HIGHLIGHTER

REAL TIME MONITORING OF SLOPE STABILITY IN EASTERN OKLAHOMA

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PROJECT TITLE
REAL TIME MONITORING OF SLOPE STABILITY IN EASTERN OKLAHOMA

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Implementation of Research for Transportation Excellence

OVERVIEW DOTs can understand, recognize, and address landslide prone areas by creating a functional landslide hazard map to assist in building and maintaining infrastructure to predict and prevent future transportation corridor blockages (slides). There were three primary objectives of the research. The first was to establish a comprehensive landslide database, the second was to create a first-cut regional landslide map and the third was to relate safe and stable constructed slope geometry to soil type and geologic setting with site-based in-situ monitoring and modeling experiments. Accomplishing the project objectives involved collecting historical and current landslide information from around the state, as well as climate, rainfall history, geology and topography information for recorded landslide sites. From this comprehensive database, a landslide susceptibility map was derived. In addition, in situ measuring equipment was used to monitor a selected slide to verify a site-based landslide modeling system.

RESULTS During this project, 113 historic and current landslides were identified, mapped and analyzed across the state (Figure 1). The ODOT Division engineers in Divisions 1, 2 and 3 provided 23 locations and the USGS provided 80. Soil information from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) was collected for all 113 sites, and more detailed soil information, including moisture contents, Atterberg Limits and Grain Size Distributions was collected for currently problematic landslides. In addition, all currently active landslides were mapped, if accessible, to determine the extent of the sliding.

Figure 1 Active Slide in Eastern Oklahoma

Figure 2 Weather Station

One site in McCurtain County near Idabel along Route 70 was monitored for in situ moisture, temperature and rainfall, among other parameters, since October of 2012 (Figure 2). Inclinometers, to measure the slope movement, were installed September 2013. Pairing the weather station data with the inclinometer data over a wet-season would have helped inform the slope movement and validate the SLIDE model more completely, but several important

recommendations can still be made. The slope at Idabel consists of a fat clay, CH, with a PI of 46% and a uniformly high in situ moisture content throughout the depth of the slide mass around 25%. While the slope of this site is only 30%, or roughly 3:1, the geology (shallow limestone), and highly weathered Hollywood soil series, creates a perfect sliding scenario. When it rains, the clay absorbs the water, gets heavy, and slides. Mitigation in the area has included rock drains parallel with the slope in order to get the water out of the slope more quickly. If right-of-way (ROW) is available, it would also help to lay back the slope to even shallower angles when roadways are built or maintained through similar geology. The SLIDE model needs to be modified so that rainfall plays a much bigger role in predicting landslides, and that cohesion does not just act as a resisting force, but as an indicator to soil adsorption and loss of suction with rain infiltration. Throughout the following years, the in situ monitoring equipment will continue to be used to validate the model until it can predict a slide occurrence accurately.

After establishing a comprehensive landslide database for Divisions 1, 2 and 3 (based on experiential knowledge of the landslide locations from the ODOT Division Engineers) a regional landslide map was created (Figure 3). This map better refines the problematic areas of the state and shows that slope, soil texture type, land cover have a large impact on the susceptibility of the site to slide, whereas, elevation had relatively no impact. Almost all of the landslide locations provided fell within the high and very high susceptibility ratings, which demonstrates the ability of GIS-based weighted linear combination models in predicting landslide hotspots.

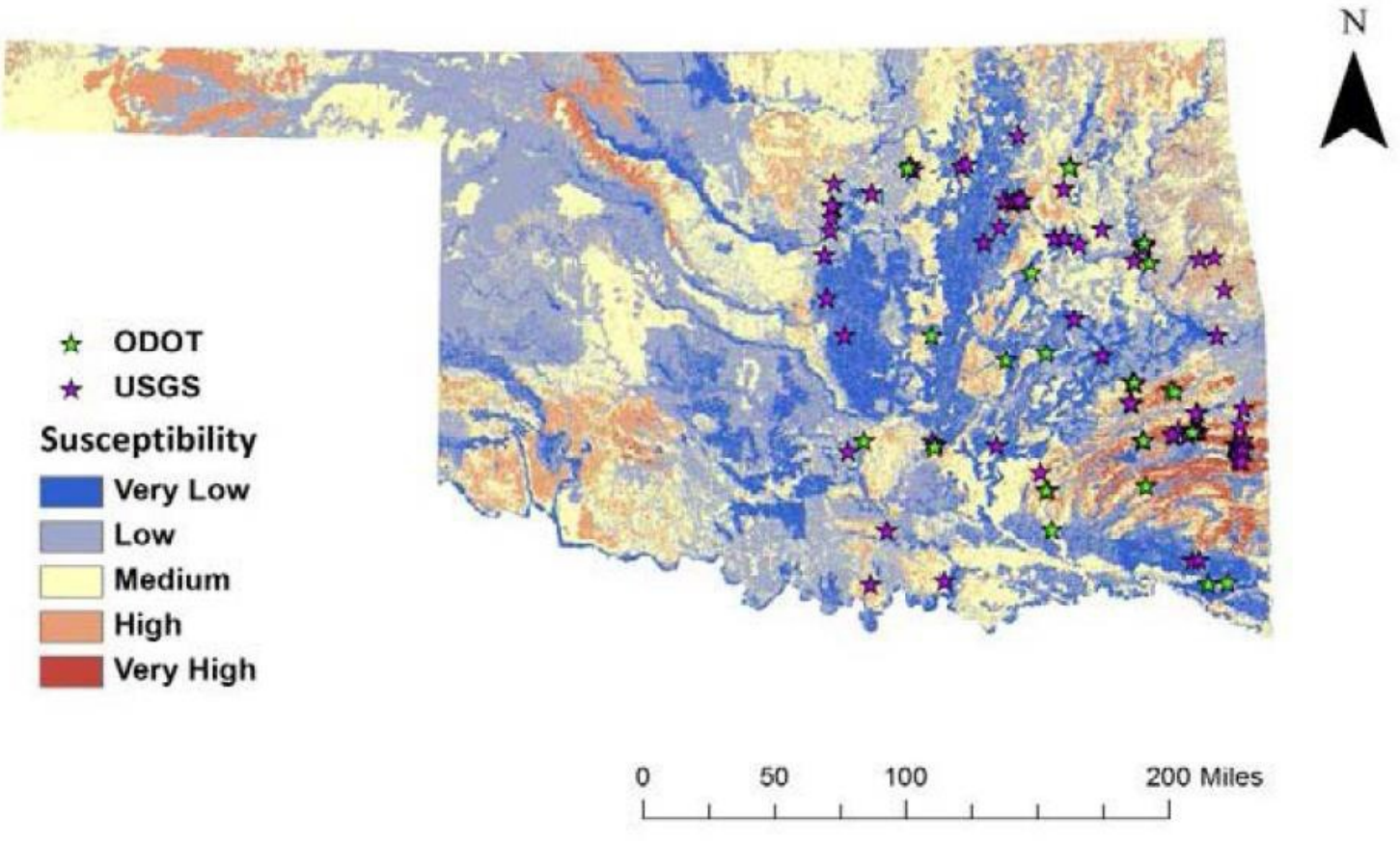

Figure 3 Landslide Susceptibility of Oklahoma

BENEFITS This research established a landslide database that will lay the groundwork for a future real-time monitoring and prediction system for Oklahoma Transportation officials to use as a warning system to minimize life-lost as well as interruptions to critical transportation corridors.