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

Leilah Lyons
Assistant Professor
Computer Science,
Learning Sciences
llyons@uic.edu

Moira Zellner
Assistant Professor
Urban Planning & Policy,
Institute for Environmental Science & Policy
mzellner@uic.edu

Emily Minor
Assistant Professor
Biological Sciences,
Institute for Environmental Science & Policy
eminor@uic.edu

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:

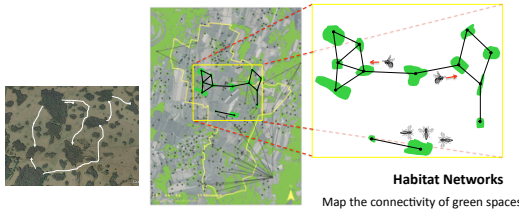
(1) Agent Based Modeling (ABM), a tool for computer-based simulations of complex systems, and
(2) Reasoning skills associated with ABM

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

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



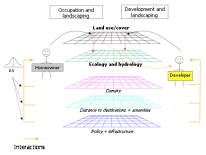
Habitat Networks
Map the connectivity of green spaces in urban/ suburban areas. Important to understanding how animals and plants exist and interact when fragmented by human structures

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



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

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:

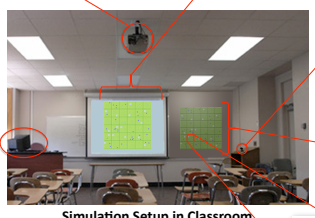
1. How to teach targeting concepts with ABMs?

   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

Step 5. Scaling up
Students subsequently create symbols that represent entire blocks, areas, and regions, using webcams and a low-cost black and white printer



Step 4. Paper-based inputs are used to seed an ABM simulation, projected for the class to view

Step 3. Webcam "reads" paper-based configurations & converts to simulation parameters

Step 2. Individual student landscape designs can be combined to form a region by taping them up on the classroom wall

Step 1. Each student designs a landscape using stickers

Simulation Setup in Classroom

Pre-printed sticker booklets
Each sticker can be recognized via computer vision, and represents an element in the simulation