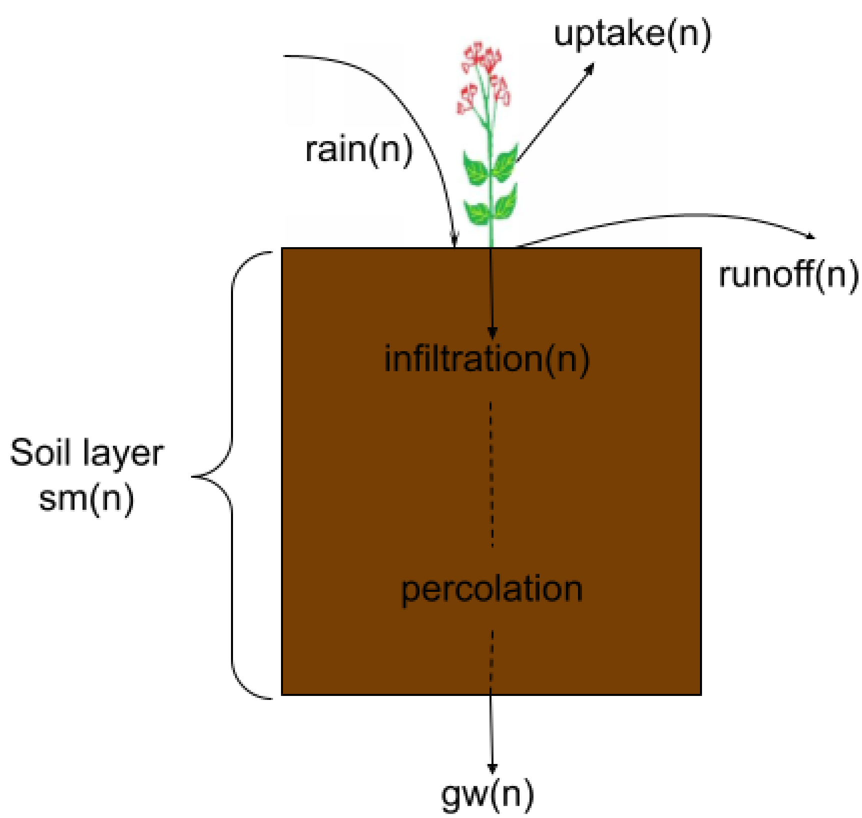
PoCRA assignment - mini simulator for point wise daily soil water balance

This assignment is designed to test your ability to grasp a new problem domain (soil water balance) and model it in code. Use daily rainfall data from “daily_rainfall_*2022.csv” for this assignment.

daily_rainfall_*2022.csv link:
https://drive.google.com/file/d/12t-T65_t_7WmXnVR89oIGcxCT0GN3hrJ/view?usp=sharing

Objective

Generate daily soil water balance at an imaginary point with given soil and crop characteristics. Soil layer at a point is a one dimensional entity, spanning surface on the ground till a certain depth. All quantities in this assignment are therefore expressed in mm / meters. Soil water balance is the distribution of rainfall (mm) into runoff, soil moisture, crop uptake and groundwater recharge. See the diagram below:



Definitions

A. Soil layer can hold at most **C** mm of moisture. Soil moisture contained in the soil layer at the end of day n is denoted by ***sm(n)***.
B. Soil layer receives a total of ***rain(n)*** mm as rainfall during day n.
C. A fraction of the rainfall runs off the soil surface without entering the soil layer. Remaining fraction of the rainfall infiltrates the soil surface to replenish the soil moisture. On a day n, ***runoff(n)*** denotes fraction of the rainfall that runs off the surface and ***infiltration(n)*** denotes fraction of the rainfall that contributes to soil moisture.
D. A crop is growing in the soil and it demands 4 mm per day of soil moisture. The soil moisture used by the crop on a day n is denoted by ***uptake(n)***. Note that

    uptake(n) <= demand = 4mm

E. The fraction γ determines the amount of soil moisture that drains off the soil layer and contributes to groundwater below. The groundwater recharge on a day n is denoted by

    gw(n) = γ . sm(n)

F. On a day n, if infiltration exceeds moisture holding capacity, the excess water

    excess(n) = infiltration(n) + sm(n-1) - C

    flows off the surface and contributes to runoff(n). The total runoff on this day is:

    runoff(n) + ***excess(n)***

G. Runoff is defined as runoff(n) = α . rain(n) where α is given by:

    0.2 if 0 <= rain(n) < 25 mm
    0.3 if 25 mm <= rain(n) < 50 mm
    0.4 if 50 mm <= rain(n) < 75 mm
    0.5 if 75 mm <= rain(n) < 100 mm
    0.7 if rain(n) >= 100 mm

H. Let's define two soil types, deep and shallow as follows:

Soil type	**Moisture holding capacity C**	**Groundwater fraction** γ
Deep	0.2 * 500 mm = 100 mm	0.2
Shallow	0.14 * 300 mm = 42 mm	0.4

Problem statement

Given the definitions in the previous section, write a program in your preferred programming language to compute daily soil water balance at the imaginary point during kharif season, which is from June 01 till October 10. The output should be a CSV file having schema as defined below, with one row per day. Please comment on the results obtained. The program should accept soil type as input: "deep" and "shallow".

Day	Rainfall in mm	Runoff + excess runoff in mm	Crop water uptake in mm	Soil moisture in mm	Percolation to groundwater in mm

Validation

The basic principle is mass conservation. Water received as rainfall can neither be destroyed nor be created.

On any day, the following invariant must hold:n

rain(n) = sm(n) - sm(n-1) + runoff(n) + excess(n) + uptake(n) + gw(n)

On the last day of the simulation, the following must be true:

∑rain(n) = sm(n) + ∑runoff(n) + ∑excess(n) + ∑uptake(n) + ∑gw(n)

The summations are over the simulation interval.

Submission format

- Push your code to a git repository (GitHub / GitLab) and share a link. The repository must have working code and a readme file containing instructions to run the code. The repository must also have an “output” directory where the CSV files for both input soil types “deep” and “shallow” should be found.
- Write one or two pages (shared document) commenting on the results, comparing output of good vs bad soil type.
- Share a Google drive link to a demo video as well, showcasing the functioning of the code end-to-end. The video should be no longer than 5 minutes. An explanation of the key features as well as the code should also be included in the demo video.