USGS
science for a changing world

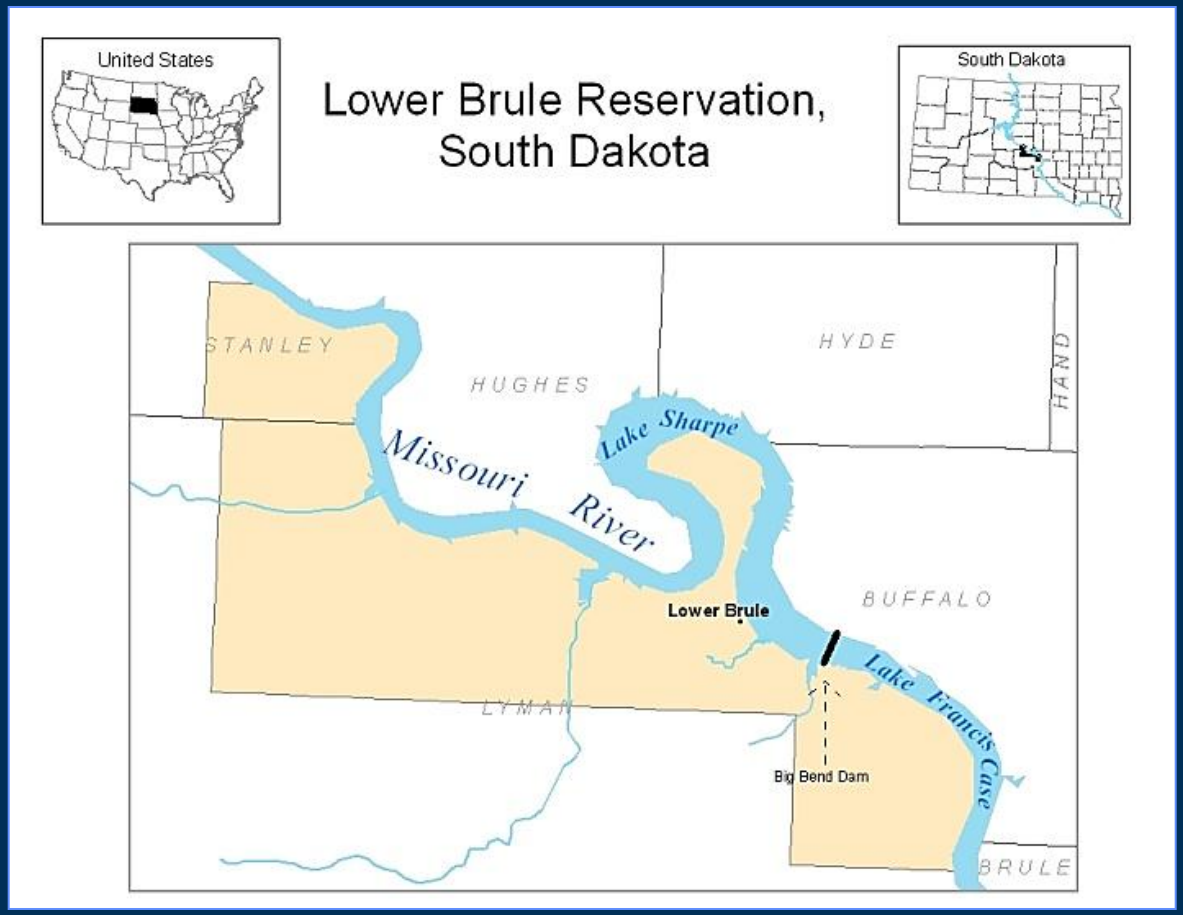
KUL WICASA OYATE
Lower Brule Sioux Tribe

Monitoring Bank Erosion On the Missouri River, Lower Brule Reservation

A cooperative study between the Lower Brule Sioux Tribe's Environmental Protection Office and the U.S. Geological Survey, with assistance from the Oglala Lakota College.

U.S. Department of the Interior
U.S. Geological Survey

Missouri River Bank Erosion On the Lower Brule Reservation



This study was designed to monitor the physical changes that occur along the Missouri River bank during the study's two-year period, beginning Jan. 2011.

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Missouri River Bank Erosion On the Lower Brule Reservation

Construction of the main stem dams on the Missouri River were completed under the Flood Control Act of 1944.

The dams created reservoirs that flooded large areas and consumed forests, prairie, farms and communities.

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Ft. Randall Dam

- Construction began in 1946
- Completed in 1956
- Formed Lake Francis Case

Big Bend Dam

- Construction began in 1959
- Completed in 1963
- Formed Lake Sharpe

Missouri River Bank Erosion On the Lower Brule Reservation

Sonar picture of
St. Mary's Church
(top structure)
in the original
Lower Brule
community.

(courtesy of Lower Brule tribal personnel, summer 2012)

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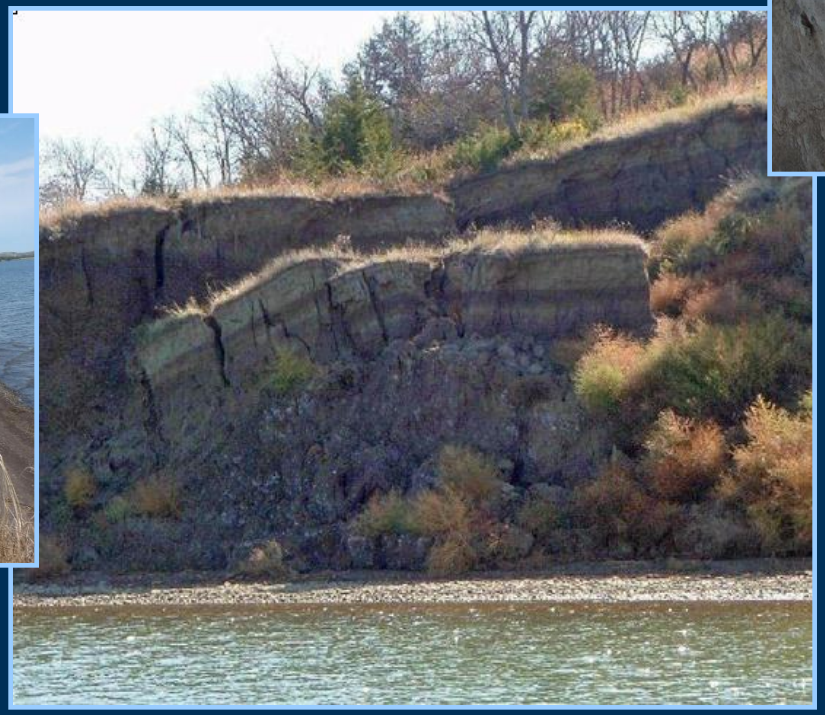
Missouri River Bank Erosion On the Lower Brule Reservation

Cultural, historical, infrastructural, recreational and riparian areas have been lost to the Missouri River…



…and the erosion continues today.

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Missouri River Bank Erosion On the Lower Brule Reservation

Bank erosion takes on many forms.

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Missouri River Bank Erosion On the Lower Brule Reservation

Seven-Mile Study Area

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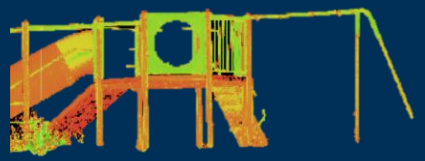
Lower Brule Sioux Tribe

3 Types of Significant Digital Data:



- Light Detection And Ranging (**LiDAR**) measurements (in collaboration with Oglala Lakota College, Oglala Sioux Tribe, SD)

- Unmanned aerial system (**UAS**) to collect aerial photography (with assistance from the USGS UAS Project Office – Rocky Mountain Geographic Science Center, Denver, CO)

- **RTK** measurements

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LiDAR

LiDAR was used to obtain precise land-surface elevation data at two locations in March, 2011.

The LiDAR objective called for a comparison of the 2011 data to data collected in 2012, then to develop a measurement of the volume of soil that may have eroded.

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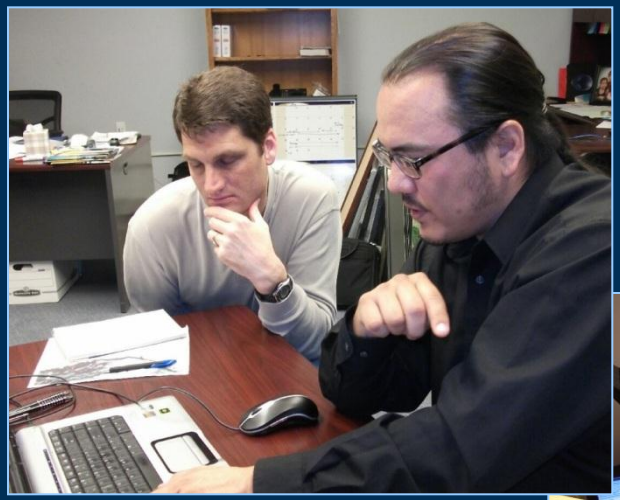
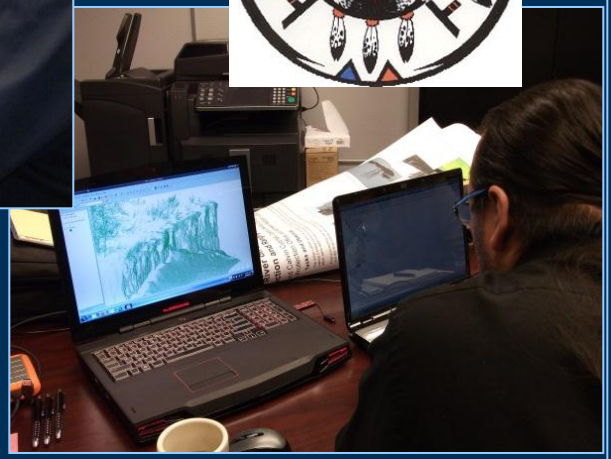
Missouri River Bank Erosion On the Lower Brule Reservation



LiDAR



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The Oglala Lakota College (OLC) is collaborating with the LBST & USGS on the LiDAR objective of this study, providing the LiDAR equipment and assisting with the collection and post-processing.

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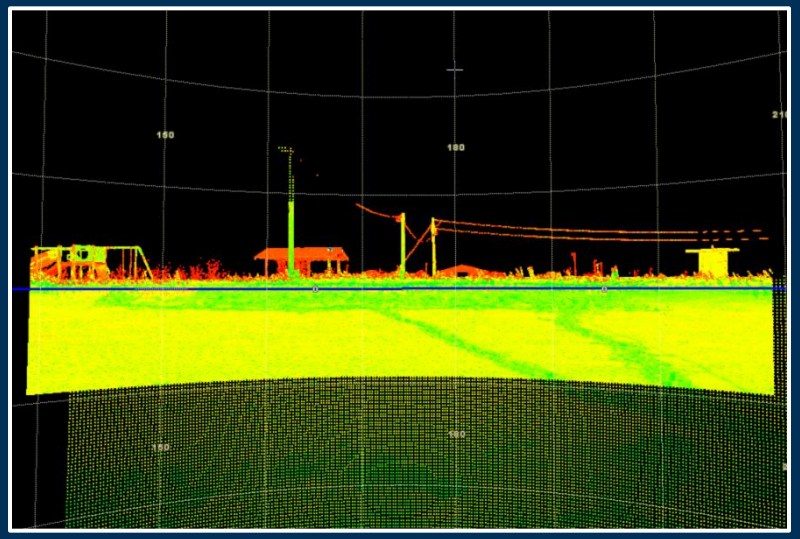
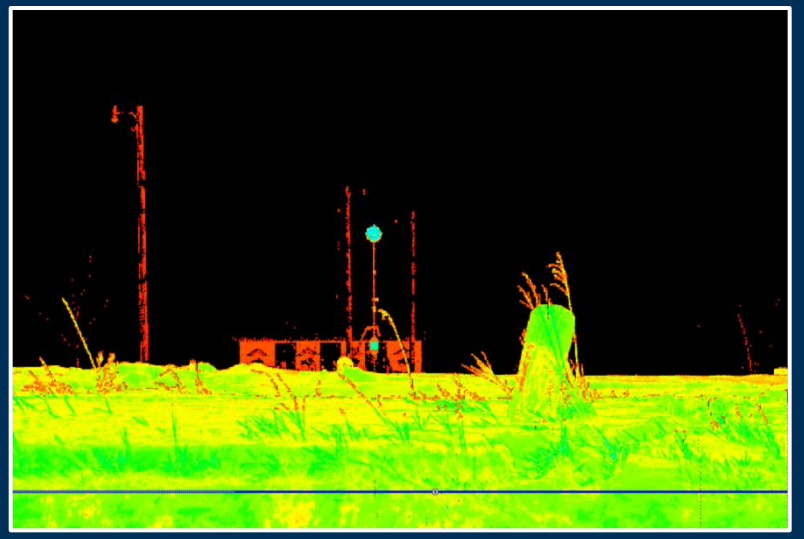
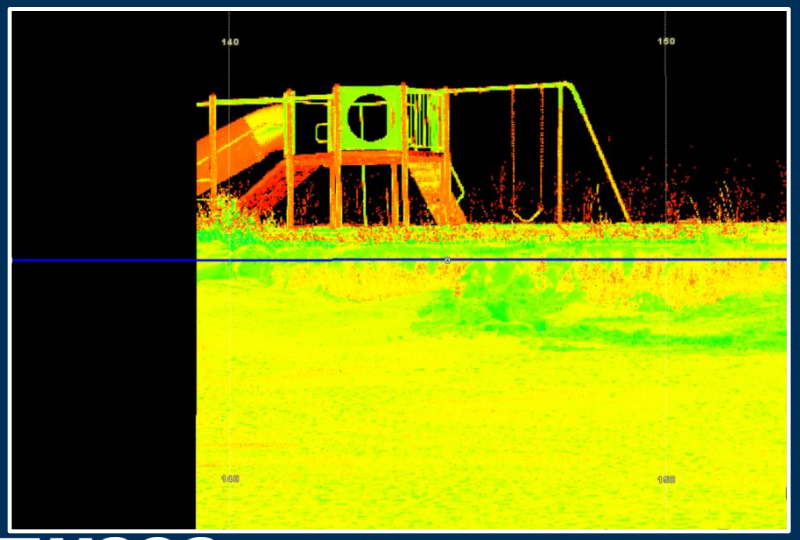
Jim Sanovia, OLC Professor, has been working with us, and a student is also involved.

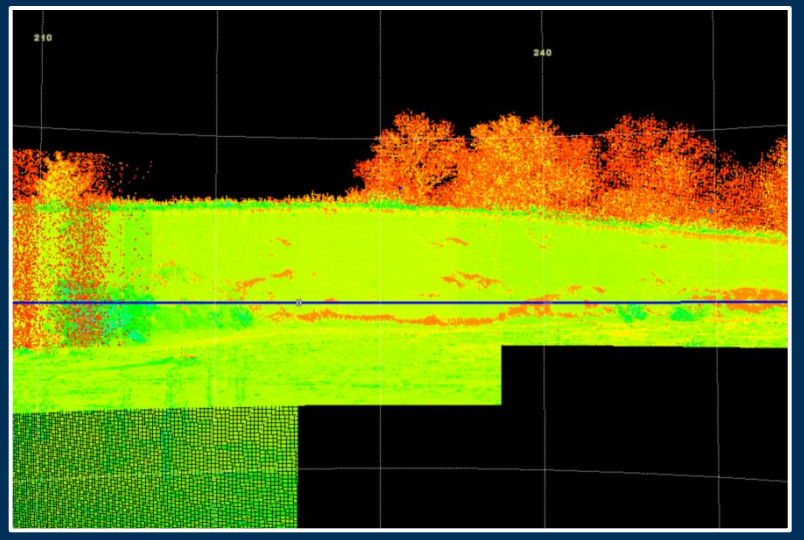
Missouri River Bank Erosion On the Lower Brule Reservation

Examples of images collected during the LiDAR effort.









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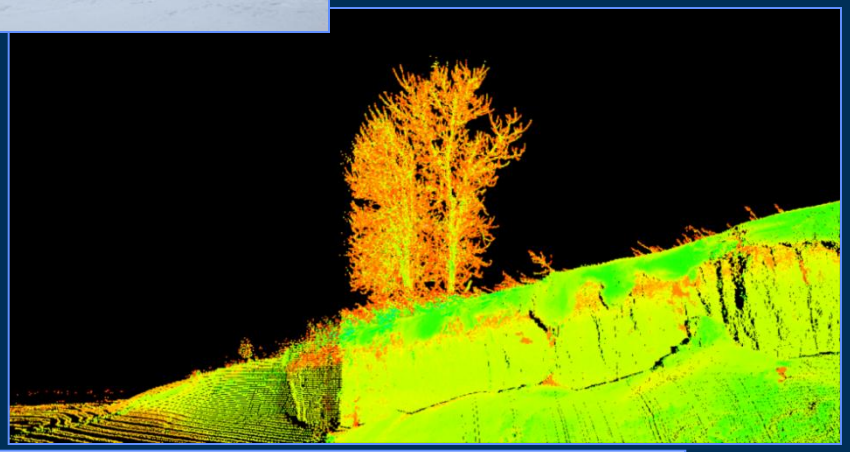
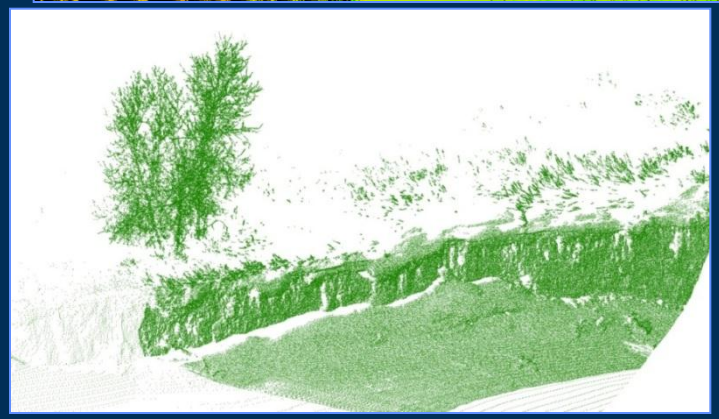
Missouri River Bank Erosion On the Lower Brule Reservation

Post-processing LiDAR Data

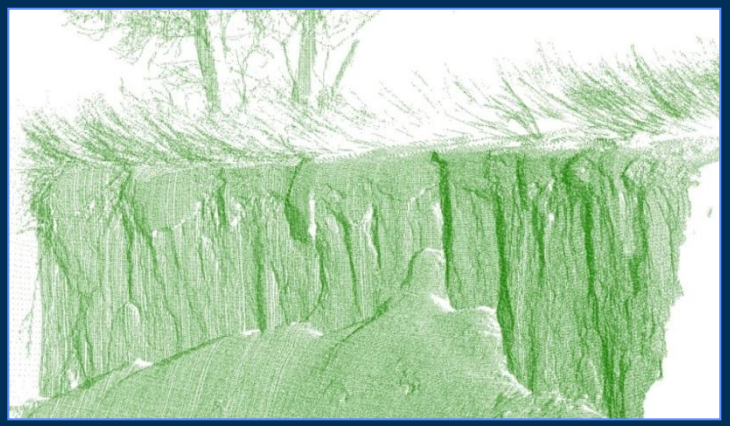
Comparing: 1) a photo at the 'high-bank area' to…



(2) the image created by one of the test LiDAR scans, (note the resolution from one meter on the far left to 0.3-meter resolution on the center & right), to…



(3) the point-cloud data imported to ArcGIS, to…



(4) a zoomed image.

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Missouri River Bank Erosion On the Lower Brule Reservation

The 2012 effort could not be completed as the Winter of 2012 was extremely warm and there was insufficient safe ice. Thus we have extended the study's ending date to the end of April, 2013, allowing us to hopefully complete this effort in March of 2013.

Update:
During a May, 2012 site visit, we found we will definitely have a measureable loss of soil as we found we had lost "our LiDAR tree" to erosion).

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Missouri River Bank Erosion On the Lower Brule Reservation

Unmanned Aerial System (UAS)

Flights were conducted during August, 2011 and 2012.

The small, unmanned aerial vehicle (UAV), used for this study was a Raven RQ-11A.

The study's fly-zone includes a no-fly zone over Lower Brule. The flight path is along the shoreline.

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Missouri River Bank Erosion On the Lower Brule Reservation

The USGS Rocky Mountain UAS Project Office has provided support to guide us through the required FAA & military procedures and provide pilots.

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An additional proof-of-concept trial included the first boat launch, and the hand-off of control to a 2nd pilot (located at the base tent).

Missouri River Bank Erosion On the Lower Brule Reservation

Aerial targets are placed in strategic locations for the UAS flights.

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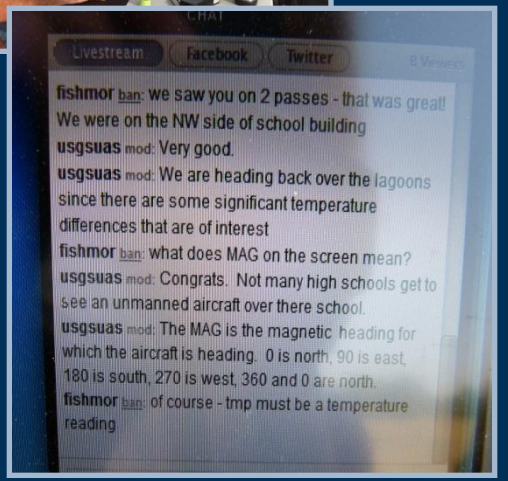
Missouri River Bank Erosion On the Lower Brule Reservation

The laptop allows the mission controller to set flight points and view the UAS's location. The video window allows the controller to see to video that is being captured.

Once the UAS is in the air, it can also be flown by the laptop only, by moving the flight points.



Live-streaming was utilized in 2012. The Lower Brule High School Science Class interacted with USGS personnel.

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Missouri River Bank Erosion On the Lower Brule Reservation

Captures from IR camera looking at the lagoons: Black-hot and White-hot.

Examples of electro-optical (EO) camera photos.

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Missouri River Bank Erosion On the Lower Brule Reservation

Example of still-pictures captured from the video.

playground3 - Notepad

File Edit Format View Help

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Example of data captured with each real-time picture saved.

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Missouri River Bank Erosion On the Lower Brule Reservation

Comparing Results of Annual Flights

2011 flights provided baseline data.

This playground equipment is obviously in danger, but how long will it take to reach the bordering wood frame that is approx. 2 to 4 feet back?

2012 flights documented that the bank had eroded, allowing the front of the wood frame and surrounding soil to disappear during the year around this playground equipment.

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Missouri River Bank Erosion On the Lower Brule Reservation

Comparing UAS Results With Other Types of Data

A technique called 'Rubber-Sheeting' was used to match the screen captures with the 2011 National Agriculture Imagery Program (NAIP) data by visually examining the photos & metadata.

The final product was then overlaid with the 2004 shoreline (illustrated from 2004 NAIP data), revealing the loss of shoreline in those six years.

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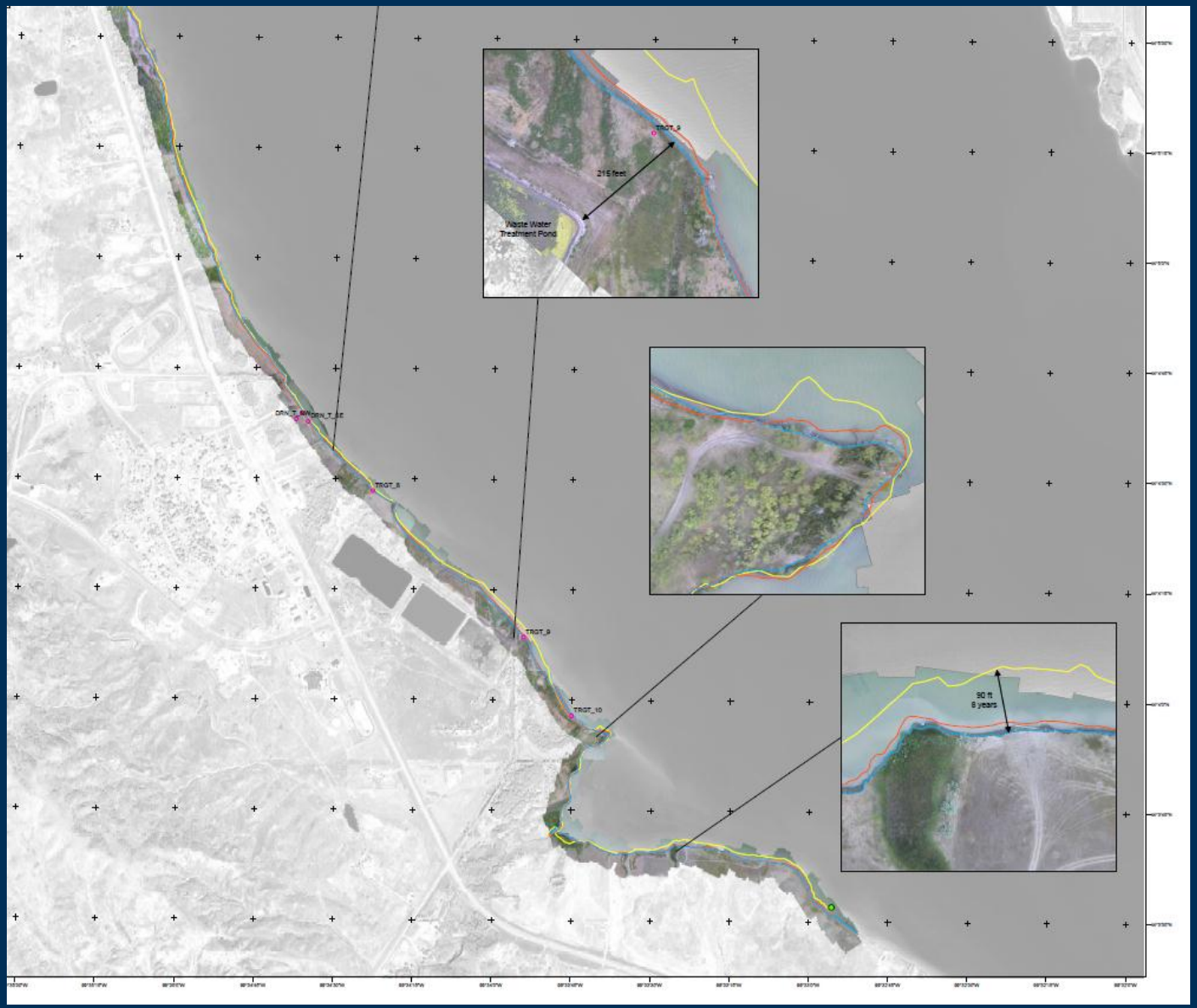
Missouri River Bank Erosion On the Lower Brule Reservation

The UAS Project Office is using a new software package to post-process the 2012 data, allowing for faster and improved output.



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Missouri River Bank Erosion On the Lower Brule Reservation

BEND Site Located approx. three miles north of Lower Brule

The line shown on the screen captures below was drawn at the approximate shoreline in 2010-2011 using historical imagery and tools from Google Earth™. The yellow line was estimated by connecting 'bankshot' readings made on Nov. 16, 2010 (blue markers) and March 3, 2011 (red markers). The background images were altered between 1991 and 2004, using the 'time slider' tool in Google Earth. The estimated distance of the sketched line is 0.19 mile.

Background: Google Earth™ Image: U.S. Geological Survey, ***1991***

Estimated change in approx. 19 years (from 1991 to 2010) by measuring from the blue markers to the shoreline shown on the image.

Estimated change (in feet):

Northern: 85-95
Central: 97-110
Southern: 170-200

Background: Google Earth™ Image: USDA Farm Service Agency, ***2004***

Estimated change in the recent six years (from 2004 to 2010) by measuring from the blue markers to the shoreline shown on the image.

Estimated change (in feet):

Northern: 35-39
Central: 36-38
Southern: 65-82

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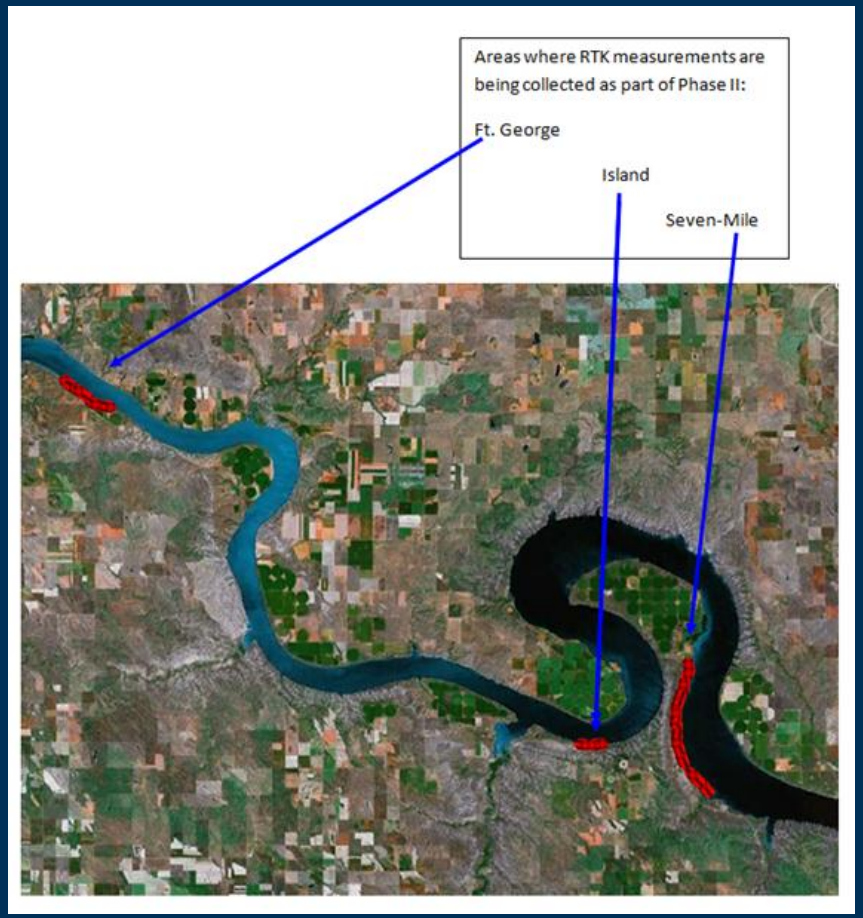
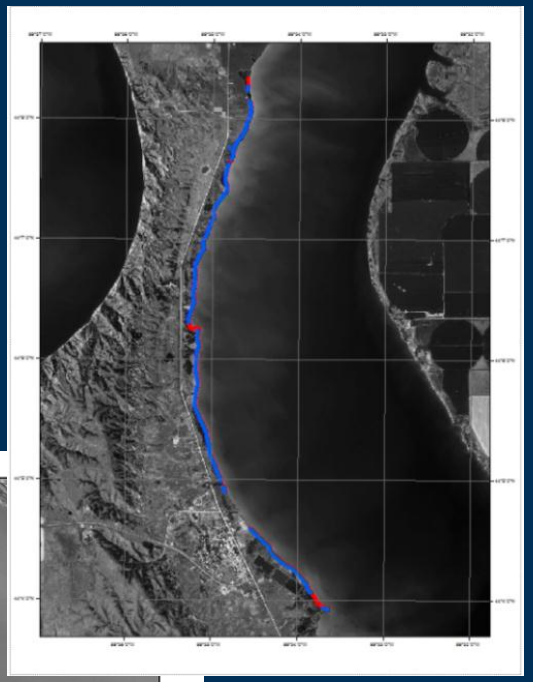
Missouri River Bank Erosion On the Lower Brule Reservation

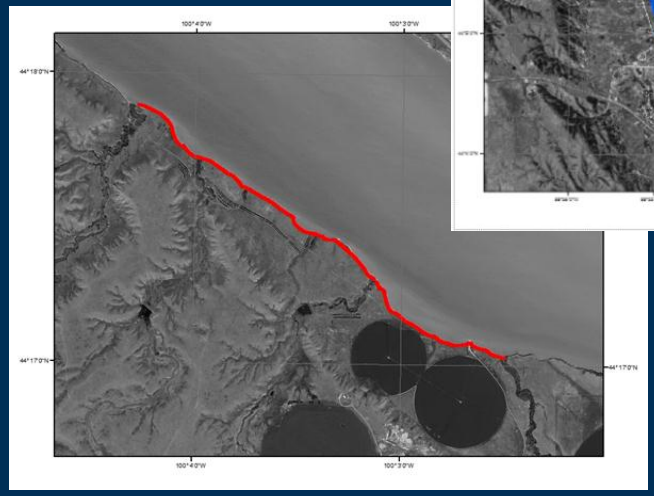
Target Areas

3 sites were monitored on a quarterly basis.

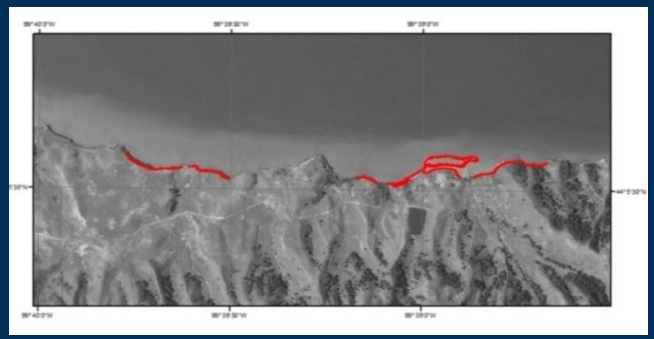


"Seven-mile" (the original, primary study area)



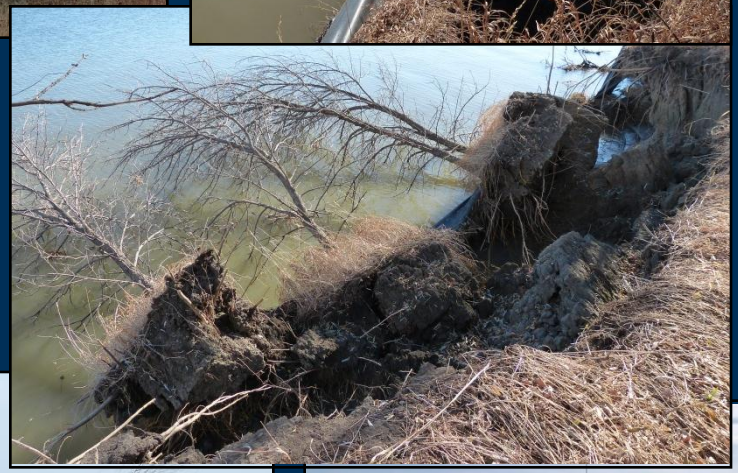


"Fort George"



"Island"

Missouri River Bank Erosion On the Lower Brule Reservation



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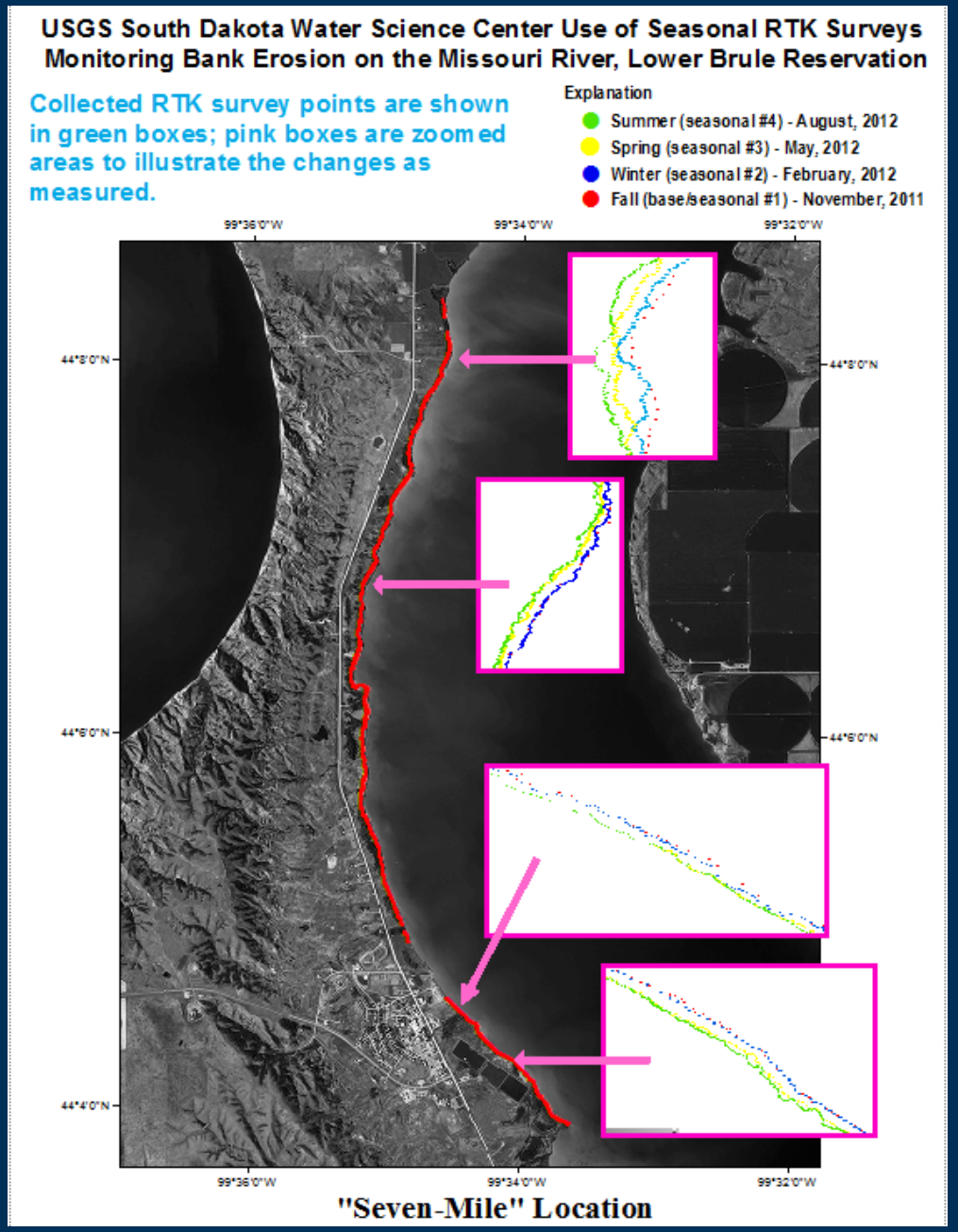
Missouri River Bank Erosion On the Lower Brule Reservation

Results from the quarterly RTK monitoring were severe in many areas during the nine months from Nov., 2011 to Aug., 2012. Loss of bank ranged from zero to over 14 feet in the seven-mile study area.



Estimated maximum amount of lost shoreline:

- 14 ft
- 11 ft
- 12 ft
- 13 ft

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Missouri River Bank Erosion On the Lower Brule Reservation

Future plans:

- Originally funded through 2012.
- The UAS efforts have been completed and the results are being investigated
- The LiDAR effort has been amended due to the lack of ice in 2012, extended through April, 2013.

The phase II portion was also extended, to run through 2013. Plans are to collect annual RTK measurements and UAS flights.

A new UAS, the T-Hawk, will be used during the next flights, along with new and improved cameras.

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