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PRELIMINARY REPORT ON POPULATION PROJECTIONS (1980 - 2015) FOR NINE CARIBBEAN COUNTRIES

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FOREWORD

We wish to acknowledge the invaluable assistance provided by the Mexico government through its National Population Council, CONAPO, in the implementation of this programme. Special thanks are due to Dr. Sergio Campos Ortega for the development of the initial software and to Mr. Javier Perez Astorga for his very competent technical support.

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Background

1. The present exercise in population projections for nine Caribbean countries represents a follow-up to the recently completed ECLAC/CELADE Training Seminar in Population Projections held in Port of Spain, 28 April - 7 May 1986. Participants comprised representatives from ten Caribbean countries - Bahamas, Belize, the British Virgin Islands, the Commonwealth of Dominica, the Commonwealth of Grenada, Montserrat, Saint Christopher-Nevis, Saint Lucia, Saint Vincent and the Grenadines and the Republic of Trinidad and Tobago.

2. During this seminar, preliminary analyses were made of trends in the components of population growth for each country - fertility, mortality and migration. Data for the period 1960 - 1985 were reviewed, while graphs, tables and other analytical tools were developed. Finally, the first drafts of population projections were developed by participants for each country.

3. The current set of projections represents a refinement of the output from the seminar which includes further census data evaluation, adjustments of data, development of alternative scenarios and refinement of assumptions.

4. The results of this exercise will be submitted to Directors of National Statistical Offices as well as members of the University of the West Indies for review, in order to achieve concurrence on the final official results.

Introduction

5. The basic data utilized as inputs into the projection exercise were vital statistics and census.

6. With regard to the vital statistics, as noted in the earlier report on the "Population Projections Seminar" <1>, May 1986, an evaluation had already been conducted in 1985 through the UNFPA funded project titled "Training in Demographic Analysis" <2>. The general findings were that the vital registration data for eight english-speaking countries of the region were of fairly high quality. As a result, it was not considered necessary to carry out any further evaluation of that data. Instead, emphasis was placed on the analysis of census data.

<1> See "Report on ECLAC/CELADE Regional Training Seminar on Population Projection, Trinidad, 28 April - 7 May 1986. August 1986. (Doc.LC/CAR/G.190)

<2> See "Report on CARICOM/ECLAC/CELADE Training Course in Population Policy Formulation, Saint Christopher/Nevis, 27 October - 5 November 1985. (Document LC/CAR/G.186)

A. ANALYSIS OF CENSUS DATA

Measurement of Age-accuracy - United Nations Index

7. An attempt was made to measure the age-accuracy of the census data using the United Nations Index <3>. The latter consists of the computation of sex-ratios and age-ratios for five-year groups of ages, up to age 70. In the case of sex-ratios, successive differences between one age group and the next were noted, and their average taken, irrespective of signs. For age-ratios of either sex, deviations from 100 were noted and averaged irrespective of sign. Three times the average of sex-ratio differences is then added to the two averages of deviations of age-ratios from 100, to compute the index.

8. It is to be noted that this index is affected by irregularities arising in certain age-groups as a result of migratory movements.

9. The results obtained for all countries are as follows:

Table 1
Measurement of Age-accuracy - United Nations Index

Country	Index
Bahamas	29
Belize	22
The British Virgin Islands	75
Commonwealth of Dominica	33
Commonwealth of Grenada	32
Montserrat	51
Saint Christopher-Nevis	41
Saint Lucia	27
Saint Vincent and the Grenadines	34

10. A general classification <4> was developed to interpret these index values as follows:

More than 40: Deficient information.

Between 20 and 40: Data of Intermediate quality.

Less than 20: Satisfactory data.

<3> United Nations "Methods of Appraisal of Quality of Basic Data for Population Estimates", Manual II. (ST/SOA/Series A/23).

<4> Chackiel, J. and Maccio, G., "Evaluación y corrección de Datos Demograficos", No. 6, 1978, CELADE, Chile.

11. As can be seen, the quality of data for most of the countries falls within the range of "intermediate quality", (despite the effects of migration on the age-sex structure). Thus, it was considered unnecessary to carry out any further adjustments to the age structure. Two countries, the British Virgin Islands and Montserrat, proved to be the main exception, possibly as a result of their very small size which renders the age structure extra sensitive to migratory impacts.

Sex-ratio by age

12. With regard to the sex-ratios by age, certain inconsistencies were found. However, it could be argued that these irregularities can be attributed, in large part, to the impact of heavy migration in the region <5> Further analysis revealed that these movements are not uniform by age and sex. This is clearly illustrated in the structure of survival ratios calculated from the 1970 and 1980 census data. (See also age-sex pyramids in projection reports for individual countries).

Cohort differences

13. An estimate was made of the differences in cohorts between the two censuses 1970 and 1980. For this purpose ten-year census survival ratios were estimated and the absolute cohort differences compared. Some irregularities were observed among certain age-groups. Since the census data of most countries is considered of good quality, these differences could be largely attributed to the impact of migration which does not exert a uniform effect on all age-groups.

B. PROJECTION BASE POPULATION

14. The 1980 census was used as the base population. In the case of some countries (Saint Vincent and the Grenadines, Saint Lucia and Belize) the officially adjusted census was used.

15. Each census population was carried forward to the mid-year (30 June) using the growth rate of 1970 - 1980. In the case of the two countries, in which the census was taken in 1981, the Commonwealth of Grenada and the Commonwealth of Dominica, the census population was moved backwards to mid-year 1980.

<5> See Guengant, Jean-Pierre and Marshall, D. "Caribbean Population Dynamics: Emigration and Fertility Changes". Letchworth Press, Barbados, 1985.

C. PROJECTION OF MORTALITY

Mortality

16. The health conditions in the countries have improved tremendously over the past two decades as illustrated in the high expectation of life at birth, ranging from 63 to 71 years for males and 67 to 75 years for females.

Life tables

17. Life tables were constructed for 1970 and 1980 using the Reed-Merrell method and compared with those constructed earlier by ISER, UWI, at the ECLAC/CELADE Projections Seminar in May 1986. As little differences were found between the life tables (small variations due to differences in methods used to smooth the nqx curve), it was decided to retain those developed at the Projections Training course for most countries. However, some adjustments had to be made to the survival ratios.

Mortality projections

18. Future trends in mortality were estimated through the projection of the level of expectation of life at birth for each period. Instead of adopting a linear rate of increase in the evolution of expectation of life, a logistic function was used to project the level to the various period. Using the logistic model which assumes that mortality will increase according to an asymptotic curve, the expectation of life at birth is projected for each five-year period of the projection according to the following formula:

$$Y_t = K_1 + \frac{K_2}{1 + e^{a + bt}}$$

Where:

K_1 = the lowest asymptote

$K_1 + K_2$ = the highest asymptote

$a + b$ = parameters

19. In developing these projections, the following principles were considered:

(i) that the expectation of life at birth increases with time;

(ii) that the differences between sexes grows wider over time; and

(iii) that the rate of gain in life expectancy diminishes over time.

20. However, for some countries, it was not always possible to adhere strictly to these principles, given the past trends in their mortality experience which often indicated certain deviations from the standard mortality behaviour. A projection of life expectation at birth is presented in Table 2.

Table 2
Projection of expectation of life at birth by sex for each quinquennial period

Country	Expectation of life at birth						
	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015
Bahamas							
Males	65.45	66.41	67.24	67.96	68.58	69.12	69.57
Females	73.33	74.66	75.64	76.34	76.83	77.19	77.43
Belize							
Males	70.38	71.08	71.67	72.19	72.62	73.00	73.31
Females	72.60	73.37	74.04	74.62	75.12	75.55	75.92
British Virgin Islands							
Males	65.45	66.41	67.24	67.96	68.58	69.12	69.57
Females	73.33	74.66	75.64	76.34	76.83	77.19	77.43
Dominica							
Males	62.81	63.54	64.19	64.80	65.37	65.90	66.38
Females	67.93	69.82	71.42	72.75	73.84	74.72	75.42
Grenada							
Males	66.73	67.75	68.66	69.44	70.13	70.71	71.22
Females	73.03	74.34	75.23	75.83	76.23	76.50	76.73
Montserrat							
Males	62.18	63.54	64.19	64.80	65.37	65.90	66.38
Females	67.93	69.82	71.42	72.75	73.84	74.72	75.42
Saint Christopher-Nevis							
Males	62.81	63.54	64.19	64.80	65.37	65.90	66.38
Females	67.93	69.82	71.42	72.75	73.84	74.72	75.42
Saint Lucia							
Males	67.00	67.87	68.56	69.11	69.54	69.87	70.13
Females	72.57	73.71	74.56	75.21	75.69	76.04	76.30
Saint Vincent and the Grenadines							
Males	65.62	66.84	67.85	68.69	69.37	69.93	70.38
Females	70.87	72.18	73.28	74.18	74.92	75.52	76.01

21. After the projection of the levels of mortality was completed, the age structure was then projected using the survival ratios from the 1980 national life tables as the point of departure in the initial period of projection and adapting the Coale and Demeny West model life tables to project the age structure according to the projected levels of expectation of life.

22. It is interesting to note the incongruity observed in the gap between the male and female infant mortality rates, which increase as the expectation of life at birth rises in the projections. Indeed, it appears that the rate decline for females is faster than that for males, thereby resulting in an excessive widening of the gap between the sexes.

23. This finding has also been noted for other countries <6> and seems to reflect a limitation of the model life tables being used. It has been found to occur especially when the expectation of life of a country is of a high level.

24. Given the predictable nature of mortality in these countries and the small effect on the age composition, only one hypothesis was assumed for the projections.

D. FERTILITY

25. An average of the data on births by age of mother for the three years surrounding the 1970 and 1980 censuses as well as the mid-year female population were used to calculate the age specific fertility rates (ASFR) after which the total fertility rates (TFR) were established.

26. As illustrated in Table 3, despite the wide variations observed, the level of fertility among most of the countries is comparatively low (with the exception of Belize and possibly Saint Lucia). The structure also corresponds closely to that of a young fertility model, with the peak occurring in the younger age-group (20 - 24).

Table 3
Total Fertility Rate (1960 - 1980)

Country	1960	1970	1980
Bahamas	6.3	3.6	2.8
Belize	...	6.3	5.7
The British Virgin Islands	...	3.6	2.4
Dominica	7.4	...	3.1
Grenada	6.3	4.3	3.4
Montserrat	...	4.1	2.4
Saint Christopher-Nevis	6.8	5.1	3.4
Saint Lucia	6.9	6.1	4.1
Saint Vincent and the Grenadines	7.3	6.1	3.9

<6> Ortega Antonio - "Tablas Limites de Mortalidad Preparadas en CELADE-San Jose para su uso en proyecciones de Población"., CELADE, 1984.

27. The projection of fertility was conducted in two stages. In the first stage, the level of fertility was projected in accordance with the logistic function. Then, secondly, the age structure was projected adopting two approaches for analytical purposes. The first used the United Nations age schedule model while, in the second, the ASFR's were adjusted linearly according to changes in the TFR over time.

28. The reason for adopting both approaches was based on the fact that, although the use of the model age schedule was considered more appropriate, some small differences were observed in the age structure of the ASFR's for the United Nations model in comparison to that for the Caribbean countries. Essentially, the ASFR for the age-groups 15 - 19 in the United Nations model was lower while that for the ages 20 - 24 appeared higher.

29. However, as illustrated, results from the projections indicate minor differences (of less than 3%) between the total populations projected under alternative approaches. On the whole, the total projected populations utilizing the United Nations age schedule were higher than those with projected linear declines in the ASFR's. The differences, which varied between .4% to 3.0% depending on the level of fertility of the country, appeared to be largely the result of the higher proportion of females in the 20 - 24 age-group (most fertile period) for the United Nations model.

Fertility level

30. Having analyzed the fertility trends over the past three decades, and taking into account the TFR for two or three periods, the future evolution of fertility was estimated based on the theory that the behaviour of fertility decline follows the shape of a logistic curve:

31. The function adopted is as follows:

$$TFR(t) = K_1 + \frac{K_2}{1 + e^{a + bt}}$$

TFR = Total Fertility Rate at time t

$K_1 + K_2$ = The highest asymptote, corresponding to the highest TFR observed for the country in the past

K_1 = The lowest asymptote - the lowest value in the transition process over the projected period (possibly replacement level)

a and b = Parameters

32. The value of a and b are then derived from the following system of equations:

$$a = \ln \frac{K_1 + K_2 - TFR(0)}{TFR(0) - K_1}$$

$$b = 1/t \ \ln \frac{K_1 + K_2 - TFR(t)}{TFR(t) - K_1} - a$$

33. The main advantage in selecting a logistic curve to depict the fertility evolution is that variations in the TFR are more gradual, thereby reducing the possibilities of irregularities in the projected total number of births and the consequent inconsistencies in the age-sex structure of future populations.

Projection of Fertility age structure

34. After completing the projection of the fertility levels, the age structure of these levels was estimated utilizing two methods.

35. In the first approach, the United Nations theoretical model <7> of medium fertility with the early peak was selected. Taking the age structure of the model as a limit and the ASFR of the country as the starting point, the ASFR's for the projected periods are interpolated in relation to the projected levels of TFR.

36. With regard to the second method, the ASFR's are obtained through linear interpolations taking into account only the values of the calculated total fertility rates.

E. MIGRATION

37. A number of data sources were used to establish the level of migration in the countries. These included:

a. Annual statistics (1971 - 1983) on Caribbean immigrants to United States and Canada, obtained from the United States and Canadian immigration departments;

b. Data on net migration from National Statistical Offices; and

c. Data from the Eastern Caribbean Migration Project Survey of 1984.

<7> See United Nations - "Population Bulletin No. 7", New York, 1963.

38. In addition, the residual method technique was utilized to estimate the total number of migrants between 1970 and 1980. In this method, the 1970 and 1980 census data were used to calculate ten-year census survival ratios. The latter were then applied to the 1970 and 1980 censuses to make forward and backward projections.

39. An average was then made of the differences between the actual and estimated populations for 1970 and 1980 thus yielding an estimate of net migration for the ten-year period. Thus:

$$M_1^{x+t} = P_t^{x+t} - sP^{o}$$

Where: x = age-group

t = census interval

P^{o} = Population aged x at first census

P_t^{x+t} = Population in next census age x + t

s = survival rate

$$M_2 = \frac{P_t^{x+10}}{s} - P_o^{x}$$

and average net migration =

$$M = \frac{M_1 + M_2}{2}$$

40. The results of the residual method were found to correspond closely to those from other data sources. Thus an average was used as a basis for projecting total migrants.

41. With regard to the age-sex composition, an age structure, based on the average of three years of recent data on migrants from the Republic of Trinidad and Tobago and Jamaica obtained from the United States Immigration Office was selected.

F. PROJECTIONS - METHODOLOGY AND ASSUMPTIONS

Methodology

42. For this population projection exercise, the Projection Computer Programme of the United Nations, which relies on the component method, was utilized.

43. The basic input data comprises the following:

- base population, distributed by age and sex.
- the expectations of life at birth for 5 year periods and the corresponding survival ratios by age and sex.
- the total fertility rates for each 5 year period as well as the related age-specific fertility rates.
- total number of migrants by sex and distribution.
- the value of the sex-ratio at birth.

44. The general methodology of this programme is as follows. First, the age-sex specific survival ratios are applied to the corresponding age-sex of the base population to estimate the survivors age 5 and over. Then age-specific fertility rates are multiplied by the average numbers of women in the reproductive age-groups, 15 to 49 years, in the projection interval, yielding the sum of the number of births during the five-year period. Next, throught the application of the sex-ratio at birth and the survival ratios for births 0 - 4, the numbers of males and females aged 0 - 4 at the end of the five-year period are obtained and added to the survivors aged 5 years and over. Finally, the estimates of the net numbers of migrants by age and sex during the projection interval are added to the projected base population, thereby producing the total population by age and sex at the end of the five-year period.

Fertility

45. In general, three alternative assumptions about the trend of future fertility were made for each country:

(i) High assumption - Constant: Total fertility rate remains constant at the 1980 level throughout the projection period;

(ii) Medium Assumption - Total fertility rate declines to the replacement level at a late date (between approximately 2000 - 2005) depending on the initial level and speed of decline of each country; and

(iii) Low Asssumption - Total fertility rate reaches replacement level at an earlier date between (1990 - 2000), again corresponding to the initial level and speed of decline of the TFR.

46. The latter assumptions were formulated after due consideration was given to the socio-economic fertility determinants and development policy thrusts of the governments of each country as well as a review of past demographic trends.

Migration

47. Three alternative assumptions concerning the net annual number of migrants are used:

(i) Large: It is assumed that a large flow of net migration would be maintained. Thus migration is kept constant;

(ii) Medium: Emigration declines linearly to 50% of the net annual out-flow at an early date (1995) and then remains constant; and

(iii) Small: The tapering off of migration is much slower than in the previous assumption, as emigration declines to 50% of its annual outflow at a later date (2005) after which it remains constant.

48. In the case of countries experiencing mainly immigration (Bahamas and the British Virgin Islands), it is assumed that outmigration will increase over time thereby reducing the net inflow ultimately to zero (either at an early or later date).

Mortality

49. The average life expectancies at birth for each country are assumed to increase moderately in a logistic fashion depending on the initial levels in 1960 and 1970 as well as the shape of the slope. On average, the rate of increase corresponds to approximately .5 to 1 year every five-years.

50. Only one assumption is made, for mortality, given the small effect on the age composition and growth of the population due to the low mortality levels prevailing.

Choice of Projection Scenarios

51. Given the importance of net migration on the population growth rates of the Caribbean countries, the decision was made to combine the three migration assumptions with each fertility assumption. Thus, a combination of fertility, migration and mortality assumptions yields a total of approximately ten scenarios for each country.

52. An additional set of scenarios was developed to compare the use of the different methods for projecting the ASFR's - (linear versus United Nations model).

53. The above selections were made for the purpose of initial analyses and in consideration of the need to provide a plausible range of growth possibilities for each country. After consultation with the governments of each country, the latter will be reduced to a more manageable combination of scenarios.