# Landslide Susceptibility Pilot Study - Berkeley County, West Virginia

Dr. Maneesh Sharma and Kurt Donaldson
West Virginia GIS Technical Center, West Virginia University
Morgantown, WV 26505

## Background

The West Virginia Statewide hazard mitigation plan provides statewide guidance to reduce loss and prevent injury from natural and man-made hazards. The landslide risks addressed in the 2013 West Virginia Statewide hazard mitigation plan are mainly based on USGS work on "Landslide overview map of Conterminous United States" (Radbruch-Hall et.al., 1982). The study delineates areas of reported landslides and areas which are susceptible to landslide. The focus of the USGS study was to identify areas of landslide risk at the regional level (digitized polygons from the study are at a scale of 1:3,750,000). In this study, most of the West Virginia is displayed as a high-risk area. However, this generalized delineation of potential landslide areas does not help in hazard mitigation planning on local and county scales. For better landuse planning, there is a strong need to develop a better methodology that can show more granularity in landslide hazard identification at the sub-county level, and help identify the slopes that are most susceptible to landslide at a higher resolution. Here, we present a preliminary study that utilized a different methodology to identify landslide susceptibility in Berkeley County. The landslide susceptibility map prepared using our model shows a strong contrast to the map prepared by old methodology using the USGS data. This highlights the need of using new methodologies and conducting landslide hazard studies at higher resolution for devising better landslide mitigation strategies.

## Study Methodology

Few studies have attempted to identify landslide susceptibility at the county level for hazard mitigation plans. One such pilot study done in Schenectady County, New York used a weight-based method for determining landslide susceptibility (Kappel et al 2007). Here we present a preliminary study from Berkeley County, West Virginia that utilizes the US Department of Agriculture Natural Resource Conservation Service's SSURGO Digital Soil Survey and United States Geological Survey's1/3 arc second resolution Digital Elevation Model (DEM). The SSURGO soil data has several attributes that can be used to model landslide susceptibility. The soil attributes used in the current study are:

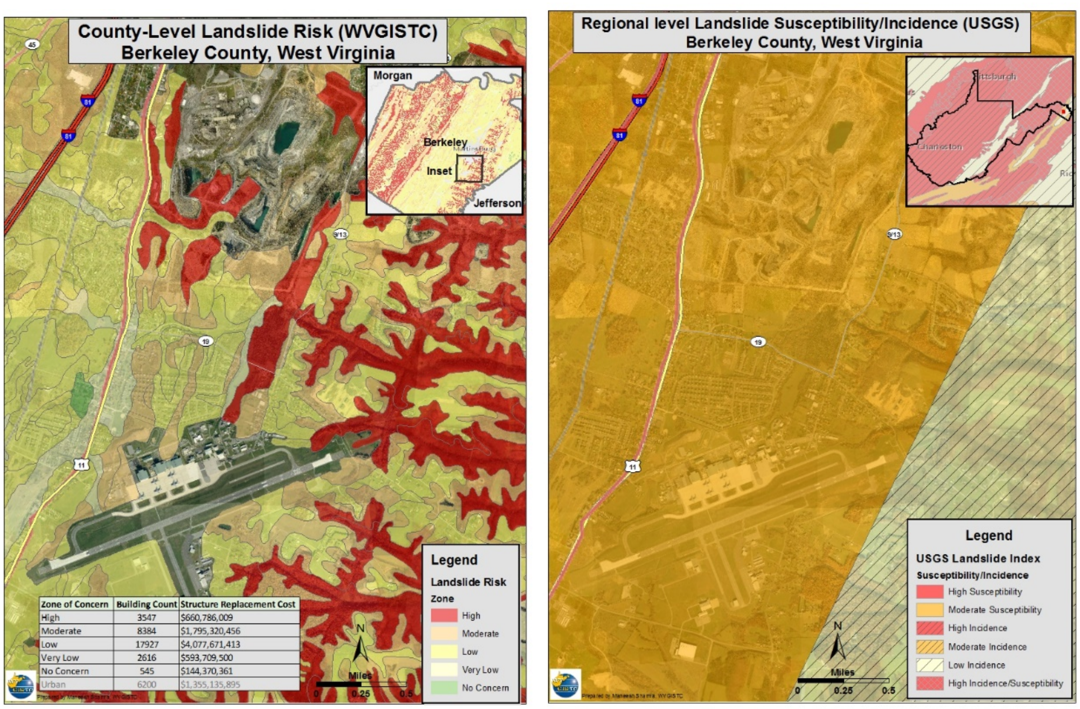
1. American Association of State Highway and Transportation Officials (ASSHTO) Soil Classification
2. Liquid Limit
3. Hydrologic Group
4. Physical Soil Properties (%silt and %clay); and
5. Hazard of Erosion

The above-mentioned soil attributes were used in conjunction with DEM derived slope to develop a landslide hazard model for the study area. Each of the attributes was assigned a weighted value based on their contributing factor in predicting landslide susceptibility (Table 1)

| Prediction Properties | Weight Range | Source |
|---|---|---|
| ASSHTO Soil Classification | 1-14 | SSURGO |
| Liquid Limit | 2-8 | SSURGO |
| Hydrologic Group | 1-4 | SSURGO |
| Physical Soil Properties | 1-4 | SSURGO |
| Hazard of Erosion | 1-12 | SSURGO |
| Slope | 10-50 | DEM |

*Table 1: The list of attributes and their calculated weighted range used to predict landslide*

Since the slope is one of the most important controls on landslide susceptibility it is assigned the highest weighted value, in the range of 10-50. The six properties containing the weighted values were then summed to establish a landslide susceptibility "total score". The total score ranged from 37 to 84. Range groupings were established from "total score" values to assign landslide susceptibility descriptive zones as "High" – greater than 75 (Red); "Moderate" – 61 – 75 (Orange); "Low" – 51 – 60 (Yellow); "Very Low" – 41 – 50 (Beige); "No Concern" – less than 41 (Green) (Figure 1a). The approach for calculating landslide susceptibility in this pilot study shows high variability in landslide susceptibility risk in Berkeley County (Figure 1a). This is a sharp contrast to the landslide susceptibility map of the area presented in a previous USGS study that primarily has just three areas (Radbruch-Hall et.al., 1982), (Figure 1b).




a) b)

*Figure 1: (a) Map on the left showing county level landslide risk for Berkeley County, WV performed by WVGISTC using weight based methodology, and (b) Map on the right showing county level landslide risk for Berkeley County, WV performed by USGS. Note the sharp contrast in delineation of landslide susceptibility using different methods*

This preliminary study and the comparative maps highlight the importance of delineating landslide susceptibility utilizing better techniques at a higher resolution for planning mitigation strategies.

**Risk Assessment**

In addition to delineating landslide susceptibility, an initial analysis of landslide risk assessment to building infrastructure was also performed. This was performed by intersecting landslide risk zones with the location of major infrastructure. The centroid of the tax parcel was used as a surrogate for the building location to assess the risk. The replacement cost of buildings in various zones of landslide susceptibility was calculated and are depicted in Table 2.

| Zone of Concern | Building Count | Structure Replacement Cost |
|---|---|---|
| High | 3547 | $660,786,009 |
| Moderate | 8384 | $1,795,320,456 |
| Low | 17927 | $4,077,671,413 |
| Very Low | 2616 | $593,709,500 |
| No Concern | 545 | $144,370,361 |
| *Urban (No relevant attributes) | 6200 | $1,355,135,895 |

*Table 2. Risk Assessment table showing building count along with replacement cost in individual landslide zones of concern.*

**Urban represents areas where analysis was not done due to lack of all the soil properties*

**Model Limitation and Future Work**

Our preliminary study depicts the utility of SSURGO soil database for mapping areas susceptible to landslides. However, the SSURGO soil database contains only soil data attributes that are designated as agriculture and does not include relevant soil properties of the “Urban” soils. This resulted in no weights for the soil properties that were needed for assessment. GISTC utilized slope values derived from DEM, hence, we had weights only for DEM in urban areas. Therefore, the “total score” in these areas was not reflective of the actual susceptibility. As a result, these areas have not been displayed on the map. Future extension of these types of studies can include other methodologies to identify and model landslide susceptibility in all of the areas. The model needs to integrate infrastructure, vegetation cover and effect of proximity to streams to further refine it. Model validation studies also need to be performed. Presently, landslide data inventory does not exist in West Virginia like it does in other states. Currently, we are acquiring some past landslide data from the WV Department of Transportation, WV Geological and Economic Survey and other sources to validate our preliminary model and also potentially increase its prediction accuracy.

**References**

1. Radbruch-Hall, D.H., Colton, R.B., Davies, W.E., Lucchitta, I., Skipp, B.A. and Varnes, D.J.1982. Landslide Overview Map of the Conterminous United States, Geological Survey Professional Paper 1183, U.S. Geological Survey, Washington.

2. Kappel, W., Kelley, W., Kozlowski, A., O’Brien, D., McWhirter, J., Zhang, R., Kalohn, J., Storti, M., Minnitti, T., and Emerick, S. 2007. Landslide Susceptibility – A Pilot Study of Schenectady County, New York. New York State Hazard Mitigation Plan.