

### III. ESTIMATES BASED ON THE RESULTS OF INCOMPLETE CENSUSES AND NON-CENSAL COUNTS

#### 1. Types of incomplete enumerations and non-censal counts

This chapter refers to population estimates derived from two types of basic data: (a) the results of population censuses which failed to achieve a complete, or nearly complete, enumeration of the people; and (b) the results of non-censal counts, that is, counting operations pertaining to individuals, groups of individuals, or categories of the population, which are not equivalent in procedure or in the validity of results to real censuses of the population. These two types of data are considered in general to be of a similar order of reliability as bases for population estimates. Estimates based on such data are clearly more reliable than conjectures, for they are at least substantiated by some quantitative observation relating to the population itself. On the other hand, they do not have the same validity as estimates based on actual population censuses, which may be defined as nearly successful attempts at counting the whole population, person by person, within a single year.

Estimates based on the results of sample censuses of the population are not included in the category discussed in this chapter. Although such censuses do not aim at complete coverage of the population, they can, under favourable conditions, give results as accurate as those of a complete census. The problems of making current population estimates with the use of sample census figures are therefore similar to the problems encountered in putting the results of complete censuses to the same use; they are discussed in a later chapter of this Manual.

Some counting procedures have often been called "censuses", but must really be regarded as non-censal counts:

"The existence of a census is something of a prestige item indicative of a certain progress. Consequently there has been a tendency to promote rough head counts and even much cruder estimates to the categories of censuses in official publications . . . Many of the so-called 'censuses' listed as such in international compendia are in fact censuses only in the loosest meaning of the word.

"In Africa, almost all of the so-called censuses of colonial dependencies are true enumerations only for the infinitesimal European minority. Figures for the natives are often based on such evidence as the reports of local chiefs or administrators, whose returns may be much influenced by their purpose to which they assume the figures to be put. Thus, in their minds, enumeration may be associated with taxation, road service, or other levies. In this circumstance, there is a very understandable inclination to return a low estimate. Conversely, when population is used as a basis for determining administrative prestige and distribution of funds, etc., there is an equally understandable

inclination to exaggerate. Even when the local administrators make a sincere effort to count people under their jurisdiction, this is normally in the form of some rough approximation such as counting the number of huts and estimating the average number of inhabitants."

For the present purpose, the following three major types of "non-censal counts" may be distinguished:

1. Enumeration of individuals by registration boards.
2. Enumeration of groups rather than of individuals.
3. Enumeration of individuals with specific qualifications.

There are also enumerations which are not primarily censuses of population although they incidentally furnish statistics relating to either the whole population or some parts of it. Examples are agricultural censuses, industrial censuses, housing censuses and school censuses. With respect to the determination of population size these must be regarded as counts of the second or the third type above.

In many of the countries where true population censuses have been taken, various other counting procedures are also frequently practised. The results of the latter need not be utilized for estimates of population because the results of the population censuses are, in nearly all cases, far more reliable. Non-censal counts may, however, serve temporarily as a basis for estimates in countries where important events, such as a major war, have rendered the results of previous censuses obsolete for the purpose of current estimates. This was the case in some European countries in the years immediately following the Second World War, until new censuses were taken. In cases like these, the reliability of non-censal counts is usually fairly high and can also be evaluated with the aid of corroborating evidence.

#### 2. Incomplete or defective census enumerations

An enumeration by actual census methods is sometimes carried out successfully in only a part of a country. An incomplete census enumeration of this kind can lead to an estimate of total population by means of supplementary estimates (conjectural, or based on non-censal counts) for the remainder of the country. For example, the 1946 census of South West Africa was executed only in the Police Zone, where 176,000 persons were enumerated; the population in the remainder of the territory was estimated in that year at 185,000.

<sup>1</sup> Dudley Kirk, "Problems of Collection and Comparability of International Population Statistics", in Milbank Memorial Fund, *Problems in the Collection and Comparability of International Statistics*, New York, 1949, p. 22.

An incomplete census may, incidentally, help to improve estimates for those parts of the country where the population was not enumerated. Thus, a comparison between estimates made previously and the census results in areas where the census enumeration took place can show whether the estimates made by previous methods tended to be too large or too small. If population estimates in the remainder of the country are made by the same or similar methods, there is some reason to believe that these are subject to a similar error, and they may be "corrected" accordingly. This latter assumption cannot be made, however, if the population enumerated in the census is not similar to the non-enumerated population. For example, if a census taken only in urban areas shows in what manner previous estimates for these urban areas tended to err, it cannot be assumed that the estimates previously made by the same methods in rural areas erred in the same direction or to the same extent.

A census enumeration may also have been undertaken in the entire country but may have failed as a result of poor organization, faulty procedures, or obstacles encountered in the process. For instance, this is believed to have been the case with the census of Haiti in 1918-19, which did not yield complete returns for the whole country. In such a case, it is not necessary to reject entirely the results of the census, even though they are defective, because by careful examination of the completeness of enumeration in each area and detailed comparisons of local census results with other estimates for the same localities, an improved population estimate can be constructed for the whole country.

Observation and local reports may provide important clues for identifying those areas where enumeration was most nearly complete; in those areas the census results may be regarded as the best population estimates available for the census date and should properly form the basis for subsequent estimates of local population. In some of these areas, a comparison of census results with the results of previous methods of estimating the population may furnish an indication of the nature and extent of the error arising from other estimating procedures; population estimates, made by such procedures, can be "corrected" accordingly in those areas where the census enumeration was unsuccessful. Some areas may also be found where fairly reliable estimates can be made by other procedures, but where the census results were very incomplete. For these areas a coefficient of incompleteness of the census enumeration can be estimated, and this coefficient may be applied to other areas where census results were probably incomplete to a similar extent but where no adequate estimates can be formed by alternative methods.

### 3. Enumeration of individuals by registration boards

Attempts at enumerating every individual in the population are sometimes made by non-censal methods for specific purposes. Some examples of this type of enumeration are afforded by the establishment of a

ration register in French Morocco prior to the count in 1947, and the development of the central register of identity cards in Iran in the course of several years up to 1941. Such "civil registers" are usually kept up-to-date, so far as possible, by adding the reported births and subtracting the reported deaths. However, they must not be confused with continuous population registers, since internal checks for accuracy are insufficient and, in particular, since there are no adequate provisions for the transfer of records in cases of change of residence. Nor is the establishment of such a register equivalent to the taking of a census, because of the great difference in procedure.

The Moroccan registers were originally established for purposes of food rationing, a purpose which is conducive to over-registration, since there is a tendency not to report deaths or departures. In 1947, the Moroccan population was enumerated from these rationing lists, and the result was a total of 8,293,000 (excluding French and foreigners). However, on the basis of sampling investigations, it was believed that this figure was an overestimate of at least 4 per cent, and it was consequently replaced by an estimate of 7,900,000 Moroccans.<sup>2</sup>

After the partition of Palestine, the population of territories surrounding the new State of Israel was swelled by large numbers of Arab refugees. The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWAPRNE) attempted to enumerate the refugees who were on relief, in May 1950, and arrived at a total of 957,000, including many double registrations. After repeated revisions of the relief rolls, the total number was found to be about 876,000 in June 1951,<sup>3</sup> a figure which was believed still to be slightly excessive.

The establishment of a civil register of Iran took many years. It was originally intended to serve the purposes of military conscription, but no accurate registration could be obtained. Later, it became a central register of identity cards issued, cards being added for each birth and withdrawn for each death. By 1940, the registration of live persons was believed sufficiently complete to serve as a basis for estimates of the country's total population. By the end of 1950, the population total, according to this register, amounted to 18,952,000 persons. It was, however, believed at that time that, if an accurate count of the population could be taken for the whole country, it would result in a total of about 20 million.<sup>4</sup>

## 4. Group enumeration

Group enumerations of the population are often carried out for purposes other than that of determining

<sup>2</sup> *Annuaire Statistique de l'Union française Outre-Mer*, 1939-46, Chapitre B — Territoire et Population, Paris, 1948, p. 83.

<sup>3</sup> United Nations. *Report of the Director of the United Nations Relief and Works Agency for Palestine Refugees in the Near East, Supplement No. 6 (A/1905)*. Paris, 1951, p. 3.

<sup>4</sup> Iran, Ministère de l'intérieur. *Bulletin de statistique*, No. 4. Ordibéhechte. 1330. (21 avril — 21 mai 1951) pp. 2-3.

the population size. For example, in a housing census, the primary object of the enumeration is to establish the numbers of dwelling units of different types and characteristics; since one of the important characteristics of a dwelling is the number of persons living in it, a housing census leads incidentally to an enumeration of the great majority of the population, on a household basis. Group enumerations of this type are frequent in countries where there are also true population censuses; in those countries, the results of the group enumerations ordinarily need not be employed for the purpose of estimating total population, particularly because the results of the population censuses are nearly always more reliable.

In some countries, however, group enumerations are made specifically for the purpose of determining the size of the population. This method is used especially in countries where there are serious obstacles to individual enumeration. In many parts of Africa it has not been found possible to take a real census of the population because a sufficiently large staff of literate, co-operative and well-instructed enumerators to make a person-by-person enumeration could not be rapidly assembled, or because funds for hiring and training such staff were insufficient. A small number of enumerators, therefore, have to cover large territories within a brief space of time. Generally this is done by asking village headmen or chiefs of tribal divisions and subdivisions to report on the numbers of persons under their jurisdiction.

Theoretically, group enumerations may give results which are no less accurate than those obtained by individual enumeration. In practice, this is seldom the case because errors are introduced by lack of complete knowledge of the group on the part of the individual who reports it, or by the inattention or carelessness of that individual or his unwillingness to give full and accurate reports. The danger of error is especially large when the contact between the local populace and the central administration of the country is a rather loose one. A certain amount of diplomacy is often required to elicit satisfactory answers from tribal or village headmen. There may be frequent misunderstandings, both as regards the purpose of the enumeration and the precise kind of answers which are required. Local dignitaries may sometimes also lack the necessary authority to determine the numbers of persons in their respective territories. In some instances they may not take the trouble to ascertain exact numbers, while in other instances they may be motivated either to exaggerate or to minimize the number of people. In some areas there is a reluctance to declare the numbers of women, while in others, small children are not considered as "persons" that should be counted. There may also be varying practices regarding the inclusion or exclusion of persons who have originated in another village or tribal group, or of persons who have left the particular group but are still loosely associated with it. A great drawback of group enumerations is that it is usually impossible to say whether they have resulted in an under-count or an over-count.

Thus, a "census" by group enumeration was taken in Nyasaland in 1945. On this occasion, it was frankly admitted in the official publication that neither the procedure nor the accuracy of the results was comparable to that of a real census. "As on previous occasions, it was not possible to deal with individual Africans separately. Each village was treated as a separate entity and a return entered for that village."

"... the tables of statistics should be only treated as a useful and, in the aggregate, a fairly accurate estimate of the African population, based on a count".<sup>6</sup>

Some group enumerations have been performed in such cursory fashion that they differed little in practice from estimates derived from tax lists, described in the following section. Thus, in the 1911 "census" of Sierra Leone, "It was recognized that to take such a detailed Census of the aboriginal natives [as of the non-natives] of the Protectorate would be quite impracticable . . . and accordingly it was decided that the Census should be limited to obtaining such information as could by approximation be furnished by the District Commissioners." However, it turned out that such information was derived largely from tax lists, and that population figures for most districts were returned with varying arbitrary proportions of the population reported as men, women and children (20 per cent men, 30 per cent women, 50 per cent children, in some districts; 30 per cent men, 40 per cent women, and 30 per cent children in other districts; various other percentages were also used).

##### 5. Enumerations of individuals with specific qualifications

Examples of this type of enumeration are tax lists, where only taxable persons (e.g., able-bodied males, heads of households) or taxable units (huts, tents, households) are enumerated; voting lists, where the numbers of persons eligible to vote are registered; conscription lists, recording the numbers of persons liable for military service; school censuses, in which the number of children of pre-school and school age are counted; and agricultural censuses with incidental enumeration of the agricultural population.

Whereas the types of counts previously discussed can lead to estimates of total population size either directly or by the application of correction factors for under-enumeration or double reporting, enumerations which are restricted to special categories of the population can only lead to a figure of total population with the application of a multiplier. Estimates based on this type of count are sometimes not much better than conjectures, since they are subject to a double error, one pertaining to the accuracy of the count itself, the other to the selection of a representative multiplier. The accuracy of such estimates is usually much more

<sup>5</sup> *Nyasaland Census Report*, 1945, pp. 1-2.

<sup>6</sup> *Ibid.*, p. 11.

<sup>7</sup> Kuczynski, R. *Demographic Survey of the British Colonial Empire*, vol. I, p. 33.

affected by the selection of a suitable multiplier than by the accuracy of the count itself. In most cases, however, the basis of estimating is likely to be improved by the fact that such counts are usually repeated periodically, leading to improved procedures and increased experience. In some cases, special efforts are made to arrive at a representative multiplier.

Enumerations of the population of the Cameroons were made under German administration. It was reported about a particular district:

The number of men has been ascertained through direct enumeration, but it will be, of course, too low, since there are chiefs who will, either intentionally or unintentionally, make wrong statements. The number of women and children has been calculated by means of a table which, to judge from sample tests, may be considered as more or less accurate.

This table provided that the number of women and the number of children were to be calculated by multiplying the number of men for four tribes by 1.25 and by 1.5 respectively, and for the other three tribes by 1.5 and 2 respectively.<sup>8</sup>

A special problem in enumerations of this type arises where there is difficulty in defining sharply the category of the population which is to be counted. Thus, in the territory of Tanganyika, population estimates were formerly based on tax counts, but "the details of the system have varied. The principal features of the system have been as follows: A hut tax has to be paid for every dwelling owned by an African. Where an African has more than one wife living with him in a hut, a tax is levied in respect of each additional wife. A poll tax has to be paid by every adult male not liable to hut tax. An adult male was formerly defined as a male who appears to be over the age of 16. Since 1934 this age limit has been 18 years".<sup>9</sup> In cases like these, where the definition of the enumerated category is somewhat complex or necessarily vague (since for many Africans the exact age is not known), it is particularly difficult to find multipliers which can express adequately the ratio between the numbers counted and the total size of the population. Moreover, some persons may escape registration while others are exempt from tax payment. Therefore, "changes in numbers of taxpayers may reflect changes in population, or they may reflect changing fiscal legislation, changing numbers of exemptions, or differences in the procedures developed for allocating migrant men to specific areas".<sup>10</sup>

In the years 1943-47, the total population of Tanganyika was derived from tax reports by multiplying the number of taxable males by 3.5. Similar methods were also used in earlier years. Whether as a result of inaccurate counting, or because of an important error in the multiplier, the estimates were far too low. Whereas the estimate for 1947 was 5,838,000, the census of the following year, which is believed to have been the first fairly accurate enumeration of the population, resulted in a total of no less than 7,478,000. It appears that popu-

lation estimates of Tanganyika derived by tax counts fell short of the true population size by about 20 per cent.

In Kenya, the numbers of native huts were repeatedly enumerated for purposes of a hut tax, but much difficulty was experienced in selecting suitable multipliers. In 1913-14, population figures were estimated by assuming an average of three persons per hut, and entering a round figure which approximated to the results obtained. In 1924, instructions were issued which stipulated:

In Districts where Officers are not satisfied as to the accuracy of their census of native children, it is recommended that their figures be compiled upon the principle of taking the adult population as 63% and the child population as 37% of the general total.<sup>11</sup>

The number of adult females was first determined by assuming a ratio of forty-seven adult males to fifty-three adult females, and the number of children was then added according to instructions stated above. Neither of these ratios had any statistical foundation whatever, and it is probably largely owing to the use of improper ratios that the population estimate for Kenya, which stood at 4,200,000 in 1947, had to be raised on the basis of the census of 1948 to 5,382,000 in the following year. Population estimates of Kenya must have been some 20 per cent short of the true population size.

In 1932, a special inquiry was conducted in the Digo District on the Kenya coast, where a population of 26,000 persons was enumerated with distinction of age and sex. It was found that the ratio of adult males to adult females was, in fact, roughly forty-seven to fifty-three (which may be a mere coincidence), but that of the total population 52 per cent — not 37 per cent — were children.<sup>12</sup> The Digo District may not have been at all representative of Kenya as a whole. Nevertheless, if the findings in this inquiry had been utilized, the population estimate for Kenya in 1947, would have amounted to some 5.5 million, a figure not greatly different from the census result. Although this may be only a coincidence, it is very probable that if the assumed multipliers had been based on some actual observation, like that made in the Digo District, population estimates would have been much more accurate than they were.

## 6. Determining improved multipliers

It appears from the foregoing discussion that the accuracy of estimates based on enumerations of specific categories in the population, such as estimates based on tax lists, depends very largely on the accuracy of the multiplier. It is therefore surprising that, despite the expense and labour involved in counting the households or special categories in the population, efforts to establish a reasonable multiplier have often been quite insufficient. True, for purposes of taxation, a knowledge of actual population size is not necessary so long as

<sup>8</sup> Kuczynski. *The Cameroons and Togoland*, p. 21.

<sup>9</sup> United Nations. *The Population of Tanganyika* (ST/SOA/Series A, No. 2), Lake Success, 1948, p. 71.

<sup>10</sup> *Ibid.*, p. 87.

<sup>11</sup> *Quarterly Bulletin of Statistical Research for British East Africa*, vol. I, part I, p. 21 (quoted in Kuczynski, R., *Demographic Survey of the British Colonial Empire*, vol. II, p. 136).

<sup>12</sup> Kuczynski, R. *Demographic Survey of the British Colonial Empire*, vol. II, p. 155.

the number of taxable units is known with a fair amount of accuracy, but knowledge of the size and composition of the population may be regarded as an important by-product of such non-censal counts, where the obstacles to real census-taking seem insuperable.

A means of determining the ratios which should be used in converting, say, numbers of taxable males into total population estimates is to actually enumerate the population, with distinction of the special categories, in selected localities. The ratio found in such an enumeration, which may be confined to a relatively small part of the population, may then be assumed to be approximately true for the rest of the population, on condition that the enumerated localities can be regarded as typical.

Reference has already been made to the enumeration in the Digo District in Kenya, which might have been utilized to establish multipliers better than the ratios actually used. It is, however, doubtful whether the Digo District could have been regarded as typical of the country as a whole, and some variations in this ratio should have been allowed for to take account of varying conditions in different parts of the country. An example of such practice can be found in the case of Togoland under German administration, where, in 1912-13, some estimates were made in the following fashion:

In Lomé-Land the vaccination of the population in the entire District, started by the vaccination physician, offered an opportunity for counting the huts and the natives in a large part of the District. This showed that on an average 4.4 inhabitants have to be reckoned for one person subject to taxation. By applying this ratio also to that part of the District in which an enumeration could not yet be effected, a population of 136,400 inhabitants was calculated for the whole District, a figure which exceeds the former estimates—119,000—not inconsiderably. In the Anecho District the population was ascertained on the basis of the tax rolls by multiplying the number of persons taxed by a coefficient which according to the local conditions varies between 4 and 4.5. The coefficient itself was ascertained through enumeration in various localities. The population figure computed by means of this procedure showed 123,237 native inhabitants while the population formerly had been estimated at 112,000.<sup>13</sup>

However, such methods of obtaining improved multipliers are not a sufficient safeguard against errors. In the first place, there can be no certainty that conditions in the enumerated localities can be regarded as representative of those in the districts or territories to which these multipliers are applied. Secondly, the accuracy and completeness of the actual counting of taxable individuals or households remain in doubt, even if the multiplier is accurate. Finally, there are probably considerable variations in the precision with which taxable subjects are defined in various localities, as was shown in the case of Tanganyika (see p. 21).

An adequate procedure would require an enumeration, independent of the non-censal count of the total population in suitably selected localities, and the determination of the ratio between the inexact count of

<sup>13</sup> Kuczynski, R. *The Cameroons and Togoland*. Oxford University Press, London, New York, Toronto. Issued under the auspices of the Royal Institute of International Affairs, 1939, p. 375.

taxable subjects and the relatively exact enumeration of total population. This ratio may, of course, differ somewhat from the true multiplier (i.e., from the true ratio if taxable subjects were counted accurately), since it also contains an element of correction (i.e., a factor of adjustment for inaccuracy in the count of taxable subjects).

An example of this method is furnished by the practice in the Belgian Congo. "Sample centres, as far as possible typical of a large area, are chosen where counts are made each year; by 1935, studies of this kind covered one-sixteenth of the estimated total population. From these detailed studies, a coefficient is calculated for each region to four decimals, and the estimated population for the whole region is obtained by multiplying the number of tax-payers by this figure."<sup>14</sup>

#### 7. Time adjustment of estimates derived from non-censal counts

Some non-censal counts, particularly tax counts, are performed at regular intervals such as once a year, and therefore result in current estimates without need for time adjustment. An annual series of such figures has important defects. There may be year-to-year fluctuations in the figures which, though reflecting in part actual changes in population size, are probably mainly the result of the varying errors to which annual figures are subject. An imprudent user of statistics, in glancing at a series of such annual estimates, is apt to conclude that population has increased or decreased markedly during particular years, although such a conclusion is entirely unfounded in view of the varying errors of each separate estimate. A comparison of figures separated by a long time interval can be likewise misleading since the general accuracy of the estimates could have improved with the progress of time.

It is therefore necessary, where figures are secured annually, to give sufficient explanation of the manner in which these figures were derived, whether they can be strictly compared from one year to another, and also whether it is believed that estimates have become progressively more accurate. Without such indications, the comparison of consecutive current estimates can be misleading, even though each current estimate represents the best estimate which was possible at the particular time. On the whole, it would seem that an annual repetition of non-censal counts is likely to lead to greater and greater accuracy, with increased experience and avoidance of past mistakes on the part of the enumerating officials and greater responsiveness on the part of the population; but experience has shown that this is not necessarily true.

*Example.* The difficulty of deriving a plausible rate of population increase from a series of population estimates of varying accuracy can be illustrated with the annual estimates for the African population in the indigenous sultanates of Ruanda-Urundi. In that territory, non-censal counts of able-bodied males used to be taken annually and estimates of total population were derived by means of special investigations designed to establish the ratios between enumerated persons and total

<sup>14</sup> Hailey. *An African Survey*, p. 121.

population. The following results were obtained (numbers in thousands):

1932 .....	3,451	1941 .....	3,832
1933 .....	3,244	1942 .....	3,840
1934 .....	3,165	1943 .....	3,803
1935 .....	3,340	1944 .....	3,577
		1945 .....	3,386
1936 .....	3,449		
1937 .....	3,603	1946 .....	3,495
1938 .....	3,725	1947 .....	3,662
1939 .....	3,766	1948 .....	3,761
1940 .....	3,798	1949 .....	3,807
		1950 .....	3,863

The figures show a rapid decline for 1932-34, then an increase, at first rapid, then gradual, up to 1942, a sharp decline to 1945, a rapid increase to 1948 and a more gradual increase to 1950. It is believed that in 1932-34 population may in fact have declined (though not as drastically as suggested by the figures) as a result of famine conditions; part of the decline in the figures may, however, be due to the disorganization in the collection of statistics occurring under these conditions; similarly, part of the rapid increase in subsequent years may be a result of statistical reorganization. In the years from 1941 to 1946, budgetary restrictions impeded the collection of accurate statistics, but in the years 1946 to 1948, more accurate statistical procedures were re-established.<sup>18</sup>

The figures yield the following geometric rates of increase for the periods before 1950:

1948-1950 .....	1.3% per annum
1945-1950 .....	2.7% per annum
1941-1950 .....	0.1% per annum
1934-1950 .....	1.3% per annum
1932-1950 .....	0.6% per annum

As in the case of mere conjectures, it is not advisable to hold an estimate derived from a non-censal count at some time in the past at a constant figure, unless there is reason to believe that the population has in fact remained nearly stationary. Unless non-censal counts are repeated annually, it is desirable to apply adjustments for population change up to the current date. The methods of time adjustment which may be used include assumed rates of increase, extrapolation and the use of vital statistics.

The use of assumed rates of increase has been discussed in the preceding chapter (chapter II, p. 16). Even if the assumptions relating to population growth are considerably in error, this error can form only a small part of the total error in the current population estimate because the base figures are not highly reliable. The error in estimated growth can contribute substantially to the total error in current estimates only if many years have passed since the last non-censal count (for an illustration, see the example in chapter I, p. 4).

Estimates by extrapolation, in the case of non-censal counts, can only be made with greatest caution. In particular, full consideration must be given to the fact that successive counts are usually not comparable with regard to completeness or accuracy. In many cases, it is probable that recent counts are more reliable than those taken in the more remote past. An extrapolation from counts of varying degrees of accuracy is apt to carry forward some of the efforts contained in the less

accurate counts. However, provided the accuracy of successive counts is somewhat comparable, extrapolation may be better than assumed rates.

*Example:* In a non-censal count, taken twenty years ago, the population was found to be 1,000,000. A second count, taken ten years later, resulted in a population figure of 1,200,000. For the current year, an estimate by means of arithmetic extrapolation would be 1,400,000.

If the first of the two counts was incomplete, and the population was underestimated by some 100,000, the method of extrapolation used would imply an exaggerated rate of population growth, and the current estimate should be lowered accordingly, to about 1,300,000.

If, on the other hand, the first count was relatively accurate but the second count omitted about 100,000, the rate of growth implied in the extrapolation is understated, and the current estimate should be raised to about 1,600,000.

Extrapolation of totals based on non-censal counts should never be carried over a very long period. This fact was appreciated with regard to population estimates in Northern Rhodesia:

"The native population of the Territory is estimated on the basis of the ratio of increase (or decrease) over the last five years . . . This system of estimating the population is an innovation, and cannot be used indefinitely, as it cannot reasonably be applied to those districts that attract immigrants from adjoining Territories." (Northern Rhodesia. *Report upon Native Affairs, 1928*, p. 5).<sup>19</sup>

Methods of extrapolation will be discussed more fully in chapter V.

There are only a few countries using non-censal counts where extensive vital statistics are available. Where this is the case, the accuracy of statistics on births and deaths is probably doubtful. The use of statistics of births and deaths appropriately corrected is, however, greatly preferable to an assumed rate of increase, particularly since the statistics reflect, even if inaccurately, the real year-to-year fluctuations in rates of growth. Where non-censal counts exist in the form of statistics obtained by registration boards (other than "continuous population registers", discussed in chapter VII), there is reason to assume that registration of births and deaths is subject to the same biases as the original population count. If the purpose of registration is rationing or the allocation of benefits, it is probable that births are fully registered but that many deaths are not reported. If the registers serve purposes of military conscription or the imposition of other levies, there may be a tendency not to report births. Therefore, wherever vital statistics are used in adjusting estimates derived from non-censal counts, their probable accuracy should be carefully examined. It may be found preferable, for instance, to substitute for the recorded data some estimated numbers of births and deaths based on assumptions with regard to the probable completeness of registration.

#### 8. Comparability and consistency of estimates based on non-censal counts

Sometimes non-censal counts cannot be made simultaneously for an entire country, but may extend over a

<sup>18</sup> Figures are taken from United Nations, *The Population of Ruanda-Urundi* (in press 1952).

<sup>19</sup> Kućzynski, R. *Demographic Survey of the British Colonial Empire*, vol. II, p. 402.

certain period of time. This means some loss of accuracy in the total results, particularly if numbers in various localities are affected by seasonal movements. It is therefore desirable to indicate in the publication of results the entire time-period during which the count was taken. In some cases, a count may be taken for one section of the population or for one part of the country at one time, and for the remainder at another time. In such cases, it is desirable to adjust the results of one sectional count so that it conforms to the date of the other and explain this adjustment.

The observations regarding inclusion or exclusion of specific categories of the population which were made in chapter I apply in the case of non-censal counts as well as census enumerations. The standard definition (modified *de facto* population) should be compared carefully with the categories included in the count, and deviations from the standard should be noted by indications, or further estimates should be made to allow for adjustments necessary in order to make the estimate conform with the standard definition. Counts based on voters' lists or tax lists are particularly likely to omit temporary residents or the dependants of migrant workers, and care should be taken to determine whether the estimate includes these or not. Similarly, refugees, displaced persons or prisoners of war in camps may not figure in a count of ration-holders, voters or taxpayers, but they should be included in a country's total *de facto* population.

If an estimate, based on non-censal counting procedures, has been derived from a combination of various counts pertaining to various sections of the population and differing considerably in accuracy, figures for each section should be shown separately, since the figures resulting from estimates of higher accuracy may be amenable to certain statistical uses from which the figure for the total population must be excluded owing to its low reliability. If an estimate is based on a non-censal count covering the majority of the population, but estimates of special categories (e.g., displaced persons in camps) from other sources are added to the total, this fact and the relevant figures should also be stated.

#### 9. Improvement of estimates based on non-censal counts by full utilization of existing knowledge

In a number of countries, non-censal counting procedures may be in operation though they have never been utilized for population estimates. There should, therefore, be a survey of all the statistical information available in the country. It is quite possible that certain counting procedures will be found well suited for the purpose of estimating the population.

In some cases, population estimates are based on only one type of non-censal count, although the results of other counts are also available. The possibility that the latter will yield population estimates of the same or greater reliability should be fully explored. A comparison of estimates, each derived independently and on a different basis, may be very helpful in confirming

the result of any particular method or in determining and narrowing its possible margins of error.

Full advantage should be taken of every indication bearing on the completeness and exactitude of the non-censal counts. Reports of enumerators should include their opinion as to whether figures collected locally are fairly exact or whether they are likely to be exaggerated or understated, and to what extent. If such reports exist, they should be fully utilized in formulating a judgment concerning the reliability of the total figure and the possible direction and magnitude of its bias.

If the enumeration is of the kind which results in a total of certain units of population (e.g., households, families), or certain of its categories (e.g., voters, heads of households, taxable subjects, children of school age), it is important to utilize fully all available information which may be helpful in determining the multiplier. Estimates of sizes of households, of the proportion of persons in certain ages, of the average size of a family, etc., may already have been made, if not for the given country, perhaps for other countries where conditions are presumably comparable. The utilization of such knowledge may help greatly in improving the accuracy of multipliers. Of particular value are investigations carried out on a representative sample basis. Sampling investigations may be suitably combined with the counting procedure itself. However, if it is intended further to "correct" the results of counts for errors in counting, sampling investigations must be pursued independently of the count, by separate enumerations in selected localities.

There may also be unutilized information regarding the accuracy of the counts. The sifting of such evidence is a prerequisite to the use of extrapolation of the results of successive counts, since it is essential that the accuracy of the extrapolated figures be at least somewhat comparable.

In some cases, where the reliability of the results of a count is very low, a conjectural estimate may be made independently of the count for comparison.

The utilization of the results of a partial or defective census has been discussed in section 2 of this chapter. Similar methods may be used where censuses or superior counts have been taken only in small parts of the country or in particular localities. A comparison of the results of the latter with the results, for the same localities of the country-wide count, can furnish the basis for evaluating the accuracy of the count and for applying some "corrections", if needed.

A patient search may yield various pieces of information relevant to rates of population increase. The great variety of background knowledge which is helpful in making reasonable assumptions for population growth has been indicated in section 6 of chapter II. Perhaps the best adjustments for population change, where vital registration is not in effect, can be made by estimating vital rates on the basis of sampling investigations. A brief outline of the uses of sampling procedures for such purposes will be found in appendix B of this Manual.