Agricultural Classification of Multi-Temporal MODIS Imagery in Northwest Argentina Using Kansas Crop Phenologies

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RESEARCH QUESTIONS

Can I...

- develop a phenological classification toolset?
- extract crop signatures from Kansas data?
- classify an Argentina study area with the Kansas signatures?

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OUTLINE

1. Background
2. Study Areas
3. Data and Methods
4. Results and Discussion
5. Conclusion

BACKGROUND

DEFORESTATION IN ARGENTINA

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- 1998 to 2002: 940,000 ha deforested
- *Ley de Bosques* passed in 2007
  - Classified red, yellow, and green areas

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DEFORESTATION IN ARGENTINA

Table: Deforestation in Argentina, 2006 to 2011

Time Period	**Hectares Deforested**
2006 to *Ley de Bosques* (2007)	573 296
Ley de Bosques to OTBN (2009)	473 001
OTBN to 2011	459 108
Total	1 505 405

DEFORESTATION IN ARGENTINA

- Deforestation has remained extremely high
- The effect of the the *Ley de Bosques* has been questioned

SOY AND ITS EFFECTS

- Argentina's soybean cultivation has continually increased
  - 5 million ha in 1993 to 19 million ha in 2011

SOY AND ITS EFFECTS

- Soy production highly mechanized
- Over 99 percent of Argentine soy is genetically modified
  - Resistance to glyphosate = heavy pesticide use
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- Better understanding of the dynamics of deforestation
- More effective land management policies

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Questions

- What if two crops have similar VI values on a single date?
- How does one determine a crop's VI values?

VEGETATION INDICIES

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What if two crops have similar VI values on a single date?

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Question

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Answer

Use imagery from multiple dates.

TIME SERIES IMAGES

NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) Sensor

- Terra and Aqua satellites
- Each images the Earth once per day
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Time Series Image (TSI)

- Each band is a 16-day VI composite
- Bands are sequential composites
- Contains enough bands to cover an entire growing season

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TIME SERIES IMAGES

Key Points

- A TSI pixel shows VI values over time
- Each crop's phenology exhibits a unique temporal signature

CROP TEMPORAL SIGNATURES

Graphics/wardlowCropSignatures.png

(From Wardlow and Egbert 2005)

PHENOLOGICAL CLASSIFICATION

Question

How does one determine a crop's VI values?

PHENOLOGICAL CLASSIFICATION

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How does one determine a crop's VI values?

Answer

Existing approaches require training sites.

PHENOLOGICAL CLASSIFICATION

Problem

What if you don’t have training sites?

TIME SERIES IMAGES

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Sounds a lot like hyperspectral remote sensing...

TIME SERIES IMAGES

Idea

Could we use a hyperspectal-like method to fit known crop signatures to unknown pixels?

TIME SERIES IMAGES

Graphics/transformations.pdf

TSF METHOD

Two-Step Filter (TSF) method from sakamoto2010a-two-step

- Two steps: (1) wavelet smoothing and (2) curve fitting
- Curve fitting can fit reference signature to unknown pixels

TSF METHOD

TSF Equation 1

$$RMSE = \left[\frac{1}{365/s} \sum_{x = j(0),\, j(1)\ldots}^{n} \left(f(x) - g(x) \right)^2 \right]^{\frac{1}{2}}$$

where

- n is the number of dates in the TSI
- $f(x)$ is the temporal signature for a given pixel in a dataset
- x is the DOY, as defined by $j(y)$

TSF METHOD

TSF Equation 2

$$g(x) = yscale \times \ h\left(xscale \times (x + tshift)\right)$$

where

- $yscale$ and $xscale$ are coefficients controlling the vertical and horizontal scaling of a reference signature $h(x)$
- $tshift$ is a constant representing the horizontal shift, in days, of $h(x)$
- x is the DOY

TSF METHOD

Graphics/transformations.pdf

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Minimizing Equation 1 with appropriate constraints on *yscale*, *xscale*, and *tshift* will find the fit of a a reference signature to a pixel.

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Answer

The TSF equations allow the classification of unknown pixels using a library of crop signatures.

STUDY AREAS

KANSAS STUDY AREA

- 2012 Kansas top crops:
  - Winter wheat
  - Corn
  - Soy
- Ground truth: USDA Cropland Data Layer

Graphics/KSstudysite.pdf

DEPARTMENT OF PELLEGRINI

Graphics/argentinaOverview_landscape.pdf

Table: Deforestation in Pellegrini, 2001 to 2011

Period		Hectares Cleared	Percent of Land
2001	to2005	5.968	0.9
2006	to2011	75.249	10.8

DATA AND METHODS

RESULTS AND DISCUSSION

CONCLUSION