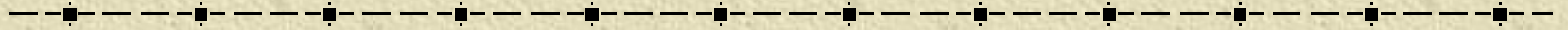


# CHARACTERIZING MISSISSIPPI RIVER LEVEE SEGMENTS USING SOILS AND GEOLOGIC DATA



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

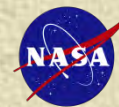
**Symposium on the Application of Geophysics to Engineering and Environmental Problems  
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**Project Purpose: Develop new methods and software for improving knowledge of the condition of levees, giving levee managers new tools to prioritize their efforts.**

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# Objectives

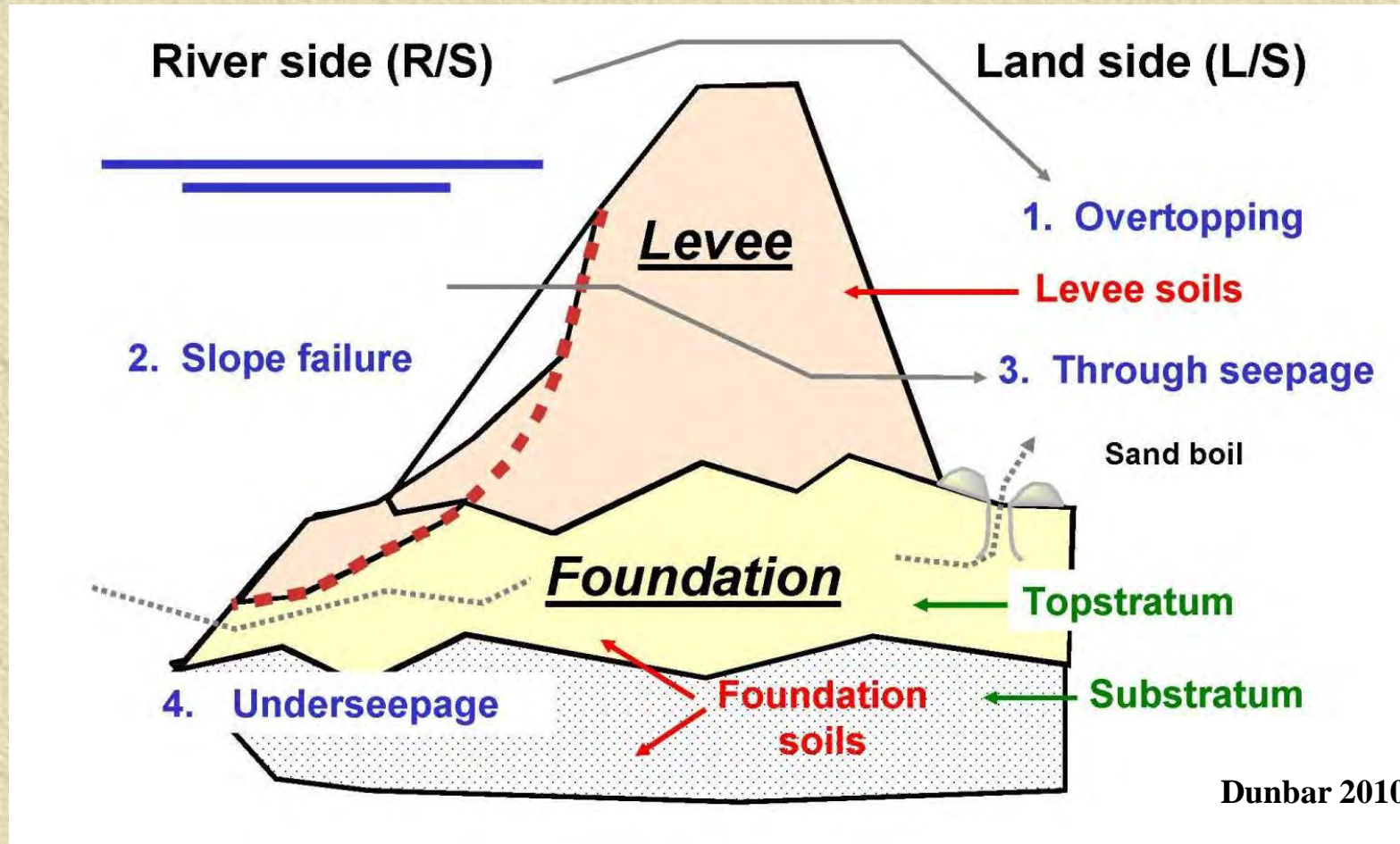
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- **Develop new methods** of using remotely sensed data; primarily SAR, to support an efficient and cost-effective levee condition assessment and screening procedures.
- **Deliver software** supporting these techniques with robust levee segmentation and classification algorithms for performing rapid assessment of levee condition.
- **Disseminate this technology** to key stakeholders, involving them in the testing and evaluation.

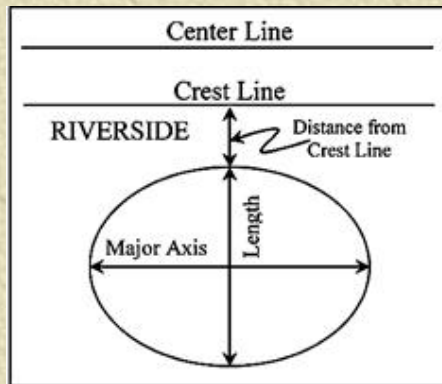
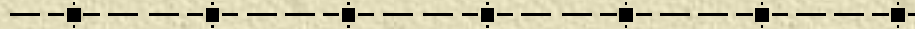




# How Levee Fails?



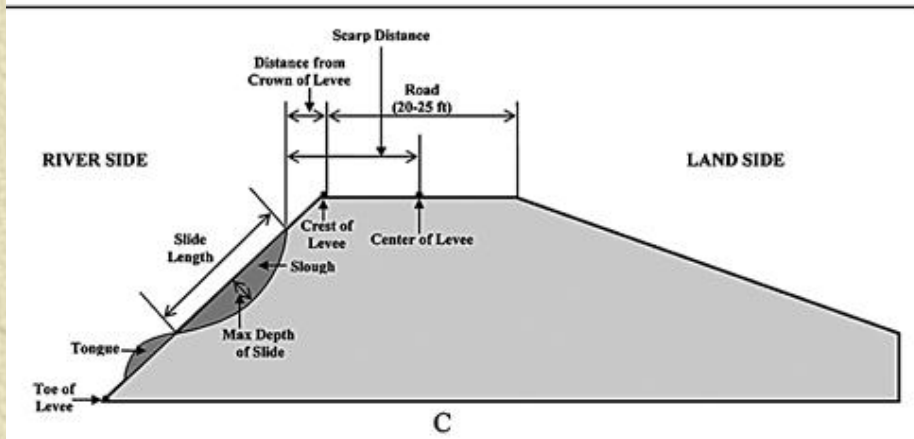
# Characteristics of the Slough Slides; Occurs in the Riverside of the Levee



A



B

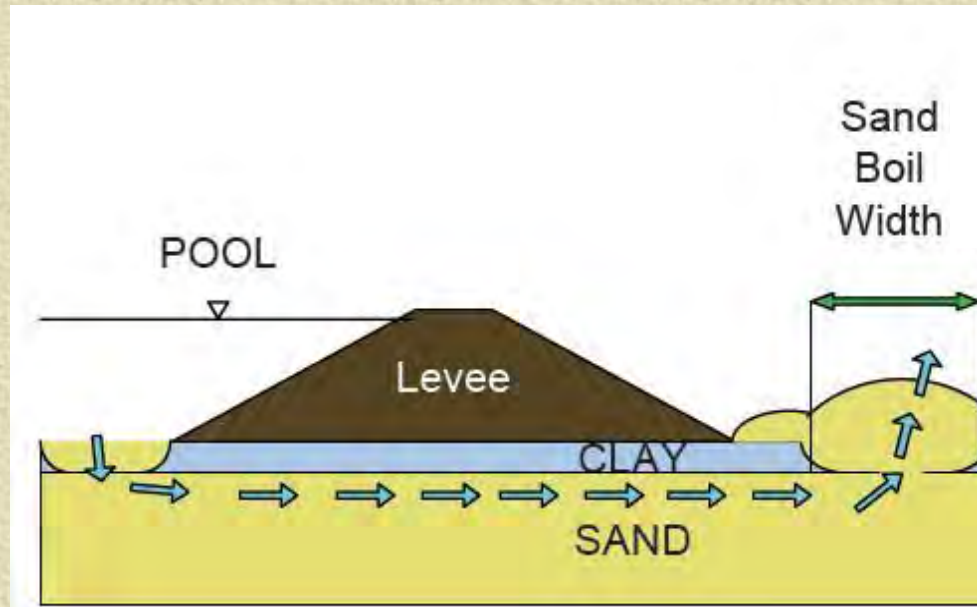


C





# Characteristics of the Sand Boils; Occurs in the Landside of the Levee



# Where Levee fails?

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## ● 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

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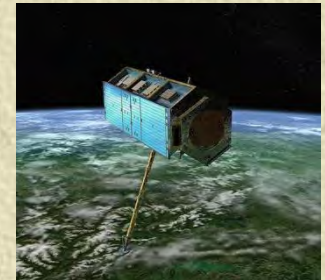
## ● SAR Remote Sensing

- 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





# Status of SAR Data

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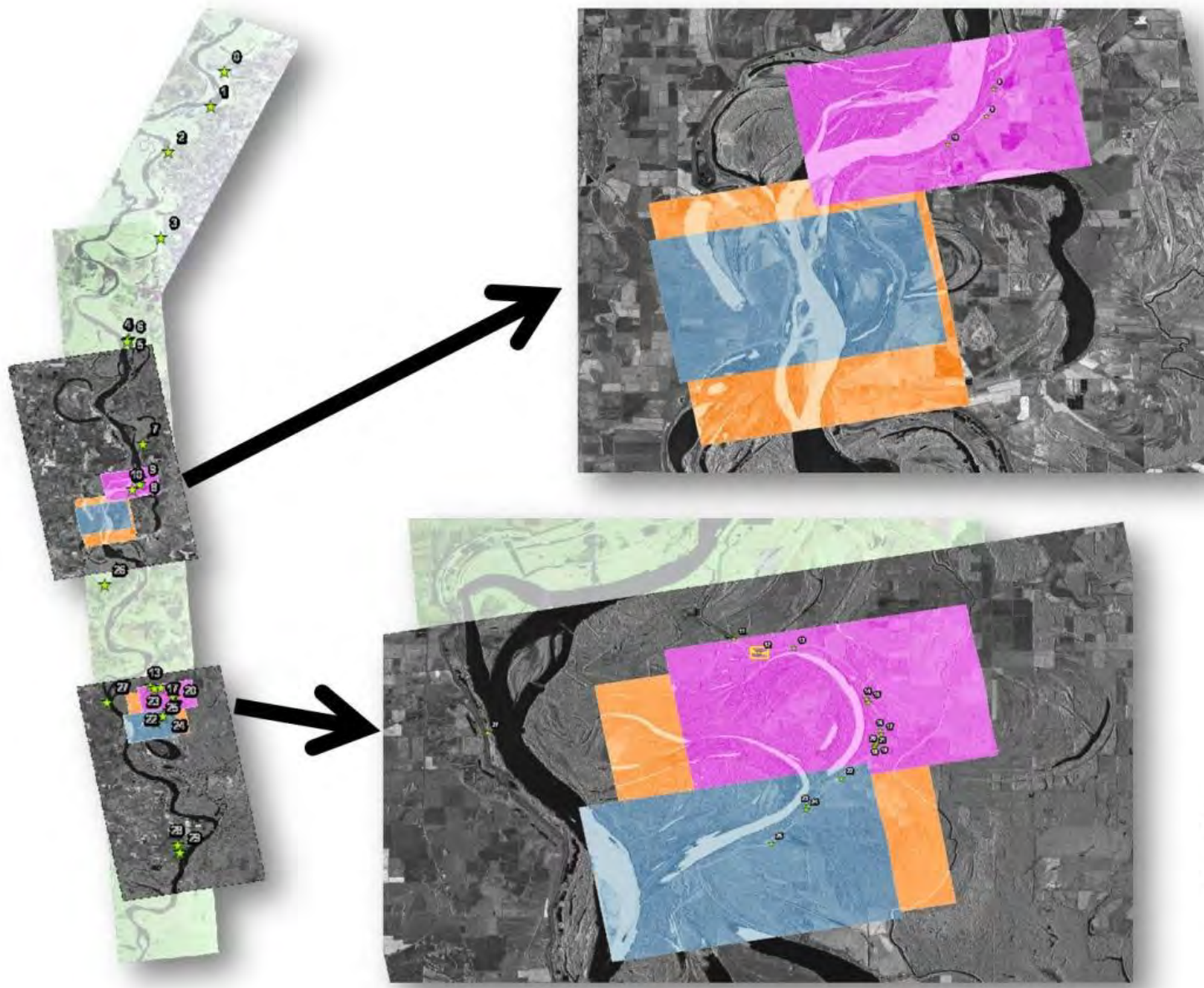
## ● UAVSAR data

- 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)





- 15Sep2010 █
- 26Sep2010 █
- 04Sep2010 █
- 24Aug2010 █



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# Status of SAR processing

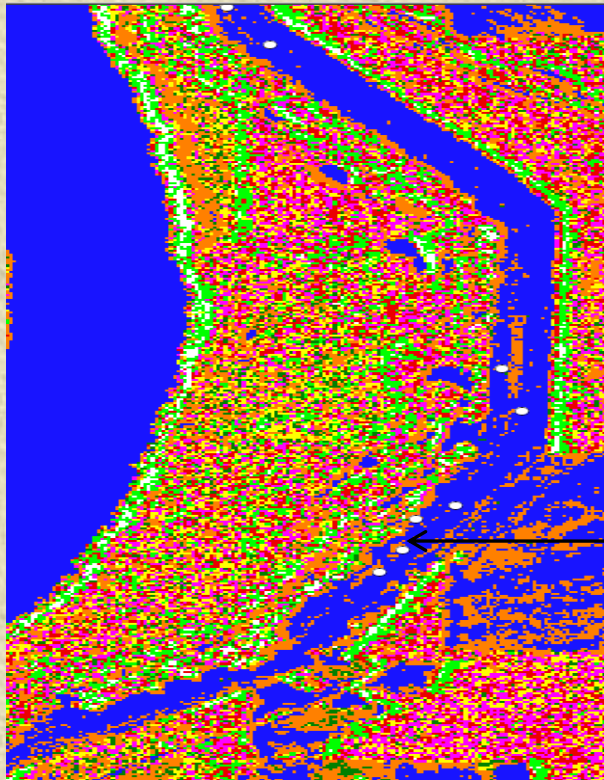
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## ● Ongoing with promising outputs

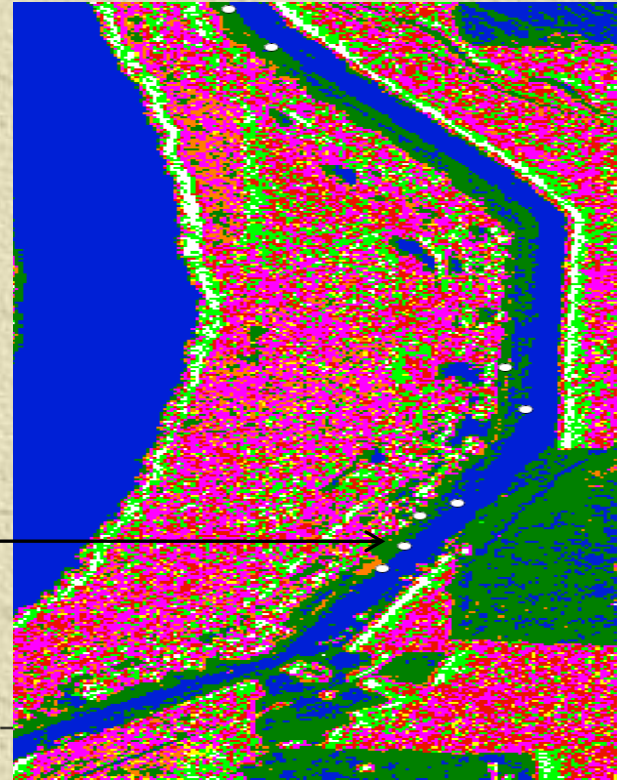
- Entropy, Anisotropy, H- $\alpha$  Classification
- Artificial Neural Network
- Textural Classification
- Multi-temporal vegetation classification
- Soil moisture mapping
- Interferometry to detect surface movement
- Ideas to come....

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

June 2009 UAVSAR

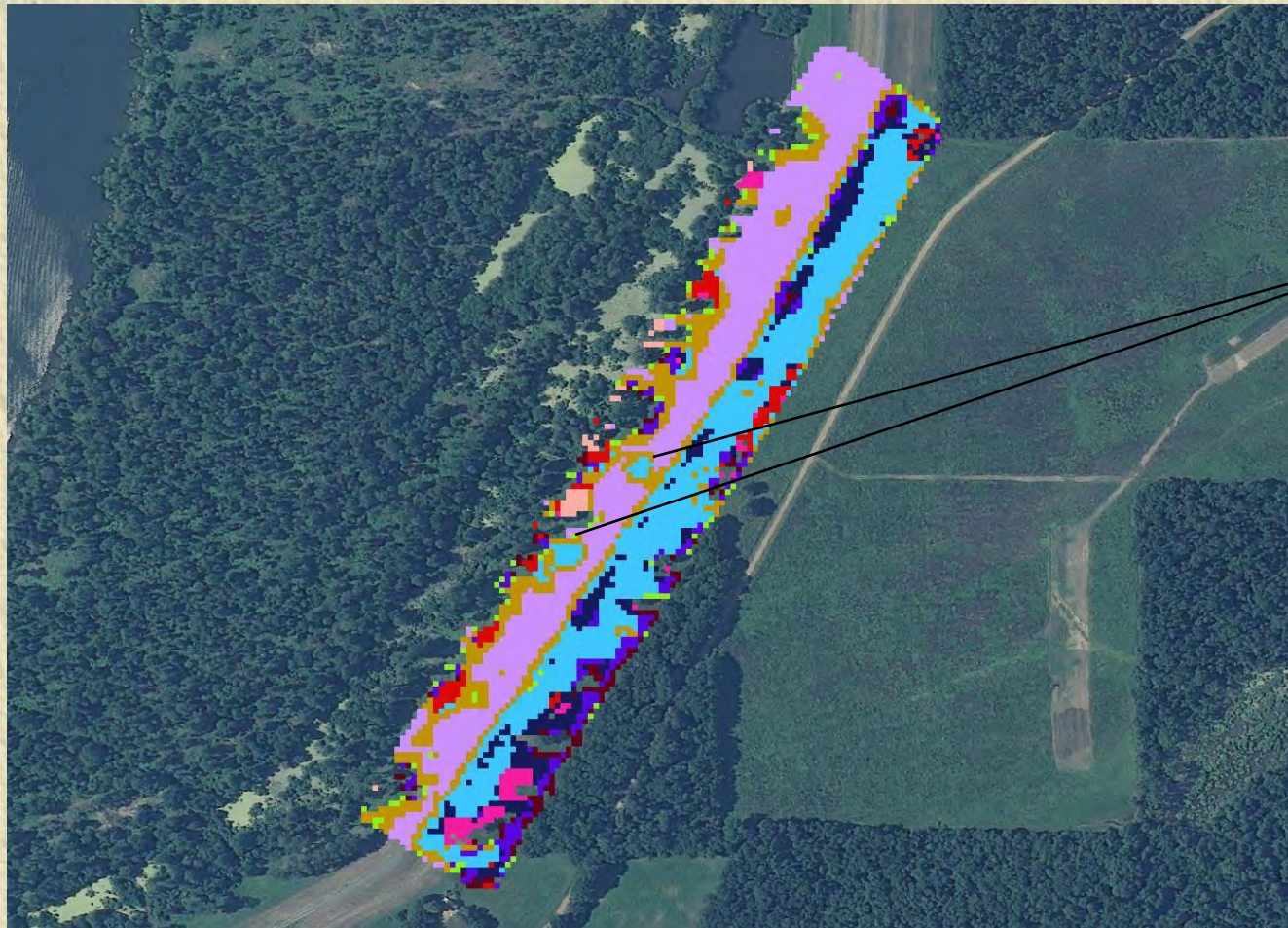


January 2010 UAVSAR





# Clustering Along Levee Using UAVSAR HH, VV, HV backscattering with wavelet and texture features



Slides



# GIS Analysis of unfavorable parameters to identify/narrow vulnerable zones

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- **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**

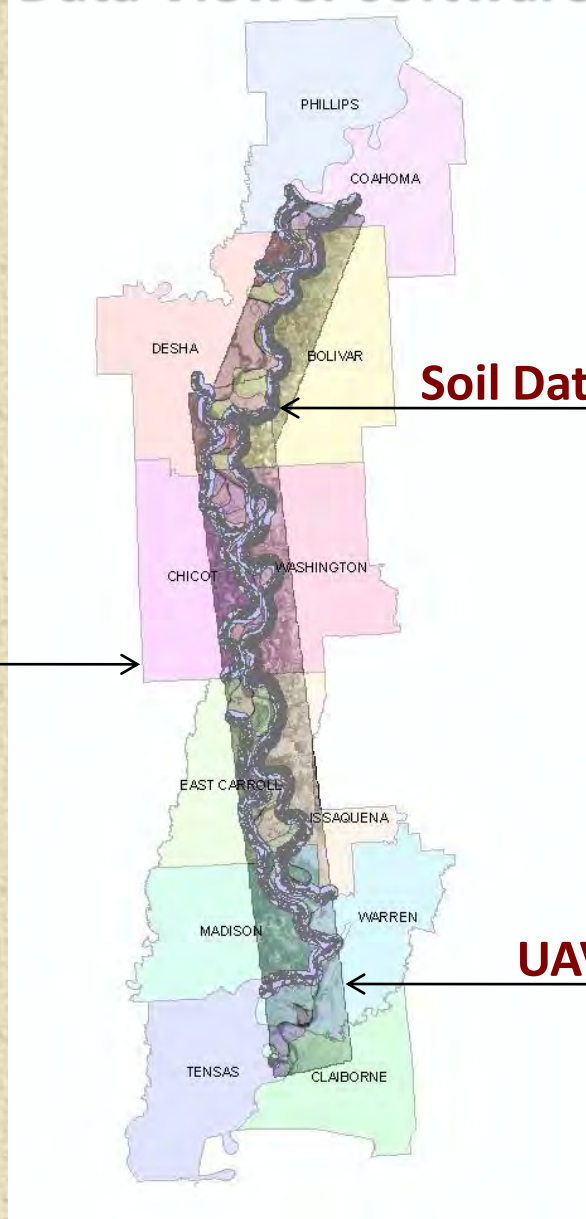


# Soil Data and Soil Data Viewer software from NRCS, USDA

**County Boundaries**

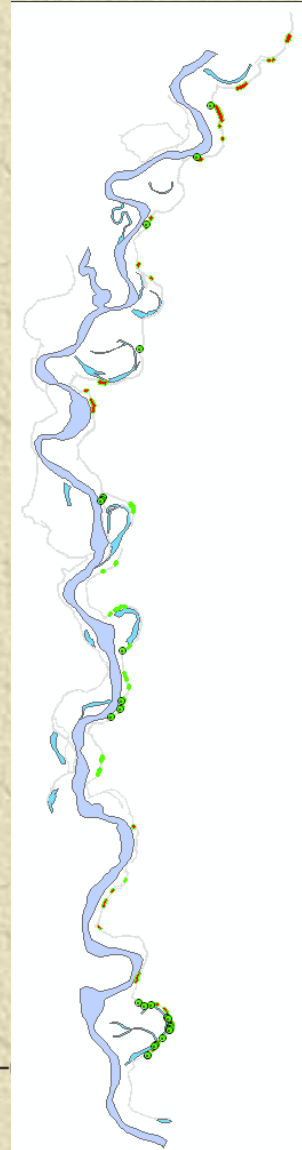
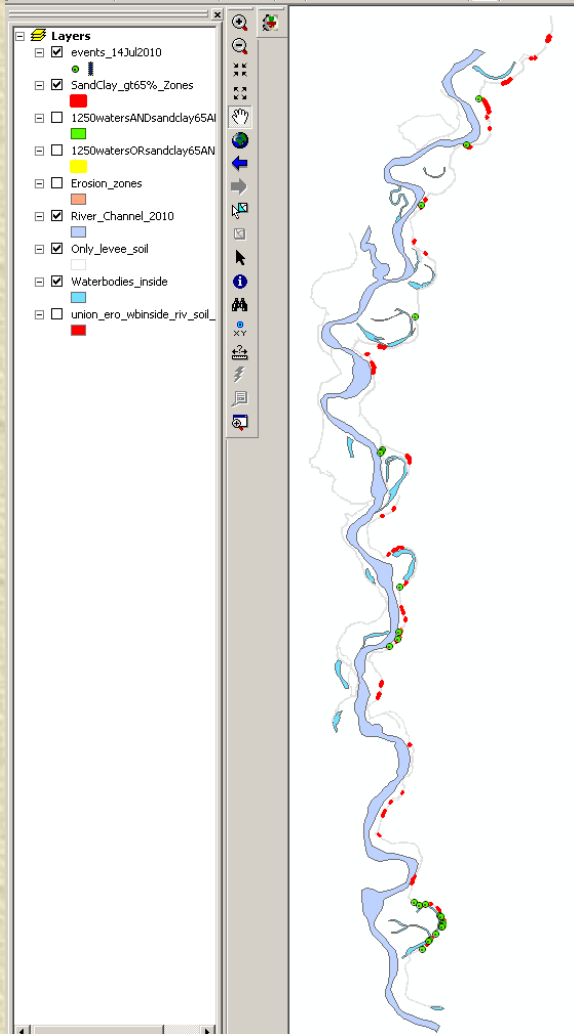
**Soil Data Buffered along Levee**

**UAVSAR Image Extent**

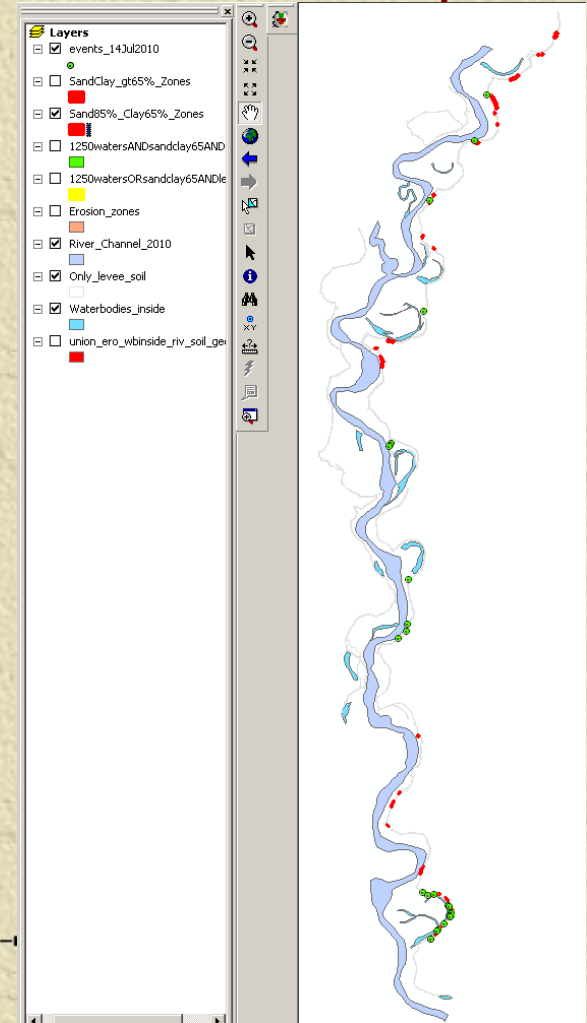


# 26 slide events reported by levee board in 2010

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

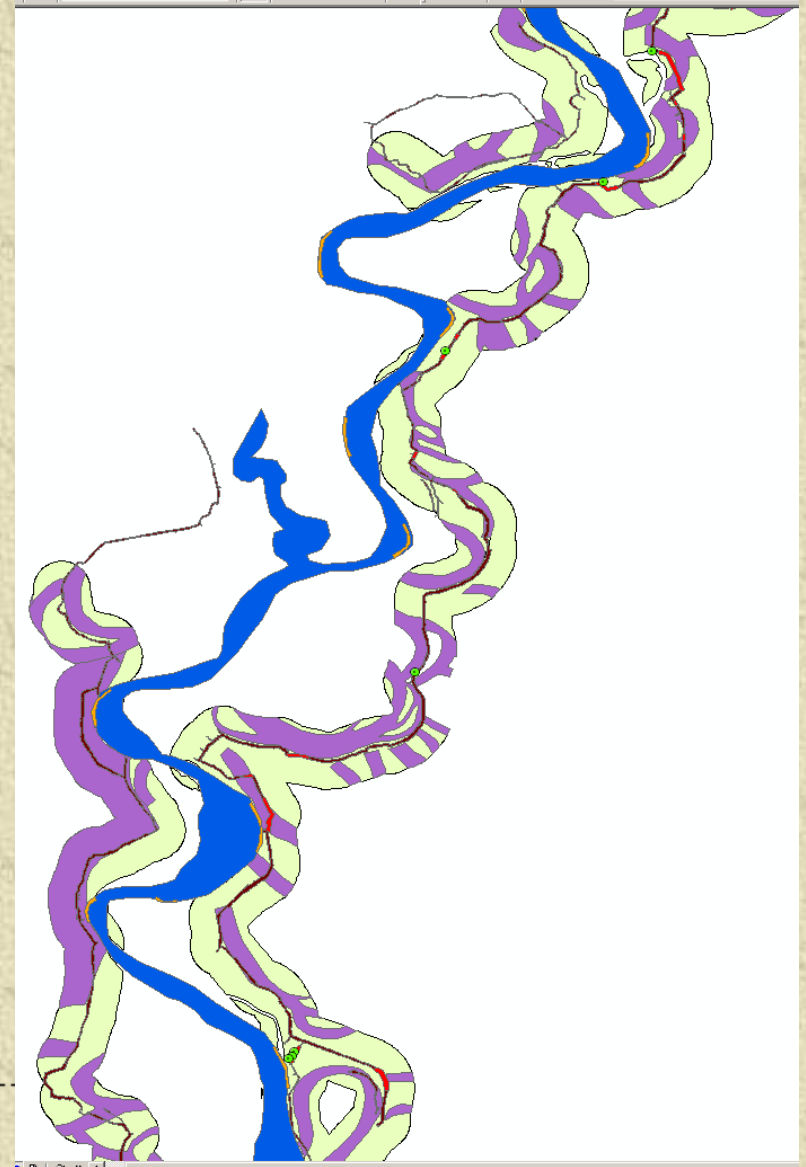
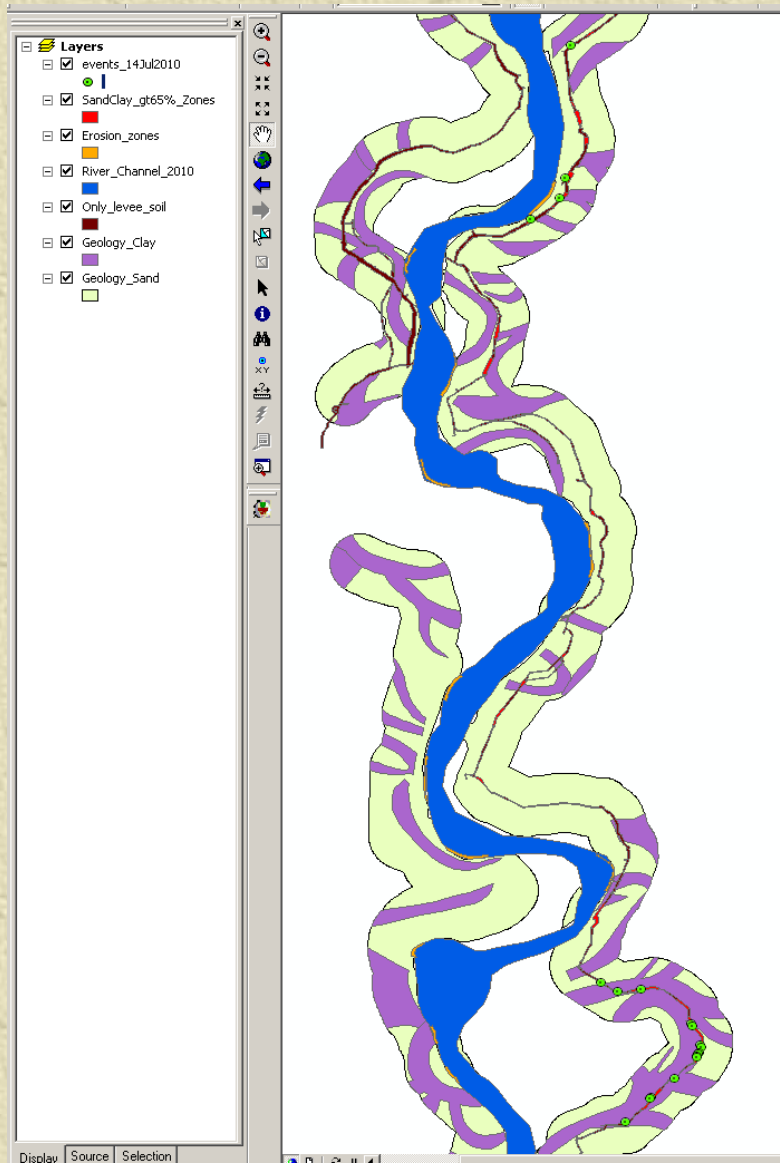


13 within 85% Sand (RS) and 65% Clay (LS) zones, Misses the central part

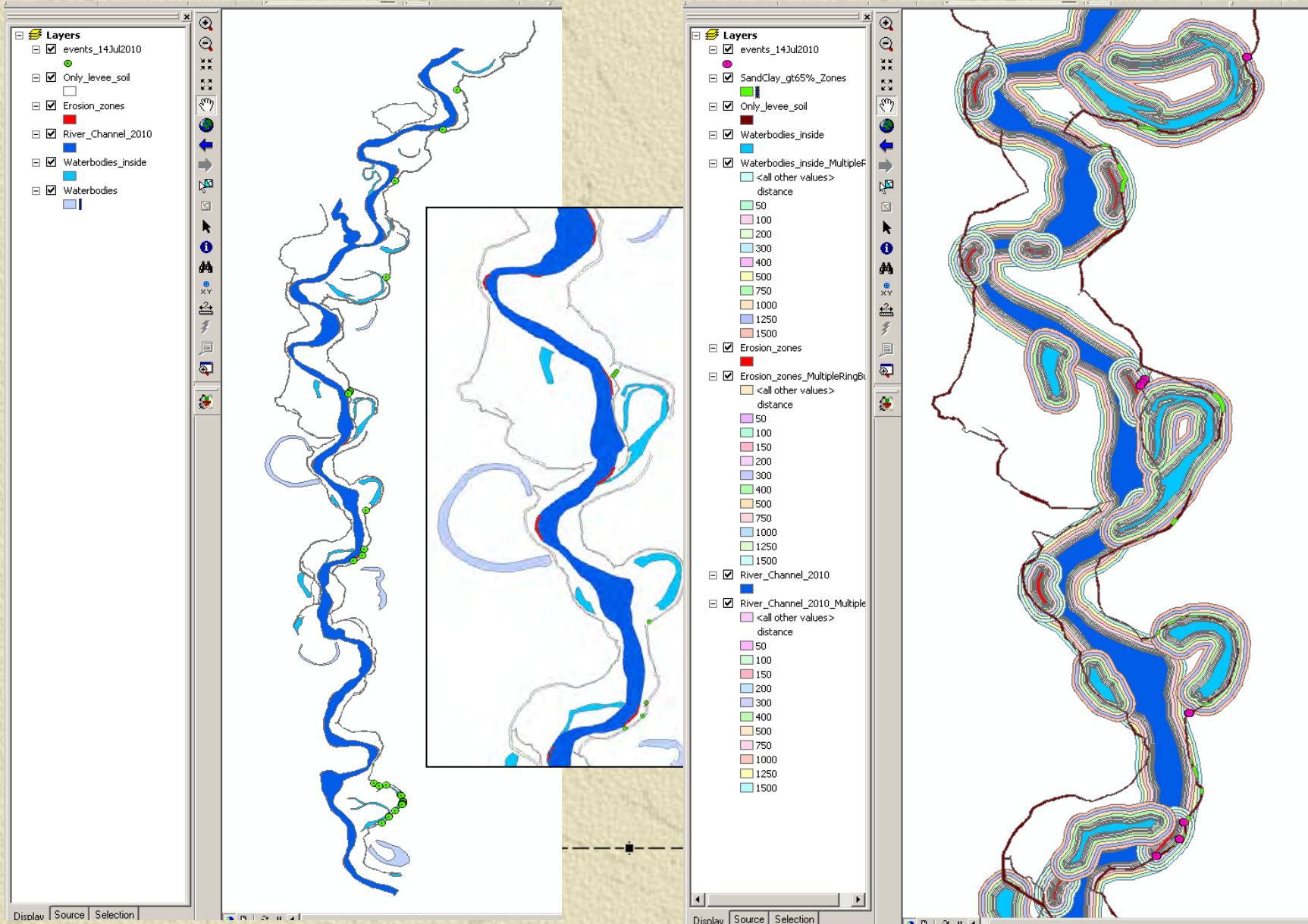




# Geology map need more details to be useful in zoning



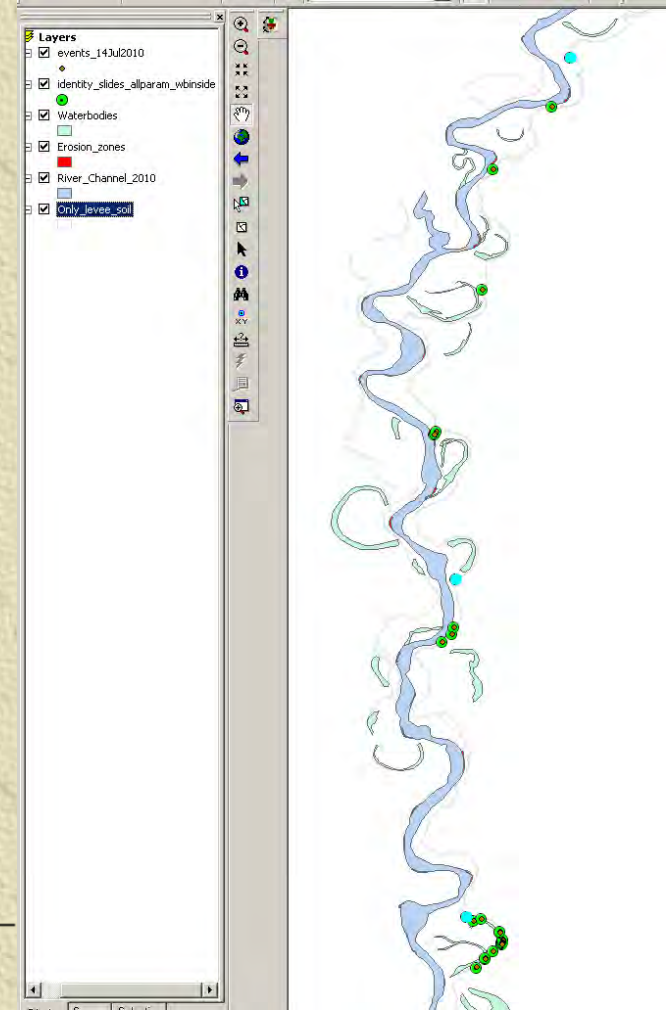
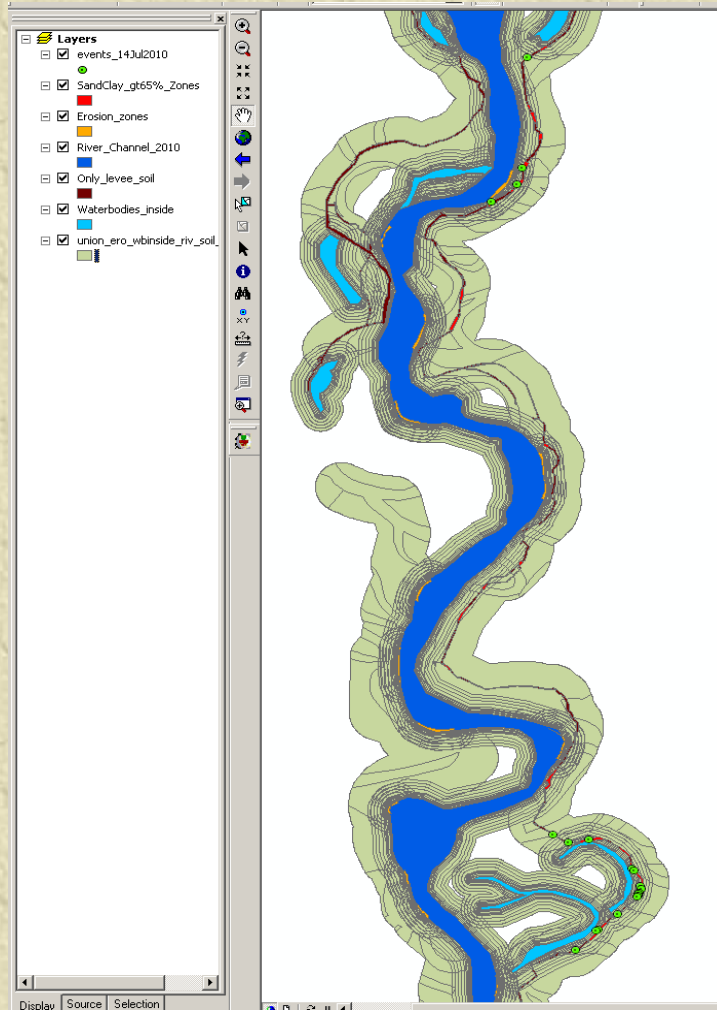
# Buffering River, Waterbody & Erosion zones to calculate proximity to Slides





# 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

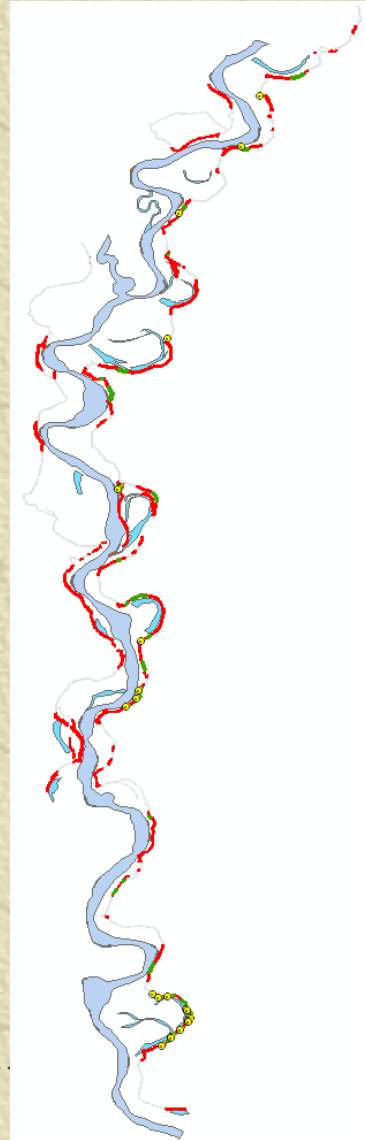
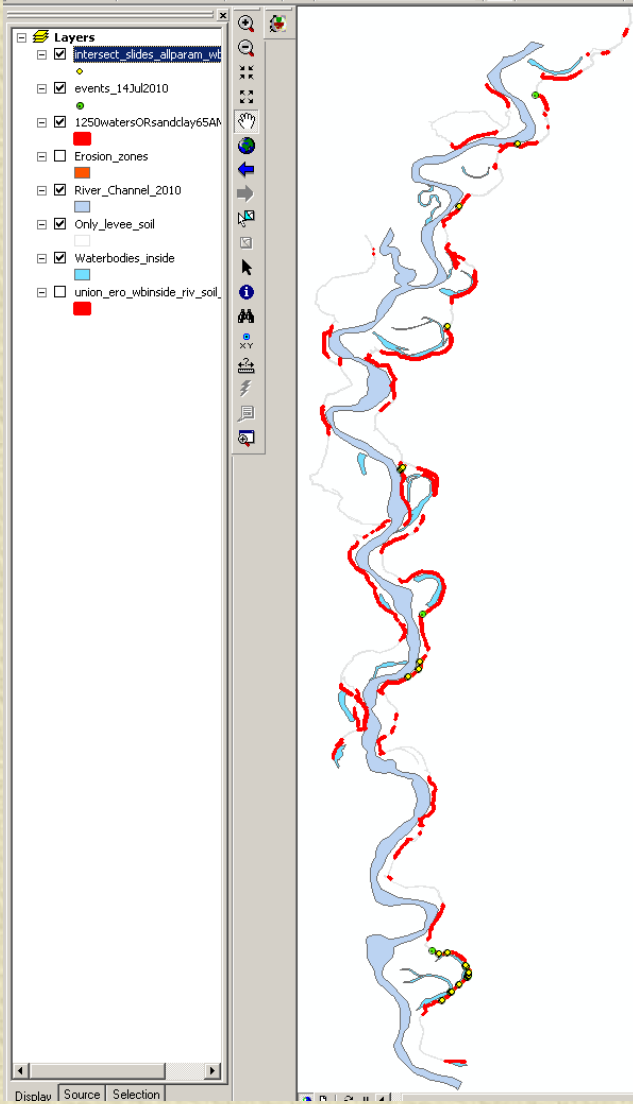
## Slides are closer to: Lakes in the south, River in the north

	A	B	C	D	E	F	G
1	FID_events	distance (waterbody)	distance (river)	Sand85_bad_textur	sandclay65_bad_text	Geo_Units	distance (erosion)
2	25	1000	0			Aban. Chan Depo	0
3	24	400	0	Yes	Yes	Aban. Chan Depo	0
4	23	400	0	Yes	Yes	Aban. Chan Depo	0
5	22	500	0			Aban. Chan Depo	0
6	21	750	0	Yes	Yes	Aban. Chan Depo	0
7	20	750	0	Yes	Yes	Aban. Chan Depo	0
8	19	750	0	Yes	Yes	Aban. Chan Depo	0
9	18	750	0	Yes	Yes	Aban. Chan Depo	0
10	17	1000	0	Yes	Yes	Aban. Chan Depo	0
11	16	750	0	Yes	Yes	Aban. Chan Depo	0
12	15	400	0	Yes	Yes	Point Bar (M Scroll	0
13	14	400	0	Yes	Yes	Point Bar (M Scroll	0
14	12	400	0			Aban. Chan Depo	0
15	13	100	0	Yes	Yes	Aban. Chan Depo	0
16	11	0	0			Point Bar (M Scroll	0
17	10	0	400		Yes	Point Bar (M Scroll	300
18	9	0	1000			Aban. Chan Depo	750
19	8	0	750		Yes	Point Bar (M Scroll	750
20	7	0	0			Point Bar (M Scroll	0
21	6	0	500		Yes	Point Bar (M Scroll	500
22	5	0	750		Yes	Point Bar (M Scroll	750
23	4	0	1250		Yes	Point Bar (M Scroll	1250
24	3	1250	0			Aban. Chan Depo	0
25	2	0	1000	Yes	Yes	Point Bar (M Scroll	1250
26	1	0	300	Yes	Yes	Point Bar (M Scroll	0
27	0	0	0			Point Bar (M Scroll	0
28							
29	TOTAL = 26	15 events within 1250m	8 events within 1250m	13 events	18 events	14 clay, 12 Sand	7 events within 1250m

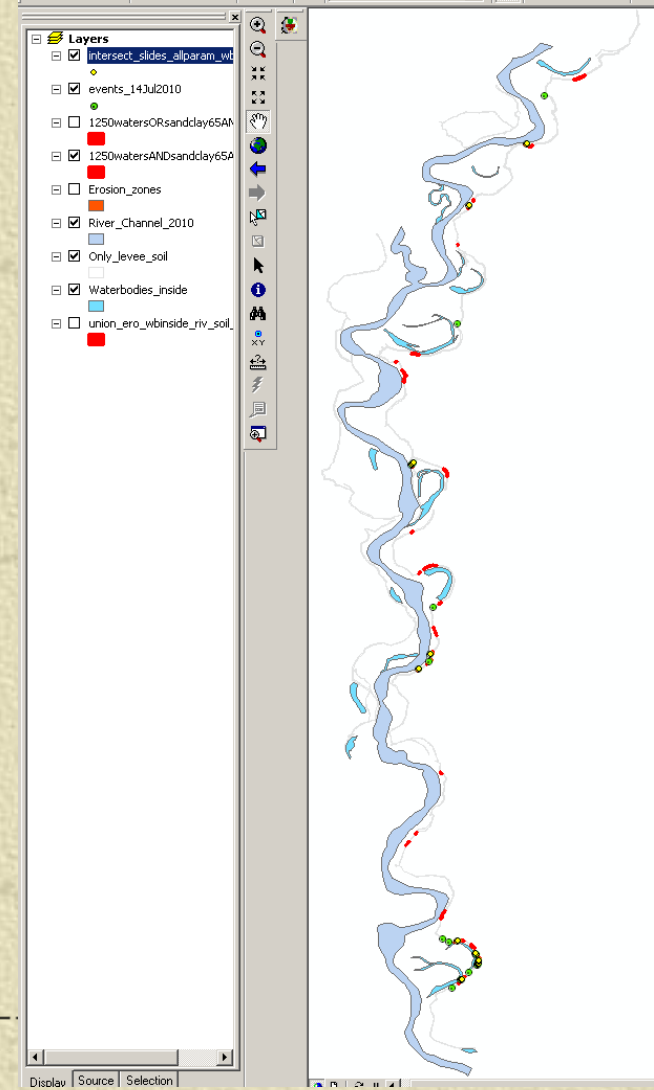




High Vulnerability  $\leq 1250$  m from all water OR sand/clay  $\Rightarrow$  65%, 23 slides



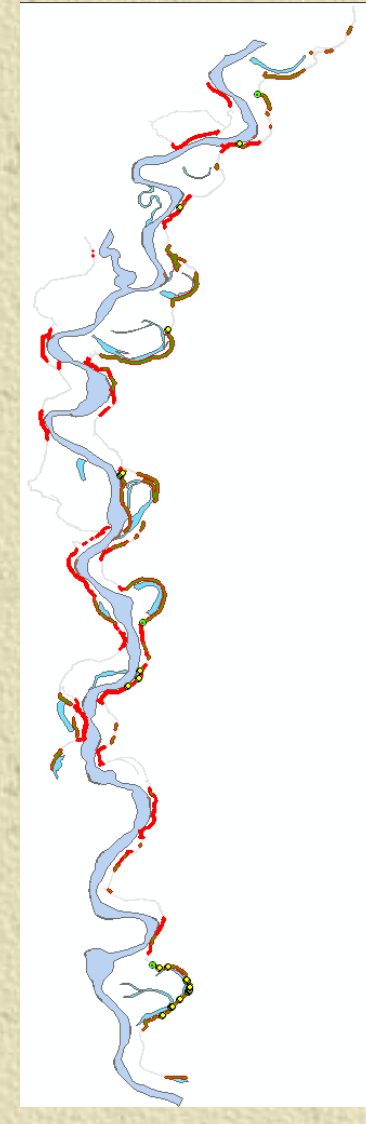
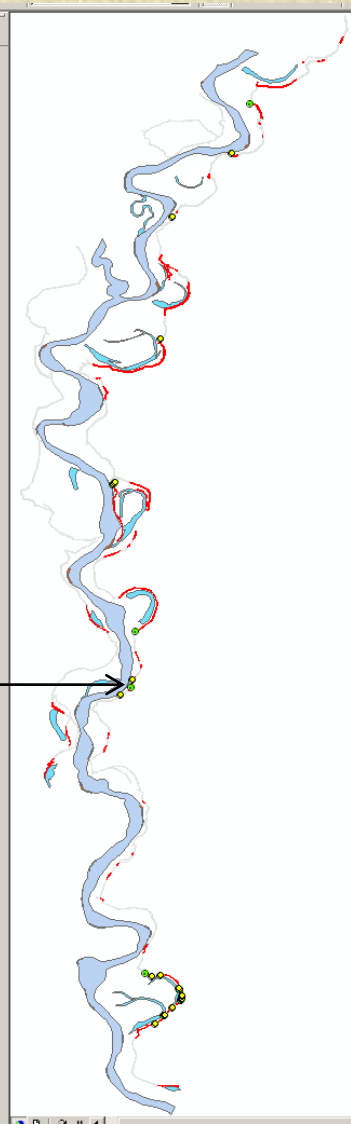
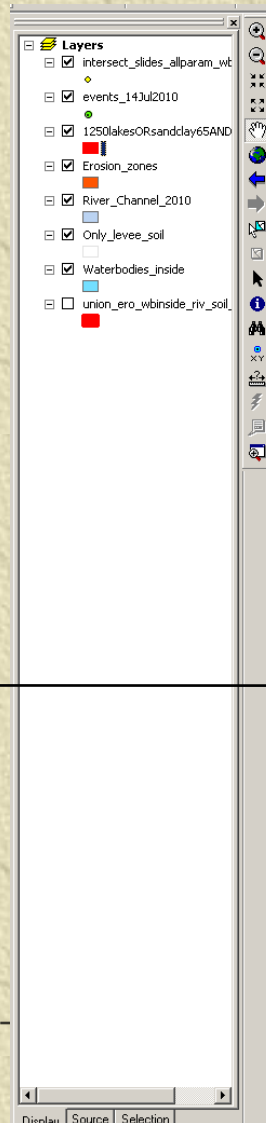
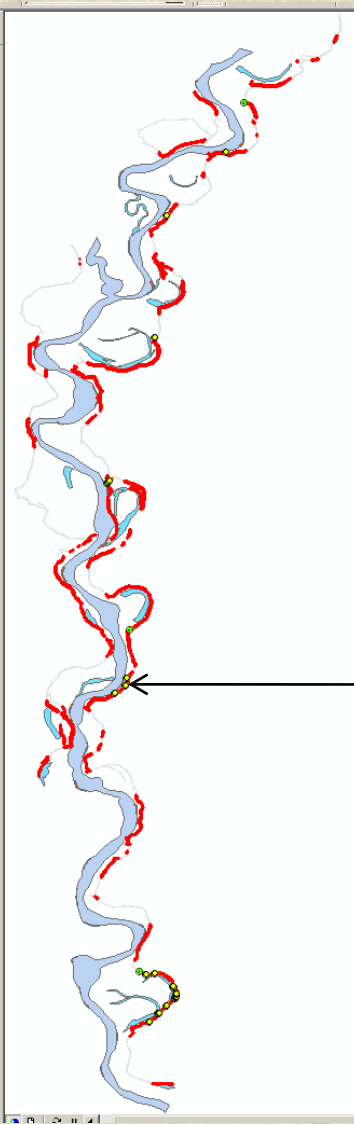
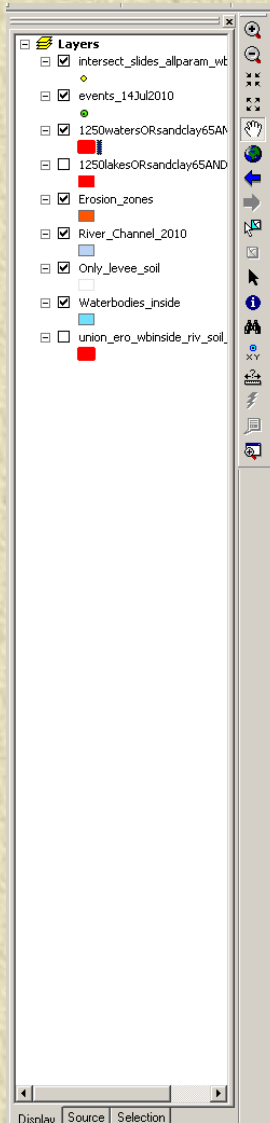
Mod Vulnerability  $\leq 1250$  m from all water AND sand/clay  $\Rightarrow$  65%, 18 slides (slightly less area than sand vs. clay 65%)



High Vulnerability  $\leq 1250$  m from all water OR sand/clay  $\Rightarrow$  65%, 23 slides

High Vulnerability  $\leq 1250$  m from all Lakes OR sand/clay  $\Rightarrow$  65%, 22 slides, AND option discarded; shows 11 events

Significant reduction in vulnerable section



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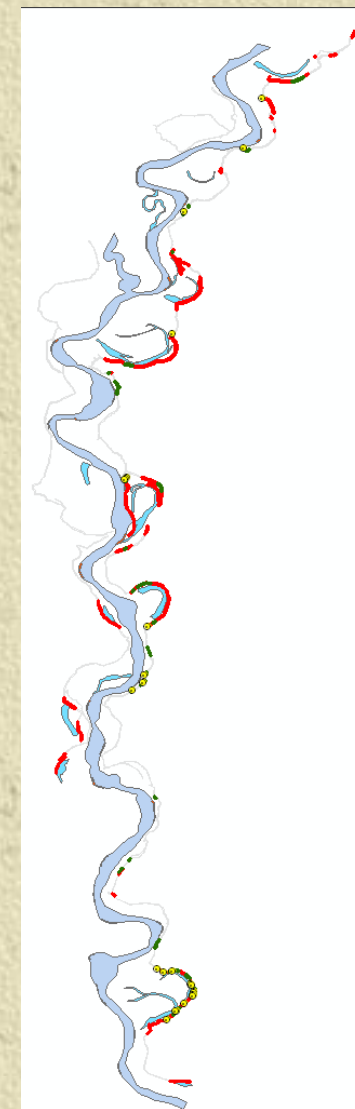
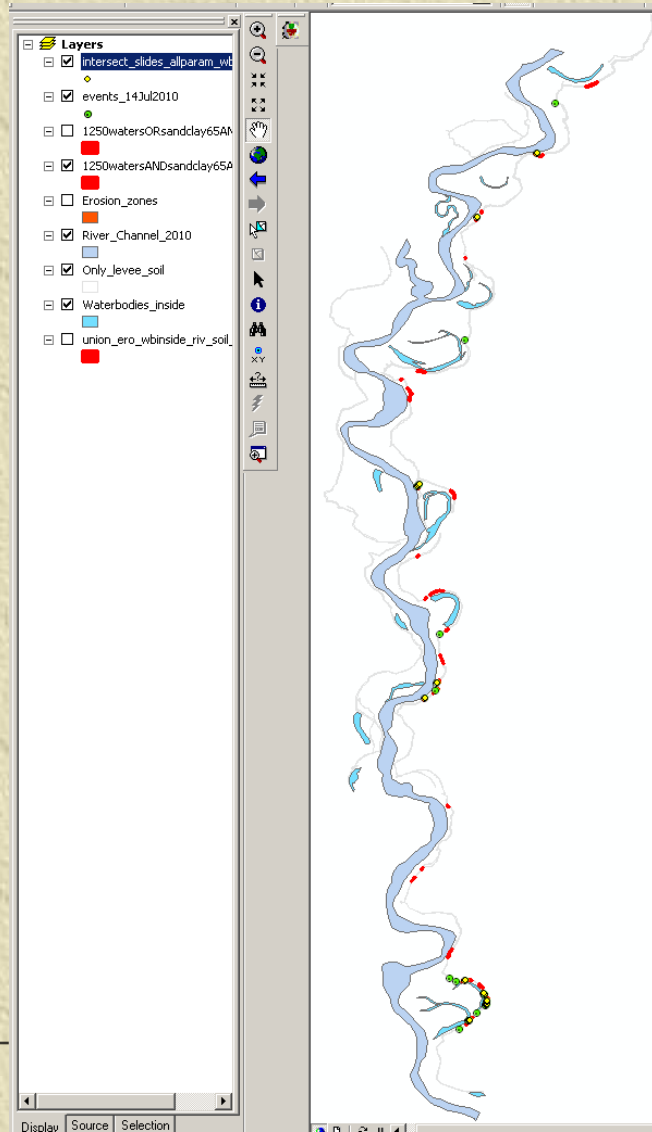
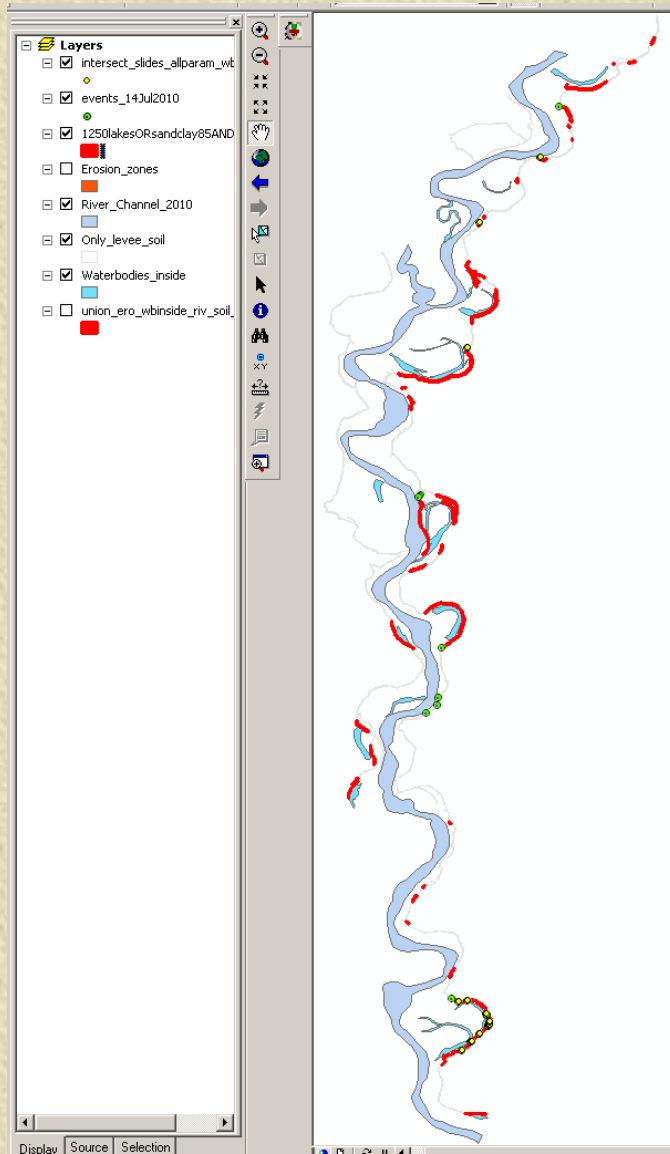
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Mod Vulnerability <=1250 m from all  
Lakes OR sand => 85% Clay 65, 17slides

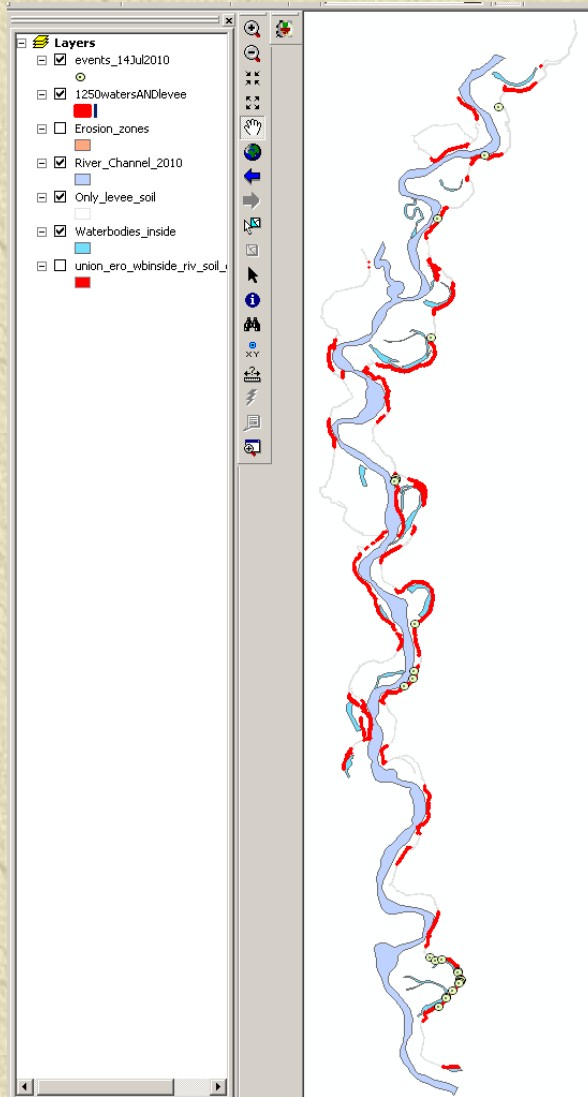
Mod Vulnerability <=1250 m from all  
water AND sand/clay => 65%, 18 slides

Significant reduction in  
vulnerable section

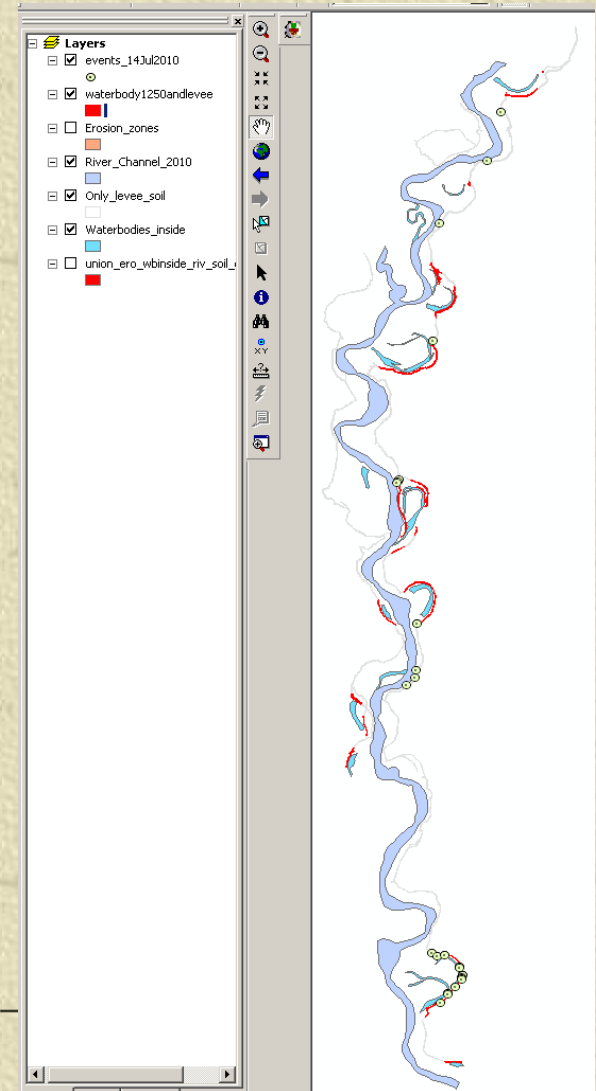


High vulnerability <=1250 m from all lakes and river banks; 23 slides, slightly less area than all water OR Sand/clay => 65%

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



## Other Options Tested



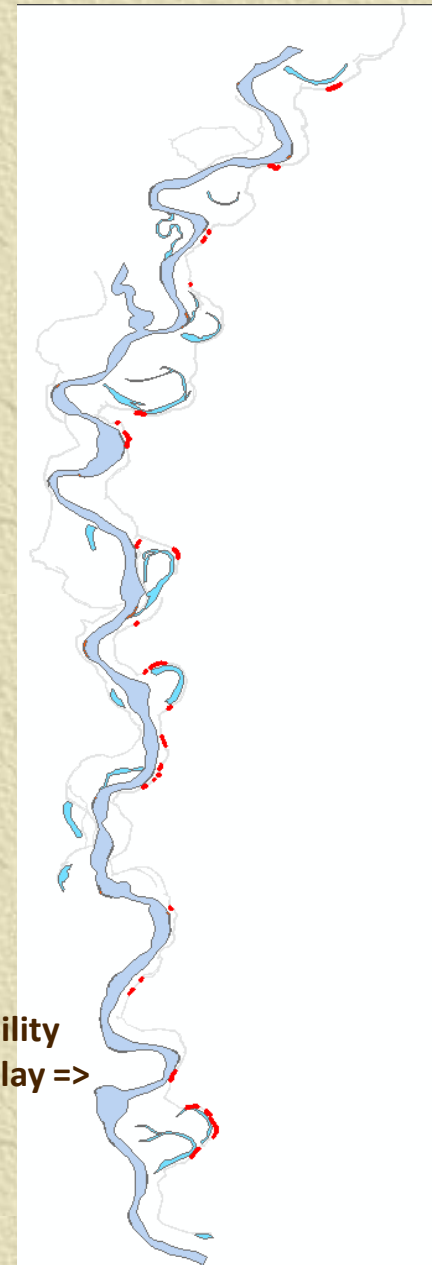
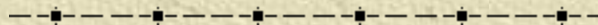


**This will help in identifying zones with greater potential of vulnerability based on the natural parameters and will support the SAR study in narrowing down target areas on the Levee**



**Best Option with High Vulnerability**  
 **$\leq 1250$  m from all Lakes**  
**OR sand/clay  $\Rightarrow$  65%, 22 slides,**

**Best Option with Moderate Vulnerability**  
 **$\leq 1250$  m from all water AND sand/clay  $\Rightarrow$  65%, 18 slides**



# Questions?



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