Evaluation of the variability of sediment and nutrient loading into San Antonio Bay

September 27, 2016
U.S. Geological Survey
Texas Water Science Center
Gulf Coast Program Office

Texas Water Development Board
USGS
1. Collection of periodic water-quality samples in the Guadalupe River (USGS station 08188810).

2. Develop regression model to estimate suspended-sediment concentrations using backscatter signal from ADVM at streamgaging station.
3. Develop a continuous record of suspended-sediment concentrations for period of gage operation and evaluate nutrient relations with in situ parameters.

4. Evaluate historic flow data for the Guadalupe and San Antonio River below Victoria, Texas.
STREAMFLOW AND WATER-QUALITY MONITORING IN COASTAL WATERSHEDS IN TEXAS
INDEX-VELOCITY GAGE

Discharge = Velocity x Area
• The ADVM transmits acoustic energy at a known frequency and measures the change in frequency of the acoustic energy reflected back (backscattered) from particles in the water column.

• Acoustic waves passing through a water-sediment mixture will scatter and attenuate as a function of fluid, sediment, and acoustic instrument characteristics.
ADVANTAGES OF ACOUSTIC BACKSCATTER

• High Temporal Resolution & Real Time
• Greater Accuracy
• Concurrent Velocity and Streamflow Data
• Reduced Cost and Maintenance
• Large Sample Volume
DATA COLLECTION

- Water-quality samples
  - Suspended-sediment
  - Nutrients (N, P & C)
  - Physical water properties
- Concurrent and continuous acoustic backscatter data from ADVM
(A) Horizontally-oriented profiler

- Blanking distance
- Flow
- Bins
- Bin velocity components

Graph:
- Backscatter, in decibels
- Distance along acoustic axis beam, in meters
- Distance range: 0 to 20 meters
- Backscatter range: 0 to 70 decibels
SCB = MB + 20\log_{10}(\psi r) + 2r(\alpha_w) + 2r\alpha_s

- Measured Backscatter
- Beam Spreading
- Water Absorption
- Sediment Attenuation \( \alpha_s = SAC \)
DATA MANAGEMENT

![Graph showing backscatter in decibels vs. distance along acoustic axis beam, with lines for Measured Backscatter, Water Corrected, and Sediment Corrected.](image-url)
Sediment attenuation coefficient: 0.893

Slope = -1.7862

Distance along acoustic axis beam, in meters

Backscatter, in decibels (dB)
SEDIMENT ACOUSTIC INDEX DEVELOPER TOOL
GUADALUPE RIVER PRELIMINARY MODEL

- Predictive variables considered:
  - Sediment corrected backscatter
  - Sediment attenuation coefficient
  - Discharge
GUADALUPE RIVER PRELIMINARY MODEL

$\log_{10}(SSC) = 1.70 \alpha_s + 1.26$

$R^2 = 0.90$
GUADALUPE RIVER PRELIMINARY MODEL
SUSPENDED-SEDIMENT LOADING IN 2015

--Preliminary data, subject to revision--
# Water-Quality Data

- 3 samples collected in 2016
- 34 since 2013

<table>
<thead>
<tr>
<th></th>
<th>Concentration (mg/L)</th>
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<tbody>
<tr>
<td></td>
<td>Min.</td>
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<tr>
<td>Nitrate</td>
<td>0.44</td>
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<tr>
<td>Total Nitrogen</td>
<td>1.25</td>
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<tr>
<td>Total Phosphorus</td>
<td>0.269</td>
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</tbody>
</table>

--Preliminary data, subject to revision--
FINDINGS

• Sediment attenuation coefficient, an acoustic backscatter variable, appears to be highly correlated to suspended-sediment concentrations at USGS station 08188810.

• Additional samples are needed to include high suspended-sediment concentrations in calibration and for model verification.
What’s Next?

• Collection of more samples to expand and maintain surrogate model
• Publish real-time suspended-sediment concentration data on the web
• Evaluate potential surrogates for nutrient parameters
• Evaluate historic flow data in the lower watershed to assess magnitude of unaccounted flow