

Flood Risk in R

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Introduction

Rivers inherently will always carry a risk of flooding due to factors such as unstable water levels, flow and elevation and it can severely damage nearby infrastructure and property. We believe R would be a great tool to creating a calculated risk score that we can visualize. Specifically, we will be analyzing the Missouri River near Jefferson City since this area is very prone to severe flooding and has recent catastrophe’s such as the 2011 Missouri River Flood.

Data

For our data we will be using DEM images acquired from USGS for our primary raster data. As well, we will use the USGS National Hydrography Data set for vector data containing the waterway shapefiles. We also acquired vector data for addresses from the Jefferson city Open Data Portal.

Methods

We created three different flood risk evaluations via various calculations and functions in R based on our DEM data combined with vector data. Our first risk we calculated based on subtracting the elevation values of the DEM divided by the maximum. Our second risk was calculated via the terrain() function from the raster package which gives a value of slope for the DEM. Our third risk was based on proximity to the river which we calculated by finding distance between the DEM values and the vector shapefile of the waterways. Finally, we normalized the values and created a final risk score by combing all three of these risk factors which when plotted gave us our flood risk Map.

Code

Cropping the DEM

```
dem <- raster("RiverUSGS.tif")
plot(dem, col = rev(terrain.colors(50)))
ext <- extent(-92.2, -92.0, 38.4, 38.6)
demnew <- crop(dem, ext)
```

Flood Risk Factor (Elevation):

```
# Extract elevation values at each cell
elevations <- getValues(demnew)
# Calculate flood risk
flood_risk <- (1 - (elevations /
max(elevations)))
```

```
# Create raster object for flood risk layer
flood_risk_raster <- raster(demnew)
values(flood_risk_raster) <- flood_risk
```

Flood Risk Factor (Slope)

```
#calculate slope map
slope <- terrain(demnew, opt = "slope")
plot(slope, col = rev(terrain.colors(50)))
```

Flood Risk Factor (Proximity)

#calculate proximity from waterways

```
waterway_raster <-
rasterize(waterways_crop, demnew, field = 1)
proximity <-
raster::distance(waterway_raster)
```

Final Risk Score

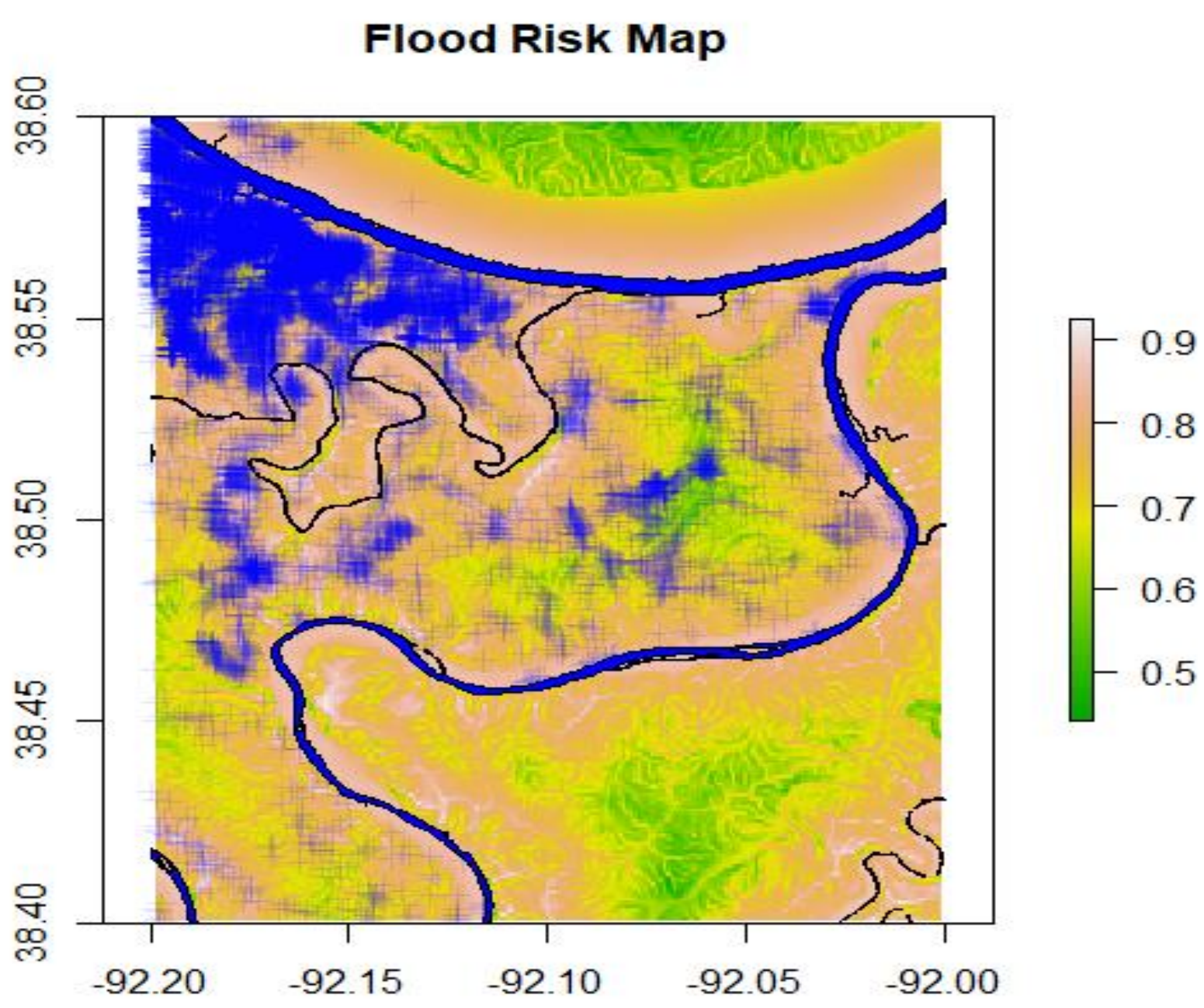
#Normalizing values

```
slope_norm <- slope / cellStats(slope, "max")
proximity_norm <- proximity /
cellStats(proximity, "max")
#Calculate risk score based off slope,
elevation, and proximity to waterways.
risk_score_withfloodrisk <- 0.333 * (1 -
slope_norm) + 0.333 * (1 - proximity_norm)
+ .333 * (1 - flood_risk)
plot(risk_score_withfloodrisk, main = "Flood
Risk Map", col = terrain.colors(100))
```

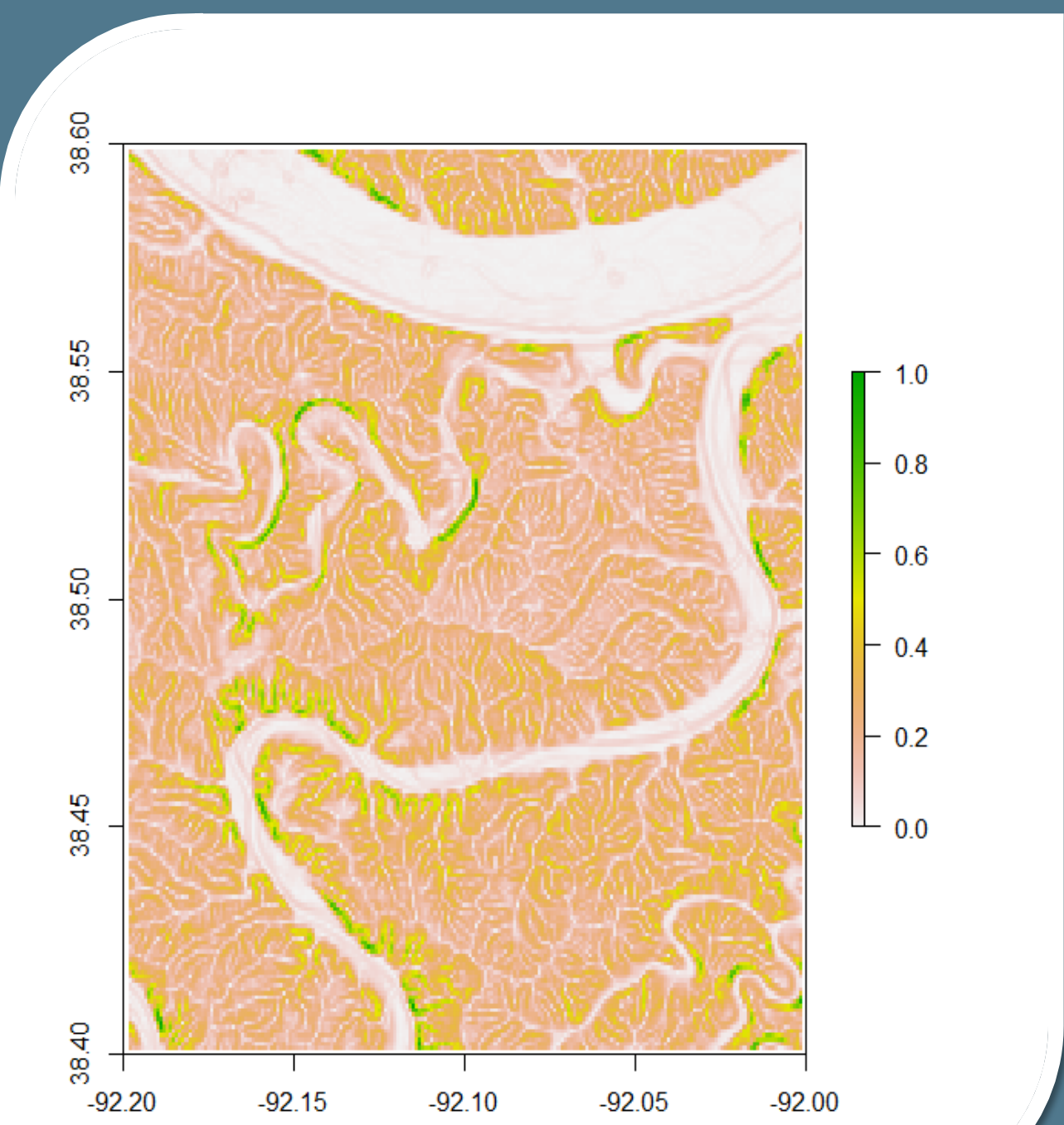
Results

Our slope map indicates the overall lack of steepness creating risk for flooding. Our proximity map shows the distances of the DEM file to the waterway shapefile. Then, our flood risk map gives us a map based on a 0-1 score with a 1 meaning high flood risk. Lastly, we added address points in our last map.

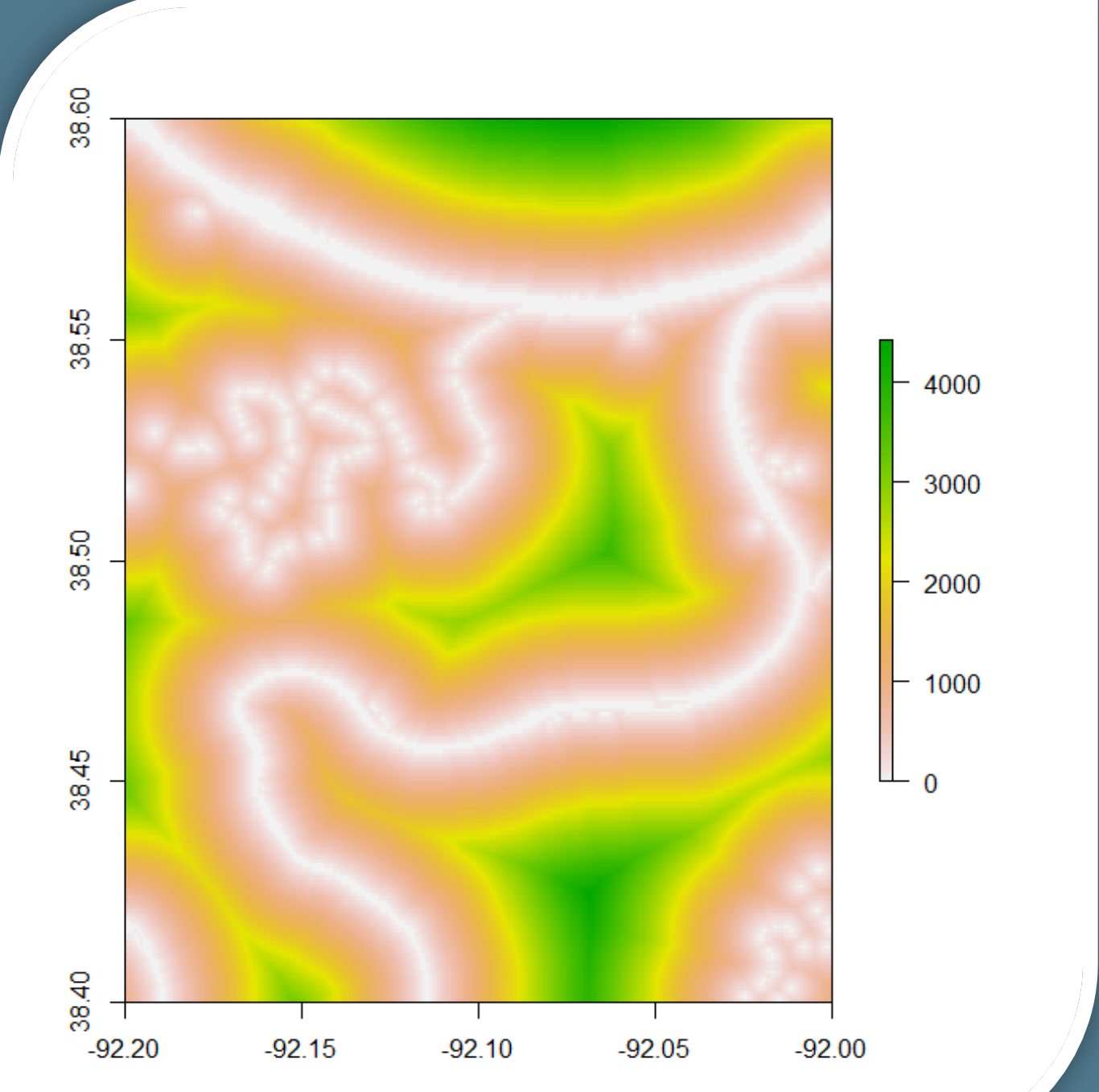
Flood Risk Map with Addresses



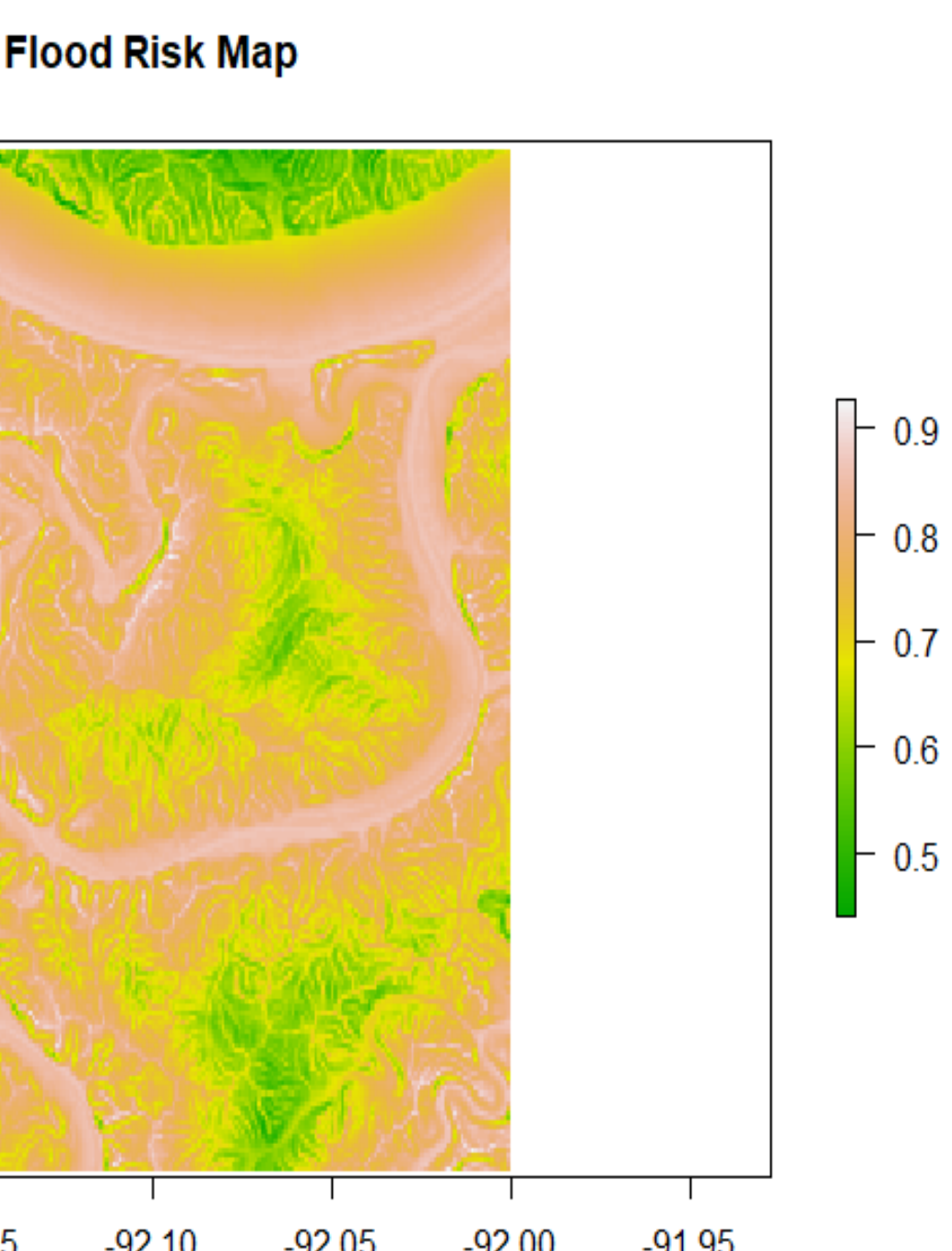
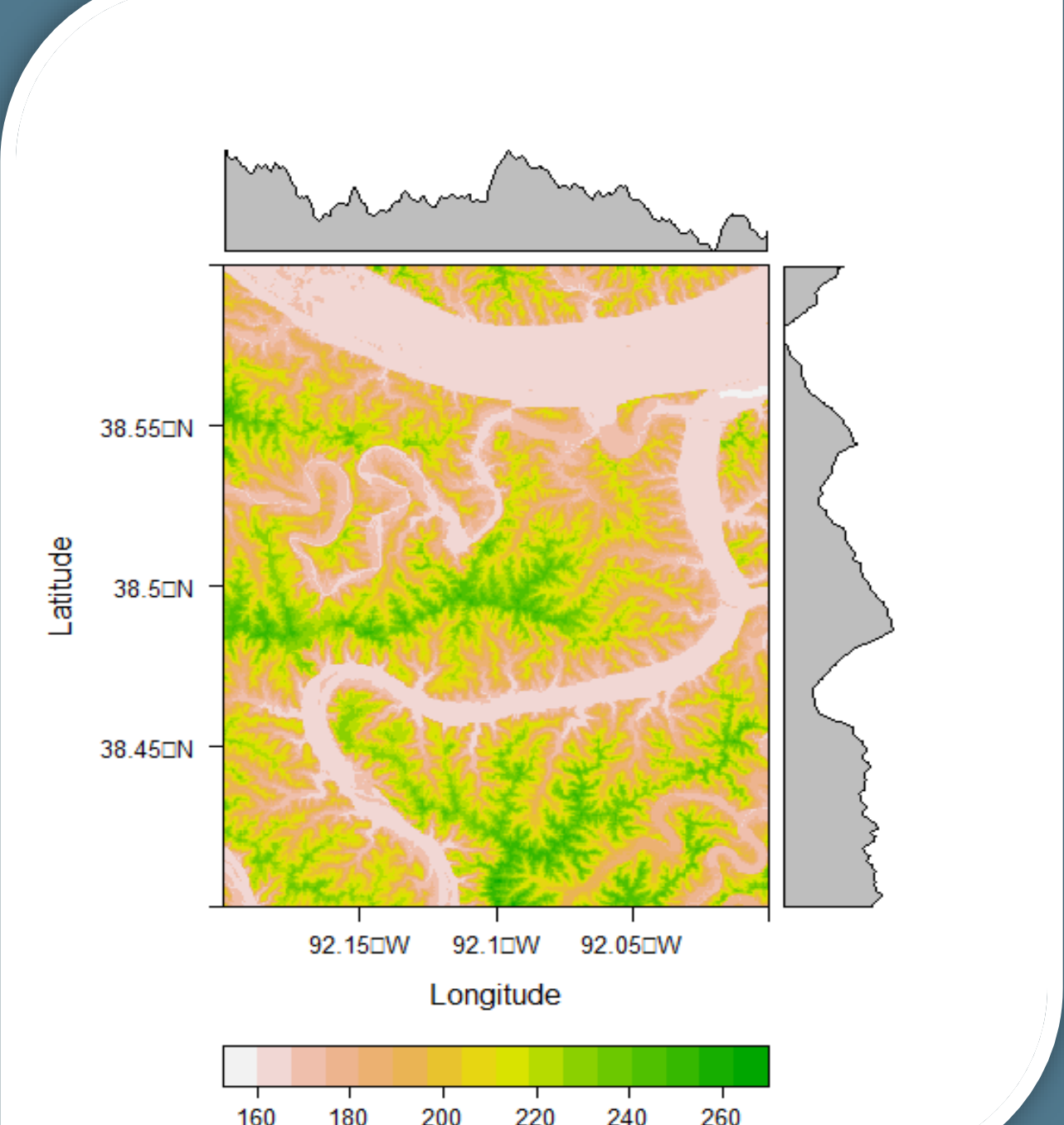
Slope Map



Proximity Map



Original DEM



Conclusions

- Our flood risk map shows that several people are living in areas prone to severe flooding, specifically ones that are living in Jefferson City and on the outskirts.
- Waterways that are close to each other tend to see a higher rate of flooding in between each other.
- Our flood risk map is only an estimate of dangerous areas and does not show guaranteed flood zones.

References and Data

- USGS
- Jefferson City Open Dat Portal
- Allen, S. B., Dwyer, J. P., Wallace, D. C., & Cook, E. A. (2003). Missouri River flood of 1993: Role of woody corridor width in levee protection.