Eastern Illinois University
New Course Proposal
BIO 4820 – Spatial Analysis for Environmental Sciences

1. Catalog description
   a. BIO 4820
   b. Spatial Analysis for Environmental Sciences
   c. (3-3-4)
   d. F
   e. Spatial Analysis
   f. An introduction to how spatial data are synthesized and interpreted in the environmental sciences. The course will focus on interpretation of remotely sensed data, point pattern analysis, and digital elevation models. Students will become familiar using appropriate software such as Geographic Information Systems (GIS), statistical and modeling software.
   g. Prerequisite: Permission of the instructor
   h. Fall 2006

2. Student Learning Objectives and Evaluation
   a. Students will:
      1. apply the principles of data interpretation and manipulation to environmental problems, including synthesis of multiple data layers (spatial hierarchy);
      2. apply principles of spatial hierarchy to develop conceptual models dealing with environmental problems;
      3. analyze spatial data within a conceptual model framework using appropriate software (such as ArcGIS, Python);
      4. describe how to access world-wide-web sites that serve existing geodata sets (e.g. satellite imagery; soil conservation maps);
      5. identify a group project, write a final report, and present an oral report similar to what would be expected in government or private industry, thus gaining experience in both verbal and written communication;
   b. Assessment will be based on two term exams and a final exam (30 %); class participation (10 %); laboratory exercises (40%), laboratory project, written report and oral presentation (20%)

<table>
<thead>
<tr>
<th>Objective</th>
<th>(30%) Term exam (2) and final exam (1)</th>
<th>(10%) Class participation</th>
<th>(40%) Laboratory exercises (weekly)</th>
<th>(20%) Laboratory project, report and presentation</th>
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<tbody>
<tr>
<td>Apply the principles of data interpretation and manipulation to environmental problems</td>
<td>X</td>
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<tr>
<td>Apply principles of spatial hierarchy to develop conceptual models</td>
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Analyze spatial data with a conceptual model framework using appropriate software

| Describe how to access world-wide-web sites that serve existing geodata sets |
|---|---|---|---|
| Identify a group project, write a final report, and present an oral report |

- Analyze spatial data with a conceptual model framework using appropriate software
- Describe how to access world-wide-web sites that serve existing geodata sets
- Identify a group project, write a final report, and present an oral report

**c. Not technology delivered**

**d. Requirements for students enrolling for graduate credit:**

1. An additional objective for graduate enrollment is to develop more advanced conceptual modeling skills. Specifically, graduate students will learn how to construct diagrammatic flow charts to demonstrate their conceptual models. They will implement their flow-charts in the “model building” sub-program in ArcGIS.

2. While undergraduates will primarily be working with a partner or in a group for laboratory assignments and projects, graduate students will have to work independently. Additionally, the expectation for more advanced communication skills will be put upon the graduate students which will be reflected in the grading of their assignments.

3. Students enrolling for graduate credit will be tested more rigorously during the term and final examinations via an additional section on examinations that will have them demonstrate their achievement of the additional course objective.

4. Assessment will be identical to the undergraduate outline except the above components (1-3) will be integrated into their exams, laboratory exercises and final project.

- Apply the principles of data interpretation and manipulation to environmental problems
- Apply principles of

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<td>Term exam (2) and final exam (1). <em>Graduate students will have additional questions.</em></td>
<td>Class participation</td>
<td>Laboratory exercises (weekly)</td>
<td>Laboratory project, report and presentation</td>
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| Apply the principles of data interpretation and manipulation to environmental problems | X | X | X | X |
|---|---|---|---|
| Apply principles of | X | X | X | X |
Spatial hierarchy to develop conceptual models. *Graduate students will learn how to develop diagrammatic flowcharts.

Analyze spatial data with a conceptual model framework using appropriate software. *Graduate students will apply their flowcharts within ArcGIS’s model builder.

Describe how to access world-wide-web sites that serve existing geodata sets.

Identify an independent project, write a final report, and present an oral report.

<table>
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<th>3. Outline of the Course</th>
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<td><strong>a. Units of time:</strong> 3 fifty-minute lectures and 1 three-hour laboratory for 15 weeks.</td>
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**Week 1**
- Basic terminology
- Why spatial data analysis is different

**Week 2**
- Spatial data models and how they constrain/define spatial data analysis
- Basic statistics and graphs

**Week 3**
- Defining and describing data sets
- Concepts: mapping, geovisualization,

**Week 4**
- Exploratory spatial data analysis
- Map basics

**Week 5**
- Isopleth maps
- Visualizing extreme values, outlier maps

**Week 6**
- Statistical maps vs. conditional maps
- Mapping environmental phenomena
Week 7
- Analysis of counts and proportions
- Probability mapping

Week 8
- Forest image enhancement
- Analysis of image data

Week 9
- Point pattern
- Complete spatial randomness (CSR)

Week 10
- Nearest neighbor statistics
- Ripley's K function

Week 11
- Spatial autocorrelation terminology
- Spatial weights

Week 12
- Randomization concepts
- Bootstrap, and Monte Carlo methods

Week 13
- Variogram concepts and applications
- Kriging; inverse distance weighting

Week 14
- Final project presentations

Week 15
- Final project presentations

Finals week: Final exam

b. Not technology-delivered

4. Rationale
a. Purpose and need: Spatial data analysis is one of the fastest growing fields in environmental sciences. As technology has progressed to capture spatial data remotely, biologists must learn how to use and manipulate these data in a scientific framework. This course will introduce to students many of the concepts needed to understand spatial data as well as provides hands on training to students. In addition, students will learn how to employ the most widely used software packages in their field.

b. Justification of the course level and prerequisites: This course is intended for upper-level undergraduate or graduate students. Ecology is recommended so students have the background in ecological concepts needed to understand examples utilized in class. Additionally, this course will introduce students to the foundations of spatial data analysis. Therefore, the course level is intended for undergraduate and graduate students who understand the need for a quantitative approach to understanding spatial phenomena.

c. This course does not significantly overlap with any existing course within our or any other program. However, it does complement two courses in Geology /
Geography: GEG 3885 – Quantitative Methods in Geography, GEG 4890 – Geographic Information Systems. GEG 3885 explores some spatial statistics, but this is not the focus of the entire course and it does not use them in a modeling framework. GEG 4890 is an introductory course to geographic information systems and focuses on the “input, storage, retrieval, manipulation, analysis, and cartographic display of geocoded data”. The proposed course focuses on how to analyze and model spatially explicit data. It is not a course focused on learning a software system as is GEG 4890. Moreover, students who take both GEG 4890, and the proposed course will have a rigorous education in both the principles and application of spatial data analysis, which is extremely important in the environmental sciences. Lastly, this course will also complement BIO 5380: Landscape Ecology which explores “pattern and heterogeneity across large spatial scales… and implications for populations communities and ecosystem processes”.

Quantitative analysis for BIO 5380 strongly focuses on landscape metrics, which will not be explored in the proposed course. However, those who take BIO 5380 prior to this course will recognize the need to better understand spatial analysis and those who take the proposed course prior to BIO 5380, will have a more rigorous understanding of how to quantify spatial pattern.

d. Program impact:
   1. Elective for undergraduates in the Biological Sciences major and minor.
   2. This course can be used as an elective for graduate students in Biological Sciences.

5. Implementation
   a. The course will be taught by Dr. Karen F. Gaines or any other qualified member of the department of Biological Sciences
   b. No additional costs required.
   c. Texts:

6. A community college course will not be judged equivalent to this course.

7. Date approved by the Departmental Curriculum Committee: 24 October 2005

8. Date approved by COSCC: 11 November 2005

9. Date approved by CGS: 17 November 2005

10. Date approved by CAA: 6 December 2005