Isn't That Spatial

Mapping Your Field Data and GPS Coordinates

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Field studies have always been critical to geography education. Because the locations of data gathered in the field are key to the understanding of the phenomena studied, Global Positioning Systems (GPS) have become an extremely useful tool for educators. While the number of educators in nonformal, primary, secondary, technical education, community college, and university settings using GPS technology continues to grow, many of them stop the project immediately after the GPS collection is complete. The purpose of this column is to explain the options for taking field data and GPS coordinates to the next step—mapping the data in their correct locations.

As geography educators, we all know the value and advantages of making a map of any phenomenon. By mapping the data that you and your students collect, you can then begin to analyze the distribution and pattern of the waypoints, routes, and tracks from the field. In so doing, your students will begin asking the whys of where—the heart of geographic analysis.   How does one go about mapping these data, and what are the advantages and disadvantage of each of the options available? In addition, adding geotechnologies such as GPS and Geographic Information Systems (GIS) increase student engagement and interest

Several categories of mapping tools exist for the mapping of GPS coordinates: (1) mapping software, (2) web-mapping services, (3) virtual globes, (4) Geographic Information Systems (GIS) software.

With any of these tools, you first need to get the coordinates from the GPS into a computer. Here, too, you have several options. The two methods of bringing coordinates from a GPS receiver to a computer are to either manually type them into a file, or to bring them in via a computer cable. Manual entry can be into a plain text file, a word processing document, or a spreadsheet. These files usually have to be saved in specific formats for a mapping package to ingest, such as text (.txt), Excel (.xls), or Dbase (.dbf). The text file typically has the following format, with the first line as the header line:

Point, latitude, longitude
1, 39.65749, -105.10458
2, 39.65782, -105.10411

Using a spreadsheet is a bit easier, but just make sure that the spreadsheet does not truncate the significant digits. These digits are extremely important in accurate mapping. In Excel, for example, it is a fairly straightforward process to format the latitude and longitude cells to ensure that all of the
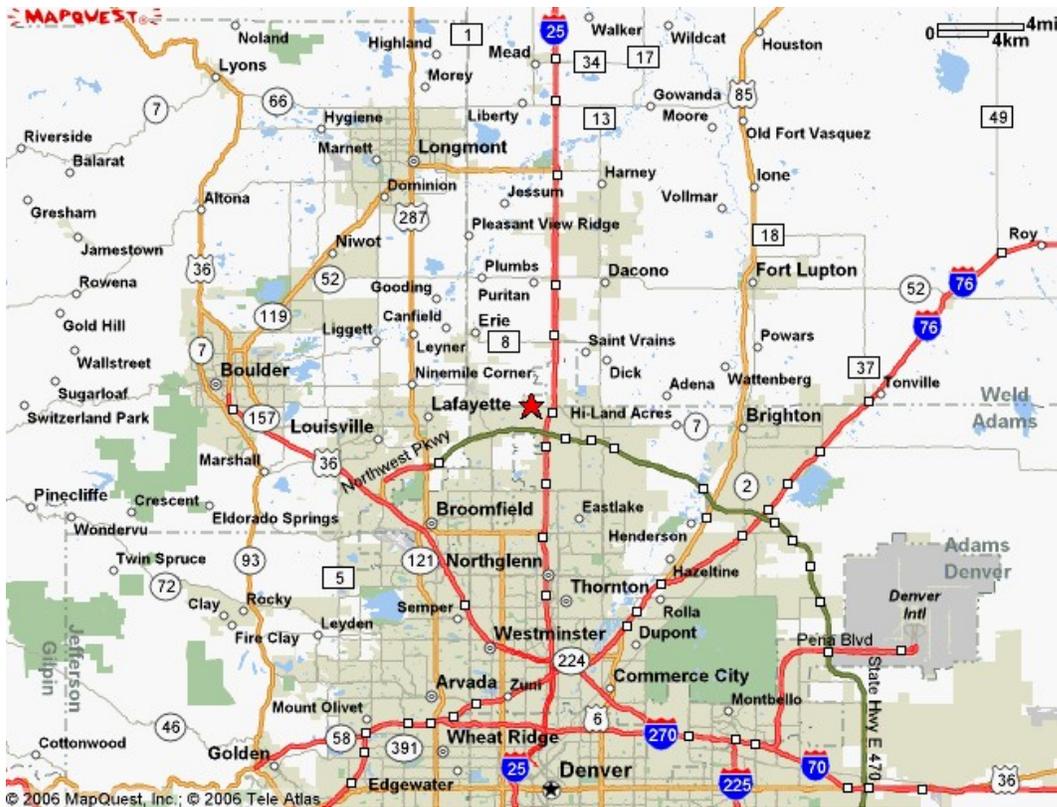
significant digits are kept. Oftentimes, students ask if they can "round" the digits. No! Or, turn this into a teaching moment and see where the points that are rounded end up on the final map. They could be many kilometers off of their true location.

The automated method involves a cable that is connected at one end to the GPS and on the other end to a serial or USB port on a computer. Most GPS units have a data port on the back that allows the cable to be connected. These data ports vary by the manufacturer and model of GPS, so make certain that you purchase the type of cable that will fit your specific GPS unit.

To bring the GPS coordinates from the receiver to a computer, free and commercial software is available. One of the best free tools is the Waypoint software written by the Minnesota Department of Natural Resource, but it only works with Garmin GPS receivers. Commercial mapping software also has the capability to bring in GPS coordinates using a simple menu choice, with your GPS unit connected.

From a pedagogical perspective, the advantages of the automated method are that the students spend less time data processing and can more quickly jump to analyzing the data. However, I advise using the manual method at least for a few points. This helps the students not only understand what is happening "behind the scenes," but also about coordinate systems, and what happens when someone inevitably transposes digits. How far **is** 39.0100 latitude from 39.1000 latitude? These mistakes can be turned into powerful teaching moments because the computer will map the points exactly how they were entered.

You don't even need mapping software to map your GPS coordinates.   GPS visualizer (http://www.gpsvisualizer.com) allows for coordinates to be entered on a web browser and mapped on a satellite image. Even common mapping tools such as Google Maps and MapQuest can be used to plot latitudes and longitudes. A string that plots a point at 40 degrees north and 105 degrees west would look like this in MapQuest:

The MapQuest map created by the following URL:

http://www.mapquest.com/maps/map.adp?latlongtype=decimal&latitude=40&longitude=-105

Topozone (http://www.topozone.com) is another web-based mapping tool that can be used to make online maps with specified coordinates.

With most of these tools, west longitude and south latitude need to be entered as negative values, as they are on the "left" and "below" the x and y-axis, respectively, of the Earth from a Cartesian coordinate system. Also, GPS units output the data as latitude-longitude, regardless of whether they were collected in some other coordinate system, such as the Universal Transverse Mercator (UTM) system.

Mapping software ranges from low-end free packages (such as TopoGrafix's *Easy GPS)* to higher-end packages (such as National Geographic's *TOPO!,* MapTech's *Terrain Navigator Pro,* TopoFusion, ExpertGPS, OziExplorer, and DeLorme's *TopoUSA)* that provide topographic map and aerial imagery bases and allow for 3-D flythroughs.

Virtual Globe software, as I have written about in my last two columns, are some of the most exciting new developments in geotechnologies. NASA WorldWind, Google Earth, and ESRI's ArcGIS Explorer all can show latitude-

longitude coordinates entered by the user. They can also import GPS coordinates from a file or from a GPS receiver. The user can fly to each point on a 3-D globe. In addition, thousands of coordinates gathered by others can be flown to and analyzed with Virtual Globes, such as USGS-gathered earthquake epicenters in Google Earth's KML format, on:
http://earthquake.usgs.gov/eqcenter/recenteqsww/catalogs/

Remember that bringing in the latitude-longitude coordinates from a GPS is only half of the story. The other half is the actual field data that you and your students have collected—the pH of the water bodies visited, the height of the trees, the age of the houses, the number of vehicles crossing the street, the price of gasoline at that location, the field trip overlook notes, and so on. These data can be entered while in the field using a variety of mobile computing devices, such as a handheld computer, or added later to the data table once in the lab.

GPS coordinates can also be brought in and mapped using GIS software. The advantage to using GIS as the mapping package is that not only can the spatial distribution of the points, lines, or polygons be analyzed, but the field data attached to those features can also be analyzed. This means that students can investigate the spatial distribution of the pH, tree heights, prices, and other data described above. ESRI's *ArcExplorer Java Edition for Education* (*AEJEE*) is a free package that works well for this purpose, and more robust packages such as ESRI's *ArcGIS,* Northwestern University's *MyWorld GIS,* and Intergraph's *GeoMedia* also work well with field data and coordinates.

Waypoints and tracks displayed on top of a USGS aerial photograph.

These technologies are rapidly evolving, presenting the geography educator with a plethora of options that we only dreamed about a few years ago. I applaud your efforts in getting students out in the field, and I encourage you to use geotechnologies in conjunction with field work. Geotechnologies can

be used to support field work by helping students analyze what they have just collected, with the potential to deepen their understanding and curiosity about the Earth.

For More Information

My GPS resources, educational ideas, and guidelines:
http://education.usgs.gov/common/lessons/gps.html

GPS to GIS guidelines:
http://education.usgs.gov/common/lessons/gps2gis.html

The Minnesota Garmin Waypoint GPS software:
http://www.dnr.state.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html

Article about students studying a wildfire with GPS and GIS:

Fox-Gliessman, Debra, and Joseph J. Kerski. 2005. Technology and the study of wildfire: Middle school students study the impacts of wildfire. *Meridian—A Middle School Technology Journal (8).* Winter. http://www.ncsu.edu/meridian/win2005/wildfire/

Dozens of excellent books have been written on this topic. One of my favorites is:

Owings, Rich. 2005. *GPS Mapping—Make Your Own Maps.* Fort Bragg, CA: Ten Mile Press. 374p. ISBN 0-9760926-3-8.

All of commercial products listed in this article are from my personal experience and do not imply endorsement from the US Government.