Vegetation monitoring with remote sensing

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Vegetation monitoring with remote sensing, multi-scale

Commodity traders
UNODC, LUCAS 2012/15

Magellium,
DMCii Ltd.

Growers,
ESA

**Scale**

**Regional crop inventory**
- Food security
- Asset management
- Governance (tax)
- Policy

**Field level inventory**
- Food security
- Asset management
- Enforcement (Levy)
- Environmental modelling

**Precision Farming**
- Food security
- Sustainable agriculture
- Precision Irrigation
- Environmental compliance
Contents

• What’s possible with remote sensing imagery?
• Imagery at different scales – spatial resolution and NDVI
• Case studies:
  – Yield assessment
  – Disease monitoring
  – Crop area estimates
  – Vegetation productivity indicator
What’s possible with Remote Sensing imagery?

- Exploit an underlying physical relationship between a crop biophysical parameter and spectral response, e.g. %cover, LAI, GAI, biomass
- Vegetation indices such as NDVI are often used to calibrate crop yield indicators, to assess crop development, or disease
- Apply at different spatial scales (within-field to farm scale and above)
Different scales 250 to 1 m, (satellite, aerial and ground)
Different scales <1 m

Near ground
1 m quadrat

0.1 m pixel

0.6 m

0.25 m

0.1 m
Yield/Production estimation using vegetation indices

- Biomass
  - Pasture
  - Forage
- Grain/fruit
  - Harvest index
  - Harvest losses
- Roots/tubers
  - Harvest index
  - Harvest losses
- Extract
  - Sugar
  - Opium gum
Intermediate relationships implicit to correlations with yield

Photosynthetically Active Vegetation PAV
NDVI: R-NIR images captured simultaneously (0.5 m pixels)

Near Infrared (840 nm)  
Visible-Red (640 nm)
Normalised difference vegetation index (NDVI)

\[ NDVI = \frac{IR - R}{IR + R} \]

\[ = \frac{DN_{IR} - DN_{R}}{DN_{IR} + DN_{R}} \]

\[ = \frac{\rho_{IR} - \rho_R}{\rho_{IR} + \rho_R} \]

Reflectance values

NDVI is dimensionless with a range of -1 to 1
Ground data collection for NDVI calibration

NDVI sensor

Cranfield UNIVERSITY
Lettuce monitoring with UAV using NDVI

- NDVI values correlates with plant canopy
- Plant population (> 95% accuracy)
- Mean foliar diameter (> 96% accuracy)
- Yield potential in lettuce
Derived crop information – cauliflower (30 cm NDVI)

Predicting Harvest resource and planning marketing
lettuce yield variation with soil

Max diff of 286g
Disease detection and progression - Celery

Crop survey using a UAV with multispectral camera enable to detect the location of areas affected by *Septoria Apiicola* (late blight)

Affected area can be measured from imagery and tracked back to variety, planting batch, seed lot...

False colour composite images form UAV. Evolution of an organic celery patch affected by 'late bright' in a week difference (Oct-2014)
Integration of UK-DMC and IKONOS for opium and wheat cultivation estimates in Afghanistan

Impact: Poppy cultivation estimates were used to inform UK and international counter narcotics policy.
Figure 1. NDVI profiles from MODIS imagery at agricultural locations in
- Helmand (Altitude 741 m, Latitude 31.43° N),
- Balkh (Altitude 1463 m, Latitude 35.80° N) and
- Badakhshan (Altitude 2502 m, Latitude 36.31° N)

Ref: Taylor, et al., 2010
Vegetation productivity indicator (VPI) crop information across Afghanistan
What is the appropriate spatial and temporal scale?