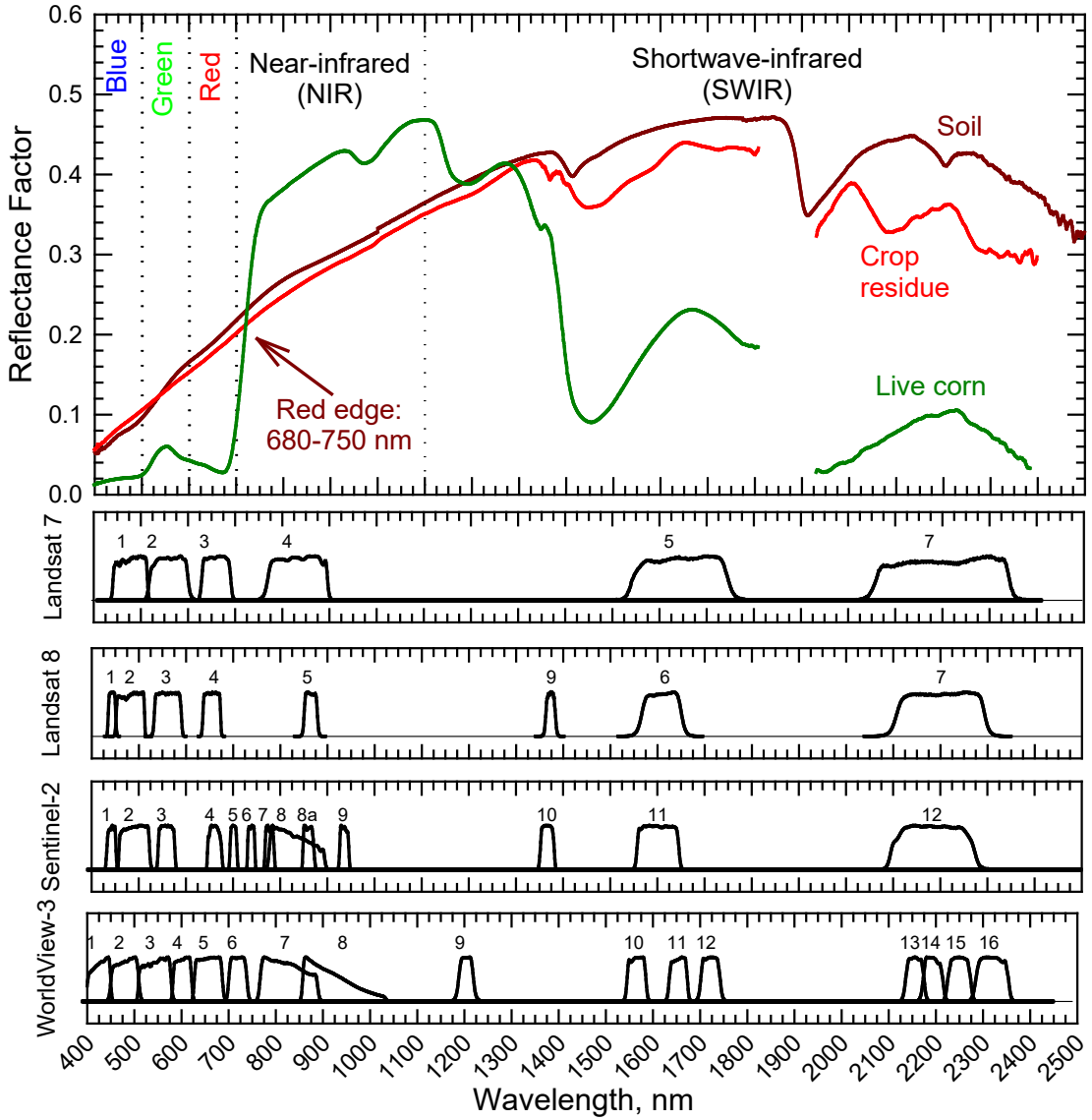
How can we best map NPV?



- Soils, NPV can be spectrally similar in visible and NIR.
- NPV is primarily dry cellulose and lignin.
- Dry cellulose has a unique absorption feature at 2100 nm.
- Exact position dependent upon lignin content.
- However, most satellite sensors lack appropriate spectral bands.



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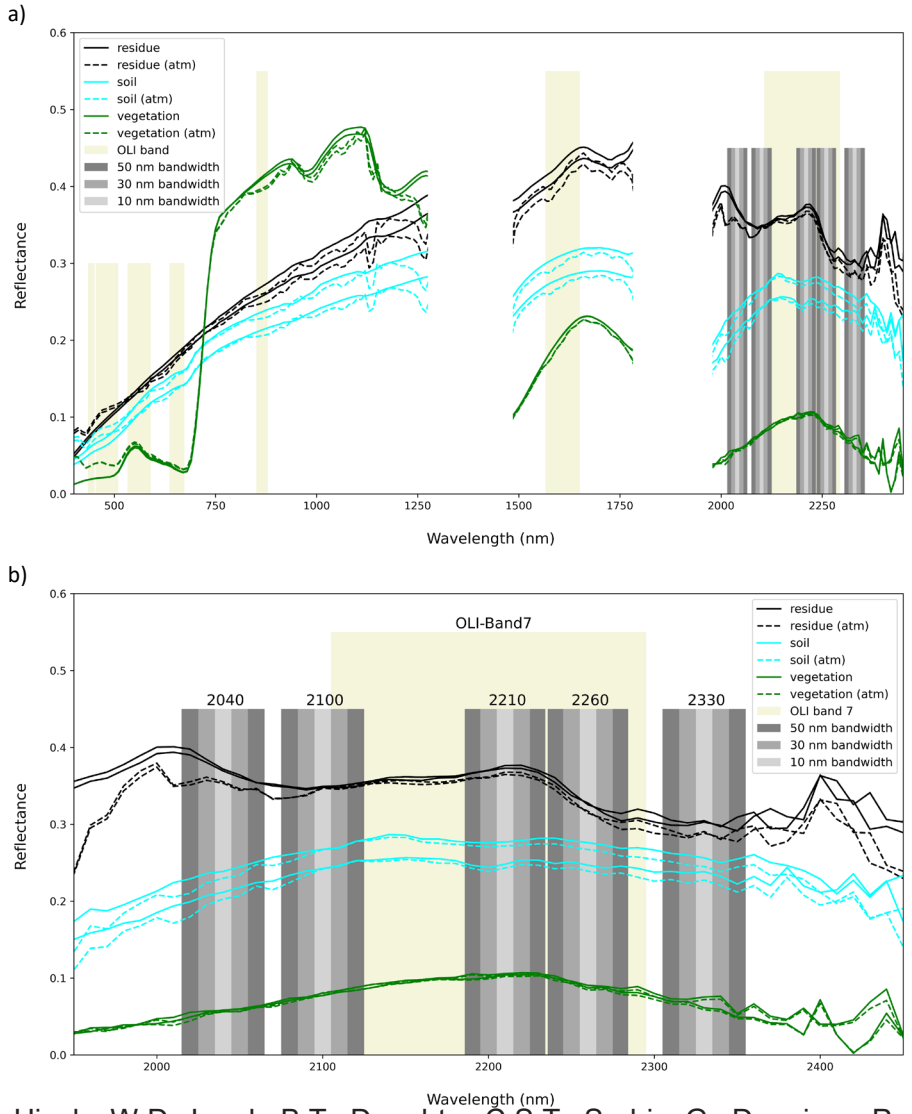
Spectral indices and bands used for NPV



- Cellulose Absorption Index:

$$CAI = (0.5 * (R_{2000} + R_{2200})) - R_{2100}$$

- Ligno-Cellulose Peak Centered Difference Index:

$$LCPCDI = (2 * (R_{2210})) - (R_{2100} + R_{2260})$$

- Shortwave Infrared Normalized Difference Residue Index:

$$SINDRI = (R_{2210} - R_{2260})/(R_{2210} + R_{2260})$$

- CAI performs the best under all conditions
  - SINDRI 2nd best performer
- LCPCDI bands would provide spectral continuity with Landsat TM/ETM+/OLI band 7, Sentinel 2 MSI band 12.

Hively, W.D.; Lamb, B.T.; Daughtry, C.S.T.; Serbin, G.; Dennison, P.; Kokaly, R.F.; Wu, Z.; Masek, J.G. Evaluation of SWIR Crop Residue Bands for the Landsat Next Mission. *Remote Sens.* **2021**, *13*, 3718. https://doi.org/10.3390/rs13183718

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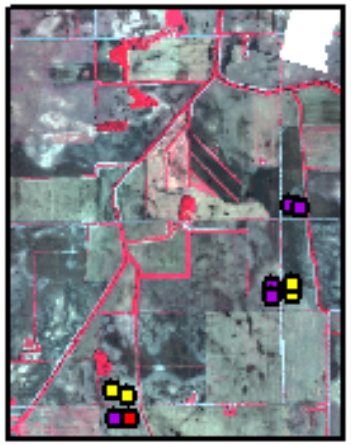
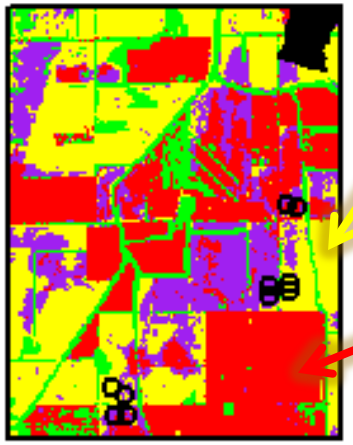
Remotely Sensing NPV





Legend

- No data
- Green vegetation
- Intensive-till
- Reduced-till
- No-till

0 700 1,400 2,800 Meters

Intensively tilled field

No/ zero-tilled field

Serbin, G.; Hunt, E.R., Jr.; Daughtry, C.S.T.; McCarty, G.W.; Doraiswamy, P.C. An Improved ASTER Index for Remote Sensing of Crop Residue. *Remote Sens.* **2009**, *1*, 971-991. https://doi.org/10.3390/rs1040971

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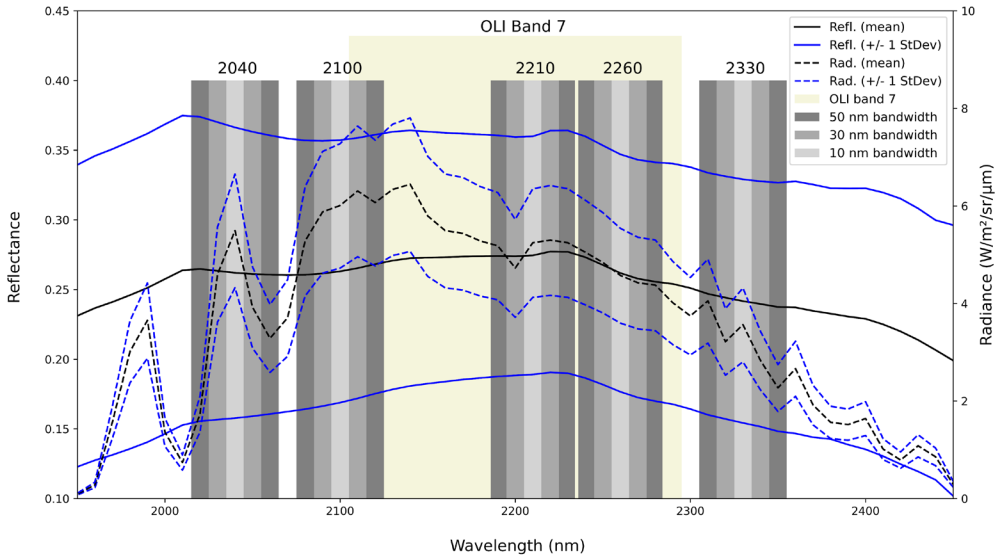
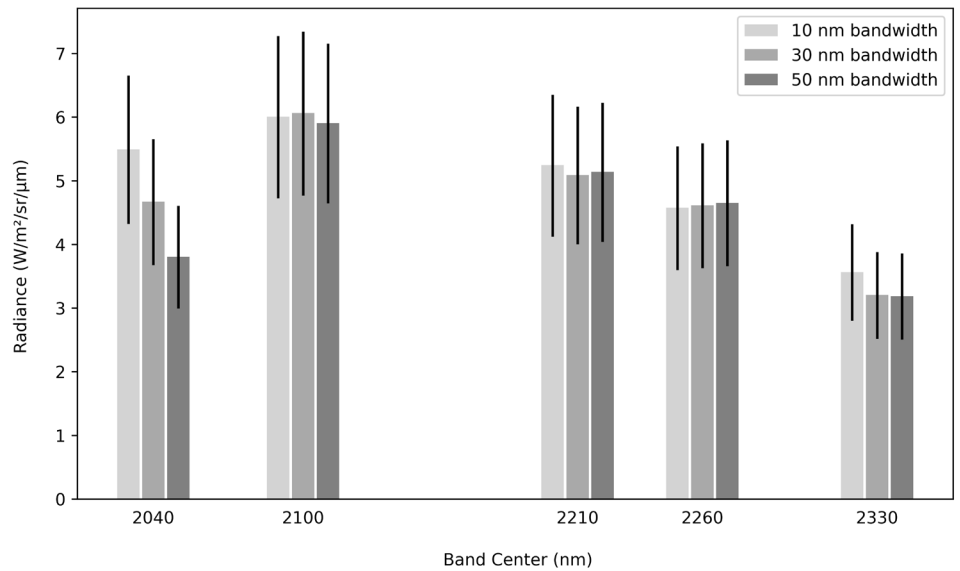
Issues with NPV detection





- Atmospheric gas absorptions:
  - Broad H_2O centered at 1920 and 2500 nm;
  - CO_2 at 2010 and 2060 nm
  - **These affect CAI bands.**
- Low photon counts in SWIR:
  - Can be a problem at higher latitudes in late autumn and early winter
  - Wider bands don't necessarily mean higher radiance values.
- SWIR detector cooling requirements add mass, cost:
  - Cheaper, lighter sensors needed.

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Thank you!

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Sentinel-2A image acquired over Ireland on 4 May 2017