FUNCTIONAL SOIL MAPS

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Soil Survey – Illustrates soil structural/visual differences

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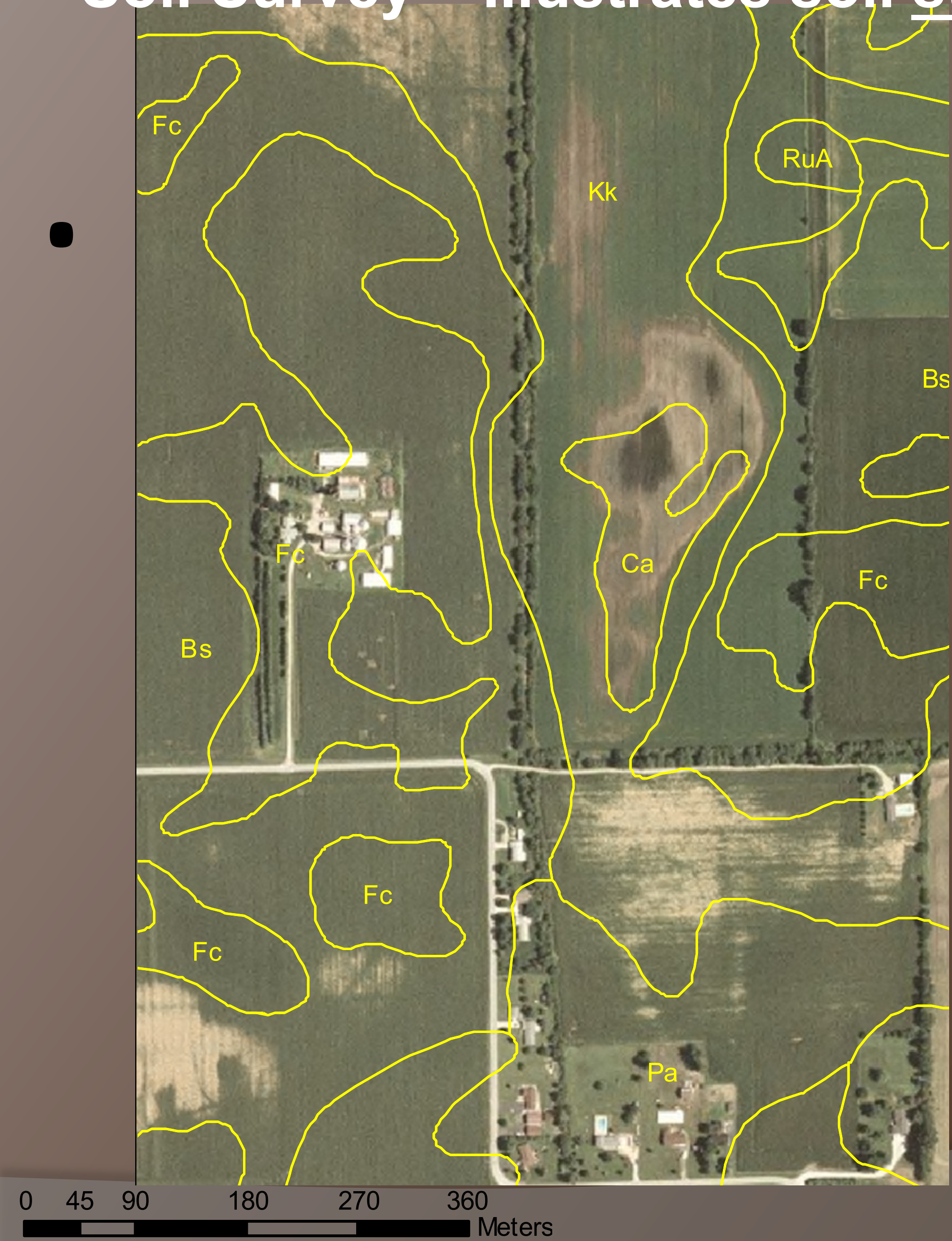


Fc – Fincastle: Fine-silty, mixed, superactive, mesic Aeric Epiaqualfs

Bs – Brookston: Fine-Loamy, mixed, superactive, mesic Typic Argiaquolls

Kk – Kokomo: Fine, mixed, superactive, mesic, Typic Argiaquolls

Pa – Patton: Fine-silty, mixed, superactive, mesic, Typic Endoaquolls

Ca – Carlisle muck: Euic, mesic, Typic Haplosaprist

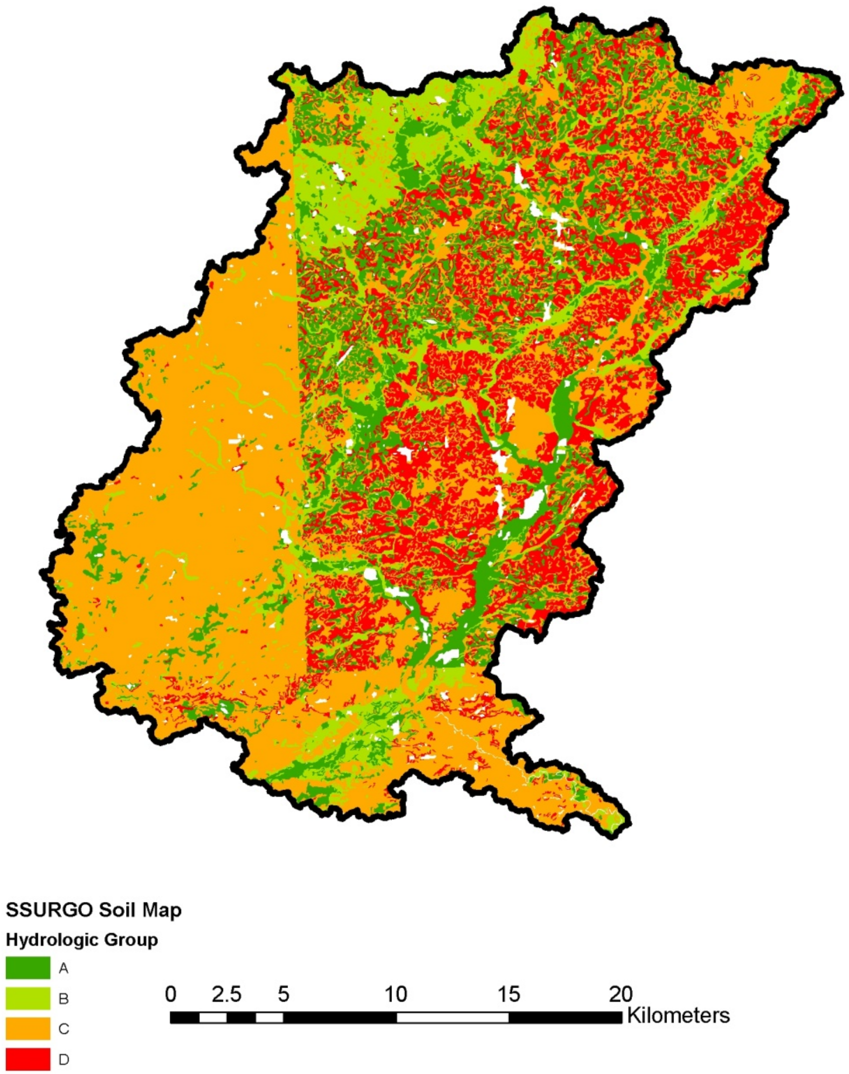
Limitations

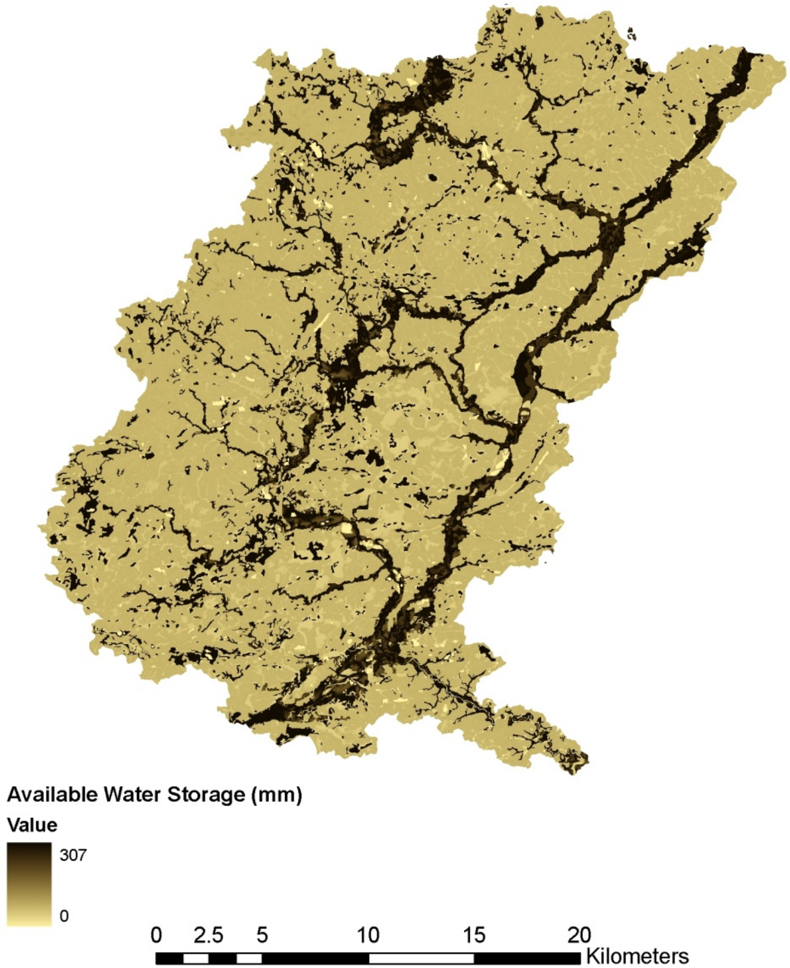
- Soil Survey has hard boundaries
- Up to 2 acres of inclusions
- Interpretations are not based on management
- Created using best available technology at the time

Soil Survey Disclaimer

- Warning: Soil Ratings Map may not be valid at this scale.
- You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:20,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale.
- Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

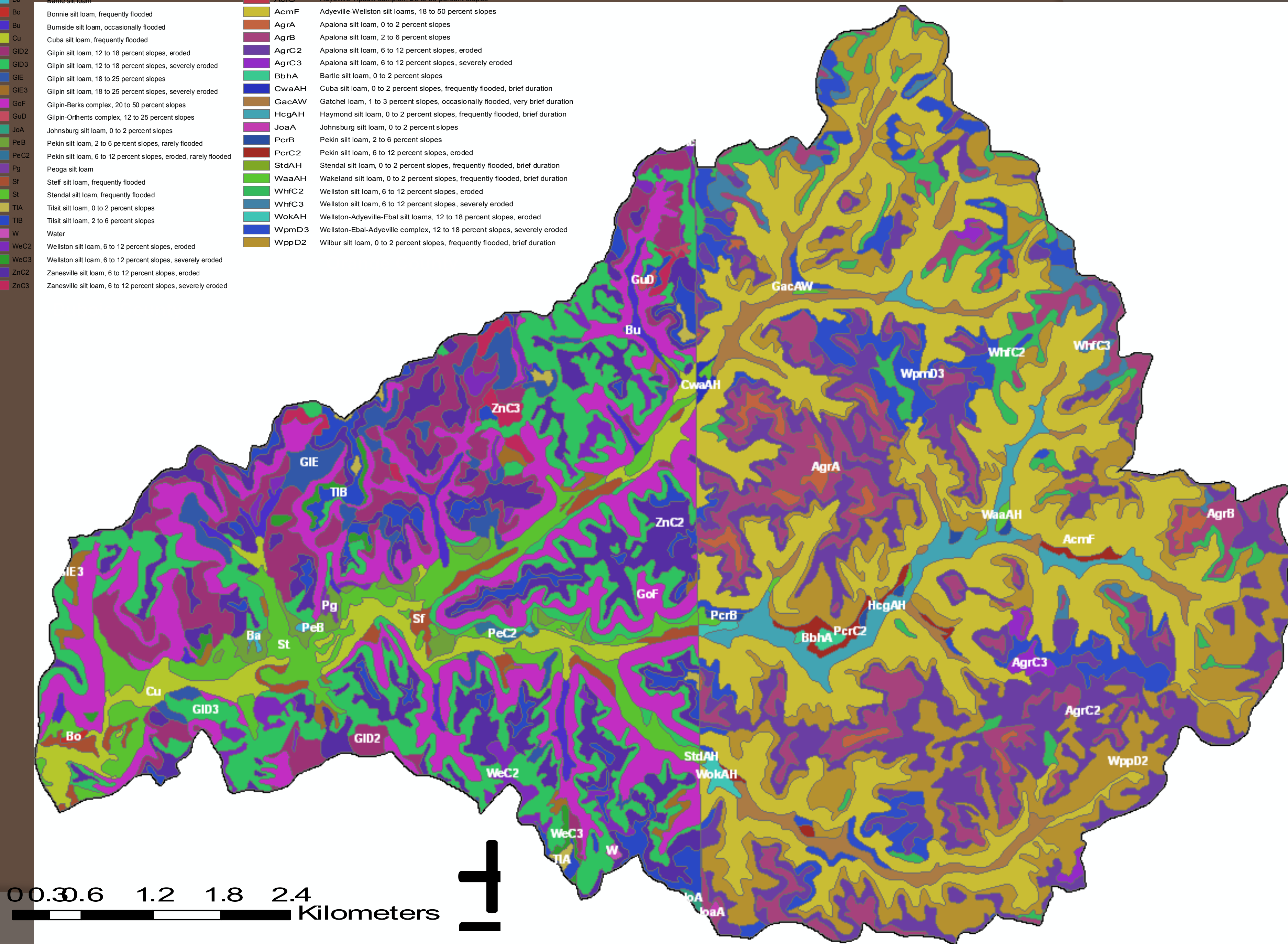
Cedar Creek Watershed (700 km^2)

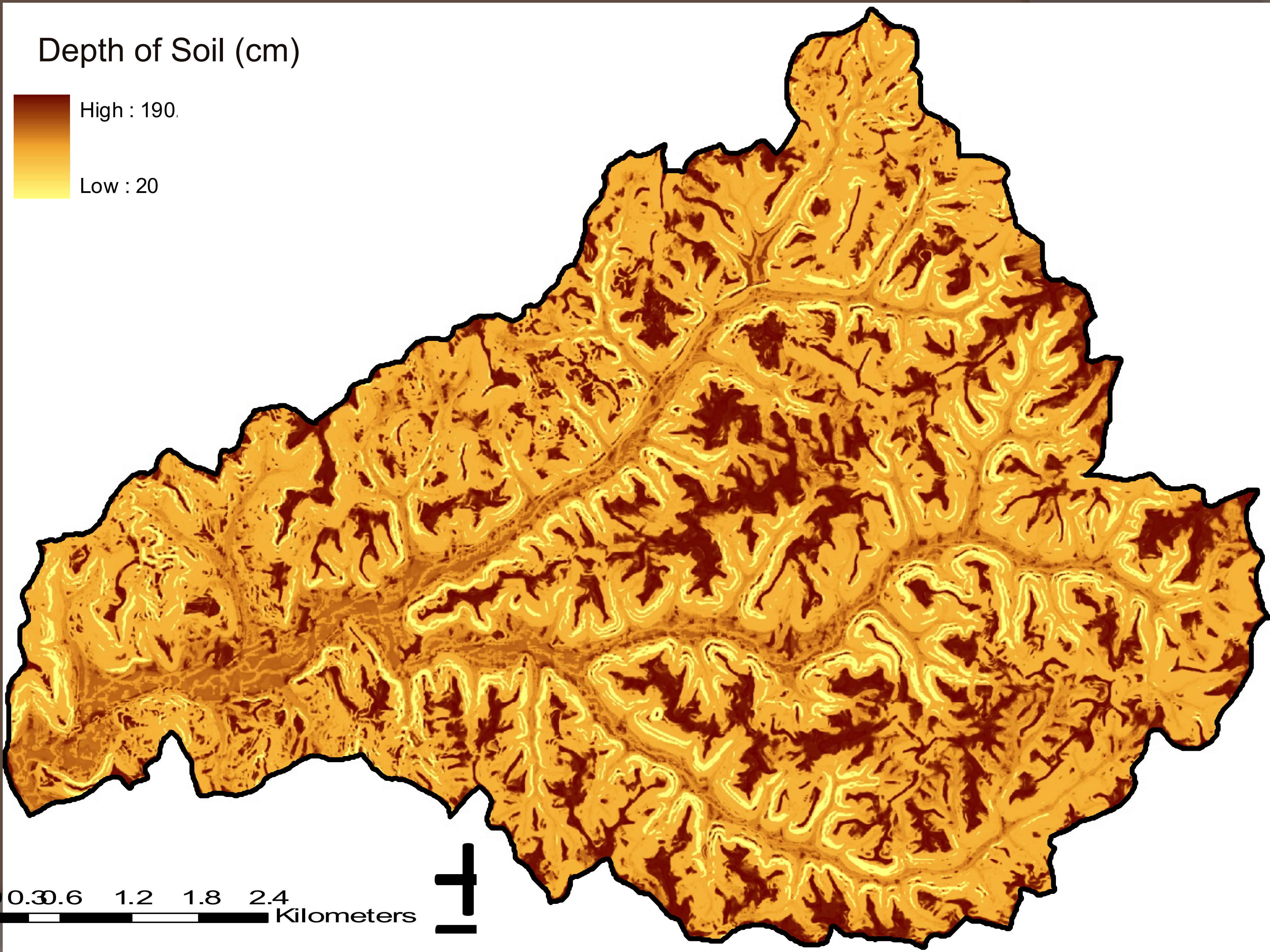




Symbol	Map Unit
Ba	Bartle silt loam
Bo	Bonnie silt loam, frequently flooded
Bu	Burnside silt loam, occasionally flooded
Cu	Cuba silt loam, frequently flooded
GlD2	Gilpin silt loam, 12 to 18 percent slopes, eroded
GlD3	Gilpin silt loam, 12 to 18 percent slopes, severely eroded
GlE	Gilpin silt loam, 18 to 25 percent slopes
GlE3	Gilpin silt loam, 18 to 25 percent slopes, severely eroded
GoF	Gilpin-Berks complex, 20 to 50 percent slopes
GuD	Gilpin-Orthents complex, 12 to 25 percent slopes
JoA	Johnsburg silt loam, 0 to 2 percent slopes
PeB	Pekin silt loam, 2 to 6 percent slopes, rarely flooded
PeC2	Pekin silt loam, 6 to 12 percent slopes, eroded, rarely flooded
Pg	Peoga silt loam
Sf	Steff silt loam, frequently flooded
St	Stendal silt loam, frequently flooded
TlA	Tilsit silt loam, 0 to 2 percent slopes
TlB	Tilsit silt loam, 2 to 6 percent slopes
W	Water
WeC2	Wellston silt loam, 6 to 12 percent slopes, eroded
WeC3	Wellston silt loam, 6 to 12 percent slopes, severely eroded
ZnC2	Zanesville silt loam, 6 to 12 percent slopes, eroded
ZnC3	Zanesville silt loam, 6 to 12 percent slopes, severely eroded

Symbol	Map Unit
AciG	Adyeville-Tipsaw complex, 20 to 60 percent slopes
AcmF	Adyeville-Wellston silt loams, 18 to 50 percent slopes
AgrA	Apalona silt loam, 0 to 2 percent slopes
AgrB	Apalona silt loam, 2 to 6 percent slopes
AgrC2	Apalona silt loam, 6 to 12 percent slopes, eroded
AgrC3	Apalona silt loam, 6 to 12 percent slopes, severely eroded
BbhA	Bartle silt loam, 0 to 2 percent slopes
CwaAH	Cuba silt loam, 0 to 2 percent slopes, frequently flooded, brief duration
GacAW	Gatchel loam, 1 to 3 percent slopes, occasionally flooded, very brief duration
HcgAH	Haymond silt loam, 0 to 2 percent slopes, frequently flooded, brief duration
JoaA	Johnsburg silt loam, 0 to 2 percent slopes
PcrB	Pekin silt loam, 2 to 6 percent slopes
PcrC2	Pekin silt loam, 6 to 12 percent slopes, eroded
StdAH	Stendal silt loam, 0 to 2 percent slopes, frequently flooded, brief duration
WaaAH	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded, brief duration
WhfC2	Wellston silt loam, 6 to 12 percent slopes, eroded
WhfC3	Wellston silt loam, 6 to 12 percent slopes, severely eroded
WokAH	Wellston-Adyeville-Ebal silt loams, 12 to 18 percent slopes, eroded
WpmD3	Wellston-Ebal-Adyeville complex, 12 to 18 percent slopes, severely eroded
WppD2	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration




Depth of Soil (cm)
High : 190.
Low : 20
0 0.3 0.6 1.2 1.8 2.4
Kilometers

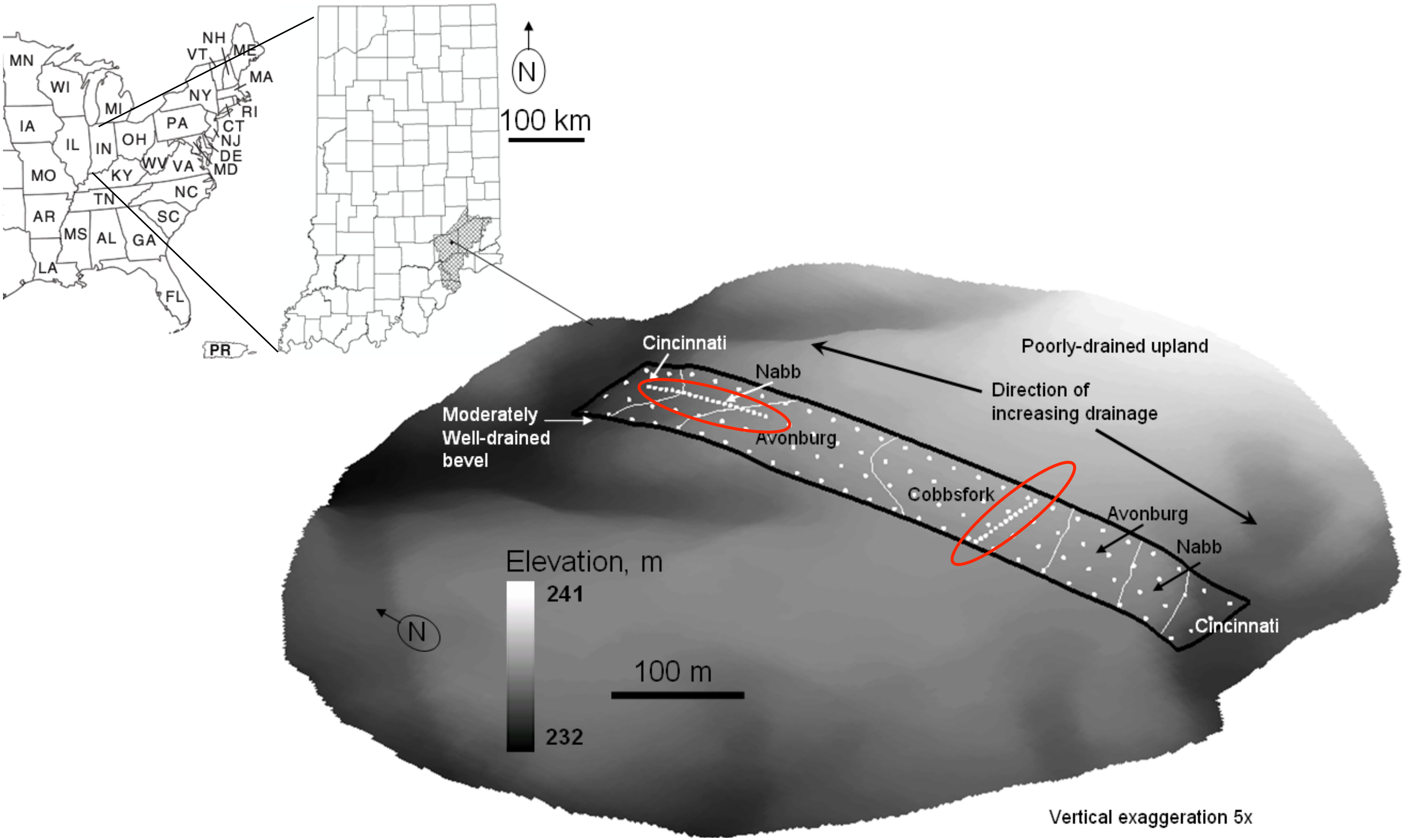
Validation

- Dillion Creek Watershed – 127 geo-referenced field observations
- Compared SSURGO RV predictions vs. measured: Average difference = 57 cm (22 inches)
- Compared Functional Map predictions vs. measured: Average difference = 22 cm (8 inches)

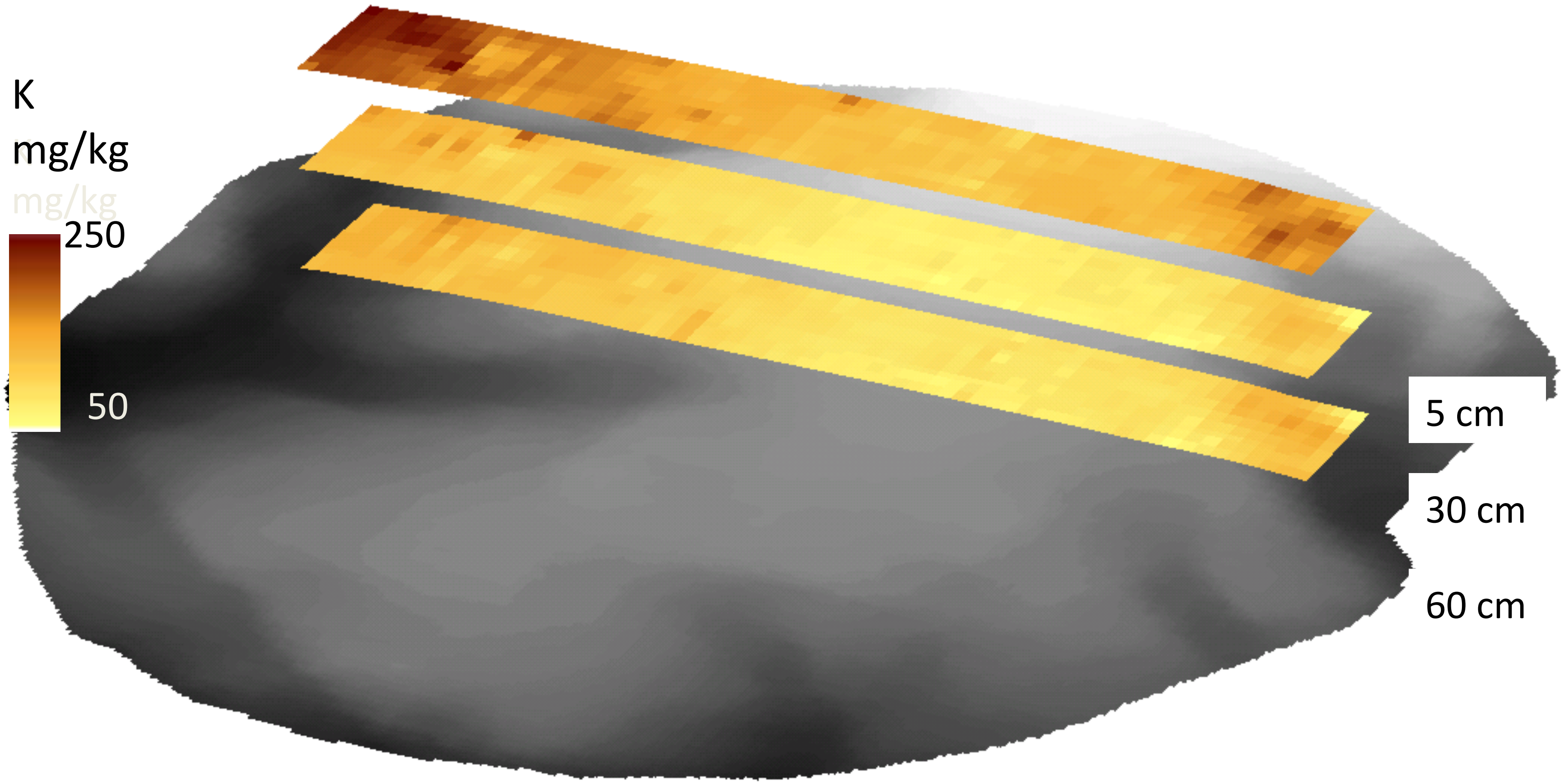
My Research Goal?

- Make soil maps that are useful and relate to soil function
- Utilize technologic advancements to achieve that goal

Potassium variability across a drainage catena



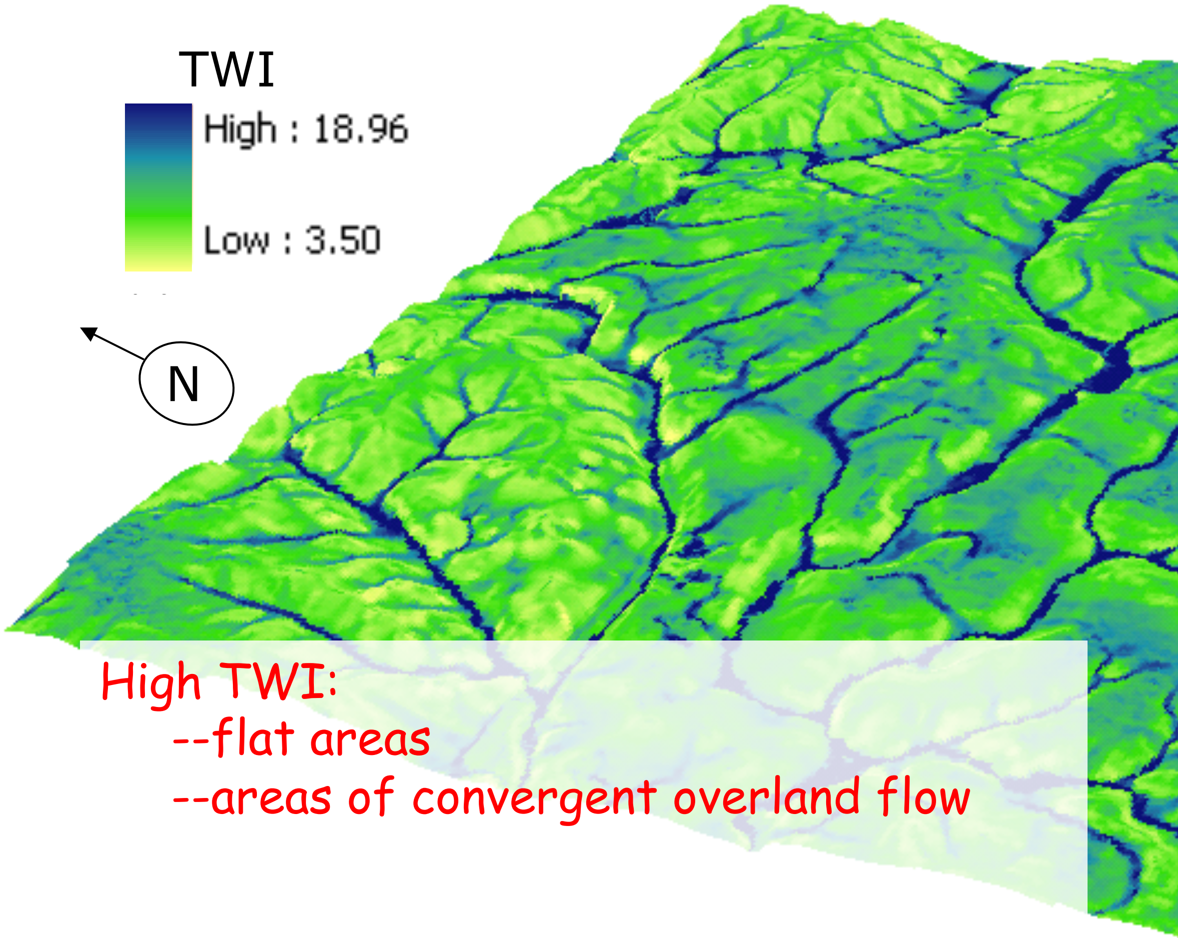
Exchangeable K

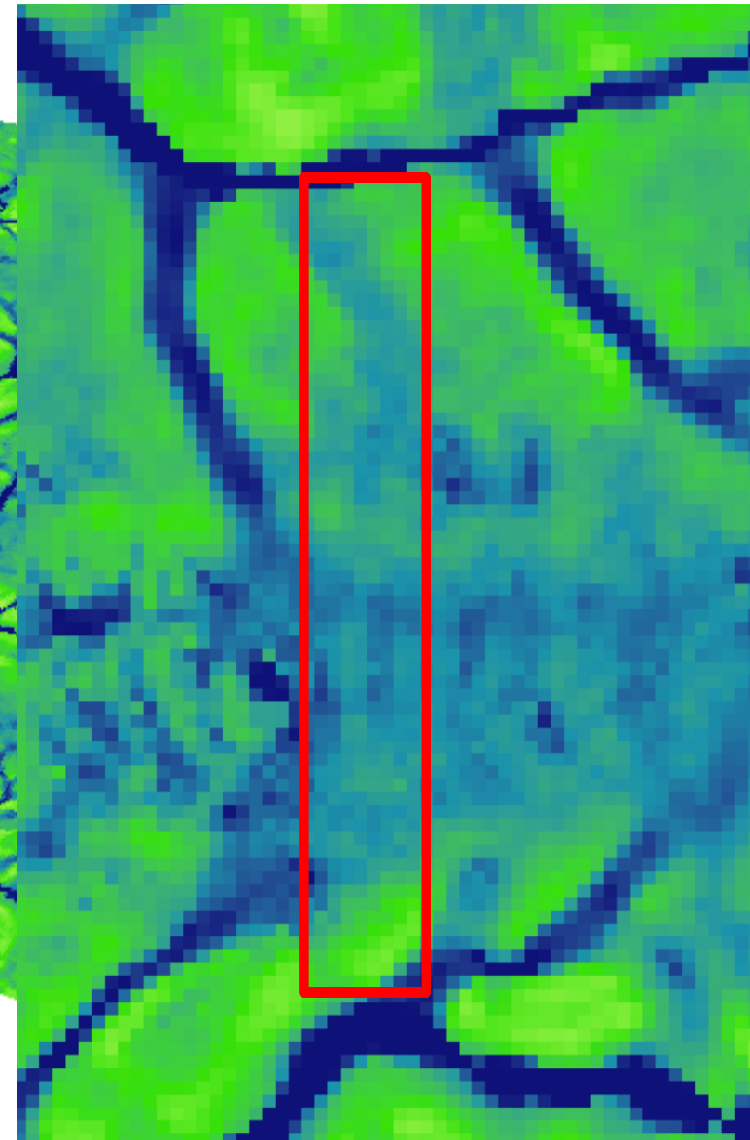


* - Need to sample approximately 30 m to capture variability

* - Soil properties were predictable by using topography

Topographical wetness index, TWI





High TWI:

--flat areas

--areas of convergent overland flow

- TWI = ln(a/tan(B)) (Quinn et al 1995).

Catena Concept – G.A. Milne, 1934

Soils follow repeatable patterns based on topography

DSM - Approach

- Soil State Model (Jenny, 1941)
- Five soil forming state factors:

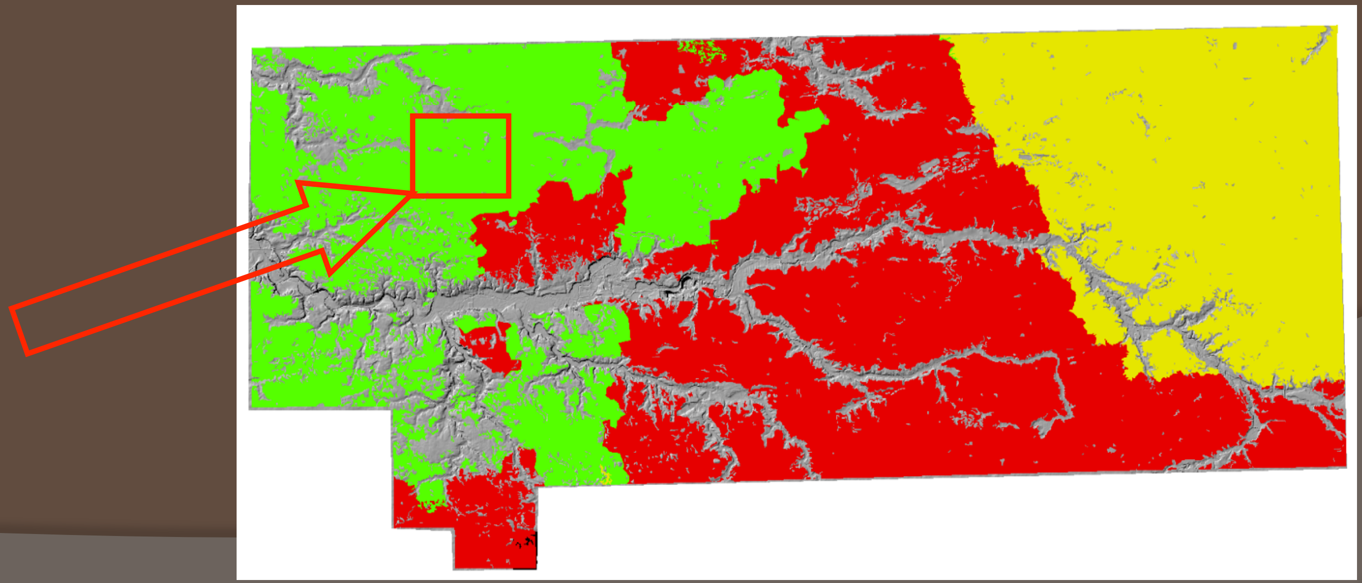
$$S = f(cl, o, r, p, t)$$

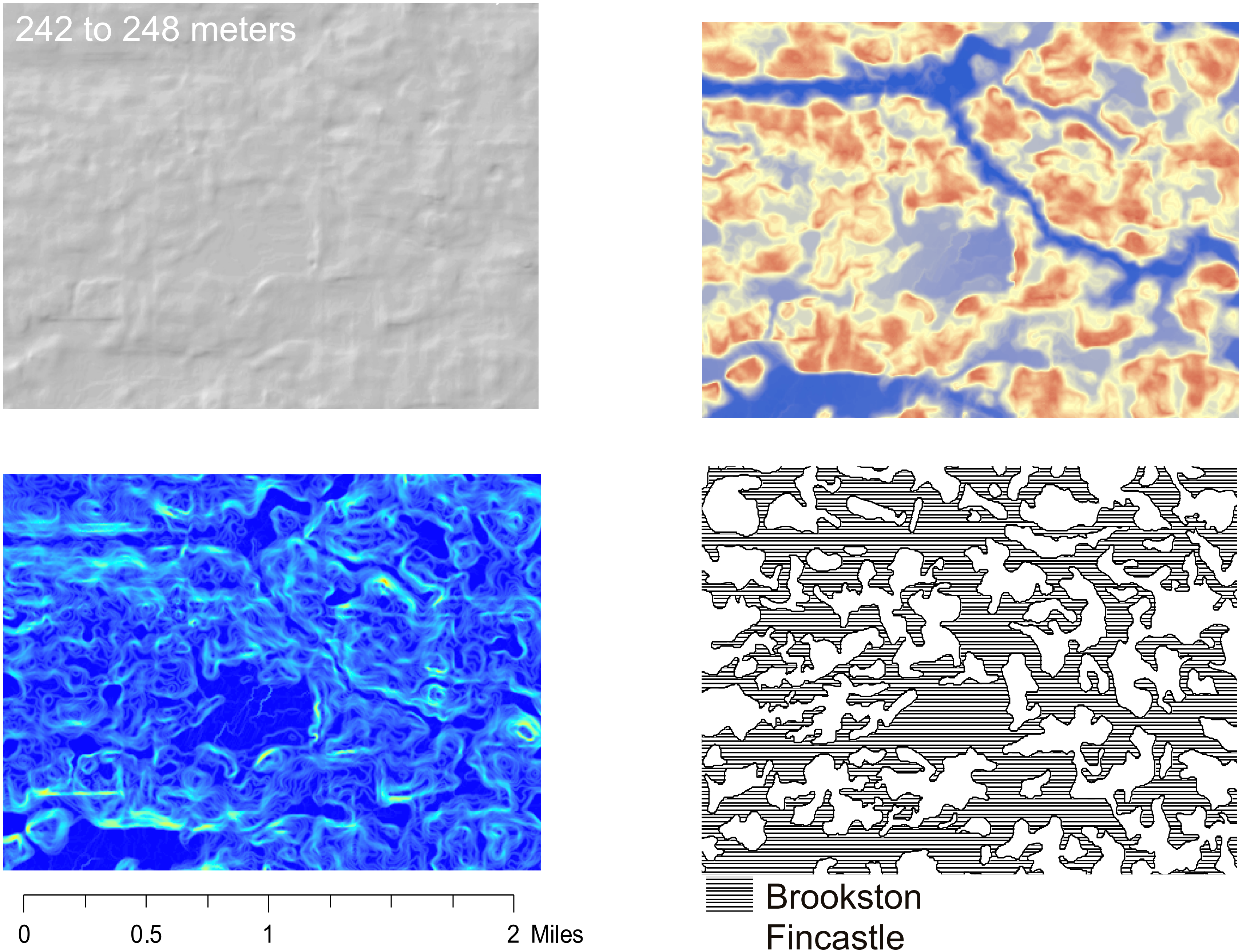
where:
cl = climate
o = organisms
r = relief (topography)
p = parent material
t = time

- Solve for one factor (**topography**) in Jenny's equation of the soil forming factors.

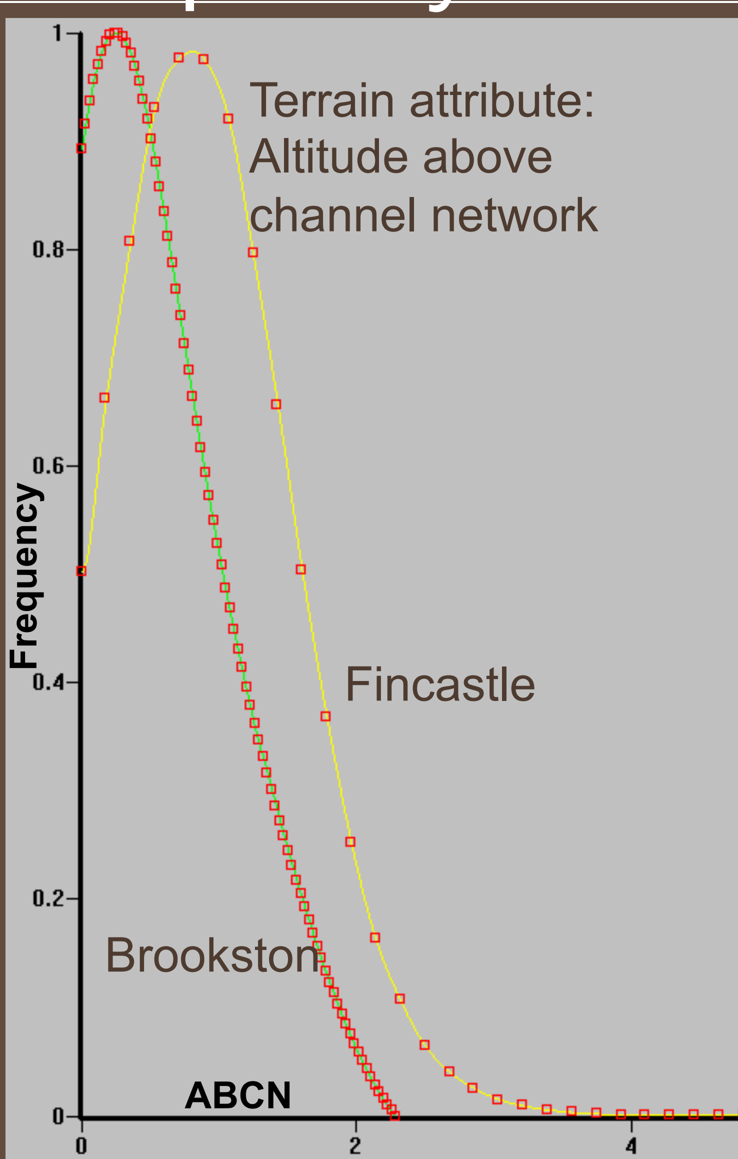
Example in Howard County, IN

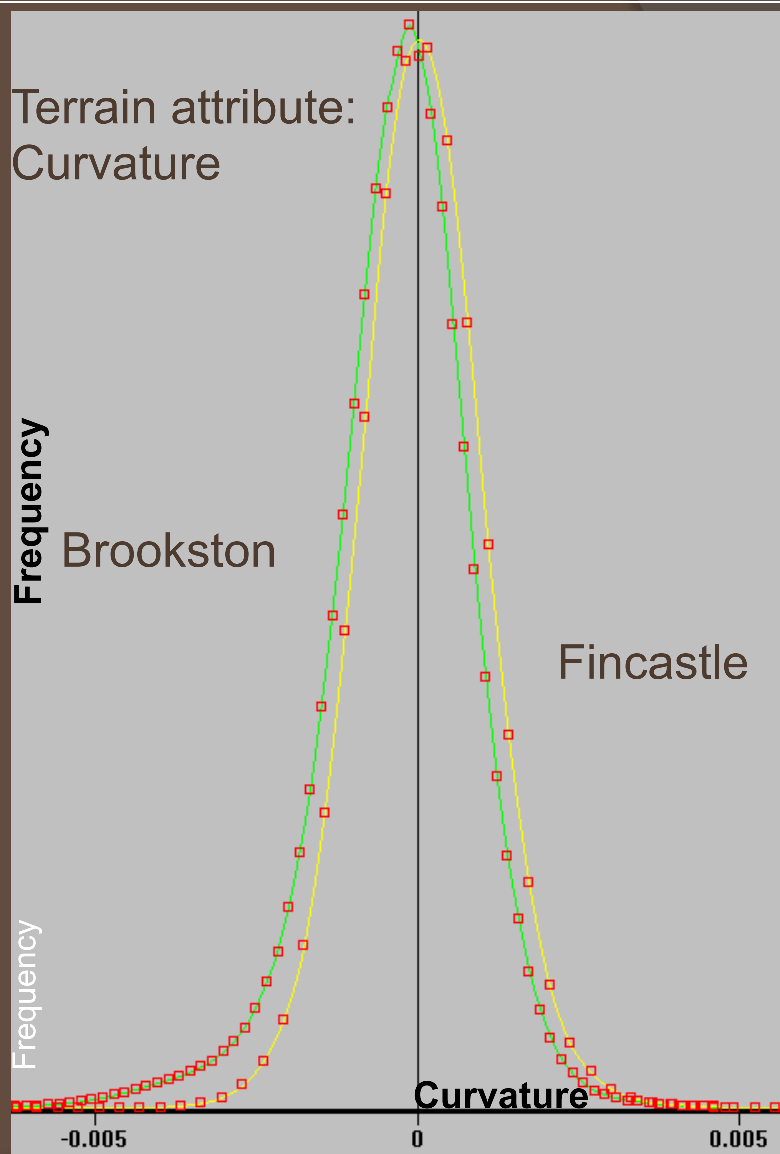
- 5 soils cover 80% of the land on Howard County
- Are there relationships between these 5 soils and terrain attributes?
- Can we use those relationships to improve the survey in an update context?




242 to 248 meters
0
0.5
1
2 Miles
Brookston
Fincastle

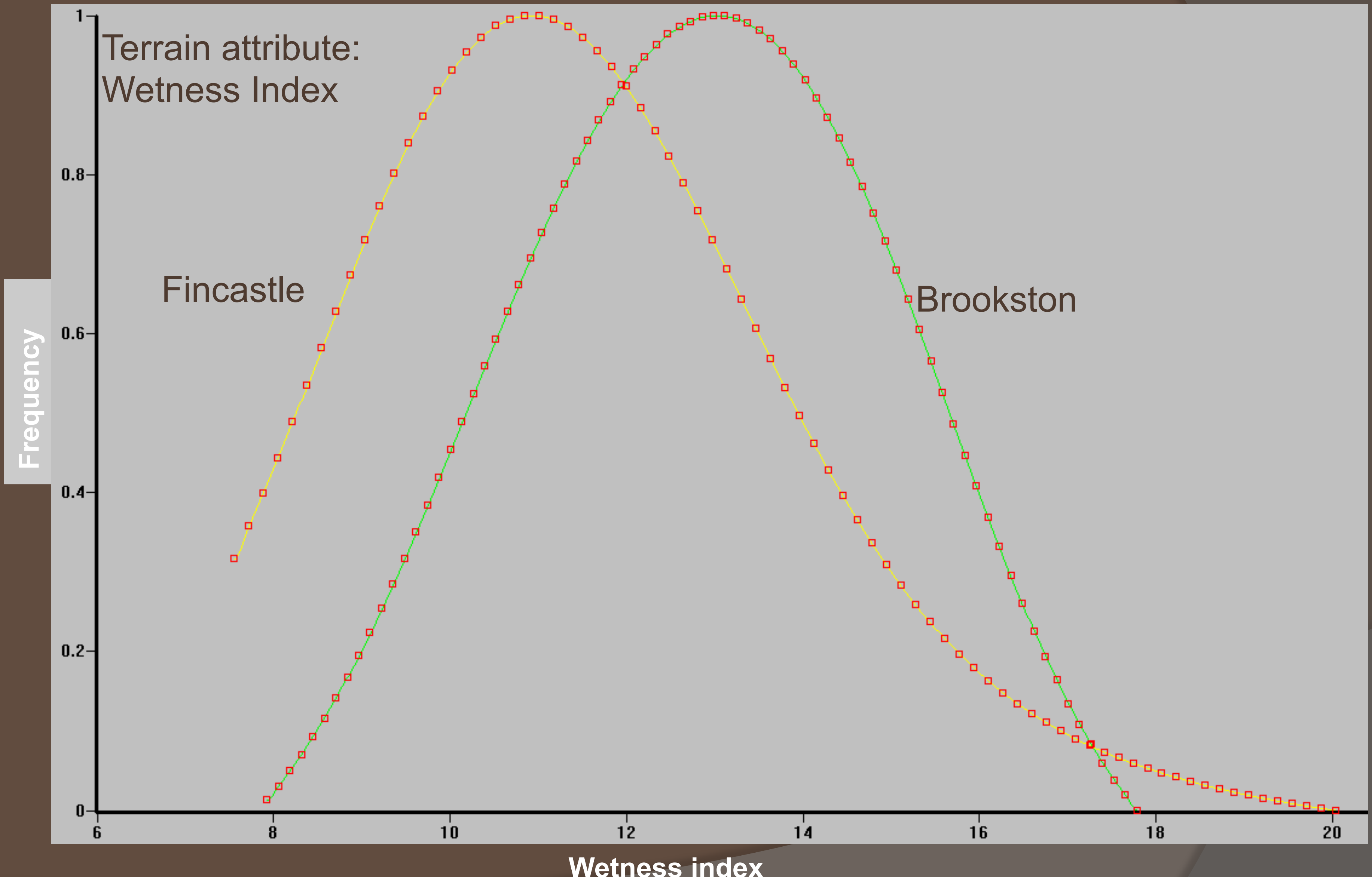
Frequency distributions





*Data extracted with Knowledge Miner Software

Frequency, Wetness Index



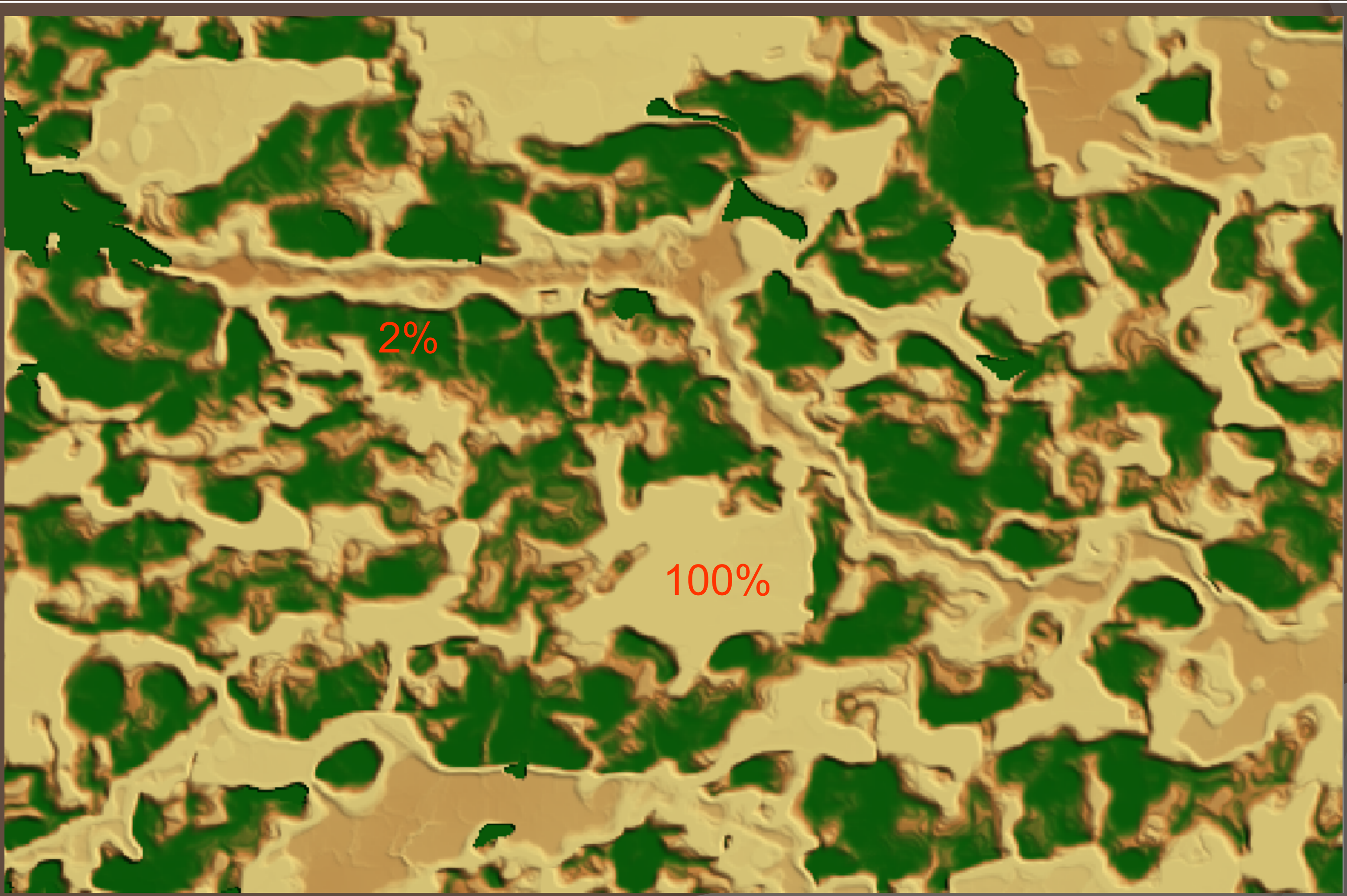
*Data extracted with Knowledge Miner Software

Formalize the Relationship

- Example:
- If the TWI = 14 then assign Brookston
- If TWI = 10 then assign Fincastle
- Other related terrain attributes (or other spatial data with unique numbers) can be used.
- That provides a membership probability to each pixel

Terrain-Soil Matching for Brookston

Fuzzy membership values (from 0 to 100%)



*Information derived from Soil landscape Interface Model (SoLIM)

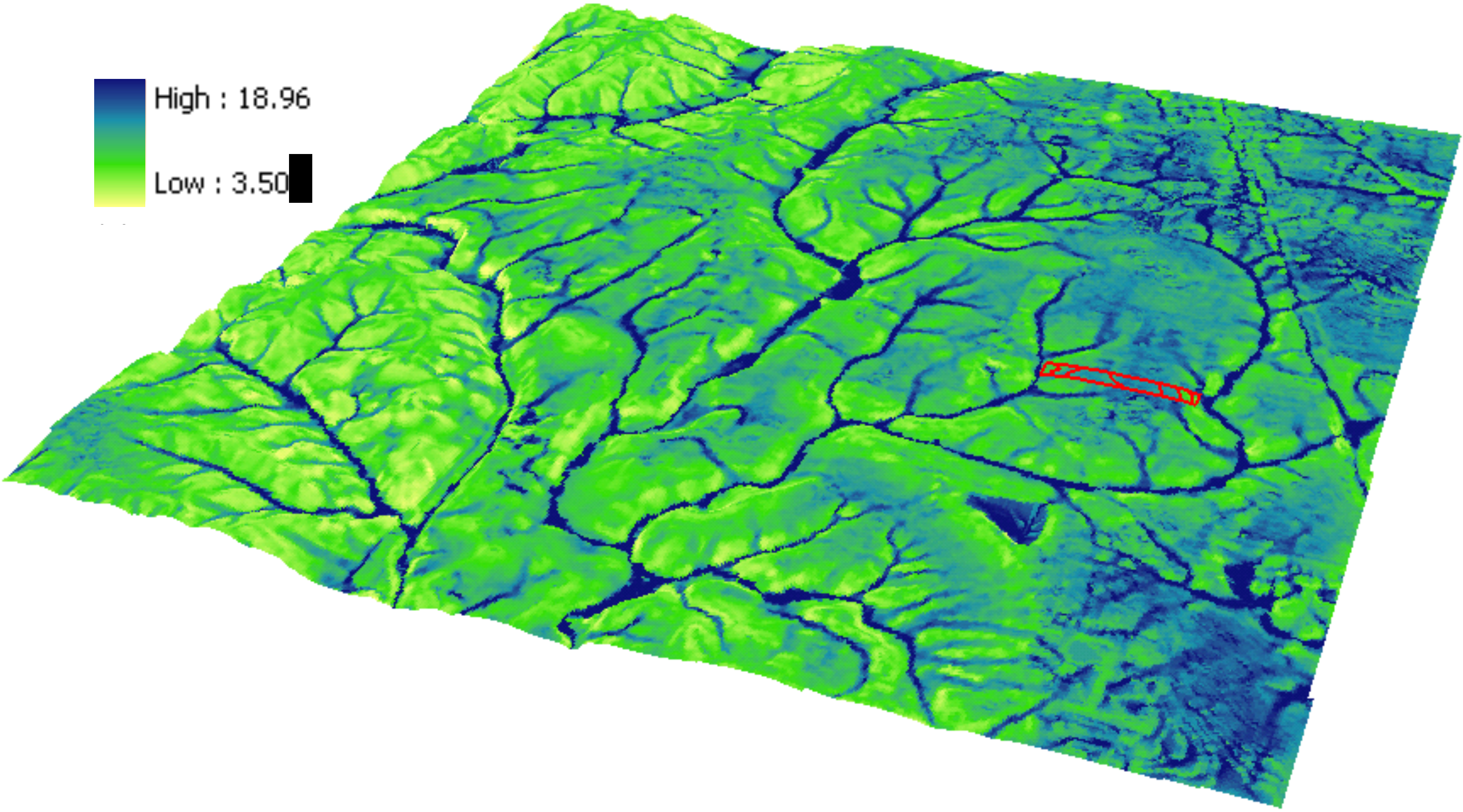
Create Property Map with SoLIM

To estimate the soil property SoLIM uses:

$$D_{ij} = \frac{\sum_{k=1}^{n} S^k{}_{ij} * D^k}{\sum_{k=1}^{n} S^k{}_{ij}}$$

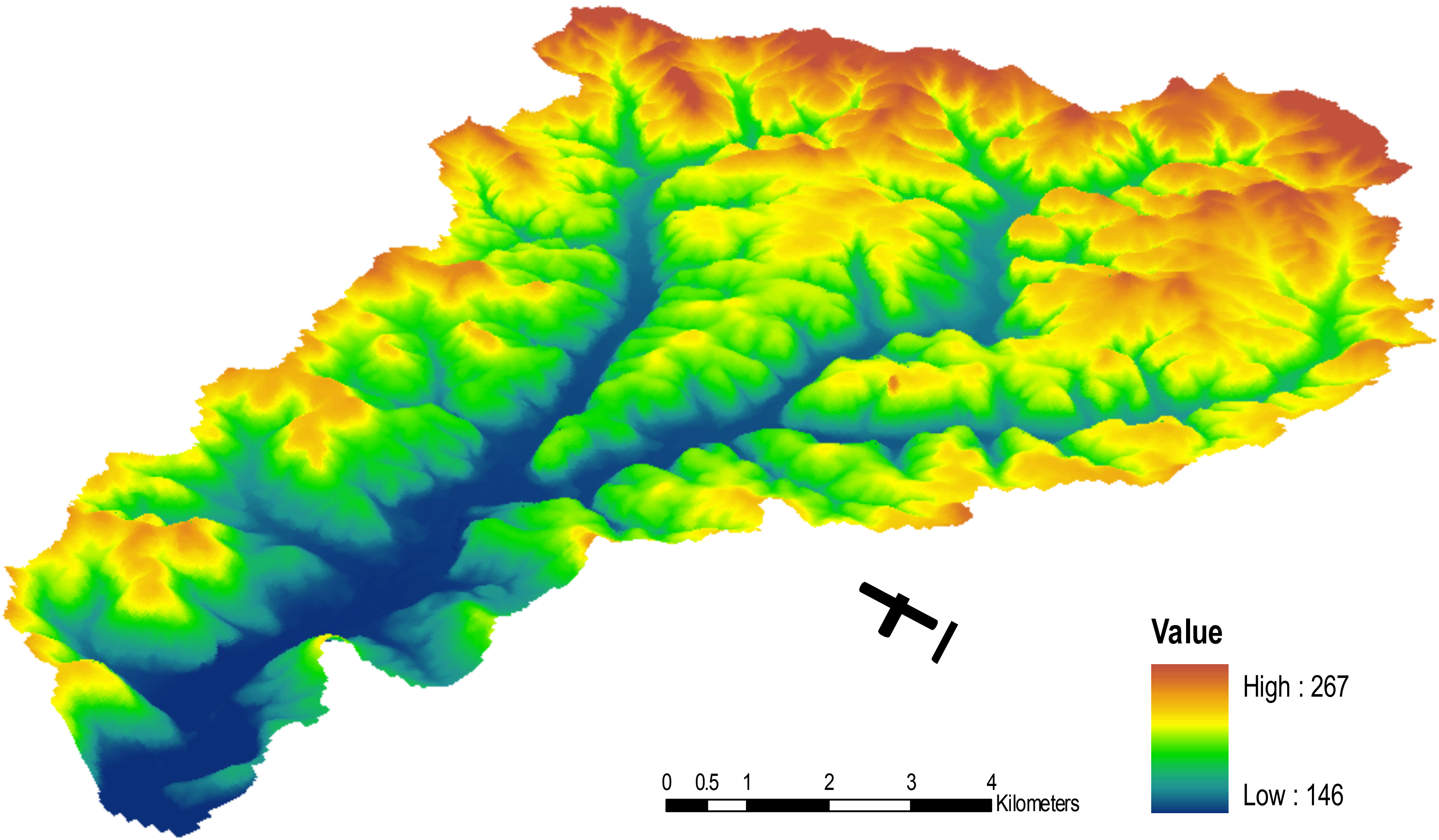
D_{ij}: the estimated soil property value at (i, j);
$S^k{}_{ij}$: the fuzzy membership value for kth soil at (i, j);
D^k: the representative property value for kth soil.

Topographical wetness index, TWI

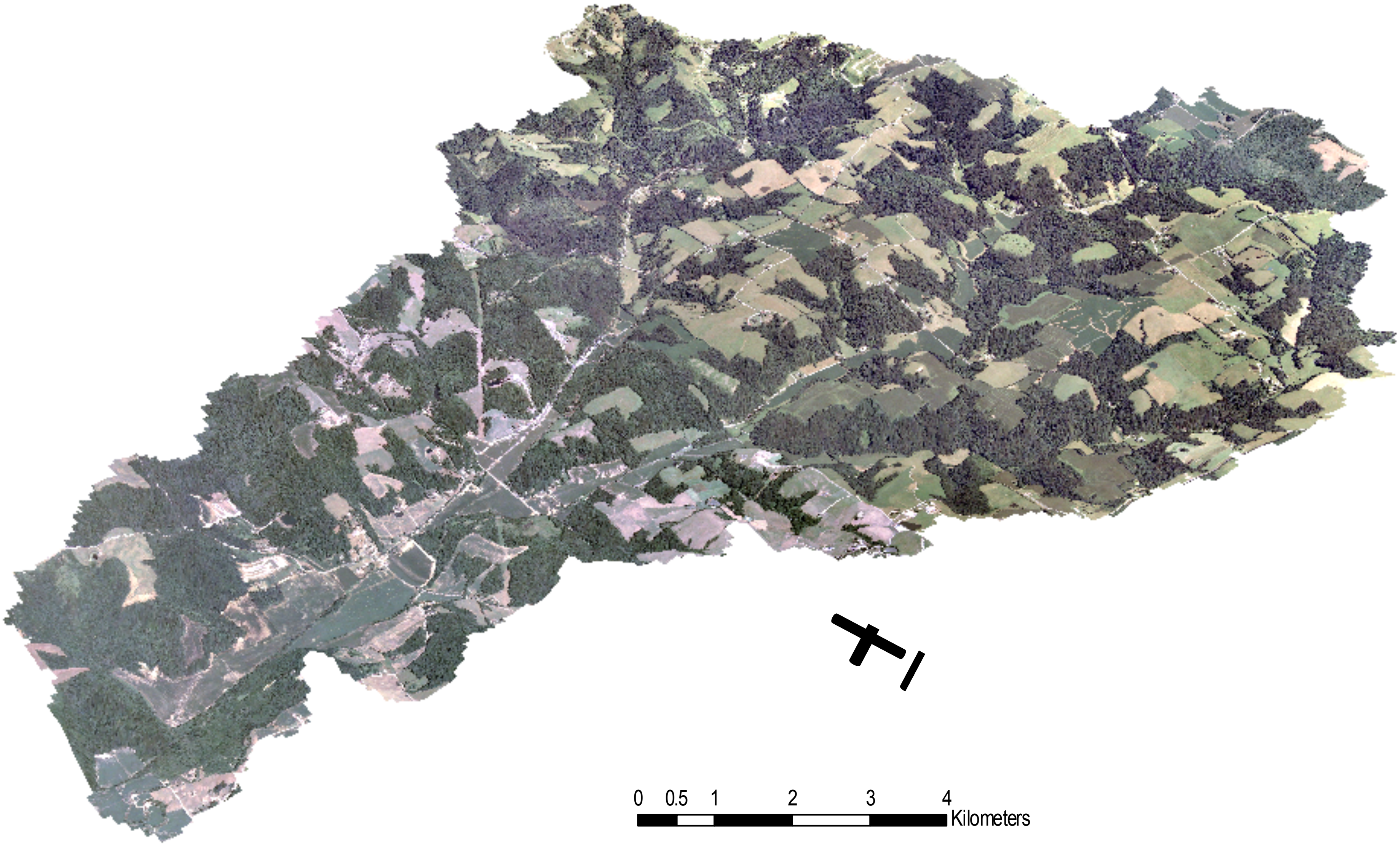


Digital Elevation Model

Dillon Creek, Dubois County, Indiana

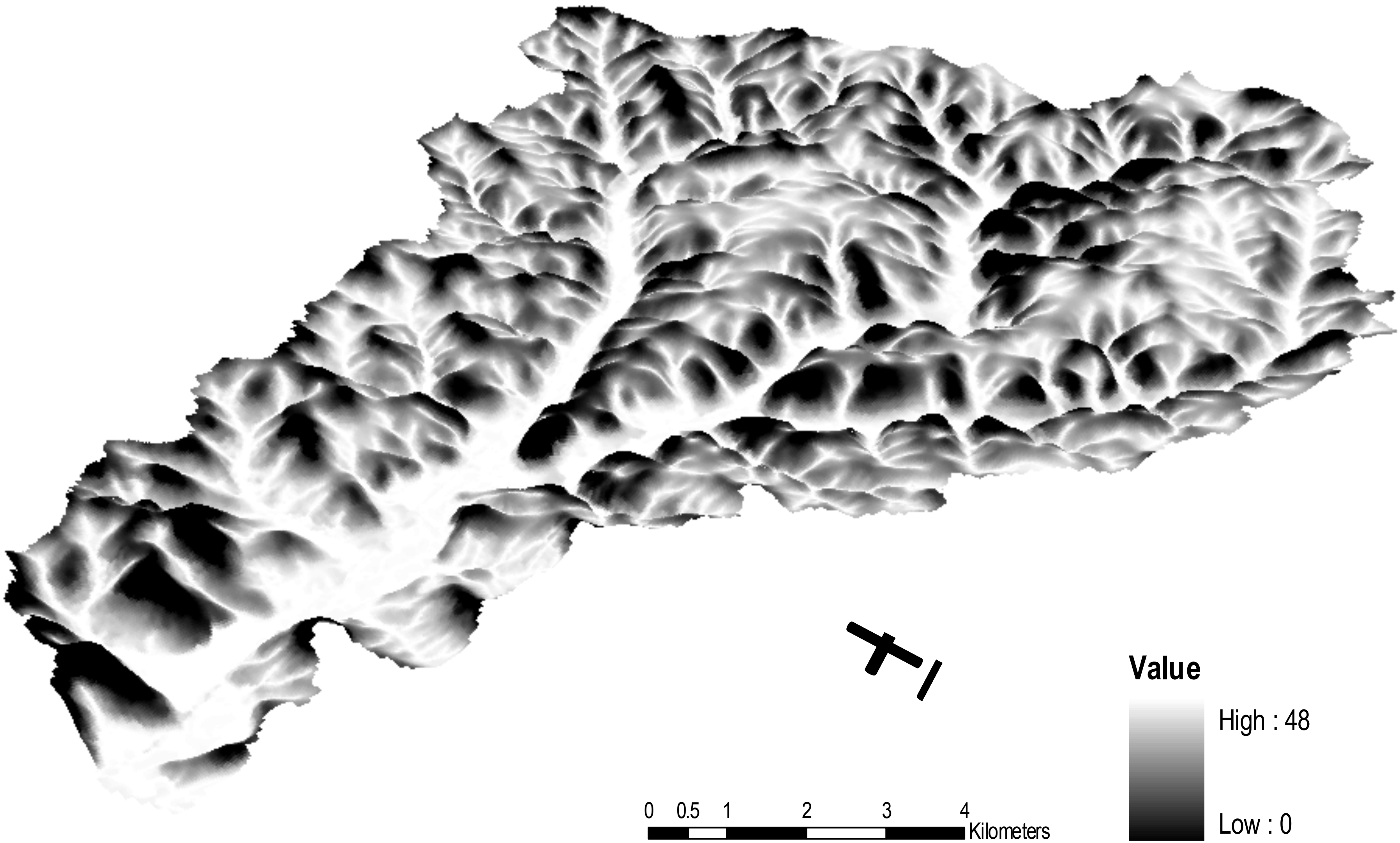


Aerial Photo draped over 3-d view



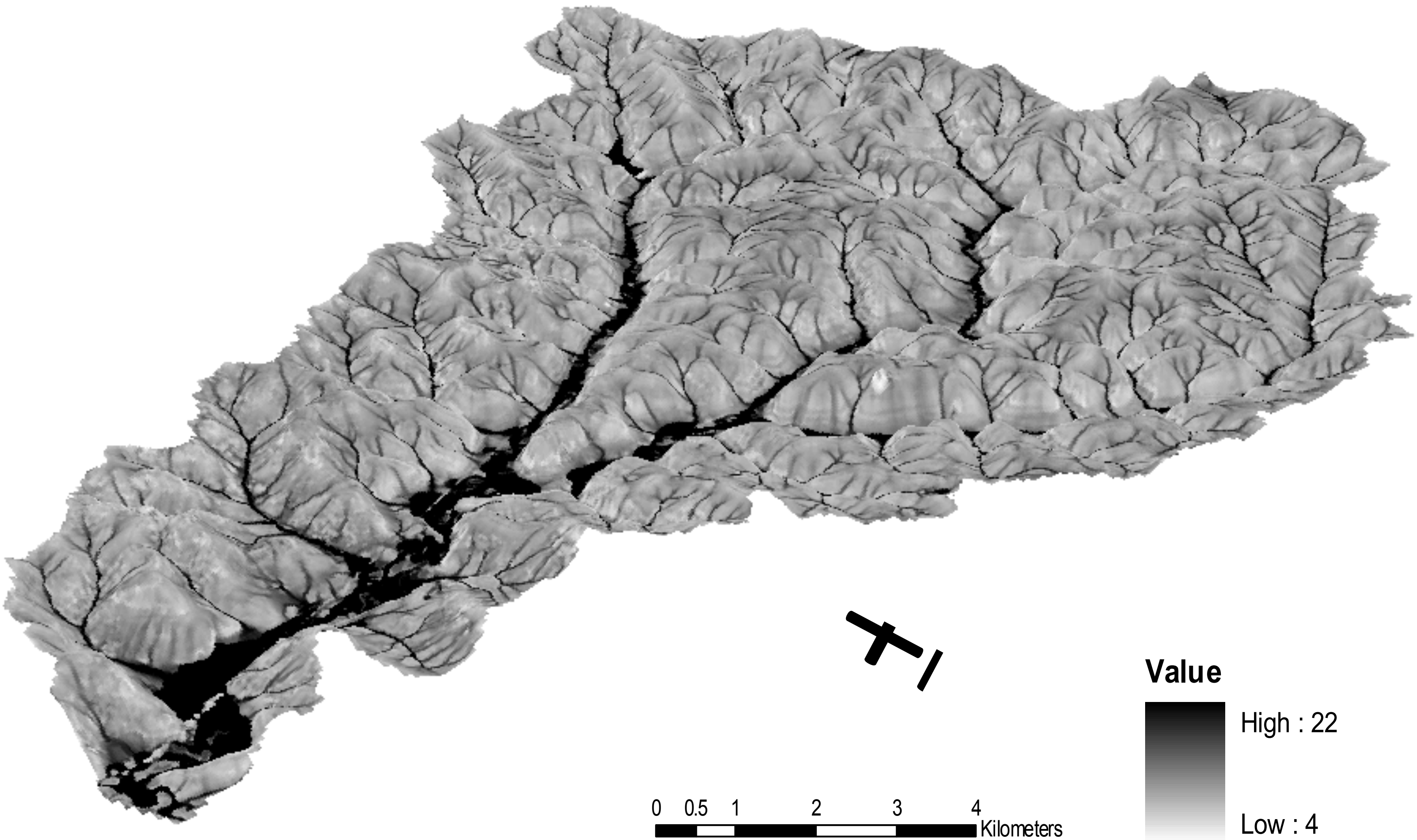
Altitude Above Channel

Dillon Creek, Dubois County, Indiana



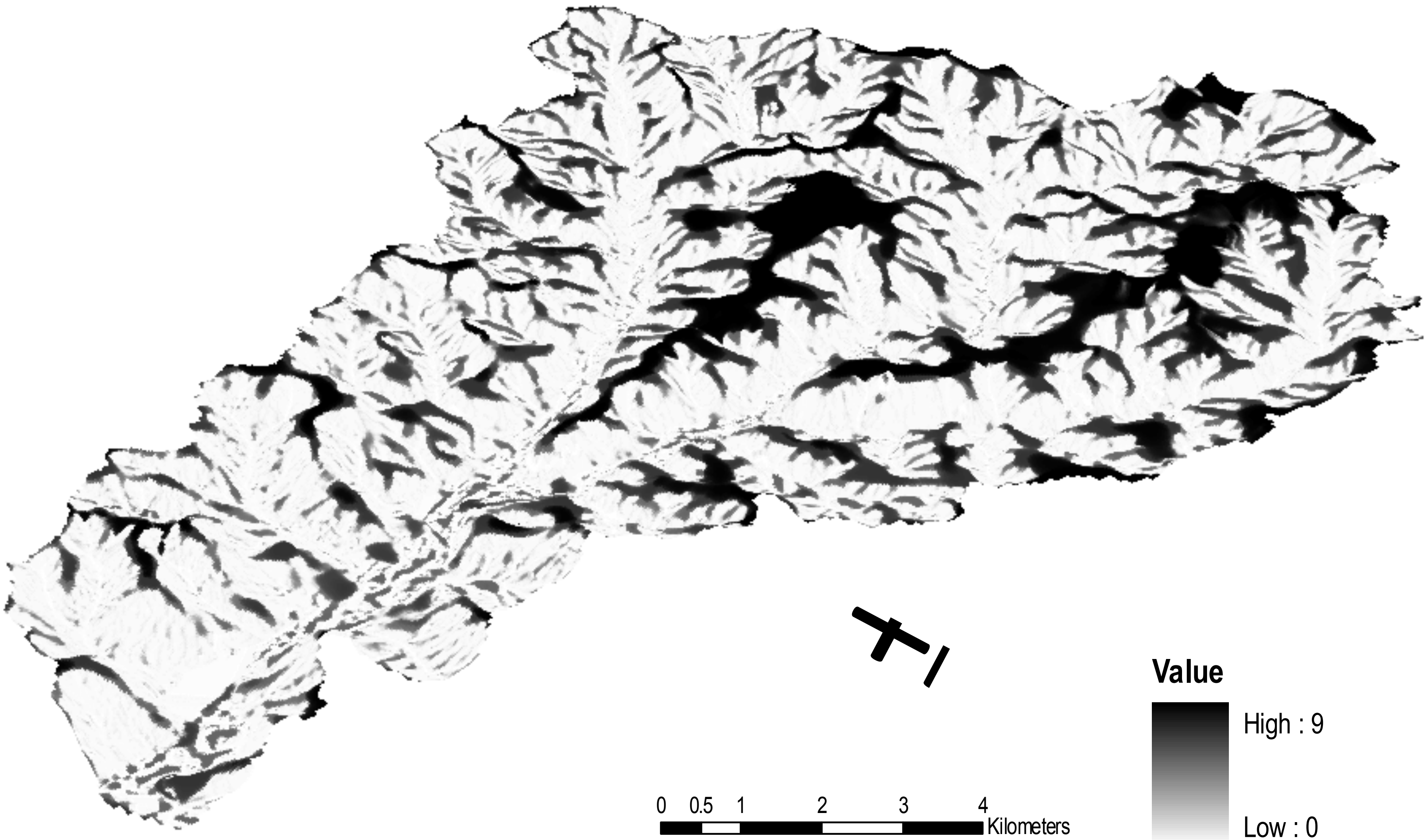
Topographic Wetness Index

Dillon Creek, Dubois County, Indiana



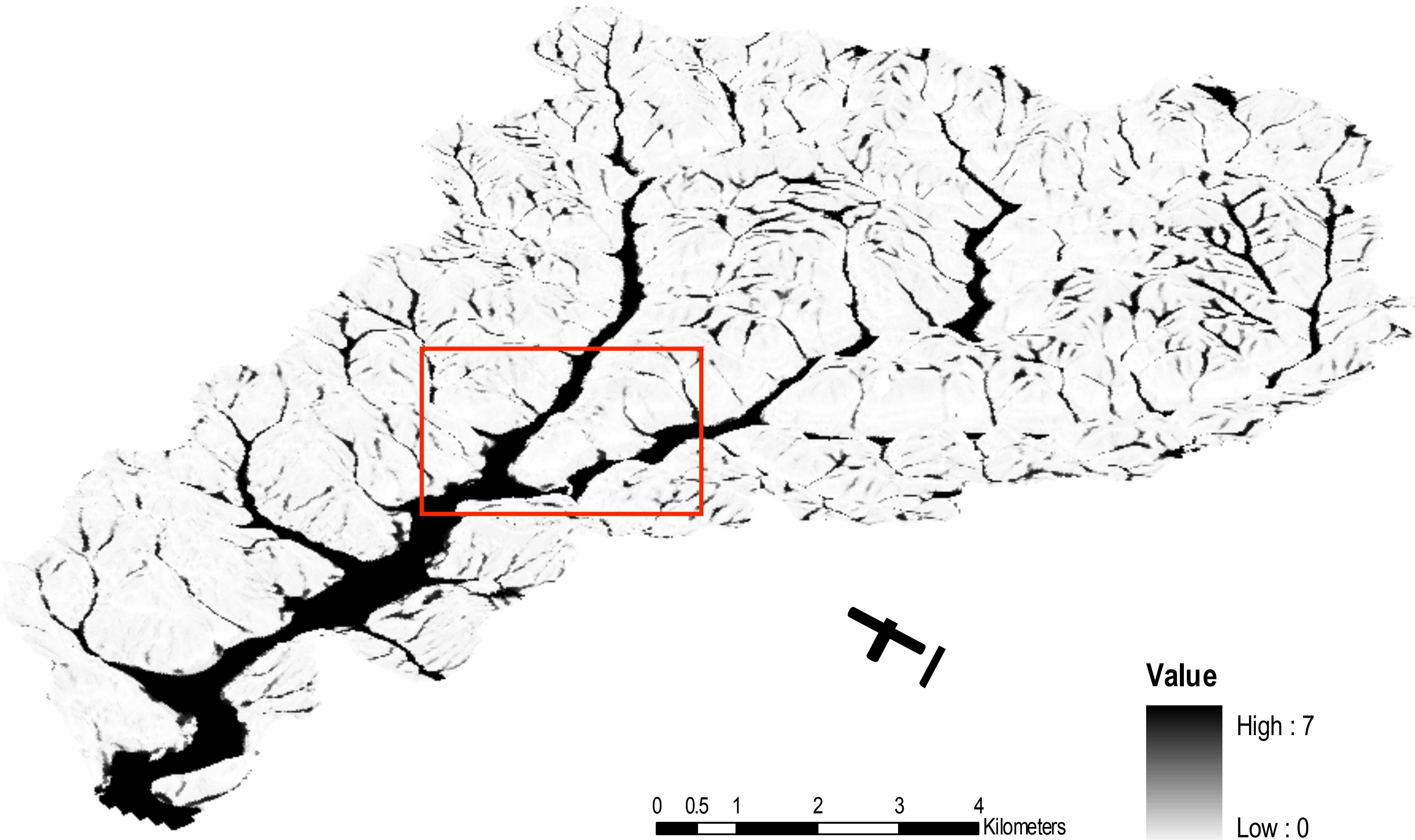
Multi Resolution Ridge Top Flatness

Dillon Creek, Dubois County, Indiana

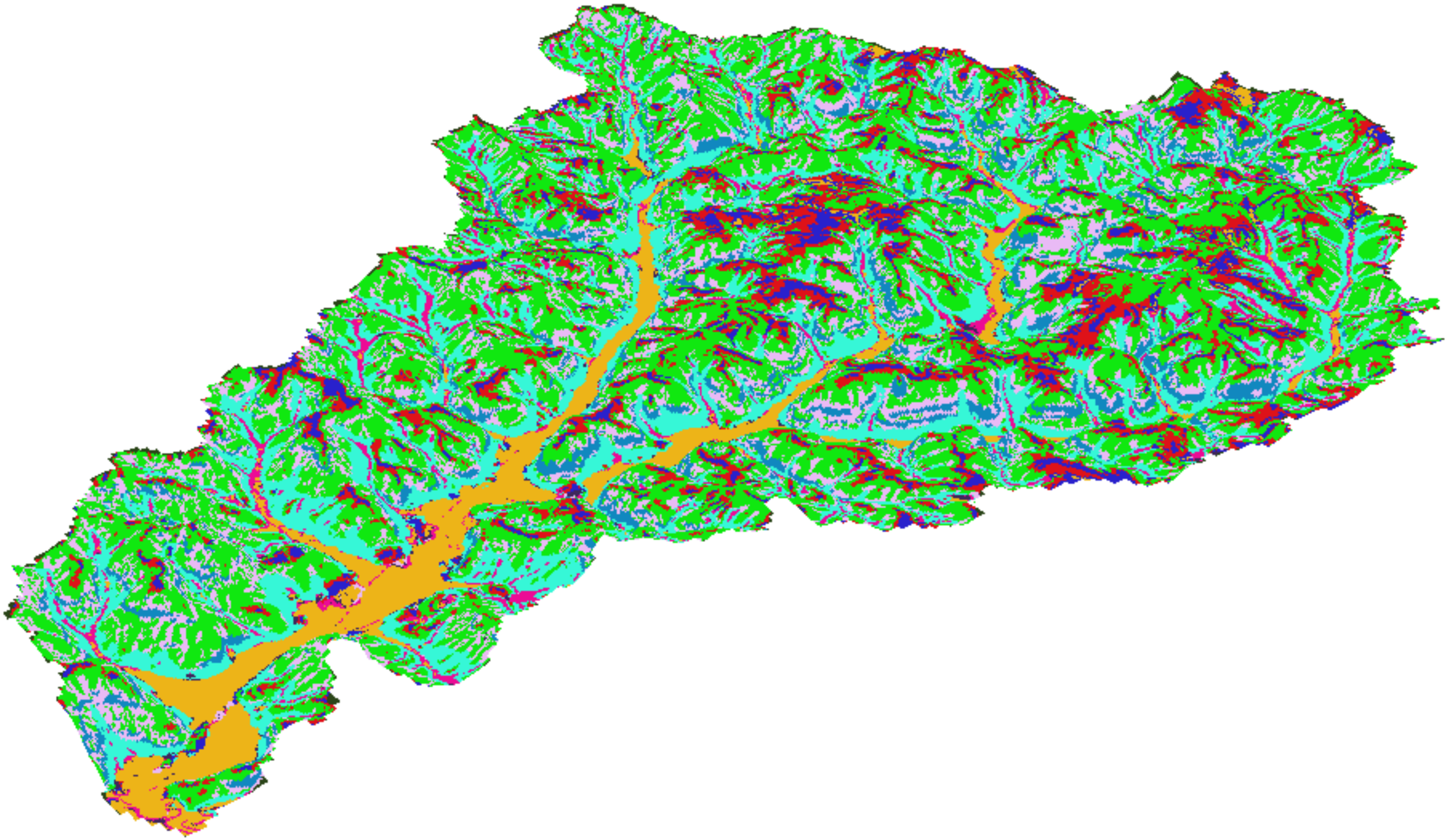


Multi Resolution Valley Bottom Flatness

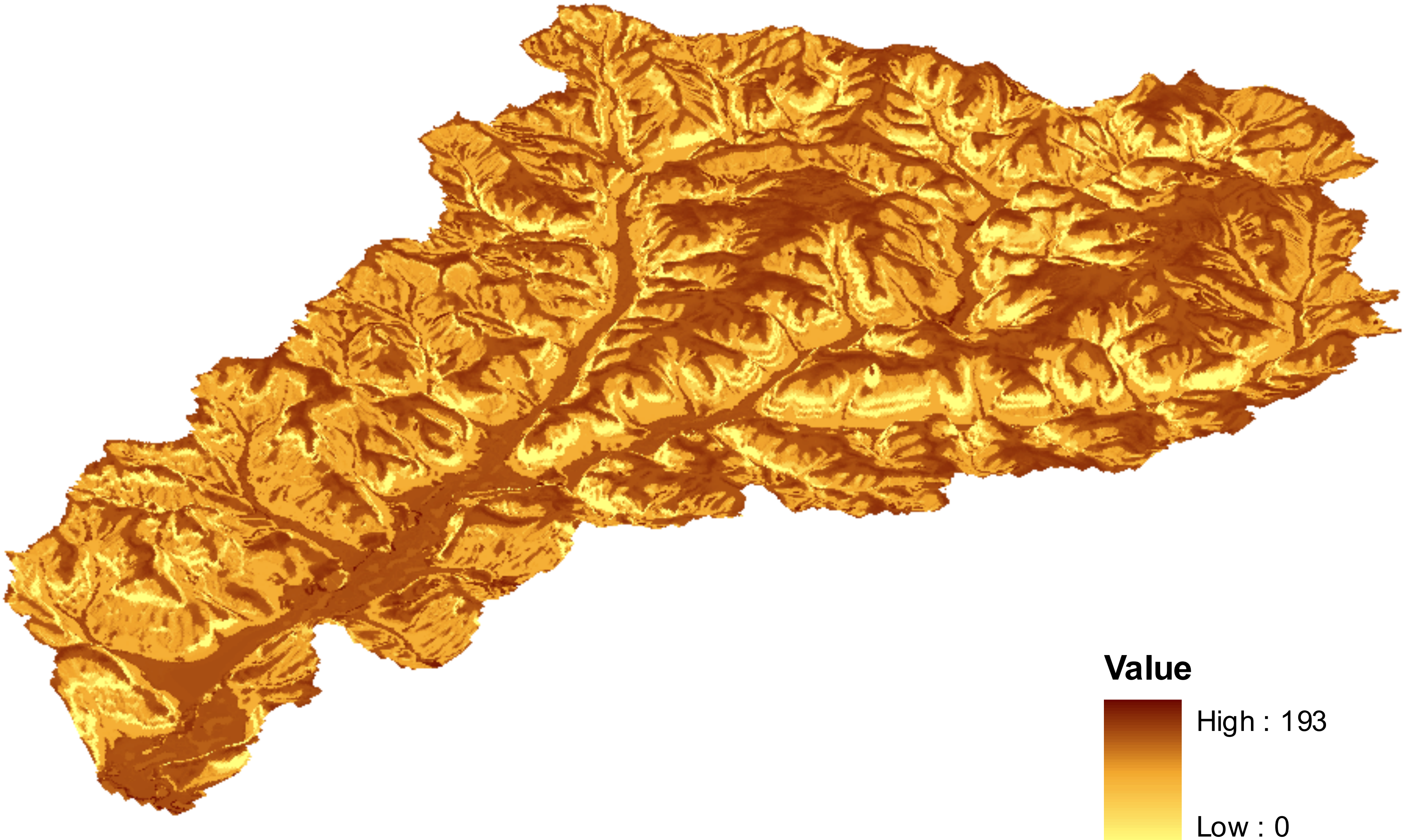
Dillon Creek, Dubois County, Indiana



Hardened Polygon Map



Dillion Creek – Dubois County Indiana
Depth to Limiting Layer



Mapping Soil Function

- Soil fertility - analysis and fertilizer recommendations are adequate (state dependent)
- Fertility is only part of the story!
- Water redistribution is next step (topography and terrain)

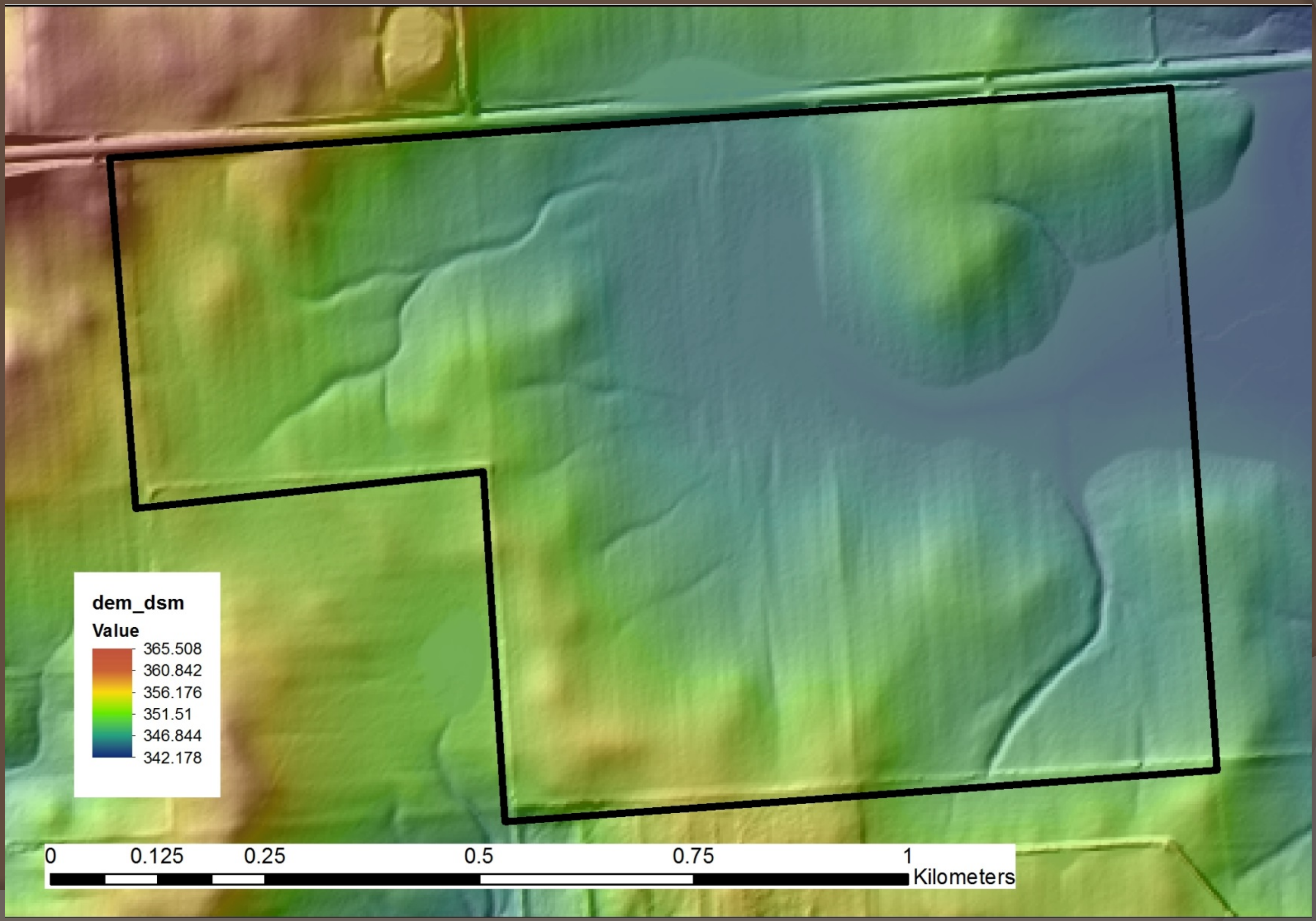
Soil Function = Soil + Water

- Function in regards to yield must account for water and soil
  - Terrain is one of several factors determining how soils function for crop yield.
  - Soil variability is related to terrain and is key to understanding yield differences.
  - Goal of production is often to <u>minimize</u> the influence yield variability as we maximize production.

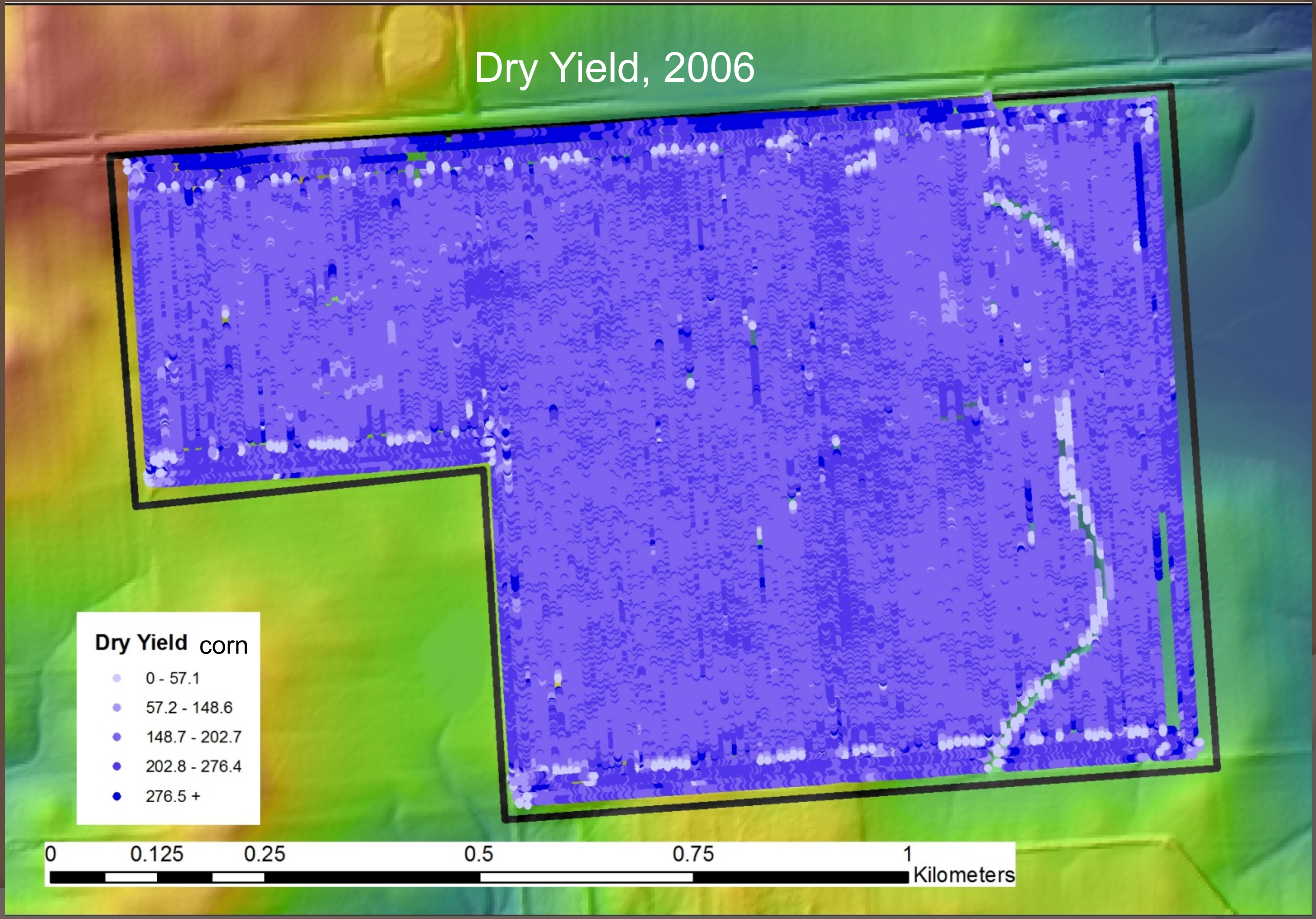
Two Examples

- Highly uniform yield at Farm in Iowa
  - Little influence of terrain and soils on yield
  - Soil variability influenced by terrain but soils buffer topography differences
- Variable yield at Farm in Indiana
  - Variability within field and across years
  - Patterns of yield consistent with patterns of soil variability
  - Patterns of water convergence governed by terrain also influence yield

Yield Uniformity and Soil/Terrain Heterogeneity, Iowa



Yield Uniformity and Soil/Terrain Heterogeneity, Iowa



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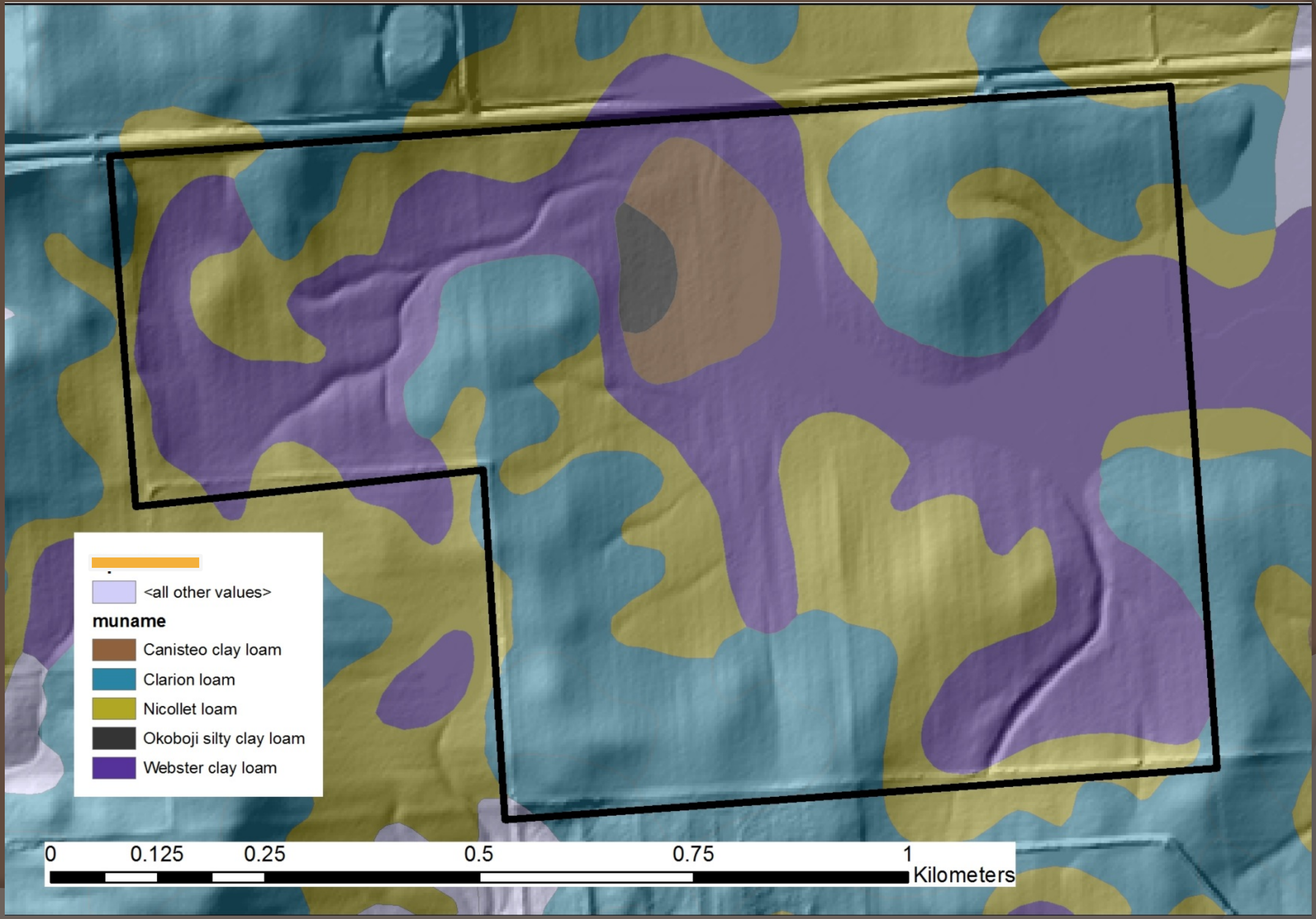
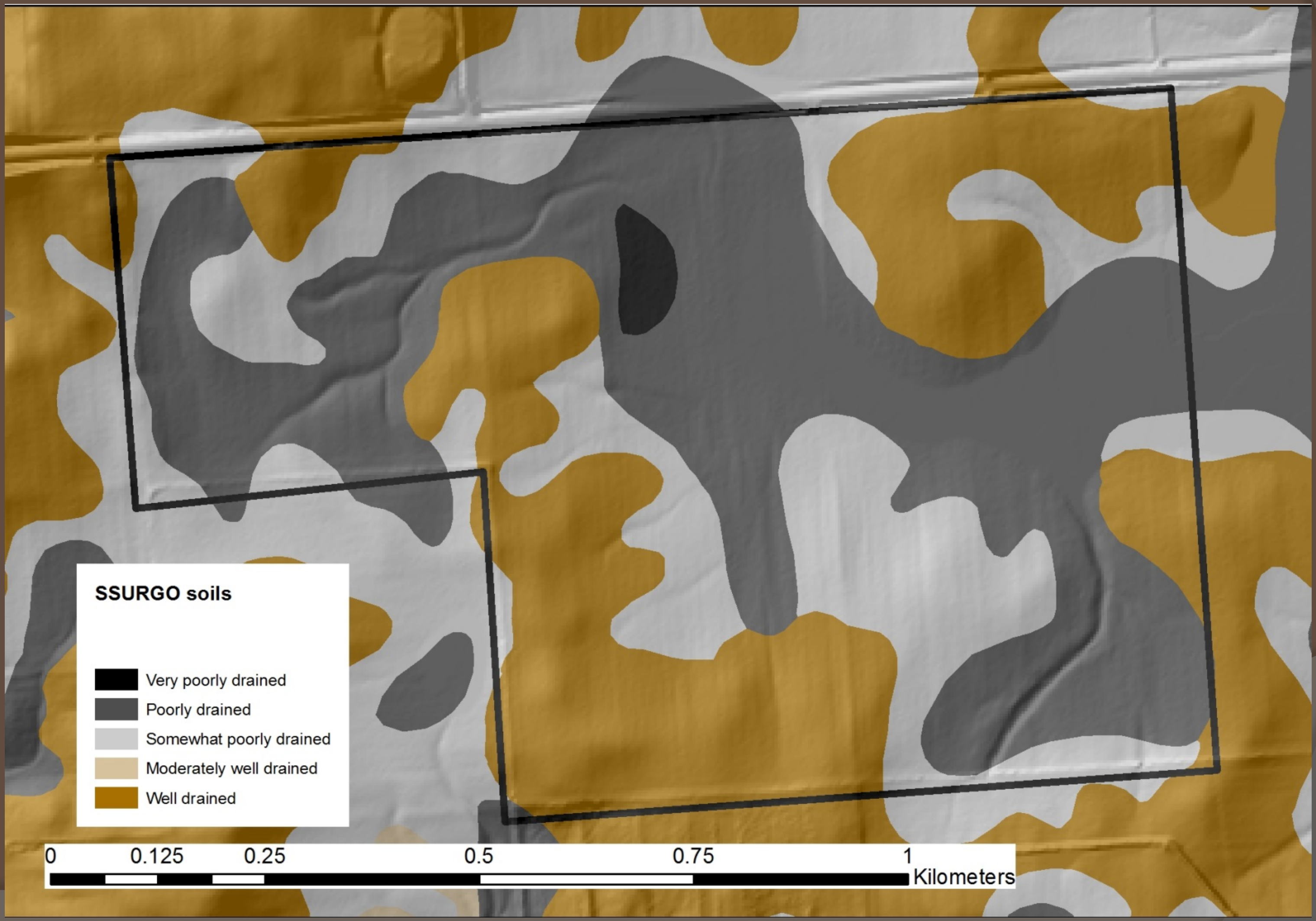
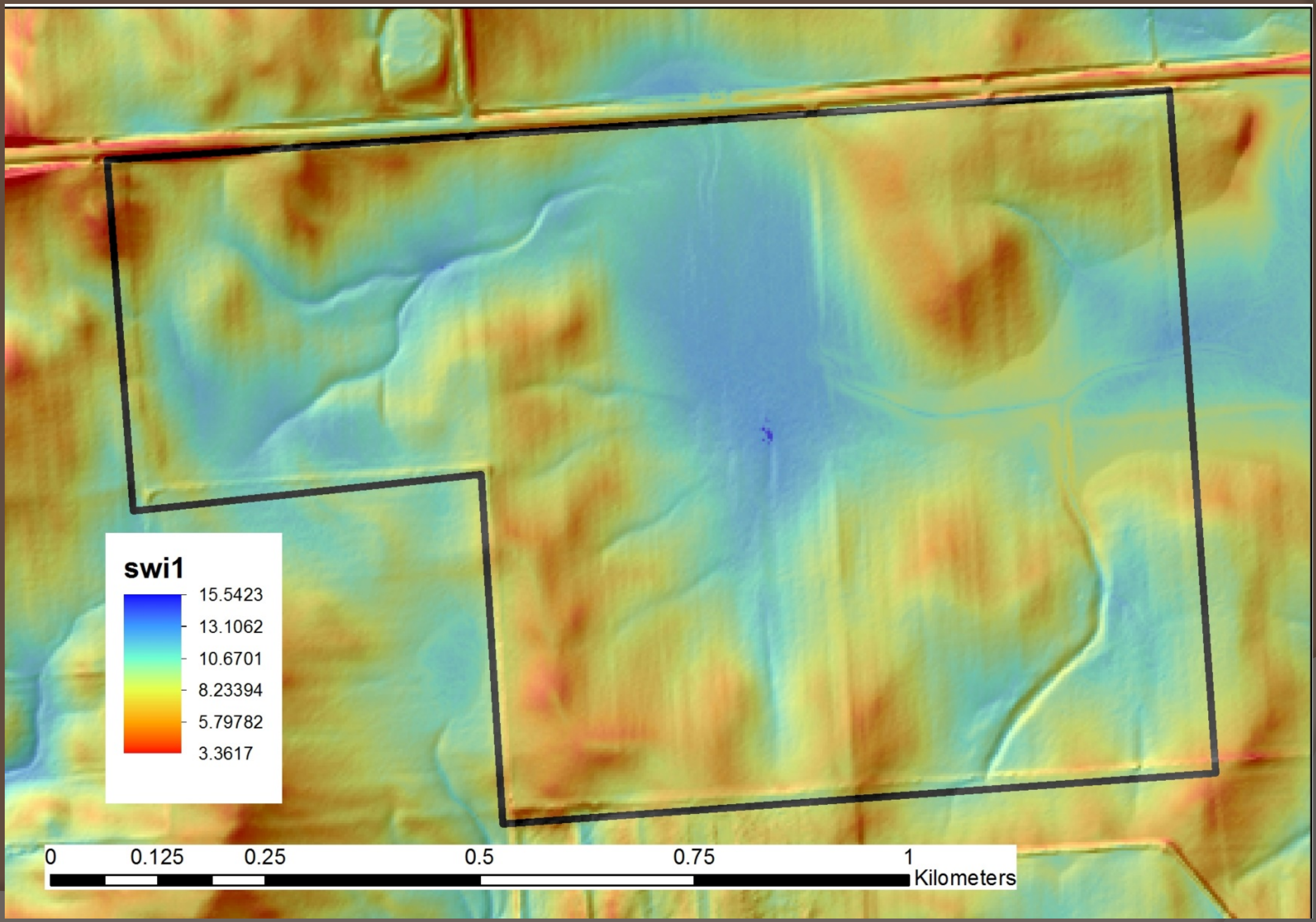


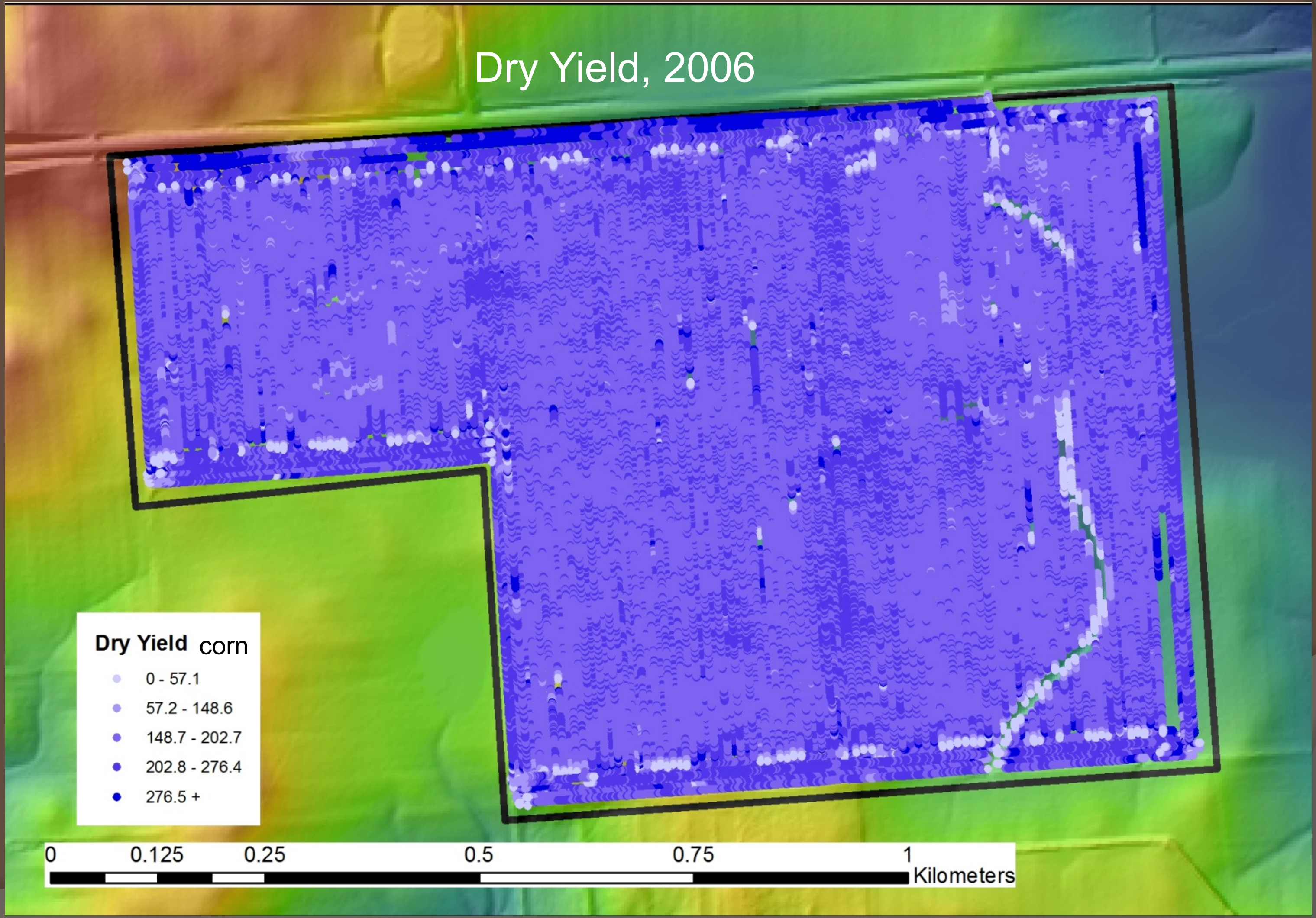
Yield Uniformity and Soil/Terrain Heterogeneity, Iowa



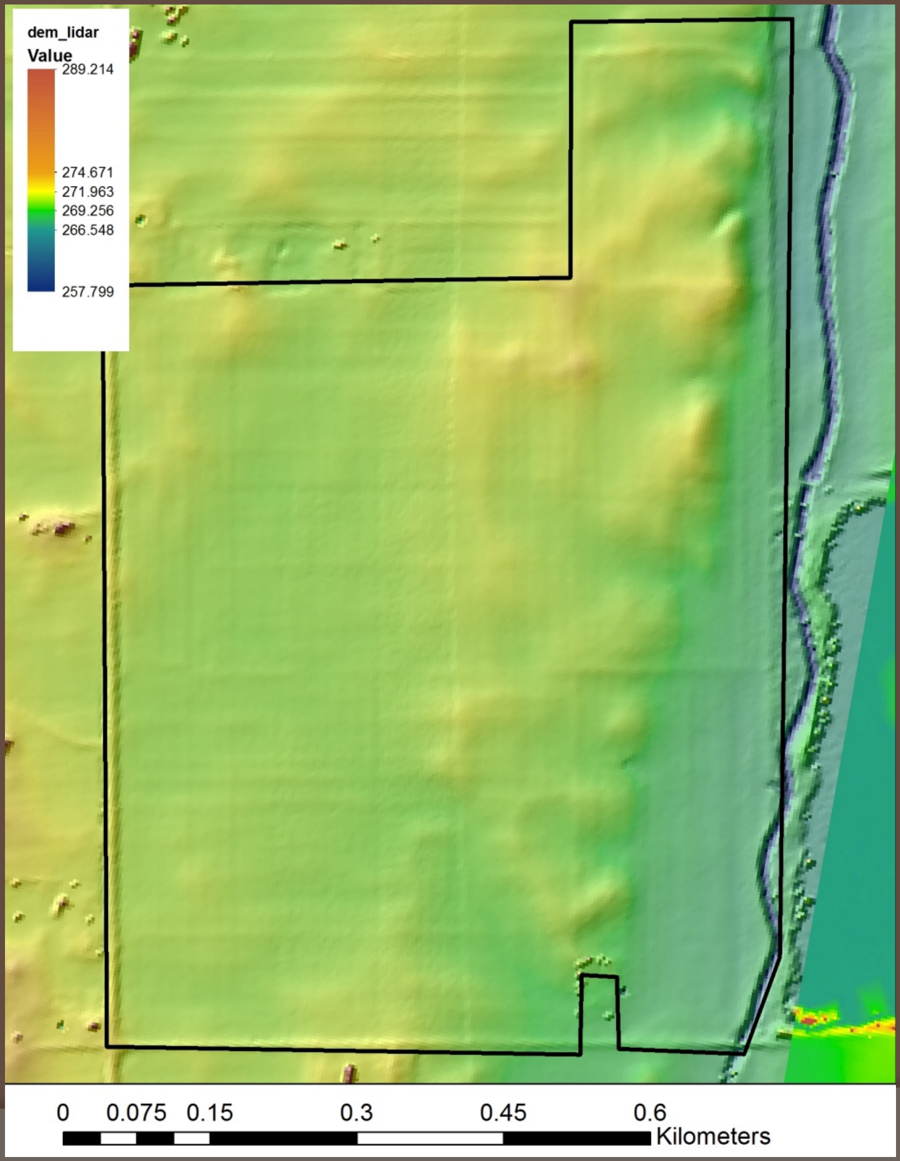
Terrain explains soil variability in this drainage catena, wetness index

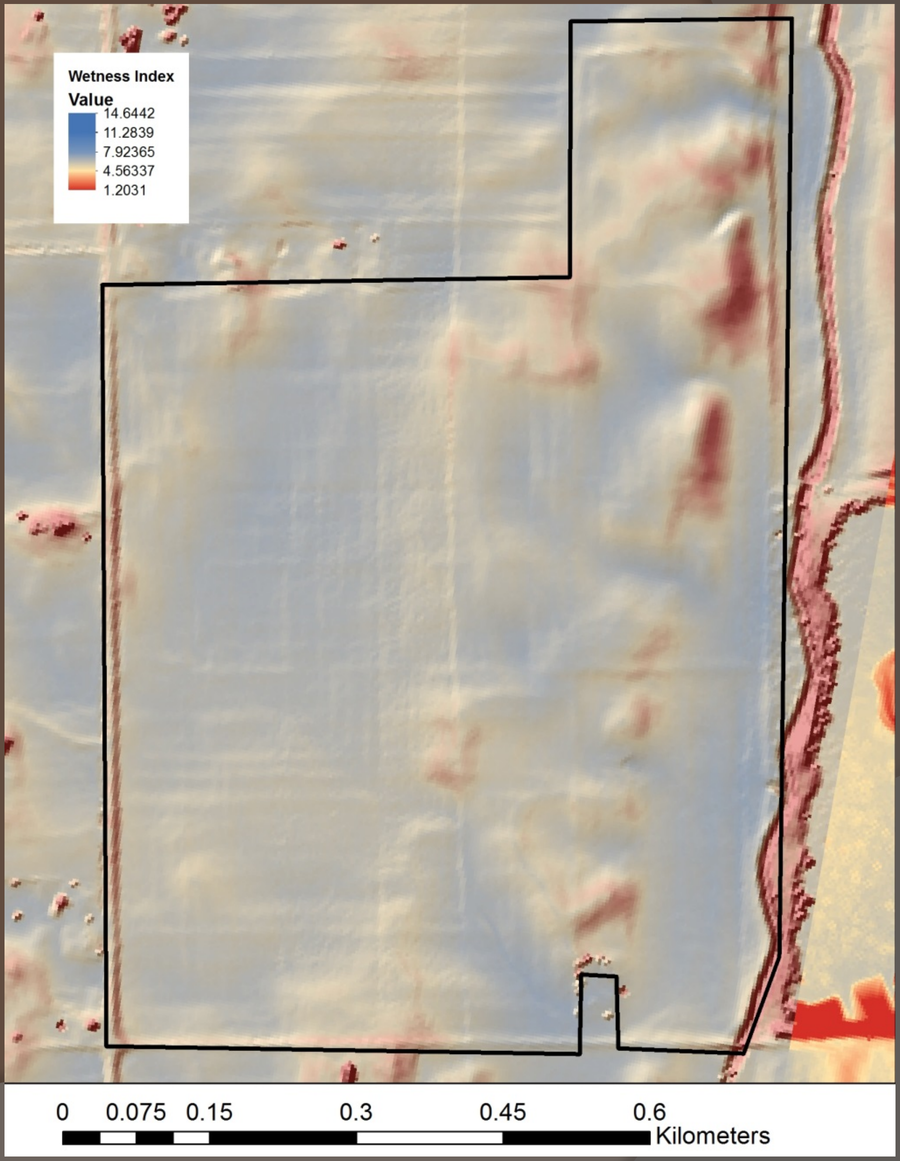


Yield Uniformity and Soil/Terrain Heterogeneity, Iowa

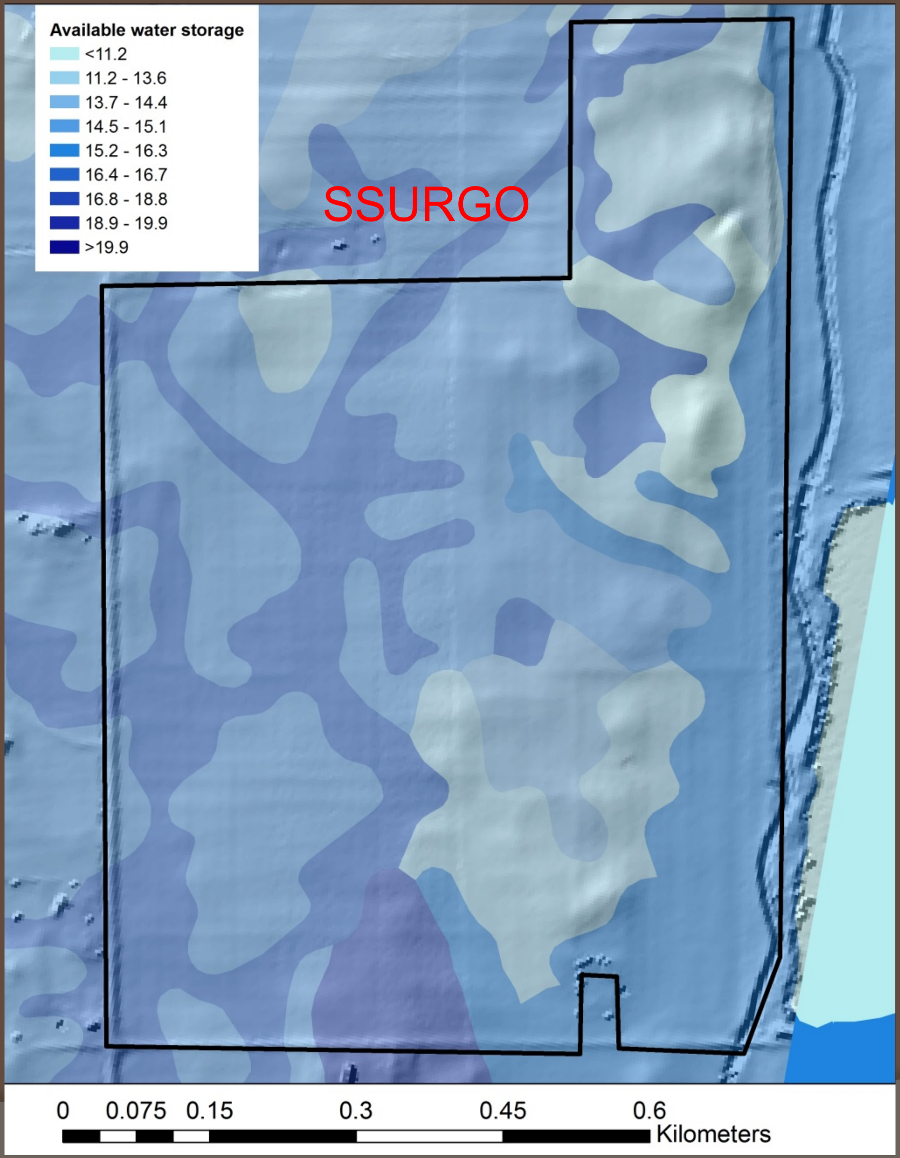


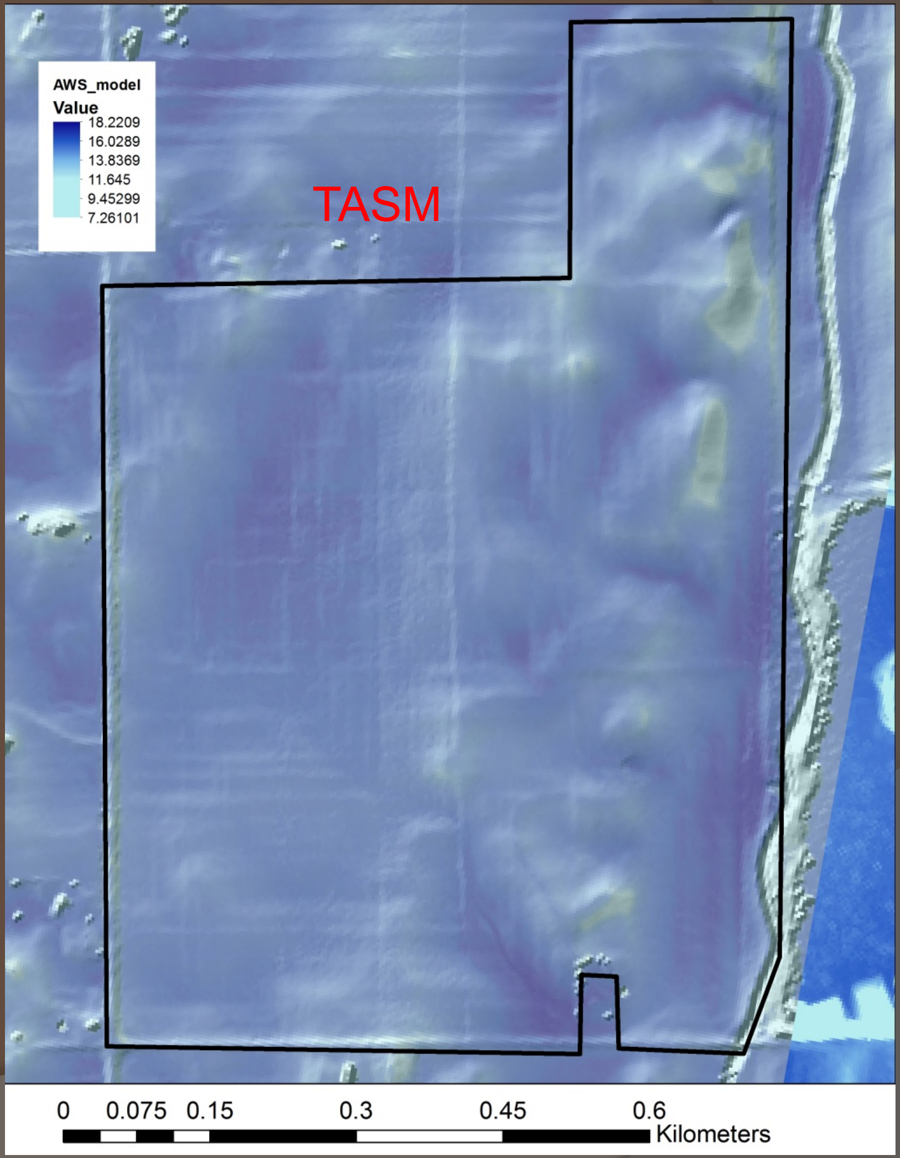
Indiana Farm



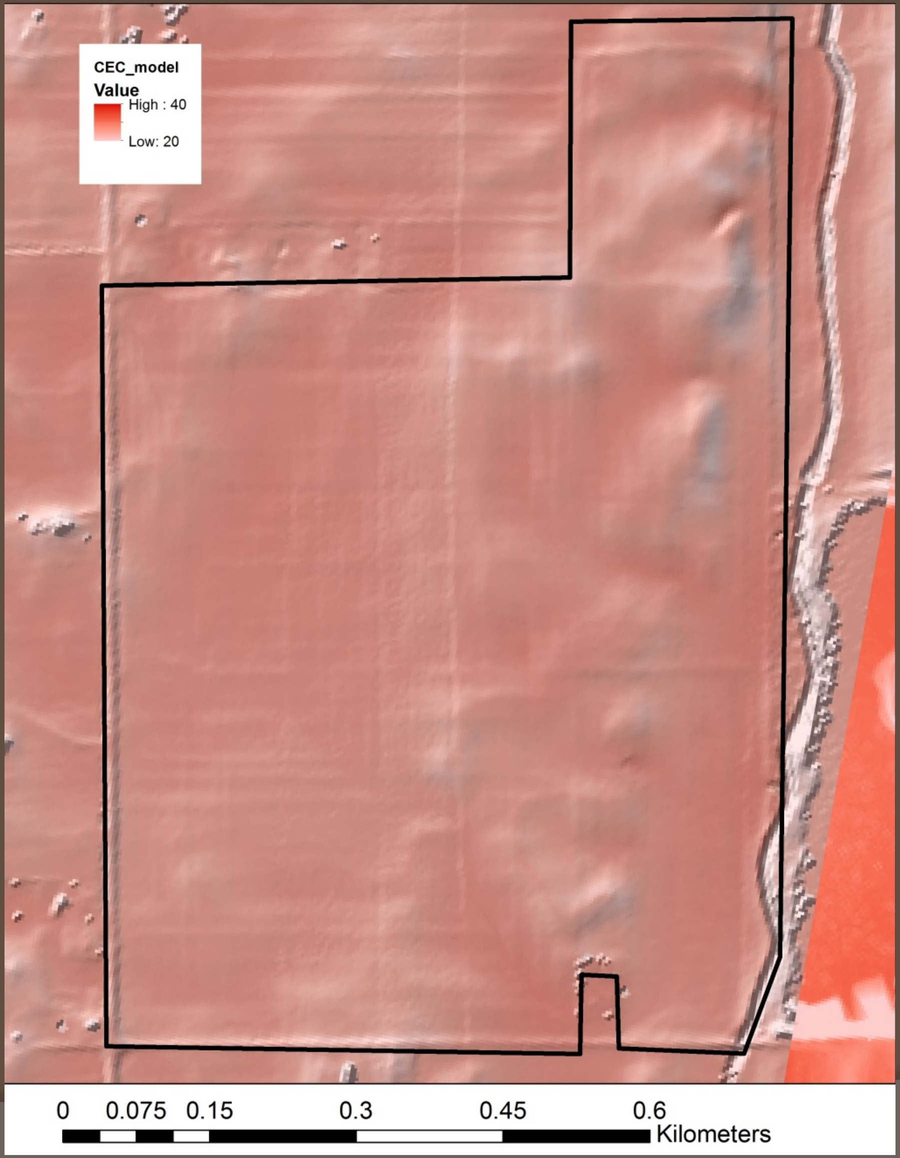


Soil Property Maps: available water storage, Indiana, 0 – 100 cm

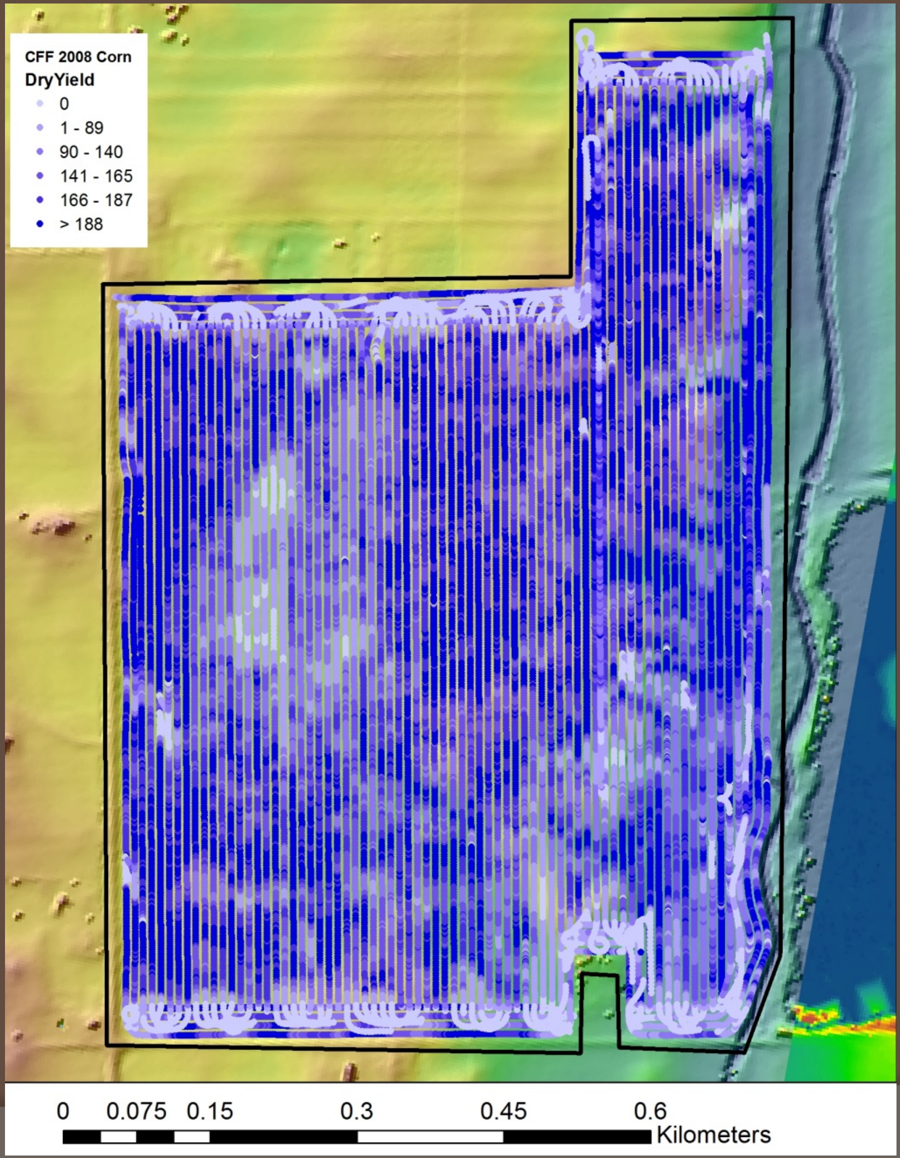


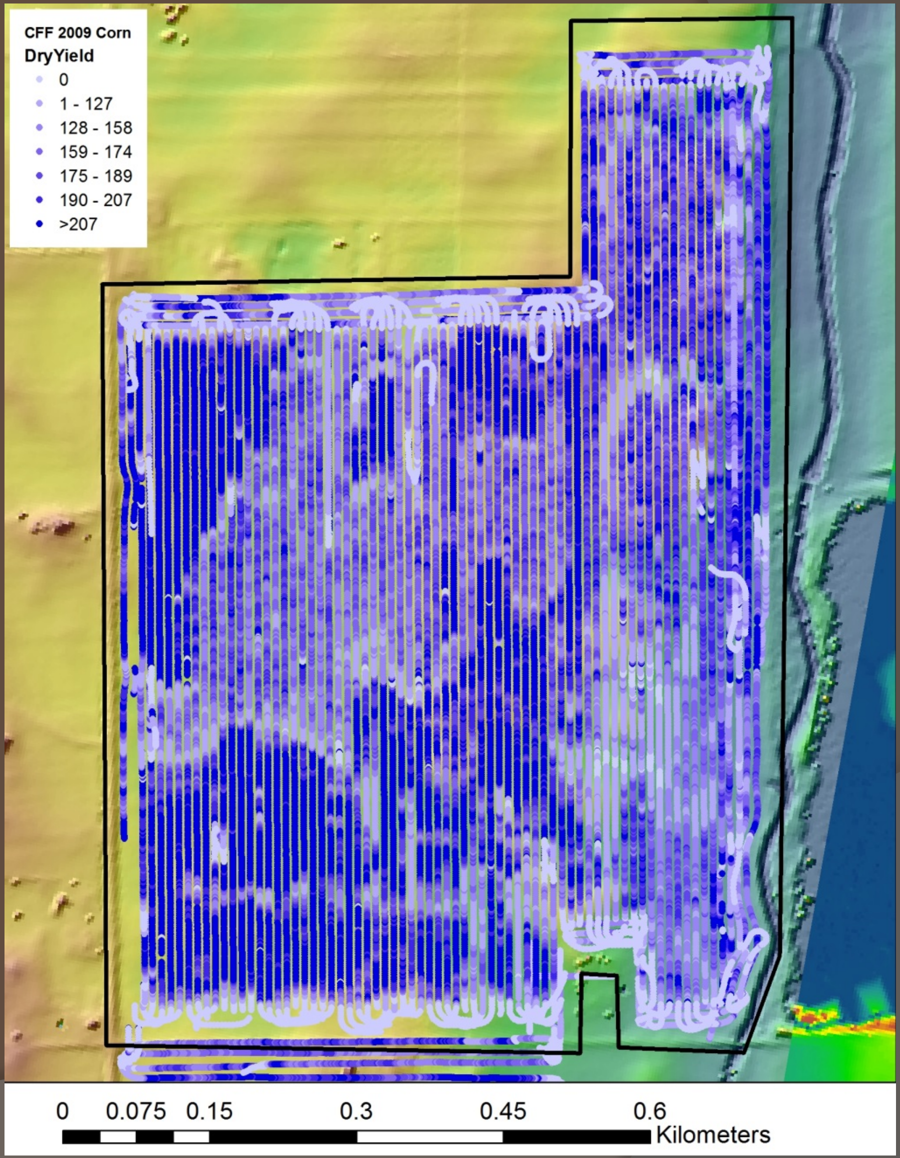


Soil Property Maps Indiana: CEC, OM



Indiana Farm





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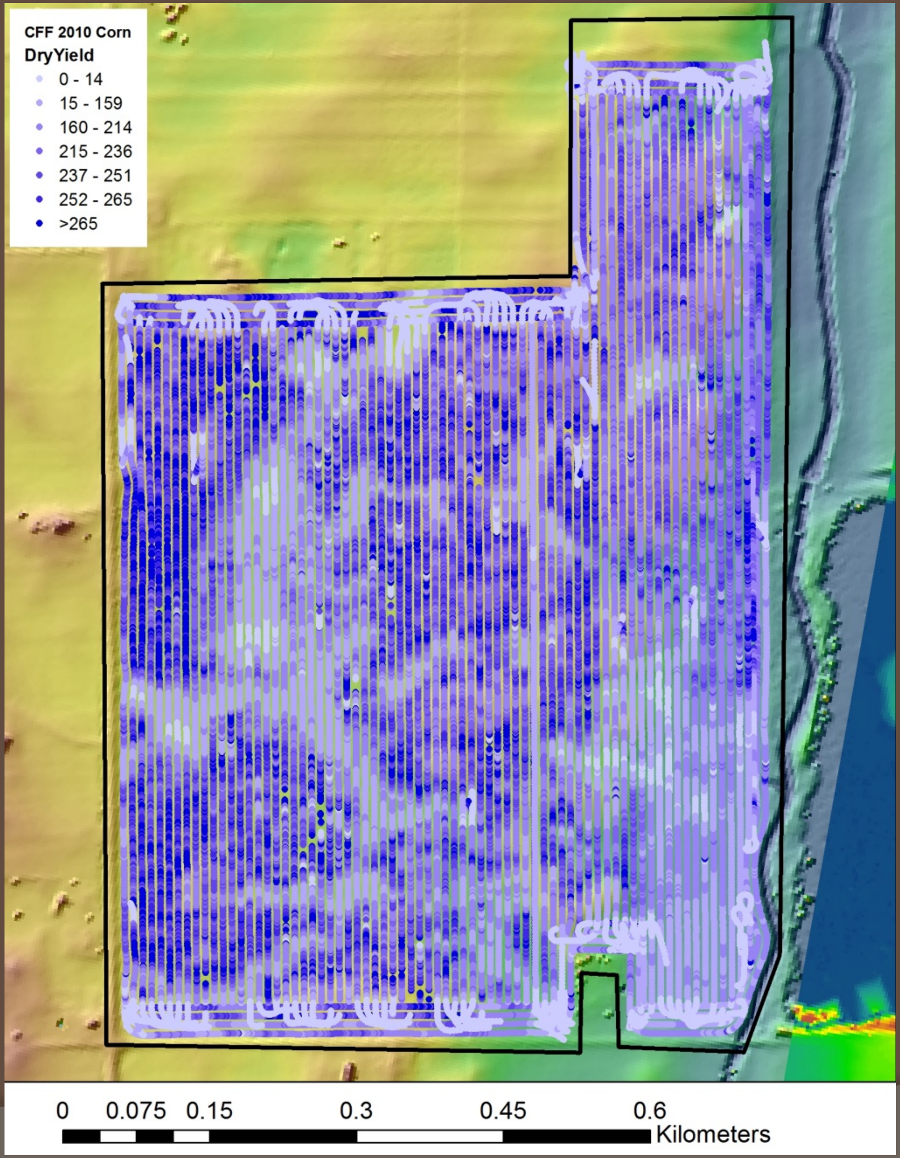
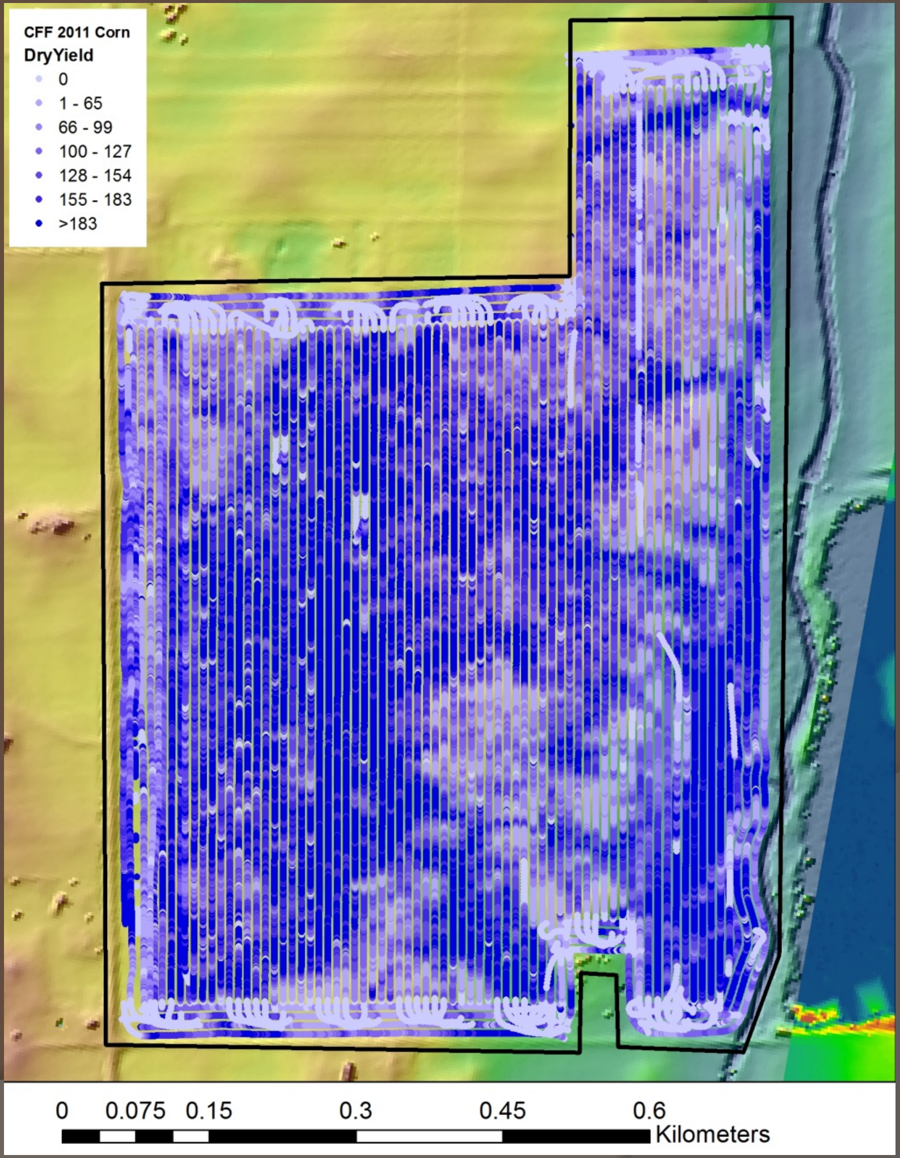
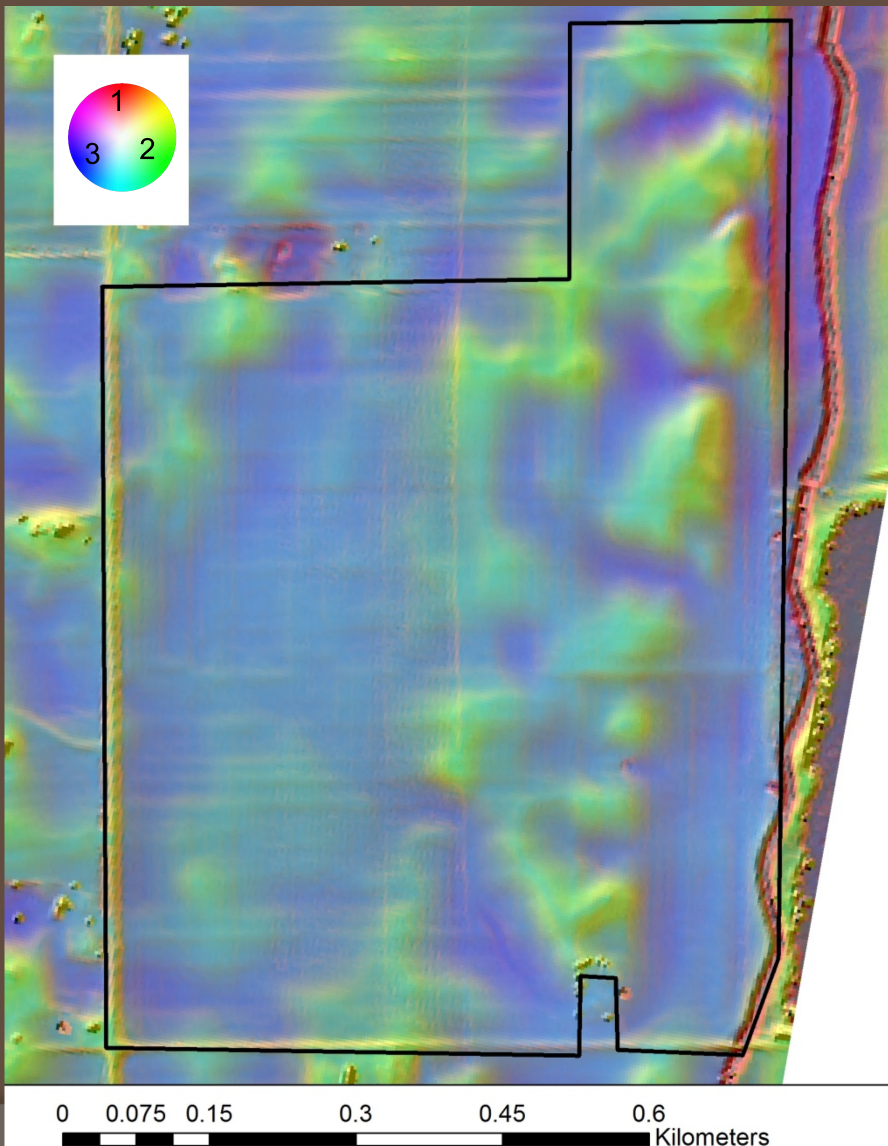
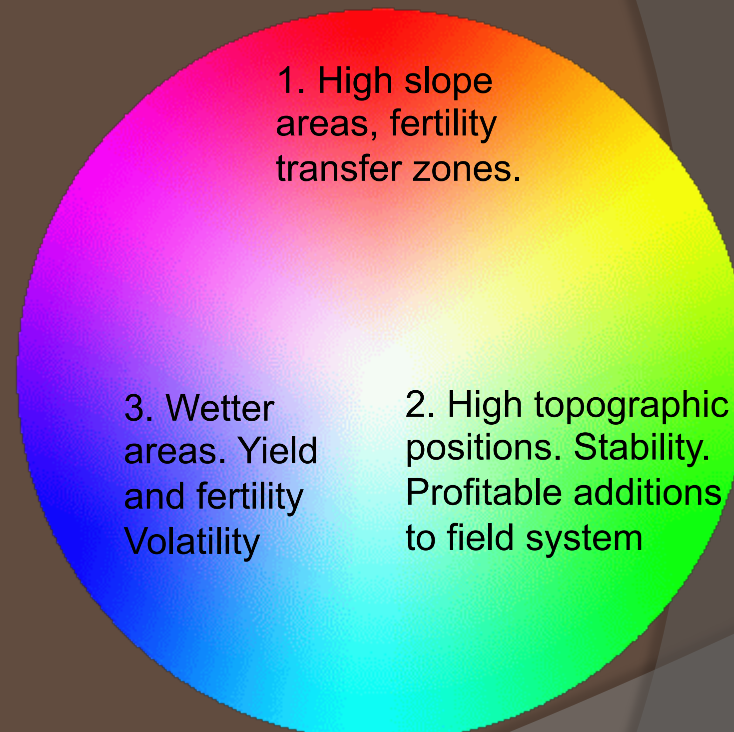




Example - Soil Management Index, Indiana Farm



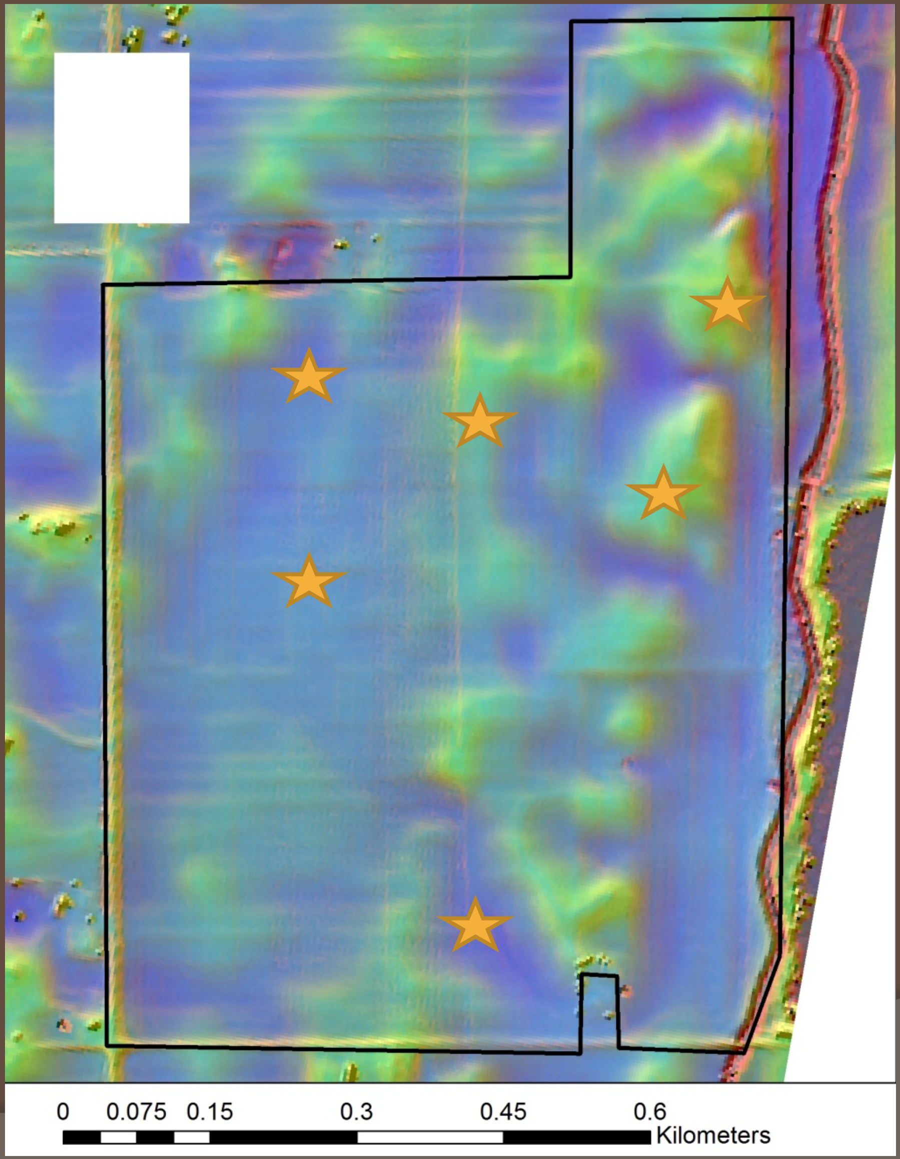


Zone 1: not conducive to high fertility additions
Zone 2: profitable additions to field system without loss. Zone 2 losses are moved from zone 1 to zone 3.
Zone 3: Yield and fertility volatility expected.
Overlap of zones is usual (no need for discreet boundaries).
When zone 3 overlaps with 1 avoid heavy fertilizer additions because of expected losses. When 3 overlaps with 2 heavier fertility additions are helpful.

Comparison, Iowa Farm vs. Indiana Farm

- Iowa farm shows minimal differences between terrain and yield for 1 year (weather specific in some cases)
- Indiana Farm shows good relationship between terrain and yield
- Soils can buffer the differences (Iowa Example) so topography alone is not the total answer

Soil Sampling



140 acre field

Maps Improve Over Time

- Create a platform for data to add value to soil samples
- Soil data from each year can be added to the model to refine the soil maps
- Across years – utilize yield data, management and soil data to understand individual responses for yield

Mapping Soil Properties

- Soil property predictions are created for every pixel (15 ft x 15 ft in Indiana)
- Properties include soil texture, soil organic matter, available water, pH, etc.
- Properties can be combined to create and index.
- Properties can be used to relate to plant genetics and plant responses.
- Most importantly…. Water can be linked to soil properties

Soil Functional Maps

- Soil + Water = Function
- The tools and technology are available now.
- This type of spatial data product is the future for research, development and application for managing fields.

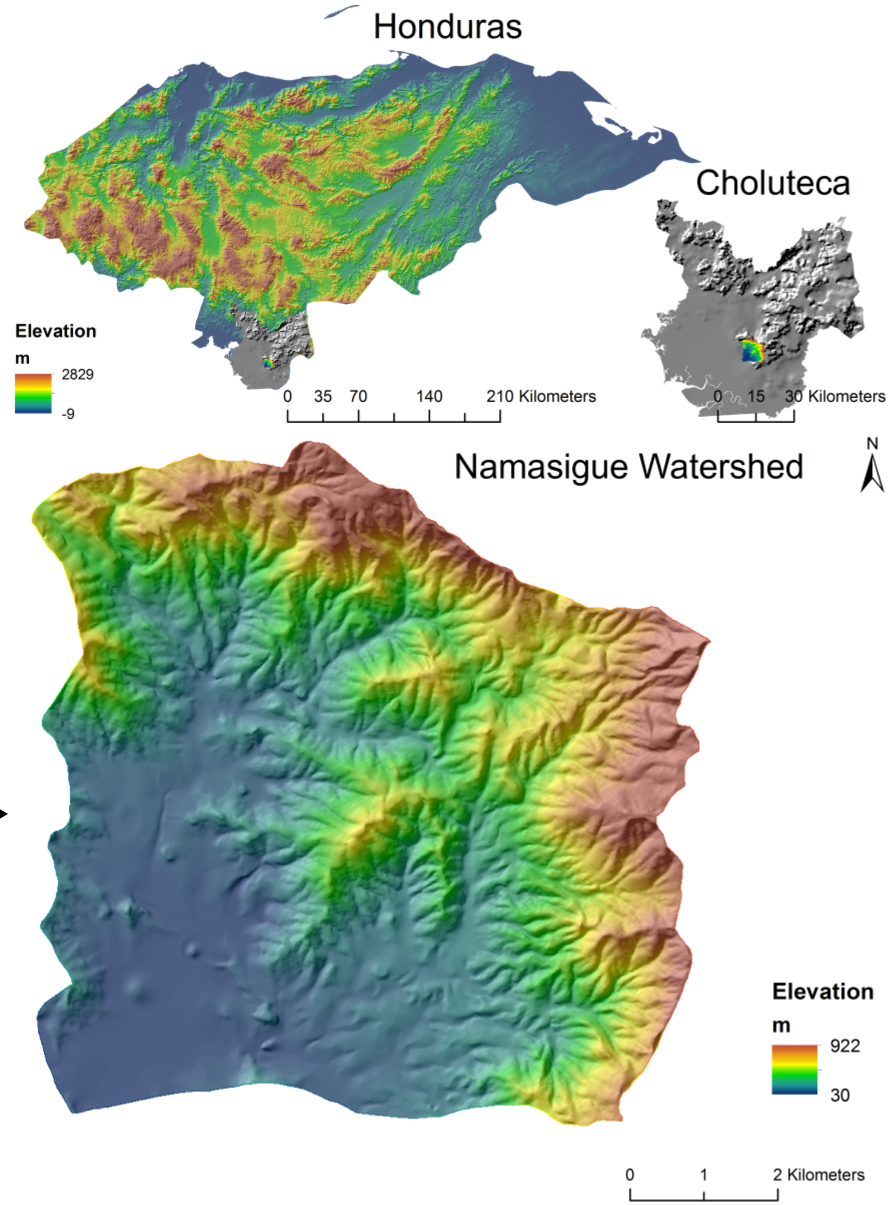
Functional Map Process Internationally

- Maps are being made for El Salvador, Honduras, Nicaragua and Guatemala, Kenya

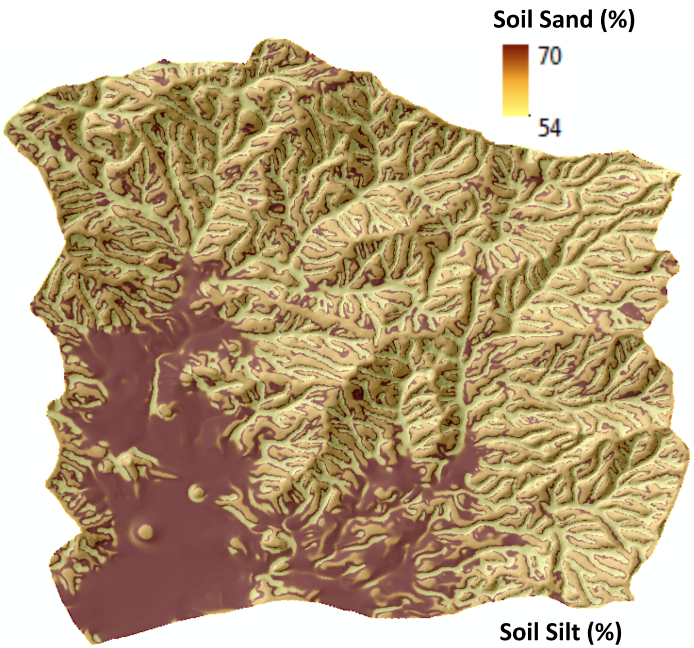
- Parts of Colombia, Brazil and Afghanistan

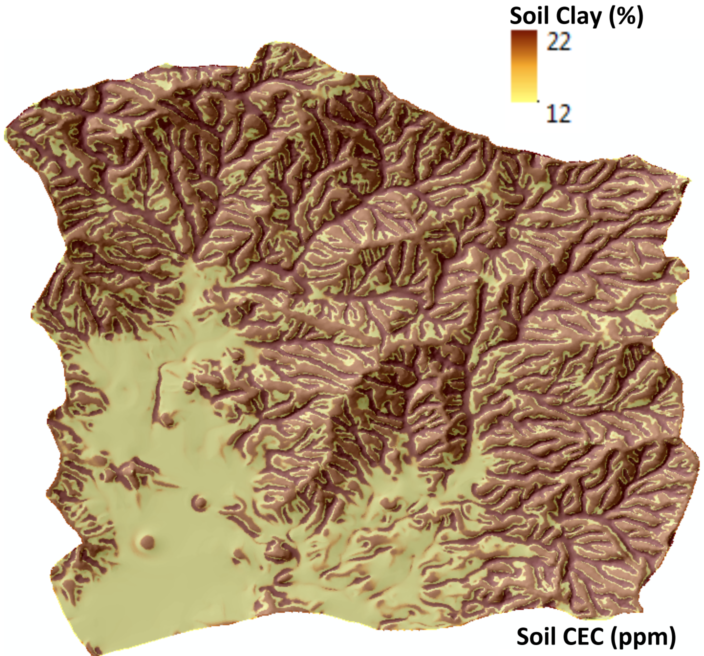
Namasigue Watershed Study Area at Los Espabeles - Honduras

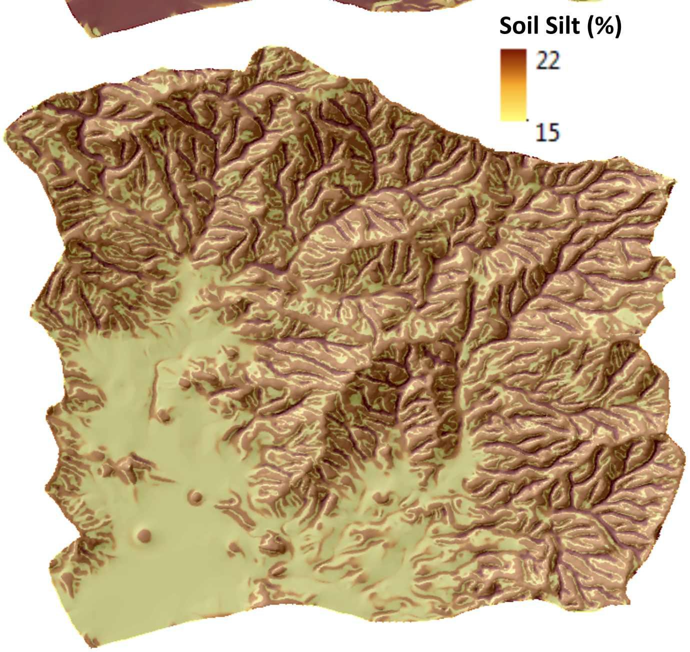
Approximate 10 m DEM was created from topography paper map of contours

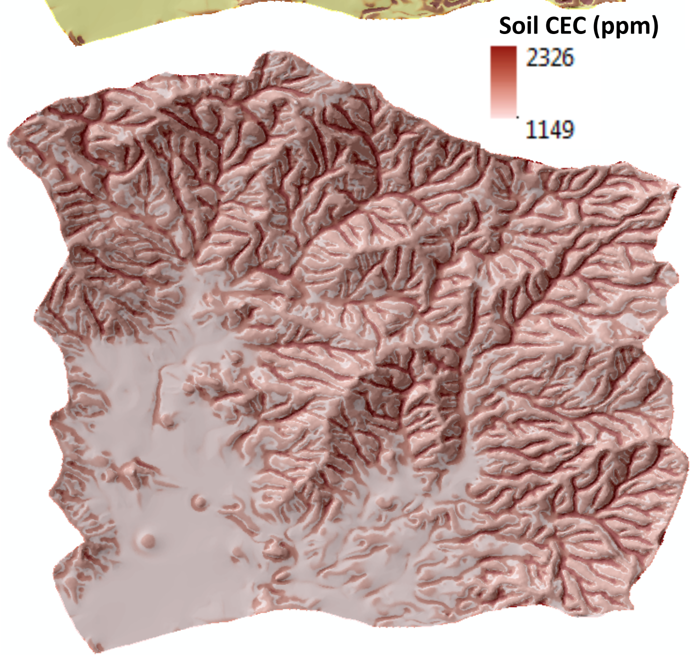


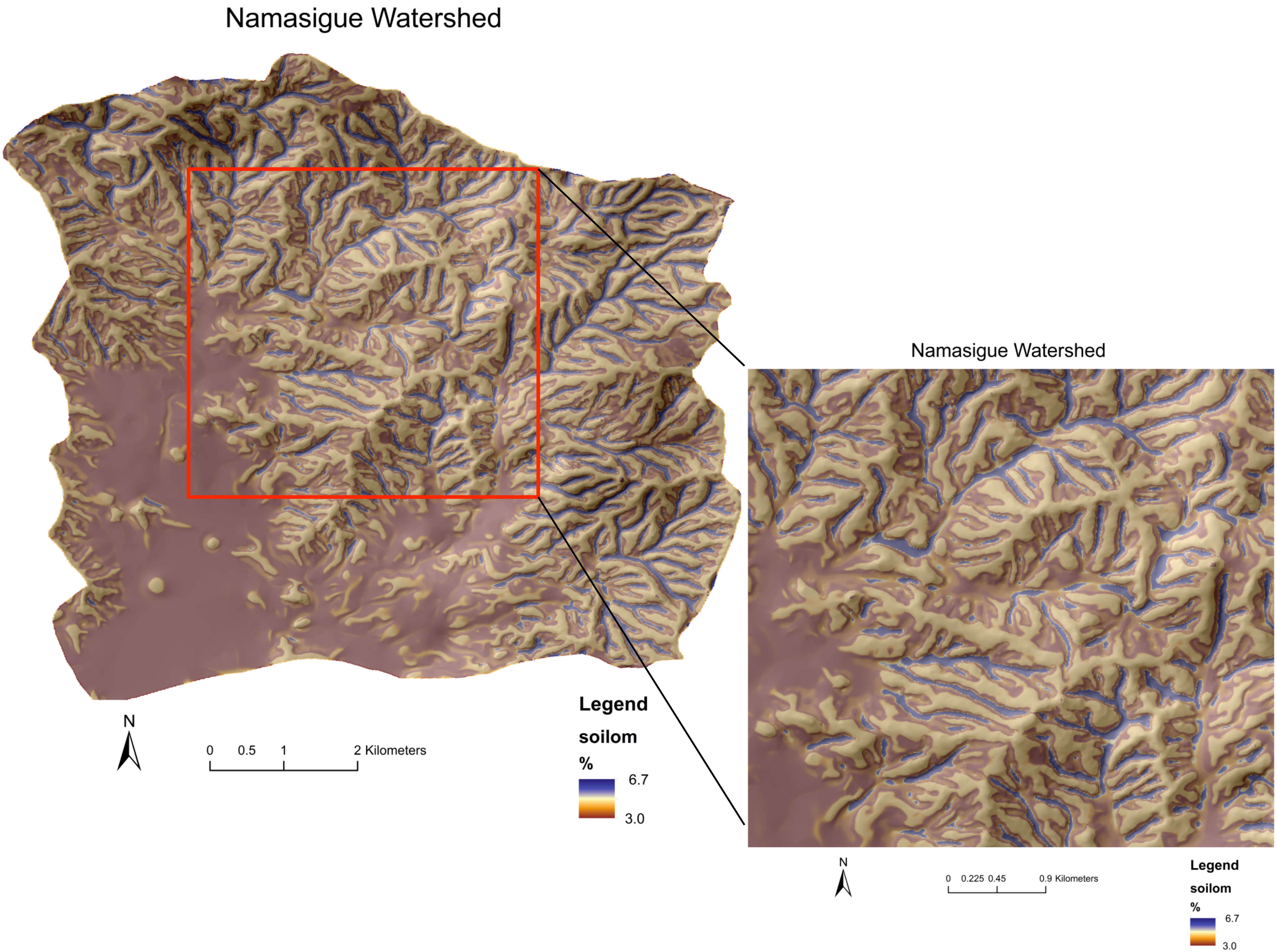
Creating Continuous Soil Property Maps

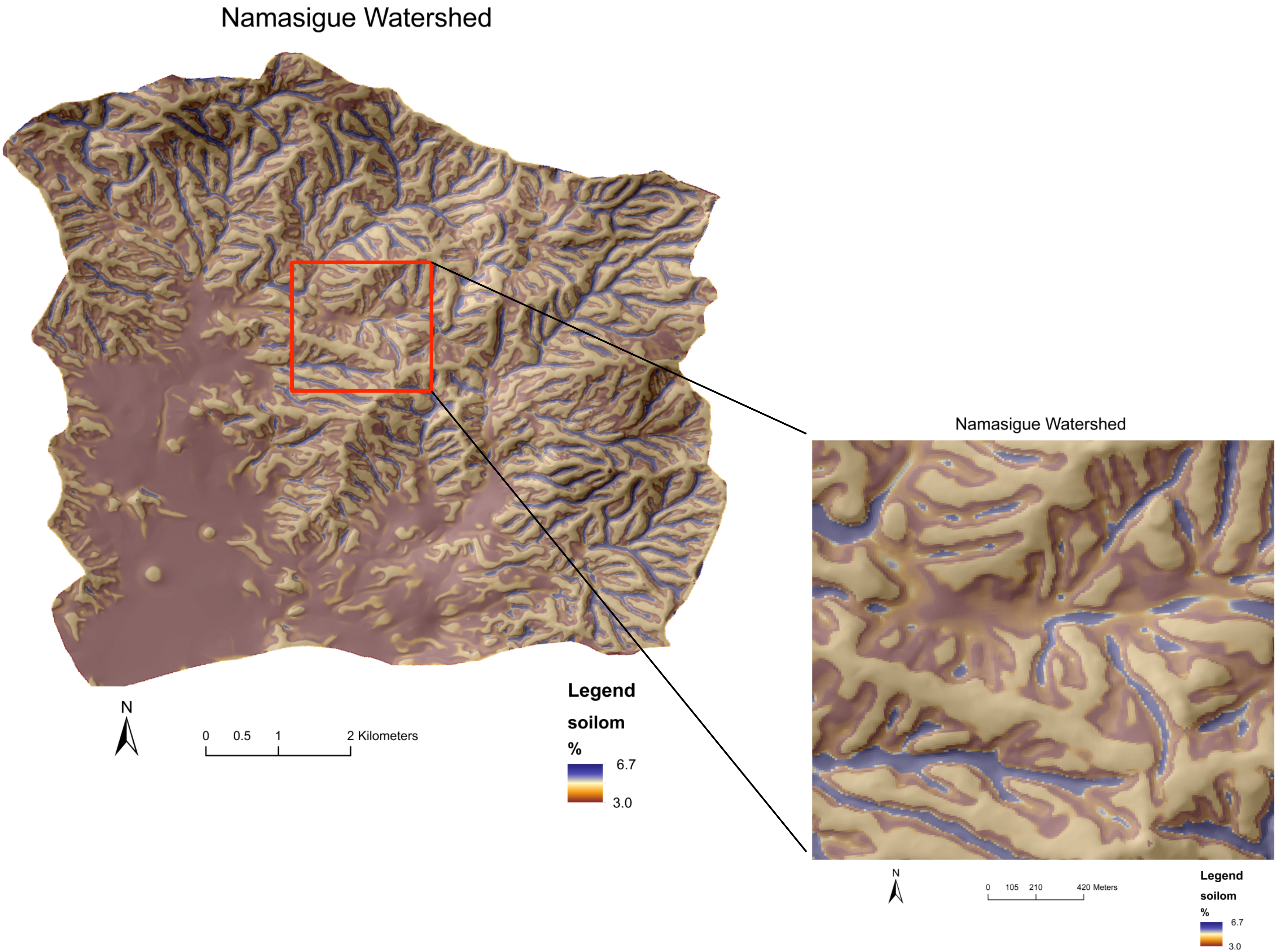


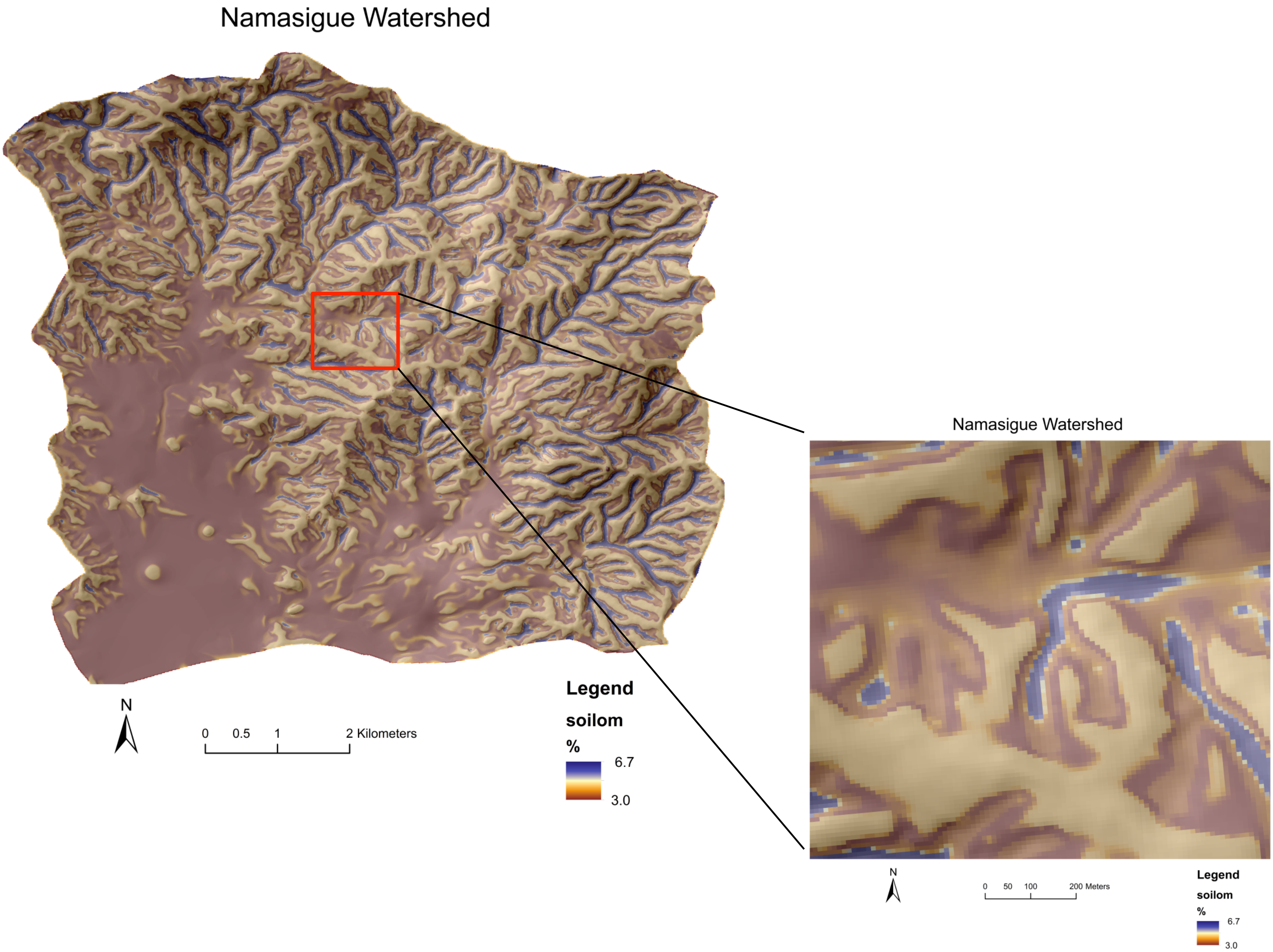




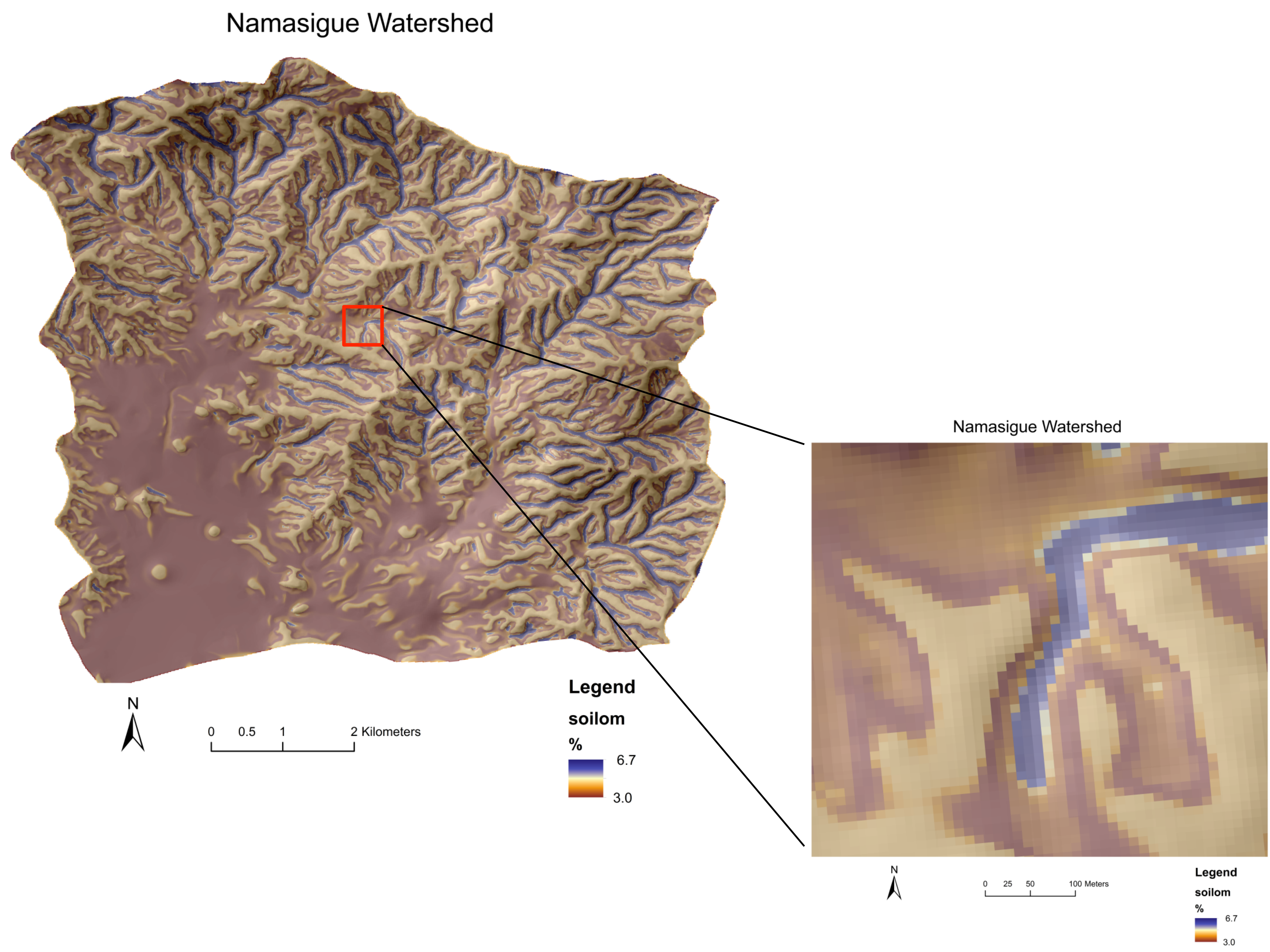



Namasigue Watershed
N
0 0.5 1 2 Kilometers
Legend
soilom
%
6.7
3.0
Namasigue Watershed
N
0 0.225 0.45 0.9 Kilometers
Legend
soilom
%
6.7
3.0


Namasigue Watershed
N
0 0.5 1 2 Kilometers
Legend
soilom
%
6.7
3.0
Namasigue Watershed
N
0 105 210 420 Meters
Legend
soilom
%
6.7
3.0



Namasigue Watershed
N
0 0.5 1 2 Kilometers
Legend
soilom
%
6.7
3.0
Namasigue Watershed
N
0 50 100 200 Meters
Legend
soilom
%
6.7
3.0


Namasigue Watershed
N
0 0.5 1 2 Kilometers
Legend
soilom
%
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Namasigue Watershed
N
0 25 50 100 Meters
Legend
soilom
%
6.7
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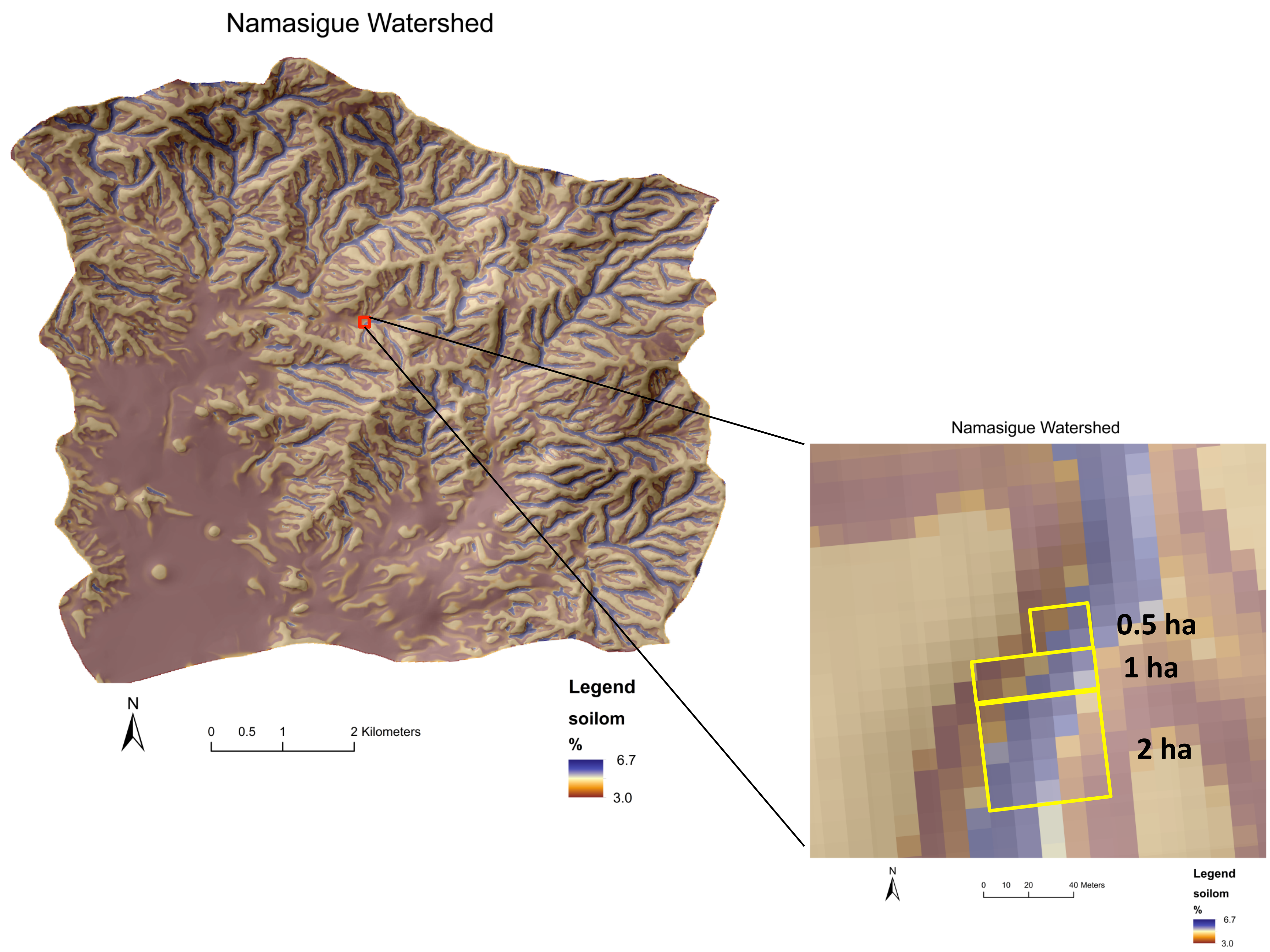
Namasigue Watershed
N
0 0.5 1 2 Kilometers
Legend
soilom
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Namasigue Watershed
0.5 ha
1 ha
2 ha
N
0 10 20 40 Meters
Legend
soilom
%
6.7
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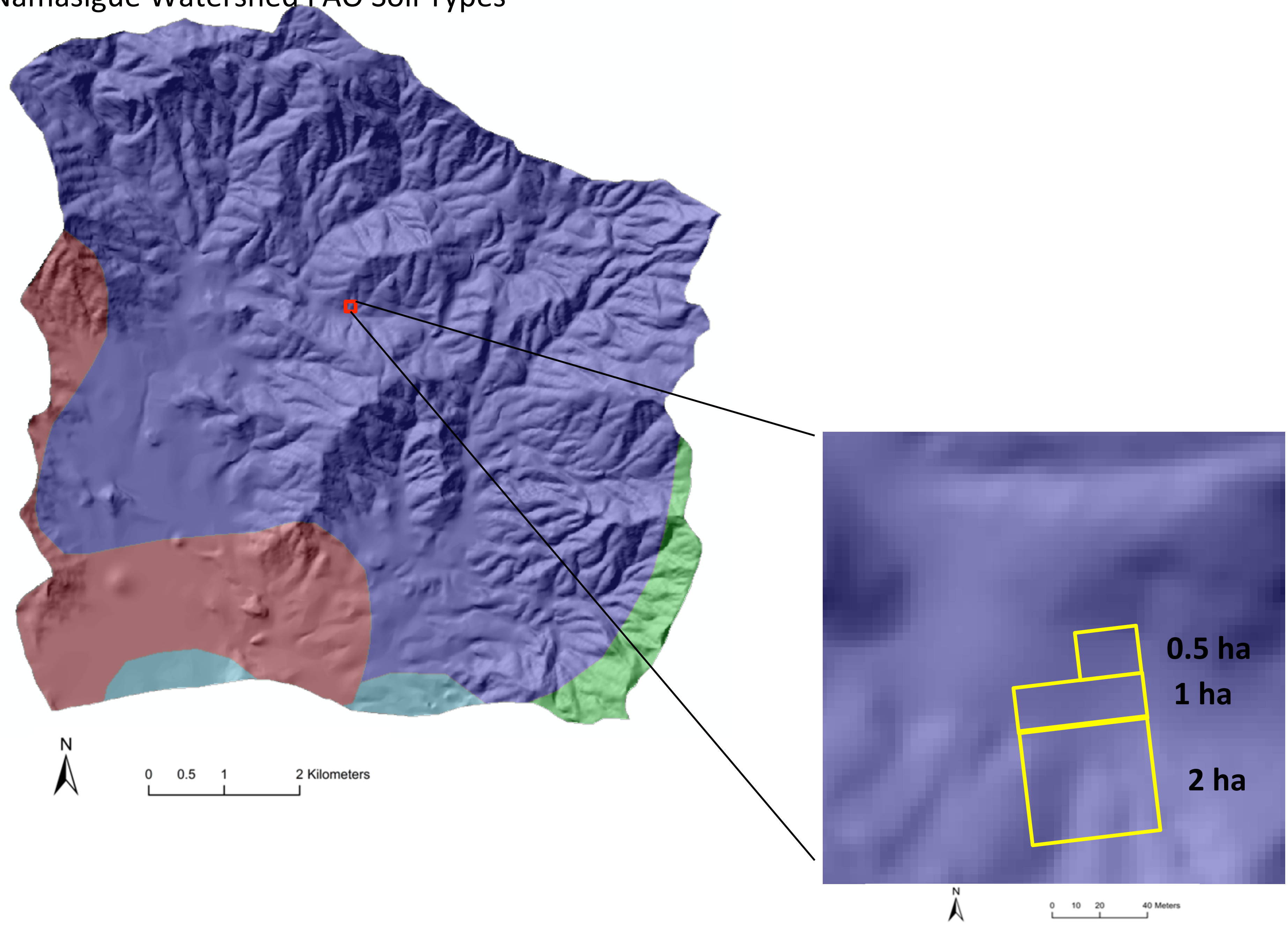
Namasigue Watershed FAO Soil Types



http://otc-prf.org/news/purdue-mapping-technology-could-help-farmers-better-understand-their-soils-functionality