Integrated Study of
Natural resources, Human Impact, and Environmental Policy:
Making complex systems accessible for secondary learners

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The study of environmental science has long relied on simulations of complex systems (e.g., ecosystems). Although these simulations are useful to inform policies that affect us all, future citizens and scientists leave high school with little exposure to the tools and reasoning skills associated with constructing and interpreting these simulations. Our work aims to develop a month-long environmental science unit for high school courses that introduces:

1. Agent Based Modeling (ABM), a tool for computer-based simulations of complex systems, and
2. Reasoning skills associated with ABM

**Goal: meet emerging educational standards**

Forthcoming educational standards* stress the need for:

- The use of appropriate tools and methods
- Understanding the intersection of science and policy
- Introducing scientific concepts like:
  - Models as Explanations, Evidence and Representations
  - Scale, Equilibrium, and Interaction
- Multidisciplinary approaches to learning science
- Systems-based analyses of scientific phenomena

**Content area: Green Infrastructure**

"an interconnected network of green spaces that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Schilling & Logan, 2008).

Chosen for:

- Relevance to students’ everyday lives
- Integration of multiple disciplines (Urban Planning, Biology, Environmental Science)
- Importance of models, scale, equilibrium, and interaction to understanding impacts of decisions

**Pedagogical challenges:**

1. How to teach targeting concepts with ABMs?

   **Solution:** conduct iterative, design-based research with sustained input from content experts, classroom teachers, educational experts, and technology experts

2. How to implement computing needed for ABMs in real classrooms?

   **Solution:** rely on existing or low-cost equipment (single desktop computer, projector, webcams, paper) but strive to give access to all students

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*College Board College Preparatory, College Board AP standards for Biology and Environmental Science, Common Core standards of the National Governors Association and the Council of Chief State School Officers

Tools: Agent-Based Models (ABMs)

Computer programs comprised of a set of rule-based agents and a spatially-defined substrate, wherein the interactions among agents (e.g., humans selling property to one another) and with the substrate (e.g., humans building a paved parking lot) can generate emergent patterns at a larger scale (e.g., habitat fragmentation or changes to the hydrological system)

Chosen for:

- Relevance to modern environmental science practice
- Ability to model both natural and human processes, including policy
- Ability to represent standards-promoted issues of Scale, Equilibrium, and Interaction

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**Agent Based Models (ABMs)**

Individual rule-based entities within the models (residents, developers, animals) make decisions in response to scenario conditions.