Urban Ecology & Coupled Human-Natural Systems

2010-2011 Annual Symposium

Interdisciplinary PhD Program in Urban Design and Planning
University of Washington

Seattle, April 29 2011
Urban Ecology & Coupled Human-Natural Systems

Emerging Research Agendas

Three Perspectives

1) Complexity, Resilience, and Adaptation in Coupled Human-Natural Systems
   Marina Alberti and the UERL Team

2) Fully Integrated Physical-Bio-Cultural Phenomena, Including Design &
   Historical Constitution & Value-Orientation: Well-Being, Health, and Justice
   Bob Mugerauer

3) Decisions and Consequences about Infrastructure/Urbanization, the
   Economy, Environmental Systems, and Human Health
   Jan Whittington
Complexity, Resilience, and Adaptation in Coupled Human-Natural Systems
Marina Alberti and the UERL Team
Coupled Human-Natural Systems
Research Questions

1. How do dynamic, coupled human-natural systems evolve to generate emergent patterns of urbanization?

2. How do urbanization patterns and ecosystem processes interact across multiple time and spatial scales?

3. What nonlinearities, thresholds, and path dependencies explain divergent trajectories of coupled human-natural systems?

4. How does urbanization influence ecosystem functioning and human wellbeing, their adaptation, and resilience?

5. How might the resilience of coupled human-natural systems change under alternative future scenarios?

6. How can urban planning integrate this knowledge to enhance resilience and adaptive capacity in urbanizing regions?
Coupled Human-Natural Systems

Diagram:
- Drivers → Patterns → Processes → Functions → Multiple Equilibria → Scenarios
- Scales and scenarios indicated in the diagram.
Collaborative and Affiliate Faculty

Participants and their relationships to integrative questions

Yocom Landscape Architecture
Lawler Forest Resources
Bradley Resource Planning
Shen Urban Design and Planning
Moudon Urban Planning
Blanco Urban Planning
Lettenmaier Civil Engineering
Brett Engineering
Schindler Fisheries
Kim Forest Resources
Tewksbury Biology
Marzluff Wildlife Ecology
Newton Oceanography
Ruesink Biology
Magruder Urban Design and Planning
Sabine Oceanography
Handcock Statistics
Whittington Urban Design and Planning
Salathe Climate Impact Group
Layton Public Affairs
Snover Climate Impact Group

Towards an Integrated Approach to Watershed Planning: The role of land cover, human preference, and biotic condition in managing Puget Sound lowland streams

Assessing the relationships between land cover and housing prices in King County, Washington using Bayesian Model Averaging

Building Political Community via Annexation in White Center: The Role of Culture and Translation

Land use/land cover dynamics: A case study from Palestinian West Bank
Resilience of Hybrid Ecosystems
Resilience of Development Patterns
Resilience of Development Patterns

Diagram showing the relationship between Ecosystem Function and Urbanization, with points A, B, and C indicating different stages or patterns of development.
Resilience of Development Patterns
Pattern Diversity and Resilience
Do Urban Patterns Have different impacts on...

Primary productivity?

Hydrological function?

Nutrient cycling?

Biodiversity?

Disturbance regimes?
Linking Patterns to Ecosystem Function

Patterns
- Land Use
- Land Cover
- Transportation
- Infrastructure

Drivers
- Climate
- Topography
- Economics
- Demographics
- Land Use Policy

Processes
- Climate
- Hydrological
- Biogeochemical
- Biotic interactions

Functions
- Primary Productivity
- Hydrological Function
- Nutrient Cycling
- Biodiversity
- Disturbance Regimes
Linking Patterns to Ecosystem Function

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TIME/SPACE SCALES

FUTURE SCENARIOS
Linking Patterns to Ecosystem Function

TIME/SPACE SCALES

Patterns
- Land Use
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Functions
- Primary Productivity
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Processes
- Climate
- Hydrological
- Biogeochemical
- Biotic interactions

Drivers
- Climate
- Topography
- Economics
- Demographics
- Land Use Policy

Gradients:
- Form
- Density
- Connectivity
- Heterogeneity

FUTURE SCENARIOS
Linking Patterns to Ecosystem Function

TIME/SPACE SCALES

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- Land Use
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Drivers
- Climate
- Topography
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- Demographics
- Land Use Policy

Stressors
- Emissions
- Forest conversion
- Impervious surface
- Heat island

Processes
- Climate
- Hydrological
- Biogeochemical
- Biotic interactions

Functions
- Primary Productivity
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- Nutrient Cycling
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FUTURE SCENARIOS
Linking Patterns to Ecosystem Function

TIME/SPACE SCALES

Patterns
- Land Use
- Land Cover
- Transportation
- Infrastructure

Legacies
- Native ecosystems
- Land cover/use Management

Drivers
- Climate
- Topography
- Economics
- Demographics
- Land Use Policy

Gradients
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FUTURE SCENARIOS
Linking Patterns to Ecosystem Function

**Patterns**
- Land Use
- Land Cover
- Transportation
- Infrastructure

**Stressors**
- Emissions
- Forest conversion
- Impervious surface
- Heat island

**Drivers**
- Climate
- Topography
- Economics
- Demographics
- Land Use Policy

**Processes**
- Climate
- Hydrological
- Biogeochemical
- Biotic interactions

**Legacies**
- Native ecosystems
- Land cover/use
- Management

**Mechanisms**
- Plant uptake
- CO2 N Fertilization
- Plant soil/respiration
- Earthworm activities
- Litter/Woody debris
- Species competition

**Functions**
- Primary Productivity
- Hydrological Function
- Nutrient Cycling
- Biodiversity
- Disturbance Regimes

**Future Scenarios**
Linking Patterns to Ecosystem Function

TIME/SPACE SCALES

Patterns
- Land Use
- Land Cover
- Transportation
- Infrastructure

Legacies
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Drivers
- Climate
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Gradients
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Stressors
- Emissions
- Forest conversion
- Impervious surface
- Heat island

Processes
- Climate
- Hydrological
- Biogeochemical
- Biotic interactions

Mechanisms
- Plant uptake
- CO2 N Fertilization
- Plant soil/respiration
- Earthworm activities
- Litter/Woody debris
- Species competition

Impacts
- Climate change
- Air Pollution
- Biodiversity
- Ecosystem heath
- Human wellbeing

Functions
- Primary Productivity
- Hydrological Function
- Nutrient Cycling
- Biodiversity
- Disturbance Regimes

FUTURE SCENARIOS
Impacts of Urban Patterns on Watershed Quality

Urban Carbon Budgets

Aboveground Carbon 2005 - 2050

Impacts of Urban Patterns on Bird diversity

Predicting Land Cover Change 2000-2050
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers.

One Variable | Multiple Drivers
---|---

**Economy**

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>High</td>
</tr>
<tr>
<td>B</td>
<td>Med</td>
</tr>
<tr>
<td>C</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Climate Change**

<table>
<thead>
<tr>
<th>Economy</th>
<th>Impact</th>
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<tbody>
<tr>
<td>A</td>
<td>High</td>
</tr>
<tr>
<td>B</td>
<td>Minor</td>
</tr>
<tr>
<td>C</td>
<td>Low</td>
</tr>
<tr>
<td>D</td>
<td>Major</td>
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</tbody>
</table>
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers
Hypothetical Example:

Impact of Futures Scenarios on Carbon Budget

Economy

Boom and Bust:
- Global, high turn-over, in out migrations, low job security, private investments, income disparity, instability.

Slow and Steady
- Diversified, long tenure, steady job security, minor population growth, public investments, low steady growth, overall stability

Climate Change

Major Impacts: IPCC Scenario A1
- Temperature increase, summer draughts, winter flooding, high Sea level rise, glacial melting,

Minor Impacts: IPCC Scenario B1
- Few regional events from change in temperature and hydrology
Hypothetical Example: Impact of Futures Scenarios on Carbon Budget

**Economy**

**Boom and Bust:**
- Global, high turn-over, in out migrations, low job security, private investments, income disparity, instability.

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- Diversified, long tenure, steady job security, minor population growth, public investments, low steady growth, overall stability

**Climate Change**

**Major Impacts:** IPCC Scenario A1
- Temperature increase, summer draughts, winter flooding, high Sea level rise, glacial melting,

**Minor Impacts:** IPCC Scenario B1
- Few regional events from change in temperature and hydrology
How might scenarios influence future carbon fluxes + stocks?

Climate Change

- **Major**
  - Past: Blue line, future: Blue line
  - Past: Red line, future: Dashed red line

- **Minor**
  - Past: Blue line, future: Blue line
  - Past: Red line, future: Dashed red line

**Economic growth**
- Past, time, future

**Slow and steady**
- Carbon: Past, time, future

**Boom and Bust**
- Carbon: Past, time, future

- Blue: Stocks
- Red: Emissions
Scientific Challenges

- Better characterization of urban pattern-ecosystem function interactions (gradients, patterns, processes, mechanisms, effects, legacies, and scale).
- Empirical longitudinal studies to assess alternative hypotheses about mechanisms linking urban patterns to slow and fast variables that govern resilience.
- Comparative studies across cities, regions, and biomes to assess mechanisms under different settings and development pathways.
- Assessments of tradeoffs between slow and fast variables associated with patterns of urbanizations.
- Explorations of opportunities for transformation that link patterns of urbanization to technological innovation and behavioral changes.
A New Pedagogic Paradigm

We propose a *transdisciplinary approach and team based* PhD education in which students, faculty, and practitioners work together towards integrating a diversity of knowledge and methods to advance the study of coupled-human natural systems.

- Address key societal questions on the complexity and resilience of urban systems and adaptation to environmental change.

- Develop methods of inquiry and communication skills that overcome the dichotomy between the natural and human worlds;

- Agree on a common set of standards to conduct research that reflects the diversity of world views and research models;

- Integrate sophisticated quantitative and qualitative methods to generate new powerful research strategies and approaches