#1) $H_{ES} = P_{ES} - E_{ES} = 655 - 460 = 195$ mm

Vol from ES = 0,195 · 55800 = 10 881 km^3

#2)

Z(m)	A(km^2)
400	0
350	20
325	40
300	60
200	80
50	100

Avg altitude = $\frac{VOL}{A_{watershed}}$

$= \frac{20(400+350+325+300+20...}{100}$

$= \frac{20 \cdot 1625}{100} = 325$ m

Avg height = Avg altitude − Min altitu...

= 325 − 50 = 275 m

Median altitude = Altitude (50% of the area) = 312,5 m

Median height = 312,5 − 50 = 262,5 m.

#3) Albedo = $\frac{\text{Reflected energy}}{\text{Incident energy}} = \frac{5}{20} = 25\%$

#4) R_A = 900 cal/cm^2/day R_c = 550 cal/cm^2/day T = 15°C

$ETP = 0,4 \cdot \frac{15}{15+15}(550+50) = 0,2 \cdot 600 = 120$ mm

#5)

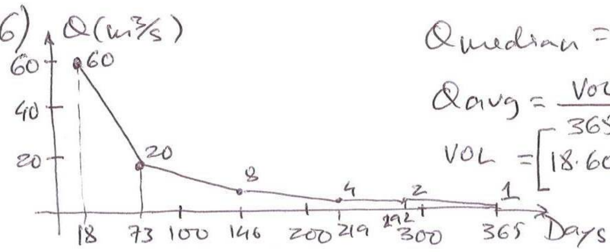
Time	Z(m)	Q(m^3/s)
0	0,5	2,5
6	1,5	15,0
12	1,25	10,0
18	1,00	7,5
24	0,5	2,5

VOL = 6·3600 (2,5 + 15,0 + ... + 2,5

= 6·3600 · 37,5 = 810 000 m^3

QMD = 810000/(24·3600) = 9,3 m...

#6)



Qmedian = $Q_{180day} \simeq 6$ m^3/s

Qavg = $\frac{Vol}{365 \cdot 24 \cdot 3600}$

VOL = $\left[18 \cdot 60 + \frac{60+20}{2} \cdot (73-18) + \frac{20+8}{2}(146-... + \frac{8+4}{2}(219-146) + \frac{4+2}{2}(29... + \frac{2+1}{2}(365-292)\right] \cdot 24 \cdot 36...$

#Days ≥ 3 m^3/s → 255 days!

VOL = 431 611 200 m^2

QMD = 13,7 m^3/s

$Y = \ln Q$

#7) LN: $S_y = 0{,}26 \cdot \bar{Y} = 0{,}2 \cdot 3{,}9 = 1{,}014 \; m^3/s$

$90 = e^{3{,}9 + z \cdot 1{,}014}$

$\rightarrow z = 0{,}592$

$\rightarrow F(x) = 0{,}722$

$\rightarrow T = \frac{1}{1-F} = 3{,}6$ years

Gumbel $S_Q = 1{,}28 \cdot 83{,}9 = 107{,}4 \; m^3/s$

$90 = 83{,}9 + k_G \cdot 107{,}4 \; m^3/s \longrightarrow k_G = 0{,}0568$

$\rightarrow F(x) = 0{,}593$

$\rightarrow T = 1/_{1-F} = 2{,}5$ years

#8)

$A = 0{,}3$ ha

$\theta_{up} = 0{,}08 \; (\theta_i)$

$k_S = 0{,}4$ mm/min

$\theta_S = 0{,}15$

$\psi = -40$ mm

$t_p = 10$ min

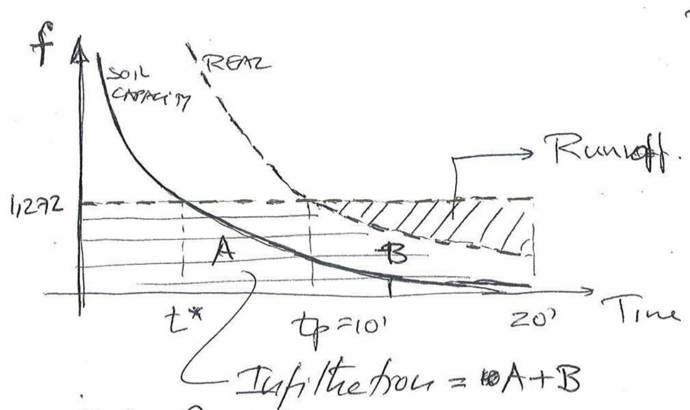
Duration of precipitation = 20 min

$t_p = 10 \text{ min} = \frac{40 \cdot (0{,}15 - 0{,}08)}{p\left(\frac{p}{0{,}4} - 1\right)}$

$2{,}5p^2 - p - 2{,}8 = 0$

$p = 1{,}277$ mm/min $= 76$ mm/h

$P_{TOTAL} = 76 \cdot 20/_{60} = 25{,}3$ mm



Too compute t^*, one needs the formula that provides f at soil capacity. This formula was not given. So we can only say that runoff is less than 25,3 mm

Inf + Runoff = 25,3 mm

A = 1,272 · 10' B = F(20-t*) − F(t*)

#9) $R = S_y \cdot \frac{\Delta h}{\Delta t} = 0{,}02 \cdot \frac{6{,}55 - 4{,}72}{1\,year} = 36{,}6$ mm/year

#10) $T_e = 80 - 30 = 50$ min

$P = 45\left(\frac{50}{60}\right)^{0,6} = 40{,}34$ mm (for T = 50y)

$P_u = 0{,}75 \cdot P = 30{,}25$ mm (for T = 50y)

$\hookrightarrow \Delta P = 30{,}25/5 = 6$ mm

(in each 10 min, 6 mm of precipitatio occurs).

We now need the unit hydrograph for 10':

$15 = 5 \cdot u_1 \rightarrow u_1 = 3\ m^3/s/mm$

$55 = 5(u_1 + u_2) \rightarrow u_2 = 8\ m^3/s/mm$

$75 = 5(u_1 + u_2 + u_3) \rightarrow u_3 = 4\ m^3/s/mm$

$70 = 5(u_2 + u_3 + u_4) \rightarrow u_4 = 2\ m^3/s/mm$

$35 = 5(u_3 + u_4 + u_5) \rightarrow u_5\ 1\ m^3/s/mm$

$15 = 5(u_4 + u_5 + u_6) \rightarrow u_6 = 0\ m^3/s/mm$

We can now apply the 50y precipitation event to the unit hydrograph → 5 blocks of 6 mm of precipitation

$Q_1 = 6 \cdot 3 = 18\ m^3/s$

$Q_2 = 6 \cdot (3+8) =$

$Q_3 = 6 \cdot (3+8+4)$

$Q_4 = 6(3+8+4+2)$

$Q_5 = 6(3+8+4+2+1) = 108\ m^3/s$

↑ Peak flow

$Q_6 = 6(8+4+2+1)$

$Q_7 = 6(4+2+1)$

$Q_8 = 6(2+1)$

$Q_9 = 6 \cdot 1$

$Q_{10} = 0$

Another aproximate solution could be obtai using the rational formula.

$A = \frac{Vol\ UH}{Precip} = \frac{162000}{0{,}015} = 10{,}8\ km$

Assuming C = 0,75 (this is an aproximation for C also reflects attenuation (not only infiltration).

$Q = C \cdot i \cdot A = 108{,}9\ m^3/s$