INSTITUTE FOR DEVELOPMENT STUDIES
UNIVERSITY COLLEGE, NAIROBI

Discussion paper No. 22

# MEASURING CURRENT POPULATION CHANGES

D. F. Heisel

Presented at
The African Population Conference
Ibadan, Nigeria.

January, 1966

# MEASURING CURRENT POPULATION CHANGES

## I. INTRODUCTION.

Accurate and up-to-date information on the composition and patterns of change of population is a primary requisite of intelligent decision making in a modern nation state. Fundamental to all else, it is necessary to know population size, rate of growth, and the component patterns of fertility and mortality. This is particularly true for states with developing economies whose resources must be husbanded with meticulous care. Planning for growth obviously requires the best possible knowledge of the characteristics and prospects of the population being planned for.

The most commonly used apparatus for producing such information is the census-registry system: a periodic enumeration of the population concurrent with the recording of births and deaths as they occur. Information obtained in this manner lends itself to use in the occurrence/exposure rate concept basis to demographic analysis. Registered events are the occurrences while person-years of exposure are estimated from the enumerated populations. However, a fully effective census-registry system is not found in any African nation today. A variety of only partial approximations to the ideal system are found such that the data which are produced require special scrutiny and analysis before they can be made useful. The conclusions which they provide must be taken with substantial margins of likely error. Furthermore, the prospects of establishing effective national census-registry systems must be considered poor for any reasonably near future. If nothing else, the costs are likely to be prohibitive in these developing societies where there is so much to be done with so little capital.

The following comments will suggest a line of development which might usefully be considered in the light of these needs for information and the shortage of useable and reliable data. First, the nature of existing sources of data and the more important difficulties they present will be briefly described. Then, a cursory review will be given to some of the methods developed to extract maximum information from these data. Finally, since the products of the use of these methods do not fully meet the needs for information, one additional set of procedures, the use of frequent enumeration with or without continuous registration in sample areas, will be introduced. Specific instances of the use of such procedures will be described and some general remarks on their possible relevance in Africa will be made. Attention will be limited throughout to procedures which have relevance to a whole national population.

## II EXISTING PROCEDURES.

Existing sources of demographic data are restricted to censuses, surveys, and special inquiries. There are no national systems of registration of vital events at the levels of completeness sufficient to provide useful demographic information. Complete registration is found in some smaller geographic areas and for special segments of some populations, but nowhere on the

continent on a universal national scale. The difficulties of establishing a complete registration system appear to be the most intractable of all those hindering the improvement of the supply of demographic data.

In the absence of registration, enumeration or cross-sectional/survey procedures provide most of the useful information about population. In his review of sources, vande Walle indicates that demographic data gathered by means of such procedures is currently available for just over four-fifths of Tropical Africa's population[1]. In most cases, sample surveys were employed in place of complete enumerations. In general, this investment in the quality as opposed to the quantity of individual records seems to have been fully justfied.

There has been considerable variation from one inquiry to the next in the amount of detail recorded. Censuses and survey have ranged from highly elaborate multi-purpose investigations using sophisticated schedules down to what are little more than head-counts. What is of particular importance here is the gathering of cross-sectional data which can be used to fill the gap left by the absence of current registration of vital events. The goal is still to obtain occurrence/exposure rates. The attempt has been made to get a record of births and deaths by means of questions on the survey, thereby producing information comparable to what could be available if the events were recorded as they occurred. For example, women over age 15 may be asked to report children born during some recent time period (usually a year), children ever born, or both. Deaths to children ever born and deaths in a household during a recent time period can provide information on mortality. (The different time periods-preceding year, lifetime, or other - can be used to increase accuracy through methods to be discussed below.) Additional specification may be available through detailed recording of mother's age and marital status, sex and birth order of children, sex and age of the deceased, and so forth. In particular, the utility of information on fertility and mortality is obviously much enhanced if detailed information on age is also available.

Experience gained over recent years has shown that the census-survey can indeed produce useful demographic information in the absence of an effective census-registry. However, experience has also shown that there are persistent and difficult patterns of error in the data. These difficulties would, of course, plague us if other data producing systems were used, as well.

Specific reference is made here to patterns of error commonly found in Africa; comparable problems will be found to some degree in almost any other population. The following are among the most serious:

.../

(1) E. vande Walle, "Availability of Demographic Data by Regions in Tropical Africa". Paper presented at the First African Population Conference, Ibadan, 1966.

A. The complete omission of some individuals who should be included. This becomes especially serious when some particular sub-group is enumerated with unequal completeness or when there is varying completeness between successive censuses or surveys.

B. Failure to report all vital events particularly, but not solely, when long periods of recall are involved. For example, older women exhibit a consistent tendency to under-report the number of children they have ever born and especially the number born who have died through their lifetime. In general, it appears that the longer the period of recall, the higher the likelihood of omission.

C. When vital events are reported, their erroneous dating. A birth or death which in fact occurred more than 12 months earlier may be reported as having occurred in the previous year. Conversely, a more recent vital event may be ascribed an earlier date. This pattern of error is more serious when a population shows a systematic tendency either to update or to predate. Moreover, the tendency to systematically misdate may be correlated to other characteristics such as age, level of education, and so on.

D. Age mis-statement. First, where single year age distributions are reported, they show heaping on the -5's and -0's at truly heroic levels; clearly, accurate knowledge of age is not common. In addition, there are marked patterns of avoidance of certain broader age categories. For example, African age distributions show shortages, most noticeable for females, of persons reported in their teens or early twenties. There is often a corresponding inflation of the adult years. Finally, there may be a tendency for all ages to be reported on the average either too high or too low.

Given census-survey data laced with such errors, methodologists have developed an impressive array of analytical techniques to extract as much reliable information as possible. Used along with the demographer's traditional tools, these techniques have greatly furthered analysis of African data. They have been ably surveyed elsewhere and so will be only briefly noted here (1). Three of the most important contributions have been the development and application of: A, methods for converting reports of lifetime experience of vital events into current rates (and vice versa); B, model life tables; and C, stable and quasi-stable population theory.

.../

(1) William Brass "Methods of obtaining basic demographic measures where census and vital statistics registration systems are lacking or defective". World Population Conference, Belgrade, 1965.

A. Where fertility experience of women of given age groups has been recorded for two time periods, lifetime and (usually) previous year, it is most useful for analytic purposes to be able to compare the two values directly. This can be done if it is recognised that, in the absence of sustained trends, the two kinds of reports measure the same fertility pattern in different ways. Techniques worked out by Brass convert measures based on one period of report into the corresponding measures on the other. A powerful method is available to evaluate fertility patterns with reasonable accuracy or to locate and measure errors of reporting.

In the case of mortality, attention must be given primarily to the possibilities of extracting information from retrospective reports by mothers of various ages concerning children ever born who have died. A procedure, again developed by Brass, provides a means of converting such reports of proportions of dead children into life table mortality rates, ${}_xq_o$.(1)

B. The ${}_xq_o$ values obtained from women's reports can provide no more than an estimate of mortality conditions affecting a population. Since it is largely the experience of children that is considered, survivorship can be estimated only for the earlier years. However, the use of model life tables gives much broader relevance.

It is an empirical observation of great importance that the age patterns of human mortality for each sex is quite regular. Thus it has been possible to construct mathematical functions such that if mortality for one age is given, that for all other ages is determined with good accuracy. For example, if infant mortality can be satisfactorily estimated, a complete life table is available.2)

.../

(1) Detailed references on the sources and application of these methods can be found in the paper by Brass cited above.

(2) Widespread use of model life-tables began with the set published by the United Nations in 1955. (Age and Sex Patterns of Mortality St/SOA/Series A. No. 22. United Nations, New York, 1955) More recent developments are described in Brass, op cit and Coale, "Estimates of Demographic Measures through the Quasi-Stable Age Distribution," in Emerging techniques of Population Research. Proceedings of the 1962 Annual Conference of the Milbank Memorial Fund. New York, 1962.

C. In addition to the analysis of fertility and mortality each apart from the other, as the techniques just described facilitate, it is most useful if they can be considered in their mutual relationship. This can be done by means of stable or quasi-stable population theory.(1)

The central idea is that a specific proportional age distribution will result from unchanging schedules of fertility and mortality in a closed population. Along with this stable age distribution, a variety of other parameters of the stable population are thus determined. In addition, it has more recently been found that the requirement of unchanging mortality is not strictly essential. If the mortality schedule alters in a regular fashion (for example, if the change can be described as a movement from one level of mortality to another for a given set of model life tables), the resulting age distribution, which is called "quasi-stable", very closely resembles the completely stable case. Where the assumptions of quasi-stability are reasonable, analysis can proceed by constructing the implied age distributions and determining other parameters. These can then be used directly to describe the population or, more commonly, made the basis of critical analysis through comparison with empirically observed values.

The application of these methods and others to census-survey data has given considerable effectiveness to African demography. However, it has not by any means answered all of the questions one might wish to ask and the answers produced often fall short of the levels of accuracy wanted. From the point of view of both demographic scholarship and the application of demographic information to policy problems, we are left with uncomfortable margins of possible error and lack of detail.

Furthermore, there is, at times, interest in precisely those kinds of information which the data and methods just described are least well-suited to produce. The methods often proceed most effectively on the assumption that fertility is and has been essentially constant or that mortality is varying in some regular and relatively simple fashion. However, it may be of importance to make the validity of this assumption a matter of empirical investigation. This might be especially the case where policies are established with the understanding that they will have a significant impact upon fertility or mortality.

.../

(1) See, for example, Bourgeois-Pichot, "Utilisation de la notion de population stable pour mesuerer la mortalite et la fecondite des populations des pays sous-developpees, "Bulletin of the International Statistical Institute, 36 (2), 1958; Coale, opcit; United Nations, The Future Growth of World Population. St/SOA/Series A, No. 28, United Nations, New York 1958.

For another example, the rate of population growth is an item of great importance to the economic and social planner. A single census-survey or even a succession of enumerations is very limited in its ability to provide this information on a reasonably up-to-date basis, especially where vital processes are changing quickly.

In general, one would hope to see African demography grow most rapidly by a continuing development of both field procedures and methods of analysis. As a probably useful supplement to procedures now widely employed, we may consider the use of intensive enumeration in sample areas possibly accompanied by continuous registration.

## III. INTENSIVE FIELD PROCEDURES.

Experiments for the improvement of demographic data by use of intensive field procedures have been carried out in a number of countries using somewhat varying approaches. Broadly speaking, they all show two characteristics. First, in no case is there an attempt to cover the total population of the nation. Either purposively selected or probability samples are used. Second, recording procedures are especially adapted to coping with patterns of error such as those described above. These procedures are distinguished from the techniques already discussed in that they place emphasis on field operations rather than on subsequent analysis leading to the estimation of error. The emphasis on field work takes the form of more intensive contact with the respondents.

Some of the more useful possibilities can be brought out by consideration of specific cases.(1) The following comments do not attempt a complete description of any of the experiments. Selected aspects are discussed in order to suggest the range of possibilities.

### A. Experiments using frequent enumeration and continuous registration.

Pakistan(2). One of the most ambitious operations of this type is the so-called "Population Growth Estimation" experiment, begun in Pakistan in 1962. A probability sample was used comprising 24 regions with about 5,000 persons in each. There are 12 regions in East Pakistan and 12 in the Western section of the country.

.../

(1) A very useful review of these experiments in greater detail than is possible here can be found in W. P. Mauldin, "Estimating Rates of Population Growth", paper presented at the International Conference on Family Planning Programmes, Geneva, 1965.

(2) N. Ahmed and K. Krotki, "Simultaneous Estimations of Population Growth". The Pakistan Development Review, Vol. III. No. 1 Spring 1963; K. Krotki and N. Ahmed, "Vital Rates in East and West Pakistan - Tentative Results from the P. G. E. Experiment. "The Pakistan Development Review, Vol. IV, No. 4, Winter 1964.

In most of the regions, there is both registration of vital events and frequent enumeration. Registration is carried out by a full-time paid worker who actively moves through his region seeking out births and deaths.

Complete enumerations are made once each year and then are updated quarterly. Annual fresh enumerations are carried out without reference to the previous year's lists. Comparison of the successive year's lists with matching of individuals could presumably be made but has not been attempted. At each quarterly visit, respondents are asked to report vital events that occurred in the preceding year. Thus, each vital event should be recorded 5 times - 4 times in enumeration and once by the registrar.

Enumeration procedures are independent from the activities of the registrars, and vice versa. Personnel, administration, and records of the two systems are kept completely separate in the field work phase. Therefore, the model for estimating births, deaths, and the extent of registration developed by Chandrasekar and Deming seems to be applicable(1). The analysis then necessitates the matching of all vital events recorded by registration with those reported in enumeration. Where there is a failure to match, rechecks are made in the field to resolve the discrepancy. This stage of the procedure has proven to be time-consuming, arduous, and not entirely satisfactory.

In general, however, the Population Growth Estimation experiment shows an impressive capability to accurately detect and record vital events in a situation where large scale errors should be expected. It has offered a fruitful try-out for a variety of techniques which might be adapted to other conditions. Indeed, India and Thailand are beginning similar experiments - but with smaller sample units.

Turkey(2). Another major experiment in intensive field operations has recently begun in Turkey. A notable feature of this case is the sample design which takes into account the high level of regional heterogeniety in the country. Turkey has been divided into 5 regions and 3 main cities. Samples (consisting of rural villages and urban blocks) will be drawn separately in each segment and successive segments are being taken into the field operations between 1965 and 1968.

Procedures in the Turkish experiment are a bit simpler than those employed in Pakistan. Enumerations with reporting of vital events are made on an annual basis. Intensive registration will be carried out in only one-fifth of the villages or blocks. Comparisons of enumeration data with that

.../

(1) C. Chandrasekar and W.E. Deming, "On a Method of Estimating Birth and Death Rates and the Extent of Registration", Journal of the American Statistical Association, Vol.44, No. 245, March 1949.

(2) N. Fisek. Y. Heperkan, and J. Rumford, "The Role of the Turkish Demographic Survey in the Family Planning and Rural Health Programmes," Ministry of Health and Social Welfare, Republic of Turkey, Ankara, 1965.

produced by the registry will not include matching on an event-by-event basis but will be done in terms of gross numbers. How ever, a programme of intensive re-enumeration of a sample of recently enumerated households will be used to improve reliability. Results are not yet available to permit empirical evalution of this experiment.

B. Experiments using frequent enumeration with overlaping recall periods.

India[1]. Through use of the National Sample Survey, a series of experiments to estimate vital events have been made. These have used frequent enumerations without attempting to register events upon occurrence. The mode of questioning resembled that used in the quarterly enumeration phase of PGE. Upon enumeration, the respondents were asked to report vital events that had occurred during a preceding time period. The time period was made sufficiently long so that it overlapped earlier enumeration. Therefore vital events accurately reported should be recorded more than once, with the specific number of times dependent upon the length of the time period and the frequency of enumeration.

Emphasis in the analysis of these data was given to the problem of omission of vital events in reporting. Two findings are especially noteworthy. First, it has been possible to estimate the magnitude of "recall lapse," that is, the progressively greater omission of events as the time between the events and its reporting increases. Som carefully analyzed reports for the previous year by number of months before reporting. He showed that, if the correct death rate with no recall lapse is taken to be 100, the index for the twelfth month earlier dropped to 67 in Indian data for 1953-54 and to 90 for Upper Volta for 1960-61. Moreover, a regular function of declining index values by month could be reasonably fitted to the data.

Similar results were obtained when the total recall period was altered to two years (respondents were asked to report vital events "last year" and before last) and the enumerations were made annually. Levels of the omission were, as could be expected even greater for the longer time span.

A second noteworthy finding was that it is useful to employ a longer time span of reporting which is divided into segments. It was found that then the segments closer in time to the actual date of reporting show less omission than if those segments alone were used. For example, the respondent is asked to report births last year and births year before last. He will then apparently report births during the preceding 12 months with fewer omissions than if he was merely asked to report births in the previous year alone.

.../

(1) R. K. Som, "On Recall Lapse in Demographic Studies." International Population Conference, Wien, 1959; India Statistical Institute, "The Use of the National Sample Survey in the Estimation of Current Birth and Death Rates in India," International Population Conference, New York, 1961.

Morocco[1]. Another experiment using overlapping recall periods was carried out in Morocco. A random sample of some 64,000 persons was used in the period 1961 - 1963. In this case, analytic emphasis was placed on the importance of mis-dating of events which were in fact reported.

Field procedures consisted of three "rounds" of contacts with respondents. The first and second rounds were carried out completely independently. Reports of vital events during overlapping periods were requested on the first two rounds and the discrepancies were checked and reconciled on round three. It was found that for 85 percent of the reported births and 59 percent of the reported deaths there was complete agreement between the first two rounds. In the remaining cases various rules were applied to resolve conflicting reports. Although frequent, on the average the errors of dating tended to concel out, in this Morocco case.

These results from India and Morocco suggest an important general point: Even without an accompanying program of continuous registration, intensive enumeration with question designed to fully make use of the field procedures, can substantially raise levels of reliability of reports.

C. Experiments using frequent enumeration alone.

Guanabara - Cauquenes.[2] These experiments were designed to determine the extent to which demographic data could be obtained using the simplest possible intensive enumeration field procedures. The basic method starts with the enumeration of a sample of households. Then, on subsequent contacts with members of the sample, vital events which have occurred since the previous visit are recorded. Neither continuous registration nor overlapping recall periods are built into the procedures. (In fact, an overlapping recall period was used in Guanabara on the terminal visit. However, this device does not seem to have been considered an intrinsic part of the design and is apparently not going to be used in the forthcoming Cauquenes program.) Visits are approximately quarterly.

The Guanabara study (on an urban population) has been completed; in Cauquenes a replication on a largely rural population is underway. Random samples of 12,000 and 20,000, respectively, were used. The results appear to have

.../

(1) G. Sabagh and C. Scott. "An Evaluation of the Use of Retrospective Questionnaires for Obtaining Vital Data: The Experience of the Moroccan Multi-Purpose Sample Survey of 1961-1963, "World Population Conference, Belgrade, 1965.

(2) United Nations, Guanabara Demographic Pilot Survey. ST/SOA/Series A/35. United Nations New York, 1964; C. Arretx, G and J. L. Somoza, "Survey Methods, Based on Periodically Repeated Interviews, Aimed at Determining Demographic Rates", Demography, Vol. 2 1965.

been reasonably satisfactory in Guanabara. Birth and death rates (with an important assist from the overlapping recall data of the final round) as well as other demographic characteristics, accord well with evidence from other sources.

However, the lack of more extensive internal checks provides no direct measures of accuracy beyond plausibility of appearance. On the other hand, it must be recognized that the simplicity of the method achieves lower costs and very quick results.

Senegal.(1) Procedures similar to those used in Guanabara and Cauquenes have been experimented with during recent years in Senegal. Here, however, revisits are made annually. In addition, random sampling methods were not employed. Two homegeneous political districts comprising together some 50,000 people well purposively selected for the study.

Independent field operations which might be used as mutual checks of reliability were not attempted. On subsequent visits, previously made records were in the hands of the field staff. An advantage was the speed of reporting - results were published and distributed three months after the end of field operations. However, reliability remains problematic.

It is worth noting that simple and flexible procedures of the Guanabara - Cauquenes or Senegal type have the further advantage of providing a most useful frame for special studies. In Guanabara, investigation of shool-leavers was made on one round; in Senegal, extra attention was given to women who had not borne a child during two years' duration of the study.

## IV. GENERAL COMMENTS.

The proceding discussion has shown something of the range of possibilities for using intensive field procedures. The rather considerable variation itself suggests that no single optimum set of techniques can be established *a priori*. There will have to be adaptation and innovation in response to the conditions found in any given situation. However, a few final generalizations seem worth making.

First, these procedures will necessarily require sampling methods - and, specifically, representative samples if the results are to be fully useful. This will demand careful attention but it is not essentially a different problem from that already faced in the sampling done for the single contact demographic surveys now widely in use in Africa.

In one particular detail, however, a difficulty does seem to be more serious. These methods almost always involve area sampling at some stage, along with the continuing

.../

(1) P. Cantrelle, "Repeated Demographic Observation in a Rural Area in Senegal." *World Population Conference, Belgrade*, 1965.

contact with individuals. Therefore, the handling of migration, especially more out of the sample areas, requires greater care. In several of the experiments - Guanabara stands out - this problem has been approached with considerable sophistication. Further attention would undoubtedly be rewarding, though.

Secondly, it must be recognized that these procedures may seem expensive in comparison to the small amounts that have sometimes been given to the gathering of demographic data in Africa. However, the costs of carrying out such research must be weighed against the costs of not having the information. In addition, in some cases the expenses may not be all that high. Some requirements may be met by sharing (e.g., data processing equipment) and some by loan (e.g., advisory personnel from international agencies, foundations, and so on). As a case in point, it has been estimated that for the Guanabara - Cauquenes experience, U. S. $5,000/- year should suffice for samples of 12 to 20,000 persons. In general, however, costs will depend on the complexity of the procedures used in the specific local context.

Finally, it is obvious that in the array of procedures, we have not yet discovered any one best. It remains to be determined how the balance between precision and simplicity can most effectively be struck. On the one hand, it is essential to avoid piling check upon doublecheck until the procedures sink under the weight of their own elaboration. On the other, there is no gain if simplicity is obtained at the cost of reliability.

It is in this area of innovation and adaptation that the greatest development is possible. The effectiveness of these procedures can be substantially increased. For example, experiments in matching and comparison using only sub-samples might be further explored. Greater exploitation within the framework of intensive field operations could be given to the methods developed to analyze census-survey data. In general, continuing experimentation and application should be expected to make a substantial contribution to African demography.

---