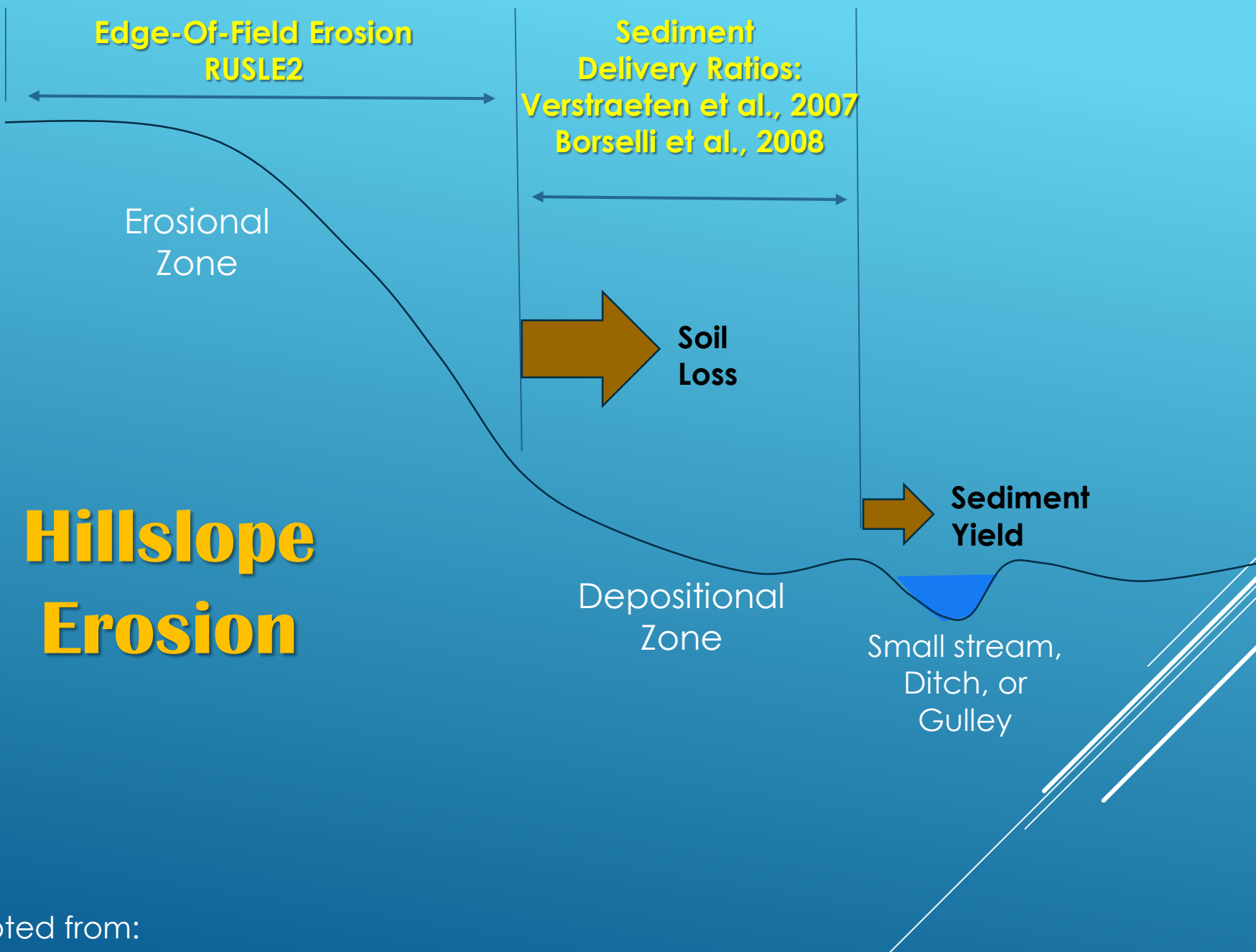# An Excellent Phase 6 Adventure:

Estimating Upland Erosion
&
Sediment Delivery
(to very small streams)

Peter Claggett and Gary Shenk, USGS
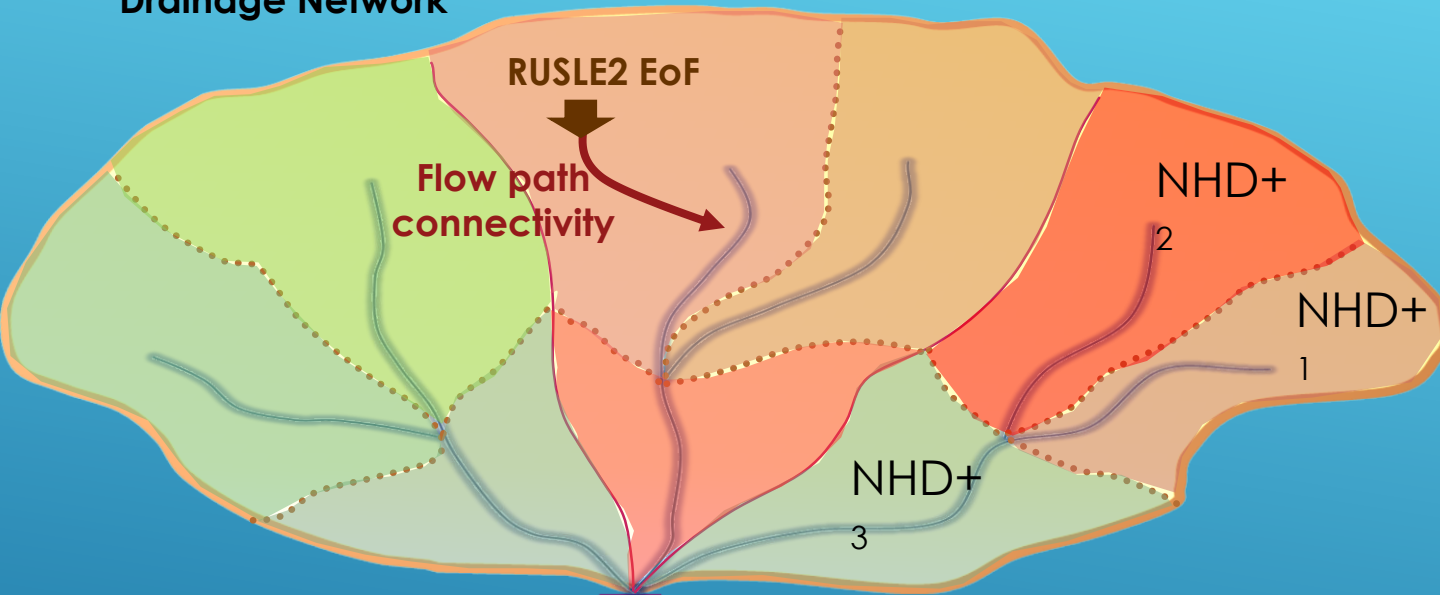David Saavedra and Alex Riddle, UMBC
Gopal Bhatt, Penn State/CBPO

November 3, 2015
CBP Modeling Quarterly
Annapolis, Maryland

Edge-Of-Field Erosion
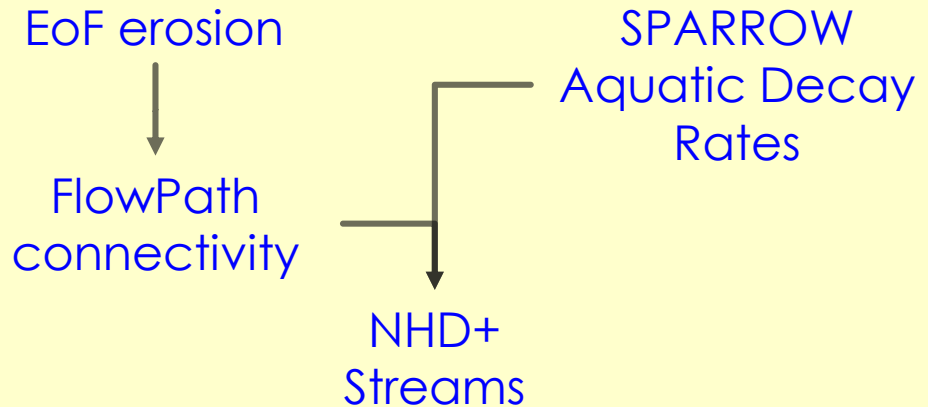RUSLE2

Sediment
Delivery Ratios:
Verstraeten et al., 2007
Borselli et al., 2008

Erosional Zone

Soil Loss

Hillslope Erosion

Depositional Zone

Sediment Yield

Small stream, Ditch, or Gulley

Adapted from:
http://www.ars.usda.gov/Research/docs.htm?docid=6016

Sediment Delivery to Simulated Rivers

Drainage Network

RUSLE2 EoF

Flow path connectivity

NHD+ 2

NHD+ 1

NHD+ 3

P6 Simulated River

Phase 6-beta Modeled NHD Catchment Processes

EoF erosion

SPARROW Aquatic Decay Rates

FlowPath connectivity

NHD+ Streams

Sediment Delivery to Simulated Rivers

Drainage Network

RUSLE2 EoF

Flow path connectivity

NOE

NHD+ 2

NHD+ 1

NOE

NHD+ 3
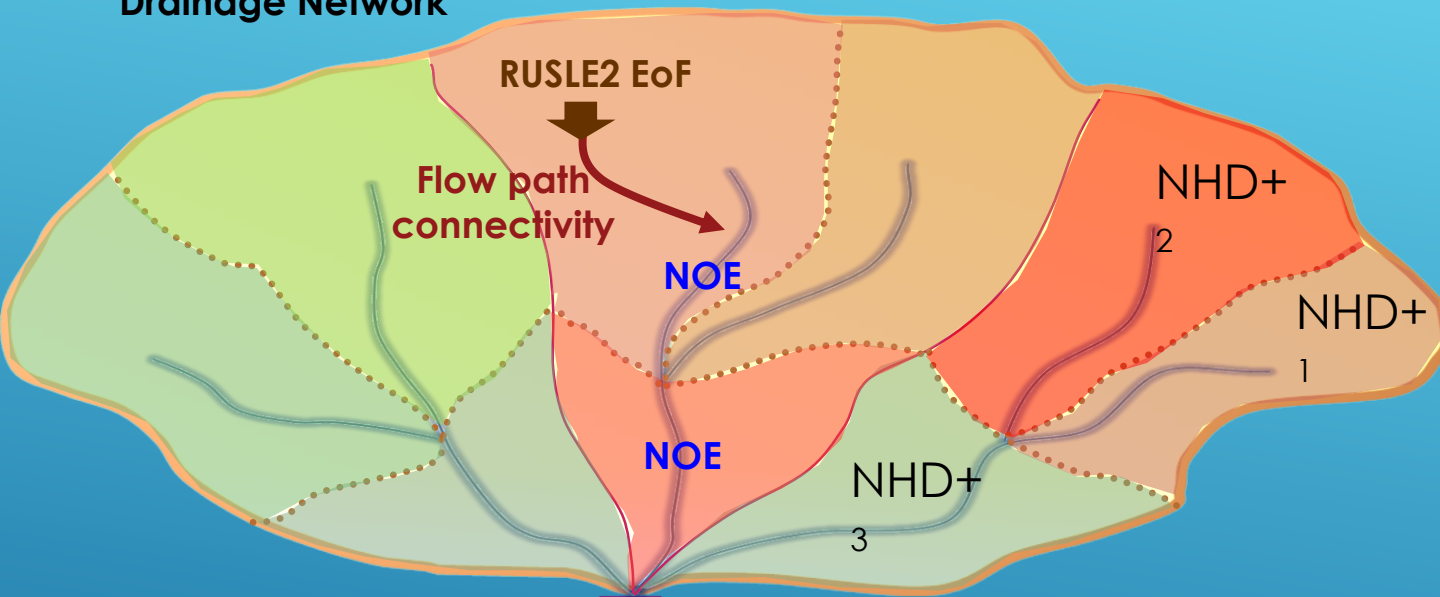
P6 Simulated River

**Phase 6 Modeled
NHD Catchment Processes**

EoF erosion

Bank Erosion

FlowPath connectivity

Floodplain Deposition

Synthetic Streams
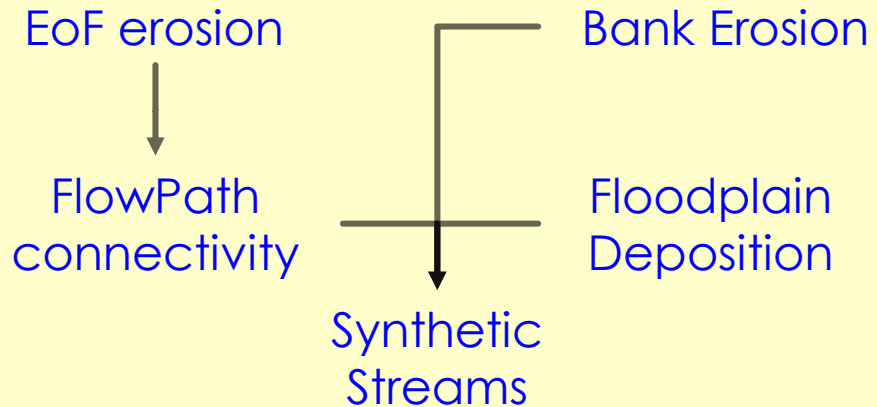
North Fork Shenandoah River
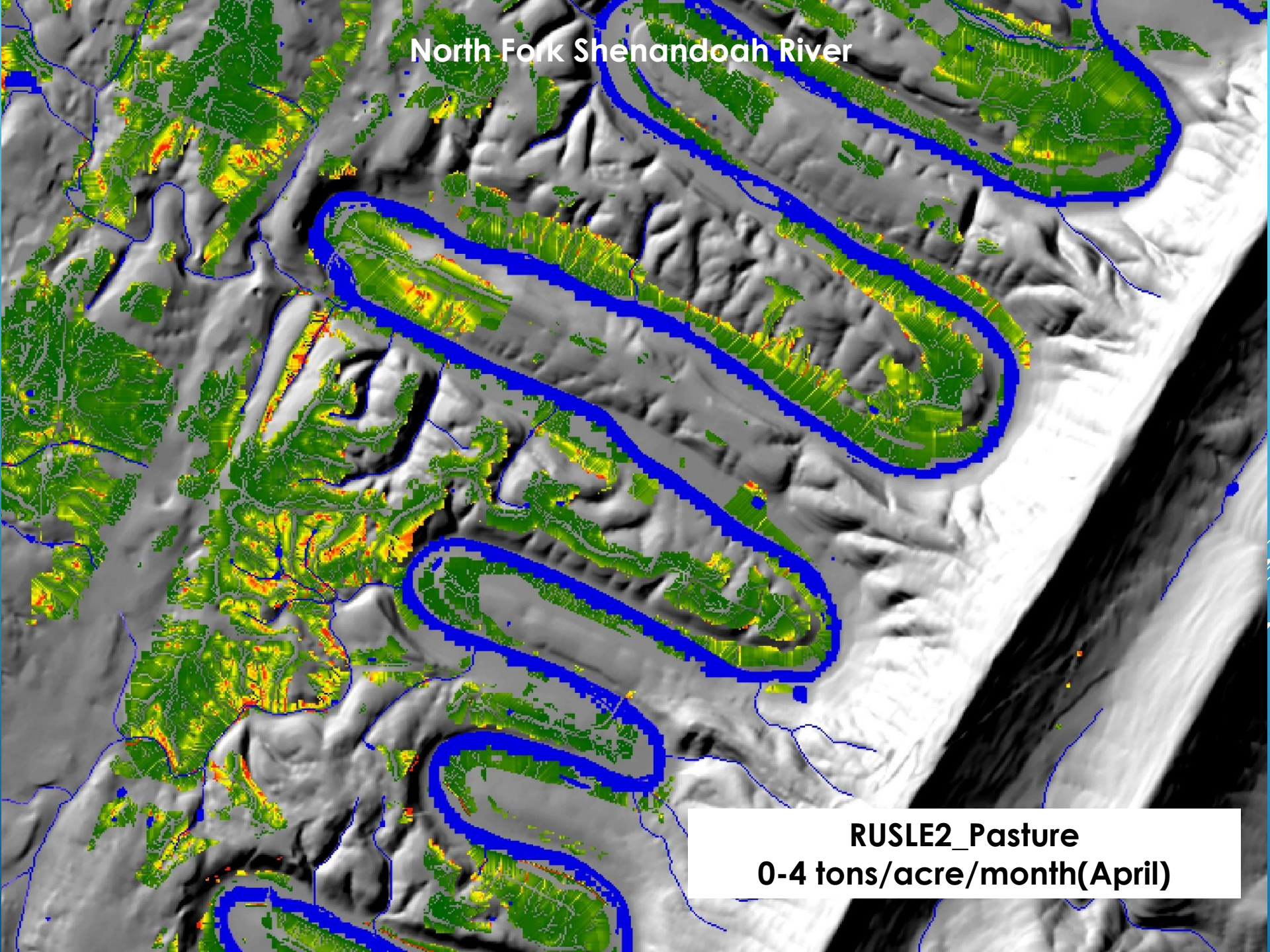
RUSLE2_Pasture
0-4 tons/acre/month(April)

Revised Universal Soil Loss Equation 2

Erosion (tons/acre/yr):

$$r * k * l * s * c * p$$

where,
r = erosivity factor
k = soil erodibility factor,
l = slope length factor,
S = slope steepness factor,
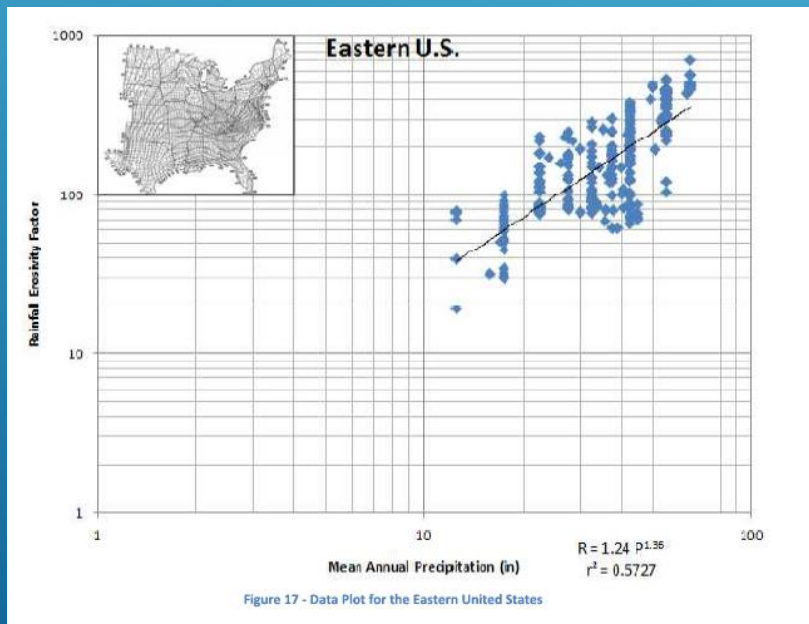c = cover-management factor, and
p = supporting practices factor (assumed to equal "1" due to lack of data)
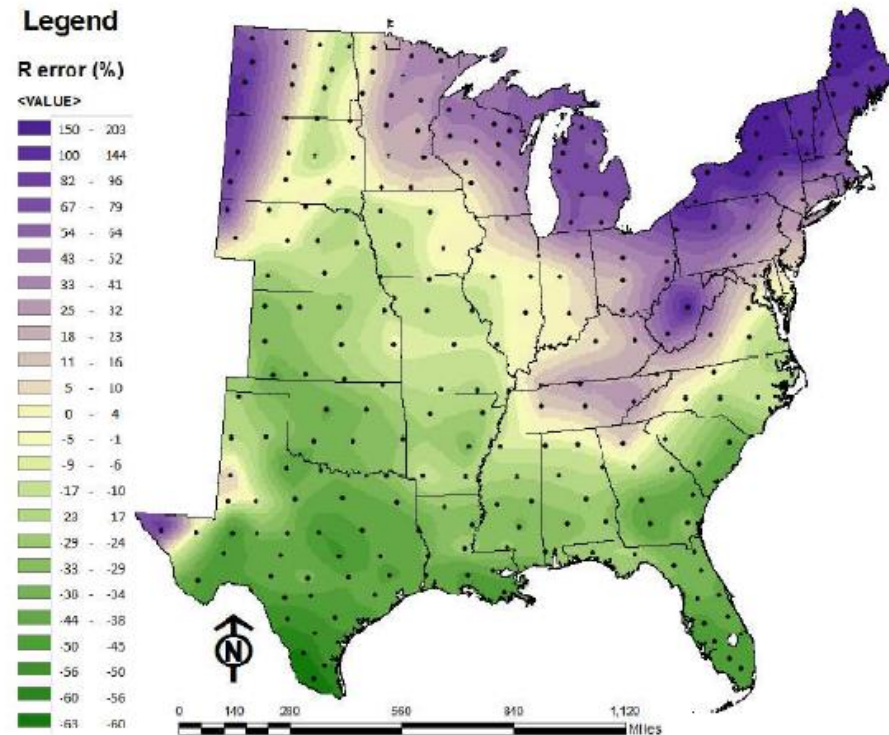
r –> Erosivity Factor (monthly)

$r = 1.24 * p^{1.36}$

p = precipitation (inches)

Cooper's equation* relates the storm intensity and kinetic energy required to initiate motion of sediment particles to annual precipitation. Long-term (30-year monthly mean precipitation data from PRISM (800m2-resolution) was used to represent "p".

Figure 17 - Data Plot for the Eastern United States

*http://www.engr.colostate.edu/~pierre/ce_old/Projects/linkfiles/Cooper%20R-factor-Final.pdf

Figure 25 - Error Between the Actual and Predicted R-Factors in the Eastern United States

k$_w$ –> Soil Erodibility Factor

Now with Rocks!

Represents susceptibility of soil to erosion and the rate of runoff.

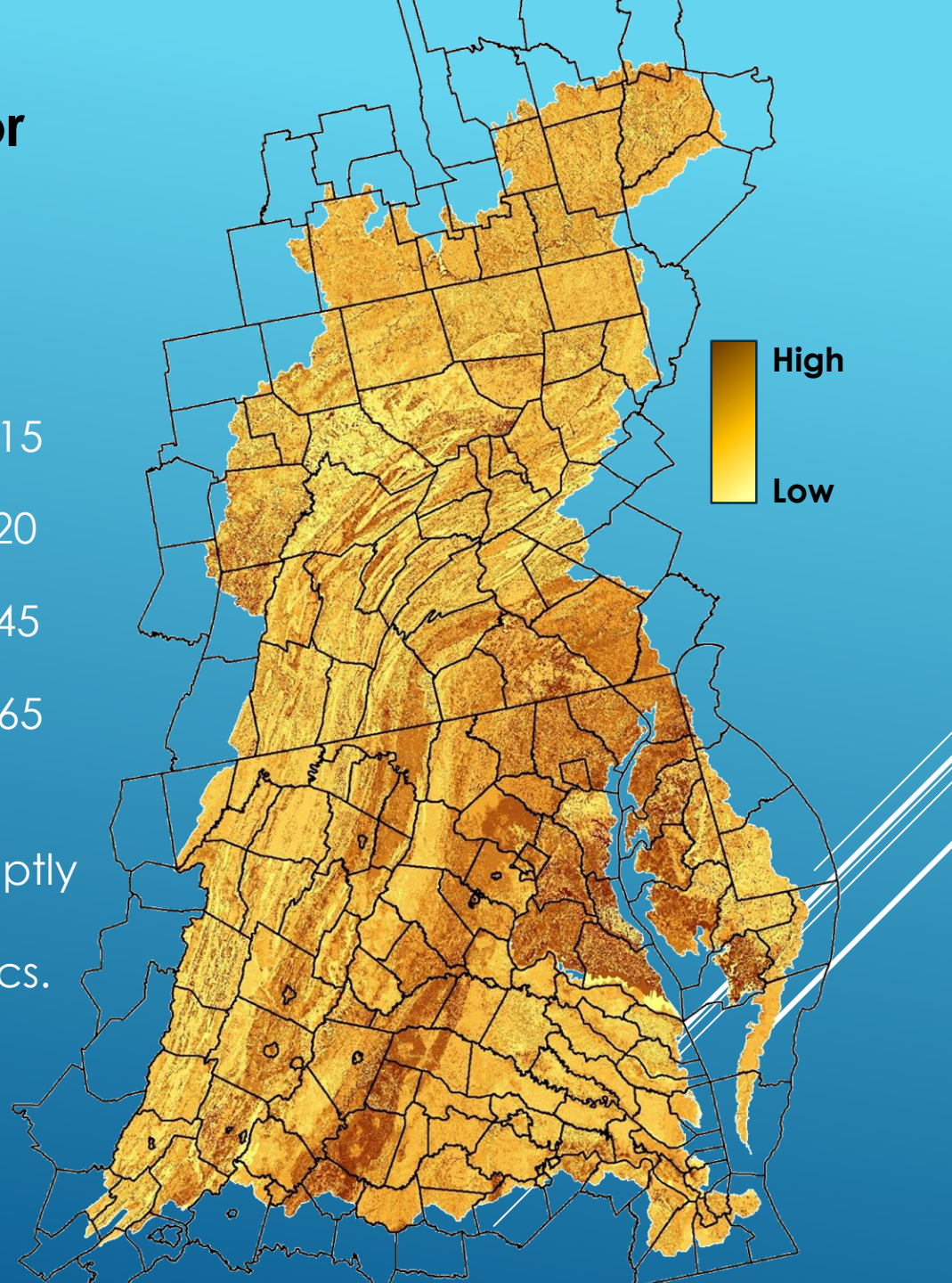Fine textures: (clays)   0.05-0.15

Coarse textures: (sands)   0.05-0.20

Medium textures: (loams)   0.25-0.45

Silts: 0.45-0.65

K-factor values may change abruptly at county lines due to varying interpretations of soil characteristics.

c –> Crop Management Factor
(monthly for crop, pasture, turf, impervious, forest)

- crop type,
- planting/grazing date,
- Planting technique
- Harvesting/grazing end date
- Harvesting/grazing

Crop Management Zones

C-factors estimated separately for:

Alfalfa Hay Harvested Area	Potato
Broccoli, spring	Snap Beans
Cabbage	Soybean
Corn & Wheat	Soybean & Wheat
Corn for Grain	Tomato
Corn for Silage	Watermelon
Cucumber	Wheat for Grain
Other managed hay Harvested Area	Soybean Wheat - Relay
Pasture / Range	

CMZ 04.1
CMZ 65
CMZ 62
CMZ 66
CMZ 59
CMZ 64
CMZ 67

0 25 50 100 Miles
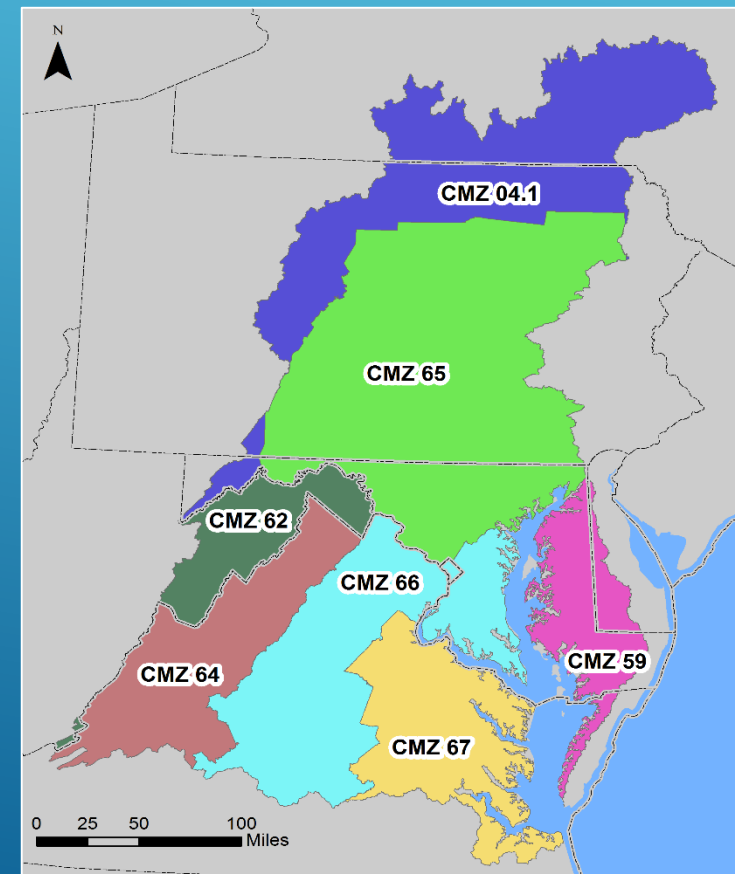
L –> Slope Length Factor
(relative to a 22.1m field unit with uniform 9% slope)

$$L = (m+1)(Area/22.1)^m$$

Area = upslope drainage area (m^2)
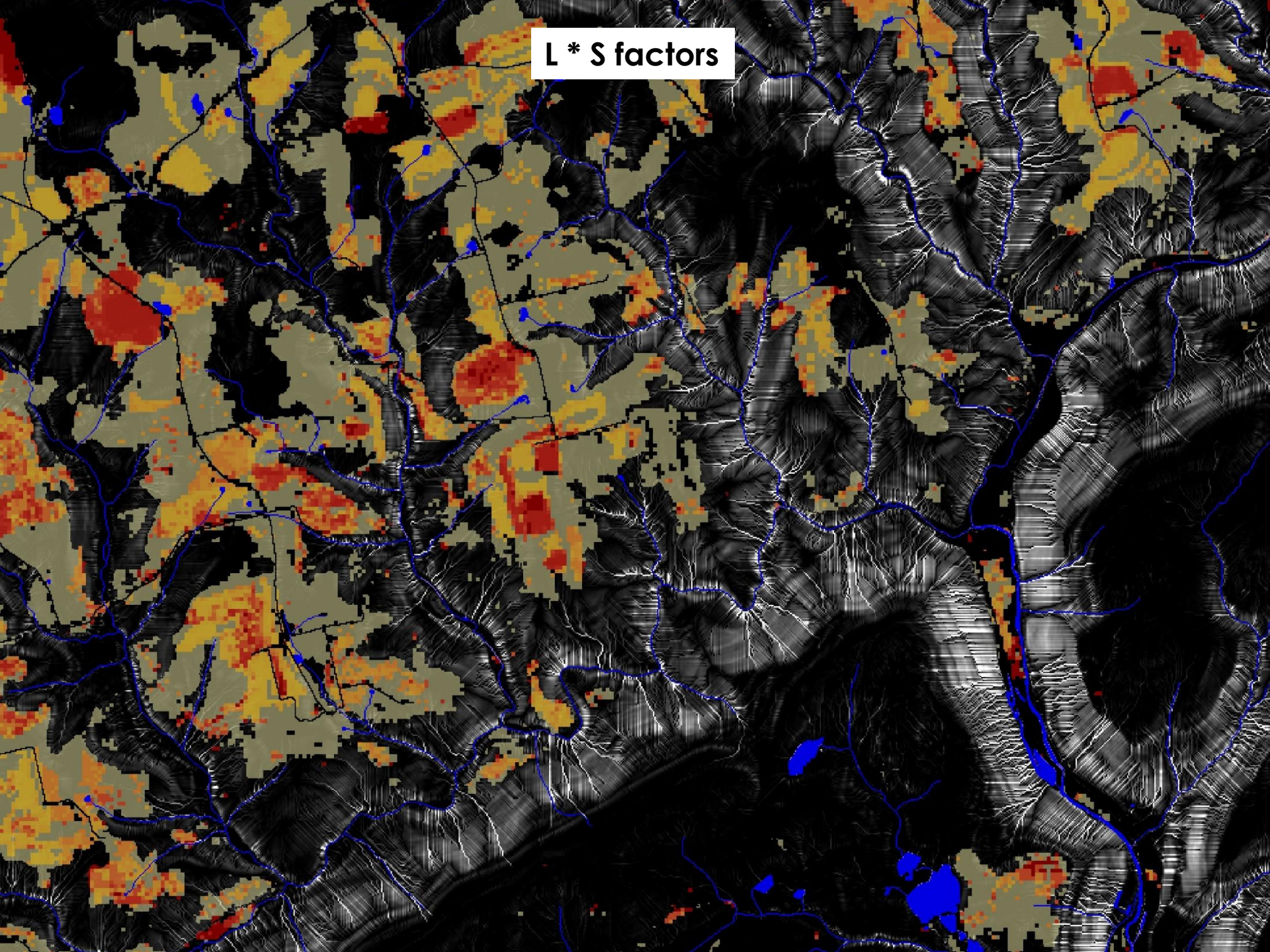m = empirical measure of soil susceptibility to erosion, aka the rill-to-interrill ratio.

S –> Slope Steepness Factor
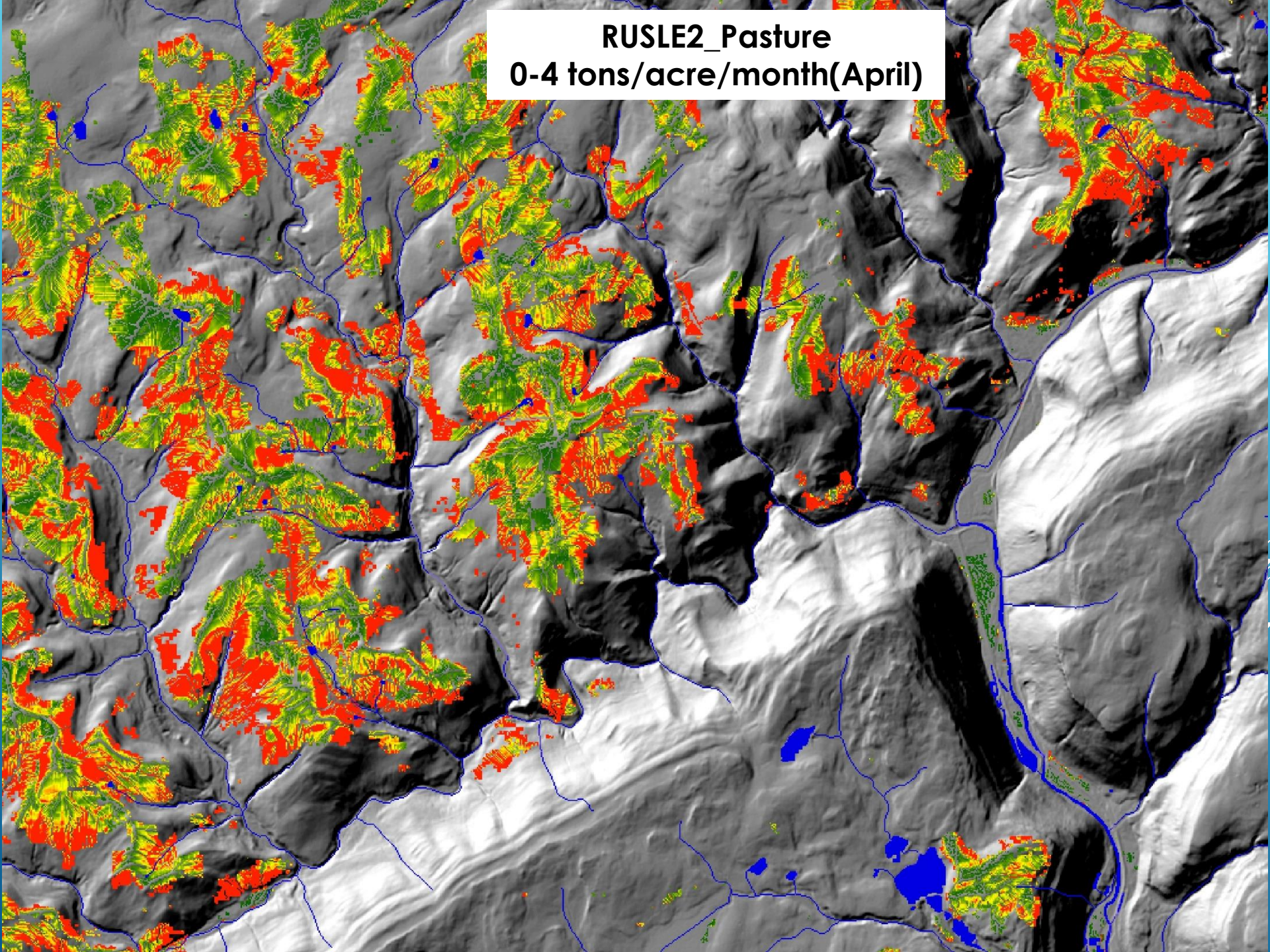
$$S = sin(t)/0.09)^{m+1}$$

t = slope in radians

L * S factors

RUSLE2_Pasture
0-4 tons/acre/month(April)

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