

GEOG 3511 – HYDROLOGY -- Review for Third Exam

The third exam will be similar to previous exams, consisting of fill-in-the-blank or short-answer questions, plus a question or two requiring calculations. Focus on material covered in lectures- anything presented in lectures and labs is fair game, including points discussed on handouts.

The exam will focus on topics covered since the last exam- evaporation and surface water; however, you shouldn't forget some of the basic concepts discussed in the first two weeks of class.

I. Basic Hydrologic Concepts

- review the equations for the water balance and the energy balance, and give some thought apply this equation to various hydrologic problems, e.g. estimation of evaporation;

II. Evaporation

- Be able to summarize the approaches for estimating evaporation and evapotranspiration (e.g. water balance, energy budget, pans, lysimeters, mass-transfer equations), and discuss their differences;
- Be prepared to answer questions regarding the "mass transfer approach", e.g. why is it used? how is a mass transfer equation developed? what does the mass transfer coefficient represent? Hopefully class notes are clear; if not, see pp. 277-280.
- Why was the Penman equation developed? why is this called a "combination" equation?
- Review lecture notes on transpiration, and the connection to carbon cycling. Review important points and results from the paper on limits to tree height.
- Review lecture notes on effects of vegetation change on runoff and floods.

III. Stream Response to Precipitation

- General comments: Stick very tightly to the lecture notes. The book contains a lot of material that I did not cover in class, plus it is organized very differently from the way I presented it.
- Make sure you can explain the differences in hillslope runoff processes (HOF, DOF SSSF); if points made in lecture are not clear, see pp. 205-209. The text goes into more detail than necessary in describing TOPMODEL. The most important part of this discussion is the role of the topographic index, eqn. 9.19.
- Review lecture notes discussing differences between hillslope runoff and runoff in large basins.
- Review notes on drainage basin properties; you should be able to define *drainage density* and draw the basic relations between stream order, numbers of streams, and stream length (Horton ratios, discussed in lab. On the basis of the lab exercise, can you explain how network properties might vary with climate or some other environmental variable?
- Review the steps and assumptions involved in flood frequency analysis; the book explains statistical models and techniques in Appendix 3. Important points: why is this method used? What's involved? What are the limitations? If I gave you the mean and std. deviation of a sample of floods, could you plot the flood frequency curve?
- Review lecture notes on open-channel flow; the book covers much more than we had time for, so stick with the lecture notes.

Additional thoughts:

- we have used three different terms for vapor pressure; these are defined as follows
 - e_a : vapor pressure at some height above the surface (ground, snow, lake or vegetation);
 - e_s : vapor pressure at the surface;
 - e_{sat} : saturation vapor pressure, i.e. vapor pressure at 100% RH; could be with respect to the reference height “a” or the surface;
- example: the turbulent transfer equation for latent heat flux contains the term $(e_a - e_s)$, which is just the difference between the vapor pressure at “a” and the vapor pressure at the surface.
- the mass transfer equations contain the same variables, but reversed, i.e. $(e_s - e_a)$; I assume that this is done simply to give a positive value for the evaporation rate;
- the Penman and Penman-Montieth equations contain the term $(e_{sat_a} - e_a)$, which is different from above; in this case $(e_{sat_a} - e_a)$ represents the difference between the saturation (potential maximum) vapor pressure at “a” and the observed vapor pressure at “a”; think of this as a vapor pressure deficit.
- Another equation that we’ve seen a lot is the logarithmic equation for velocity:

$$u = u_* \frac{1}{\kappa} \ln \frac{z}{z_o}$$

where u is the velocity at height z , u_* is the shear velocity, κ is von Karman’s constant (0.4) and z_o is the roughness height. The term u_* has the units of velocity, but it is really a measure of the stress or force per unit area that is creating the flow; it’s also a measure of the intensity of the turbulence. If u or u_* go up, the turbulence will be more intense and more sensible and latent heat will be transferred from the surface to the atmosphere. The term z_o is theoretically the height above the surface where the velocity is zero; this is impossible to measure because it is usually a fraction ($\sim 1/10$) of the height of the roughness. Thus, if the surface gets rougher, z_o gets bigger, and, for the same u_* , u gets smaller.

- the equations for sensible and latent heat transfer both have the following term:

$$\frac{u}{6.25 \left[\ln \frac{z}{z_o} \right]^2}$$

This term is essentially u_*^2 , which is sort-of what you get if you rearrange the above equation.

I will provide complex equations, i.e. those with more than about 3 terms; however, you should know what the terms in these equations represent in a physical sense.