Application of spatial quantitative methods to study the dynamics of relations between socioeconomic and natural systems

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Research directions

• ‘Application of spatial quantitative methods to study dynamics of relationships between socioeconomic and natural systems’
  – D1. Theoretical issues: natural & man-dominated systems
    • Ecology of territorial systems
    • Microbial Geographical Information System
    • Transformation of former military units into entrepreneurial centers
    • Relationship between ecology and theology
  – D2. Methodological elements for D1
    • Spatial statistics, geo- and biostatistics
    • Management of electronic health records
  – D3. Educational principles and methods for D1 & D2
Ecology of territorial systems: Personal views

- Basic principles: systemic approach, critical reasoning, quantitative & spatial thinking
- System: functional structure
  - Structure: elements & relationships
- Diversity as a key feature of systems
  - Spatial interpretation
- Urban systems vs. ecosystems
- Temporal & spatial scale of landscapes
- Extension of ‘land use’ to natural systems
### Ecology of territorial systems: Diversity

<table>
<thead>
<tr>
<th>Diversity</th>
<th>Ecology</th>
<th>Geography</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eco-diversity</td>
<td>Geodiversity (geology)</td>
</tr>
<tr>
<td></td>
<td>Biodiversity</td>
<td>Geodiversity (geography)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Ecosystem</th>
<th>Geosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotope</td>
<td>Biocoenose</td>
<td>Abiotic sub-system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biotic sub-system</td>
</tr>
</tbody>
</table>

Inter-relationships
## Ecology of territorial systems: Correspondence of the hierarchies of systems in geography, ecology and spatial planning and spatial diversity

<table>
<thead>
<tr>
<th>Hierarchy of ecological systems</th>
<th>Hierarchy of geographic systems</th>
<th>Hierarchy of territorial systems</th>
<th>Spatial diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural &amp; functional subunits of ecosystems</td>
<td>Nano- &amp; micro-structures, house/ block, company/ unit/ section, street/street segment</td>
<td>-</td>
<td>α, ω</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Geosystem, geofacies, geotope, local system</td>
<td>NUTS V (LAU II)</td>
<td>α, ω</td>
</tr>
<tr>
<td>Regional ecological complex</td>
<td>Natural region, geographical region, regional system</td>
<td>NUTS III</td>
<td>β, γ, ω</td>
</tr>
<tr>
<td>Macro-regional ecological complex</td>
<td>Domain, zone, national/ supra-national, continental system</td>
<td>NUTS II/ I, national territory, continent</td>
<td>γ, δ, ε, ω</td>
</tr>
<tr>
<td>Ecosphere</td>
<td>Geosphere, planetary system</td>
<td>Globe</td>
<td>ω</td>
</tr>
</tbody>
</table>
Ecology of territorial systems: Reverted energy pyramid

- Energy used to adapt the territory to dynamic human needs
- Energy used by adaptive processes based on available territorial resources
- Human energy pyramid
  - Humans rapidly develop technologies to access resources and energy
  - Animals
  - Cycling - Balancing

- Biotic energy pyramid
  - Plants

- Solar and geochemical energy
Ecology of territorial systems: Spatial approach to diversity based on the Nomenclature of Territorial Units for Statistics

<table>
<thead>
<tr>
<th>Diversity</th>
<th>NUTS levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Hydro-geomorphologic units (relief)</td>
<td>x</td>
</tr>
<tr>
<td>Biogeographical regions</td>
<td>x</td>
</tr>
<tr>
<td>Ecological regions</td>
<td>x</td>
</tr>
<tr>
<td>Types of ecosystems and/or habitats</td>
<td>CORINE I Anderson 1</td>
</tr>
</tbody>
</table>

- x – indicates that diversity can be approached at a given spatial scale.
Ecology of territorial systems: Diversity

Diversity seen as scatter around a central trend

Maximum homogeneity expressed by unique mode and low coefficient of variability

Homogeneity expressed by unique mode, heterogeneity by low coefficient of variability

Diversity as a collection of homogeneities

Heterogeneity expressed by more modes, but a low coefficient of variability

Maximum heterogeneity expressed by more modes and a high coefficient of variability
Ecology of territorial systems: Human impact

- CLIMATE CHANGE
  - Ecological & biological effects
  - Natural processes
  - Biogeochemical cycles

- HUMAN SOCIO-ECONOMIC SYSTEM
  - Energy
  - Changed biotic conditions
  - Land cover and/or use changes
  - Anthropic processes
  - Socio-economic effects

- NATURAL SYSTEMS
  - Lesser goods and services
  - Ecological effects
  - Natural processes

Deterioration of the environment

Joint effects

Anthropic processes

Socio-economic effects
Ecology of territorial systems: Dynamics of human systems

- Emergence of new structures
- Adaptation
- Urban morphogenesis
- Genesis of rural settlements
- Natural systems
- Creative rural destruction
- Maturity
- Destruction
- Optimal environmental insertion

Increased complexity
Ecology of territorial systems: Sustainability

Conceptual framework: holistic approach

- The environment as hierarchy of organized systems
- Socio-ecological systems as functional structures
- Sustainable development: co-development of socioeconomic systems and natural capital
- Socioeconomic system as a parasite of natural systems (energy and resources)
- Conservation of resources by exploitation within environmental carrying capacity limits

Past: ecological restoration

Present: impact assessment, internalization of externalities

Future: conservation of biodiversity

Sustainable development

Theoretical side
- Application for projects, policies and strategies
- Satisfaction of present and future needs at equal rates
- Integration of socioeconomic, ecological and cultural aspects

Practical side

Territorial dimension
- Focus on human individuals and communities
- Approach at community, local, microregional, national, macroregional, global levels

Cohesion
- Policentricity
- Preservation of identities
Research on the territorial effects of climate change.
Research on urban development analyzed via LC&U changes
Conservation of biodiversity
Hierarchy of geographical, statistical and geostatistical methods: (1) “pure” statistical methods; (2) “pure” geographical methods; (3) very abstract geostatistical methods, belonging more to statistics; (4) less abstract geostatistical methods, belonging more to geography; (5) geostatistical methods equally distanced from statistics and geography – interference area; (6) statistical methods; (7) geographical methods
Methodological developments

- Regression of individual units
- Geo-statistical analysis of time series
- Potential accessibility
- Path efficiency
- Principal Component Analysis integrated with GIS

Species richness in Merhei Lake (DD)
Microbial Geographical Information System: Theoretical background
**Microbial Geographical Information System: Methodology**

Hypothesis: there are differences between regions and structures delimited in space; one of them is the reference

Images of the reference region

Images of the other region, specified by the hypothesis

Image processing to improve its quality, delimiting the components better

Total classification or feature extraction

Transform images in vector GIS maps

GIS analysis with a quantitative output (e.g., computation of areas, angles etc.)

Statistical comparison of the two regions
Microbial Geographical Information System: Results
• Metrics (February 14, 2014)
  – 270 printed papers
    • 126 journal papers (110 cit., 29 mentions, 232 index.)
    • 29 books/chapters (14 cit., 23 mentions, 19 index.)
    • 5 theses (6 cit., 13 index.)
    • 22 conference papers (3 cit., 5 index.)
    • 65 conference abstracts (26 index.)
    • 3 Internet articles
    • 3 Internet abstracts
    • 17 research reports
  – 212 presentations
    • 28 posters (1 cit.)
    • 94 conference presentations (1 cit., 17 mentions)
    • 7 public presentations
    • 83 courses/lectures
  – 27 plans
  – 1 paper in progress
Future directions: Principles

Teaching
- Finding solutions to create quality
- Sending more students abroad
- Improving and updating my courses
- Promoting multi-, inter, and trans-disciplinary approaches

Research
- Integrating trans-disciplinary approaches
- Better subordination of teaching to research
- Completing all projects
## Future directions: Projects

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied statistics</td>
<td>Ongoing / depends on collaborators; Polish study</td>
</tr>
<tr>
<td>Research on climate change impacts &amp; biodiversity at a large scale</td>
<td>Grant submitted in 2013 competition, results due in 2013: “Geographical Information System (GIS) for monitoring the dynamics of biodiversity within urban areas” – URBIOGIS</td>
</tr>
<tr>
<td>New research areas</td>
<td>Energy</td>
</tr>
<tr>
<td>Third doctoral degree</td>
<td>Habilitation in urban planning</td>
</tr>
<tr>
<td>Editorial activity</td>
<td>Research for Sustainable Settlements</td>
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</tbody>
</table>
Future directions: Advertisement

Senior researcher, holder of two PhDs (Ecology & Geography) and a Habilitation Attestation in Urban Planning, without any political affiliation, searching for a serious university able to allow for my career development through a position fitted to my professional achievements and aspirations. Serious offers only, please.

Thank you for your attention and

Welcome your questions.