**Laboratory 6: Simple Soil Water Balance Model**

**BSEN 5250/6250**

**Version: September 2022**

**What to Turn In:** Turn in your spreadsheet program.

The purpose of this laboratory is to develop a simple soil water balance model for a soil with a warm season grass. A template spreadsheet containing data and some model components can be found on the Canvas site under \files\Labs\Lab 6-Soil Water Balance with ET-Template 2022.xlsm.

The water balance model should compute the daily runoff and infiltration, as well as update the soil water content state variables each day, accounting for daily evapotranspiration from each soil layer.

**Sequence of Calculation**

1. Read in all inputs.

2. Compute monthly average temperature for Blaney-Criddle method of Evapotranspiration.

3. Set up loop to compute daily water balance for 365 days.

4. Compute daily ET from monthly ET parameters.

5. Compute fraction of daily ET to take from each soil layer.

6. Compute daily runoff, Q, using SCS Curve Number Method. ***Note that if rainfall is < 0.2\*S then there is no runoff and no infiltration.*** All of the rainfall remains on the leaves and surface residue. Next compute daily infiltration. If rainfall < 0.2\*S then infiltration = 0. If Infiltration is < 0 then Infiltration = 0. Define Infiltration as drainage from layer 0 (the soil surface) in the variable DRAIN(0).

7. Set all drainage variables DRAIN(i) to 0 each day, then recompute them in step 8.

8. Create a loop through soil layers to compute drainage from each layer and update soil water state variables including loss of water from ET. The math for Layer 1 and layer 2 is shown below. You can generalize this using a loop and the loop index can be used as the soil layer index for the variables SW(L), Drain(L), Thick(L) and FrET(L).

***Example of equations for Layer 1***

1. Check to see if there is drainage from layer today:

If SW(1) > DUL(1) then

DRAIN(1) = (SW(1)-DUL(1))\*THICK(1)\*SLDR

Endif

1. Update state variable today

SW(1) = SW(1) + (DRAIN(0) – DRAIN(1))/Thick(1) – DailyET \* FrET(i)/Thick(i)

1. If water content in Layer 1 exceeds the saturated water holding capacity, add the excess water above SAT(1) to DRAIN(1).

IF SW(1) > SAT(1) then

DRAIN(1) = DRAIN(1) + (SW(1)-SAT(1))\*THICK(1)

SW(1) = SAT(1)

ENDIF

***Example of equations for Layer 2***

1. Check to see if there is drainage today

If ( SW(2) > DUL(2) then

DRAIN(2) = (SW(2)-DUL(2))\*THICK(2)\*SLDR

Endif

1. Update state variable today

SW(2) = SW(2) + (DRAIN(1) – DRAIN(2)) / Thick(2) - DailyET \* FrET(i)/Thick(i)

1. If water content in Layer 2 exceeds the saturated water holding capacity, add the excess water above SAT(2) to THICK(2).

IF SW(2) > SAT(2) then

DRAIN(2) = DRAIN(2) + (SW(2)-SAT(2))\*THICK(2)

SW(2) = SAT(2)

Endif

The general logic needed for a loop computing SW for each layer is shown below. Follow the examples given for layers 1 and 2.

For i=1 to NLAYR

1. Check for drainage
2. Update state variable
3. Check for saturation
4. Output SW(i) to spreadsheet

Next i

**Definitions**

SW(i) = volumetric soil water content, cm3 cm-3

DUL(i) = drained upper limit, cm3 cm-3

LL(i) = lower limit of water holding capacity, cm3 cm-3

SAT(i) = saturated water holding capacity, cm3 cm-3

DRAIN(i) = depth of water to drain from layer I, cm

INFIL = infiltration into top soil layer, cm

NLAYR = number of soil layers

THICK(i) = thickness of each soil layer, cm

SLDR = soil drainage rate, fraction per day

DailyET = daily ET, cm

FrET(i) = fraction of daily ET that comes from layer i

**Notes:**

1. To convert volumetric water content in a layer to a depth of water in the layer, multiply water content by the layer thickness THICK(i).
2. To convert depth of water flowing into and out of a layer into volumetric water content, divide by the layer thickness THICK(i).

**Solution for Baseline Case with Pasture Grass**





