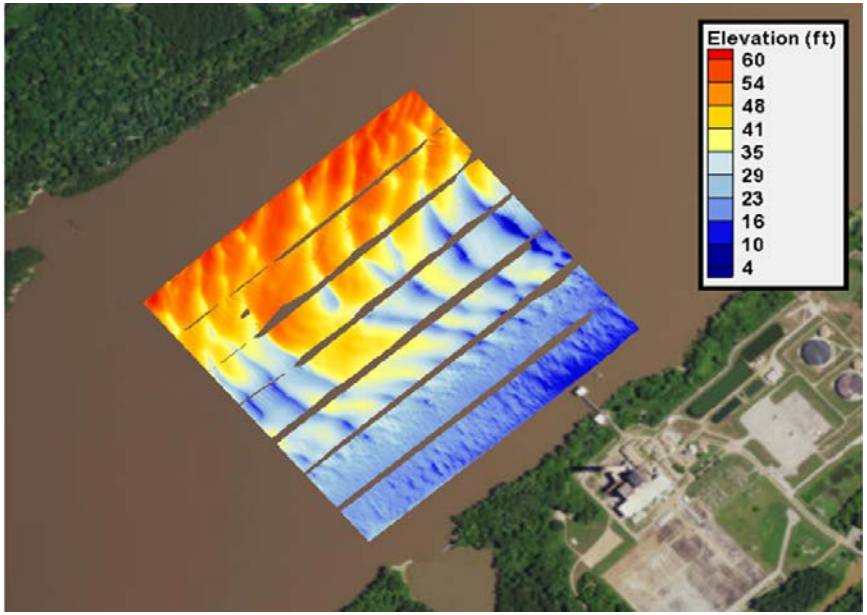
FY18 RSM IPR
ISSDOTv2 Improvements

Tate O. McAlpin, David Abraham, David May, and Keaton Jones

BLUF: The ISSDOTv2 method provides a means to measure bed-load transport in large, sand bed rivers. Measurements have been taken on the Mississippi, Ohio, and Missouri Rivers (among others) and utilized for various purposes including: development of bed-load rating curves, defining suitable endangered mussel habitat, validation of numerical model results, forecasting/hindcasting of bed-load transport rates, and validation of bed-load transport functions.

Challenge/Objectives

- Modify the method to account for varying wave shapes
- Modify the method to directly calculate the “lost” area between surveys
- Modify the method to accurately combine the transport in individual waves



FY18 RSM IPR
ISSDOTv2 Improvements

PDT Members

Mr. Tate O. McAlpin, Dr. David Abraham, Mr. David May, and Mr. Keaton Jones (CHL)

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Dr. Clinton Willson and Dr. Kory Konsoer (LSU)

Leveraging/Collaborative Opportunities

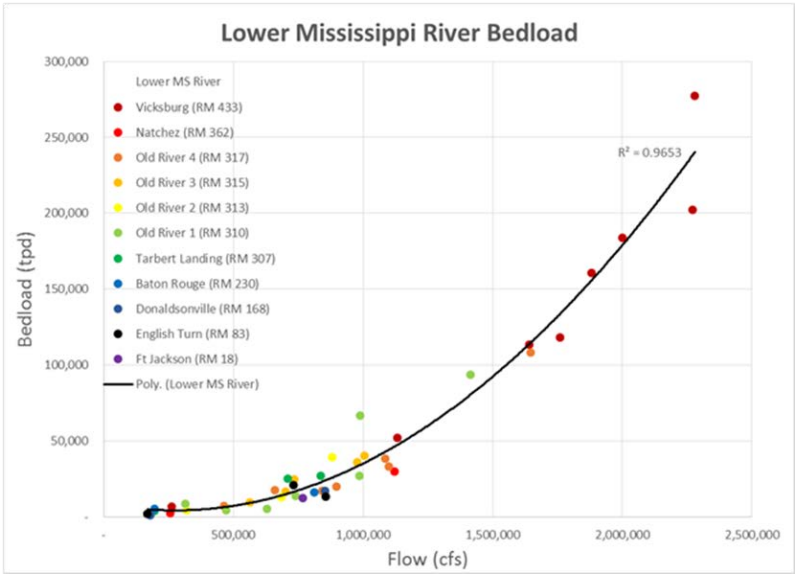
The CHL bed-load transport team has been discussing collaborative opportunities with the USDA ARS/NSL to performed flume studies and provide additional validation datasets for the ISSDOTv2 method.

Mr. Tate McAlpin was accepted to the ERDC Long Term Training program and will be taking classes at LSU. Improvements to the ISSDOTv2 method and analysis of the large database of measurements will be a significant portion of Mr. McAlpin's dissertation.

USGS collaboration with the Chippewa River RSM Study

Stakeholders/Partners

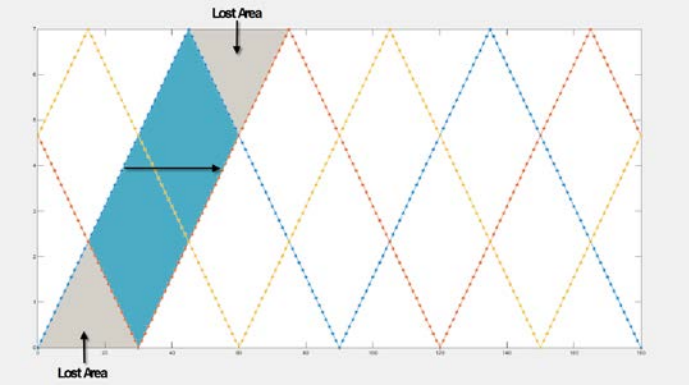
As evidence of the value placed on obtaining bed-load measurements, 7 - USACE Districts (St. Paul, Kansas City, Vicksburg, Omaha, New Orleans, Walla Walla and Louisville) have asked ERDC-CHL to apply the ISSDOTv2 method.

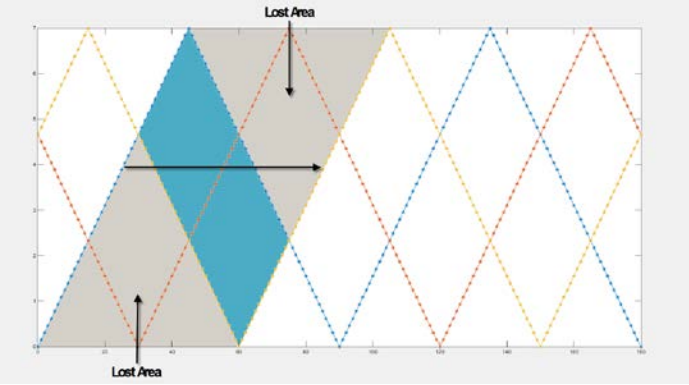


FY18 RSM IPR
ISSDOTv2 Improvements

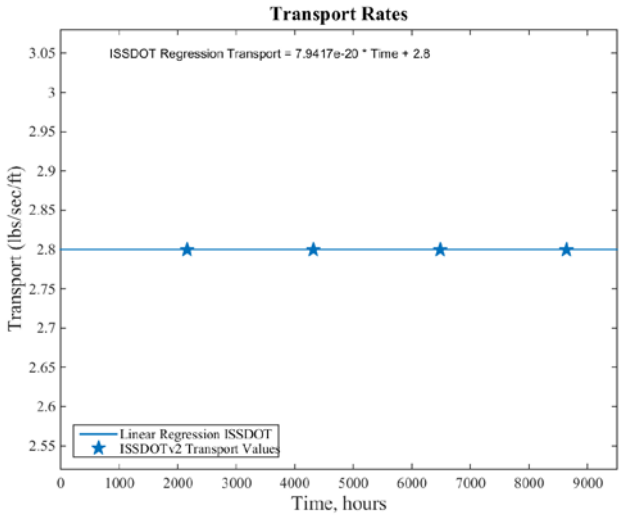
Modifications to directly calculate the "lost" area for the scour volume.

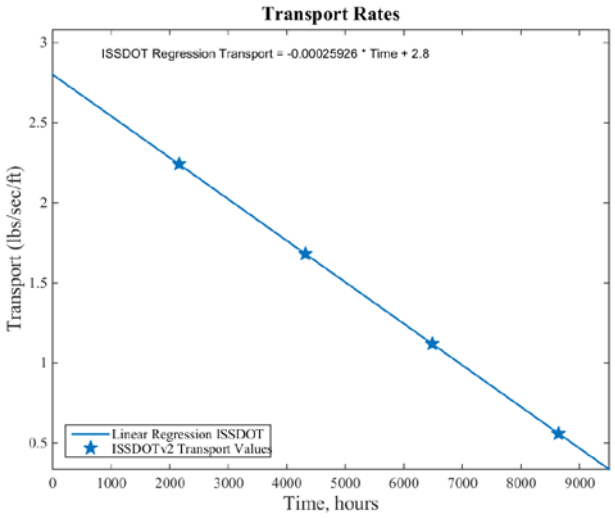
$$g_{sb} = \frac{\rho(1-p)V}{2\Delta t}$$





This modification will reduce the required number of multi-beam datasets required to obtain and accurate bed-load transport rate thereby reducing time/costs associated with the method.

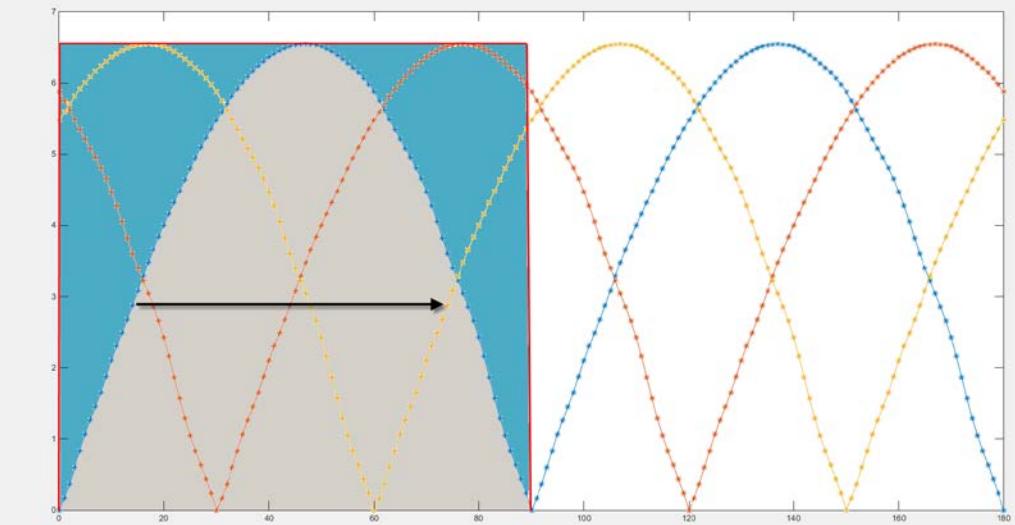




FY18 RSM IPR
ISSDOTv2 Improvements

Removal of the Triangular Wave Assumption

For triangular waves, the transport rate is half the scour rate. This is why the scour volume in the ISSDOTv2 equation is divided by 2.0, but for nontriangular waves this value is not 2.0 and is in fact some number between 1.0 and 2.0 and varies for each wave. In the example above, the divisor (2 in the previously shown ISSDOTv2 equation) should in fact be (Area in Blue + Area in Grey)/(Area in Grey). For the hypothetical wave in the figure above, the divisor value was determined to be 1.58 indicating an error of approximately 10 % using the triangular assumption.

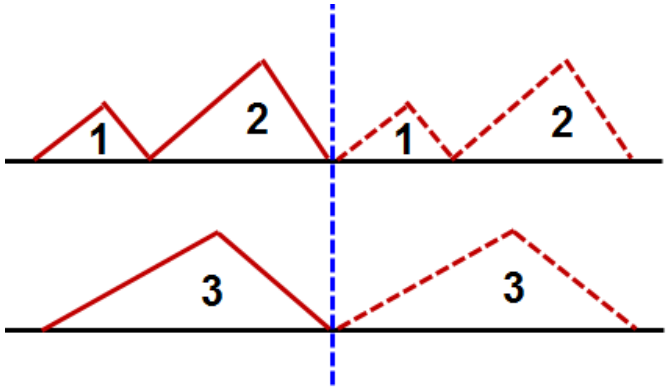


$$g_{sb} = \frac{\rho(1-p)V}{1.81\Delta t} \rightarrow g_{sb} = \frac{\rho(1-p)V}{1.58\Delta t}$$

FY18 RSM IPR
ISSDOTv2 Improvements

Proper Weighting of Waves

Previous studies have reported the bed-load transport at a location as the average transport per wave (Nittrouer et al. 2008, Nittrouer et al. 2011, Allison and Meselhe, 2010, Abraham et al. (2010), Abraham et al. (2015)) but this approach is only appropriate if all waves possess the same transport or there is an even distribution of wave sizes and transports about the mean value.



Triangle 1
- **Area = A1**
- **Length = L1**
- **Height = H1**

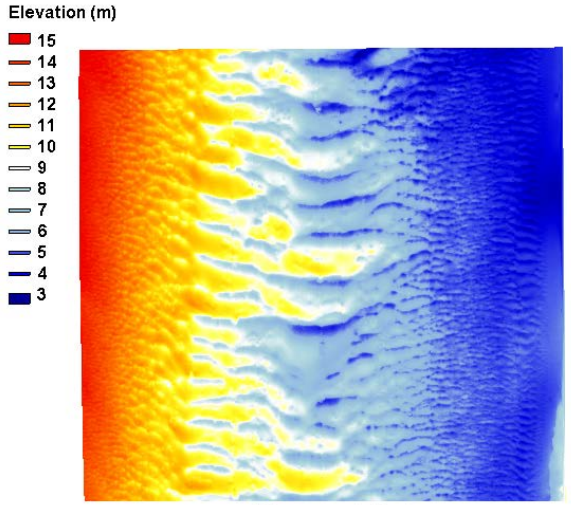
Triangle 2
- **Area = A2**
- **Length = L2**
- **Height = H2**

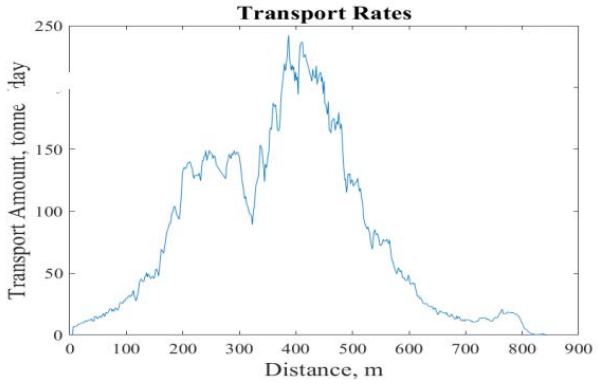
Triangle 3
- **Area = A3 = A1+A2**
- **Length = L3 = L1+L2**
- **Height = H3 = 2*(A1+A2)/(L1+L2)**

$$g_{sb} = \frac{\sum_{n=1}^{N}\left[L_n \frac{\rho(1-p)V_n}{2\Delta t} \right]}{\sum_{n=1}^{N} L_n}$$

FY18 RSM IPR
ISSDOTv2 Improvements
Challenges/Path to Completion

The previously discussed improvements were implemented on analytical tests cases and resulted in the expected improvements BUT upon implementation with flume measurements (non ideal data) some obstacles were identified. This primarily consisted of issues addressing the high frequency variations in the data (“noise”). The current approach is the utilize some as yet to be identified filtering process using Fourier transforms to more accurately identify the waves in the datasets.





FY18 RSM IPR
ISSDOTv2 Improvements

Benefits:

- **Improved accuracy in the bed-load transport measurements**
- **Improved efficiency in the matlab code**
- **Reduced time/costs associated with data collections efforts**
- **Improved collaborative opportunities with both LSU and the USDA National Sedimentation Laboratory**

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ISSDOTv2 Improvements

Questions?