IV. ESTIMATES BASED ON ONE CENSUS ONLY

1. Importance of a census for accurate population estimates

A census is defined for the present purpose as an individual enumeration of the whole population, or at least a great majority of the population, during a period of not more than one year. Though censuses vary greatly in accuracy, as a rule they give much more reliable measures of population size than non-censal counts. The main reason for this is that the determination of population size is one of the primary objectives of a census; the census procedure is designed to realize this objective as accurately as possible.

The first census taken in a country is usually not as accurate as subsequent censuses can be, since successful census-taking under the conditions prevailing in any country is in part a matter of local experience. It is highly important for purposes of population estimates to evaluate the accuracy of a census enumeration and to "correct" the census result accordingly if it is found that there have been omissions or double counting. The accuracy of a first census is, however, more difficult to appraise than that of subsequent enumerations, which provide the means of a comparison of results for two or more dates.

The accuracy of population estimates based on a census is, of course, greatly affected by the length of the time interval which has elapsed since that census was taken. We shall, therefore, give separate consideration to estimates based on a recent census and to those based on a census taken in a more distant past, assuming in both cases that this was the country's only census.

2. Estimates based on one recent census

For the date of the census, the census result can be regarded as the best possible estimate of population size, provided there is no reason to believe that it is above or below the mark. If there is evidence of over-enumeration or under-enumeration, the census figure should be "corrected" and it should be stated, in the publication giving the subsequent estimates of population, that this correction has been made.

Time adjustment for population changes since the census date[1] can be made in a number of ways, some of which are discussed elsewhere in this Manual. The use of birth, death and migration statistics for this purpose is considered in chapter VI,[2] and the assumption of a plausible rate of increase, where no better method can be found, is taken up in chapter II.[3] The following paragraphs refer to two methods which are particularly likely to be useful in a country where a census has been taken for the first time: (*a*) the calculation of rates of increase from results of non-censal counts, and (*b*) the estimation of rates of increase from data obtained in the census itself.

If non-censal counts were used to estimate the population before the census was taken, these may permit an estimate of the increase after the census date.

Example. In the census of Tanganyika as of 2 August 1948, a population of 7,477,677 was returned. There was no reason to suppose that this figure was too high or too low. Comparison of the census total with previous estimates based largely on tax lists and group enumerations showed that the latter were too low. The estimate for 1947 was 5,838,000 and that for 1928 was 4,741,000. On the assumption that the extent of under-estimation was the same in 1947 as in 1928, the average annual increase during the interval was calculated at 1.1 per cent. One method of estimating the mid-year 1949 population (though not the one used in making the official estimate) is to add eleven-twelfths of 1.1 per cent to the 1948 census total, which gives an estimate of 7,550,000. (The fraction, eleven-twelfths, is used because the 1948 census date was one month after the middle of the year.)

The derivation of an assumed rate of increase from non-censal counts rests on an assumption that the non-censal counts for various years have erred in the same direction and to the same extent. This assumption may not be tenable in some cases. Non-censal counts performed after the taking of the census may differ in accuracy from those performed before the census, particularly if the staff employed for the non-censal counts take advantage of the information and experience acquired at the census. If counts of unequal accuracy are compared, the derivation of an estimated rate of increase is still possible by arbitrarily selecting a value somewhere between extreme values resulting from the comparison of several counts.

It is usually not safe to derive a rate of increase directly from a comparison of a non-censal count with the census result, as the latter is probably more accurate and not subject to the same kinds of error.

Given some knowledge of the mortality rates, the rate of population increase may sometimes be estimated,

[1] A time adjustment is needed even in making an estimate for the year of the census, unless the census was taken near the middle of the year. The census result should be increased or diminished by the estimated amount of population change during the fraction of the year between the census date and 1 July, in order to ensure comparability with other mid-year estimates.

[2] Comprehensive data on these subjects are likely not to be available in countries where the first census has recently been taken.

[3] See chapter II, section 6.

at least very roughly, from the results of the census itself, classified by age groups. A possible way of estimating the birth rate is to use the number of infants aged under one year who were enumerated at the census, with suitable allowance for infant mortality, to arrive at the number of births in the preceding year from which these infants have survived. The method, of course, requires some information about infant mortality. Moreover, few censuses succeed in an accurate enumeration of infants. Considerable proportions of infants under one year of age are often omitted from the enumeration, while some of those enumerated may be reported as more than one year old. A comparison of the numbers of infants reported as under one year of age with the numbers reported at ages of one, two, three, or four years may provide some basis for correcting the figure for the age under one year, and thus lead to an improved estimate of the birth rate. By similar methods, estimates of births over a period of several years may be made from the returns on children of various ages.

Example. Mortara, utilizing the results of the Brazilian census of 1920, estimated the birth rate of Brazil during the years 1910-20 on the assumption of certain coefficients of survival and inaccuracies in age statements.

That ages were reported inaccurately could be seen from the fact that more children were reported at ages of 2 or 3 years than at ages of one or under one year. However, despite this inaccuracy, Mortara applied survival coefficients to these numbers to arrive at a first approximation, as follows:

Years of age	*Persons enumerated*	*Coefficient of survival*	*Number of births (first estimate)*	*Year preceding census*
1	828,000	0.883	934,000	1
2	776,000	0.780	996,000	2
3	1,015,000	0.736	1,378,000	3
4	1,006,000	0.717	1,404,000	4
5	950,000	0.706	1,345,000	5
6-10	4,537,000	....	6,576,000	6-10
TOTAL	9,112,000	....	12,636,000	

Assuming that a total of about 12,500,000 births had indeed occurred during the ten years preceding the census, but allowing for the fact that, in an increasing population, the annual number of births increases under a fairly constant birth rate, he recomputed the series with corrected estimates. According to these second estimates, the number of births in the year preceding the census was about 1,363,000, and the estimated birth rate was 47.2 per 1,000.[4]

Census data on population by age groups can be used also to estimate the death rate, but in this case the results of at least two censuses are ordinarily needed for accurate estimation.

Information regarding fertility and mortality can also be obtained from special questions asked in a census enumeration, either of the whole population or a sample. On the occasion of the censuses of Tanganyika, Kenya and Uganda, in 1948, questions relating to the numbers of births and deaths which had occurred in the preceding year were asked among 10 per cent of the enumerated population. The resulting information made it possible to estimate rates of births, deaths and natural increase prevailing in these territories. These estimated rates are being used in making estimates of current population size. Fertility and mortality rates can be estimated also by means of sampling investigations independent of the census. This is being done at present in a selected area of India, in the course of a field study being conducted jointly by the United Nations and the Indian Government. The experience obtained in that study is expected to be helpful as a guide for similar investigations in other countries where reliable vital statistics are lacking.

3. Estimates based on a census taken in the more distant past

The usefulness of a census result for current population estimates diminishes with the passage of time, for two reasons. On the one hand, cumulative errors due to inaccurate assumptions with respect to population growth tend to remove current population estimates more and more from reality the more time has elapsed since the last census. On the other hand, in most countries where there has been a census at some time in the past, other statistical series have also been established and their accuracy has been improved. Eventually reliance on other statistical information leads to better estimates than reference to an old census.

Example. A census has been taken, the result of which is believed to have been in error by no more than 3 per cent. The error in annual estimates of population increase may be, on the average, 0.5 per cent of the population. The cumulative effect of the latter error can lead, after twenty years, to a total error in estimates amounting to 3 per cent plus 20 times 0.5, i.e., to 13 per cent of the population.

Supposing also that non-censal counts, which are taken regularly, can be used to make population estimates subject to an error of no more than 10 per cent. It appears that, after twenty years, it is better to rely on the non-censal counts for current estimates than to continue basing them on the census result.

This does not mean that the census loses all its usefulness, because it can still be utilized in an appraisal and improvement of current statistics. A census, even though taken in the remote past, may also be very helpful in the design of samples for current investigations of the population.[5]

In some countries, no national census has been taken for a long time, but there have been provincial censuses from time to time. A comparison of the results of such provincial censuses with those of the previous national census may be used for estimating the increase in the population of the country as a whole since the date of the national census, with appropriate allowance for differences in the rates of increase in various parts of the country.

In Argentina, for instance, no national census was taken during the interval from 1914 to 1947. However, censuses were taken in the cities of Buenos Aires (1936) and Santa Fé (1923), in the provinces of

[4] United Nations. *Methods of using census statistics for the calculation of life tables and other demographic measures* (with application to the population of Brazil). By Giorgio Mortara. Lake Success, November 1949, pp. 14-16.

[5] See appendix B.

Buenos Aires (1938) and Mendoza (1942), in Chaco Territory (1934), Pampa Territory (1935), and National Territories (1920). Censuses of children of school age were taken in Santa Fé province (1912, 1918, 1925, and 1937) and in Rosario city (1934).[6] The results of these local censuses, together with the current registration statistics of births, deaths and migration, probably permitted fairly adequate provincial population estimates to be maintained during the long period between the two national population censuses.

There may be reason to believe that in the period since the last census the completeness of birth and death registration has improved. If so, current estimates may eventually have to be reconstructed: earlier estimates in post-censal years, when birth and death registration was presumably less accurate, may have to be revised before an improved series of post-censal estimates can be carried up to the current date.

4. Evaluation and improvement of the quality of estimates based on one census only

Where the results of one census are available, the most obvious method of improving current population estimates is to taken another census. Owing to the fact that the taking of a census involves important considerations of planning and expense, frequent census taking is not always practicable. But after a long time the results of a census lose most of their usefulness especially where the registration of births and deaths and the records of migration are not very accurate, or are lacking entirely. Under those conditions, after twenty years or so, the state of information about the population is little better than if no census had ever been taken. If it is intended to maintain a standard of statistical information above that of countries in which there has been no census, the census must be repeated.

As an alternative, though not an entirely adequate substitute, a sample census may be taken. Even after a considerable number of years has passed, the results of a previous census can provide a framework for a highly efficient sample census, an opportunity which should always be kept in mind.

The rapidity with which the results of a previous census lose their usefulness depends on the accuracy of information with regard to rates of population change. If only vague assumptions regarding rates of increase can be made, errors of estimates accumulate very rapidly. If, on the other hand, tolerably accurate vital statistics are at hand, a longer interval of time may pass before time adjustments fall greatly out of line with actual population changes. Hence a great interest attaches to the availability of vital statistics, by means of which the value of the census results can be preserved over a longer period of time. Sampling for estimates of birth and death rates can be very helpful where it is not found practicable to establish a well-functioning registration system within any short time. Sampling, however, is at best a poor substitute for a complete system of vital registers.

In the absence of statistics of births and deaths, the considerations which should govern the assumption of rates of increase, and the kind of information which may be helpful in making such assumptions, have been discussed in preceding chapters and should also apply where a census has been taken. However, as was shown in the present chapter, special methods for the derivation of possible rates of increase can also be used where a census result is available. A combination of all possible information is likely to lead to more realistic assumptions than the reliance on one method only.

Information on the accuracy of a country's first census can best be obtained in quality checks by means of samples;[7] the census itself also provides various internal evidence of its possible degree of accuracy; discussion of this topic is, however, reserved for a later manual.

The appraisal of the quality of non-censal statistics is often possible in the light of the census, particularly if non-censal counts were taken near the date of the census. Such knowledge is of importance if the census is rather old and if more reliance must be placed on non-censal data for purposes of current estimates.

For all estimates based on a census, care should be taken that the definition of the population (*de jure, de facto,* etc.) corresponds if possible to international standards. If necessary, census figures may be adjusted by means of estimated numbers of persons in certain categories, in order to conform to the standard definition of the total population. The definition of the population, if deviating from international standards, should be indicated.

Some censuses, although conducted in the greater part of the country, or for a majority of its population, do not include special parts of the population (e.g., tribal Indians, displaced persons, merchant seamen aboard vessels, etc.). To obtain estimates of total population, special estimates must be made for these categories and added to the census total, with indication that this was done. If the numbers involved in the adjustment are large, it is desirable that they be also shown separately with statement of the method by which they were estimated.

[6] United States Bureau of the Census. *Argentina. Summary of Biostatistics.* Washington, February 1945, pp. 7-9.

[7] See appendix B.