Environmental Engineering-I

Water quantities Requirement

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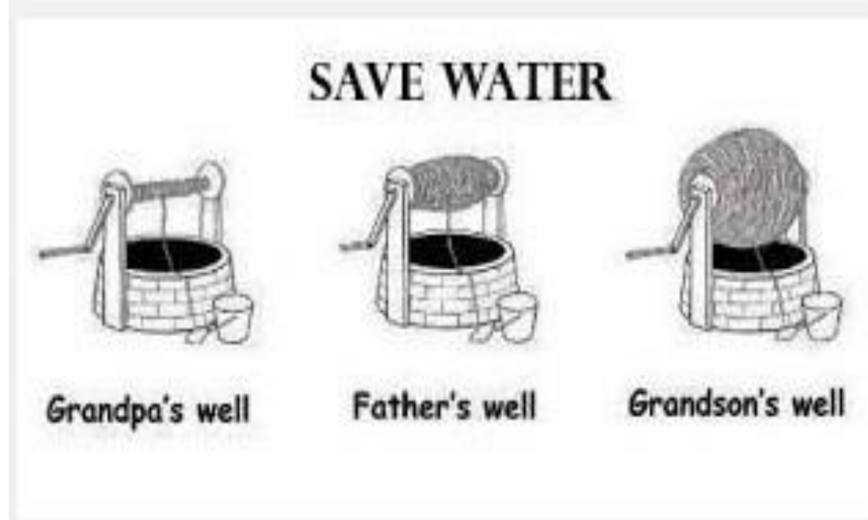
Importance of Water

Future water security?


Water


SAVE WATER
Grandpa's well
Father's well
Grandson's well

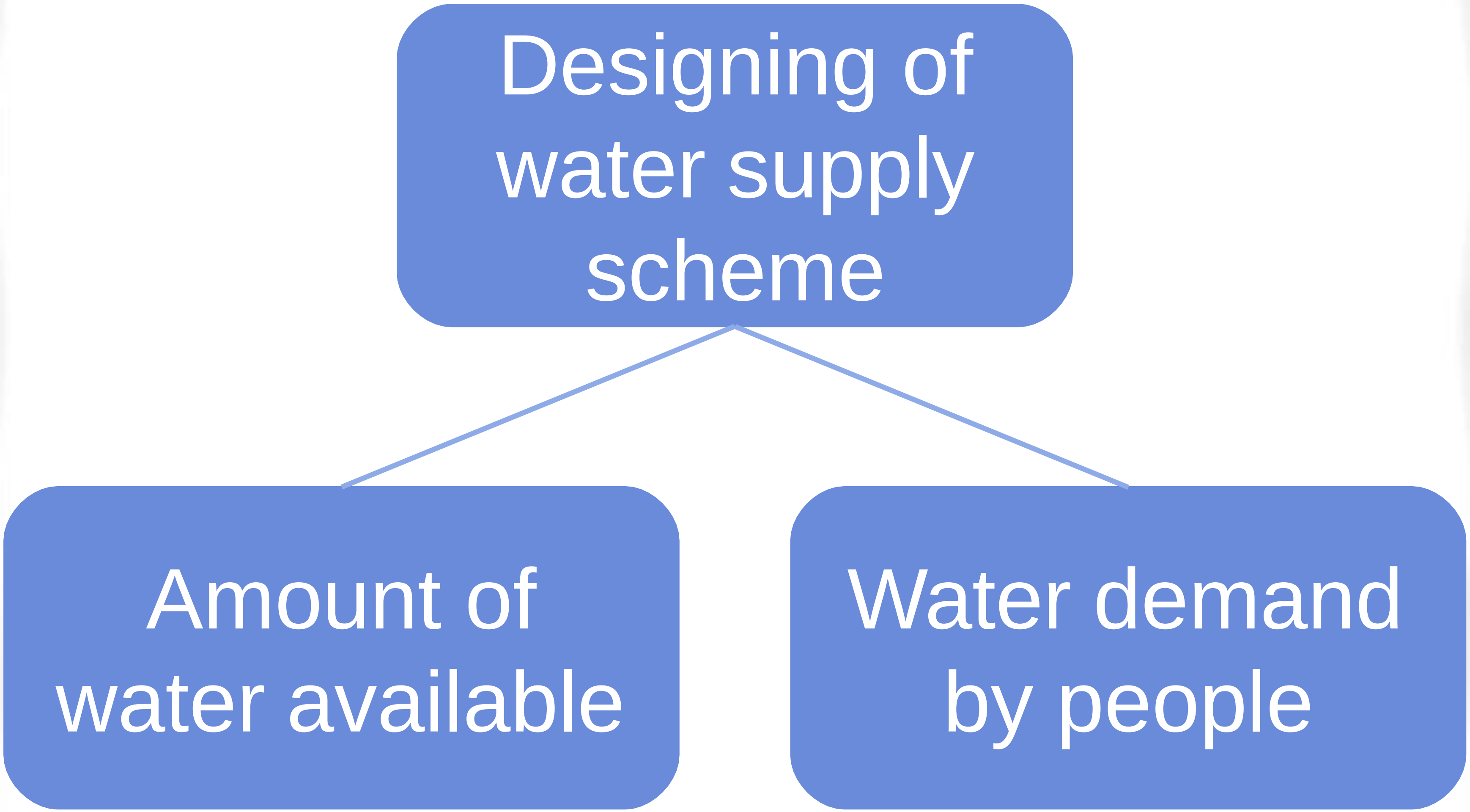

DAD!


VOTE FOR MY COUSIN -- ELSE I'LL CUT OFF MY WATER SUPPLY !!
AJIT POWER THREATS VILLAGER

Course Content...

Water demand, Types of demands, Factors affecting per capita demand, waste and losses, variations in demand, design periods, population forecasting methods & problems.

Role of Designer



Various Water Demand

- Total annual volume (V) in liters or ML
- Annual average rate of draft in lit/day i.e V/365
- Annual avg. rate of draft in lit/day/person called per capita demand
- Average rate of draft in lit/day per service i.e. (V/365) X (1/No. of services)
- Fluctuations in flows expressed in terms of percentage ratios of maximum yearly, monthly, daily or hourly rates to their corresponding average values.

Water Quantity Estimation

- The quantity of water required for municipal uses for which the water supply scheme has to be designed requires following data:

- Water consumption rate *(Per Capita Demand in litres per day per head)*
- Population to be served.

♣ *Quantity = Per capita demand x Population*

Water Consumption Rate

- Very difficult to assess the quantity of water demanded by the public, since there are many variable factors affecting water consumption.
- Certain thumb rules & empirical formulas ued to assess this quantity.
- Particular method or formula for particular case has to be decided by the intelligence & foresightedness of the designer.

There are various types of water demands in a city.

- Domestic water demand
- Industrial Water demand
- Institution and commercial Water demand
- Demand for public uses
- Fire demand
- Water required to compensateLoses in wastes & thefts

Domestic Demand





... let's see if I can warm up the house!




Gardening & Car Washing

Domestic water demand

- water required in the houses for drinking, bathing, cooking, washing, lawn sprinkling, gardening, sanitary purposes etc.
- mainly depends upon the habits, social status, climatic conditions and customs of the people.
- As per IS: 1172-1963, under normal conditions, the domestic consumption of water in India is about 135(weaker & LIG) - 200 (full flushing) litres/day/capita.

Full flushing system

The details of the domestic consumption are

a) Drinking ------	5 litres
b) Cooking ------	5 litres
c) Bathing ------	75 litres
d) Clothes washing ------	25 litres
e) Utensils washing ------	15 litres
f) House washing ------	15 litres
g) Flushing of waterCloset, etc------------	45 liters
h) Lawn watering & gardening------------	15 liters
	--------------------------
	200 litres/day/capita

Weaker section & LIG

The details of the domestic consumption are

a) Drinking ------ 5 litres

b) Cooking ------ 5 litres

c) Bathing ------ 55 litres

d) Clothes washing ------ 20 litres

e) Utensils washing ------ 10 litres

f) House washing ------ 10 litres

g) Flushing of water
Closet, etc ------- 30 litres

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135 litres/day/capita

Total domestic water consumption usually accounts to 50-60% of total water consumption
The Is code lays down a limit on domestic water consumption between 135-225 l/h/d
In developed & effluent country like USA, this figure this figure usually goes as high as 340 l/h/d. This is because more water is consumed in rich living in air-cooling, bathing in bath-tubs, dish washing of utensils, car washing, home laundries, garbage grinders,etc

Domestic water demand = designPopulation x Per capita domestic demand

Industrial demand

- Industrial water demand = Water demand of Existing or likely to be started industries in near future.
- this quantity vary with types & no. of industries, which are existing in the city.
- Per capita consumption on account of industrial needs is generally taken as 50 l/h/d
- In industrial city this demand may be as high as 450 l/c/d

Industrial demand

- The water required by factories, paper mills, Cloth mills, Cotton mills, Breweries, Sugar refineries etc. comes under industrial use.
- The quantity of water demand for industrial purpose is around 20 to 25% of the total demand of the city.
- Automobiles- 40kl/vechile, Paper - 200-400 kl/Tonne, Petroleum Refinery- 1-2 kl/tonne of crude, Steel- 200-250 kl/tonne, distillery- 122-170 kl/ kl, Textile- 80-140 kl/tonne of goods, special Qualitypaper- 400-1000kl/tonne.

Institution and commercial demand

- Universities, Institution, commercial buildings and commercial centres including office buildings, warehouses, stores, hotels, shopping centres, health centres, schools, temple, cinema houses, railway and bus stations etc comes under this category.
- On an average this value is taken as 20 l/h/d & for highly commerciallised cities it may be 50l/c/d

Indivisual water requirement

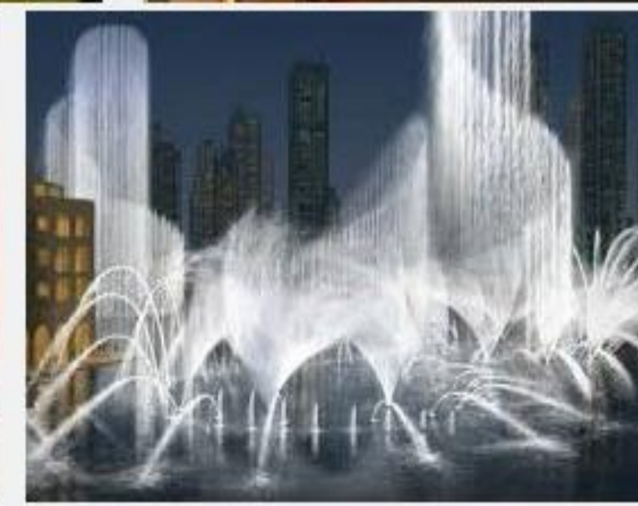
S. No.	Type of Institution or Commercial establishment	Avg demand in l/h/d
1	offices	45-90
2	Hostels	135-180
3	Restaurants	70 per seat
4	schools a) day school	45-90
	b) Residential	135-225
5	Factories a) Where bath rooms are provided	45-90
	b) No bath rooms provided	30-60
6	Hospitals (Including laundry) a) beds less than 100	340 per bed
	b) beds more than 100	450 per bed
7	Nurses homes & medical quarters	135-225
8	Cinema hall	15
9	Airports	70
10	Railway station	23-70

Demand :Public Use - Gardening

Public fountain

Public Fountain

Public Fountain



Street Sweeping

Demand for public use

- Quantity of water required for public utility purposes such as for washing and sprinkling on roads, cleaning of sewers, watering of public parks, gardens, public fountains etc. comes under public demand.
- To meet the water demand for public use, provision of 5% of the total consumption is made designing the water works for a city.
- A figure of 10 l/c/d is usually added.

The requirements of water for public utility shall be taken as…

Sl.No.	Purpose Water	Requirements
1	Public parks	1.4 litres/m2/day
2	Street washing	1.0-1.5 litres/m2/day
3	Sewer cleaning	4.5 litres/head/day

Fire Demand






Fire demand

- During the fire breakdown large quantity of water is required for throwing it over the fire to extinguish it, therefore provision is made in the water work to supply sufficient quantity of water or keep as reserve in the water mains for this purpose.
- Fire hydrants are usually fitted in water mains at about 100 m to 150 m apart & fire fighting pump is fitted to it in case of fire.

These pumps throw water at very high pressure. Pressure available at fire hydrants be of the order of 100 to 150 kn/m^2 & should be maintained even after 4 to 5 hours of constant use.

Three stream jets are simulteneously thrown from each fire hydrant; One on burning property & one each on adjacent propertyon either side of the burning property.the discharge of each stream should be 1100lit/min.

The per capita fire demand is generally ignored while computing total per capita demand.

Kilo liters of water req. = 100 $(P)^{1/2}$ P= population in thousands

- The quantity of water required for fire fighting is generally calculated by using different empirical formulae.
- For Indian conditions kuiching's formula gives satisfactory results.

$$Q=3182\sqrt{p}$$

- Where 'Q' is quantity of water required in litres/min
- 'P' is population of town or city in thousands

Losses & Thefts

Losses & Theft

Loses and wastes

- Losses due to defective pipe joints, cracked and broken pipes, faulty valves and fittings.
- Losses due to, continuous wastage of water.
- Losses due to unauthorised and illegal connections.
- While estimating the total quantity of water of a town; allowance of 15% of total quantity of water is made to compensate for losses, thefts and wastage of water.

Water Consumption for Various Purposes

	Types of Consumption	Normal Range (lit/capita/day)	Average	%
1	Domestic Consumption	65-300	160	35
2	Industrial and Commercial Demand	45-450	135	30
3	Public Uses including Fire Demand	20-90	45	10
4	Losses and Waste	45-150	62	25

Per capita demand

- If ‘Q’ is the total quantity of water required by various purposes by a town per year and ‘p’ is population of town, then per capita demand will be

- Per capita demand = $\dfrac{Q}{P \times 365}$ litres/day

Break up of Per Capita Demand for an Average Indian City

USE	Demand in l/h/d
Domestic use	200
Industrial use	50
Commercial use	20
Civic use or public use	10
Wastes & thefts, etc	55
Total	335 = per capita Demand (q)

- Per capita demand of the town depends on various factors like standard of living, no. and type of commercial places in a town etc.
- For an average Indian town, the requirement of water in various uses is as under-

Domestic purpose	--------	135 litres/c/d
Industrial use	--------	40 litres/c/d
Public use	--------	25 litres/c/d
Fire Demand	--------	15 litres/c/d
Losses, Wastage and thefts	--------	55 litres/c/d

Total : 270 litres/capita/day

Factors affecting per capita demand

- 1. Size of the city: Per capita demand for big cities is generally large as compared to that for smaller towns .
- 2. Presence of industries & commercial activities
- 3. Climatic conditions
- 4. Habits of people and their economic status
- 5. Pressure in the distribution system
- 6. Quality of water supplied
- 7. Development of sewerage facility
- 8. System of supply
- 9. Cost of water
- 10. policy of metering & Method of charging

- 11. Quality of water: If water is aesthetically & medically safe, the consumption will increase .
- 12. Efficiency of water works administration: Leaks in water mains and services; and unauthorised use of water can be kept to a minimum by surveys.
- 13. Cost of water
- 14. Policy of metering and charging method: Water tax is charged in two different ways: on the basis of meter reading and on the basis of certain fixed montly rate

FACTORE AFFECTING THE WATER DEMAND

- **Size of the city**

Big city

Small towns

Example: Delhi 244 l/c/d — Vijayawada 135 l/c/d

- **Climate condition**

more in summer

less in winter

- **Cost of water**

rate

demand

rate

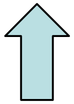
demand

- <u>Distribution System</u>

Pressure high

demand

Pressure low

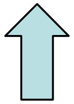


demand

- <u>Supply system</u>

Good supply

demand



demand

Bad Supply

- Industry

industry demand industry demand

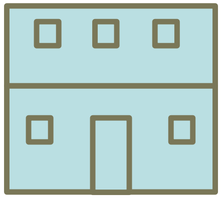
- Quality of water

good demand bad demand

- Habit of people

(Living style)

EWS demand



MIG demand

Factors affecting losees & Wastes

- Water tight joints
- Pressure in distribution system
- System of supply
- Metering
- Unauthorised connections

Losses & Thefts

Losses & Theft

Fluctuations in Rate of Demand

- Average Daily Per Capita Demand
  = Quantity Required in 12 Months/ (365 x Population)

- If this average demand is supplied at all the times, it will not be sufficient to meet the fluctuations.

- Maximum daily demand = 1.8 x average daily demand

- Maximum hourly demand of maximum day i.e. Peak demand

  = 1.5 x average hourly demand

  = 1.5 x Maximum daily demand/24

  = 1.5 x (1.8 x average daily demand)/24

  = 2.7 x average daily demand/24

  = 2.7 x annual average hourly demand

- **Seasonal variation**: The demand peaks during summer. Firebreak outs are generally more in summer, increasing demand. So, there is seasonal variation .

- **Daily variation** depends on the activity. People draw out more water on Sundays and Festival days, thus increasing demand on these days.

- **Hourly variations** are very important as they have a wide range. During active household working hours i.e. from six to ten in the morning and four to eight in the evening, the bulk of the daily requirement is taken. During other hours the requirement is negligible.

- Moreover, if a fire breaks out, a huge quantity of water is required to be supplied during short duration, necessitating the need for a maximum rate of hourly supply.

- So, an adequate quantity of water must be available to meet the peak demand.

- To meet all the fluctuations, the supply pipes, service reservoirs and distribution pipes must be properly proportioned.

- The water is supplied by pumping directly and the pumps and distribution system must be designed to meet the peak demand.

- The effect of monthly variation influences the design of storage reservoirs and the hourly variations influences the design of pumps and service reservoirs.
- As the population decreases, the fluctuation rate increases.
- Coincident Draft: It is extremely improbable that a fire may braek out when water is being drawn by the consumers at maximum hourly draft. Hence total draft is not taken as sum of maximum hourly demand & fire demand, but is taken as sum of maximum daily demand & fire demand, or the maximum hourly demand, whichever is more. The maximum daily demand when added to fire draft for working out total draft, is known as coincident draft.

Effect of variations on components of water supply scheme

- Source of supply such as wells, etc may be designed for maximum daily consumption.
- The pipe mains from source to service reservoirs may be designed for maximum daily consumption
- Filters & other units of treatment unit- Maximum daily draft. An additional provision of reserve is made for break-down & repairs. Hence designed for twice the daily avg. demand instead of 1.8 times the avg. daily
- Pumps for lifting the water- Maximum daily draft plus some reserve for break-down & repairs. Hence designed for twice the daily avg. demand instead of 1.8 times the avg. daily.

Design Periods

- The future period for which a provision is made in the water supply scheme is known as the **design period**.
- Design period is estimated based on the following:
- (Factors affecting Design Period)
- 1. Useful life of the component, considering
- 2. obsolescence, wear, tear, etc.
- 3. Expandability aspect.
- 4. Rate of interest

- 5. Anticipated rate of growth of population, including industrial, commercial developments & migration- immigration.

- 6. Available resources.

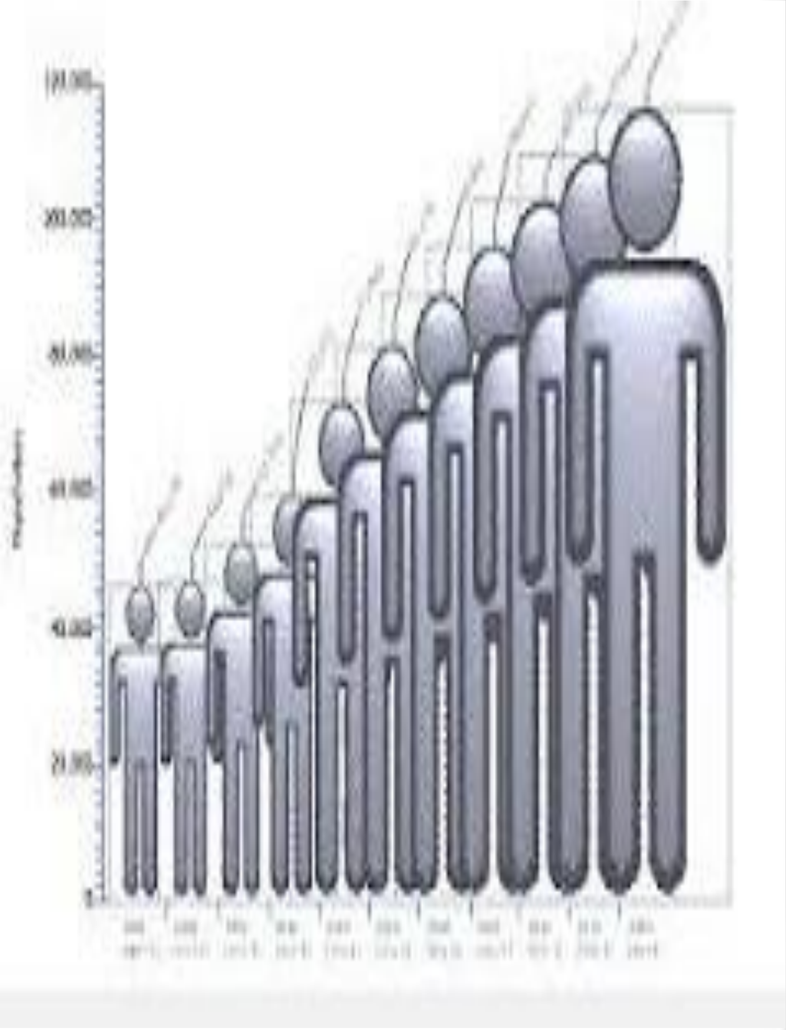
- 7. Performance of the system during initial period.

- 8. The rate of interest on borrowing.

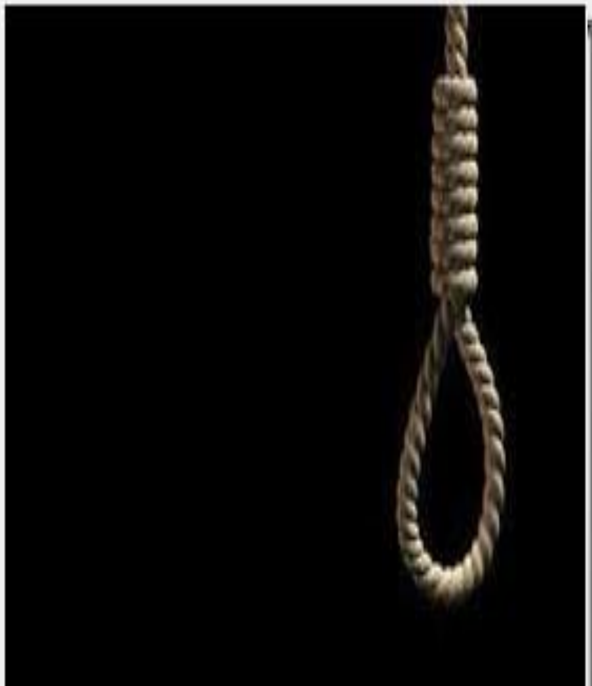
Design period for different components of water supply scheme (GoI Mannual)

Sr. no.	Item		Design Period in Years
1	Storage by dams		50
2	Intake works		30
3	Pumping	1Pump house	30
		2Electric motors & pumps	15
4	Water treatment units		15
5	Pipe connections to several treatment units & other small appurtenances		30
6	Raw water & clear water conveying units		30
7	Clear water reservoirs, balancing reservoirs, ESR,GSR, etc		15
8	Distribution system		30

Population forecasting

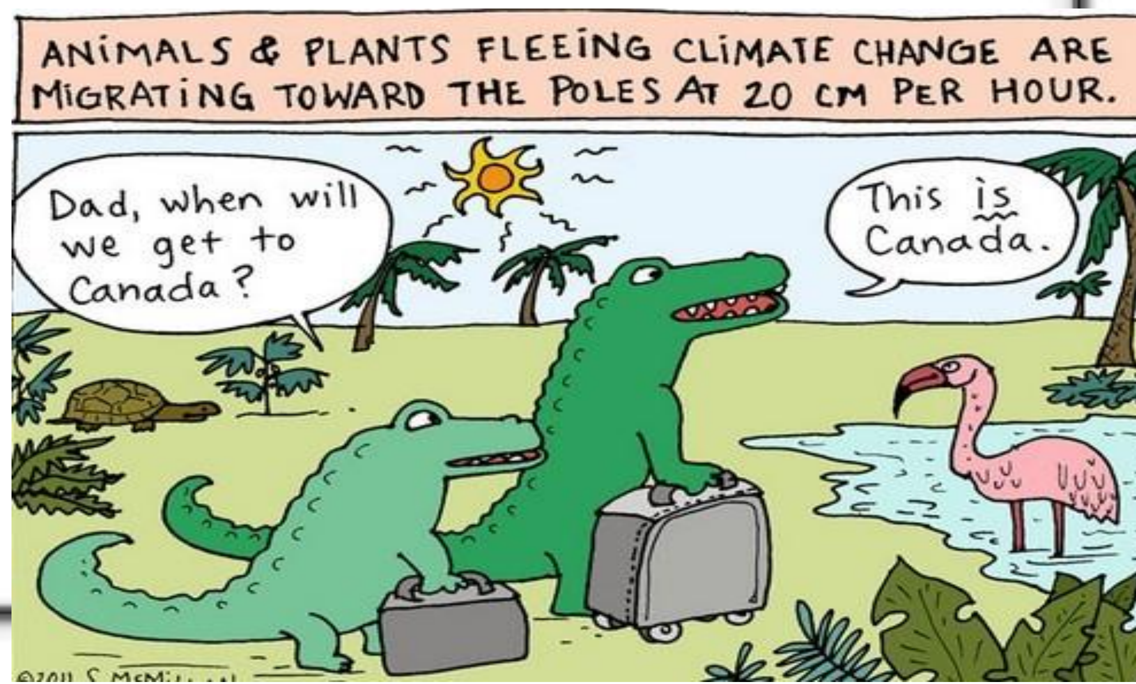


Birth, Death, Migration



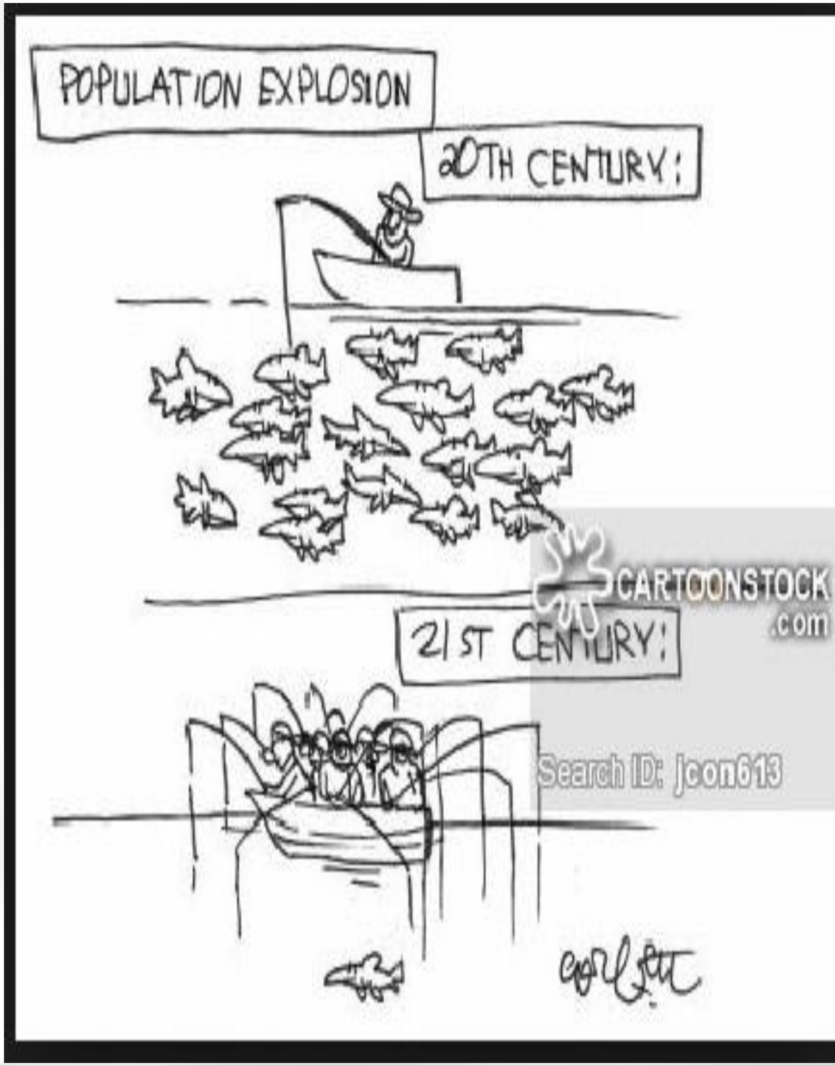

HERE LIES
EVERYONE
250,000 - 2110


हे राम


ANIMALS & PLANTS FLEEING CLIMATE CHANGE ARE MIGRATING TOWARD THE POLES AT 20 CM PER HOUR.
Dad, when will we get to Canada?
This is Canada.

Population Forecasting Methods

- The present population of city is determined by conducting an official enumeration, called census.
- Population growth- a) Births b) Deaths c) Migrations.
- The various methods adopted for estimating future populations .
- The particular method to be adopted for a particular case or for a particular city depends largely on the factors discussed in the methods, and the selection is left to the discretion and intelligence of the designer.


POPULATION EXPLOSION
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- Arithmetic Increase Method
- Geometric Increase Method
- Incremental Increase Method
- Decreasing Rate of Growth Method
- Simple Graphical Method
- Comparative Graphical Method
- The master plan method
- The apportionment method
- The logistic curve method

Arithmetic Increase Method

- This method is based on the assumption that the population is increasing at a constant rate.
- The rate of change of population with time is constant. The population after 'n' decades can be determined by the formula

$$P_n = P_0 + n.\bar{x} \text{ where}$$

- $P_0 \rightarrow$ population at present
- $n \rightarrow$ No. of decades
- $\bar{x} \rightarrow$ average of Population increase of 'n' decades

Geometric Increase Method

- This method is based on the assumption that the percentage increase in population from decade to decade remains constant.
- In this method the average percentage of growth of last few decades is determined.
- The population at the end of 'n' decades is calculated by- $Pn = P_0 \{1 + r/100\}^n$ where
- $P_0 \rightarrow$ population at present
- $r \rightarrow$ average percentage of growth of 'n' decades
- $r = (r_1 + r_2 + \text{---} + r_n)/t$ $r = \sqrt[t]{r_1 . r_2 .... r_t}$ $r = \left\{ \sqrt[t]{(P_2/P_1)} - 1 \right\}$

Incremental Increase Method

- This method is improvement over the above two methods.
- The average increase in the population is determined by the arithmetical method and to this is added the average of the net incremental increase once for each future decade.
- $P_n = P_0 + nx + \frac{n(n+1)}{2} \cdot \bar{y}$

THANK U ALL…