Landslide Prone Areas of Douglas Pass, Colorado and Potential Transportation Hazards

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Outline

1. Introduction and Problem Formulation
2. Data Collection and Data Processing
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Introduction and Problem Formulation

Douglas Pass is an area in Garfield County, Colorado that experiences landslides on a regular basis due to topographic and geologic factors. Landslides can damage property and injure people, but there can also be economic "damage," especially since oil and gas development in the area is very active, making the Douglas Pass corridor an increasingly important transportation route.

For this project, we will identify roads that are most at risk be to damaged by landslides by figuring out which areas of Douglas Pass are most susceptible to landslides, and identifying roads that pass through those areas. A digital elevation model (DEM) of Douglas Pass as well as the location of the study area is shown below in figure 1.

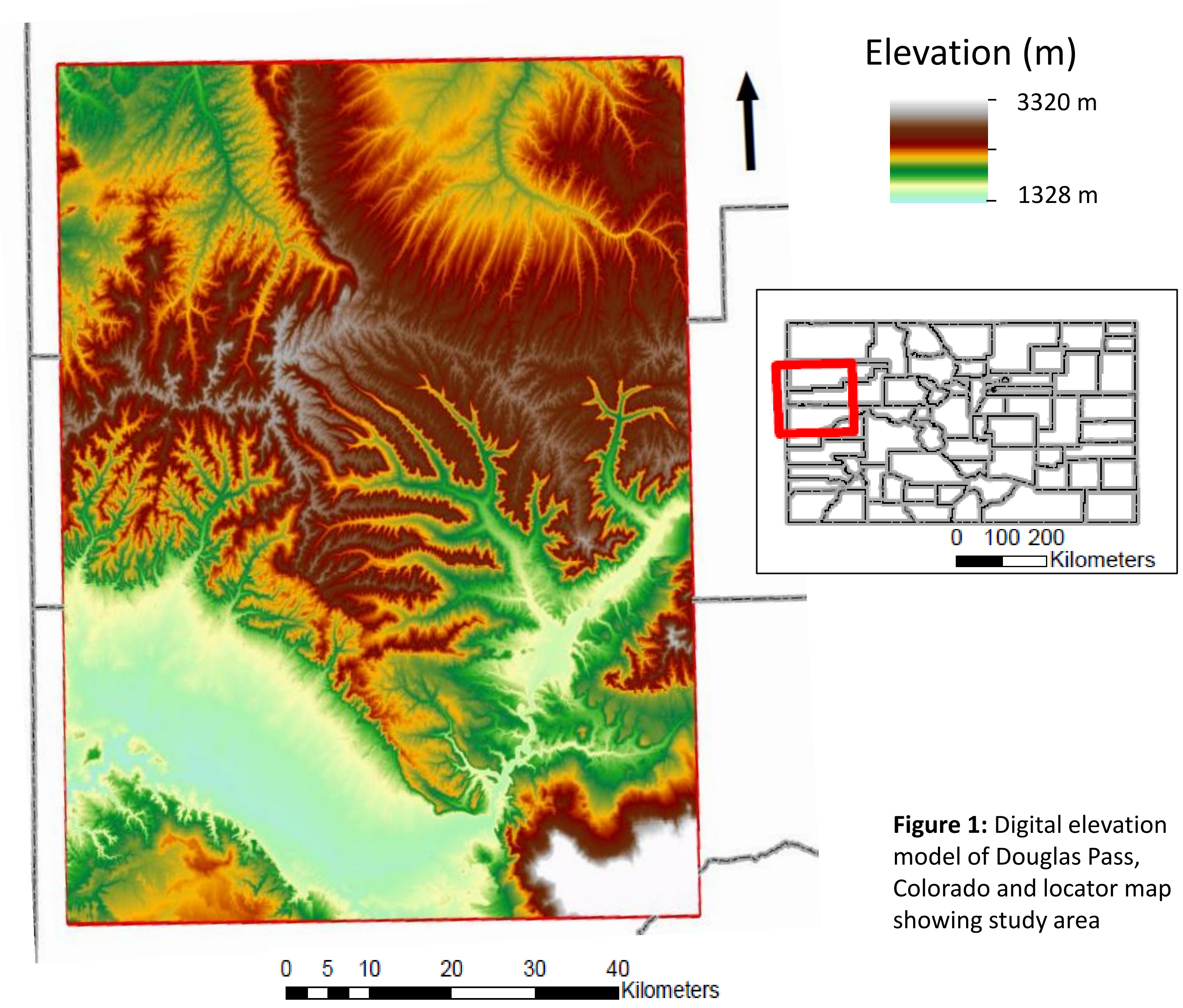

Figure 1: Digital elevation model of Douglas Pass, Colorado and locator map showing study area

Data Collection and Data Processing

Digital elevation models were obtained through the USGS' *National Map Viewer* via the link listed below.

- http://viewer.nationalmap.gov/viewer/

Vector shapefiles were obtained through the USDA's National Resources Conservation Service via the link listed below.

- http://datagateway.nrcs.usda.gov/GDGOrder.aspx

Both websites delivered the data via email. Once downloaded and unzipped, all the data pertaining to this project was stored locally in a personal geodatabase.

Once downloaded to the personal geodatabase, ArcCatalog was used to project all data into Colorado's central state plane zone (NAD 1983, Lambert Conformal Conic projection).

ArcGIS Processing and Methodology

After using ArcCatalog to set appropriate spatial references for the data, layers were all pulled into ArcMap for further analysis.

The DEM of the Douglas Pass area covers an area of 9,565 square km, and a polygon was digitized around the DEM to constrain analysis only to this area. All layers were then clipped to this area of interest in order to optimize drawing and geoprocessing time.

According the Geological Society of America (GSA), the factors that most influence landslide susceptibility are slope, geology, and precipitation. The following layers were used for this analysis:

- DEM
- Geology
- Annual precipitation
- Roads

The first step was to do some geoprocessing on the DEM layer in order to derive slope calculations. Slopes in our area of interest are shown in figure 2.

Geology and precipitation layers were queried down by rock type and inches, respectively. All data was classified using the Jenks natural breaks method. Once data was sorted and classified, vectors were converted to rasters and slope, geology, and precipitation layers were reclassed and assigned ranks based on the their likelihood to influence landslides. The more likely for one of these factors to influence landslide activity, the higher the rank (i.e., the area with the heaviest rainfall will be assigned a '4', while the areas with the least amount of rainfall is assigned a '0'). A summary of the input values and associated ranks is summarized in figure 3. Reclassed rasters showing geology and precipitation are shown in figures 4a and 4b.

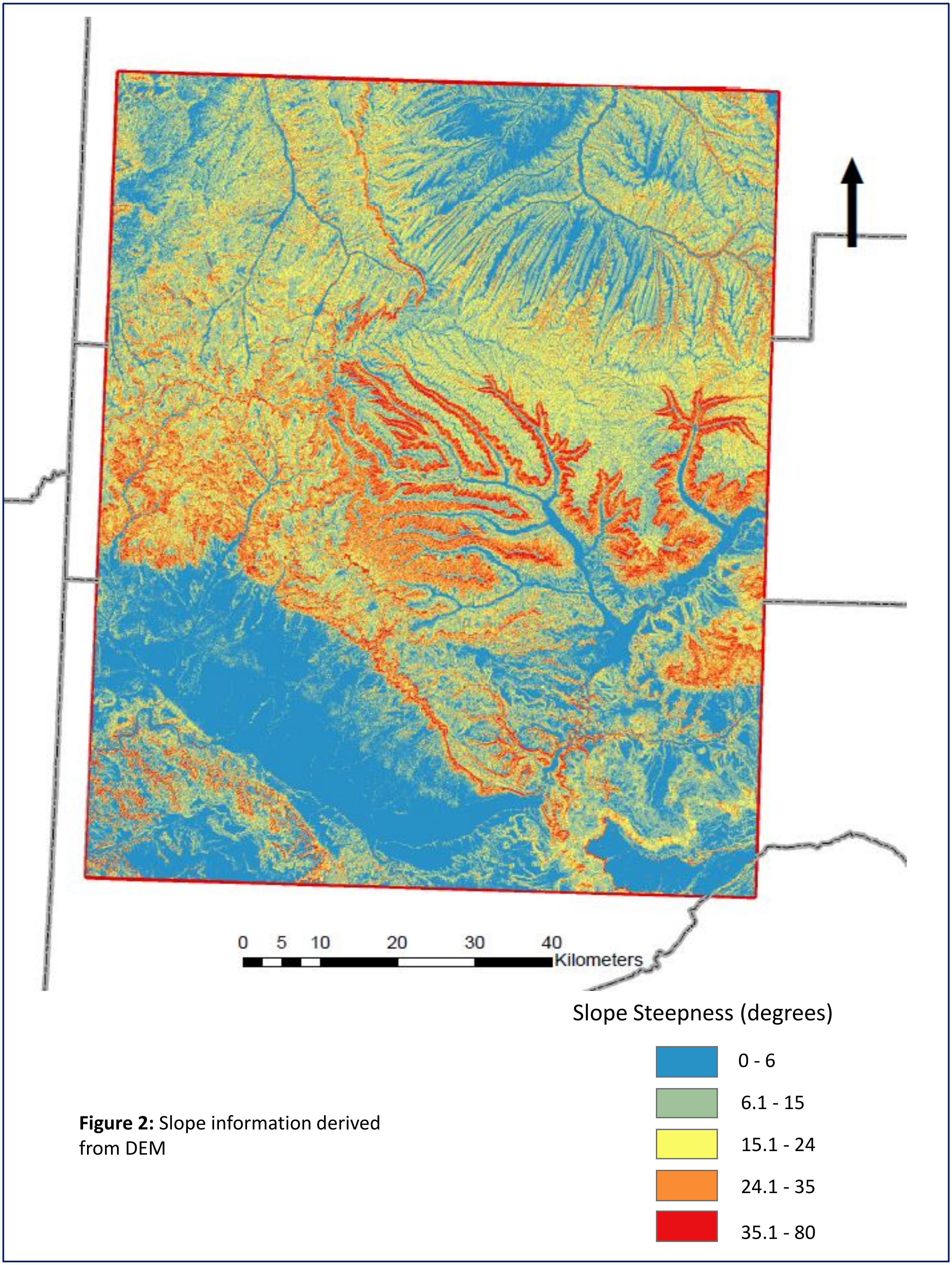

Figure 2: Slope information derived from DEM

Slopes

Rank	Steepness (Degrees)
0	0 – 6
1	6.1 – 15
2	15.1 – 24
3	24.1 – 35
4	35.1 - 81

Precipitation

Rank	Precipitation (inches)
0	8 – 13
1	13.1 - 17
2	17.1 -24
3	24.1 – 35
4	35.1 - 46

Geology

Rank	Rock type
0	No data/water
1	Basement
2	Sandstones
3	Mudstones
4	Landslide

Figure 3: Input values and associated ranks used. For this analysis, rock types were grouped as follows:

- Basement: Basalt, gneiss, granite
- Sandstone: Alluvium, dune sand, glacial drift, gravel, sandstone
- Mudstones: Claystone, mudstone, shale
- Landslide: Landslide

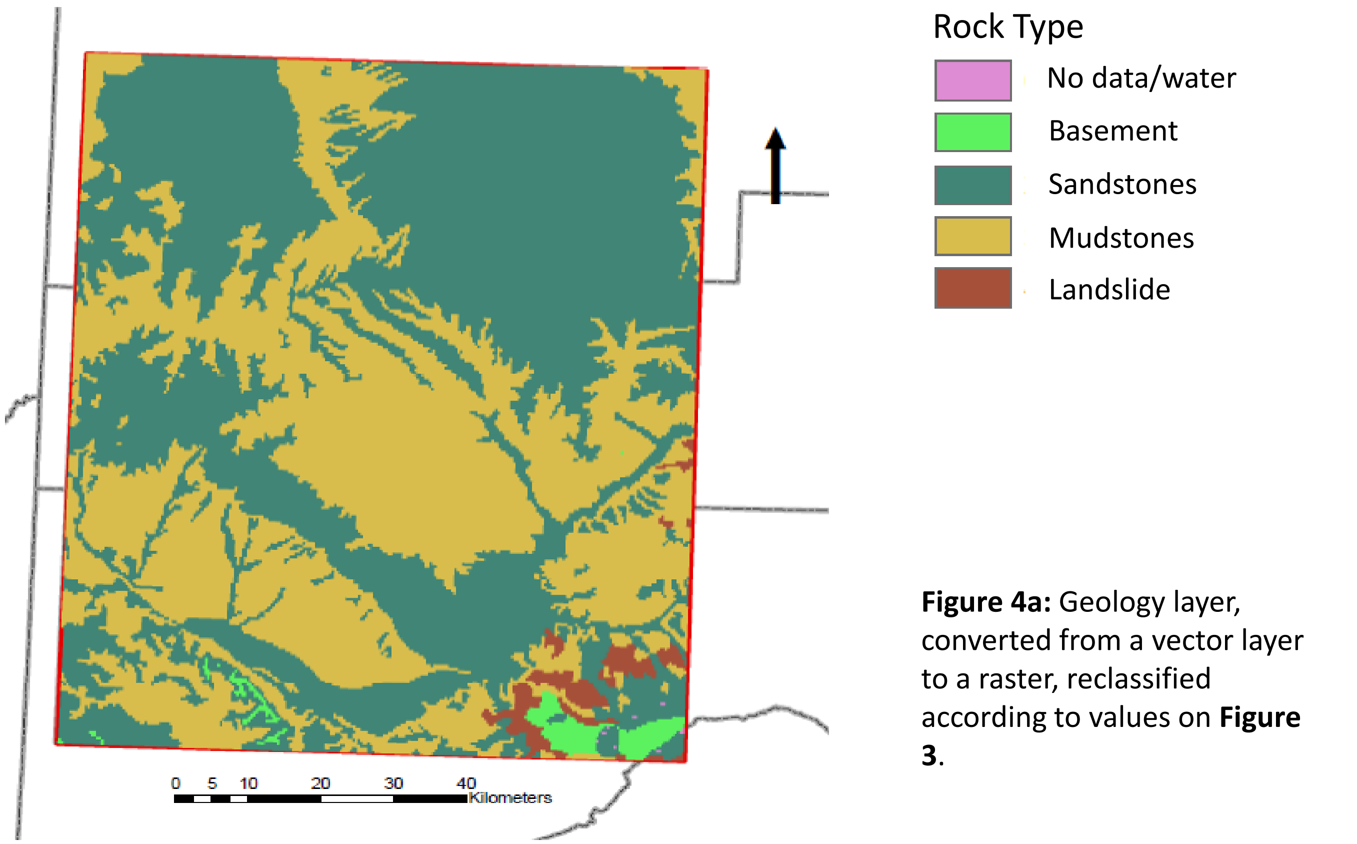

Figure 4a: Geology layer, converted from a vector layer to a raster, reclassified according to values on **Figure 3**.

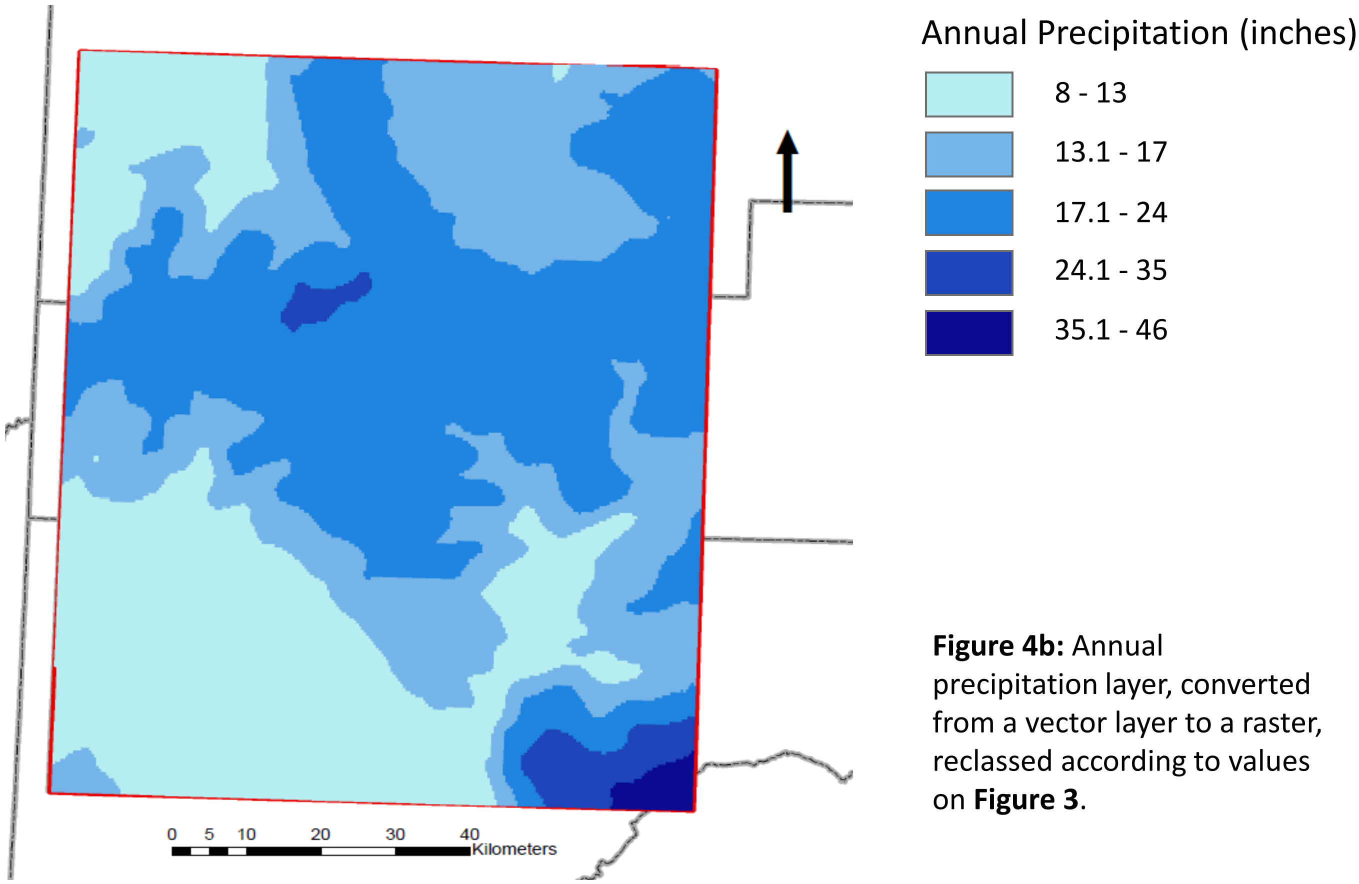

Figure 4b: Annual precipitation layer, converted from a vector layer to a raster, reclassed according to values on **Figure 3**.

Once all layers are converted to rasters and reclassed, the raster calculator is used add these layers together and calculate areas more susceptible to landslides, using inputs from above. Once calculated, I took the three highest values (11, 10, 9 out of a possible 12) and designated these the most landslide prone areas.

This raster was then converted to a vector shapefile so we are able to perform a “select by location” query in order to isolate road segments that intersect those areas designated as the most landslide prone. The final result is shown in figure 5.

Conclusions

The combined length of roads that pass through our study area is 9,848 km. Out of that total, 1,036 km of roads lie within areas designated as the most landslide prone. This kind of data can be used to predict occurrences of landslides, as well as to plan future roads through less treacherous terrain.

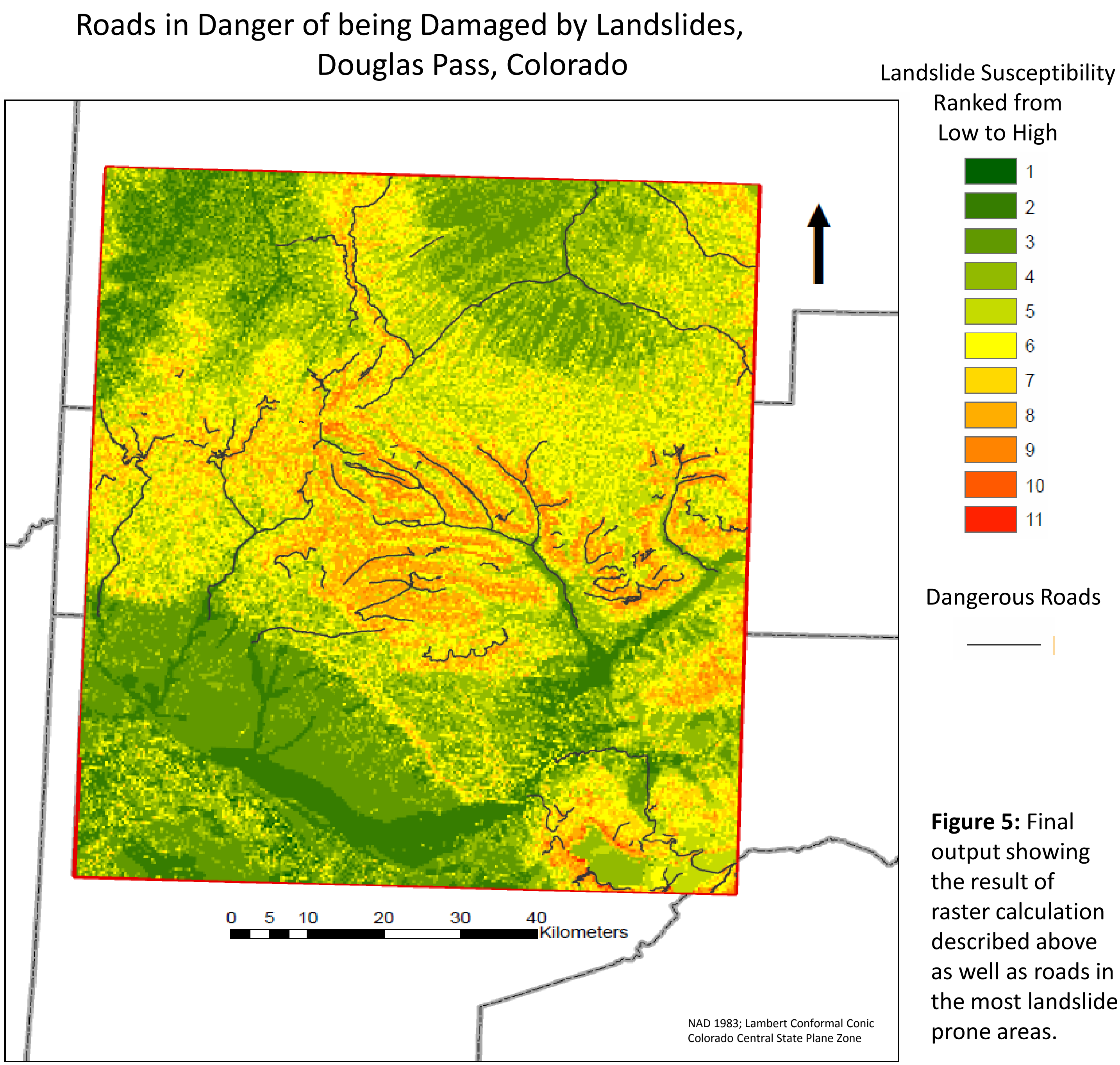

Figure 5: Final output showing the result of raster calculation described above as well as roads in the most landslide prone areas.