Nebraska
Department of Natural Resources

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

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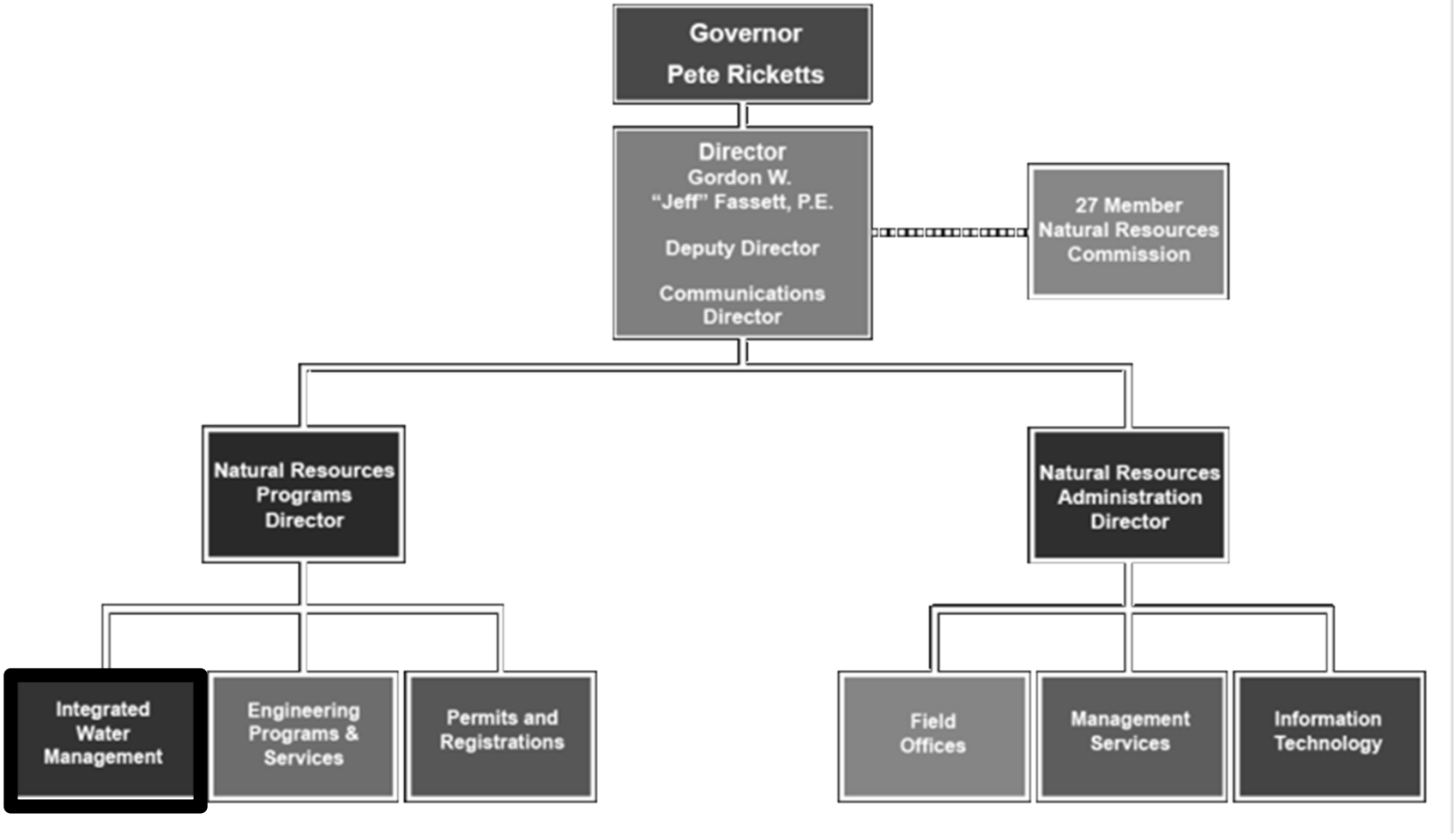
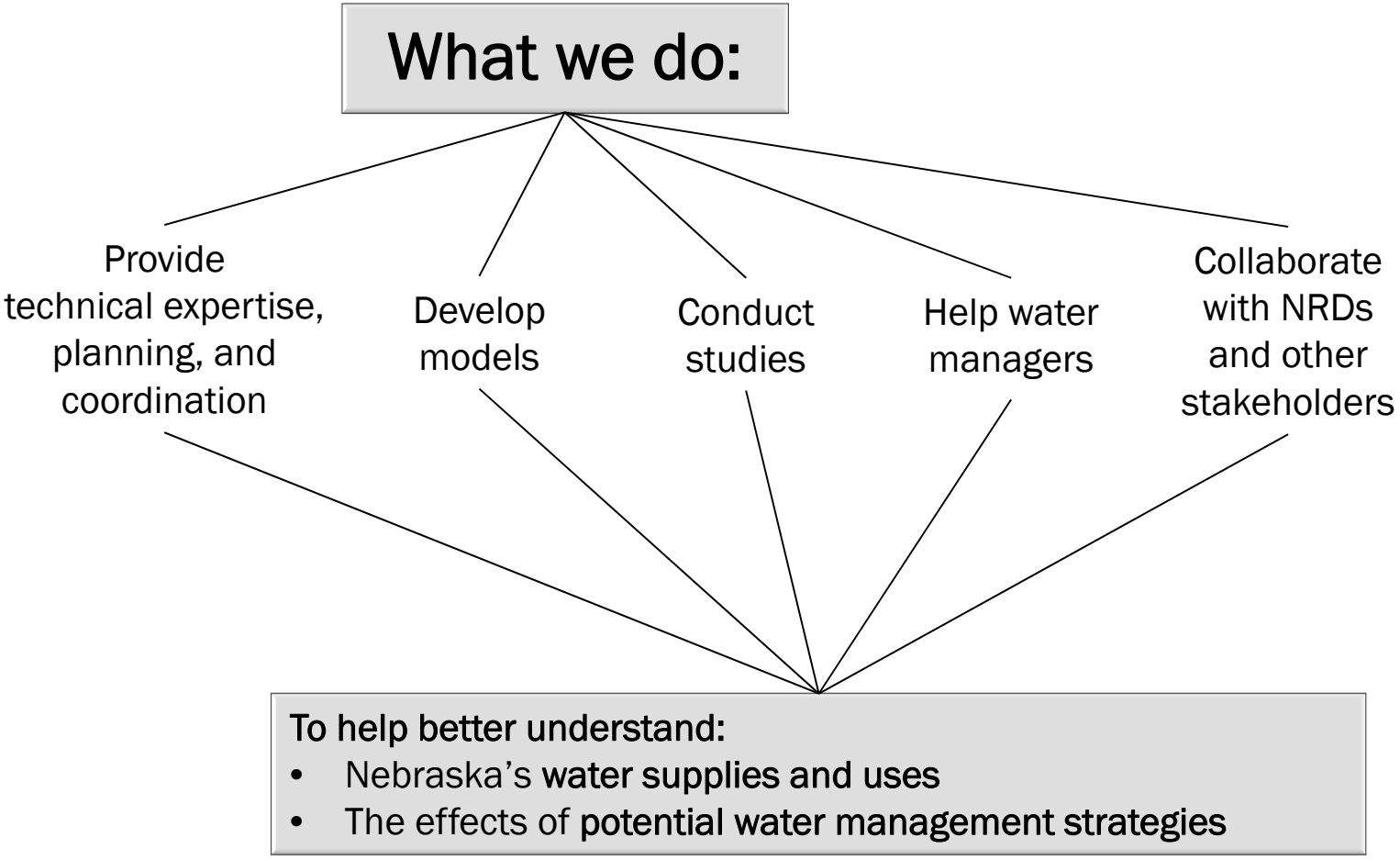
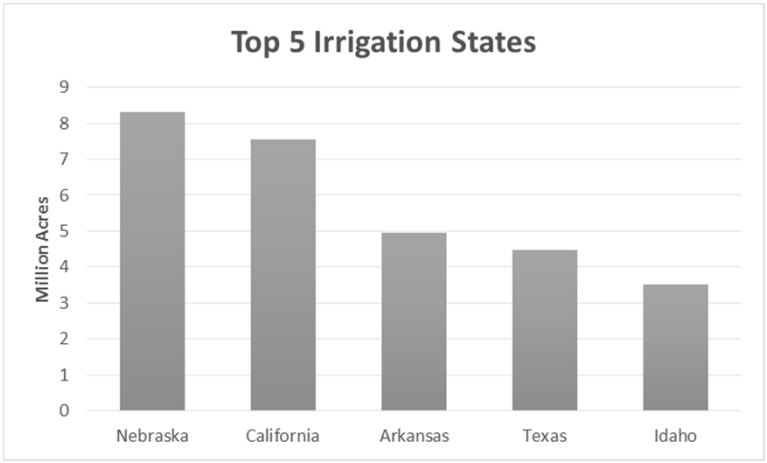


Integrated Water Management Division



Irrigated Agriculture in Nebraska

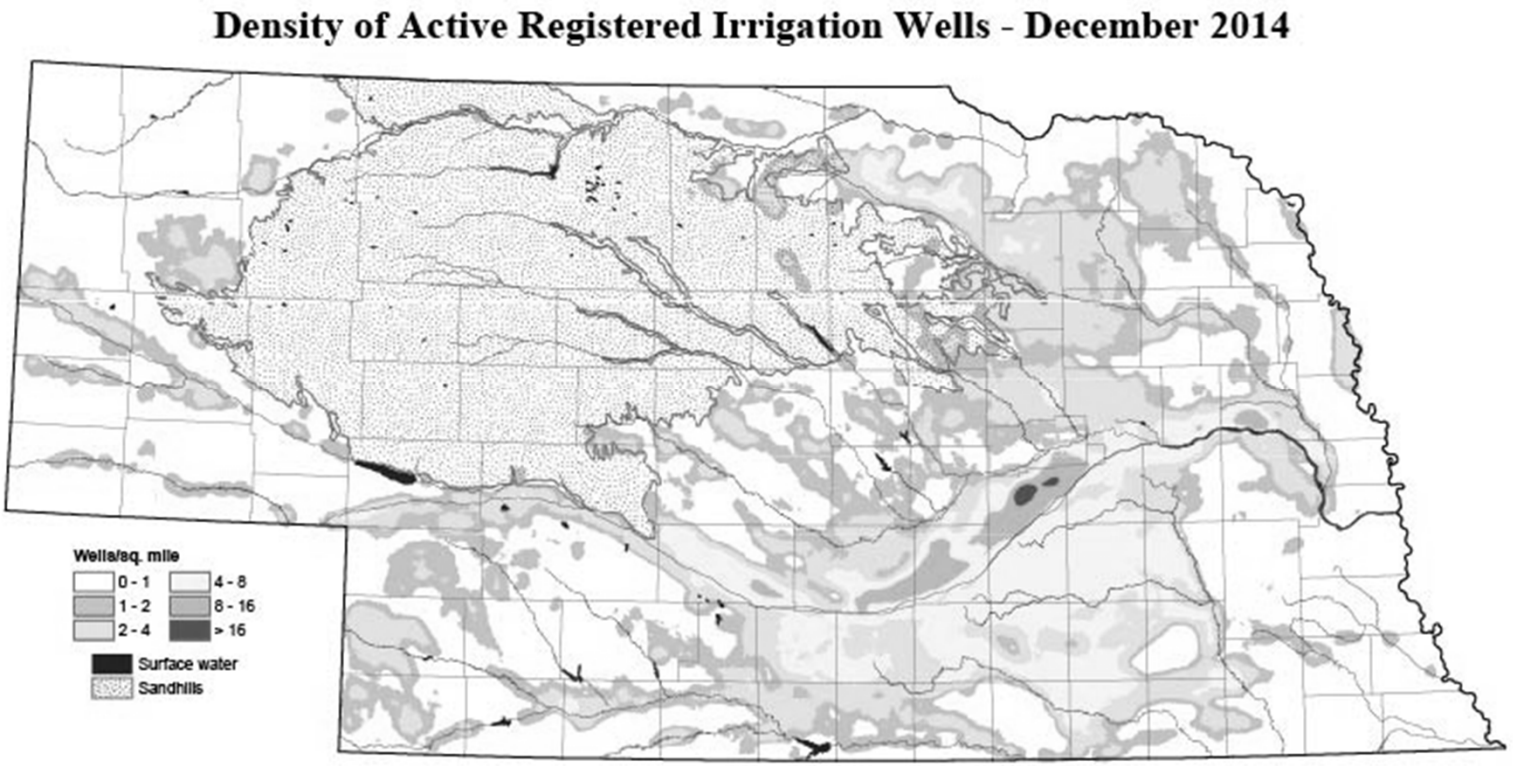
- Agriculture plays a pivotal role in Nebraska economy
- Nebraska ranks 1st in irrigated acres



Source: USDA (2013)

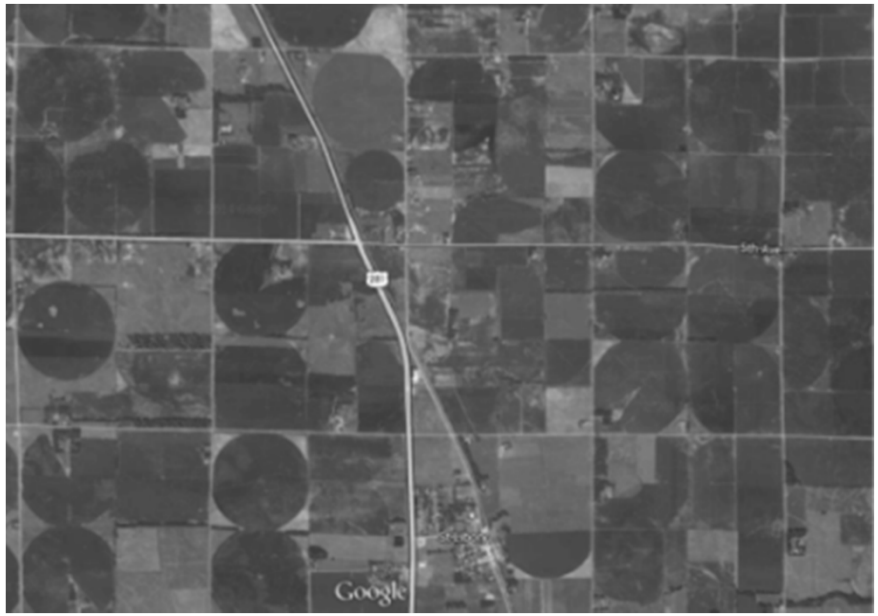
Impacts of Irrigation

- Managing Impacts of Irrigation

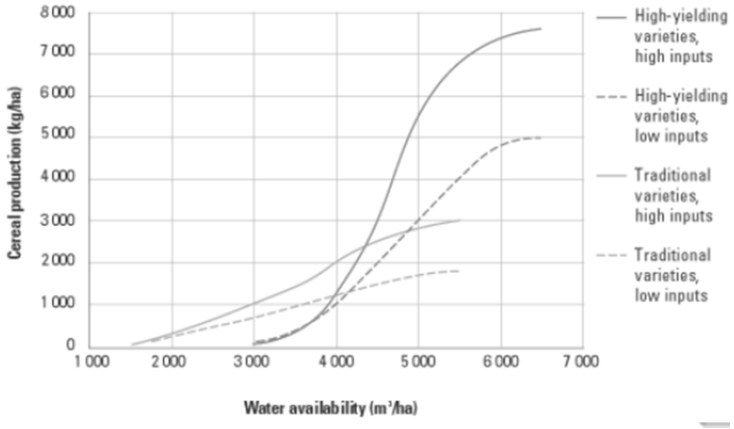


Irrigated/Non-irrigated Farmland

- 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



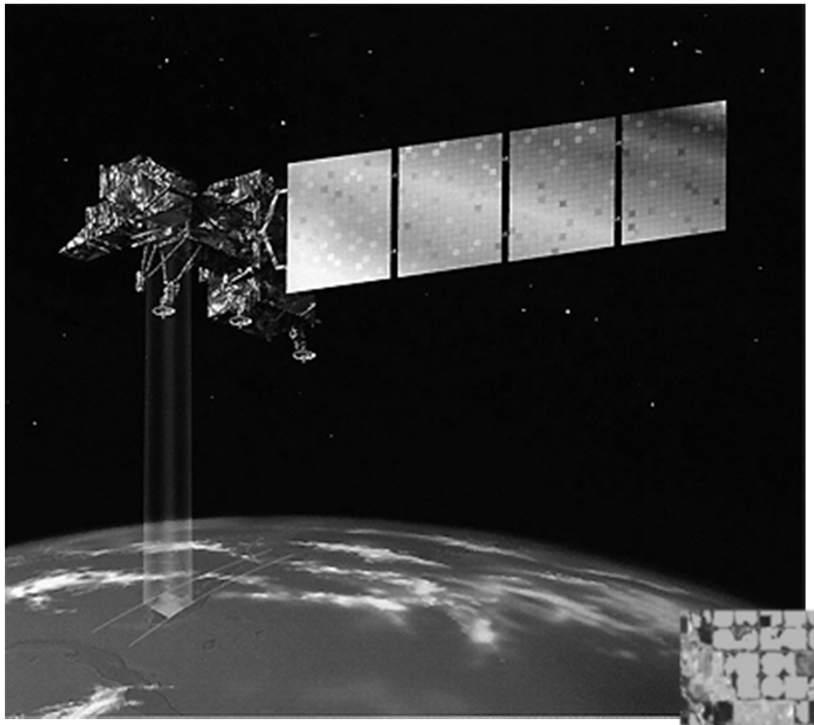
Source: http://www.fao.org/docrep/006/y4683e/y4683e07.htm

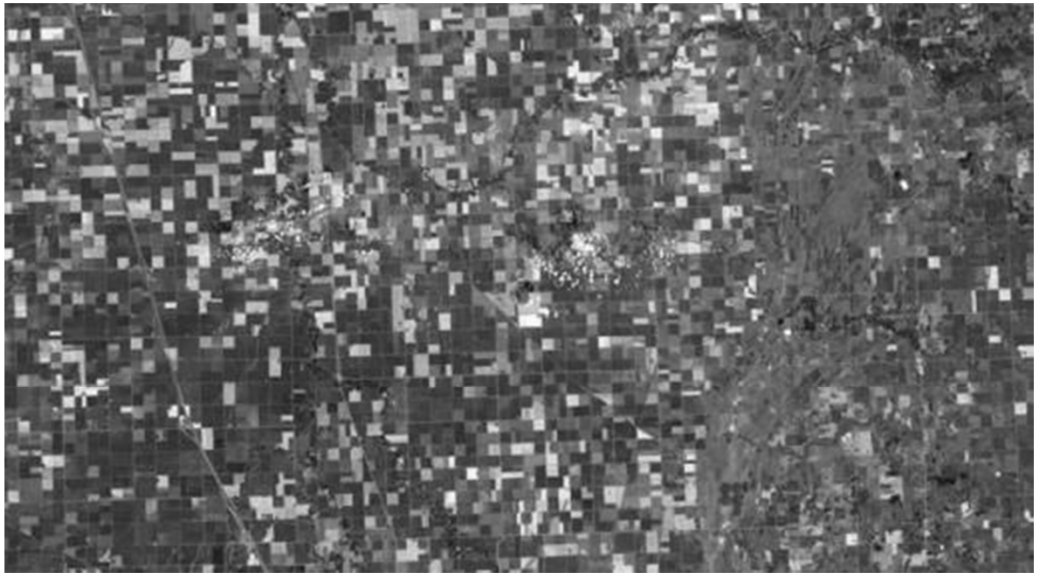
Project Goals

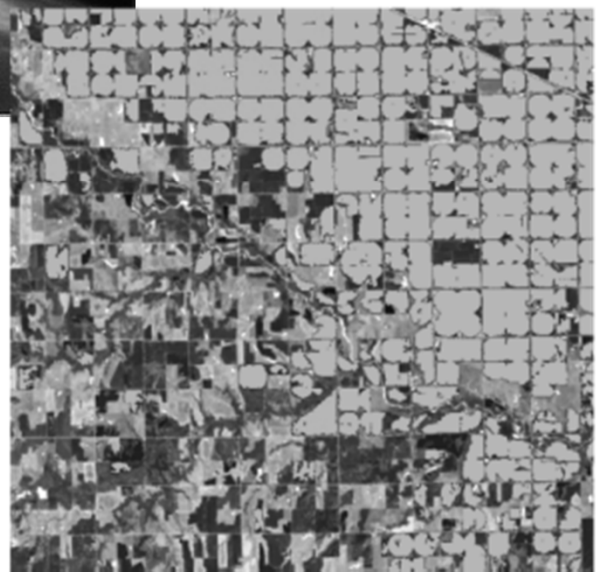
- To develop a scientifically defensible and cost-effective technique for classifying irrigated and non-irrigated farmland using remote sensing techniques

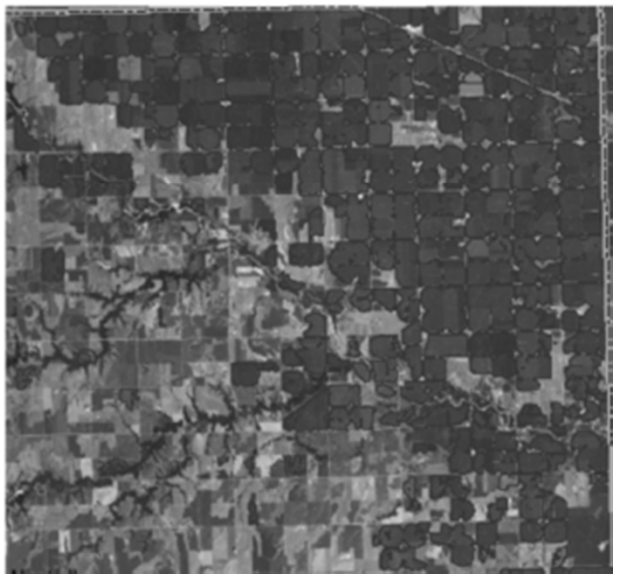
- Methodology that would work in normal, dry, and wet years

Remote Sensing Technique









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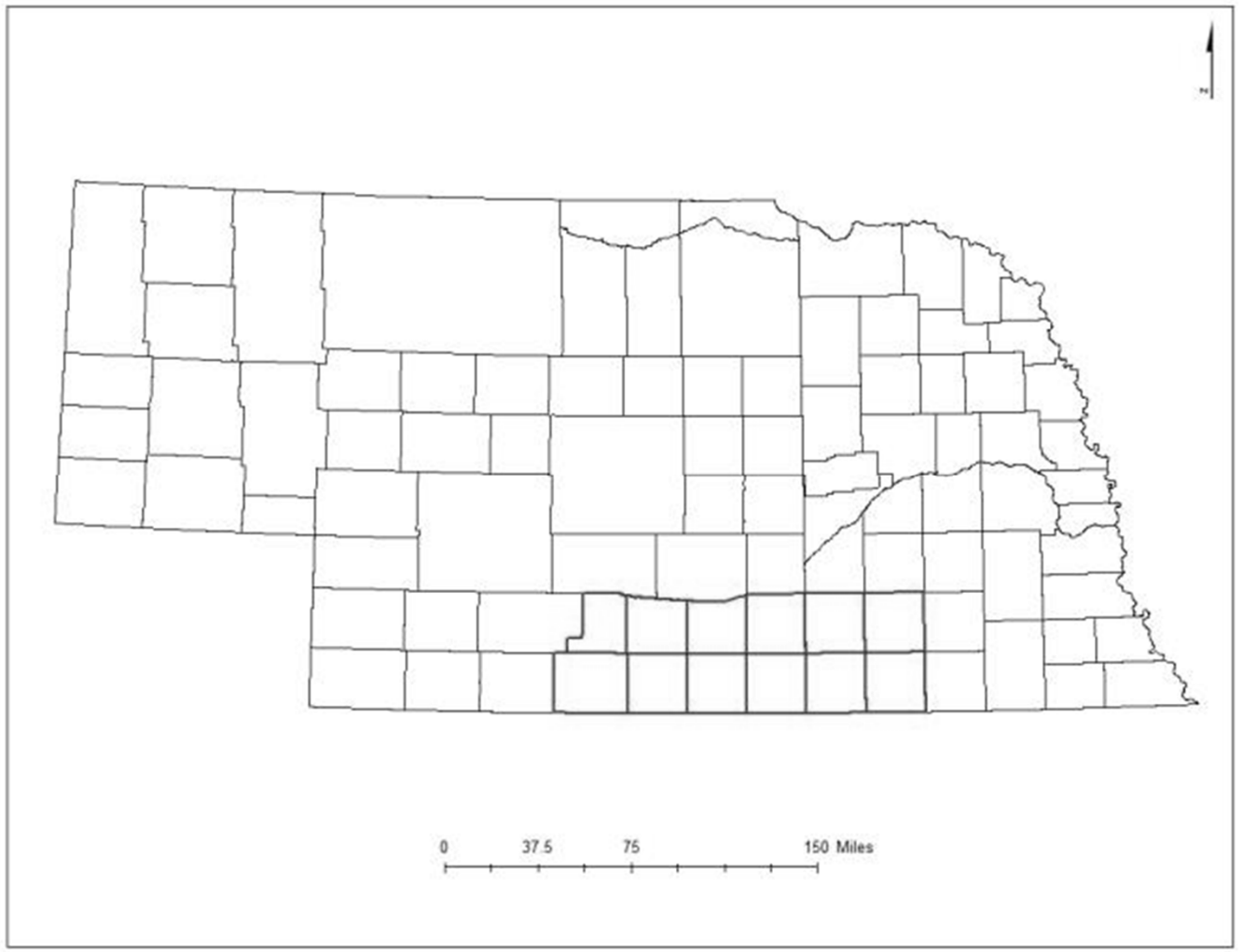
Study Area



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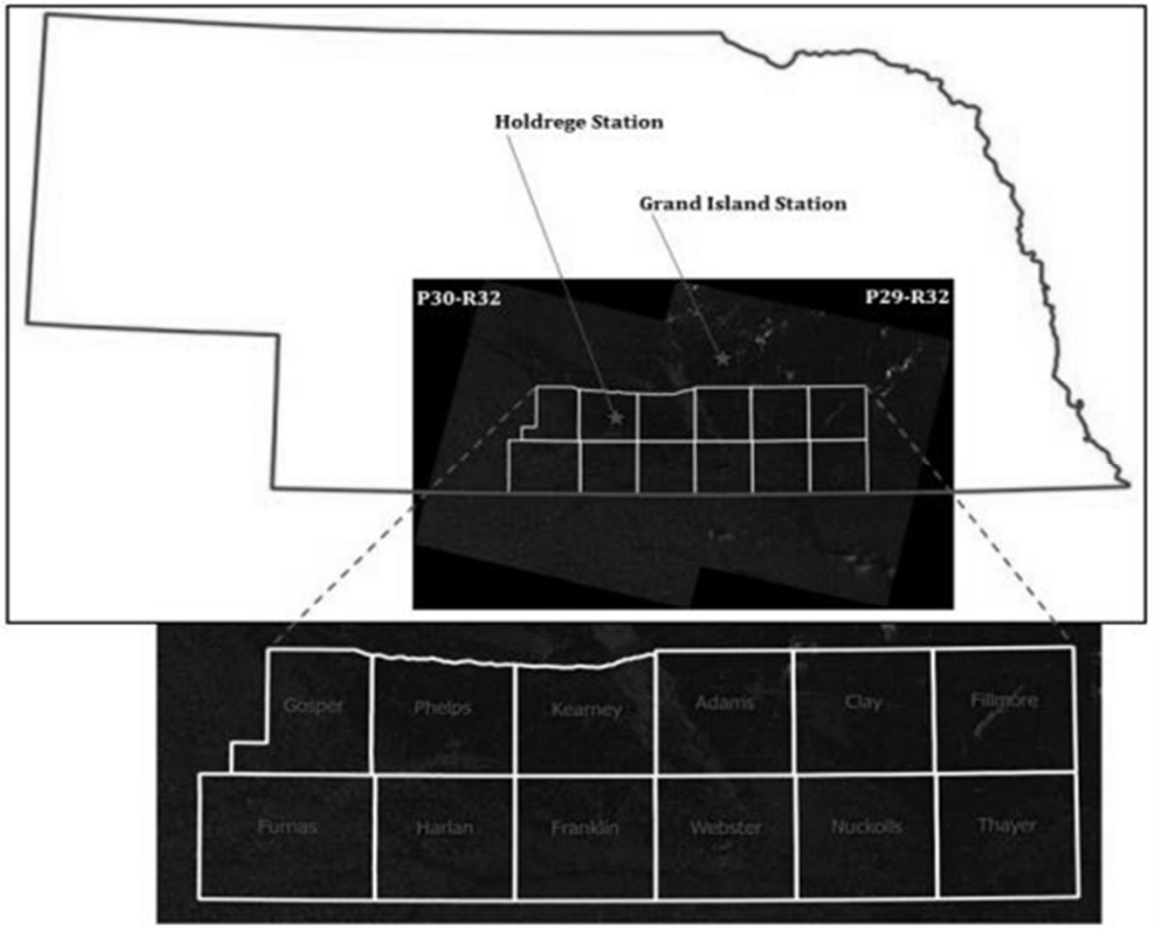

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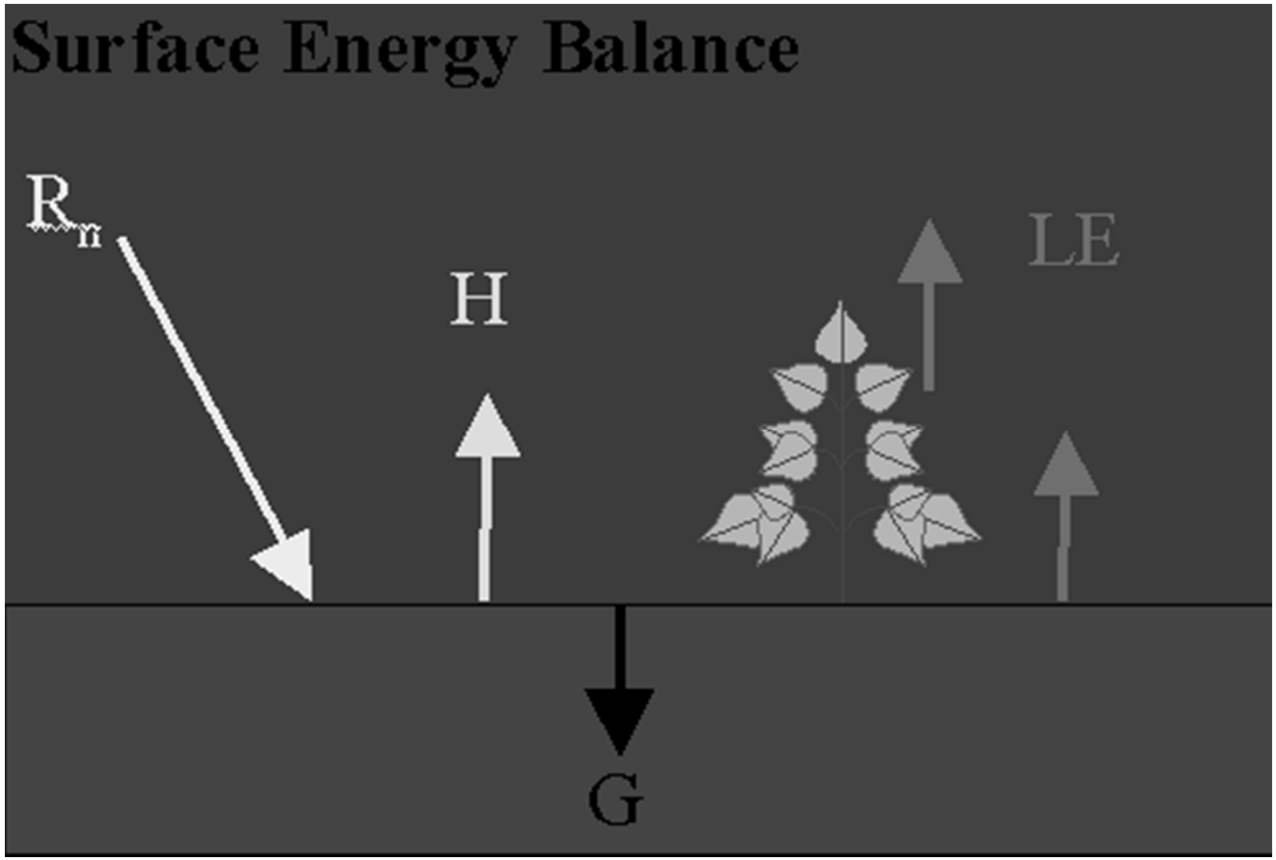
Methods—Pixel-based Classification

- 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)

$$ETrF = \frac{\lambda E}{Rn - G}$$

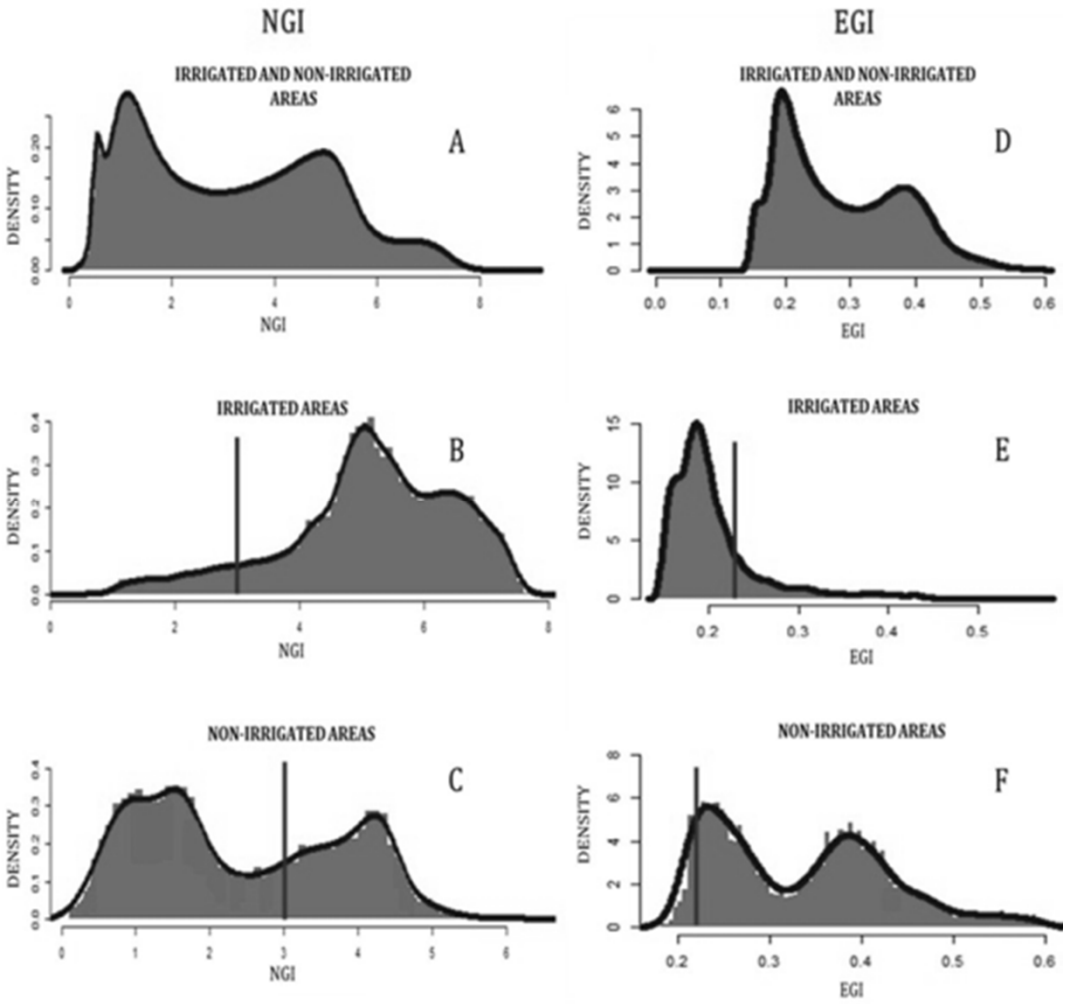
Methods—Pixel-based Classification



$$R_n = H + G + LE$$

Methods—Pixel-based Classification

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



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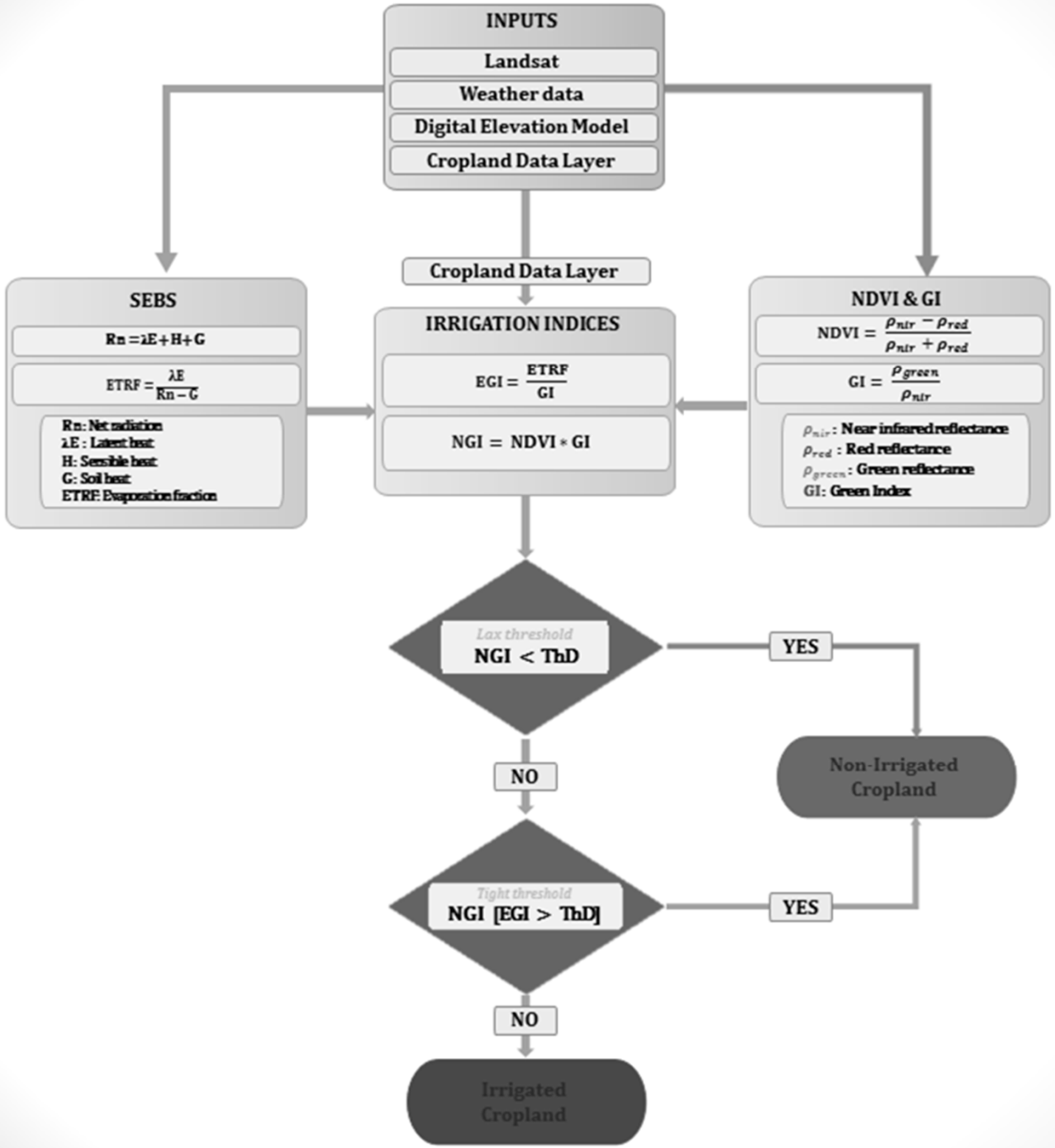
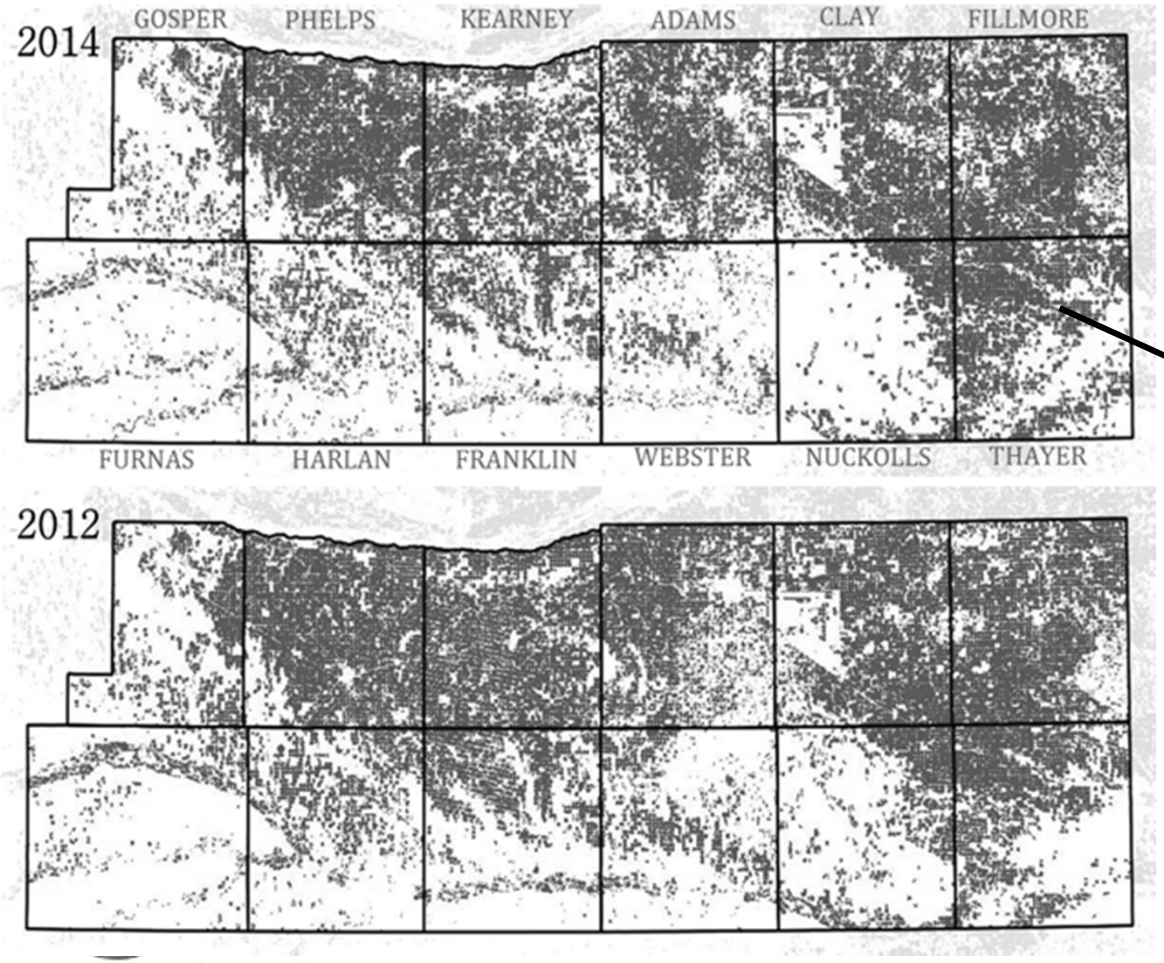
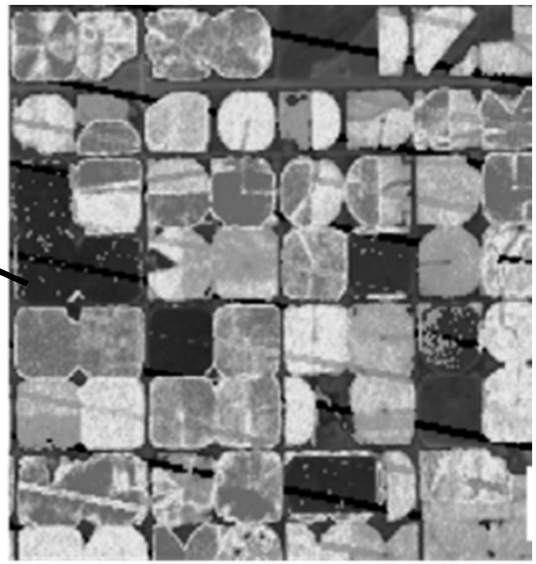

INPUTS
Landsat
Weather data
Digital Elevation Model
Cropland Data Layer
Cropland Data Layer
SEBS
Rn = λE + H + G
ETRF = λE / (Rn − G)
Rn: Net radiation
λE : Latent heat
H: Sensible heat
G: Soil heat
ETRF: Evaporation fraction
IRRIGATION INDICES
EGI = ETRF / GI
NGI = NDVI * GI
NDVI & GI
NDVI = (ρnir − 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

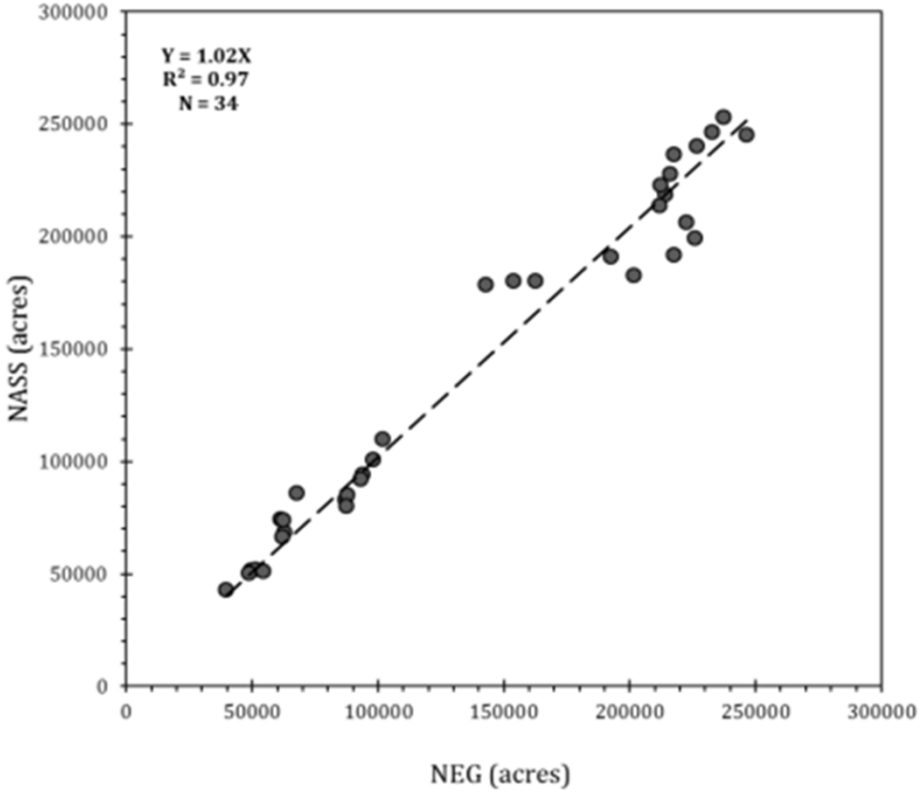
Results—Pixel-based Classification





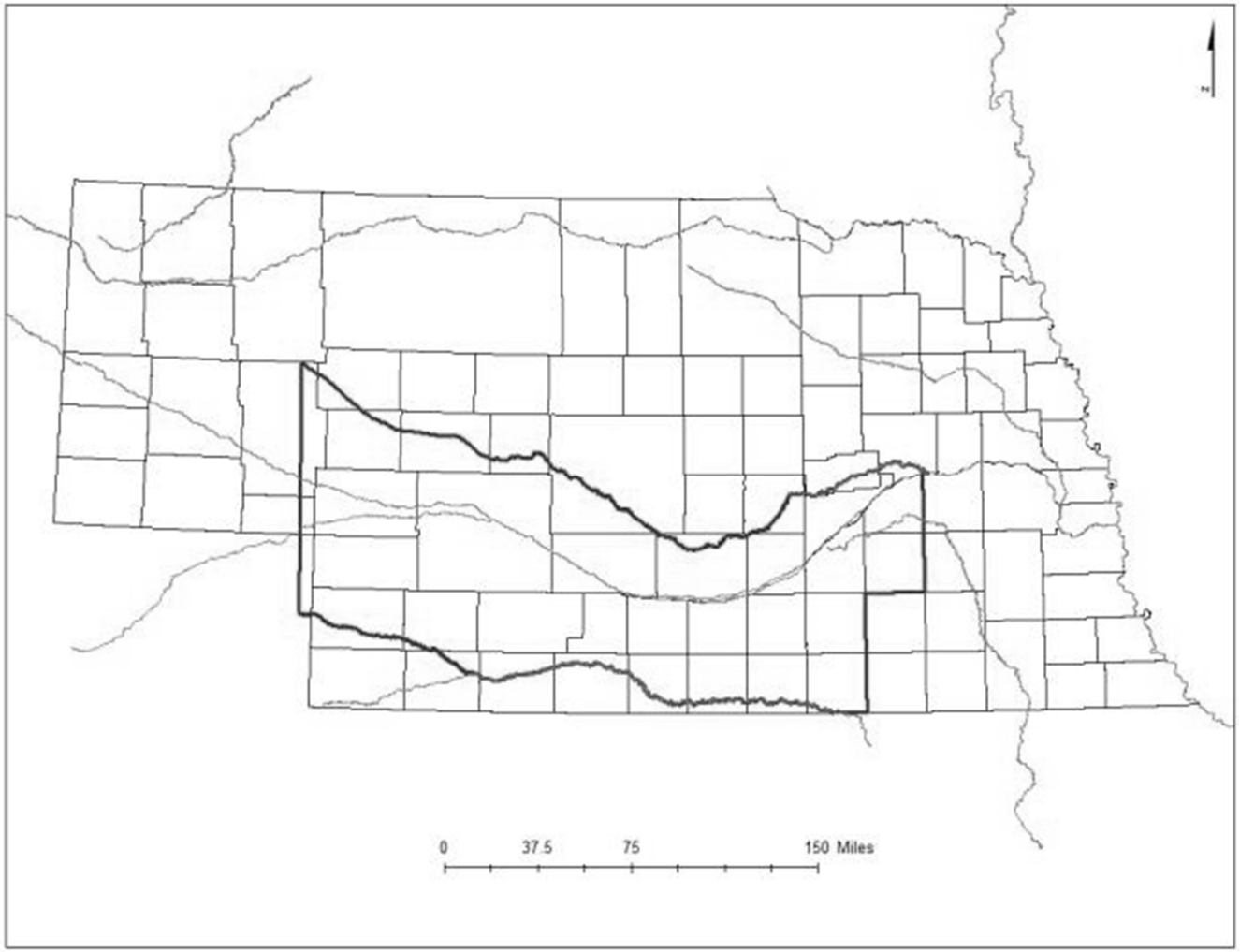
Results—Pixel-based Classification

- 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

Study Area



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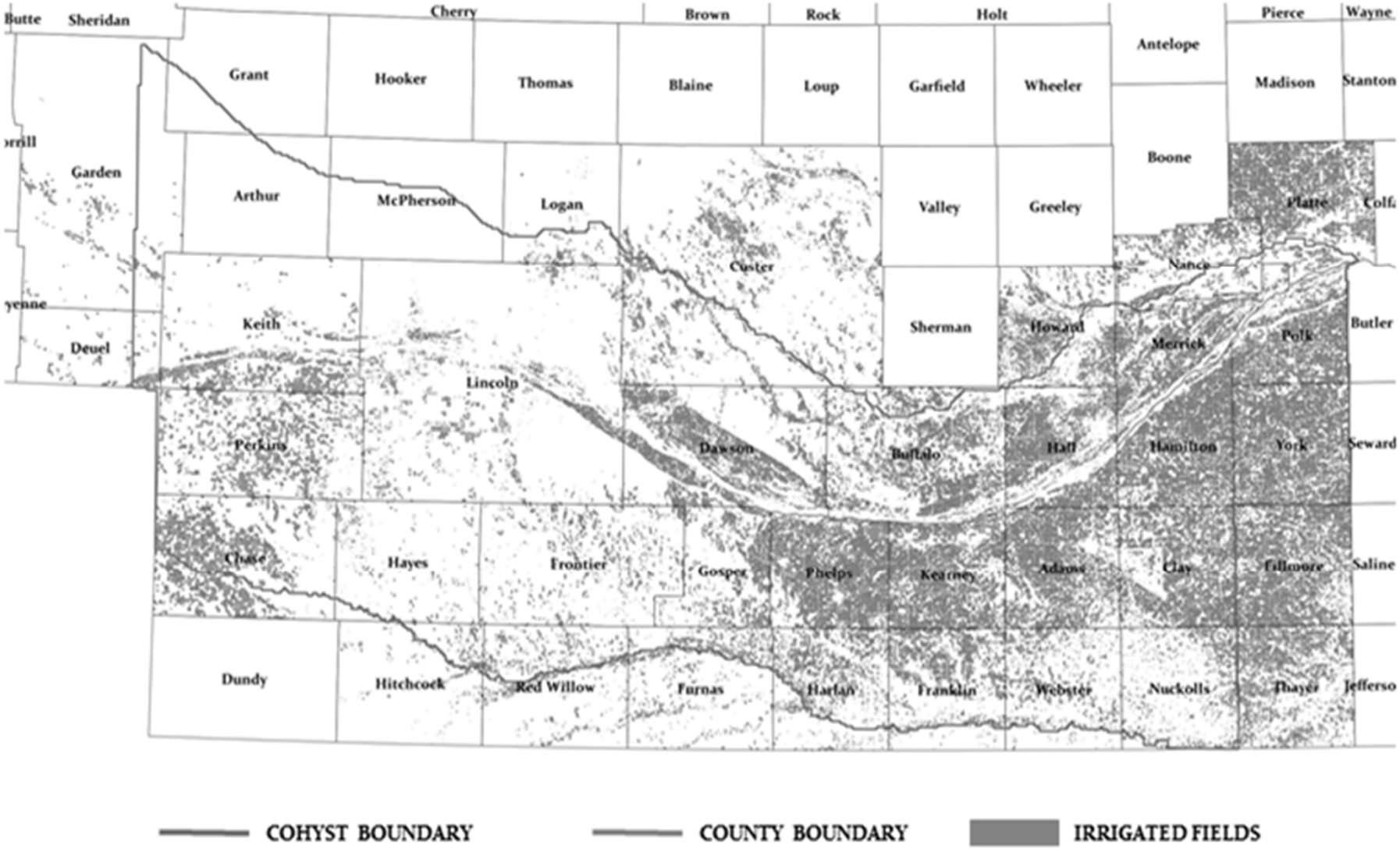

Results—Pixel-based Classification

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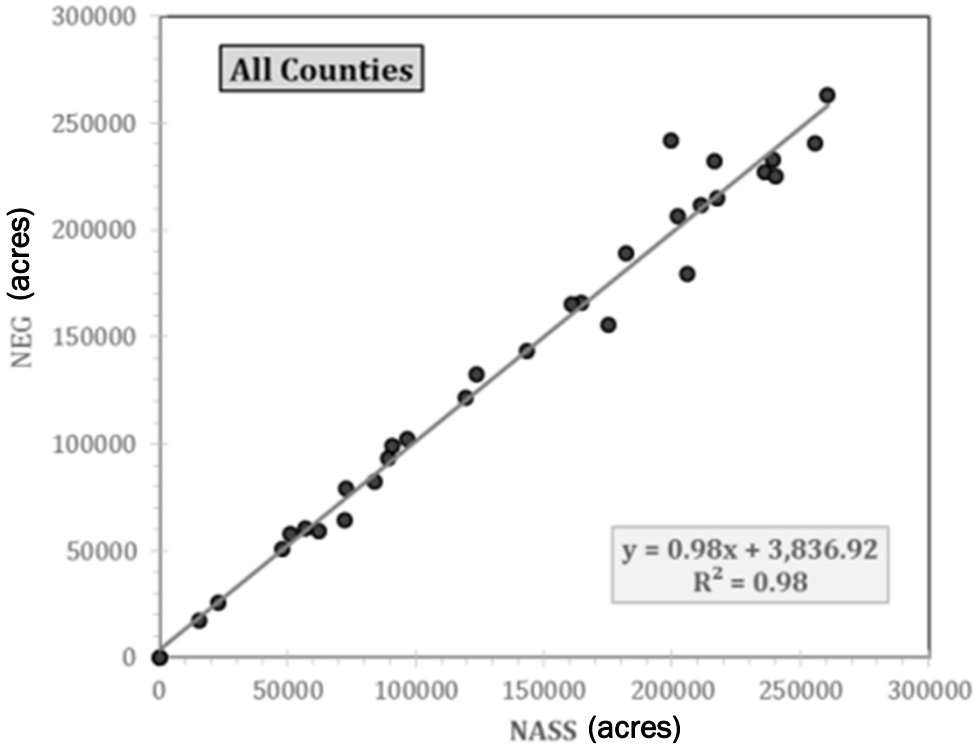
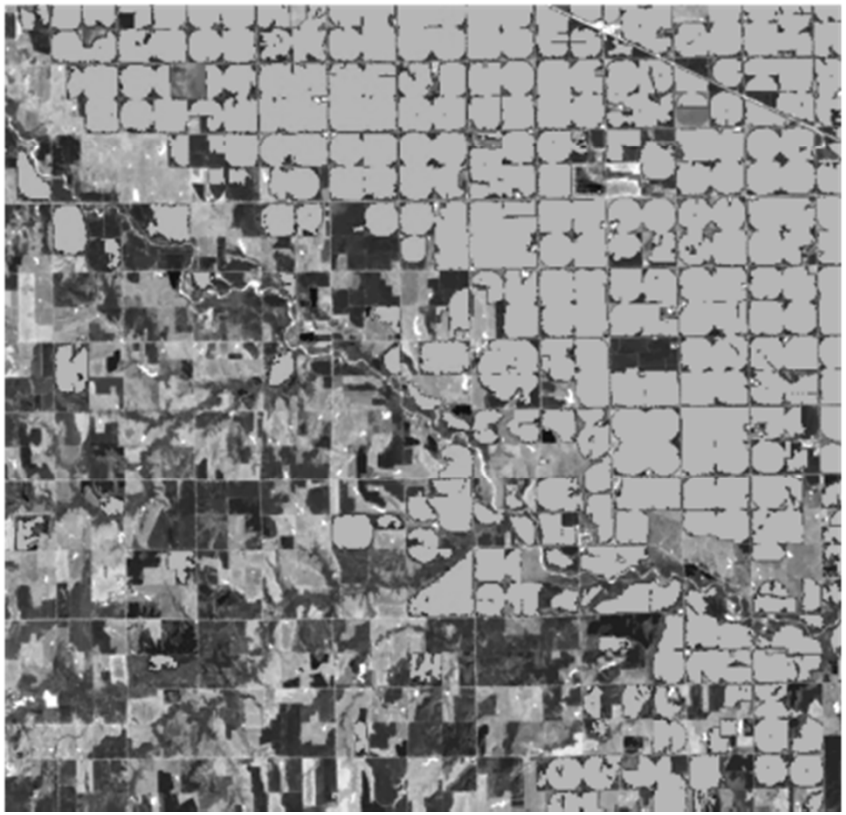


COUNTY	NASS (acres)	NEG (acres)	% Error
ADAMS	217700	215136	1.18
ARTHUR	0	29	NA
BUFFALO	236300	227114	3.89
CHASE	164400	165823	-0.87
CLAY	201900	206204	-2.13
CUSTER	181800	189297	-4.12
DAWSON	240200	225069	6.30
DEUEL	15700	17701	-12.74
FILLMORE	216500	232085	-7.20
FRANKLIN	96700	102578	-6.08
FRONTIER	72400	64042	11.54
FURNAS	51200	57906	-13.10
GARDEN	23300	25889	-11.11
GOSPER	84100	82415	2.00
HALL	205800	179455	12.80
HAMILTON	255600	240710	5.83
HARLAN	89200	93345	-4.65
HOWARD	119300	121597	-1.93
KEARNEY	211300	211870	-0.27
KEITH	90900	98885	-8.78
MCPHERSON	0	30	NA
MERRICK	175300	155678	11.19
NANCE	73100	79074	-8.17
NUCKOLLS	62400	58999	5.45
PERKINS	123800	132399	-6.95
PHELPS	239400	232992	2.68
PLATTE	199700	241863	-21.11
POLK	160800	165624	-3.00
RED WILLOW	48000	51128	-6.52
THAYER	143500	143293	0.14
WEBSTER	57200	60457	-5.69
YORK	260600	263079	-0.95

Results—Object-oriented Classification

Classification	NASS	Difference
63624	61100	4%



Summary and Conclusion

- There is an advantages 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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