Socio-Environmental Science Investigations that Support NGSS Teaching and Learning

Alec Bodzin, James Carrigan, David Anastasio, Kate Popejoy, Tom Hammond, Breena Holland, Dork Sahagian, Scott Rutzmoser, William Farina
Lehigh University
Socio-Environmental Science Investigations (SESI)

- Inquiry-based investigations
- Map-based mobile data collection
- Analysis with Web-based mapping software
- Pedagogical frameworks of place-based education and socio-scientific investigations
- Local issues
- Field work in the local setting
Context

- 9th grade students (and teachers) - urban public school
- All economically disadvantaged
- 2/3 Hispanic or Latino
- 21% ELL, 19% IEPs
- Many (~10-20%) are reluctant learners
  - Unmotivated to learn
  - Do not complete tasks
  - Avoid challenging work
### Geospatial Thinking and Reasoning

<table>
<thead>
<tr>
<th>Investigative Questions</th>
<th>Geospatial Data Visualizations</th>
<th>Geospatial Data Analysis</th>
<th>Constructing Explanations</th>
<th>Arguments and Claims</th>
</tr>
</thead>
</table>

### Geospatial Science Technological Pedagogical Content Knowledge
- Interactions between geospatial technology and pedagogical content knowledge to produce effective environmental science teaching and student learning.
- Modeling geospatial data exploration and analysis techniques.
- Scaffolding students’ geospatial thinking and analysis skills.

### Earth and Environmental Science Content
- Human-Environment Interactions: Know and apply geographic information about relationships between nature and society.
- Physical Geography: Know and apply geographic information about processes shaping the structure of the Earth’s surface, physical landscapes, natural hazards, weather, climate, and atmospheric processes.

### Social Studies Content
- Human-Environment Interaction: Place, Regions, and Culture
- Human Population: Spatial Patterns and Movements

### Geospatial Science and Analysis Skills
- Use GIS to manage, display, query, and analyze geospatial data.
- Use geospatial analysis to process geospatial data for the purpose of making calculations and inferences about space, geospatial patterns, and geospatial relationships.
- Use geospatial data analysis in which geospatial relationships such as distance, direction, and topologic relationships (e.g. adjacency, connectivity, and overlap) are particularly relevant.
- Use inductive and deductive reasoning to analyze, synthesize, compare, and interpret information.
- Use logic and reasoning to identify strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
Prototype SESI Investigations (Spring 2017)

- **Urban Heat Islands**
  
  Students investigate the school property to identify different types of ground surface heat radiation.

- **Trees and Ecological Services**
  
  Students identify trees and explore the environmental and societal benefits that trees provide in their city. They also investigate the relationship among trees and crime in their city.

- **Zoning and Me**
  
  Identify land use zones and compare to the official city zoning map.
Urban Heat Islands: How do surface properties affect heat?
Temperature Observation: grass

Surface Type: grass
Surface Shade: no shade
Surface Condition: dry
Surface Temperature Degree C: 34.30

Weather Condition
Air Temperature Degree C

Notes: A bunch of leaf litter
created_user: 115231_B21
created_date: April 11, 2017
last_edit_user: 115231_B21

Zoom to Get Directions
Artifact – Assigned City Area

- Estimate the amount of each land cover type
- Map drawing - reduce the urban heat island effect
- Articulate changes to reduce the urban heat island effect
**Tree Observations:**

<table>
<thead>
<tr>
<th>Tree Type</th>
<th>Genus and Species</th>
<th>Common Name</th>
<th>Origin</th>
<th>Height meters</th>
<th>Circumference cm</th>
<th>Notes or Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>native</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tree Observations: Kwanzan cherry

- Tree Type: Deciduous (leaves)
- Genus and Species: Prunus kwanzan
- Common Name: Kwanzan cherry
- Origin: exotic
- Height (meters): 6
- Circumference (cm): 117

Attachments:
- Photo1.jpg

Zoom to Get Directions
Percent Canopy

Legend

Prototype Eco Services Observations
- Deciduous (leaves)
- Evergreen (needles)

Ecological Services Areas

Allentown Percent Canopy Cover

Percent Canopy Cover:
- > 71.8 to 88
- > 59.9 to 71.8
- > 49.5 to 59.9
- > 42 to 49.5
- > 35.5 to 42
- > 29.6 to 35.5
- > 24.2 to 29.6
- > 18.6 to 24.2
- > 12.6 to 18.6
- 4.8 to 12.6
Personal and Property Crime
Personal and Property crime and % tree canopy
Analysis – Local Neighborhood

- Estimate the amount of trees
- Compare tree canopy to other city areas
- How would you improve your neighborhood to get more value out of trees? What benefit would be most important to your neighborhood?
Some Findings

- Strong growth in teacher’s G-TPACK (see poster T124)
- Effective modeling to guide students’ GIS analysis
- Additional skill building activities needed – 2 scavenger hunts during first weeks of school
- Interfaces, visualizations, and scaffolding are effective with all students