NEBRASKA’S WATER MANAGEMENT RESOURCE

Providing the sound science and support for managing Nebraska’s most precious resource.

Use of Remote Sensing and Surface Energy Balance Model to Map Irrigated and Dryland Cropland

2015 AWRA Annual Water Resources Conference
Denver, Colorado
November 18th, 2015

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Nebraska Department of Natural Resources
Nebraska Department of Natural Resources

- Governor
  - Pete Ricketts

- Director
  - Gordon W. “Jeff” Fassett, P.E.
  - Deputy Director
  - Communications Director

- Natural Resources Programs Director
  - Integrated Water Management
  - Engineering Programs & Services
  - Permits and Registrations

- Natural Resources Administration Director
  - 27 Member Natural Resources Commission
  - Field Offices
  - Management Services
  - Information Technology
What we do:

- Provide technical expertise, planning, and coordination
- Develop models
- Conduct studies
- Help water managers
- Collaborate with NRDs and other stakeholders

To help better understand:

- Nebraska’s water supplies and uses
- The effects of potential water management strategies
Irrigated Agriculture in Nebraska

- Agriculture plays a pivotal role in Nebraska economy
- Nebraska ranks 1st in irrigated acres
Impacts of Irrigation

- Managing Impacts of Irrigation
Irrigated/Non-irrigated Farmland

- **Irrigated Farmland**
  - Irrigation meets the crop needs when lack of rain during the growing season

- **Non-Irrigated Farmland**
  - Only rain-fed crops
  - Susceptible to drought

Source: http://www.fao.org/docrep/006/y4683e/y4683e07.htm
Project Goals

• To develop a scientifically defensible and cost-effective technique for classifying irrigated and non-irrigated farmland using remote sensing techniques

• Methodology that would work in normal, dry, and wet years
Remote Sensing Technique
Study Area
Study Area
Methods—Pixel-based Classification

- Normalized Difference Vegetation Index (NDVI)
  - Popular vegetation and irrigation monitoring tool
- Greenness Index (GI)
  - Sensitive to soil moisture stress than NDVI
- Evaporative fraction (ETRF)
  - Indicating water stress; more responsive than NDVI
  - Surface Energy Balance System (SEBS)

\[
ETRF = \frac{\lambda E}{Rn - G}
\]
Methods—Pixel-based Classification

Surface Energy Balance

\[ R_n = H + G + LE \]
Methods—Pixel-based Classification

• Two new indices
  - Enhance the spectral contrast
  - Calibration with Ground-truth data
  - Verification with the NASS data

\[
\begin{align*}
NGI &= \text{NDVI} \times GI \\
EGI &= \frac{EFRF}{GI}
\end{align*}
\]

\[
MAPE = \frac{1}{N} \sum \left( \frac{|NASS - NEGI|}{NASS} \right)
\]
**INPUTS**
- Landsat
- Weather data
- Digital Elevation Model
- Cropland Data Layer

**SEBS**
\[ R_n = \lambda E + H + G \]
\[ ETRF = \frac{\lambda E}{R_n - G} \]
- \( R_n \): Net radiation
- \( \lambda E \): Latent heat
- \( H \): Sensible heat
- \( G \): Soil heat
- \( ETRF \): Evaporation fraction

**IRRIGATION INDICES**
- **EGI**
  \[ EGI = \frac{ETRF}{GI} \]
- **NGI**
  \[ NGI = NDVI \times GI \]

**NDVI & GI**
- \( \text{NDVI} = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}} \)
- \( \text{GI} = \frac{\rho_{green}}{\rho_{nir}} \)
- \( \rho_{nir} \): Near infrared reflectance
- \( \rho_{red} \): Red reflectance
- \( \rho_{green} \): Green reflectance
- \( GI \): Green Index

**Flowchart**
- **Low threshold**
  - NGI < ThD
  - **Yes**
    - Non-Irrigated Cropland
  - **No**
    - **High threshold**
      - NGI \( (EGI > \text{ThD}) \)
      - **Yes**
        - Irrigated Cropland
      - **No**
        - Irrigated Cropland
Results—Pixel-based Classification
Results—Pixel-based Classification

- Verification with USDA NASS irrigated acres

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Study Area
Results—Pixel-based Classification
Results—Pixel-based Classification

- Verification with USDA NASS irrigated acres

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Results—Object-oriented Classification

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Nuckolls County
Summary and Conclusion

• There is an advantage of remote sensing techniques for estimating irrigated and non-irrigated fields.

• **ET** is an important component for differentiating spectral signature of irrigated/non-irrigated fields.

• Better decisions on water resource management can be made with this method.

• More work will be done to integrate and automate the entire work flow.
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Providing the sound science and support for managing Nebraska’s most precious resource.

THANK YOU

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Recently developed classification method working on image objects rather than pixels

What is object?
- A cluster of adjacent pixels with similar spectral values
- Can be linked with real ground objects
- Allows a rich collection of descriptors
  - Such as texture, color, shape, topology

eCognition Software
- Rich set of tools working with objects
Methods—Object-oriented Classification

• Image segmentation
  - Grouping pixels into objects!

• Image classification
  - Classification of objects
  - A combination of methods

• Classification refinement

• Vectorization
  - Output as vector data
Methods

• Data
  - Landsat Remote Sensing Imagery

• Stage 1
  - Development of irrigated land area based on pixel-based classification

• Stage 2
  - Development of irrigated land area using object-oriented classification

• Stage 3
  - Automate the entire process