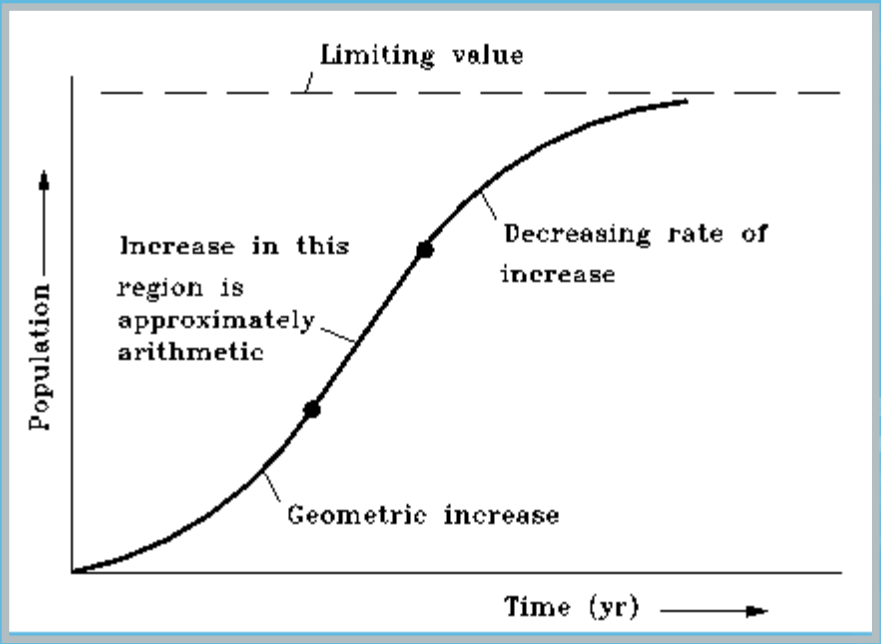
Prediction of population

- **Method of forecasting:**
  - **Arithmetic .** الطريقة الحسابية
  - **Geometric.** الطريقة الهندسية
  - **Annual growth.** معدل الزيادة السنوية
  - **Decreasing rate of increase.** تناقص معدل الزيادة
  - **Graphical extension.** التمديد الرسومي
  - **Graphical comparison.** مقارنة رسومية

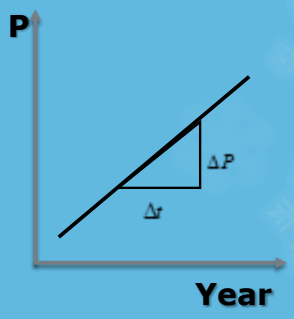


1- Arithmetic method

The rate of increase is constant

- $Ka = \frac{dp}{dt}$
- $\int_{Po}^{Pn} = Ka * \int_{to}^{tn} dt$
- $P_n - P_o = K_a(t_n - t_o)$
- $K_a = \frac{Pn-Po}{tn-to} = \frac{\Delta p}{\Delta t}$

$P_n = P_o + K_a (t_n - t_o)$



- ✓ **P_n: The population in the future.**
- ✓ **P_o : The population in the present.**
- ✓ **n: Design period.**
- ✓ **K_a : Uniform growth rate constant معدل ثبات النمو المنتظم**

Ex: Find the population of the city (A) at 2020 using arithmetic method

Gives		Solution		
years	P	$P_n - P_o$ (ΔP)	$t_n - t_o$ (Δt)	$Ka = \frac{\Delta P}{\Delta t}$
1910	45000	15000	10	1500
1920	60000	27000	10	2700
1930	87000	28000	10	2800
1940	115000	14000	10	1400
1950	129000	20000	10	2000
1960	149000	16000	10	1600
1970	165000			

$\sum Ka = 12000$

$Ka\ (average) = \frac{\sum Ka}{No.of\ Ka} = \frac{12000}{6} = 2000 \frac{capita}{year}$

$P_{2020} = 165000 + 2000 (2020 - 1970) = 265000$ capita

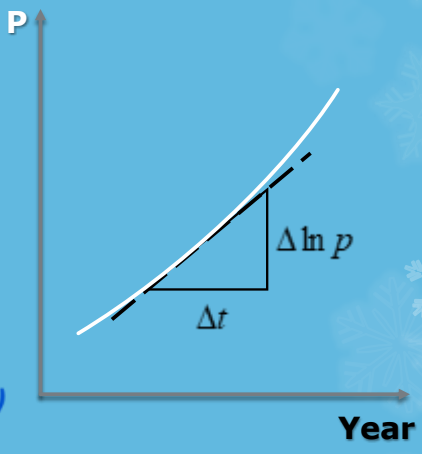
2- Geometric method

The rate of increase is Proportional to population

- $\frac{dp}{dt} = K_g \times P$
- $\int_{Po}^{Pn} \frac{dp}{P} = K_g \int_{to}^{tn} (t_n - t_o)$
- $lnP_n - lnP_o = K_g\,(t_n - t_o)$
- $\Delta lnP = K_g\,(\Delta t)$
- $K_g = \frac{\Delta\, lnP}{\Delta t}$

❑ $ln\ Pn = ln\ Po + K_g\,(t_n - t_o)$

✓ $Kg = \frac{\Delta lnP}{\Delta t}$



Ex: Find the pop. The city (A) at year 2020 using geometric method

Given		Solution			
Year	p	ΔlnP	tn-to	ln Pn-Po	Kg
1910	45000	10.7144			
1920	60000	11.0021	10	0.2877	0.02877
1930	87000	11.3737	10	0.3716	0.03716
1940	115000	11.6527	10	0.279	0.0279
1950	129000	11.7676	10	0.1149	0.01149
1960	149000	11.9117	10	0.1441	0.01441
1970	165000	12.0137	10	0.102	0.0102

$\sum Kg$ = 0.13/6

$K_g\ (\text{average}) = \frac{\sum Kg}{No.of\ Kg} = \frac{0.13}{6} = 0.02167$

$lnP_{2020} = ln(165000) + (0.02167) \times (2020 - 1970)$

$P_{2020} = 487575$ c

3- Annual Growth Rate

- $Pn = Po\left(1 + \frac{m}{100}\right)^{n}$
- $n = tn - to$
- $m = \left[\left(\frac{Pn}{Po}\right)^{\frac{1}{n}} - 1\right]$

- n : Design Period
- m : Annual growth rate

Ex: Find the pop. The city (A) at year 2020 using annual rate.

M=2.195%
Po=165000 c
Year =1970

$m = 0.02195$

$P_{2020} = 165000(1 + 0.02195)^{2020-1970}$

$P_{2020} = 488615$ capita

Water consumption

Water uses :

Domestic use	50%
Industrial use	20%
Commercial use	15%
Public use	5%
Losses and wastes	10%

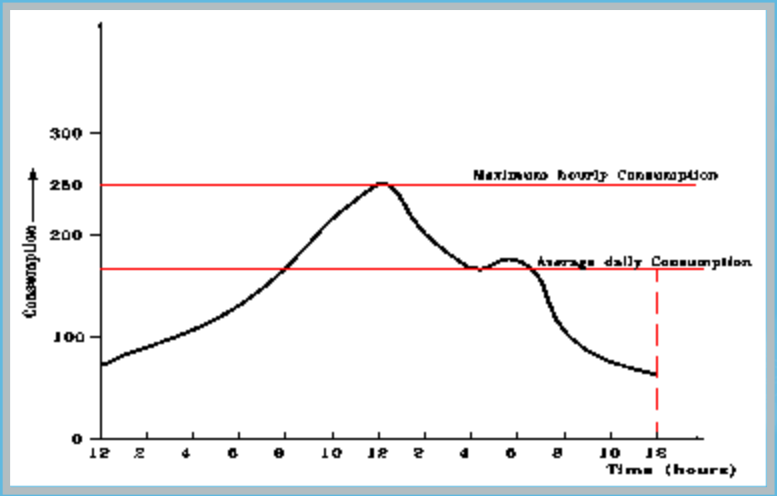
Factors affecting the water consumption

- Climate
- Type of community(economic condition)(standard of living)
- City size
- Water pressure
- Water quality
- Cost of water
- Wastewater projects

Variation in water consumption

التفاوت في استهلاك المياه

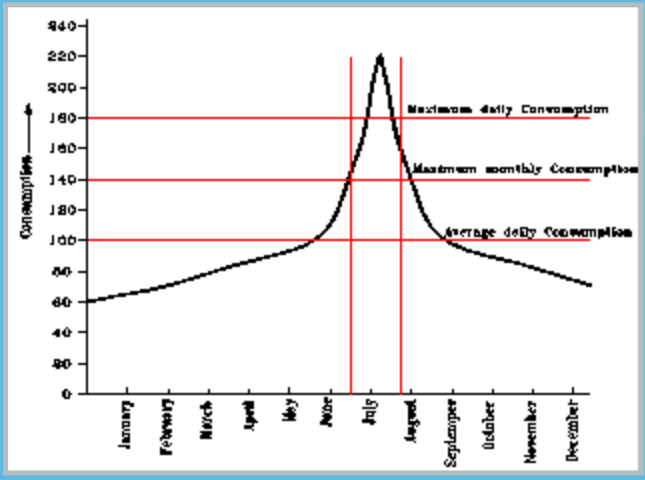
*Daily change



Characteristic hourly consumption curve

Fluctuation of consumption for various periods of time

تقلبات الاستهلاك لفتره زمنية مختلفة



Increasing in water consumption

- Water consumption (% increase) = $\left(\left(\frac{p_n}{p_o}\right)^{0.125}-1\right)*100$
- Completely metered system % increase = $\left(\left(\frac{p_n}{p_o}\right)^{0.11}-1\right)*100$
- Annual growth % increase = $\left((1+r)^n-1\right)*100$

r = (1/10) *m annual growth rate

n = Design period

$$q_f = (1+\%increase\ )* q_{present}$$

Design flows

- **Average flow (Q av)= p * q**
- **Maximum monthly flow (Q max. monthly)**
- **Q max. monthly = 1.4 Qav**
- **Maximum daily flow (Q max. daily)**
- **Q max. daily = 1.8 Qav**
- **Maximum hourly flow (Q max. hourly)**
- **Q max. hourly = 2.5 Qav**

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$Q_{average} = \frac{277 * 552632}{1000} = 153079 m^3 / d$

$Q_{max.\ Monthly}$ =1.4Qave = 214311 m^3 / d

$Q_{max.daily}$ = 1.8Qave = 275542 m^3 / d

$Q_{max.\ Hourly}$ = 2.5Qave = 382698 m^3 / d

Characteristics of water

Chemical characteristics :

1- PH : Ranged from (6.5-9.5)

2-Dissolved Solids :

Manganese <=0.1 mg /l Iron and manganese <= 0.3 mg/l

Calcium <=200 mg/l sodium <= 200mg/l

Iron <=0.3 mg/l Magnesium <= 150 mg/l

Sulphate <=400 mg/l chloride <= 500 mg/l

Copper <=1.0 mg/l Nitrate <= 10 mg/l

Nitrate <=0.005 mg/l lead <= 0.05mg/l

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