Screening of Earthen Levees Using Synthetic Aperture Radar

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The Problem:

- 100,000 miles of dams and levees nationwide
- National Committee on Levee Safety * recommends
  - "expand the existing federal National Levee Database (NLD) to include inventory and inspection... of all levees"
- No funds have been allocated for extending the inspection portion of this work beyond the small subset of these levees which are managed by the Corps of Engineers.

* 2009 report to Congress

Project Purpose: Develop new methods and software for efficiently improving knowledge of the condition of levees, based on remotely sensed data: airborne multi-polarized imaging synthetic aperture radar.

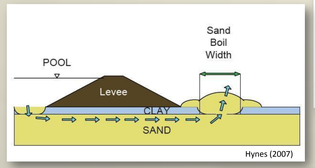
Expected Outcome: Improved knowledge of the status of levees will significantly enhance the allocation of precious resources to inspect, test, and repair the ones in most need.

Technical Approach

1. Remotely Sensed Data collection
   - 1.1 Develop collection plan: choose sites /dates, ancillary data
   - 1.2 UAVSAR Flight 1 collection; Flight 2 collection
   - 1.3 Ancillary descriptive and image data
2. Data exploration: compute statistics, visualize. Identify anomalies
3. Ground site visits (guided by data anomalies) and soil tests
4. Classification algorithm development
   - 4.1 polarimetric SAR data relation with soil moisture variability
     - 4.1.1 Texture-based features
     - 4.1.2 H-A-alpha based features (PolSARpro)
   - 4.2 Interferometric algorithms to map subsidence
   - 4.3.Refine and test algorithms

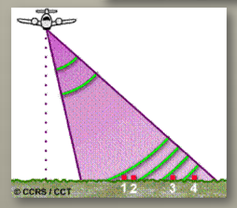
UAVSAR RADAR

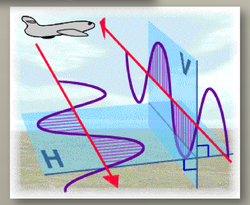
Parameter	Value
Frequency	L-band
Bandwidth	80 MHz
Range Resolution	1.8 m
Polarization	Full Quad-Polarization
Raw ADC Bits	12 baseline
Waveform	Nominal Chirp/Arbitrary Waveform
Antenna Dimensions	0.5 m range/1.5 azimuth
Azimuth Steering	Greater than ±20°
Power	> 2.0 kW
Polarization Isolation	<-20 dB

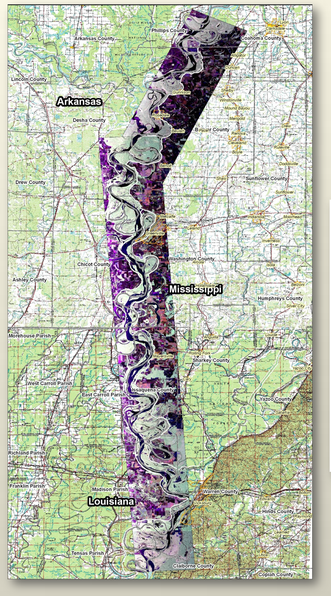


Under-seepage and erosion can lead to levee failure. Can we detect potential weakness via airborne radar?

UAVSAR is a high-resolution, multi-polarization, L-band SAR, currently flown on a NASA research aircraft (Gulfstream-3). L-band signal penetrates vegetation and up to 1 m of dry soil; Backscatter carries information related to soil moisture variation.

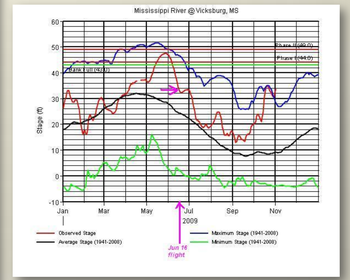


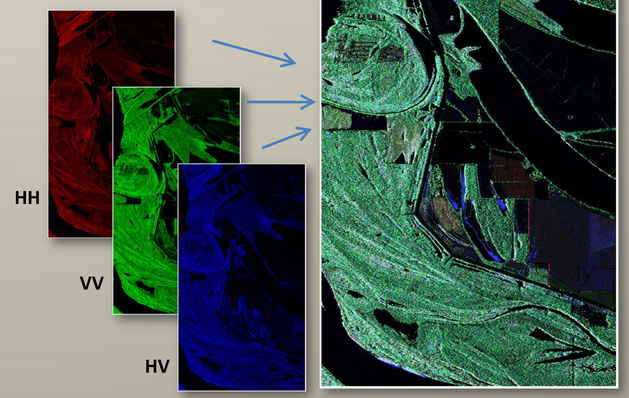




Test area: 240 km of Mississippi River levees

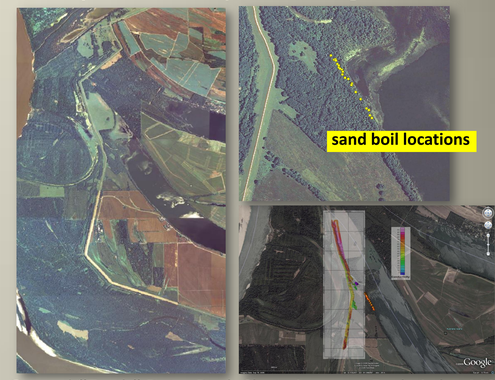
UAVSAR flight 1: June 1, 2009





Multiple-polarization radar data color composite image of Buck Chute levee vicinity, Eagle Lake, MS.

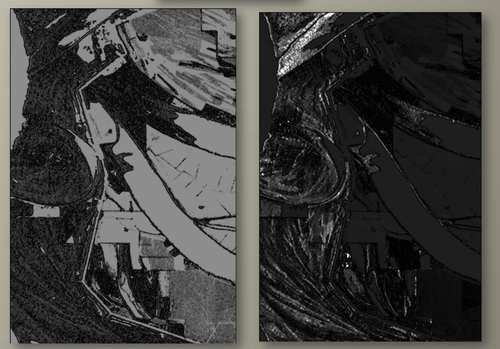
Preliminary Results from Exploration of Flight 1 Radar Data



Ground "Truth" Data: Buck Chute Levee at Eagle Lake, MS

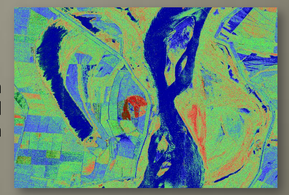
Soil conductivity monitoring station

Sand boil at Buck Chute



Statistical distance image between sand boil pixels and others in AOI for Gray Level Co-occurrence Matrix features:
(L.) homogeneity in HV; (R.) Window mean in HH

H-Alpha Classification from PolSARpro of Grand Lake, AR seepage area



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