**Volumetric Analysis of Sediment Transport in a Simplistic Flume**

**Overview**

We have read several papers discussing the application of flumes in aiding our conceptualization of erosional and depositional processes that operate over timespans too long for us to observe in nature (Schumm and Khan, 1972; Ethridge et al., 2005). Now we will put our sandbox to the test and see whether or not we can recreate experiments performed in much larger flumes and obtain similar results. In addition to running the physical experiments and observing process, we will also take depth measurements across our model landscape at set time intervals and generate digital representations of those instances in time. This will enable us to create maps of net change and quantify sediment volumes, which will help us to understand and conceptualize spatial and temporal patterns of erosion and deposition. We will bring these data into ArcGIS for the digital modeling component. As a final product, I would like us to put a single-panel poster together that outlines our experimental setup, our observations, our results, and our conclusions, showcasing the digital photographs and maps we generated.

**Experimental setup**

We are somewhat limited by the size of our sandbox and many things that are modeled in large flumes cannot be reproduced at this scale. Drainage-network evolution, for example, cannot be modeled well given our spatial limitations; however, we can model incision and knickpoint generation/migration along with its resulting downstream deposition. Recreating this process in our sandbox serves as an analogue for understanding the formation and evolution of gullies, incised channels, valleys, alluvial fans, and deltas.

**Assignment**

1. You will formulate hypotheses regarding erosion and sedimentation processes in our flume box, design the experimental setup, run the experiment, and create digital models of the changing landscapes, which will be used to calculate sediment volumes (See the example on the next sheet). Photos we take of the experiment as it unfolds will be georectified in ArcGIS, which will help determine how well our digital models represent the actual topographies we generate. We will meet in the GIS lab one or two more times this semester to go over the methods for this part of the assignment.
2. At the end of the semester you will hand in an abstract summarizing our work with the sandbox. The abstract should guide the reader through the experimental setup, hypotheses formulated, observations made, and conclusions drawn from the different runs. The abstract should be around 250 words in length.
3. We will also generate a poster as a class that showcases our sandbox and what we can model with it. I encourage equal participation from all students.

**Fig. 1 - Example of a surface model; this is what the landscape might look like at the beginning of the experiment. The landscape as shown is recreated between runs while the inclination of the flume box (α) is changed.**

**Using ArcGIS to generate DEMs of our Landscape Model and perform Volumetric Calculations of Sediment Erosion and Deposition**

1. We need to bring our x,y,z coordinates that were measured every 1.5 min throughout the experiment into Arc. You will find the data in our shared data folder on the MSS-drive. The files are in a sub-folder entitled “Flume Experiment 1”. You will find four .txt-files corresponding to our measurements at t=0, t=1.5 min, t=3 min, and t=4.5 min, respectively. Start a new ArcGIS project, set the coordinate system to UTM Zone 18 and import our data (we’ll have to keep in mind that we’re not working in meters, but in inches):
   1. *Tools*
      1. *Add x,y data*
2. Now we want to create a grid from the points we measured. We will use the Kriging method of interpolation:
   1. *Spatial Analyst*
      1. *Interpolate to Raster*
         1. *Kriging*
            1. Select your input points
            2. Make sure you have the right Z-value selected
            3. We’ll use *Linear Semivariogram* model
            4. Search radius = variable
            5. Output cell size is our vertical sampling interval of 0.25
            6. Name your output raster
3. We can now display the generated rasters. To help us determine how well these generated DEMs represent the actual features we measured, we can import and geo-reference images taken of the flume box from above:
   1. Add the appropriate image. It will lack spatial reference.
   2. Open the *Georeferencing* extension
      1. Select the layer you wish to georeference
      2. Zoom to the plotted data points, which delineate the spatial extent of the image once it’s georeferenced
      3. *Georeferencing*
         1. Click on ‘*fit to display*’ (this should place the image in its approximate place)
         2. Add ‘*control points’* by clicking on a location on the image and then on its actual position (as identified from our grid nodes). The ‘*view link table’* lists the control points used to place the image; you can delete and add as many points as necessary to give you the desired fit.
         3. Select ‘*R*ectify’ from the ‘*Georeferencing’* drop-down menu to create a new raster file of the image in its current place.
4. We can generate net-change maps by subtracting ‘older’ DEMs from ‘younger’ ones using the *Raster Calculator*. These maps will show us exactly where change occurred between time-steps. We will then use this information to calculate volumes of sediment lost and gained.
5. Ideally, we would want to end up with a delta that contains the amount of material we lost to erosion from the original landscape. Subtract the original landscape model from the final using the *Calculator* and save this grid in a location you can easily access. We will now look at these volumes using the *ArcScene* tool:
   1. *ArcScene* is a tool you can access from the main control bar to the left of *ArcGlobe* and the zoom-tools. Once you have opened this tool, add the data you generated.
      1. To look at our layers in 3D:
         1. Right-click on the layer
            1. Properties

Base Heights

Select ‘obtain heights for layer from surface’

I recommend a Z-unit factor of 2; vertical exaggeration should help the visualization.

* 1. *3D-Analyst*
     1. *Surface Analysis*
        1. *Area and Volume*

This tool enables us to calculate volumes above and below a reference plain. We can now analyze our net-change maps and quantify how much positive change has occurred and how much negative between timesteps.

**Hand in the following by next week’s lab:**

1. **A printout of the net-change maps:**
   1. **0-1.5 min**
   2. **1.5- 3 min**
   3. **3-4.5 min**
2. **A paragraph explaining what happened between timesteps using appropriate terminology to explain process and morphology. You may put arrows on the maps to help with this part.**
3. **The answer to the following question:**
   1. **Do our budgets cancel out? In other words: Did we gain as much material in the delta as we lost from our landscape? Why or why not?**