ASSIGNMENT 1 – SOLUTION
CVG3120 Hydrology

Problem 1:

- **Data:**

$Area = 49\ 776.33\ m^2$
$H_{prec} = 3\ m$
$H_{evap} = 8\ {}^{cm}/_{week} = 0.0114\ {}^{m}/_{day}$
$Consumption = 455\ {}^{litres}/_{day} = \ 0.455\ {}^{m^3}/_{day}$
$\Delta t = 3\ weeks = 3\ weeks * \frac{7\ days}{1\ week} = 21\ days$

- **unknown:**

$Storage\ after\ 3\ weeks\ during\ the\ dry\ season\ (S_3) = ?$

- **Equation :**

Water balance equation: $\frac{\Delta S}{\Delta t} = Q_{in} - Q_{out}$

- **Solution:**

Storage during the dry season,
$Storage\ (S_i) = Area * H_{prec} = 49776.33\ m^2 * 3\ m = 149\ 329\ m^3$
$Q_{in} = 0\ {}^{m^3}/_{day}$
$Q_{out} = Evaporation + Consumption$
$= \left(0.0114\ {}^{m}/_{day} *\ 49\ 776.33\ m^2\right) + \left(0.455\ {}^{m^3}/_{day}\right) = 568\ {}^{m^3}/_{day}$
Based on the water balance equation:

$$\boldsymbol{\frac{\Delta S}{\Delta t} = Q_{in} - Q_{out}}$$

$\frac{s_3 - s_i}{21\ days} = 0 - 568\ {}^{m^3}/_{day}$
$s_3 = 21\ days * (-1) * (568\ {}^{m^3}/_{day}) +\ 149\ 329\ m^3\ = \mathbf{137\ 401\ m^3}$

Problem 2:

- First, you have to set the values of height reading on graphs with 2.5 ft increments as specified in the question.

- Then read the graphs Storage (Volume) and flow (Discharge) for each height value chosen in step 1, then convert storage values in acre.ft to cubic feet (NB: The values you read are approximate).

- Calculate the change of storage by taking the volume to the given height minus the volume to the previous height.

  E.g., storage variation at height of 55 ft, change volume =8,712,000 cf - 4356000 cf cf = 4.356 million

- Estimate the average flow rate between two heights by taking the flow rate is at or is higher the value for the previous pitch halving.

  Ex: average rate for a 55 ft Average flow $= \frac{62+64}{2} = 63\ cfs$

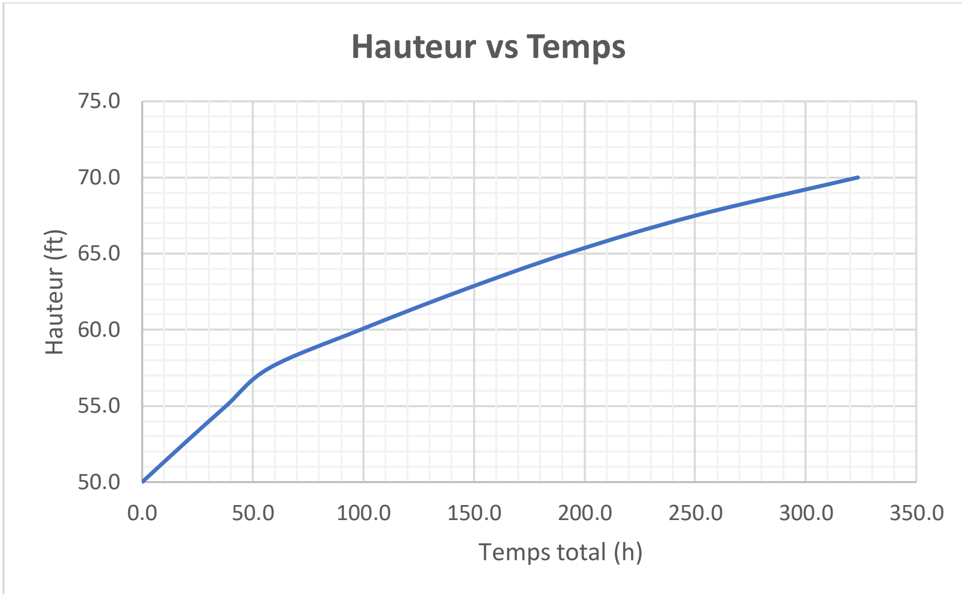
- We the find the time increment.

$$\Delta t = \frac{\text{storage variation}}{Average\ flow} = \frac{4\ 356\ 000\ \text{cf}}{63\ cfs} = 69142.86\ seconds = 19.2\ hours$$

- The total time is the sum of all previous time increments. Plot the height vs. the total time.

Result:

Height (ft)	**Total Volume (ft Acre)**	**Total Volume (cf)**	**Change in volume (cf)**	**Flow rate, Q (cfs)**	**Debit Middle, Qmoy (cfs)**	**Variation of time, Δt (h)**	**Total time (h)**
50.0	0	0		65		0	0.0
52.5	100	4356000	4356000	64	64.5	18.8	18.8
55.0	200	8712000	4356000	62	63.0	19.2	38.0
57.5	300	13068000	4356000	61	61.5	19.7	57.6
60.0	500	21780000	8712000	57	59.0	41.0	98.7
62.5	700	30492000	8712000	52	54.5	44.4	143.1
65.0	900	39204000	8712000	47	49.5	48.9	192.0
67.5	1100	47916000	8712000	36	41.5	58.3	250.3
70.0	1300	56628000	8712000	30	33.0	73.3	323.6



Problem 3:

- **Data:**

$Aire = 10\,000\, m^2$
$Precipitation = P$
Storage:

For H = 0m, S = 0 m, Q= 0 m^3/s
For H = 100 m, S, Q= 10 000 $m^3 = 10\, m^3/s$

- **Solution:**

Part 1:

a) Inflow depends solely on precipitation, thus:

$$Q_{in} = A \times P = 10\,000P$$

b) Based on the data, it is clear that the relationship between storage and the height is linear. So :

$$H = \frac{10}{10\,000} S = 0.001S$$

c) The same linear relationship is used: $Q_{out}[\frac{m^3}{h}] = \frac{10m^3/s}{10\,000\,m^3} S[m^3] \times \frac{3600s}{h} = 3.6S$

Part 2

Water balance equation

$\frac{\Delta S}{\Delta t} = Q_{in} - Q_{out} \Rightarrow \frac{\Delta S}{\Delta t} = 10\,000P - 3.6S \Rightarrow \Delta S = \Delta t(10\,000P - 3.6S)$

$$\Rightarrow \boldsymbol{S_{i+1} = \Delta t(10\,000P - 3.6S) + S_i}$$

With P taken in m / h Δt in h

part 3 :

$P = 10 \frac{mm}{h} = 0.01 \frac{m}{h} = 2.78 \times 10^{-6}\ m/s$ of 1 to 2 days

$P = 0\ \frac{m}{h}$ of 3 to 5 days

$\Delta t = 10$ min $= 1/6$ h,, $t_0 = 0\ hS_0 = 0\ m^3$

For , $\boldsymbol{t_1} = 1/6$ h

- S storage
  From the equation derivedin Part 2,

$$S_1 = (\frac{1}{6}h)\left(10\,000 \times 0.01 \frac{m}{h} - 3.6 \times 0\ m^3\right) + 0\ m^3$$

$$\boldsymbol{S_1 = 16.67\ m^3}$$

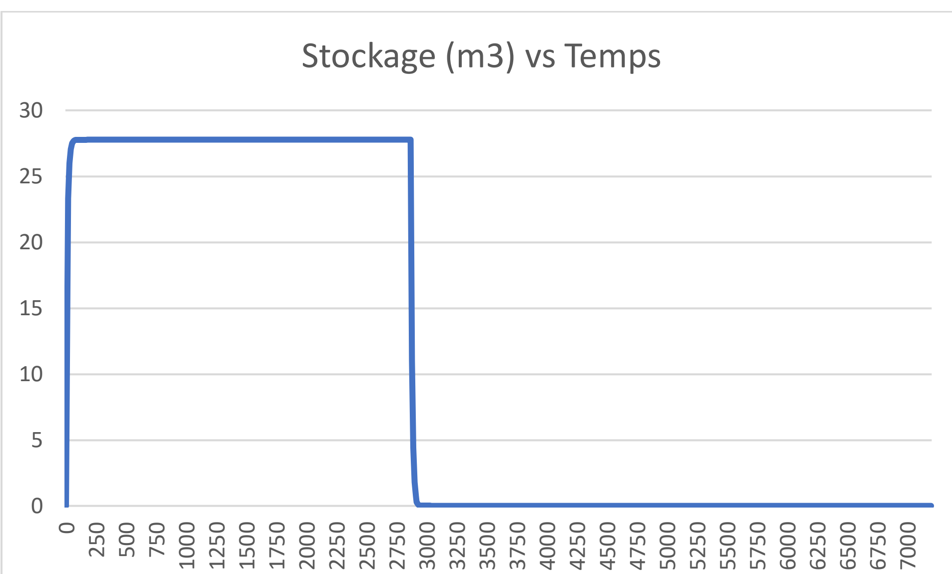
- Height H
  From the equation derived in part 1.b)

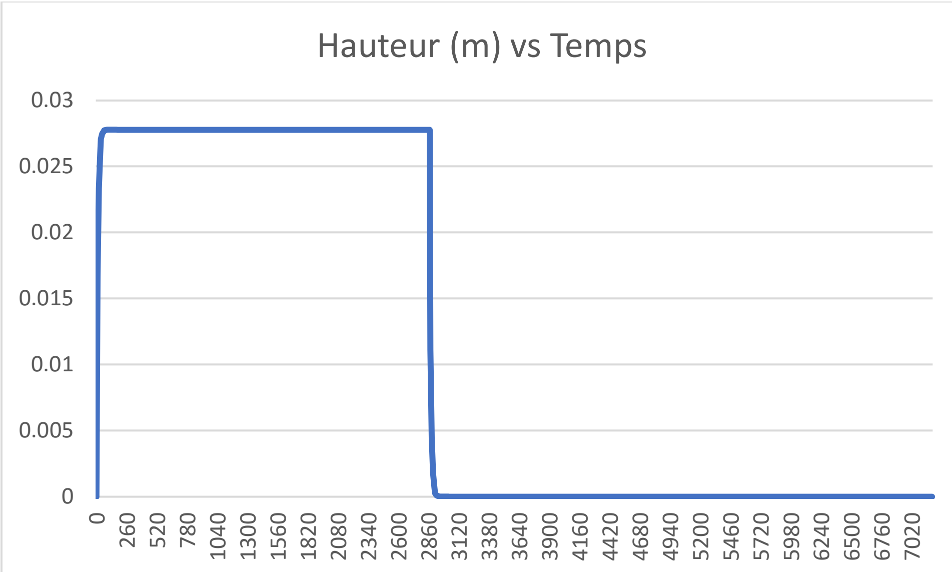
$$H_1 = 0.001 S_1 = 0.001 \times 16.67\ m^3$$
$$\boldsymbol{H_1 = 0.0167\ m}$$

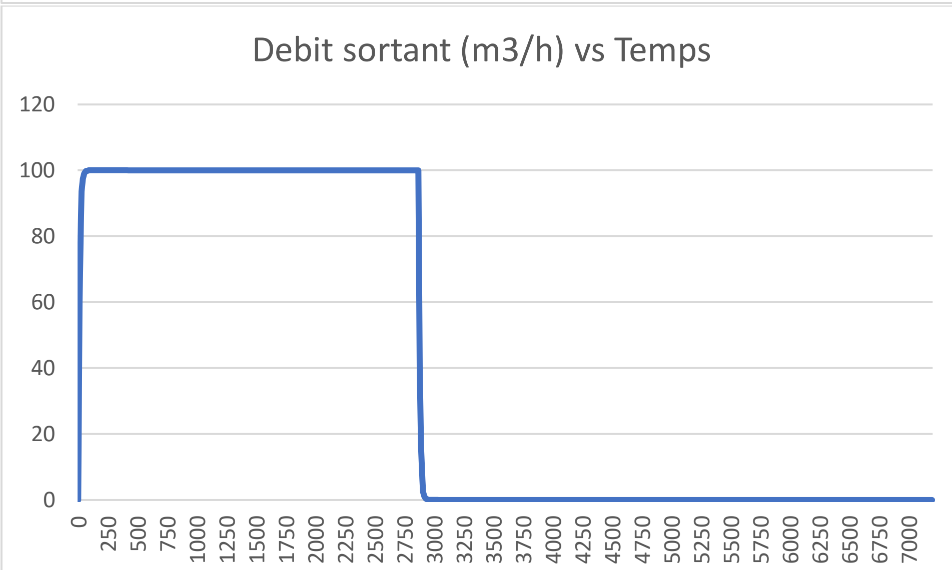
- outflow Q_{out}
  From the equation derived in part 1.c)

$$Q_{out} = 3.6S = 3.6 \times 16.67\ m^3$$
$$\boldsymbol{H_1 = 60.012\ \frac{m^3}{h}\ ou\ 0.0167}\ \frac{m^3}{s}$$

The following graphs are obtained using excel:







Part 4.a:

day 1	day 2	day 3	day 4	day 5
25 mm / h	0 mm / h	30 mm / h	5 mm / h	0 mm / h

Similar to the previous question,

$\Delta t = 1/6$ h,, $t_0 = 0\ hS_0 = 0\ m^3$

For , $\boldsymbol{t_1} = 1/6$ h

- S storage
  From the equation determined in Part 2,

$$S_1 = (1/6h)\left(10\ 000 \times 0.025\frac{m}{h} - 3.6 \times 0\ m^3\right) + 0\ m^3$$

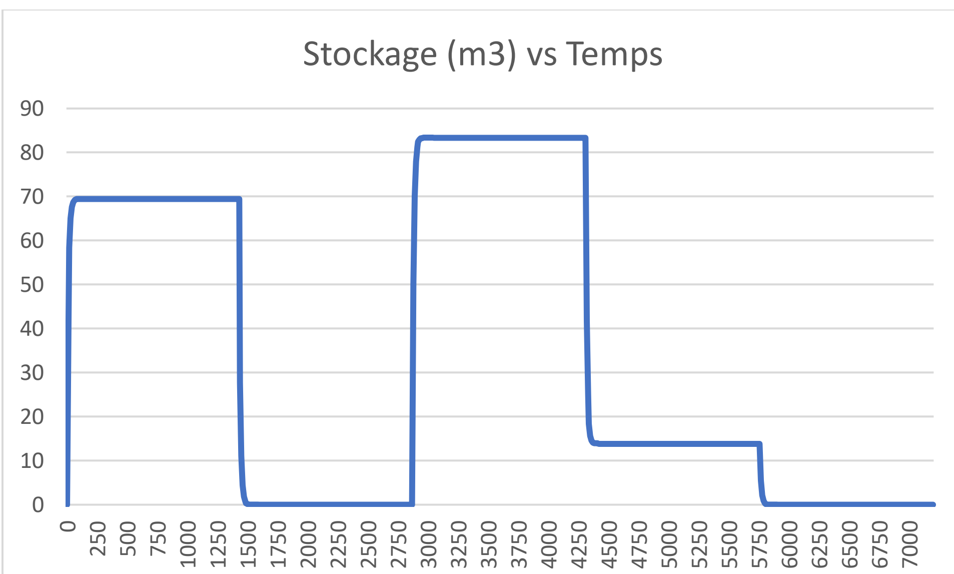
$$\boldsymbol{S_1 = 41.67\ m^3}$$

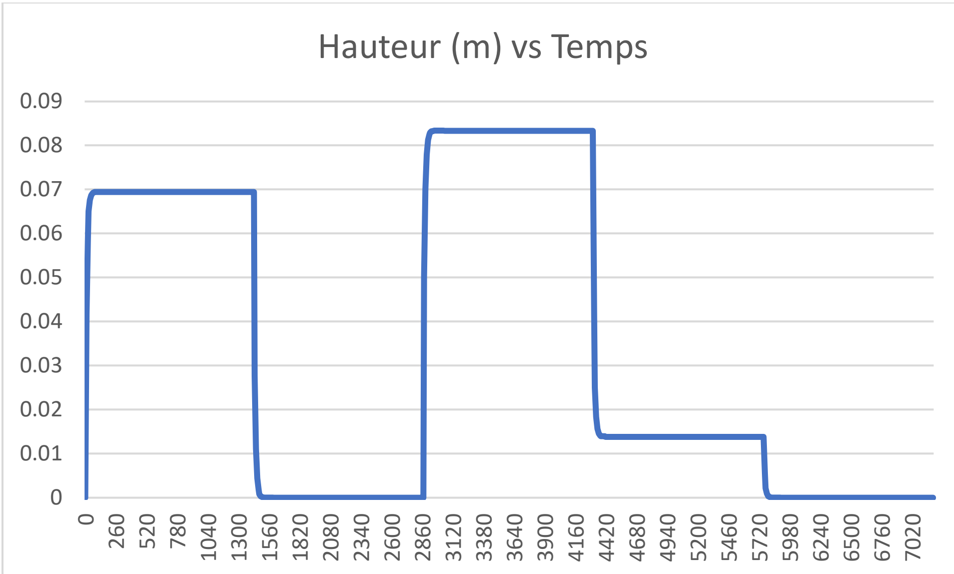
- Height H
  From the equation determined in part 1.b)

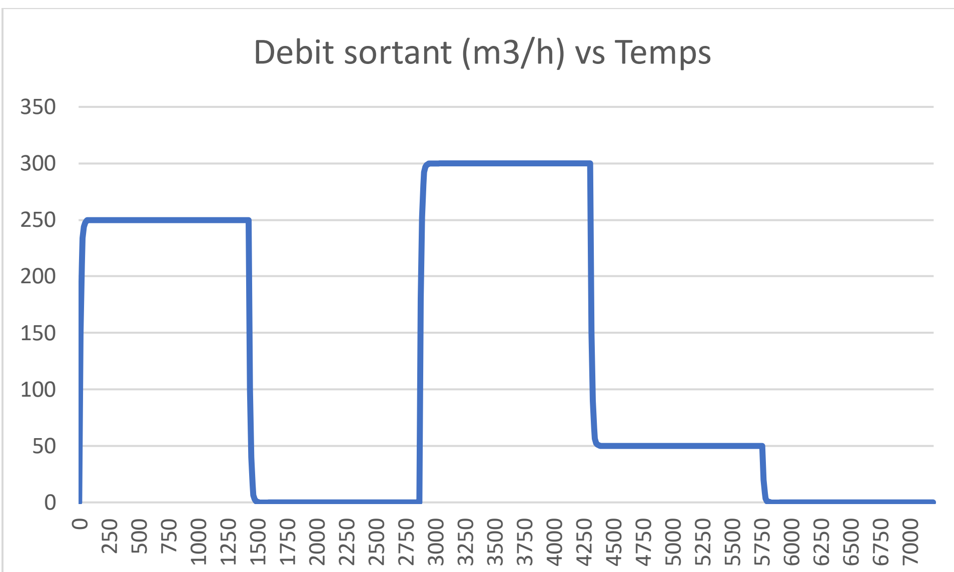
$$H_1 = 0.001S_1 = 0.001 \times 41.67\ m^3$$
$$\boldsymbol{H_1 = 0.04167\ m}$$

- outflow Q_{out}
  From the equation determined in part 1.c)

$$Q_{out} = 3.6S = 3.6 \times 41.67\ m^3$$
$$\boldsymbol{H_1 = 150.012\ \frac{m^3}{h}\ ou\ 0.04167}\ \frac{m^3}{s}$$







b) Hmax <3m so no flooding.

c) No flooding