



# GEOL 305/545: Earth Surface Processes

Course Syllabus – Spring 2011

Class meetings: Mon and Wed, 2:00-3:30 pm

**Instructor:** Prof. Douglas Jerolmack  
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**Office hours:** Mon and Wed, 4:00-7:00pm

## **Description.**

Patterns on the Earth's surface arise due to the transport of sediment by water and wind, with energy that is supplied by climate and tectonic deformation of the solid Earth. This course presents a treatment of the processes of erosion and deposition that shape landscapes. Emphasis will be placed on using simple physical principles as a tool for (a) understanding landscape patterns including drainage networks, river channels and deltas, desert dunes, and submarine channels, (b) reconstructing past environmental conditions using the sedimentary record, and (c) the management of rivers and landscapes under present and future climate scenarios. The course will conclude with a critical assessment of landscape evolution on other planets, including Mars. This course is quantitative, however all required physics are taught in the class itself.

## **Field Trips.**

This course includes an optional one week trip to White Sands, New Mexico, that will occur over spring break (March ~6-12). White Sands is a desert dune field arising from the white gypsum deposits of a spectacular dried-up lake, and is flanked by alluvial fans depositing sediment eroded from nearby mountains. This unique and bizarre environment is often used as an analogue for the study of ancient Mars. Students will break into teams to undertake independent research projects, providing the opportunity to apply skills learned in class directly to a problem of personal interest.

***There is a limit to the number of students that can participate, so contact Prof. Jerolmack as soon as possible if you are interested.*** The cost of the trip will be partially covered by departmental funds, and students are strongly encouraged to come.

In addition, the class has potentially 2 weekend field trips: (1) to local rivers to assess human impacts, and (2) to the Catskill Mountains to study waterfalls. In addition, there will be a hands-on laboratory component.

## Texts and Resources

1. I recommend, but do not require, the textbook:  
Leeder, M. Sedimentology and Sedimentary Basins. Oxford:  
Blackwell Science Ltd., 1999, 592 pp. ISBN: 0632049766.
2. Gary Parker's freely available E-book: Supplemental -  
download at:  
[http://cee.uiuc.edu/people/parkerg/morphodynamics\\_e-book.htm](http://cee.uiuc.edu/people/parkerg/morphodynamics_e-book.htm)
3. **There are no other textbooks.** I will supply supplementary  
material from a variety of primary and secondary sources.

## Course Structure

The course is structured into two (2) 80-minute lectures per week. The first ten minutes of each lecture will be dedicated to discussion regarding earth-surface processes in current events, where each discussion will be led by a different student. In addition to these lectures there will be 1-2 laboratory experiments that will take place in Hayden 56, at times convenient to students. There will also be one 1-day field trip to local streams, and a weekend trip to the Catskill Mountains to study river dynamics, and a ~week long trip to White Sands, New Mexico to study sediment transport and deposition by wind and water.

## Grading

### 1. Distribution of Marks

Class participation	10%
Assignments (5@ 8% each)	40%
Mid-term exam	20%
Final Project	<u>30%</u>
	100%

- Participation is judged by your ability to lead and participate in class discussions related to current events and problems/questions with assignments. Participation in laboratory and the Catskills field trip is required.
- On the mid-term exam, you will be tested on your ability to apply the principles you have learned to problems that may be directly related to topics covered in class, or may be new topics that can be addressed using physical reasoning developed in class.
- Assignments will require the use of some (fairly simple) mathematics, and application of spread-sheet based numerical models. Some assignments will use data collected in the lab or field. These homeworks may be worked on in groups, however **it is required that participants in homework groups list all group members.** Working together is

different from copying, and I will look for original contributions from each student.

- **This class has no final exam, but rather a final project report.** This report will use concepts developed in class to frame a problem, of the students' interest, that may be addressed using methods covered in the course. The report may be considered as a literature review for undergraduates. Graduate students' papers require development of testable hypotheses using mathematical expressions. **Students who participate in the White Sands trip are required to write their paper on that research.** All students must read and cite primary sources.
- The graduate section (545) will require additional quantitative project work.
- I will deduct 20 percentage points for each 24 hours that a graded homework assignment is late. Notify me as soon as any problems arise regarding homeworks (questions, computer problems, etc.), or else points will be deducted for late assignments.

### **Lecture Topics** (Mondays and Wednesdays)

**(No Class Wed., Jan 12 due to travel)**

**(No Class Mon., Jan 17 - Martin Luther King Day)**

1. Wed., Jan. 19: Introduction to Landscapes: patterns and processes.

*Reading: Southard Notes, Chapters 1-3. Ritter, Chapters 1-2. Anderson, Little book of geomorphology, Chapters 1 & 3.*

2. Mon., Jan. 24. Uplift, subsidence and base level change.

*Reading: Anderson, Chapter 2. Southard, Chapter 4.*

3. Wed., Jan. 26. Basic fluid mechanics 1.

*Reading: Southard, Chapter 5. Ferguson and Church paper.*

4. Mon., Jan. 31. Basic fluid mechanics 2.

*Reading: Wiberg and Smith paper. Southard, Part II, Chapters 1-2.*

5. Wed., Feb. 2. Initiation of sediment motion.

*Reading: Southard, Part II, Chapter 3.*

6. Mon., Feb. 7. Modes of sediment transport 1.

*Reading: Jerolmack paper on wind-blown ripples on Earth & Mars.*

7. Wed., Feb. 9. Modes of sediment transport 2.

*Reading: Parker E-book, Chapter 7.*

8. Mon., Feb. 14. Modes of sediment transport 3.

*Reading: Ritter, Chapter 5. Southard, Part II sediment transport summary.*

9. Wed., Feb. 16. Profile of a river from source to sink.

*Reading: Montgomery and Dietrich, 1992 paper.*

10. Mon., Feb. 21. Hillslope processes and channel initiation.

*Reading: Straub et al., 2007 paper on network scaling.*

Wed., Feb. 23. Continuation of hillslopes and channels.

Mon., Feb. 28. Midterm preparation.

Wed., March 2. Midterm exam.

**MARCH 6-12: White Sands Field Trip.**

11. Mon., March 14. Hillslope processes and drainage basins.

*Reading: Church, 2006 review paper.*

12. Wed., March 16. Large-scale patterns in alluvial rivers.

*Reading: Jerolmack and Mohrig, 2007 Geology paper.*

13. Mon., March 21. Hydraulic geometry of rivers.

*Reading: Parker E-book, Chapter 3.*

14. Wed., March 23. Alluvial river bed forms.

*Reading: Southard, Part II, Chapter 4.*

15. Mon., March 28. Alluvial river bar forms and meandering.

*Reading: Tal and Paola, 2007 paper in Geology.*

16. Wed., March 30. Equilibrium channel geometry of rivers.

*Reading: Jerolmack et al., 2004 paper on Mars fan.*

17. Mon., April 4. Fluvial processes on Mars

Time permitting:

17. Fluvial processes on other Planets: Mars.

18. More on paleo-hydraulic reconstruction using the rocks.

19. The Mississippi Delta: human management and sea level rise.

Wed., April 20. Final project presentations 1.

Mon., April 25. Final project presentations 2.