GIS in Water Resources (CIVE 853-3 credit hours), Fall 2017
University of Nebraska-Lincoln

Course Information
Date: Tue- Thu, 12:00-1:15 PM
Location: Scott Engineering Center (SEC) N15 (computer lab). City campus
Website: http://snr.unl.edu/kilic/giswr/2017

Course Instructor: Dr. Ayse Kilic
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Course Description
Application of Geographic Information Systems in Water Resources. Familiarization with a wide range of spatial information used in hydrologic and water resources analysis. Development of expertise in GIS systems, especially ArcGIS. Digital mapping and analysis of water resources information. Spatial coordinate systems and reprojection. Hydrologic terrain analysis using digital elevation models. Integration of time series and geospatial data. Hydrologic Information Systems. River and watershed networks. Evapotranspiration, Precipitation (PRISM), Soil, and Landuse maps, and databases. Use of Remote Sensing tools. The use of ArcPy programming and Google Earth Engine.

Prerequisites
Graduate standing in Engineering or a related discipline in Natural Resources or Earth Science.

Course Objectives
The course exercises and labs will enable you to:

- Create a base map of a study region including watersheds, streams, and aquifers by selecting features from regional maps;
- Use ESRI database products from the ESRI web site and ESRI cloud computing;
- Interpolate measured data at points to form raster surfaces over a region, and spatially average those surfaces over polygons of interest;
- Conduct hydrologically related calculations using map algebra on raster grids;
- Build a geometric network for streams and rivers;
- Analyze a digital elevation model of land surface terrain to derive watersheds and stream networks;
- Plot a map of a hydrologic region including measurement sites and associate it with time series of data measured at those locations; Develop a Hydrologic Information System that links time series of water observations to locations where the measurements are made;

- Use remote sensing information (Evapotranspiration, vegetation indices) along with PRISM precipitation, SSURGO soil information, and NLCD (National Land Cover Dataset) landcover maps to produce water balance information for a basin
- Introduction to Google Earth Engine - Cloud computing platform for processing Earth observation data
- Develop spatial maps of hydrologic impacts of intense precipitation events

The course content will also include:

Remote Sensing component

- Principles of Satellite-based Remote Sensing
- Derivation of surface reflectance, and biophysical variables including vegetation indices, Landuse Maps, and surface temperature maps
- Application with satellite data (Landsat)
- Production of Evapotranspiration maps using Google EEFlux

Programming/Cloud computing for handling spatial datasets

- Introduction to Model Builder within ESRI
- Introduction to ArcPy (Python site package to perform geographic data analysis, data conversion, data management, and map automation with Python)
- Development of expertise in GIS systems, especially ArcGIS with an introduction to tools that utilize ESRI-based cloud computing and stored resources and data layers within ESRI-ArcGIS systems.
- Introduction to Google Earth Engine JavaScript for processing earth observation data (Satellite Remote Sensing data) and calculation of hydrological variables.

The labs/exercises that we will develop will utilize data from the following important regions where currently conflicts and competition for water exist:

i. Klamath Basin, California, and Oregon
ii. Everglades, Florida
iii. Platte River, Loup River, Nebraska
iv. Colorado River Basin (Colorado, Wyoming, Arizona, Nevada, California)

Tentative Class Schedule (Exercises are in yellow)

Week	Day and Date	Subject
1	T, Aug 22	Course Overview. Introduction to GIS in Water Resources.
1	TR, Aug 24	Introduction to ArcGIS software
2	T, Aug 29	Geodesy, Map projections, Reprojection, and Coordinate systems
2	TR, Aug 31	Exe. 1. Datum, Scales, and Projections.docx
3	T, Sep 5	Data sources for GIS in water resources
3	TR, Sep 7	Exe. 2. Building a Base Map
4	T, Sep 12	Spatial analysis using grids
4	TR, Sep 14	Exe. 3. Spatial analysis (Model Builder geoprocessing capability to program a sequence of ArcGIS functions/Raster Calculator to calculate watershed attributes/Spatial Interpolation)
5	T, Sep 19	The Concept of Reference Evapotranspiration/ASCE-Standardized Reference Evapotranspiration Equation
5	TR, Sep 21	Exe. 4. Weather data and Quality Assessment and Control of Automated Weather Data
6	T, Sep 26	Digital Elevation Based Watershed and Stream Network Delineation.
6	TR, Sep 28	Exe. 5. Watershed and Stream Network Delineation
7	T, Oct 3	Remote Sensing: Principles of Electromagnetic Radiation/ Spectral Characteristics of Vegetation & Water bodies/Creating Color Composites from individual bands
7	TR, Oct 5	Exe. 6. Working with Landsat Imagery, NLCD, and DEM
8	T, Oct 10	Exe. 7a. Estimation of Evapotranspiration from Landsat NDVI
8	TR, Oct 12	Exe. 7b. Evapotranspiration- Energy Balance Algorithms/EEFLUX (Earth Engine Flux)
9	T, Oct 16-17	***Fall Break*** *(Student Holiday - UNL offices open)*
9	TR, Oct 19	Continue on Exe 7.
10	T, Oct 24	Introduction to Programming in Python and ArcPy

10	TR, Oct 26	ArcPy Programming (raster calculator, extract subdataset, clipping etc): Processing NLDAS gridded data
11	T, Oct 31	Water Data in Space and Time
11	TR, Nov 2	Exe. 8a. Space-time Analysis of water data via ArcGIS
12	T, Nov 7	Python/ArcPy. Dynamically change file names, 2.Loop through a text file to read parameters (use if, elif, for in, split etc.)
12	TR, Nov 9	Exe 8b. Spatial interpolation via ArcPy and Data visualization (space-time analysis of water data)
13	T, Nov 14	ArcHydro Ground Water Model (Dr. Maidment)
13	TR, Nov 16	Google Earth Engine- - Introduction to Earth Engine Playground/ Accessing earth observation data and visualization
14	T, Nov 21	Cloud Computing via Google Earth Engine: Analysis of Gridded Weather and Land Information System (NLDAS/GRIDMET)
14	TR, Nov 22-26	**Thanksgiving break!!**
15	T, Nov 28	More on Google Earth Engine Playground and Cloud Computing
15	TR, Nov 30	Individual study and Assistance for Term Projects
16	T, Dec 5*	Individual study and Troubleshooting for Term Projects (* 15 week policy)
16	TR, Dec 7*	Catchup and Review, Course evaluation (* 15 week policy)
	TR, Dec 14	FINAL EXAM (Oral Presentation of Term Project - TR, 3:30 to 5:30 p.m.)
	F, Dec 15	Submission of written report (F, Dec 15/5:00 pm)

Course Web Sites

http://snr.unl.edu/kilic/giswr/2017/. This website will contain copies of the course outline, PowerPoint presentations and class exercises, and term papers from past years.

The lectures will be live streamed using Adobe Connect: https://connect.unl.edu/giswr/

Some lectures/exercises might be recorded at the discretion of instructor.

Method of Instruction

The course has six elements: lectures, assigned reading materials, homework (labs) exercises, a term paper, class interaction, and take home examinations. All students will prepare a term project in Adobe pdf format that will be posted on the course web site. The course material is divided into modules with each module having one or two lectures and a homework and lab exercise involving extensive use of GIS software.

Term Project

The purposes of the term project are:

1. To explore an aspect of use of GIS in water resources that is of interest to you and to develop experience in the use of GIS technology to solve a specific problem.
2. To provide experience in the formulation, execution and presentation of original research, including the proper documentation of a GIS project.
3. To make an oral presentation and produce a report that will be informative to you and to your classmates.

The time steps in carrying out the term project are:

1. Prepare a 1-page proposal by Oct 24 specifying the objective of your project and outlining how you plan to go about executing it. After making any revisions in your proposal that seem necessary in the light of an assessment by the instructor, this proposal defines the scope of your term project.
2. Prepare a 2 page status report on your project to be submitted by Nov 14. You are expected to make some progress by mid-semester but the main effort on your term project will be in the later part of the course once you've learned more about the methods in the course. This report will be read and commented on by the instructor, and perhaps other students.
3. Make an oral presentation in class during the final examination on Dec 14, Thursday (you will have about 10 minutes for your presentation).
4. Prepare a written report (term paper) and submit it electronically by 5:00 pm on December 15, Friday.

If you would like to work in a group to pursue a term project, that is fine, but you must carry out a particular section of the project on which you will present orally and as a written report. However, an individual term project is highly recommended. You will find specific guidelines for each part of tem project (oral presentation and written report) at the end of this syllabus.

Course Computer Environment
This course uses the ArcGIS version 10.2 (or 10.5) software. The Spatial Analyst and 3D Analyst extensions of ArcGIS will also be used in the course. These programs run under the Windows operating system. ArcGIS is available in the College of Engineering Lab (N15) in Nebraska Hall (City Campus). The software is also available at SNR teaching Labs (Rooms 142 and 141) of Hardin Hall in East Campus.

If you have access to the software elsewhere, you can do the computer assignments at that location. You should plan to back up your work on a removable drive (e.g. zip or thumb) to avoid complications from lack of disk space in your personal area.

The instructor should have student copies of ArcGIS freely available to load on your personal computers (not on any UNL computers).

Course Readings
There is no book required for this class. Readings for this course will be given out as in-class handouts, links to resources on the web, including the ArcGIS help site, which is quite useful and helpful, and written class power point slides.
Recommend Reading: Arc Hydro: GIS for Water Resources by David R Maidment, Scott Morehouse http://www.amazon.com/Arc-Hydro-GIS-Water-Resources/dp/1589480341

Method of Evaluation
Course grades will be based on a weighted average of results as follows:

1. Homework 60%
2. Class participation/interaction: 10%
3. Term Project: 30%
    3a. Term Project Written Report 20%
    3b. Term Project Oral Presentation 10%

Letter grades will be assigned as follows:
A = 95 – 100%; A- = 90 – 95%
B+ = 87 – 90%; B = 83 – 87%; B- = 80 – 83%
C+ = 77 – 80%; C = 73 – 77%; C- = 70 – 73%; D = 60 – 70%; F < 60%

- There will be no make-up or incomplete grades in this course. We reserve the right to change the date of an exam or drop an exercise with notice in advance.
- Class attendance will not be recorded in this class and will not form part of the criteria for establishing grades. However, the lectures are NOT recorded, therefore, attendance is strongly encouraged.

Course/Instructor Evaluation Plan
Course/Instructor evaluation will be conducted according to the policies of university.

Students will receive an email with a link to the evaluation website. In addition, there is going to be a link to the evaluation website via blackboard.

I encourage students to speak to me on any problems related to the course during the semester.

Students with Disabilities
The University of Nebraska provides upon request appropriate adjustments for qualified students with disabilities. For more information, 132 Canfield Administration Building or contact the Office of the Dean of Students at 472-3787.

Course Drop Policies
Refer to university Course drop policies and dates at
http://law.unl.edu/academics/academic_calendar.shtml

Acknowledgement:
This course was previously co-taught by the three universities of University of Texas- Austin (Dr. David Maidment), Utah State University (Dr. David Tarboton), and University of Nebraska (Dr. Ayse Kilic). As of 2014 the course is offered independently at University of Nebraska by Dr. Kilic. Acknowledgement is given to University of Texas and Utah State University for the use of some of their original lecture materials.

GUIDELINES FOR YOUR TERM PROJECT

Here are some guidelines for your term project.

1. Grading. Term paper (20%) + Oral Presentation (10%) of your overall grade.
2. Term project has (a) written report (paper format) and (b) presentation parts. The specific details for each part are given below.
3. The format and grading policy for your term paper is based on (a) Content of paper (70%) and presentation of materials in the paper (30%).
4. The due date for your term paper is 5:00 pm on December 15.
5. You can email me (akilic@unl.edu) either a word or pdf file of your term paper. Please include "GIS in WR" or "CIVE 835" on the subject of your email
6. Term paper should be 8 -10 pages that is prepared in word or PDF. It should include text, maps and graphs that comprise your project.
7. Each student will give an oral presentation on the day of final exam date.
8. Each student can use up to 10 minutes for his/her presentation. The ppt should be composed of not more than 15 slides. You need to email me your power point presentation prior to class and bring a copy (flash drive)

Guidelines for Presentations

1. You will have **10 minutes** for your talk – 8 minutes for the presentation and 2 minute for answering questions. You must not go over time or you will be cut off
2. Don't spend too much time on the introduction, one or two slides is enough, and then get to the heart of what you want to say
3. Think of the **one concept** or image or idea that you want your audience to take away from your talk and arrange all your material around that
4. There is not time to say everything important, only what is **most important**
5. Use **pictures** and **diagrams** wherever possible, they are more effective than words on slides
6. For slides with just words on them
7. Have a maximum of **five** bulleted points per slide, four is better than five.
8. For each bulleted point, have a maximum of 10 words, preferably 5 or 6 words, **less is better** than more
9. Highlight in **color** the one or two key words in each bulleted phrase
10. Use large font size on all text and labels of graphics so that they can be viewed from the back of the class room.
11. Stay away from red fonts, symbols and lines, which do not project well, and especially reds and green colors that can not be distinguished by people with color blindness

Guidelines for Term Papers

(A) Content of the paper

1.Correctness. Is the analysis and interpretation technically correct?
2.Substance. Is the analysis and interpretation sufficiently substantial that demonstrates some original thinking and application beyond what has been done in class exercises? The work done should be sufficient to address the objective or questions posed.
3. Understanding. Does the work presented show understanding of the problem being addressed and include an interpretation of what the results or outcomes mean in the context of the problem posed?
4.Use of GIS. Does the work done use GIS for producing maps (nicely labeled and quantitatively annotated with scale, labeling and legend appropriate for the context), gathering and organizing the data and performing spatial analysis?

(B) Presentation
5.Writing. Is the writing clear, concise and organized? Should include introduction, statement of objectives or problem, method, results, discussion, conclusion. These should be balanced. The writing should be simple and direct, avoiding jargon to the extent possible.
6.Do not copy text directly from the web, ArcGIS help or a paper. That is plagiarism and is a serious academic offense. I want you to 'digest' the material and restate it in your own words. You can copy figures or equations from the paper as long as you provide the citation for it (to give credit).
7.Visuals (Maps, Figures and Tables). Are the maps, figures and tables clearly presented with axes labeled, units given, and presented in the best way possible to support the analysis and interpretation?

POTENTIAL TOPICS FOR TERM PROJECT:

1. Spatial interpolation within ArcGIS for transforming point based hydrological measurements to a gridded surface.
2. Create GIS hydrologic data for a watershed that you select
    a. Delineate watershed to create base map with outline and streams as blue lines,
    b. soil map, elevation, land use
    c. Conduct an analysis with these dataset beyond what has been done in class exercises
3. Python/ArcPy application to conduct hydrologic analysis
4. Google Earth Engine Application with any or multiple earth observation data including Landsat, GRIDMET, NLDAS, GLDAS and conduct hydrologic analysis.
5. Applying a hydrologic process model such as below to a watershed. The model can include
    a. EEFLUX (Earth Engine FFlux) or METRIC- land surface energy balance model for estimating evapotranspiration
    b. Data from MODFLOW or another groundwater model
    c. SWAT (Soil and Water Assessment Tool) model
    d. HEC-HMS/HEC-RAS model
    e. VIC (Water Infiltration Capacity) model for water budget analysis
    f. Simulation of infiltration using HYDRUS
    g. CROPSIM model