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Department of Natural Resources

NEBRASKA'S WATER MANAGEMENT RESOURCE

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

Classification of Irrigated and Non-Irrigated Land Using Remote Sensing Techniques:

A Case Study in Nebraska

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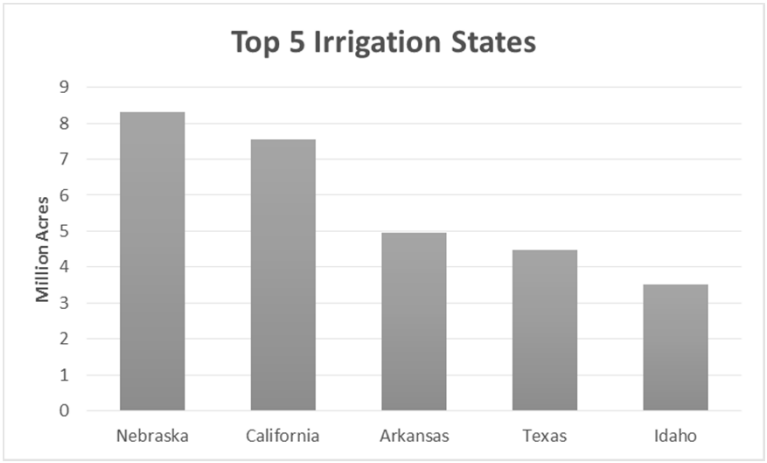
Irrigated Agriculture in Nebraska

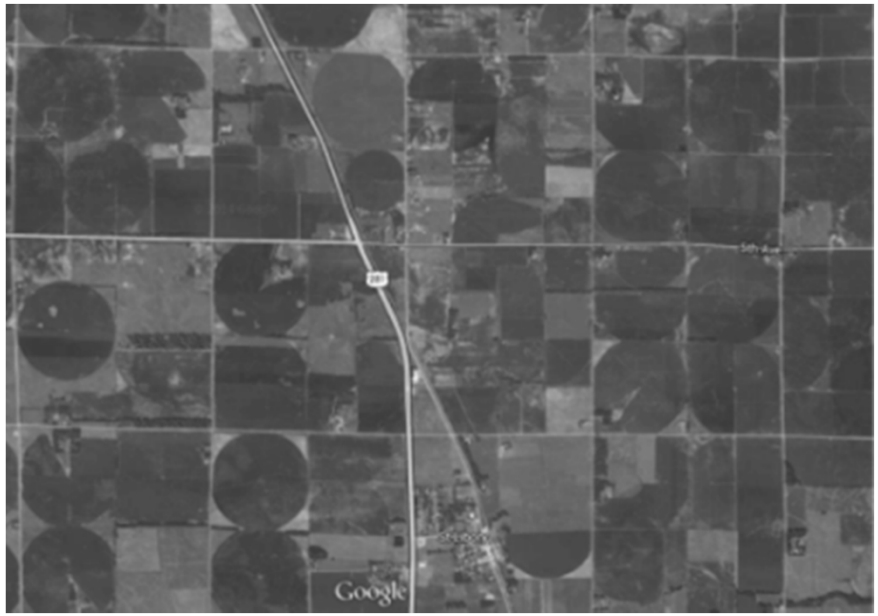
- Agriculture plays a pivotal role in Nebraska economy
- Nebraska ranks 1st in irrigated acres



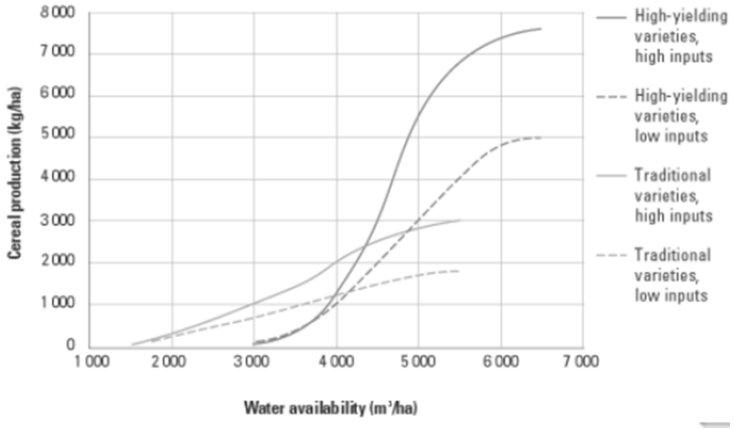
Source: USDA (2013)

Irrigated/Non-irrigated Farmland

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



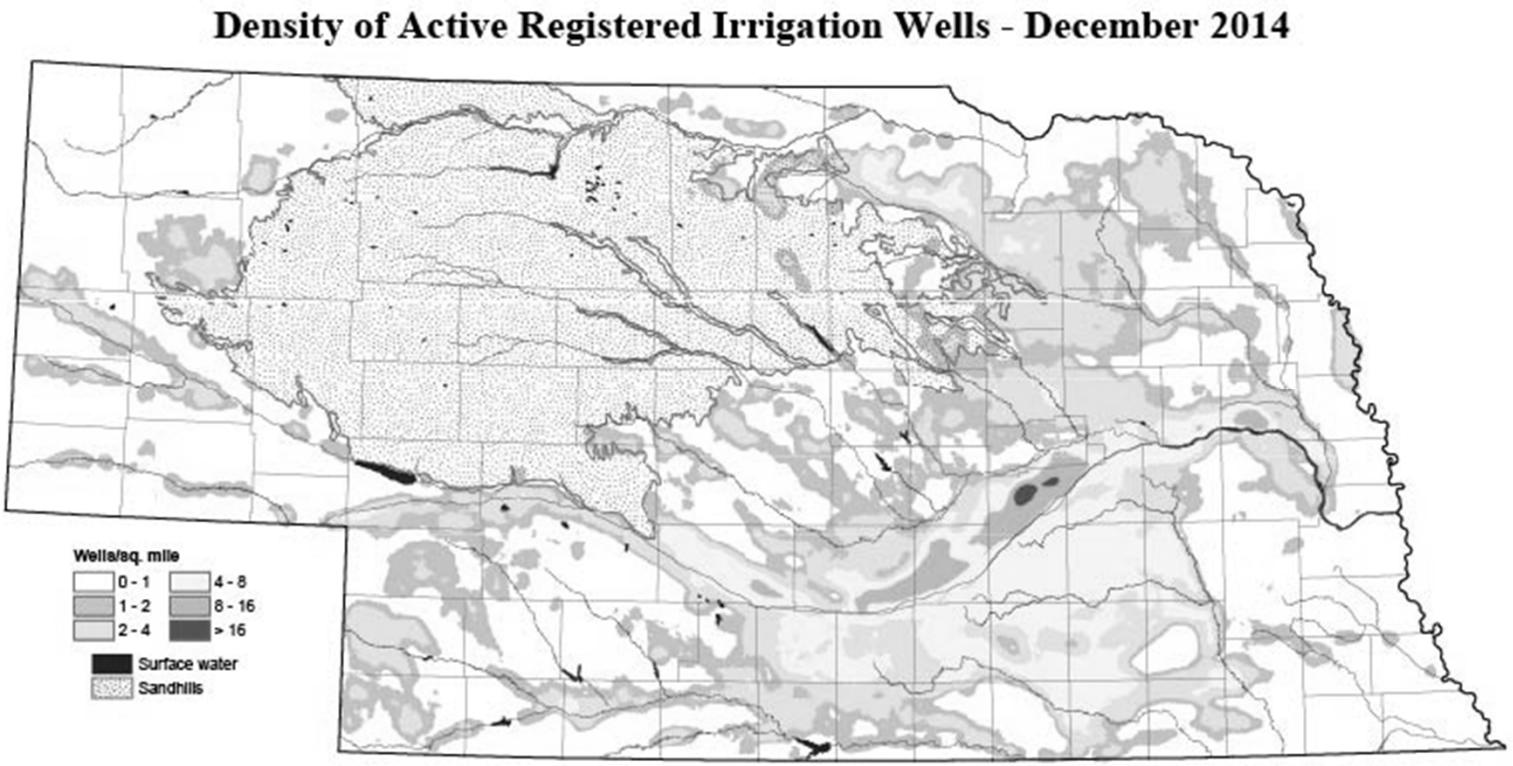
- Non-Irrigated Farmland
  - Only rain-fed crops
  - Susceptible to drought



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

Impacts of Irrigation

- Managing Impacts of Irrigation



Project Goals

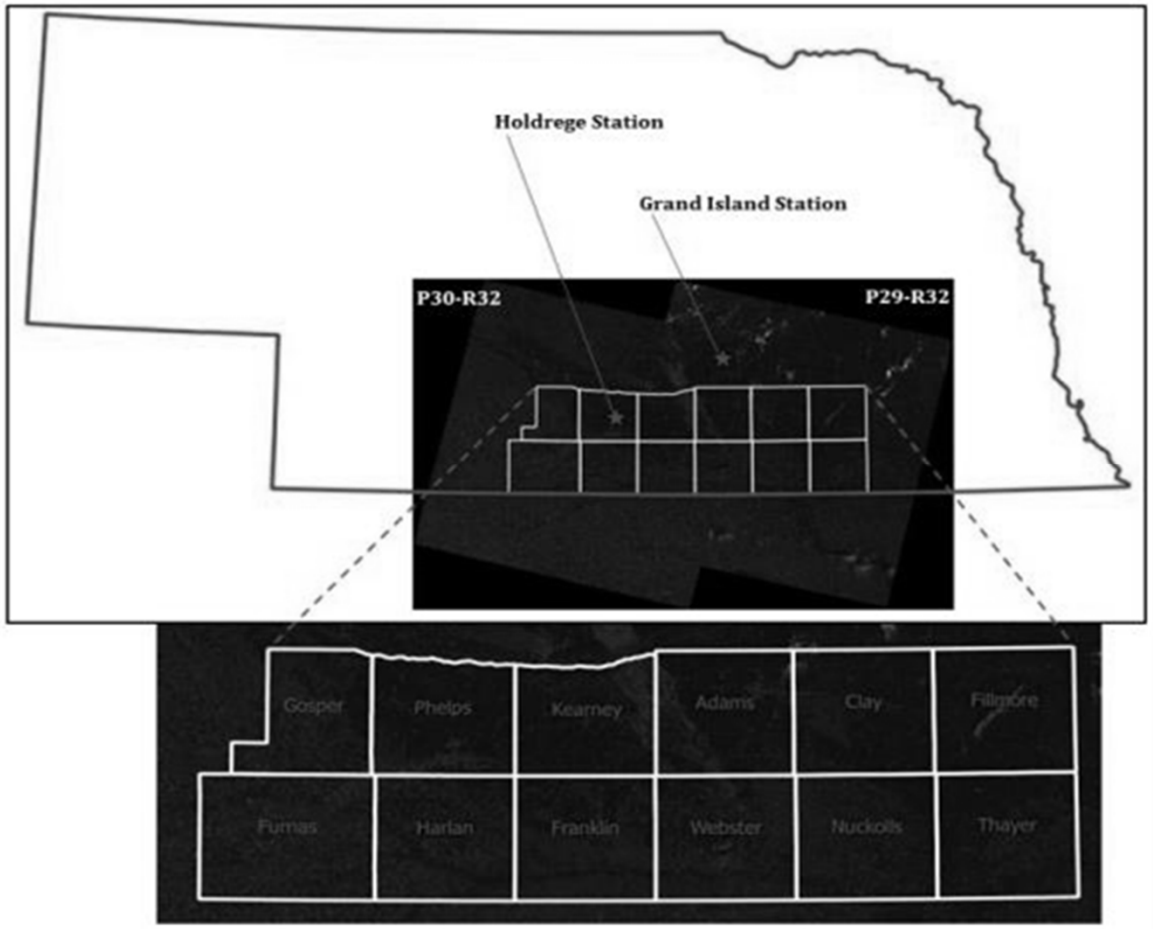
- To develop a scientifically defensible and cost-effective technique for classifying irrigated and non-irrigated farmland using remote sensing techniques

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

Study Area



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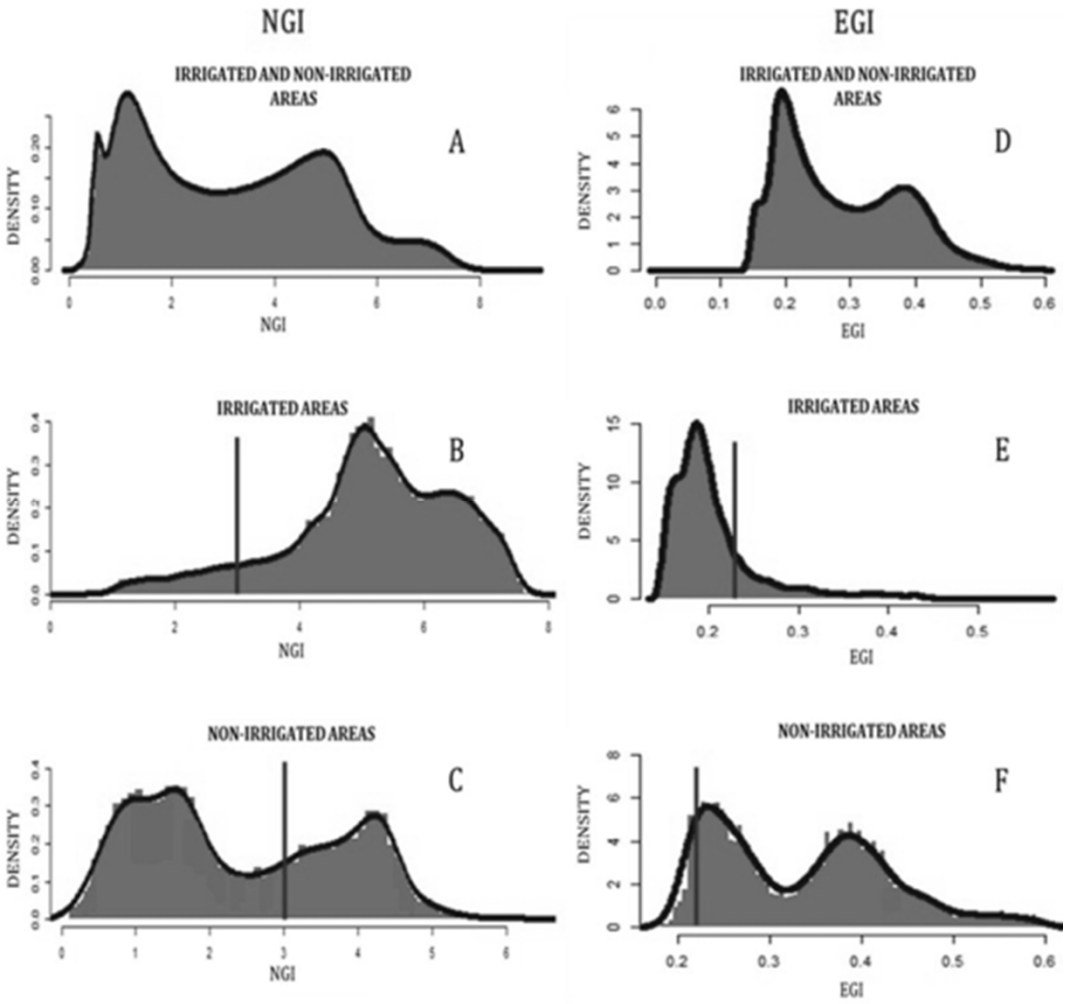
Methods—Pixel-based Classification

- 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

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



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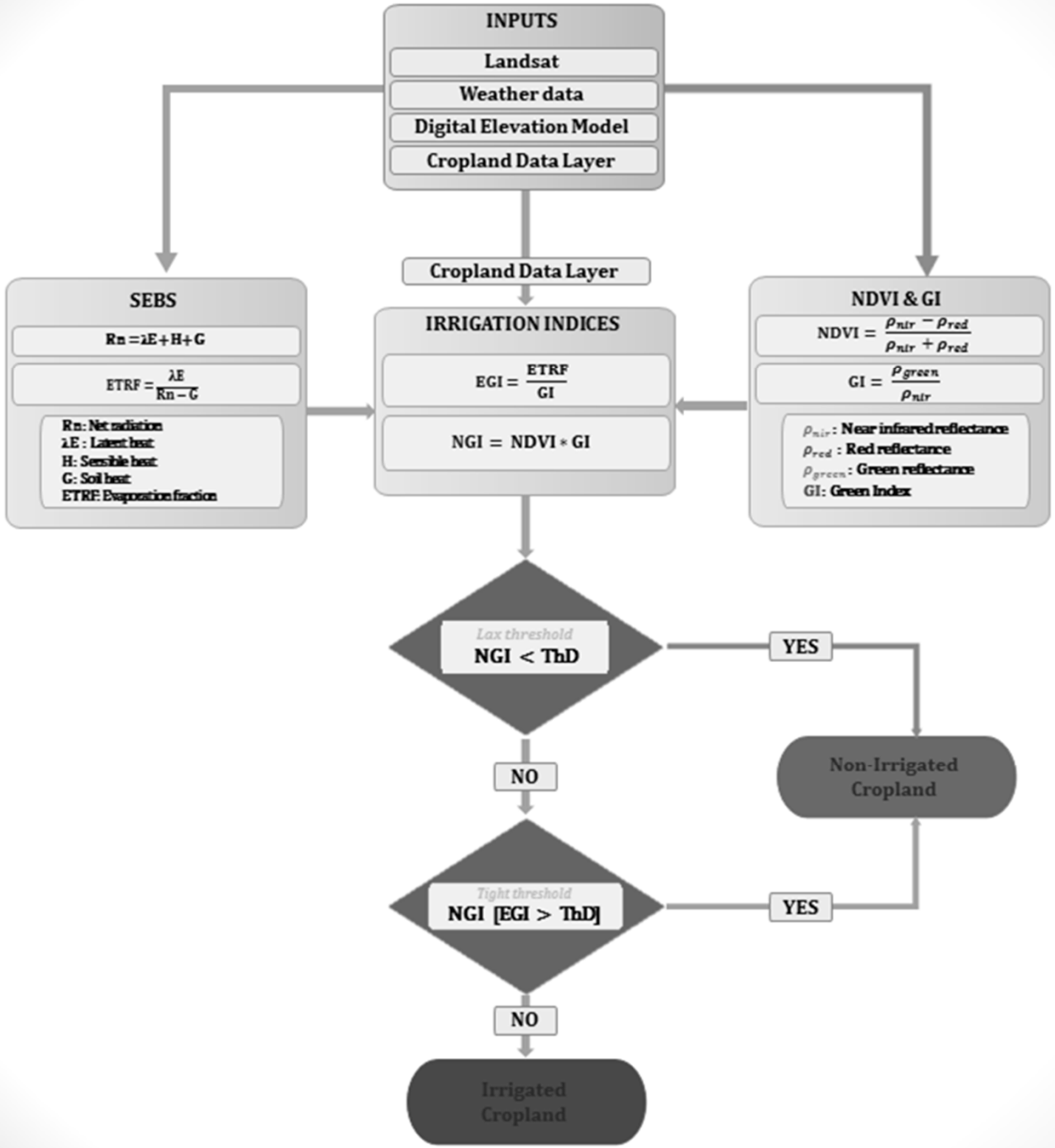
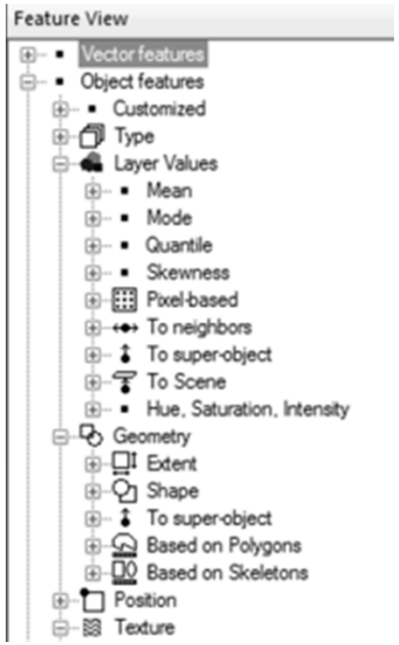

INPUTS
Landsat
Weather data
Digital Elevation Model
Cropland Data Layer
Cropland Data Layer
SEBS
Rn = λE + H + G
ETRF = λE / (Rn − G)
Rn: Net radiation
λE : Latent heat
H: Sensible heat
G: Soil heat
ETRF: Evaporation fraction
IRRIGATION INDICES
EGI = ETRF / GI
NGI = NDVI * GI
NDVI & GI
NDVI = (ρnir − ρred) / (ρnir + ρred)
GI = ρgreen / ρnir
ρnir: Near infrared reflectance
ρred : Red reflectance
ρgreen: Green reflectance
GI: Green Index
Lax threshold
NGI < ThD
YES
NO
Non-Irrigated Cropland
Tight threshold
NGI [EGI > ThD]
YES
NO
Irrigated Cropland

Methods—Object-oriented Classification

- Recently developed classification method working on image objects rather than pixels

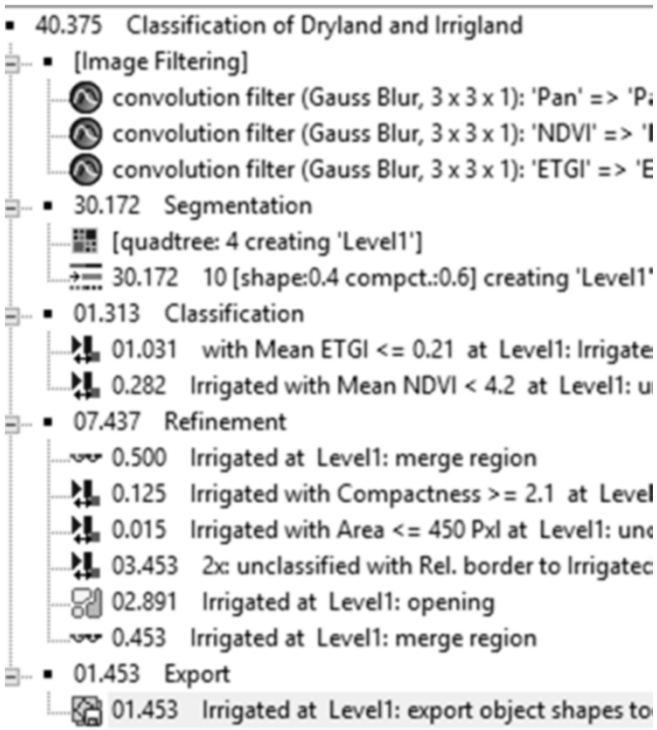
- What is object?
  - A cluster of adjacent pixels with similar spectral values
  - Can be linked with real ground objects
  - Allows a rich collection of descriptors
    - Such as texture, color, shape, topology

- eCognition Software
  - Rich set of tools working with objects

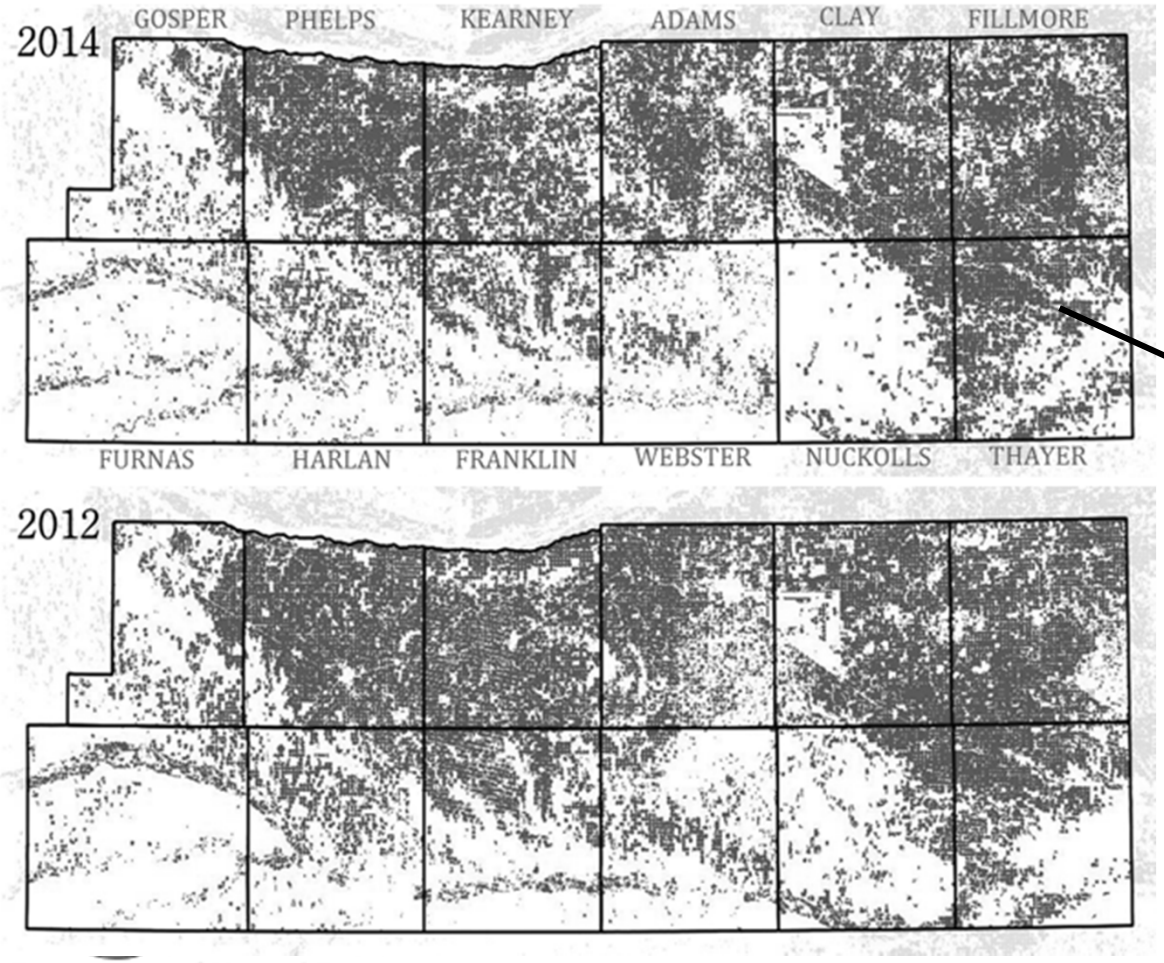


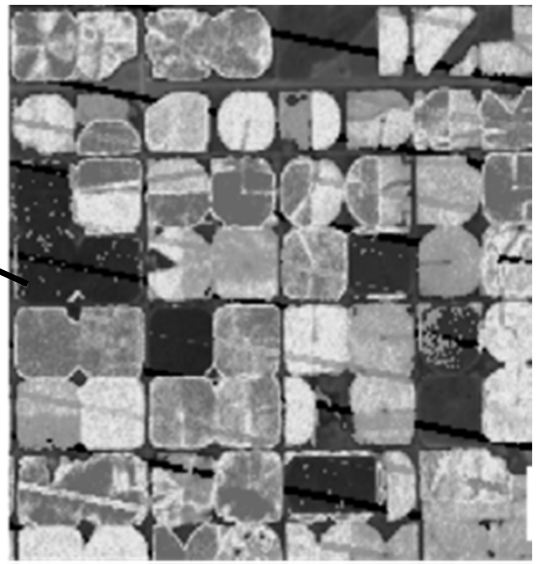
Methods—Object-oriented Classification

- Image segmentation
  - Grouping pixels into objects!
- Image classification
  - Classification of objects
  - A combination of methods
- Classification refinement
- Vectorization
  - Output as vector data



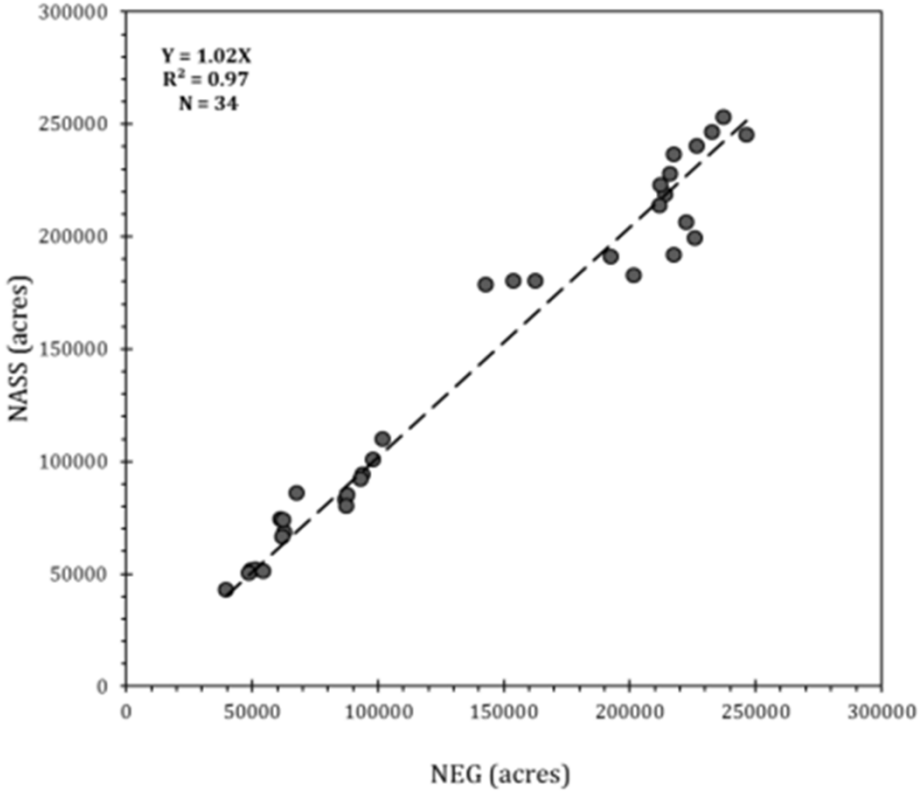
Results—Pixel-based Classification





Results—Pixel-based Classification

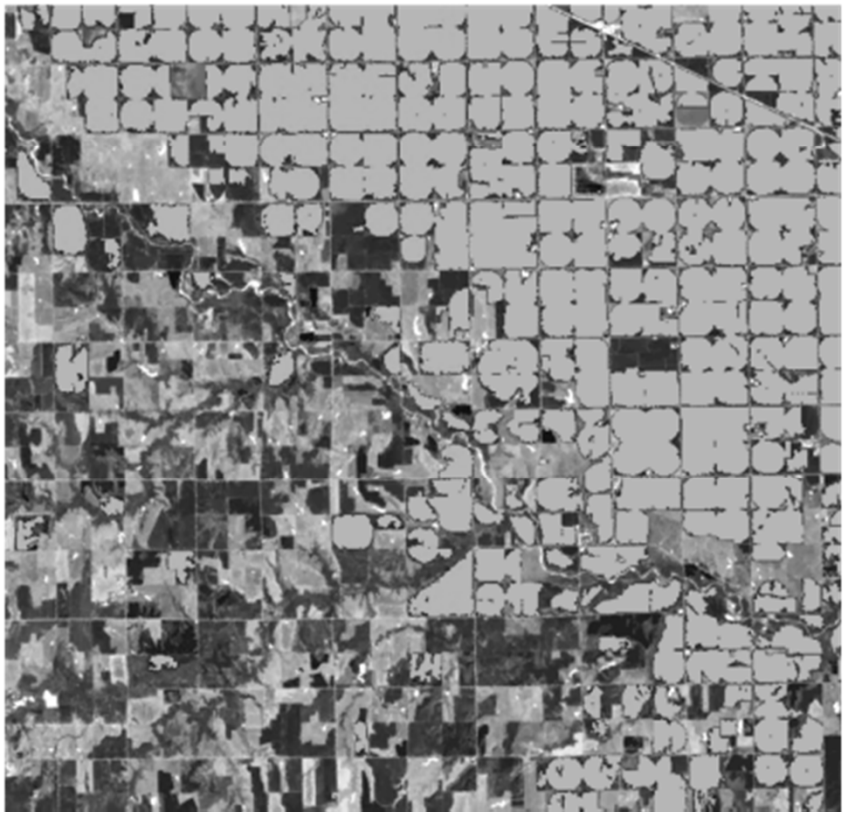
- Verification with USDA NASS irrigated acres



COUNTY	NASS	NEG	% Error	NASS	NEG	% Error
YEAR		2014			2012	
Adams	222400	206452.8	-7.2	225700	199703.3	-11.5
Clay	214000	219221.8	2.4	211900	223073.7	5.3
Fillmore	232400	246762.3	6.2	226300	240420.2	6.2
Franklin	93500	94689.35	1.3	101600	110192.9	8.5
Harlan	49000	52035.87	6.2	92700	92546.36	-0.2
Kearney	192200	191280.2	-0.5	215700	228001.1	5.7
Nuckolls	61100	74725.22	22.3	67300	86034.42	27.8
Thayer	162300	180392.9	11.1	153600	180392.9	17.4
Webster	51200	52499.34	2.5	62300	69067.2	9.8
Furnas	39400	43389.83	10.1	54100	51665.36	-4.5
Phelps	*	232239.9	-	246200	245411.2	-0.3
Gosper	*	79196.6	-	86700	83523.59	-3.7

Results—Object-oriented Classification

Classification	NASS	Difference
63624	61100	4%



Discussion

- ET is an important component for differentiating spectral signature of irrigated/non-irrigated fields even during the wet year (2014)

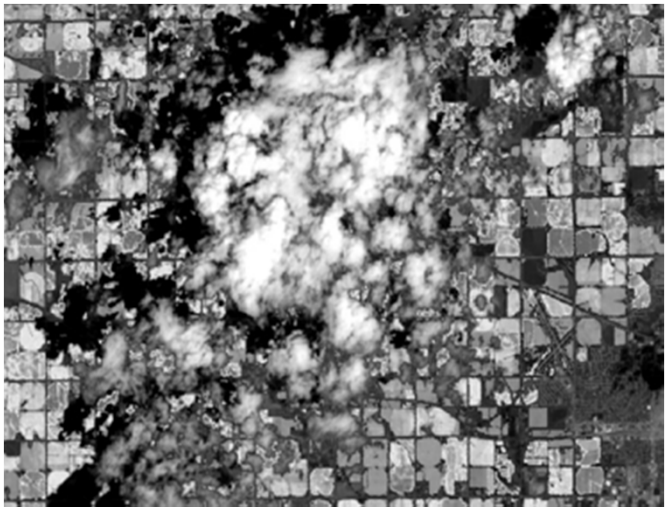
- The pixel-based classification can produce results comparable with NASS county data

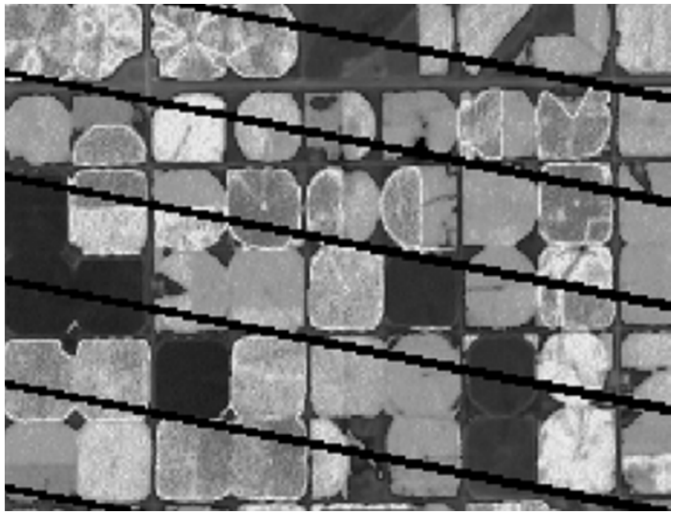
- The object-oriented approach can help refine the results and automate the work flow

- The method and results can help improve water resource decision making

Discussion

- Limitation
  - Assuming the NASS county-level irrigated acres are ‘accurate’
  - The spatial distribution of ground truth was limited by the accessibility of field crews and funding
  - Cloud and scan-line gaps are interpolated





Future Work

- Comparing pixel-based and object-oriented classification results for each county
- Calibrating with better ground-truth data
- Building an automated work flow
  - Combining two methods into one
- Auxiliary data can be used for refinement

Summary

- This study shows the advantages of remote sensing techniques for estimating irrigated and 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

Any Questions?

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THANK YOU

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