Lecture 10, September 23, 2010 (Key Points)

A Hydrologic-Laboratory Module

You will learn new research software, a numerical hydrology laboratory called CUECAS (Mantilla and Gupta, 1995). It will enable you to visualize important physical features of drainage basins. Later in the course, CUENCAS would be used to look at hydrologic data in space and time, and analyze those features that determine the hydrologic response of a drainage basin. CUENCAS is a numerical GIS simulation tool that has been developed for research in multi-scale hydrology.

10.1 Learning *CUENCAS*

1. Downloading files needed for the CUENCAS Lab

- Download 2 files on the Desktop:
  wrar360.exe
- Double click the downloaded file to install WRAR.

- Go to the website of CUENCAS:
  http://www.iihr.uiowa.edu/~ricardo/cuencas.htm

  Download the database file on the Desktop:
  Locate Goodwin Creek experimental Watershed (GCEW) database near bottom of page. GCEW was introduced in Lecture 4 to show the presence of power laws in annual flood quantiles (Ogden and Dawdy, 2003).

- Double click on the Goodwin Creek file on the desktop (this is the zip file you just downloaded). The program WRAR will uncompress the dataset. You may have to select 'Extract' in a WRAR window.

2. Starting CUENCAS

- Go to the website of CUENCAS again:
  http://www.iihr.uiowa.edu/~ricardo/cuencas.htm

- Click on RUN CUENCAS in the middle of the page. This will download the 'cuencas.jnlp' file to your computer. Click on the file to execute the java program (In some computers the file will begin execution automatically).

- A new window (with a blue background) will appear that is the interface of CUENCAS.

3. Viewing GCEW DEM as an Example

GCEW near Oxford, Mississippi is a 21 km^2 experimental basin of the Agriculture Research Service (ARS), USDA. A variety of data sets including rainfall and stream flows in both space and time have been collected for nearly 30 years. The data sets have been used in scaling analyses of peak flows (Ogden and Dawdy, 2003).

- In the CUENCAS window, click through the following tabs:
  File > Open File > Open DEM

- In the window that opens, go to the Desktop and move through the following directories:

  Goodwin Creek > Rasters > Topography > 1_ArcSec_USGS >

- Highlight the file ending in 'metaDEM' and click the Select button

- Open 'Digital Elevation Model' in the window that appears

- A DEM image of the area containing Walnut Gulch will appear.

<u>Q1</u>: A number called 'Value' appears in upper right corner of the image window. It records elevation at the cursor's location. Where are the lowest and highest points in the basin?

- Image manipulation:

- To move image - Hold down the left button of the mouse and move the cursor. Image may move slowly depending on computer power.

- To zoom +/- on image – Hold down shift-key and left button of mouse. Move cursor up to zoom in, down to zoom out.

<u>Q2</u>: Zoom in on image to view the pixels that make up the DEM. Are there 1000 or more than 1000 pixels in the entire DEM image? When you're done, zoom back out.

4. Viewing GCEW

- In the image window, click on the 8th little box from left. This presents a list of predefined outlets of GCEW and some subbasins.

- Click on the basin outlet at the top of the list.

- On the DEM image, an outline of the basin will appear along with its outlet in red.

Q3: Are the basin's headwaters and outlet consistent with the elevation values recorded by the cursor?

- Right-click on the red point that denotes the outlet of GCEW.

- A window appears with 4 or more buttons. Click on the top button, 'Geomorphology Analysis'.

- Click on Horton Laws

- You may play with other applications that are listed here after the course is over.

10.2 Partitioning a Basin into Hillslopes and Channel Links

1. We will use a real world example to illustrate the discrete partitioning of a drainage basin into hillslope-link pairs. For this we will use CUENCAS.

2. Right-click (Option+click on a Mac) on the outlet red dot. A window will appear. Click on geomorphology analysis option. Several windows will appear at the top. Click on the "Self Similarity" tab. You will see a scale at the bottom. Put it on number 1.

3. Use your mouse wheel (or Shift+drag up and down) to magnify the image to see a partioning of the GCEW into hillslope-link pairs.

4. Typically, the hillslopes areas vary in sizes. Let us assume for illustration that the mean hillslope area is 0.05 km^2. This means that the number of hillslopes in GCEW is ~21/.05 = 420. It has ~210 channel links. Why?

5. Show the aggregation of topography into sub watersheds and the loss of hillslope-link partitioning on the landscape through aggregation! It is a foundational issue for hydrology that is explain and illustrated below, and later in this course.

10.3 Visualizing the Partitioning of a Landscape in Google Earth using CUENCAS

1. Open CUENCAS by clicking on

http://cires.colorado.edu/~ricardo/cuencas/cuencas-google-earth.htm

2. The six images from the top to the bottom show the fundamental idea mentioned in item 1 above. The 2.13 km^2 Quartz Hill basin in western New Mexico is used as an example. The channel network extracted by CUENCAS using 30 m digital elevation model (DEM) is overlayed on the 3-D landscape of the basin, and the unique partitioning into hillslope-link pairs that exist of the terrain can be clearly seen.

3. The last image shows the whole Quartz Hill basin as a sub watershed, which combines all the Hillslope-link pairs into one. If a basin is partitioned arbitrarily into sub watersheds, as commonly done in the existing engineering rainfall-runoff models, it makes it nearly impossible to scale-up hydrologic equations from the laboratory scale to sub watersheds.

4. Item 3 serves as the foundation to modernizing 5333. We can hope to obtain hydrologic equations for hillslope-link pairs by "scaling-up" physical equations at the local scale (Lecture 9), but this goal gets confused when arbitrary sub watersheds are considered.

References

Ogden, F. and D. Dawdy, *J. Hydrologic Eng.* (*ASCE*), March/April, 64-73, 2003

Mantilla, R. and V. Gupta, 2005. A GIS numerical framework to study the process basis of scaling statistics on river networks. *IEEE Trans. Geophysical and Remote Sensing Letters*, 2(4): 404-408.