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LONG-RANGE GLOBAL POPULATION PROJECTIONS
- based on data as assessed in 1978 -

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This paper is one in a series of working papers dealing with population issues. Complimentary copies of this paper as well as earlier ones are available from the Population Division, United Nations, New York. Comments and suggestions are welcome and may be sent to the Population Division.

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INTRODUCTION

1. There is growing interest today among development planners, public administrators, social scientists and many others, both at national and international levels, towards the scientific assessment of future population growth. The interest ranges from population prospects of individual nations in the immediate future to a long-range perspective of the global population. For the past 30 years the United Nations has provided a series of global population projections, including projections for individual countries covering the period up to the year 2000. (The projection span will be extended to 2025 in the 1980 round of the projections.) However, the limited span of projection to the future has naturally aroused fresh concerns about further growth perspectives of the global and regional population beyond the year 2000. This concern for the long range future has a legitimate basis because of the fact that the world population over the past few decades has been growing at an unprecedented, rapid pace in the history of mankind, which growth has generated a fear of unmanageable population explosion in the future. This study is an attempt to explore the possible growth paths of the global population in the 21st century and beyond by extending the latest United Nations population projections.

2. According to the 1978 round of the United Nations estimates, the world population today is growing at an annual rate of 1.8 per cent. It implies that world population will double in 39 years if this rate should be sustained. For the less developed regions as a whole, which comprise nearly three quarters of the world total population, the average annual growth rate is 2.2 per cent. This means that the number of years required for doubling the population of the less developed regions would be 32 years. The significance of these figures, although the assumption of constant growth rate is purely hypothetical, should be obvious when one reminds oneself of the millions of years needed for human population to grow to its current size.

3. Of course, it is very unlikely that the current growth rate will remain unchanged in the future. In the past it has gone through rather significant ups and downs. For the world as a whole, the growth rate of population, which had been very slow until the middle of the 18th century, started to rise gradually since then. The increase apparently gained a momentum after world war II and reached a peak of around 2 per cent per year in the early 1960s. After 1965, however, there are indications that the rate began to fall gradually and that it will continue to fall throughout the current century. According to the United Nations medium-range projections, the annual rate of increase of the world population will drop from the current 1.8 per cent to 1.5 per cent by the year 2000.

4. The observation of these population trends seems to render some substantive support to the view that the current rapid population growth of the world is a transitional phenomenon in the history of the human being which will eventually be abated, and that the global population will become stationary. This view, often referred to as the demographic transition

theory, serves in the present study as the fundamental hypothesis on the basis of which future population trends are projected. Precise sequences of demographic transitions and their causes have yet to be established by further studies. But if the theory is valid as the explanation of today's events, recent demographic trends in the less developed countries, especially in East Asia and Latin America, indicate that they are entering the latter phases of the demographic transition in which existing wide gaps between birth and death rates are narrowing as birth rates continue to fall more rapidly than death rates. If future demographic trends in Africa and South Asia should follow a similar pattern, population projections presented in the present report would not be too far from the actual course of development.

5. The improvement in the collection and analysis of demographic data in recent years helps to undertake an exercise of long-range population projection like the present one. According to the experiences at the United Nations the accuracy of projection will never be assured if the knowledge about the present situation is deficient. Thanks to the efforts of all the governments as well as the international organizations, statistical data collection has been improved tremendously in the past twenty years or so, providing fairly accurate measures of population sizes and levels of fertility and mortality. A very significant development in this respect was the recent access to demographic information from China. Because of her population size, any estimates or projections of the global population will lose reliability if China's population trends are not precisely known, which was the case until a few years ago. Demographic projections can now be provided with more confidence than before because of the improvement in the basic demographic information in many other countries as well.

6. Nevertheless the present demographic theory and substantive knowledge do not allow us yet to make precise predictions of the future. In the medium-range population projections of the United Nations, allowances for the deviations of future demographic trends from our standard projections (medium variant) are provided by the high and low variants of projections. Differences among those variants are primarily the result of our assumptions about how fast the currently high fertility levels among the developing countries will fall. To a lesser extent, however, different assumptions were also provided for many countries about the tempo of mortality decline. In the long-range projections presented in this study, three variants of projections are presented as the extensions of the corresponding variants in the medium-range projections of the United Nations beyond the year 2000. It is our view that future population growth will likely, but not necessarily, follow a path moving within a range outlined by the high and the low variants respectively barring catastrophe, large-scale war, and other unexpected events.

7. In addition to the three variants, two hypothetical variants are presented in the text for an illustrative purpose. One is based on the assumption that the currently existing fertility levels are maintained unchanged in the future. Another variant assumes an immediate shift of fertility levels to the replacement level, that is a net reproduction rate of one, which is maintained ever after. Both assumptions are unrealistic, but they will serve to define the limits of the ranges of possible future demographic trends.

8. It is believed that demographic changes so far have evolved in response to non-demographic development surrounding the human population, and will do so in the future as well. At the same time, population growth has affected, and will continue to affect, the socio-economic and political development of the world around us. In the present study, however, no attempts are made to relate the demographic projections to non-demographic factors, except to assume that the on-going development in the social and economic fields, population policies of governments and non-governmental population activities will be sustained, thus enabling the demographic transition to proceed uninterruptedly.

METHODS AND ASSUMPTIONS

9. There are many alternative methods of population projections available today ranging from very simple to very sophisticated ones such as multi-variable simulation models which became fashionable with the introduction of high-speed computers. One of the simplest ways of population projection currently in use is to assume that the present rate of population growth will remain unchanged or will change in a certain way in the future. One of the problems often found with this method, however, is that an assumption about future growth rate tends to become rather arbitrary. As the result, we often find differences too great to accept as valid among alternative projections prepared by this method. On the other hand, the more sophisticated method, such a multi-variable computer model, usually requires a large amount of input data including economic, social, environmental as well as demographic ones which are not easy to provide in most cases. Moreover, the inclusion of many variables makes it extremely difficult to formulate concrete functional relations among them which should remain valid at present as well as in the future.

10. In this study, therefore, one of the widely-used demographic methods of projections, namely the component method of projection, was used to project long-range population trends. This method, which has been described more fully elsewhere, 1/ begins with estimation of the base population classified by age and sex at the starting point in time and subsequent application to it of assumptions on age-specific fertility rates, survival ratios and migration rates for successive future periods. In actual computations, however, these age-specific rates are substituted for by the gross reproduction rate and the expectation of life at birth, which are later converted into age-specific fertility and mortality rates by built-in

1/ "Development of the methodology used in the United Nations global projections", Prospects of Population: Methodology and Assumptions (United Nations publication, Sales No. E.79.XIII.3), pp. 12-41.

subprogrammes in the United Nations demographic projections programme. ^{2/} With respect to international migration, no migration is assumed in this study beyond the year 2000, because this component is very difficult to predict and will not directly affect the global total anyway.

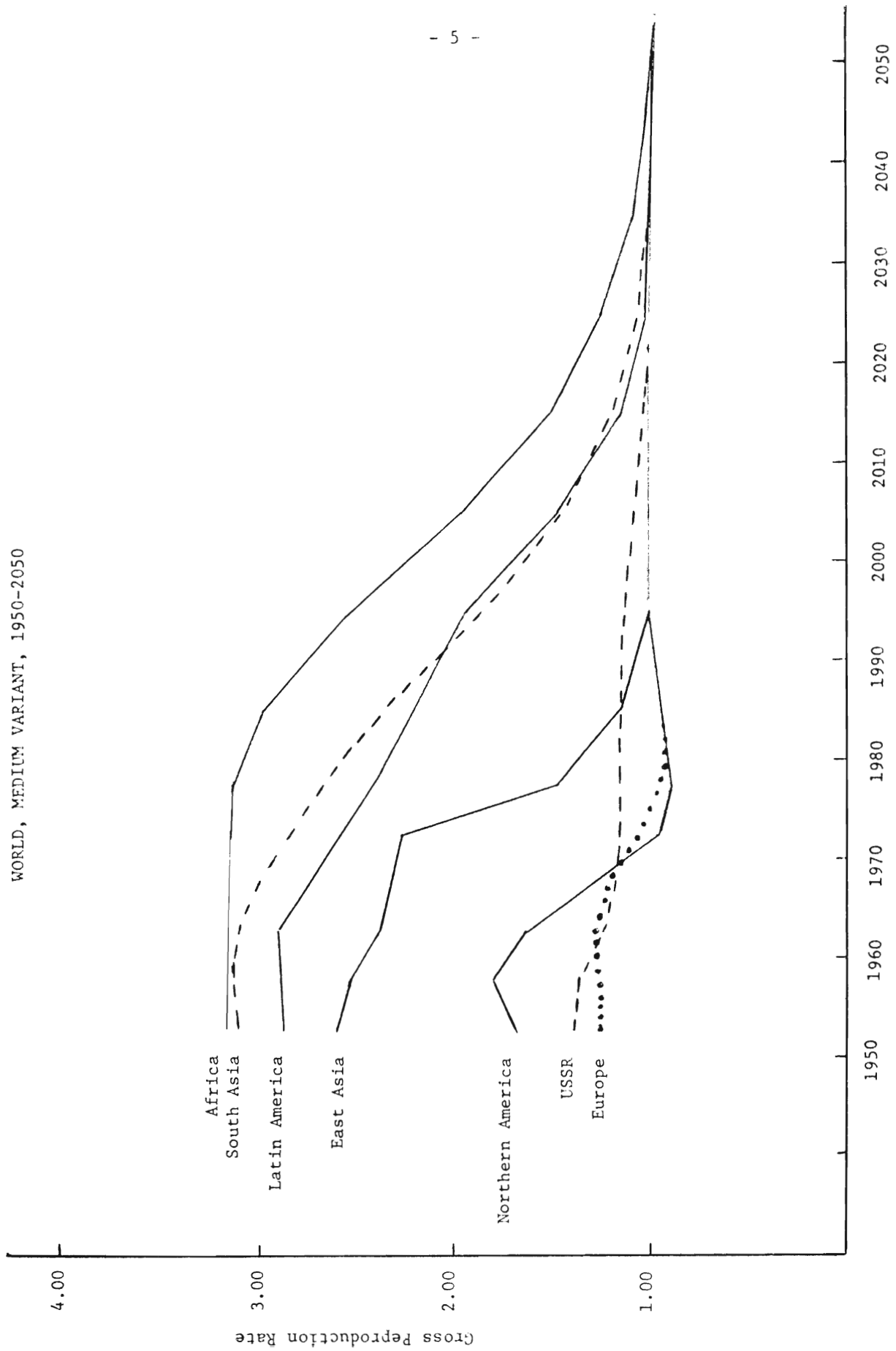
11. As mentioned earlier three variants of the long-range projections are prepared in this study as the extension of corresponding variants of the United Nations demographic projections up to the year 2000. In the latter, it was stated that the medium variant represents those future demographic trends that seem most likely to occur in view of observed past demographic trends, expected social and economic progress, ongoing government policies and prevailing public attitudes towards population policies. On the other hand the high and low variants are intended to indicate the plausible, but not necessarily exhaustive, range of future deviation from the medium projections. In formulating assumptions no catastrophes such as large-scale war, famine or epidemics which would inevitably affect demographic trends are assumed.

12. With respect to fertility, the United Nations demographic projections assumed for each country with a traditional high fertility level, (a) fertility will decline as economic and social development takes place; (b) existing or anticipated government policies and programmes as well as non-governmental activities aimed at such a goal will expedite the process of fertility decline; and (c) once the decline begins, it will begin slowly, gain momentum, and then slow down again. For those countries with fertility levels near or below the replacement level, it is assumed that fertility will begin to converge to replacement level starting from the end of this century.

13. The long-range projections presented in this report are made for each of the 24 regions of the world instead of each country, and it is assumed that the timing of the convergence of fertility to the replacement level differs from one region to another and from one variant to the next. In the medium variant, the duration of a whole fertility transition from the traditional high to the replacement level would take 30 to 70 years depending on socio-economic conditions of each region. (In case fertility is already falling, due adjustments are made.) In the high variant, it is generally assumed that the transition will take 20 years longer than in the medium variant. In the low variant, it is assumed that the gross reproduction rate in most cases will drop to the replacement level 20 years earlier than in the medium variant, then decline further before coming back to the replacement level 30 years later. For regions where fertility rates are currently under the replacement level, a recovery to the replacement level is assumed with different timing among the variants. In the case of Western Europe, for example, a net reproduction rate of 1.00 is assumed to be regained in the year 2000 for the medium variant, 1990 for the high variant and 2010 for the low variant. Figure 1 shows the fertility assumptions for the major areas

^{2/} A User's Guide to the Population Projection Computer Programme of the Population Division of the United Nations (United Nations publication, Population Division Working Paper), forthcoming.

Figure 1
 ESTIMATES AND PROJECTIONS OF GROSS REPRODUCTION RATES FOR THE MAJOR AREAS OF THE
 WORLD, MEDIUM VARIANT, 1950-2050



of the world which are computed from the assumptions for each regions within the respective areas. Table 1 compares the assumptions among three variants. (For more detailed assumptions, see appendix table 5A.)

Table 1. Fertility Assumptions for Three Variants: High, Medium and Low

Major areas	The year in which gross reproduction rate first reaches replacement level		
	Medium	High	Low
World	2040	2060	2020
More developed regions ^{a/}	1990	1985	2010
Less developed regions	2040	2060	2020
Africa	2050	2070	2030
Latin America	2030	2050	2010
Northern America ^{a/}	2000	1985	2010
East Asia	1990	2020	1980
South Asia	2030	2050	2020
Europe ^{a/}	2000	1990	2010
Oceania	2030	2060	2020
USSR	2010	2020	2000

^{a/} In "More developed regions", "Northern America" and "Europe", the respective average fertility level is below the replacement level as of 1975-1980.

14. With respect to mortality, the three variants had practically the same assumptions, that is the gradual increase in the life expectancy in all parts of the world to an upper limit of 73.5 years for males and 80 years for females with some time lags among the regions. It may be argued, however, that the maximum limit of the life expectancy mentioned above may be too low when the projection span is extended into the 21st century and beyond. But this limit was adopted from a practical reason that no life table beyond this limit was readily available. It was also felt that further increase in the life expectancy will not affect the future population size to a significant extent. The mortality assumptions used in this study may be found in the appendix table 6A.

15. In addition to the three variants mentioned above, two hypothetical variants of projection are added in this study for illustrative purposes. The first of the hypothetical variants of projection is based on an assumption that the current level of fertility will be maintained without any change in the future. As will be shown in the next chapter, this variant would show, on the one hand, a drastic decline and eventual extinction of the currently developed populations, accompanied, on the other hand, by the exponential growth of the population in the less developed regions. Another hypothetical variant is based on the assumption that fertility levels in all parts of the world converge to the replacement level concurrently and immediately so that any population change in the future depends purely upon the demographic inertia from the past which is embodied in the present age structure of population.

RESULTS

Global population growth

16. According to the United Nations estimates, the world population has been growing with an increasing rate during the first three quarters of this century. The size of the world population was 1.6 billion at the beginning of the present century, grew to 1.9 billion in 1925, 2.5 billion in 1950 and 4.0 billion in 1975. The average annual growth rate for the successive 25-year periods since 1900 was 0.8, 1.1 and 1.9 per cent respectively. However, there were indications in the past 10 years that the pace of population growth was slightly slowing down, providing a base for a projected average annual growth rate of about 1.7 per cent for the fourth quarter of this century. This leads to a projected population in 2000 of 6.2 billion.

17. The medium variant of the long-range population projections beyond the year 2000, the methods of which were outlined in the previous chapter, indicate that further reduction of the growth rate of the world population will continue in the 21st century: projected average growth rates per annum for each of the successive 25-year periods after 2000 are 1.2, 0.6, 0.3 and 0.1 per cent respectively. This means that the world population would come closer to the stationary state in the beginning of the 22nd century when the world population reaches 10.5 billion, which is about 2.4 times larger than the estimated 1980 population of 4.4 billion.

18. In spite of these declining growth rates, however, it is also evident, according to the projection, that the size of the global population will continue to expand rapidly in the next century. The annual increment to the world population will remain at the present level of 80 million or more for the coming 50 years and will fall below the present level only after 2050. In other words, problems arising from a rapid population growth in the third world will remain to be acute for nearly seventy years.

Table 2. Estimates and Projections of the World Population,
Medium Variant, 1900-2100

	Population (million)	Increase over the previous date	
		Population (million)	Average annual rate (%)
1900 ^{a/}	1,550	-	-
1925 ^{a/}	1,907	357	0.8
1950 ^{b/}	2,513	606	1.1
1975 ^{b/}	4,033	1,520	1.9
2000 ^{b/}	6,199	2,166	1.7
2025	8,354	2,155	1.2
2050	9,775	1,421	0.6
2075	10,405	630	0.3
2100	10,525	120	0.1

a/ The Future Growth of World Population (United Nations publication, Sales No. 58.XIII.2), p. 23.

b/ World Population Trends and Prospects by Country, 1950-2000: Summary Report of the 1978 Assessment (United Nations publication, document ST/ESA/SER.R/33).

Range of alternative projections

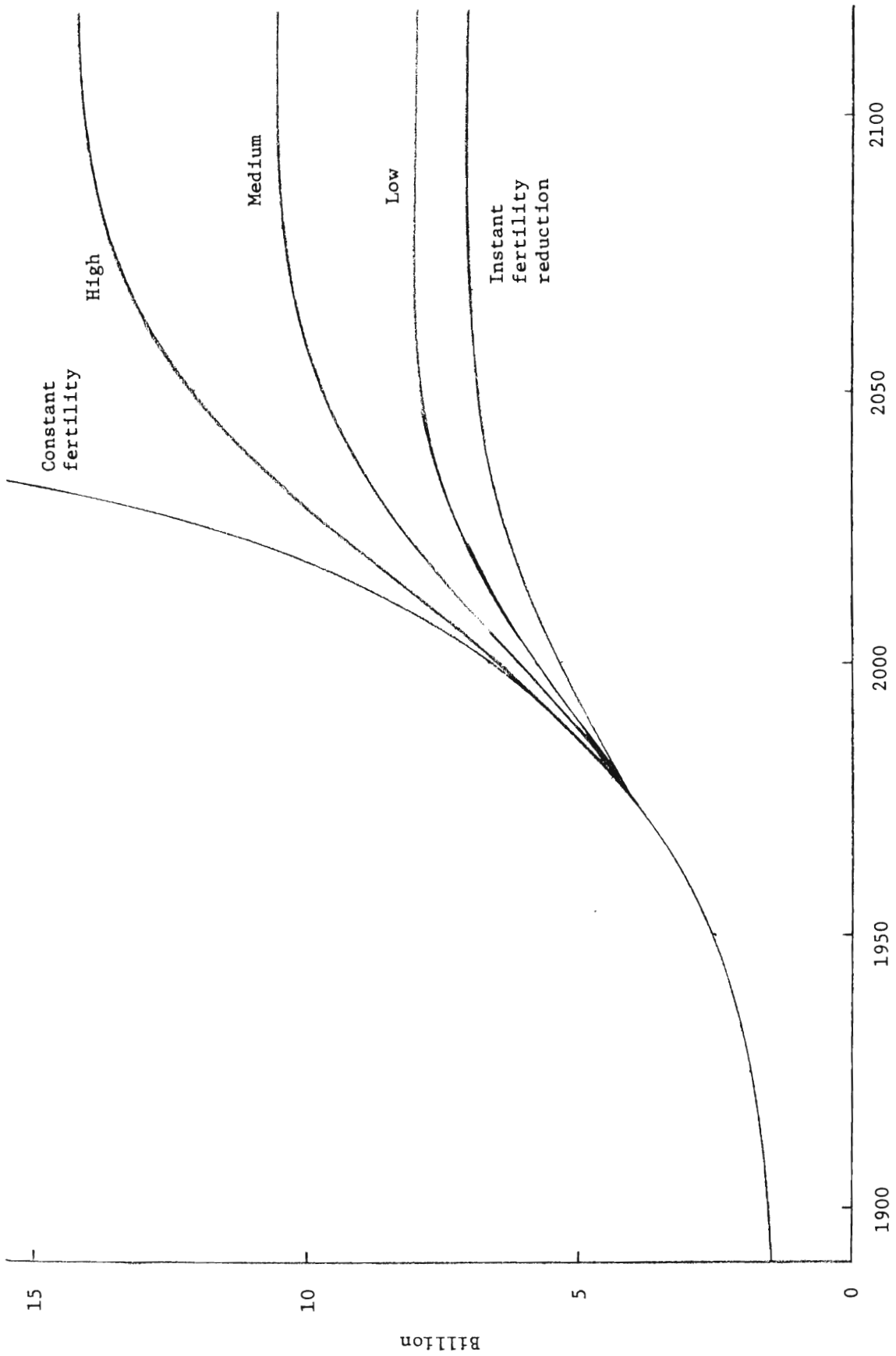
19. Since demographic variables are difficult to predict precisely, especially in a long-range projection such as presented here, it would make sense to examine the range of variation of plausible alternative projections. In table 3 below four variants of projections are compared with the standard, medium variant. There are two hypothetical variants to delimit the upper and lower boundaries of possibility and the high and the low variants to represent the extension of respective variants in the United Nations medium-range projections.

Table 3. Comparison of Alternative Projections of the World Population

	(Population in billion)				
	(1) Variant of Instant fertility reduction in 1980	(2) Low Variant	(3) Medium Variant	(4) High Variant	(5) Constant Fertility Variant
1975	4.0	4.0	4.0	4.0	4.0
2000	5.2	5.9	6.2	6.5	6.7
2025	6.0	7.3	8.4	9.5	12.1
2050	6.2	8.0	9.8	12.1	22.4
2075	6.2	8.1	10.4	13.6	42.1
2100	6.2	8.0	10.5	14.1	79.5
2125	6.2	8.0	10.5	14.2	150.2

20. The first hypothetical projection, in column 1, is calculated on the basis of an assumption that the fertility rate in all parts of the world will instantly drop to the replacement level in 1980 and will remain at that level thereafter. This assumption, though deemed as unrealistic because of the still prevailing high fertility rate among many developing countries, would indicate the smallest possible size of the future world population that could be expected, barring unexpected catastrophe which would bring high mortality or a sustained significant drop of fertility level below replacement. Under this assumption, the world population will continue to grow to 6.2 billion by 2050 due to the demographic momentum from the past which is embodied in the current age structure of the population. Another hypothetical projection presented in column 5 is based on the assumption that the current fertility levels will remain unchanged in the future. This assumption means a nearly

Figure 2
LONG-RANGE GLOBAL POPULATION PROJECTIONS, BY FIVE VARIANTS, 1900-2150



constant future growth rate of the world population and therefore progressively increasing size of annual increments. This variant shows that the world population could grow at least theoretically to 22 billion by 2025 and to 80 billion by 2100. In this variant, the projected population in 2100 will be 18 times larger than the world population in 1980 and nearly 8 times larger than the projected population in 2100 of the medium variant of projection.

21. If the range delimited by the two hypothetical projections above is taken as the maximum and the minimum limits of future possibility, the extension of the high and the low variants of the United Nations projection, columns (2) and (4) in table 3, would provide more realistic alternatives to the medium variant projections. As discussed before, it is assumed in the high variant that future decline of fertility rate would be more gradual, thus taking a longer duration to reach the replacement level in the medium variant. On the other hand, in the low variant it is assumed that fertility decline will be more rapid and will complete the transition in a shorter duration. According to these projections, differences among them are already significant in 2000, that is, 6.5 billion vs 5.9 billion. But the difference becomes much greater during the course of the 21st century, leading to a projected population of 14.1 and 8.0 billion in 2100 by the high and the low variant, respectively. They mean a respective addition to the present world population by 9.7 billion or 3.6 billion during the 120 years from today. Compared with the 1980 world population of 4.4 billion, the projected population for 2100 will be 3.2 or 1.8 times larger under the high and the low assumptions, respectively.

22. It is not possible with the current state of knowledge to predict which alternative projection will eventually come closer to reality. However, since the three variants, namely high, medium and low, are deemed to be within the plausible range, it can be said that the long-range global population trends will be affected to a considerable extent by the future development of events that will affect fertility and mortality, events presumably including the implementation of development plans and population policies by the respective governments.

Regional growth differentials

23. One of the most important findings of this study is that the future population increase of the world will occur almost entirely in the areas currently classified as the less developed regions. It is estimated that as of 1980 there are 3.3 billion people living in the combined areas of the less developed regions which are defined for statistical purposes of this study to include Africa, Asia (excluding Japan), Latin America and Oceania (excluding Australia and New Zealand). This population will grow, according to the present projection, to 4.9 billion by 2000 and 8.4 billion by 2050 and 9.1 billion by 2100. These projections indicate that the population of the less developed regions will increase by 1.6 billion between 1980 and 2000, by 3.5 billion between 2000 and 2050 and 700 million between 2050 and 2100. During the same periods, the more developed regions, which

include Europe, Northern America, Union of Soviet Socialist Republics in addition to the three countries excluded from the less developed regions as mentioned above, will increase their population only marginally: by 140 million before 2000 from the current population of 1.1 billion, by 110 million between 2000 and 2050 and by 9 million between 2050 and 2100. Thus, the less developed regions will occupy 92, 97 and 99 per cent of the global population increments in each of the 1980-2000, 2000-2050 and 2050-2100 periods respectively.

Table 4. Population Projections for the World, More Developed Regions and Less Developed Regions, Medium Variant, 1950-2125

Year	Population in millions		
	World	More developed regions	Less developed regions
1950	2,513	832	1,681
1975	4,033	1,093	2,940
(1980)	4,415	1,131	3,284
2000	6,199	1,272	4,927
2025	8,354	1,361	6,993
2050	9,775	1,381	8,394
2075	10,405	1,389	9,016
2100	10,525	1,390	9,135
2125	10,530	1,390	9,140

Period	Average rate of change per annum (%)		
1950-1975	1.89	1.09	2.24
1975-2000	1.72	0.61	2.07
2000-2025	1.19	0.27	1.40
2025-2050	0.63	0.06	0.73
2050-2075	0.25	0.02	0.29
2075-2100	0.05	0.00	0.05
2100-2125	0.00	0.00	0.00

Note: More developed regions include Northern America, Europe, Australia, New Zealand, Japan and USSR. Less developed regions include Africa, Latin America, Asia (excluding Japan) and Oceania (excluding Australia and New Zealand).

24. These figures are, however, still somewhat misleading in the sense that they conceal large and important growth differentials existing within the less developed regions. For instance, the growth rate for the less developed regions is deflated by the projected relatively slow population growth of China, the largest single population in the world. If, then, China is excluded from the calculation, population growth in the remaining less developed regions in the coming 50 years would be 154 per cent instead of 124.

Also, the same exclusion shows the population of the less developed regions at the end of the 21st century will reach 7.7 billion, which is 3.3 times larger, instead of 2.8, than the present size of 2.3 billion.

25. In the coming 120 years towards the end of the next century, Africa is likely to be the continent where most rapid population growth will occur. If the basic projection assumptions hold, the current population of Africa which is estimated as 470 million will grow to 830 million in 2000, 1.9 billion in 2050 and reach 2.2 billion by 2100. The projected ultimate size of Africa's population is therefore nearly 5 times greater than the present one. Latin America will follow in its projected high growth rate. The current population of Latin America of 370 million will nearly double in 30 years to 730 million by 2010, triple in 70 years, then reach a stationary level with the population size of 1.2 billion around the year 2100. This projected maximum population is about 3.2 times larger than the present population.

26. Asia is not the region where the highest growth rates are projected into the 21st century. But because nearly 60 per cent of the world population is living there, projected population increase in Asia will be the largest among the major areas of the world and contribute most to the global population growth. By 2100 the population of Asia will grow to 5.9 billion or 2.3 times larger than the present 2.6 billion. In South Asia which includes India, Indonesia, Pakistan, Bangladesh, Iran and Arab countries in the Middle East among others, projected growth rates are comparable to those of Latin America and the population will grow from the present 1.4 billion to 4.1 billion, or by 190 per cent by the end of the next century.

27. As a result of these growth differentials, distribution of the world population by the major geographical areas will be changed significantly by the end of the next century. The percentage of the world population living in the currently more developed regions, that is, Europe, Northern America, Japan, Australia, New Zealand and USSR, will shrink into a half of the present share, that is, 27 per cent in 1980 to 13 by 2100. The same will be true for China whose current share in the world total of 22 per cent will drop to 14 in the same period. On the other hand, Africa, South Asia and Latin America will increase their shares considerably. The most notable increase will occur for Africa where the current share of 10 per cent will double to 21 per cent. South Asia will have a comparable increase in percentage points of its share from 31 per cent in 1980 to 39 per cent in 2100. In Latin America, a rapid expansion of population in Middle America and Tropical South America is partly cancelled out by relatively slow growth projected for Caribbean and Temperate South America, and the overall share of Latin American population will moderately increase from 8 to 11 per cent in the coming 100 years or so.

Figure 3
DISTRIBUTION OF THE WORLD POPULATION BY THE MAJOR AREAS, MEDIUM VARIANT, 1980 AND 2100

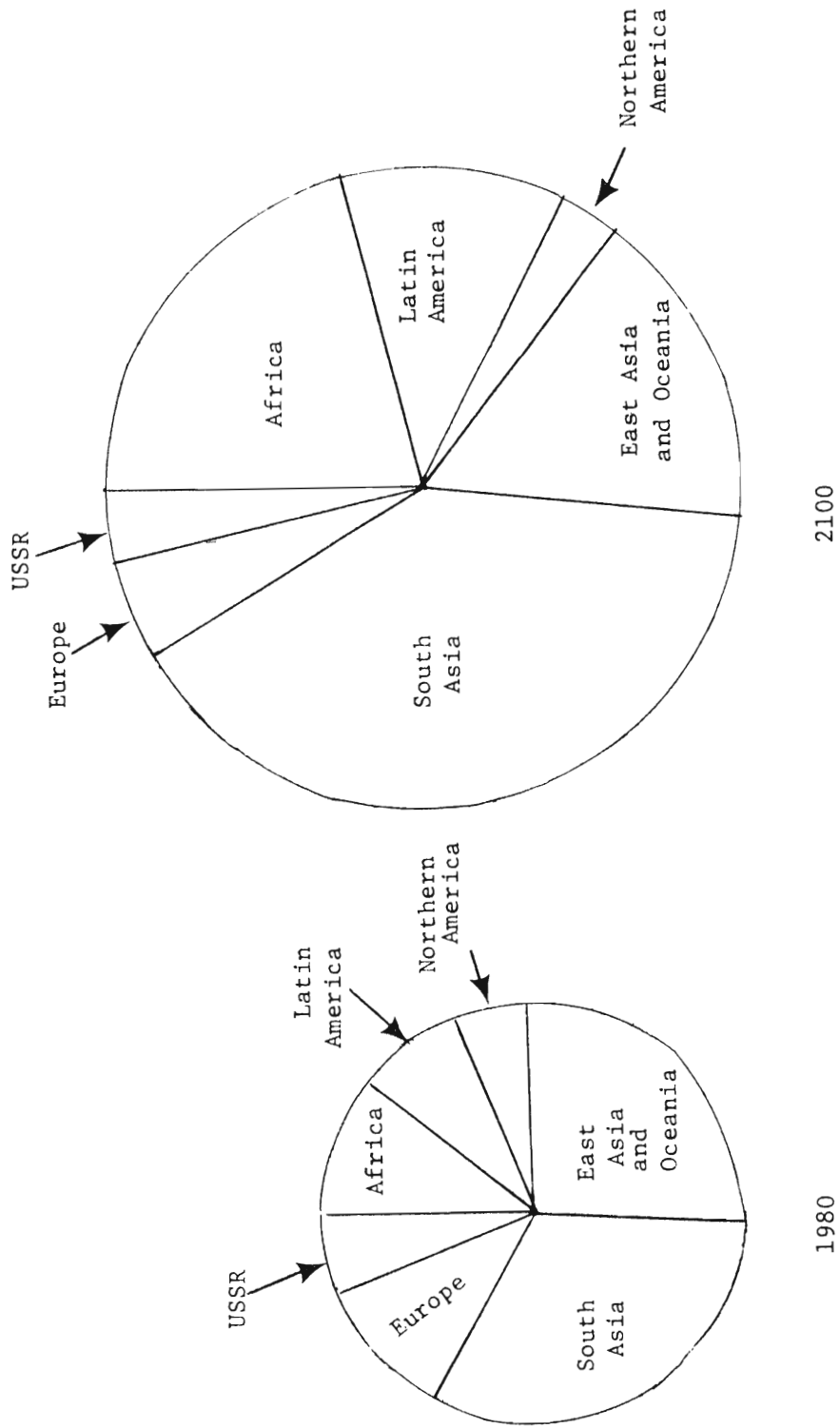


Table 5. Population Projections for the Major Areas of the World,
Medium Variant, 1950-2125

(Population in millions)									
	World	Africa	Latin America	Northern America	East Asia	South Asia	Europe	Oceania	USSR
1950	2,513	219	164	166	673	706	392	13	180
1975	4,033	406	323	236	1,063	1,255	474	21	254
(1980)	4,415	469	368	246	1,136	1,422	484	23	267
2000	6,199	828	608	290	1,406	2,206	520	30	312
2025	8,354	1,391	897	315	1,642	3,182	541	36	349
2050	9,775	1,857	1,102	317	1,709	3,840	540	40	370
2075	10,405	2,119	1,182	318	1,724	4,103	541	41	377
2100	10,525	2,189	1,187	318	1,726	4,145	540	41	379
2125	10,530	2,193	1,187	318	1,726	4,146	540	41	379
Average rate of change per annum (%)									
1950-1975	1.89	2.46	2.71	1.41	1.83	2.30	0.76	2.06	1.38
1975-2000	1.72	2.85	2.54	0.81	1.12	2.25	0.37	1.35	0.81
2000-2025	1.19	2.07	1.55	0.34	0.62	1.47	0.16	0.80	0.46
2025-2050	0.63	1.16	0.82	0.03	0.16	0.75	-0.01	0.35	0.22
2050-2075	0.25	0.53	0.28	0.01	0.04	0.27	0.00	0.13	0.08
2075-2100	0.05	0.13	0.02	0.00	0.00	0.04	-0.00	0.02	0.01
2100-2125	0.00	0.01	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00

Ultimate size of world population

28. What will be the ultimate size of the world population and its distribution, if the current demographic trends should continue to change as projected? And how soon can the stationary population be attained? According to the present projections which assume a convergence of fertility rates to the replacement level at different times for different regions of the world, the ultimate size that the world population may reach is, as shown earlier, estimated to be between a low of 8.0 billion and a high of 14.2 billion with the medium projection of 10.5 billion. The stationary state of the global population growth will be reached around the beginning of the 22nd century: 2110 by the medium variant of projection, and 2070 and 2130 by the low and high variants respectively.

29. Since the current population is estimated as 4.4 billion for 1980, the projected ultimate population will be greater by 2.4 times than the current one according to the medium variant of projections. The ultimate size could vary between 1.8 times and 3.2 times the current one according to the alternative low and high variants respectively. The range of projections is still quite large, but it seems in any event that the world will have to be prepared for a substantial increase of its population for quite a long time before it ceases to grow any further.

30. The projected size of the maximum population and the timing of its achievements for the major regions of the world are listed in table 6 below. According to the medium variant, the more developed regions, whose current population is about 1.1 billion, will have 1.4 billion by 2080, which is about 23 per cent increase over a century, when it reaches the stationary state. The less developed regions, on the other hand, will have 9.1 billion population by 2110 which is greater than the 1980 population of 3.3 billion by 5.8 billion or by 178 per cent. As a result the percentage of the world population living in the less developed regions will increase from the current level of 74 to 86 per cent by the beginning of the 22nd century.

Changes in age composition

31. Some of the social and economic problems in development processes are caused not only by the growing size of population but more frequently by the composition of population. Of various characteristics of population composition, the aging of population will be one of the most salient demographic features accompanying the long-range transition towards population stabilization which would bear important social and economic implications.

32. To begin with, it is necessary to recognize the significant difference currently existing in the age structure of population between the more developed and the less developed regions. As of 1980, the child population under age 15 occupies 23 per cent of the total population of the more developed regions, whereas the proportion is as high as 39 per cent in the less developed regions. On the other hand, the old-age population at age 65 and over occupies 11 and 4 per cent of the total population in the respective

Table 6. The Ultimate Size of Stabilized Population and the Year of Stabilization, According to the Three Variants of Projections

Geographical regions	(Population in million)					
	Medium		High		Low	
	Population	Year	Population	Year	Population	Year*
World	10,529	2110	14,200	2130	8,023	2080
More developed regions	1,390	2080	1,601	2100	1,218	2020
Less developed regions	9,139	2110	12,599	2130	6,805	2070
Africa	2,193	2110	3,359	2130	1,399	2080
Latin America	1,187	2100	1,684	2120	888	2070
Northern America	318	2060	418	2080	263	2020
East Asia	1,725	2090	1,877	2090	1,493	2030
South Asia	4,145	2100	5,794	2130	3,128	2070
Europe	540	2030	597	2070	482	2020
Oceania	41	2070	53	2100	33	2030
USSR	379	2100	418	2110	337	2040

Note:

Less developed regions include Africa, Latin America, East Asia (excluding Japan), South Asia and Oceania (excluding Australia and New Zealand).

More developed regions include Northern America, Europe, USSR and the three countries excluded from the less developed regions as mentioned above.

* For the low variant, the year of stabilization refers to the one in which the respective population reaches the maximum, which will subsequently be reduced somewhat to the stabilization level.

groups of regions. The difference in the extent of the aging process of population, which has been caused by the differential fertility and mortality trends in the past between the two groups, is also evident in the median age of population: 31.4 and 20.0 years in 1980 for the more developed and the less developed regions respectively. Though it is expected that aging will progress in both regions, the gap in the median age of two population groups will further increase at least until 2000, because the aging process is taking place more rapidly in the more developed regions at present and in the near future.

33. In contrast to the present state, the age composition of population at the end of the 21st century is expected to be more or less identical in both developed and developing regions and will be closer to that of a stationary population. According to the projections, the proportion of children under 15 and old-age people over 65 will occupy 19 and 18 per cent of the total population respectively and the working age population will be 63 per cent. This means that there will be about 60 dependents (children and old-age people) to 100 working-age population in the year 2100. The dependency ratio will be up from the present 52 for more developed regions and down from the present 76 for less developed regions.

34. During the course of transition from the present to a stationary age composition, there will be a gradual stagnation of growth rate of child population, coupled with a continual rapid increase of old-age population, especially in the less developed regions. At the same time, a rapid increase of the working age population will be a conspicuous phenomenon in the rest of this century and the first half of the 21st century.

35. In terms of the volume of net addition to the working-age population in the less developed regions, the projections are rather alarming. The average addition will be 57 million per year in 1980-2000 to be compared with 30 million per year in 1950-1980. This is an average increase of 2.4 per cent for the period. If the rate is calculated excluding China, which seems to have achieved rather dramatic fertility decline in the 1970s, the average annual rate of increase will be 2.8 per cent for the working age. Beyond the year 2000, the increase in the number of the working age population per year in the less developed regions as a whole is projected to remain more or less at the 1980-2000 level until 2050, though the rate of increase will decline considerably.

36. For the periods beyond the year 2000, it appears likely that rapid increase of the old age population will emerge as an additional problem for the less developed regions as well. The average annual increase of the old age population will be 16 million which is three times larger than the projected annual increase of 5 million for 1980-2000 and 8 times larger than 2 million per year for 1950-1980. Concomitantly, the old age dependency ratio in the less developed regions will rise from 7 per 100 working age population in 1980 and 8 in 2000 to 19 in 2050.

37. If the assumed long-range decline of fertility and mortality rates holds, change in the age structure of the less developed regions will be relatively less significant after 2050 than previous periods and the structure will come close to that of a stationary population by 2100.

Table 7. Age Structure of Future Population in More Developed Regions and Less Developed Regions, 1950-2100

	More developed regions				Less developed regions			
	All ages	0-14	15-64	65+	All ages	0-14	15-64	65+
	<u>Population (million)</u>							
1950	832	231	537	64	1,681	641	976	64
1980	1,131	260	742	129	3,284	1,286	1,869	129
2000	1,272	274	831	167	4,927	1,684	3,014	229
2050	1,381	268	869	243	8,394	1,768	5,583	1,043
2100	1,390	269	871	250	9,135	1,764	5,707	1,664
	<u>Percentage distribution</u>							
1950	100	28	65	8	100	38	58	4
1980	100	23	66	11	100	39	57	4
2000	100	22	65	13	100	34	61	5
2050	100	19	63	18	100	21	67	12
2100	100	19	63	18	100	19	63	18
	<u>Annual rate of increase (%)</u>							
1950-1980	1.0	0.4	1.1	2.4	2.2	2.3	2.2	2.3
1980-2000	0.6	0.3	0.6	1.3	2.0	1.4	2.4	2.9
2000-2050	0.2	-0.0	0.1	0.8	0.8	0.1	1.2	3.0
2050-2100	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.9
	<u>Dependency ratio</u>							
	Total	Child	Old age		Total	Child	Old age	
1950	55	43	12		72	66	7	
1980	52	35	17		76	69	7	
2000	53	33	20		63	56	8	
2050	59	31	28		50	32	19	
2100	60	31	29		60	31	29	

38. Meantime, the aging of population in the more developed regions will continue gradually after 2000 through 2050. During this period, increase of the child and the working age population will practically cease, while the old age population will continue to increase, pushing up the old age dependency ratio to 28 from the present level of 17 and from the expected level of 20 in the year 2000.

COMPARISON WITH OTHER LONG-RANGE POPULATION PROJECTIONS

39. Since the rapid growth of population in the world has caused a public concern about the consequences of its further expansion, it is not surprising to find a number of studies devoted to the examination of long-range population prospects. In the past ten years, there were about eleven studies on this subject which came to our attention. And the list will have to be enlarged as search for studies on the subject continues.

40. In chronological order, there was a study by Meadows and others which was published in 1972 as a report to the Club of Rome with the title The Limits to Growth.^{3/} This study appears to be unique among the studies surveyed here in respect to both methods and results. In the first place, population was only one of several components of the study, including industrial output per capita, food per capita, resources and pollution, all of which are integrated into a computer model and trends were simulated under various assumptions for a period from 1900 to 2100. Another feature which distinguishes this study from others is that it projects a rapid decline of population after a certain future date. The report does not present these results in concrete numerical terms, but in the graph labelled as World Model Standard Run, it can be roughly said that population is to grow until the middle of the 21st century (reaching about 10 billion or so) and to decline rather rapidly thereafter to about 6 billion by 2100, about the same size projected at the beginning of the 21st century in the study.

41. In contrast to Meadows and others (1972), other studies including a study by Mesarovic and Pestel (1974),^{4/} in which population was also treated as one of several components in a more comprehensive model, had the common feature that a growing population trend was projected until it reached a ceiling of one level or another and remained stationary thereafter. These studies include those of United Nations (1974 and 1977), World Bank (1980) and individual researchers like Papaioannou (1972), Frejka (1973), Mesarovic and

^{3/} Donella H. Meadows, Dennis L. Meadows, Jørgen Randers and William W. Behrens III, The Limits to Growth, A Report for the Club of Rome's Project on the Predicament of Mankind (New York, Universe Books, 1972).

^{4/} Mihajlo Mesarovic and Eduard Pestel, Mankind at the Turning Point, The Second Report to the Club of Rome (New York, E.P. Dutton and Company, Inc., 1974).

Pestel (1974), Kahn and others (1976), Littman and Keyfitz (1977), United Nations (1977), Bogue and Tsui (1978), and Frejka and Mauldin (1981). ^{5/} (Studies which merely quote population figures from those original studies are not mentioned here.)

42. However, there are significant variations in the ceiling level to which projected population will grow and the timing of reaching it among those studies by different authors and among variants projected by the same author. Of 25 variants in 10 studies which appeared before the present study (excluded here are two variants in Frejka (1973) and one variant by Frejka and Mauldin (1981) which are called by the authors unrealistic projections), the highest level of ceiling is given by Papaioannou (1972) at 50 billion (high variant) and the lowest is given by Kahn and others (1976) at 7.5 billion (low variant). As to the timing of reaching the ceiling, the longest time span is projected by Kahn and others (1976) to be after 2200 (medium and high variants) and the shortest time span is projected by Papaioannou (1972) to be around 2030 (low variant). Exactly speaking, projections are truncated at various years in three studies, namely United Nations (1974) at 2075, Littman and Keyfitz (1977) at 2075 and Bogue and Tsui (1978) at 2050. But projected population trends in these studies are obviously near or at the ceiling, so that the comparisons given above may not be affected too much.

43. Here the projections presented in the two studies by Papaioannou (1972) and Kahn and others (1976) are quite conspicuous not only in their very extreme high or low ceiling and the long or short time span needed to reach it but also in a very wide variation among the variants within each study. For example, the ceiling in the highest and the lowest variants are 50 and 20 billion in Papaioannou (1972) and 30 and 7.5 billion by Kahn and others (1976). It appears that these wide variations are not unrelated with the method of projection adopted in these two studies. The method is essentially a projection of growth rate of population from the past to the future and/or rather arbitrary setting of a certain level of ceiling to the maximum population. The growth rates are not decomposed to fertility and mortality as in the case of other studies. Moreover, global population was treated in these studies as a unit and was not decomposed into smaller geographic units as in other studies. As a result, it was apparently possible to formulate future assumptions more freely in the two studies.

44. The remaining 8 studies are made by the component method of projection, a method the present United Nations study also relies on. Littman and Keyfitz (1977) and World Bank (1980) each provided one series of projection; others provided two or more variants. In spite of differences among the studies in ways in which assumptions are formulated, results are surprisingly similar, if comparable variants of these studies are compared. In the medium variant of projections, though some studies do not identify the variants as such,

^{5/} For the exact references, see footnotes of table 8.

projected maximum population ranges between 8.1 billion by Bogue and Tsui (1978) and 12.0 billion by United Nations (1974). (As mentioned earlier, these two studies have a truncated projection at the year 2025 and 2075 respectively. If extended further, both projected maxima would be a little larger than the given figures.) In the low variant, the differences become narrower: 7.8 billion by Mesarovic and Pestel (1974) and also by Bogue and Tsui (1978) vs. 9.0 billion by the United Nations (1974). Differences among the high variants of projections are between 11.9 billion by Mesarovic and Pestel (1974) and 16.0 billion by the United Nations (1974).

45. These differences are mostly caused by different assumptions in the spread of future fertility decline for developing nations. If one tends to expect moderate fertility decline like Frejka (1973) and United Nations (1974 and 1979), projected maximum population exceeds 11 billion (medium variant); if faster decline is assumed as in the study by Littman and Keyfitz (1977) and Bogue and Tsui (1978), the results are below 8.5 billion (medium variant). More recent studies by World Bank (1980) and Frejka and Mauldin (1981) in addition to the present United Nations study (1981) which presumably reflect the recent fertility changes in East Asia and Latin America are projecting around 10 to 10.5 billion in their medium variants.

46. The surprising similarity of the results of long-range population projections does not, however, guarantee the accuracy of prediction. It should be remembered that these projections covering the future period of 100 years or longer are based on statistical observations of past demographic trends of 20 to 30 years for most developing countries. In fact, alternative projections presented in several studies indicate the magnitude of general confidence in the accuracy of predictions. In other words, it is quite possible to see that future population trends move along towards a goal which may lie between 8 and 14 billion or a slightly larger range.

CONCLUSION

47. An extension of the United Nations medium-range population projections into the 21st century and beyond indicates that the global population will reach 8 to 14 billion with a medium estimate of 10.5 billion by the beginning of the 22nd century before it will be stabilized. Preceding studies by various authors on the same subject gave results different from the above but differences are relatively minor whenever the component method of projection was adopted. However, projections differed to a greater extent if other methods of projection were used.

48. The implications of these projections are that, though the prospects are less alarming than some earlier views which caused a fear of uncontrollable population explosion, the expected population growth in the coming 50 to 70 years would be very substantial calling for a careful attention to it. This is especially true with respect to the growth of working age population in developing countries which will be intensified through the rest of the present

Table 8. Comparison of Selected Long-Range Population Projections in the Past 10 Years

Study (year of population)	Method	Truncated	Variant	Maximum Population		Note
				Size	Year	
1. Meadows and others (1972) ^{a/}	C	No	Standard run	<u>Billion</u> About 10	About 2050	Population decreases after 2050.
2. Papaioannou (1972) ^{b/}	B	No	High (1)	50	2120	
			High (2)	50	2190	
			Middle (1)	35	2090	
			Middle (2)	35	2060	
			Low (1)	20	2060	
			Low (2)	20	2030	
3. Frejka (1973) ^{c/}	A	No	5	15.1	2120*	*These are the year when crude birth rate equals crude death rate.
			4	11.2	2120*	
			3	8.4	2095*	
4. United Nations (1974) ^{d/}	A	2075	High	15.8	After 2075	
			Medium	12.2	"	
			Low	9.5	"	
5. Mesarovic and Pestel (1974) ^{e/}	A	No	2	11.9	2070	pp. 70-82. pp. 180-193.
			3	9.6	2060	
			4	7.8	2050	
6. Kahn and others (1976) ^{f/}	B	2176	High (a fortiori)	30	After 2200	
			Medium (surprise)	15	After 2200	
			Low (free)	7.5	Around 2176	
7. Littman and Keyfitz (1977) ^{g/}	A	2075	One variant	8.4	After 2075	
8. United Nations (1977) ^{h/}	A	No	High	14.0	After 2125	
			Medium	11.0	2125	
			Low	8.8	Before 2125	
9. Bogue and Tsui (1978) ^{i/}	A	2050	Medium	8.1	After 2050	
			Low	7.8	Around 2050	
10. World Bank (1980) ^{j/}	A	No	One variant	9.9	2175	Last countries reaching a stationary population: 2175

Table 8 (continued)

Study (year of population)	Method	Truncated	Variant	Maximum Population		Note
				Size	Year	
11. Frejka and Mauldin (1980) ^{k/}	A	2100	1	<u>Billion</u> 13.4	After 2100	
			2	10.6	"	
			3	8.5	"	
12. United Nations (1981) ^{l/}	A	No	High	14.2	2130	
			Medium	10.5	2110	
			Low	8.0	2070	

Note: Methods of projection are grouped as follows: A - The component method of projection; B - Projection of growth rate or a ceiling setting to population growth; C - Use of a multi-variate model involving demographic and non-demographic variables.

Sources:

a/ Donella H. Meadows, Dennis L. Meadows, Jørgen Randers and William W. Behrens III, The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind (New York, Universe Books, 1972).

b/ John A. Papaioannou, "Population projections", Ekistics, 199 (June 1972), pp. 435-437.

c/ Tomas Frejka, The Future of Population Growth, Alternative Paths to Equilibrium (New York, John Wiley and Sons, 1973).

d/ Concise Report on the World Population Situation in 1970-1975 and Its Long-Range Implications (United Nations publication, Sales No. E.74.XIII.4).

e/ Mihajlo Mesarovic and Eduard Pestel, Mankind at the Turning Point, The Second Report to the Club of Rome (New York, E.P. Dutton and Company, Inc., 1974).

f/ Herman Kahn, William Brown and Leon Martel, The Next 200 Years, A Scenario for America and the World (New York, William Morrow and Company, Inc., 1976).

g/ Gary Littman and Nathan Keyfitz, The Next Hundred Years (Harvard University Center for Population Studies Working Paper Number 101, 27 June 1977).

h/ "Development of the methodology used in the United Nations global projections", Prospects of Population: Methodology and Assumptions (United Nations publication, Sales No. E.79.XII.3), pp. 12-41.

Table 8 (continued)

Sources:

i/ Donald J. Bogue and Amy Ong Tsui, "Zero world population growth?", The Public Interest, 55 Spring 1979), pp. 99-113.

j/ The World Bank, Population Projections, 1980-2000 and Long-Term (Stationary Population), Development Economics Department, Population and Human Resources Division paper prepared by K.C. Zachariah and My Thi Vu, June 1980.

k/ Tomas Frejka and W. Parker Mauldin, "Long-Term Global and Regional Population Growth Prospects" (mimeo), 1980.

l/ Revised projections presented in this report.

century and into the next. In the long run, however, the aging of population may become an increasingly serious problem in both developed and developing countries.

49. Future population trends are closely related to development perspectives. The demographic projections presented in this report are deemed plausible only if socio-economic progress is sustained among the less developed countries in the future. Without this progress the expected transition of demographic events that is prescribed in this study may have to be modified rather drastically.

50. Another implication of the long-range projections is that the future population trends are far from determined. The large differences among the alternative, plausible projections present very different future prospects. This means that population policies of governments and non-governmental population activities, among other things, could have an important role in the evolution of the future world. In this connexion, the monitoring of the global population trends and policies of governments by the United Nations will continue to be vital not only to provide the basis for the formulation and implementation of development strategies but also for the precise assessment of the current and future population.

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LONG-RANGE GLOBAL POPULATION PROJECTIONS

- based on data as assessed in 1978 -

Corrigendum

1. Page 7, paragraph 10

Line 5 should read

the coming 50 years and in the less developed regions it will fall below the level in the 1950s only after 2050.

2. Page 18, paragraph 36, line 4

After ... 16 million, insert in the 2000-2050 period.

3. Page 19

Add Medium Variant to the title of table 7.
