Promoting Geospatial Analysis in High School: Urban Heat Island Investigation

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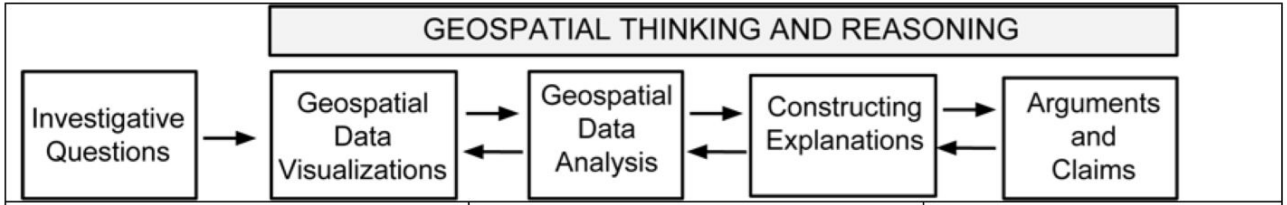
What do we mean by SESI?

Socio-Environmental Science Investigations

- Inquiry-based investigations
- Map-based mobile data collection
- Analysis with Web-based mapping software
- Pedagogical frameworks of place-based education and socioscientific investigations
- Local issue exploration
- Field work in the local setting

Framework



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

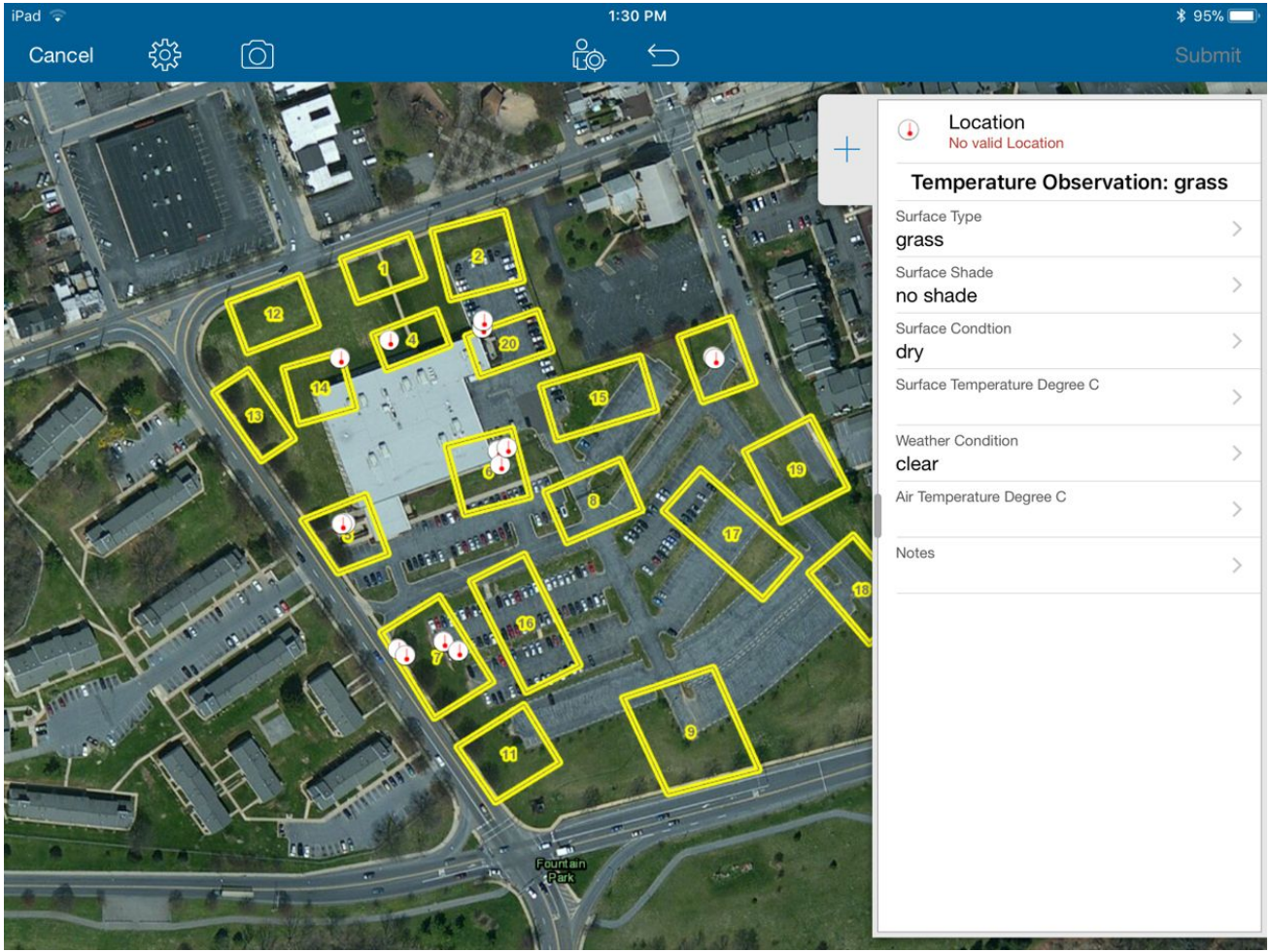
- Use GIS to manage, display, query, and analyze geospatial data.
- Use geospatial analysis to process geospatial data for the purpose of making calculations and inferences about space, geospatial patterns, and geospatial relationships.
- Use geospatial data analysis in which geospatial relationships 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.

About our urban public school setting

- Freshman class of 150-165 students
- All students economically disadvantaged
- Two-thirds Hispanic or Latino
- 21% ELL, 19% have IEPs
- Many (~10-20%) are unengaged learners
  - Do not complete tasks
  - Avoid challenging work

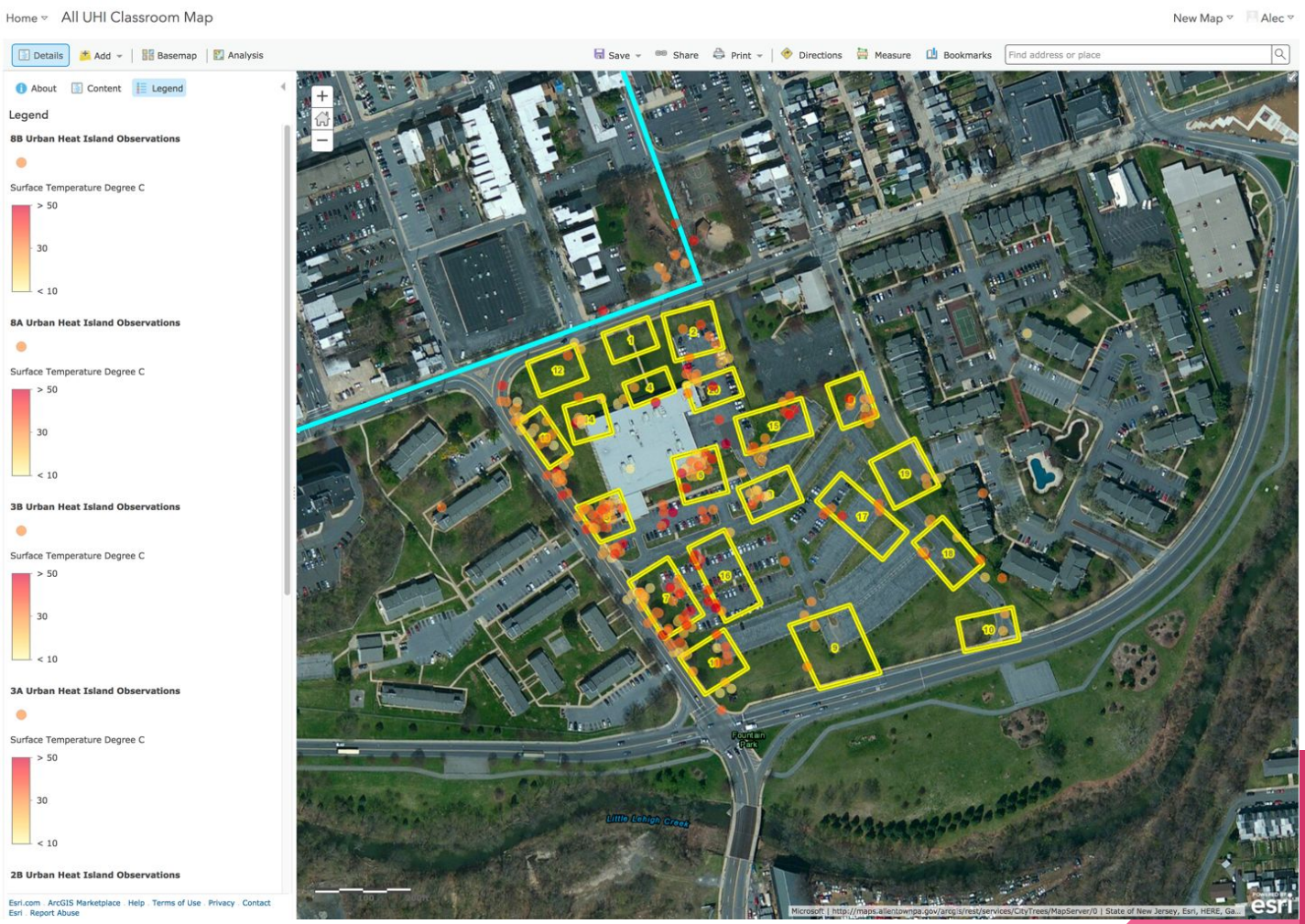
SESI Investigations

- Urban Heat Islands: Students investigate the school property to identify different types of ground surface heat radiation.
- Other investigations: Trees & Ecological Services, Ecosystem Scavenger Hunt, Built Environment Scavenger Hunt, Transportation Modes, Carbon Sequestration, Zoning
- Projects: Tree Planting Project & Culminating Project

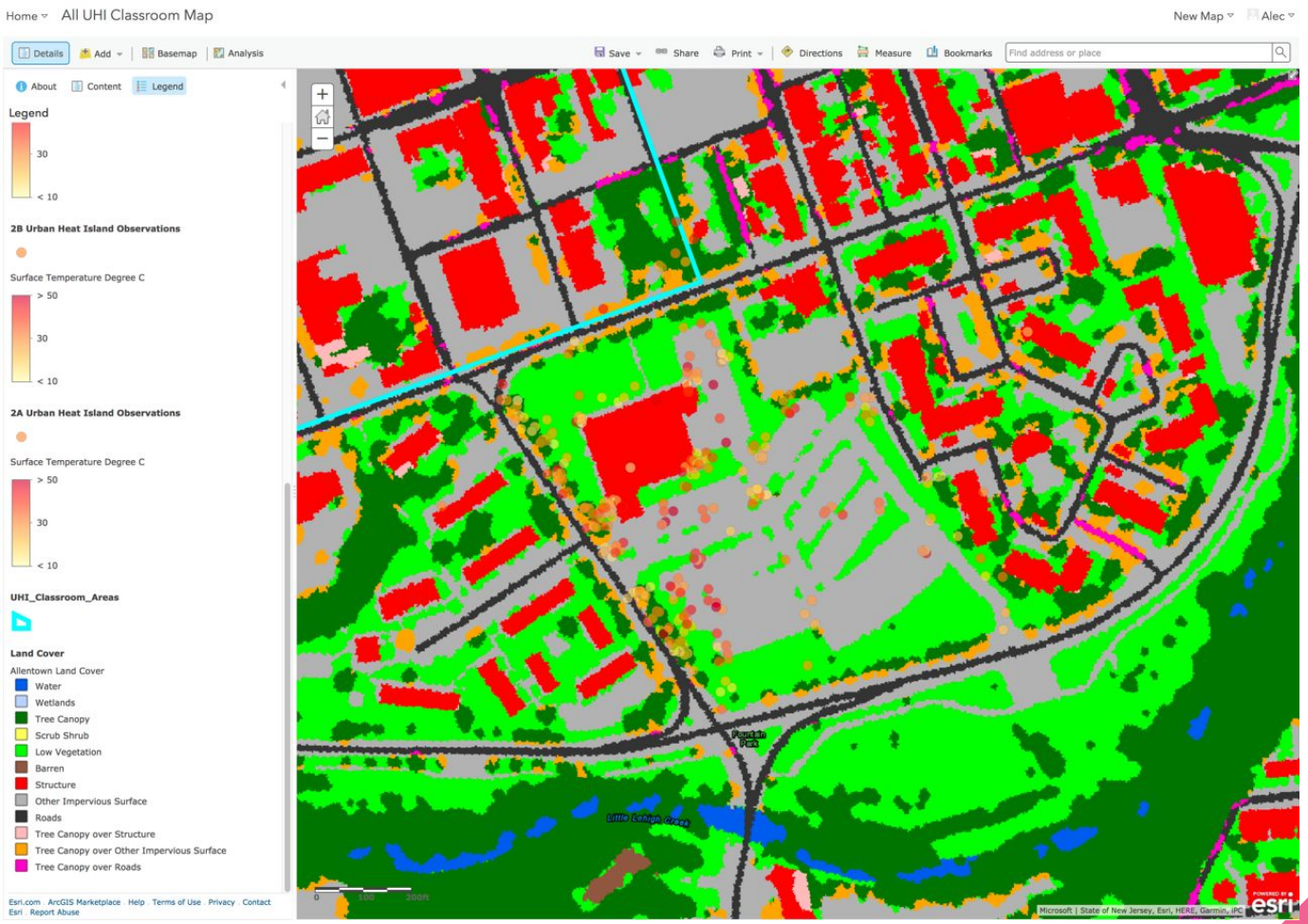


Data Gathering Interface

Observation Point for Analysis



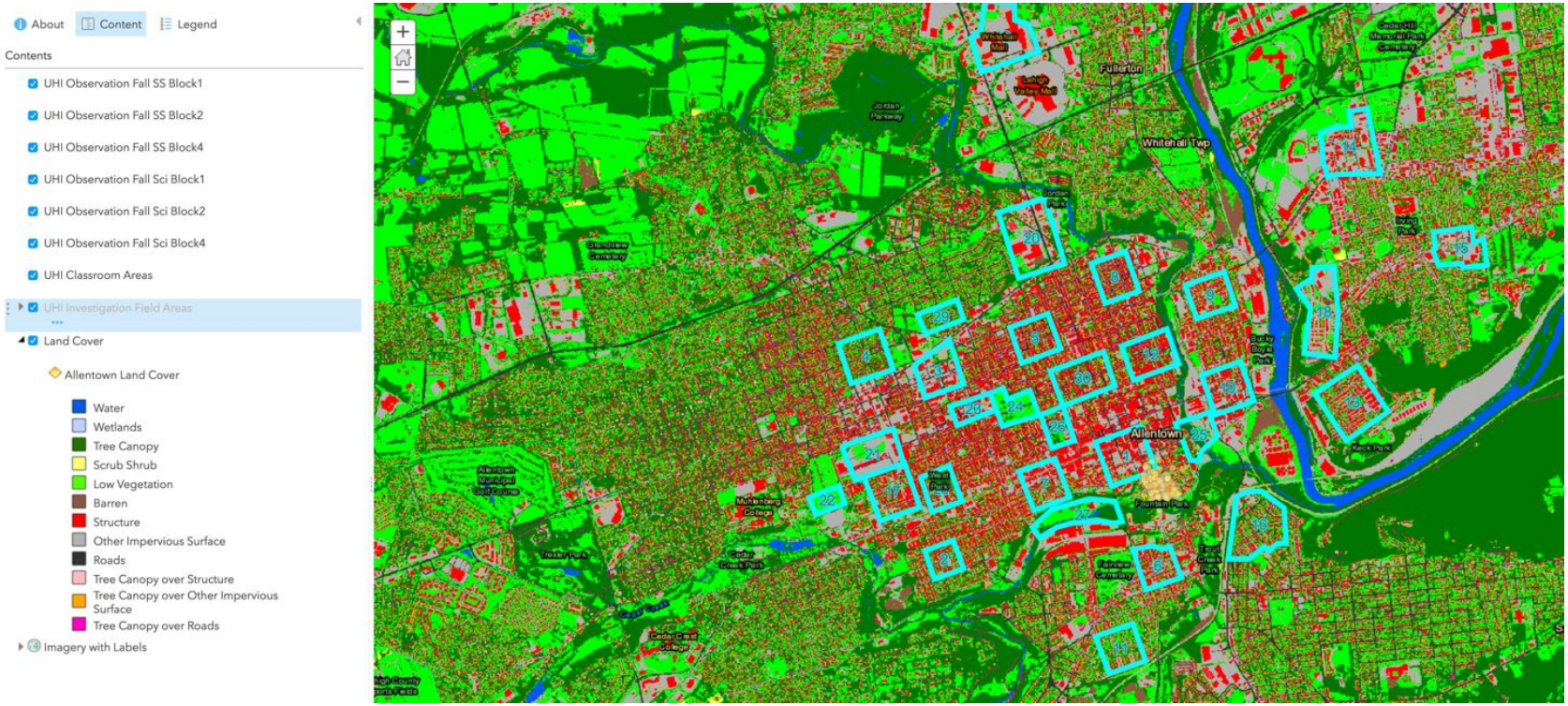
How do surface properties affect heat?



Surface type data layer

Data Analysis Questions

- What surface gave your group the highest temperature reading?
- How did temps of the same surface vary between shaded areas and unshaded areas?
- Rank the averaged surface temps from hottest to coldest (grass, dark asphalt, light asphalt, concrete, dirt, other).
- What is the temperature difference between the hottest and coldest surfaces?
- What was the average air temperature during data collection? How does that compare to your hottest & coldest surface temps?
- How would your measurements change at different times of the year?
- Challenge Question: The weather can change very quickly. Do you think ground temp changes at the same rate as air temp? Why or why not?

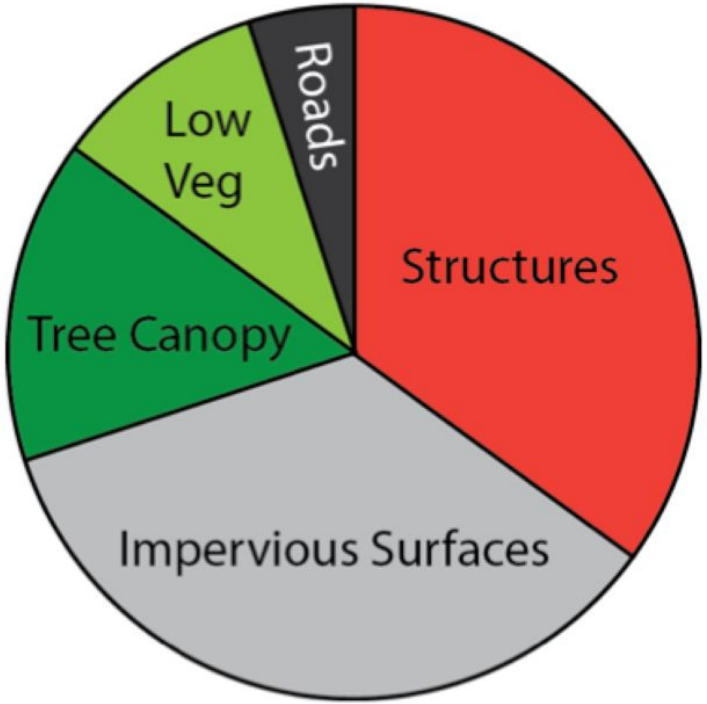


City Land Cover

Analysis questions about the city

- How does the land cover of the center of the city compare to the suburbs (areas outside the center of the city)? Using the data your class collected around the high school, do you predict that downtown Allentown would be warmer or cooler than the suburbs?
- The assigned areas in Allentown are all roughly the same size, but have different amounts of each land cover (buildings, roads, trees, grass, etc.). List two areas that you think would be warmer than average and two areas that would be cooler than average.

Surface	Percentage (%)
Structure	35
Roads	5
Other Impervious Surface	35
Tree Canopy (all kinds)	15
Water	0
Low Vegetation	10
Barren	0



What is your assigned area in Allentown? Estimate the amount of each land cover type in the table. In the circle, draw a pie chart based on your data table. **Label your pie chart.**

Student Artifact: Assigned city area

- Map drawing: Reduce the urban heat island effect
- Articulate changes to do that

Blue polygons signify assigned neighborhoods for student groups.

- Suburban (west)
- Commercial district (central)
- Dense residential (east)

Student Work Sample #1

Student has added:

- Tree canopy (regular polygons)
- Tree canopy over roads (purple lines)
- Green roofs (irregular polygons)

Student Work Sample #2

Student has added:

- Green roof with garden on building (purple)
- White roof instead of black roof (pink)
- Change street to light asphalt (yellow)

Data Analysis Questions

- Some surfaces such as dark asphalt increase the urban heat island effect, but they also are used for vehicle traffic. How can you reduce the effect of asphalt on urban heating while still having roads for people to travel?
- What changes would you make within your selected area to reduce the urban heat island effect without altering land use?
- If you **were** allowed to alter land use, what changes would you make within your selected area to reduce the urban heat island effect?

Implementation Suggestions

- **Prior activities** to get students used to data collection & analysis tools
  - Ecosystem scavenger hunt
  - Trees & Ecological Services
- **Mentors**
  - STEM-related careers, use of geospatial technologies
  - Comfortable working with students
  - Provide orientation
- Work closely with your school's **IT networking** support staff
- Explicit **modelling & scaffolding**
  - Effective for all learners, especially ELLs & students w/ disabilities

Questions & Comments?

- SESI materials are available at: http://www.ei.lehigh.edu/eli/sesi/
- Papers available at: http://www.ei.lehigh.edu/eli/research/pubs.html
- Crime and tree canopy: https://www.fs.usda.gov/treesearch/pubs/40701