Development of Watercourse Aggradation Risk Index for New Mexico

Project No. NM10DSN-01

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May 9, 2013

Public Presentation

Project Summary

- Combine publicly available data for soil type (*SSURGO*), precipitation ($_{100}P_{24}$), vegetation (*NDVI*), crop management factor (*C*) and terrain (*DEM*) into statewide *ArcGIS* maps.

- Develop a NM statewide soil erosion risk map based on the above parameters, the Universal Soil Loss Equation (*USLE*), and fuzzy logic routines.

- Through collaboration with NMDOT, identify culverts on NM highways with improperly designed or problematic drainage structures with respect to sediment deposition.

- From risk maps, identify culverts on NM highways expected to have been placed in areas of high soil erosion risk.

Project Summary

- Determine the hydrologic attributes (peak discharge and runoff volume) of the contributing drainage area to selected culverts with *ArcHydro* and *HEC-HMS*.

- Develop a NM statewide bulking factor (*BF*) correlation based on a single event soil loss equation (*MUSLE*) and watershed attributes that can be used in the design of drainage structures (culverts).

- Bulking factor (*BF*) for culvert design:

  - *BF* = function of clean water and sediment load

    - *BF* > 1 means that a larger culvert would be required compared to the culvert design for clean water flow

    - *BF* = 1.5 represents mud flow

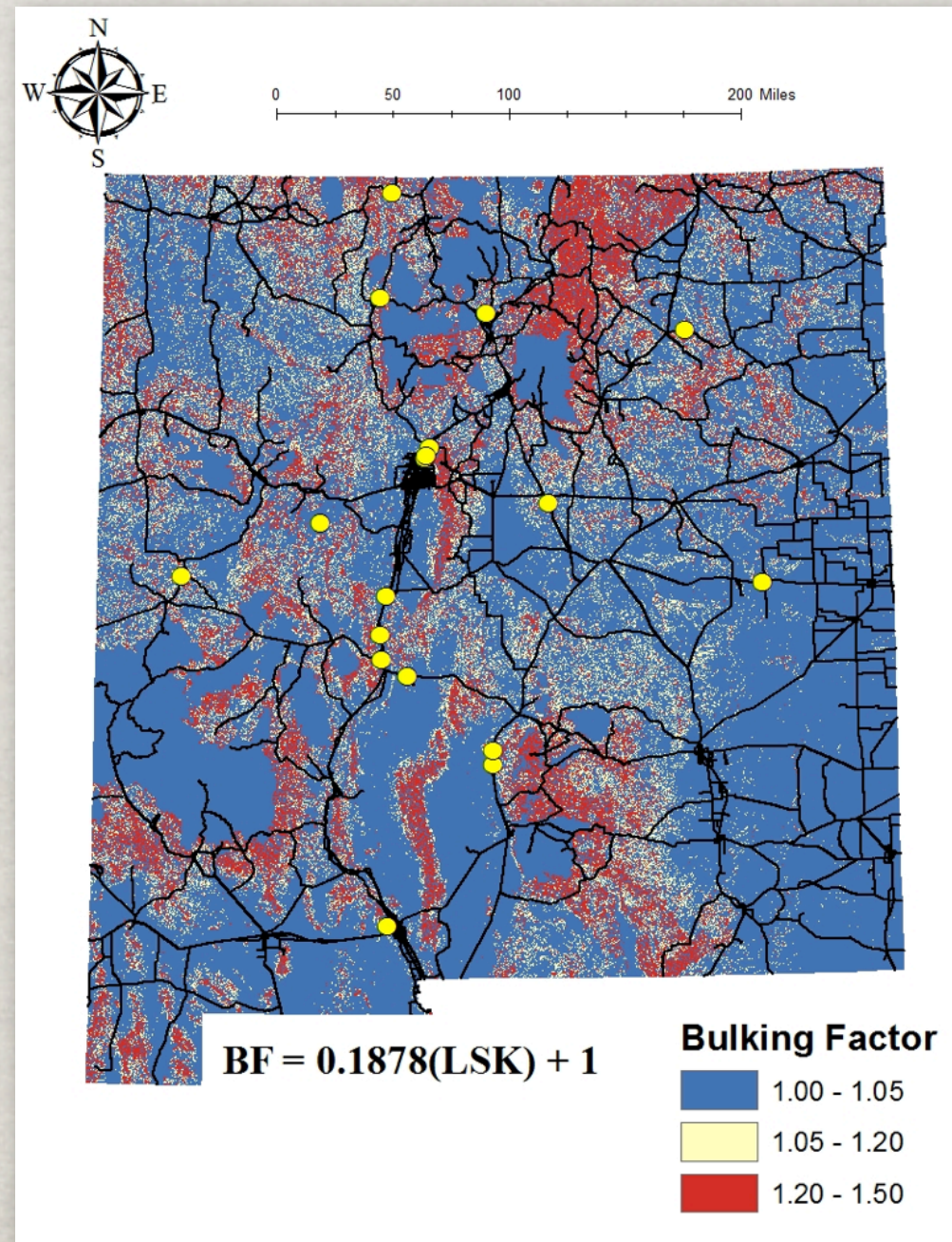# Statewide Maps for Specific Attributes
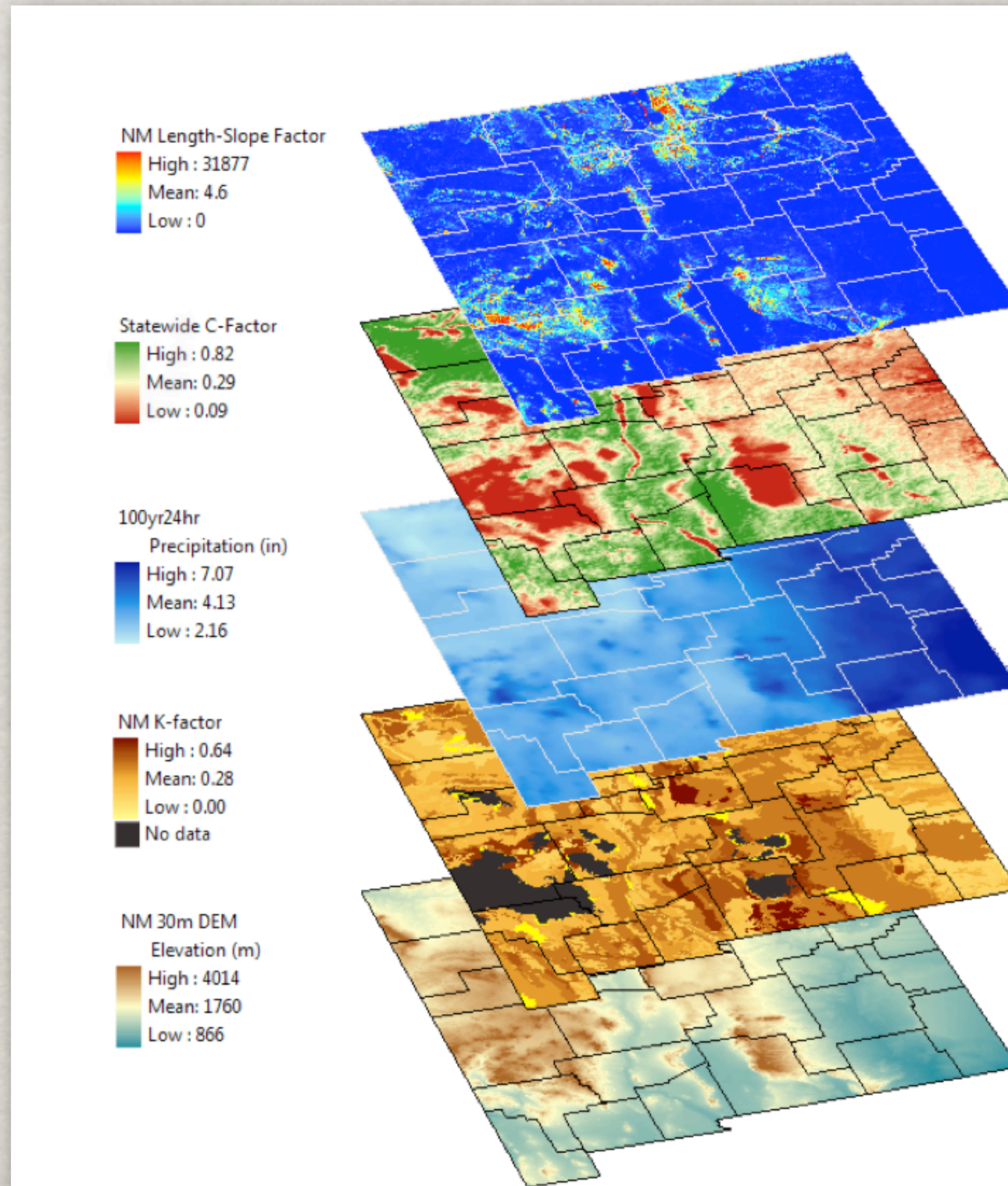
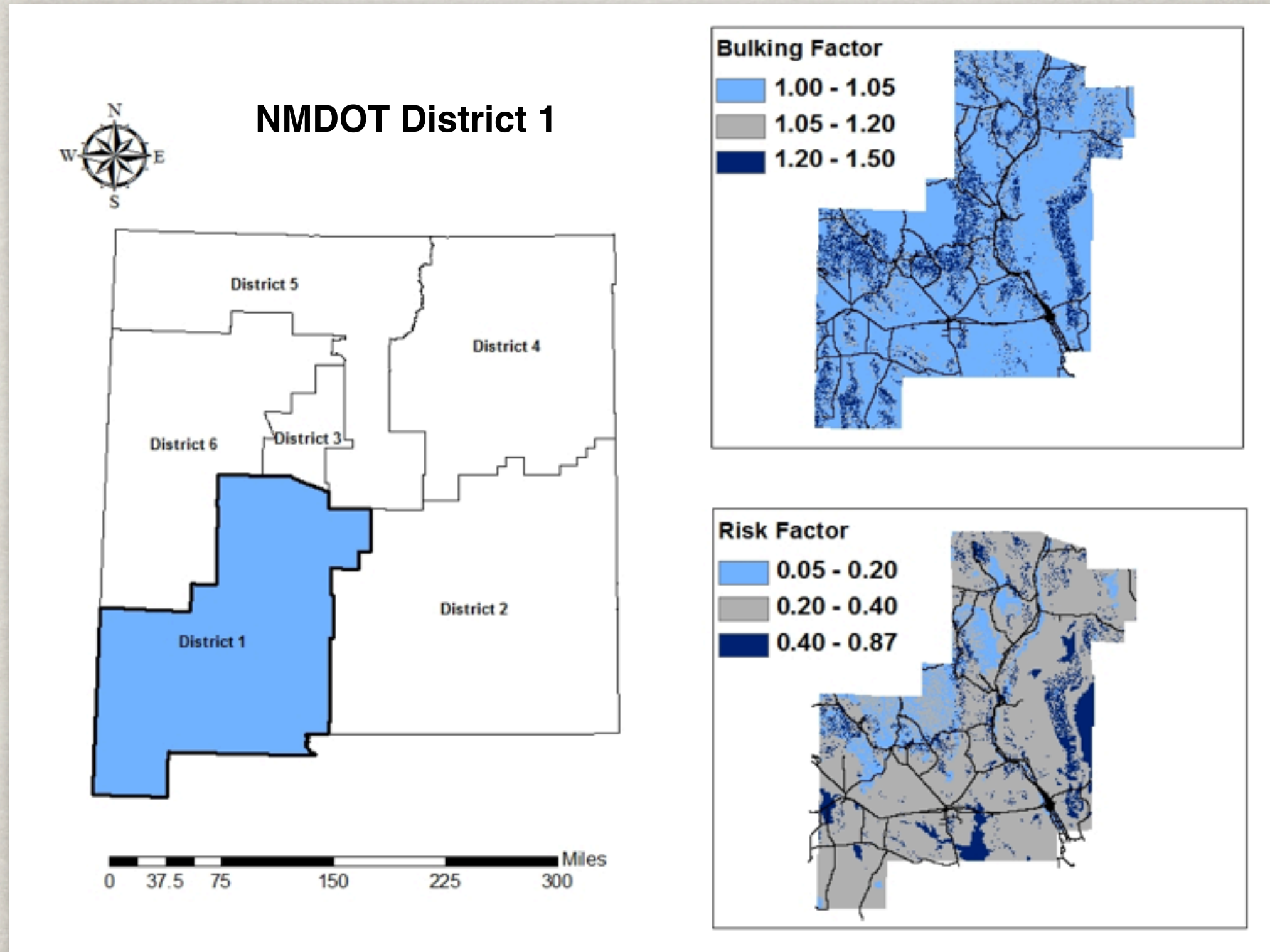# NM Erosion Risk Distribution using *FuzzyCell*
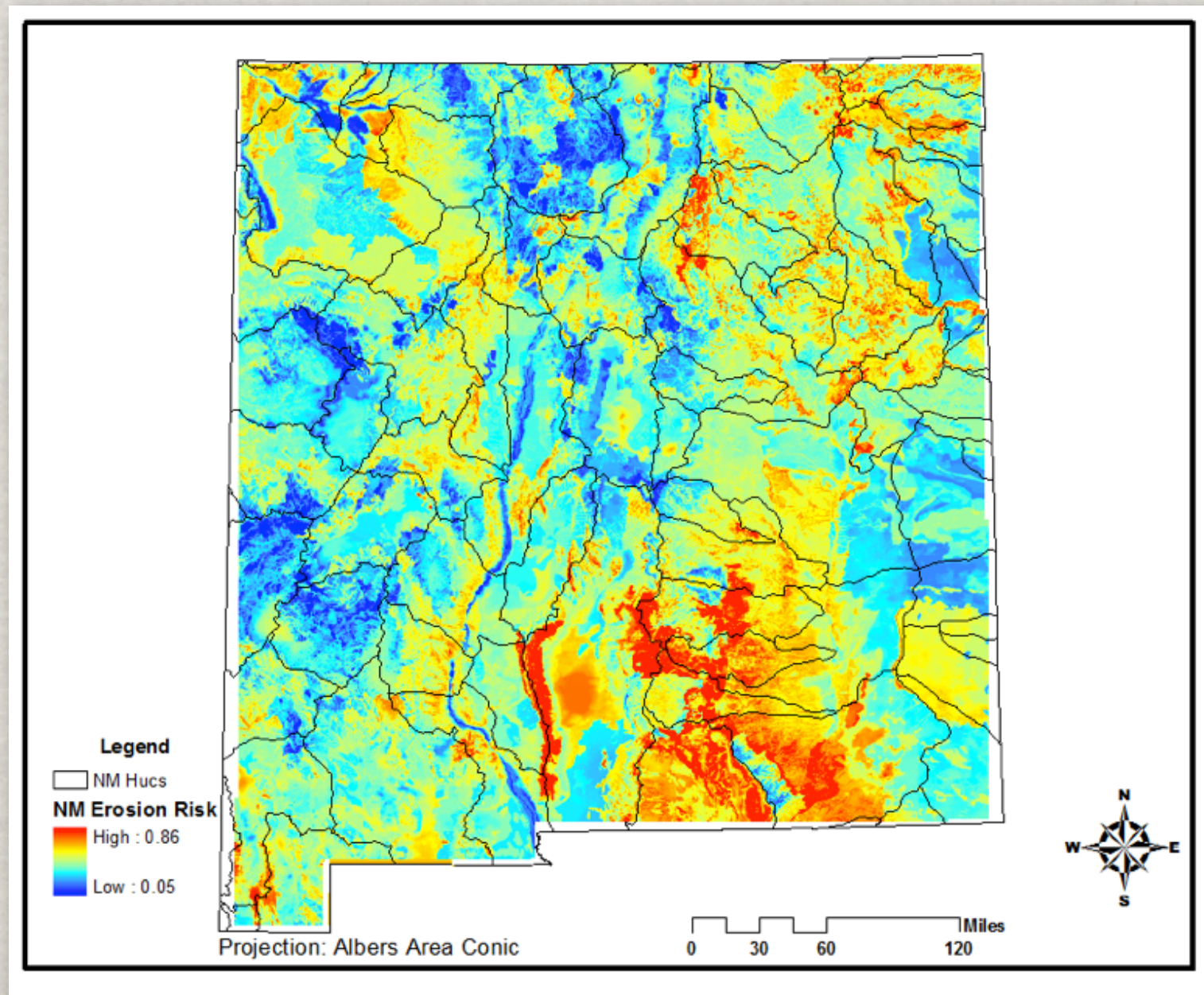
New Mexico statewide erosion risk map developed using specific attribute maps and fuzzy logic routines.

Bulking Factor Map
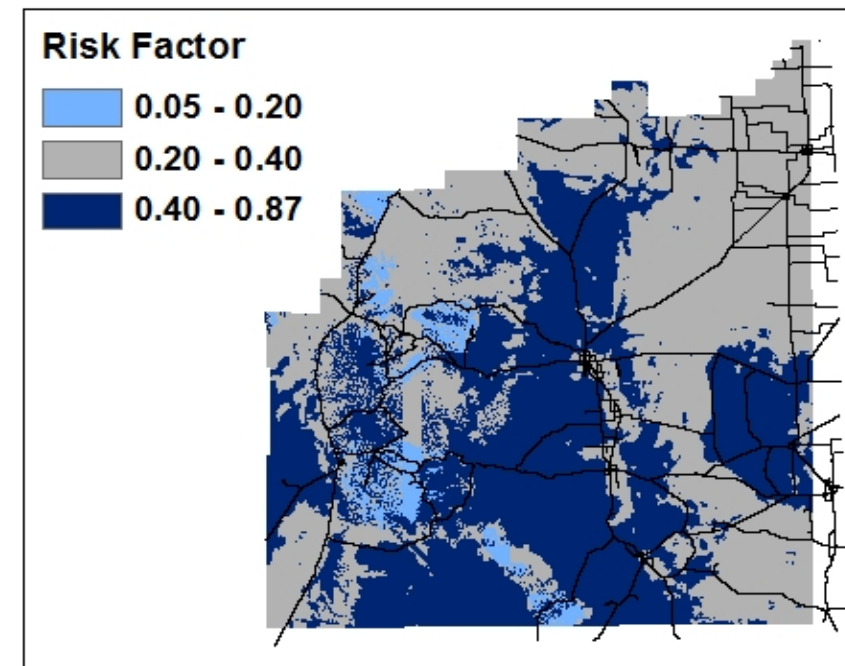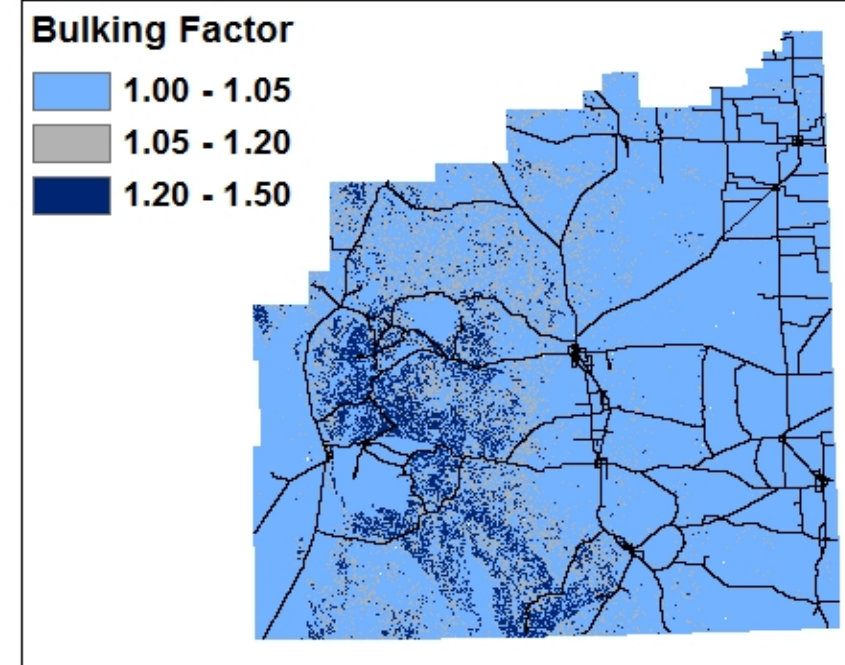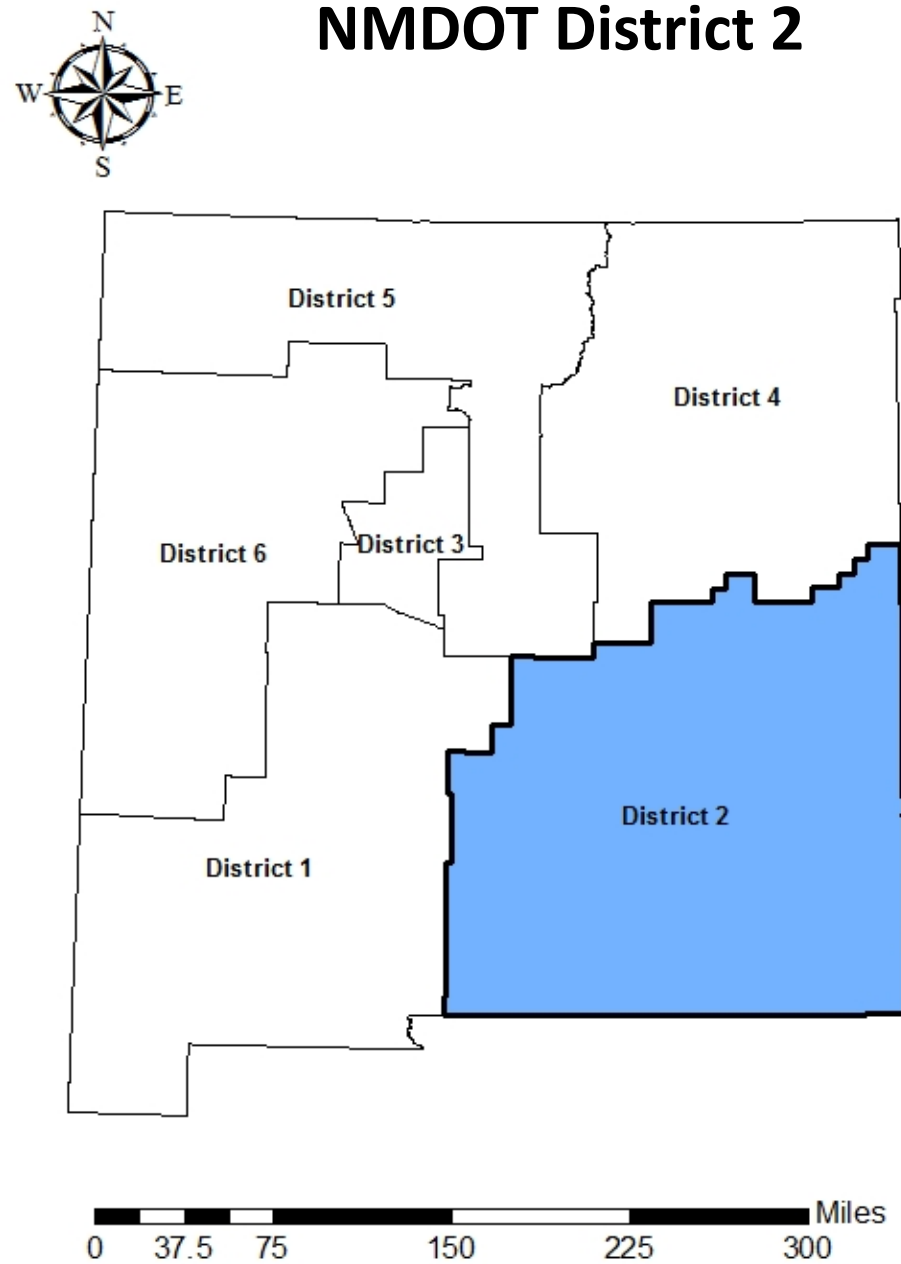# (Linear Correlation with 1-D LS Factor)

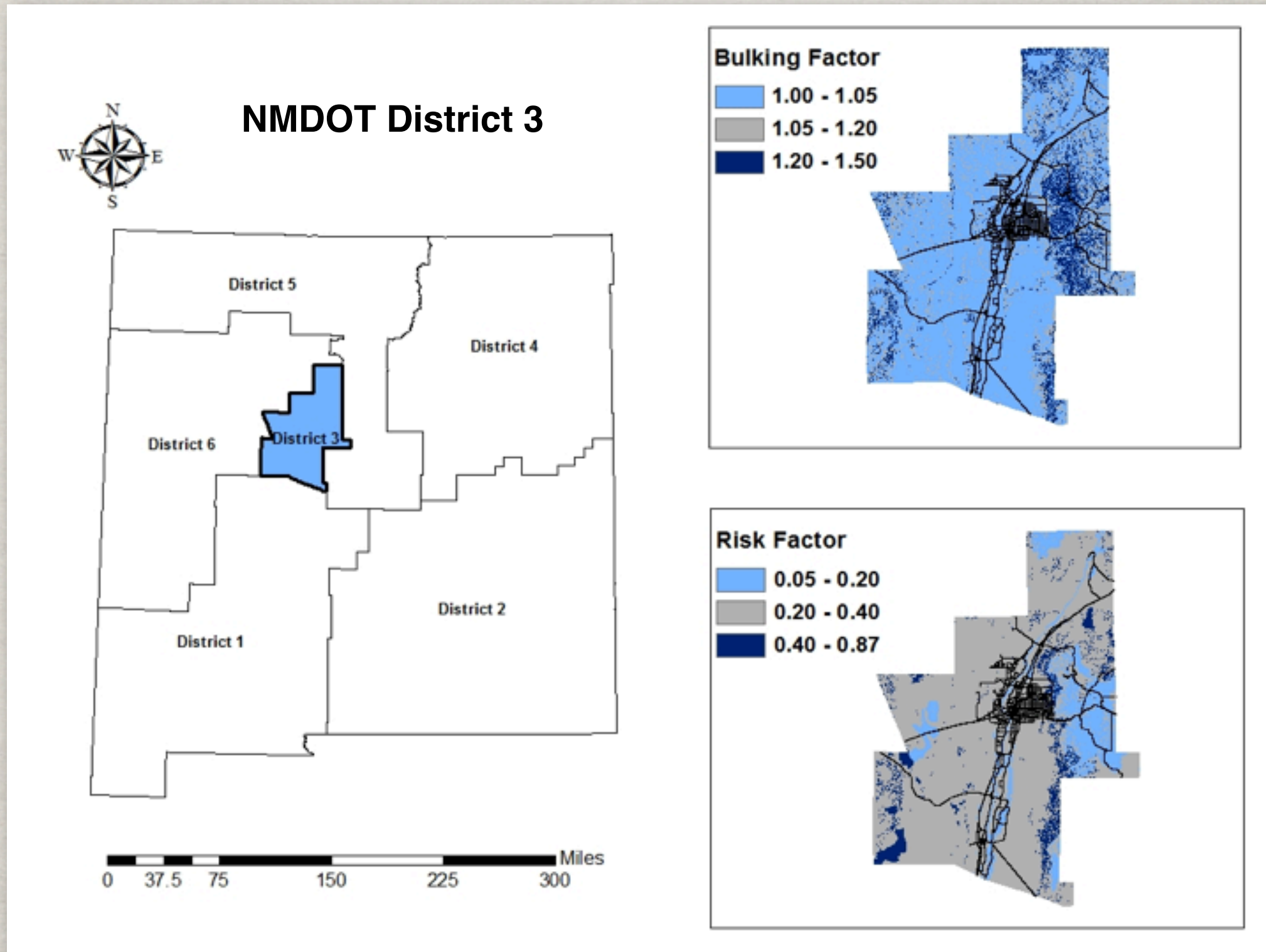The bulking factor (BF) map was generated using a 1-D *LS*-factor and *K*-factor linear relationship.

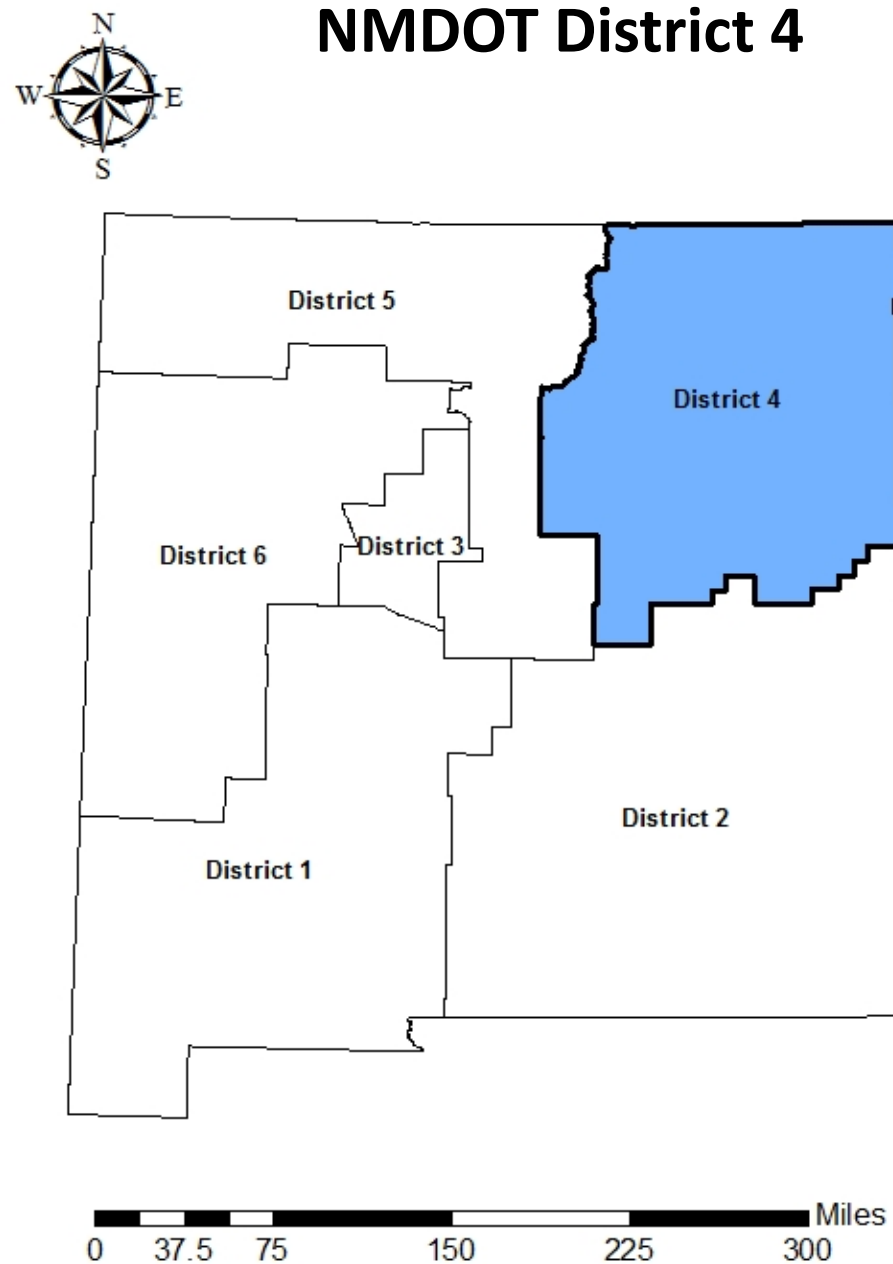# Bulking Factor and Risk Maps for NMDOT District 1

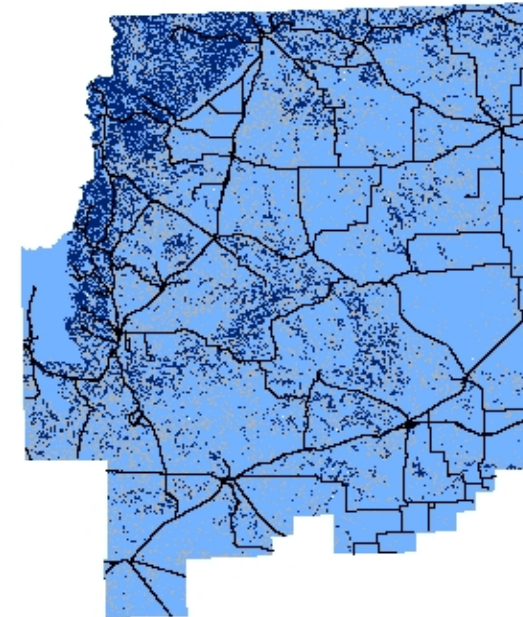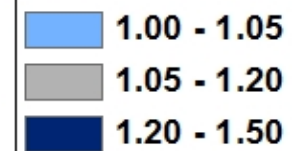# Bulking Factor and Risk Maps for NMDOT District 2

Bulking Factor and Risk Maps for NMDOT District 3

Bulking Factor and Risk Maps for NMDOT District 4

Bulking Factor and Risk Maps for NMDOT District 5
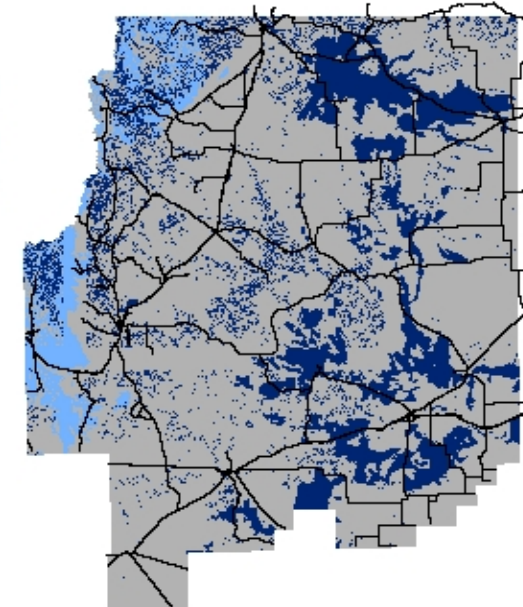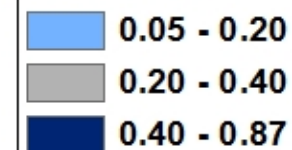
Bulking Factor and Risk Maps for NMDOT District 6
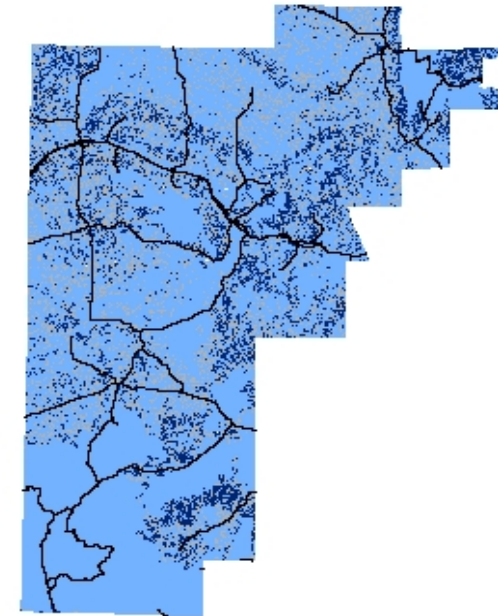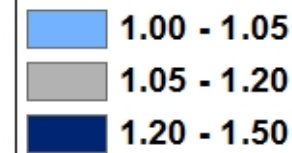
Case Study

Catron County NM 36, MP 12.5

Buried Culvert, Catron County NM 36, MP 12.2

Upstream Watershed

Buried 10-ft Diameter Corrugated Steel Culvert

Catron County, NM 36, MP 12.2 – Culvert Inlet

When this field site was visited on 9/29/2011, NMDOT personnel were in the process of cleaning the culvert.

Catron County, NM 36, MP 12.2 – Culvert Outlet

View of Culvert Downstream

Highway 36, Mile Post 12.2

Watershed Attributes HWY36 MP12.5

TOC	0.46	hrs
100P24	2.98	In
25P24	2.32	In
Qp100	7.42	m^3/s
Qp25	4.99	m^3/s
CN	75	

Watershed Area

2008 ft

© 2011 Google
Image © 2011 DigitalGlobe
© 2011 INEGI
Image NMRGIS

Google

Imagery Date: Jul 1, 2005   lat 34.493050° lon -108.389628° elev 7205 ft   Eye alt 26590 ft
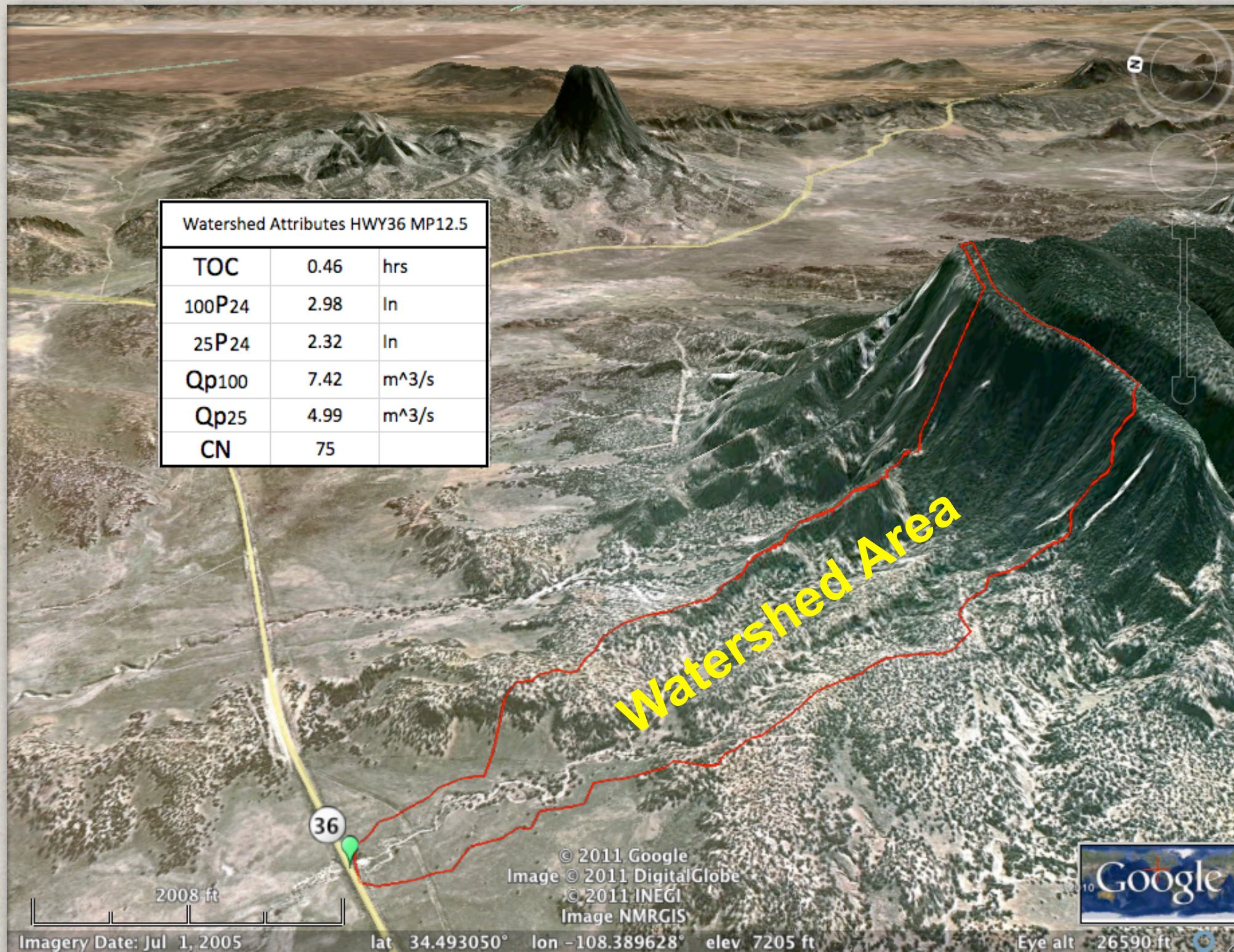
Precipitation Data for Catron County NM-36, MP 12.2
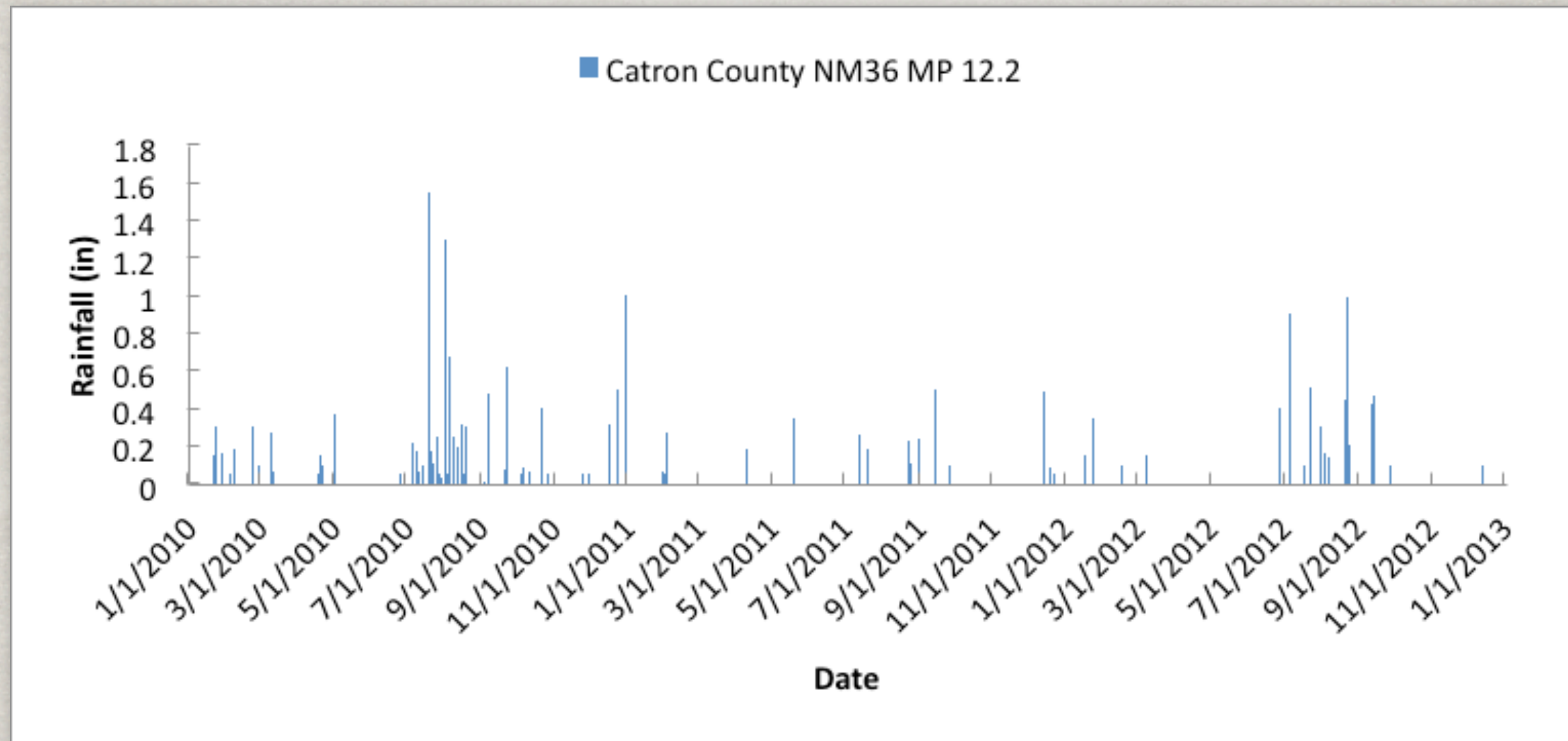
Precipitation data can vary widely within New Mexico, and it is often characterized by high intensity, short duration events.

Bulking and Risk Factors for District 1
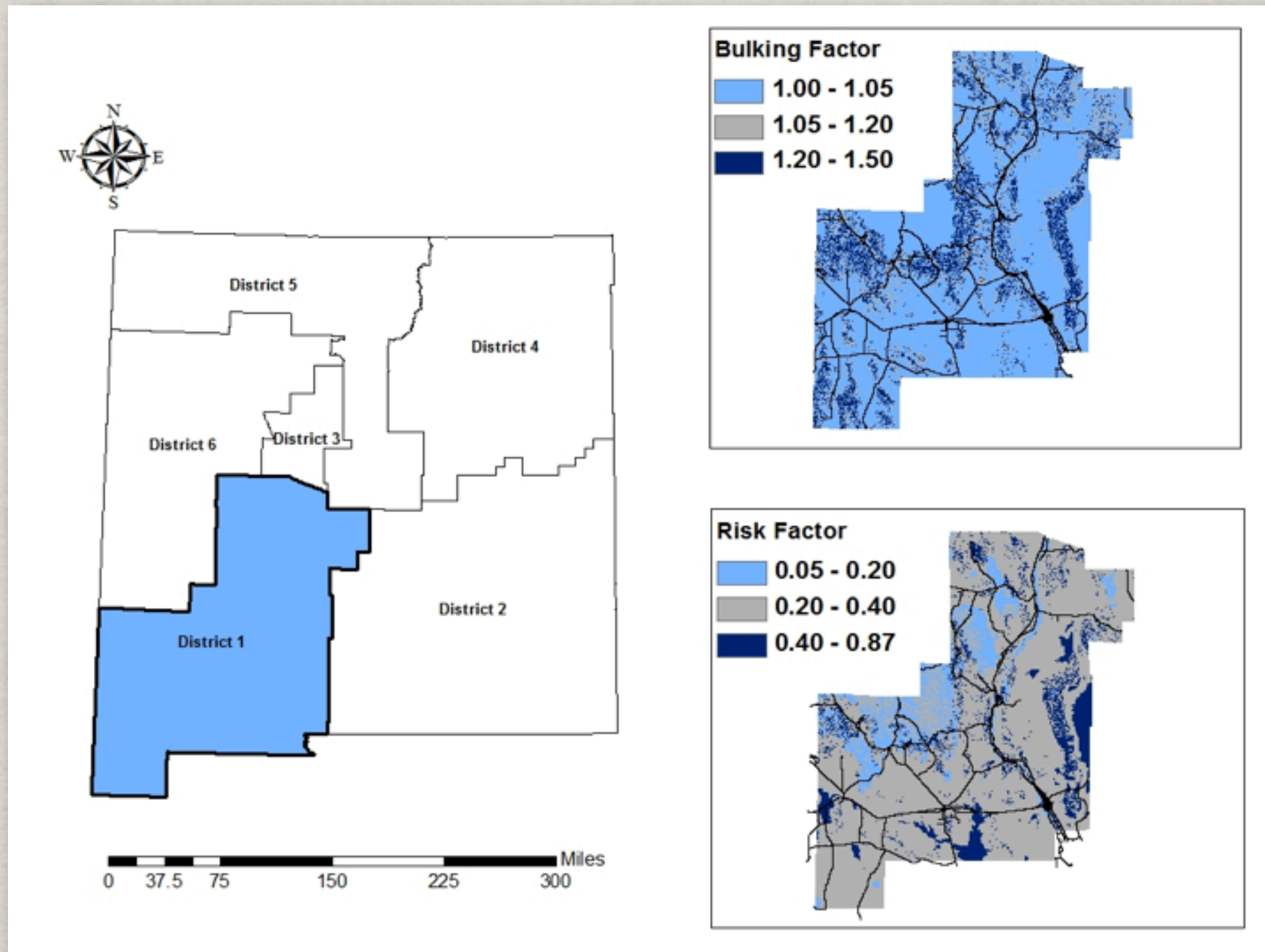
Bulking and Risk Factors for Catron County

Bulking Factor

- 1.00 - 1.05
- 1.05 - 1.20
- 1.20 - 1.50

Catron County - Hwy 36, MP 12.2
Bulking Factor and Risk Maps

Risk Factor

- 0.05 - 0.20
- 0.20 - 0.40
- 0.40 - 0.87

0   0.45   0.9   1.8 Miles
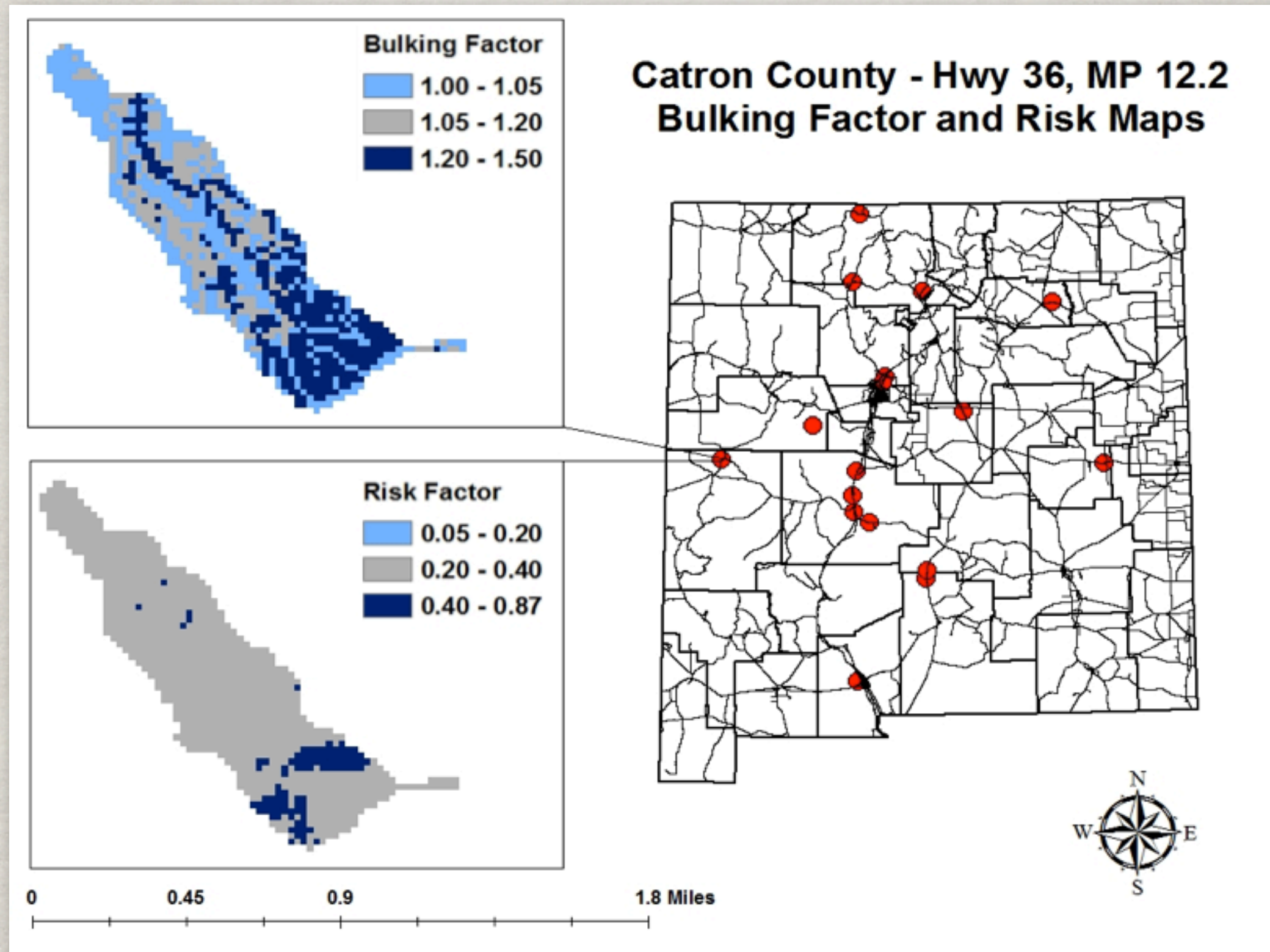
Catron County – Bulking Factor, Risk Factor and Slope
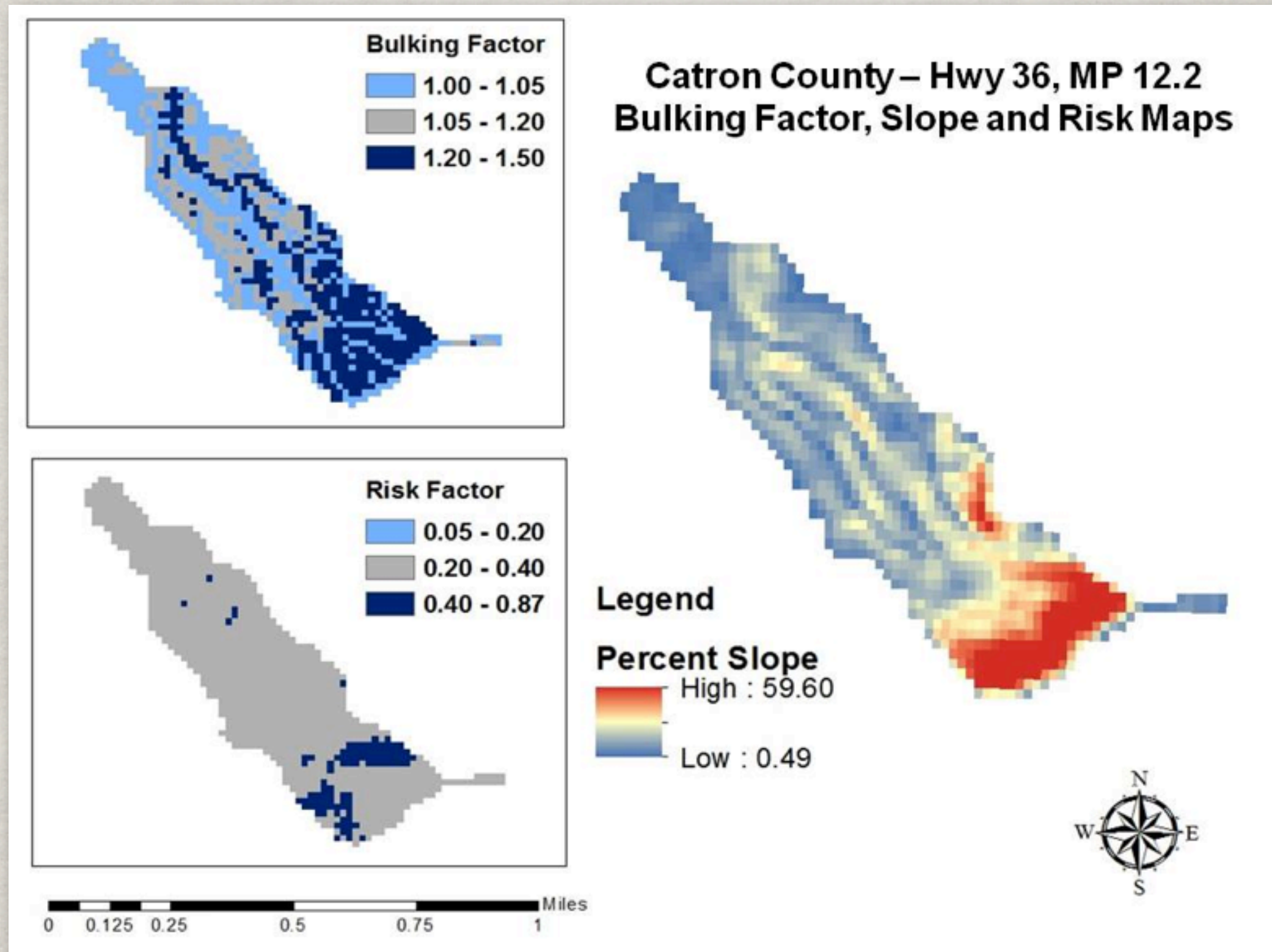
Culverts with Adverse Grades – Hwy. 36 CMP Culvert, MP 12.2

Some culverts in this study had adverse grades, which contributed to soil aggradation.

Conclusions

- Use of *ArcGIS*® is indispensable for this type of study, providing a large variety of toolsets necessary to combine and relate extensive amounts of data. Collectively, the data obtained and/or generated can be used for investigation, calculation, and the ultimate characterization of a wide range of watershed attributes pertaining to soil erosion, sediment transport, and deposition phenomena. Virtually any given watershed location with assessable and/or derivable GIS data can be analyzed physiographically using the methodologies employed and/or developed in this study.

Conclusions

- Correlations between the calculated bulking factor (*BF*) and various watershed attributes were investigated. Based on average watershed attributes of *LS* and *K*, a linear regression equation was developed and a statewide raster map of *BF* was generated.

Recommendations

- Additional field verification for the *BF* regression could prove useful for refinement of a statewide bulking factor map.

- Given time and effort, additional watershed sites can be investigated using this methodology. With additional data and proper field verification, use of a statewide bulking factor map based on a physiographic approach could become standard practice for design of drainage structures.

- A larger watershed dataset, however, is required to verify the observed trends and correlations. The preliminary bulking factor map and other statewide GIS attributes should be used to identify additional watershed sites for evaluation based on the magnitude of *BF*, *LS*, *K*, and perhaps *C*, instead of using random watershed selection.

Recommendations

- With more data points, extensive field verification, higher resolution data, and additional investigation of sediment transport and deposition related trends and attributes, a deeper understanding of factors directly and indirectly contributing to drainage structure clogging may be realized. A field verified bulking factor and soil erosion map would allow for prediction of high-risk areas prone to sediment accumulation from upstream soil erosion and provides a means to adjust the hydraulic design capacity of new, potentially impacted, drainage structures.