Proposal for Analyzing Efficiency of Land Building with Different Crevasse Management Strategies in the Lower Mississippi River Delta

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Abstract

Management of the Mississippi River is vital to counteract rising sea level and land loss in Southeastern Louisiana. Cutting crevasses into the levee is effective at delivering water and sediment to the floodplain and building land. To explore how different crevasse regimes allow for land building, a Delft3D Hydrodynamic and Morphodynamic simulation was created under various management scenarios with and without vegetation. Sedimentation patterns change with different vegetation regimes and throughout the time duration of the simulation. Figures created display changes in sedimentation throughout the simulation and how the presence of vegetation affects sedimentation.

1 Introduction and Background

Louisiana is experiencing extreme land loss due to high relative sea level rise [e.g. BR09] and decreased riverine sediment supply [e.g. BR09] that has drastic implications for the economy, recreation, and transportation of the entire Mississippi Valley region [Bar19]. The heavily engineered river and floodplains require further engineering to direct sediment to optimal land-building locations while allowing natural fluvial and deltaic processes transport and deposit sediment to allow for land building [NTE18]. The Mid-Barataria sediment diversion is one project that hopes to leverage natural processes and aid engineering efforts to combat land loss close to Metropolitan New Orleans, LA [NTE18].

Vegetation impacts deltaic landscapes by localizing flow 1 [TMS+12]. Vegetation impacts water flows by slowing velocities, routing water around patches of vegetation, and therefore impacting sedimentation 3. Vegetation is vital to include in modelling efforts in order to accurately predict landscape evolution because of its large geomorphic impacts in deltaic systems. It influences channel-floodplain connectivity, facilitating the flow of sediment-rich water into the back marsh floodplains [HP15]. Factors such as vegetation type and density greatly influence landscape evolution, making field efforts to study vegetation vital to improving models 2.

The goal of this project is to write Python codes that plot Delft3D output model data in publication ready figures. Preliminary field data shows changes in velocity vectors as a result of the presence of the patch of vegetation. For the purpose of the course project, I will model geomorphic changes in a idealized model domain to see changes in sedimentation, and be able to plot those changes over the course of the simulation time. With the codes produced in this project, I will have ways to plot results once the final model is complete to look at land-building in the region given management strategies.

this is where i include this info

2 Project Overview

The Delft3D simulation results will show how different management techniques will impact sedimentation and land building on the Bird's Foot Delta. For the purposes of this project, I will write codes in Python to analyze output from Delft3D. The output of Delft3D 4 simluations is in a .trim and .trih file, which there is a simple code to convert that output into a netcdf. Once I have the netcdf file, I will be able to analyze the results and plot figures to convey messages. Because I don't have the

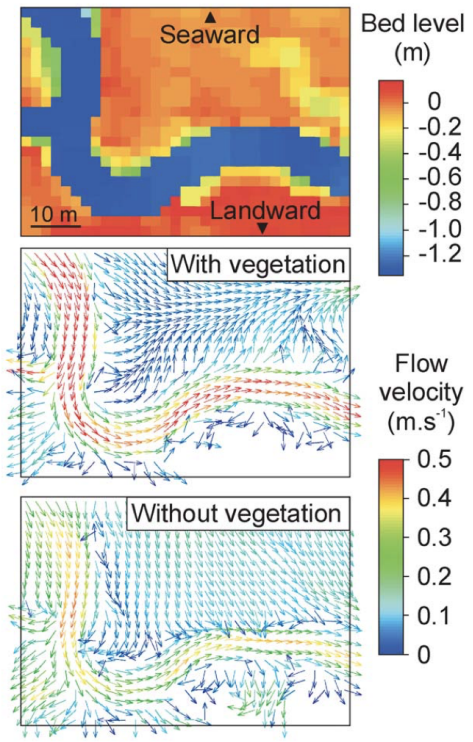

Figure 1: Taken from Temmerman et al. 2012. How flow localization shapes a deltaic landscape, and how vegetation can impact the landscape evolution in deltaic environments [TMS+12].

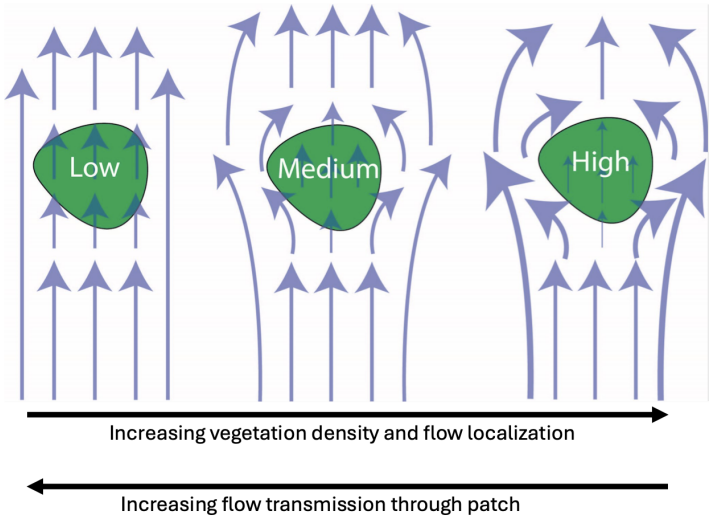

Figure 2: How density of vegetation impacts water routing and velocities through and around the patch.

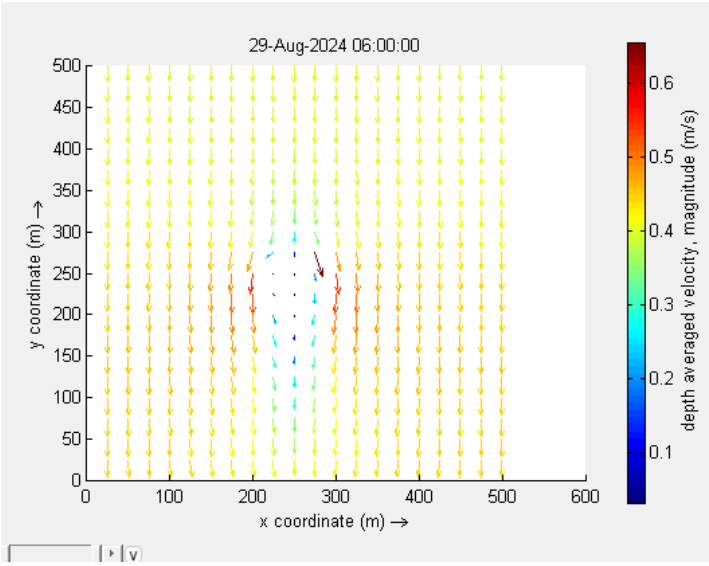

Figure 3: Delft3D model output of velocity vectors influenced by a patch of vegetation.

simulations completed already, I will use a sample output. I will write/find codes to do the following tasks:

1. Convert Delft3D output files into netcdf's (code already on a Github)
2. Plot the total subaerial land area over the course of the simulation
3. Show the simulation land area colored by elevation at one time step
4. Map of the simulation domain colored by change in elevation from the beginning the end of the simulation
    - Would have to use the same time within the tidal cycle, so for simplicity, I would use the first and land high tide

Each of the figures will be publication-ready with the proper color scheme and axes. Once I have the actual simulations, I will be able to use my codes written for this project for those scenarios. However, for this project, I will use the domain and patch of vegetation from Figure 3 3.

I hypothesize that when vegetation is included in the model, more overall sedimentation will occur across the domain. However, there will be more erosion in some places as the vegetation will provide differences across the domain. In the scenarios with no vegetation, there will be little spatial variation in sedimentation.

2.1 Analysis

In order to determine the efficiency of the project, I will create figures using my codes from sample Delft3D output. I will make sure each of the codes are properly commented out in order to use them later. The figures produced will be included in the final presentation and report.

2.2 Timeline

In order to complete this project, I will have the following weekly goals shown in table 1.

3 Conclusion and Broader Impacts

This project will provide a way to analyze Delft3D output from simulations that explore management techniques of the Lower Mississippi River delta. Management of the Mississippi River delta is important

Week	Task
Week of Oct 27-Nov 2	create/find sample Delft3D simulation, convert to netcdf
Week of Nov 3-Nov 9	plot map at one time step
Week of Nov 10-Nov 16	plot scatterplot of total subaerial land area over simulation
Week of Nov 17-Nov 23	plot difference between beginning and end of simulation
Week of Nov 24-Nov 30	write paper
Week of Dec 1-Dec 7	write paper, make presentation, present

Table 1: Weekly breakdown of tasks to complete the project

for mitigating land loss, preserving valuable wetland habitats, and protecting coastal cities including New Orleans. Vegetation is one type of nature-based solution that has the capacity to help all of these efforts, therefore it is vital that it's role in shaping the landscape is incorporated into modeling efforts. The goal for this project to set up analysis code that can display and answer questions about the efficiency of different management techniques. The accurate Delft3D simluations will be completed on a later date as part of my dissertation, but the codes written for the project will help data analysis.

References

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[BR09] Michael D Blum and Harry H Roberts. Drowning of the mississippi delta due to insufficient sediment supply and global sea-level rise. *Nature geoscience*, 2(7):488–491, 2009.

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[NTE18] Jaap H Nienhuis, Torbjörn E Törnqvist, and Christopher R Esposito. Crevasse splays versus avulsions: A recipe for land building with levee breaches. *Geophysical Research Letters*, 45(9):4058–4067, 2018.

[TMS+12] Stijn Temmerman, Pieter Moonen, Jonas Schoelynck, Gerard Govers, and Tjeerd J Bouma. Impact of vegetation die-off on spatial flow patterns over a tidal marsh. *Geophysical Research Letters*, 39(3), 2012.