Global GIS :

Exploring The Globe with GIS

Author: Joseph J. Kerski, Ph.D.
Geographer
US Geological Survey
jjkerski@usgs.gov
rockyweb.cr.usgs.gov/outreach/

Description

In these lessons, students use Geographic Information Systems (GIS) together with the tools and data from the Global GIS CDs to investigate the following topics in different continents at a local, regional, and continental scale:

- Natural hazards, including earthquakes, volcanoes, and tsunamis;
- Population growth, demographics, land use, and patterns;
- Water resources, including river systems, oceans, and seas;
- Minerals and Manufacturing.

The lessons can be used with other data in the Global GIS project to investigate these topics in other continents. Furthermore, the methods used here can be applied to other map themes contained within the Global GIS datasets.

What is GIS?

Maps have always been powerful ways to represent information. A GIS combines the power of maps, satellite images, and aerial photographs with databases that store information behind the maps and images. One way to think about GIS is to break it up into its three initials. The “G” part of GIS could be a map, a three-dimensional representation of the Earth’s surface, or an image. The “I” part of GIS is the Information, or the database, containing attributes behind each map feature. This could be the magnitude of an earthquake, for example, or the population of a country. The "S" part of GIS is invisible to the user, but this Systems part makes it possible to analyze the maps and attributes together.

Another way to think about GIS is to think of it in terms of computer hardware, software, methods, and a human explorer.   GIS requires computer hardware and software to use. In the case of this lesson, ArcReader and ArcView software from ESRI, Inc. will be used. GIS involves specific methods, or procedures. In this lesson, students will have the opportunity to use many of these procedures, such as querying, sorting, changing legends, creating buffers, and others. GIS also requires certain kinds of spatial data. These are produced by national governmental organizations such as the United Nations, the Ordnance Survey, USGS, the US Census Bureau, NASA, and others, as well as tribal, state, and local government, nonprofit organizations, and private industry. However, the most important component of a GIS is the user. It is the person that must make sense of what the GIS tools and methods are saying, and it is the person who must decide what action to take.

Why Use GIS in Education?

As the world becomes ever more monitored, mapped, and surveyed, students have the opportunity as never before to take advantage of the same tools that scientists are using. One tool essential for analyzing the Earth is a Geographic Information System (GIS). A GIS allows the user not just to create computerized maps, but also to *analyze* patterns, linkages, and trends that exist above, on, or below the Earth's surface. Oceanographers, geologists, geographers, seismologists, climatologists, biologists, chemists, zoologists, and other scientists regularly use GIS to help them make wise decisions about the planet. Why not tap into this powerful tool for teaching and learning?

A GIS user is not confined to the static content, locked scale, and symbols of a paper map. Rather, a GIS allows the user to create his or her *own* map—one that is customized to address the issues and problem at hand.

Analyzing the Earth with a GIS in the classroom provides for inquiry-based, problem-solving learning. Students ask a question, acquire the necessary tools and data to address the question, analyze the data using the GIS and other tools, and assess the results of their investigation. This may lead to further investigation and additional questions. In addition, learning with GIS allows for the integration of field data collection with Global Positioning Systems (GPS) to obtain the precise coordinates of where the data were collected. It also allows for interdisciplinary learning that is exciting and relevant to address the major issues of the 21st Century, such as biodiversity, population growth, climate change, natural hazards, and energy. In this lesson, students are given the opportunity to analyze a specific natural hazard—earthquakes—using GIS software and methods of analysis.

Linkages to Educational Content Standards

Geography Standards

The World in Spatial Terms

Geography studies the relationships between people, places and environments by mapping information about them into a spatial context. The geographically informed person knows and understands:

1. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
2. How to use mental maps (a person's internalized picture of a part of Earth's surface) to organize information about people places, and environments.
3. How to analyze the spatial organization of people places, and environments on Earth's surface.

Students using GIS create their *own* maps to analyze the Earth. These maps are dynamic--the student can change the scale, the symbology, the content, the projection, the classification, and other characteristics of each. GIS is an analysis tool to ask questions about an investigate the Earth. In the Global GIS lessons, students create many different kind of maps at many different scales to investigate hydrology, land use, natural hazards, population, and other phenomena.

Places and Regions

The identities and lives of individuals and peoples are rooted in particular places and in those human constructs called regions. The geographically informed person knows and understands:

4. The physical and human characteristics of places.
5. That people create regions to interpret Earth's complexity.
6. How culture and experience influence people's perceptions of places and regions.

Students who use GIS can examine human and physical characteristics of places and regions within one tool. In fact, GIS was created to do exactly that--separate the Earth's hydrology, biology, landforms, rivers, transportation, land cover, climate, vegetation, and other features into layers so that, when combined, the Earth could be understood holistically. Students investigate such places as Alaska, California, Portugal, Turkey, Costa Rica, and Chile in the Global GIS lessons.

Physical Systems

Physical processes shape Earth's surface and interact with plant and animal life to create, sustain, and modify the ecosystems. The geographically informed person knows and understands:

7. The physical processes that shape the patterns of Earth's surface.
8. The characteristics and distribution of ecosystems on Earth's surface.

Through the Global GIS lessons, students investigate such physical processes as earthquakes, volcanoes, and plate boundaries, examining the patterns across the Earth's surface and linkages between them.

Human Systems

People are central to geography in that human activities help shape Earth's surface, human settlements and structures are part of Earth's surface, and humans compete for control of Earth's surface. The geographically informed person knows and understands:

9. The characteristics, distribution and migration of human populations.
10. The characteristics, distribution and complexity of Earth's cultural mosaics.
11. The patterns and networks of economic interdependence.
12. The processes, patterns, and functions of human settlement.
13. How the forces of cooperation and conflict among people influence the division and control of Earth's surface.

Through the Global GIS lessons, students investigate such processes as population distribution, concentration, and relationship to rivers, climate, vegetation, and natural hazards.

Environment and Society

The physical environment is modified by human activities largely as a consequence of the ways in which human societies value and use Earth's natural resources and human activities are also influenced by Earth's physical features and processes. The geographically informed person knows and understands:

14. How human actions modify the physical environment.
15. How physical systems affect human systems.
16. The changes that occur in the meaning, use, distribution, and importance of resources.

Students who use the Global GIS lessons analyze the relationships between people and the physical environment, such as earthquakes and volcanoes versus the distribution and size of cities and population clusters, between rivers and cities, and between climate and cities, to name a few.

The Uses of Geography

Knowing geography enables people to understand the relationships between people, places, and environments over time. The geographically informed person knows and understands:

17. How to apply geography to interpret the past.
18. How to apply geography to interpret the present and plan for the future.

Through GIS-based inquiry, students are using a real-world geographic set of tools and real-world geographic data to analyze patterns, linkages, and trends.

Teaching Standards

These lessons support national teaching science standards because the lessons were developed as an inquiry-based approach to teaching. Specifically, they support Teaching Standard A because they are interdisciplinary and nurture a community of science learners. Teaching Standard B focuses on modeling the skills of scientific inquiry, which students do while analyzing earthquakes and other phenomena within a GIS environment. Teaching Standard C is supported because the questions use multiple methods of assessment, and many sections of the lesson do not have one “right answer;” rather, the questions encourage students to reflect upon their learning. They support Teaching Standard D because through the Global GIS project, they make the available science tools, materials, media, and technological resources accessible to students. Teaching Standard E is supported because students are encouraged to collaborate with each other, and because the lessons model and emphasize the skills, attitudes, and values of scientific inquiry. In short, with GIS, constructivist teaching is supported because students are not memorizing facts, and the teachers’ role changes to one of guiding the students in their inquiry.

Professional Development Standards

Teaching with GIS support the vision of professional development standards for the teaching of science. Specifically, in the learning of science content through inquiry standard, GIS was created as an inquiry-based, problem-solving tool. It was not something “made up” for the classroom. Rather, teachers using GIS are themselves learning science content in the same way as a scientist in government, business, or a nonprofit organization does everyday on the job. Furthermore, the development of the understanding and ability for lifelong learning is supported because GIS is not a “plug and play” CD. It is a *system*, and indeed, geographic information *science* is a science in its own right. Therefore, teaching with GIS cannot be dismissed as easy. It is hard work, but in so doing, teachers learn continual reflection, new strategies, best practice, and learning alongside the students. Despite the work involved, most teachers using GIS in the classroom indicate that it is a worthwhile endeavor.

Science Content Standards

Investigating the Earth with a GIS supports science content standards. For example, the “unifying concepts and processes” standard is integrated into the lesson in that students are provided with a system, a way of organizing their data within a GIS. They are also provided evidence for earthquake and volcano hazards as real scientific data. Students *examine evidence* and *explain the distribution of phenomena* across Earth's surface. They *measure* phenomena and they analyze *changes* over time and space.

Investigating Earth with a GIS also addresses the science as inquiry standard, because students learn scientific concepts (plate tectonics) by developing the skills scientists use on the job. GIS is a real-world tool used by thousands of scientists daily. The process of inquiry within a GIS is more important than the "final answer" that the students provide. GIS-driven inquiry gives students an appreciation of scientific investigation, because it is the same tool that scientists use. Using GIS, students ask questions, acquire or generate necessary data, analyze the data, draw conclusions, and ask new questions. They conduct their own investigations in a hands-on way. In so doing, they are developing skills necessary to become independent inquirers about the natural world.

Students using GIS through this lesson begin to see that their analysis hinges largely on the quality of the data provided. They learn to be critical of the data. Too often, when data are viewed on the computer, they are considered to be perfect; without error. However, computer-based data are no more accurate or precise than the paper maps and original sources they were derived from. This is especially important with map data because maps are representations of the Earth. They all contain inaccuracies because they are based on specific map projections, which distort the three-dimensional earth to depict it on a two-dimensional paper map or computer screen. Being critical of data and recognizing the limitations of data and analysis are essential science learning skills.

Using these data sets and lessons, emphasis is on investigation and analysis, rather than on demonstration. The GIS skills the students are learning are in context with the lessons on seismicity or population, for example, and they are using multiple skills—process, computer, analysis. Instead of simply providing answers to questions, students are communicating science explanations about science content through their maps, tables, and charts from GIS. Their conclusions must be backed by real-world data.

The lesson supports the physical science standards because students learn about tectonic forces, motions, and patterns, and the structure of the earth system. The science and technology standards are addressed because students learn science *through* GIS *technology.* Natural hazards are a component in the science in personal and social perspectives standards. With the earthquakes lessons, for example, students assess risks and benefits of living with earthquakes, and the relationship of earthquakes to cities and critical infrastructure such as roads, utility lines, and railroads.

GIS Skills Involved

1) Navigating through and effectively using a GIS interface and software.
2) Changing map symbology to create different thematic maps.
3) Manipulating tabular information, including selecting attributes, querying tables, and sorting tables.
4) Querying map data, including proximity analysis.
5) Downloading and formatting data from the Internet for use in GIS.
6) Changing map projections.
7) Creating new information from existing data.

Options for Running the Software:

1. After installing the data and the ArcView Data Publisher, start the “<Continent> Global GIS” icon from the Windows start bar under the ‘Global GIS’ folder, where <Continent> refers to Europe, North America, South Pacific, and so on. A few sections of the lessons (incorporating data from the Internet, for example) require the use of ArcView GIS, but ArcView Data Publisher users will be able to complete most of these lessons.

2. Users who own a version ArcView 3.x can open the ArcView GIS project named “europe_global_gis5_v3.apr” directly off the Global GIS CD. This will give the user the opportunity to save his/her project.

- Notes: Before starting, please see http://www.agiweb.org/pubs/globalgis/ under "support and downloads" for any data updates or project updates. The ArcView project delivered on this disk is not compatible with ArcView version 3.0 because of the use of the MrSID image format. ArcView version 3.1 and higher will work. Thus, for Macintosh ArcView version 3.0, users will need to download a compatible Macintosh project, which removes the MrSID image references from the AGI site mentioned above.

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URL:http://rockyweb.cr.usgs.gov /public/outreach/globalgis/overview.html
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