



Predicting Shallow Surficial Failures in the Mississippi River Levee System Using Airborne Hyperspectral Imagery



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Goals

To develop a hyperspectral imagery based model to predict slides in the Mississippi River levee system.

PROJECT OVERVIEW

Shallow surficial failures or levee slides in the Mississippi River levee system are very common. The current method for detecting slides is visual inspection through driving along the levee, which is not efficient in either time or cost. Currently no tool is available to predict the location of slides before they occur.



Figure 1: Developing Slide in the Mississippi River levee system (Credit: MS Levee Board)

After completion of a successful study to detect levee slides by University of Mississippi Geoinformatics Center (UMGC), we realized that it would be useful to have a remote sensing based technique to detect the potential weak zones along the levee, which are not detected by visual inspection. Based on results from previous research, this study was conducted to develop model to predict levee slides or detect potential surficial weak zones in the levee system using digital image processing techniques and commercially available high resolution hyperspectral imagery. A 3-mile levee reach along the Mississippi River in Bolivar County, Mississippi was selected as the study site for this study. The selected levee reach,

located between station 375 and station 500, near Mississippi State Highway 1 is maintained by the Mississippi Levee Board.

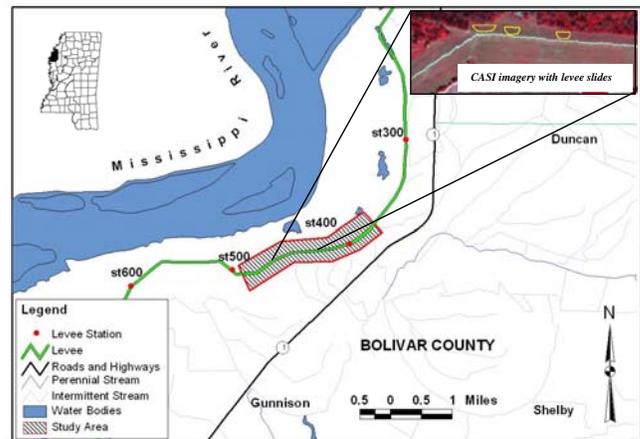


Figure 2. Location of study site and levee slides shown on the analyzed CASI II imagery

Studies of the slide occurrence mechanisms suggest that probable slide affected areas are characterized by anomalous vegetation. Compact Airborne Spectrographic Imager II (CASI II) imagery acquired on September 25, 2001 was analyzed for selected levee sites in association with slide inventory data and field observations. Normalized Difference Vegetation Index (NDVI), Red-edge Vegetation Stress Index (RVSI) and Red Edge Position Index (REP) were calculated from the CASI II imagery. The vegetation indices were used to locate the stressed or anomalous vegetation and predict levee slides with the results evaluated by semi-variogram analysis.

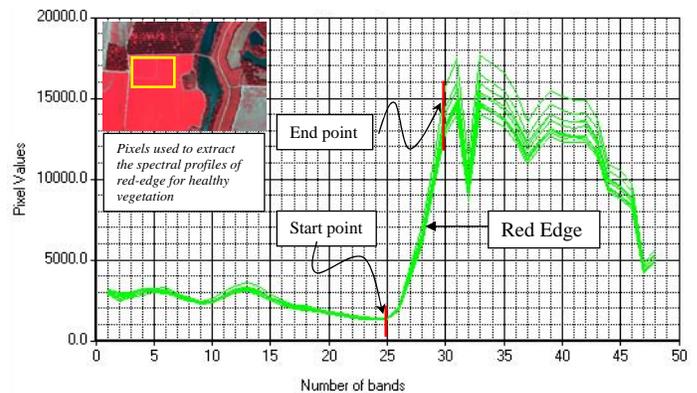


Figure 3. Spectral profile of healthy vegetation for CASI II imagery in the study site

The slide prediction model was developed by combining the single predictors, categorized vegetation indices, into a model based on all three predictors.

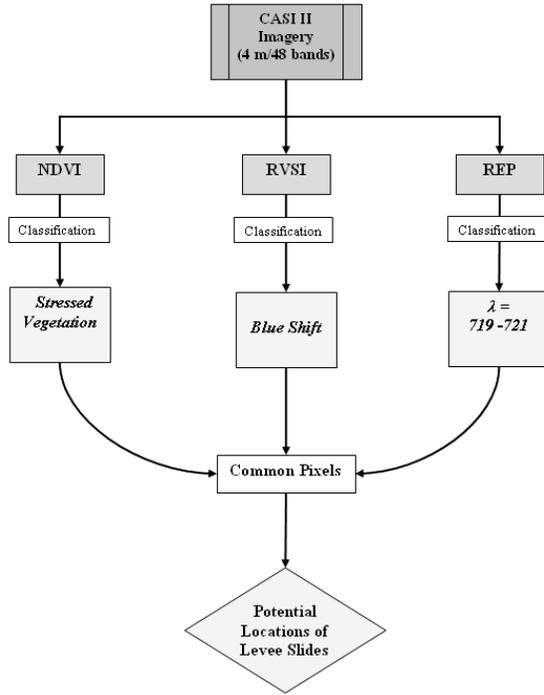


Figure 4. Slide Prediction Model

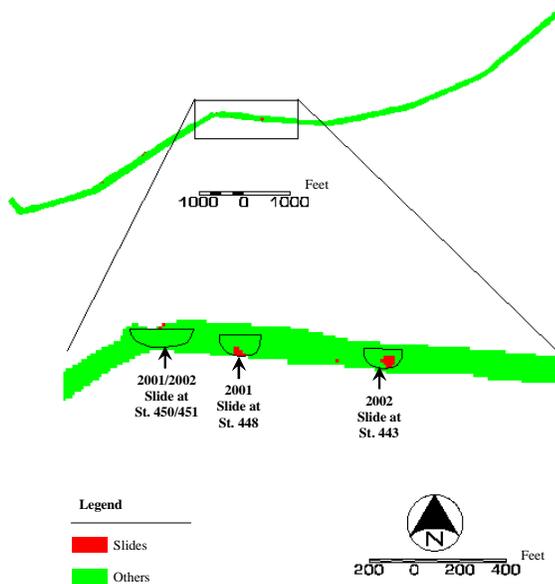


Figure 5. Slide prediction map by slide prediction model

CONCLUSIONS

This study indicates that high resolution hyperspectral imagery may be used to develop a model for levee slide prediction. Vegetation indices such as, NDVI, RVSI and REP from CASII imagery were found to be spatially and statistically significant as inputs to a slide prediction model. A slide prediction model that uses NDVI, RVSI and REP index images achieves higher values of Failure Index (0.43) and Percentage of Search Area Reduction (PSAR) (99.5). It would be able to identify areas that have potential for surficial failures along the levee systems similar to our study site.

IMPACTS

The prediction model developed by this project can assist in the early detection of weak zones in the levee, which could target repairs prior to rainy seasons or hurricane season. Detection of the potential failure zones repair would assist in the allocation of maintenance funds for the repair of the levees.

Collaborators

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