CHARACTERIZING MISSISSIPPI RIVER LEVEE SEGMENTS USING SOILS AND GEOLOGIC DATA

Khaled Hasan, James V. Aanstoos, Majid Mahrooghy, Lalitha Dabbiru, Joseph B. Dunbar

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**Project Purpose:** Develop new methods and software for improving knowledge of the condition of levees, giving levee managers new tools to prioritize their efforts.
Objectives

- **Develop new methods** of using remotely sensed data; primarily SAR, to support an efficient and cost-effective levee condition assessment and screening procedures.

- **Deliver software** supporting these techniques with robust levee segmentation and classification algorithms for performing rapid assessment of levee condition.

- **Disseminate this technology** to key stakeholders, involving them in the testing and evaluation.
How Levee Fails?

1. Overtopping
2. Slope failure
3. Through seepage
4. Underseepage

Levee soils
Sand boil
Topstratum
Foundation soils
Substratum

Dunbar 2010
Characteristics of the Slough Slides; Occurs in the Riverside of the Levee
Characteristics of the Sand Boils; Occurs in the Landside of the Levee
Where Levee fails?

Unfavorable parameters:

- **Soils** – expansive, cohesion, varying permeability
- **Sediments** – influences soil characteristics
- **Hydrology** – flooding, seepage/piping
- **Climate** – alternating wet and dry seasons
- **Geomorphology** – erosion, proximity to water
Tools to identify Weak Zones

- **SAR Remote Sensing**
  - Airborne UAVSAR L band
  - Satellite based TerraSAR-X

- **Field data to support RS**
  - USACE and Mississippi Levee Board
  - Collected by field teams

- **Unfavorable parameters data**
  - Collected from responsible agencies

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Status of SAR Data

- **UAVSAR data**
  - 2 sets acquired (June 2009 and January 2010)
  - 2 more to be acquired (May and June 2011)

- **TerraSAR-X data**
  - 4 sets acquired in 2010 (August – September)
  - 4 sets acquired in 2011 (February – April)
  - 11 sets to be acquired in 2011 (April – July)
Status of SAR processing

- Ongoing with promising outputs
  - Entropy, Anisotropy, H-α Classification
  - Artificial Neural Network
  - Textural Classification
  - Multi-temporal vegetation classification
  - Soil moisture mapping
  - Interferometry to detect surface movement

Ideas to come....
The Wishart classification results detected some slough slides (in Orange) in June 2009 image but by January 2010 they were repaired and no longer detected by the classifier.
Clustering Along Levee Using UAVSAR HH, VV, HV backscattering with wavelet and texture features
GIS Analysis of unfavorable parameters to identify/narrow vulnerable zones

- Soils: Sand (Riverside) meets Clay (Landside) at the levee – from NRCS/STI
- River Channels and/or large lakes at close proximity to the levee – from Images
- Erosion zones at close proximity to the levee – from images
- Slide events – data from Levee Board
Soil Data and Soil Data Viewer software from NRCS, USDA

County Boundaries

Soil Data Buffered along Levee

UAVSAR Image Extent
26 slide events reported by levee board in 2010

18 within 65% Sand (RS) and 65% Clay (LS) zones

13 within 85% Sand (RS) and 65% Clay (LS) zones, Misses the central part
Geology map need more details to be useful in zoning
Buffering River, Waterbody & Erosion zones to calculate proximity to Slides
Uniting them all!

If Geology factor is not considered, only 3 events are not associated with any of these unfavorable parameters.
### Relationship between Slides and Unfavorable Parameters

Slides are closer to: Lakes in the south, River in the north

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**TOTAL = 26** 15 events within 1250m  8 events within 1250m  13 events  18 events  14 clay, 12 Sand  7 events within 1250m
High Vulnerability <=1250 m from all water OR sand/clay => 65%, 23 slides

Mod Vulnerability <=1250 m from all water AND sand/clay => 65%, 18 slides (slightly less area than sand vs. clay 65%)
High Vulnerability <=1250 m from all water OR sand/clay => 65%, 23 slides

High Vulnerability <=1250 m from all Lakes OR sand/clay => 65%, 22 slides, AND option discarded; shows 11 events

Significant reduction in vulnerable section
Mod Vulnerability $\leq$1250 m from all Lakes OR sand $\Rightarrow$ 85% Clay 65, 17slides

Mod Vulnerability $\leq$1250 m from all water AND sand/clay $\Rightarrow$ 65%, 18 slides

Significant reduction in vulnerable section
High vulnerability <=1250 m from all lakes and river banks; 23 slides, slightly less area than all water OR Sand/clay => 65%

Low vulnerability <=1250 m from lakes; 15 slides of which 14 in south, misses most slides of the north, DISCARDED

Other Options Tested
This will help in identifying zones with greater potential of vulnerability based on the natural parameters and will support the SAR study in narrowing down target areas on the Levee.

Best Option with High Vulnerability
<=1250 m from all Lakes
OR sand/clay => 65%, 22 slides,

Best Option with Moderate Vulnerability
<=1250 m from all water AND sand/clay =>
65%, 18 slides
Questions?