

Mapping and Geographic Information System Exercises for Freshman and Sophomore College Students

By Adam M. Davis, Steven R. Bryant, Clayton A. Peach, Katherine Burkhart, Jonathon P. Wirthwein, Judith K. Brown, Matthew R. Fleck, and James M. Steel

Department of Earth Science and Agriculture
McCormick Science Center
Vincennes University
Vincennes, IN 47591
Telephone: (812) 888-4092
email: adavis@vinu.edu

Introduction

The mapping and Geographic Information Systems (GIS) content of Earth Science Department courses at Vincennes University is designed to provide quality field and GIS experience to freshman and sophomore college students through short duration exercises. These exercises have been conducted in the GIS, Physical Geology, and Mineralogy courses at Vincennes University since 2006.

In the GIS course, students are given hands-on experience with specific aspects of GIS through exercises carried out over two to three class periods, and a half-semester group project that involves planning, data processing, analysis, and a poster presentation.

The Physical Geology and Mineralogy courses contain short, focused mapping exercises that

- Teach field mapping concepts in one lecture, lab, or field introduction.
- Familiarize students with local geologic map units, by conducting one or two lectures and (or) a tour in the field.
- Involve efficient, focused field data collection (in other words, 3 hour lab or 5 hour traverse).
- Include GIS days (1-2 lab periods) involving a combination of student initiative and instructor input.
- Train students to use the ArcGIS functions necessary for specific tasks (for example, Adding XY data, and polygon editing).

GIS Course Exercises

The first half of the GIS course at Vincennes University is built around a series of map assignments - each assignment teaching students one or two important GIS concepts. One assignment familiarizes students with how to display layers of GIS data in the ArcMap module of ArcGIS (ESRI, 2009). Another shows students how to incorporate their own GPS data and display them with aerial photographs. A third assignment introduces students to thematic mapping using data provided with ArcGIS software or through IndianaMap (IGS, 2009). Figure 1 is a student thematic map that uses both proportional symbols and choropleth (color gradation) symbologies to display two themes on the same map. The assignment that students find most challenging requires the use of the spatial analyst extension of ArcGIS to perform raster data transformations and calculations. This assignment requires students to manipulate a Digital Elevation Model (DEM) obtained from IndianaMap to find groundwater seep locations in a hilly region of southern Indiana. Figure 2 is a student map resulting from these analyses.

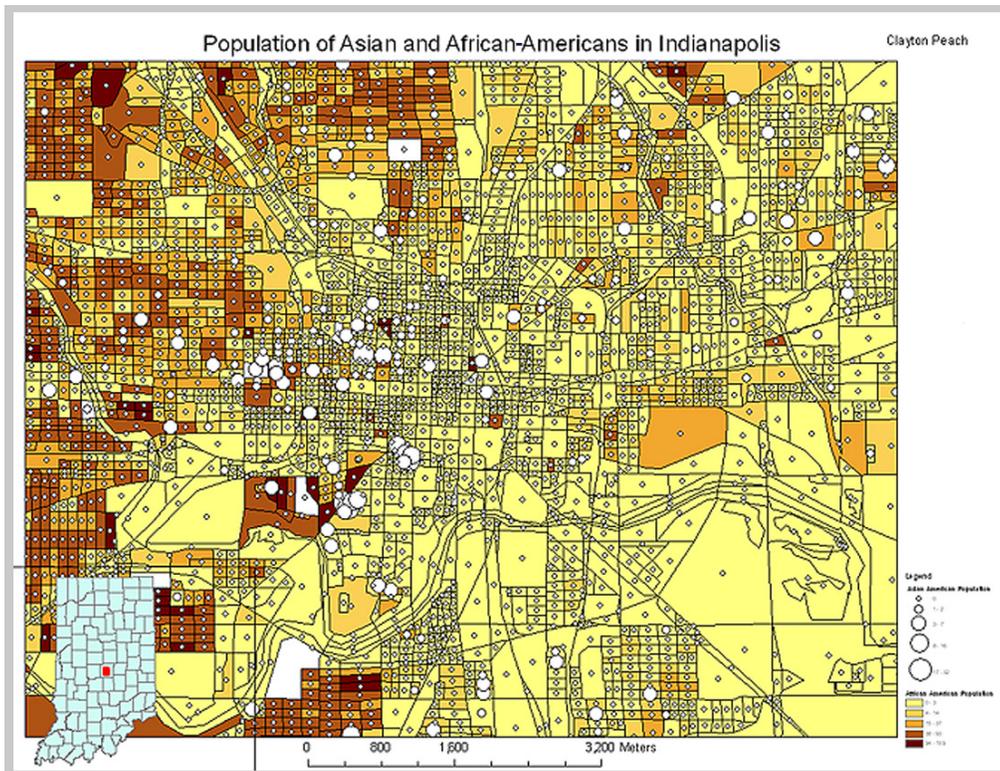


Figure 1. A thematic map showing Asian and African-American populations by Census Block Groups in Indianapolis, IN.

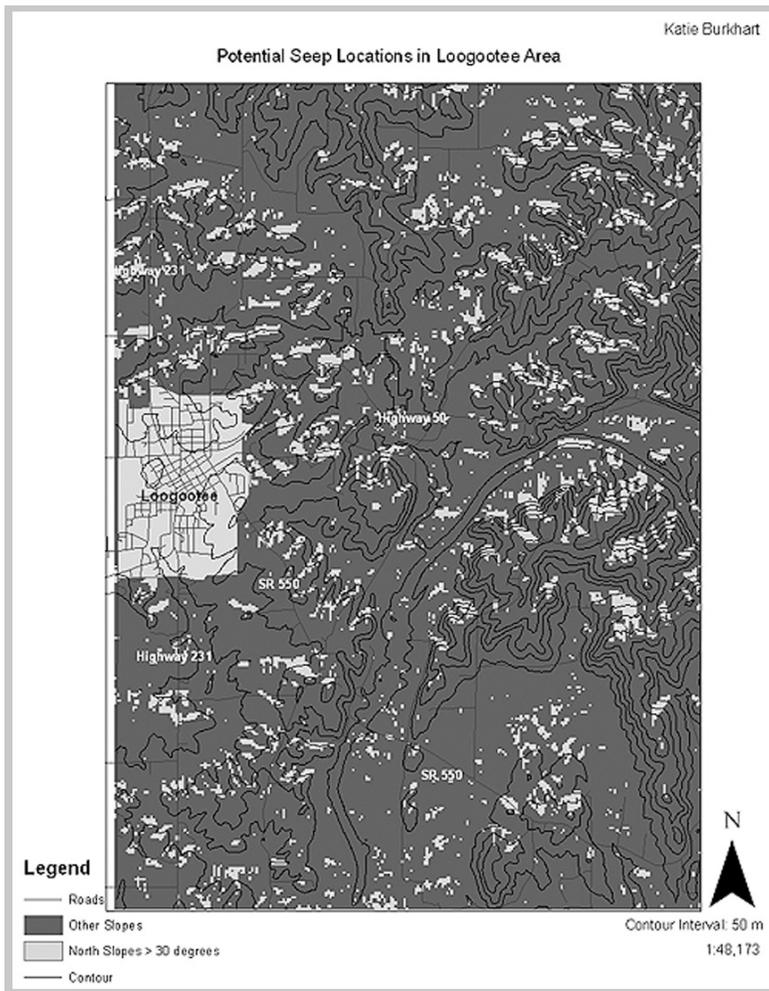


Figure 2. A map showing potential groundwater seep locations in Martin County, IN. The seep locations were determined by slope and aspect analysis of a Digital Elevation Model.

GIS Course Project

The half-semester projects of the GIS course involve planning and carrying out a GIS analysis and presenting the results. The students are required to work in groups and to show initiative in defining the problem they wish to solve as well as planning the GIS analysis steps required to solve it. Some structure is provided to give them smaller steps with deadlines dispersed through half of the project. These steps include a statement of work, flowchart of analysis, draft maps, draft poster, and final poster presentation.

Student projects have covered a number of topics including crime analysis in the City of Chicago, market analysis for siting businesses and health services, determination of the best location for coal mines and wind farms, watershed pollution analyses, forest change analysis, and exploration of connections between geology and forest character.

Land cover change projects typically use the USGS land cover datasets compiled from Landsat satellite data. For Indiana projects, these data are downloaded from IndianaMap (formerly the IN GIS ATLAS) (IGS, 2009). One of the maps from a Southern Indiana forest change analysis is shown in figure 3.

Geographic targeting is one of the GIS principles that is emphasized during the half-semester project. Students are required to use several GIS analysis steps to identify locations that are part of the solution to a relevant societal issue. One group of students combined coal bed thickness data, distances from coal burning power plants, and locations of existing mines in order to determine a location for a new coal mine. The analysis pointed to a region in northern Knox County,

IN. Two of the maps produced by these students during their analysis are shown in figures 4 and 5. Coincidentally, a new coal mine has been sited in the region highlighted by the student project.

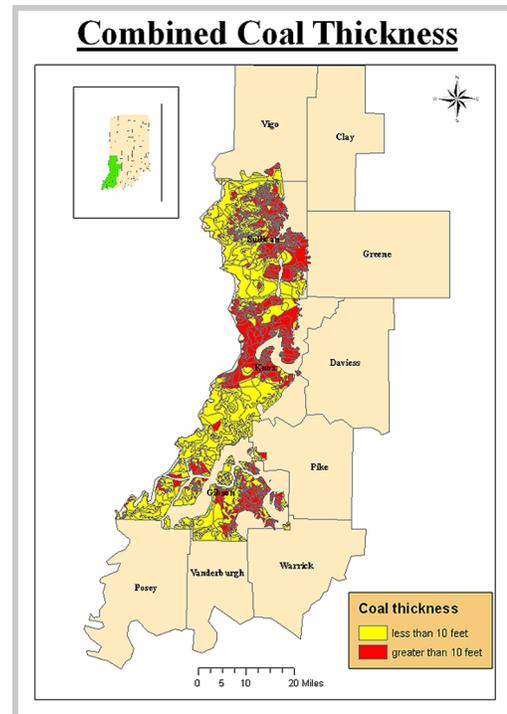


Figure 4. Map showing coal thickness in southwestern Indiana. IndianaMap (IGS, 2009) was the source of the raw data for this analysis.

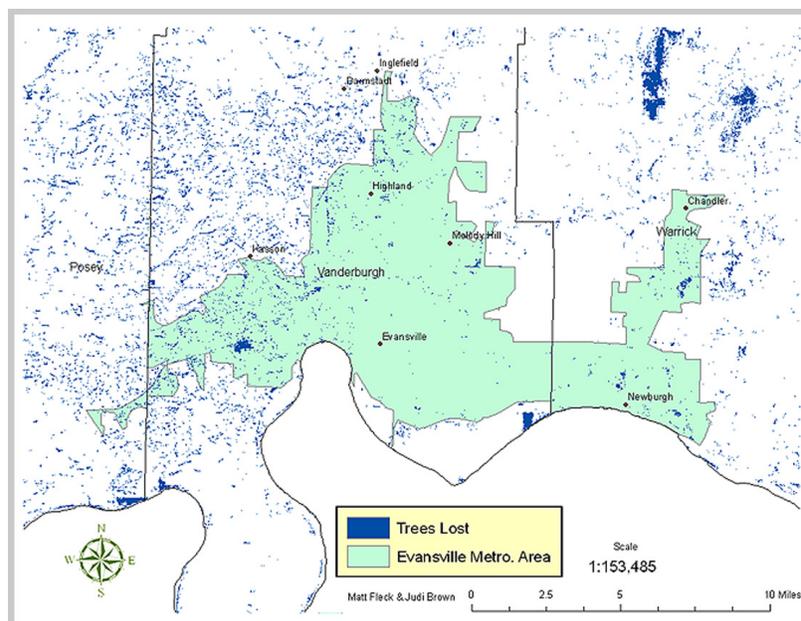


Figure 3. A map showing forest loss in the area of Evansville, IN, determined from raster calculations using satellite data from 2002 and from 1993.

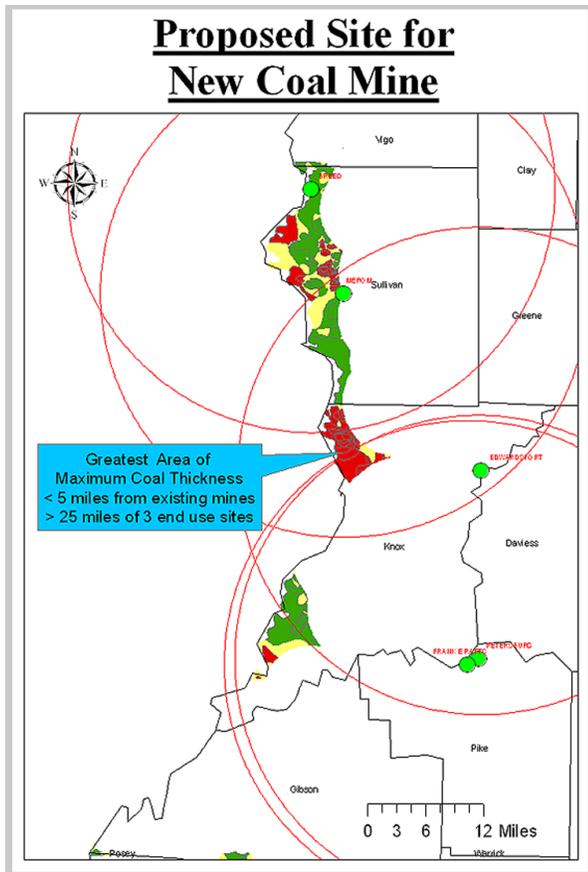


Figure 5. Map showing the preferred location of a new coal mine. IndianaMap (IGS, 2009) was the source of the raw data for this analysis.

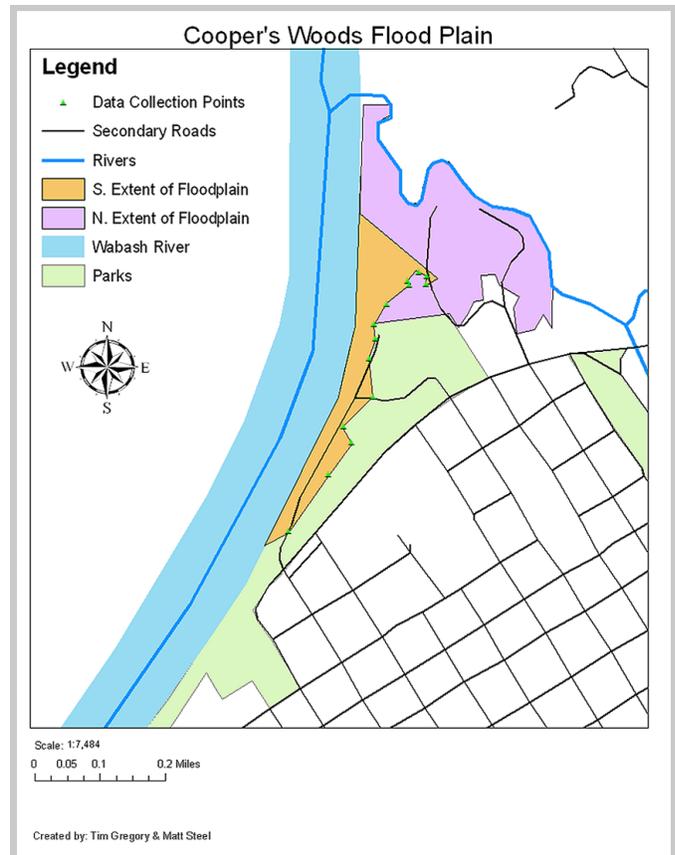


Figure 6. Map of the extent of Wabash floodwaters in late April 2009, produced by Vincennes University students.

Physical Geology Field and GIS Exercises

The Physical Geology laboratory course at Vincennes University involves a mapping exercise in place of four labs at the end of the semester. One to two of these labs involve field work in a local floodplain forest ecosystem along the Wabash River upstream from the Vincennes University campus. In one or two additional lab sessions, the mapping groups (two to four students) bring their field data into ArcMap, draw and edit polygons, and produce a map. Finally, the groups present their finished maps to the class.

Topics for the Physical Geology mapping exercises have included soils, landforms, landuse, stream flow, sedimentary features, and floodwater extents along the Wabash River. Figure 6 is a student map showing the extent of Wabash floodwaters in late April 2009.

Focused Geologic Mapping Exercise

A mapping project conducted with the Mineralogy class in spring 2008 taught students some field fundamentals and GIS functionality through a brief exercise. Students were tasked with mapping a geologic contact between a Precambrian granite and a volcanic rock formation. The field work was conducted in the St. Francois Mountains, MO, and the GIS work done in a follow-up laboratory session at Vincennes University.

During a lecture prior to the field work, geologic maps and literature were consulted. From the geologic maps of Kisvarsanyi and others (1981), the students were introduced to the purpose of their mapping exercise: the verification of the southern contact between the Silver Mine Granite and a volcanic formation.

Other preparations included short demonstrations of how to walk traverses in the field using a compass, how to describe rocks in the field, and how to collect data with hand held GPS receivers.

The exercise involved one long field day. In the morning, students became familiar with the geology of the region and the specific units involved in their mapping problem. In the afternoon, the students formed two groups and conducted traverses across the contact (fig. 7). They followed preplanned routes provided to them on a base map (fig. 8). These preplanned traverses were spaced 0.3 miles apart, allowing the instructor to move between each of the student groups and provide guidance.

Upon returning to the GIS lab, the students used their rock descriptions and GPS data to help them decide where to draw the contact between the Silver Mine Granite and the volcanics. Students used ArcMap to combine their contact lines and base map information.



Figure 7. Photograph of students mapping in the St. Francois Mountains, MO.

Conclusions and Future Improvements

The GIS emphasis in Vincennes University courses strives to provide students with mapping and GIS skills that can be applied to “real world” problems. The focused mapping and GIS exercises seem to convey concepts in an efficient manner. Students have responded well to the structure and content of the exercises. In addition, students have been able to use the familiarity that they gain with the ArcGIS software to their benefit in internships and later coursework.

The instructor of these courses is currently discussing the teaching model and student work with professionals and educators and plans to incorporate their suggestions into future iterations of the courses. One area that has already been identified for improvement involves connecting the coursework with mapping efforts of Federal, State, and local levels of government as well as the private sector.

Acknowledgments

Students of the GIS, Physical Geology, and Mineralogy courses at Vincennes University inspired the hands-on, focused approach to incorporating mapping and GIS into teaching discussed in this paper. The efforts of students have been an important part of the evolution of the coursework, and the writing of this article. These students include: Brian J. Barber, Derek A. Birt, Matthew J. Dixon, Isaac D. Freeman, Joshua L. Graham, Nathan D. Jines, Mark A. Royal, Todd J. Schmidt, Avijit Verma, Matthew R. Wagoner, Jennifer R. Williams, Wesley R. Zellers, Charlotte L. Burnside, Justin A. Diskson, Christopher R. Fogle, Timothy W. Goodwin, Jeremy A. Newhouser, Jarrod S. Perry, Ian P. Wilhite, Sean P. Wood, Kelsey C. Marshall, Wade W. Salmons, Alex P. Watson, Jenny

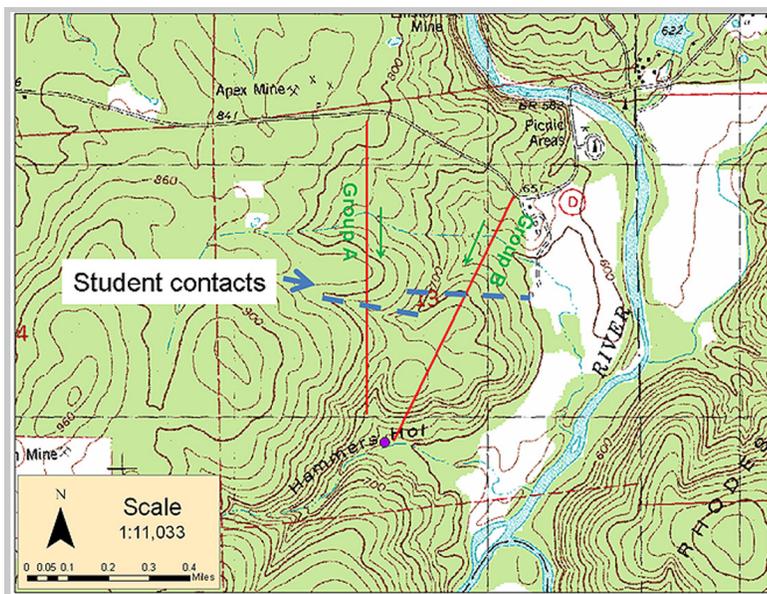


Figure 8. Base map for St. Francois Mountains mapping exercise showing traverses (red lines) and the contact between the Silver Mine Granite and a volcanic formation as drawn by the two student groups.

M. Weeks, Scott E. Whaley, Dathan Wright, Jarrod Albright, John M. Astell, Christopher C. Bledsoe, Joshua A. Galloway, Bryce E. Holtsclaw, Wesley P. Miller, Dustin L. Osborne, Skyler A. Potts, Jason R. Strong, Michael D. Thomas, Christopher R. Allender, Logan M. Croup, Jonathon C. Emly, Tyler J. Thompson, Joseph C. Warren, Amy L. Byrer, Christopher A. Carver, Richard J. Chevalier, Wesley D. Eberhardt, Daniel A. Goedde, Matthew J. Hoffman, Daniel R. Jenny, Robert E. Otten, Alex M. Windes, Erin M. Cash, Adam V. Nease, Stacia K. Pence, and Jessika C. Sanders. Faculty members and administrators at Vincennes University have supported the GIS program, including attending the GIS course poster sessions. Department Chair John Parsons, Dean Richard Shippee, Assistant Professor Curt Coffman, and Adjunct Faculty member Neal Catt have all supported the mapping efforts. The manuscript of this article was reviewed by Shannon N. Doran.

References

- ESRI, 2009, ArcGIS: Environmental Systems Research Institute, <http://www.esri.com/software/arcgis/whats-new/index.html>.
- IGS, 2009, IndianaMap: Indiana Geological Survey, accessed at <http://inmap.indiana.edu/index.html>.
- Kisvarsanyi, E.B., Hebrank, A.W., and Ryan, R.F., 1981, Guidebook to the geology and ore deposits of the St. Francois Mountains, Missouri: Missouri Division of Geology and Land Survey, Report of Investigations no. 67, Contribution to Precambrian Geology No. 9.