Syllabus: Meteo 448

Storm Water Hydrology
Spring 2005
T,R, 1430-1545 304 Willard

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Notes: please purchase class notes for course at Gnomon Copy Center on College Avenue next to State Theatre. Cost: about $6.

Text: Class notes. We will be basing material pertaining to physical hydrology which can be found in the texts, *Applied Hydrology* by Chow et al. (McGraw-Hill) and the *Handbook of Hydrology* edited by Maidment, also published by McGraw-Hill. (Note that considerable overlap exists between these two texts and the latter is very expensive though much more extensive in scope.) Lectures on water quality will be based partly on the book *Environmental Engineering* by Ray (PWS Publishing Co) and by others listed below in the list of references.

Overview

This course uses material from conventional hydrology and water quality texts and relates that material to field and laboratory measurements for storm events that we have obtained in previous years. Our approach will be similar in some respects to what real engineers and watershed managers and urban developers must do in order to assess storm water runoff. For these people, such calculations can mean the difference of tens of thousands of dollars in expenses. Many of the methods I will present are highly empirical, yield uncertain results and go back a hundred years or more. Yet this is all we have at the moment.

The course will address several issues:

(1) how to analyze the hydrograph in order to determine useful and quantitative information about surface runoff
(2) how to assess surface runoff for streams given land use, rainfall data, and previous soil moisture history
(3) how to interpret stream chemistry in conjunction with the hydrograph and to identify possible non-point sources for the surface runoff constituents
(4) how to assess the effect of urban construction sites on runoff, including determining how big to build discharge conduits for road and housing construction sites.

More generally, the purpose in my teaching Meteo 448 is to understand the runoff response to storm events and the relationship between surface runoff and urbanization and water quality. The material is diverse, practical, and cross disciplinary, requiring the instructor to act alternately as team leader and lecturer.

One focus of our attention is the Spring Creek Watershed in State College and three of its subsheds, Thompson Run (State College), Upper Slab Cabin Run and Slab Cabin Run. Stream gauges for the three sites are all within two miles of Walker Bldg. We will use measurements taken at these sites in conjunction with Meteo 448 in previous years; these include hydrograph, local rainfall data and water quality measurements. A trip to visit these streams will be scheduled.

Another focus in this course is the effect that a proposed housing development in State College will have on surface runoff and steps that can be taken to ameliorate the deleterious effects of the runoff. This part of the course will entail estimating runoff based on housing density, terrain slope, soil type, etc. No complex models will be used in this course, as the important thing is to understand how such models approach the calculation of runoff, rather than how analyze the output from a black box. In fact, I hope that the students in this course will take a proactive approach in their learning, such as taking the initiative to incorporate external sources of data, including perhaps their own measurements, in trying to learn the material. A short field trip will be made to the site of a proposed housing development, after which a

homework problem will ask how much surface runoff is likely to occur as the result of future construction on this site.

Three field trips are planned. The first trip will be a short one to view the streams where previous data was taken for the purpose of this course. Another short excursion will be made to the aforementioned construction site where developers are proposing to put up a large housing development and to a road site where construction of storm water drainage was obviously necessary. In homework exercises, we will then calculate effects of housing construction on surface runoff for one small portion of this construction site and also estimate the amount of runoff and the size of the drainage pipe necessary to conduct the additional surface runoff from a newly constructed road site. These two trips will take up one class period.

A third, and more lengthy field trip will address the effect of runoff from a region of excavated acid rock (iron pyrites) on a local stream, specifically to what degree has the acidity (pH) of that stream been increased as the result of nearby road construction; this is the now-infamous I 99 acid rock affair. Acid rock drainage is similar to acid mine drainage (a focus of last-year's field project). Acid mine drainage is caused by excavation of seams of coal, exposing residual rock and coal materials which cause the runoff water to become highly acidic. Acid runoff can also occur when certain types of rocks become exposed to the surface runoff in the course of road construction. The acid rock field trip will be conducted when the weather permits (probably in March). Field activity will consist of taking pH measurements along Buffalo Run, a stream that may have been profoundly affected by the acid rock drainage. This excursion should occupy the better part of one day.

Note: during the five years of teaching Stormwater Hydrology, students in this class have submitted for publication a total of four research papers in their own names based on measurements taken as part of Meteo 448. My intention in conducting field projects, from which original and often very interesting data has been obtained, is to offset the more sedate and passive form of learning from the professor or from books and notes by active outdoor expeditions in the quest for new knowledge.

Structure of Course

Classroom

Because lectures are sequential, yet assimilation of the information, including field data, requires synthesizing many elements of hydrology and water chemistry. Because of this cross disciplinary and perhaps initially strange material, the concepts may be hazy at first but will gradually become clearer as the term progresses. A set of notes is provided and can be picked up at the Big Blue Bookstore on College Avenue for a cost of around $15. Some supplementary material may have to be gleaned in the library or elsewhere. This is the way intellectual and professional processes really work. Exams are an artifice with a low shelf life value. A term paper (or possibly class project) will be required, however. The subject of the term paper, I hope will be based at least loosely on classroom material, but of the students' choosing. (Last year the term paper was folded into a class project in which the student wrote a paper based on their pH measurements made on Cold Stream in Philipsburg. I later submitted the paper on the students' behalf. We can see if this type of project is feasible this year.)

The course grade is based on the homework (including the aforementioned field work) (50%), on a term paper whose content will be discussed in class (30%), and on my perception of your willingness to participate in the class discussions and field trips (20%). No special computer knowledge is required although facility with EXCEL or Quattro (or other similar spread sheet compatible with EXCEL) will be useful, as the data will be in the form of EXCEL sheets.

A word of advice: material in this course may seem to closely resemble that in courses offered in other departments. To some extent this is true and, to some extent, this is a good thing, as the material will help you integrate ideas and technical approaches presented in other classes. I urge you, however, not to become complacent and fall behind, thinking that all of this is 'old hat'. My approach to the material is quite different from other courses. It is especially important to keep up with the homework, as each successive assignment may be based on the results of a previous homework and it will be necessary for the instructor to evaluate each homework before the student can go on to the next level of complexity, i.e., the next homework assignment. Be thankful that I hate exams as much as you do.

Course Outline

(Roughly corresponding to successive sections of class notes)

Week (approx)	Subject
1-2	**Hydrology Balance; surface flow, streamflow, the hydrograph**
2-3	**Direct runoff, base flow, excess rainfall, initial loss, standard Hydrograph. Field trip to stream sites**
4-5	**Runoff coefficients, SCS method, urbanization, land use; field trip to stream sites**
5-6	**Urban runoff, continued: road, building, housing construction, importance of vegetation; field trip to urban construction site**
7-8	**Runoff and development; runoff coefficients, SCS methodology Field Trip to Spring Creek. Guest lecture**
9-10	**Urban effects, non-point source pollution. Guest lecture**
11-13	**Stream contaminants; non point source pollution; pH; Dilution curves; hysteresis loops**
14-15	**Discuss field projects**

SUGGESTED READING MATERIAL

Ray, Bill T., 1995: Environmental Engineering, PWS Publishing Co (ISBN 0-534-20652-2), 496 pp.

Urban Hydrology for Small Watersheds, 1975: Engineering Division, Soil Conservation Service, USDA, Technical Release No 55,

Bedient, P. B., W. C. Huber, 1992: Hydrology and Floodplain Analysis, Addison-Wesley Publishing Co, ISBN 0-201-51711-6, 692 pp.

Chow, V. T., D. R. Maidment, L. W. Mays, 1988: Applied Hydrology, Mc Graw-Hill Publishing Co. ISBN 0-07-010810-2, 572 pp.

Harbor, J. M., 1994: A practical method for estimating the impact of land-use change on surface runoff, groundwater recharge and wetland hydrology, Planner Notebook, J. Amer Planning Assn. Vol 60, 95-108.

Booth, D. B. and C. R. Jackson, 1998: Urbanization of acquatic systems: degradation thresholds, stormwater detection, and the limits of mitigation. J. Amer. Water Resources Assn., 1077-1090.

Little Miami River Preliminary Assessment of USE Attainability (PAUSE), 1997: Final Report submitted to Water Resources Managers of Municipalities and Counties within the Little Miami River Watershed, prepared by the Dept. of Civil and Environmental Engineering and the Dept. of biological Sciences, University of Cincinnati, BBS Corporation, Cincinnati and XCG Ltd., July, 1997.53 pp.

Handbook of Hydrology, 1992: D. R. Maidment, Ed. McGraw-Hill, ISBN 0-07-039732-5,

P. E. Black, 1991: Watershed Hydrology, Prentiss Hall, Advanced Reference Series, 408 pp.

Manhart, E., 1998: Seasonal and Episodic Water, Nutrient and Sediment Interactions in the Little Miami River, MS Thesis, Dept. of Civil and Environmental Engineering, University of Cincinnati.