Problem 5-16

Consider two alternative ways to add water to the surface of a soil. If the surface is held at a constant negative water pressure, then the flux into the soil will vary as a function of time until steady-state is reached (if steady state is possible). If the water flux to the surface is maintained at a constant rate (say by a sprinkler system) then the water content and water pressure at the surface will change over time.
In this problem you will run a series of calculations with HYDRUS-1D under the following conditions:

- One-dimensional homogeneous soil profile 1 m deep.
- Duration of simulation: 1 day
- Soil material: Loam
- Discretization: 51 nodes equally distributed with depth (i.e. 2 cm per element)
- Initial condition: Soil water pressure head is -100 cm
- Lower boundary condition: Free drainage ($dh/dz = 0$ at $z = -1$ m)

Run the simulation for all four boundary conditions at the soil surface:

- Constant pressure head (-10, -1 cm),
- Constant flux (5.38, 17.80 cm d^{-1})

a. Calculate the flux into the soil as a function of time.

<u>Answer:</u>
See attached HYDRUS-1D modules 5-16A through 5-16D. The flux into the soil as function of time is depicted in Figure 5-12.

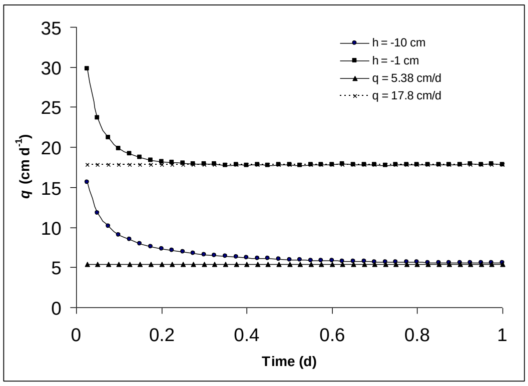

Fig. 5-12: Fluxes at the surface (absolute values)

b. Calculate the flux past z = -1 m as a function of time

<u>Answer:</u>
See HYDRUS-1D modules (5-16A through 5-16D). The flux at the 1 m depth as a function of time is depicted in Figure 5-13.

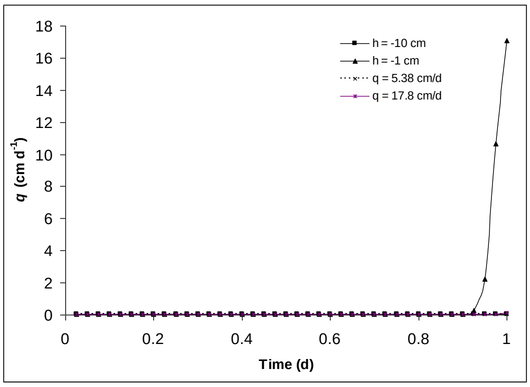

Fig. 5-13: Fluxes at the bottom boundary (absolute values)

c. Calculate the soil water content and soil water pressure head as a function of depth at t = 0.25, 0.5, 0.75, and 1 day.

<u>Answer:</u>
Consider the following cases: Cases A and B are with constant head boundary condition, where the constant head is a negative 10 cm (A) and a negative 1 cm (B); cases C and D are constant flux boundary conditions, with the flux being 5.38 cm/d (C) and 17.8 cm/d (D). See Figures 5-14 and 5-15 below.

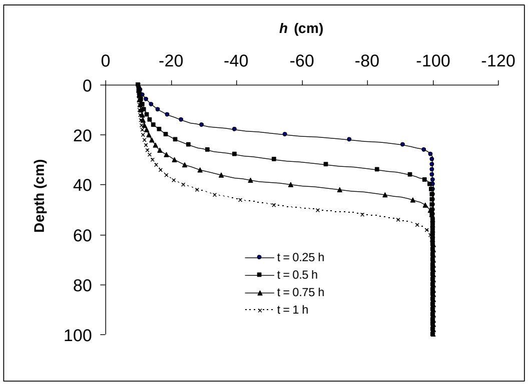

Fig. 5-14: Pressure heads at different times for cases A

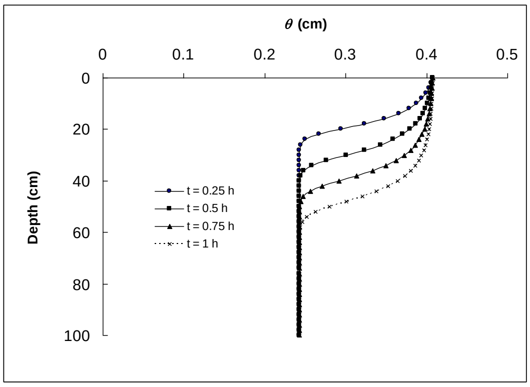

Fig. 5-15: Water contents at different times for case

d. Which management strategy allows the greatest amount of water infiltration into the soil? Why?

<u>Answer:</u>
Figure 5-12 presents the surface flux obtained in the four cases. The fixed head strategy (A and B) allows more water entry into the soil. The numbers between the two strategies are roughly balanced so that the long-term infiltration rates will be equal for cases A and C and equal for cases B and D). Therefore, the difference between the different cases is with regards to initial infiltration rates, which are higher with a fixed pressure head. Therefore, case B allows the most water infiltration into the soil (increase in profile water content of 19.5 cm, compared with values of 7.8 cm in case A, 6 cm for case C, and 18.5 cm in case D).

e. Which management led to the greatest amount of drainage water collected water past z = -1 m? Why?

Answer:
Figure 5-13 presents the bottom flux in the four cases. Since the initial water content is equal between the different scenarios, the boundary conditions which allow the greatest infiltration into the soil are also those that will generate the most flow at z = -1 m, which is case B.

f. Which management kept the surface the driest (i.e., the lowest value of h)? Why?

Answer:
As the different cases were balanced in terms of long-term infiltration rates, the late-time water contents are also roughly equal (pressure heads of -10 cm for cases A and C, and -1 cm for cases B and D). The difference is in the early times, where the fixed flux conditions led to a drier soil surface.