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Estimation of Net Migration in Gujarat 1951-60 and 1961-70

Introduction,

MIGRATION, births and deaths are the three factors which are of relevance in preparing population estimates and projections for an area. The net change in the population between two points of time or the difference between the population at the terminal point and that at initial point is attributable to only two factors, viz. natural increase i.e., excess of births over deaths and *net-migration* i.e. excess of *in-migrants* over *out-migrants* during the period. Given the change during a period, it is often useful to determine the relative importance of these two factors in the process of change. When the change is rapid, it is particularly important to draw attention to the process of migration. This paper attempts to estimate net-migration in Gujarat during 1951-60 and 961-70, using fertility ratios and Life Table techniques.

Generally, migration to any area depends on the industrial and socio-economic development of that area. People migrate for employment and job opportunities. In Gujarat, there has been a marked acceleration in the rate of industrial growth and urbanisation over the last few decades [3]. The State comes third, after Maharashtra and West Bengal, in industrial development in terms of new factories established, value added, value of output etc. [2]. Hence, the importance of exploring the trends of migration in the population of Gujarat during last two decades.

The decenial censuses provide some data on migration based on place of birth and residence. These data have their own limitations, which are quite well-

known. The present attempt, therefore, seeks to derive the estimates of net-migration by an indirect method i.e. without using the census statistics on migration.

Method

The exercise is conducted in two steps. The first step consists in estimating the net-migration in the new-bron cohort i.e. the net-balance between the new-born who had out-migrated from the State during the decade and those born to the migrant-mothers before the mothers in-migrated to the State during the intercensal period and are counted in the age-groups (0-4) and (5-9) in the second census. The second step consists in estimating net-balance between out-migrants during the intercensal period and are counted in the age-group 10-years and above in the second census.

In essence, we can estimate the survivors of the initial population at the first census to the date of the second census by applying the life table survival rates to the initial population and in the same way we can estimate the initial population by 'younging' the terminal population to the date of the first census by applying the 'reverse survival rates' to the terminal population. The differences, positive or negative, between, the survivors of the initial population at the second census and the actual population of the second census can be called a 'forward estimate of net-migration' and in the same way difference between the estimated population at the initial census and the actual population at the initial census can be called a 'reverse estimate of net-migration' during the intercensal period. This logic is used in the second step for estimating the net-migration in the age-group 10 years and above, while for new born cohort the child-women ratio has been used.

The basic data required for the estimation of net-migration in the present approach are the distribution of population by sex in the *quinquennial* age-groups for each census and survival rates computed from appropriate life tables. Since census data on the distribution of population by age-groups are subject to errors due to inaccurate reporting of ages, we have adopted smoothed distribution of population by age and sex for 1951, 1961 and 1971. The smoothing of for census 1951, 1961 and 1971 population is done by the Carrier-Farrage Ratio Method (1). The survival rates required for deriving forward or reverse estimate of population should, in principle, be obtained from the life tables prepared for the given area and for the given period. In absence of appropriate life tables for Gujarat, the 'West Model Life Tables' published by the Registrar General, India for 1951-60 and 1961-70 have been used [5 and 6].

Step I—Estimation of net-migration in the New-born Cohort. The estimates of net-migration in the new-born cohort have been derived under following assumptions'

(i) CONSTANT FERTILITY RATIO. It is assumed that the fertility ratios for women throughout the intercensal period have remained constant and that the fertility ratios for all women in child-bearing age in the State and for in-migrant mothers are identical;

(ii) EVEN FLOW OF MIGRATION. It is assumed that the flow of migration throughout the intercensal period was even, i.e. the rate of migration was constant and even during the decade.

Under these two assumptions the estimate of net-migration for the new-bora cohort has been derived by using child-women ratios : children aged (0-4) to women aged (15-44) and children aged (5-9) to women aged (20-49) as under:

If *CW and CW are* the ratios of children aged (0-4) to women aged (15-44) and children aged (5-9) to women aged (20-49), then,

$$CW = \frac{C_1}{f_1} \text{ and } CW' = \frac{C_2}{f_2}. \qquad (1)$$

Where C_1 and C_2 are the number of children aged (0-4) and (5-9) respectively and f_1 and f_2 are the women aged (15-44) and (20-49) respectively.

Let *M(f}* and *M '(f)* be the estimates of net-migration of females aged (15-44) and (20-49), which are derived according to Step-11 discussed later on, and mo and m_s are the estimates of net-migration of the new-born,'who are counted in the age-groups (0-4) and (5-9), respectively at the second census.

Under the two assumptions narrated earlier, we can say that one-fourth of the younger children aged (0-4) and three-fourth of the older children aged (5-9) would have been born before their mothers in-migrated. Because most of the children under 5 at the second census were born on an average 2.5 years earlier; so that only one-fourth of their mother's *migratian* occured after that date. Similarly children aged (5-9) years at the second census were born on an average 7.5 years earlier, so that three-fourth of their mother's migration occured after that date.

Thus, the total net-migration *(m)* in the new-born cohort is derived as under:

$$m = m_0 + m_5 = \frac{1}{4} \cdot CW \cdot M(f) + \frac{3}{4} \cdot CW' \cdot M'(f)$$

$$= \frac{1}{4} \cdot \frac{C_1}{f_1} M(f) + \frac{3}{4} \cdot \frac{C_2}{f_2} \cdot M'(f) \cdot \qquad (2)$$

Step II -Estimation of Net-migration in the Cohort other than those Born during the Intercensal Period. Let ${}_nP'_x$ and ${}_nP^0_{x+}$* be the population in the age-group (X" to $X + n$) at the second census and population1years younger at the first census respectively.

Let M_1 and M_2 be the forward and reverse estimates of net-migration of the persons aged 10 years and above, then,

$$M_1 = \sum_{x=10}^{70+} ({}_nP'_x - {}_nS_x \cdot {}_nP^0_{x-t}) \tag{3}$$

$$M_2 = \sum_{x=10}^{60+} ({}_nP'_x \cdot {}_nS'_x - {}_nP^0_{x-t}). \tag{4}$$

Where t = 10 and „&, is the *quiniquennial* survival rates for the age-group *(x* to x + n) derived from the life table as under :

$${}_nS_x = \frac{{}_nL_{x+10}}{{}_nL_x}, \tag{5}$$

and

$${}_nS'_x = \frac{1}{{}_nS_x}. \tag{6}$$

It may be seen that the survival rates of applied in equation (3) for estimating survivors of the initial population to the date of second census, while in equation (4) they are applied for estimating the initial population. Hence both M_1 and M_2 which are the functions of the survival rates n*Sx* and n*Sx* may either overestimate or underestimate the number of (implied) deaths during the intercensal period. Therefore a more satisfactory estimate (M_3) of net-migration can be derived by averaging *(M_1* and *(M_2)* as under :

$$M_3 = \frac{M_1 + M_2}{2}$$

$$= \tfrac{1}{2} \Sigma [{}_nP'_x (1 + {}_nS'_x) - {}_nP^0_{x-t} (1 + {}_nS_x)] \cdot \tag{7}$$

The estimate M_3 is derived separately for each sex and added up to get total net-migration in the age-groups 10 years and above.

Total Net-Migration. Three estimates E_1, E_2 and E_3 of total net-migration for all the age groups are derived as under :

$$E_1 = m + M_1, \quad (8)$$

$$E_2 = m + M_2, \quad (9)$$

$$E_3 = m + M_3. \quad (10)$$

The estimates E_1, E_2 and E_3 of total net-megration are worked out for 1951-60 and 1961-70 as shown below

Results

Net-Migration in New-born Cohort. The estimates of net-migration in the new-born cohort during 1951-60 and 1961-70 derived by equation (2) are given in Table-1 below :

TABLE I—ESTIMATED NET-MIGRATION IN THE NEW-BORN **COHORT DURING** 1951-60 AND 1951-70, GUJARAT,

(Fig. in Lacs)

Decade	*Estimated net-migration (m)*
1951-60	0.81
1961-70	0.66

Above estimates show that the net-migration in the age-group (0-9) was higher, i.e. about 1.2 times during 1951-60 as compared to the net-migration in 1961-70.

Net-migration in the Age-groups 10 Years and Above. Forward, reverse and average estimates computed by equations (3), (4) and (7), respectively are presented below in Table-2.

TABLE 2-ESTIMATED NET-MIGRATION IN THE AGE-GROUP 10 YEARS AND ABOVE BY SEX, 1951-60 AND 1961-70

(Fig. in LACS)

Decade	*Estimated net-migration*								
	M_1			M_2			M_3		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*	*Males*	*Females*	***Total***
1951-60	1.23	0.91	2.14	1.46	1.14	2.60	1.35	1.02	2.37
1961-70	1.97	0.79	2.76	2.17	0.78	2.95	2.07	0.79	2.86

The estimate (M_3) which is the average of the forward estimate (Afi) and reverse estimate *(Ms)* reveals that more than 2 lacs of" persons during 1951-60 and about 3 lacs during 1961-70 had in-migrated in excess of those out-migrated during the period in age-group 10 years and above,

The estimates of total net-migration in all the age-groups are shown in Thable-3 below:

TABLE 3-ESTIMATED TOTAL NET-MIGRATION BY SEX

(Fig. ia lacs)

Decade	*Estimated migration*								
	£1			E_2E_3					
	Males	*Females*	*Total*	*Mates*	*Females*	*Total*	*Males*	*Females*	*Total*
1951-60	1,.64	1.30	2.94	1.87	1.53	3.40	1.75	1.41	3.17
1961-70	2,,31	M1	3.42	2.51	1. 10	3.61	2,41	1.11	3.52

Estimated E_1, E_2 and E_3 are derived from the equations (8), (9) and (10), where estimate E_3 may be considered a more satisfactory estimate, since it rests on the estimates (m) and the average estimate M_3. It is seen that the total net-migration during 1951-60 and 1961-70 was about 3.2 lacs and 3.5 lacs respectively. Further it is observed that female net-migration was higher during 1951-60 as compared to the net-migration during 1961-70,

Net-migration Rate. Three estimates of net-migration rate have been computed as under :

Net-migration rate $$(R_i) = \frac{Ei}{P \cdot t} \cdot K. \qquad (11)$$

Where t = 10, i = 1, 2, 3, P is the mid-period population and K is a constant, here equal to 1,000, The net-migration rate can also be derived roughly by residual method as under :

Net-migration rate $$(R') = r - (BR - DR). \qquad (12)$$

Where r is the exponential growth rate of population per 1000 per year worked out by the equation $P_1 = P_0 e^{rt}$ BR and DR are the birth and death rates for the intercensal periods as computed by the census actuaries.

The migration rates R_l, R_s, R_3 and R' are presented in Table-4;

TABLE 4-ESTIMATED NET-MIGRATION RATES FOR 1951-60 AND 1961-70 GUJARAT

Period	Net-migration rale			
	R_1	R_2	R_3	R'
1951-60	1.6	1.8	1.7	1.6
1961-70	1.4	1.5	1.5	1.2

The net-migralion rates R_1, R_2 and R_3 are computed with respect to estimates E_1, E_2 and E_3 of the net-migration and R' is the residual estimate of net-migration. The estimate R_1 ,R_2 and R_3 suggest that the rate of net-migration varied between 1.6 to 1.8 per 1000 mid-population per year during (1951-60) but between 1.4 to 1.5 per 1000 mid-population per year during 1961-70.

It is also observed that the residual estimate *(R')* of net-migration rate is lower than the estimate R_3 in both the decades. Since R^r is computed on the basis of birth rates and death rates computed by the census actuary, it is subject to errors of estimates of both birth and death rates. Hence R' cannot be treated as sufficiently good estimate of the net-migration.

Conclusions

The estimates of net-migration derived by the method discussed in this paper are suggestive broadly of total effective contribution of migration to the State's total population growth during the intercensal period. This approach may prove very useful for arriving at quick estimates of net-migration in absence of reliable statistics from other sources. The net-migration during 1951-60 and 1961-70 in Gujarat has been estimated nearly 3.17 lacs and 3.52 lacs respectively. The average estimate of net-migration rate comes to 1.7 and 1.5 per 1000 population per year during 1951-60 and 1961-70 respectively.

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APPENDIX

TABLE 1—SMOOTHED* POPULATION BY AGE AND SEX, 1951, 1961 AND 1971

(in -000)

Age Group	Census 1951			Census 1961			Census 1971		
	Male	female	Total	Male	Female	Total	Male	Female	Total
0 - 4	1462	1396	2858	1900	1809	3709	2386	2255	4641
5 — 9	1046	997	2043	1330	1255	2585	1747	1636	3383
10 — 14	999	942	1941	1306	1208	2514	1694	1557	3251
15—19	852	804	1656	1016	958	1974	1439	1248	2687
20 — 24	711	690	1401	954	900	1854	1272	1200	2472
25 — 29	632	607	1239	820	773	1593	973	931	1904
30 - 34	593	562	1155	716	677	1393	894	857	1751
35 - 39	507	483	990	607	559	1166	754	707	1461
40 - 44	408	386	794	521	474	995	642	600	1242
45 - 49	328	312	640	423	402	825	550	525	1075
50 - 54	260	239	499	369	337	706	455	420	875
55 - 59.	197	182	379	248	225	473	353	320	673
60 - 64	149	137	286	169	160	329	281	265	54
65 - 69	95	97	192	118	122	240	184	190	374
70 - 74	41	43	84	78	80	158	99	101	200
75 - 79	34	35	69	38	40	78	57	60	117
80 +	18	19	37	20	21	41	22	23	45
Total :	8332	7931	16263	10633	10000	20633	13802	12895	26697

Smoothing is done by Carrier-Farrago method—t**he** population ***in*** **age** groups **(0-4) and (5-9) is then** adjusted as suggested in U.N. **Mannual-III** Methods for **Population Projections** by Age and **Sex.**

TABLE 2—ESTIMATED* CHILD-WOMEN RATIOS, 1951-60 AND 1961-70, GUJARAT

Ratio	*1951-60*	*1961-70*
CW	0.8341	**0.8448**
CW	06780	**0.6935**

***the estimate are** based **on** the **mid-period** population **of the children and women.**

TABLE 3—ESTIMATED NET-MIGRATION IN THE NEW-BORN COHORT, 1951-60 AND 1961-70, GUJARAT

(in '000)

New-birth Cohort	Estimated net-migration					
	1951-60			1961-70		
	Males	Females	Total	Males	Females	Total
(0-4)	10.7	10.2	20.9	11.3	10.8	22.1
(4-9)	30.6	29.1	59.7	22.5	21.4	43,9
Total: (0-9)	41.3	39.3	80.6	33.8	32.2	66.0

***Net-Migration in the** age-groups **(0-4)** and (5-9) are the estimates mo and m_5 **of the new born-cohort.**

TABLE 4—ESTIMATED NET-MIGRATION IN THE COHORTS OTHER THAN NEW-BORN COHORT BY AGE-GROUP AND SEX, 1951-61 AND 1961-71, GUJARAT

(in '000).

Age Group	Estimated net-migration*					
	1951-61			1961-71		
	Males	Females	Total	Males	Females	Total
10—14	(-) 58.0	(-) 69.0	(-) 127.0	(-) 33.5	(-) 66.0	(-) 99.5
15-19	5.0	2.0	7.0	195.0	615	259.5
20—24	(-) 7.0	—	(-) 7.0	44.5	36.5	81.0
25-29	6.0	11.0	17.0	21.0	4.0	25.0
30-34	52.0	42.0	94.0	4.0	(-) 2.0	2.0
35-39	45.0	32.05	77.5	(-) 8.5	(-) 2.0	(-)10.5
40-44	20.5	12.5	33.0	(-) 19.5	3.5	(-) 16.0
45-49	12.0	19.5	31.5	—	44.5	44.5
50—54	56.0	46.0	102.0	2.5	18.5	21.0
55—59	7.0	(-) 2.0	5.0	2.5	(-) 18.5	(—) 16.0
60-64	(-) 6.0	1.0	(-) 5.0	(-) 12.5	(-) 12.0	(-) 24.5
65-69	4.0	19.0	23.0	1.5	17.0	18.5
70+	(-) 2.0	(-) 12.0	(-) 14.0	10.0	(-) 9.5	0.5
Total 10 Years & Above:	134.5	102.5	237.0	207.0	78.4	285.5

Average estimate of Net-migration (M_3).

TABLE 5-ESTIMATED NET-MIGRATION RATE BY RESIDUAL METHOD

Period	*Exponential population grown rate**	*Birth rate***	*Death rate***	*Net-migration rate per 1000 population per year*
1951-61	**23.8**	**45.7**	**23.5**	**1.6**
1961-71	**26.0**	**41.6**	**16.8**	**1.2**

*Exponential growth rate for a given period of time allows for continuous increase in the population and is calculated by using the equation $P_1 = P_0 e^{rt}$.

**Birth rate and death rate estimated by Census Actuaries (Source quoted in Table 6 for survival rules).

TABLE 6—SURVIVAL RATES COMPUTED FROM WEST MODEL LIFE TABLES, 1951-60 AND 1961-70 (GUJARAT)

Age-Group (Terminal Census)	*Survival Rates (nSx)*			
	1951-60		*1961-70*	
	Males	*Females*	*Males*	*Females*
10-14	0.9315	0.9126	0.9085	0.8952
15—19	0.9670	0.9589	0,9397	0.9446
20—24	0.9620	0.9556	0.7411	0.9638
25-29	0.9552	0.9479	0.9375	09675
30-34	0.9363	0.9225	0.9329	0.9548
35-39	0.8936	0.8708	0.9296	0.9167
40-44	0.8466	0.8231	0.9230	0.8813
45-49	0.8135	0.7961	0.9055	0.8650
50—54	0.7836	0.7700	0.8687	0.8506
55-59	0.7373	0.7270	0.8289	0.8373
60-64	0.6686	0.6663	0.7907	0.8181
65—69	0.5844	0.5937	0.7360	0.7798
70+@	0.3588	0.3852	0.4075	0.4484

Computed from Registrar General, India, "West Model Life Tables, 1951-60, Census of India, 1961 Census" and West Model Life Tables, Series I—India, Paper of 1977.

@Survival rates for this age-group have been adopted as the average of 1951-60 and 1961-70 rates for both the decades.