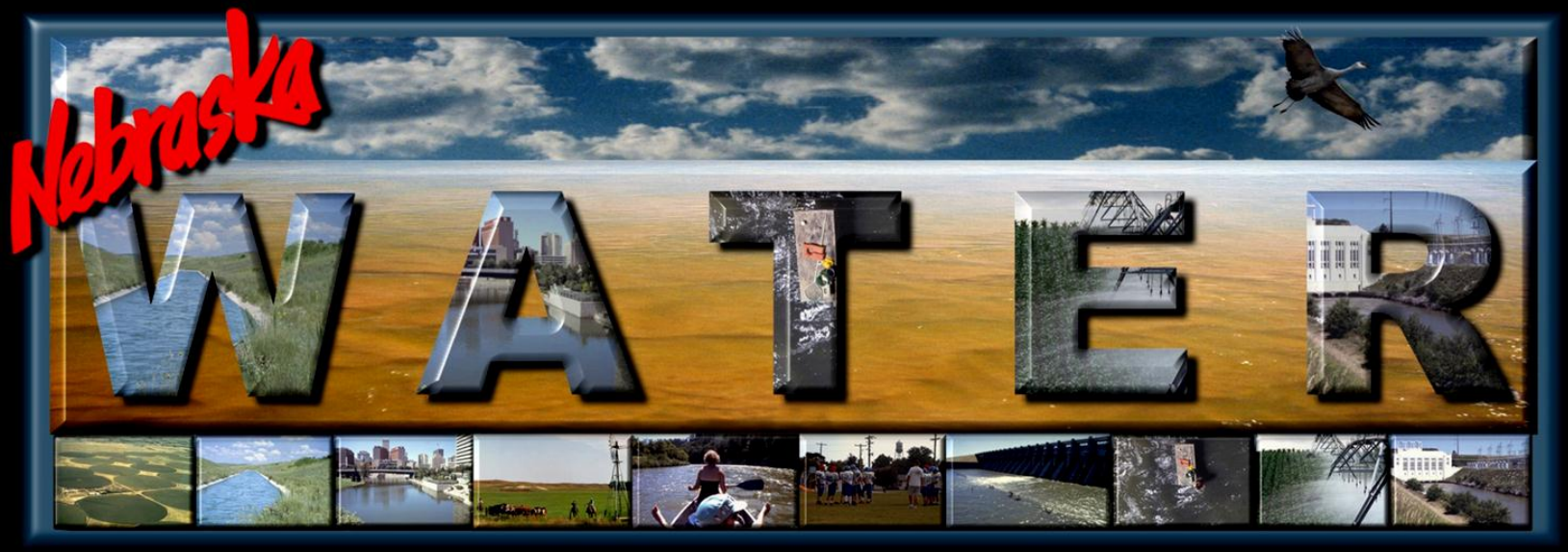


Niobrara River Update: Studies & Planning

NE Farm Bureau—Bassett, NE

Brandi Flyr, Ph.D.

Integrated Water Management Division

Nebraska Department of Natural Resources

Overview

- Project Purpose & Goals
- Model Approach
- Upper & Lower Model Progress
- Scenario Development
- Planning Activities

Purpose

- Model the hydrologic surface-groundwater interactions and economic effects of various water management strategies in order to develop water management tools

Goals

- Develop Tools for Water Managers
- IMP Data Development
- Water Use Optimization
- Evaluate Effects of a Variable Water Supply
- Evaluation of Management Options

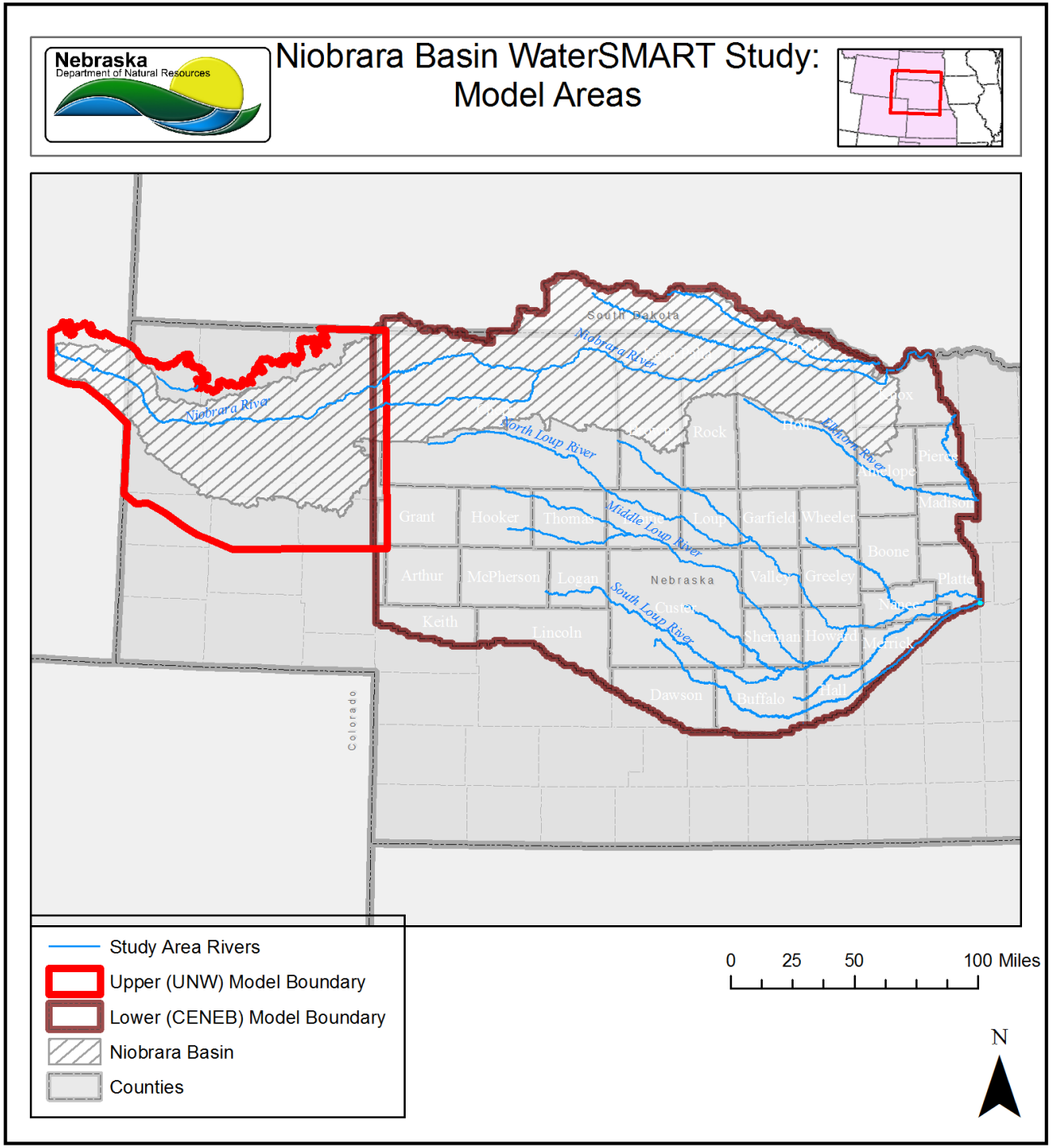
Objectives

- Characterize & quantify basin water resources
- Determine current/future water demands
- Provide foundational info for development andimplementation of IMPs
- Identify opportunities for meeting water supply needs (i.e. aquifer storage, retiming, water banking)
- Evaluate future operations of basin reservoirs through variable supply conditions

NDNR & USBR: Project Components

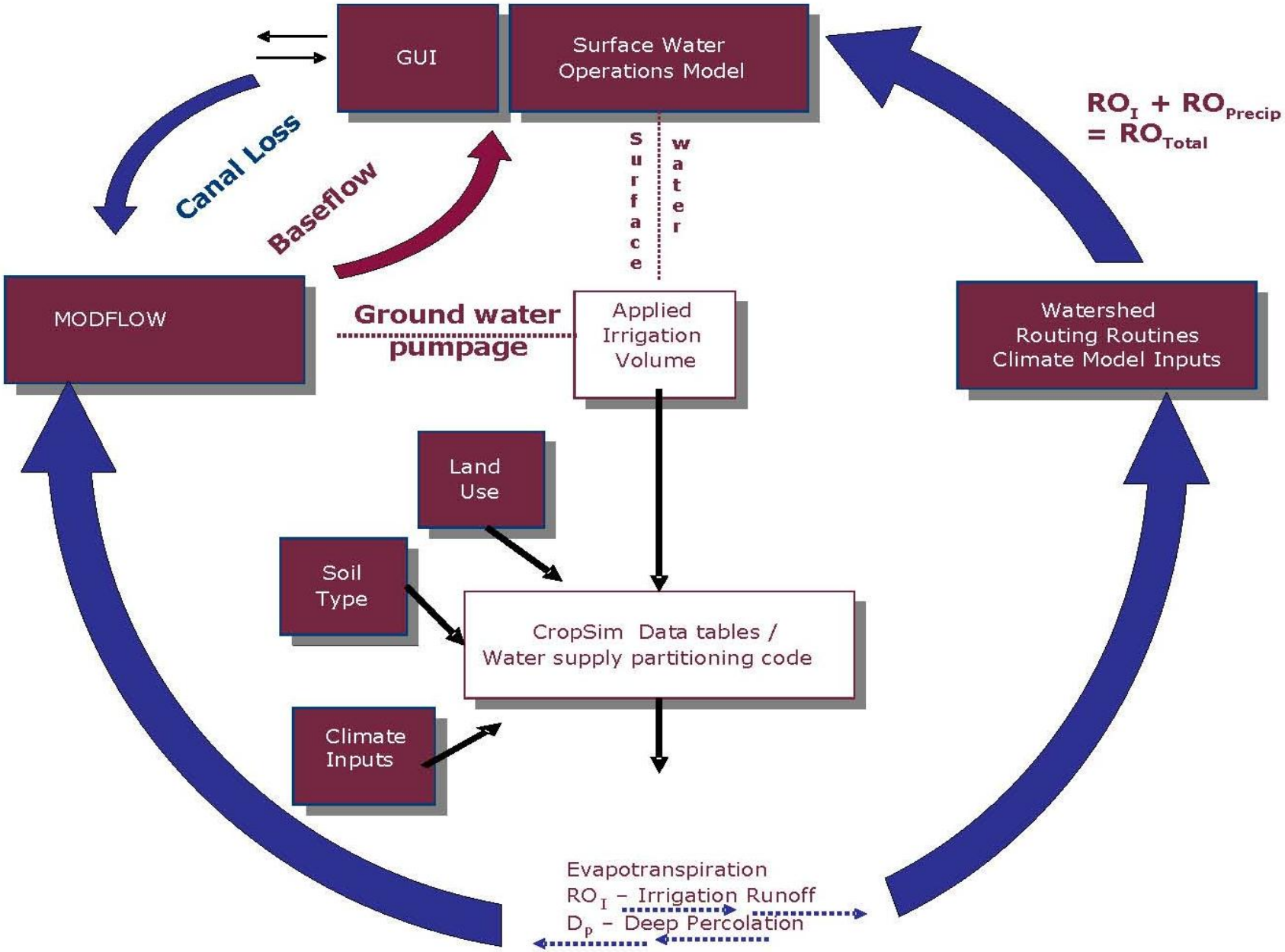
- Integrated land-surface-groundwater model (NDNR)
- Economic tool development and analyses (Bureau)
- Effects of variable water supply (Bureau)

Study Area map



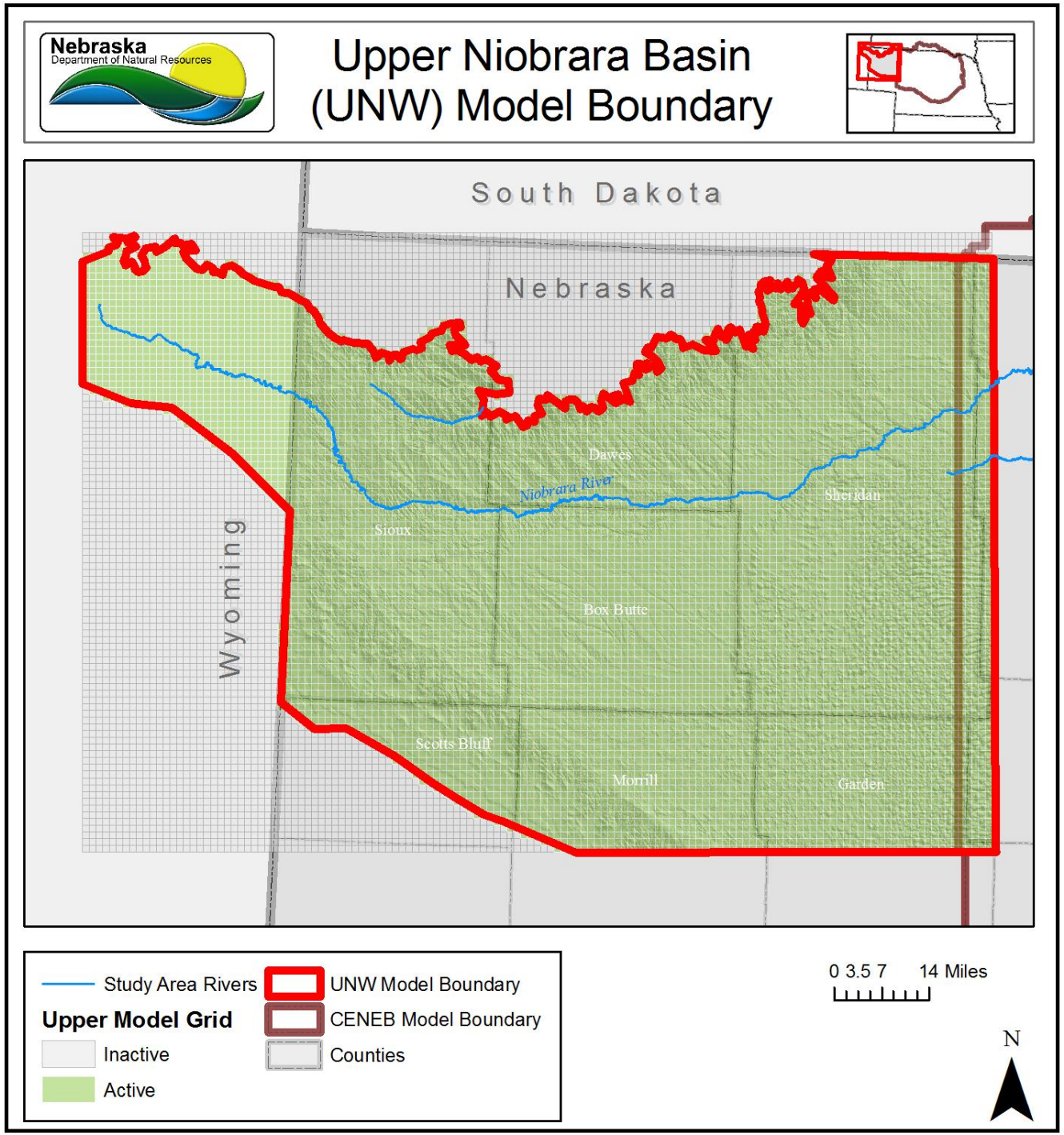
NDNR: Integrated Hydrologic Models

- CROPSIM – formulates crop water demands, recharge, & runoff
- MODFLOW – Models effects of changing recharge & pumping on groundwater flow
- STELLA – Approximation of water routing through streams, canals, & reservoirs


GUI
Surface Water Operations Model
Canal Loss
Baseflow
surface water
$RO_I + RO_{Precip} = RO_{Total}$
MODFLOW
Ground water pumpage
Applied Irrigation Volume
Watershed Routing Routines Climate Model Inputs
Land Use
Soil Type
CropSim Data tables / Water supply partitioning code
Climate Inputs
Evapotranspiration
RO_I – Irrigation Runoff
D_p – Deep Percolation

UPPER BASIN MODEL

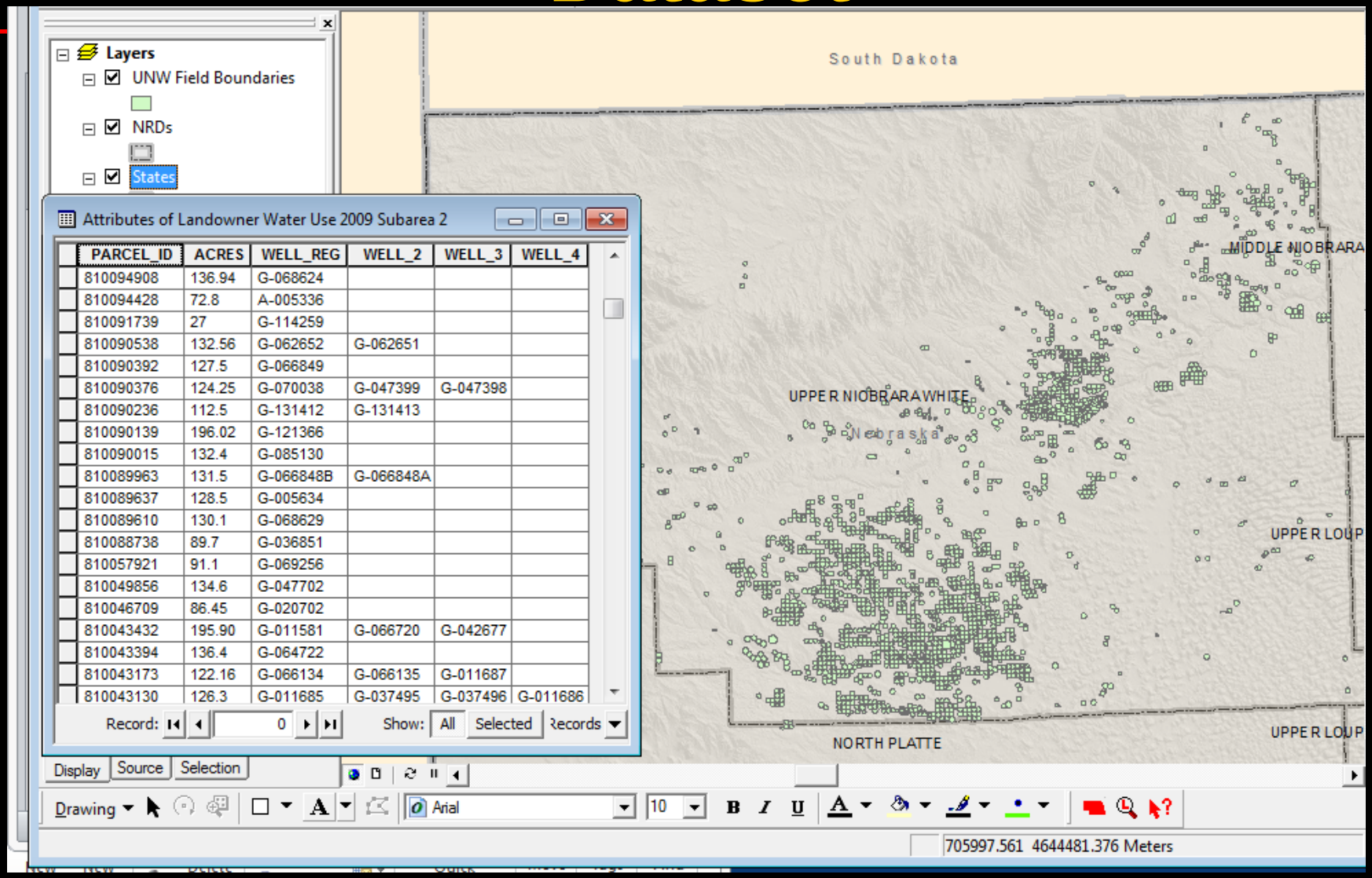
Upper Basin Model Area



Land Use

- Purpose: To estimate land cover, ie crop types through the length of the model
- Data Sources
  - UNWNRD Certified Acres
  - NASS annual county acres data
  - COHYST landuse (outside of UNWNRD)
- 1940-Present

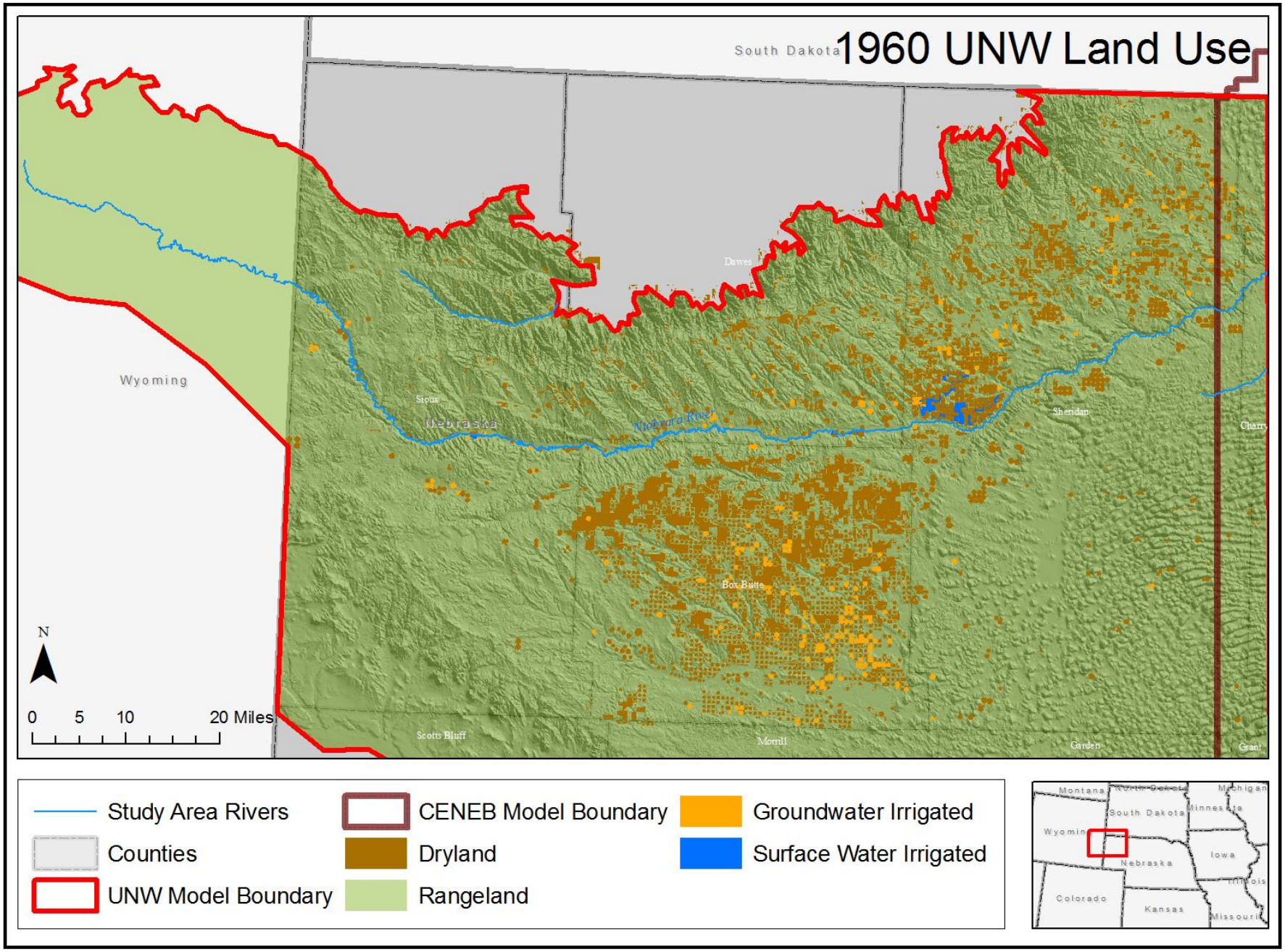
UNWNRD Certified Acres Dataset

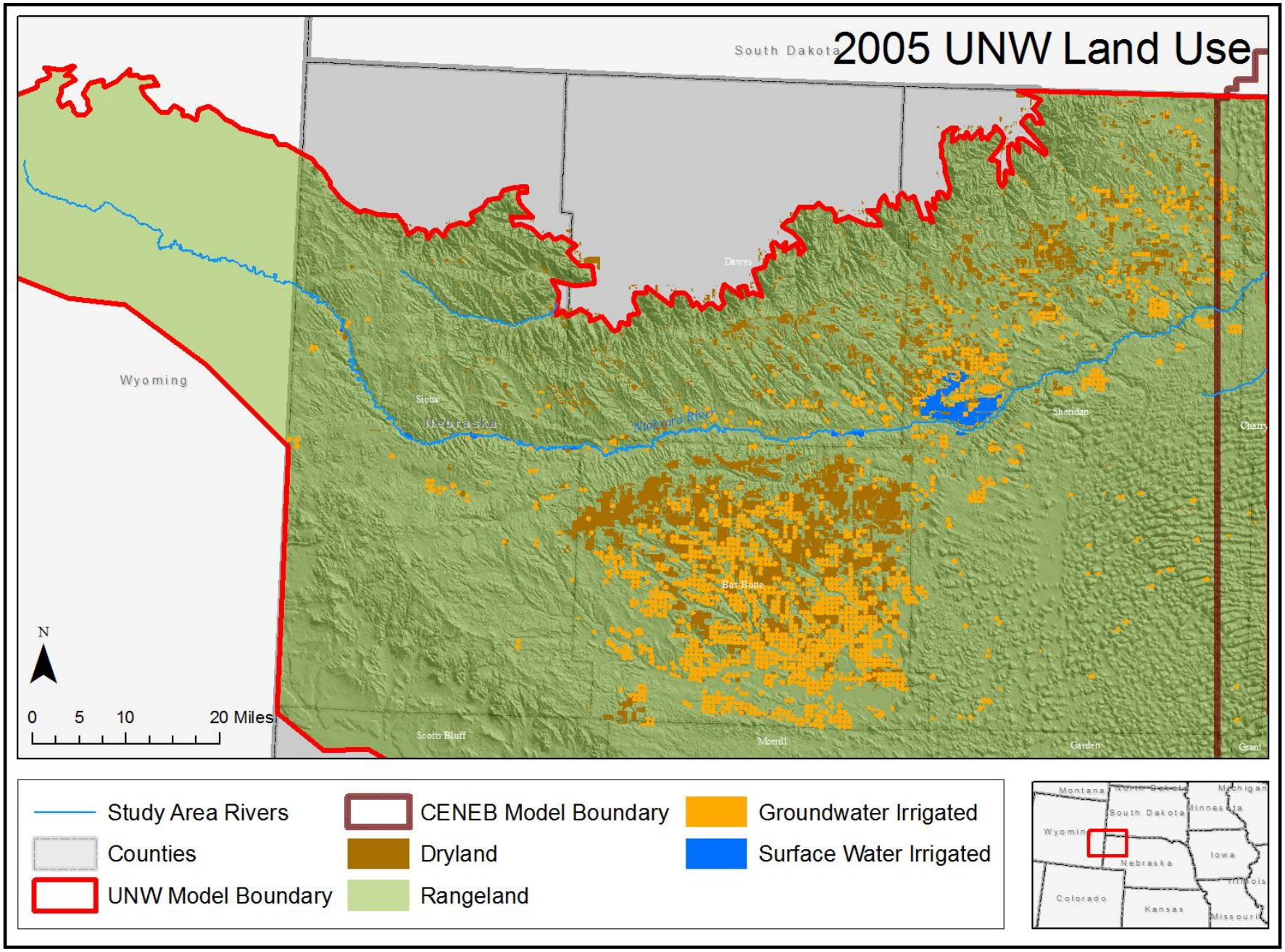


Attributes of Landowner Water Use 2009 Subarea 2

PARCEL_ID	ACRES	WELL_REG	WELL_2	WELL_3	WELL_4
810094908	136.94	G-068624			
810094428	72.8	A-005336			
810091739	27	G-114259			
810090538	132.56	G-062652	G-062651		
810090392	127.5	G-066849			
810090376	124.25	G-070038	G-047399	G-047398	
810090236	112.5	G-131412	G-131413		
810090139	196.02	G-121366			
810090015	132.4	G-085130			
810089963	131.5	G-066848B	G-066848A		
810089637	128.5	G-005634			
810089610	130.1	G-068629			
810088738	89.7	G-036851			
810057921	91.1	G-069256			
810049856	134.6	G-047702			
810046709	86.45	G-020702			
810043432	195.90	G-011581	G-066720	G-042677	
810043394	136.4	G-064722			
810043173	122.16	G-066134	G-066135	G-011687	
810043130	126.3	G-011685	G-037495	G-037496	G-011686

Record: 0 Show: All Selected Records


1960 UNW Land Use
South Dakota
Wyoming
Nebraska
Niobrara River
Dawes
Sioux
Sheridan
Box Butte
Scotts Bluff
Morrill
Garden
Grant
N
0 5 10 20 Miles
Study Area Rivers
Counties
UNW Model Boundary
CENEB Model Boundary
Dryland
Rangeland
Groundwater Irrigated
Surface Water Irrigated
Montana
South Dakota
Minnesota
Wyoming
Nebraska
Iowa
Colorado
Kansas
Missouri


2005 UNW Land Use
South Dakota
Wyoming
Nebraska
Niobrara River
Dawes
Sioux
Sheridan
Box Butte
Scotts Bluff
Morrill
Garden
Grant
N
0 5 10 20 Miles
Study Area Rivers
Counties
UNW Model Boundary
CENEB Model Boundary
Dryland
Rangeland
Groundwater Irrigated
Surface Water Irrigated
Montana
South Dakota
Minnesota
Wyoming
Nebraska
Iowa
Colorado
Kansas
Missouri

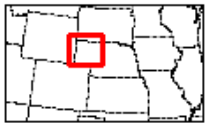
CROPSIM

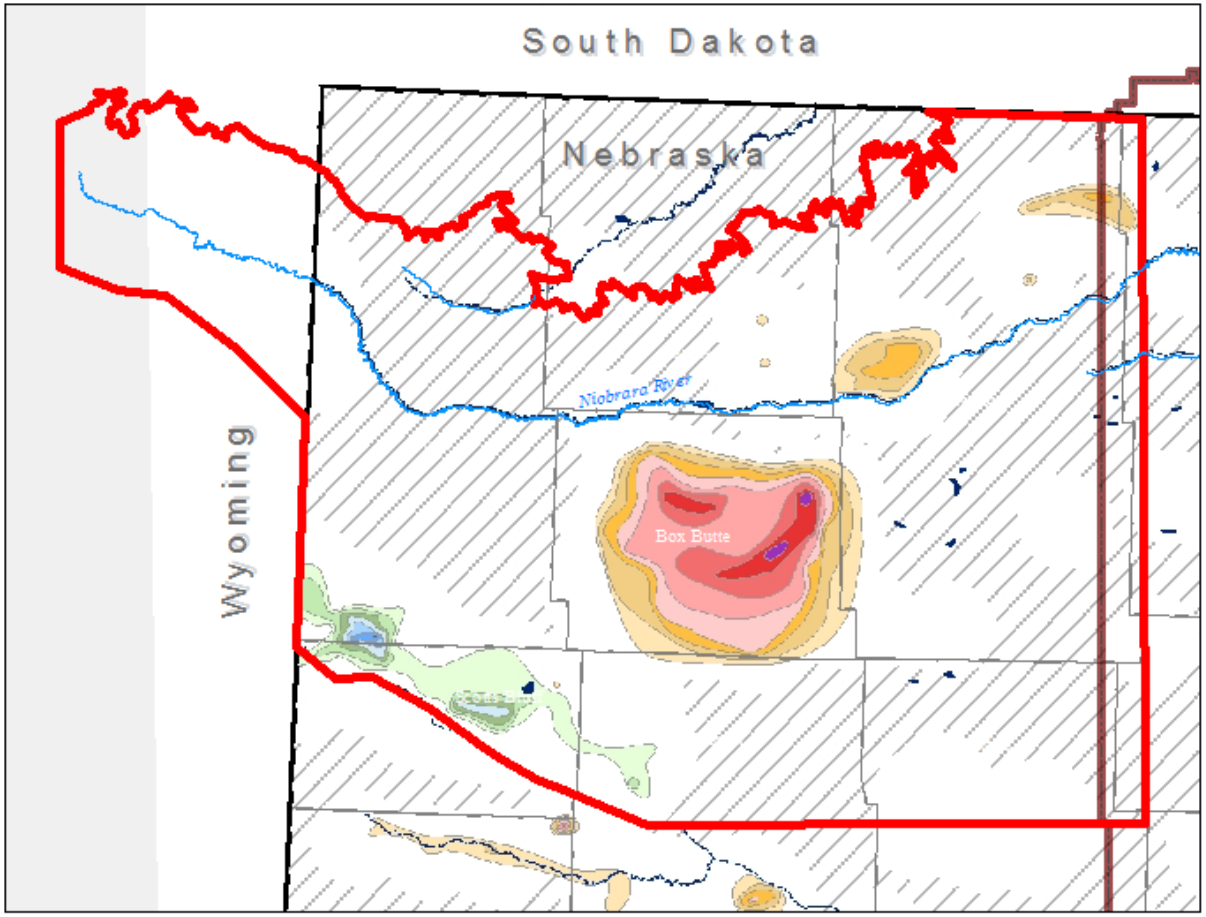
- Model Program that:
  - Determines crop irrigation requirements
  - Determines estimates of pumping and recharge
  - Provides input to both surface and groundwater models

Upper Niobrara Basin Groundwater Model

- MODFLOW—Groundwater Flow Model
- Relevant Outputs
  - Drawdown in Box Butte County
  - Groundwater Contribution to Niobrara River Flow
  - Gain/Loss of Box Butte Reservoir

CSD Reported Drawdown Predevelopment to Spring 2011





Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

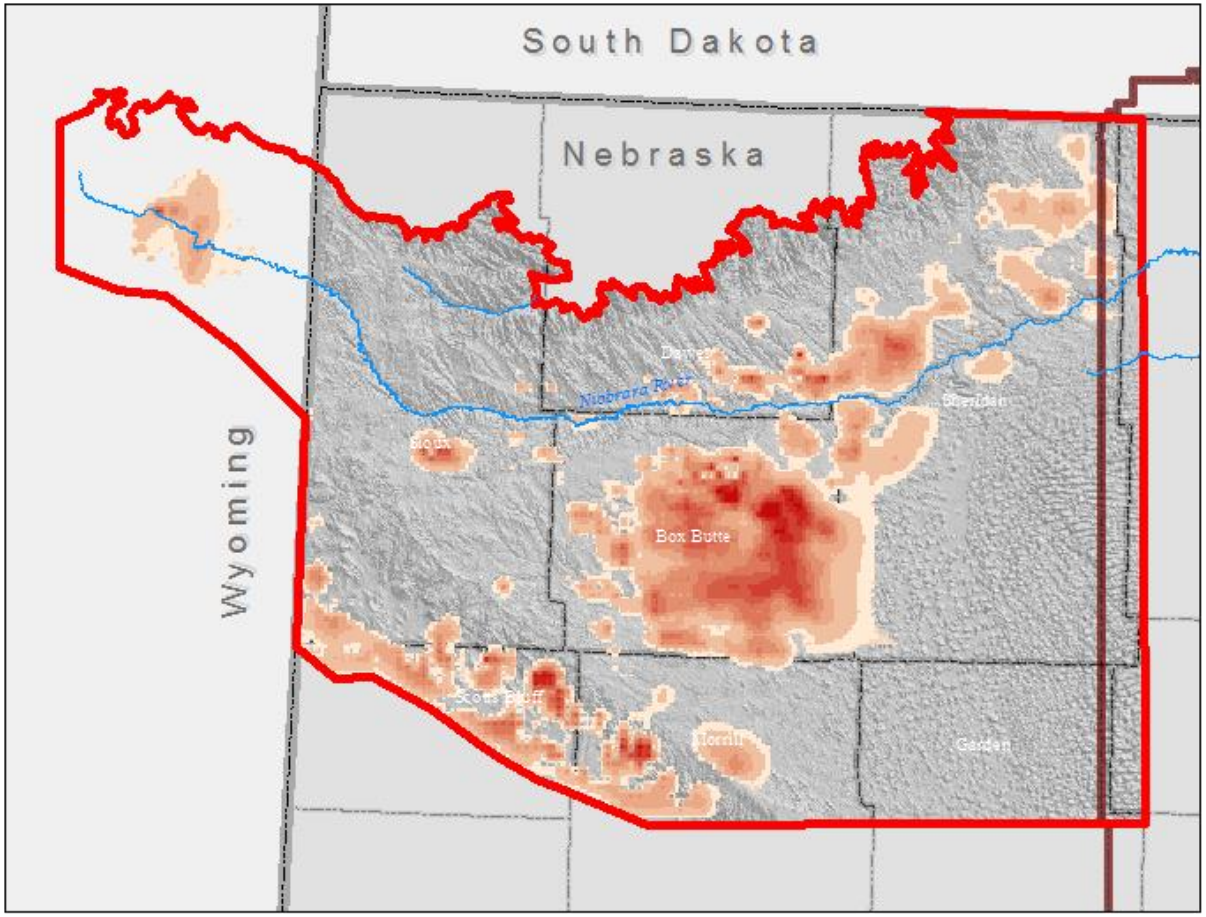
Decline in feet
5 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
> 70

This image is a georeferenced Figure 13 from "Nebraska Statewide Groundwater-Level Monitoring Report, 2011"
Nebraska Water Survey Paper Number 79
Conservation and Survey Division

0 5 10 20 Miles

N

Modeled Drawdown



Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

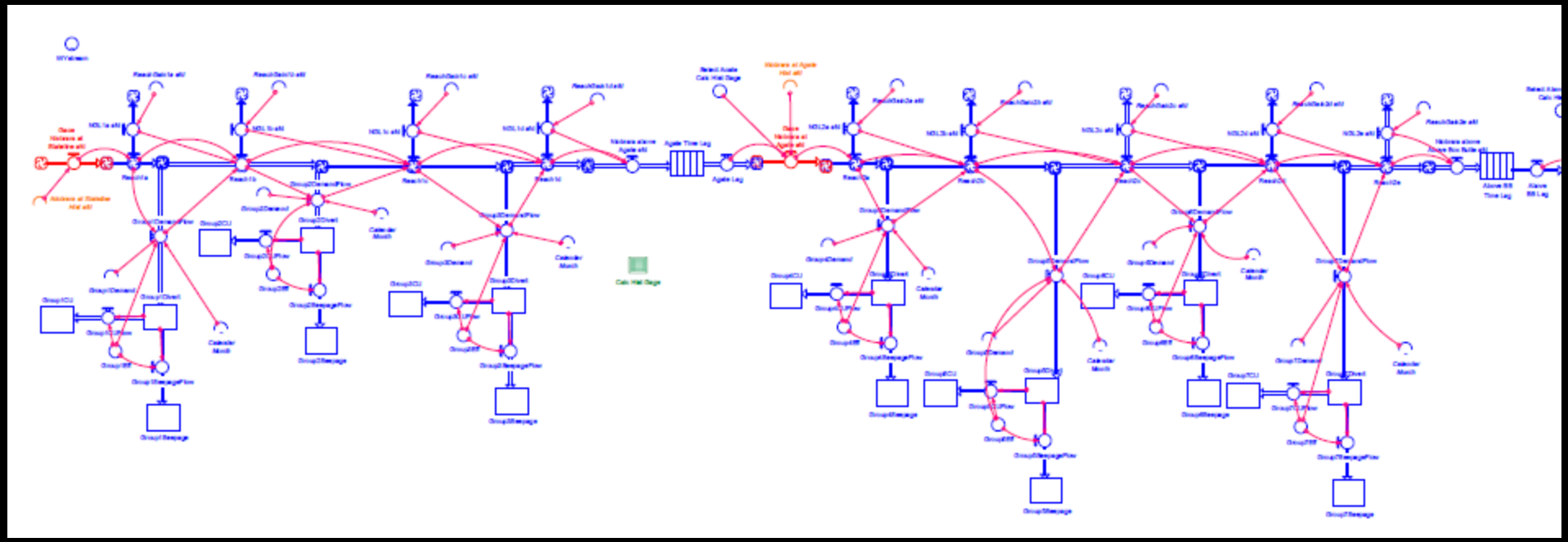
Modeled Drawdown

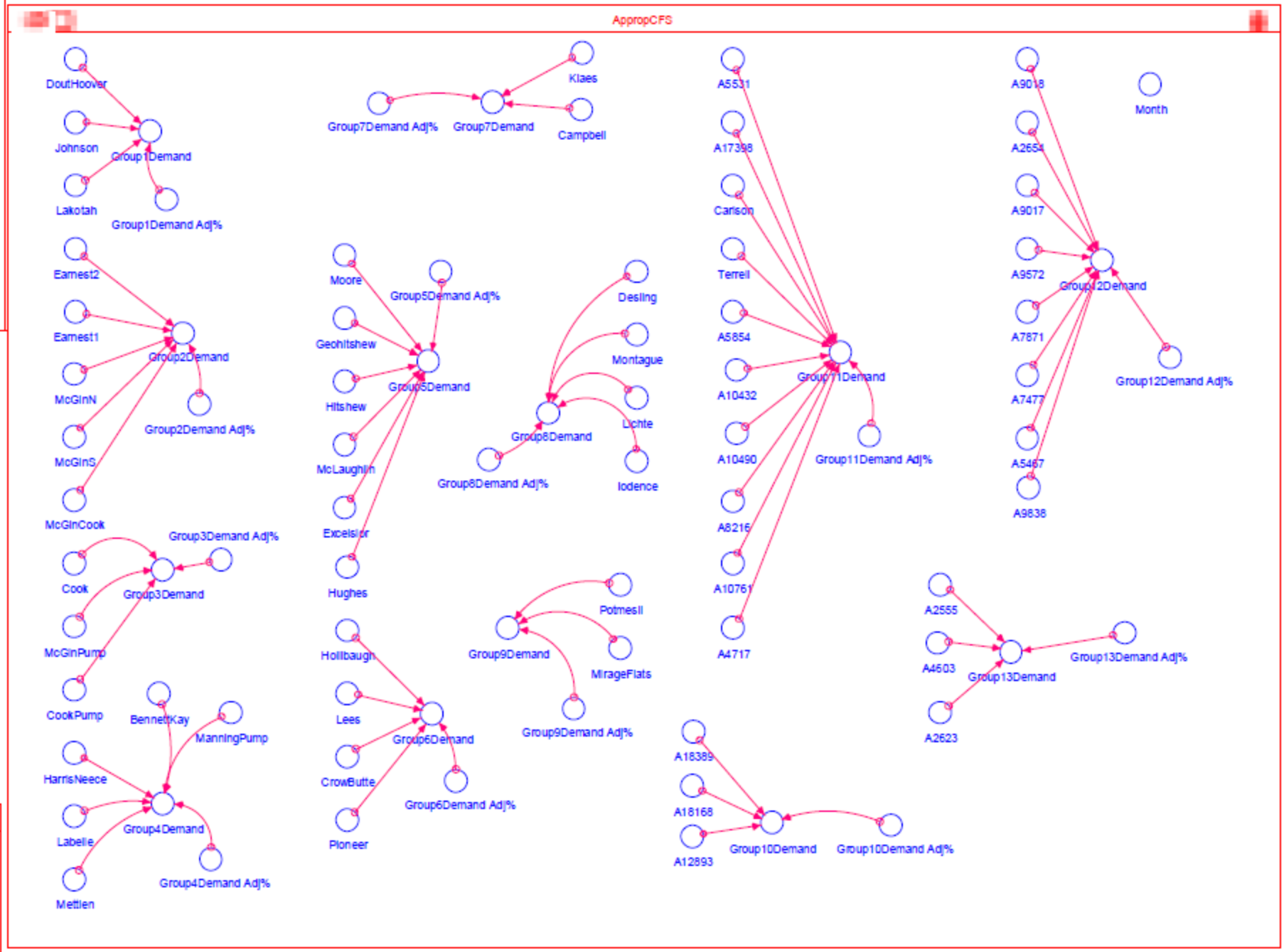
Low
High

0 5 10 20 Miles

N

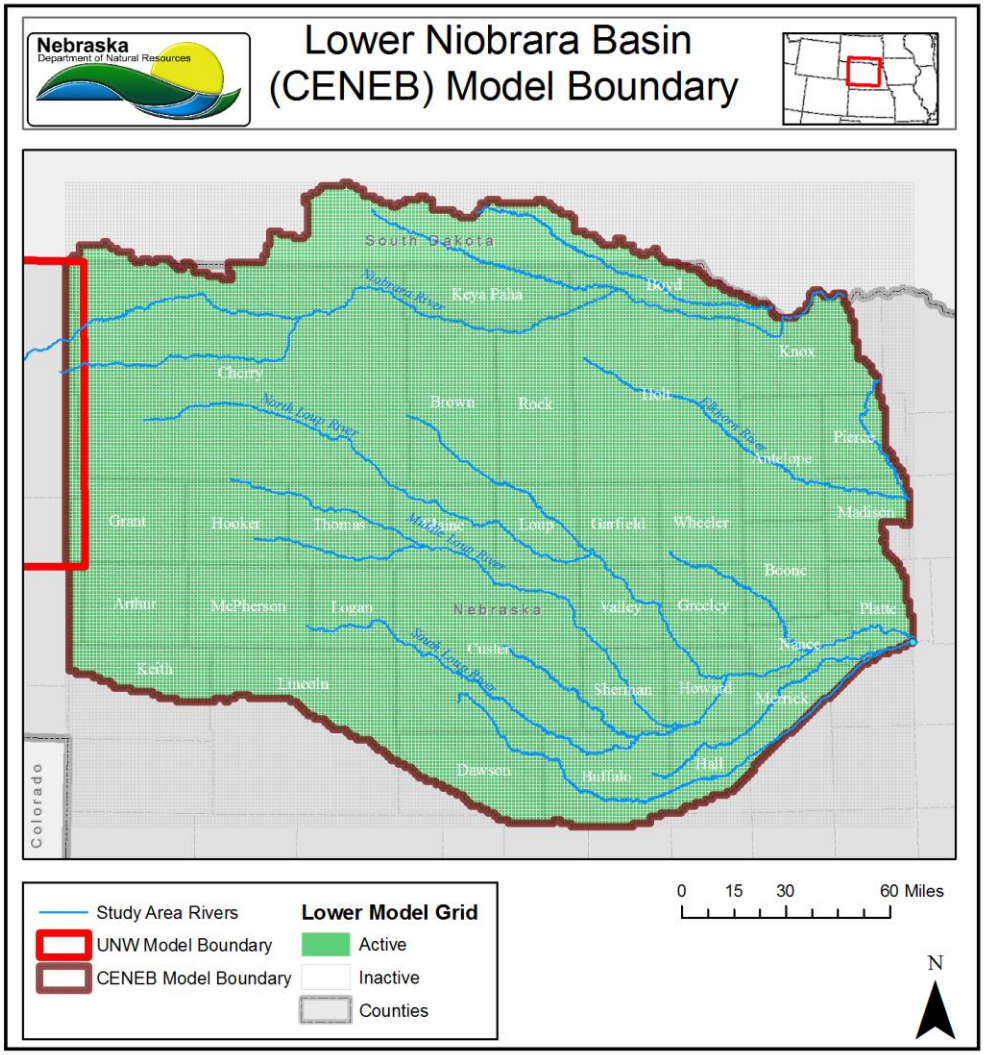
Surface Water Operations Model




ApropCFS
DoutHoover
Johnson
Group1Demand
Lakotah
Group1Demand Adj%
Klaes
Group7Demand Adj%
Group7Demand
Campbell
A5531
A17398
Carlson
Terrell
A5854
A10432
Group11Demand
A10490
Group11Demand Adj%
A8216
A10761
A4717
A9018
Month
A2654
A9017
A9572
Group12Demand
A7871
Group12Demand Adj%
A7477
A5467
A9838
Earnest2
Earnest1
Group2Demand
McGlnN
Group2Demand Adj%
McGlnS
McGlnCook
Moore
Group5Demand Adj%
Geohitshew
Group5Demand
Hitshew
McLaughlin
Excelsior
Hughes
Desling
Montague
Lichte
Group8Demand
Group8Demand Adj%
Iodence
Group3Demand Adj%
Cook
Group3Demand
McGlnPump
CookPump
BennettKay
ManningPump
HarrisNeece
Group4Demand
Labelle
Group4Demand Adj%
Mettlen
Hollibaugh
Lees
Group6Demand
CrowButte
Group6Demand Adj%
Pioneer
Potmesil
Group9Demand
MirageFlats
Group9Demand Adj%
A2555
A4603
Group13Demand
Group13Demand Adj%
A2623
A18389
A18168
Group10Demand
Group10Demand Adj%
A12893

LOWER BASIN MODEL

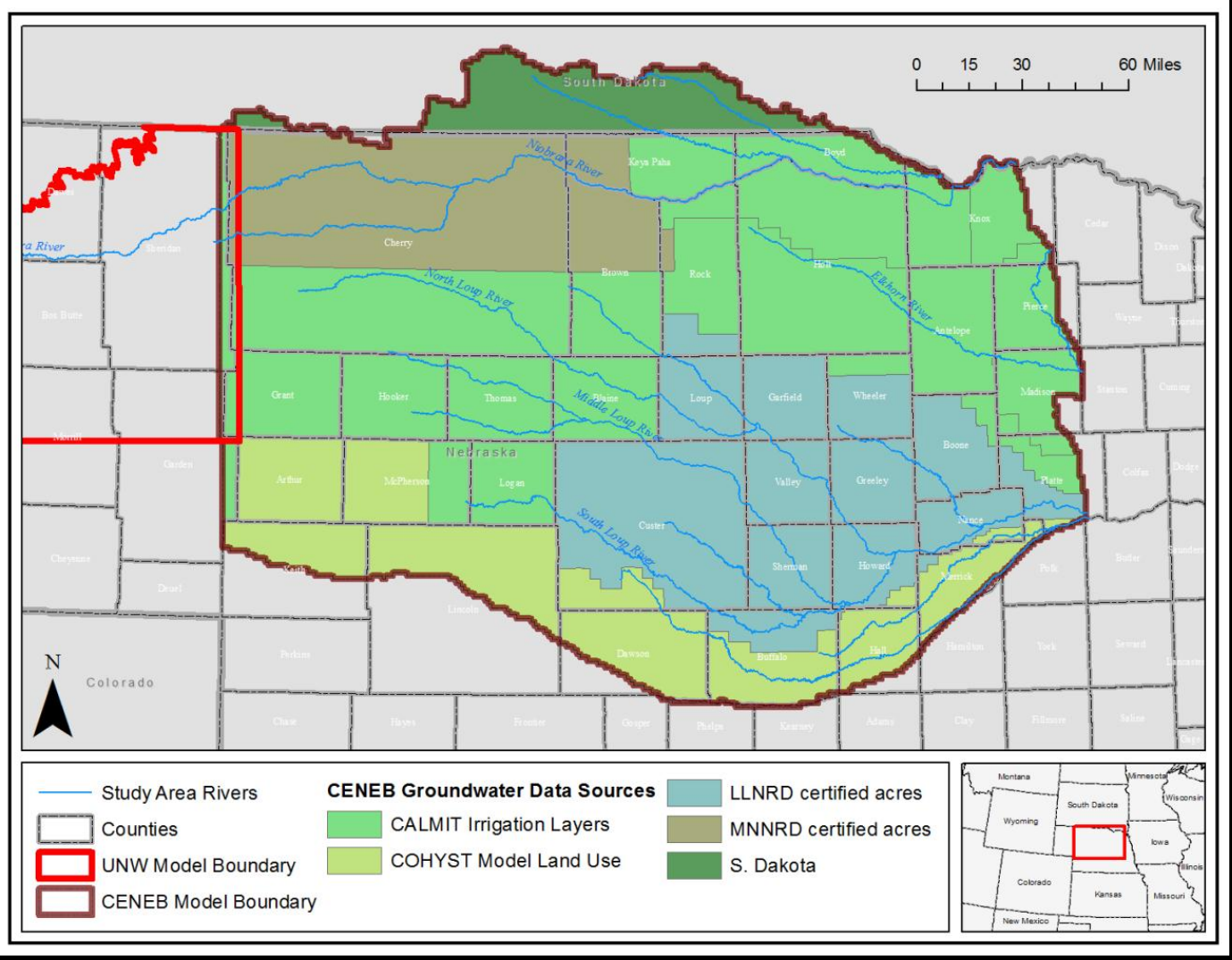
Lower Basin Study Area Map

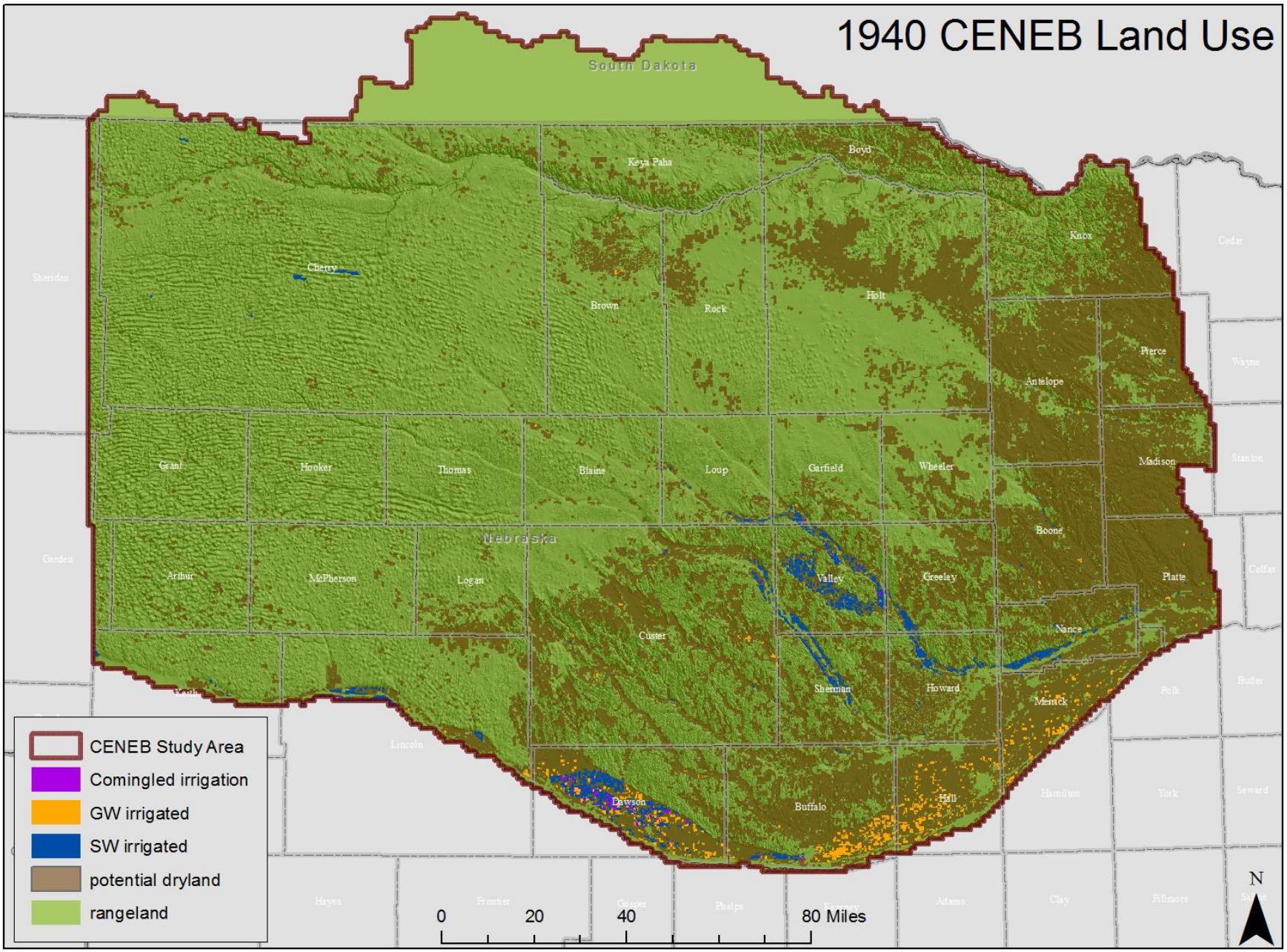


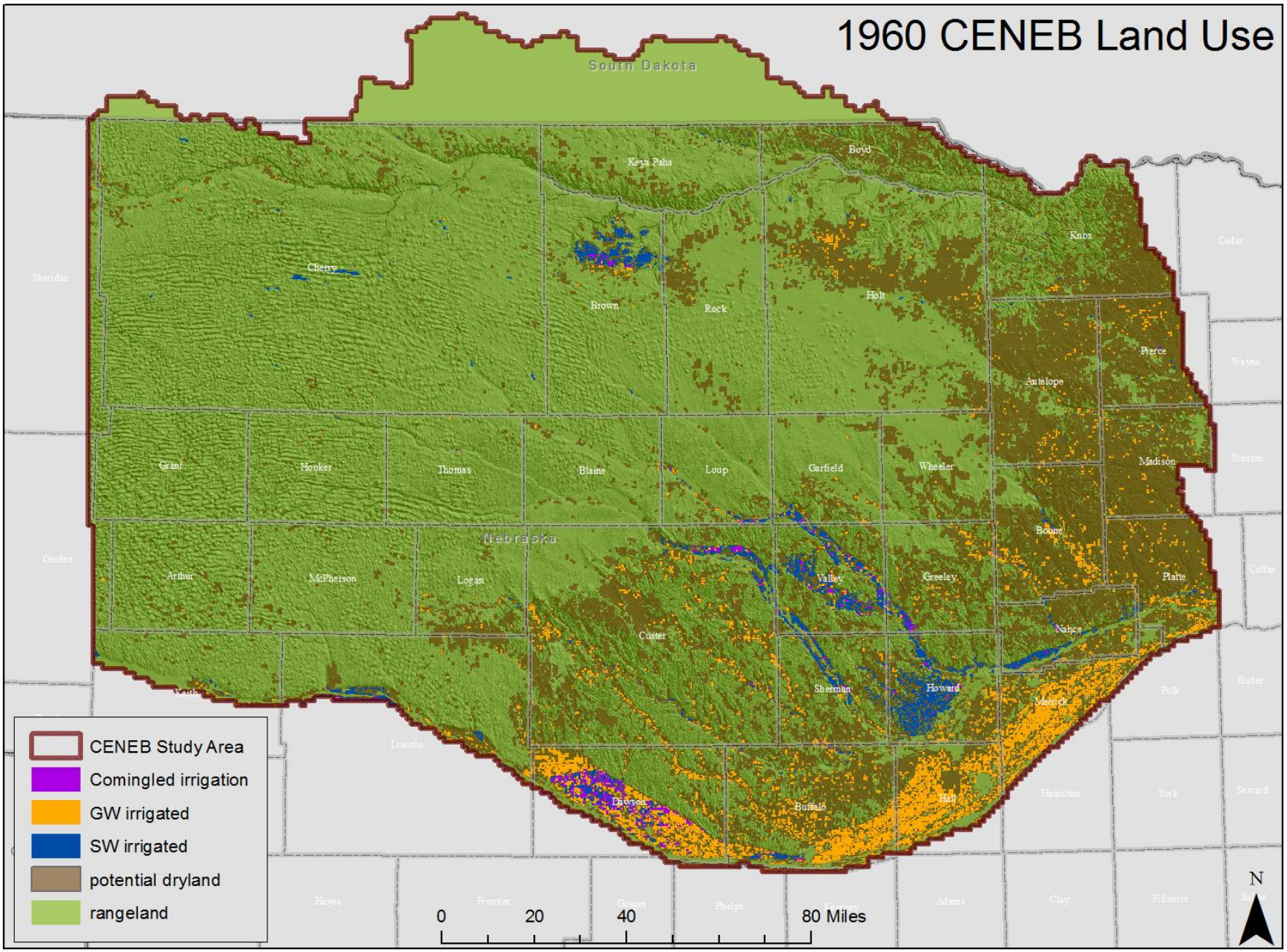
Land Use

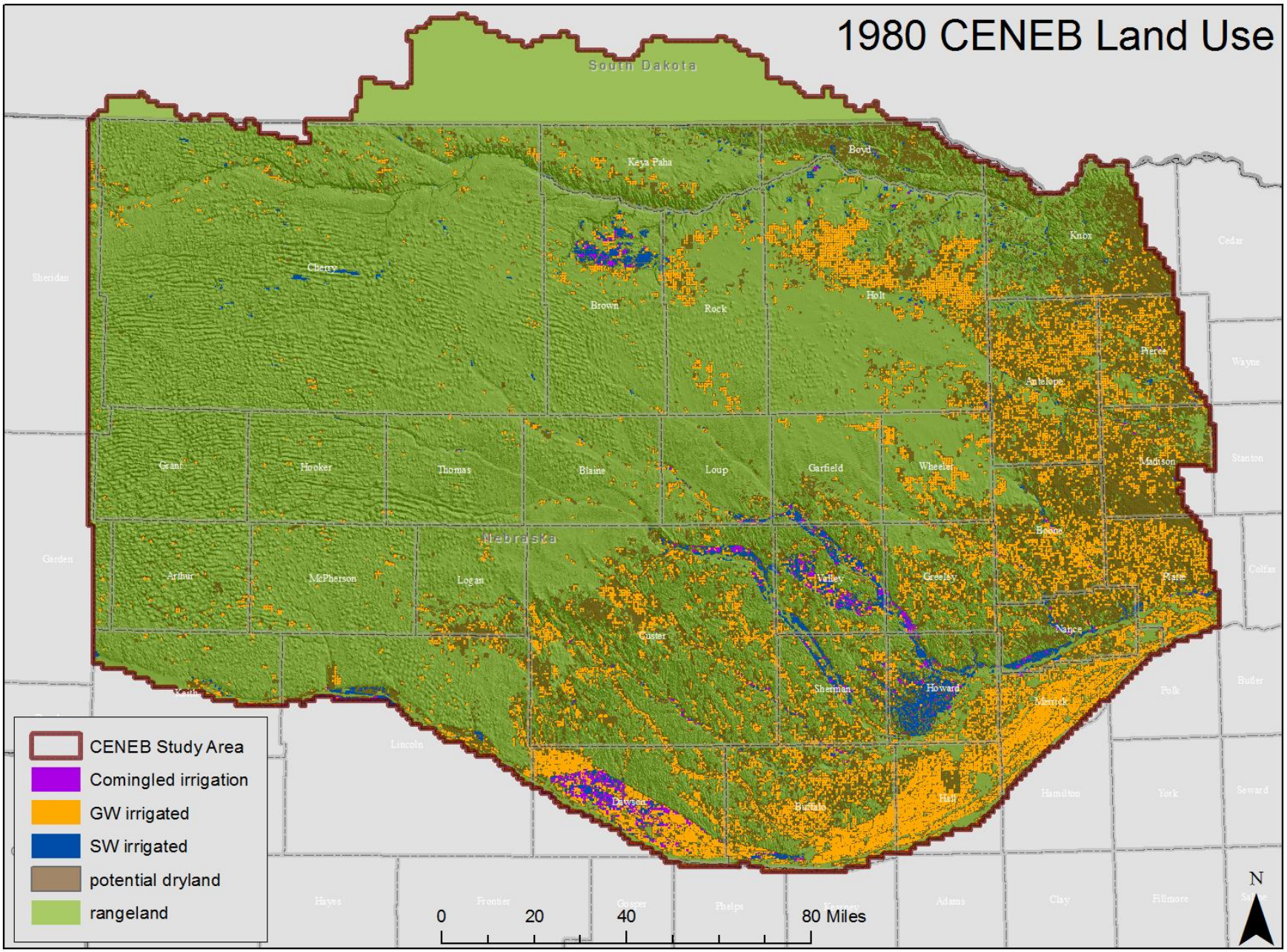
- Purpose: To estimate land cover, ie crop types through the length of the model
- Data Sources
  - NRD Certified Acres
  - COHYST
  - CALMIT 2005 state-wide coverage
  - NASS annual county acres data
- 1940-Present

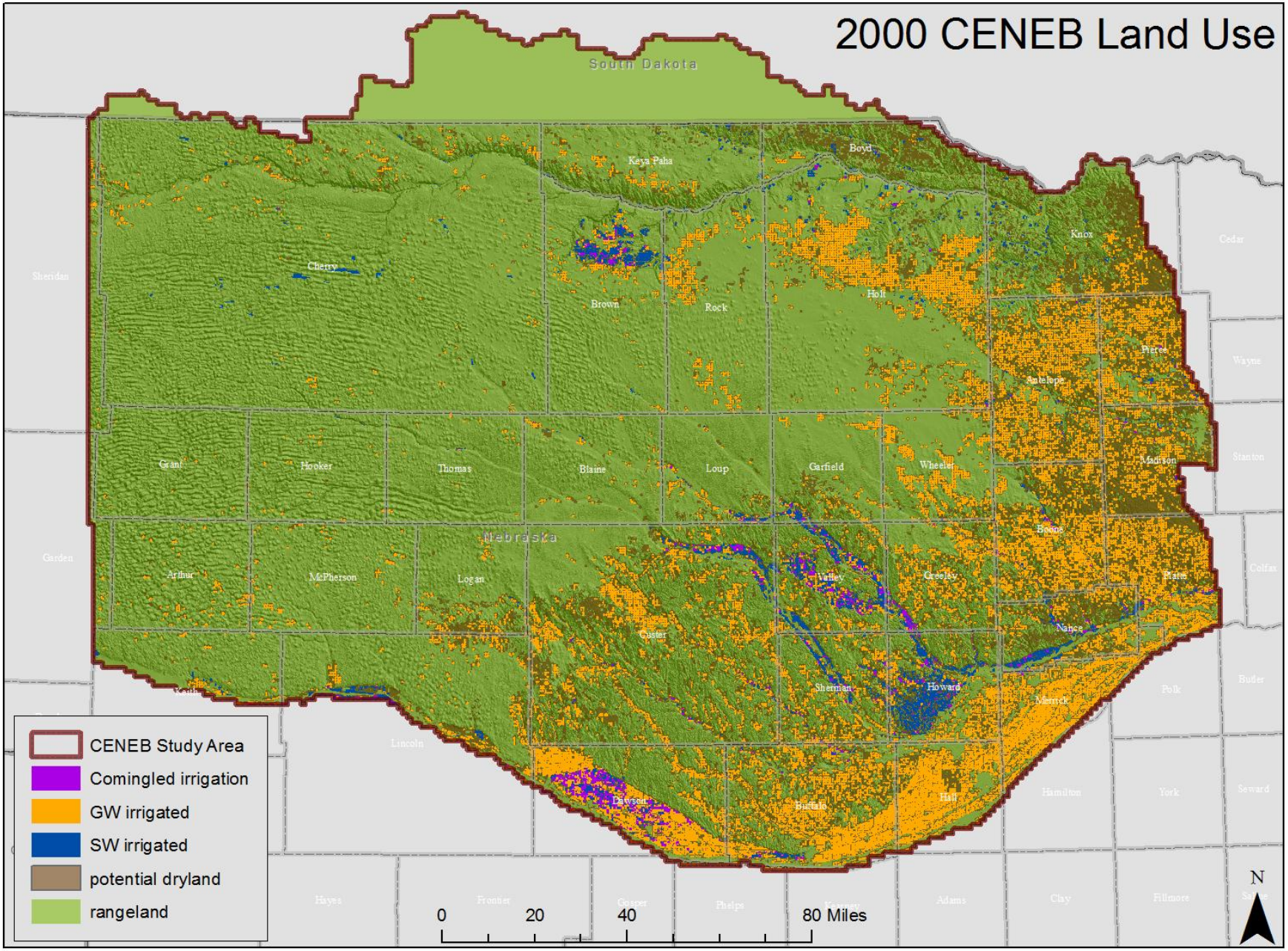
Land-Use

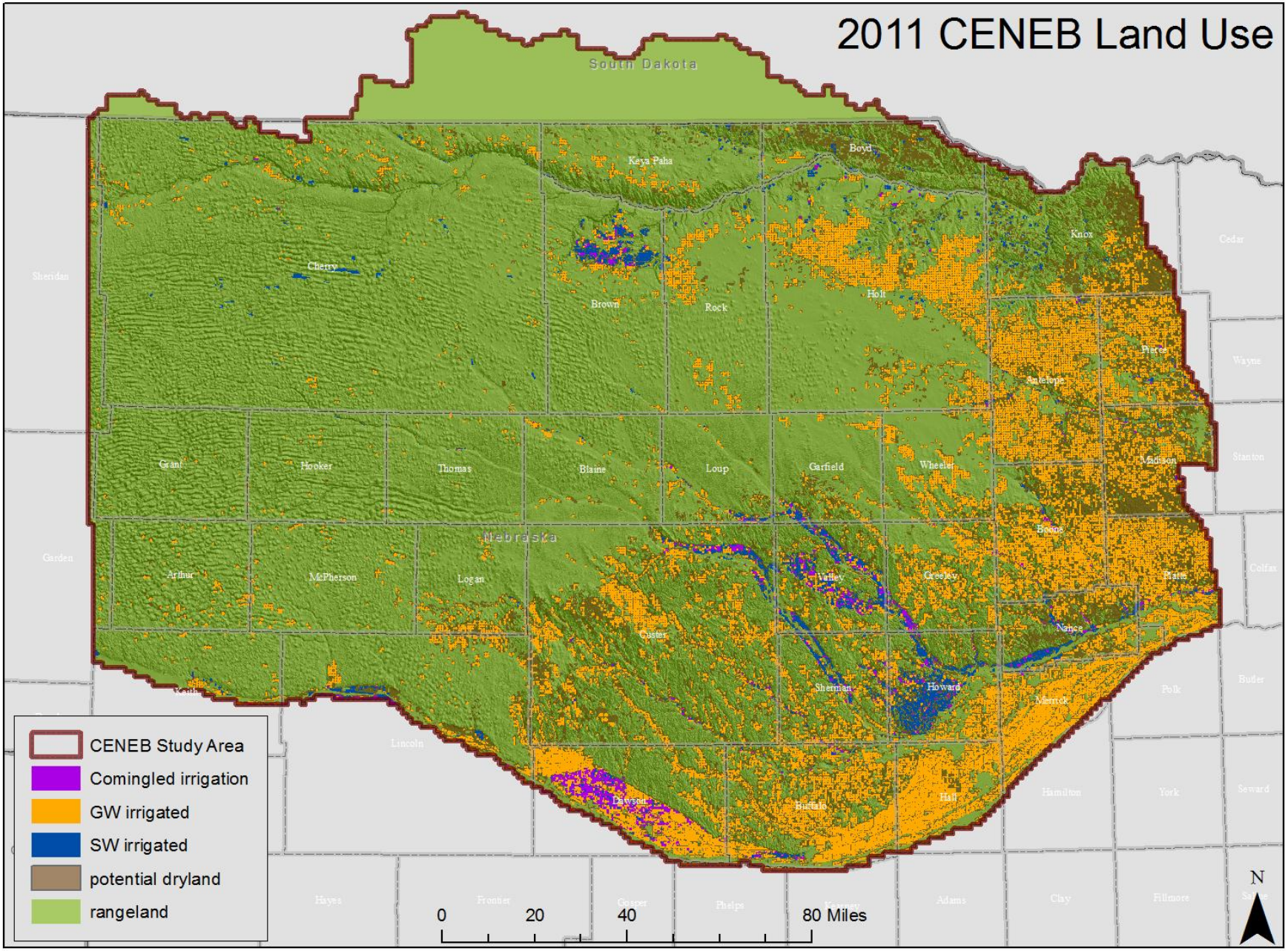

0 15 30 60 Miles
South Dakota
Niobrara River
North Loup River
Middle Loup River
South Loup River
Elkhorn River
Keya Paha
Boyd
Knox
Cherry
Brown
Rock
Holt
Pierce
Antelope
Madison
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Boone
Platte
Nebraska
Arthur
McPherson
Logan
Valley
Greeley
Nance
Custer
Sherman
Howard
Merrick
Dawson
Buffalo
Hall
Colorado
N
Study Area Rivers
Counties
UNW Model Boundary
CENEB Model Boundary
CENEB Groundwater Data Sources
CALMIT Irrigation Layers
COHYST Model Land Use
LLNRD certified acres
MNNRD certified acres
S. Dakota
Montana
Minnesota
Wisconsin
South Dakota
Wyoming
Iowa
Illinois
Colorado
Kansas
Missouri
New Mexico


1940 CENEB Land Use
South Dakota
Nebraska
Keya Paha
Boyd
Knox
Cedar
Sheridan
Cherry
Brown
Rock
Holt
Pierce
Wayne
Antelope
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Madison
Stanton
Boone
Garden
Arthur
McPherson
Logan
Valley
Greeley
Platte
Colfax
Nance
Custer
Sherman
Howard
Merrick
Polk
Butler
Lincoln
Dawson
Buffalo
Hall
Hamilton
York
Seward
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
CENEB Study Area
Comingled irrigation
GW irrigated
SW irrigated
potential dryland
rangeland
0
20
40
80 Miles
N


1960 CENEB Land Use
South Dakota
Nebraska
Keya Paha
Boyd
Knox
Cedar
Sheridan
Cherry
Brown
Rock
Holt
Pierce
Wayne
Antelope
Madison
Stanton
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Boone
Garden
Arthur
McPherson
Logan
Valley
Greeley
Platte
Colfax
Nance
Custer
Sherman
Howard
Merrick
Polk
Butler
Lincoln
Dawson
Buffalo
Hall
Hamilton
York
Seward
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
CENEB Study Area
Comingled irrigation
GW irrigated
SW irrigated
potential dryland
rangeland
0
20
40
80 Miles
N


1980 CENEB Land Use
South Dakota
Nebraska
Keya Paha
Boyd
Knox
Cedar
Cherry
Sheridan
Brown
Rock
Holt
Pierce
Wayne
Antelope
Madison
Stanton
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Boone
Garden
Arthur
McPherson
Logan
Valley
Greeley
Platte
Colfax
Nance
Custer
Sherman
Howard
Merrick
Polk
Butler
Lincoln
Dawson
Buffalo
Hall
Hamilton
York
Seward
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
Saline
CENEB Study Area
Comingled irrigation
GW irrigated
SW irrigated
potential dryland
rangeland
0
20
40
80 Miles
N


2000 CENEB Land Use
South Dakota
Nebraska
Keya Paha
Boyd
Knox
Cedar
Cherry
Sheridan
Brown
Rock
Holt
Pierce
Wayne
Antelope
Madison
Stanton
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Boone
Garden
Arthur
McPherson
Logan
Valley
Greeley
Platte
Colfax
Nance
Custer
Sherman
Howard
Merrick
Polk
Butler
Lincoln
Dawson
Buffalo
Hall
Hamilton
York
Seward
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
Saline
CENEB Study Area
Comingled irrigation
GW irrigated
SW irrigated
potential dryland
rangeland
0
20
40
80 Miles
N


2011 CENEB Land Use
South Dakota
Nebraska
Keya Paha
Boyd
Knox
Cedar
Cherry
Sheridan
Brown
Rock
Holt
Pierce
Wayne
Antelope
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Madison
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Garden
Arthur
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Valley
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Sherman
Howard
Merrick
Polk
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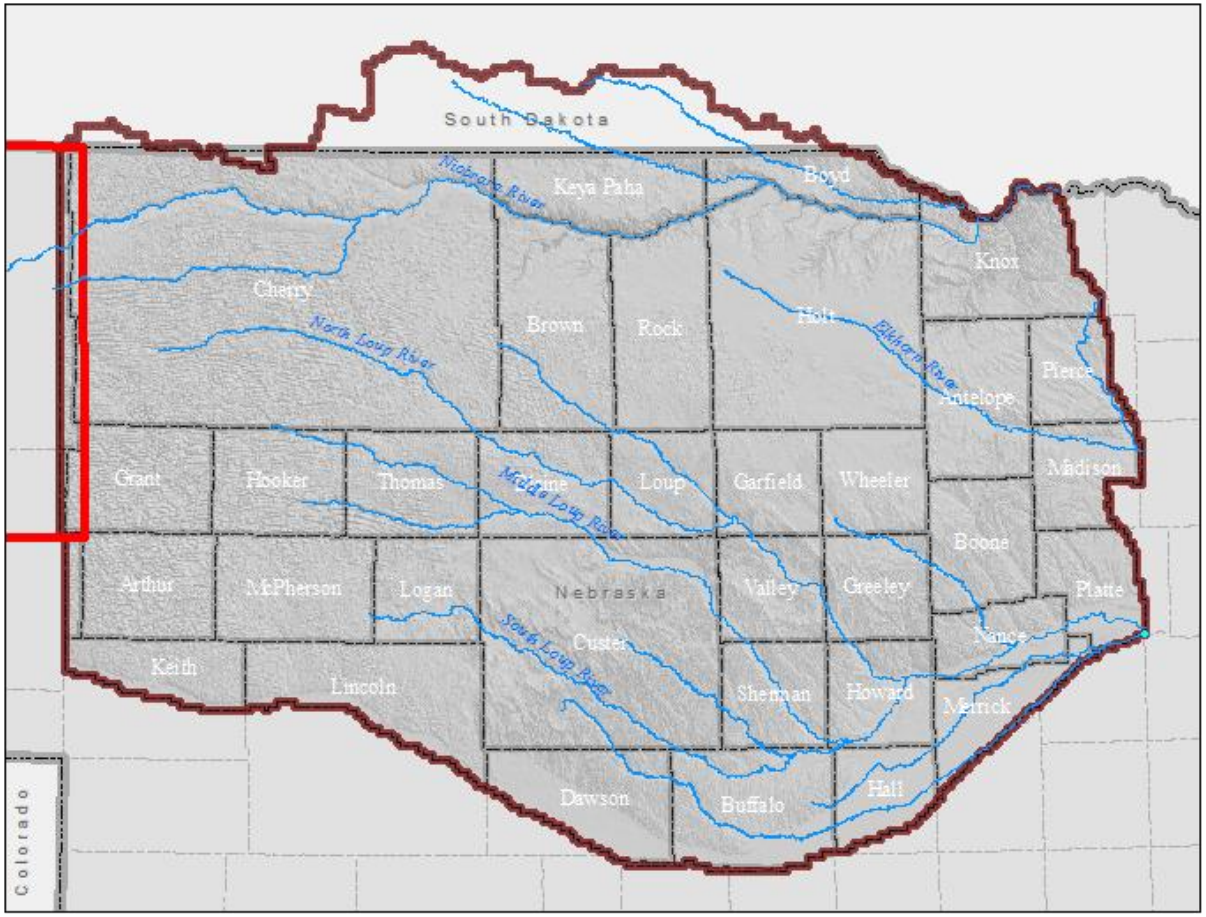
Dawson
Buffalo
Hall
Hamilton
York
Seward
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
CENEB Study Area
Comingled irrigation
GW irrigated
SW irrigated
potential dryland
rangeland
0
20
40
80 Miles
N

Groundwater Model

- To model the potential impacts to groundwater by changing recharge and pumping rates and locations
- Model potential water management alternatives

CENEB Streams

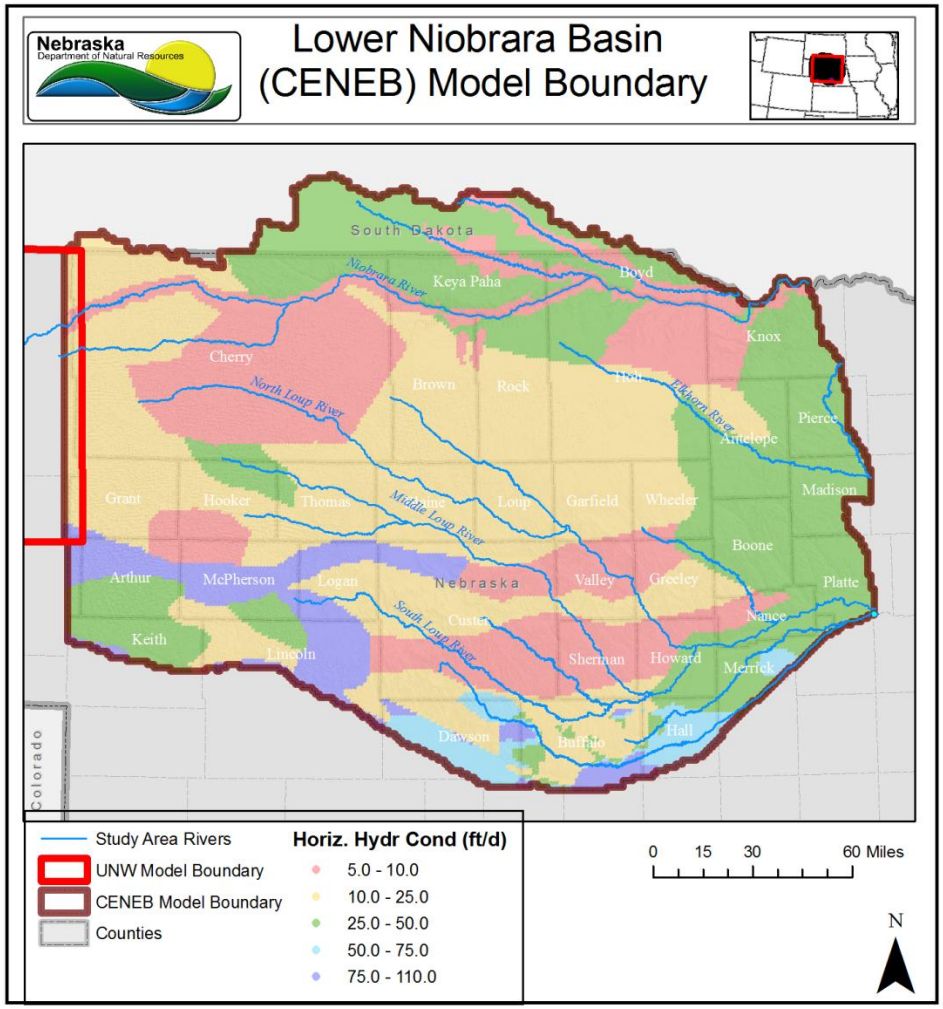


Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

0 12.5 25 50 Miles

N

CENEB GW Model



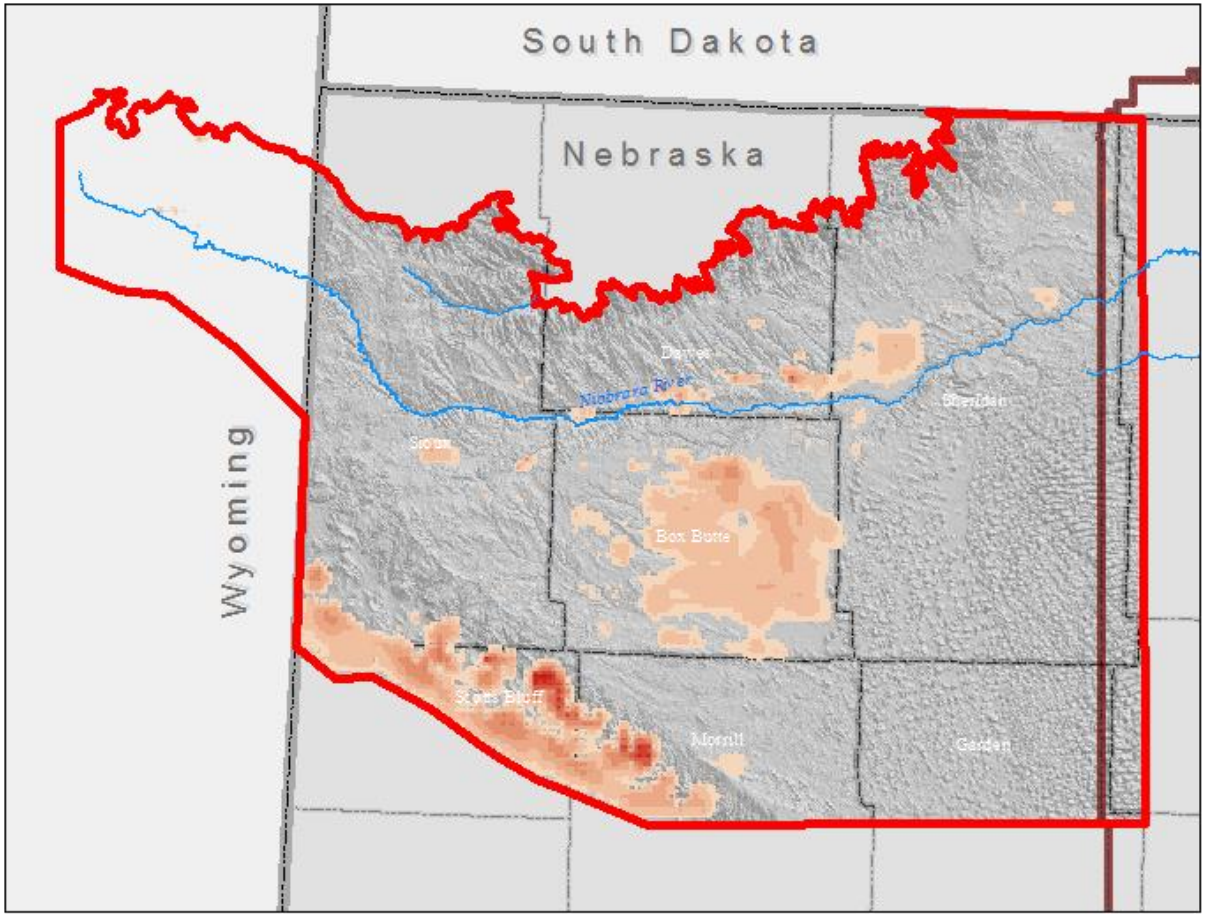
Surface Water Operations Model

- Will include
  - Merritt Reservoir/AID operations
  - Spencer Hydropower demands
  - Senior/Junior appropriators

Scenario Development

- How these tools help us manage water resources
- Examples of simple scenarios
- Stakeholder Input

Modeled Drawdown
10% Pumpage



Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

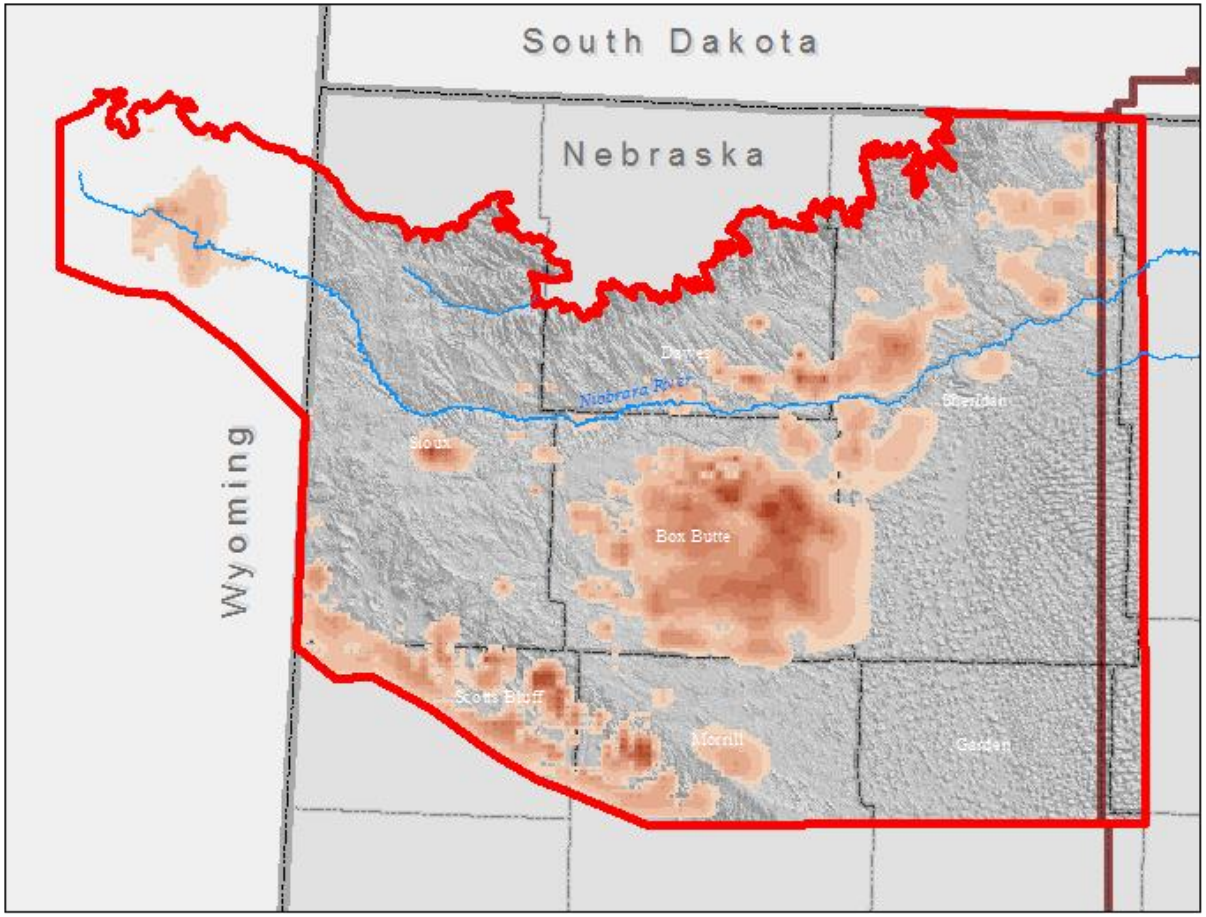
Modeled Drawdown

Low
High

0 5 10 20 Miles

N

Modeled Drawdown
80% Pumpage



Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

Modeled Drawdown

Low
High

0 5 10 20 Miles

N

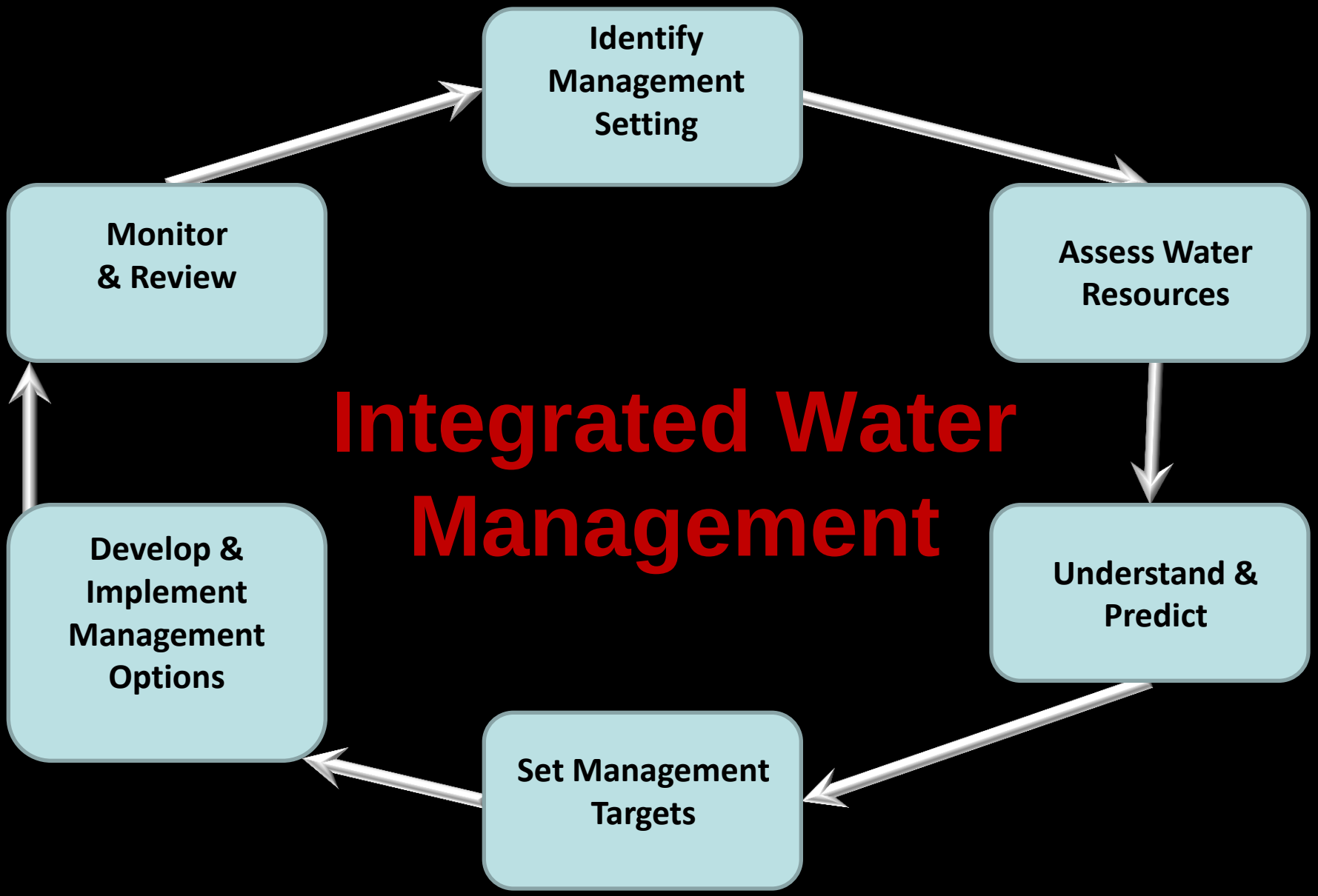
Timeline

- Project completion April 2013

Model Summary

- Combine hydrologic, economic, and climate models to evaluate water management strategies
- Hydrologic models broken into the Upper & Lower Basin components
- Hydrologic models include land-use, surface water, & groundwater models

NIOBRARA RIVER BASIN PLANNING EFFORTS


Integrated Water Management
Identify Management Setting
Assess Water Resources
Understand & Predict
Set Management Targets
Develop & Implement Management Options
Monitor & Review

Upper Niobrara-White NRD Planning

- Integrated Management Plan in place
- Certified Acres
- Plan to use developed tools to aid in management and planning

Lower Niobrara NRD Planning

- Voluntary IMP in development
- Currently in stakeholder process
- Plan to use developed tools to aid in management and planning

Brandi Flyr, Ph.D., IWM Division
Nebraska Department of Natural Resources