Civ E 676
Case Studies in Groundwater Management

Assignment 3.

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Due: March 6

The objective of assignment 3 is the estimation of groundwater recharge in the vicinity of the UW weather station on the north campus using i) an engineering "rule-of-thumb" of a percentage of precipitation and ii) the HELP3 model. The impact of temporal averaging will also be explored. The assignment will take you through the steps of acquiring site data, manipulation of data, data synthesis and finally estimation of recharge. The use of ArcView GIS would be a superior platform for accomplishing the work but its use is beyond the scope of this course.

The data required to estimate groundwater recharge includes:

- Weather data: precipitation, temperature, solar radiation, relative humidity and wind speed.
  - A 40 year record of Precipitation, Temperature and Solar Radiation data for Waterloo are on the course website. I also included the files in the dosbox_c_drive zipped file in the directory C:\dosbox_c_drive\HELP3\DATA
  - You can estimate evapotranspiration using synthesized relative humidity, wind speed and growing season dates using Syracuse New York data (it has the same latitude as Waterloo)
  - In HELP3 when entering weather data (for example precipitation), choose ASCII, metric data and then enter the complete path name for your data.
  - If you are familiar with Microsoft Access, an alternative is as follows: Download the data from http://weather.uwaterloo.ca/
    1. go to archives
    2. select a year (your choice)
    3. download precipitation, temperature, solar radiation, relative humidity, wind speed (note that it is every 15 minutes)
    4. There could be missing data that you will need to generate. If this is the case, state your method and assumptions
    5. For use in HELP3, be careful of units. For example, the weather station data for solar radiation is W/m^2 while HELP3 units are mj/m^2
    6. you will need to average the data for use in HELP3; state your method
    7. you will run HELP3 for a 5 year period by copying and pasting the downloaded yearly data to generate a 5 year record (note that you could download a 5 year record but this may require more data synthesis)

8. in HELP3 when entering weather data (for example precipitation), choose ASCII, metric data and then enter the complete path name for your data.

- Land use
  - If you had access to ArcView GIS you could download land use maps from GeoGratis (use Google to find and explore the site)
  - As an alternative, you can classify the land in the vicinity of the weather station yourself using imagery from: http://maps.region.waterloo.on.ca/locator/locator.htm (past URL into your browser) or, from **Google Earth**
    1. zoom in to the area of Columbia Lake
    2. select view > imagery and then colour on the left menu
    3. zoom in on the area with the weather station
    4. classify the data as appropriate: grass, forest, bare field etc.
    5. select appropriate LAI and evaporative zone depths etc.
    6. estimate the curve number required in HELP3 using the TR-55 report (use Google to locate it and refer to class notes). You could correct for the percent imperviousness. Note that you will need the soil data to estimate the curve number. You will need to estimate slope. You can do this using topographic maps, but a reasonable estimate and sensitivity analysis will suffice.
- Soil data
  - Download the soils report (a pdf) for Waterloo Region from the CanSIS site by using google to locate the address. The availability and knowledge of ArcView GIS would facilitate the download and manipulation of the soil maps for the region.
    1. From the soils report, determine the bedrock geology for the university area
    2. review the regions soils and the location of such features as the Waterloo Moraine (note that much of the information in this report is repeated in Phase I and Phase II remediation reports for sites in the region – now you know where the words come from).
    3. the paper map in the report that includes the North campus is map 19 on page 125 of 147 in the report.
    4. for the soil types in the vicinity west of Laurel Creek and North of Columbia Street, determine the detailed soil profile, using the report, that will be used in HELP3. Use default HELP3 parameters for the soils in the profile.
- Download HELP3 from the web and install on your computer

QUESTIONS

1. Prepare plots of the monthly recharge, evapotranspiration and runoff for the last year of your analysis for each land use/soil combination. Plot your results in a manner that facilitates comparison. Provide and discuss, where appropriate, all parameters used in the estimation; for example: data for each layer in the soil column, LAI,

evaporative zone depth, Curve Number **etc**.

2. Estimate the annual average recharge for the combined area in the vicinity of the weather station using a reasonable "rule-of-thumb". Provide calculations used in making the estimate.
3. Comment on scale issues (averaging over different temporal periods) and the spatial variability of the results. Note that you have calculated daily recharge for a 40 year period. How do weekly, monthly or yearly values compare? How do the recharge estimates compare for the different land use and soil property combinations?
4. For one of your land use/soil areas with forest, determine the impact on the recharge of a change to residential construction (remove trees, increased imperviousness etc.) . Provide and describe supporting information.