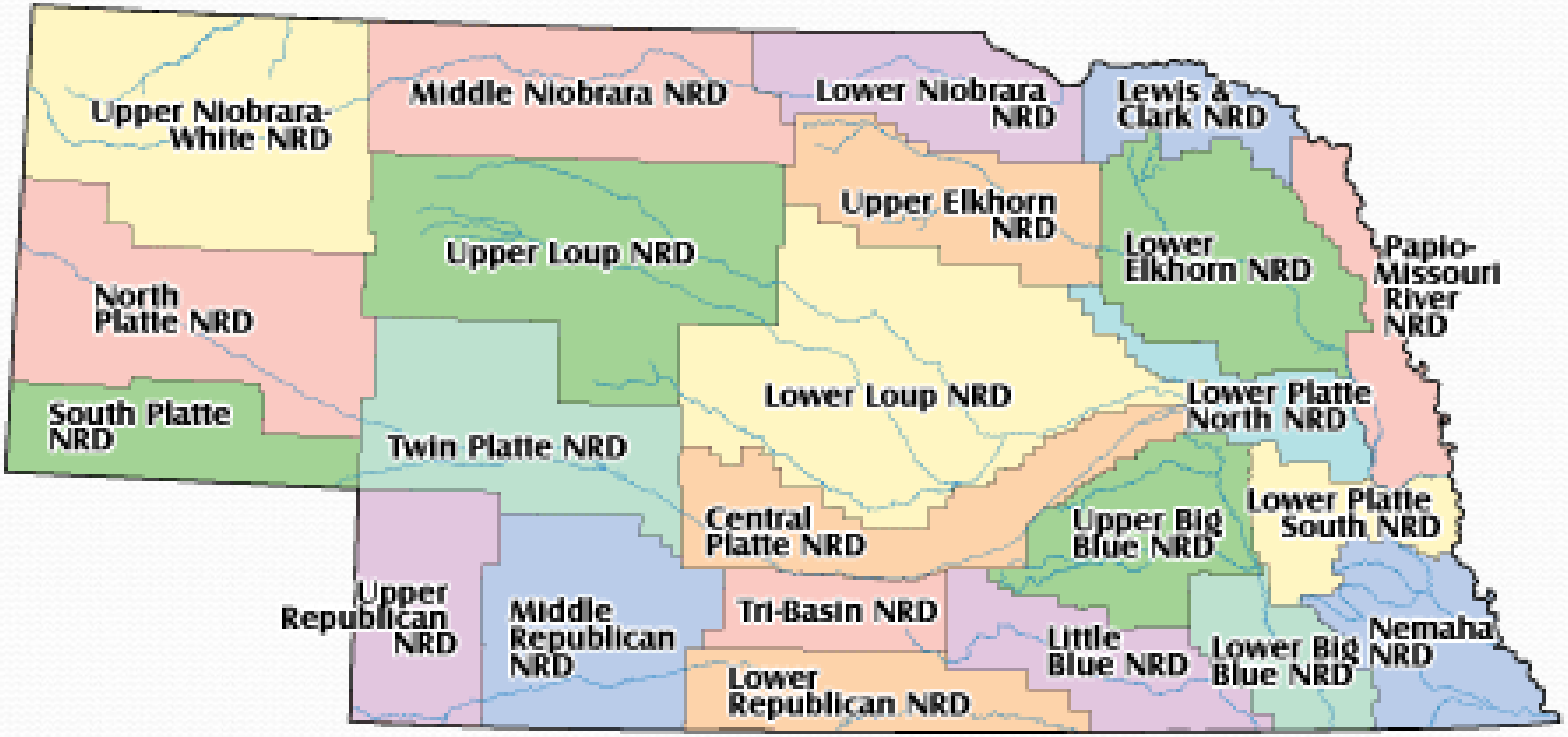
ET Mapping on the Great Plains: Support of Conjunctive Management of Ground Water and Surface Water

Duane Woodward, Central Platte Natural Resources District,
Grand Island, Nebraska

Central Platte
Natural Resources District

Natural Resources Districts (NRDs)

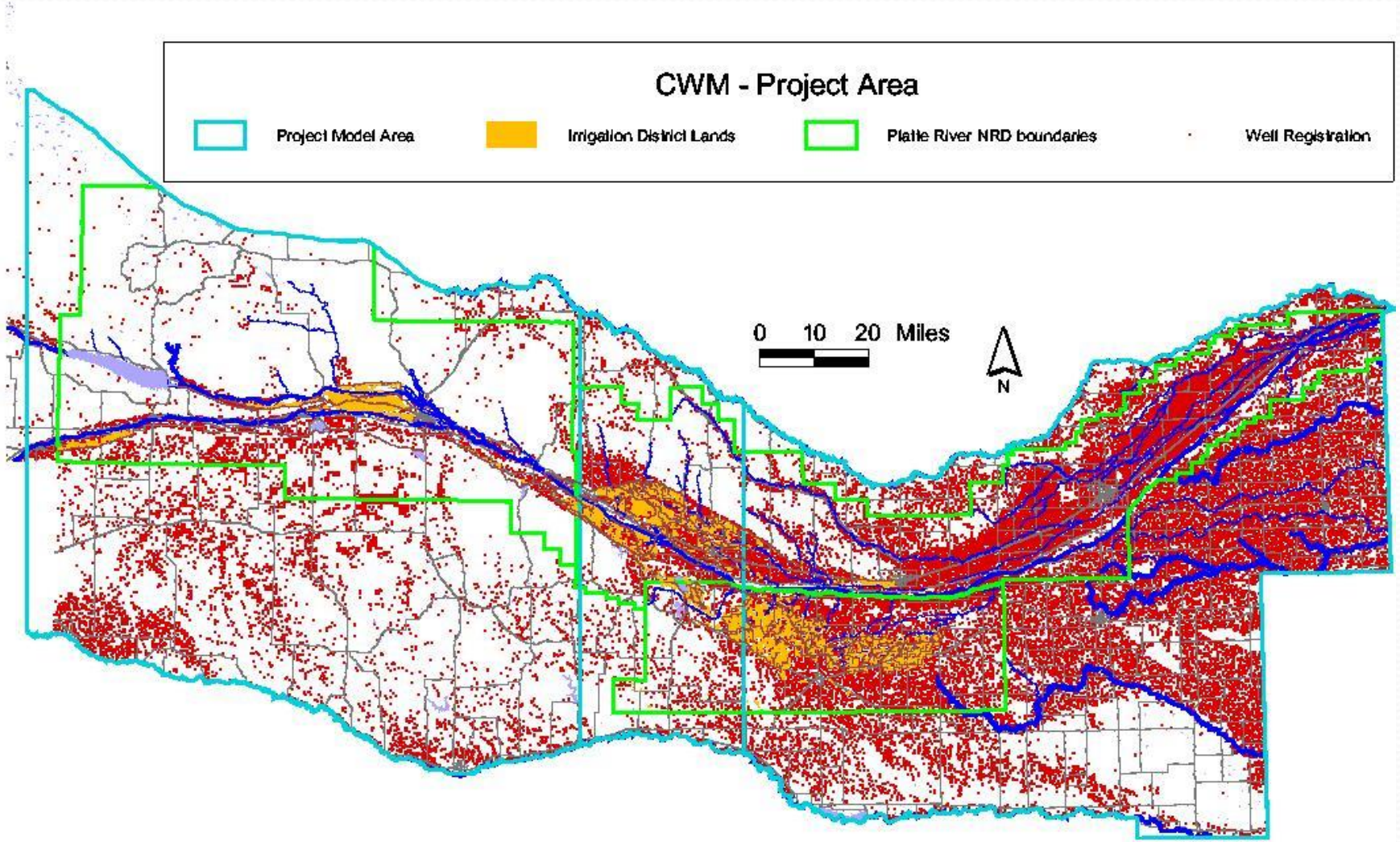


- The Nebraska Legislature enacted laws in 1972 to combine154 special purpose entities into 23 NRDs
- NRD programs: Water, Soil, Grazing lands, Trees and wildlife habitat, Flood control, Urban conservation, Recreation, Conservation and natural resources education

Conjunctive Management of Ground Water and Surface Water requires good Hydrologic Data

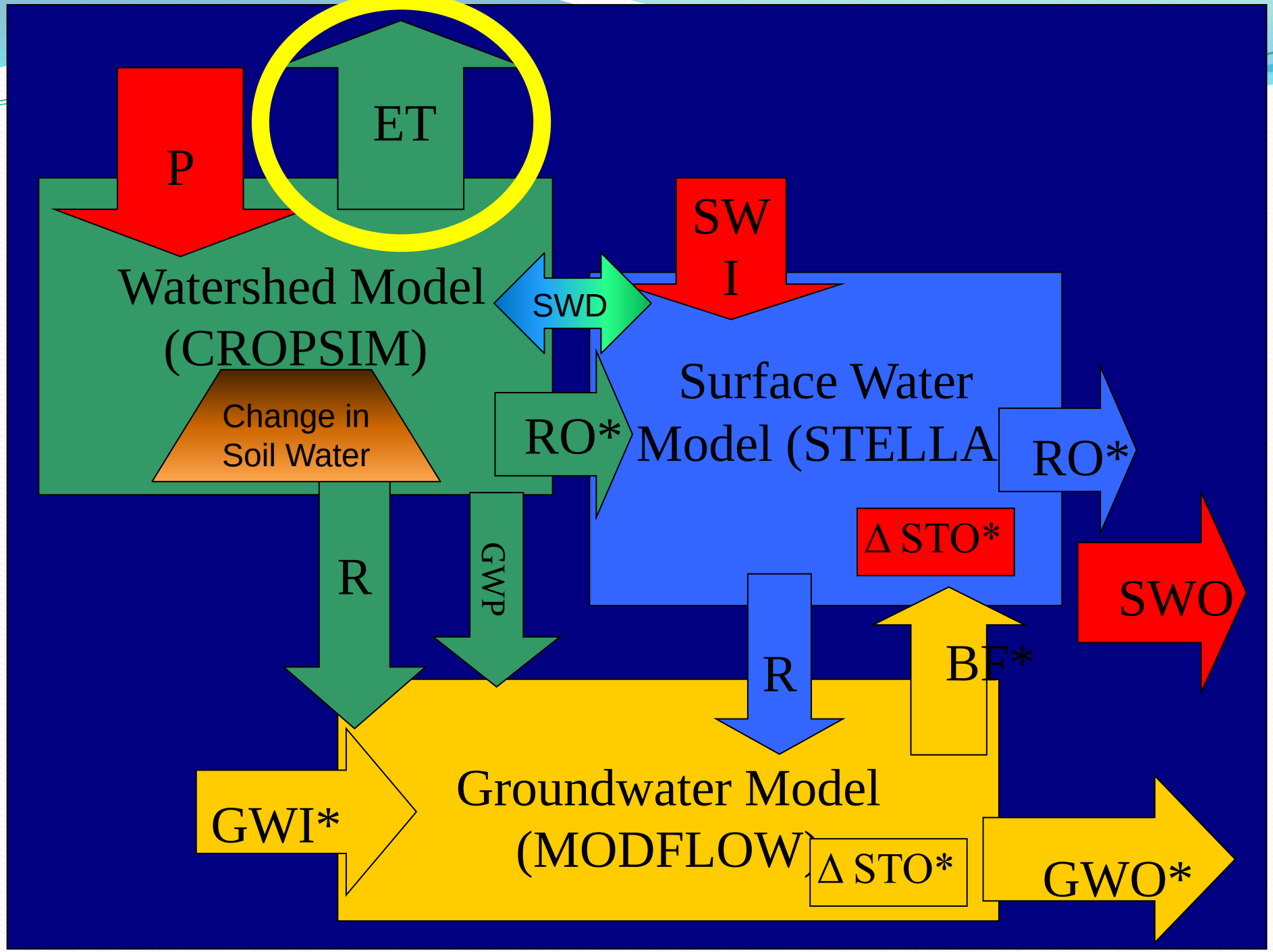
CPNRD area

2 million acres
1 million acres certified irrigated
60,000 acres SW irrigated
940,000 acres GW irrigated

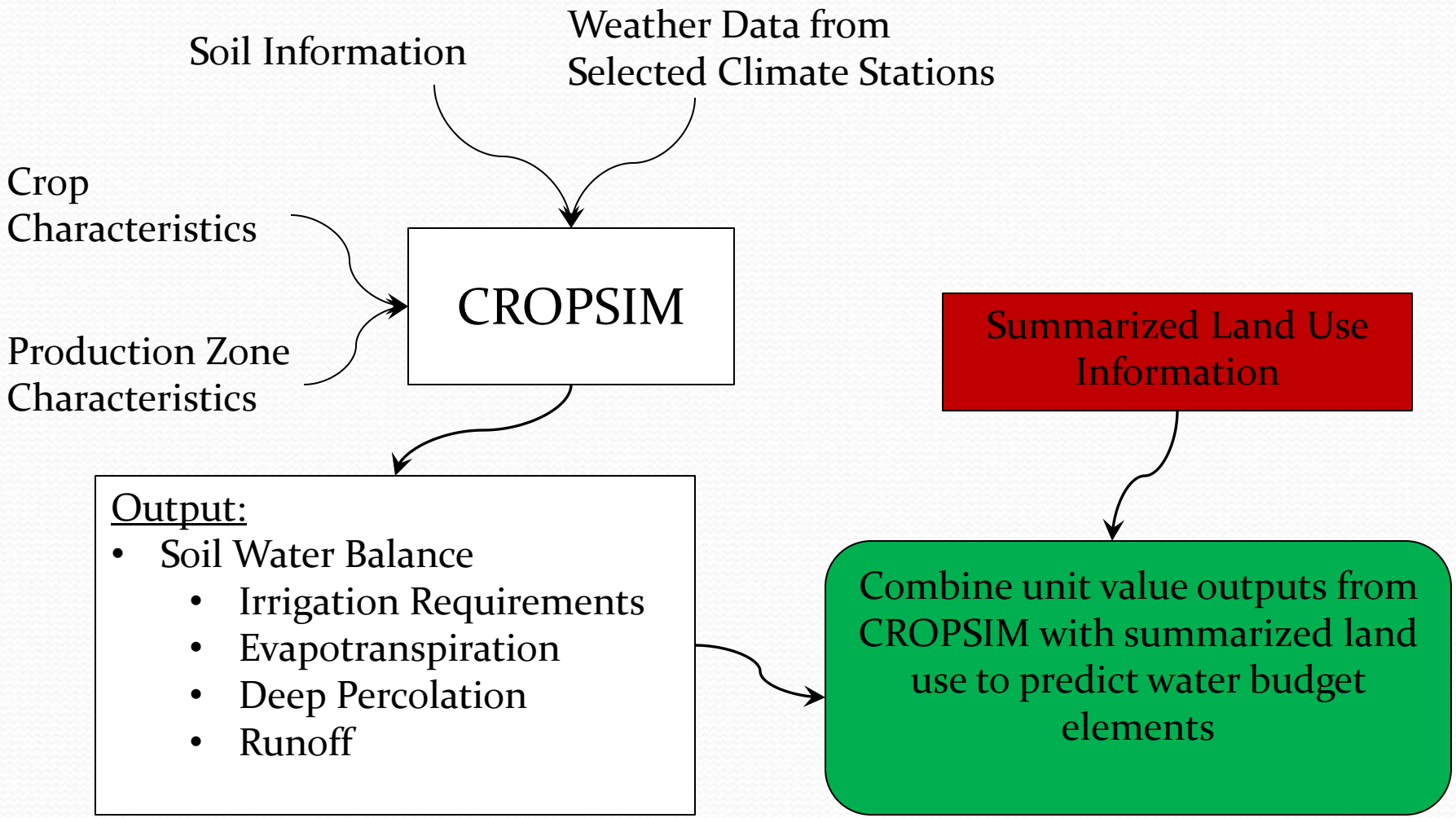


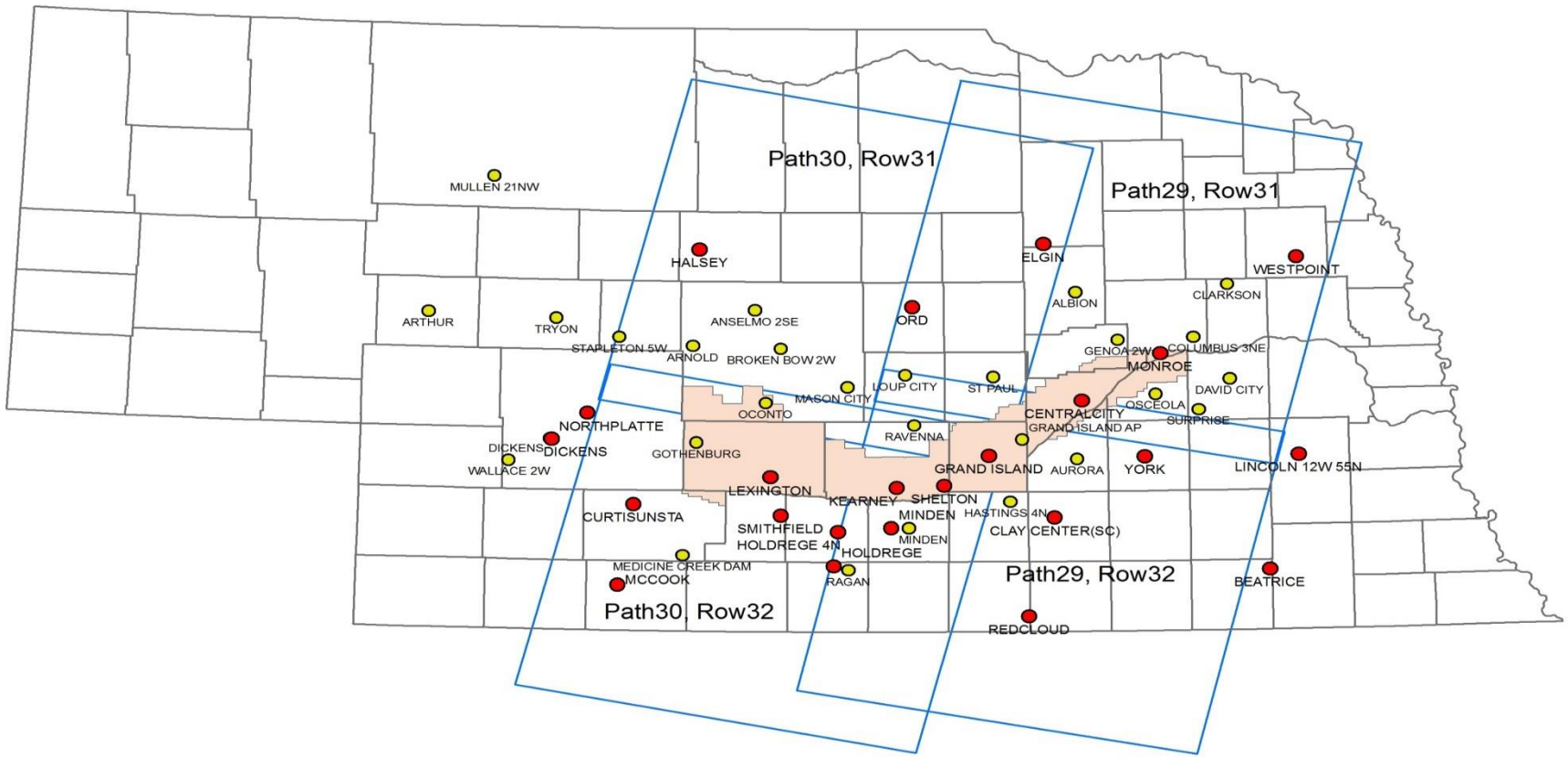
Conjunctive Management of Ground Water and Surface Water can be accomplished with a Water Budget Analysis

- Water Budget approach for the Platte River Basin was implemented by creating Modeling tools to make a number of analysis.
- The modeling tools included a Watershed model, a Surface Water Accounting Model, and a Groundwater Simulation Model.
- Key Hydrologic Inputs and Computations to the Models included;
  - Watershed Model – Precipitation, ET, Land Use data, Surface Water demands, Groundwater pumping, Recharge, and Runoff
  - Surface Water Model – Historic flows, Reservoir operations, Diversion information, and Travel time.
  - Groundwater Model – Aquifer Properties, Stream Properties data, Recharge, and Pumping datasets


P
ET
Watershed Model
(CROPSIM)
Change in
Soil Water
SWD
SW
I
Surface Water
Model (STELLA
RO*
RO*
Δ STO*
SWO
R
GWP
R
BF*
GWI*
Groundwater Model
(MODFLOW)
Δ STO*
GWO*

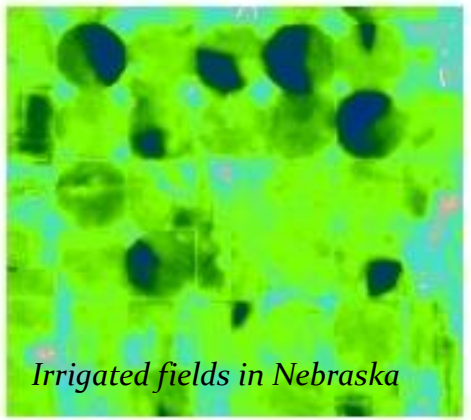
GENERAL APPROACH for Watershed Model




Path30, Row31
Path29, Row31
Path29, Row32
Path30, Row32
MULLEN 21NW
HALSEY
ELGIN
WESTPOINT
CLARKSON
ALBION
ARTHUR
TRYON
ANSELMO 2SE
ORD
STAPLETON 5W
ARNOLD
BROKEN BOW 2W
GENOA 2W
COLUMBUS 3NE
MONROE
LOUP CITY
ST PAUL
DAVID CITY
MASON CITY
OSCEOLA
CENTRALCITY
OCONTO
GRAND ISLAND AP
SURPRISE
NORTHPLATTE
RAVENNA
DICKENS
DICKENS
GOTHENBURG
WALLACE 2W
GRAND ISLAND
AURORA
YORK
LINCOLN 12W 55N
LEXINGTON
KEARNEY
SHELTON
HASTINGS 4N
CURTISUNSTA
MINDEN
CLAY CENTER(SC)
SMITHFIELD
HOLDREGE 4N
MINDEN
HOLDREGE
MEDICINE CREEK DAM
MCCOOK
RAGAN
BEATRICE
REDCLOUD

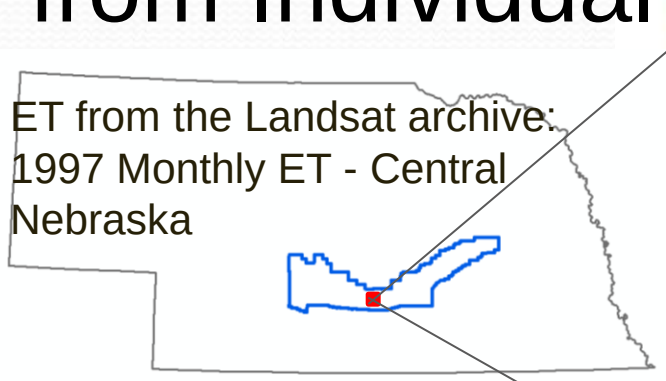
What do we use Evapotranspiration maps for?

- Better understanding of behavior of water consumption; timing. How it varies with crop type.
- Better water balances for hydrologic studies
- Ability for improved water management (Kc management)
- Ability for improved crop production
- Knowledge of water consumption by crop
  - Improved crop coefficient curves
- Improvement in overall irrigation efficiency

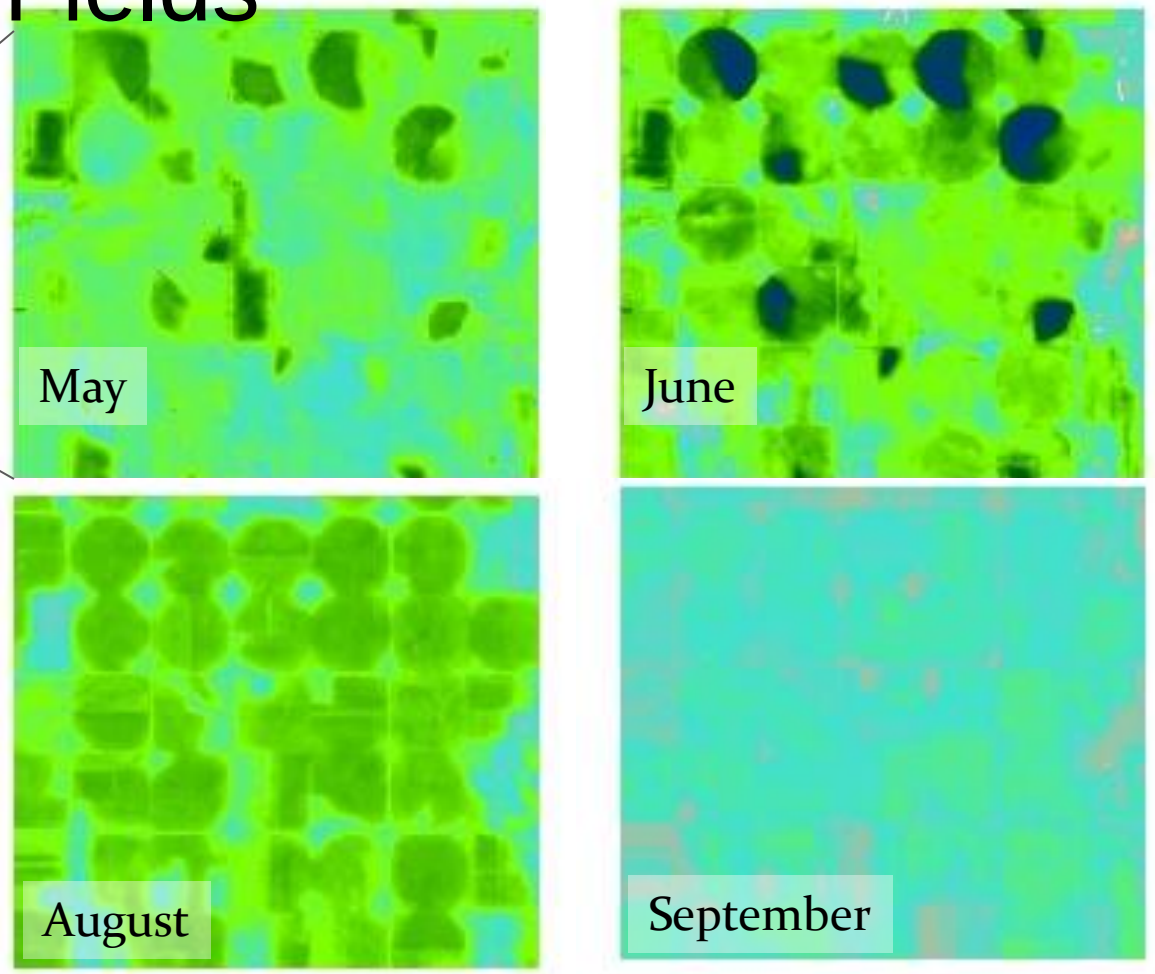


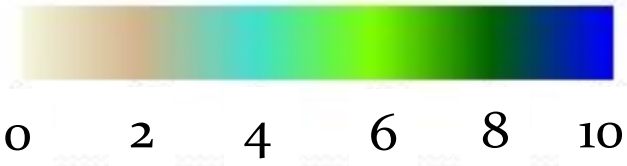
Irrigated fields in Nebraska

Landsat Can View Evapotranspiration from Individual Fields



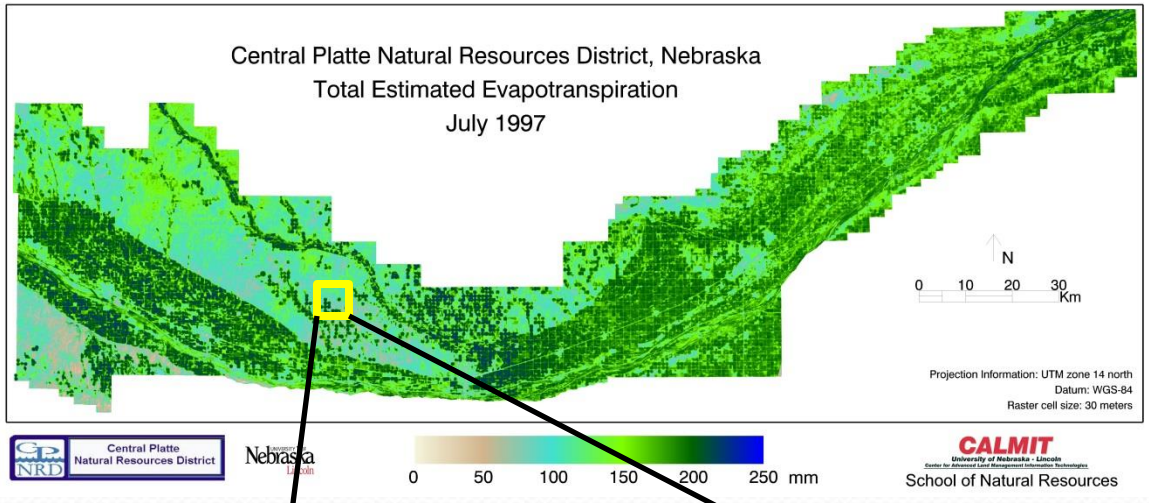
Dr. Ayse Kilic, UNL

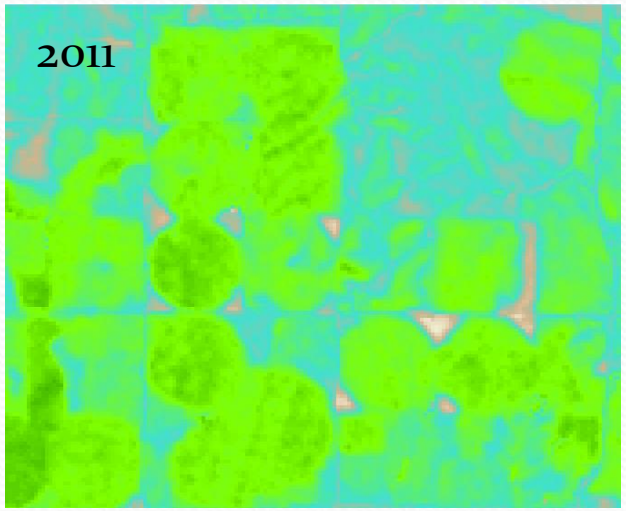


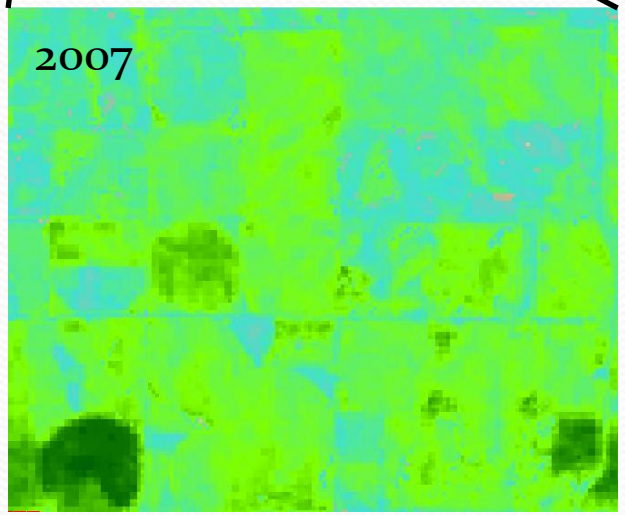


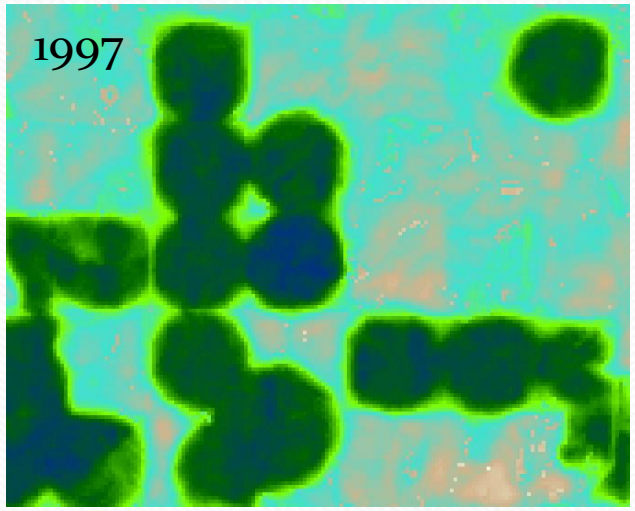
This is a close-up of ET from Nebraska fields during months of the growing season.

Variation in ET among years (Month of July)

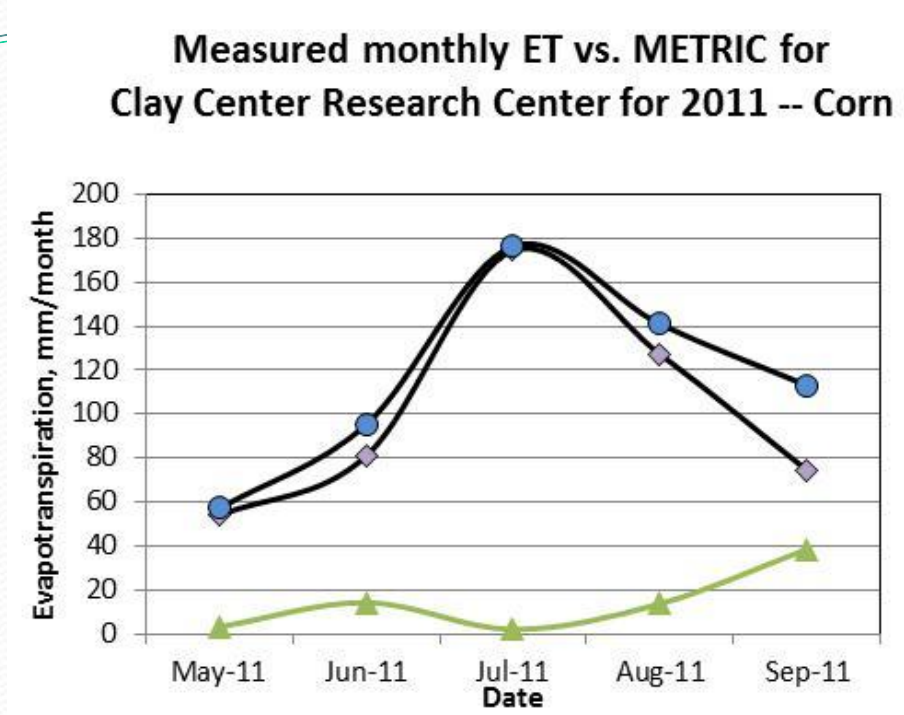




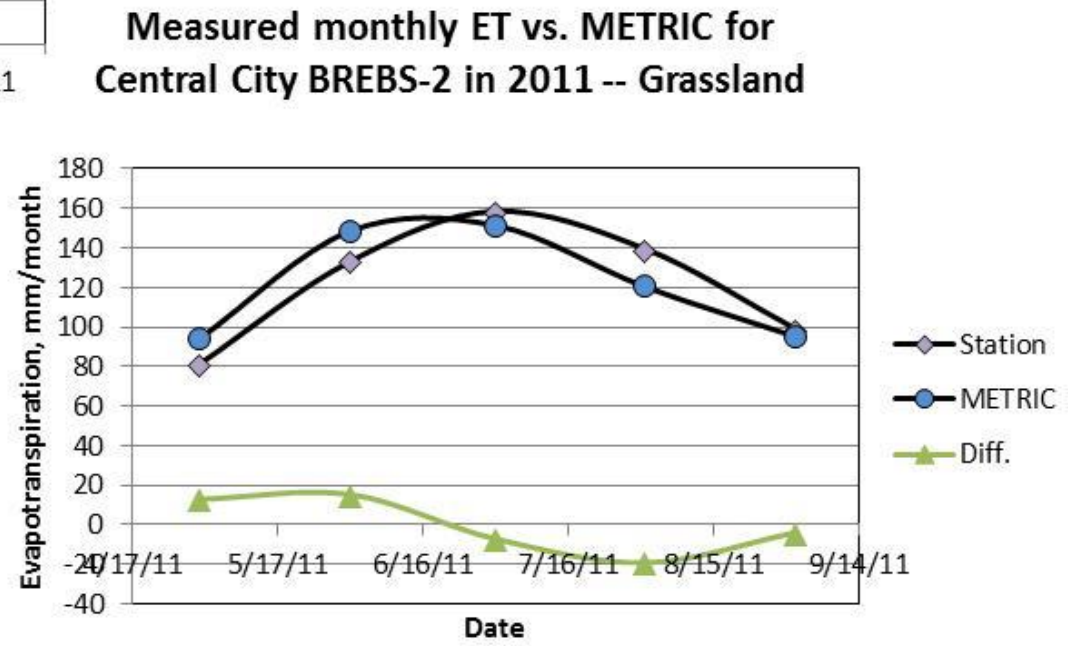




Accuracy of ET maps

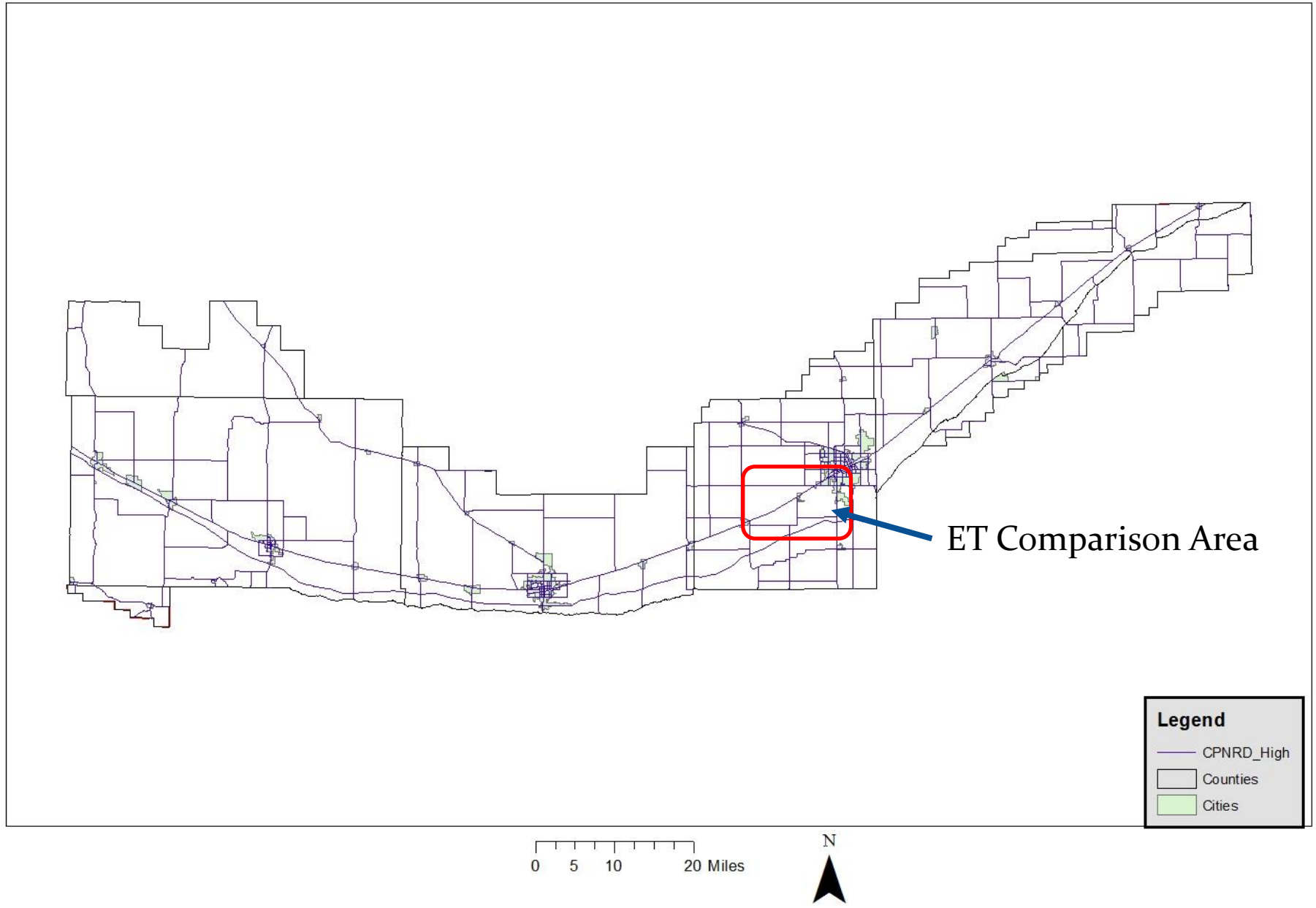


Monthly ET estimates from METRIC were averaged over about 20 fields.
Monthly ET estimates were similar to measured ET.

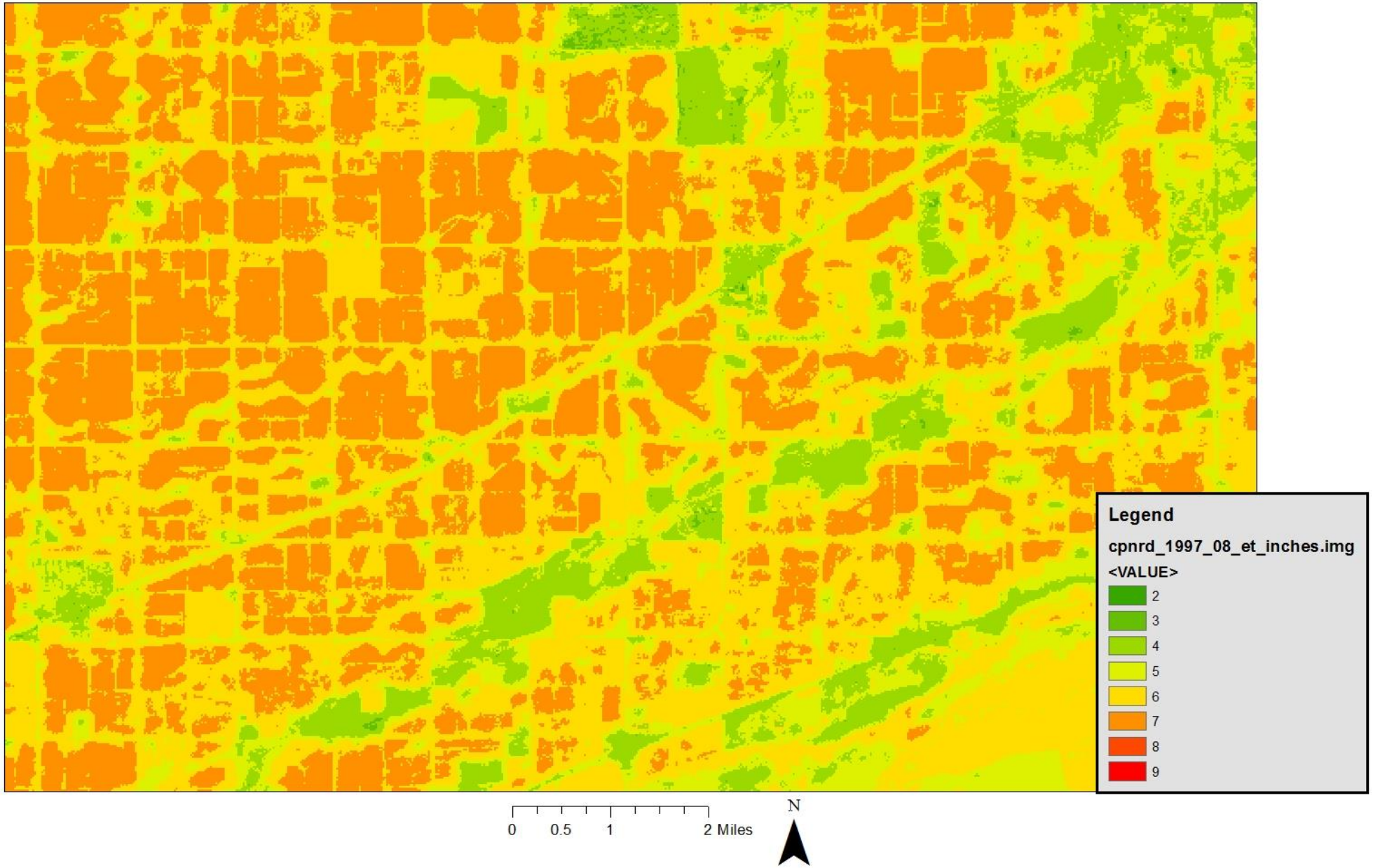


-- Bowen Ratio energy Balance System (BRBS) data by Dr. Suat Irmak, BSE

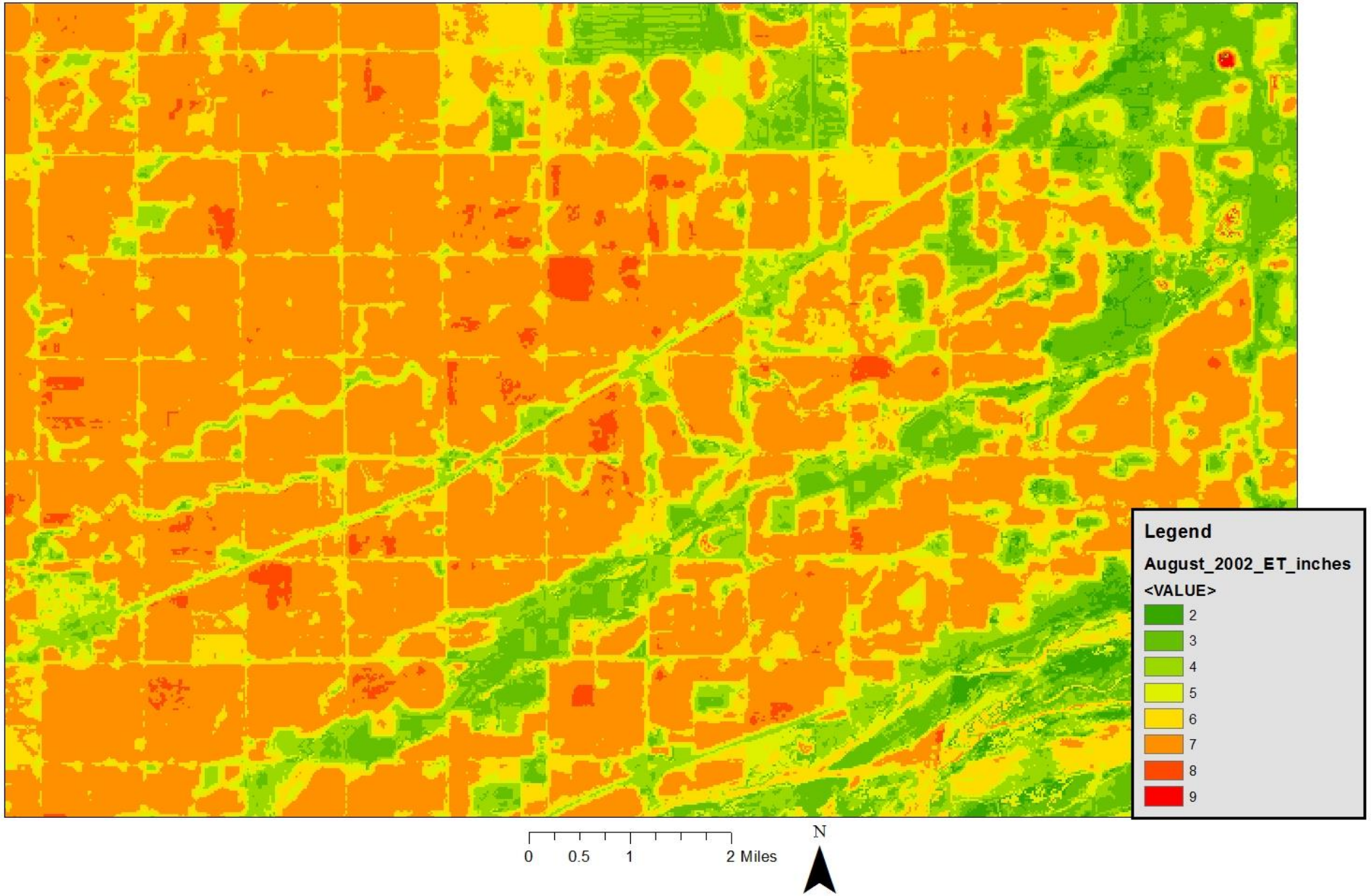
Central Platte NRD ET mapping area



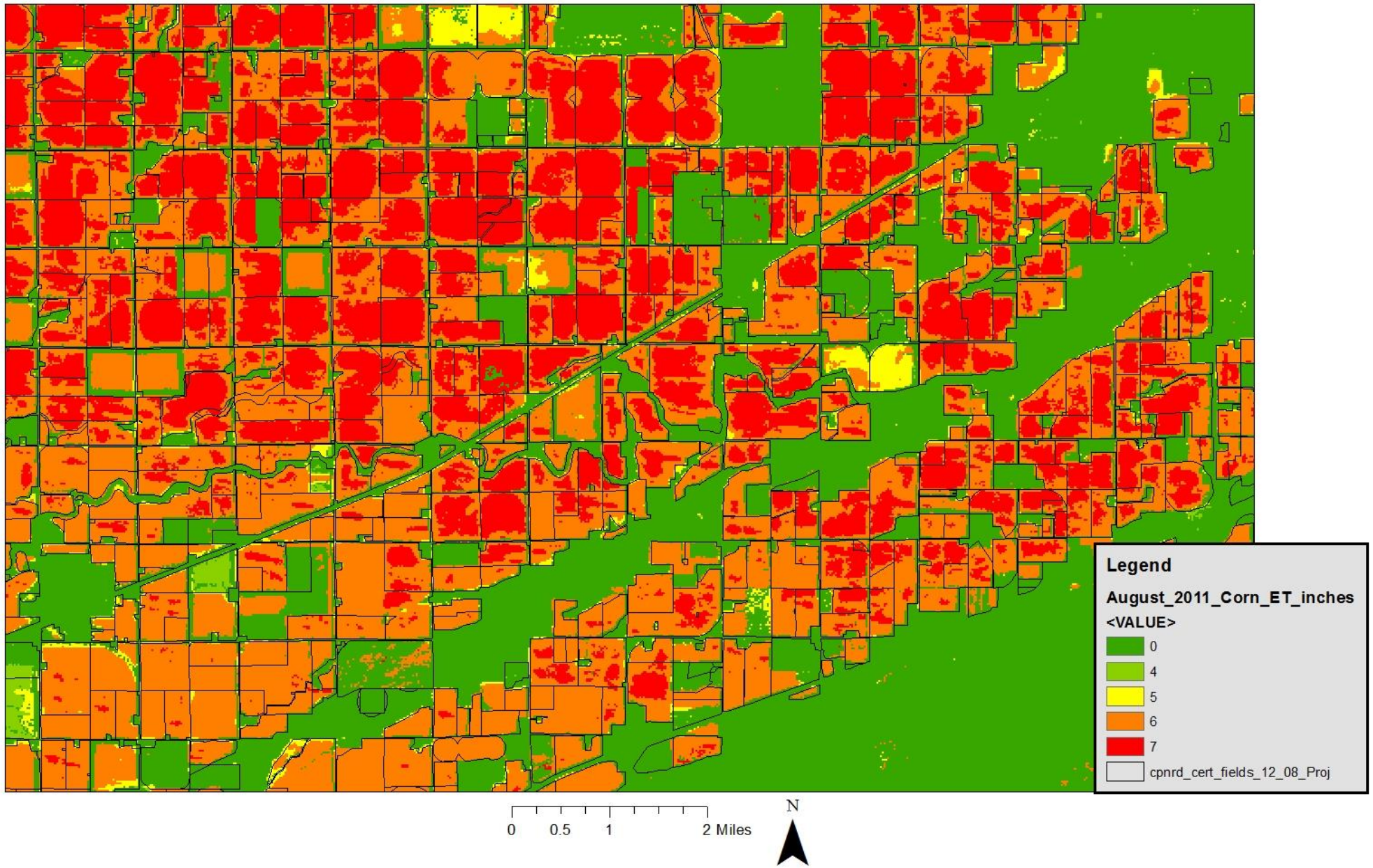
Metric ET data August 1997



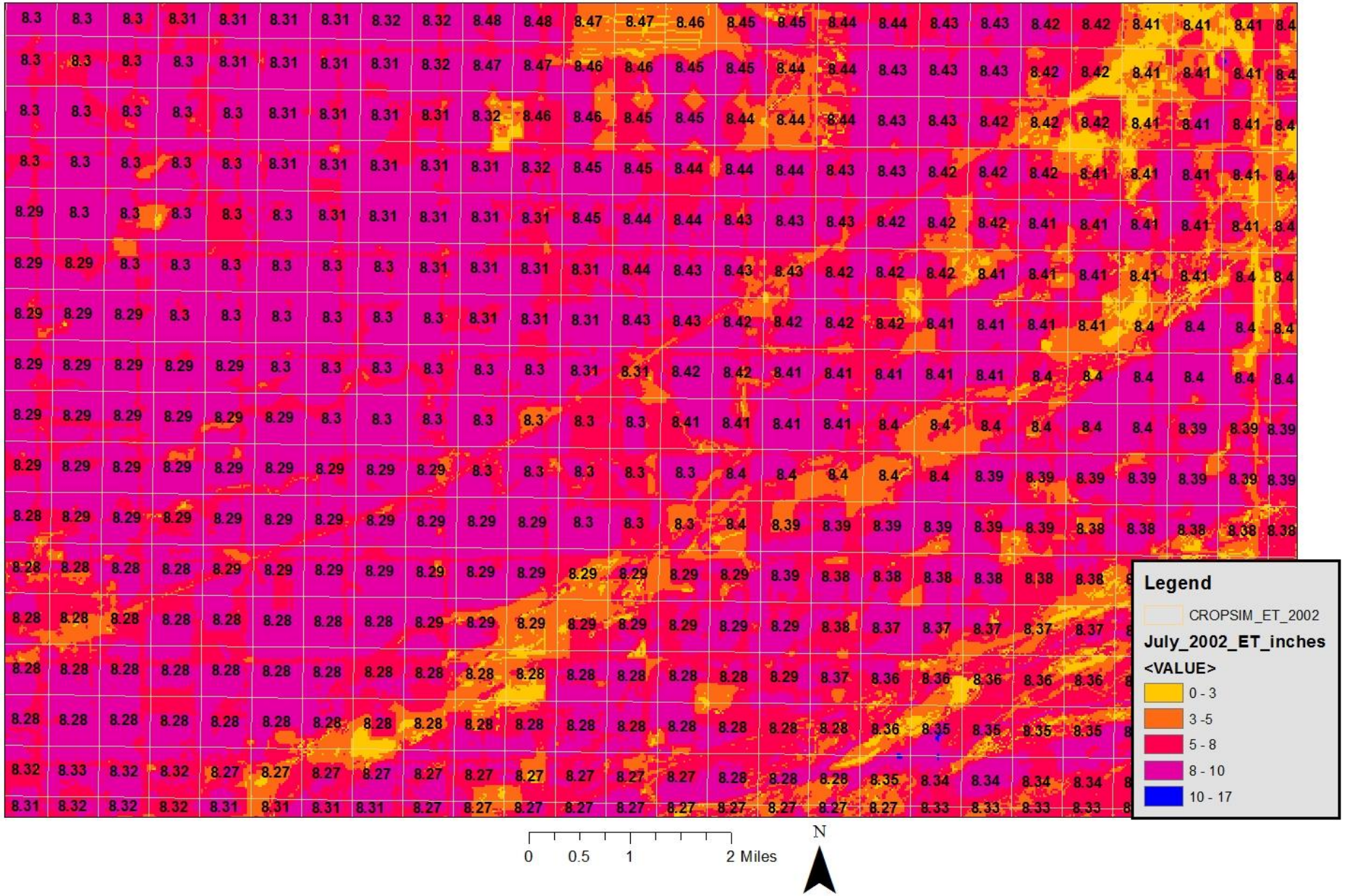
Metric ET data August 2002



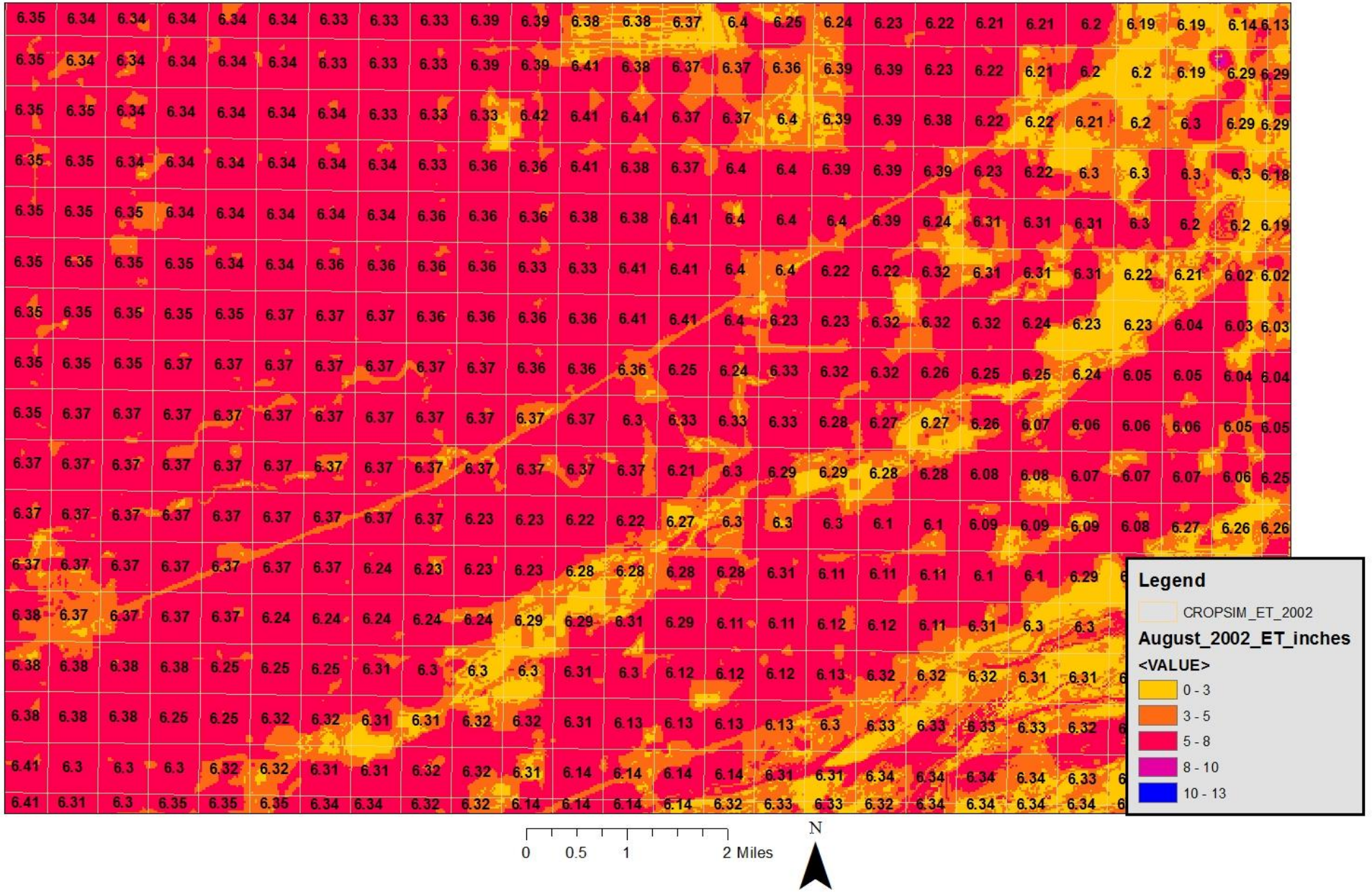
Metric ET data by Crop August 2011



ET Compairson of CROPSIM Irrigated Corn and Metric ET analysis



ET Compairson of CROPSIM Irrigated Corn and Metric ET analysis

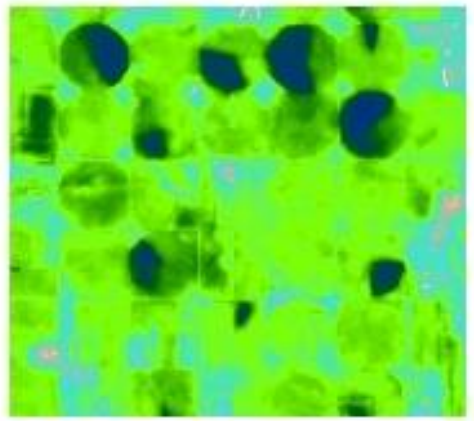


ET Mapping on the Great Plains: Support of Conjunctive Management of Ground Water and Surface Water

- *Conjunctive Management of Ground Water and Surface Water is being Studied and Implemented within the Central Platte NRD in Nebraska.*
- The study work is done using a Water Budget approach to create Modeling tools to preform analysis.
- Currently 3 models are used to complete analysis of the Water Supply and Water Use (1. The watershed model that uses a soil water balance analysis called CROPSIM) ,(2. The Surface Water flow routing Model uses Stella software) and (3. The ground water model was developed using USGS MODFLOW).
- Metric ET analysis was completed by University of Nebraska at Lincoln to provide comparison in ET data for the Watershed model and potential model input datasets.

Why is mapping Evapotranspiration (ET) at the field scale important?

- **In the US** – Irrigated Agriculture:
  - covers 50 million acres
  - 8 million acres in NE
  - Value of water rights associated with irrigated lands is > **$200 billion**

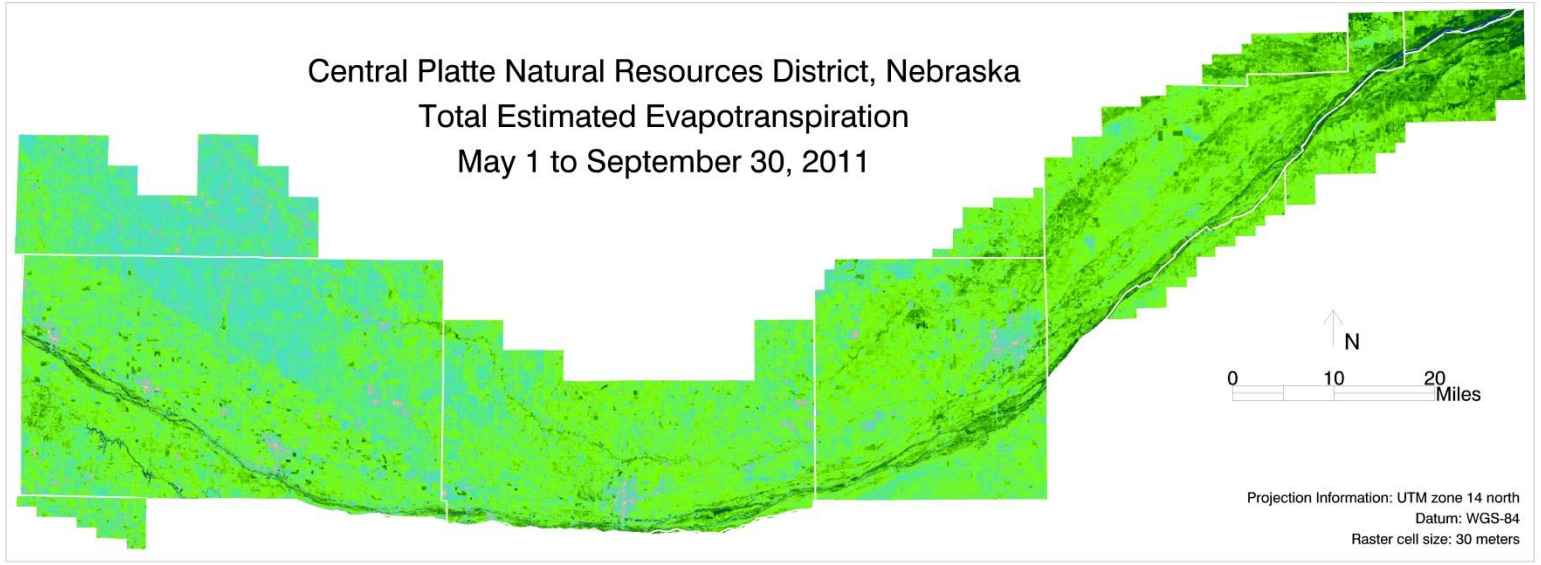


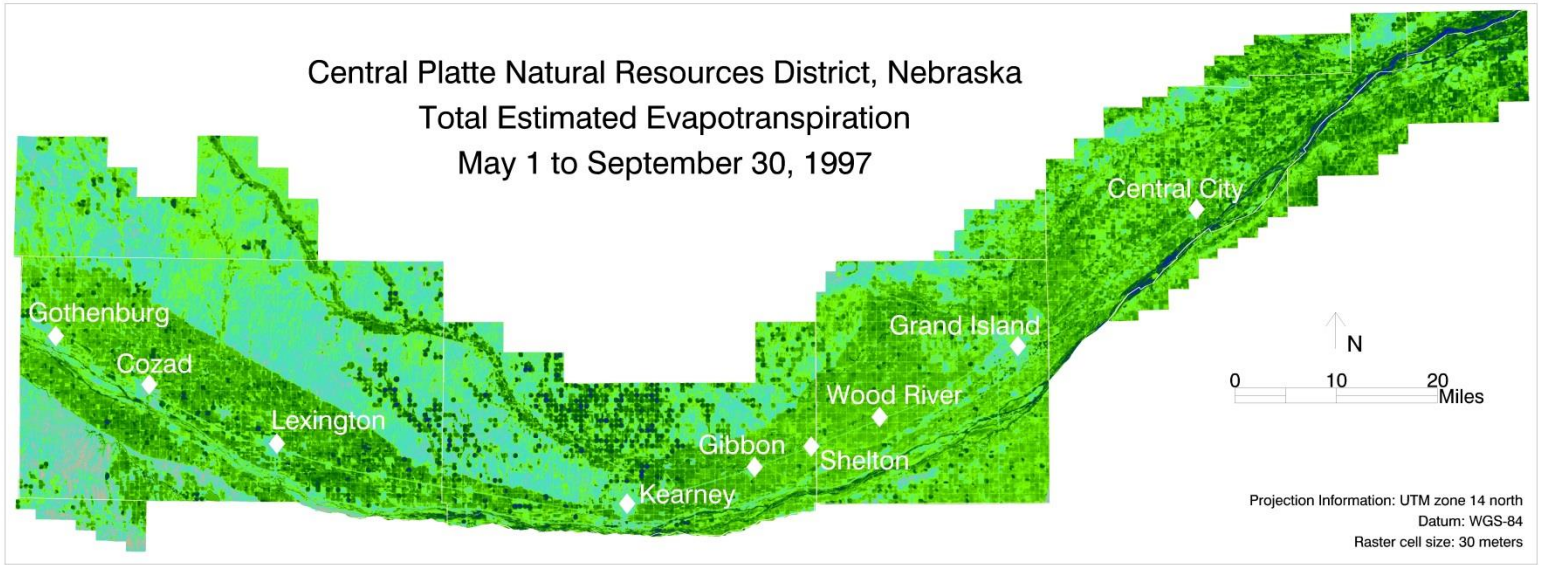
- Serious Estimates of Water Consumption are needed to manage properties by field and the water resources available to it.

- Therefore, we need to use Landsat and similar satellites having 30 m pixel size or smaller

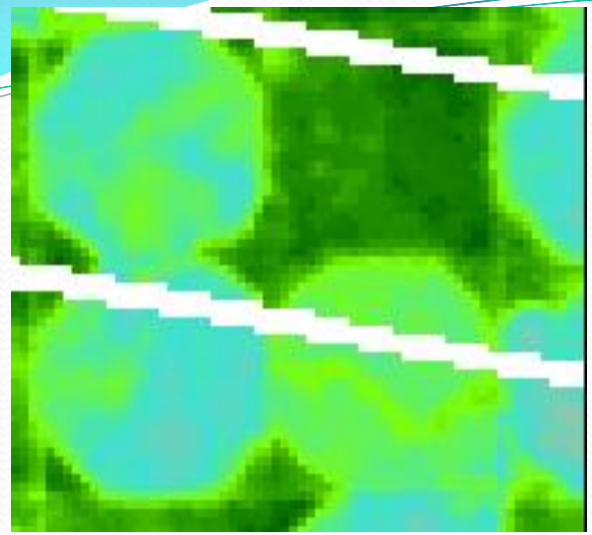
Nebraska

- Landsat 5, 7, 8 Applications in the Central Platte Natural Resources District (NRD).
- Objective: Manage water use from the High Plains Aquifer. ET from irrigators extracts substantial amounts of water from the aquifer and can lower the levels.
- LB962- Recognized that surface and ground water must be managed together for sustainability of water resources.
- They have to reduce ground water depletion to sustainable levels.
- **Central Platte NRD has adopted the use of Landsat based ET**

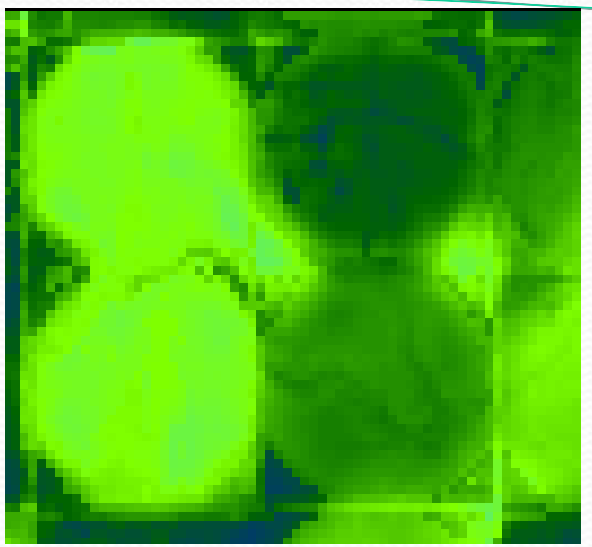

Central Platte Natural Resources District, Nebraska
Total Estimated Evapotranspiration
May 1 to September 30, 2011
N
0 10 20
Miles
Projection Information: UTM zone 14 north
Datum: WGS-84
Raster cell size: 30 meters
Central Platte Natural Resources District
NRD
University of Nebraska Lincoln
0 5 10 15 20 25 30 35 40 inches
CALMIT
University of Nebraska - Lincoln
Center for Advanced Land Management Information Technologies
School of Natural Resources


Central Platte Natural Resources District, Nebraska
Total Estimated Evapotranspiration
May 1 to September 30, 1997
Gothenburg
Cozad
Lexington
Gibbon
Kearney
Shelton
Wood River
Grand Island
Central City
N
0 10 20
Miles
Projection Information: UTM zone 14 north
Datum: WGS-84
Raster cell size: 30 meters
Central Platte Natural Resources District
NRD
University of Nebraska Lincoln
0 5 10 15 20 25 30 35 40 inches
CALMIT
University of Nebraska - Lincoln
Center for Advanced Land Management Information Technologies
School of Natural Resources

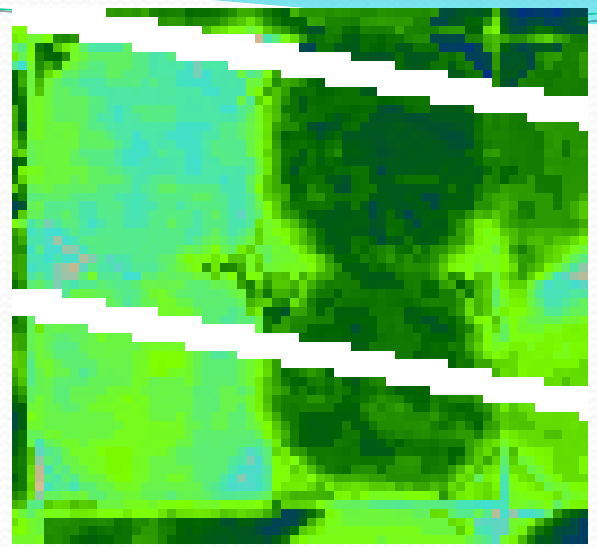
8 June 2015 – Landsat 7



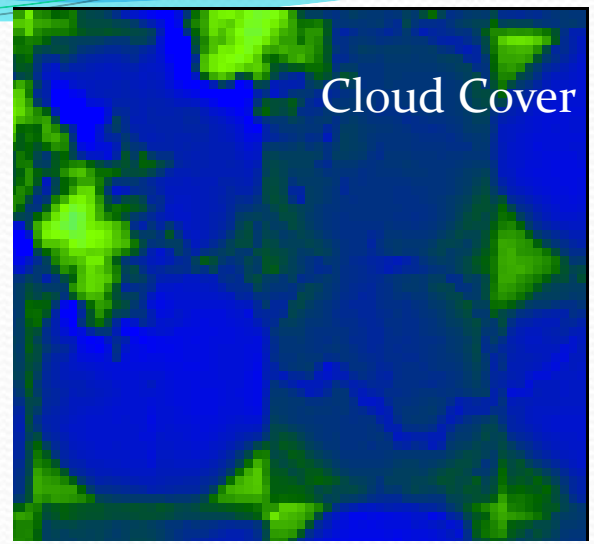
16 June 2015 – Landsat 8



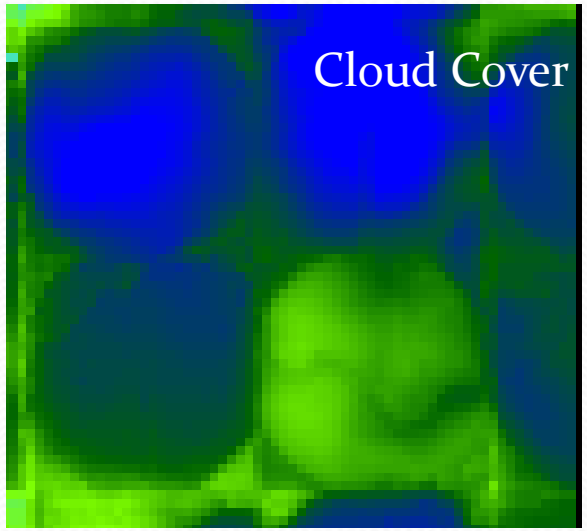
24 June 2015 – Landsat 7



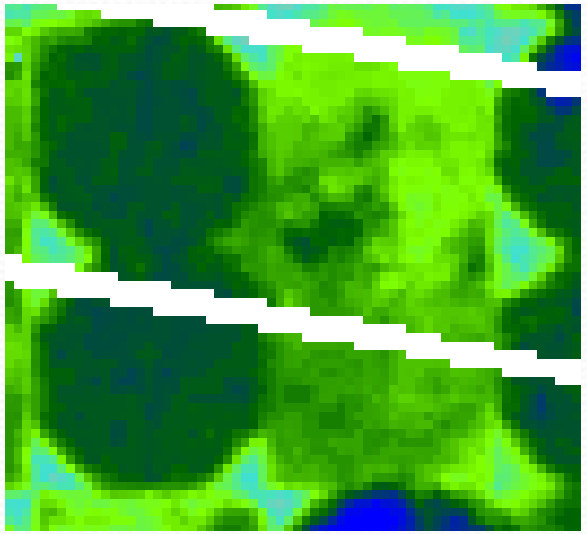
2 July 2015 – Landsat 8



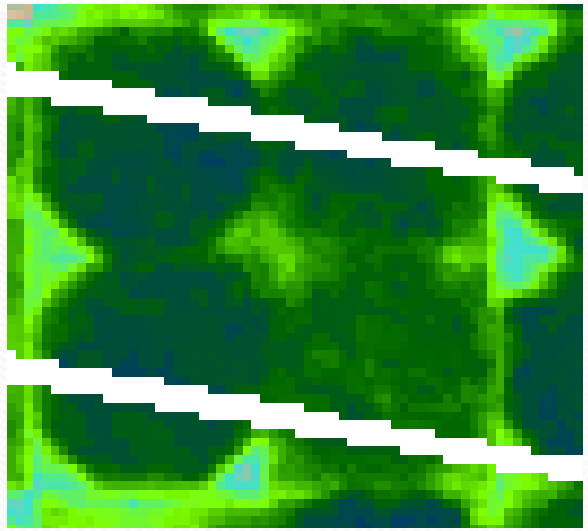
18 July 2015 – Landsat 8



26 July 2015 – Landsat 7



11 Aug 2015 – Landsat 7



4 Sept 2015 – Landsat 8