Water Supply & Sanitary Engineering (DI05006021)

Unit 2: Quantity and Quality of Water

Lecture 5: Population Forecasting Methods

GTU Diploma Engineering

Agenda

- Concept of Design Period
- Factors Affecting Design Period
- Population Growth Dynamics
- Arithmetic Increase Method
- Geometric Increase Method
- Incremental Increase Method
- Decreasing Rate of Growth Method
- Comparative Suitability

Need for Population Forecasting

- Water supply projects take years to build and are expensive.
- They cannot be easily replaced or expanded once installed.
- Systems must be designed for the population expected at the end of their useful life.
- This future timeframe is called the 'Design Period'.

Design Period

- Typically ranges from 15 to 30 years for water supply components.
- Dams and reservoirs: 50 years.
- Treatment plants: 15 years.
- Distribution pipes: 30 years.

Factors Affecting Population Growth

- Birth rates and Death rates (Natural increase).
- Migration (Inward and Outward due to jobs, education, refugees).
- Industrial and commercial expansion.
- Annexation of surrounding suburban areas.

Methods of Population Forecasting

- Mathematical Methods:
- 1. Arithmetic Increase Method
- 2. Geometric Increase Method
- 3. Incremental Increase Method
- 4. Decreasing Rate of Growth Method
- Graphical Methods (Simple, Comparative, Master Plan).

Arithmetic Increase Method

- Assumes the rate of growth is constant.
- Formula: P_n = P_0 + n * c
- Where: P_n = Future pop., P_0 = Present pop., n = decades, c = average increase per decade.
- Suitable for large, old, established cities that have reached saturation.

Geometric Increase Method

- Assumes the percentage rate of growth remains constant.
- Formula: P_n = P_0 * $(1 + r/100)^n$

- Where r = average percentage growth rate per decade.
- Suitable for young, rapidly expanding cities with vast scope for development.

Incremental Increase Method

- A combination of both Arithmetic and Geometric methods.
- Formula: P_n = P_0 + n*X + [n(n+1)/2]*Y
- Where X = average increase, Y = average incremental increase.
- Best suited for average cities with normal, moderately changing growth.

Decreasing Rate of Growth Method

- Populations eventually reach a saturation point due to limited resources/space.
- As a city matures, its growth rate naturally declines.
- This method applies a decreasing percentage to future decades.
- Used for older cities showing a clear downward trend in growth rate.

Graphical Methods

- Simple Graphical: Plot past census data on a graph and extend the curve smoothly.
- Comparative Graphical: Compare the city's curve with older, similar cities when they were at the same population.
- Master Plan Method: Growth controlled strictly by zoning regulations (e.g., max density per sector).

Comparative Suitability

Concept 1	Concept 2
Arithmetic: Old, saturated cities (Lowest values)	
Geometric: Young, booming cities (Highest values)	
Incremental: Normal, growing cities (Moderate values)	
Engineers must choose the method that best matches the city's specific socio-economic profile.	

Summary

- Water projects are designed for a future 'Design Period' (usually 30 years).
- Population growth is driven by births, deaths, and migration.
- Geometric method yields the highest forecast; Arithmetic the lowest.
- Incremental Increase method is the most commonly recommended for average cities.