II. CONJECTURAL ESTIMATES

1. The nature of conjectural estimates of total population

A population estimate may be described as "conjectural" if it is not based on numerical data relating to the population itself. Conjectural estimates depend mainly on quantitative and qualitative information concerning one or more factors which are related to population size. Among such factors are land area, types of settlement and the population density which, under given conditions, may appear feasible, or the total production or consumption of a staple commodity and estimated per capita rates of production and consumption.

Estimates based on numerical data pertaining more directly to part or all of the population, for example a count of houses, huts or tents, numbers of tax-payers, voters, or recipients of rations, are not conjectural; though not constituting actual population enumerations, they are based on counting procedures which must be regarded as "non-censal".

In some countries and territories, estimates of population have been derived, in part or entirely, from local population estimates, such as those supplied in reports of local administrators to the central administration. The basis of some or all of the local estimates is often unknown, and the quality of many is highly dubious. Owing to these uncertainties regarding the local figures, estimates of total population made by compiling the reports of local administrators should also be considered as conjectural, though they are probably superior to direct conjectures on total population size.

Sometimes, a small part of a country's population may have to be estimated by conjecture, the rest being estimated by superior methods. This is frequently the case with aboriginals in remote areas of a country, about which information is scarce. In such cases it is important, for the sake of a proper indication of the reliability of the total estimate, to state the fact that it includes a conjectural estimate of part of the population.

The first distinction to be made among estimates based on conjectures is that between conjectural "base figures" and estimates adjusted for a current date. A conjectural estimate made in the past is very often regarded as so unreliable that, whether or not population has changed in the meantime, it is still considered as the best estimate of current population size. The population of Ethiopia, for instance, has been estimated at a round 15 million, it being understood that this figure represents only a rough approximation. In the absence of further information, this same figure is also used as an estimate of probable population size in the past, and is likely to be retained for several years in the future unless new attempts are made to obtain a more reliable estimate. Nevertheless, it should be realized that the retention of the same figure over a series of years creates the impression that population size has, in fact, remained nearly constant. It is not advisable where there is reason to believe that population is either increasing or decreasing.

Thus although the population of Liberia was estimated by a rough conjecture in 1947 at the round number of 1,600,000 it was estimated in 1949 at 1,648,000, on the assumption that population is increasing at a rate of approximately 1.5 per cent per annum.

In a conjectural base figure estimate, two elements must be distinguished: the *circumstantial data* (e.g., total land area, or any other measure to which population may be thought to be in a certain relation), and the *multiplier* (e.g., the population density, i.e., number of persons per unit of land area, or any other ratio expressing the assumed relation between population and the circumstantial measure). Errors in the estimate can arise from both these components, each of which must be derived separately. The greatest difficulty usually attaches to the selection of a plausible multiplier, and this is the main reason why conjectural estimates are usually of a low order of reliability.

There are considerable areas of the world where, at the present time, population size cannot be determined on any firmer basis. A conjectural estimate, however, is always possible, and it is useful to make the best conjecture that can be made under given circumstances.

2. Conjectural estimates made by explorers and travellers

In 1885, travelling through the remote inner regions of China, the Russian explorer Potanin encountered a branch of sedentarized Mongols on the upper reaches of the Yellow River, near the present borders of Kansu and Chinghai Province, whom he called the Shirongol-Mongols. He estimated their numbers, by conjecture, as follows:[1]

> In San-chuan, i.e., in the area between Gyango-gol and Unchzhagol, there are 1,200 households; assuming five souls of either sex per household, we obtain 6,000 souls for San-chuan. If we allow for the population of Bouchzha-aral, Itel-gol, and Sombra with Badu-ol a figure of 2,000 souls, then the total population of this section amounts to 8,000. In Tun-syan one

[1] G. N. Potanin. *Tangutsko-tibetskaya okraina Kitaya i tsentralnayo Mongoliya.* Moscow, 1950, p. 377.

reports thirty-six imyks, i.e., villages; estimating that there are 100 households per village, one may put these at 18,000 inhabitants; however, assuming that the figure thirty-six is exaggerated, we may reduce the estimate for the population of Tun-syan to 10,000. The Shirongolian population of the lower part of Sinin-gol and of Day-tong-gol may also be accepted at 10,000. In the surroundings of U-yan-bu and Mubayshintu there can hardly be more than 20,000 souls. Around Bou-nan there are, probably, no more than 2,000 souls. These estimates result in the following total:

	Persons
San-chuan	8,000
Day-tong-gol	10,000
Tun-syan	10,000
U-yan-bu	20,000
Bou-nan	2,000
TOTAL	50,000

The author himself had travelled only through San-chuan and Bou-nan and had an opportunity to estimate these parts of the Shirongolian population from personal observations. Utilizing his personal knowledge regarding the average size of households, average numbers of households per village, and possible population densities, he proceeded to make an inference on possible numbers of population in neighbouring areas which he had not visited but the approximate extent of which he knew from local reports.

Stanley, travelling through the region of Uganda in 1878, estimated the population of "Uganda proper" at 750,000, and that of the entire empire of Uganda at 2,775,000, with this remark: "But it is to be understood that it is only a rough estimate, made by a traveller who has had to compile his figures by merely taking into consideration the number of the army assembled at Nakaranga, and enumerating districts and villages along the line of his travels."[2]

The population of French Equatorial Africa was estimated at 9 million in 1911 and at 5 million in 1914. These high estimates probably rested on an assumption that the population of remote and little travelled areas was comparable in density to that of better known areas in which French administration was already well established. The count of 1921 (largely an estimate based on a compilation of local reports) resulted in a figure of only 2,850,000.[3]

Vastly divergent conjectures were made in early years regarding the population of Madagascar:

Benyowski, judging by the uninhabited forests of the Bay of Antogil, estimated the total population of the island at less than 300,000 inhabitants. Jean Laborde, who was mostly familiar with Imerina, raised this figure to 8 million. Grandidier, who had traversed the entire island, made a more exact computation by placing, after 1868, the figure at 3 million. The first enumeration in 1900, which was still rather deficient, resulted in 2,500,000.[4]

Of special interest is Czekanowski's method of estimating the population of Ruanda on the basis of the observations which he made in the course of an exploration expedition in 1907-08 — one of the earliest explorations in this part of Africa. His method is described in detail in the case of an estimate for part of Mpororo, an adjoining region where, on the occasion of a trip of 25 kilometres in length, he had counted 100 huts. Assuming that his range of observation on the trip included a strip of territory of an average width of about one kilometre, he regarded these 100 huts as representing the population in an area of 25 square kilometres. Since it had been observed that the average population per hut was about four persons, he computed a population density of sixteen persons to the square kilometre. Applying this computed density to the area of the region, estimated from a map, he obtained a population estimate for the entire region which he believed to be "fairly close to the truth".[5]

Using similar methods for estimating the population of each separate region of Ruanda, he arrived at an estimate for the total population of Ruanda, within an area of 28,900 square kilometres, of 1,710,000.[6] This estimate, though based on extremely rough methods, is surprisingly close to recent estimates, placing the population of Ruanda, within a somewhat smaller area of 24,306 square kilometres, at 1,752,000 (official estimate for 1947).

In this connexion it may be pointed out that the use of airplanes in modern times may offer an opportunity to make far more reliable estimates by using similar methods. In particular, it is most uncertain that the area under observation on Czekanowski's trips (supposedly contained within a strip one kilometre in width "in the open country", and of different width in different terrain) could be estimated with any degree of exactness. On the other hand, it is very likely that the itineraries were largely confined to more densely inhabited areas, while avoiding the more difficult terrains where population was relatively sparse. Both of these sources of error are eliminated if huts are counted from aerial photographs taken in various places irrespective of the difficulties of travel along the surface and with an unlimited field of vision.

Conjectural estimates made by these early explorers were often wide of the mark. The observations of travellers led, in many cases, to overestimates because these persons travelled along the most convenient routes, and these routes were likely to be more heavily populated or more favourable to a dense population than other parts of those countries. Thus, Czekanowski's estimate was soon revised downward when it was found that some parts of Ruanda-Urundi were not at all favourable to dense settlement and that settlement was indeed the densest along his route of travel. Similarly, when the islands of Western Samoa were visited by the French navigator, La Perouse, in 1787, judging by the high density of settlement along the coastline, he esti-

[2] Kuczynski, R. *Demographic Survey of the British Colonial Empire*, vol. II. Oxford University Press, 1949, p. 235.

[3] Bunle, H. "Notes Statistiques sur la Demographie des Colonies Françaises", *Metron*, vol. IV, no. 3-4. June 1925, pp. 605-805, ref. to p. 658.

[4] Deschamps, H. *Madagascar, Comores, Terres australes.* l'Union Française, 1951.

[5] Wissenschaftliche Ergebnisse der deutschen Zentral-Afrika-Expedition 1907-1908, Band VI, Erster Teil. Dr. Jan Czekanowski, editor, Leipzig, 1917.

[6] *Ibid.*, pp. 111-115.

mated the population at 80,000 persons. Half a century later, when a number of missionaries had become active on the islands and it had become known that there was very little settlement in their interior, the estimate was reduced to 47,000 (in 1839) and to 32,000 (in 1849).[7]

The population of Swaziland was estimated in 1890 on the basis of its estimated fighting strength, as follows: "The numbers of the Swazie nation may be roughly estimated at 63,000. The calculation is made by taking the fighting men at 9,000 strong and multiplying by 7."[8]

3. Composite basic estimates compiled by an administration

Considerable gains in accuracy can be expected if population estimates are made piecemeal, separately for each part of a country, and added together. It is then possible that many of the errors of individual estimates, some upward and others downward, will be compensated and result in a smaller error in the total. It may be of interest to recount here the history of early official estimates of the population of the Gold Coast Colony.

In his report on the Blue Book for the year 1846, Lieutenant-Governor Winniett stated:

> There has not been any census of the native population of this colony ever been attempted to be taken; from certain data, however it may be safely assumed that the aggregate number of the population of those districts which acknowledge and are amenable to the jurisdiction of this Government is not less than 275,000, scattered over a territory of about 6,000 square miles.

The Blue Book for 1849 said:

> A Census of the Population of this Settlement was attempted to be taken this year but from the Suspicious and jealous eye with which the Natives view giving any information to Government Officials especially respecting numbers caused this important measure to fail.
>
> The population is however rapidly increasing and the peaceful and continued prosperity of the Settlement, which in the absence of Statistical information, renders it impossible to form an accurate estimate of, may be Stated at fully 5 per Cent above that Assumed to have been the Population in 1846, Viz. 275,000 (as Stated in the Blue Book of that Year) . . .

In his report on this Blue Book, Acting Lieutenant-Governor Fitzpatrick wrote:

> . . . I find the population is estimated at 288,500. I have no means of corroborating or correcting this estimate, but I apprehend it can scarce be an exaggeration, as, with the exception of a few sea-side towns, the vast district extending from Assinee to Pram Pram and back to Ashantee, is all under the jurisdiction of the British authorities.

But in the following year Lieutenant-Governor Bannerman wrote to Earl Grey:

> Upon the subject of population, where no census has been taken, and especially throughout such an extensive country, it would be impossible to state anything with certainty regarding actual numbers. My own opinion is that there has been exaggeration upon this point, as the country is far from being thickly populated; although, taking into account the immense space over which our jurisdiction extends, even without exaggeration the number must be great . . . Since the last Report to your Lordship, the territory formerly under the Danish flag has been added to our rule. This has nearly doubled the amount of population claiming English protection . . .

In his report on the Blue Book for 1851 Governor Hill took account of the increased area and population.

> . . . taking into consideration the opinion of men who have resided many years in this country, and travelled much, I am led to conclude that the total number may be put down as at least amounting to 400,000 under British protection, occupying about 8,000 square miles of country.

This report, dated 26 April 1852, was the first to put the population of the Gold Coast at 400,000, a figure which, as we shall see presently, became the standard estimate of the Administration for a whole generation . . .

In the years 1852 to 1883, various estimates were also made of the population of the Gold Coast Colony on the basis of numbers of persons found subject to the poll tax. However, since there were doubts regarding the completeness of the tax census, and regarding the numbers of dependants per person subject to tax, there was much controversy regarding the reliability of those figures. A different type of conjectural population estimate for the Gold Coast Colony was made in 1883.[10] It was estimated that in the Central Districts there were 72,000 fighting men. This number was multiplied by six "as allowing for every fighting man the existence of one woman and 4 old people and young children", resulting in a total of 432,000. For the district of Wassau, it was estimated that there were 10,000 fighting men which, this time multiplied by five, gave a total of 50,000. Estimates for other tribes and districts, derived in different ways, amounted to 169,000, giving a grand total of 651,000 as the estimated population of Gold Coast Colony in 1883.

All these estimates for Gold Coast Colony, although derived by various and unreliable methods, do not appear entirely unreasonable in the light of results of the censuses of 1891 and 1901. Both of these censuses consisted in group enumerations of most of the population, augmented by supplementary estimates. They resulted in totals of 895,350 and 1,043,350 respectively.

It may be assumed that in many cases the conjectural estimates of travellers, missionaries, administrators and military persons in particular areas were taken into consideration and were either added up, or were taken as a basis for estimating the population in those areas where this kind of information was not forthcoming. An interesting attempt at systematizing local conjectures for the purpose of estimating the population of a large area was made by the administration of Southern Nigeria:[11]

The early official reports state that it is impossible to estimate the native population of Southern Nigeria. On 11 January 1904 instructions were issued for the "Collection of Intelligence respecting Districts" which dealt also with population estimates:

[7] United Nations. *The Population of Western Samoa.* Lake Success, 17 January 1948.

[8] Kuczynski, R. *Demographic Survey of the British Colonial Empire,* vol. II, p. 25.

[9] Kuczynski, R. *Demographic Survey of the British Colonial Empire,* vol. I, pp. 404-405.

[10] *Op. cit.,* pp. 410-412.

[11] *Op. cit.,* pp. 582-586.

II. In estimating the population of towns an Officer should estimate the average number of persons in a house and the average number of houses in a compound; the number of compounds is easily ascertainable and consequently an approximate estimate can be made of the population. When the population of one or more towns has thus been ascertained it is easy for an Officer to make a "preliminary estimate" of the population in a place through which he travels for the first time; the entries in the Intelligence Book should always show whether the population is based upon a "preliminary estimate" or the reverse.

Probably, on the basis of such estimates for some districts, the total population was put for 1904 at 2,000,000. But on 17 February 1905 the Acting Secretary published a detailed estimate which yielded a population of over 3 millions.

The following rough estimate of the Population of Southern Nigeria, is published for general information. The statistics have been compiled by District Officers and are estimates of the towns and villages known to them. Many parts of the Protectorate have not yet been visited, and the returns are necessarily only very approximate.

The "estimates by some District Officers" were very rough indeed. Thus, the officer for Ikot-Ekpene put the number of women (111,786) exactly at twice the number of men (55,893), and the number of children (224,141) at almost exactly twice the number of women. Some other officers likewise overstated the number of children while others evidently understated it.

This attempt was evidently a failure since, already in 1907, the population estimate for Southern Nigeria was raised to 6 million, and in 1911 to nearly 8 million. This failure was probably due not so much to local misreporting as to uncritical compilation of those reports that were available. Instead, a critical examination of available local reports might have yielded better estimates for those areas concerning which local reports were clearly faulty or deficient, and an improved estimate might have been made for the country as a whole.

The procedure attempted by the Southern Nigeria administration, if carried out scientifically, would have some resemblance to a sampling procedure. In selected localities, precise averages of sizes of households, numbers of households per compound, numbers of compounds per settlement, and numbers of settlements, could have been determined; these averages could then have been applied to larger areas in which conditions could be assumed to be similar. From these estimates in larger areas, a total for the whole country might have been derived with a certain margin of error.

4. Other types of conjectural estimates

The foregoing examples have shown that conjectural estimates can be based on considerations of population density, of the average size of households and numbers of households per village or town, or the sizes of armed forces. This list by no means exhausts the possibilities of population conjectures. The following examples show that it is possible to derive conjectural population estimates also by other means.

The population of parts of Bengal and Bihar was estimated, in 1807-1814, by Dr. Francis Buchanan, who obtained a figure not far different from that found sixty years later at the first census of India (in 1871-72). The mode which he adopted was to ascertain the extent of cultivation, and, allowing five or six acres (according to the character of the district) to each plough, which he assumed to represent five persons of all ages, to calculate the aggregate agricultural population, whence, by consulting the most intelligent inhabitants as to the proportion which the agriculturists bore to other classes in that district, he arrived at the total number. This rough estimate was in some cases checked by ascertaining the aggregate agricultural produce, and, after abatement for exports, calculating the number of mouths for which the remainder would suffice. The result of Dr. Buchanan's survey was that . . . he reckoned the population to be 15,443,220 . . . The population of this tract by the last census was 14,926,331.[12]

A less elaborate conjecture of population size was also made in another area of India:

In the year 1813, Mr. Butterworth Bayley, at that time the Judge and Magistrate of Burdwan, endeavoured to ascertain the population of his district. By inquiries among the Native proprietors of estates and of European residents, he satisfied himself that an average of 5½ persons should be allowed for each dwelling, and that the number of houses might be taken at 262,634, which gave a population of 1,444,487. The territory as comprised in the district as then constituted appears from the recent census to contain 322,830 houses, with a population of 1,305,316 souls, or 4½ to each house.[13]

However, much simpler devices have also been used to estimate population. Thus, the population of Hong Kong used to be estimated by the amount of nightsoil which had to be disposed of by a certain contractor, the estimate being derived with the use of some suitable multiplier.[14]

In former French Indochina, "censuses" were made every five years by means of group enumeration. The heads of villages received forms which they had to fill out in detail, but it is doubtful whether they knew enough of the required detail or whether they took the trouble actually to count the persons in their villages. For Annam, a figure of 4,183,000 was returned, but this was declared to be understatement. On the grounds that the returns of Cochinchina were relatively accurate, a ratio between the population figure of Cochinchina and its salt consumption (subject to tax) was computed; on the assumption that the same ratio would apply also in Annam, the known salt consumption (subject to tax) was multiplied by this ratio, and a "corrected" figure of 4,933,000 was obtained. However, no trouble was taken to ascertain whether a fixed ratio of salt consumption (subject to tax) to population could be regarded as a valid assumption.[15]

Many other methods than those described would be applicable. Much depends on conditions in a particular area and the amount of available knowledge. It is, however, always desirable to seek confirmation of a vague conjecture by making alternative conjectures, based

[12] *Memorandum on the Census of British India of 1871-72.* London, 1875, p. 9.

[13] Loc. cit.

[14] Edge, G. *Vital Statistics and Public Health Work in the Tropics,* p. 56.

[15] Congrès International de la Population, Paris 1937. Vol. VI, *Démographie de la France d'outre-mer.* T. Smolski, "Les statistique de la population indochinoise", and Pierre Gourou, "La densité de la population dans le delta du Tonkin".

on different information, as was done by Dr. Buchanan in the example quoted above.

Often, for instance, there is fairly reliable information on the size of district capitals, though the remainder of the population of most districts may never have been counted. If there is reason to believe that, on an average, a more or less fixed percentage of each district population resides in the district capital, it is possible to use a multiplier by which the country's total population is estimated from that of the district capitals.

Example: In a certain district, which is fairly typical for the country, the population is known to be 120,000, while the population in the chief town is 15,000. The multiplier may then be assumed in the neighbourhood of eight. If the sum of the population of all district capitals is, say, 225,000, the population of the entire country may be estimated at 1,800,000. This, however, must be recognized as an extremely unreliable figure.

In a country with varied physical characteristics, population density often varies greatly; and it may not be feasible to estimate an average density. However, the density of agricultural settlement is likely to vary to a smaller extent. If the amount of cultivable, or cultivated, land is known, the use of agricultural density as a multiplier is preferable in estimating a chiefly agricultural population, or in estimating the agricultural segment of a total population. The relatively small variation in the density of agricultural settlement can be demonstrated by means of statistics of mainly agricultural countries where over-all population density varies widely. Thus, the general population density (number of inhabitants per square kilometre of total territory) of Puerto Rico in 1949 was 246, that of the Philippines in 1939 was fifty-three, that of Thailand in 1937 was twenty-eight, that of Mexico in 1940 was ten, and that of Venezuela in 1941 was four. The number of males actively engaged in agriculture per 100 hectares (i.e. one square kilometre) of arable land in these countries was as follows: Puerto Rico: fifty-nine; Philippines: thirty-six; Thailand: sixty-four; Mexico: thirty-eight; and Venezuela: thirty-nine.[16] The smaller variation in the latter ratio suggests that agricultural density provides probably a safer multiplier than over-all population density. In some cases it may be used to advantage provided the total agricultural area can be estimated within safe limits.

In a country with a nomadic population, the numbers of tribes and tribal subdivisions are usually known. Some investigation may provide a clue as to the average size of tribal subdivisions of each major tribe or in each major region. This should make it possible to estimate the nomadic population. Confirmation of such an estimate should be sought by considering land areas needed for grazing, or actually in use during certain seasons, in order to maintain certain sizes of herds, and by considering the sizes of herds required for the needs of an average family.

There are undoubtedly many other, hitherto unexplored, possibilities for making conjectural estimates. Thus, the consumption of tobacco or salt (particularly if such commodities are subject to tax, and the amount on which tax was collected is known) may furnish the basis for a plausible population estimate. Depending on local conditions, other useful indications may also be found. The making of conjectural population estimates is a subject which has not yet been fully explored and, with ingenuity, many new devices may be discovered which will make it possible to make improved conjectures.

[16] Figures computed from *Yearbook of Food and Agricultural Statistics, 1950,* vol. IV, part I. Food and Agriculture Organization of the United Nations, Washington, D. C., 1951.

5. The reliability of a conjectural estimate

As already indicated, the reliability of a ***simple*** conjectural estimate depends on the margins of error of the data (area, number of villages, size of cities, volume of salt consumption, etc.) as well as those of the multiplier (population density, average size of villages, ratio of urban to total population, per capita consumption of salt, etc.). The margin of error of the population estimate has to be determined by considering the extreme values of the two components. Expressed as a percentage, it is usually the approximate sum of the percentage errors in each component:

Example: The area of a country is estimated at 100,000 square kilometres, subject to an error of plus or minus 5 per cent. The population density is estimated at twenty persons per square kilometre, subject to an error of plus or minus 15 per cent. The total population of the country may then be estimated at no less than 95,000 times 17, i.e., 1,615,000, and no more than 105,000 times 23, i.e., 2,415,000. The figure for total population may then be expressed as approximately 2,000,000, subject to an error of plus or minus 20 per cent.

The number of villages may be estimated in a country at 6,000 (with an error of plus or minus 10 per cent), and the average size of a village at 500 inhabitants (with an error of plus or minus 15 per cent). The total population may be no less than 5,400 times 425, i.e., 2,295,000, and no more than 6,600 times 575, i.e., 3,795,000 or at an intermediate value of about 3 million, subject to an error of about 25 per cent.

In *composite* conjectural estimates (i.e., those derived by compilation of local estimates), the margin of error may be greatly reduced, on condition that errors in local estimates are not all in the same direction and may in part cancel each other. If local estimates have been made by closely similar methods or by the same person, there is some likelihood that most of them err in the same direction. In this case, the estimates may be described as *systematically biased,* and the estimate of total population, derived by addition of the local estimates, may be almost as much in error as if it had been derived directly by a simple conjecture for the entire country. If, however, local estimates have been made in various ways and by different persons, it is likely that some local populations have been overestimated and others have been underestimated, and that the error in the total is consequently reduced. In an actual situation, it may be difficult to decide to what extent the local estimates are likely to be systematically biased, since the methods used in many cases are somewhat similar, or multipliers may have been bor-

rowed from one local area and applied to another. The usual situation is probably intermediate between an assumption of systematic bias and an assumption of absence of bias.

If bias is completely absent, and the local estimates apply to populations of comparable sizes, the probable percentage error in the total, according to laws of probability, should be equal to the mean percentage error in local estimates, divided by the square root of the number of local estimates. If, on the other hand, bias is completely systematic, the percentage error in the total will be the same as the mean error in local estimates.

Example. In a country of sixteen provinces, the population of each province has been estimated by conjecture, these provincial estimates being subject, on an average, to an error of about 30 per cent.

If it is assumed that bias is totally absent, and that consequently some of the errors are likely to compensate each other in the total, the probable error in the total may be considered as only 8 per cent (i.e., 30 per cent divided by the square root of sixteen).

If, on the other hand, provincial estimates are systematically biased, the error in the total would also be about 30 per cent.

If, after realistic consideration of the possible nature of errors in provincial estimates, it is believed that estimates are partly, but not systematically, biased, the probable error in the total may be set at some intermediate value, possibly 15 or 20 per cent.

The error in a sum of unbiased estimates is, however, not reduced in the same manner, if the estimates are for component areas of greatly different population size. Thus, if a large proportion of the country's total population lives in one province, the error in the estimate for that one province has a strong effect on the error in the total, despite compensating errors in some of the smaller provinces. In such a case, the error in a total of unbiased estimates has to be computed after some of the local estimates have been grouped together to form units of more nearly equal population size.

So far, margins of error have been expressed from the mid-value of the range within which an estimate may be supposed to fall. Most conjectural estimates may, in fact, be adequately expressed as the mid-point of such a range. There are, however, instances where it is not desirable to do so. If, for instance, several independent conjectures are made, the estimate resulting from the probably most reliable method should be regarded as the best possible estimate, but the maximum estimate may deviate from this value by a greater or smaller amount than the minimum estimate. Similarly, if the margin of error of a conjectural estimate is almost as great as the estimate itself, it is more realistic to place the estimate at a value below the middle of the range and to allow for a larger possible error in the upward direction then in the downward direction.

Example. In commenting on the official estimate of the population of British Somaliland, which is a very rough figure, Kuczynski stated: "The native population of British Somaliland has been estimated in the Blue Books for many years at 344,700. There is no evidence as to how this figure was obtained, and it should, I think, be treated at best as a reasoned guess with a margin of error of + 200,000 / — 100,000."[17] It follows that the population may be estimated anywhere between the extremes of about 150,000 and 550,000.

6. Time adjustment of conjectural estimates

As has already been mentioned, it is frequent practice to retain a conjectural estimate, once made, over a long series of years without adjustment for possible changes in the population size, although retention of the figure implies that population is regarded as nearly constant. Such unadjusted estimates have no precise time reference, since they apply over a long period of time.

For purposes of international comparability, however, it is desirable to state a time reference. This may be taken as the date, or the middle of the period, as of which the observations were made, or to which the circumstantial data used in the estimate referred.

There can be little advantage in publishing the result of a new conjecture every year without appropriate revision of previously published figures. Conjectures made by different methods lead to divergent results which in no way express real changes in population size. It is, however, obvious that a conjectural estimate cannot be retained indefinitely since, after a long period, population may indeed have changed considerably, and an old estimate may no longer be the best which can be made.

If an old estimate is replaced by a new one, the result is usually an abrupt change in estimated population size from one year to the next. Such a result is unrealistic since most changes in population size occur gradually and continuously. It is, therefore, preferable to adjust a conjectural estimate, once made, year by year, by an amount which reflects the presumed change in population size.[18] In addition, it may be desirable to utilize such further information as is available. The use of refined methods of time adjustment in the case of conjectural estimates cannot be recommended, but it would appear useful at least to assume a rate of population growth which in the light of existing knowledge appears plausible.

Example. The population of a country was estimated by conjecture at 1 million in 1940. It is believed that under normal conditions the population increases at a rate of possibly 1 per

[17] Kuczynski, R. *Demographic Survey of the British Colonial Empire,* vol. II, p. 97.

[18] "Any method which attempts to estimate merely the *increase* of the population possesses an advantage over those which aim at estimating directly the *actual* population. For since the *increase* generally bears only a small ratio to the *actual* population, a large error in the computation of the former may lead to a comparatively small one in the latter. Any reasonable method of estimating the *increase* of population should, therefore, be worth trying." (*Source:* Snow, E. C. "The application of the method of multiple correlation to the estimation of post-censal populations", *Journal of the Royal Statistical Society,* May 1911, vol. LXXIV, part VI, p. 586).

cent per annum. Aside from this "normal" assumption, it is believed that the population was further augmented in 1941 by an unusual immigration of 50,000 individuals, but that in 1949 some 5 per cent of the total population perished in a severe epidemic. The conjecture may then be adjusted for each of the years 1940-50 as follows:

Year	*Estimate*	*Rounded nearest 10,000*
1940	1,000,000	1,000
1941	(1,010,000 + 50,000) 1,060,000	1,060
1942	1,070,600	1,070
1943	1,081,306	1,080
1944	1,092,119	1,090
1945	1,103,040	1,100
1946	1,114,070	1,110
1947	1,125,211	1,130
1948	1,136,463	1,140
1949	(1,147,828 — 57,391) 1,090,437	1,090
1950	1,101,341	1,100

Severe *rounding* of figures may be desirable in the estimate for the base date. This estimate may be so rough that it may not be justifiable to show more digits than the first one or two. However, to express rates of change, subsequent adjusted estimates cannot be rounded to the same extent. The degree of rounding in each case has to be determined in such a way that no significant information is lost with regard either to the size of the population or its increase.

The assumption of a rate of population increase raises a special problem in a country with no censuses or national vital statistics. Among the considerations which may be useful in estimating a rate of increase for such a country are the following:

1. There may be visible evidence of population growth or decline. The desertion of former settlements may bear witness to depopulation, whereas the rise of new settlements, clearing of new lands, or increased parcellization of land holdings may indicate growth of numbers.[19] Unless these signs of change are studied very carefully, however, they may be misleading. The abandonment of lands in one part of the country may be balanced by an extension of settlement elsewhere, or by increased density of settlement in other lands, or by movement to non-agricultural areas. Likewise, changes in the production or consumption of a given staple commodity may often reflect shifts in tastes, technology, productivity, etc., rather than population change.

2. There may be indications of the order of magnitude of the birth rate, the death rate, and the inflow or outflow of migrants, even though no records are kept. Available information relating to marriage customs, frequency of separation, taboos on sexual intercourse, abortion, the use of contraceptive devices, and observation of sizes of families may permit an inference regarding the birth rate.[20] Signs of a high or a low death rate may be found in observations relating to sanitary conditions, the prevalence of various diseases, malnutrition, etc.

3. In certain localities registration of births and deaths may be in force, or statistical studies of fertility and mortality may have been made by other means. The results of such registration or local studies, together with available comparative information regarding the relevant conditions in these areas and in the rest of the country, may be used to estimate the rate of growth of the whole population.

4. A knowledge of events such as migratory movements, internal warfare, poor harvests, floods, droughts and epidemics, may be taken into account.

5. Statistics of births, deaths, migration and population growth may be available for neighbouring countries or even for distant countries where conditions are similar to those in the country where conjectural estimates are being made. These statistics interpreted in the light of all available information as to the similarities or differences in relevant circumstances may be helpful in arriving at an estimate.

The publishing of new conjectures within brief intervals of time is not ordinarily useful unless a new conjecture can be regarded as a real improvement over an old one. It is, however, advisable, constantly to check published conjectures by making new conjectures whenever existing information makes this possible. Eventually a new conjecture should replace an old one for purposes of publication, either because it is believed that a new conjecture is based on more reliable information, or because with the lapse of time the old conjecture can no longer be regarded as representing current conditions.

7. Standards of comparability for conjectural estimates

Owing to the very crude nature of most conjectures, little can be gained by further refinement for purposes of international comparability. However, attention should be given to the following points:

1. Conjectural estimates should be accompanied by a time reference.

2. If at all possible, they should be adjusted for every current year.

3. The nature of the estimate should be indicated by cautionary remarks. Thus, it should be pointed out

[19] "A large extent of fresh ground has been brought under cultivation, and the population as well as the livestock has been increased by the arrival of a good many Basutos returning with their earnings from the Free State and Cape Colony" (Cape of Good Hope, *Blue-Book on Native Affairs 1874*, p. 35, reporting on Basutoland). Quoted in Kuczynski, R., *Demographic Survey of the British Colonial Empire*, vol. II, p. 17.

[20] "The reason for the great overcrowding to-day, to my mind, is that the last fourteen or fifteen years have seen a tremendous change in native custom as it affects birth and population. Formerly, no Kikuyu woman was allowed to conceive a second child until the first child had stopped suckling, which was usually not until after the end of the second year, so there were generally intervals of about three years between the children. That has been broken down entirely. It used to be considered unlucky, but now they have discovered that is not true, and children are being born now — according to figures from the Kabete Mission — about one every one-and-a-half years." (Kenya Land Commission, 1932, *Evidence and Memoranda*, vol. I, p. 676. Quoted in Kuczynski, R., *Demographic Survey of the British Colonial Empire*, vol. II, p. 216.

that the estimate is conjectural and whether or not it has been adjusted for population change in time. If the estimate is composite, being a compilation of local estimates made by unknown methods, this should also be indicated.

4. In rare cases, e.g., if the territory consists largely of a trading port or a military establishment, attention should be paid to the definition of the population, i.e., resident or present population, with or without inclusion of merchant seamen, armed forces, temporary travellers, etc.

8. Improvement and appraisal of conjectural estimates through full utilization of existing knowledge

No conjectural estimate can be regarded as an adequate substitute for population statistics such as are obtained from actual enumeration and registration of vital events. However, where the latter cannot be supplied it is worth while to take care that the estimates made are the best possible under the circumstances.

The first step in making a conjecture as to population size should be a survey of all available information which has any bearing on the question. Much relevant information may be found in reports made by administrators, missionaries, health officers, travellers and military personnel. These should be surveyed systematically. Pertinent information may also be found for other countries where conditions are similar.

Full use should be made of available maps. A study of a good map may be helpful in determining whether conditions are likely to be similar or variable in various parts of the country. An aerial survey can be even more useful than maps. Aerial photographs suitably assembled may give a concrete picture of the densities of settlement in various parts of the country.

The available information has to be examined by a person sufficiently acquainted with the geography and culture to judge what is typical or atypical of conditions in various parts of the country. For reasons already discussed, it is preferable to estimate the population piecemeal, area by area, rather than for the country as a unit.

There is an advantage in making several alternative estimates on the basis of different types of information whenever the opportunity to do so exists. In this way it may be possible not only to arrive at a better estimate of the most probable size of the population, but also to get a clearer indication of the range of error than could be obtained from an estimate by one method only.

In many cases, the reliability of conjectural estimates can be greatly improved by adding to the information which is available through special studies or investigations of actual conditions in the whole country or in certain areas. For example, it may be possible to ascertain more exactly the average size of villages or tribes, or the variations of population density, by small-scale field studies in certain localities, even though a comprehensive census or even a full-fledged sample enumeration is not practicable. Likewise, it may be feasible by small-scale studies to obtain an improved estimate of per capita production or consumption of certain staples where the absolute volume of such production or consumption is being used as a basis for population estimates.

The quality of a conjectural estimate depends in the last resort on the qualifications and objectivity of the person making it, his resourcefulness, his familiarity with the country, and his knowledge of factors which influence population size and growth.