**ESS326 Geomorphology Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab 5: Hypsometric curves and landscape evolution**

Due: Typed at the beginning of Lab 6

**Introduction**:

Hypsometry is a method of describing the distribution of elevations in a given area. The study area is split into cells, with each cell having a certain elevation. The number of cells at each elevation is totaled up and put into a histogram of cell value/elevation with number of occurrences. This is what the plot at right represents.

Often though, we want to look at the distribution of elevations as a cumulative plot. So we add up the occurrences for each elevation to get a cumulative distribution function (CDF in statistics terms). This is what the other figure shows. In this plot, for a given elevation we can say that X fraction of the basin lies above that elevation point. For instance, in this plot, we can see that 50% of the Earth’s total area is above ~4km below sea level. Most hypsometry curves won’t have absolute elevations on the y-axis, but will show the normalized elevations ranging from 0 to 1.

One of the most important things to get out of a hypsometric curve is the shape of it. For instance, in the curve of Earth’s elevations, the curve has 2 flat regions to it. These flats indicate that a large amount of the area lies at one elevation (at the continental platform, we see 10 to 30% of the cumulative area, so 20% total, is at ~0.5 km above sea level, so we can say that 20% of the earth’s surface is ~0.5 km above sea level).

Factors that influence the shape of a basin are also those that influence the shape of a hypsometric curve. Thus, climate, tectonics, and rock erodibility will all have strong controls on the evolution of a basin and also on the hypsometry of the basin. In this lab, we will use an online landscape evolution model, called WILSIM, to model the formation of landscapes by controlling the tectonics, climate, and erodibility, and we will compare the 3D landscape to the resulting hypsometric curve.

**Setting up WILSIM:**

We will set up the model together as a class, then I encourage you to read through the introduction on the model and run through some of the online tutorials.

WILSIM can be found at <http://www.niu.edu/landform/wilsim.html>. It’s a Java Applet, but you may get an error pop-up saying an unsafe website has been blocked. This is a problem internal to Java, but easy to fix. Navigate through the Start menu to ‘Configure Java’ (search for this in the start menu). Go to the ‘Security’ tab on the top of the window. Click ‘Edit Site List’, click ‘Add’, then type in the web address of WILSIM, being sure to include the http. Click OK twice to exit Configure Java. Now you can reload the webpage, clicking ‘Run’ on the pop-up. The model homepage should display.

Now you should be all set up with WILSIM. The interface isn’t perfect, and often the buttons seem stuck, but will work once you click on another button. Explore the interface using the default conditions. Run the model while looking at the ‘Hypsometry’ tab. Run it while looking at the ‘Profiles’ tab. If you feel like it, read through the short introduction (link to this at the top of the WILSIM webpage).

**QUESTIONS**

**Simulations:**

Let’s run through a couple scenarios to get acquainted with WILSIM, and to get a good sense of how hypsometry is related to the landscape.

*Simulation 1:*

**Inputs:**

Default conditions &:

 Climate: constant at 0.05

 Erodibility: constant at 0.01

 Tectonics: Break at y=40, upper section uplifting at 0.0001

Based on the inputs, what sort of environment are we modelling? Is this an arid or wet environment? Soft or hard rock? Can you think of a modern analogue for this scenario?

Run the model. Pay special attention to the hypsometric curves and the snapshots. How does this landscape evolve over time? Describe what happens to the topography and the fluvial systems. What about the distribution of elevations? Are they evenly distributed, or does one dominate?

*Simulation 2*:

**Inputs:**

Default conditions &:

 Climate: Constant at 0.15

 Erodibility: Constant at 0.01

 Tectonics: None/Constant at 0

Based on the inputs, what sort of environment are we modelling? Is this an arid or wet environment? Soft or hard rock? Can you think of a modern analogue for this scenario?

Run the model. Pay special attention to the hypsometric curves and the snapshots. How does this landscape evolve over time? Describe what happens to the topography and the fluvial systems. What about the distribution of elevations? Are they evenly distributed, or does one dominate?

Supposed you want to model a region with soft rocks (high erodibility), a wet climate (high climate), and a low amount of uplift. Try this with uplift at y=40, at the same rate as Scenario 1. What happens? Why do you think this is? What process is dominating in this landscape?

**Glacial Landscapes:**

A lot of mountainous basins have been glacially eroded. We know that glacial valleys tend to be U-shaped, meaning there is a lot of low elevations relative to high. What sort of hypsometric curve would this produce? Sketch below.

**Relative area**

**Relative height**

If you wanted to model this in WILSIM, what inputs would you use? Would it help to modify the initial conditions (slope, run iterations)? Try a few scenarios and see what you get. Describe the inputs you used and the resulting snapshots and hypsometric curves below:

*Trial scenario 1*:

**Inputs:**

**Results:**

*Trial scenario 2:*

**Inputs:**

**Results**:

Did your trial scenarios produce the expected results? Why do you think this might be? What limitations are there to WILSIM? Read through the ‘How it Works’ section linked at the top of the webpage. What erosion mechanisms are accounted for? Which are not? Overall, do you think this model is an accurate representation of landscape evolution? How might you improve upon this model?