

GIS For Environmental Analysis and Modeling

(GIS5305 – Spring 2008)

Instructor:

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Class Hours:

Tuesdays: 2:00 - 4:30 p.m., 0035 Bellamy Building

Office Hours:

Thursdays and Fridays: 2:00 – 3:30 p.m. or by appointment.

Teaching Assistant:

Libin Zhou (lz06c@fsu.edu); Her office hours will be announced later.

Computing Lab Manager (any problem related to computer system):

Mr. Shawn Lewers (SWL2727@fsu.edu)

Course Objectives and Description

The purpose of this course is to train students environmental problem-solving skills using geographic information systems and related analytic techniques. It focuses on the GIS principles, methods, and techniques that are particularly relevant to and useful for problem solving in environmental science and management. Specifically, this course has four major components: an overview of selected GIS principles including data models, scale and spatial sampling, ecological fallacy and modifiable unit problem, time representation, distance, and spatial autocorrelation; a review of the major techniques or issues for environmental data acquisition (GPS-based *in-situ* measurement and aerospace remote sensing) and integration (georeferencing, errors and uncertainties, and spatial interpolation); an introduction to environmental analysis and modeling techniques including cell-based modeling, statistical modeling, cartographical modeling, neural networks, cellular automata, and agent-based modeling; and a discussion of several applied areas of environmental modeling techniques as related to landscape ecology (landscape pattern analysis), hydrology (surface analysis, hydrological feature extraction, soil erosion, and non-point source pollution), natural hazards (flood and wildfire), natural resources management (land cover modeling), environmental planning (land suitability analysis and urban growth modeling).

The course will be taught at the advanced level, with instructor-led lectures, unsupervised lab assignments, reading and discussions, and an independent research project. The lecture focuses on selected topics related to GIS principles, techniques and applications. A substantial component of this course consists of computer-based lab assignments involving the use of one or more GIS-related software packages. Weekly discussion of selected research articles is required for each participant. Each student needs to complete an independent research project and present the result to the entire class.

Prerequisite

An introductory GIS course or equivalent (please check with the Instructor if not sure about this). In

addition to this formal prerequisite, students are expected to have a reasonable background in physical geography, college algebra and univariate and multivariate statistics.

Computing Environment, Software and GIS Lab Policies

Windows based ArcGIS (and some extensions), IMAGINE or/ and IDRISI software packages will be used for class assignments. *However, you must be aware that this is not a software training course. If you are looking for such a course (learning a specific software package), you should visit the homepages for specific software packages. These vendors may provide short training courses or more software-specific training materials.*

You will be given a temporary account in order to log on a computer in COSS GIS Lab. This account may expire by the end of the semester. When you are at the computer lab, you must observe the COSS GIS lab and FSU's related policies. The GIS lab rules include (on the following page):

- *No food or drink in the lab.*
- *Lab computers are for GIS work only. Your other class work is to be done in other labs.*
- *Lab printers are for GIS work only.*
- *DO NOT install software without permission from your instructor or the lab manager. If you need software, ask!*
- *DO NOT save your work on the local machines. Use your Z:\ drive. If you use the local machine or temp directory, others will be able to see your work and it may not be there later.*
- *DO NOT waste color prints, as they are expensive. Use the black and white printer whenever possible.*
- *Be courteous of others in the lab and stay quiet.*
- *Clean up after yourself. Lab attendants will throw out things that are left behind.*
- *DO NOT remove equipment that belongs in the lab from the lab. You will be criminally prosecuted if you are caught.*
- *DO NOT download MP3 or movie files. Most of these websites are compromised by viruses.*
- *Always log-off the computers when you are done, but DO Not shut them down.*
- *No instant messaging is allowed.*
- *Follow the FSU Honor Code and Code of Conduct rules and behave in an adult-like manner.*

It is your responsibility to check and observe these rules. Any violation of these rules can result in the loss of privileges to use this facility. If that happens, it is your responsibility to find an alternative so that you could work on your lab assignments. If you are unsure about a rule or rules, ask a lab employee or Shawn Lewers (swl2727@fsu.edu).

Course Blackboard Site

The Blackboard will be used to host the course lecture and lab materials. You may find the lecture slides there, but there is no guarantee that these lecture materials will be available on time. You will still need to take notes during a lecture session. You are required to check that site from time to time because some important announcements may be posted there. The Blackboard address is: <http://campus.fsu.edu>. You will need to use your FSU email account username and password to access this site. Note that some materials are copyright protected, and you must not share them with any third persons. If you have any questions about this please contact the instructor.

Grading Polices

System:

A	94-100	C	72-76
A-	90-93	C-	70-71
B+	87-89	D+	66-69
B	84-86	D	62-65
B-	80-83	D-	60-61
C+	77-79	F	< 59

In qualitative terms, the grade standards are: **A**, Outstanding, few errors or omissions (if any); **B**, Good, only minor errors/omissions; **C**, Satisfactory, at least one major error/omission; **D**, Poor, several major errors/omissions; and **F**, Fail: many major errors/omissions.

Components:

Components	Description	Weight
Lab assignments	There are 10 lab assignments to be completed within a fixed period of time	25%
Two exams	Non-cumulative; open book and need to be completed within 24 hours	2X20%
Journal article review and discussion	Review a major research article published within recent five years, discuss your review in the class with a powerpoint presentation of 20 minutes or so, and write a review report (no more than 4 pages in double space). Active participating in the discussion is required and bonus points are provided	10%
Research project	Identify a technical or applied topic, write a short proposal, conduct research, present the findings to the entire class, and write a final report (12 pages in double space excluding tables and figures)	25%

Attendance:

Students are required to attend all classes and be punctual. Missing even one lecture can affect your grade substantially. Announcements regarding the course outline and the schedule of the lectures, labs and exam (including changes of these) may be made in class. All organizational/administrative announcements made during the class period are assumed to be known by all students. *Cell phones, pagers, alarms, laptops, calculators, and other electronic devices must be turned off in class at all times. In a lecture session, please do not log on any lab computer!*

Exams:

The exams can involve any material covered in lectures, reading or discussion assignments, and labs. There is no provision for extra credit work. A make-up exam might be arranged only when you present an acceptable excuse: documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Most other excuses for missing an exam are not acceptable. This policy will be strictly

applied.

Lab grading policies:

Grades of your lab exercises are based on the quality of your answers. Any answer should be concise and be well organized. They must be **in print**. The grade for each of the exercises is reported as *points_scored /total_points_of_exercise*. For example, if an assignment is worth 20 points and your answers score 16 points then you should see 16/20 on your marked assignment.

Each of the assignments will have a due day clearly written on the first page of your lab assignment. The due time is 5:00 p.m. on the due day. Any assignment that is turned in after the due time on the due day is considered late, which will receive penalty strictly.

The penalty for a late assignment is based on the number of days late (including weekends). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. Late assignments are penalized **20%** per day. Here is the formula for calculating the points of a late assignment:

$$\text{Points}_{\text{get}} = \text{Points}_{\text{scored}} - 0.20 * \text{num_days_late} * \text{Points}_{\text{scored}}$$

The minimum value of *Points_get* is 0. Assignments handed in after I have returned the graded assignment to class (usually one week after the due date) will receive no points. Again, you must provide acceptable excuse (see exam section) in order to receive more time for you to complete lab exercises without penalty applied. You should discuss with your lab instructor about your situation no later than the due day. This policy will be applied stickily.

Note that every person must hand in his or her own lab assignments. Working together is permitted and encouraged, BUT each person will be graded separately, must answer "creative response" questions independently, and must create his or her OWN maps. Turning in identical or substantially similar assignments will result in significant grade reduction.

Journal article review and discussion:

Each participant is required to review at least one major research article chosen by yourself. The article must be chosen from a major scholarly journal (check Section Course Materials for details). You are **NOT** allowed to use any web materials to replace a journal article. Each participant needs to do a 15-minute powerpoint presentation and lead discussion for one article. The leader is expected to prepare a set of questions (5 or so) for that particular article in one week before the actual discussion. These questions should be posted on the Blackboard site momentarily with the help of the Instructor, and each student will need to address these questions when reading through that article. The leader should prepare some slides to initiate the discussion, and summarize the major findings resulting from the classroom discussion. The summary report is due one week after the discussion. Each discussion session could last up to 30 minutes depending upon the topic. All students are expected to participate the discussion.

Research project:

Will be discussed in a separate document.

Course Materials

There is no required text for this class. However, you should have at least two books on hand for reference: one book on environmental or physical geography and the other on GIS fundamentals.

Here are two recommended books on environmental or physical geography:

- **Marsh, W. M. and Grossa, J. M., 2002. *Environmental Geography: Science, Land Use, and Earth Systems* (2nd edition). New York: Wiley and Sons: 440p.**
- Strahler, A. and Strahler, A., 2006. *Introducing Physical Geography* (4th edition). New York: Wiley and Sons: 728p.

There are a few recommended books on GIS fundamentals:

- Burrough, P.A. and R. A. McDonnell, 1998. *Principles of Geographic Information Systems*. New York: Oxford University Press, 333 p.
- **Lo, C. P. and A. K. W. Yeung, 2007. *Concepts and Techniques of Geographic Information Systems* (2nd). Prentice Hall, New Jersey, 492p.**
- Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. 2005. *Geographical Information Systems (Abridged; 2nd)*. New York: Wiley and Sons. 358p (with CD).
- Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. 2005. *Geographical Information Systems and Science*. New York: Wiley and Sons. 454p.
- McMaster, R. B. and User, E. L. (Ed.), 2004. *A Research Agenda for Geographic Information Science*. CRC Press (note that most of the materials included in this book can be accessed from UCGIS website-www.ucgis.org; go to priorities/research)
- **Zeiler, M., 1999. *Modeling Our World: The ESRI Guide to Geodatabase Design*. ESRI Press, Redlands, California, 199p.**

Here is a list of useful GIS books relating environmental applications :

- Bartlett, D., 2004. *GIS for Coastal Zone Management*. Taylor & Francis. 328p.
- Bourgeron, P. S., Jensen, M, and Lessard, G., 2001. *A Guidebook for Integrated Ecological Assessments*. Springer, 552p.
- Clarke, K. C., Parks, B. O. And Crane, M. P., 2002. *Geographic Information Systems and Environmental Modeling*. New Jersey: Prentice Hall. 306p.
- Convis, C. (eds.), 2001. *Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism*. Redlands, CA: ESRI.
- Costanza, R., Constanza, Voinov, A., 2003. *Landscape Simulation Modeling*. Springer, 330p.
- DeMers, M. N., 2002, *GIS Modeling in Raster*. New York: John Wiley & Sons. 203p.
- Goodchild, M. F. et al. (eds), 1993. *Environmental modeling with GIS*. New York: Oxford University Press. 520p.
- Goodchild, M. F., Steyaert, L. T., Parks, B. O, Johnston, C., Maidment, D., Crane, M., and Glendinning, S. (eds), 1996. *GIS and Environmental Modeling: Progress and Research Issues*. Wiley and Sons, 504p.
- Gurnell, A. M.and D.R. Montgomery (edited), 2000. *Hydrological Applications of GIS*. John Wiley, New York, 176 p.
- Halls, P. J., 2001. *Spatial Information and the Environment*. Taylor & Francis, 328p.
- Heuvelink, G. and Goodchild, M. F., 1998. *Error Propagation in Environmental Modelling With GIS*. Taylor & Francis, 127p.
- Johnston, C. A., 1998. *Geographic Information Systems in Ecology*. Blackwell Publishing,

- 239p.
- Lang, L., 1998. *Managing Natural Resources with GIS*, Redlands, Redlands, CA: ESRI.
 - Long, E. T., 2003. *Coastal and Marine Geo-Information Systems*. Springer, 620p.
 - Longley, P.A., Goodchild, M.F., Maguire, D., and Rhind, D.W., 2005. *Geographical Information Systems (2nd Edition) (Abridged)*, New York: John Wiley & Sons. 358p.
 - Lyon, J. G., 1995. *Wetlands and Environmental Applications of GIS*. CRC Press, 400p.
 - Maidment, D. and Djokic, D., 2001. *Hydrologic and Hydraulic Modeling Support W Geographic Information Systems*. Redlands, California: ESRI. 216p.
 - Maidment, D. and Morehouse, S., 2002. *ArchHydro: GIS for Water Resources*. Redlands: ESRI. 220p.
 - Malczewski, Jacek, 1999. *GIS and Multicriteria Decision Analysis*. John Wiley, New York, 392 p.
 - Millington, A., Walsh, S. J., and Osborne, P.E., 2001. *GIS and Remote Sensing Applications in Biogeography and Ecology*. New York: Springer. 344p.
 - Mladenoff, M. G. and Baker, W.L., 1999. *Spatial Modeling of Forest Landscapes*. Cambridge University Press, 364p.
 - Shamsi, U.M., 2002. *GIS Tools for Water, Wastewater, and Stormwater Systems*. ASCE Publications, 375p.
 - Skidmore, A. (ed), 2002. *Environmental Modelling With GIS and Remote Sensing*. Taylor and Francis.
 - Wainwright, J. And Mulligan, M. (Ed.), 2004. *Environmental Modeling: Finding Simplicity in Complexity*. Wiley, 408p.
 - Wilson, J. P. And Gallant, J.C., 2000. *Terrain Analysis: Principles and Applications*. New York: John Wiley, 479p.
 - Wright, D. J. (ed), 2001. *Undersea with GIS*. Redlands: ESRI Press. 253p.

Journal articles:

In this course, journal articles will be recommended to students to read. Students should constantly check the following journals for useful articles on GIS theories and applications:

- *International Journal of Geographic Information Science*
- *Transaction in GIS*
- *Computer, Environment and Urban Systems*

Because students in GIS classes come from different disciplines, they can refer to professional journals in their own fields to find useful GIS application papers, e.g. for landscape architects, a journal such as *Environmental Planning* and *Landscape and Urban Planning* will be useful. Two other geography journals are also useful: *Applied Geography* and *The Professional Geographer*. Also environmental management and natural resources journals contain more and more GIS papers (e.g. *Landscape Ecology*, *Ecological Modeling* or *Journal of Environmental Management*)

Electronic discussion groups and internet for GIS:

Students with an electronic mail account can sign up for an electronic discussion group on GIS. The most important group is called GIS-L. There are many discussion groups for individual software, e.g., there is one for ARC/INFO, one for IDRISI.

Another trend in GIS is the use of Internet to deliver GIS data and maps. Some GIS analyses can also

be done through the Internet. You should constantly check the websites. There are many websites on GIS. You can use a search engine, such as <http://www.yahoo.com/> to search for them. If you are reading this syllabus in our GIS class website, you will be directed to link to a number of important websites for information on programs and data. The following websites (URL) are a must for you to explore:

- <http://www.usgs.gov/> [USGS WEBSITE]
- <http://www.esri.com/> [ARC/INFO WEBSITE]
- <http://www.idrisi.com/> [IDRISI WEBSITE]
- <http://www.census.gov/> [US CENSUS BUREAU WEBSITE]

Honor Code

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at <http://dof.fsu.edu/honorpolicy.htm>.)

PLAGIARISM: All submitted assignments must be your own original, independent work. All sources must be properly cited(especially in the graduate student paper). Ask the instructor if you are unsure what to do. Plagiarism will result in significant grade reduction.

ADA Requirements

Students with disabilities needing academic accommodation should:

- (1) register with and provide documentation to the Student Disability Resource Center; and
- (2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the:

Student Disability Resource Center
97 Woodward Avenue, South
108 Student Services Building, FSU
Tallahassee, FL 32306-4167
(850) 644-9566 (voice)
(850) 644-8504 (TDD)
sdrc@admin.fsu.edu
<http://www.disabilitycenter.fsu.edu/>

Spring 2008 Tentative Schedule

Weeks	Date	Lectures	Labs	Readings	Discussion/ Comments	
1	1/8	Introduction: Course overview, GIS overview, environment and GIS, and ArcGIS overview	Lab 0: Introduction to ArcGIS (optional)	Zeiler (3)/Lo (1)/handouts	Video: the world in a box	
2	1/15	GIS principles I: Data models, scale, and spatial sampling	Lab 1: Exploring the structure of geodatabase	Zeiler (1)/Lo (3)/handout	Discussion guideline	
3	1/22	GIS principles II: Ecological fallacy and MAUP, time representation, distance and spatial autocorrelation	Lab 2: Spatial variability of environmental data	Peuquet (8)/Tracking Analyst Extension	Project guideline/article title/pdf due	
4	1/29	Environmental data acquisition and integration I: Online databases/GPS/remote sensing	Lab 3: Handling temporal data	Lang (33)/Barnsley(33)/ Lo(8)	Questions for first 2 papers due	
5	2/5	Environmental data acquisition and integration II: Georeferencing and issues of error and uncertainties	Lab 4: Georeferencing raster data	Seeger (30)/ Fisher (13)/Understanding MapProjections	Proposal due/Review 1	
6	2/12	Environmental data acquisition and integration III: Spatial interpolation of environmental data	Lab 5: Interpolating environmental data	Mitas(34)/Yang(2000)/ArcGIS Extension	Review 2	
7	2/19	Exam One				
8	2/26	Environmental data analysis and modeling I: GIS-based spatial analytic techniques and introducing environmental modeling techniques	Lab 6: GIS for natural resources management	Getis(16)/Openshaw(18)/Couclelis(2002)	Review 3	
9	3/4	Environmental data analysis and modeling II: Cell-based modeling and geo-hazard analysis	Lab 7: GIS-based geo-hazard analysis	Zeiler(9)	Review 4	
10	3/11	FSU Spring Break				
11	3/18	Environmental data analysis and modeling III: Digital elevation model, surface analysis and wild fire modeling, and hydrological network modeling	Lab 8: GIS-based hydrological network modeling	Band(37)/Floriani(38)	Review 5	
12	3/25	Environmental data analysis and modeling IV: Soil erosion modeling and non-point source pollution modeling	Lab 9: Soil erosion modeling	Handout	Review 6	
13	4/1	Environmental data analysis and modeling V: Landscape metrics and spatial pattern analysis	Lab 10: Landscape pattern analysis	Turner(2000)	Review 7	
14	4/8	Environmental data analysis and modeling VI: Land cover change modeling and urban growth modeling	Lab 11: Land cover change modeling	Handout	Review 8 Bonus video show	
15	4/15	Exam Two				
16	4/22	Research Presentations/Report Due Midnight April 22				