#1)

Res. inflow $= 450 \cdot 10^6 \, (1200 - 450) \cdot 10^{-3} = 202500 \, m^3 = 202,5 \, hm^3$

$V_{P-ET} = 15 \cdot 10^6 \cdot (1200 - 950) = 3,75 \, hm^3$

$V_{eco} = 3 \cdot 3600 \cdot 24 \cdot 3600 = 94,61 \, hm^3$

$V_{for\ uses} = 202,5 + 3,75 - 96,61 = 111,64 \, hm^3 = 3,54 \, m^3/s$

#2)

$R_C = (\alpha + \beta \frac{n}{N}) R_A \quad \alpha = 0,25 \, ; \; \beta = 0,50$

→ function of cloud cover, dust and aerosols

Clean sky: $R_C = 0,75 \, R_A$; Cloudy sky: $R_C = 0,25 \, R_A$

#3)

P – Peaks in the winter

PET/ETP – Peaks in the summer, when available energy for evapotranspiration is maximum.

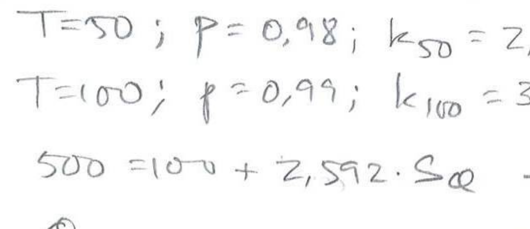
AET/ETR – Follows PET but is always less than PET. Peaks earlier than PET because in the summer there is no water in the soil to evapotranspire.

H – Follows P and ETR; Peaks later than Precipitation due to the contribution of groundwater flow.

#4)

$Q = 5 \, m^3/s$ — $D = 175$ days – Power plant will not work for 90 days

$Q = 10 \, m^3/s$ — $D = 120$ days – Power plant will work at full power for 120 days



$Vol = 120 \cdot 10 + (150 - 120) \cdot \frac{10 + 7}{2} + (175 - 150) \cdot \frac{7 + 5}{2} =$

$= 1605 \, m^3/s \cdot day = 138,7 \, hm^3$

#5)

$T = 50 \, ; \; p = 0,98 \, ; \; k_{50} = 2,592$

$T = 100 \, ; \; p = 0,99 \, ; \; k_{100} = 3,137$

$Q_T = \bar{Q} + k_T \cdot S_Q$

$500 = 100 + 2,592 \cdot S_Q$ — $S_Q = 154,3 \, m^3/s$

$Q_{100} = 100 + 3,137 \cdot 154,3 = 584,1 \, m^3/s$

#6 $h = 0{,}8$ m ; $n = 30\%$ $\theta_{fc} = 200$ mm

a) $\theta = 180$ mm

VOIDS	30% → $0{,}3 \cdot 800 = 240$ mm
SOLID PARTICLES	70%

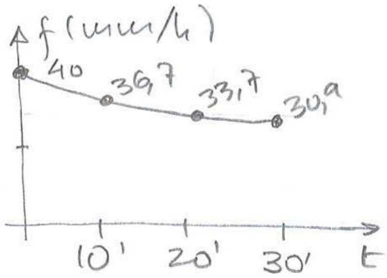
$\theta_s = 240$ mm

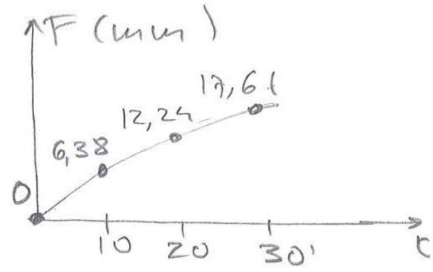
$S = \theta / \theta_s = 180/240 = 75\%$

b) $\theta' = \theta_i + 30 = 180 + 30 = 210$ mm $> \theta_{fc}$

$\theta_{final} = \theta_{fc} = 200$ mm ; 10 mm will drain vertically

#7 $f_0 = 40$ mm/h
$f_c = 5$ mm/h
$K = 0{,}6\ h^{-1}$
$D = 30$ min





#8) a) $T_c = 120 - 90 = 120$ min

Vol. hydrog. $= 30 \cdot 60 \cdot (30 + 10 + 176 + 160 + 80 + 24) = 1058400\ m^3$

$A = V/P = 1058400 / 0{,}042 = 25\ 200\ 000\ m^2 = 25{,}2$ km

b) Since the new event is exactly 1,5 times the original event

$Q^{new} = 1{,}5\, Q^{ORIG}$; $Q = 0; 45; 165; 264; 240; 132; 36; 0$

Alternatively, there is the long way: Compute UH and then the new hydrograph

10·UH	20·UH	12·UH	Q^{ORIG}
$10U_1$			30
$10U_2$	$20U_1$		110
$10U_3$	$20U_2$	$12U_1$	176
$10U_4$	$20U_3$	$12U_2$	160
$10U_5$	$20U_4$	$12U_3$	88
$10U_6$	$20U_5$	$12U_4$	24

→

UH	15·UH	30·UH	18UH	Q^{NEW}
$U_1 = 3$	45			45
$U_2 = 5$	75	90		165
$U_3 = 4$	60	150	54	264
$U_4 = 2$	30	120	90	240
$U_5 = 0$	0	60	72	132
		0	36	36
			0	

#9) $Q = f \cdot C \cdot i \cdot A / 3{,}6$

$i = 350 \cdot 90^{-0{,}524} = 33{,}1$ mm/h $Q^{no\,maj} = 0{,}75 \cdot 33{,}1 \cdot 50/3{,}6 = 344{,}8\ m^3/s$

$i = aD^b$ $P = a \cdot D^n = aD^{b+1}$ $n = 1 - 0{,}524 = 0{,}476$

$f = 2 - \sqrt{0{,}476} = 1{,}31$ $Q = f \cdot C \cdot i \cdot A = 1{,}31 \cdot 344{,}8 = 451{,}7\ m^3/s$

#10) Groundwater is a much more resilient resource than surface water and therefore more resistant to prolonged drought periods. Thus, one of the measures to adapt to the impacts of climate change is an integrated water catchment management of surface and groundwater resources of different origins towards the increase of resilience in different scenarios.