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Slope Stability Risk Assessment in Urban Development, Eastern Tennessee Hillslope

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Introduction

The Study area is within northern Johnson City and focuses on a set of housing development, and the road leading to them, have been built on the Knox Group (Ock), a limestone unit that is overlain by the Sevier Shale (Osv), a unit that is above the housing in elevation. The soils that overlie the rock units directly on the property are from weathered shales, limestones, and siltstones, typical of what would be expected from the rocks within the area. The area drains to the northeast by way of two small streams that join Boone Lake, TN.

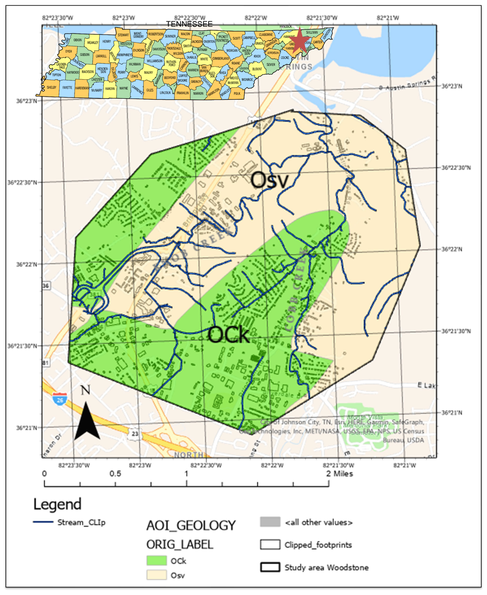

Figure 1: Study area with Geology Information.

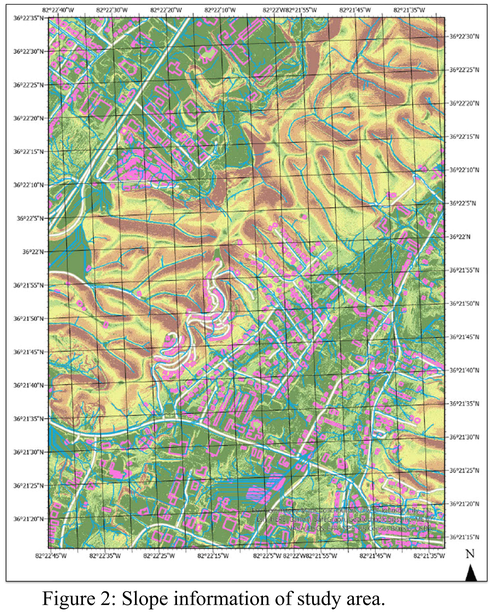

Figure 2: Slope information of study area.

Abstract

Landslides are common geohazards within the Appalachians causing economic and environmental damage, and even loss of life. Urban development on the hillslope further destabilizes slope and accelerates failure. The objective of this project is to examine the slope stability condition in an urban community in eastern Tennessee and assess the relative risk in the area.

The first step included a digital survey of the study area. This data was collected from a multitude of sources including but not limited to the USGS (United States Geological Survey), ESRI (Environmental Systems Research Institute), and Tennessee State Government resources. After this, a process of field verification was required to confirm the validity of acquired digital data. The data collected from the previous digital survey and field verification trips were used to prepare a landslide hazard prediction map using Weighted Overlay method in ArcGIS Pro software. To validate the accuracy of the hazard map, a UAS (Unmanned Aircraft System) drone survey will be completed in April 2023. A final Slope Stability Hazard Map will be produced for the urban community and the report will be shared with the community members to inform them about the slope instability risks.

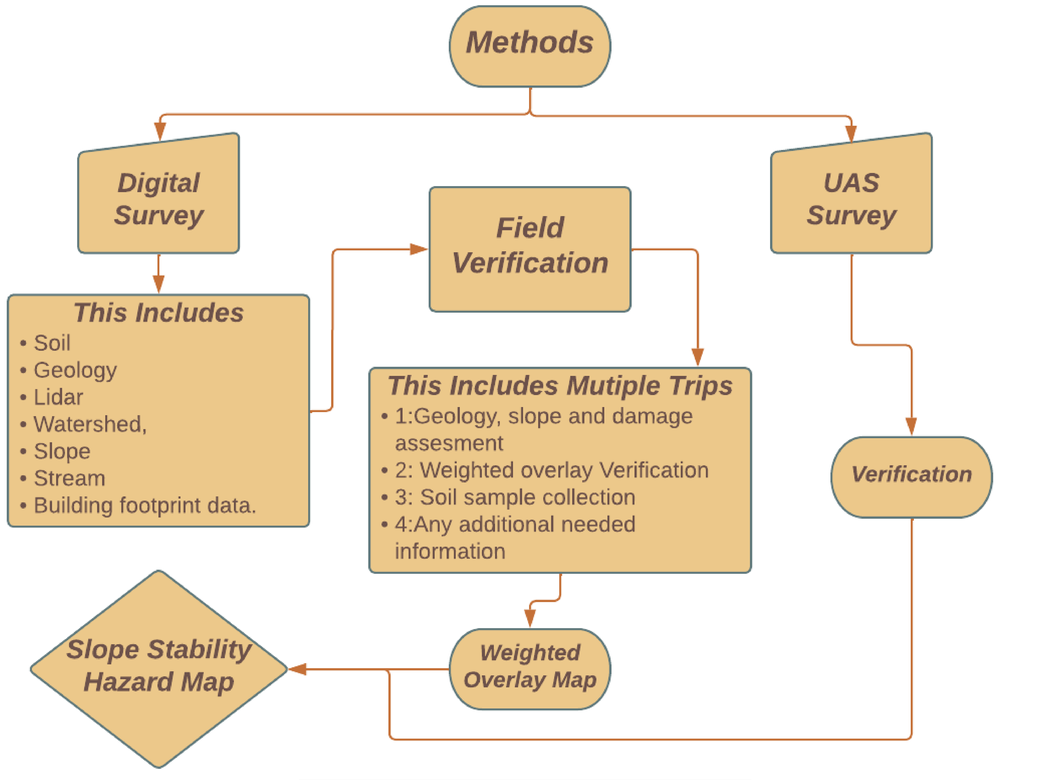

Figure 3: A picture of Sevier Shale outcrop showing the bedding of the shale.

Figure 4: A picture of a steep slope behind some of the houses, the slope here was 51°.

Figure 5: Repaired stress cracks, resulting from unstable ground.

Weighted Overlay Maps

The process of creating a weighted overlay map was an essential part of this project as it combined soil, geology, stream, and slope data to produce a slope stability risk assessment map.

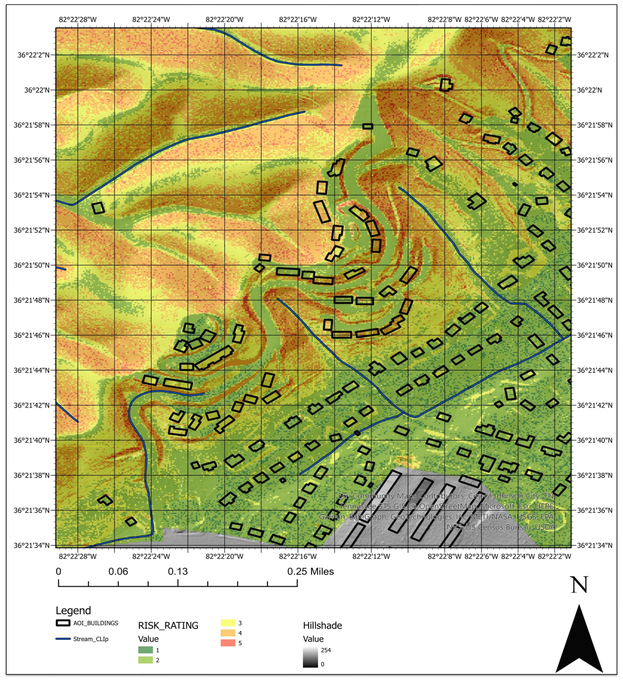

Figure 8: A finial slope stability risk assessment map.

Figure 7: A soil sample, this was one of the more complete soil samples within the study area as there was so much fractured shale in the soil it was often difficult to obtain a core.

Figure 6: A steep slope showing outcrop of Sevier Shale, this area has had slope failures as recent as 2022.

What can be done?

To completely stop slope instability is impossible, but with careful mitigation techniques such as planting trees, diversion of waterways, reducing the load of the top of a slope, the impacts can be reduced. The best solution would be to install engineering structures, such as retaining walls, soil nails or anchors, and proper drainage system.