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ENVSCI 281

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Taken Home Final Exam

1- What is Geographic Information System (GIS) & why is GIS so widely used and its market continuing to grow at a very fast pace?

The acronym GIS can be understood to stand for a wide range of three-word-phrases, the common thread of which is geographic/geospacial information systems/science. All this to say that GIS concerns the study and manipulation of geographic data information and the systems used to manipulate that data. GIS is a spatial decision support system.

Geospacial Information Science is the meeting together of Cartography, Thematic Mapping, Photogrammetry, Remote Sensing, Surveying, and the data manipulation capabilities of modern computers.

The market for such services is growing rapidly, you encounter examples of GIS everywhere you look. Every time you use Google Maps to find the best route to your destination, that’s GIS. Online retailers calculating the cost of shipping to your address, GIS. How a musician (or their management) decides which cities to preform in during a tour or how a local business decides what radio station to buy advertising time from- all GIS!

The decision making power that an understanding of GIS offers is enormous.

2- What are the two most commonly used data models or data structures in digital representations of geographic or geospatial features? how are the geographic features in the real world represented in each of these models? and what are their respective advantages and disadvantages?

The two most commonly used data structures in digital representation are raster and vector data structures. Each has it’s applications and draw backs, ultimately both are used. Raster represents data in grid matrices where each cell represents specific information, whereas vector represents data using sequential points or vertices that have discrete boundaries. Generally speaking, raster data structures are used to represent simple data sets that can be arranged in columns and rows. Vector is used for complex data such as when the data is relational or dependent on other data.

3- Please provide a detailed explanation of each of the following key concepts in cartography that all GIS users need to understand:

Geodetic Datum –

Geodetic Datum are reference surfaces from which relational data can be extrapolated. An example would be sea level or the height of Mount Everest or the Prime Meridian in Greenwich, England. This provides a known location from which to begin surveying and making maps. Without Geodetic Datum for reference, collected data would lack an anchor to the real world.

Coordinate Systems –

Coordinate systems are ways of representing three dimensional objects in 2 dimensions, most often spheres to represent the Earth. Latitude and longitude lines come together to create the coordinate system of the globe.

Map Projections –

Map projections are different answers to the question, “How do we represent this three dimensional shape in two dimensions?” with the knowledge that you cannot preserve both size and shape simultaneously. The most commonly used projection for our Earth is the Mercator projection which has a number of flaws. For instance, Greenland appears to be similiar in size to South America where in fact Greenland’s land area is only 836,300 square miles compared to South Americas land area of over 6 million square miles. This is due to Greenland’s proximity to the north ‘edge’ of the projection, elongating it’s shape and therefor losing information.

The Mercator Projection is appealing to those looking to observe the Atlantic ocean as a continuous body of water but if you were hoping to observe the island distribution in the pacific ocean, you might be better suited by the Peirce quincuncial projection, or any number of other projections that preserve distance.

Map Scale, Map Precision and Accuracy –

Map scale is the representative ratio of distance typically between 1:1 million and 1:1000

Map Precision and Accuracy is an issue of liability, especially where it has to do with things like public utilities. This is why it is so important to cite where you get your data from and date your maps. If a data set you use later turns out to be inaccurate, you will not be held liable for that inaccuracy, the source will.

4- What does each of our first eight lab exercises/assignments cover? What key GIS concepts and ArcGIS functions are involved in understanding and completing each of these exercises/assignments?

Exercise 1 covers how to utilize labels of attribute data along with their outline, we used this to display the names of the counties in Massachusetts. We also created layers for the major roads and rivers as well as major ponds and areas of environmental concern. The main focus of the map is the location of colleges in Massachusetts represented with a small red dot so they’re eye catching.

Exercise 2 is all about different ways of representing quantities with different classifications. We used the same population data displayed using 4 different classifications to get an idea of how data can be displayed in different ways to make information clearer. The 4 classifications are Equal Interval, Natural Break(Jenks), Quantile, and Geometrical Interval.

Exercise 3 covers more about data representation, this time with symbols. We looked at 3 symbology methods, Proportional Symbols, Graduated Symbols, and Dot Density to represent the same population data from Exercise 2.

In Exercise 4 we created a land use map of the Boston area as well as a graph and table to go along with the map. In this exercise we used the table feature and graph feature for the first time. We used the Clip Geoprocessing function to ‘cut-out’ the Boston area from a larger shape file.

In Exercise 5 we looked deeper into the population data of the Boston area to get demographic information of the population. We chose to symbolize this information with pie charts corresponding to each borough. We reduced our scale to really ‘zoom-in’ on our area of interest.

Exercise 6 covers Digital Terrain Models (DTM) Files. We looked at the Blue Hills area where Quincy, Milton, and Randolph meet. X, Y, and Z data points are used to represent the topography of the Blue Hills 4 ways- Hill-Shaded Images, Two-Meter Contours, Digital Elevation Model (grey scale), and Digital Elevation Model (color ramp).

Exercise 7 covers highlighting selected areas in the map. We highlighted the outline of towns containing Home Depot stores.

Exercise 8 was a fun one. We used the drawing tools in ArcGIS to draw the Umass Boston shuttle bus 1 route point by point. We became very familiar with the zoom and pan functionality to navigate our maps.

5- Please provide a detailed report on the term project for “Prioritizing Areas in Massachusetts for Environmental Conservation” (Exercises 9-12): the project focus or questions to be answered, the relevant variables considered, the detailed process for project design and implementation, the core ArcGIS functions used, the findings of the project and their implications, and possible improvements or enhancements if more time and resources are available.

The questions our term project seeks to answer concern how to Prioritize Areas in Massachusetts for Environmental Conservation, as the name would suggest. We wanted to convey 1) what areas need to be protected? 2) What areas already have full protection? 3) What areas currently have temporary protection? 4) What areas currently have limited protection? 5) What areas are in need of protection but currently have no protection? 6) What areas would benefit most/generate the most ecological benefit to prioritize?

We sought to answer this question with a series of maps looking at land protection coverage state wide. We also compared these to BioMap2 maps which used the same data set.

The relevant variables we considered were areas of Core Habitat (Forest, Species of Conservation Concern, Priority Natural Communities, Wetlands, Aquatic, and Vernal Pool) and Critical Natural Landscape (Landscape Blocks, Aquatic Buffer, Wetland Buffer, Coastal Adaptation Analysis, and Tern Foraging). We used these two data sets as well as a number of polygons to create shape files to visualize the areas of highest environmental priority in Massachusetts.

We first defined the scope of our project, choosing to focus on Massachusetts and the surrounding coastline rather than, say, the whole of New England or even the entire United States of America. We chose this ‘medium’ scale to keep the information from being overwhelming or too small to be relevant.

We then started the process of data manipulation and preparation. We created a ‘cookie-cutter’ to encompass Massachusetts and the surrounding coastal area by using the Union Geoprocessing function. We then extracted the land use data for food production and created a 100-meter buffer for major highways.

We ranked each data layer to get a priority level for each Core Habitat and Critical Natural Landscape which we used extensively to compare different elements of the data.

Union and Dissolve were the 2 big ArcGIS functions we used in this project. We used Union to create our composite state plus coastal area polygon. Dissolve was used to bring together the 21 shape files into one for better visualization.

I think out project implies that we need greater protections for our water ways. The coastal areas in the top two priority map currently have no protection.

I would be very interested to see how our current maps interact with recreational areas. A comparison with residential density could also be very interesting.