INTRODUCTION

The smaller the geographical unit, the greater is the importance of migration in determining population change from one period to the next. Projections at the national level often do not require much attention to migration. In many countries, international migration is relatively small compared with natural increase and can either be ignored or be incorporated with a simple approach, into the process of preparing population projections. If, however, one is interested in projecting the population of regions or smaller divisions, migration becomes a much more significant component of change and its estimation is not a simple matter. For example, Frey and Speare (1988) found that variations in rates of migration accounted for about 93 per cent of the total variation in growth of metropolitan areas of the United States of America between 1970 and 1980.

This publication deals with population projections for regions of countries; urban versus rural areas or any grouping of geographical areas. It also deals both with the preparation of migration data for the projection of a single region and with the preparation of a set of consistent projections for all the regions of a country. Although it is not possible to provide a comprehensive discussion of all the available methods, considerable attention is given to those methods which are appropriate for countries with limited or deficient data on migration. The examples and problems discussed here are intended to represent some of the most common situations encountered, especially in developing countries. Each country, however, is likely to have some unique problems, relating either to specific types of migration or to the quality and availability of some of the data, which may require unique solutions.

When projections for all the regions of a country are desired and the appropriate data are available, a multiregional approach should be considered, as it is the only way to guarantee that the total migration flows between regions will sum to zero (or to the assumed level of international migration). Multiregional methods for projection have been developed by Rogers (1985) and Willekens and Rogers (1978) and have been used in several European countries. These methods have not been widely used in developing countries, however, because of the lack of adequate migration data and the difficulty of applying the methods. Multiregional methods require the estimation of separate age-specific migration rates between each region and every other region of the country, and such detailed data are rarely available. Although it is possible to estimate some of the missing data (see Willekens, Por and Raquillet, 1979), the task of preparing data can become overwhelming if there are many regions. For example, a country with 30 regions would require estimating migration rates by age and sex for 30 times 29, or 870 migration streams. If there are only a few streams, however, the multiregional method is the best method to use.

If multiregional methods are not used, because of either lack of data or the computational complexity involved, the next best approach is to estimate separate flows into and out of a region and to adjust these flows to be roughly consistent with the flows into and out of other regions. When this process is not possible, estimates of net migration can be used, although these are more likely to lead to internal contradictions among projections for different regions in future periods.

The task of preparing migration data for subnational projections can be divided into three major tasks: (*a*) the development of suitable baseline estimates of the total amount of migration between regions; (*b*) the determination of the age and sex distribution of migrants for each region; and (*c*) the use of these baseline estimates and other data or assumptions to prepare projections of future migration rates. All of these tasks are difficult.

Estimating the volume of migration can be difficult because few countries provide complete tabulations of migration flows between regions and many do not even provide the total number of in-migrants and out-

migrants for each region over a fixed time interval. A variety of the methods to process the different types of migration data available in different countries are described below.

The second task, the determination of the age and sex distribution of migrants, is straightforward when in-migrants and out-migration for each region are tabulated by age and sex for a period of time corresponding to the desired projection interval (usually either one year or five years). When the data are incomplete or based on a different time interval, adjustments must be made. In making adjustments, the model age schedules developed by Rogers and Castro (1981) are very helpful. In fact, because of the regularity in age patterns of migration throughout the world, these model schedules can be used in cases where there is no information on the age distribution of migrants.

The third task is equally difficult because migration trends frequently change over time. Areas that receive unusually large numbers of migrants during the base period of observation may not continue to do so for the next 10-20 years, and areas that receive little migration during the base period may become growth areas in the future. This situation is particularly true of areas where there is extraction of natural resources, but migration patterns to urban areas may change due to shifting patterns of job opportunities, and migration to rural areas can be greatly affected by resettlement and agricultural development programmes. For these reasons, the simple projection forward of migration rates observed during the base period, although useful for purposes of comparison, may not provide the best forecast of the future. Various alternative methods for adjusting base- period rates in the future are described.

This report focuses entirely on cohort-component projections. Other methods of subnational projection are discussed by Rogers (1985) and Pittenger (1976), but those methods do not provide reliable age and sex distributions and are most useful for small areas for which little migration data are available. Cohort-component projections are preferred because the basic components of population change--births, deaths and migrants--are very sensitive to changes in the age distribution. It is essential that cohort projections be used so that the changes in the age structure and their impact on the total number of births, deaths and migrants can be properly modelled. Secondly, cohort-component projections result in age and sex distributions for each projection period, which are often needed for planning purposes. Computer programs for producing such projections are readily available, and it is also possible to compute projections using spreadsheet programs, such as EXCEL and LOTUS 1-2-3, if sufficient care is taken in constructing the formulas linking the cells of the spreadsheet.

Further disaggregation of projections by race, ethnicity or other characteristics is not discussed. To the extent that these characteristics are assigned at birth and do not change over a lifetime, such projections can be made separately for each subgroup of the population, following the procedures discussed herein, However, seemingly unchanging characteristics, such as race, can still present problems if there is intermarriage of persons of different characteristics and the children born to these couples do not automatically take the characteristic of the mother. For such characteristics as education and labour force participation which can change over time, it is better to apply age-specific ratios to the results of the population projection to obtain the population of each subgroup.

This report contains four major chapters. Chapter I provides a brief review of the various types of data that can be used for estimating migration for the base period. Chapter II describes with the estimation of the volume of interregional migration from available data and covers a variety of methods that can be used, depending upon the form of the data. Chapter III discusses alternative methods for determining the age and sex composition of migration streams, as well as model age schedules for migration rates and how they can be used when age data are unavailable or as a means of smoothing or adjusting existing migration data by age. Chapter IV discusses different approaches to projecting base migration rates into the future and the conversion of gross migration data into net migration data when the computer program being used requires net migration. A brief concluding chapter describes desired questions and tabulation plans for future censuses and surveys which would facilitate the preparation of subnational projections.