GIS INTRODUCTION TO RASTER GRIDS AND VECTOR MAP ELEMENTS
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Purpose: To explore the raster grid and vector map element concepts in GIS.

PART A. RASTER GRID NETWORKS

Task A- 1 Examine the attached topographic map (Figure 1). The contour lines are displayed with UTM Northing and Easting coordinates. Answer the following preliminary questions.

1-1. What is the contour interval of the topographic map? (assume that elevation units are in feet AMSL)
5 feet

1-2. The UTM Coordinate system is in what unit of distance measurement? Meters.

1-3. Determine the UTM coordinates for the following point locations:

	X (Easting) meters	Y (Northing) meters
Point A	3200 M	14750M
Point B	7800 M	9700 M

1-4. Determine the following map boundaries relative to the UTM Easting / Northing coordinate system (fill in the chart below).

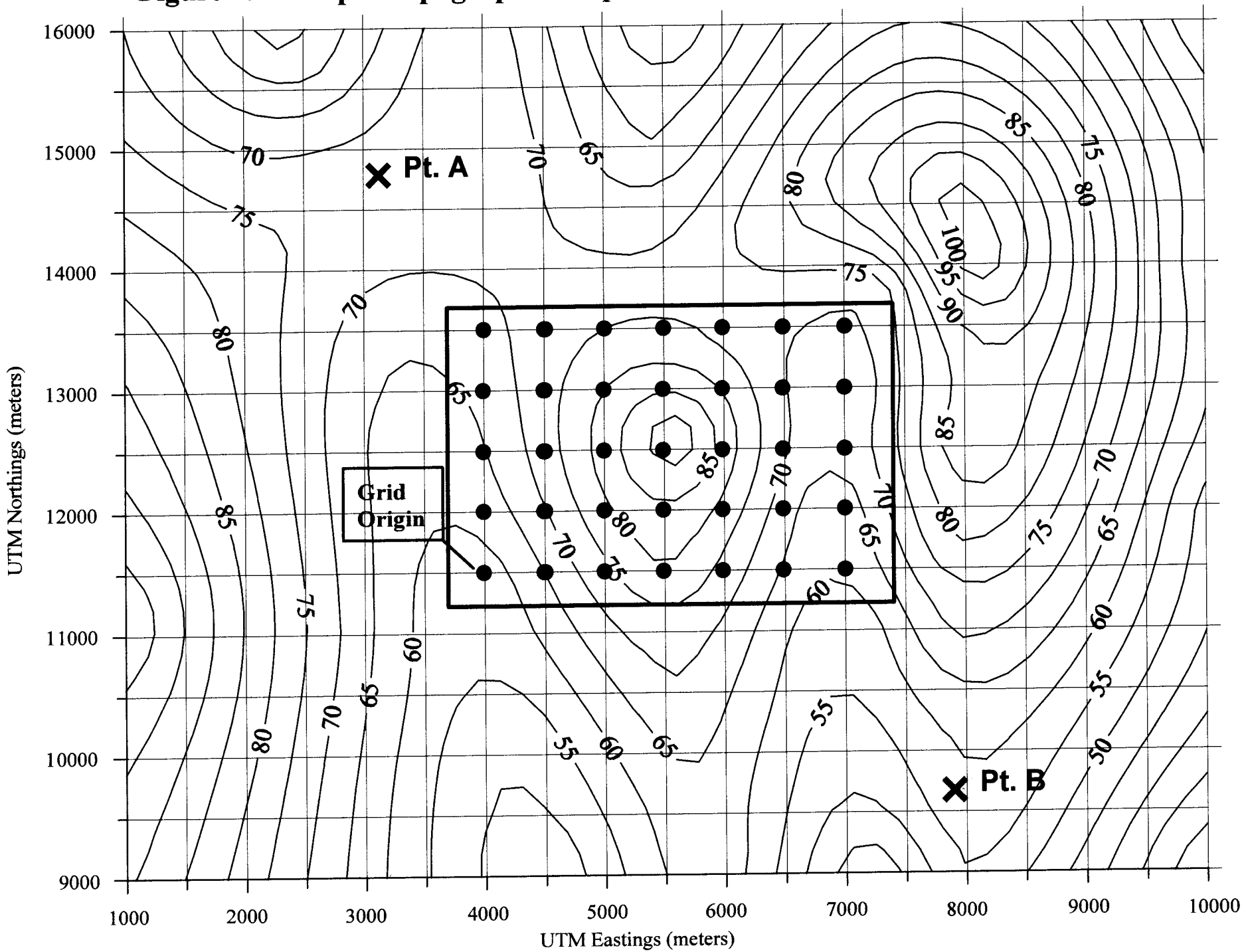
Maximum X (Easting) coordinate of map	10000 M
Minimum X (Easting) coordinate of map	1000 M
Maximum Y (Northing) coordinate of map	16,000 M
Minimum Y (Northing) coordinate of map	9000M
Total X unit distance displayed on map	9000 M
Total Y unit distance displayed on map	7000 M

1-5. Observe the grid overlay on the topographic map. Where each of the grid lines intersect, this point is referred to as a "node". Determine the following:

How many total rows of grid lines do you observe on the map?	14
How many total columns of grid lines do you observe on the map?	18
Divide the total X unit distance (from 1-2) by the number of columns	500
Divide the total Y unit distance (from 1-2) by the number of rows	500
What is the X unit distance covered between each node?	500M
What is the Y unit distance covered between each node?	500 M

Are the nodes distributed on a perfectly square or rectangular grid network? Yes

Figure 1. Example Topographic Map with Grid Overlay



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1-6. Consider a hypothetical example (not related to the attached figure). Assume the following map coordinate relationships:

Maximum X (Easting) coordinate of map	15,000 m
Minimum X (Easting) coordinate of map	13,000 m
Maximum Y (Northing) coordinate of map	8000 m
Minimum Y (Northing) coordinate of map	6500 m

Your goal is to create a "10 m" grid for this hypothetical map (i.e. 10 m between each grid node).

What is the total X distance covered on the map?	2000 m
What is the total Y distance covered on the map?	1500 M
How many grid line rows do you need to specify?	~~200~~ 150
How many grid line columns do you need to specify?	~~150~~ 200

Task A-2. Raster data in geographic information systems is basically a grid network of data, with X,Y node coordinates and a "Z" value (i.e. some attribute) attached to each node point. In the case of "digital elevation models" (also known as DEM's), the "Z" attribute value is elevation relative to sea level. Your task here is to create a digital elevation model (gridded elevation data) for the area selected on the Figure 1, as outlined with the dark rectangle in the center. The selected nodes are highlighted with a heavy "dot".

- Assume that the first row and first column of the grid starts in the lower left hand corner (i.e. the southeast corner of the marked grid). This point is marked as "grid origin" on the map. This is analogous to a Cartesian coordinate system used in mathematical graphing. Fill in the following charts:

Easting Coordinates

Column 1	4000M
Column 2	4500 M
Column 3	5000 M
Column 4	5500 M
Column 5	6000M
Column 6	6500M
Column 7	7000M

Northing Coordinates

Row 1	11,500 M
Row 2	12,000 M
Row 3	12,500 M
Row 4	13,000M
Row 5	13,500M

Gridded Elevation Data (fill in the elevations for each node on the grid, interpolate elevations as needed)

	Columns						
	1	2	3	4	5	6	7
Row							
1	58	65	74	79	74	65	62
2	63	70	79	84	79	68	64
3	65	73	82	90	84	71	67
4	67	73	80	84	80	71	68
5	68	73	75	76	73	72	69

Concluding Statement to Part A Raster Grids

You now have an understanding of how raster grid data is created and stored in Geographic Information Systems. The study area is divided into a mesh of grid cells, with each node attached to some attribute information (i.e. "Z" values). Each cell is given a numeric identifier or value. Raster systems are good for representing data over continuous space, examples include:

Digital pictures or images (each cell is assigned a color value, here a cell is called a "pixel")
Digital Elevation Models (each cell is assigned an elevation)
Rainfall Maps (each cell is assigned a rainfall value - inches of precipitation accumulated over time)
Vegetation maps (each cell is assigned a vegetative index number)

Last Question: Think up three examples of spatial map data, other than the examples listed above, that could employ digital raster techniques.

Idea 1 Vegetation

Idea 2 Soil type

Idea 3 temperature

PART B. VECTOR MAP REPRESENTATION

Vector map elements represent map data as a collection of points, lines, and polygons. Below are geometric definitions of each as related to digital map elements (see **Figure 2** for Examples).

Points - individual points in map space represented by a very specific X, Y coordinate.

Straight Line Segments - straight lines that connect any two points (represented by two pairs of X,Y coordinates).

Polylines - lines with multiple segments of differing orientation (multiple sets of X,Y coordinates)

Polygons - regular to irregularly shaped polyline sets that completely close on themselves (i.e. the end point of the polyline exactly matches the origination point of the polyline).

***A Side Note:* In the case of the vector approach to map elements, two software files are required: (1) a vector graphics file with the geometric coordinates and map element types. Here the map element is assigned an internal code, and (2) a database information file that links attributes to the internal code of the map elements. This is different than the raster grid data structure above, in which all data can easily be stored in one data file. Hence, vector map layers usually require multiple data files to manage the same information that one raster data file represents.**

Examine Figure 2A for a comparison of polygon map elements represented in a vector vs. raster data structure.

Task B-1. Refer to Figure 3. This is a map grid in UTM-meters, with several digital map features listed A through E. Identify which type of map element is represented by each feature in the table below (point, line, polyline, or polygon).

Feature	Map Element Type
A	Point
B	Point
C	straight line
D	Polygon
E	polyline

Task B-2. Build a vector data file for each map feature (A through E) in the table below.

Feature	Node Coordinates	
	X coordinate	Y coordinate
A	2225	14,775
B	3000	14,000
C		
node 1	5500	13,000
node 2	7000	14,000
D		
node 1	5500	10500
node 2	5500	11,000
node 3	6500	11500
node 4	7500	11,000
node 5	8000	10,500
node 6	7500	10006
node 7	7000	9500
node 8	6500	9500
node 9	6500	10000
node 10	6000	10,500
node 11	5500	10,500
E		
node 1	2000	11,000
node 2	2500	11,500
node 3	3,000	11,000
node 4	3000	10,500
node 5	2500	10,000

Questions:

Which data type do you think requires more computer storage memory and processing time, vector or raster? Why? Vector data requires more memory because the data must be managed using multiple files, whereas raster data can be stored in one file.

Which spatial data type is also used in digital image files that are found on the internet (like *.tif, or *.jpg). Raster data is used closed polygon

Compare feature D to feature E in terms of data structure. What is the primary difference between the two feature types? feature D is a closed polygon
feature E is a polyline

Using a red colored pencil (or any other color of your choosing), convert vector map elements A through E to "Raster map elements". Using the grid network shown on Figure 3, color in the raster version of each of the elements (hint: refer to Figure 2A for some ideas).

Task B-3. Refer to the Monmouth Quadrangle paper maps available in the class room. Identify the following map elements by the vector method that would best represent them in digital map space (point, line, polyline, polygon):

Map Element	Vector Method
Highways / Roads	Polyline
City Limits	polygon
Contours	polylines
Small Creeks	polyline
Major Rivers	polyline
School Buildings	polygon
WOU Property Boundary	polygon
Benchmarks	point
County Outlines	polygon
County Boundaries	polygon
Sewage Ponds	polygon
Fire Hydrants	point
Lamp Posts	point

Now visit the Monmouth Quad. Geologic Map available on the west wall in RM 218 of NSB. Try the same game:

Map Element	Vector Method
Faults	polyline
Map unit Qal	polygon
Map unit Tss	polygon