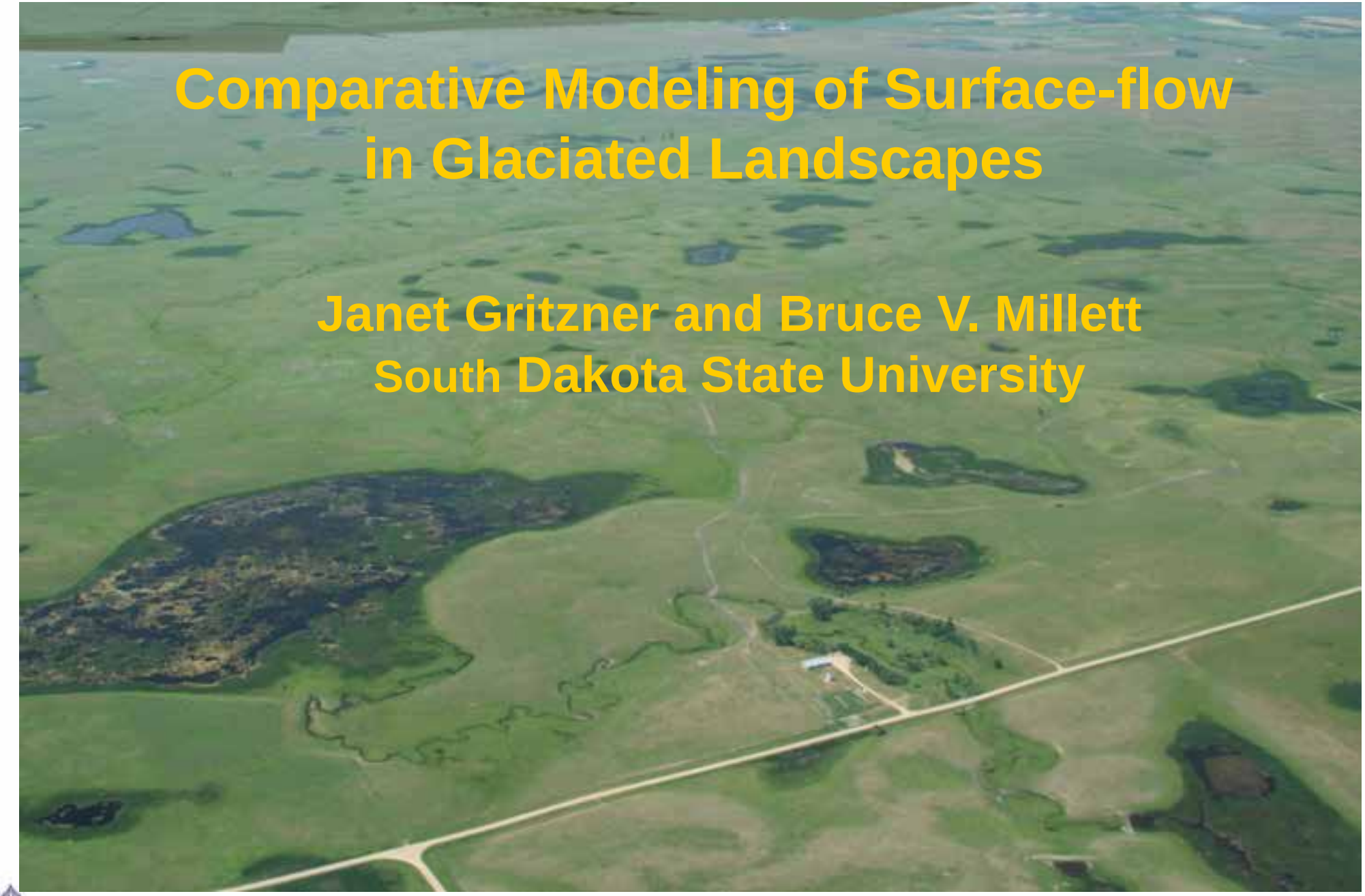

Comparative Modeling of Surface-flow in Glaciated Landscapes

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SDSU Department of Geography

Outline

Background

Research Objectives

About Glaciated Landscapes

Data Sources

Methodology

Analysis

Results

Conclusions

Clean Water Act
33 U.S.C. §1251 et seq. (1972)

The Clean Water Act (CWA) protects "navigable waters", defined as "waters of the United States“

Regulations by the US Environmental Protection Agency (EPA) and US Army Corps of Engineers (Corps) further define what are considered "waters of the US"

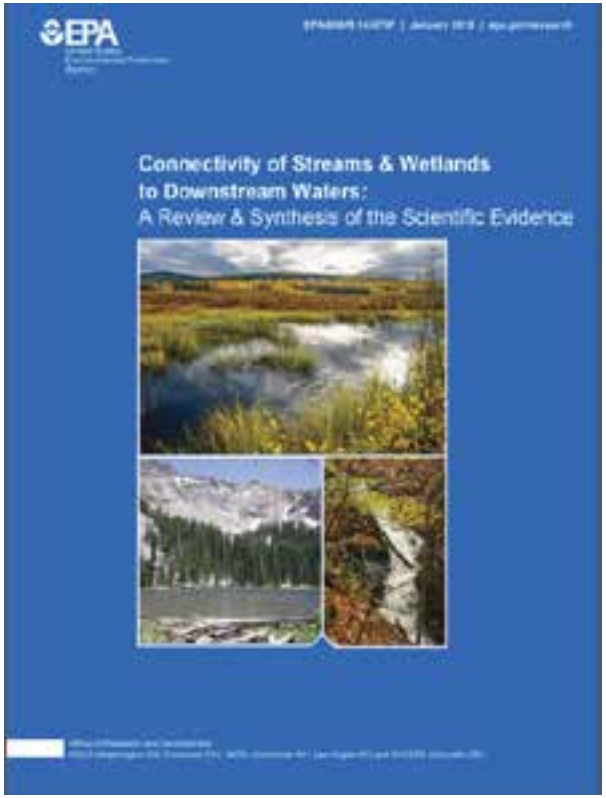
- Prior to 2001, any tributary of a navigable water and all delineated wetlands, because of their potential to serve as migratory bird habitats were regarded as jurisdictional

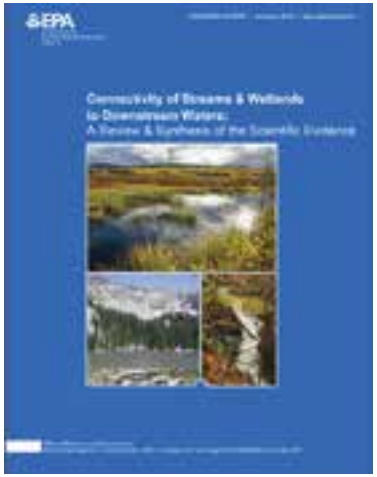
- So called SWANCC ruling, the supreme court held that present of migratory bird was in sufficient sole basis for asserting CWA jurisdiction over isolated, intrastate non navigable waters, but did not invalidate regulations defining “waters of the US’.

EPA Report Published January 2015

- Recent US Supreme Court cases (2006) have created new legal standards for determining jurisdictional waters under the Clean Water Act (CWA)

- Led to publication of ***Connectivity of Streams and Wetlands to Downstream Waters: A Review & Synthesis of Scientific Evidence***





Scientists Endorse Connectivity of Streams and Wetlands to Downstream Waters as a Clear, Accurate, and Thorough Compilation of the Best Available Science (over 1200 publications)

Key Statements Regarding Geographically Isolated Wetlands

- Report notes type and degree of connectivity of certain unidirectional wetlands in certain regions maybe of sufficient consistency to establish a collectivity connectivity to downstream waters.

- Report's case study on prairie potholes concludes when proper climatic or topographic conditions occur, measurable influence on condition and function of downstream waters is highly likely.

- Caveat – *the literature we reviewed does not provide sufficient information to evaluate or generalize about the degree of connectivity (absolute or relative) or the downstream effects of wetlands in unidirectional landscape settings*

Research Objective 1

GIS hydrologic modeling techniques are used to better understand regional surface-flow in the Prairie Pothole Region of North America.

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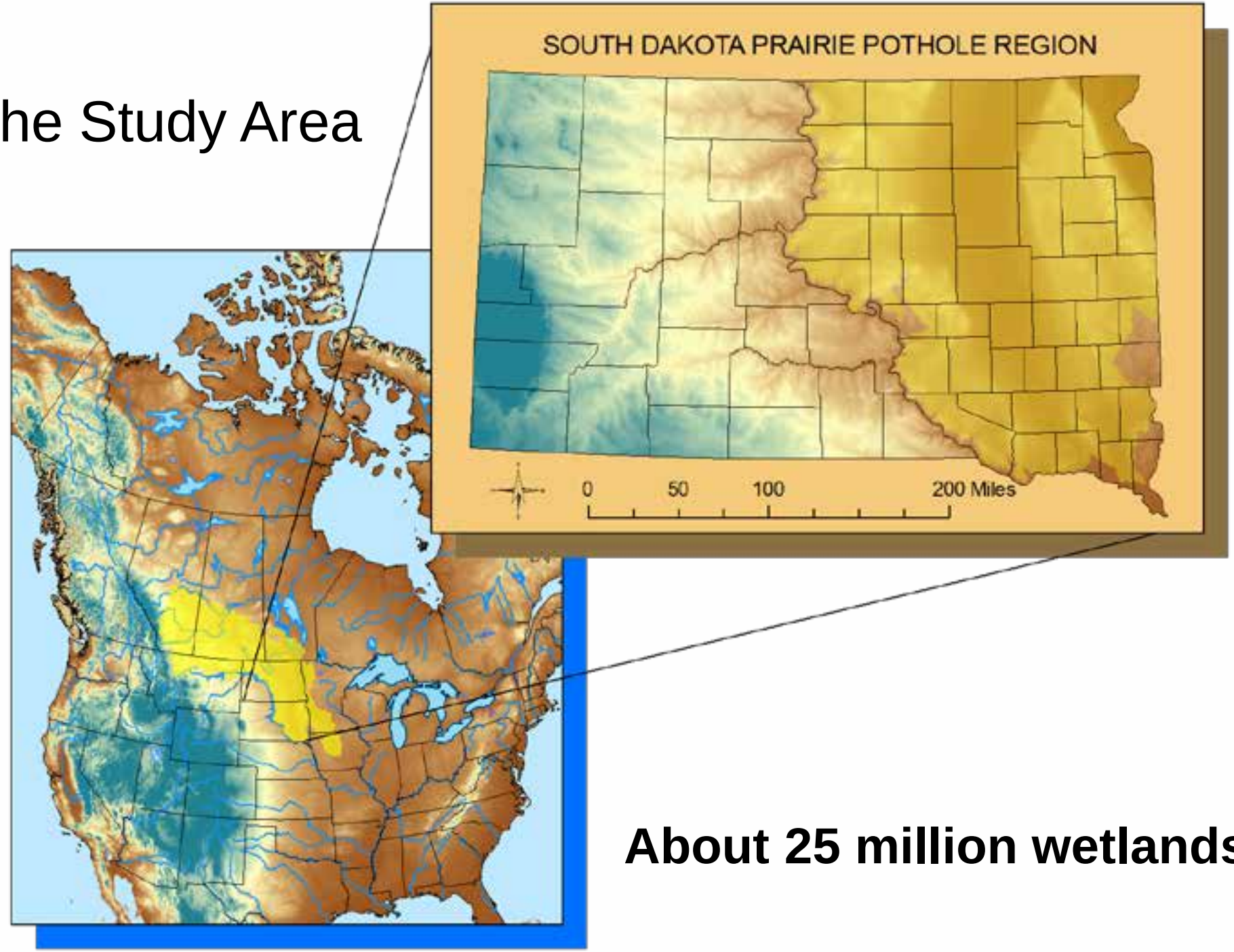
The Study Area



About 25 million wetlands

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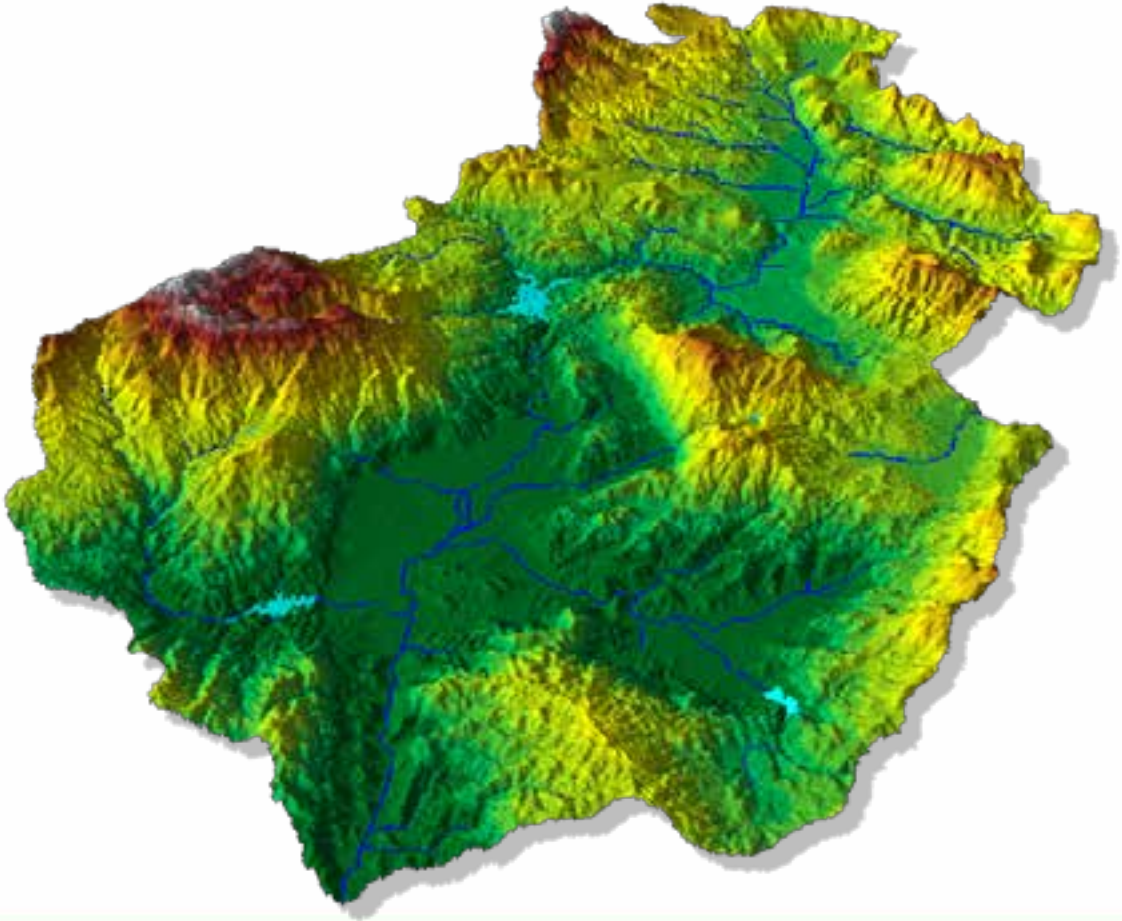
Research Objective 2:

GIS modeling of surface flow utilizes a variety of widely available high resolution elevation datasets.

Hydrologic modeling starts with good elevation data!

Comparisons made of:

- IFSAR
- National Elevation Data (NED)



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Data Sources

- IFSAR Digital Terrain Models 2005 (5m)
- National Elevation Data 1/3 Arc Second (9m)
- National Wetlands Inventory Data
- National Agricultural Imagery Program 2006

Specific Objectives of Study

- Look at the distributional characteristics of depressional features – wetlands and non-wetland depressions – as they relate to linear drainage systems.

Field Sites

Crystal Springs and Orchid Meadows Wetland Complexes, Deuel County, SD

Methodology & Procedures:

Identify depressions and depression areas

- Evaluate elevation datasets for sinks
- Fill selected sinks in IFSAR and NED

Develop general utility datasets

- Filled DEM & Filled DEM with sinks
- Flow direction
- Flow accumulation

Methodology & Procedures:

Develop derivative datasets

- Stream definition with various thresholds
- Stream features

For drainage connectivity study of Orchid Meadows and Crystal Springs

Advanced ArcHydro tools and procedures for deranged drainages are employed.

Methodology & Procedures:

Analyze Surface-flow in Glaciated Terrain

- Derive synthetic drainage networks
- Intersect depressional features with synthetic drainages
- Generate statistics for linked and isolated depressions
- Detail drainage connectivity for Orchid Meadows and Crystal Springs study sites

Results:

Linked depressional features with generalized and detailed drainages

Isolated depressional features with generalized and detailed drainages

Area and depth statistics for linked and isolated depressions

Drainage connectivity Orchid Meadows and Crystal Springs

Area and Depth Measures
Linked and Isolated Depressions

Type	Count	Area in hectares	Mean Area	Max Area	Mean Depth	Max Depth
L - G	5384	96954	17.9	11938	0.9	17
I - G	63894	88731	1.4	238	0.7	48
L - D	54664	181444	3.3	11938	0.7	48
L - I	14614	3741	.25	2	0.6	7

L - G : Linked Generalized
I - G : Isolated Generalized
L - D : Linked Detailed
I - D : Isolated Detailed

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Stream Comparisons

Derived from IFSAR 5m and NED 9m

Stream Definition Threshold Values

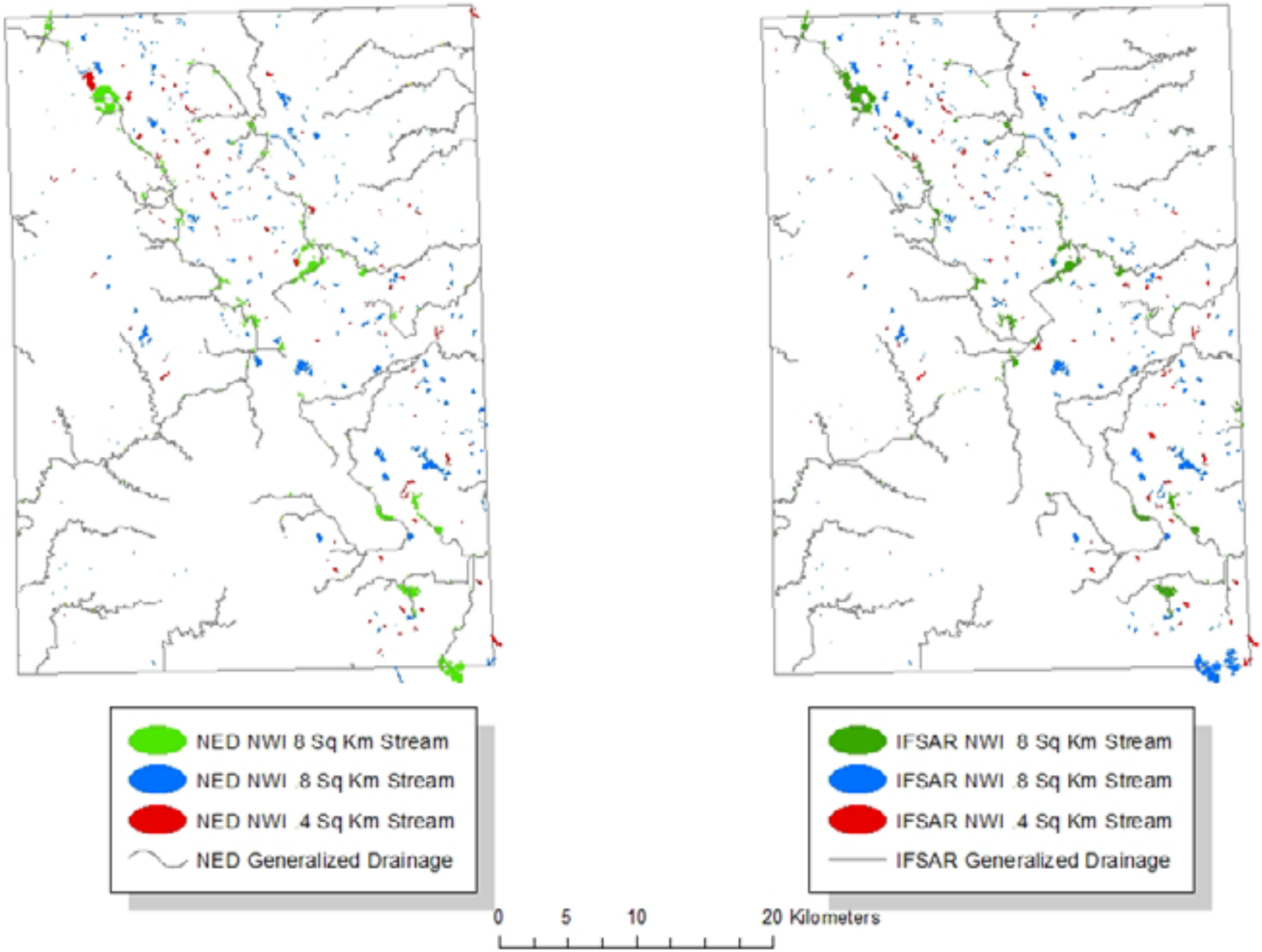
- Level 1 - 8 sq miles
- Level 2 - 4 sq miles
- Level 3 - .8 sq miles
- Level 4 - .6 sq miles
- Level 5 - .4 sq miles

Deuel County Stream and Wetland / Depression Intersection

DATA	FILL	SQ Mi	% SINKs	% NWI
IFSAR 5m	ALL	8	4 %	8 %
IFSAR 5m	ALL	.8	9 %	29 %
IFSAR 5m	ALL	.4	11 %	37 %
NED 9m	ALL	8	6%	8%
NED 9m	ALL	.8	15%	27%
NED 9m	ALL	.4	18%	36%
Total Polys			INFSAR 141643 NED 95898	2451

NWI Intersection with IFSAR and NED Streams

Deuel County, SD



Drainage Connectivity

Crystal Springs

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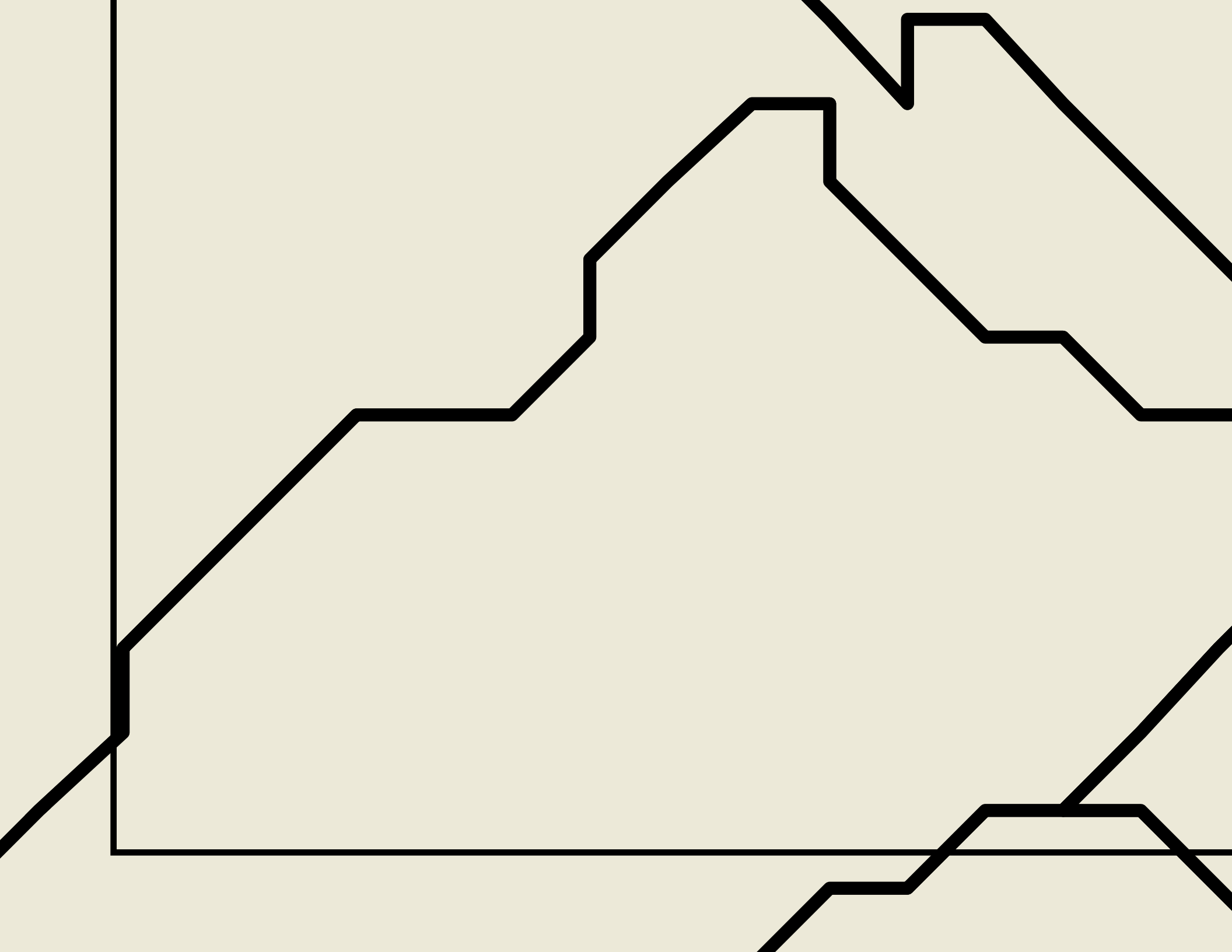
Crystal Springs



Synthetic Drainages

Drainage Patterns

Crystal Springs

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Drainage Patterns

East Central Deuel County, SD

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Conclusions:

Some 7.7% of depressions identified by IFSAR intersected generalized drainage, while 78.9% of depressions intersected the detailed drainages for multi-county region.

Numbers of intersected NWI wetlands showed little difference between IFSAR and NED derived streams regardless of stream detail.

Large shallow depressional features, many of them wetlands, intersect the generalized drainage – average size 17.9 hectares.

Synthetic drainages show direction of flow of connected depressions.

Under high water conditions, wetlands and non wetlands will likely display modeled drainage linkages and depressions could in time disappear as the landscape matures.

Truly isolated wetlands/wetland complexes can begin to be identified.

Questions?