Problem 1

<u>Solution</u>

1) Population at 2030
2) Lpcd at 2030
3) Total average daily demand, Q_{avg} in 2030

- No specify which method, we use <u>Arithmetic</u> method

$P_{2030} = P_{2010} + K_a\ t$

$K_1 = \Delta P/\Delta t = (8990-8100) / (1980-1970) = 89$

$K_2 = (11400-8990) / (1990-1980) = 241$

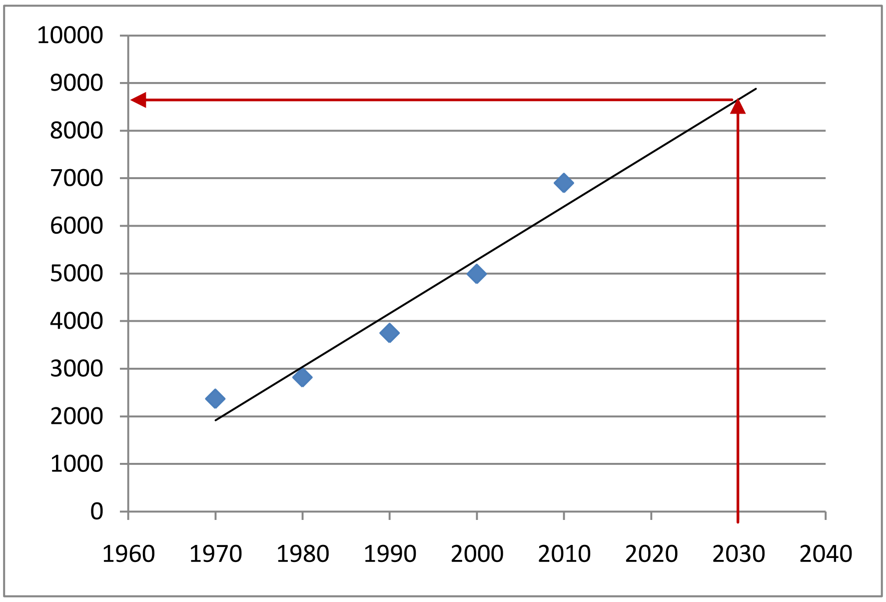
$K_3 = 340$

$K_4 = 380$

$$K_{avg} = \frac{\sum K}{n} = \frac{89+241+340+380}{4} = 262.5$$

$P_{2030} = 18600 + 262.5\ (2030-2010)$
$= 23850$ capita

To determine Q_{avg} in 2030 a linear regression that passes through the points in a relationship between flow (m^3/d) and years, finding the flow in 2030



3) at 2030 $Q_{avg} = 8600\ m^3/d$

2) water consumption per capita = 8600 / 23850 = 0.3605 m^3/c = 360.5 Lpcd

Problem 2

Given: P_0 = 56000 person , Q_{avg} = 9,499,500 m^3/12months

$Q_{max(daily)}$ = 43,000,000 L $P_{after\ 10\ yr}$ = 72,600

Find: Q_{avg} & Q_{max} after 10 yr

<u>Solution</u>

w.c. per capita = 9499500(1000) / 12 (30) (58000) = 455 Lpcd

Factor = Q_{max} / Q_{avg} = $\frac{43000000}{(1000)(9499500)/(12)(30)}$ = 1.63

Assuming that no change in the w.c.per capita

Q_{avg} = 72600 (455) = 33033000 L/d = 33033 m^3/d

Q_{max} = 33033 (1.63) = 53843.79 m^3/d

Problem 3

Given: P_{20} = 36000 c , P_0= 28500 c , w.c. = 16200 m^3/d

W.T.P design capacity = 18900 m^3/d

Find: in which year (t) w.c. will reach design capacity?

<u>Solution</u>

Present w.c. = 16200 / 28500 = 0.568 m^3/cd

Population when design capacity is reached = 18900 / 0.568 = 33275 c

Arithmetic rate of growth, K = $\Delta P / \Delta t$ = (36000 – 28500) / 20 = 375 (c/y)

To find t when w.c. will reach 18900 m^3/d with a population of 33275 :

$P = P_0 + K\ t$ ➔ $t = (P-P_0) / K$

= (33275 – 28500) / 375 = 12.73 years

Problem 4

Given: ultimate popu. Density = 14500 per km^2

Total area = 115000 m^2 , avg. WW.flow = 300 Lpcd

Find: max WW flow ..

<u>Solution</u>

Population = 14500 (115000 / 1,000,000) = 1667.5 = 1668 capita

Q_{avg} = 300 (1668) = 500400 L/d

Q_{max} = 1.8 (500400) = 900720 L/d

Problem 5

<u>Solution</u>

1) Arithmetic: - find $K_{a\,(1960\text{-}1970)} = (P_{1970} - P_{1960})/\Delta t$

$$= \frac{(90-80)*1000}{1970-1960} = 1000$$

$K_{a\,(1970\text{-}1980)}$, $K_{a\,(1980\text{-}1990)}$, $K_{a\,(1990\text{-}2000)}$, $K_{a\,(2000\text{-}2015)}$

- find average K_a
- $P_{2025} = P_{2015} + K_a\ t = 270{,}000 + K_a * 10$

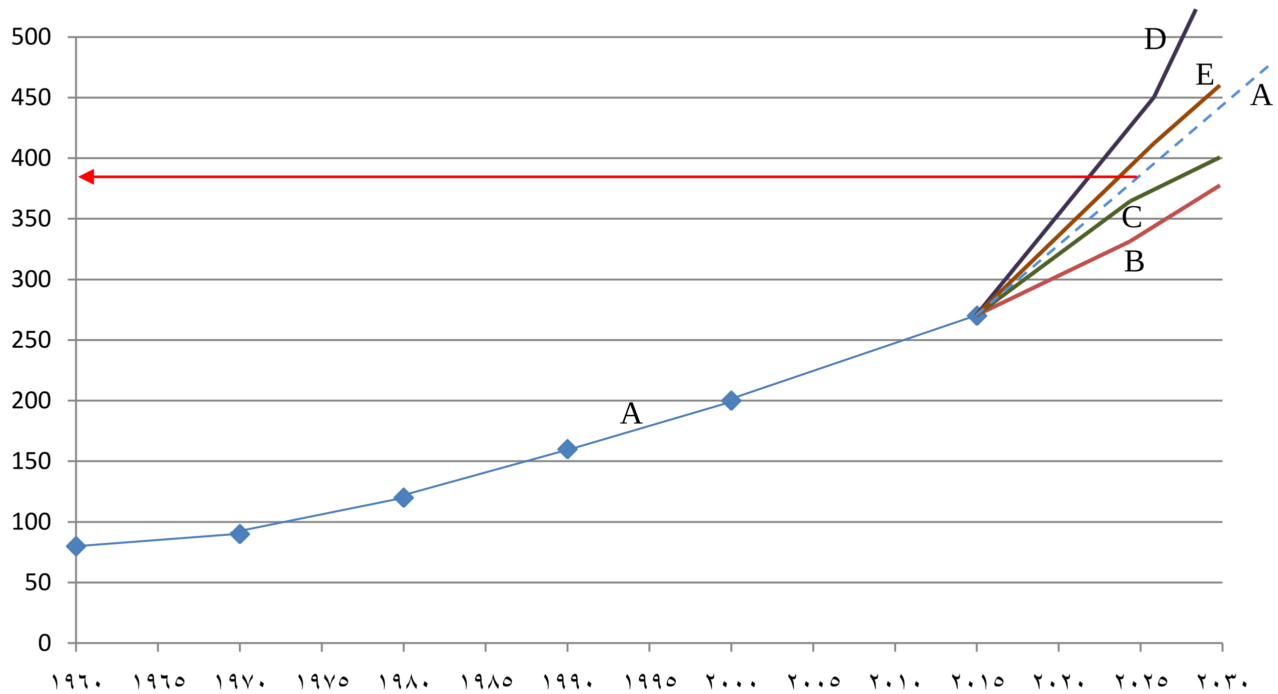
2) Geometric: - find $K_{g\,(1960\text{-}1970)} = \ln (P_{1970}/P_{1960})/\ \Delta t$

$$= \ln (90/80) / (1970\text{-}1960)$$

$K_{g\,(1970\text{-}1980)}$, $K_{g\,(1980\text{-}1990)}$, $K_{g\,(1990\text{-}2000)}$, $K_{g\,(2000\text{-}2015)}$

- find average K_a
- $P_{2025} = P_{2015}\ e^{\Delta t\ Kg} = 270{,}000 * e^{10(\ Kg)}$

3) Comparative:



B	1960	1970	1980
C	1970	1980	1990
D	1960	1970	1980
E	1980	1990	2000

4) Logistic:

$$P_t = \frac{P_{sat}}{1+e^{(a+b\ \Delta t)}} \quad \text{where} \quad P_{sat} = \frac{2P_0P_1P_2-P_1^2(P_0+P_2)}{P_0P_1-P_1^2}$$

$$a = ln(\frac{P_{sat}-P_2}{P_2})$$

$$b = \frac{1}{n} ln\left[\frac{P_0(P_{sat}-P_1)}{P_1(P_{sat}-P_0)}\right]$$

Note: P_0 , P_1 and P_2 must have (n) the same time intervals between it

To find P at t=2025
Take P_0 at 1980, P_1 at 1990 and P_2 at 2000 with n=10

$$P_{sat} = \frac{2(120)(160)(200) - (160)^2(120+200)}{(120)(200)-(160)^2} = 320 \quad \times 10^3$$

$$a = ln(\frac{320-200}{200}) = -0.51$$

$$b = \frac{1}{10} ln\left[\frac{120\ (320-160)}{160\ (320-120)}\right] = -0.051$$

$\Delta t = t_{P\ estimate} - t_{P0} = 2025 - 1980 = 45$ yrs

$$P_t = \frac{320}{1+e^{(-0.51+-0.051\ (45))}}$$

$= 301.806 \times 10^3$
$= 301806$ person