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Yale School of Forestry and
Environmental Studies

Assessing the Impact of the Rains on Travel to Eastern Mennonite University

The Task

The final meeting for this year's mud sale is to be held next Saturday at Eastern Mennonite University, and it is expected draw participants from Amish homes throughout the Stauffer Run watershed. About 100 will be arriving by scooter, and they may well have to contend with the impact of extraordinarily heavy rains that are now forecast for Friday evening. Your task is to assess that impact, given the several assumptions that are presented on the following page. In particular, two questions must be answered.

1) By what percentage will the rain increase travel time from any given location?
2) By what percentage will the rain increase or decrease scooter traffic over any given location?

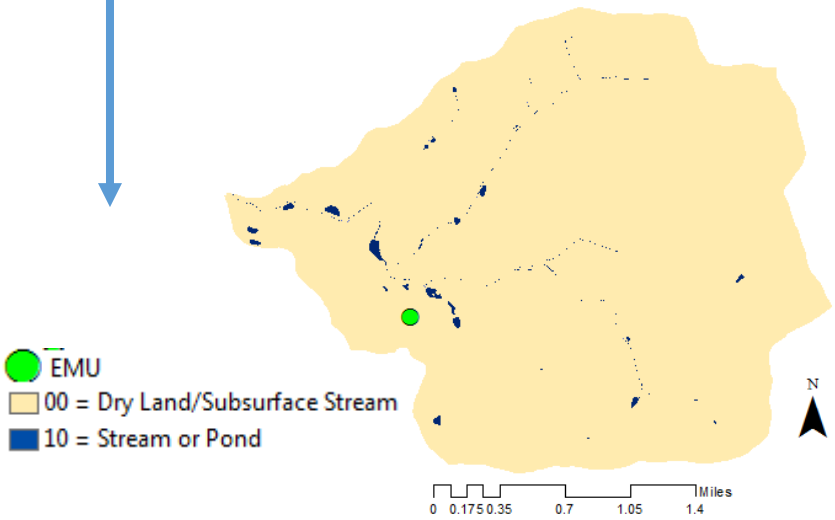

Before the Rains!

Combine Development and Hydrology Layers

1) Reclassify hydrology layer

Old values	New values
00 = Dry Land	0
01 = Subsurface Stream	0
02 = Stream or Pond	10
NoData	NoData

2) Use raster calculator to combine the reclassified hydrology & development layers



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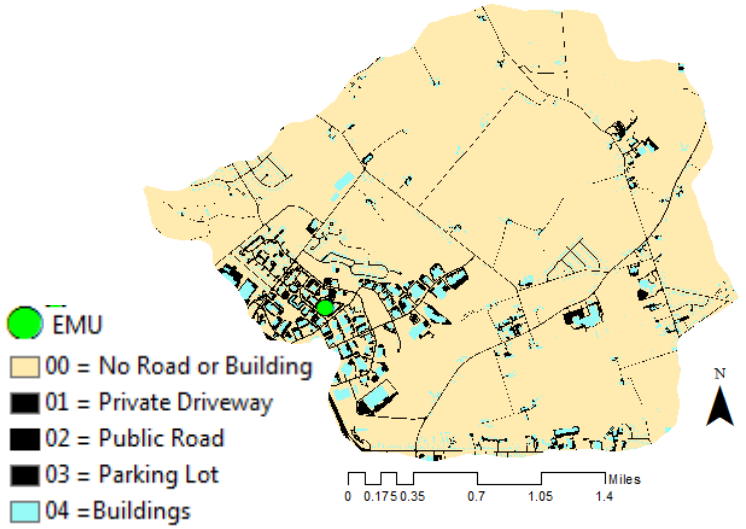

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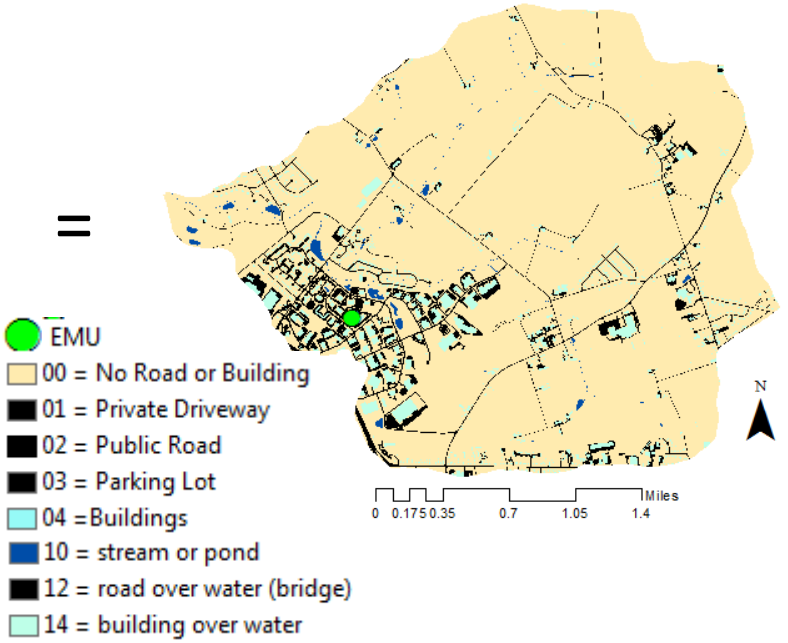
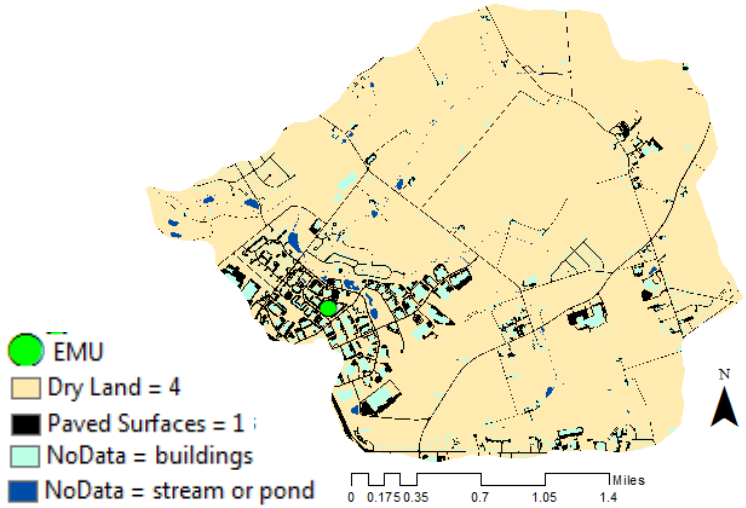


Travel Times Before the Rains

1) Create “friction” layer for Time 1 (T1): Before the Rains

Old values	New values
0	4
1	1
2	1
3	1
4	NoData
10	NoData
12	1
14	NoData

Use reclassify to assign “friction” values to land cover types. “Friction” represents the speed (per pixel width) at which the pixel could be traversed (orthogonally). Here, a value of 4 indicates that that pixel could be traversed at a rate of 4 meters per second.



2) Reclassify “termini” layer, into 2 distinct component layers

1) The first layer specifies a real value only for the **pixel location of Eastern Mennonite University**.

termini

Rowid	VALUE	COUNT
0	1	100
1	2	1

These layers will be used as inputs to subsequent operations

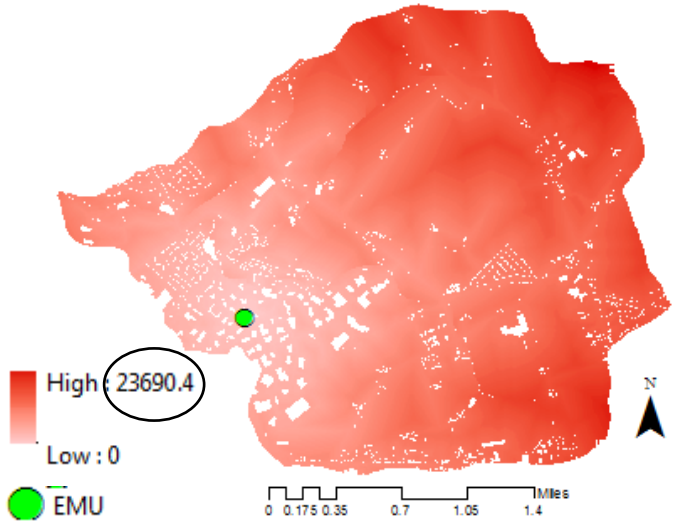
2) The second layer specifies a real value only for **the pixel locations of the Amish attendees.**

Old values	New values
1	NoData
2	2
NoData	NoData

Old values	New values
1	1
2	NoData
NoData	NoData

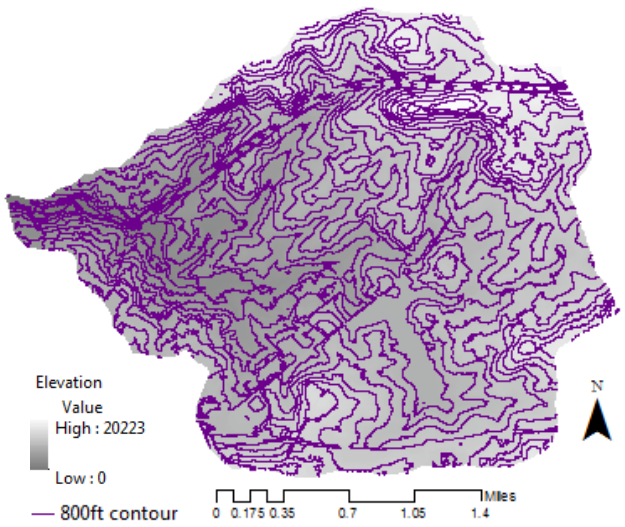
3) Cost Distance

Generates a grid for which each pixel’s value indicates its distance to EMU in terms of the minimal accumulation of incremental costs or “friction” values associated with intervening pixels. For the pixel with the highest travel time, it would take 23,690 seconds (over 6 hours!) to reach EMU.



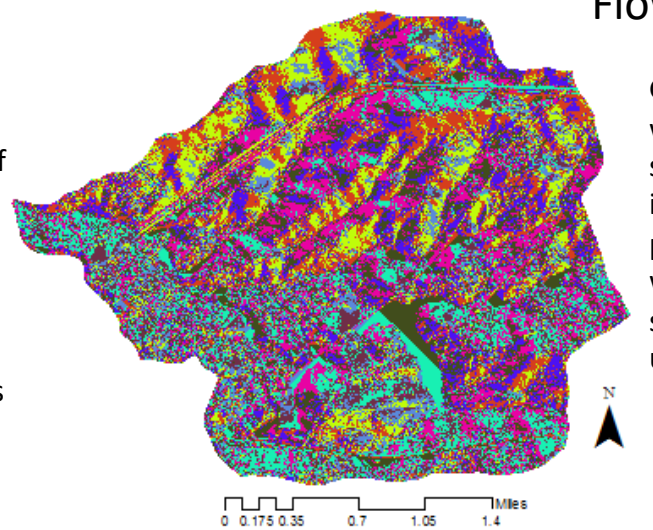
After the Rains!

Assessing Impact of Rains on Soil Wetness and Flooding



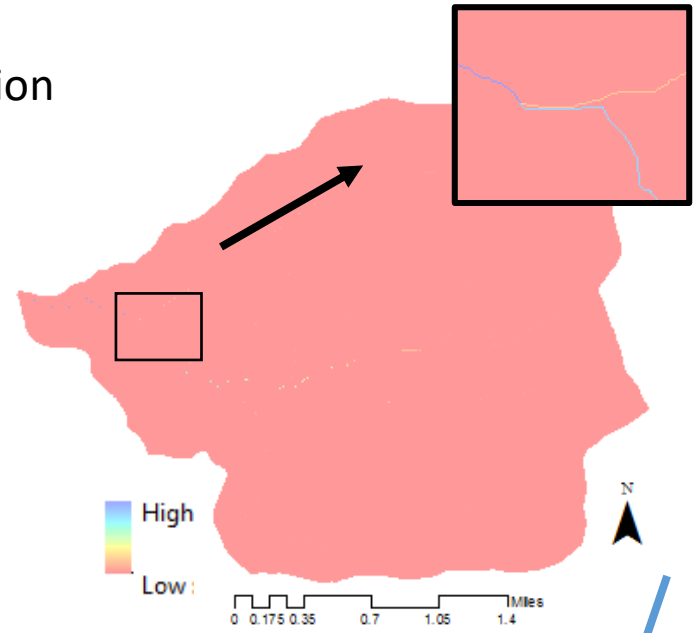
Flow Direction

Generates a grid from the elevation layer showing the direction of downstream flow from each pixel to one or more of its adjacent neighbors. Each color represents a different direction of flow. This is a prerequisite step for the flow accumulation operation.



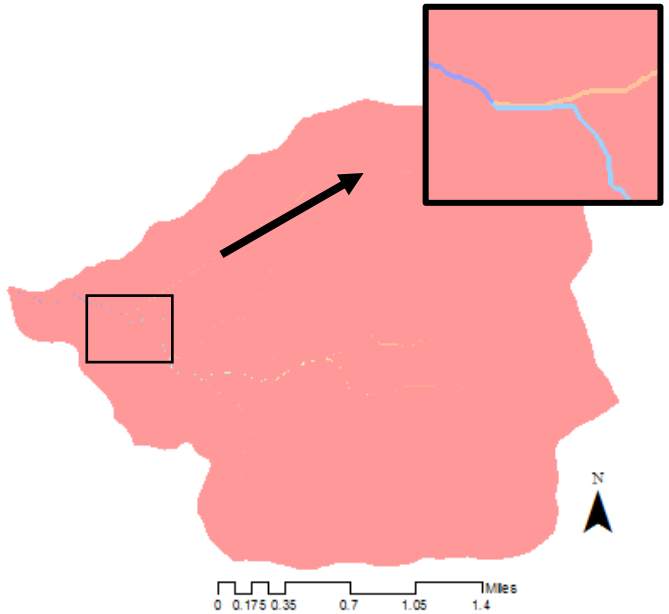
Flow Accumulation

Generates a grid in which each pixel is set to a value indicating that pixel's upstream watershed (the sum of all pixels upstream of it).



Focal Maximum

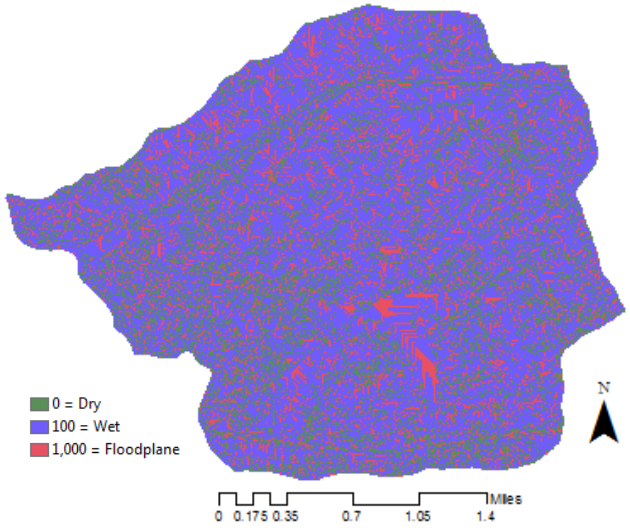
Each pixel takes on the maximum watershed value of all pixels within a 5 meter radius. From a birds-eye perspective, this results in a buffering effect of high value pixels. (Compare zoom-in here and in previous map). These values will serve as the basis for our classification of water saturation levels across the landscape.



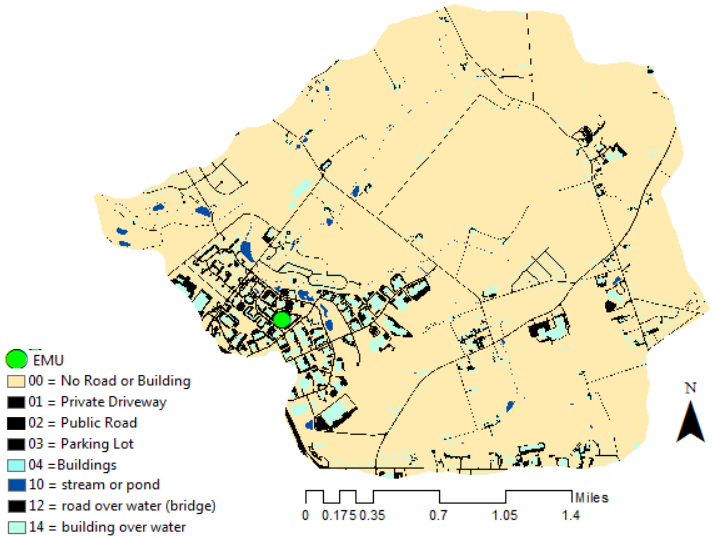
Reclassify

Old values	New values
0 - 5	0
5 - 200	100
200 - 13626910	1000
NoData	NoData

Reclassify to distinguish between dry land, wet land, and floodplain (post rain) according to criteria outlined in the assignment parameters



Assessing Impact of Rains on Soil Wetness and Flooding (Continued)



Raster Calculator

Combine the wetness layer with development/ hydrology layers

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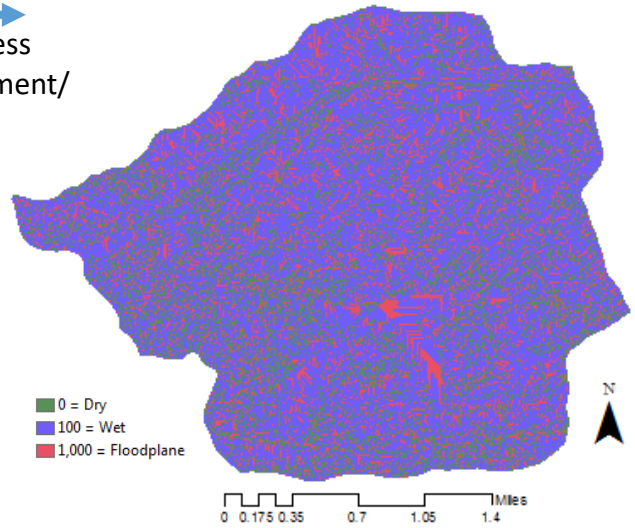

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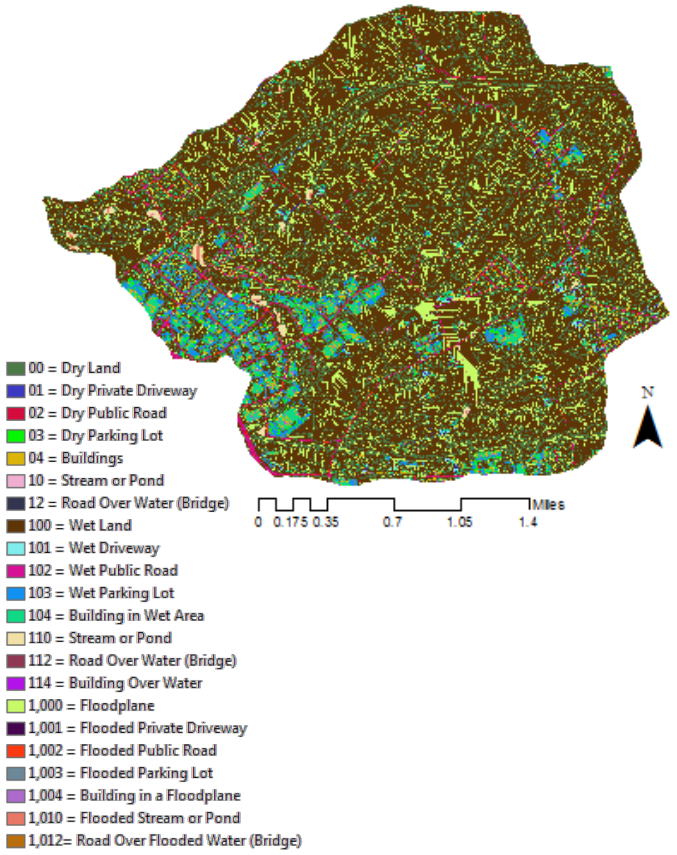
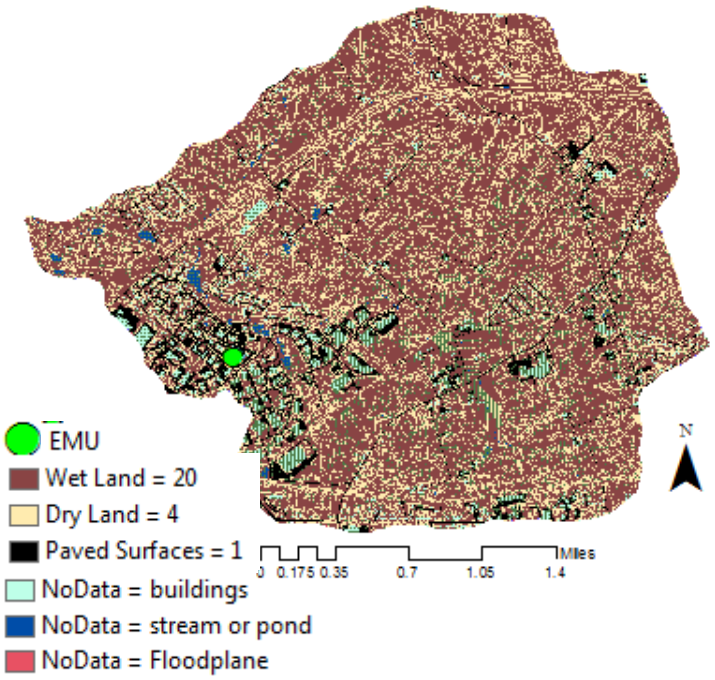


Travel Times After the Rains

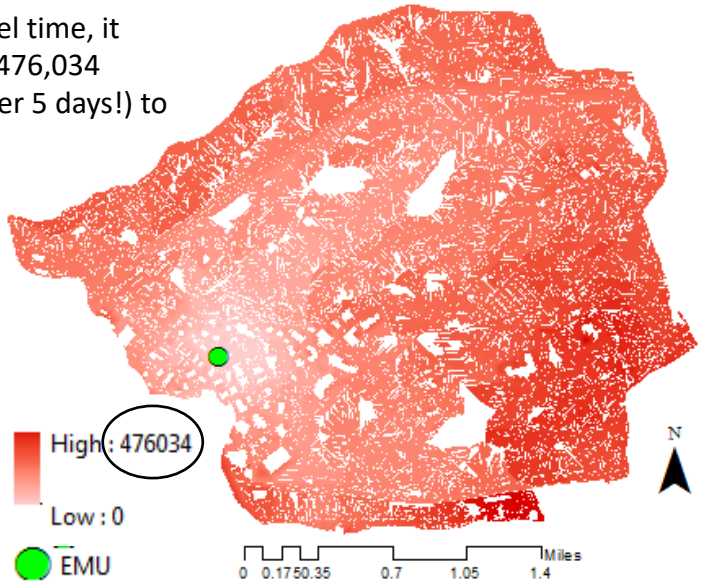
Reclassify to adjust “friction” layer for Time 2 (T2): After the Rains

- 00 = Dry Land -> 4
- 01 = Dry Private Driveway -> 1
- 02 = Dry Public Road -> 1
- 03 = Dry Parking Lot -> 1
- 04 = Buildings -> NoData
- 10 = Stream or Pond -> NoData
- 12 = Road Over Water (Bridge) -> 1
- 100 = Wet Land -> 20
- 101 = Wet Driveway -> 1
- 102 = Wet Public Road -> 1
- 103 = Wet Parking Lot -> 1
- 104 = Building in Wet Area -> NoData
- 110 = Stream or Pond -> NoData
- 112 = Road Over Water (Bridge) -> 1
- 114 = Building Over Water -> NoData
- 1,000 = Floodplane -> NoData
- 1,001 = Flooded Private Driveway -> 1
- 1,002 = Flooded Public Road -> 1
- 1,003 = Flooded Parking Lot -> 1
- 1,004 = Building in a Floodplane -> NoData
- 1,010 = Flooded Stream or Pond -> NoData
- 1,012= Road Over Flooded Water (Bridge) -> 1



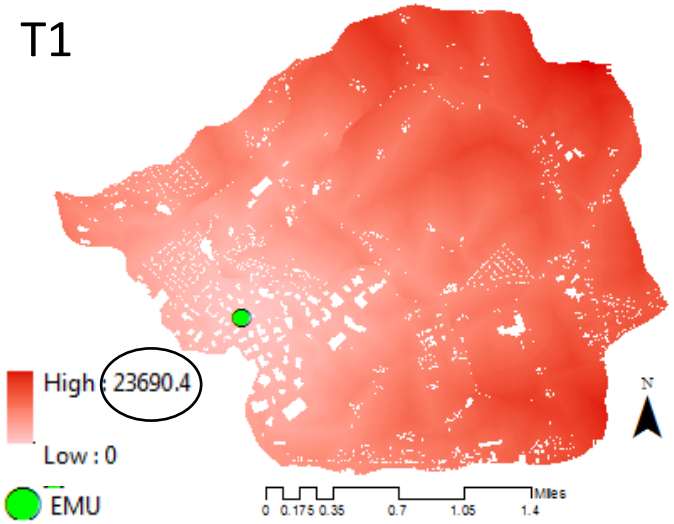
Cost Distance

For the pixel with the highest travel time, it would take 476,034 seconds (over 5 days!) to reach EMU

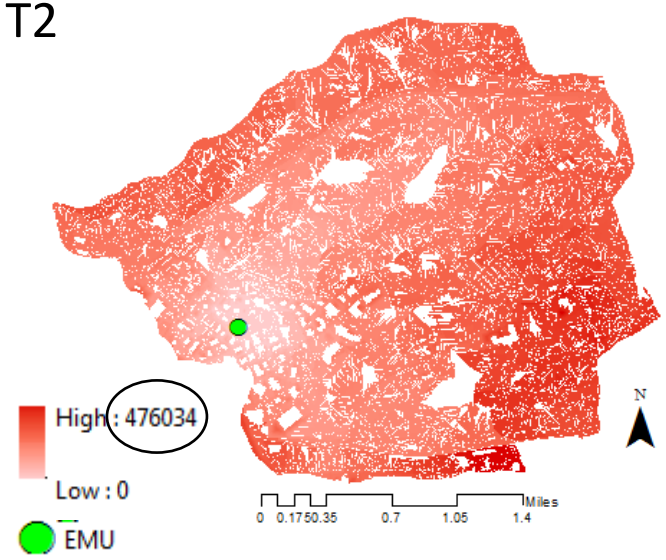


Calculating Percentage Change in Travel Time Before and After the Rains

T1

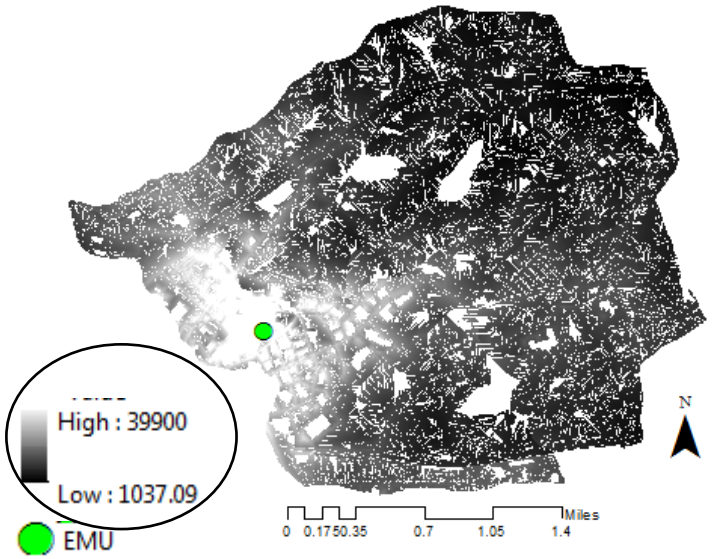


T2



Raster Calculator

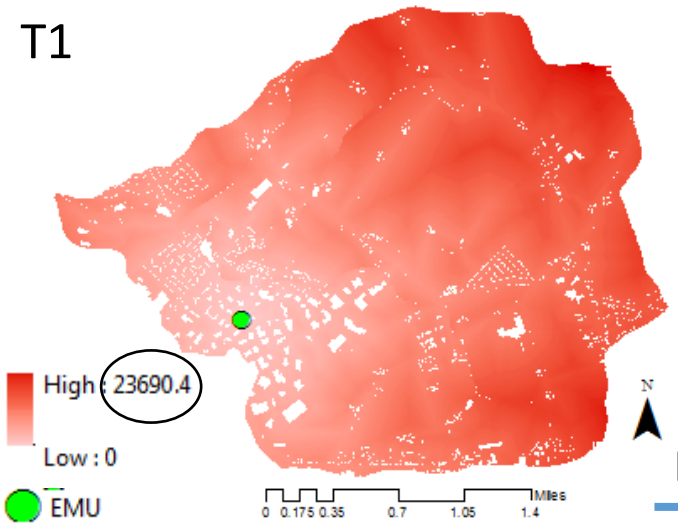
[(T2-T1)/T1] *100



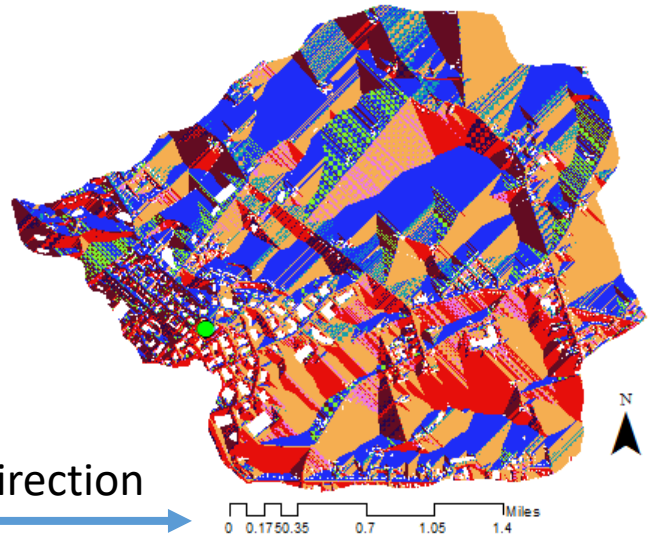
Travel time is projected to increase ~1000% to ~40000% after the rains!

Calculating Traffic Before and After the Rains

T1



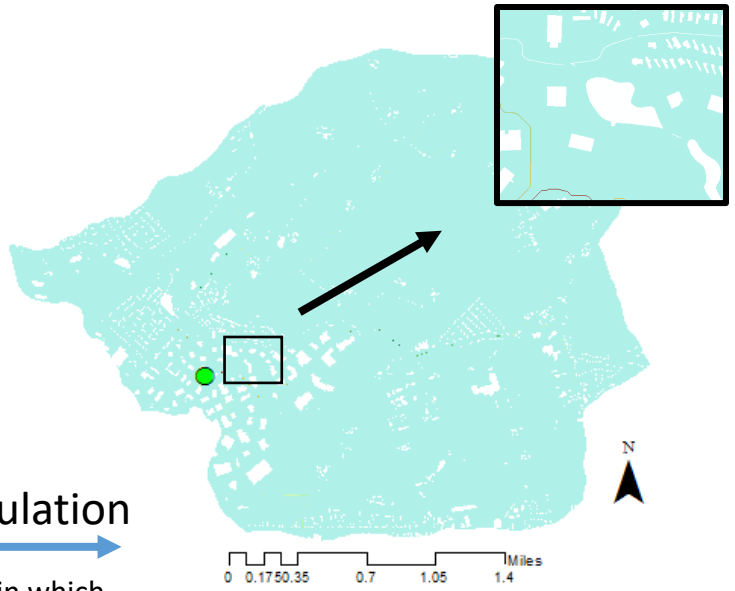
Flow Direction



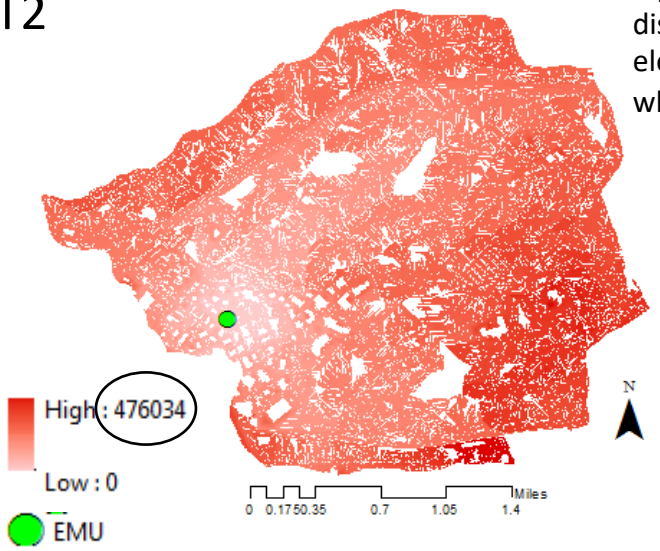
Calculate flow direction, inputting the cost distance grids as the elevation layers from which fluid would flow

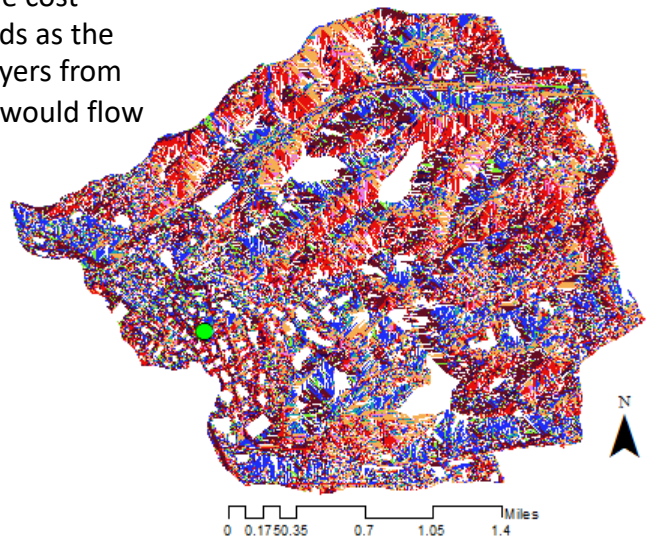
Flow Accumulation

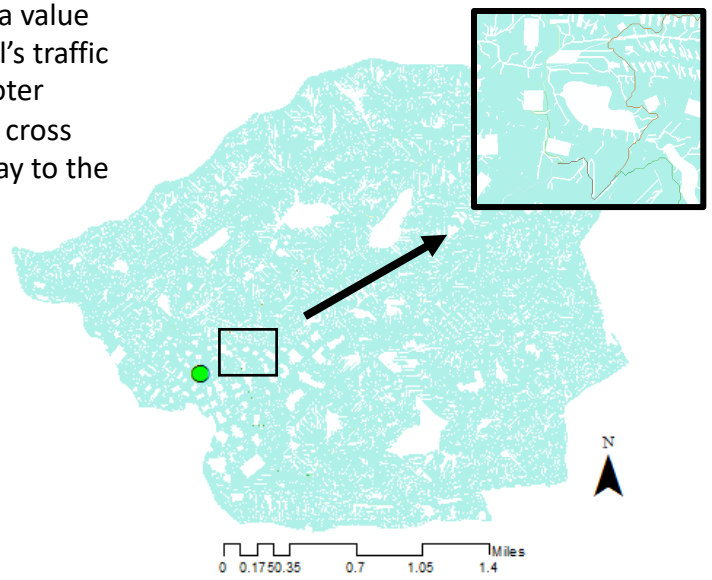
Generates a grid in which each pixel is set to a value indicating that pixel's traffic (the sum of all scooter attendees who will cross that pixel on the way to the mud sale).



T2

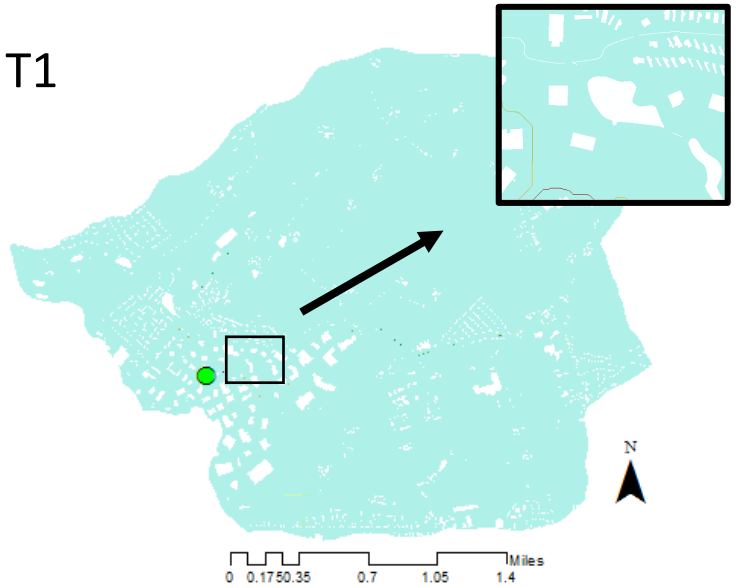




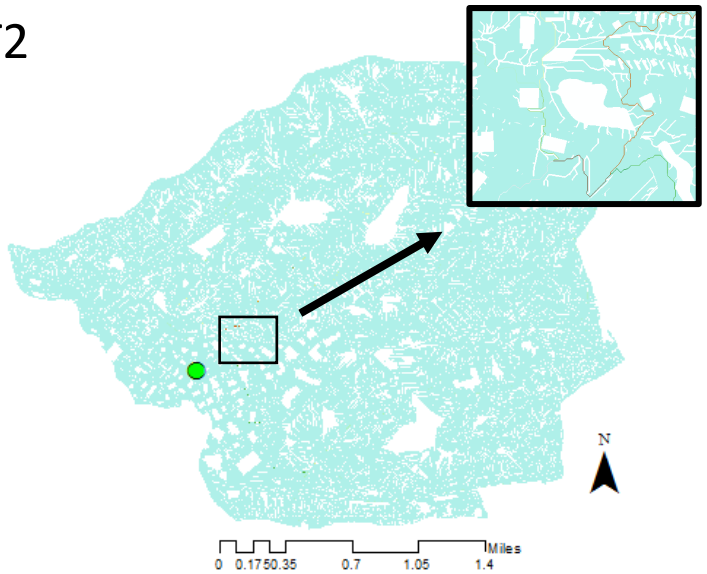


Calculating Percentage Change in Traffic Before and After the Rains

T1

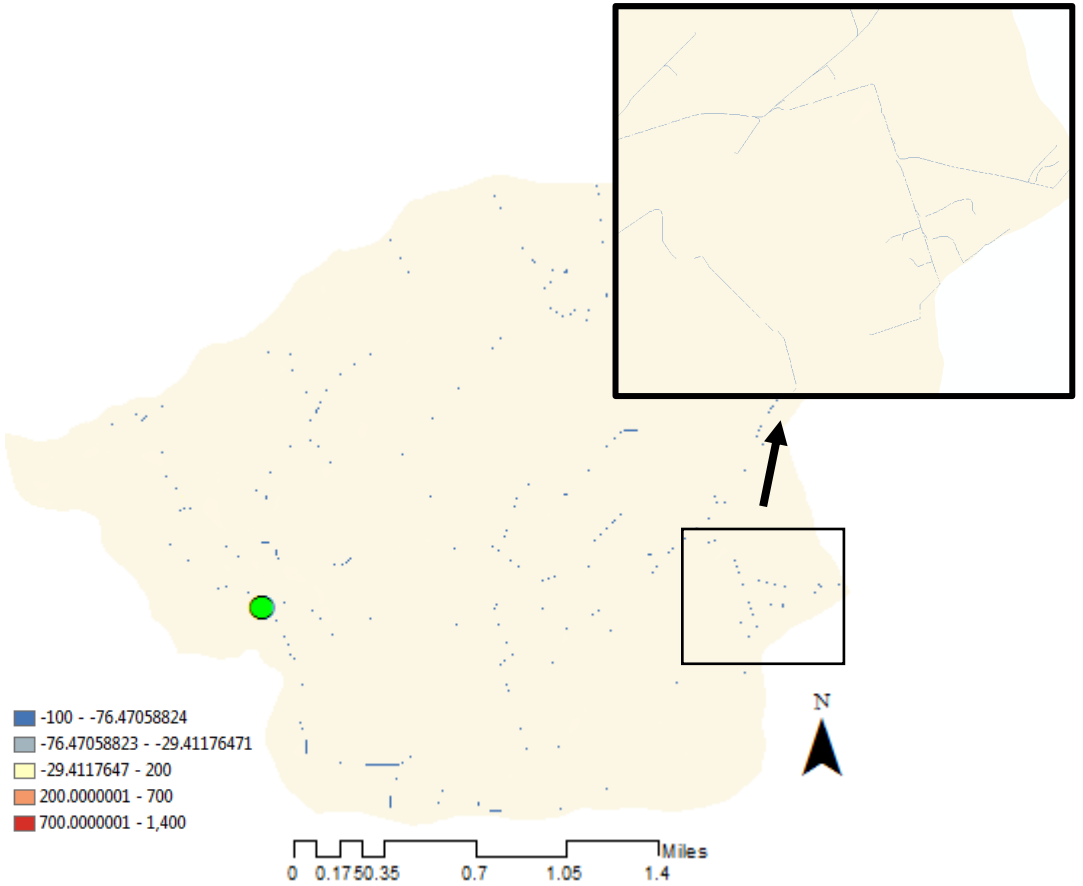


T2



Raster Calculator

[(T2-T1)/T1] *100



Pixels that have a negative percentage change values describe situations in which there was more traffic across that pixel before the rains than after the rains. Pixels that have positive percentage change values describe situations in which there was more traffic across that pixel after the rains than before the rains. Most pixels have a negative value because after the rains, the attendees are taking much more homogenous routes along roadways, so most pixels see a decline in their traffic.