Case Teaching Notes for "Snowboarding in New York State: A GIS Case Study"

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Introduction / Background

This case study provides a realistic scenario to introduce and reinforce concepts presented in introductory level geography courses, particularly in cartography and in human, physical, or environmental geography. It evolved as a capstone project for an introductory course on maps and mapping, and was designed to organize and use ideas presented throughout the semester. Geographic information systems (GIS) typically receive little coverage in a course like this, hardly more than one chapter or lecture. The learning curve associated with GIS software is a prime reason for its omission. This is unfortunate because the technology is founded upon many of the concepts presented in a class of this nature and is an excellent resource with which to promote student comprehension of topics such as spatial analysis, principles of map design, and data format limitations. In this context, the case study represents an effort to effectively integrate GIS technology into the introductory course curriculum and accomplish the following two goals: to develop a realistic context to reinforce abstract course concepts and to introduce students to the analytical capabilities offered by GIS technologies.

The case study describes a scenario in which a land developer is looking to purchase an existing New York State ski area and convert it into a resort that caters to snowboarders. Students play the role of consultants hired to conduct an analysis of eight existing resorts and determine the most suitable site for investment. The analysis is based upon an assortment of spatial variables such as a population, income, education, transportation networks, and annual snowfall. As consultants, the students are required to outline a series of criteria to use in determining the optimal site, analyze the available datasets, and present a proposal based upon their findings.

The design of the case study is similar to that of ESRI's (Environmental Systems Research Institute's) ArcVoyager. ESRI, a leading GIS software developer, released ArcVoyager as an educational tool to promote the introduction of its software in secondary education. The tool is designed to familiarize students with the capabilities of GIS, but not bog them down with the technical aspects of the software. Technical issues regarding the collection, organization, format, and projection of data resources are standardized prior to use and are relatively transparent to the user. However, the datasets provided with the ArcVoyager software are typically limited and restrict students' abilities to analyze data at geographic scales smaller than a national scale. To overcome these limitations, this case provides a topic and an assortment of data resources specific to New York State. The case study is designed to provide students with a wide variety of data sources to explore, analyze, and build their argument. In this manner, students learn to apply cartographic concepts discussed in class while at the same time developing an understanding of the potential applications of the course content through the use of GIS technology.

Objectives

The primary objectives and expected student outcomes of this case are as follows:

- Develop an introductory understanding of GIS software (e.g., ESRI's ArcView) for map design and spatial analysis.
  Outcome: After completing the case, students should have a general understanding of map overlay analysis, attribute data, map tools (e.g., pan and zoom), and layouts.
- Develop an introductory understanding of spatial data and its use as discussed in class.
  Outcome: Students should have an understanding of data types, sources, formats, and limitations to its use, such as resolution of data. Students are expected to be familiar with specific data types such as orthophotos, USGS topographic maps, digital elevation models (DEMs), and feature data resources (vector data).
- Develop a basic understanding of the fundamental principles of cartographic design. This includes the distinction between nominal, ordinal, interval, and ratio data, and cartographic techniques for representing each.
  Outcome: Students should have an understanding of how to create basic choropleth, contour, or dot distribution maps including basic map features such as title, legend, scale, and orientation.
- Develop a basic understanding of cartographic generalization and data classification methods.
  Outcome: Students should have an understanding of the concepts of generalization and bias in cartographic output. They should also be familiar with examples of effective ways to present spatial information given a predefined purpose. Students should be able to describe the differences among the following data classification methods: natural breaks, quartile, and equal interval.
- Develop a basic understanding of multi-criteria decision-making and how maps and spatial information are used in this process.
  Outcome: Students should be able to develop a set of criteria for decision-making and justify their choices. Students should be able to draw logical conclusions that support their final choices for site selection.
- Develop a final research report using mapping as a tool for supporting claims made.
  Outcome: Students should construct a final report that develops logical arguments, uses evidence, summarizes findings, and makes conclusions about a problem domain.

Classroom Management

Background

As mentioned above, the case study was originally designed for introductory level geography courses in which students typically have little or no experience using GIS. Since that time it has also been modified for use in an undergraduate/graduate level introduction to GIS course. In both, we found the case study to be a useful exercise to which students responded positively. Anecdotally, there were few problems with students learning the technical aspects of GIS. Specific problems with the software were addressed in person by the instructor and students were able to complete assignments on time, although the majority of the work was done near the end of the semester. It is also worth pointing out that students worked in groups in the GIS lab, where there were many opportunities for informal learning to occur among students on a peer-to-peer basis and from other undergraduate and graduate students who use the lab for academic work and research projects.

In the maps and mapping course, the case was implemented in its current state as a capstone project. We think this is an appropriate use of the case if (1) there is sufficient class time available to dedicate

approximately four weeks to the project and (2) if there is time available for the instructor to provide the proper guidance (both technological and theoretical). This is a product of the fact that the case is somewhat broad. It is often necessary to work closely with students to introduce the technology, refine a limited set of criteria, and help students simplify or refine their presentation arguments. If either of these factors is limited, there are many points at which the case can easily be modified to suit the particular course. For instance, the instructor could simplify the assignment by outlining a series of criteria for analysis and focus instead on the use of the technology to introduce and reinforce relevant cartographic design principles, such as cartographic design, data classification methods, and cartographic generalization.

In the introduction to GIS course, a modified version of the case study was presented to students on the first day of lab. Students were asked to outline a broad set of criteria for analysis as a basis for introducing the snowboarding context. This task was useful because it made students think of the types of data that would be useful to analyze in the GIS software. Next, they were asked to complete a series of tasks building upon the "Getting Started with ArcView" portion of Appendix A. In addition, students were instructed to use ArcView to investigate the datasets listed in Appendix B. As students attempted to complete the tasks, their questions and problems served as a basis for discussion both in the lab and throughout the semester. The lab provided a useful foundation from which to introduce topics such as raster and vector data models, file formats, data quality, and GIS data sources. At the end of the semester, the entire case study was presented as a final project for one group of students. The results of the group analysis were presented to the class (Stone's investors), which already had a base familiarity with the project from lab 1.

Overall, the tool primarily caters to introductory maps and mapping and geographic information systems (GIS) coursework. In cartography courses, we propose that it is best suited to be used as a final project. In the GIS course, it would likely serve as a preliminary project or a single component of a series of lab exercises. However, regardless of whether the instructor decides to use the case as currently designed, the data resources will no doubt be of value in the preparation of other labs and/or assignments. In addition, provided access to other data sets, the case may be expanded easily for use in other natural science and social science courses. For instance, by incorporating more meteorological data, the case could be used in a physical geography course to study spatial and temporal trends in annual snowfall or the impact of the Great Lakes upon annual snowfall in the state.

GIS Data Resources

The data CD that accompanies the case study offers a wide array of data resources designed to work with the ESRI ArcView or ArcMap suite. The .apr file is designed to work with ESRI ArcView 3.3, but the data can be used with any older versions of ArcView or ArcGIS. The GIS data resources are projected according to NAD 1983 UTM Zone 18. The data resources include:

- Atmospheric data (average annual snowfall), census data (population, labor, education, and income at county and tract level), political boundaries, and roads for New York in ESRI Shapefile format.
- Digital orthophotos, digital elevation models (DEM), and USGS topographic maps of the individual ski resorts.
- Website links to the eight potential New York ski resorts.
- A PDF file detailing resort information such as trail length, number of trails, ski lifts, and terrain attributes.

A detailed listing of the data resources along with attribute information can be found in Appendix B of the case study. Permission to use the names and web resources of the eight ski resorts was granted from

the individual resorts for educational purposes only. For more information on the data resources used in the case, contact Jeff Brunskill at **jeffb@eng.buffalo.edu**. For a copy of the data CD, contact **snowboard@sciencecases.org**.

GIS Learning Curve

The case study is designed for instructors with prior knowledge of ESRI ArcView software. There are two primary reasons for this. First, it may be necessary for the instructor to make slight modifications to the data resources to accommodate available computing facilities. Second, the instructor also plays an important role in helping students to learn the necessary GIS software and concepts needed to complete the case study.

Appendix A contains instructions detailing the basic functionality of ESRI ArcView. In courses in which the case study has been tested, this instruction set was used as a primer to introduce students to the software. After students worked with the software for a period of time, the instructor provided assistance to clear up any questions. This procedure turned out to be a quick and effective mechanism to introduce the software and overcome many of the technical issues that typically arise from its use. The GIS software was not a factor limiting the successful completion on this project. However, it may be necessary to clearly state to certain students that the focus of the case study is not simply to learn a software package. The software is a tool to facilitate analysis and presentation of results.

Introductory Geography Course

This case study is designed as a final project for introductory level geography courses. These classes are typically large, so it may be beneficial to assign students to small groups. The case will likely take around four weeks to complete; however, modifications can be made to accommodate time constraints. The following section provides a brief outline of the manner in which we have used the case.

Week 1: The case is presented and the students are assigned to consultant groups. Students are given a general introduction to GIS and the manner in which the technology will be used in the case study. An optional non-software-related project is also posted for students that are not interested in pursuing the software component (the project followed a similar structure but considered topics and data found on the American Factfinder website **http://www.census.gov**). During the first week it is critical that students have access to computer facilities and the software. Students are assigned to read the case study, begin discussing the issue as a group, and identify criteria they feel might be important for determining the most appropriate site for the snowboarding resort. We suggest a brief lecture and discussion of a similar example to help students understand the multi-criteria decision-making process and how geographic information can be used in this process. At the end of week 1, a discussion is held in class to assess student progress and allow them to give each other feedback. There are numerous criteria that students could potentially incorporate into their argument. We suggest that the instructor have students isolate the top three criteria for analysis and prepare students to defend their decisions during presentations. Students are mainly evaluated upon their ability to analyze the data and develop an argument based on these criteria alone. Otherwise, the project can easily become too broad to accomplish the learning objectives.

Week 2: It is important that students begin exploring the software and data resources as soon as possible. Before the end of the second week, students are assigned to learn the software with the help of the instructions provided in Appendix A. Once students have attempted to learn the software, a lab session is set up during which the instructor answers any questions students have about the software. This question and answer approach has been quite useful in both the introductory cartography and GIS courses. Note,

however, that the software is not necessarily intuitive, so students will likely have many questions about its basic functionality. Active exploration of the data CD with the ESRI software is intended to help students develop more insight into the data resources available to them (e.g., criteria development or limitations). It may be useful to require students to develop and submit a written proposal detailing their objectives and the three criteria used from the resources available on the CD by the end of week 2. This ungraded report is not formally outlined in the case study, but it is recommended for identifying potential problems early on.

Week 3: Students begin to analyze the data based upon the three criteria they identified. During this week students will typically begin to realize the limitations of the data resources in terms of resolution and accuracy, and the need to refine or reevaluate their criteria based upon their findings (if time permits). It may be useful to have students first explore large-scale trends in the data (e.g., statewide trends) for each of their main variables, and create a weighted ranking for each of the eight sites. This will offer students a suitable framework for structuring their analysis. Once a few select sites have been isolated, students can then focus on regional trends in the data. We highly recommend that instructors promote this statewide to regional form of analysis as some students, in the past, have felt overwhelmed by the amount of data available. By the end of week 3, students should be ready to develop their presentations for Stone and his colleagues.

Week 4: In the final week of the project, opportunities to discuss cartographic design principles arise. The wide variety of student proposals provides an excellent basis to discuss the concepts of "purpose" and "audience" as they relate to map design. Students are instructed to complete the presentation component of the project and submit a written report for review. The ability to write clear, concise reports with compelling visual aids in the form of tables, graphs, and maps is a skill that should be developed throughout a student's education. This final report gives students the opportunity to develop logical arguments, use evidence, summarize their findings, and make conclusions about a problem domain. If time allows, the GIS software offers an excellent basis for developing visual aids for oral presentations. In the past, 10-minute group presentations served as a mechanism to close out the project. It also provided students with an opportunity to develop new ideas and compare their work with others in the class. It may be worthwhile to develop a rigid outline for the presentation. This outline may stress the three criteria (three maps), a review of the top sites after initial statewide analysis, a detailed argument for the top site, and brief conclusions. Without this structure, it may be difficult for the class to realistically compare different proposals.

Beyond the Introductory Curriculum

The collection and organization of GIS data resources is very time intensive. This case study aims to help overcome this limitation and serve as a platform upon which more elaborate case studies may be developed or tailored to different fields. By incorporating more and varied sources of data, the tool may easily be extended beyond introductory cartography. As suggested above, for instance, an instructor might include detailed meteorological data (e.g., snowfall or temperature) and use the case study to explore the differences between synoptic scale events and lake-effect snow events in this context. Efforts to run the case in more advanced courses, such as our introduction to GIS course, might require the case to be adopted early into the curriculum. The case could then be used to reinforce the introductory material on cartographic principles and the communicative functions of mapping that are usually part of the GIS course content. It may also be worthwhile to develop competing scenarios in which students take opposing viewpoints and develop arguments to support their case.

Concluding Thoughts

The focus of the case is not necessarily to derive a clear-cut "winner." Rather, it is to create an environment in which students learn the technology and course content, develop a compelling argument, and present evidence to support that argument. We think this is where this case most succeeds. We also think it succeeds in the fact that it offers a robust platform from which to address many other topics in a variety of relevant domains.

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