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*Sri Lanka*

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# COUNTRY PROSPECTS

This series presents population projections in a standardized format for a number of individual countries. Each study provides alternative short-term and long-term growth trends and illustrates how changing demographic behavior could bring about various changes in the size and composition of the population under consideration. COUNTRY PROSPECTS is meant to provide information helpful to a broad national audience within each country: government officials, politicians, social and economic planners, academicians, and interested citizens.

Each study is composed of two reports: the first presents alternative demographic trends for the population of the specific country described, and the second places this subject in a worldwide perspective. The first report, entitled "Alternative Projections to a Stationary Population," establishes as an ultimate ideal objective a stationary population—one that would neither grow nor decline—and shows how particular population developments could realize this goal. Appended to this report are nine tables that present detailed computerized population projections and that form part of a larger set of world data. The second report, "The Prospects for a Stationary World Population," originally appeared in *Scientific American*.

COUNTRY PROSPECTS is based on research of Tomas Frejka of the Demographic Division of the Population Council. A limited supply of copies is available on request from the Population Council.

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# Alternative Projections to a Stationary Population

## SRI LANKA

### INTRODUCTION

In 1973 the population of Sri Lanka was around 13 million. By the year 2000 its population could be as high as 25 million or as low as 19 million. The higher number would be the result of a slow fertility decline between the early 1970's and the year 2000. The lower number would result from profound changes in the fertility behavior of the population over the two to three decades since 1970.

The possible difference in fertility trends during the coming decades can have major consequences for the social and economic development of the country. For instance, with a precipitous fertility decline around 3 million children would be in the age group 5-14 years in the year 1990, whereas with a moderate fertility decline around 5 million children would be of this age. Since the 5-14 age group contains children who should be educated, its rate of growth has a direct effect on the development of the educational system. These projections indicate that a slow fertility decline would create less favorable overall conditions for providing adequate education than would a comparatively rapid fertility decline.

The discussion that follows is based on the assumption that the population size of Sri Lanka will eventually, for all practical purposes, cease to grow. This report explores the questions of (1) When might it be reasonable to expect the condition of nongrowth to be attained? (2) What would be the size of the eventual stationary population? and (3) What is the nature of demographic trends on a particular path toward stationarity? The discussion originates with the actual demographic characteristics of Sri Lanka during the period 1965-1970. From that base line, we compute five projections of demographic trends, each of which would eventually bring about a stationary state. None of the projections are predictions of what will take place; rather, they are descriptions of trends that could take place, given the present demographic characteristics of Sri Lanka and recent fertility and mortality trends, and barring catastrophes of natural or human origin.

A number of concepts are necessary to an understanding of the processes by which population growth projections are made. The *crude birth rate* (CBR) and the *crude death rate* (CDR) show, respectively, the number of live births and the number of deaths per 1,000 population per year. In 1972, for instance, the crude birth rate in Sri Lanka was estimated at around 30 per 1,000 population and the crude death rate at around 8 per 1,000 population. Subtracting the CDR from the CBR yields the *crude rate of natural increase* (CRNI), which in 1972 was 22 per 1,000 inhabitants. This rate is customarily stated as a percentage—that is, per 100 inhabitants; thus in 1972 the crude rate of natural increase was around 2.2 percent. A reasonable approximation of average fertility patterns per woman is provided by the *total fertility rate* (TFR), the average number of live children a woman would bear if she passed through her years of potential motherhood experiencing the current fertility of women at each age; for 1965-1970 the total fertility rate in Sri Lanka was estimated at 4.5. The *gross reproduction rate* (GRR) refers to the average number of daughters a woman would bear during her childbearing years (for 1965-1970 the gross reproduction rate in Sri Lanka was estimated at 2.2). The *net reproduction rate* (NRR) provides information on how many daughters of the average woman would survive to the average age of childbearing if they experienced current mortality patterns (2.0 for 1965-1970).



**BASIC  
DEMOGRAPHIC  
MEASURES,  
1965-1970**

A net reproduction rate of 1.0 is equivalent to an eventual nongrowing population, provided the conditions giving rise to the rate persist. The fertility level corresponding to a net reproduction rate of 1.0 is called *replacement fertility*. In the early 1970's in Sri Lanka a total fertility rate of 2.3 would represent replacement fertility.

For technical reasons the data presented in this report are based on computations made with the female population. The results nevertheless approximate the features and trends of the total population. The computations do not take into account large-scale migration. If immigration and emigration of the population of Sri Lanka remain relatively small or balanced, these projections will give an adequate idea of possible future trends. Under conditions of heavy emigration, these projections would reflect an overestimation; conversely, they would reflect an understatement of possible future trends under conditions of heavy immigration.

Sri Lanka had an estimated population of 12.1 million in mid-1970. Since this population lived on a territory of 65,610<sup>7</sup> square kilometers, the density of population was 184 inhabitants per square kilometer. The age distribution was as follows: 41 percent of the population was under age 15, 56 percent was in the age group 15-64, and 3 percent was aged 65 or older. Thus, the population of Sri Lanka has a young age structure, which means, for example, that many females will be moving into reproductive age groups. The *age structure* of the population has an important influence on population growth; it is the way in which population is distributed by age.

At the end of the 1960's the average expectation of life for females (at the time of birth) was estimated to be 65 years. The crude birth rate (based on a measure of the female population only) was estimated to be 31.9 per 1,000 and the crude death rate (based on a measure of the female population only) was estimated at 7.0 per 1,000.

The crude rate of natural increase of the population during the period 1965-1970 was estimated at about 2.5 percent per year. If the population were to continue to grow at this rate, it would number 25.6 million in the year 2000 and 54.2 million in 2030. Expressed in another way, using an index scale with 1970 equal to 100, the population would be 212 in the year 2000 and in 2030 it would be 448 (more than four times its 1970 size).

**THE FIVE  
PROJECTIONS**

We have made specific assumptions about the fertility trends and other demographic characteristics on which the five population growth projections for Sri Lanka are based (*see* Tables B-F). For all projections, it is assumed that the 1965-1970 fertility pattern of an average of 4.5 children born per woman will settle eventually at the replacement level, that is, at a level of slightly more than 2 children per woman. In Projection 1 this change in fertility is assumed to take effect in the early 1970's. Projection 2 illustrates demographic trends that would appear if the fertility transition occurred from 1970 to 1980. In Projections 3, 4, and 5 the fertility transition is estimated to occur in 30, 50, and 70 years, respectively; thus replacement fertility

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**CONCISE DESCRIPTIONS OF PROJECTIONS**

- Projection 1 = immediate decline of fertility to replacement level (NRR = 1 from 1970 and thereafter)  
Projection 2 = precipitous fertility decline to replacement level (NRR = 1 in 1980 and thereafter)  
Projection 3 = rapid fertility decline to replacement level (NRR = 1 in 2000 and thereafter)  
Projection 4 = moderate fertility decline to replacement level (NRR = 1 in 2020 and thereafter)  
Projection 5 = slow fertility decline to replacement level (NRR = 1 in 2040 and thereafter)
-



# POSSIBLE GROWTH OF THE TOTAL POPULATION

is assumed to be reached in the years 2000, 2020, and 2040, respectively. In all projections once replacement fertility is reached it is assumed to persist indefinitely.

The instant decline of fertility assumed in Projection 1 seems unlikely to occur, and so the trends illustrated by this projection are unlikely to materialize. Projection 2 illustrates the consequences of a precipitous decline in fertility; Projection 3 shows what would happen in the event of a rapid fertility decline, and Projections 4 and 5 illustrate trends that would develop as a result of a moderate or slow but nonetheless meaningful decline in fertility (see Figure 1).

The trend of future mortality is the same in all the projections. It is expected to decline, so that the female expectation of life in Sri Lanka will ultimately reach 75 years (see last column of Tables B-F).

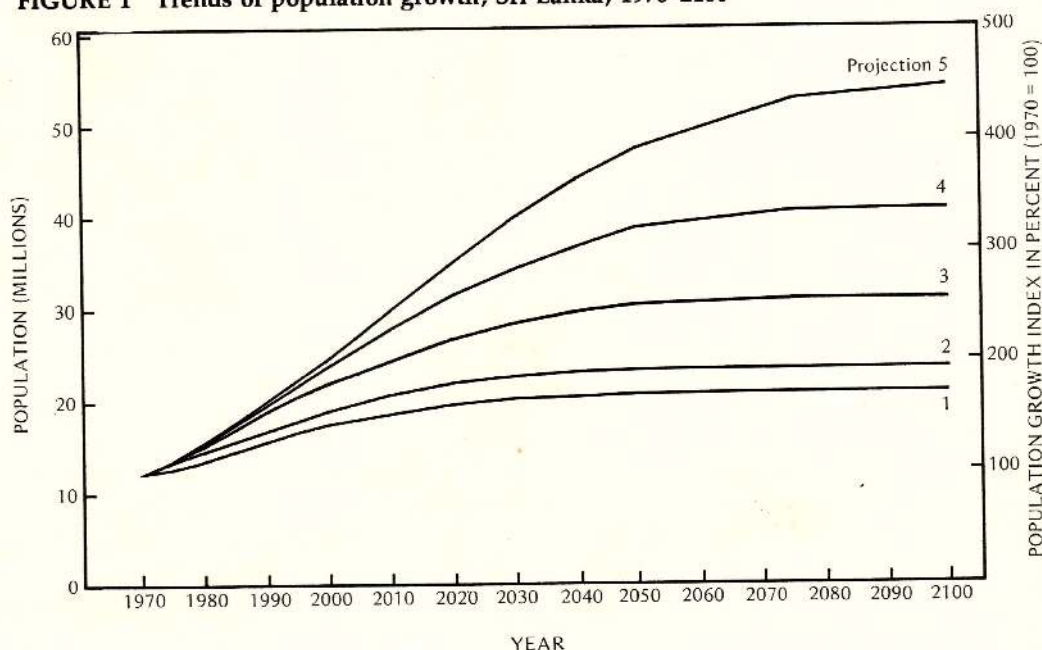
*Even if a transition to replacement fertility were to occur immediately, under Projection 1, the total population of Sri Lanka would grow about 43 percent over the next 30 years, leveling off after 2050 at a size about 69 percent larger than the 1970 size (see Table A).*

Growth would continue even after replacement fertility was attained because the young age groups would mature into larger groups of childbearers than existed formerly, and this would continue during the next 10 to 20 years. Even if that generation of childbearers had only enough children to replace themselves, the number of births occurring would cause the population to increase.

The precipitous and rapid declines in fertility assumed in Projections 2 and 3, respectively, would generate population sizes 54 percent and 79 percent larger in the year 2000 than in 1970. By about the middle of the 21st century the population of Sri Lanka would be 1.9 times larger than in 1970 according to Projection 2 and 2.5 times larger than in 1970 according to Projection 3.

The moderate and slow declines in fertility assumed in Projections 4 and 5, respectively, would generate population sizes 94 percent and 102 percent larger in 2000 than in 1970. The population would not level off until close to the end of the 21st century. According to Projection 4 the population would be 3.3 times larger than in 1970 and according to Projection 5 it would be 4.4 times larger than in 1970.

**FIGURE 1 Trends of population growth, Sri Lanka, 1970-2100**



**TABLE 1 Vital rates, Projections 2, 3, 4, and 5, Sri Lanka, 1965–2000**

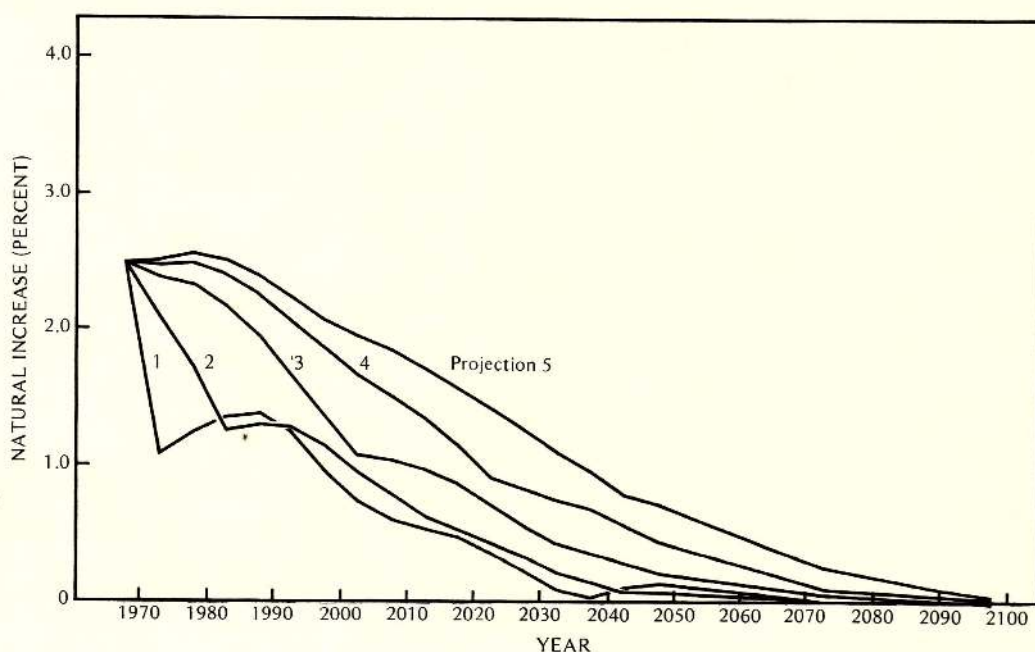
Period	Projection 2			Projection 3			Projection 4			Projection 5		
	Birth rate (per 1,000)	Death rate (per 1,000)	Rate of natural increase (in %)	Birth rate (per 1,000)	Death rate (per 1,000)	Rate of natural increase (in %)	Birth rate (per 1,000)	Death rate (per 1,000)	Rate of natural increase (in %)	Birth rate (per 1,000)	Death rate (per 1,000)	Rate of natural increase (in %)
1965–1970	31.9	7.0	2.5	31.9	7.0	2.5	31.9	7.0	2.5	31.9	7.0	2.5
1970–1975	27.4	6.4	2.1	30.4	6.5	2.4	31.2	6.5	2.5	31.6	6.5	2.5
1975–1980	23.2	6.0	1.7	29.1	6.0	2.3	30.7	6.0	2.5	31.5	6.0	2.6
1980–1985	18.4	5.9	1.2	27.5	5.8	2.2	29.8	5.8	2.4	30.8	5.8	2.5
1985–1990	19.2	6.1	1.3	25.2	5.8	1.9	28.2	5.6	2.3	29.5	5.6	2.4
1990–1995	19.2	6.4	1.3	22.5	5.9	1.7	26.2	5.7	2.0	27.8	5.6	2.2
1995–2000	18.3	7.0	1.1	19.8	6.2	1.4	24.3	5.9	1.8	26.3	5.8	2.1

Under the assumptions of the rapid fertility decline of Projection 3 the population density in 2050 would be ~~460~~ 450 persons per square kilometer. With the moderate fertility decline of Projection 4 it would be ~~587~~ 587.

#### POSSIBLE TRENDS OF VITAL RATES

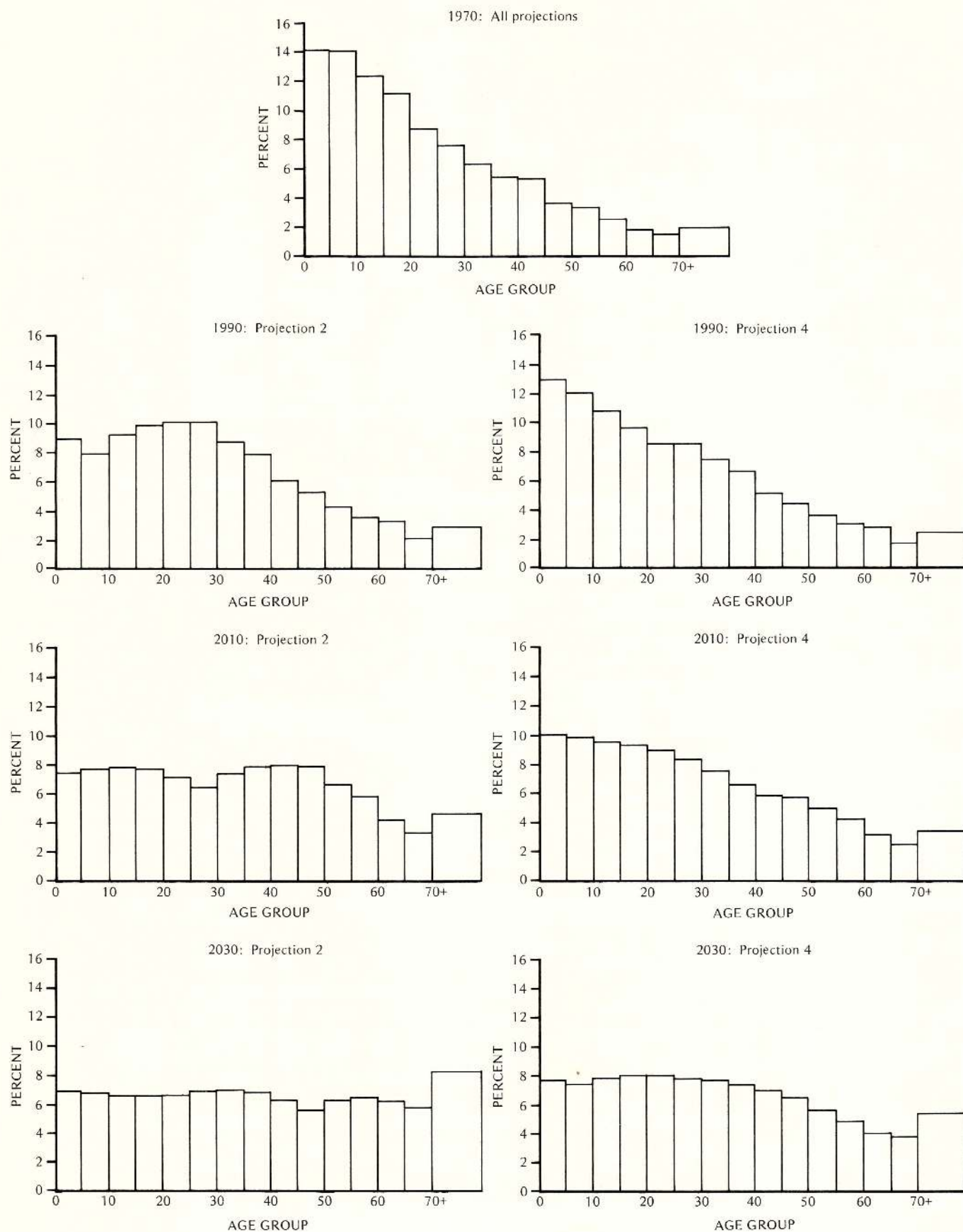
The current age structure of the population of Sri Lanka is such that a gradual change in fertility behavior during the next two decades would hardly be noticeable in terms of the crude birth rate and the crude rate of natural increase. For example, the data in Projection 4 demonstrate that the rate of growth over the next two decades will not change significantly with a moderate decline in fertility. Under Projection 4 a distinct decline in the rate of growth of the population would not be brought about until some years later (see Table 1 and Figure 2).

**FIGURE 2 Annual rate of natural increase, Sri Lanka, 1965–2100**





**FIGURE 3** Changes of age structure, Sri Lanka, 1970–2030



**TABLE 2 Absolute size and annual rate of growth, specified age groups, Sri Lanka, 1970-2000**

Age group (years) and projection	Absolute size (in thousands)				Annual rate of growth (in %)		
	1970	1980	1990	2000	1970-1980	1980-1990	1990-2000
A. 5-9 years							
Projection 2	1710	1650	1329	1583	-0.4	-2.1	+1.8
Projection 3	1710	1842	2123	2118	+0.7	+1.4	-0.0
Projection 4	1710	1895	2342	2586	+1.0	+2.1	+1.0
B. 15-19 years							
Projection 2	1353	1693	1638	1321	+2.3	-0.3	-2.1
Projection 3	1353	1693	1829	2110	+2.3	+0.8	+1.4
Projection 4	1353	1693	1882	2328	+2.3	+1.1	+2.2
C. 20-29 years							
Projection 2	1982	2803	3344	3150	+3.5	+1.8	-0.6
Projection 3	1982	2803	3344	3790	+3.5	+1.8	+1.3
Projection 4	1982	2803	3344	3966	+3.5	+1.8	+1.7

A precipitous decline in fertility, such as demonstrated in Projection 2, would bring about an immediate decline in both the crude birth rate and the crude rate of natural increase. A careful evaluation is needed, however, to assess whether a fertility decline of this magnitude is feasible. Even if the trends in population growth illustrated by Projection 2 are considered desirable, the needed fertility trends may prove to be unattainable.

#### OVERALL CHANGES IN THE AGE STRUCTURE

*The currently young age structure of the population of Sri Lanka would be transformed into a population with a more even age distribution much faster with a precipitous fertility decline as assumed in Projection 2 than with a moderate fertility decline as in Projection 4 (see Figure 3). According to Projection 4, the fraction of the total population under age 15 would decline from 41 percent in 1970 to 33 percent by 2000 and 23 percent by 2030. With the precipitous fertility decline of Projection 2 this same age group would drop from 41 percent in 1970 to 25 percent by 2000 and to 20 percent by 2030.*

Another significant consideration in population planning is the *child dependency ratio*, which is the ratio of the number of children under age 15 to the number of people aged 15-65. It identifies, for instance, the burden on the potentially "working" population for education and health services for the group of children. This ratio was 0.73 in 1970. Under Projection 4 it would drop to 0.53 by 2000; under Projection 2 in 2000 it would be 0.36.

#### CHANGES OF FUNCTIONAL AGE GROUPS

Knowledge about the possible growth of different age groups is important for various aspects of social and economic development. For example, changes in the 5-9 year age group can be considered a reasonable indication of how the numbers of potential elementary school children might change. Throughout the next three decades the growth of this group will be closely related to the rate of fertility decline (see Table 2.A and Table I).

The age group 15-19 indicates the size and especially the possible growth rates of the potential secondary school population. Also, roughly one-fifth of the 15-19 age group can well represent the number of annual entrants into the labor force. The growth of the 15-19 age group during the 1970's has been predetermined by past demographic trends, since the births occurred in the late 1950's and in the early 1960's. Beginning in the late 1980's, however, the growth of this group will reflect both current and future fertility behavior (see Table 2.B).



**TABLE 3 Age group 65 and over, Sri Lanka, 1970–2000**

<i>Absolute size (in thousands)</i>	1970	1980	1990	2000
All projections	431	572	809	1194
<i>Annual rate of growth (in %)</i>	1970–1980	1980–1990	1990–2000	
All projections	2.9	3.5	4.0	
<i>As % of total population</i>	1970	1980	1990	2000
Projection 2	3.6	3.9	4.9	6.4
Projection 3	3.6	3.7	4.3	5.5
Projection 4	3.6	3.7	4.2	5.1

The growth of the age group 20–29 has basically been determined for the period continuing through the 1980's since everyone who will be in that group in the 1980's has already been born. This age group contains women during their most fertile years. Current fertility trends will influence the growth of the group after 1990 (see Table 2.C).

The absolute growth of the age group of 65 years and over will be influenced only by future mortality trends and will not be influenced by fertility trends before the 2030's (when people born now will reach those ages). Assuming that our estimates of future mortality conditions are a reasonably good approximation of what will happen, the number of elderly people is likely to grow at a rate between 3 and 4 percent a year over the next three decades. The proportion of people of old age (see lower section of Table 3) will also grow. The growth of this proportion, however, will differ from one projection to the other, although the absolute numbers of old people are assumed to be the same. With a precipitous fertility decline the proportion of older persons will grow slightly faster (from 3.6 percent in 1970 to 6.4 percent in 2000) than with a moderate fertility decline (from 3.6 percent in 1970 to 5.1 percent in 2000), because the total population will grow more slowly under a precipitous fertility decline than under a moderate fertility decline.

#### CONCISE DESCRIPTIONS OF TABLES A–I

The detailed projections of Tables A–I illustrate alternative future demographic developments determined by the assumed fertility and mortality trends of the population.

**Table A** compares total population growth in absolute and relative numbers under the five projections.

**Tables B–F** present data—a separate projection in each table—on interrelated behavior of the vital rates—female crude birth and death rates, total fertility rate, gross reproduction rate, net reproduction rate, absolute size of the population, female average annual growth rate, and female expectation of life at birth.

**Table G** compares average annual rates of population growth under the five projections.

**Table H** compares annual increments in population size under the five projections.

**Table I** compares age structure of the population at eight different years under the five projections.



## TECHNICAL NOTE

The basic data for the population projections were gathered as a part of the larger project around the year 1970. They reflect the state of knowledge at that time and possibly do not correspond accurately to new information that has been acquired since. The differences between the old and possible new information should have no influence on the analytic and illustrative value of the computations discussed in this report.

The sources of data for the *projections* of Sri Lanka were:

Balasubramanian, K., L.B. Kahawatte, and R.N. Sharma. *Mortality Level in Ceylon 1953-63 and Life Table for 1963*. Bombay, India: Demographic Training and Research Centre Programme 1968-1969, June 1969. Mimeographed.

Department of Census and Statistics. *Statistical Abstract of Ceylon 1967-1968*. Colombo: Department of Government Printing, 1970.

Wright, Nicholas. "The Relationship of Demographic Factors and Marital Fertility to the Recent Fertility Decline," *Studies in Family Planning*, vol. 1, no. 59 (November 1970): 17-20.

The source for some of the more recent data mentioned in the text was:

United Nations Statistical Office. *Population and Vital Statistics Report*. Series A, vol. 26, no. 2. Data available as of 1 April 1974. New York.

The methods applied are discussed in detail in:

Frejka, Tomas. *The Future of Population Growth: Alternative Paths to Equilibrium*. New York: Wiley-Interscience, 1973.

Frejka, Tomas. "Reflections on the Demographic Conditions Needed to Establish a U.S. Stationary Population Growth," *Population Studies*, vol. 22, no. 3 (November 1968): 379-397.



TABLE A TOTAL POPULATION (IN MILLIONS) AND INDICES OF POPULATION SIZE (1970 = 100), 1970-2150  
LINEAR DECLINE OF FERTILITY TO NRR LEVEL OF 1.0

SRI LANKA	YEAR	PERIOD IN WHICH NET REPRODUCTION RATE OF ONE IS REACHED	PROJECTIONS 1 - 5				
			1970-1975 PROJ 1	1980-1985 PROJ 2	2000-2005 PROJ 3	2020-2025 PROJ 4	2040-2045 PROJ 5
	1970	12.1 100	12.1 100	12.1 100	12.1 100	12.1 100	12.1 100
	1975	12.8 105	13.5 110	13.6 112	13.7 112	13.7 112	13.7 113
	1980	13.6 112	14.6 120	15.3 126	15.5 127	15.6 128	15.6 128
	1985	14.5 119	15.6 128	17.0 140	17.4 143	17.6 145	17.6 145
	1990	15.6 128	16.6 137	18.8 154	19.5 160	19.8 163	19.8 163
	1995	16.5 136	17.7 146	20.4 167	21.6 177	22.1 182	22.1 182
	2000	17.4 143	18.7 154	21.8 179	23.6 194	24.5 202	24.5 202
	2010	18.6 153	20.4 168	24.2 199	27.7 228	29.5 243	29.5 243
	2020	19.5 161	21.7 178	26.5 218	31.3 258	34.8 286	34.8 286
	2030	20.1 165	22.5 185	28.3 233	34.1 281	39.7 327	39.7 327
	2040	20.2 166	22.9 188	29.4 242	36.6 302	43.9 362	43.9 362
	2050	20.4 168	23.0 190	30.2 248	38.5 317	47.3 389	47.3 389
	2075	20.6 169	23.3 191	30.6 252	40.4 333	52.7 434	52.7 434
	2100	20.6 169	23.3 192	30.7 252	40.6 335	54.1 445	54.1 445
	2125	20.6 169	23.2 191	30.6 252	40.6 334	54.2 446	54.2 446
	2150	20.5 169	23.2 191	30.6 252	40.6 334	54.1 446	54.1 446



TABLE B BASIC DEMOGRAPHIC MEASURES FOR SELECTED TIME PERIODS 1965 - 2150  
LINEAR DECLINE OF FERTILITY TO NRR OF 1.0 IN 1970-5

SRI LANKA	B.4	PERIOD	FEMALE CRUDE BIRTH RATE	FEMALE CRUDE DEATH RATE	TOTAL FERTILITY RATE	GROSS REPRO- DUCTION RATE*	NET REPRO- DUCTION RATE	TOTAL POPULATION AT END OF PERIOD (IN MILLIONS)	FEMALE AVERAGE ANNUAL RATE OF GROWTH (IN PERCENT)	FEMALE EXPECTATION OF LIFE AT BIRTH
		1965-1970	31.9	7.0	4.53	2.21	1.98	12.1	2.49	65.0
		1970-1975	16.9	6.2	2.25	1.10	1.00	12.8	1.07	66.5
		1975-1980	18.4	6.1	2.22	1.08	1.00	13.6	1.23	68.0
		1980-1985	19.8	6.3	2.20	1.07	1.00	14.5	1.35	69.0
		1985-1990	20.3	6.5	2.18	1.06	1.00	15.6	1.38	70.0
		1990-1995	19.2	6.8	2.17	1.06	1.00	16.5	1.24	70.5
		1995-2000	17.0	7.4	2.16	1.05	1.00	17.4	0.96	71.0
		2000-2005	15.3	7.8	2.15	1.05	1.00	18.0	0.75	71.5
		2005-2010	14.5	8.4	2.15	1.05	1.00	18.6	0.61	72.0
		2010-2015	14.4	9.1	2.14	1.04	1.00	19.1	0.53	72.5
		2015-2020	14.6	9.9	2.13	1.04	1.00	19.5	0.47	73.0
		2020-2025	14.5	11.0	2.12	1.04	1.00	19.9	0.35	73.5
		2025-2030	14.0	11.9	2.12	1.03	1.00	20.1	0.22	74.0
		2030-2035	13.6	12.7	2.11	1.03	1.00	20.2	0.08	74.5
		2035-2040	13.4	13.1	2.10	1.03	1.00	20.2	0.02	75.0
		2040-2045	13.4	12.4	2.10	1.03	1.00	20.3	0.10	75.0
		2045-2050	13.5	12.3	2.10	1.03	1.00	20.4	0.12	75.0
		2070-2075	13.3	13.3	2.10	1.03	1.00	20.6	0.00	75.0
		2095-2100	13.3	13.4	2.10	1.03	1.00	20.6	-0.01	75.0
		2120-2125	13.3	13.4	2.10	1.03	1.00	20.6	-0.01	75.0
		2145-2150	13.3	13.4	2.10	1.03	1.00	20.5	-0.01	75.0

\* THE INITIAL AGE-SPECIFIC MATERNITY RATES ARE AS FOLLOWS

1965-1970	15-19	20-24	25-29	35-39	40-44	45-49
0.0224	0.1005	0.1210	0.0786	0.0185	0.0034	0.0034



TABLE C BASIC DEMOGRAPHIC MEASURES FOR SELECTED TIME PERIODS 1965 - 2150  
LINEAR DECLINE OF FERTILITY TO NRR OF 1.0 IN 1980-5

SRI LANKA	PERIOD	FEMALE CRUDE BIRTH RATE	FEMALE CRUDE DEATH RATE	TOTAL FERTILITY RATE	GROSS REPRO- DUCTION RATE*	NET REPRO- DUCTION RATE	TOTAL POPULATION AT END OF PERIOD (IN MILLIONS)	FEMALE AVERAGE ANNUAL RATE OF GROWTH (IN PERCENT)	FEMALE EXPECTATION OF LIFE AT BIRTH
b.4	1965-1970	31.9	7.0	4.53	2.21	1.98	12.1	2.49	65.0
	1970-1975	27.4	6.4	3.75	1.83	1.67	13.5	2.10	66.5
	1975-1980	23.2	6.0	2.98	1.45	1.34	14.6	1.72	68.0
	1980-1985	18.4	5.9	2.20	1.07	1.00	15.6	1.25	69.0
	1985-1990	19.2	6.1	2.18	1.06	1.00	16.6	1.30	70.0
	1990-1995	19.2	6.4	2.17	1.06	1.00	17.7	1.27	70.5
	1995-2000	18.3	7.0	2.16	1.05	1.00	18.7	1.14	71.0
	2000-2005	17.0	7.3	2.15	1.05	1.00	19.7	0.96	71.5
	2005-2010	15.6	7.8	2.15	1.05	1.00	20.4	0.78	72.0
	2010-2015	14.8	8.4	2.14	1.04	1.00	21.1	0.63	72.5
	2015-2020	14.4	9.1	2.13	1.04	1.00	21.7	0.53	73.0
	2020-2025	14.3	10.1	2.12	1.04	1.00	22.1	0.43	73.5
	2025-2030	14.2	10.9	2.12	1.03	1.00	22.5	0.33	74.0
	2030-2035	13.9	11.8	2.11	1.03	1.00	22.7	0.22	74.5
	2035-2040	13.6	12.3	2.10	1.03	1.00	22.9	0.14	75.0
	2040-2045	13.4	12.7	2.10	1.03	1.00	23.0	0.07	75.0
	2045-2050	13.4	12.8	2.10	1.03	1.00	23.0	0.06	75.0
	2070-2075	13.3	13.3	2.10	1.03	1.00	23.3	-0.00	75.0
	2095-2100	13.3	13.4	2.10	1.03	1.00	23.3	-0.01	75.0
	2120-2125	13.3	13.3	2.10	1.03	1.00	23.2	-0.00	75.0
	2145-2150	13.3	13.4	2.10	1.03	1.00	23.2	-0.01	75.0

\* THE INITIAL AGE-SPECIFIC MATERNITY RATES ARE AS FOLLOWS

1965-1970	15-19	20-24	25-29	30-34	35-39	40-44	45-49
	0.0224	0.1005	0.1210	0.0976	0.0786	0.0185	0.0034



TABLE D BASIC DEMOGRAPHIC MEASURES FOR SELECTED TIME PERIODS 1965 - 2150  
LINEAR DECLINE OF FERTILITY TO NRR OF 1.0 IN 2000-5

SRI LANKA	PERIOD	FEMALE CRUDE BIRTH RATE	FEMALE CRUDE DEATH RATE	TOTAL FERTILITY RATE	GROSS REPRO- DUCTION RATE*	NET REPRO- DUCTION RATE	TOTAL POPULATION AT END OF PERIOD (IN MILLIONS)	FEMALE AVERAGE ANNUAL RATE OF GROWTH (IN PERCENT)	FEMALE EXPECTATION OF LIFE AT BIRTH	PROJECTION 3
	1965-1970	31.9	7.0	4.53	2.21	1.98	12.1	2.49	65.0	
	1970-1975	30.4	6.5	4.19	2.04	1.86	13.6	2.39	66.5	
	1975-1980	29.1	6.0	3.85	1.88	1.74	15.3	2.32	68.0	
	1980-1985	27.5	5.8	3.51	1.71	1.60	17.0	2.17	69.0	
	1985-1990	25.2	5.8	3.17	1.55	1.46	18.8	1.95	70.0	
	1990-1995	22.5	5.9	2.83	1.38	1.31	20.4	1.66	70.5	
	1995-2000	19.8	6.2	2.49	1.22	1.15	21.8	1.36	71.0	
	2000-2005	17.2	6.5	2.15	1.05	1.00	23.0	1.08	71.5	
	2005-2010	17.2	6.8	2.15	1.05	1.00	24.2	1.04	72.0	
	2010-2015	17.0	7.3	2.14	1.04	1.00	25.4	0.97	72.5	
	2015-2020	16.4	7.8	2.13	1.04	1.00	26.5	0.87	73.0	
	2020-2025	15.5	8.5	2.12	1.04	1.00	27.5	0.71	73.5	
	2025-2030	14.7	9.1	2.12	1.03	1.00	28.3	0.56	74.0	
	2030-2035	14.1	9.8	2.11	1.03	1.00	28.9	0.44	74.5	
	2035-2040	13.9	10.2	2.10	1.03	1.00	29.4	0.37	75.0	
	2040-2045	13.8	10.9	2.10	1.03	1.00	29.9	0.29	75.0	
	2045-2050	13.8	11.6	2.10	1.03	1.00	30.2	0.21	75.0	
	2070-2075	13.4	13.0	2.10	1.03	1.00	30.6	0.04	75.0	
	2095-2100	13.3	13.4	2.10	1.03	1.00	30.7	-0.01	75.0	
	2120-2125	13.3	13.4	2.10	1.03	1.00	30.6	-0.01	75.0	
	2145-2150	13.3	13.4	2.10	1.03	1.00	30.6	-0.01	75.0	

\* THE INITIAL AGE-SPECIFIC MATERNITY RATES ARE AS FOLLOWS

1965-1970	15-19	20-24	25-29	30-34	35-39	40-44	45-49
	0.0224	0.1005	0.1210	0.0976	0.0786	0.0185	0.0034



TABLE E BASIC DEMOGRAPHIC MEASURES FOR SELECTED TIME PERIODS 1965 - 2150  
LINEAR DECLINE OF FERTILITY TO NRR OF 1.0 IN 2020-5

SRI LANKA	B.4	PERIOD	FEMALE CRUDE BIRTH RATE	FEMALE CRUDE DEATH RATE	TOTAL FERTILITY RATE	GROSS REPRO- DUCTION RATE*	NET REPRO- DUCTION RATE	TOTAL POPULATION AT END OF PERIOD (IN MILLIONS)	FEMALE AVERAGE ANNUAL RATE OF GROWTH (IN PERCENT)	FEMALE EXPECTATION OF LIFE AT BIRTH
PROJECTION 4										
		1965-1970	31.9	7.0	4.53	2.21	1.98	12.1	2.49	65.0
		1970-1975	31.2	6.5	4.31	2.10	1.91	13.7	2.47	66.5
		1975-1980	30.7	6.0	4.09	2.00	1.84	15.5	2.48	68.0
		1980-1985	29.8	5.8	3.87	1.89	1.76	17.4	2.40	69.0
		1985-1990	28.2	5.6	3.66	1.78	1.68	19.5	2.25	70.0
		1990-1995	26.2	5.7	3.44	1.68	1.58	21.6	2.05	70.5
		1995-2000	24.3	5.9	3.22	1.57	1.49	23.6	1.84	71.0
		2000-2005	22.8	6.0	3.00	1.46	1.39	25.7	1.67	71.5
		2005-2010	21.3	6.2	2.78	1.36	1.30	27.7	1.51	72.0
		2010-2015	19.8	6.5	2.56	1.25	1.20	29.6	1.34	72.5
		2015-2020	18.2	6.8	2.34	1.14	1.10	31.3	1.14	73.0
		2020-2025	16.4	7.3	2.12	1.04	1.00	32.7	0.91	73.5
		2025-2030	16.1	7.8	2.12	1.03	1.00	34.1	0.83	74.0
		2030-2035	15.8	8.3	2.11	1.03	1.00	35.4	0.75	74.5
		2035-2040	15.3	8.6	2.10	1.03	1.00	36.6	0.68	75.0
		2040-2045	14.8	9.2	2.10	1.03	1.00	37.7	0.56	75.0
		2045-2050	14.2	9.8	2.10	1.03	1.00	38.5	0.44	75.0
		2070-2075	13.5	12.6	2.10	1.03	1.00	40.4	0.08	75.0
		2095-2100	13.3	13.2	2.10	1.03	1.00	40.6	0.01	75.0
		2120-2125	13.3	13.3	2.10	1.03	1.00	40.6	-0.00	75.0
		2145-2150	13.3	13.4	2.10	1.03	1.00	40.6	-0.01	75.0

\* THE INITIAL AGE-SPECIFIC MATERNITY RATES ARE AS FOLLOWS

1965-1970	15-19	20-24	25-29	30-34	35-39	40-44	45-49
	0.0224	0.1005	0.1210	0.0976	0.0786	0.0185	0.0034



TABLE F BASIC DEMOGRAPHIC MEASURES FOR SELECTED TIME PERIODS 1965 - 2150  
LINEAR DECLINE OF FERTILITY TO NRR OF 1.0 IN 2040-5

SRI LANKA	B.4	PERIOD	FEMALE CRUDE BIRTH RATE	FEMALE CRUDE DEATH RATE	TOTAL FERTILITY RATE	GROSS REPRO- DUCTION RATE*	NET REPRO- DUCTION RATE	TOTAL POPULATION AT END OF PERIOD (IN MILLIONS)	FEMALE AVERAGE ANNUAL RATE OF GROWTH (IN PERCENT)	FEMALE EXPECTATION OF LIFE AT BIRTH
		1965-1970	31.9	7.0	4.53	2.21	1.98	12.1	2.49	65.0
		1970-1975	31.6	6.5	4.37	2.13	1.94	13.7	2.51	66.5
		1975-1980	31.5	6.0	4.21	2.05	1.90	15.6	2.55	68.0
		1980-1985	30.8	5.8	4.05	1.97	1.84	17.6	2.51	69.0
		1985-1990	29.5	5.6	3.88	1.89	1.78	19.8	2.39	70.0
		1990-1995	27.8	5.6	3.72	1.82	1.72	22.1	2.22	70.5
		1995-2000	26.3	5.8	3.56	1.74	1.65	24.5	2.05	71.0
		2000-2005	25.2	5.8	3.40	1.66	1.58	27.0	1.94	71.5
		2005-2010	24.2	5.9	3.24	1.58	1.51	29.5	1.83	72.0
		2010-2015	23.2	6.1	3.07	1.50	1.44	32.2	1.71	72.5
		2015-2020	22.0	6.3	2.91	1.42	1.37	34.8	1.57	73.0
		2020-2025	20.7	6.6	2.75	1.34	1.30	37.3	1.41	73.5
		2025-2030	19.4	6.9	2.59	1.26	1.22	39.7	1.25	74.0
		2030-2035	18.1	7.2	2.43	1.18	1.15	41.9	1.09	74.5
		2035-2040	16.9	7.3	2.27	1.11	1.08	43.9	0.95	75.0
		2040-2045	15.6	7.8	2.10	1.03	1.00	45.6	0.78	75.0
		2045-2050	15.5	8.4	2.10	1.03	1.00	47.3	0.71	75.0
		2070-2075	13.7	11.2	2.10	1.03	1.00	52.7	0.26	75.0
		2095-2100	13.4	13.1	2.10	1.03	1.00	54.1	0.03	75.0
		2120-2125	13.3	13.3	2.10	1.03	1.00	54.2	0.00	75.0
		2145-2150	13.3	13.3	2.10	1.03	1.00	54.1	-0.00	75.0

\* THE INITIAL AGE-SPECIFIC MATERNITY RATES ARE AS FOLLOWS

1965-1970	15-19	20-24	25-29	30-34	35-39	40-44	45-49
	0.0224	0.1005	0.1210	0.0976	0.0786	0.0185	0.0034



TABLE G AVERAGE ANNUAL RATES OF POPULATION GROWTH (IN PERCENT), 1965-2150  
LINEAR DECLINE OF FERTILITY TO NRR LEVEL OF 1.0

SRI LANKA	B.4	PERIOD	PROJECTIONS 1 - 5				
			1970-1975 PROJ 1	1980-1985 PROJ 2	2000-2005 PROJ 3	2020-2025 PROJ 4	2040-2045 PROJ 5
		1965-1970	2.49	2.49	2.49	2.49	2.49
		1970-1975	1.07	2.10	2.39	2.47	2.51
		1975-1980	1.23	1.72	2.32	2.48	2.55
		1980-1985	1.35	1.25	2.17	2.40	2.51
		1985-1990	1.38	1.10	1.95	2.25	2.39
		1990-1995	1.24	1.27	1.66	2.05	2.22
		1995-2000	0.96	1.14	1.36	1.84	2.05
		2000-2005	0.75	0.96	1.08	1.67	1.94
		2005-2010	0.61	0.78	1.04	1.51	1.83
		2010-2015	0.53	0.63	0.97	1.34	1.71
		2015-2020	0.47	0.53	0.87	1.14	1.57
		2020-2025	0.35	0.43	0.71	0.91	1.41
		2025-2030	0.22	0.33	0.56	0.83	1.25
		2030-2035	0.08	0.22	0.44	0.75	1.09
		2035-2040	0.02	0.14	0.37	0.68	0.95
		2040-2045	0.10	0.07	0.29	0.56	0.78
		2045-2050	0.12	0.06	0.21	0.44	0.71
		2070-2075	0.00	-0.00	0.04	0.08	0.26
		2095-2100	-0.01	-0.01	-0.01	0.01	0.03
		2120-2125	-0.01	-0.00	-0.01	-0.00	0.00
		2145-2150	-0.01	-0.01	-0.01	-0.01	-0.00

TABLE H AVERAGE ANNUAL INCREMENTS OF POPULATION (IN THOUSANDS), 1965-2150  
LINEAR DECLINE OF FERTILITY TO NRR LEVEL OF 1.0

SRI LANKA	B.4	PERIOD	PROJECTIONS 1 - 5				
			1970-1975 PROJ 1	1980-1985 PROJ 2	2000-2005 PROJ 3	2020-2025 PROJ 4	2040-2045 PROJ 5
		1965-1970	280	280	280	280	280
		1970-1975	132	265	303	314	319
		1975-1980	161	239	331	356	368
		1980-1985	188	187	346	390	410
		1985-1990	205	208	344	410	442
		1990-1995	197	216	322	416	460
		1995-2000	162	205	284	411	473
		2000-2005	132	183	239	408	493
		2005-2010	110	155	244	400	512
		2010-2015	98	131	240	379	523
		2015-2020	90	112	223	343	521
		2020-2025	69	92	190	288	502
		2025-2030	43	73	155	277	476
		2030-2035	16	48	124	260	442
		2035-2040	4	30	107	242	407
		2040-2045	20	17	86	207	348
		2045-2050	25	13	64	167	328
		2070-2075	0	-1	11	34	135
		2095-2100	-2	-1	-2	6	15
		2120-2125	-1	0	-2	-1	1
		2145-2150	-1	-1	-1	-3	-1



TABLE I AGE STRUCTURE OF POPULATION IN SELECTED YEARS (IN PERCENTAGES), 1970-2075  
LINEAR DECLINE OF FERTILITY TO NRR LEVEL OF 1.0

SRI LANKA		B.4		PROJECTIONS 1 - 5							
YEAR		PERIOD	IN	WHICH	NET	REPRODUCTION	RATE	OF	ONE	IS	REACHED
AGE GROUP		1970-1975		1980-1985		2000-2005		2020-2025			2040-2045
		PROJ 1		PROJ 2		PROJ 3		PROJ 4			PROJ 5
1970											
0 - 4		14.2		14.2		14.2		14.2			14.2
5 - 9		14.1		14.1		14.1		14.1			14.1
10 - 14		12.3		12.3		12.3		12.3			12.3
15 - 19		11.2		11.2		11.2		11.2			11.2
20 - 29		16.3		16.3		16.3		16.3			16.3
30 - 44		17.1		17.1		17.1		17.1			17.1
45 - 64		11.3		11.3		11.3		11.3			11.3
65+		3.6		3.6		3.6		3.6			3.6
1985											
0 - 4		9.2		8.6		12.5		13.5			14.0
5 - 9		7.9		9.9		11.8		12.2			12.4
10 - 14		6.8		10.5		10.8		10.8			10.9
15 - 19		11.6		10.8		9.9		9.6			9.5
20 - 29		21.6		20.2		18.5		18.0			17.8
30 - 44		22.2		20.7		19.0		18.5			18.3
45 - 64		15.8		14.8		13.5		13.2			13.1
65+		4.8		4.5		4.1		4.0			4.0
2000											
0 - 4		8.1		8.6		9.3		11.3			12.2
5 - 9		8.5		8.4		9.7		10.9			11.5
10 - 14		8.4		7.9		9.9		10.5			10.8
15 - 19		7.6		7.0		9.7		9.9			9.9
20 - 29		12.2		16.8		17.4		16.8			16.5
30 - 44		27.1		25.1		21.6		19.9			19.2
45 - 64		21.2		19.6		16.9		15.6			15.0
65+		6.9		6.4		5.5		5.1			4.9
2015											
0 - 4		6.9		7.1		8.1		9.4			10.9
5 - 9		6.7		7.2		7.8		9.3			10.3
10 - 14		6.9		7.5		7.3		9.2			9.7
15 - 19		7.3		7.6		7.9		8.9			9.2
20 - 29		15.3		14.4		16.7		17.0			16.8
30 - 44		17.7		20.8		22.8		20.9			19.8
45 - 64		29.3		26.5		22.0		18.9			17.4
65+		10.0		9.1		7.5		6.5			5.9

TABLE I (CONTINUED)

SRI LANKA F.4

YEAR	PERIOD IN WHICH NET REPRODUCTION RATE OF ONE IS REACHED	PROJECTIONS 1 - 5		
		1970-1975	1980-1985	2000-2005
2030				2020-2025
0 - 4	6.8	6.9	7.1	7.7
5 - 9	6.9	6.8	7.2	7.5
10 - 14	6.8	6.7	7.3	7.9
15 - 19	6.5	6.6	7.2	8.1
20 - 29	12.8	13.6	13.5	15.9
30 - 44	21.1	20.3	21.7	22.1
45 - 64	23.1	24.9	24.6	21.5
65+	15.9	14.2	11.3	9.3
2045				2040-2045
0 - 4	6.6	6.6	6.8	7.2
5 - 9	6.5	6.6	6.7	7.2
10 - 14	6.7	6.7	6.6	7.1
15 - 19	6.7	6.7	6.7	7.0
20 - 29	13.6	13.1	13.7	13.8
30 - 44	25.6	18.9	19.4	21.4
45 - 64	15.5	24.1	25.9	24.6
65+		16.6	14.3	11.7
2060				
0 - 4	6.6	6.6	6.6	6.7
5 - 9	6.6	6.6	6.6	6.7
10 - 14	6.6	6.5	6.7	6.7
15 - 19	6.5	6.5	6.6	6.8
20 - 29	12.9	13.1	12.9	13.5
30 - 44	19.8	19.4	19.8	19.5
45 - 64	23.8	24.6	24.0	25.4
65+	17.3	16.6	16.8	14.7
2075				
0 - 4	6.5	6.5	6.6	6.6
5 - 9	6.5	6.6	6.5	6.6
10 - 14	6.5	6.6	6.5	6.6
15 - 19	6.6	6.6	6.5	6.5
20 - 29	13.1	13.0	13.2	13.1
30 - 44	19.1	19.4	19.2	19.7
45 - 64	24.6	24.2	24.8	24.4
65+	17.0	17.2	16.7	16.6



# The Prospects for a Stationary World Population

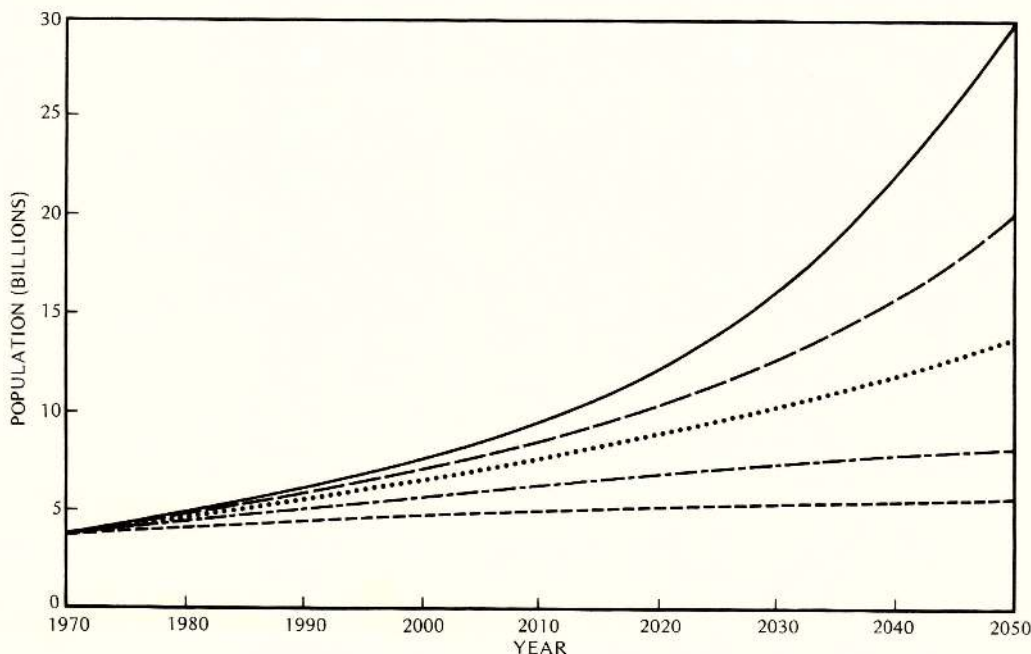
by TOMAS FREJKA

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IF A NATION wants to achieve zero population growth, when can it reasonably expect to do so? If the policymakers of another nation are concerned about a possible decline in population, what information is available to them about when the decline may begin? What alternatives of growth for the population of the world or any of its parts are realistic over the next several decades? What kind of demographic trends, mainly relating to fertility, will have to be generated if a certain desired rate of growth (and thus size of population) is to be achieved?

Questions of this kind have formed the basis for a research project in which I have been involved at the Population Council and earlier at the Office of Population Research of Princeton University. The main methodological tools were population projections, which are designed to facilitate understanding of the short-term and long-term implications of current basic demographic features and are meant to be instrumental in assessing realistic goals of population change. Among other findings, the research shows that a substantial growth of the world's population must be accepted and planned for and that the present ratio of 30 : 70 between the populations of the rich and the poor nations will swing inexorably to 20 : 80 and perhaps even to 10 : 90 [see Figure 1].

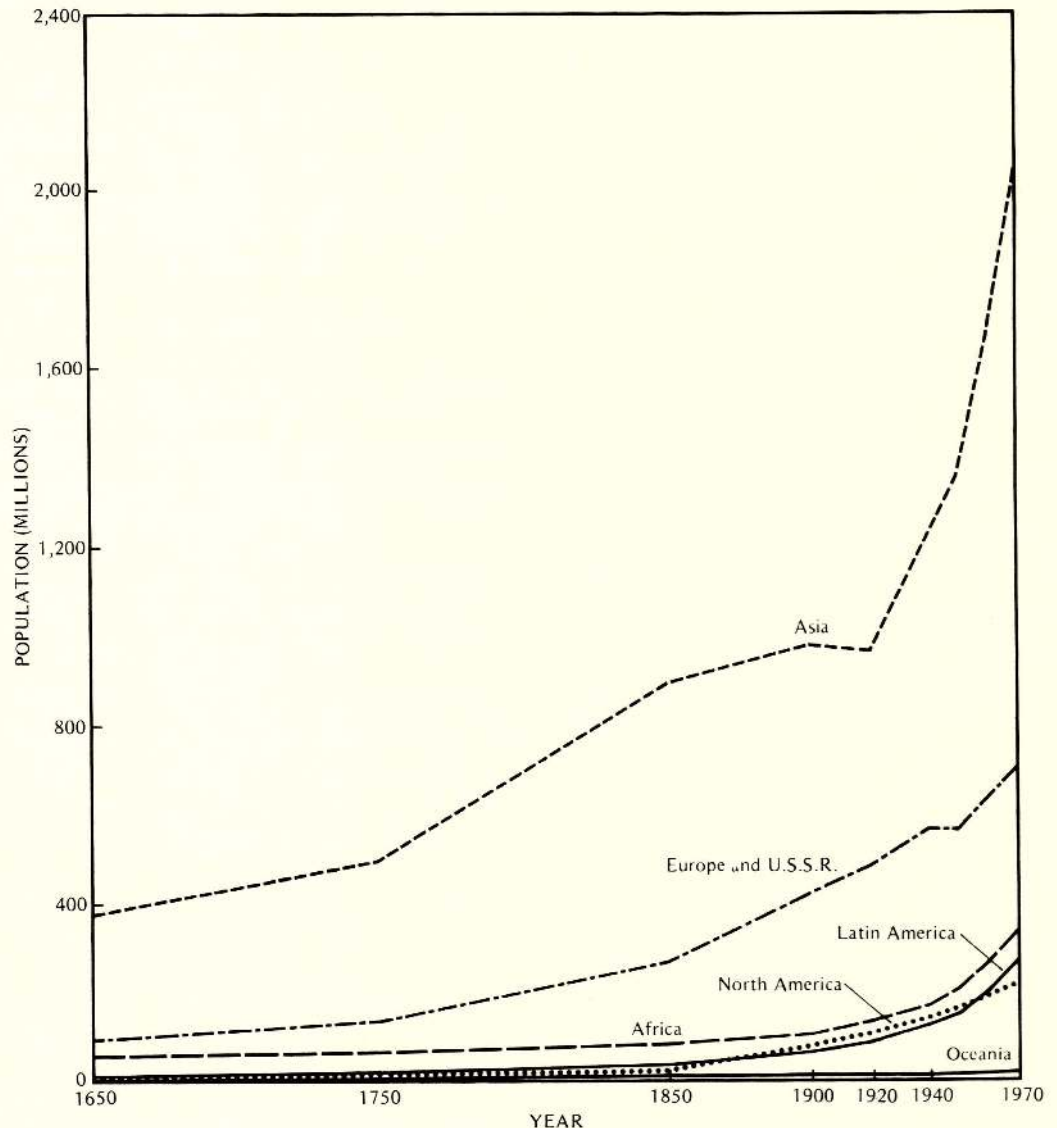
**FIGURE 1 Differing projections of the world's population on the basis of different assumptions.** NOTE: Smallest increase (*bottom*) would occur if a net reproduction rate of 1, which implies replacement-level fertility, were achieved in the early 1970's. The population would still rise for a time because many people are of childbearing age. Other projections assume that a net reproduction rate of 1 is achieved between 2000 and 2005 (*broken dashed line*) or between 2040 and 2045 (*dotted line*) that present fertility and mortality rates continue (*broken line*) and that fertility remains constant while mortality declines (*solid line*).



Until about 1700 the human population of the world grew very slowly [see Figure 2]: probably at an average rate of less than .002 percent per year. Now on a world-wide basis the rate is 1,000 times higher: 2 percent per year [see Figure 3]. The current state of affairs is the result of complex economic and social changes. They have been accompanied by a major change in the patterns of fertility and mortality that students of population call the demographic transition.

**THREE STAGES** of the demographic transition can usually be detected in every population. The first stage is characterized by high and almost equal birth and death rates and by a low rate of growth. That pattern has existed in most populations throughout most of history. In the second stage mortality declines and is followed by a lagging decline in fertility, so that the rate of population growth is high. The third stage is characterized by low birth and death rates and therefore by a rate of growth that declines gradually.

**FIGURE 2 Regional growth of the world's population from 1650 to 1970.** NOTE: At the beginning of the period the total population of the world was about 553 million. By 1850 it was 1.3 billion. Since 1900 it has gone from 1.6 billion to the present 3.6 billion.

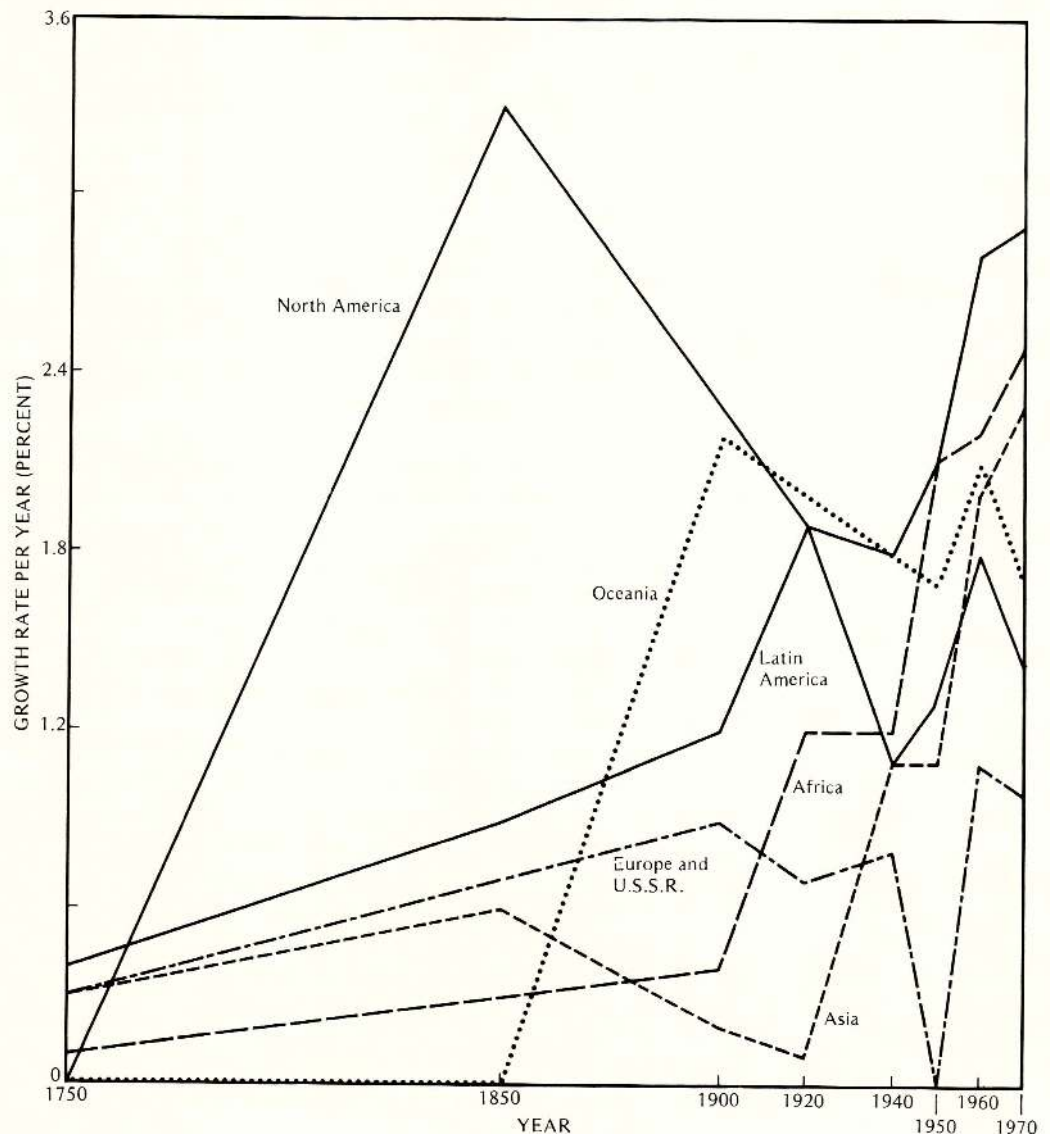




The span of time during which the demographic transition takes place varies considerably among populations. So far the transition has run most of its course only in developed countries. The majority of the developing countries are in the second stage. Moreover, the decline in mortality has been more precipitous in these countries than it was in the developed countries, resulting in growth rates that are considerably higher than the ones experienced in the developed countries. That is the principal reason the growth rate of the total human population is at the high level of 2 percent per year.

The experience of history suggests that the population of the world may eventually reach a state close to nongrowth, that is, all countries will be in the third stage of the demographic transition. What demographic developments will have to take place for that stage to be attained? How long will it take, barring catastrophes of natural or human origin? How large will the world's population be when nongrowth is achieved?

**FIGURE 3 Regional differences in growth between 1650 and 1970 expressed in terms of the growth rate (percent per year).** NOTE: For thousands of years the [world population] growth rate was about .002 percent. It is now some 2 percent.





One begins with the fact that a continuation of the present growth rate (not to mention an increase in the rate) would bring the population of the world close to seven billion around the year 2000, 14 billion in the 2040's and 28 billion in the 2070's. (It is now about 3.6 billion.) In the developed countries, however, the demographic behavior of populations has changed radically over the past few centuries. In those countries an increasing number of people have relatively small families and live to see their grandchildren grow up. Fertility and mortality patterns of this type yield rates of natural increase (a figure that ignores migration in or out) of less than 1 percent per year. Indeed, during the past decade the rate of natural increase has been decreasing in the developed countries.

The demographic behavior of populations in the developing countries is distinctly different. The conditions that generated low mortality levels in the developed countries have been spreading to the developing countries rather rapidly, whereas fertility levels in those countries have changed slowly or not at all. The average rate of natural increase has been estimated at 2.6 percent per year in the late 1960's, with a crude birth rate of more than 40 per 1,000 inhabitants and a crude death rate of about 15 per 1,000. (All evaluations of the situation in developing countries as a whole must be qualified by the fact that there is increasing evidence of changes in demographic behavior in the People's Republic of China. The magnitude and rate of the changes are unknown, at least to the rest of the world.)

In the developed countries, even though demographic patterns have varied from country to country over the past 50 years, it is clear that the populations are reproducing themselves in a regime of low mortality and low fertility; indeed, the regime has intrinsic features close to nongrowth. Yet an examination of the crude death and birth rates and the rates of natural increase gives rise to a seeming contradiction: the populations are in fact growing at an average rate of close to 1 percent per year. The paradox arises from the fact that growth trends are not determined solely by the mortality and fertility levels of a population; one must also take into account the age structure, which is a product of past mortality and fertility patterns. The crude rates provide information on relative additions to and deductions from the present population, but they are not "true" measures of the level of mortality and fertility; they are products of the mortality and fertility levels for each age group and of the number of people at each age.

**GREECE AND BELGIUM** provide an illustration of the influence of age structure on growth trends. In 1967 the crude death rate was 12 per 1,000 in Belgium and 8.3 in Greece; the crude birth rate was 15.3 in Belgium and 18.7 in Greece. As a result the rate of natural increase was .3 percent in Belgium and 1 percent in Greece. (The difference may seem small, but one should bear in mind that a persisting growth rate of .7 percent per year causes a population to double in 100 years. Moreover, Greece was growing at a rate three times higher than Belgium.) The differences in the crude rates were primarily due to differences in the age structure of the two populations [see Figure 4].

In both populations the patterns of mortality (the relative numbers of people dying at various ages) and the patterns of fertility (the average number of children born to women of various ages) were similar. The age structures, however, differed significantly because throughout the 20th century fertility has been higher in Greece than in Belgium. In 1967 Belgium had a much older population than Greece (13 percent of the people were older than 65, compared with 9 percent in Greece), meaning that significantly more of Belgium's people were in the age groups having a high frequency of death. At the same time Belgium had a smaller proportion of potential mothers than Greece: females in the age group from 20 to 34 accounted for 18 percent of the female population, compared with 23 percent in Greece. Therefore, although in both populations the same relative numbers of children were being born per 1,000 potential mothers, the absolute number of children born was higher in Greece than in Belgium, as was the crude birth rate.

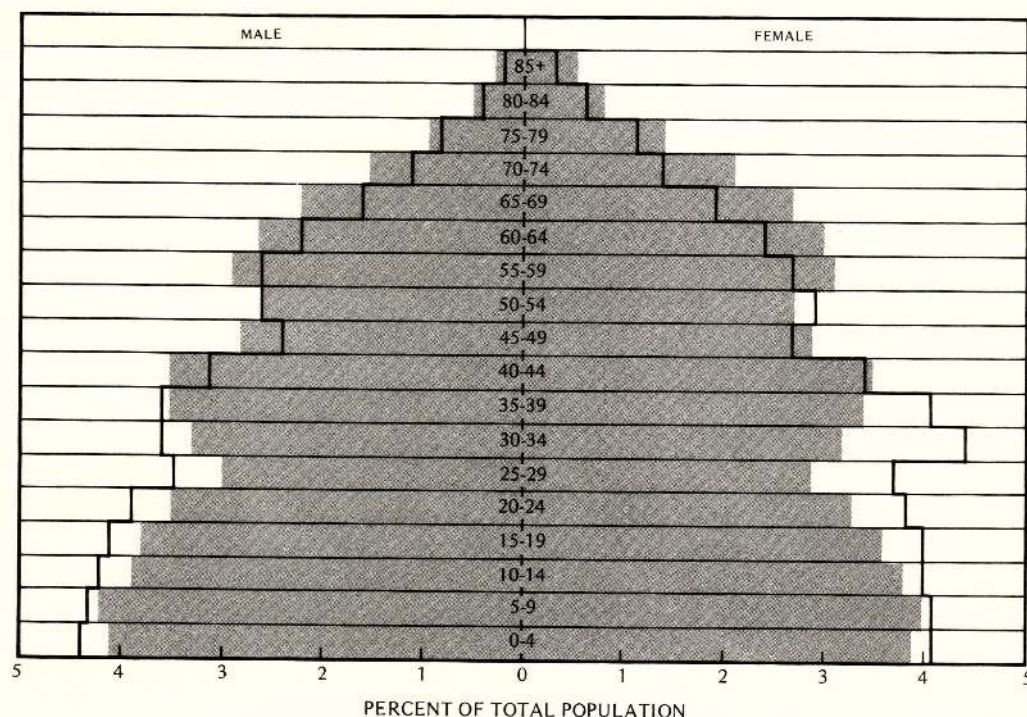


Demographic measures somewhat more complex than the crude birth and death rates provide information on fertility and mortality without regard to the age structure of the population. On the fertility side are the total fertility rate and the gross reproduction rate. On the mortality side is the expectation of life at birth. The combined effect of both fertility and mortality is expressed by the net reproduction rate.

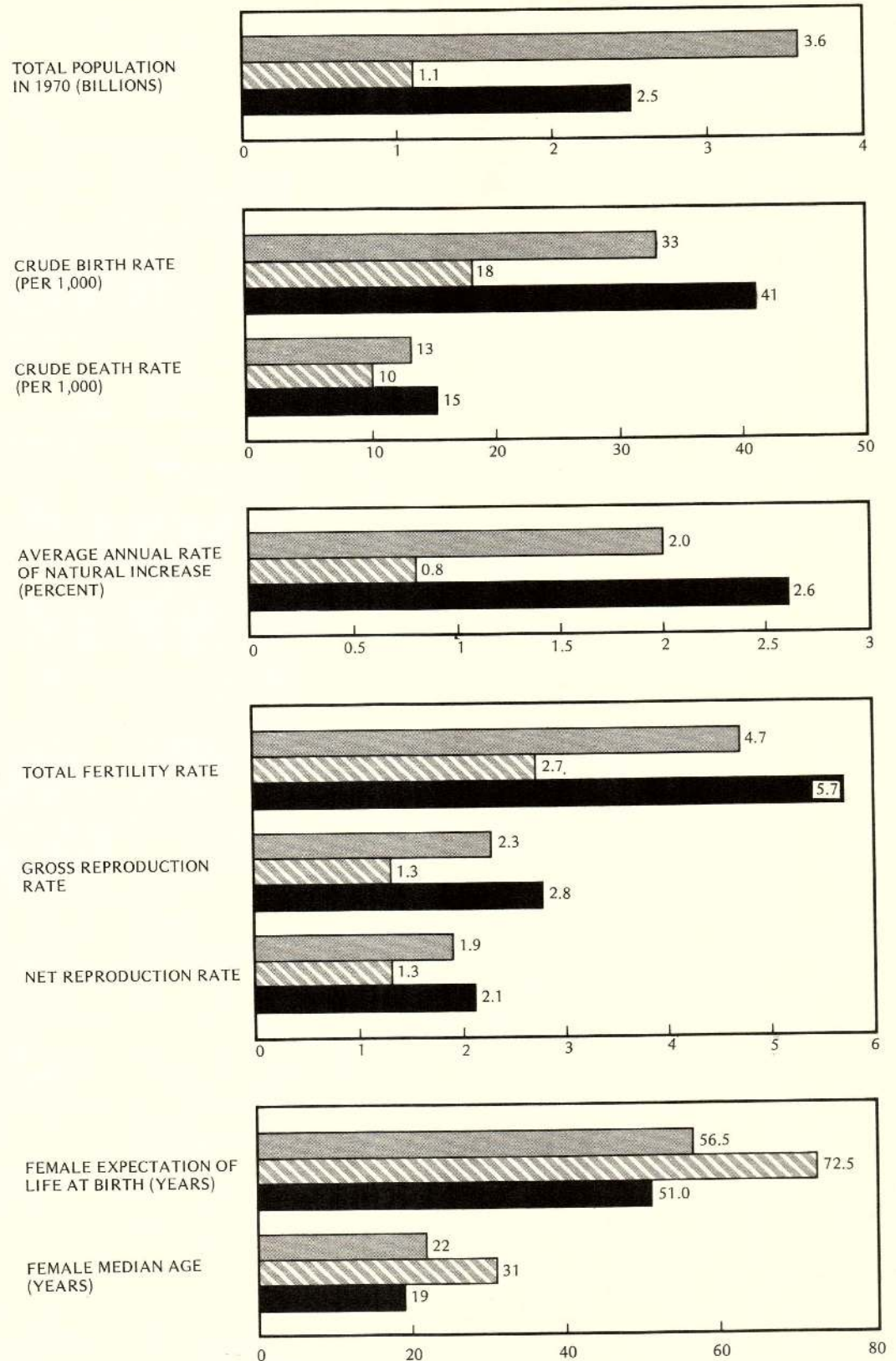
The total fertility rate is defined as the average number of live children a woman would bear if she passed through her years of potential motherhood experiencing the current fertility of women at each age. In fact, the fertility of women at one age influences their later reproductive performance, so that in 1973 the fertility of 21-year-old women (who were the ones aged 20 in 1972) may differ from the 1972 rate for the women of 21. The total fertility rate is thus an artificial measure referring to a hypothetical woman, but it does provide a reasonable approximation of the average number of children borne by a woman in the respective populations. The gross reproduction rate is built on the same theoretical base as the total fertility rate but refers only to the average number of daughters who would be borne by a woman passing through her childbearing years.

The expectation of life at birth is about 70 years in the developed countries, implying low levels of mortality at all ages. Usually fewer than 30 infants in 1,000 die before reaching their first birthday, and about 95 percent of the children born survive at least to age 20. In many developing countries the expectation of life at birth is still no more than about 40 years, although the range of mortality differences is wide. Where the life expectancy is around 40 years, the usual picture is that more than 200 infants in 1,000 die before their first birthday and that only about 60 percent of all the children born survive at least to age 20 [see Figure 5].

**FIGURE 4 Population structure in Belgium (pyramid in gray) and in Greece (pyramid outlined in black).** NOTE: In Belgium 13 percent of the people are older than 65, in Greece 9 percent. Hence Belgium has a larger proportion of people at ages where the risk of death is high. Belgium also has a smaller proportion of potential mothers than Greece, since only 18 percent of the females in Belgium are in the age group from 20 to 34 compared with about 23 percent in Greece.



**FIGURE 5 Demographic features for the world (gray), the developed nations (striped) and the developing nations (black).** NOTE: Total fertility rate is an average of live children born to a woman. Gross reproduction rate refers to the average number of daughters borne by a woman. The net reproduction rate indicates how one generation of childbearers is being replaced by the next one. A net reproduction rate of 1 implies bare replacement.





**THE NET REPRODUCTION RATE** provides information on how many daughters of the average woman would survive to childbearing age if they were subject to the current mortality patterns. Thus under conditions of high mortality the difference between the net reproduction rate and the gross reproduction rate is large, whereas under conditions of low mortality the net rate is not much smaller than the gross rate. These relations are illustrated by a comparison of Costa Rica and the Ivory Coast. The net reproduction rate is higher in Costa Rica than in the Ivory Coast, although fertility, as measured by the total fertility rate and the gross reproduction rate, is the other way around.

The net reproduction rate is an indicator of how a population is being reproduced. When the rate is around 1, it shows that the current fertility and mortality conditions are such that the current generation of childbearers would be replaced by a generation of the same size, provided that the conditions persisted. Fertility corresponding to this value is called replacement fertility. In the developed countries a total fertility rate of about 2.1 is the replacement fertility.

At the beginning of the 1970's a number of nations had fertility levels of this type. Among them were the U.S., Canada, Denmark, Finland, Sweden, Bulgaria, Czechoslovakia, Hungary, Poland, Japan and possibly other countries. Nonetheless, the populations of these countries were still growing, often at rates of close to 1 percent per year, because of their previous demographic history, which was present in and acting through the age structure.

In most of the population projections that I shall discuss it is assumed that a fertility and mortality regime with a net reproduction rate of 1 will be achieved and maintained. The value is justifiable for historic reasons (since the net reproduction rate must have been close to 1 for thousands of years) and because any other value persisting indefinitely would cause the population either to grow infinitely or to decline to zero. Moreover, in many developed countries new demographic patterns seem to be emerging that suggest a trend toward a net reproduction rate oscillating around a value close to 1.

**IN THE POPULATION** projections that I have prepared (a set of five for each population) the current demographic features of the population under consideration serve as the starting point [see Figure 6]. The projections differ by the assumed point in time when the net reproduction rate of 1 is reached and thereafter maintained. Thus they also differ by the assumed rate of fertility decline. The projections assume that the present fertility level declines to a level corresponding to a net reproduction rate of 1 immediately [Projection 1] or over a period of 10, 30, 50 and 70 years [Projections 2 through 5 respectively]. The current level of mortality of every population is assumed to decline further, settling eventually at the lowest levels now experienced. For technical reasons the computations were done only with female populations, but the results are acceptable approximations of total population features and trends.

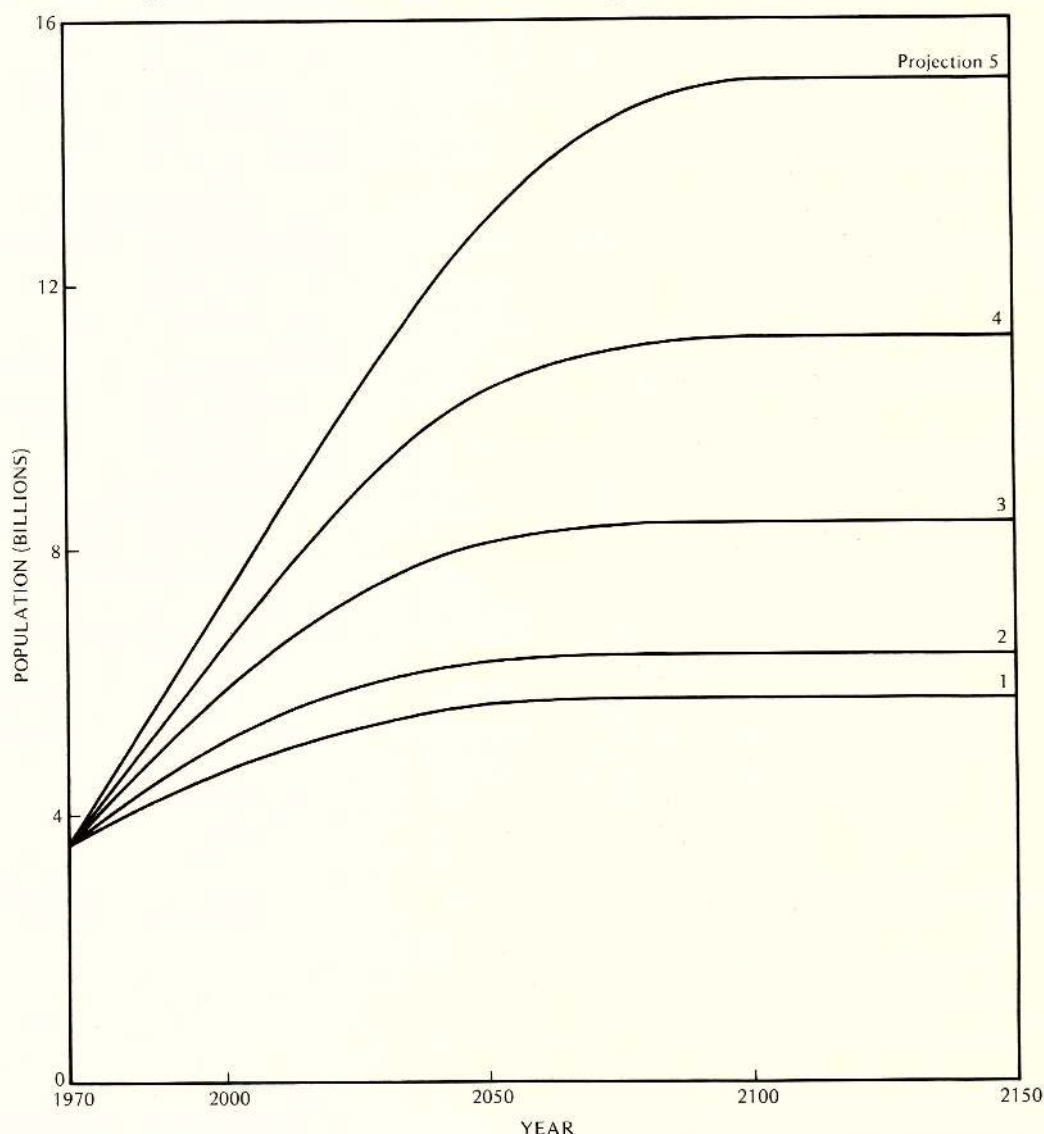
The range of possibilities for the future growth of the world's population is so large that it is well to set arbitrary limits that seem to represent the extremes. The minimum, which would be achieved if fertility declined so rapidly that a net reproduction rate of 1 was reached between 1970 and 1975, must be ruled out as highly unlikely. This minimum alternative, however, is informative because it illustrates developments that are not likely to materialize. For the other extreme one might assume constant fertility and declining mortality. This alternative seems unlikely but not impossible, since it portrays a situation that exists in a number of less developed countries.

At the minimum extreme the achievement immediately of a worldwide net reproduction rate of 1 would still result in a population increase of 30 percent in 30 years and more than 50 percent in 80 years (to a level of 4.7 billion in the year 2000 and 5.5 billion in 2050), since most populations currently have a preponderance of people of childbearing age. With constant fertility and declining mortality the population of the world could be 7.4 billion in 2000 and close to 30 billion by 2050.



Since these limits are so far apart there are many alternatives between them. The actual path will depend on the trends of mortality and fertility. Assuming that mortality will continue to decline, one can foresee that with a rather rapid decline in fertility the world's population would be about six billion in 2000 [Projection 3] and that with a moderate decline in fertility it would be 6.7 billion [Projection 5]. In the first case the current average of 4.7 children born to each woman of childbearing age would have to decline during the next 30 years to about 2.2; in the second case it could be about 3.5. If a worldwide pattern of two children per family on the average—that is, a net reproduction rate of 1—were reached by 2000 and maintained thereafter, the world's population would be about eight billion by 2050 but would not grow much more. If a net reproduction rate of 1 were reached gradually by the middle of the next century, the population would be 13 billion in 2050 and some 15 billion in 2100.

**FIGURE 6 Population projections based on five assumptions about when a net reproduction rate of 1 might be achieved and maintained.** NOTE: Reading from the bottom the dates are respectively 1970 to 1975, 1980 to 1985, 2000 to 2005, 2020 to 2025 and 2040 to 2045. With an index of 100 for the 1970 population, the indexes under the five respective projections would rise by 2050 to 153, 172, 224, 287 and 357 and by 2150 to 156, 176, 230, 306 and 416.





**TABLE 1** Changes required in demographic features to achieve certain of the population levels projected in Figure 6. NOTE: Achievement of even the upper levels would require a significant decline in the present total fertility rate.

	Year	Total population (billions)	Crude birth rate	Average annual growth rate	Average annual increment of population (millions)	period	Net reproduction rate	Total fertility rate
	1970	3.6	33	2.0	68	1965-1970	1.9	4.7
	IF IN YEAR	THE FOLLOWING CHARACTERISTICS ARE TO BE ACHIEVED				THEN IN PERIOD	THE FOLLOWING RATES ARE NECESSARY	
Projection 1	2000	4.7	18	0.8	37	1970-1975	1.0	2.5
	2050	5.6	14	0.2	9	1980-1985	1.0	2.4
	2100	5.7	13	0.0	0	1990-1995	1.0	2.3
						2000-2005	1.0	2.2
Projection 2	2000	5.1	19	1.0	49	1970-1975	1.6	3.9
	2050	6.3	14	0.1	7	1980-1985	1.0	2.4
	2100	6.4	13	0.0	0	1990-1995	1.0	2.3
						2000-2005	1.0	2.2
Projection 3	2000	5.9	21	1.2	70	1970-1975	1.8	4.4
	2050	8.2	14	0.3	21	1980-1985	1.6	3.7
	2100	8.4	13	0.0	0	1990-1995	1.3	2.9
						2000-2005	1.0	2.2
Projection 4	2000	6.4	25	1.7	106	1970-1975	1.8	4.5
	2050	10.5	14	0.5	50	1980-1985	1.7	4.0
	2100	11.2	13	0.0	2	1990-1995	1.6	3.6
						2000-2005	1.4	3.1
Projection 5	2000	6.7	28	2.0	124	1970-1975	1.9	4.6
	2050	13.0	16	0.8	97	1980-1985	1.8	4.2
	2100	15.1	13	0.0	5	1990-1995	1.7	3.9
						2000-2005	1.6	3.5

**ALTHOUGH THE FUTURE SIZE** of the world's population is to a considerable extent predetermined by the current demographic features—levels and patterns of mortality and fertility, together with the age structure—much will depend on how such characteristics change. Mortality is already fairly low and is likely to decline further, barring major and persisting catastrophes. Fertility is still rather high, being more than twice the level that would ultimately result in a nongrowing population, and even if it declines, the decline is likely to be gradual. The age structure of the world's population is highly favorable to growth because a small proportion (fewer than 6 percent) of the population are more than 65 years old and a large proportion of the women are in the childbearing ages. It is of still more importance that relatively large numbers of women will enter the childbearing ages in the coming decades, since about 37 percent of the world's population are under 15 years of age. Moreover, at least during the 1970's generations of comparable size are likely to be born and to survive, judging from current fertility and mortality levels and patterns.



If the mortality trends of the future are roughly consistent with those of the past few decades and fertility declines rather rapidly, the world's population may develop along the path indicated by Projection 3: somewhat less than six billion people in 2000 and somewhat more than eight billion by 2050. A level as low as five billion by 2000 seems highly unlikely because of the built-in potential for growth and because it is unreasonable to expect average fertility behavior to change so rapidly throughout the world that by the 1980's only two or three children will be born to each woman on a worldwide basis.

[Figure 6] presents data that give a general idea of the kind of population development that will result from various speeds of decline in the fertility rate. Projection 1, which shows that a total fertility rate of 2.5 would have to be achieved in the early 1970's for the population of the world to be as low as 4.7 billion in 2000 and below six billion in 2050, illustrates developments that are most unlikely, if not impossible. Projection 3, which assumes that the total fertility rate will drop to 4.4 in the early 1970's and 2.2 by 2000 for a world population of 5.9 billion in 2000 and about eight billion in 2050, can be considered as illustrating developments that would take place if the demographic transition (mainly the fertility decline in the developing countries) were relatively fast and the change in fertility behavior from traditional to modern were attained within about one generation. Projection 5, wherein the total fertility rate is seen as 4.6 in the early 1970's and 3.5 by 2000, with a total population of 6.7 billion in 2000 and about 13 billion in 2050, illustrates developments that might occur if the demographic transition in the developing countries were to take as much time as it did in western Europe.

The data provide a basis for an answer to the question that is often raised about whether it might be possible to achieve zero population growth for the world by 2000. The answer is that such an achievement is most unlikely and probably impossible, unless there are unexpected changes in the world's economic, political and social relations, unanticipated evolutions in education and health or unforeseen high levels of mortality. To achieve zero population growth by 2000 the total fertility rate throughout the world would have to drop far below replacement level, reaching 1.1 by 2000.

**NO MATTER** how rapidly fertility declines in the less developed countries, their population growth in the coming decades is likely to be different from the growth in the developed countries [see Figure 7]. Even if current fertility does not change, the developed countries would have only about twice their present population in 2050 where

as a drastic decline in fertility would be needed in the developing countries if their population is to be in 2050 no more than twice what it is now. Even if the less developed countries were to achieve a net reproduction rate of 1 by 2000, they would grow by about 2.5 times by 2050. With a moderate but nonetheless meaningful fertility decline that brought a net reproduction rate of 1 by about 2050, the population of the less developed countries would be about 4.5 times what it is now.

In the more developed regions a population growth of from 15 to 25 percent can be expected by 2000, and by 2050 they could have from 30 to 60 percent more people than they did in 1970. The population of the less developed countries can be expected to grow by 80 percent and perhaps by 100 percent between now and 2000. If current fertility remains constant and mortality declines, the population of the less developed countries could be more than 10 times its present size by 2050.

A logical consequence of the different growth rates of the two main segments of the world's population will be a change in their size ratio. The extent of the change will depend mainly on how fast fertility declines in the less developed countries. The shift from the present ratio of 30 : 70 to something like 20 : 80 by 2050 could also be affected by the fact that several of the nations now classified as less developed may by 2050 have become more developed [see Figure 8].



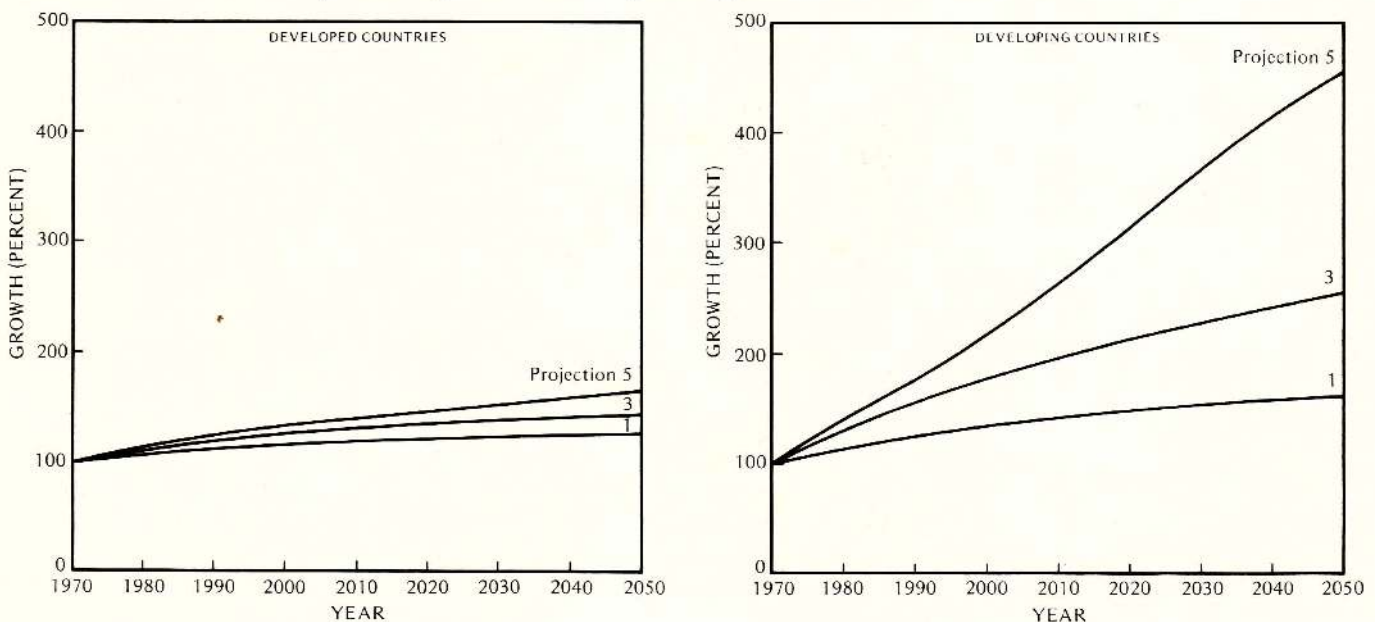
**A SOCIOECONOMIC CLASSIFICATION** employed by the United Nations divides the world into eight major areas: East Asia, South Asia, Europe, the U.S.S.R., Africa, North America, Latin America and Oceania. Current demographic conditions differ from one region to another. Latin America probably had the highest growth rate in the late 1960's (2.9 percent per year), fairly high fertility (a total fertility rate of 5.5 from 1965 to 1970) and relatively low mortality (a female expectation of life at birth of 62.5 years). Africa had the highest total fertility rate (estimated at 6.4), and yet its population growth rate was 2.5 percent per year because mortality levels in Africa are the highest in the world. (Female expectation of life at birth was estimated at 44.5 years in the late 1960's.)

Clearly the major areas of South Asia, Africa and Latin America have a high built-in potential for further population growth. For example, with a fertility decline of the Projection 5 type the population of South Asia could reach five times its present size by the middle of the next century.

A considerable unevenness in the speed of population growth from region to region can be expected and will become evident in changes in the relative distribution of population. If growth proceeds along the lines of Projection 4, for example, the proportion of the world's population living in South Asia would increase from the current 30 percent to 40 percent, in Africa from 9 to 12 percent and in Latin America from 7 to 10 percent. By the same token the proportion of the population living in Europe would decline from 14 percent to 6 percent, in the U.S.S.R. from 8 to 4 percent and in North America from 7 to about 4.5 percent.

In the demographically less developed countries where there is a consensus that a slowing down of the population growth rate would be desirable, the starting date of the decline in fertility, the speed of the decline and thus the time when fertility levels approximating replacement are reached are crucial. For such countries it would be worthwhile to make moves toward this end as soon as possible. Because the potential of most less developed countries for population growth is so high, many of them could reach four times their present size within 50 years if they did not move toward the goal of a reduced growth rate and mortality rates continued to decline as they have in recent years.

**FIGURE 7 Growth prospects for the developed countries (left) and the developing countries (right).** NOTE: The prospects are as envisioned in Projections 1, 3 and 5 of the five projections depicted in several preceding illustrations.





Several demographically more developed countries, such as Poland and France, have expressed concern about a lagging growth of population or a lack of growth. In terms of total population the fear does not seem to be justified, since these nations will experience a growth of from 20 to 30 percent if they maintain replacement fertility from now on. Only a few nations—the Federal Republic of Germany, the German Democratic Republic, Austria and Sweden—can expect their population to remain at about the present level. A decrease of numbers seems unlikely but not impossible for most populations until at least the end of the 20th century.

To achieve a nongrowing population in this century, even in most of the more developed countries, fertility would have to decline significantly below the replacement level. In the less developed countries such an event seems inconceivable during the coming 50 years, provided that mortality conditions do not deteriorate and there are no major disasters. The achievement of a nongrowing population is likely to take several decades in most of the more developed countries and many decades in the less developed countries.

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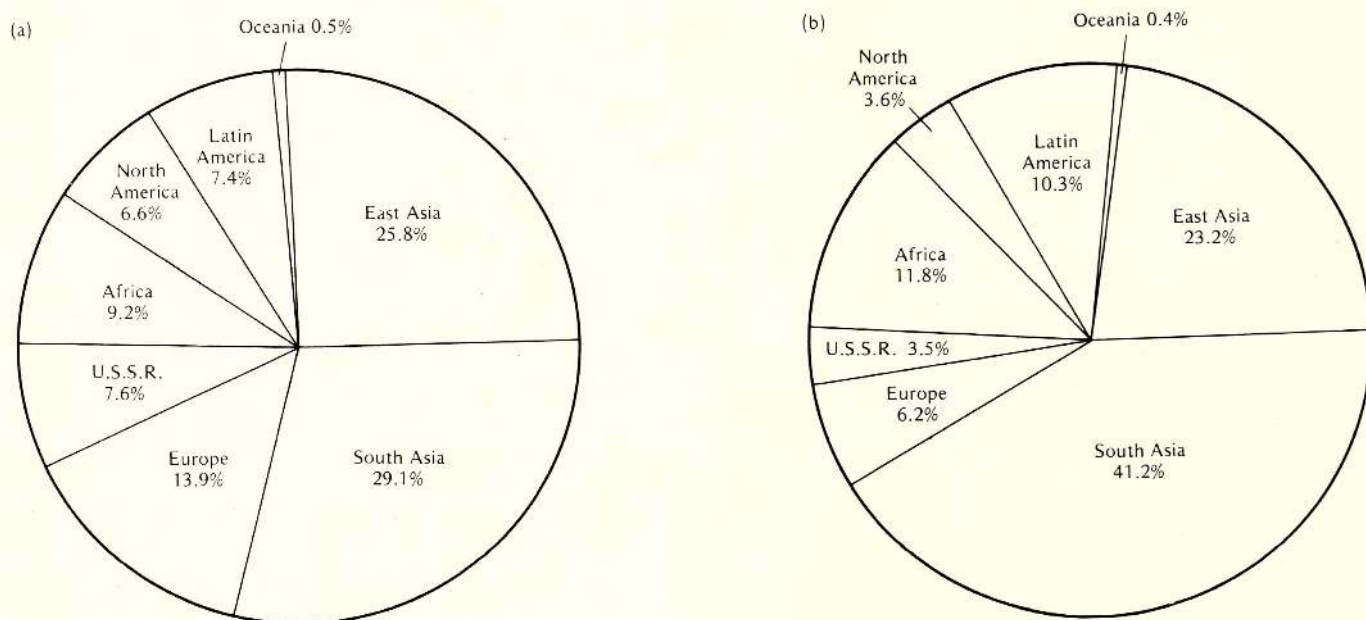
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**FIGURE 8** Shift in proportions of the population living in eight major areas of the world as it could be expected under Projection 4, which assumes a net reproduction rate of 1 by the period 2020 to 2025. NOTE: The present proportions (a) are compared with the projected proportions for the year 2100 (b). The eight areas are employed by the United Nations for socioeconomic classification.





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