Using the late Holocene stratigraphic record to quantify rates of wetland accretion in the Mississippi Delta: implications to coastal restoration

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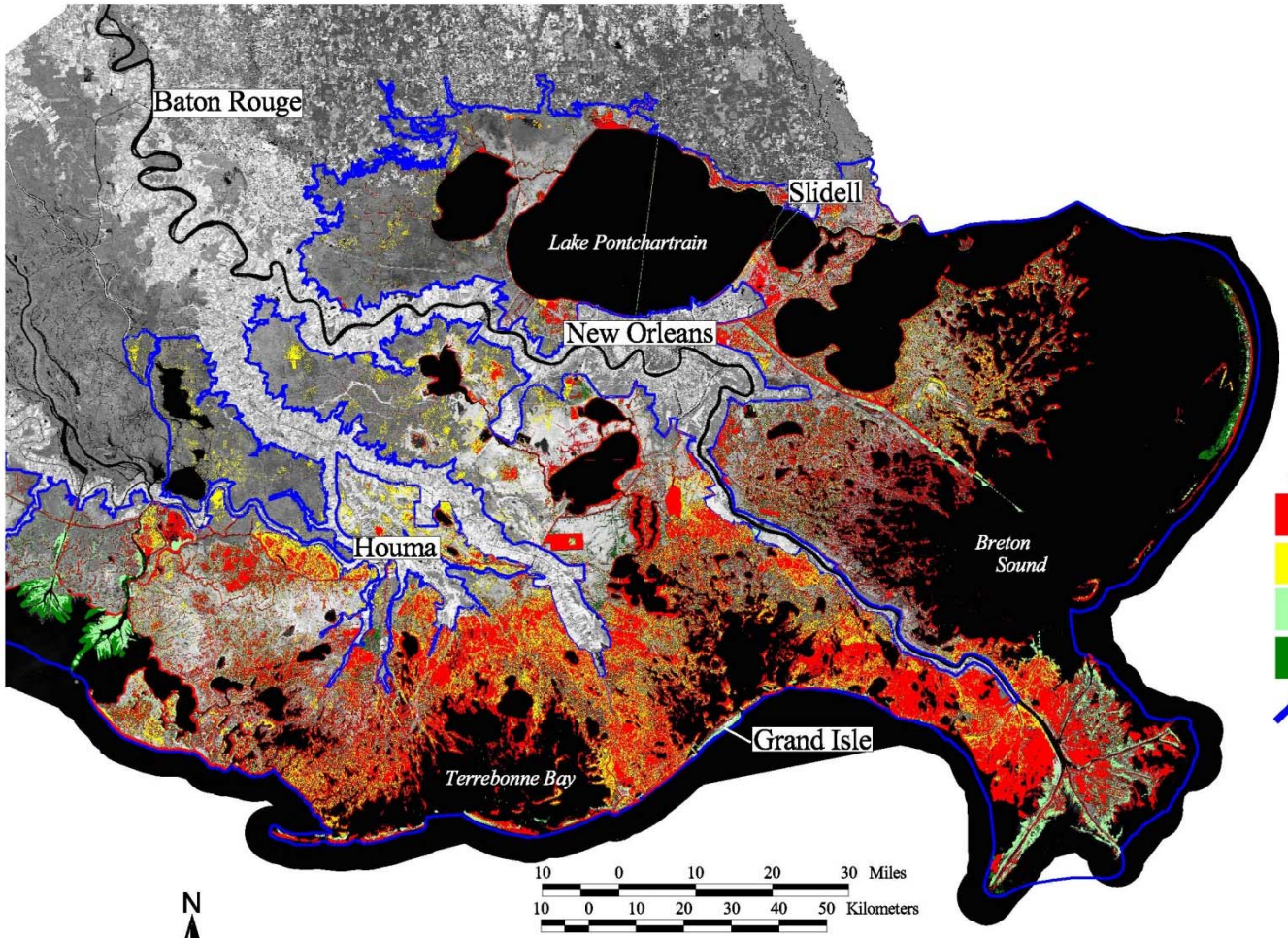
100+ Years of Land Change for Southeast Coastal Louisiana

USGS science for a changing world



LEGEND

- Land Loss 1932 - 2000
- Predicted Land Loss 2000 - 2050
- Land Gain 1932 - 2000
- Predicted Land Gain 2000 - 2050
- Louisiana Land Change Study Boundary

SUMMARY

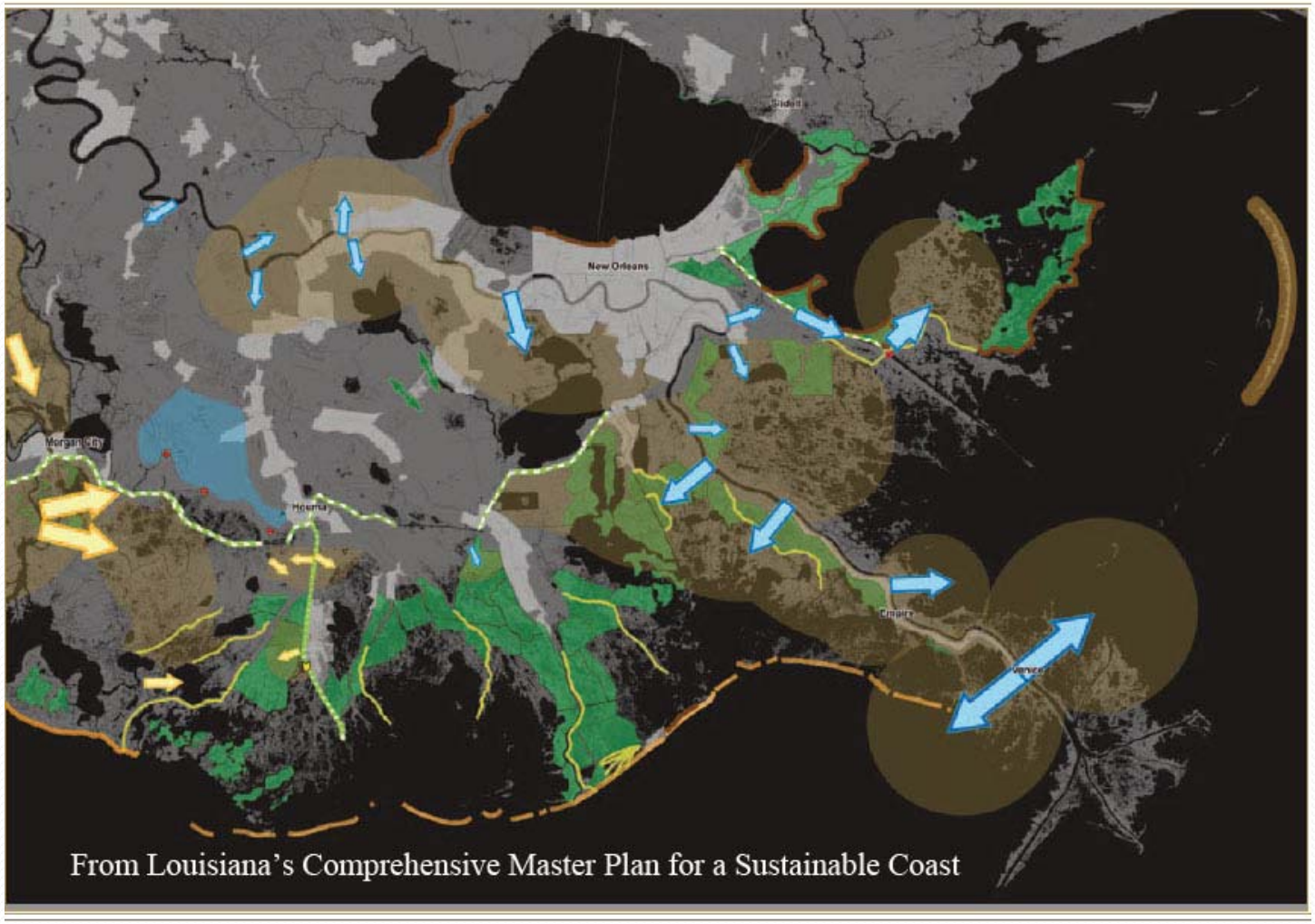
Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana has lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing is done to stop this land loss, Louisiana could potentially lose approximately 700 square miles of land, or about equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years. Further, Louisiana accounted for an estimated 90 percent of the coastal marsh loss in the lower 48 states during the 1990s. The area shown on this map represents over 75 percent of the total land loss for coastal Louisiana.

Backdrop is 2000 TM panchromatic band.

Prepared By:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

Map ID: USGS-NWRC 2003-02-0373

River diversion

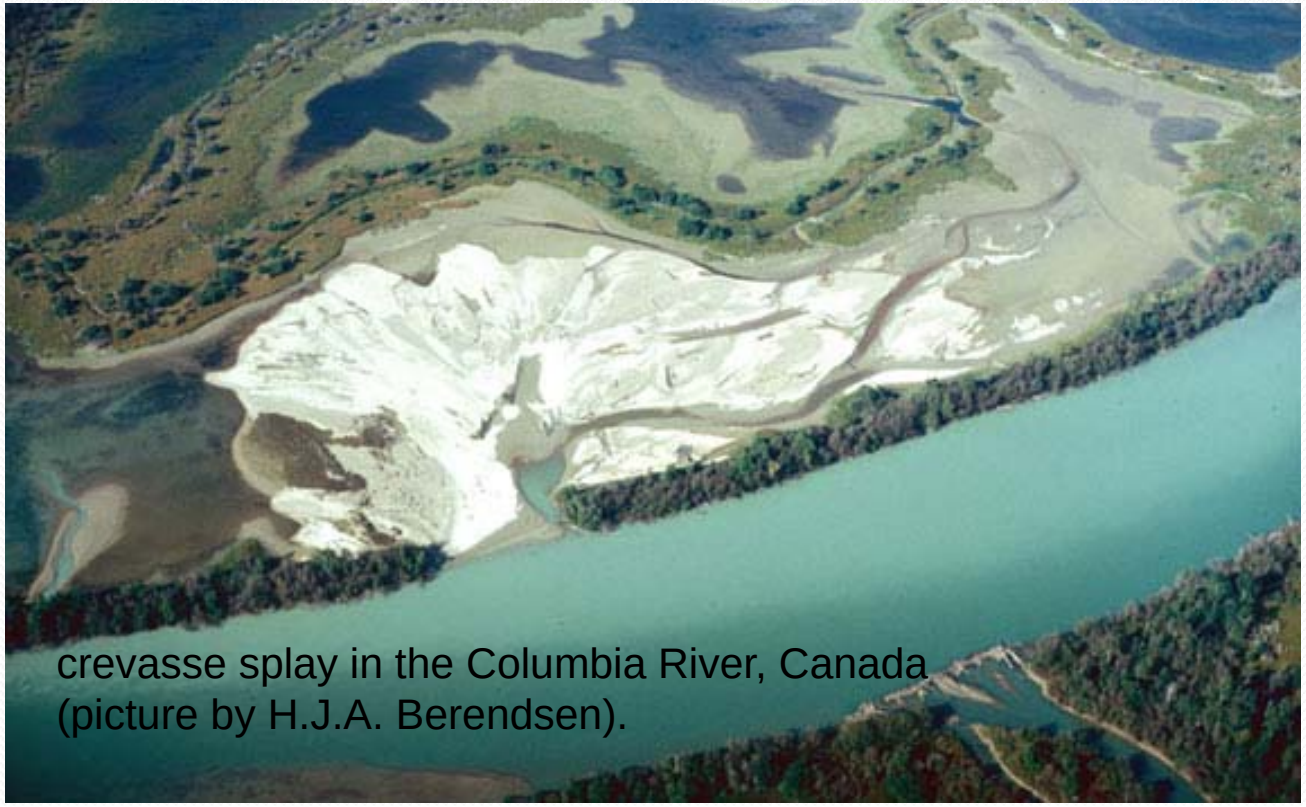


Questions: (1) Which sites have highest sediment trapping efficiency?

(2) What is the sediment accumulation rate?

Approach

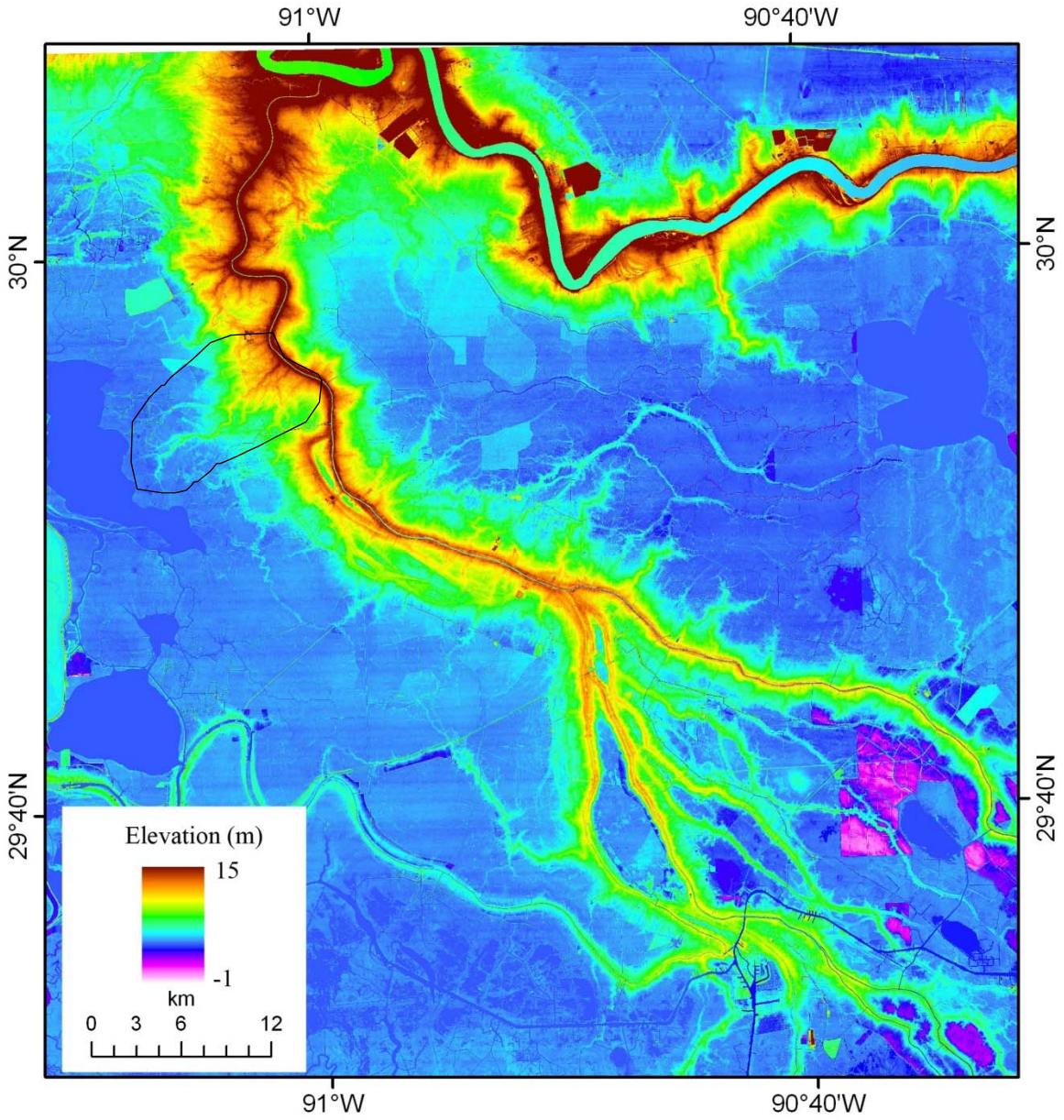
Investigating lithologic composition and sediment accumulation rate of crevasse-splay deposits using borehole date and optically-stimulated luminescence (OSL) dating, respectively.



crevasse splay in the Columbia River, Canada (picture by H.J.A. Berendsen).

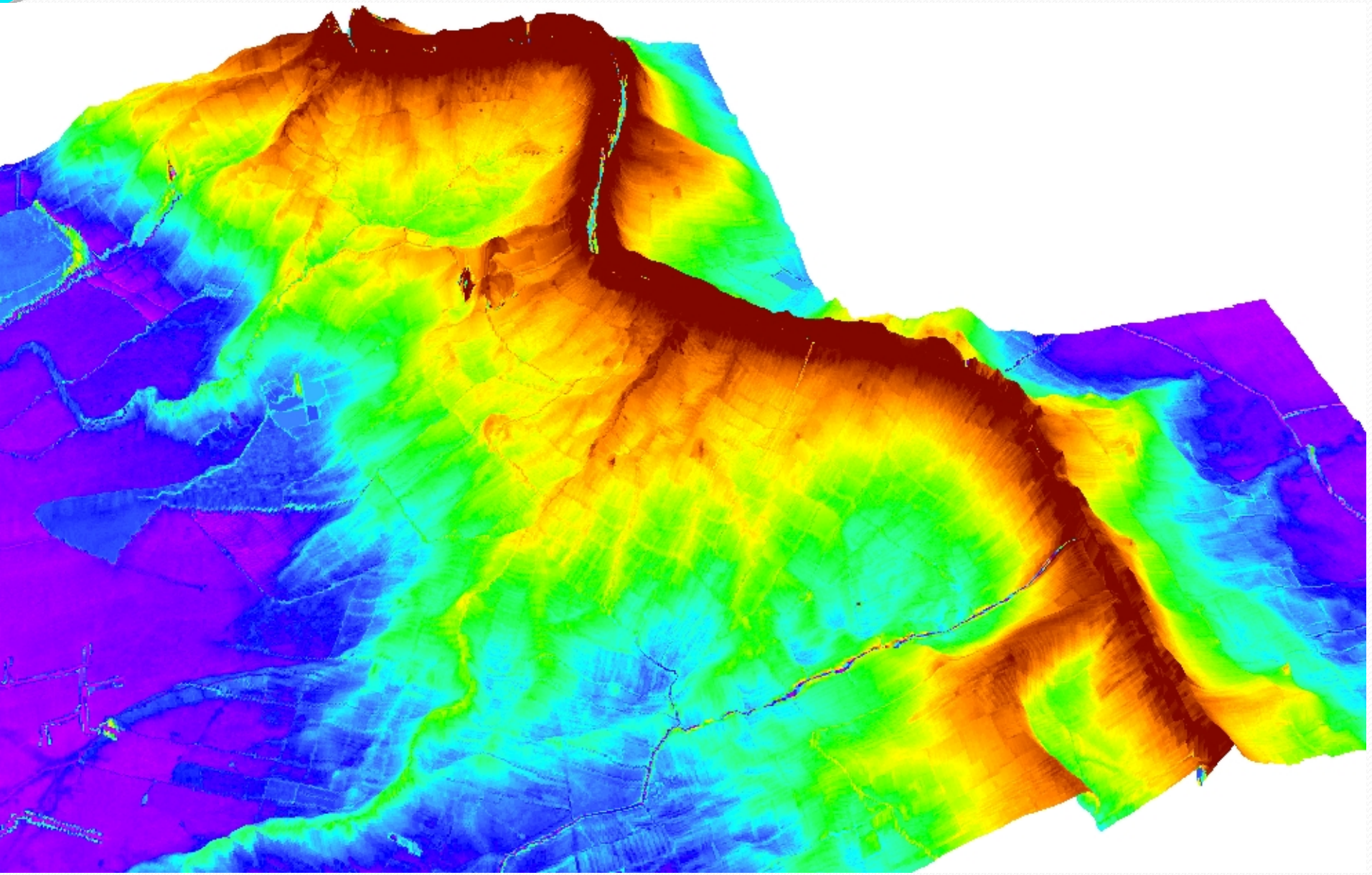
A natural analog of river diversions

Study area



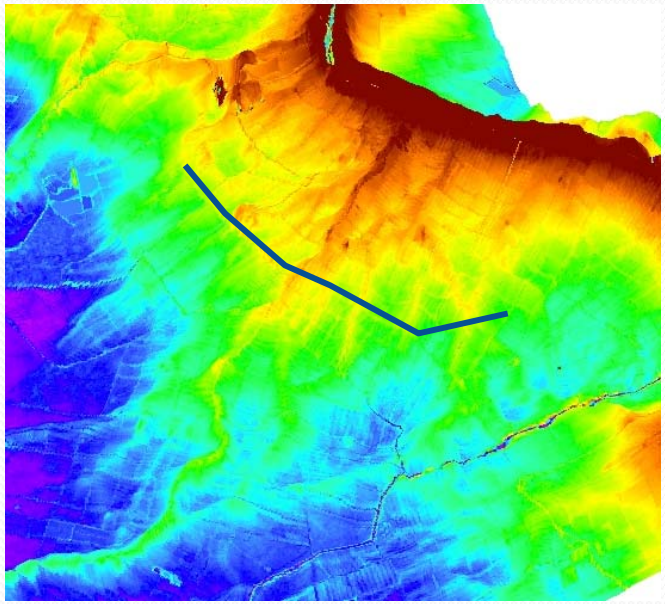
Compare Attakapas Splay with Wax Lake Delta

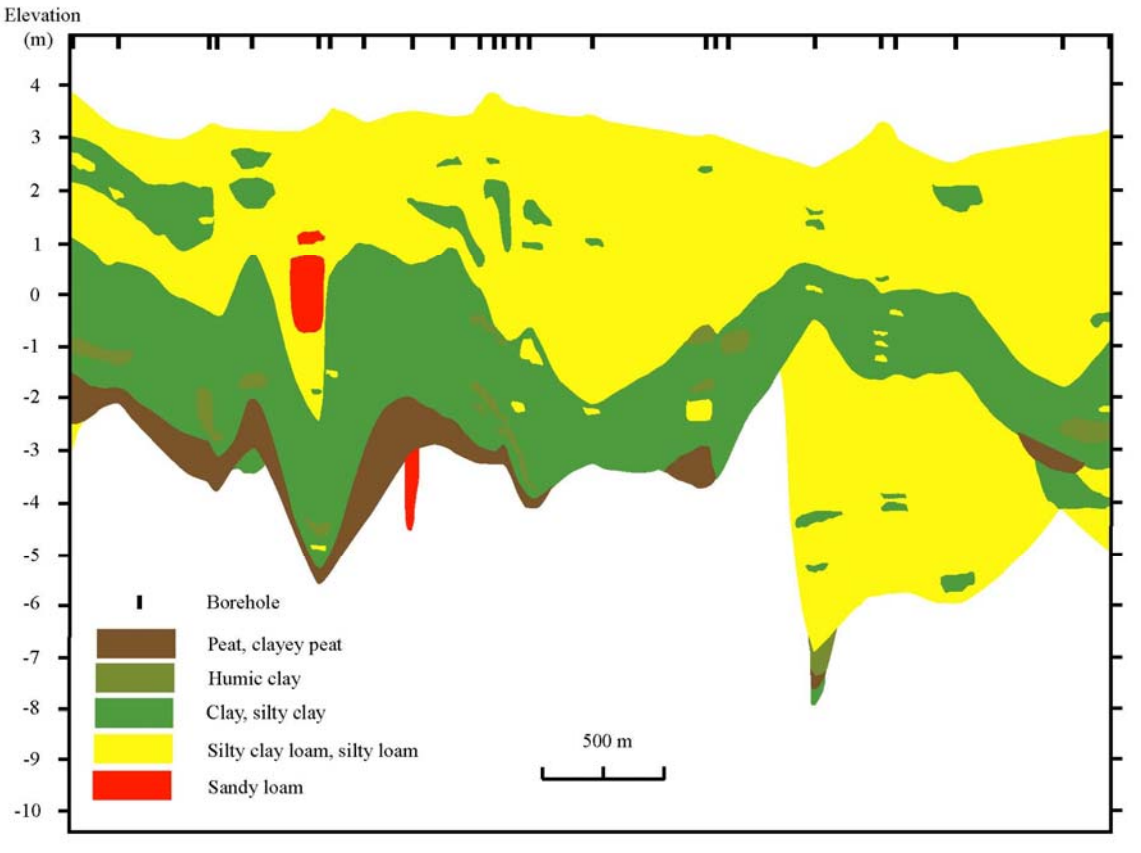
Geomorphology: Attakapas Splay



Wax Lake Delta

Lithology: Attakapas Splay



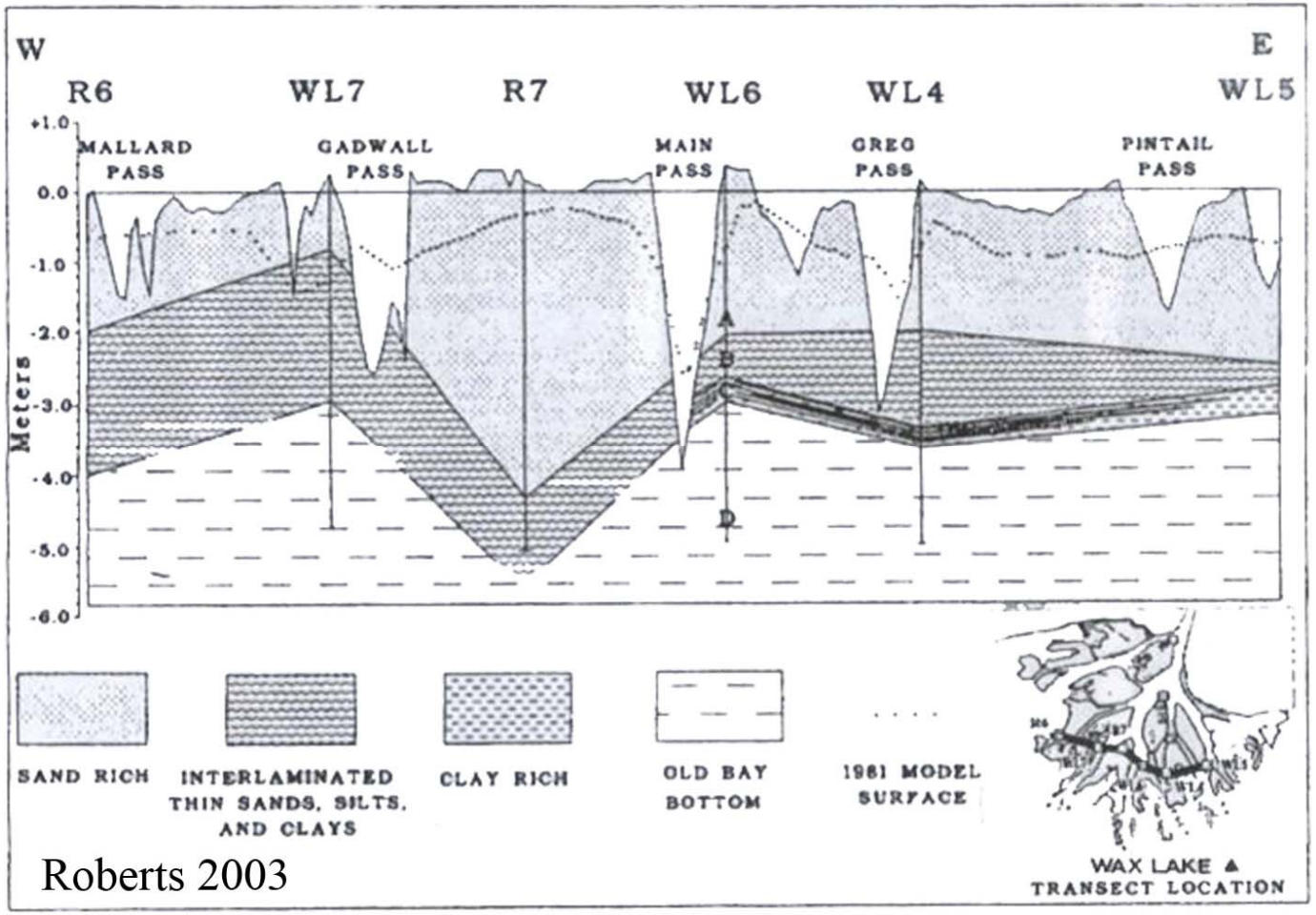


Clay and silt > 70%

Mississippi River sediment loading: 77-83% silt and clay (Allison et al., 2000; Nittrouer et al., 2008)

~60% silt and clay were trapped!!

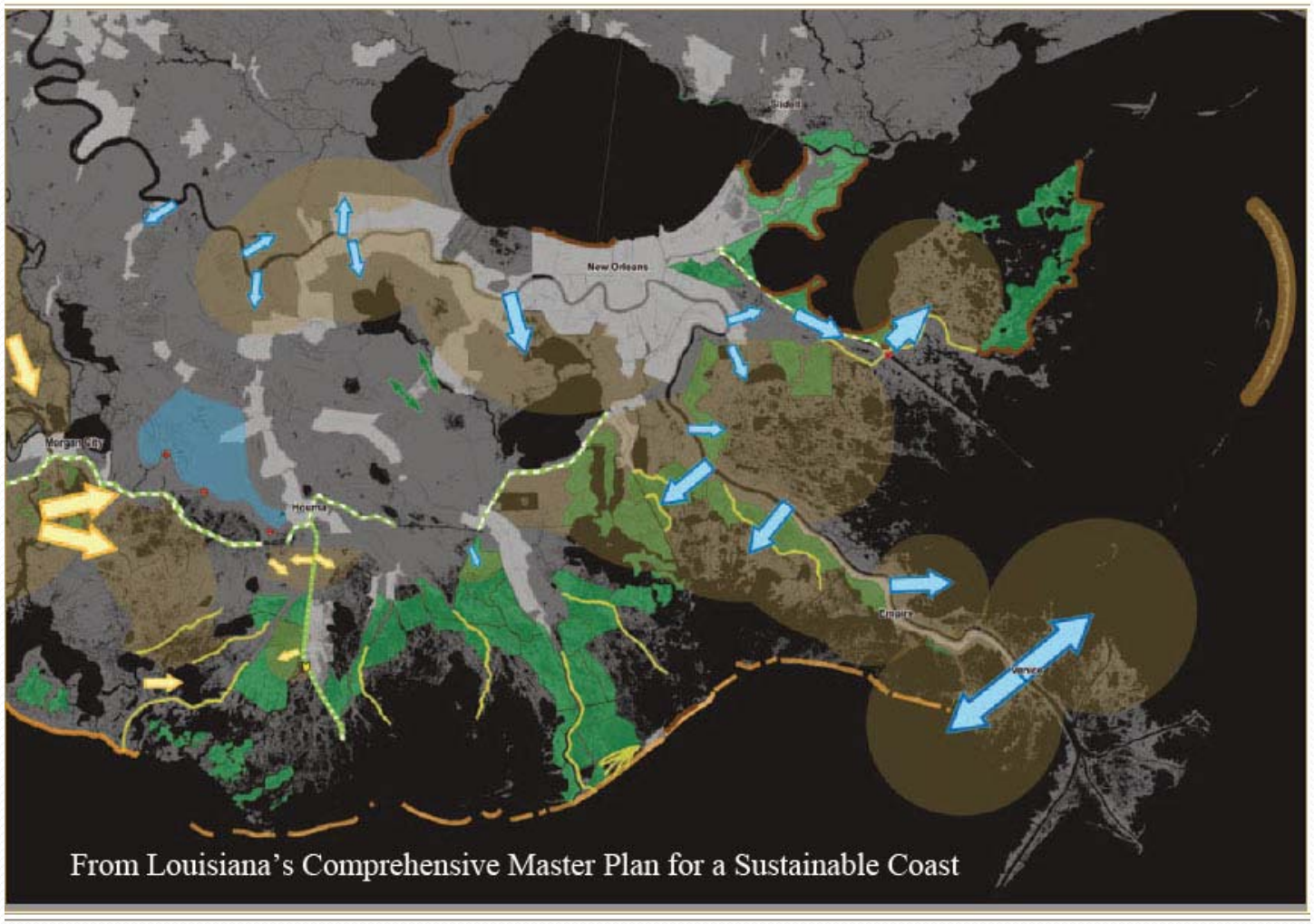
Wax Lake Delta



~70% sand (Majersky et al., 1997; FitzGerald, 1998, Roberts, 1997)

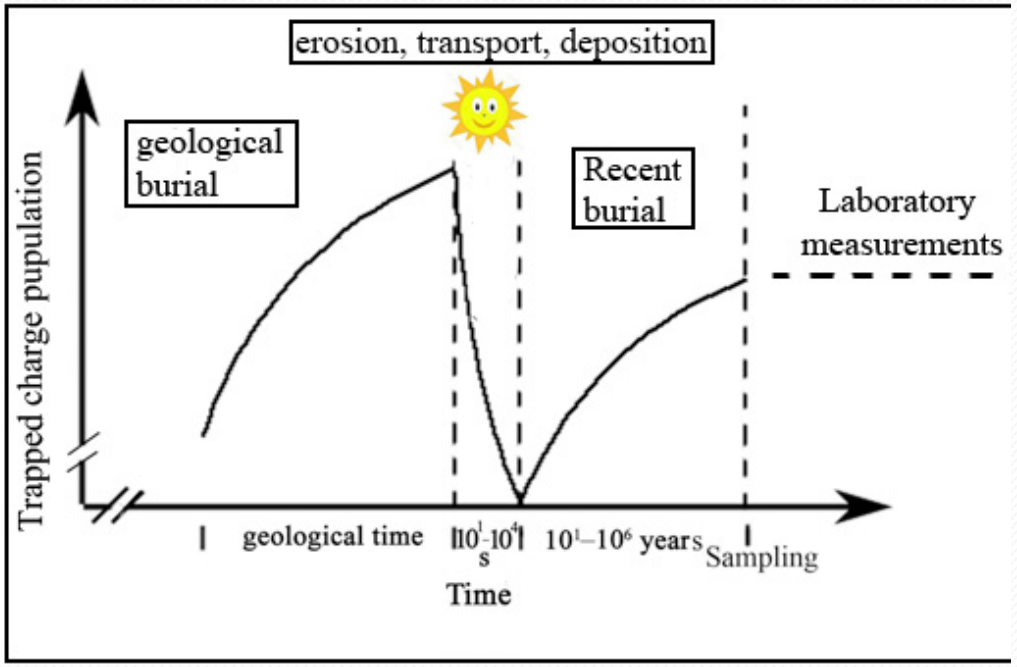
Only ~10% silt and clay were trapped!!

River diversion



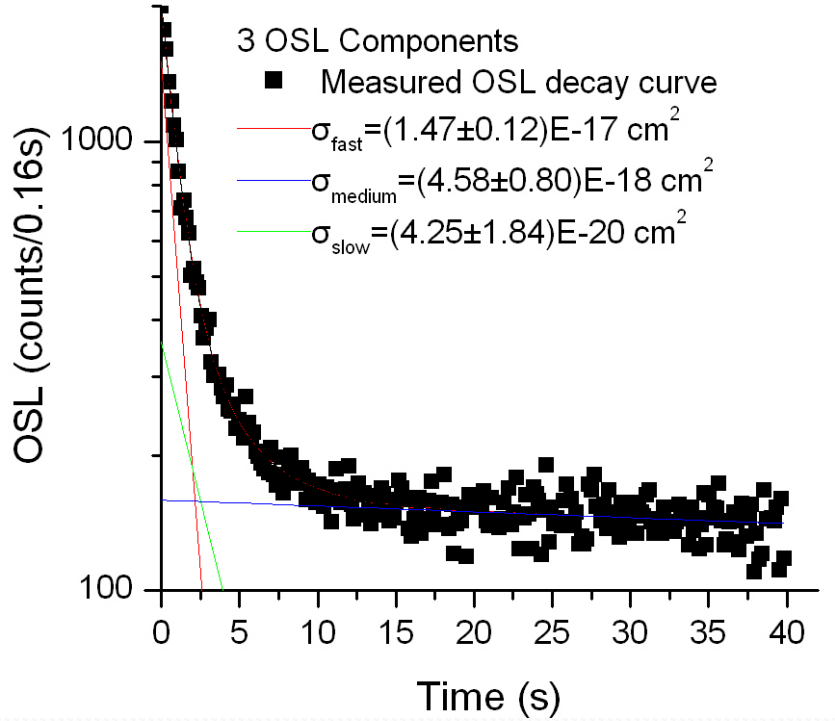
Sediment accumulation rate

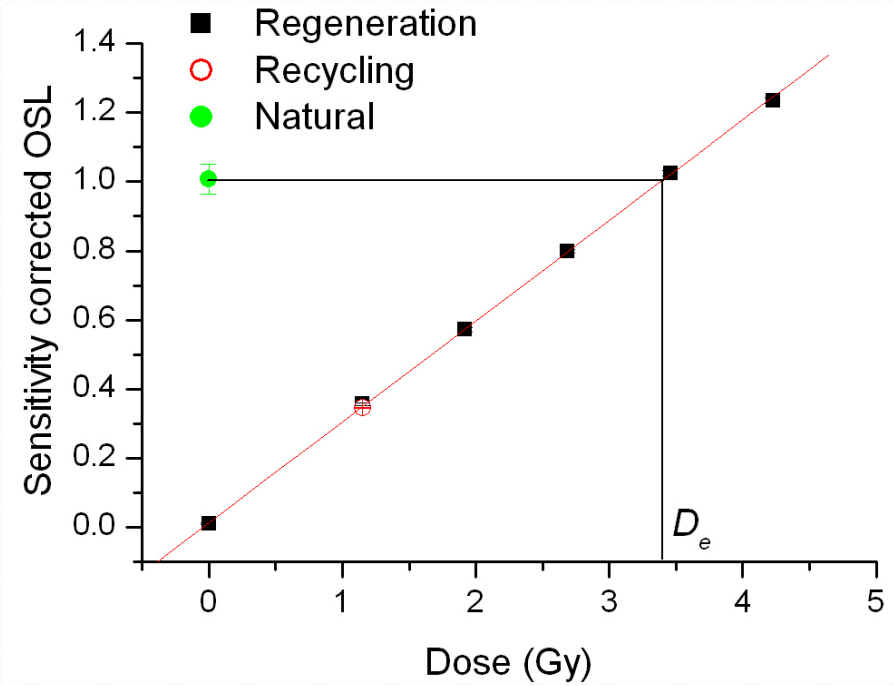
OSL dating



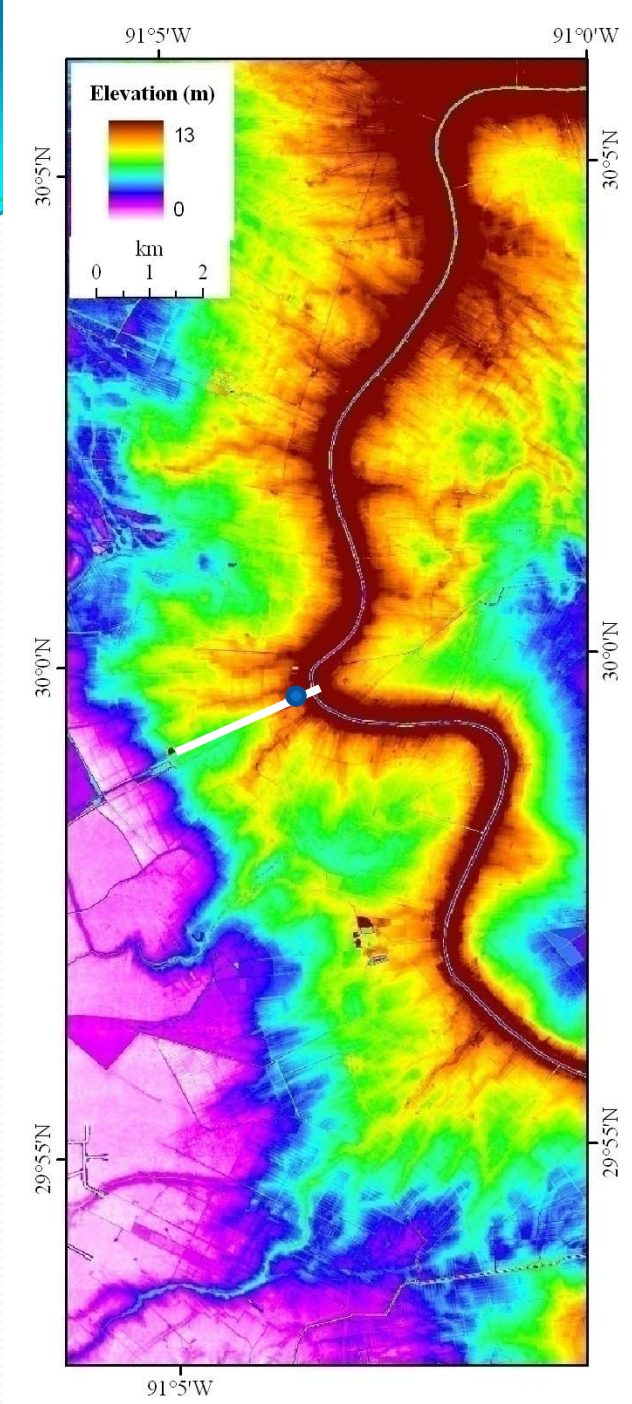
- Silty to sandy quartz is used
- Utilizing natural radiation energy accumulated within mineral crystal
- Signal resetting occurs while exposed to sunlight
- Dating the latest depositional events directly
- Age range 10-10^6 years

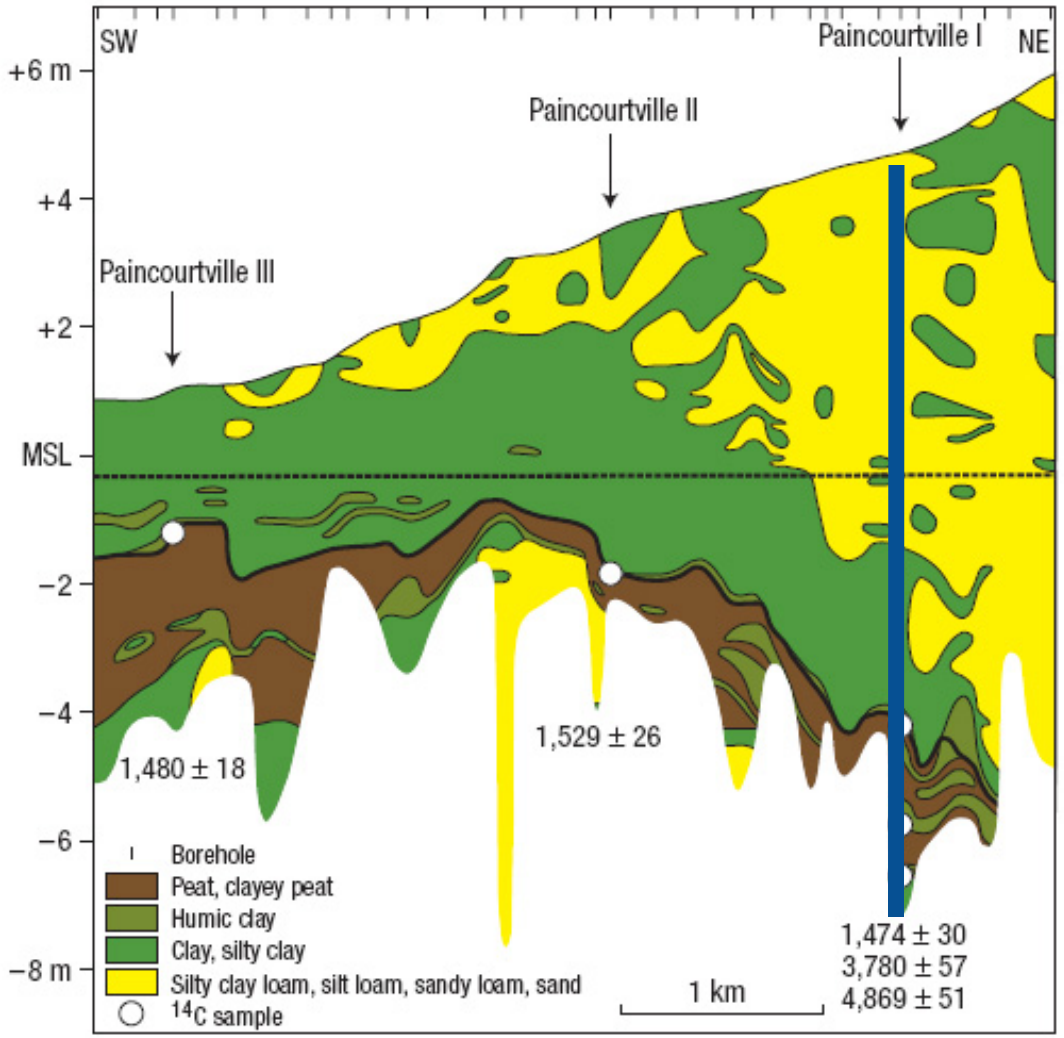
Quartz OSL properties



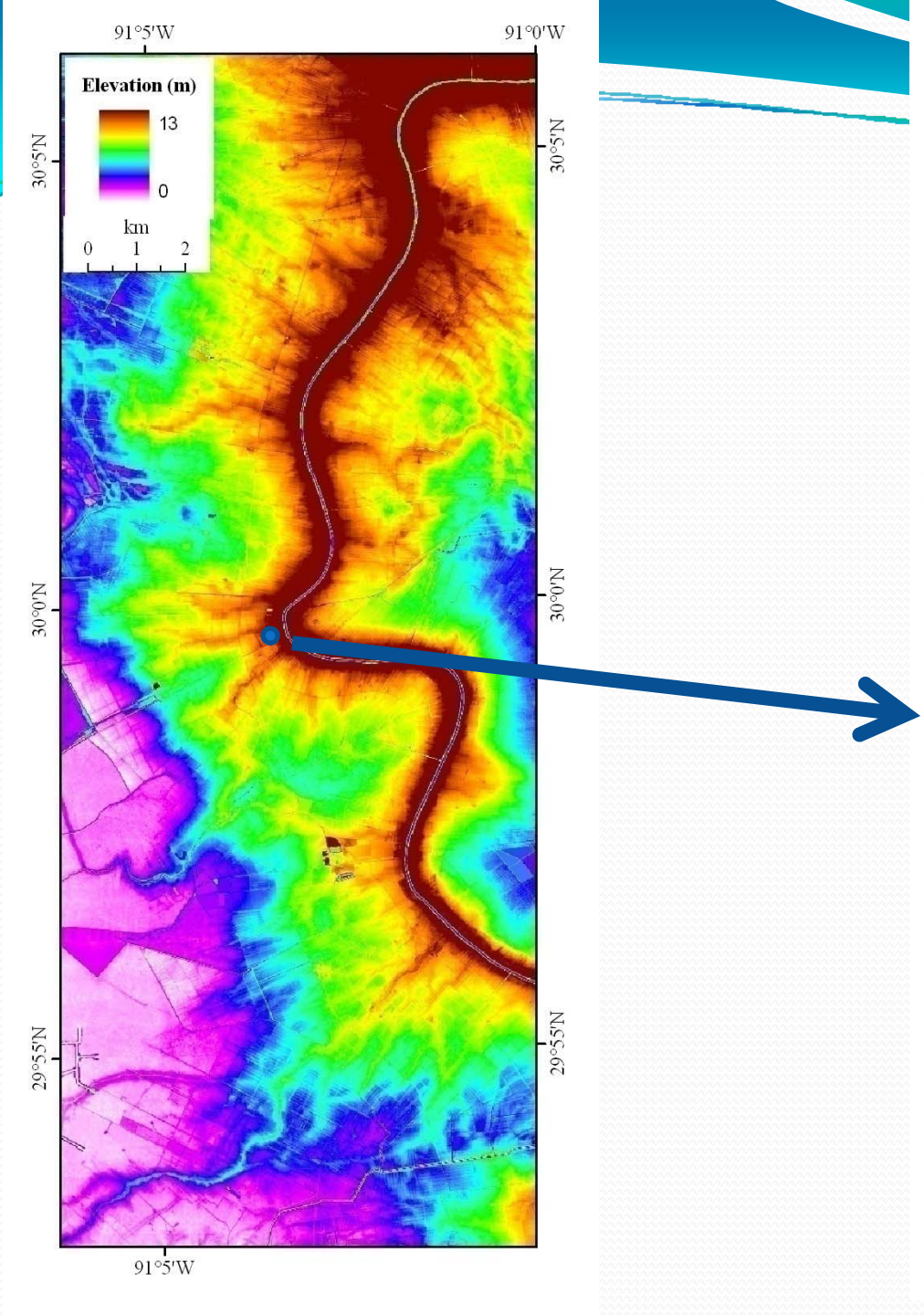


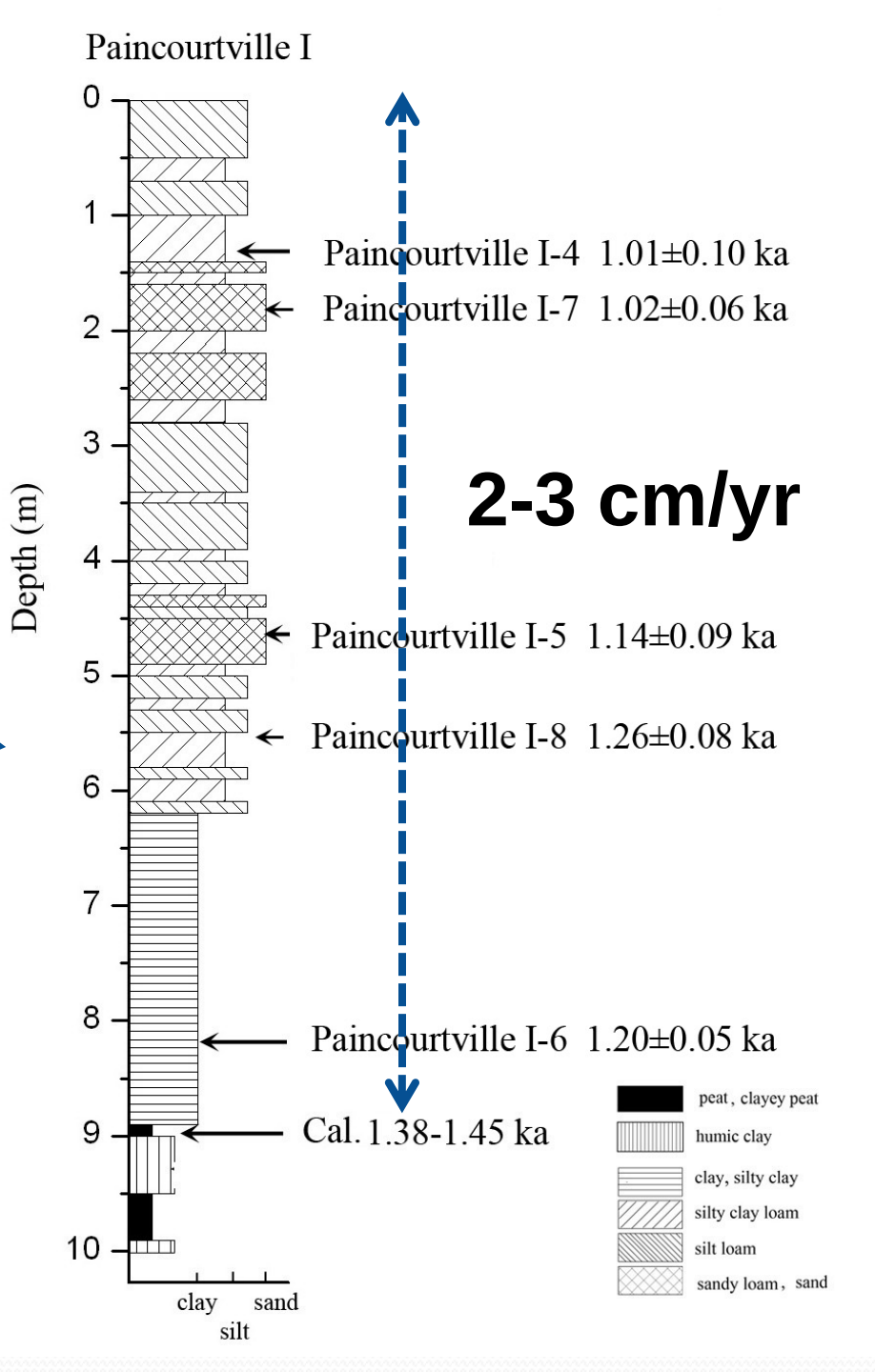
Method validation

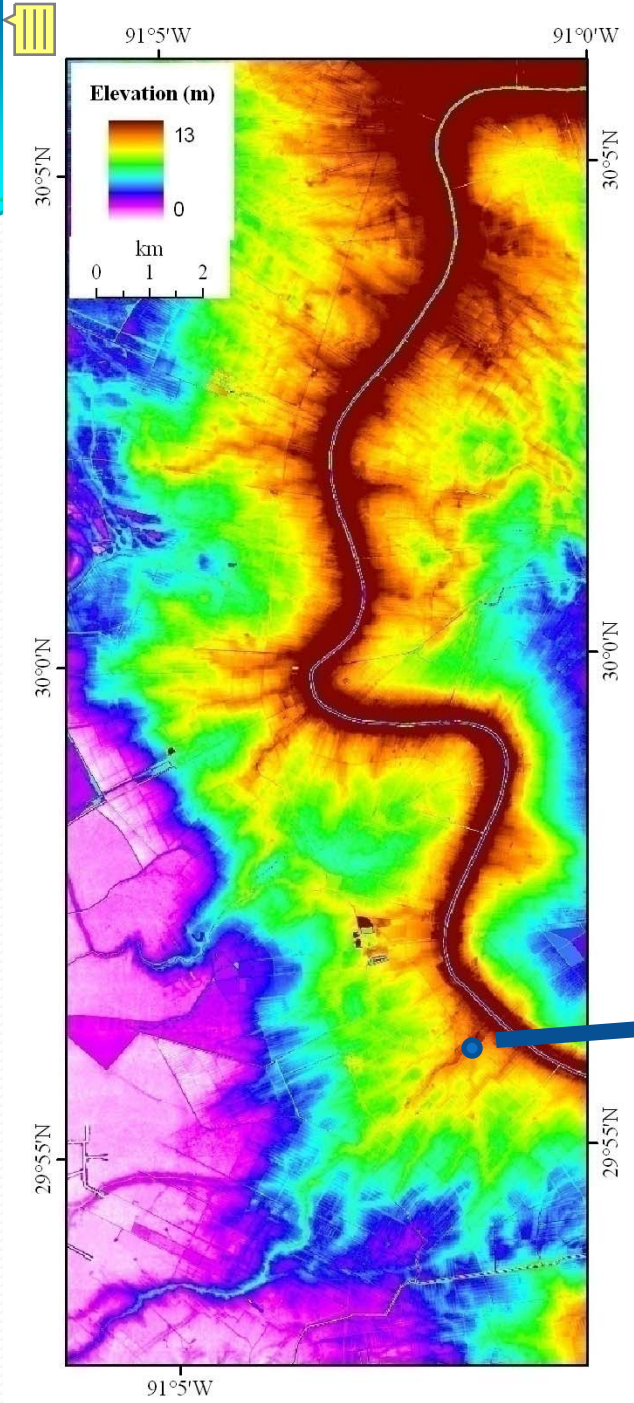


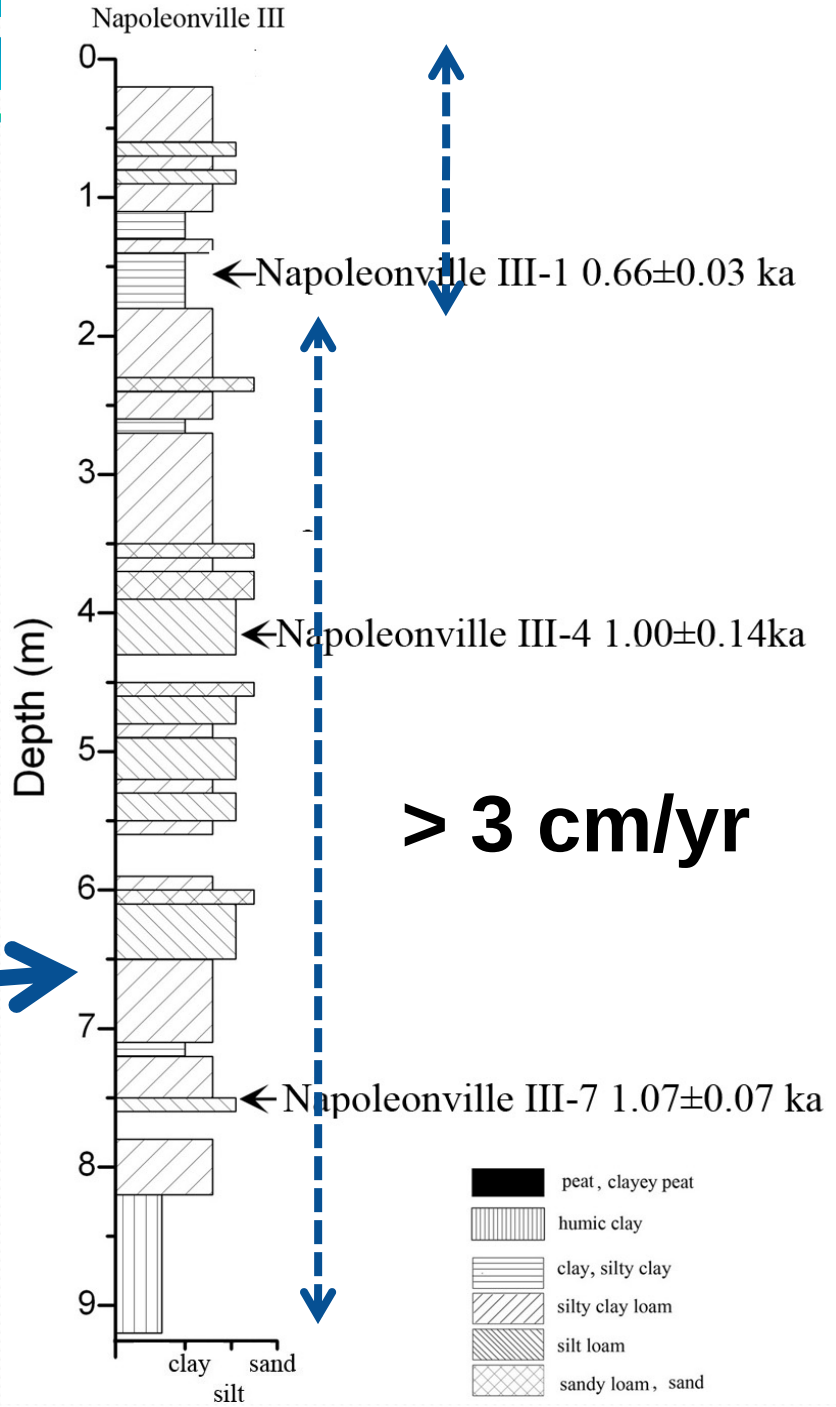


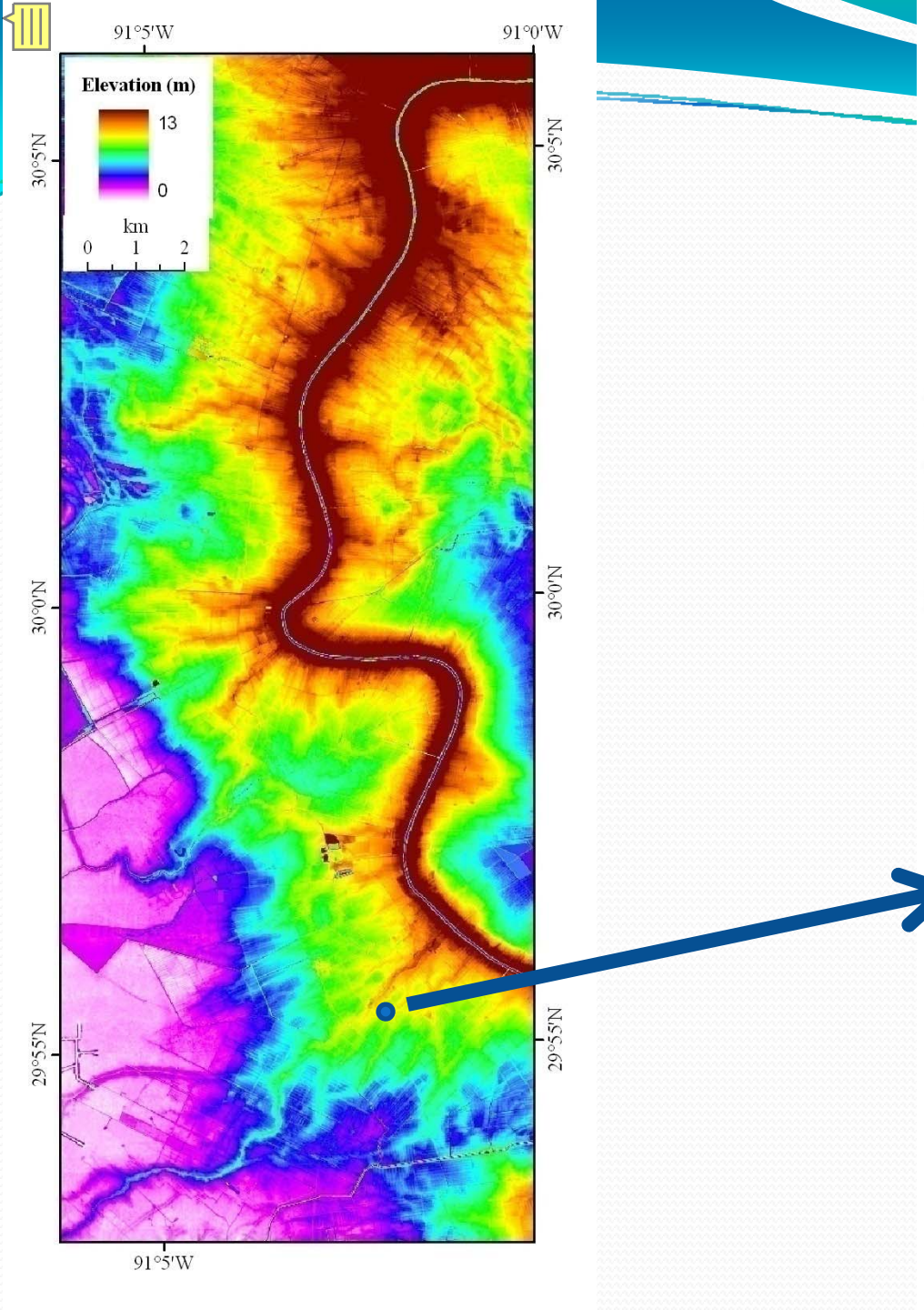
From Törnqvist et al., 2008

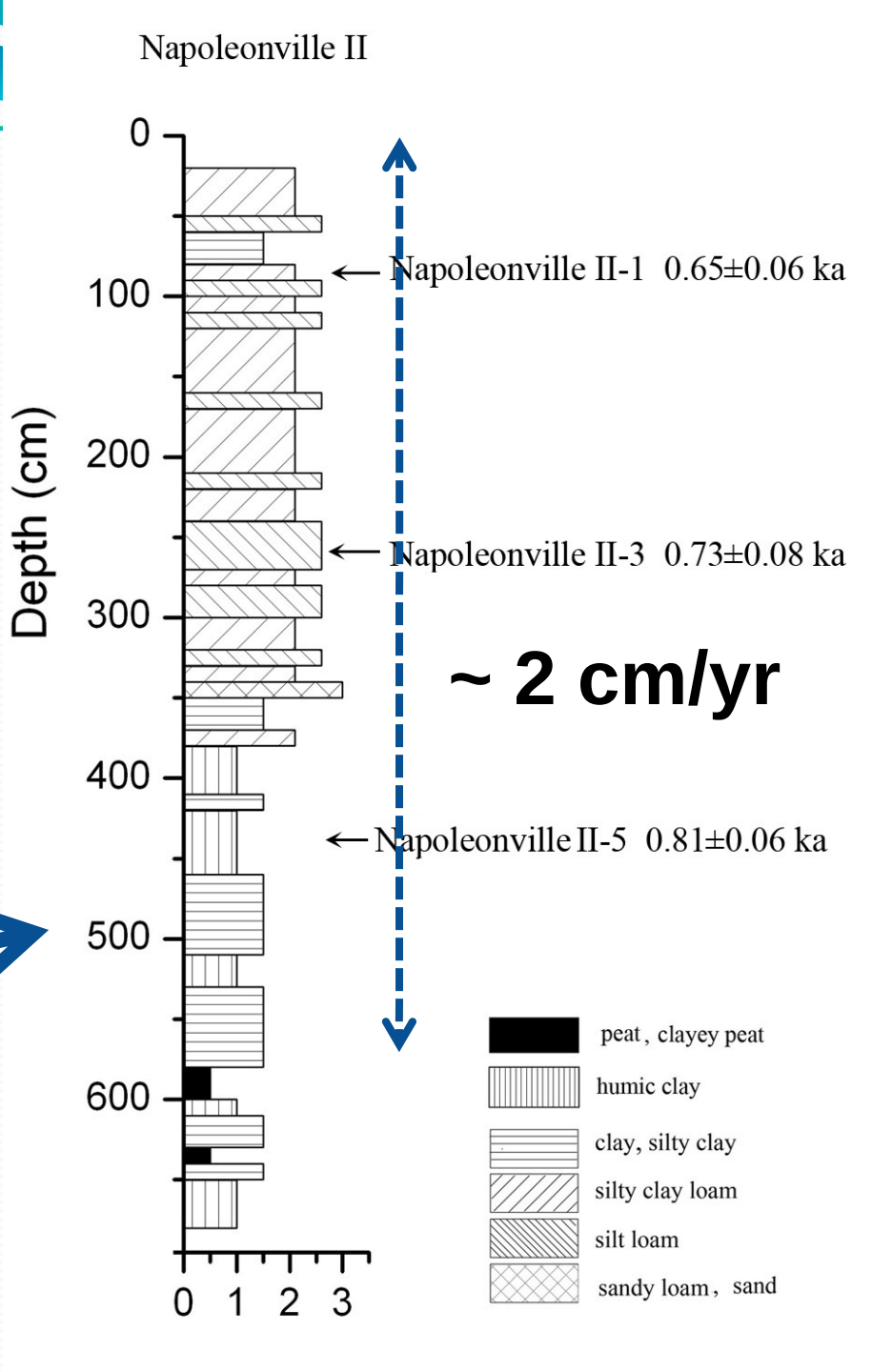

91°5'W
91°0'W
30°5'N
30°0'N
29°55'N
Elevation (m)
13
0
km
0 1 2


Paincourtville I
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
Paincourtville I-4 1.01±0.10 ka
Paincourtville I-7 1.02±0.06 ka
2-3 cm/yr
Paincourtville I-5 1.14±0.09 ka
Paincourtville I-8 1.26±0.08 ka
Paincourtville I-6 1.20±0.05 ka
Cal. 1.38-1.45 ka
clay
sand
silt
peat, clayey peat
humic clay
clay, silty clay
silty clay loam
silt loam
sandy loam, sand


91°5'W
91°0'W
30°5'N
30°0'N
29°55'N
Elevation (m)
13
0
km
0 1 2


Napoleonville III
Depth (m)
0
1
2
3
4
5
6
7
8
9
←Napoleonville III-1 0.66±0.03 ka
←Napoleonville III-4 1.00±0.14ka
←Napoleonville III-7 1.07±0.07 ka
> 3 cm/yr
clay
sand
silt
peat , clayey peat
humic clay
clay, silty clay
silty clay loam
silt loam
sandy loam , sand

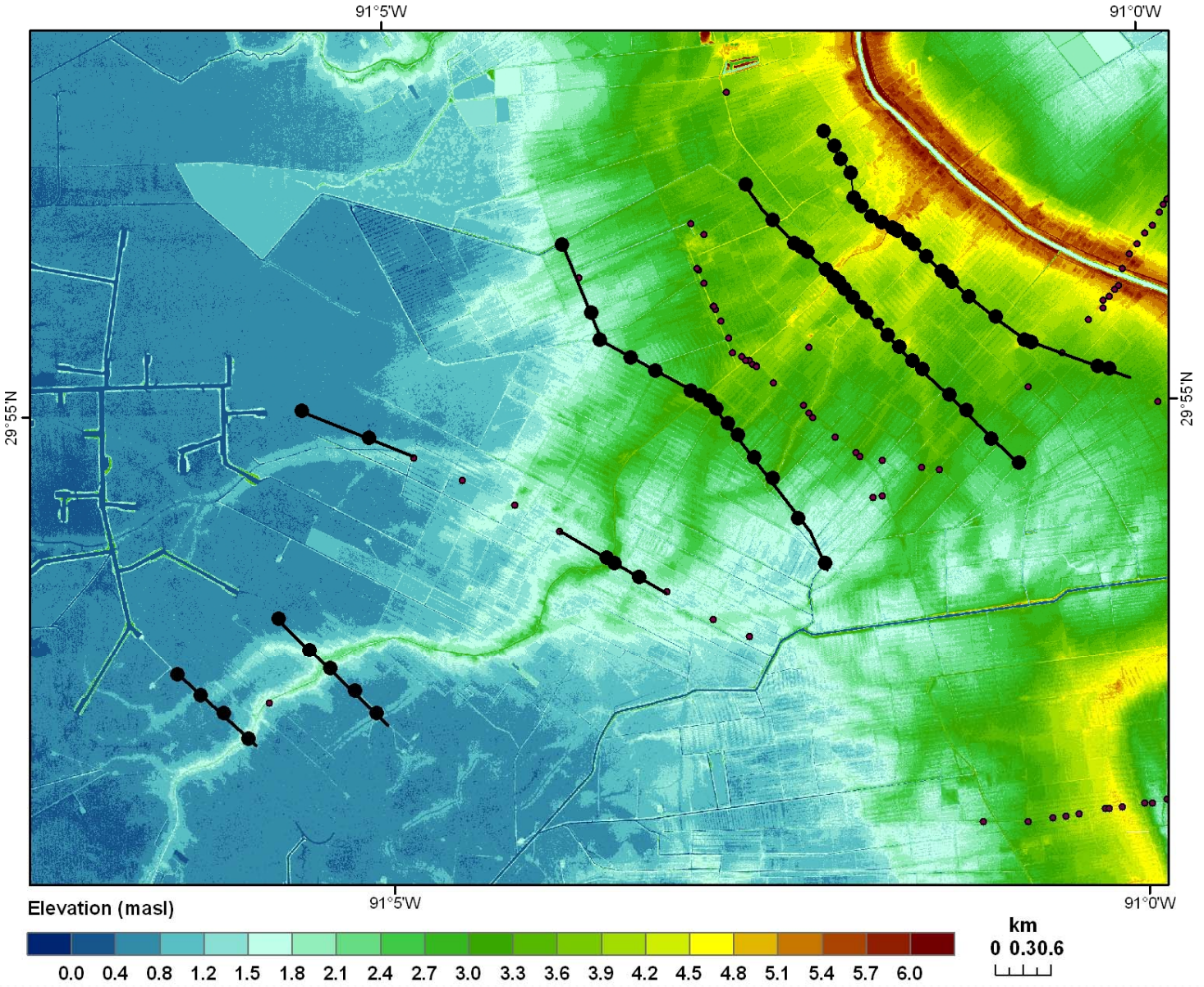

91°5'W
91°0'W
30°5'N
30°0'N
29°55'N
Elevation (m)
13
0
km
0 1 2


Napoleonville II
Depth (cm)
0
100
200
300
400
500
600
0 1 2 3
Napoleonville II-1 0.65±0.06 ka
Napoleonville II-3 0.73±0.08 ka
Napoleonville II-5 0.81±0.06 ka
~ 2 cm/yr
peat, clayey peat
humic clay
clay, silty clay
silty clay loam
silt loam
sandy loam, sand

Conclusions

- Swamps have higher efficiency than open bay regarding trapping Mississippi River sediments and deserve high priority on river diversions site choosing.
- Quartz OSL dating is suitable for dating samples younger than 1000 yr in the Mississippi Delta.
- Sediment accumulation rates are more than 2 cm/yr for crevasse-splay deposit in the Mississippi Delta.
- Coastal restoration through river diversion has the potential to achieve sediment accumulation rates higher than relative sea level rise in the Mississippi Delta.

Future work


91°5'W
91°0'W
29°55'N
29°55'N
91°5'W
91°0'W
Elevation (masl)
0.0 0.4 0.8 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.3 3.6 3.9 4.2 4.5 4.8 5.1 5.4 5.7 6.0
km
0 0.30.6