3.3 Population Distribution and Change

For many purposes age and sex data do not serve the purpose where geographic units form the bases for analysis and research, policy formulation, planning etc. There the distribution of population by geographic units such rural urban residence, provinces, districts, cities and towns etc can serve the purpose. In the most of countries of the world population is unevenly distributed to their various geographic units. Some areas are densely populated while some areas are thinly populated. Why so? To answer this, study of population distribution becomes imperative.

The following are some important measures of population distribution:

- Distribution of total population into the units
- Ranking of the units according to their size
- Population density

Table 3.1 PERCENTAGE DISTRIBUTION OF POPULATION BY PROVINCE SINCE 1951

Province	1951	1961	1972	1981	1998	~~7~~
1	2	3	4	5	6	7
Punjab	60.9	59.4	57.6	56.1	55.6	
Sindh	17.9	19.5	21.7	22.6	23.0	
NWFP North western Frontier Province	13.5	13.4	12.8	13.1	13.4	
Balochistan	3.5	3.2	3.7	5.1	5.0	
FATA*	4.0	4.3	3.8	2.6	2.4	
Islamabad*	0.3	0.3	0.4	0.4	0.6	
Total population (000)	33740	42880	65309	84254	132352	

Source 1998 Census Report of Pakistan, Statistics Division, Government of Pakistan, Islamabad.
Federally Administered Tribal Areas (FATA) and Islamabad are treated at par with provinces.

About one-third of total population is living in urban localities. In the total population of Pakistan, Punjab shares 55.6 percent followed by Sindh, 23 percent, NWFP, 13.4 percent, and least share is of Balochistan, 2.4 percent, among all provinces. Punjab and FATA are gradually loosing their population shares. Contrary to these Sindh, Balochistan and Islamabad are gaining their shares (Table 3.1). This may be due to inter-provincial migration or difference in coverage between provinces from census to census ~~or both.~~

The data given in Table 3.2 support the argument given above that population is un-evenly distributed over the area, of 119 districts, including 7 agencies and 6 tribal areas, median percentage share is 0.62 that each half of districts has share less than this percentage. Whereas on average district shares 0.90 percent in total population. This is a case of positive skewed distribution indicating that there very few large districts sharing above 3.00 percent in total population.

Table 3.2 PERCENTAGE DISTRIBUTION OF POPULATION BY NUMBER OF DISTRICTS 1998

Class Interval	X	Frequency=f	fx	cf
1	2	3	4	
0.00-0.50	0.25	51	12.75	51
0.51-1.00	0.75	35	26.25	86
1.01-1.50	1.25	10	12.50	96
1.51-2.00	1.75	11	19.25	107
2.01-2.50	2.25	7	15.75	114
2.51-3.00	2.75	3	8.25	117
3.01-4.00	3.50	0	0	117
>4.00	4.15	2	8.30	119
Total		119*	107.05	0.62

Source 1998 Census Report of Pakistan, Statistics Division, Government of Pakistan, Islamabad.
Note: among 119 units there are 106 administrative districts, 7 agencies and 6 tribal areas adjoining district.

2017 ⇒ 154 district including the islamabad, districts of Azad Kashmir and gilgit Baltistan.

Urbanization: Rural 69,625,144
Urban 40,387,298.

Scanned with CamScanner

Population density is measured as number of persons living on one square unit of land, generally kilometer is taken as unit of measurement. It is an important indicator of determination of land and population relationship in term of concentration of population. Population density of Pakistan, its four provinces, FATA and Islamabad over the census years is given in Table 3.3. Islamabad federal capital territory for obvious reasons is the most populous area of Pakistan. Among the four provinces, Punjab is the most densely populated where 359 persons are living on per square kilometer of land. The next densely populated province is NWFP having 238 persons on each square kilometer of land. On the other hand, Balochistan is the least populous province of Pakistan, where only 19 persons are occupying each square kilometer of land. The reasons for sparsely settled province is its topography, rugged mountains, deserts, severe weather, almost non availability of potable water and poor exploitation of natural resources available there which has lead to overall economic depression.

Table 3.3 POPULATION DENSITY BY PROVINCE SINCE 1951

Province	1998	1981	1972	1961	1951	Increase
1	2	3	4	5	6	7
Islamabad	889	376	262	130	106	8.4
Punjab	359	230	183	124	100	3.6
NWFP	238	148	113	77	61	3.9
FATA*	117	81	92	68	49	2.4
Sindh	216	135	100	59	43	5.0
Balochistan	19	12	7	4	3	6.3
Total	166	106	82	54	42	4.0

Source 1998 Census Report of Pakistan, Statistics Division, Government of Pakistan, Islamabad.

Interestingly Balochistan province which is sparsely settled one is growing much faster than any other province in term of population density that is 6 times since 1951, Sindh 5 times and Punjab by 3.6 times. Exception is again Islamabad which has grown more than 8 times since then.

3.3.1 *Population Change*

Population change means increase or decrease in population over time. A change could be in absolute terms or percentage of mid period population conventionally measured per year known as growth rate. (Increasing or decreasing in the number of individuals in a population).

Population change is a useful measure to know about growth pattern and trend, to interpolate population growth behavior between two points of time and to project or extrapolate population for future time.

Interpolation: is an estimation of a value within two known values in a sequence of value.

Extrapolation: is an estimation of a value based on extending a known sequence of values.

A change can be measured as by simple arithmetic calculation or linear method, compound or geometric progression, exponent method logistic model and by fitting a suitable polynomial model. Some of frequently used methods are described below:

Let P_0 is the base population at time '0' and P_t is population at time 't' then per year change is equal by

t → time between base year and at a time year.

linear method or Simple arithmetic (absolute) $= \frac{P_t - P_0}{t}$, (Percent) $= \frac{P_t - P_0}{t(P_t + P_0)/2} \times 100$

Geometric or Compound method $= [\{(P_t/P_0)^{1/t}\}-1]100$

Exponential model $= \{\ln(P_t/P_0)/t\}*100$

2017 ⇒ 207,774,520

Example: Given population in 1981 as 84253644 ($=P_0$) and in 1998 as 132352279 ($=P_t$) and time between two censuses is 17 years = t then absolute change per year by:

$$\text{Simple arithmetic (absolute)} = \frac{P_t - P_0}{t} = \frac{132352279 - 84253644}{17} = 2829331$$

$$\text{Simple growth rate} = \frac{P_t - P_0}{t(P_t + P_0)/2} \times 100 = \frac{132352279 - 84253644}{17(132352279 + 84253644)/2} \times 100 = \frac{48098635}{1841150346} \times 100$$

= 2.61percent. (Pop growth is increasing by 2.61% per year).

Compound method $= [\{(132352279/84253644)^{1/17}\}-1]100 = [\{(1.570879)^{1/17}\}-1]100$

$=(1.026923-1)100 = 0.026923*100 = 2.69$ percent.

Exponential model $= \ln(P_t/P_0)/t = \{\ln(132352279/84253644)/17\}*100$

$=[\{\ln(1.570879)\}/17]*100 = (0.451635/17)*100$

$= 0.026567*100 = 2.66$ percent.

Applicability of these three methods depends upon the validity of assumptions about the methods. If population data is a continuous function just between two points of reference the simple arithmetic method hold good for working out relative percentage change or annual growth rate of population. If population is a continuous function but changing in geometric fashion then compound method would give the best results. However if population is

Same over time

continuous function but gradually changing over time then exponential model is relatively probably give more reliable results than simple method and compound method.

4. VARIOUS DEMOGRAPHIC MEASURES

There are various demographic measures which provide useful information for study of population behavior. Some of these are related to fertility, some to mortality and still some to migration while some deals to all these three for study of population change or effect upon one variable of remaining. In this section an attempt is made to discuss fertility and mortality related measures and application of balancing equation.in the field of demography.

4.1 BALANCING EQUATION

There are six components of the Balancing equation, these are population at the end of the period 'P_t', population at the beginning of the period 'P_0', number of children born during that period 'B', number of deaths (D) taken place during that period, 'I' is the in-migration and 'O'.is the out-migration during that period. The first two components relate to population change between two points of time, the next two to natural increase/ decrease and the last two to redistribution of population due to migration. Balancing equation is a useful statistical tool for measuring any of the six variables if other five are known. Balancing equation has three changes viz population change, difference of births and deaths and net migration which represent difference of in-migrants and out-migrants. It is possible to measure any of these three changes if the other two are known and if either of the two components of estimated measure of change is known the other one can be easily estimated. Balancing equation is also applicable on any sub-group of population say male female, females of reproductive age bracket, labor force segment of population; school going population etc provided all components of balancing equation are taken from the same sub-group. The reliability of the estimator depends upon the accuracy of input components of the balancing equation. Mathematically balancing equation can be expressed as:

$P_t = P_0 + B - D + I - O$ or

$P_t - P_0 = (B - D) + (I - O)$ ....it refers to change

For study of sub-group say disabled females (df) the equation would be:

$P_t^{df} = P_0^{df} + B^{df} - D^{df} + I^{df} - O^{df}$ or

$P_t^{df} - P_0^{df} = (B^{df} - D^{df}) + (I^{df} - O^{df})$

The population of Pakistan in 1981 was 84253644 which increased to 132352279 in 1998. In th absence of statistics on vital events let us suppose that 54792560 children were born during th inter-censal period of 17 years, 10541816 persons died, 4764570 persons immigrated to Pakista and 916680 persons emigrated from Pakistan during that period.

Example

Now let us suppose population in 1998 is not known and we want to estimate it throu balancing equation, then:

$P_t = P_0 + B - D + I - O = 84253644 + (54792560 - 10541816) + (4764570 - 916680)$

$= 84253644 + 44250744 + 3847891 = 132352279.$

Example

Now let us suppose immigrants during the period are unknown and other five values are kno and we want to estimate unknown value through balancing equation, then:

$P_t = P_0 + B - D + I - O$ or

$I = P_t - P_0 - B + D + O = 132352279 - 84253644 - 54792560 + 10541816 + 916680$

$= 132352279 + 10541816 + 916680 - (84253644 - 54792560) = 143810775 - 139046204$

$= 4764570$