Geog 176A: Introduction to Geographic Information Science and Systems
Summer 2017

Lab 2: Field

Objectives

Through this lab, you will gain a deeper understanding of the concept of field by experimenting with and producing field data. You will learn how to use, analyze, transform, and generate field data in a key application area of fields, environmental information. As raster data are a typical field representation, you will also learn how to work with this basic form of GIS data in ArcGIS .

Tasks

Provide a report (as a single PDF uploaded in GauchoSpace) with answers to the following questions. Purple asterisks (*) indicate that the question requires a screenshot in your answer (26 points possible).

Getting Started

Before beginning, prepare for this lab by completing the following steps:

1. **Familiarize** yourself with Digital Elevation Models.
2. **Launch ArcMap 10.5** by typing “arcmap” into the Start menu in Windows.
3. **Download the data for Lab 2** from GauchoSpace. The zip file includes:
    a. a Digital Elevation Model (DEM.tif) - a raster from NOAA
    b. UCSB buildings (buildings.shp) - a shapefile from the Campus Map
4. **Unzip the lab data** file by right-clicking and extracting files. Always know where you are saving your files and your project output as ArcMap needs to know where your files are stored. Create and maintain your project workspace; you will specify your folder connection in ArcMap to it.
5. **Add data** and navigate to “Connect to Folder” where the lab data are stored on your machine. Connect to the folder and then add the DEM to your project. Do the same for the buildings shapefile. Drag the building shapefile on top of the DEM raster in Table of Contents so you can view both at once. If prompted to “Build Pyramids,” agree. This will help with graphics performance.
6. **Enable extensions** for 3D Analyst and Spatial Analyst via “Customize” on the top menu. Disable the Business Analyst Extension if it is enabled.
7. **Add a basemap** from OpenStreetMap that you can use as a reference layer. In the drop-down to the right of “Add Data”, choose “Add Basemap”. Be sure that this is also below the DEM and the buildings layers in Table of Contents.
8. **Adjust layers** by checking the boxes next to them on or off. To reorder them, drag them. To change their symbology, right click on the layer and choose “Properties”. Under “Display”, you can adjust their transparency. Under “Symbology”, you can adjust display appearance, such as color fill or ramp.

Scenario

UCSB is considering sites on campus to install additional solar panels. Before beginning this process, the university would like to assess the terrain, along with the locations of campus buildings, to determine which sites might be suitable.

In this lab, you will work with a Digital Elevation Model (DEM) of campus, which is a field representation of terrain. DEMs are used in a variety of application areas, including water flow models, line-of-sight analyses, and many other environmental assessments. DEMs are generally produced by remote sensing.

1. Before beginning your analysis of the campus terrain, it's important to **understand** the field data. To do this, you should first explore its metadata. To access the layer's metadata, right click on the DEM layer and select "Properties". The DEM was obtained from NOAA (8 points total).
    a. Which areas of campus does the DEM cover? Report the **spatial domain** over which the terrain field is defined by reporting its bounding box coordinates, found under "Source", "Extent". What location information should you include in order to be clear? (1 point)
    b. When were the data obtained? Report the **temporal domain** over which the terrain field is defined by reporting its survey date, referring to its full metadata under "Date Completed". (1 point)
    c. How much ground area of campus does one cell in the DEM actually cover? Report the spatial **granularity** at which the terrain field is defined from "Raster Information", "Cell Size" or from full metadata under "Cell Size". Include units in your reporting. (2 points)
    d. How is **location** represented in the DEM? Report the DEM's horizontal and vertical coordinates with respect to its reference system from full metadata "Horizontal Datum" and "Vertical Datum". (2 points)
    e. **Who** produced this DEM? Report the source listed in the full metadata under "Source". Explain why this DEM **represents field data**, based on the definition of field from the required reading. (2 points)

2. Now that you have a sense of the model's extent and quality, you should perform some statistical analysis on elevation to better understand the campus terrain. To do this, you will **query** the DEM (5 points total).
    a. On **average**, is the UCSB campus very elevated or closer to sea level? Report the average (mean) elevation of the campus DEM from "Properties", "Source", "Statistics", "Mean". Include units. (1 point)
    b. Identify three locations on campus where you might initially consider installing solar panels. Use the buildings layer to identify these locations using spatial relations. Report the **latitude**, **longitude**, and **elevation** of each location by clicking the map with the Identify Tool and identifying from "All Layers", which returns both the building name and the elevation at the clicked position. (2 points)

c. Which regions of campus have the **highest and lowest elevations**? To determine this, use the Spatial Analyst Toolbox, select Surface, and produce 10m interval contours using the Contour Tool. To select the highest contour, use the "Select Features" to select a subset of features on the map canvas by dragging the cursor. To select contours from the attribute table, right click on the contours layer in the Table of Contents and open the attribute table. To order a table column, such as elevation, in ascending or descending order, right click on the header or double-click on its header. Select the row with the corresponding feature of interest to also highlight it on the map canvas. To deselect all map features, select "Clear Selected Features". (2 points)

3. Imagine that the campus elevation data looked like Image A or Image B, where black cells have low elevation values and white cells have high elevation values. Recall **Tobler's First Law** of Geography. What type of spatial autocorrelation does each terrain demonstrate? What type of elevation value pattern does each DEM have? Complete the chart below. (3 points total)

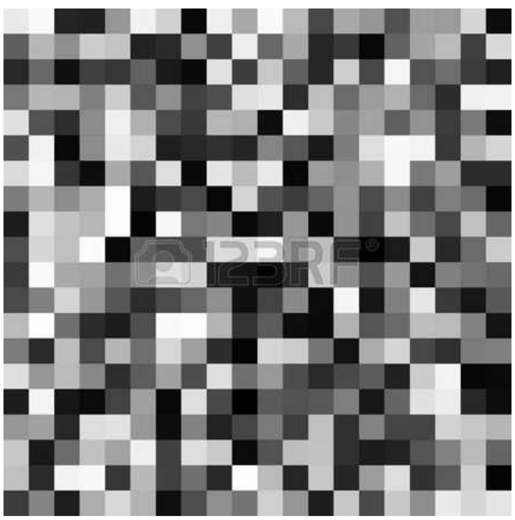


Image A: Noisy DEM

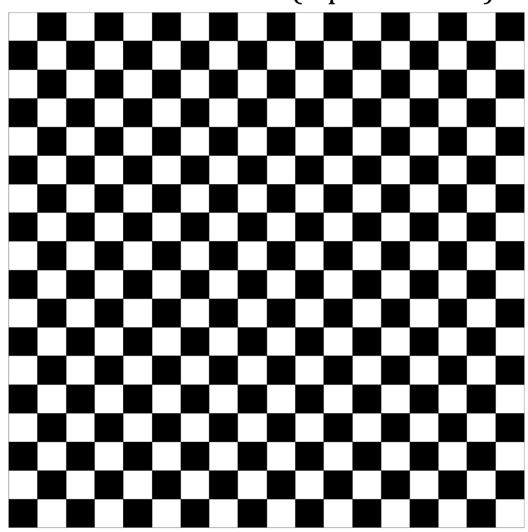
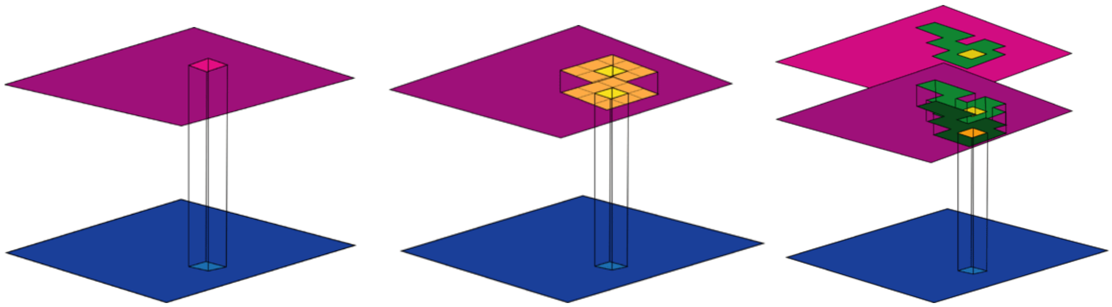


Image B: Checkerboard DEM

File	Campus DEM	Image A: Noisy DEM	Image B: Checkerboard DEM
Type of spatial autocorrelation (negative, none, or positive)			
Type of elevation value pattern (dispersed, random, or clustered)			

4. To do additional terrain analysis, generate new fields from the campus elevation DEM and perform **map algebra** on them (4 points total).



Local Operation **Focal** Operation **Zonal** Operation

   a. *Are the elevations *high*, *medium*, or *low* for each of the three campus locations you previously considered in Question 2b? Apply a **local** operation to the DEM to reclassify campus elevation into five new classes based on natural breaks, or *jenks*, which fit the class breaks based on distribution. To reclassify the DEM, use the "Spatial Analyst Toolbox", "Reclass", "Reclassify" tool. Report the elevation classes of each of the three locations on campus you previously considered. Provide a screenshot of the reclassified elevation. (1 point)
   b. What are the *slopes* for each of the three campus locations you previously considered in Question 2b? Apply a **focal** operation to obtain a field of slope values from elevation values. To derive slope from the DEM, use the "Spatial Analyst Toolbox", "Surface", and "Slope" tool. Report an approximate slope value for each of the locations on campus that you considered. (1 point)
   c. * Which buildings on campus have flat roofs? Apply a **zonal** operation to the campus DEM to figure out the average (mean) slope for each elevation zone, where each building is a zone. Use the "Spatial Analyst", "Zonal", "Zonal Statistics as a Table" tool. Use building name ("longname") as the input. Open the resulting attribute table and report which of the buildings you previously identified as candidates has the flattest roof. Provide a screenshot of the roof slopes. (2 points)

5. Assess the result of **deriving a new** field of slope values from your field of elevation values in Question 4b (3 points total).
   a. Explain how slope is derived from elevation (1 point).
   b. Report the minimum, maximum, mean, and standard deviation values for the field of campus slopes (1 point).
   c. How could you interpret each of the measures of slope in Question 5b to assess a site's solar overall solar potential? (1 point)

6. Now that you have all of the necessary elements to complete a preliminary terrain analysis of campus, use **map algebra** to determine which campus buildings might be suitable for solar panels. Determine which building has a roof slope less than 15 degrees and an elevation greater than 20 meters. Use "Spatial Analyst", "Map Algebra", "Raster Calculator" to build an expression that selects rooftops that meet the given criteria (3 points total).
    a. * Provide and interpret a screenshot of the resulting binary map to include in your lab report. What do cells with a value of 1 mean and what do cells with a value of 0 mean? (1 point)
    b. Report the formula you entered in Raster Calculator to obtain the results shown in Question 6a (1 point).
    c. Do the buildings you originally identified in Question 2b meet the criteria? Based on your knowledge of the sites and the terrain analysis you performed, do you think that these buildings would be good candidates for solar panel installation? Why or why not? (1 point)