Streamflow Uncertainty
ACWI Streamflow Collaborative

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What is uncertainty?
Why uncertainty?

• Value-added information
  • Improved decisions – water management, infrastructure design
  • Improved models – model calibration and validation

• Assessment of operational methods
  • Improve measurement/rating techniques
  • Improve streamgage network operation
  • Improve efficiency of operations
  • Understand consequences of changing methods
Sources of uncertainty

Measurements

Ratings

Stage time series

Streamflow Uncertainty
Streamflow uncertainty for publication

- Streamflow time series
  - Unit values (15-min data)

- Derived streamflow information
  - Example: mean daily discharge, monthly, annual averages
  - Need to consider serial correlation
Sources of uncertainty

Measurements

Ratings

Stage time series

Streamflow Uncertainty
Qualitative Assessments

Uncertainty in discharge

Excellent  <2% error
Good       <5% error
Fair        <8% error
Poor        >8% error

Current qualitative assessments in use by USGS, based on hydrographer knowledge of the site and conditions.
Discharge measurement uncertainty
Discharge measurement uncertainty

<table>
<thead>
<tr>
<th>Method</th>
<th>ISO method</th>
<th>IVE method (USGS, Cohn et al)</th>
<th>Despax et al (France)</th>
<th>QRev (USGS, Mueller et al)</th>
<th>QUant (Environment Canada)</th>
<th>OURSIN (France)</th>
<th>Muste et al.</th>
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<tbody>
<tr>
<td>Velocity-area method</td>
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<td>ADCP moving-boat method</td>
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Based on propagation of uncertainty from multiple identified sources.
Rating curve uncertainty - if our databases could talk...
If measurements and rating curve were perfect...
If measurements and rating curve were perfect...

Can we learn something from the actual observed differences?
Figure 1. Location of streamgages used in this study.
Measurement dataset

59,696 measurements from March 2012-December 2014

Filters:

• Must have a qualitative assessment of flow
• Discharge greater than 1 cfs
• No computed differences greater than 500%

→ 53,580 measurements
Rating curve uncertainty: a comparison experiment...
Isere River at Grenoble

Isere 95% Uncertainty Intervals
Summary of comparison experiment results

- Uncertainty estimates varied widely for the various methods, and especially at high and low flows.
- Assumptions matter -- careful description of the assumptions behind uncertainty methods is needed.
- Minimum data required:
  - information on channel and controls (stable section, natural weir, etc.)
  - measurements with dates
- Additional information are also useful in constraining the discharge uncertainty estimates (photos, known changes to channel, etc.)
Rating curve uncertainty methods – possible criteria

- Objective calculation
- Can be applied to thousands of gages – ability to automate
- Flexible across widely varying rivers and streams
  - Sensitive to hydraulic control type and conditions
  - Sensitive to number and distribution of flow measurements in stage and time
  - Complements existing USGS streamflow computations for shifting ratings
- Considers difference in uncertainty for different stage
- Considers time varying nature of streams and associated ratings
Considerations...

- Computing uncertainty of rating curves and their outputs may imply the adoption of new rating development methods.
- Some methods may merge well with current work methods and capacity, others may require a greater transition and adaptation.
- The typical rating developer may not be an expert in all scenarios and complexities! How to normalize decisions?
- The investments must also be weighed against operational gains and user benefits. This should be clarified and serve as work objectives.
Summary of work and next steps

• Discharge measurement uncertainty
  • ADCPs: QRev and QUant
  • Velocity Area: IVE
    Next steps: incorporation into database; continued collaboration with others to develop and test methods

• Stage-discharge rating uncertainty
  • Data-mining effort
  • Methods comparison
    Next steps: More testing of select methods at USGS sites, expand project.

• Stage Uncertainty
  Next steps: Project kicking off in fall

Hoping for larger USGS investment starting in Fall 2019.
Communication of Uncertainty
Discussion