G492-GIS for Earth Sciences
Raster Data Structure

I. Introduction

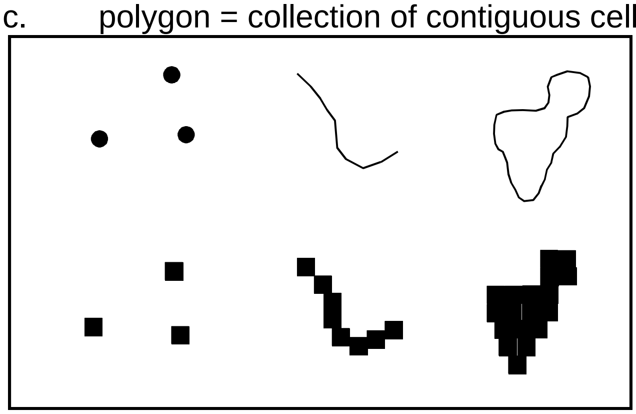
A. Basis - grid cell structure
1. representing map elements as dimensional pixels that are attached to cell attributes
2. Raster Data - applicable to map data that varies continuously in 2-D and 3-D
   a. e.g. elevation / topographic data
   b. precipitation data
   c. slope gradient
   d. any geologic data that can be contoured from discrete data points
3. Contrast Vector Data-
   a. best applied to discrete data in the form of points, lines, polygons

B. Raster Structure
1. regular grid cells, spaced at even increments
2. attributes attached as cell values
   a. e.g. analogous to digital "pixel-based" images, where each cell is assigned a color value to recreate an image

C. Example Raster Formats
1. Digital Elevation Data (DEM)
2. Satellite Images
3. Digital Orthophotos
4. Scanned Maps
5. Graphics Files (scanned graphics)

II. Elements of Raster Data Model

A. Terminology / Concepts
1. Grid - map is divided into columns, rows, and cells
   a. grid origin - commonly upper left corner of raster file
   b. rows - y values
   c. columns - x values
   d. cell address - row and column address
2. Raster repesentation of vector building blocks
   a. point = 1 pixel box (cell)
   b. line - string of pixel boxes (cells)
   c. polygon = collection of contiguous cells



Vector Representation

Raster Representation

3. Cell Values (attributes of cell)
   a. Integer - whole, positive or negative number
      (1) e.g. 1 = sandstone, 2 = shale, 3 = limestone

   b. floating-point value - a value with decimal digits

      (1) e.g. precipitation data (average annual rainfall in mm)

         cell values: 12.34 24.567 56.987

CLASS QUESTION: Do you think that raster-based gis data require an attached database file, like vector data?

   c. Grid Resolution = cell size in ground distance units

      (1) e.g. 30 m DEM: cells are spaced 30 m apart, each cell is 30 x 30 m in area = 900 sq. m.

      (2) Spatial Resolution: the smaller the cell size (the closer the spacing of rows and columns) the greater the resolution of the grid, but this does not necessarily increase the accuracy of the grid.

4. Georegistration of Raster Data

   a. Grid file requires a real-world coordinate file to place the cells in geospace (e.g. UTM, State Plane North, etc.).

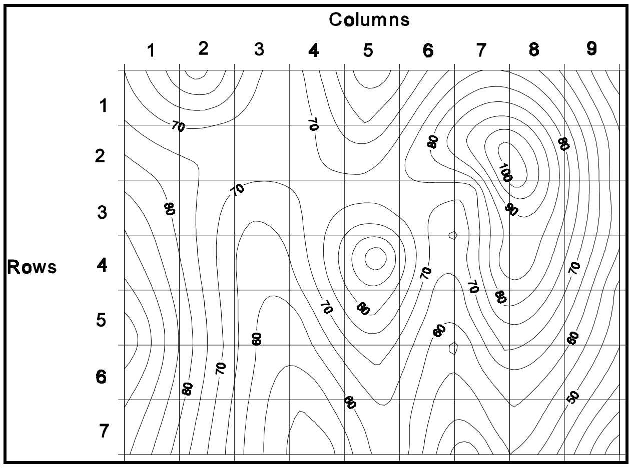
   b. Example world file that accompanies the Monmouth Quad DRG (UTM zone 10N)

Text File Contents	Explanation
2.438400	Grid size in x direction (meters)
0.000000	rotation factor for row
0.000000	rotation factor for column (0 = no rotation, 90 = 90 deg. rotation)
-2.438400	Grid size in Y direction (meters)
479098.499289	Easting (X) coordinate position of upper left (NW) corner pixel in UTM
4969672.872110	Northing (Y) coordinate position of upper left (NW) corner pixel in UTM

   c. Advantage of Raster (Grid) Data - pixel grid format is the essential structure upon which computer processing is based. It is much easier for the processor to process large amounts of raster data compared to vector data with dbase tables

In-Class Exercise:

(1) The vector-line topographic map below is overlain with a raster grid of columns and rows. Determine the elevation of the center point of each cell in integer form, then fill in the grid-table below and create a raster-based, grid DEM data set.



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(2) Assume that the scale of this map is 1:10,000, based on the grid structure, what is the resolution of the DEM in meters? (hint: you will need a ruler for this).

(3) Based on the map and grid layout, are the rows and columns of equal dimension?

(4) Assume that the UTM coordinate of the upper left grid cell is 464091.499289, 4968737.872110 and that the grid system is unrotated. Write out the associated world file for this hypothetical raster-grid data structure (i.e. in the space below, what will the world file look like?)

ES492/592 GIS Applications
In-Class Exercise: Introduction to Contouring and Digital Elevation Models

Examine the attached map figures. Fig. 8.10 shows a visual 3-D model of the Earth's surface and the depiction of corresponding topographic contour lines that connect points of equal elevation.

Task 1. Using the spot elevation data depicted in Fig. 8.11 A and B, contour each map using a contour interval of 10 feet. Map A will include lines 480, 490, 500, 510, 520. Map B will include lines 90, 100, 110, 120, 130, 140.

Task 2. Using the bar scale and a ruler, calculate the fractional scale of the maps in Fig. 8.11.

Task 3. Create a rasterized digital elevation model for your contour map. Easting (X position in meters) and Northing (Y position in meters) coordinates for the corners of Map A are as follows:

NW corner coordinates = 1,463,243 m, 538,275 m
SE corner coordinates= 1,463,293 m, 538,243 m

> 3A. Calculate the total East-West distance covered by map A in meters = ________________
> 3B. Calculate the total North-South distance covered by map A in meters = ______________
>
> 3C. Our goal is to create a raster grid to overlay map A with a cell resolution of 2 meters. Given the map boundaries and dimensions listed above, determine the number of grid rows and columns that will be required to divide the map into 2 m grid cells.
>
> No. Rows = ___________
>
> No. Columns = __________
>
> 3D. Measure the map dimensions in inches: E-W Distance = ______ inches N-S dist = ______ inches
>
> 3E. Calculate the map-scale dimensions of each 2-m grid cell in inches = ____________ (in)
>
> 3 F. Starting at the North edge, and East edge of map A, draw a series of rows and columns to scale, that depict a 2-m grid overlay on the map.
>
> 3G. Now for each cell on the map, interpolate an elevation and classify the grid cell according to the following scale (use color pencils to carefully color each cell, STAY IN THE LINES):
>
> 480-490 ft elev. = Blue
> 490-500 ft elev. = Green
> 500-510 ft elev. = Yellow
> 510-520 ft elev. = Red

Task 4: You did it! You have now overlain a rasterized 2-m Digital Elevation Model on top of a vectorized contour map. Provide a brief discussion of the differences between vector and raster data models.

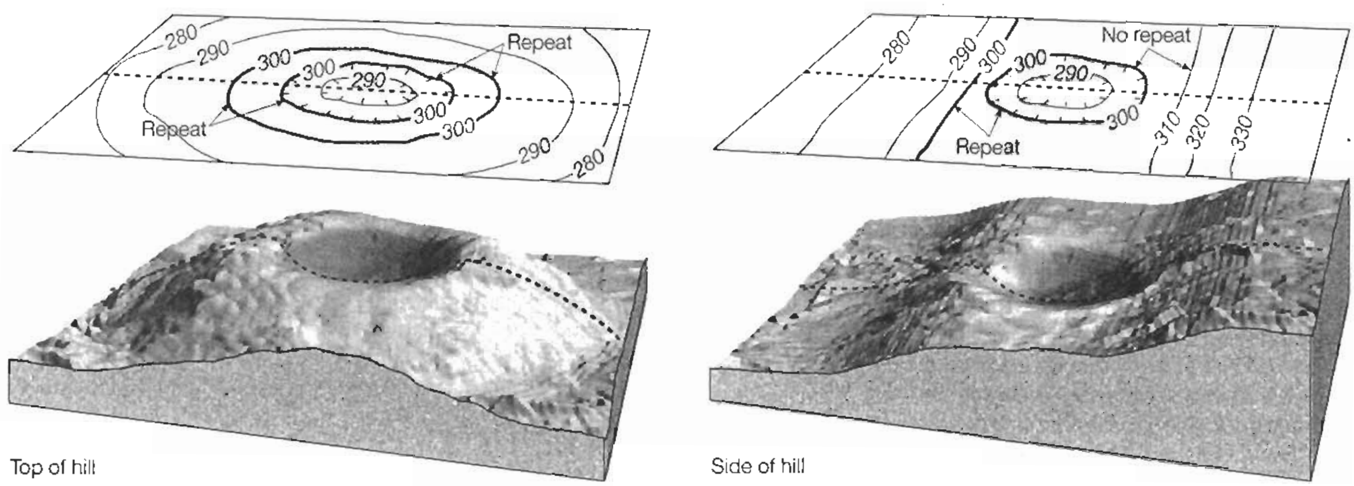
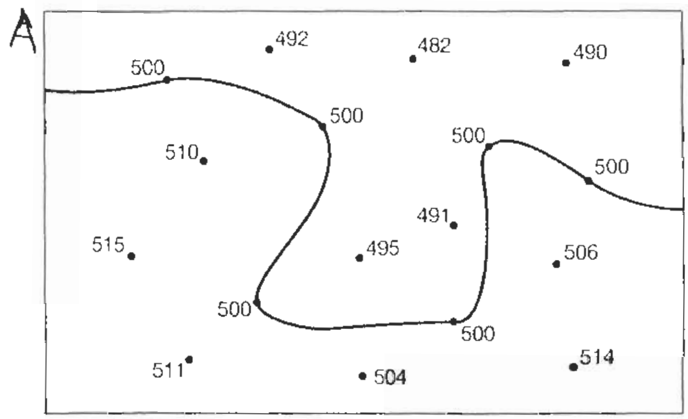


FIGURE 8.10 Contour lines repeat on opposite sides of a depression (left illustration), except when the depression occurs on a slope (right illustration).



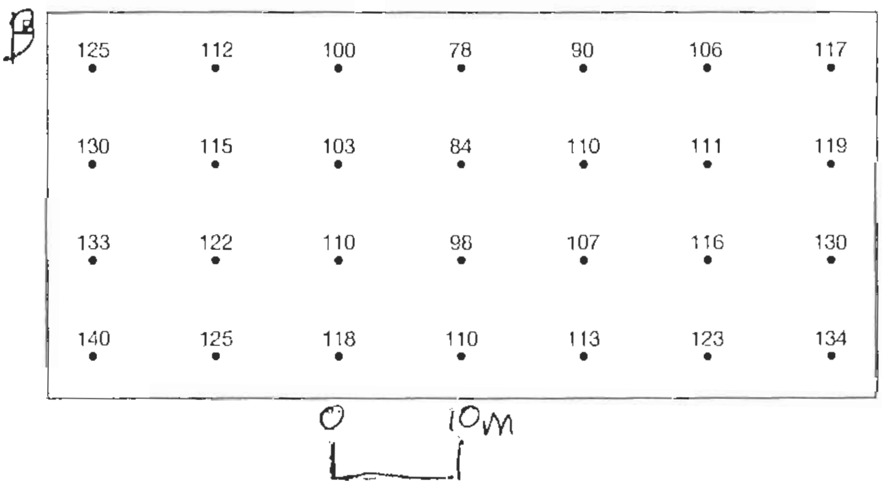


FIGURE 8.11 Topographic map construction (elevations are in feet). Notice in map **A** that a 500-foot contour line has been drawn through all the points that have an elevation of 500 feet above mean sea level. Can you finish contouring both maps using a contour interval of 10 feet?