Building the Trinity River Delta Hydrodynamic Model

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Motivation
• Mismatch of flow rates between two gages

Ultimate Goal
• Identify the fate of flow
• Where and why

Approach
• Hydrodynamic modeling

Our job
• Build a model for Trinity Delta
Hydrodynamic model

Salinity [psu]

10-Sep-2017
Phase I: Hydrodynamic model development for the Trinity River Delta (Completed)

- Mobilizing lidar data and analysis of "not-a-number" (NaN) elements
- Field work for limited checking of NaN elements and bathymetry in some channels
- Analysis of landscape data and development of a hydrodynamic model

Phase II: Building the Trinity River Delta Hydrodynamic Model (In Process)

- Sensitivity testing of the TDHM
- Implementing subgrid-scale algorithms
- Adapting Frehd-C model for coupled surface/groundwater flows
Flowchart of Phase I

Analyze lidar data
- Process raw lidar data to create raw topography
- Analyze possible errors in the topography
- Estimate bathymetry at locations without lidar measurement

Validate lidar data
- Collect field data for land elevation and water depth
- Check agreements between field data and lidar data

Develop hydrodynamic model
- Select the proper model for Trinity Delta
- Generate bathymetry as input to the model
Phase I
Task 1 – Analyze lidar data

- Lidar
- Red lidar reflected at water surface

Podhoranyi and Fedorcak (2015)
Phase I
Task 1 – Analyze lidar data

- Lidar data for wet regions are not trustworthy
Flowchart of Phase I

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Phase I
Task 2 – Validate lidar data
- Field survey with TWDB+TRA on Dec. 2016
- Trinity river 3m deeper than that on lidar
- Land data is acceptable
Flowchart of Phase I

Analyze lidar data
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Validate lidar data
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Develop hydrodynamic model
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Phase I
Task 3 – Develop hydrodynamic model

• The finest bathymetry (at 1m x 1m grid scale) contains 27600 x 20790 grid cells

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Frehd</th>
<th>SUNTANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage</td>
<td>Easy to implement</td>
<td>Fast (easy to parallelize)</td>
</tr>
<tr>
<td>Disadvantage</td>
<td>Slow</td>
<td>Hard to build mesh</td>
</tr>
</tbody>
</table>

• Combine advantages of two models by parallelizing Frehd (Frehd-C)
Phase I
Task 3 – Develop hydrodynamic model

- Automatic (unsupervised machine learning) + manual (Adobe Photoshop) approaches
- Need more data for fully automatic procedures
Final model bathymetry
Flowchart of Phase II

Test model sensitivity
• Test model sensitivity to input (tide, wind, river stage)
• Analyze performance of uncalibrated model
• Provide recommendations on future field work

Implement subgrid algorithm
• Model small-scale processes at coarse resolution
• Analyze effectiveness of the subgrid algorithm

Couple surface/subsurface flow
• Investigate different approaches of surface-groundwater coupling
Phase II
Task 1 – Test model sensitivity

- Model has to be calibrated with field data (not available) before use
- Run simulations with different input values (tide, wind, inflow)
- Use salinity as a tracer, find locations where model is sensitive to inputs
- E.g. Lower delta is sensitive to tide
Flowchart of Phase II

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Conclusions

• The project is on schedule
• We have successfully built a hydrodynamic model for Trinity Delta
• Completing the remaining tasks (subgrid and groundwater model) will further improve applicability of TDHM
• Requires more field data to achieve the ultimate goal (identify flow mismatch)
• Once extensive field data is obtained, the model will be ready to use

Q&A