Yale University School of Forestry & Environmental Studies

FES 610, Science to Solutions: How Should We Manage Water?

Lab #3

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The goal of this lab is to use a simple watershed model to explore:

- the effects of climate and land use on water and pollutant export
- various solutions that can be employed to improve the water quantity and quality picture.

The model we will use, SimWatershed – loosely based on the NYC watershed – was developed by Ginger Booth in consultation with Pete Raymond and Shimi Anisfeld, and is available at http://gingerbooth.com/flash/simwatershed/SimWatershed.html.

You should work through this worksheet on your own (with help as needed from Rich and Shimi) until you get to part 4. You should budget your time, writing down notes rather than complete answers if necessary, so that you start question 3c by 7:10 and start the discussion (part 4) no later than 7:40. Please turn in (to your dropbox) neatly-written answers to all the numbered questions below by the end of the day on October 12.

1. Exploring the base model
   Set the scenario to "nitrogen – biophysics." Change the climate and landuse and watch the effect on reservoir water inflow and nitrogen concentrations; explore a little. Then answer the questions below.
   a. A watershed is defined as "the topographic area within which apparent surface water runoff drains to a specific point on a stream or to a waterbody such as a lake." Why do you think we called the individual parts of this system "contributing areas" (CAs) rather than "watersheds"?
   b. Given current land use, provide a climate scenario in which the system can't meet water demand.
   c. One aspect of this model seems to contradict something discussed in class about the effects of land use on runoff quantity; what is it?
   d. Which has more of an impact on N levels in the model – suburban or agricultural landuse? Is this realistic?
   e. Assume your threshold for N problems is 3 mg/L. What is the greatest level of agricultural landuse at which you can avoid exceeding this threshold (assuming that the increases in agricultural land happen solely by conversion of forest)? Make sure to pay attention to where the new agricultural land is. Express your answer as the % of the watershed that is in agricultural land (see landuse pie chart).
   f. For the CAs that are on septics, the N contribution from wastewater is calculated by the model from the amount of suburban land. This is done by assuming values for the following: population density, wastewater contribution per person, and N concentration in wastewater (see sewage parameters). Demonstrate that you understand this by calculating the N contribution from wastewater in the GlenCreek CA (in Mg/yr), given its size and amount of suburban landuse. Show your work. (If you want, you can check your answer by doubling the suburban population density parameter. The total N discharged from the GlenCreek CA should increase by the amount you calculated above.)

2. <u>Exploring the future problem</u>

Set the scenario to "nitrogen 2025 – biophysics."

   a. What driving forces have changed? In what directions?
   b. Do you now have a N problem? Why or why not?
   c. Assume that you are supposed to release 120 Mm^3 yr^{-1} downstream for environmental flows. Do you now have a water problem? Why or why not?

Set the scenario to "sediment 2025 – biophysics."

   d. You must meet a regulatory standard of turbidity < 5NTU to avoid filtration. Turbidity and TSS (total suspended sediment concentration in mg/L) are generally well-correlated within a given system. Use the data below to estimate what level of TSS you should be aiming for. Show your work.

Turbidity (NTU)	TSS (mg/L)
2.1	2.3
0.8	0.5
3.8	4.2
1.7	2.3
1.5	1.9

   e. Do you have a sediment problem? Why or why not?

3. <u>Exploring solutions</u>

Set the scenario to "nitrogen 2025 – solutions." You now have available to you several types of solutions (which you may implement to different extents and in different locations):

- buy land (click on CA)
- install BMPs (click on CA)
- upgrade the STP (click on STP)
- change the price of water (click on city)

   a. What outcome is assumed by the model for BMP implementation? Is this reasonable? (BMP effectiveness parameters are found under "model parameters – solutions" in the climate box.)
   b. What outcome is assumed by the model for changing the price of water? Is this reasonable? (The demand elasticity – the percentage change in demand for a given percentage change in price – is found under "model parameters – solutions" in the climate box.)
   c. Implement solutions to come up with what you consider to be the "best" overall outcome. Produce a table listing: the solutions you implemented, how much money you spent, water supply, water demand, N concentration, and sediment concentration. You must implement at least 2 solutions, but can do as much as you want. You may also change any of the controlling parameters as part of your solution, but make sure that you justify your decision to do so.

4. <u>Discussion</u>

   Compare your solution to those of at least two other people (in a group discussion). Discuss the pros and cons of each solution set, and how they reflect your values.

5. <u>Reflection (after the lab)</u>

   a. Write up a brief summary of the conversation you had with your group.
   b. What are the strengths and weaknesses of this type of model?