Integrating Geographic Information Systems (GIS) into AP Environmental Science

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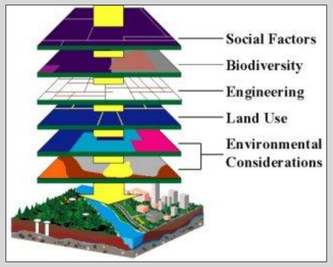
What is Geographic Information Systems?

GIS lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends.

GIS allows multiple layers of information to be displayed on a single map.



This technology is a crucial part of spatial data infrastructure, which the White House defines as

"the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data." [1,2,3]

GIS Tools We Will Use

Google Maps - a free web mapping service application technology providing street maps, high-resolution aerial, satellite, & street imaging.

Google Earth - a geobrowser, virtual globe, that accesses satellite and aerial imagery, ocean bathymetry, and other geographic data over the internet to represent the **Earth** as a 3D globe.

Google SketchUp - a free or paid downloadable 3D modeling software that interacts with Google Earth.

ESRI - Environmental Systems Research Institute - an international supplier of GIS software, web GIS, and geodatabase management applications

ArcGIS - A geographic information system (GIS) is a system for the management, analysis, and display of geographic information

Collector for ArcGIS - an app that uses handheld device to collect and update information in the field

NGSS Addressed with GIS Integration

HS-LS2-7 Ecosystems: Interactions, Energy, & Dynamics
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

HS-LS4-6 Biological Evolution: Unity and Diversity
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ETS1-4 Engineering Design
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

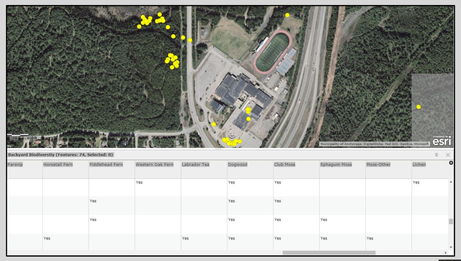
HS-ESS3-4
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

AP Environmental Scientific Practices

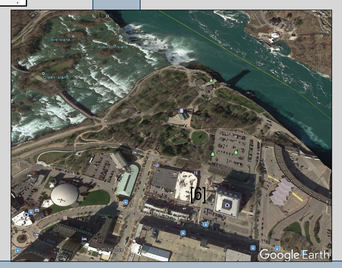
- critically observe environmental systems
- develop and conduct well-designed experiments
- utilize appropriate techniques and instrumentation
- analyze and interpret data, including appropriate statistical and graphical presentations
- think analytically and apply concepts to the solution of environmental problems
- make conclusions and evaluate their quality and validity
- propose further questions for study
- communicate accurately and meaningfully about observations and conclusions

Teaching Implementation

Backyard Biodiversity Study - http://bit.ly/BioDiverseGIS
After studying local flora and fauna, students will use Collector to identify and compile data within distinct but equal areas. around the schoolyard and community. Upon returning to the classroom, students will analyze data in ArcGIS to calculate biodiversity, species richness or our area using qualitative and quantitative means.



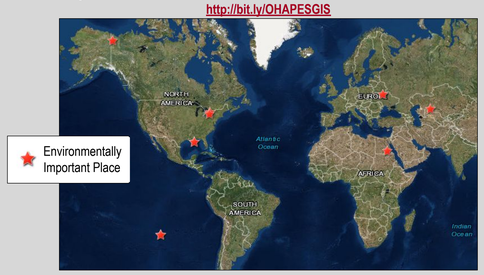
Urban Redevelopment - http://bit.ly/RedevelGIS
Analyze the current development of the city of Niagara Falls, NY with Google Earth. Debate an area in need of redevelopment to improve a specific infrastructure, residential, commercial, or recreational aspect of the community keeping in mind lessons on population, urbanization, pollution, energy, and sustaining available resources. Using Google SketchUp students will create and integrate 3D models and propose the redevelopment with rationale for the upgrade into the city. Students will predict pros and cons of the proposition and present their proposal.[4,5]



[6]

ArcGIS Story Maps Implementation

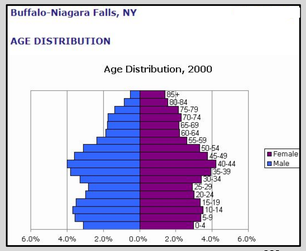
Oh, The Places You'll Go ...in APES!!!
http://bit.ly/OHAPESGIS



Given a list of environmentally important places, students will create a Story Map in ArcGIS (example http://arcg.is/2usZrUn). They will compile images, locate gps coordinates, and research information regarding the site. Students will construct a Story Map. Once completed, they will elaborate by choosing an attribute to layer onto their Map for analysis (e.g. distance, hotspots, biomes, population size, weather attributes, etc). After creating the chosen layered map, students can define parameters, isolate, specific data, and will analyze their layered map to generate correlations, causations, or environmental or population impact.

ArcGIS Story Map Analysis and Interpretation

In this Story Map, by layering the map of environmentally important places and adding a layer of the World Demographics by Country, a correlation can be made as to which places were likely to impact the most people in a given year (i.e. 2015) . The darker the brown hue the greater the population in the country. The star in the United States depicting Love Canal, NY is above the darkest brown of the locations shown thus showing more people are still impacted around this area. In addition, students can change the year to observe changes in time around the places or drill down into more detailed maps to show more specific population impacts around a given location. Age group demographics can also be isolated and arrange into age structure diagrams to predict future trends in any of the given places.



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Careers in GIS

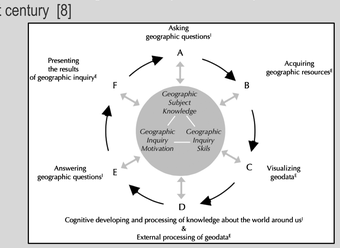
GIS is being used in many different industries and the skills required to be a successful GIS professional have evolved over the years. A successful career in GIS is a solid education in cartography, GIS, spatial analysis, database management, web technologies, and programming.

- GIS Intern
- GIS Technician
- GIS Specialist
- GIS Analyst
- GIS Coordinator
- GIS Manager
- GIO - Geographic Information Officer

[7]

Conclusions

- The presence of critical spatial thinking skills is important because it helps students to be able to access and make sense of (geo)information in order to understand the complexities of many of the spatial problems that face our world today. These interconnections are equally relevant to geographic information systems (GIS) particularly when considering GIS in the light of the recent developments of the digital earth.
- The use cases of digital earth and the development of quantitative geography emphasize the need for the focus on critical GIScience, even with all of the developments that have occurred since the early 1990s, because GIS is about how we use the technology to answer these spatial questions, as well as being about the technology itself.
- A critical spatial thinker should master the following key set of abilities and skills:
  - Understand the effect of scale and the role of assumptions in the use of spatial data.
  - Appreciate the difficulties of inferences in multidimensional data.
  - Understand the implications of problems and uncertainty with spatial data.
  - Apply geostatistical theory in the use of interpolation of spatio-temporal data.
- These defined abilities and skills provide a foundation for this article to consider how GIS education can begin to develop the critical spatial thinkers of the twenty-first century [8]



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