Modeling River Floodplain and Wave-Dominated Longshore Transport Interactions

Avulsion-CEM Lab description, October 22nd, 2010

Note for Users. This lab relies on the CSDMS Tool. The use of the CSDMS Tool is free for members, but it requires an account on the CSDMS HPCC system. You can sign up here: http://csdms.colorado.edu/wiki/Help:HPCC_account_request
You will also need a secure way of accessing the system (f.e. VPN software) and to download the CMT tool as well as Visit. More information:
http://csdms.colorado.edu/wiki/Help:Ccaffeine_GUI

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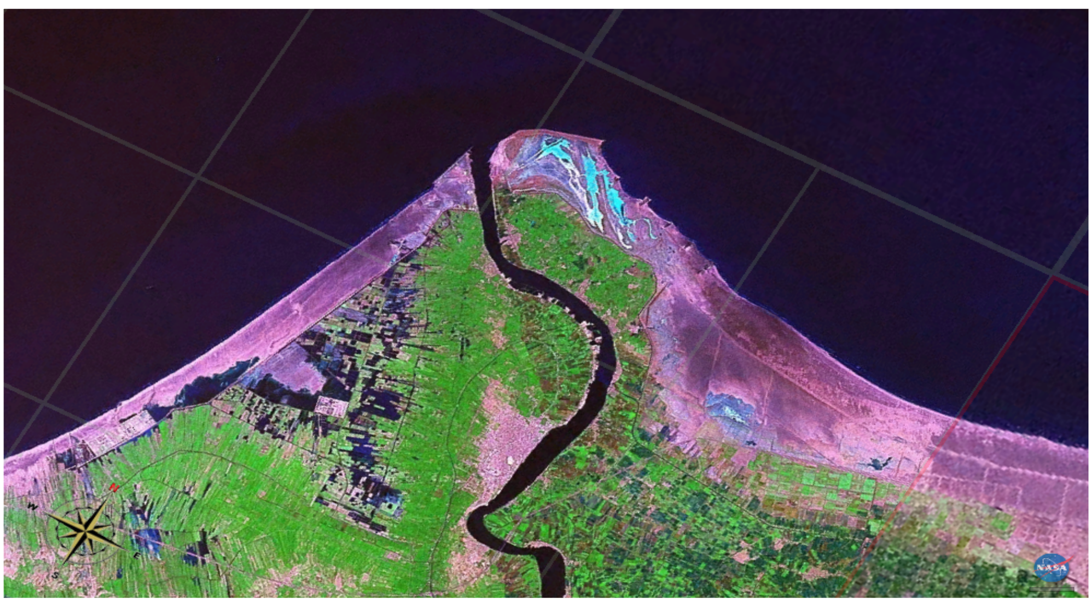


Rosetta Lobe of the Nile Delta shows typical wave-dominated delta geometry

Introduction

These experiments couple the terrestrial and coastal domains. We will be looking at a river supplying sediment to a coastal zone, along which wave-driven longshore sediment transport occurs. We will learn about the effect of during incoming wave fields, the effect of sediment supply to the coast, and whether this supply happens through a single delta channel or through multiple distributary delta channels.
We will assume a constant river discharge for the basic scenario.

Exercise 1: Generate a wave-dominated delta

1.1 Run a "base-case" simulation for 6000 time steps. Use a constant high river bedload input of 300 kg/s. Use a modest wave height (1m, 7 sec period). Run your scenarios for a single channel, with no channel avulsion.
1.2 Do you think these values are realistic? If not, why not? Can you give an example of a river or delta system that would be experiencing this influx of bedload and a comparable wave regime?
1.3 Plot up your results in VisIt; is the evolved planview delta shape reminiscent of a wave-dominated delta?
1.4 Make a movie of the evolution of the delta evolving with VisIt. Export the movie as an mpeg.

Exercise 2: Explore the influence of wave regime on delta formation

2.1 Systematically vary the wave regime: the asymmetry of the incoming wave angles (A) and the highness factor for incoming waves (U).

A ranges from 0-1. A >0.5 indicates that the majority of wave energy is approaching from the left where a designation of 1.0 indicates all wave energy approaches from the left. A = 0.5 indicates wave energy approach is evenly distributed between the left and right. A < 0.5 indicates the majority of wave energy is approaching from the right where a designation of 0.0 indicates all wave energy approaches from the right.

U controls the directional spread of the approaching waves, here split into whether waves approach from angles great than or less than the one which maximized alongshore sediment transport (~ 45 deg). High-angle waves approach with angles greater than 45 degrees and low-angle waves approach more directly onshore. U< 0.5 indicates wave energy predominately approaching from a low angle, U> 0.5 indicates a predominance of high-angle waves. For scenarios involving delta evolution, values less than 0.5 tend to be more reasonable.

Design a matrix of 9 experiments with varying A and U values.

2.2 Plot up your last time step for each of your experiments and describe the different delta shapes.

Exercise 3: Explore the influence of avulsion and multiple distributary channels on delta growth

3.1 Pick a base-case from your previous experiments (be sure to document your settings).

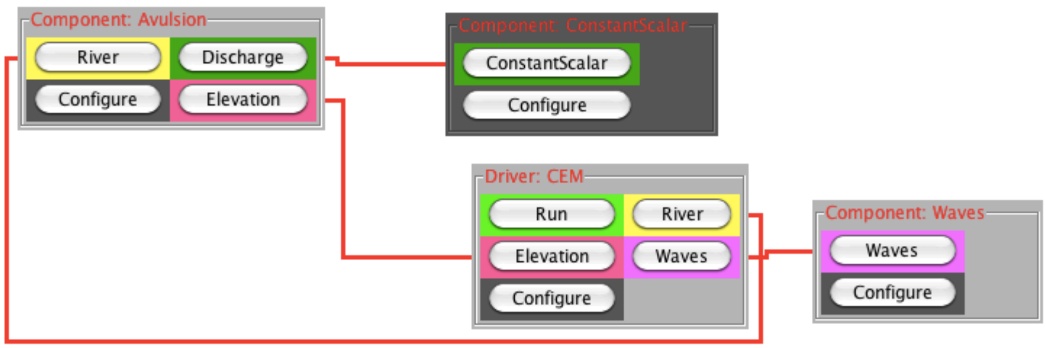
3.2 Run a simulation where you assign a much higher likelihood of channel switching by changing the standard deviation of avulsion angles. Can you describe a real-world delta system that would have a single channel and a high switching rate? Why does this happen? If yes, add a GoogleEarth image to your notes. Plot up your final time step and describe the delta geometry.

3.3 How does delta progradation change with multiple distributary channels? Run a simulation with 3 distributary channels and compare progradation rates to your 'one-channel' experiment.

3.4 Make a movie of the evolution of the delta with multiple distributaries evolving with VisIt. Export the movie as an mpeg.

Appendix 1: Notes on running coupled simulations with the CMT tool: Avulsion-CEM-WAVES

- Open the Coastal Group, choose the HydroTrend-CEM-Avulsion Project
- Drag in CEM to be the driver component.
- Drag the Avulsion Component into the Arena, you will see the connection between the River provider port and the River Use Port light up.
- Drag in the WAVES component
- Drag in the ConstantScalar component. This last component is a generic service component that can provide any scalar to another component, and it needs to be manually connected to the Discharge Port.



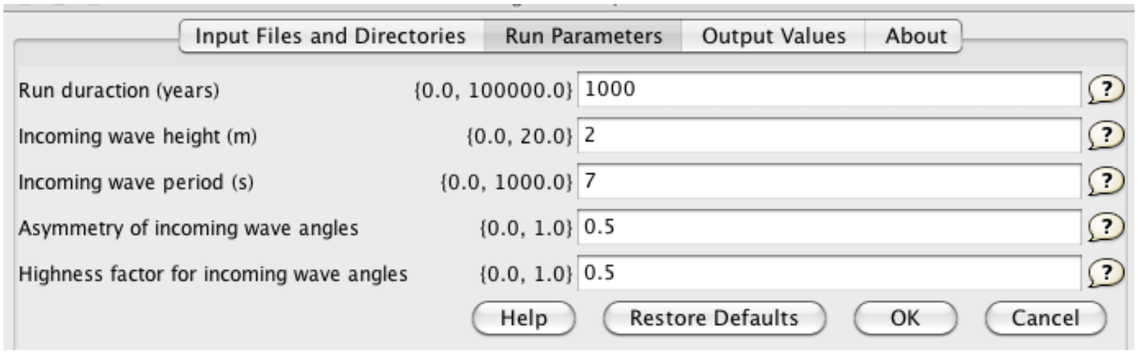
Wiring Diagram for coupled CEM-Avulsion-River simulations

Experiment 1: Simulation Base-case

Run for 6000 timesteps. Write output every 100 timesteps. Toggle on the output file for generating a grid stack of depth files. Use a fixed river discharge by using the constant Scalar component (400 kg/s). The wave settings need to be 1 m wave height, 7 sec period, A=0.5, and U = 0.5.

Experiment 2: Wave Angle Scenarios

- *Run experiments for 6000 time steps, one fixed river, constant sediment discharge (400 kg/s).*
- *Make changes to the incoming wave field by adapting the Asymmetry and Highness factors in the configure Menu of WAVES component.*



Experiment 3: High Switching or Multiple Rivers

- *Run experiments for 6000 time steps, run with constant sediment discharge (400 kg/s). The first scenario can be for widely switching channels, so you adapt the standard deviation of the avulsion angle.*
- *Make changes to the distributary channels by adapting the number of rivers in the configure Menu of Avulsion components.*