Methods of Estimation and Projection

⇒ Mathematical methods:

There are many methods for the population estimation and projection:

1- Arithmetic Increase Method.
2- Geometric Increase Method.
3- Incremental Increase Method.
4- Logistic curve method.
5- Decrease rate of growth method.
6- Simple Graphical Method.
7- Comparative Study Graphical Method.

we will read first two mathematical methods which are most frequently used methods.

Arithmetic Increase Method:

This method is use for the population estimation and projection of that country which is already developed (change in population over the time is constant)

Formula:

$$\boxed{P_n = P_o + n\bar{x}}$$

where

P_n = Population after n decades (10 years = 1 decade)
P_o = last Known population.
n = no. of decades
$\bar{x}$ = Average increase in Population.

⇒ Numerical:

Population of 5 decades from 1930 to 1970 are given in table. Find out the population after one and six decades beyond the last Known decades by using arithmetic increase method.

Year	1930	1940	1950	1960	1970
Population	25,000	29,000	34,000	42,000	47,000

(a) After one decades
1980 ?

(b) After six decades (60 years):
2030 ?

$$P_n = P_0 + n\bar{x}$$

Year	Population	Increase in Population
1930	25,000 = P_1	$x_1 = P_2 - P_1 = 3000$
1940	28,000 = P_2	$x_2 = P_3 - P_2 = 6000$
1950	34,000 = P_3	$x_3 = P_4 - P_3 = 8000$
1960	42,000 = P_4	$x_4 = P_5 - P_4 = 5000$
1970	47,000 = P_5	

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4}$$

$$\bar{x} = \frac{3000 + 6000 + 8000 + 5000}{4}$$

$$\bar{x} = 5500$$

(a) $P_{1980} = P_{1970} + n\bar{x}$

$= 47,000 + 1(5500)$

$\boxed{P_{1980} = 52,500}$

(b) $P_{2030} = P_{1970} + n\bar{x}$

$= 47,000 + 6(5500)$

$\boxed{P_{2030} = 80,000}$

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Geometric Inrease Method:

- This method is used for the estimation population and projection of that country which is rapidly growing (rapid increase in population).

Formula:

$$\boxed{P_n = P_o\left(1 + \frac{r}{100}\right)^n}$$

where

P_n = Population after n decades
P_o = last Known Population
r = assumed growth rate (%)
n = no. of decades.

→ How can we calculate growth rate?

(a) If given

P_1 = initial known population
P_2 = final Known population

Then

$$\boxed{r = \left[\left(\frac{P_2}{P_1}\right)^{1/n} - 1\right] \times 100}$$

here n = no. of years in initial and final Known population.

(b) If you have more then two Known population values then

$$\boxed{r = (r_1 \times r_2 \times r_3 \times \cdots \times r_n)^{1/n}}$$

here n = no. of rates.

→ Numerical :

1. Determine the future population of a country by gemetric increase method for the year 2011 as given in the following data.

Year	1951	1961	1971	1981	2011
Population	93,000	111,000	132000	161000	?

$$P_n = P_0\left(1 + \frac{r}{100}\right)^n$$

Year	Population	Increase in population	% increase in Population
1951	$93,000 = P_1$	$x_1 = P_2 - P_1 = 18000$	$r_1 = \frac{x_1}{P_1} \times 100 = \frac{18000}{93000} \times 100 = 19.35\%$
1961	$111,000 = P_2$	$x_2 = P_3 - P_2 = 21000$	$r_2 = \frac{x_2}{P_2} \times 100 = \frac{21000}{111000} \times 100 = 18.92\%$
1971	$132,000 = P_3$	$x_3 = P_4 - P_3 = 29000$	$r_3 = \frac{x_3}{P_3} \times 100 = \frac{29000}{132000} \times 100 = 21.97\%$
1981	$161,000 = P_4$		

$$r = (r_1 \times r_2 \times r_3)^{1/n}$$

$$= (19.35 \times 18.92 \times 21.97)^{1/3}$$

$$= 20.03$$

$$P_{2011} = P_{1981}\left(1 + \frac{r}{100}\right)^n$$

$$= 161000\left(1 + \frac{20.03}{100}\right)^3 \longrightarrow$$ 30 year difference so 3 decades

$$\boxed{P_{2011} = 278417}$$