Ecohydrology: a Mediterranean perspective
GE7049, 7.5 ETCS credits (hp)

Course booklet, Summer Term 2012

Introduction

Ecohydrology is a developing discipline that deals with the interaction between ecosystems/ecology and hydrology. As such one main goal of ecohydrology is increased understanding of the interaction between plants and the water cycle. Through improved understanding of present-day interactions, better estimates of future potential shifts in coupled hydrologic and ecologic systems can be obtained. This improved understanding is vital in, for example, many semi-arid coastal regions where deep saltwater intrusion in connection with submarine groundwater discharge are a major concern for the management of ecosystems.

In this course, students will review central concepts of ecohydrology. This will be done through a combination of seminars and state-of-the-science literature review. The goal here is to build the students' knowledge base around the question 'What is ecohydrology?' The relevance of these central ecohydrologic concepts will then be considered from a Mediterranean perspective using the Navarino Environmental Observatory (NEO) as an example. This will be done by using a combination of field investigations, experiments, and data analysis techniques. For example, students will develop relevant hydrologic models for the NEO region and estimate evaporative fluxes using energy balance relationships. These models will allow for investigation of the interaction between surface and groundwater to exemplify the interactions across different storages of water in the landscape. Detailed field experiments to test key assumptions (i.e., how constant is the net and/or solar radiation driving the evapotranspiration in this Mediterranean landscape?) will be designed and carried out by students while at NEO. From these estimates and field experiments, the interaction between plants and the water cycle in the NEO region will be put into the context of other global systems. A goal of the course is to have the students collaborate by placing NEO in an ecohydrologic framework and conduct field experiments to confirm this placement.

Contact information

Steve Lyon (*course responsible*), steve.lyon@natgeo.su.se, tel. +46 (0)8 16 4888
Physical Geography and Quaternary Geology, Stockholm University
M. Todd Walter (*course responsible*), mtw5@cornell.edu, tel. +1 (607) 255-2488
Biological and Environmental Engineering, Cornell University

Course structure

The total workload corresponds to approximately 3 weeks, full time, corresponding to 7.5 ETCS credits. This will be split into 14 days (non-continuous) of time at Stockholm University and a mandatory 5 days (continuous) visit to the Navarino Environmental Observatory (NEO) located in Messinia, Greece for project work including field experiments.

The credits are divided into the following blocks

- Seminars and literature review, 3 credits
- Project work, 4.5 credits

Literature
There is no official course book for this course. Instead, the course will follow a state-of-the-science tour of the relevant literature focusing on ecohydrology and its key concepts. This list is ever changing, but the main papers considered are:

Ecohydrological
Wilcox, B.P., 2010. Transformative ecosystem change and ecohydrology: ushering in a new era for watershed management. Ecohydrology 3(1), 126-130.
d'Odorico et al. 2010. Ecohydrology of terrestrial ecosystems. BioScience. 60 (11).
Hannah, D.M., Wood, P.J., and Sadler, J.P., 2004. Ecohydrology and hydroecology: A 'new paradigm'? Hydrological Processes 18, 3439-3445.
Rodriguea-Iturbe, I., 2000. Ecohydrology: A hydrologic perspective of climate-soil-vegetation dynamics, Water Resources Research, 36, 1, 3-9.
Bonnell, M. 2002. Ecohydrology: a completely new idea? Hydrological Sciences Journal, 47(5), 809-810.

Evapotranspiration
Brutsaert, W., 2006. Indications of increasing land surface evaporation during the second half of the 20th century, Geophys. Res. Lett., 33, L20403, doi:10.1029/2006GL027532.
Priestley, C. H. B., and R. J. Taylor, 1972. On the assessment of surface heat flux and evaporation using large-scale parameters, Mon. Weather Rev., 100, 81– 92.
Brutsaert, W., and M. B. Parlange, 1998. Hydrologic cycle explains the evaporation paradox, Nature, 396, 30.
Walter, M.T., Wilks, D.S., Parlange, J.-Y., Schneider, R.L., 2004. Increaseing evapotranspiration from the conterminous United States, Journal of Hydrometeorology, 5, 405-408.

Greek and Mediterranean
Papaioannou, G., G. Kitsara, and S. Athanasatos, 2011. Impact of global dimming and brightening on reference evapotranspiration in Greece, J. Geophys. Res., 116, D09107, doi:10.1029/2010JD015525.
Mavromatis, T., and Stathis, T., 2011. Response of the water balance in Greece to temperature and precipitation trends. Theor. Appl. Climatol. (2011) 104:13–24, doi 10.1007/s00704-010-0320-9
Kerkides, P., Michalopoulou, H., Papaioannou, G., and Pollatou, R., 1996. Water balance estimates over Greece, Agricultural Water Management, 32, 85-104.
Pumo, D., Viola, F., Noto, L.V., 2010. Climate changes' effects on vegetation water stress in Mediterranean areas, Ecohydrology, 3(2), 166-176, doi: 10.1002/eco.117

The following texts might be considered helpful in complimenting the basic hydrology and approaches considered in this course:

Rainfall - Runoff Modelling - The Primer
Beven, Keith J., John Wiley and Sons Ltd (2003)

Physical Hydrology, second edition.
S. Lawrence Dingman. Prentice Hall. (2002)

Main Goal and Intended Learning Outcomes (ILOs)
The main goal of the course was to explore central theories in ecohydrology and their connection to plant-water interactions and the water cycle in a semiarid environment. By the end of this course, you will be able to:

- Explain and differentiate the basic theories and current literature that forms the core of ecohydrology.
- Synthesize relevant data and observations to provide an ecohydrological framework to characterize a region and set up a hydrologic model
- Define, develop, and conduct field-based research experiments to test fundamental assumptions behind our state-of-the-science understanding of the interactions between the water cycle and vegetation
- Communicate via a written scientific reports and presentations how the previous three outcomes intersect for Mediterranean perspective using the Navarino Environmental Observatory (NEO) as an example

Teaching and Learning Activities (TLAs)
The intended outcomes for this course will be achieved using three main teaching/learning activities. The following summarizes these activities and the relation to the overall structure of the course.

(1) Seminars and literature review
All students are responsible to read the articles that make up the main course literature. The article list will be divided such that each student will be responsible for presenting approximately two articles from the list in discussion seminars. Based on these articles being presented, students will also be responsible for finding additional supporting articles in relevant, peer-reviewed scientific journals to present.

In discussion seminar, which will happen at SU, students will present these articles (both the ones on the list and the additional ones found in literature search) to each other and summarize the main points of the articles. The presenting student will be responsible for producing summarizing text that explains these main article points. These texts are to be prepared before arriving at NEO and exchanged across all students in the course.

Assessment for Seminars and literature review
Participation in seminar discussion and ability to lead seminars are the basis for 50% of the assessment (which is conducted by the teachers) for the 'Seminars and literature review' grade. It should be obvious that participants have covered the assigned text prior to attending the seminar based on their level of participation.

50% of the 'Seminars and literature review' grade will come from assessment of the summary text prepared individually be each student. This text should demonstrate a clear command of the information being covered in the assigned text and a clear effort to find relevant supporting literature.

(2) Project work
There will be project work making up the second part in this course. This project will consist of two main parts involve characterizing the Navarino Environmental Observatory (NEO) from an ecohydrological standpoint. This will involve both quantitative analysis (e.g., modeling the evapotranspiration for the region) and field experimentation. The basis for such analysis and experiments will be presented during teacher-lead lectures and analysis will be carried out in concert by all students involved in the course.

In the first part of the project work (carried out at SU), the students will combine relevant data to create a fundamental hydrologic model to better allow for ecohydrological characterization of the NEO region. This modeling work will be carried out in parallel by all students and combined with the literature review efforts (see previous). This will allow for comparison and contrasting of NEO to other regions and themes in ecohydrology.

In the second part of the project work (carried out at NEO), students will design and carry out short field experiments to test the fundamental assumptions behind the previously developed hydrologic model. Experimental design and implementation in the field will be facilitated by the course teachers. The students will prepare summary reports (both written and oral) describing the experimental design from hypothesis to results. This will synthesize across the literature review and first part of the project work.

Assessment of Project Work
Part one of the project work will be assessed in a discussion seminar reviewing the water balance for NEO. This group seminar will be lead by the students and accounts for 20% of the 'Project' grade.

Part two of the project work will be assessed using the final written and oral report. The project reporting will be graded to assess the student's ability to explain the connection to ecohydrological theory (building from previous literature review), experimental design (what was done), analytical understanding and reflections (why/how it was done), and writing quality (form and language). The assessment of the final project report will account for 80% of the course 'Project' grade.

Examination and study control
Students are graded based on a 7-level goal-oriented scheme:

A = Excellent
B = Very Good
C = Good
D = Satisfying
E = Sufficient
Fx = Insufficient
F = Inacceptable

The minimum grade required to pass is level E. To receive level E, the student has to have participated in all seminars in addition to being approved on his or her reported project work. Higher grades (A-D) require a higher degree of own reflections supported by course literature and related to the project work (see evaluation criteria below).

Evaluation criteria
Course elements:

- Seminar and literature review: Graded from A to F (grading criteria are specified in Table A and Table B)
- Project work: Graded from A to F (grading criteria are specified in Table B).

The final grade for the entire course is calculated as the weighted average of the grade awarded for the 'Seminar and literature review' and the 'Project work'. The 'Seminar and literature review' grade accounts for 40% of the final grade and the 'Project work' accounts for 60% of the final grade.

Table A: Evaluation of the participation and leading at seminars.

Criterion/Grade	Excellent A	Very Good B	Good C	Satisfactory D	Sufficient E	Insufficient Fx	Inacceptable F
S1: Presentation of the assigned section on the course book	1A	1B	1C	1D	1E	1Fx	1F
S2: Active participation and relevant contributions in the discussion	2A	2B	2C	2D	2E	2Fx	2F

For grade level A:
1A: Lead/initiate insightfully discussion thoroughly covering material in assigned chapters.
2A: Pay attention to presentations and actively participate in group discussions. Come prepared to all seminars having read all relevant materials.

For grade level B:
1B: Lead/initiate discussion thoroughly covering material in assigned chapters.
2B: Pay attention to presentations and actively participate in group discussions. Come prepared to all seminars having read all relevant materials.

For grade level C:
1C: Lead/initiate discussion covering material in assigned chapters.
2C: Pay attention to presentations and participate in group discussions. Come prepared to all seminars having read all relevant materials.

For grade level D:
1D: Provide discussion covering material in assigned chapters.
2D: Pay attention to presentations and participate in group discussions. Come prepared to all seminars having read all relevant materials.

For grade level E:
1E: Participate in discussion covering material in assigned chapters.
2E: Pay attention to presentations and participate in group discussions. Come prepared to all seminars having read all relevant materials.

For grade level Fx:
1Fx: Failure to participate in discussion covering material in assigned chapters.
2Fx: Failure to pay attention to presentations and participate in group discussions. Come unprepared to seminar having read none of the relevant materials.

For grade level F:
1F: Failure to participate in discussion covering material in assigned chapters.
2F: Actively disrupt presentations. Come unprepared to seminar having read none of the relevant materials.

Tables B: Evaluation of the project reports and all other texts.

Criterion/Grade	Excellent A	Very Good B	Good C	Satisfactory D	Sufficient E	Insufficient Fx	Inacceptable F
P1: Explanation of ecohydrological methods, modeling and information systems	1A	1B	1C	1D	1E	1Fx	1F
P2: Analytical understanding and reflections	2A	2B	2C	2D	2E	2Fx	2F
P3: Form and language	3A	3B	3C	3D	3E	3Fx	3F

For grade level A:
1A: Demonstrate advanced understanding of numerical methods through application in project work and thorough review of relevant scientific literature. Provide original and significant analysis with respect to the main thesis of the project work
2A: Provide insightful and thorough discussion of the results of project work. Use existing scientific literature to place project results in the context of current published theory.
3A: Appropriate use of figures and graphics combined with concise text in proper scientific tone without errors in grammar or spelling.

For grade level B:
1B: Demonstrate adequate understanding of numerical methods through application in project work and thorough review of relevant scientific literature. Provide significant analysis with respect to the main thesis of the project work
2B: Provide thorough discussion of the results of project work. Use existing scientific literature to place project results in the context of current published theory.
3B: Appropriate use of figures and graphics combined with concise text in proper scientific tone without errors in grammar or spelling.

For grade level C:
1C: Demonstrate adequate understanding of numerical methods through application in project work and review of relevant scientific literature. Provide significant analysis with respect to the main thesis of the project work
2C: Provide discussion of the results of project work. Use existing scientific literature to place project results in the context of previously published theory.
3C: Good use of figures and graphics combined with concise text in proper scientific tone with minimal errors in grammar or spelling.

For grade level D:
1D: Demonstrate some understanding of numerical methods in project work and review of relevant scientific literature. Provide analysis with respect to the main thesis of the project work
2D: Discussion of the results of project work.
3D: Good use of figures and graphics combined with concise text in proper scientific tone with minimal errors in grammar or spelling.

For grade level E:
1E: Provide analysis with respect to the main thesis of the project work with an appreciation of numerical methods.
2E: Discussion of the results of project work.
3E: Use figures and graphics combined with concise text with some errors in grammar or spelling.

For grade level Fx:
1Fx: Provide no analysis with respect to the main thesis of the project work
2Fx: Failure to discuss results.
3Fx: Poor use of figures and graphics and poorly written text.

For grade level F:
1F: No analysis with respect to the main thesis of the project work
2F: No discussion of results.
3F: No use of figures and graphics and no written text.