Impact of Water Body Classification on SWOT Discharge Retrieval

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Source of Error in SWOT Discharge Measurements

\[ Q = wdv \]

All three dimensions must be measured or estimated. Errors in all three will contribute to discharge error.

For more discussion on estimating depth and velocity, wait 30 minutes (Mike Durand).

Focus of this Presentation:

How will errors in measurement of river width affect discharge retrievals in different kinds of rivers?
Ohio
Wide, Single Channel

Tanana
Wide, Braided

Kentucky
Narrow, Single Channel

Widths: 300-1000 m
Mean Discharge: 8000 m³/s
Principal Adjustment: Depth

Widths: 300-1500 m
Mean Discharge: 1200 m³/s
Principal Adjustment: Width

Widths: 50-200 m
Mean Discharge: 285 m³/s
Principal Adjustment: Depth
RivWidth: Automatic River Flow Width Monitoring

Pavelsky and Smith (2008), IEEE GRSL
Sources of Error in Width Classification

- Misclassification of pixels as water/nonwater
  - Sources: Emergent vegetation, wet sediment
- Error in cross-section calculation
  - Source: Complex river planforms
- Boundary/edge effect errors
  - Source: Inherent in calculation of river width from binary inundation masks
  - Defined by the number of channels in a river:
    \[ E = \frac{1}{2}RC \]
    
    $E$: edge effect error  
    $R$: pixel resolution  
    $C$: channel crossings
Deriving an accurate cross-section is simple in a single-channel river.
In a complex braided river, determining the direction orthogonal to overall flow is difficult.
Sources of Error in Width Classification

- **Misclassification of pixels as water/nonwater**
  - Sources: Emergent vegetation, wet sediment

- **Error in cross-section calculation**
  - Source: Complex river planforms

- **Boundary/edge effect errors**
  - Source: Inherent in calculation of river width from binary inundation masks
  - Defined by the number of channels in a river:
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  E: edge effect error   R: pixel resolution   C: channel crossings
Boundary/Edge Effect Error

Tanana River
Ohio River

On large, single channel rivers like the Ohio, edge-effect error is relatively small.
Tanana River

Increased braiding substantially increases edge-effect errors when width is constant.

Mean Width: 611 m
Max Width: 1944 m
Min Width: 84 m

Mean Error: 17%
Max Error: 51%
Min Error: 2%
Kentucky River

As a river narrows, edge-related uncertainty becomes increasingly important.

Mean Width: 95 m
Max Width: 218 m
Min Width: 30 m

Mean Error: 35%
Max Error: 100%
Min Error: 13%
Edge-Effect Error vs. Number of Channels, Tanana River
## Examples of Discharge Errors

Assuming constant width and depth, how will width errors affect discharge calculations?

<table>
<thead>
<tr>
<th>Ohio</th>
<th>Tanana</th>
<th>Kentucky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean width/error: 4413-4946 m$^3$/s</td>
<td>Mean width/error: 1004-1442 m$^3$/s</td>
<td>Mean width/error: 125-254 m$^3$/s</td>
</tr>
<tr>
<td>Maximum error: 2563-4460 m$^3$/s</td>
<td>Maximum error: 576-1775 m$^3$/s</td>
<td>Maximum error: 0-300 m$^3$/s</td>
</tr>
</tbody>
</table>
Ways to Minimize Width Error

- Limit cross-sections used to those below a given error threshold.
- Develop a method to reliably extract subpixel inundation information.
- Average widths across multiple adjacent cross-sections or switch from width to area.
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- Limit cross-sections used to those below a given error threshold.

- Develop a method to reliably extract subpixel inundation information

- Average widths across multiple adjacent cross-sections or switch from width to area.

Most methods for extracting subpixel information on inundation use either multiple optical bands or a combination of optical and microwave sensors. Can a method be developed to extract subpixel inundation information from SWOT-like data alone?
Ways to Minimize Width Error

- Limit reaches used to those below a given error threshold.
- Develop a method to reliably extract subpixel inundation information.
- Average widths across multiple adjacent cross-sections or switch from width to area.

Relationship between reach length and the coefficient in the width-discharge power law equation for the Lena River, Siberia.

\[ w = a Q^b \]

Relationship stabilizes at 2-3x mean width.

Pavelsky and Smith (2008), *WRR*
Next Steps

- Use AirSWOT to validate and calibrate inundation retrievals
- Develop a system for classification of river reaches for SWOT discharge retrieval
  - Map likely sources of uncertainty
  - Adjustment based on Width vs. Depth
- Release an improved version of RivWidth