FUTURE POPULATION AND EDUCATION TRENDS IN THE COUNTRIES OF NORTH AFRICA

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Foreword

The North African region has one of the most rapid population growth rates of the world. Whereas the population has increased by a factor of three since 1950, it is expected to further increase by at least a factor of two, most likely a factor of four, and possibly even a factor of eight, depending on future fertility, mortality, and migration trends. Given the extremely arid climate of this world region, where fresh water availability is already a serious problem, and that current climate models project significant further warming well above the expected average warming of the world, these population projections imply that there will be serious problems for the future of this region and possibly increased migration pressure into Europe.

This report provides a concise and comprehensive review of available data on past demographic trends in the region and combines this analysis with expert opinion on alternative future demographic trends (as described in Lutz, 1996) to calculate likely ranges of future population growth.

A very important and innovative feature of this study is that it explicitly includes the educational status of the population in its projections. This is done by means of multistate population projections, a method that largely originated at IIASA. Educational projections are an important task in themselves because education, as the major component of human capital, is a key factor in national development and in society's ability to cope with arising problems. But the projection of education is also particularly suitable for the demographic cohort–component method because it is the past and present school enrollment of the young cohorts that largely determines the future educational composition of the population. It turns out that, due to the large educational fertility differentials and the great inter-cohort differences in education in the countries of North Africa, an explicit inclusion of education in projections makes the population projections more accurate.

This study is not only relevant for the North African region and its neighbors; it also demonstrates that generally it is feasible and very useful to explicitly include education in population projections.

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Director, IIASA

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1. Introduction

1.1 Research question

The population in the countries of North Africa (Algeria, Egypt, Libya, Morocco, Sudan, and Tunisia) has tripled since 1950. Whereas it took 30 years for the population to grow from 53 million in 1950 to 110 million in 1980, it took only half that time to add another 53 million to reach an estimated 163 million in 1996. This acceleration of population growth was mostly due to rapidly declining mortality rates – infant mortality declined from 19 percent of all births in 1950–1955 to an estimated 6 percent at present – together with continued high fertility rates that, until 1980, were above six children per woman. Since 1980 fertility has declined to about four children per woman, but the very young age distribution in these countries will fuel further high population growth for decades to come. By the middle of the next century the population of the region is likely to double one more time to about 340 million – between six and seven times the population in 1950.

Such rapid population growth is affecting the development of the region as well as the surrounding regions. Governments in most countries of the region recognize rapid population growth as a serious problem and have developed programs that attempt to stabilize it. Concern about this region was expressed at the 1994 World Conference on Population and Development in Cairo. This concern is largely based on the assumption that rapid population growth will increase the social and economic problems of unemployment, poverty, and poor health conditions. Environmental factors, especially those focusing on the region's acute water shortage, are also receiving attention.

Outside the region concern about the rapid population growth in North Africa is increasing. In Europe, concern is mostly focusing on possible political instability that may affect Europe and on the possibility of huge, uncontrollable migration from North Africa to Europe. Neither issue is directly linked to population growth, but both are assumed to be closely associated with it in the way that rapid population growth increases the probability of such undesirable events. Rapid population growth makes the alleviation of poverty more difficult and the reduction of unemployment among a rapidly increasing number of young people almost impossible. Whether rapid population growth translates into increasing political instability will, to a large degree, depend on local conditions. History has shown that massive unemployment is a factor in political instability. As to migration into Western

Europe, it is not clear if an increasing number of potential migrants translates into a greater number of actual migrants, although the popular press often makes this association. Past migration waves were linked more often to specific political events (such as the independence of Algeria) than to the increasing population size of the region. This pattern, which shows political crises rather than general population growth as the primary push factor, may well continue.

For these reasons, it is worthwhile to take a close look at possible alternative population trends in the countries of North Africa. This study systematically addresses the issue of population change by age, sex, and educational composition in the region. The first part presents discussions on past trends in fertility, mortality, and education. This information is then combined with expert opinions about possible alternative future trends that subsequently are quantitatively translated into alternative scenarios. An innovative element in this study is the explicit consideration of education by age and sex – assumed to be the most important component of socioeconomic structure – and its inclusion as a dimension in population projections. To our knowledge this is the first time that projections of a population's educational composition by age and sex have systematically been produced for a world region.

Originally, we considered the possibility of including the urban/rural dimension in addition to age, sex, and education. During the process of collecting data, however, we found that the data on internal migration and urban/rural differentials in fertility and mortality were too fragmentary to meaningfully incorporate them into the analysis. We also considered the option of quantitatively addressing past and future migration from North Africa to Europe. Again, not enough data were available for a thorough analysis of international migration by age, gender, and education. However, a discussion of our alternative projections of future migration and its potential impact on Europe is presented in the last section of this study.

1.2 Projection approach

This study on future population and education in North Africa follows the approach of other studies recently conducted by the Population Project of the International Institute for Applied Systems Analysis (IIASA). The approach was introduced in a 1991 book, entitled *Future Demographic Trends in Europe and North America: What Can We Assume Today?* (Lutz, 1991). In this book a group of international experts systematically describe several

possible future trends of fertility, mortality, and migration based on their analyses of the past and their general understanding of the driving forces of these demographic changes. In the final chapter, the diverse views of these experts are quantitatively translated into alternative scenarios including some rather extreme scenarios that are considered possible but not likely. This approach differs from conventional population projections in two ways: first, more emphasis is given to the substantive discussions and arguments associated with specific assumptions of future fertility, mortality, and migration; and second, a broader range of possible alternative paths is presented thus facilitating sensitivity analysis. This book was followed by a 1993 study, entitled *The Future of Europe's Population* (Cliquet, 1993). This book, produced by a working group of the Council of Europe, presents country-level scenario calculations for 20 large member states of the Council of Europe. (The full set of country tables is published in Prinz and Lutz, 1994.)

The scenario approach was further developed in *The Future Population of the World: What Can We Assume Today?* (Lutz, 1994b). This book provides thorough background analysis of 12 major world regions, along with the definition of two types of alternative scenarios: scenarios based on a systematic combination of symmetric assumptions in all three components, that is, high, central, and low assumptions defined in a way that the central is the mean of the high and low values; and specific long-range scenarios in which the components are not assumed to be independent but some alternative "stories" are developed about the ways in which future fertility, mortality, and migration trends may respond under different social, economic, political, and environmental conditions. In 1996 this book was revised, and the approach was further advanced to produce a fully probabilistic set of population projections, that is, the reader is not just presented with different scenarios of unknown likelihood but receives a best estimate – as defined by a group of experts – of the probability of a certain future path and the confidence intervals at different points in time. These projections may be the first probabilistic world population projections published.

In addition to these methodological advances on the question of how to deal with uncertainty, two further areas have recently been investigated: one deals with regional disaggregation and the other with the incorporation of structural variables other than age and sex. This study on North Africa combines advances along both dimensions. It moves from the level of world regions to that of individual countries and explicitly includes educational status by age and sex. Another study, still under development, applies the fully probabilistic approach to all countries of Eastern and Central-Eastern

Europe. For the present study of North Africa a more conventional alternative scenario approach was chosen in order to include education, which is believed to be extremely important not only for the region's demographic processes but for the sustainable development of the region as a whole. Section 7 gives a brief look at the results of the probabilistic projections of North Africa.

1.3 Relevance of education

Development economists and demographers have long identified educational status of a population as a key factor, if not the single most important determinant, in development. In the long run the human capital of a country (namely, the skills of its people) outweighs all other production factors in economic terms. From an international perspective it has been shown that the most important comparative advantage of a country lies not in its natural resources, geographic location, or wage level, but in the availability of, at least, a semiskilled labor force (Forstner and Ballance, 1990). It may be that universal basic education and literacy are more beneficial to a country's development than the existence of a highly educated elite in an otherwise illiterate population.

Going beyond its economic benefits, basic education, especially of women, seems to be a crucial aspect of empowerment. It allows men and women to participate fully in society and improves their quality of life. It also enables individuals and communities to cope better with the social, economic, and environmental changes they face. In this sense education as a proxy for learning and an increased understanding of the interconnections of the world around us may be considered the single most important determinant of every society's struggle to achieve sustainable development that combines improvements in the quality of life with environmentally benign behavior and an increasing ability to cope with all kinds of potential disasters.

In the field of demography, female education has long been identified as the single determinant in lowering fertility in countries that are in the process of demographic transition. No other variable can explain fertility differentials at the individual level, across countries, and over time better than female education. There are also good theoretical explanations for the crucial role of education. For example: more girls in schools results in fewer teenage marriages; education allows women to thoughtfully plan their life cycle; education strengthens a woman's participation in society and her

ability to realize her own, typically lower, family-size desires; an educated young woman tends to have fewer children of whom she can take better care; education tends to increase a woman's knowledge about family planning and probability of formal employment. There is much less empirical information on mortality, but the information that is available in industrialized as well as in developing countries points toward the existence of universal education mortality differentials, with more highly educated women and men living longer than less educated women and men. This is also true for the effects of parents' education on infant mortality. Again there are convincing explanations for these differentials ranging from better information and healthier life-styles to better access to health care. Educational differentials in migration have also been well documented, with more educated people having clearly greater mobility.

Given the overriding role of education in a country's development and the strong educational differentials in all three population components, it is surprising that population projections by education have rarely been attempted in the past. This may be due to the fact that the multistate population projections methods necessary for performing simultaneous projections of subgroups (such as educational groups) that interact with one another (have transitions from one group to another) have not yet been adopted by all the agencies that perform projections, even though these methods were developed at IIASA in the mid-1970s (e.g., Rogers, 1975). This, in turn, may be due to the great momentum of institutional settings with certain mandates that may be based on somewhat outdated perceptions of the problem.

Disregarding educational differentials in cases where they are significant will result in unreliable, or wrong, projections. This becomes evident when we think of the simple case in which the fertility rates remain constant in each educational group: even if school enrollment does not change in the future, the past increase in enrollment that was observed throughout the developing world will automatically result in a strong change in the educational composition of the adult population over the next decades. If educated women have fewer births and the proportion of educated women increases, the result will be a lower total number of births rather than a homogeneous population with constant fertility. Heterogeneity is a tricky issue if it goes unobserved, but if we can observe the differentials, acknowledge that they will make a difference, and have the methodology to account for this difference, there is no reason not to conduct population projections based on education.

In addition to providing useful information on the countries themselves, this study strengthens the importance of the educational component in population projections and shows that it is feasible to study this component and how it affects developing countries. The report is essentially structured into four parts. In Sections 2, 3, and 4 we discuss the information available on fertility, mortality, and education; alternative projections and a discussion of the results are presented in Sections 5 and 6. In Section 7 the projections by country are compared with the regional probabilistic projections for North Africa discussed in Lutz *et al.* (1996). Conclusions are presented in Section 8.

2. Fertility

North Africa is a region with high but declining fertility. Fertility had been maintained at a high level for a considerable period of time, but a decline has begun in each country. During the 1960s and 1970s all countries in North Africa had high fertility. The total fertility rate (TFR), which measures the average number of children a woman would have at the end of her reproductive period if she had children according to the age-specific fertility rates prevailing during a given period, was high, generally 6 or more live births per woman in each country (*Table 1* and *Figure 1*). One explanation for sustained high fertility is the tradition of early marriage. The mean age at marriage was low, 17 years or less, during the 1960s and 1970s providing the social and cultural environment for maintaining fertility at a high level. Due to the predominance of patriarchal and extended family norms, women were traditionally subordinate and illiterate; a teenage girl often went from being dominated by her parental family to domination by her husband's family. These factors were barriers to the adoption of modern contraceptive methods and deterrents to regulation of fertility. It is not surprising that during the 1960s and 1970s, there was a strong anti-family-planning stance in North Africa.

High fertility may also have been sustained by improvements in standards of living and increases in income levels. Income affects fertility in a number of indirect ways. Chances are that a woman will not work outside the home if her husband's income is rising. Income would, therefore, increase the likelihood that the wife stays at home and possibly motivates a couple to have more children. Rising incomes often improve a family's diet and health, thus contributing to lower infant and child mortality, which in turn affects

Table 1. Total fertility rates in North Africa, 1960–1992.

Country	1960–1969	1970–1979	1980–1992	Change 1970–1979 to 1980–1992
Algeria	7.5 (1966)	7.2 (1977)	4.4 (1992)	2.8 (38%)
Egypt	7.1 (1960)	5.6 (1976)	3.9 (1992)	1.7 (30%)
Libya	7.2 (1964)	7.7 (1973)	7.2 (1984)	0.5 (6%)
Morocco	7.1 (1960)	6.9 (1971)	4.0 (1992)	2.9 (42%)
Sudan	6.7 (1960)	6.9 (1979)	4.9 (1990)	2.0 (29%)
Tunisia	7.2 (1966)	5.7 (1975)	3.4 (1988)	2.3 (40%)

Sources: UN (1993); Khalifa (1994); Department of Statistics, Sudan (1991).

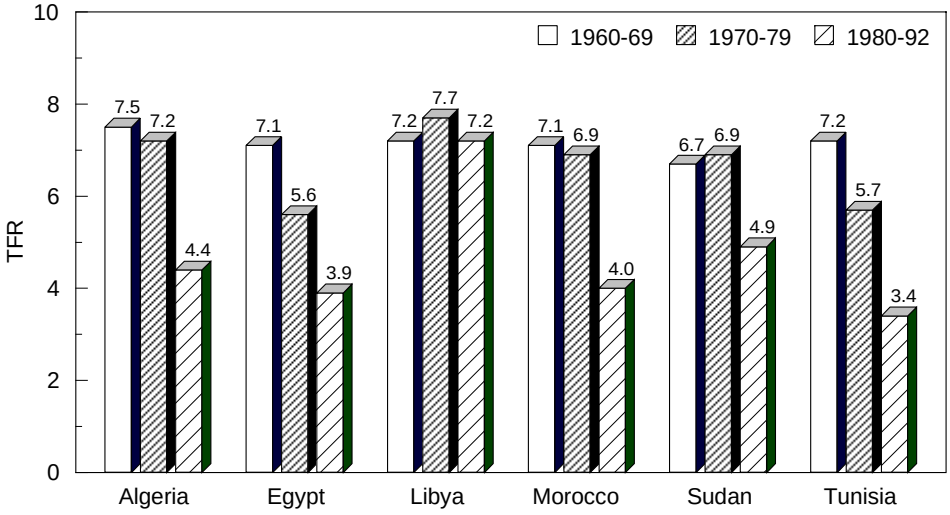

Figure 1. Trends in total fertility rates in North Africa, 1960–1992.

fertility. Moreover, rising incomes increase the incidence of bottle-feeding, as a substitute for breast-feeding, which may indirectly increase fertility. Obstacles such as the need for a dowry and the high costs of marriage and setting up a new household tend to delay marriage, so rising incomes may permit earlier marriage and earlier childbearing.

Recently, fertility in most countries of North Africa has started to decline rapidly. The level of fertility in late 1980s and early 1990s was much lower than the level in the 1960s and 1970s (*Table 1*). The largest drop occurred in the Maghreb countries: Morocco, Algeria, and Tunisia. High fertility levels

Table 2. Age-specific fertility rates per 1,000 women.

Year	15–19	20–24	25–29	30–34	35–39	40–44	45–49	TFR
Algeria[a]								
1970	114	339	388	355	282	153	42	8.4
1977	97	284	342	336	267	129	27	7.4
1981	60	256	334	274	216	115	24	6.4
1984	47	239	322	293	227	104	20	6.3
1986	35	212	263	273	212	86	17	5.5
1988	33	175	260	250	202	104	18	5.2
Egypt								
1980 (WFS)	99	256	286	217	130	48	16	5.3
1988 (DHS)	72	220	243	182	118	41	6	4.4
1991 (EMCHS)	69	215	216	192	93	40	6	4.2
1992 (DHS)	63	208	222	155	89	43	6	3.9
Libya								
1973 (UN)	249	407	360	285	151	66	29	7.7
1995[b]	110	279	313	272	190	95	20	6.4
Morocco								
1962	96	305	311	293	186	107	93	6.9
1980 (WFS)	93	265	296	222	178	98	29	5.9
1992 (ENPS-II)	40	139	183	182	138	86	39	4.0
Sudan								
1979 (WFS)	114	264	283	251	149	108	35	6.0
1983 (Census)	115	294	348	268	196	79	74	6.9
1990 (DHS)	69	183	240	236	157	82	25	4.9
Tunisia								
1978 (WFS)	34	225	304	260	199	112	36	5.9
1984 (UN)	35	173	248	238	140	54	18	4.5
1988 (DHS)	17	131	195	176	113	41	9	3.4

[a] National Board of Statistics, Algeria (1991).
[b] UN (1994) estimates for 1990–1995 medium variant projections.
Sources: UN (1987, 1993).

in Sudan and Egypt have also declined considerably in recent years. Only Libya has maintained its past high fertility levels.

The declining trend in fertility can be further studied by examining changes in age-specific fertility rates. There is a clear tendency for women to have children early in their reproductive period (*Table 2* and *Figure 2*) – this pattern is consistent with fertility levels in developing countries. Currently, women between ages 15 and 29 bear more than 50 percent of the children in these countries. The concentration of fertility in the early childbearing

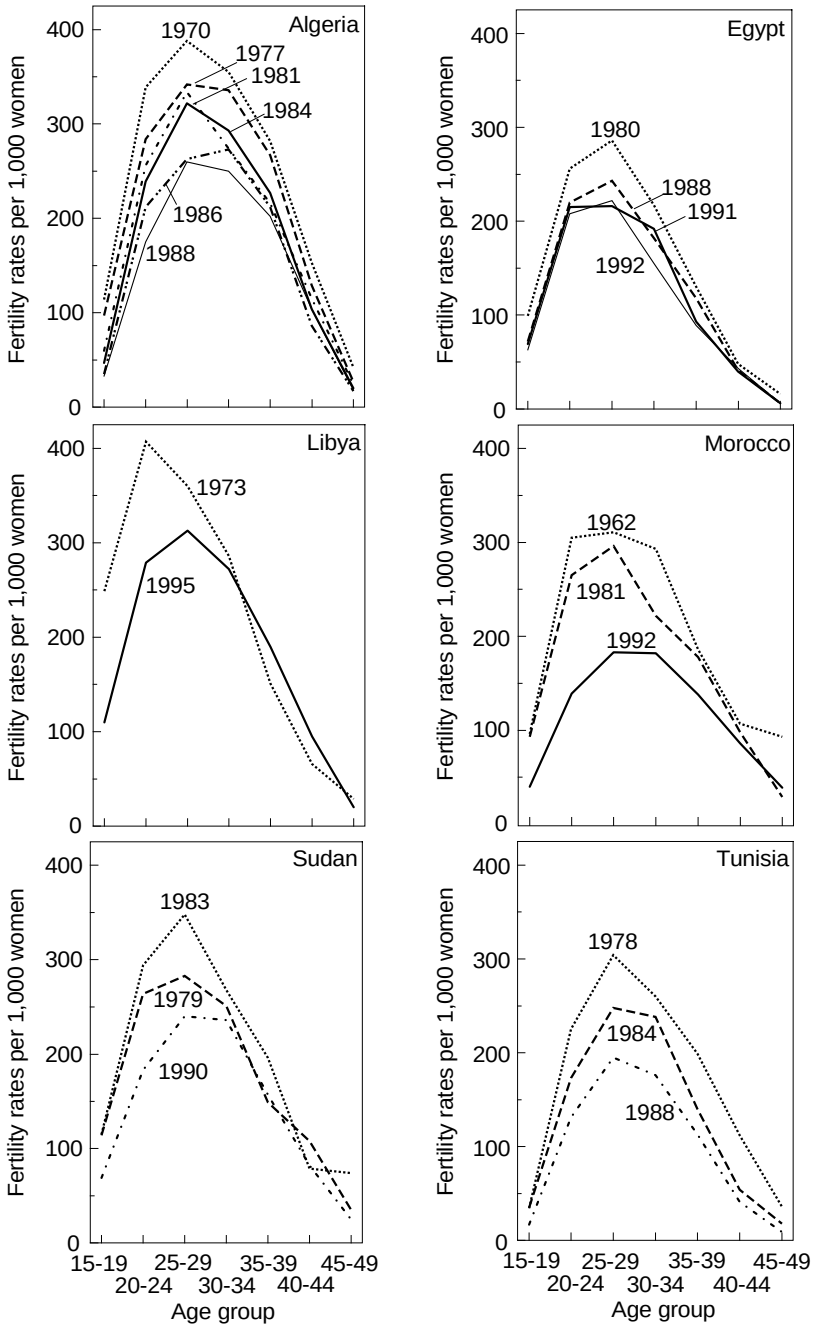

Figure 2. Age-specific fertility rates in North Africa.

period reflects early marriage and high teenage fertility, particularly during the 1960s and 1970s. There is a downward shift in the age-specific fertility curves for all countries. The largest shift is in the peak childbearing ages, between 25 and 34. Factors such as increasing use of contraceptives, improvements in women's education, older age at marriage, and social change have reduced fertility even though traditional factors may have impeded this process.

Government support for population policies and programs is gaining momentum. It is not a coincidence that the rapid decline of fertility in Egypt and Tunisia took place at a time when government intervention to resolve population issues was on the rise. In these two countries the use of family-planning methods has increased significantly during the past 15 years. What is more important is the substantial increase in women's education. The high illiteracy rates prevalent in the 1960s and 1970s declined sharply in the 1980s. For example, illiteracy rates that were above 85 percent for women in Tunisia, Algeria, and Morocco during the 1960s declined to less than 50 percent in the 1980s. Recently, the availability of education to women in Egypt, Sudan, and Libya has also increased. However, because of differences in access to educational services by place of residence, urban women are likely to be more educated than rural women. The high rate of urbanization in countries in North Africa have also contributed to reducing fertility.

2.1 Rural/Urban fertility differentials

Place of residence (rural/urban) has a pervasive influence on fertility. In North Africa rural women have substantially higher fertility than urban women. According to the World Fertility Surveys (WFS) conducted in the late 1970s, rural women in four countries in North Africa bore, on average, 2.5 more children than urban women. The fertility differential between rural and major urban areas was 2.3 children in Egypt, 3.1 children in Morocco, 1.6 children in Sudan, and 2.2 children in Tunisia (*Table 3* and *Figure 3*).[1] Recent findings from Demographic and Health Surveys (DHS) give more insights into fertility differential by place of residence. In Egypt the DHS results for 1992 (El-Zanaty *et al.*, 1993) show that women in rural areas have almost twice the total fertility rate of women in urban governorates.[2] Women in rural upper Egypt have substantially higher fertility than women in other areas. The Sudan DHS shows that fertility is lower in urban areas

Table 3. Total fertility and contraceptive prevalence rates by place of residence.

	Egypt		Morocco		Sudan		Tunisia	
Place of residence	TFR	CPR	TFR	CPR	TFR	CPR	TFR	CPR
World Fertility Survey								
Rural	6.1	13.0	7.0	10.0	6.4	2.0	7.0	21.0
Major urban	3.8	42.0	3.9	40.0	4.8	16.0	4.8[a]	43.0[a]
Other urban	4.9	36.0	4.8	35.0	5.7	9.0		
Demographic and Health Survey								
Rural	4.9	38.4	5.5	31.6	5.2	3.9	5.7	34.6
Urban	2.9	57.0	2.4	41.5	3.9	17.0	3.4	60.5

[a]Urban.

Sources: UN (1987:Tables 96, 99, 104); El-Zanaty *et al.* (1993:Tables 3.2, 5.5); Azelmat *et al.* (1992:Tables 3.2, 4.5); Department of Statistics, Sudan (1991:Tables 3.1, 4.7); Institute for National Statistics, Tunisia (1989:Tables 5.1, 6.8).

than in rural areas and that the lowest fertility is in Khartoum (TFR equal to 3.6). The DHSs for Tunisia (Aloui *et al.*, 1988) and Morocco (Azelmat *et al.*, 1992) give differences of 2.3 and 3, respectively, between rural and urban fertility (*Table 3*).

Several compositional factors help to explain the differences between urban and rural fertility. Urban households have better access to social services, particularly education and health services, and to modern employment opportunities than rural households. Moreover, households in urban areas are more likely to possess modern consumer goods. These advantages may alter reproductive behavior and facilitate the diffusion of contraceptive methods. Therefore, urban families are more likely to adopt modern fertility patterns than rural families.

Rural women are far less educated than urban women. For example, in Egypt in 1992, urban women, on average, spent five years in school compared with less than one year for rural women. The DHS for Sudan shows that 55 percent of rural women have never attended school compared with 33 percent of urban women. Rural women have limited access to and low use of contraceptive methods in contrast to urban women who have access to family-planning services. The WFS and the DHS show that urban areas have a substantially higher contraceptive prevalence rate (CPR) than rural areas (*Table 3*). It is highly probable that modern contraceptive methods have a greater role in lowering fertility in urban areas than they do in rural areas.

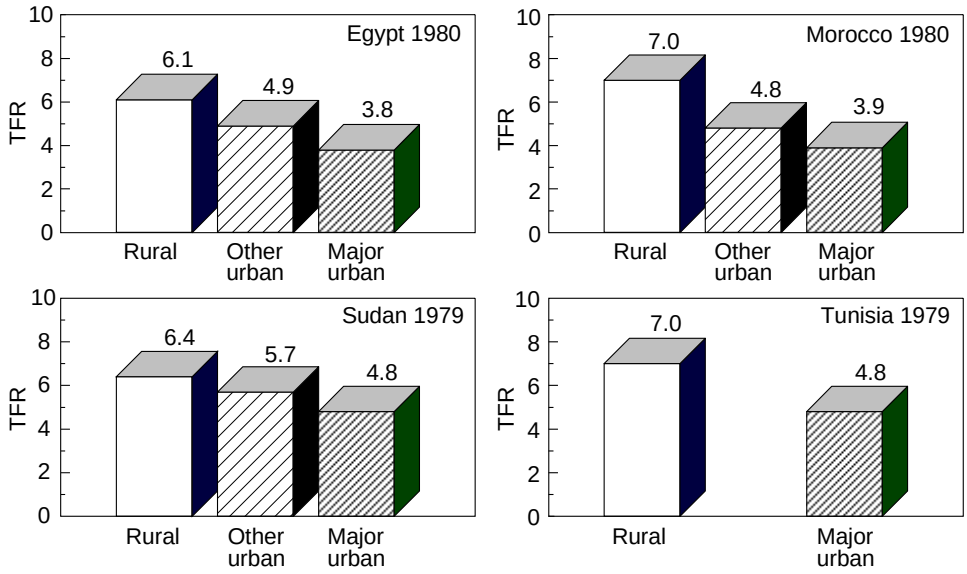

Figure 3. Total fertility rates by place of residence in Egypt, Morocco, Sudan, and Tunisia according to the World Fertility Survey.

The social and cultural environment in rural areas is more conducive to high fertility than that in urban areas. This situation is reflected in the persistence of traditional beliefs and values and the cultural support for women's reproductive role. Rural women marry at an earlier age than urban women. According to the WFS in the 1970s, the difference in the singulate mean age at marriage (SMAM) between rural and urban women was 3.2 years in Egypt, 2.9 years in Morocco, 1.9 years in Sudan, and 1.4 years in Tunisia.[3] More recent findings from the DHS indicate that the median age at first marriage is on the rise and that the rural/urban difference is widening. For women between 25 and 29, the DHS results for the Sudan give a median age at first marriage of 23.2 years for urban women and 19.0 years for rural women, a 4.2-year difference. With education spreading more rapidly in urban areas than in rural areas this result is not unexpected. In addition, fertility preferences in rural areas are higher than in urban areas. The WFS results show that, on average, rural women in Egypt, Morocco, and Tunisia in the late 1970s preferred to bear 4.8, 5.5, and 4.6 children, respectively; in contrast, women in major urban areas preferred 3.0, 3.9, and 3.4 children, respectively. The more recent DHS for Sudan shows that rural women prefer

6.3 children, while urban women favor 5.3 children (Department of Statistics, Sudan, 1991).

2.2 Fertility and women's education

Education plays a special role in the future of women. It is a key factor to their autonomy and full participation in society. At the 1994 International Conference on Population and Development, education was singled out as "one of the most important means of empowering women with the knowledge, skills and self-confidence necessary to participate fully in the development process" (UN, 1995a). Education gives every woman the chance, the knowledge, the ability, and the potential to manipulate and control her environment (marriage, work, fertility, and so on). Formal education provides an escape from the vicious circle experienced by many generations of teenage girls: school dropout, household chores, early marriage, and early and frequent pregnancies.

Education does not work alone; it is one of many societal changes that occur in the course of development. Education influences fertility directly by raising the age at marriage, but its indirect influence is even more important – by changing norms and attitudes about family formation and the status of women. Freedman's model on fertility distinguishes between the underlying determinants that shape values: intermediate determinants, which are the actual norms of behavior; and direct proximate determinants, which relate to fecundability and actual fertility control (Freedman, 1975).

A woman's knowledge has more influence on her reproductive behavior than her socioeconomic status. There are, for instance, no consistent relationships between women's employment and fertility. The factors listed below link education to behavioral changes that eventually lead to lower fertility as well as to other societal changes (McGrath, 1976; Federici *et al.*, 1993; Oppong, 1987; Noor, 1981; Freedman, 1987; UN, 1987). A more recent summary of DHS results on education and fertility is given in UN (1995b).

- At a certain level of education women begin to carefully examine their beliefs and actions and their opinions become respected in society, in general, and in their family circles, in particular. They increasingly have an influence on household decisions concerning expenses, family planning, education of children, and so on. The number of children ever born to an educated woman is probably close to her desired family size; often this means a small number of children. Women's education changes

traditional values, attitudes, and norms and strengthens women's social status within households and in communities.

- Education delays a woman's entrance into her reproductive life by increasing the age at marriage, particularly for women with a secondary or higher education. School attendance raises aspirations regarding a marriage partner. The singulate mean age at marriage is highly and positively correlated to education and to several other measures of women's access to resources.
- Schooling provides girls with information about the outside world; it expands their limit of the horizon from the household levels, giving them confidence in their capacities and abilities. It also increases their knowledge about health issues and family planning; this knowledge raises the possibility of birth control use and longer intervals between births.
- Education increases women's job opportunities in the modern sector, allowing them to work outside the home and to adopt life-styles that could be incompatible with bearing many children. Therefore, women's family-size preferences are likely to change as they receive more education.
- Educated women are likely to expect less help from their children at home because they themselves have been educated; they would rather see their children attend school than stay at home. Therefore, children are not relied on to secure the future, resulting in fewer births. As well, in almost every country, educated women have healthier children than uneducated women, so the survival rate of children born to an educated woman is very high. With higher education comes higher economic status, which results not only from women's educational level but also from other development factors. Improvements in economic status allows families to make arrangements for domestic help, which enables both parents to work outside the home.

Several conceptual models have been developed to observe the influence of education on fertility. A classic observation of fertility and education is that, in moving from no education to some threshold of low education, fertility does not change and in some cases it is higher among women with some very limited education than among those with none at all. Beyond this threshold, fertility and education are inversely related. World Fertility Surveys of 41 countries taken in the late 1970s and early 1980s verify this observation.

In fact, education leads to improvements in the social status for women and facilitates changes in fertility (UN, 1987; Casterline *et al.*, 1984;

Cochrane, 1979). Empirical evidence continues to support the strong inverse relationship between women's education and fertility. Countries differ from one another with regard to the level of education (or years of schooling) at which fertility starts to decline (Timur, 1977). Studies also show that access to educational services differs by residence. In addition, a particular level of education may affect fertility in urban and rural areas differently.

As mentioned above empirical studies have shown that the inverse effects of women's education on fertility may not appear at the lowest educational levels (Cochrane, 1979). Some primary education may increase rather than decrease fertility. Highest fertility is often found not among women without education, but among those with a few years of schooling. The positive effect of a low educational level is especially noticeable in rural areas and in less urbanized and developing countries where per capita income is low. One possible mechanism is that a few years of education in the least developed countries and most inegalitarian settings may lead to a decline in breastfeeding or improvements in health which are not offset by such effects as marriage delay. Therefore, at the pre-demographic transition stage women's education may not instigate a movement toward declining fertility. According to Caldwell (1983), schooling of many children is economically rewarding for parents, therefore fertility remains high.

2.3 Fertility and women's education in North Africa

The literature on North Africa documents varying education-fertility interrelations. In the early 1970s fertility in Morocco was almost the same at all levels of education (Timur, 1977). Studies of Egypt, Algeria, Sudan, and Tunisia during the 1960s and early 1970s document a different pattern: large fertility declines in response to increases of a few years in women's education. In Egypt during the 1960s women age 30 or older who had completed primary education had 1.3 fewer children than women in the same age group with no education (Timur, 1977). For Algerian women who had completed their fertile period, those with primary education had approximately 2 fewer children than women with no education. A 1975 survey of fertility and family planning in Sudan conducted by Caldwell (1983) as part of the Changing African Family Project unraveled fertility differences by level of education in urban Sudan. The age-standardized mean number of children ever born to women with no education was only slightly different from that born to women with a few years of education. Women with secondary education had 2 fewer children than women with no education (Richard *et al.*, 1982).

Table 4. Fertility by women's education according to the WFS and the DHS.

	Egypt	Morocco	Sudan	Tunisia
WFS,[a] *years of education*				
0	6.5	6.4	6.5	7.3
1–3	6.4	5.2	5.6	5.9
4–6	6.2	4.4	5.0	6.0
7+	3.8	4.2	3.1	3.9
DHS,[b] *level of education*				
No education	5.0	4.9	5.5	5.1
Primary	3.9	2.4	4.7	3.9
Secondary+	2.9	2.0	3.3	2.4
All levels	3.9	4.0	4.6	4.3

[a]TMFR for Egypt and Tunisia and TFR for Sudan and Morocco.
[b]TFR.
Source: UN (1987:Tables 112, 115, 122).

Data from the WFS and DHS provide comprehensive and convincing evidence in support of education-fertility interrelationships. On average, women with seven or more years of schooling tend to reduce their fertility by about three children, whereas women with only a few years of schooling have slightly higher fertility than women with no education (UN, 1987). Results from the WFS of Egypt, Morocco, Sudan, and Tunisia show large fertility differences by level of education (*Table 4*). Women with no schooling have substantially higher fertility than women with seven or more years of education. The difference between these two levels of education amounts to two and three or more children when we consider TFR and total marital fertility rate (TMFR). It is important to note that TMFR and TFR are age-standardized period measures.

The 1991 Maternal and Child Health Survey (MCHS) conducted in Egypt provides more insights into education-fertility interactions. Controlling for age at first marriage, the survey found that women with no education have systematically higher fertility than women with secondary or higher-level education (Hosam Eldin, 1994). The same differential pattern prevails when we control the use of contraceptive methods. Among ever users of family-planning methods, women with no education have, on average, 5.7 children ever born, compared with 4.2 children born to women with primary education and 3.0 children born to women with secondary or higher-level education. The DHS for Egypt (El-Zanaty *et al.*, 1993) shows low fertility at high levels of education (TFR equal to 5.03 for no education, 3.98 for

some primary education, 3.03 for completed primary or some secondary education, and 2.91 for completed secondary or higher education). The Sudan Demographic and Health Survey (Department of Statistics, Sudan, 1991) documents a similar large differential pattern by level of education. Women who received a secondary education have, on average, 3.3 children, whereas women with no schooling have 5.5 children.

Of the countries in North Africa, Sudan has the weakest family-planning policy and women's educational program. Sudan also has the highest desired fertility rate in North Africa. WFS results show that women with no education in Sudan had the highest desired fertility. The desired family size of women with seven or more years of schooling declines by 1.5 children. Recent results from the Sudan Demographic and Health Survey confirm this high desired fertility. The SDHS report states:

> [A]lthough fertility in Sudan is low compared with most sub-Saharan countries, the desire for children is strong. One in three married women wants to have another child within two years and the same proportion wants another child in two or more years; only one in four married women wants to stop childbearing. The proportion of women who want no more children increases with family size and age. The average ideal family size, 5.9 children, exceeds the total fertility rate by approximately one child. Older women are more likely to want large families than younger women, and women just beginning their families say they want to have about five children. [Department of Statistics, 1991:xvii]

This phenomenon in Sudan requires further investigation and analysis.

2.4 Fertility and family-planning policies

Fertility and family-planning policies are determined, in part, by each government. They reflect the government's understanding of population issues. At the 1974 international population conference held in Bucharest, all delegates from North Africa were against family planning as a method for resolving population problems. Ten years later, in 1984, the political stand of these governments changed, and in 1994 some countries were in an advanced stage of population policy development. Tunisia and Egypt were the first countries in North Africa to express concern about fertility, to set fertility targets, and to specify measures and plans to achieve them.

In Tunisia the government restricted polygamy in 1956 and introduced family planning and adopted a flexible stand on abortion in the early 1960s. These measures were strengthened by improving women's education and

increasing women's participation in the modern sector. The official stand of the Egyptian government progressed from skepticism to certainty. During the 1960s and 1970s population growth and its ramifications were seen as long-term problems, undeniably important, but neither pressing nor urgent (Waterbury, 1975). Population issues were of secondary importance. This situation has changed considerably in recent years. Today, the government in Egypt supports population and family planning more actively than ever before. Consequently, the use of contraceptive methods increased to about 47 percent in 1992, 37 percentage points more than in 1960.

Compared with Tunisia and Egypt, fertility and family-planning policies in Morocco and Algeria are relatively new. In Morocco the government started to support family planning in 1968 for women age 28 or older with at least four children (Sayed, 1993). In Algeria the government did not endorse family planning until 1983 when it took steps to ensure that services were available to the entire population. The population programs in Sudan and Libya are also very new. In Sudan there is as yet no clear agreement on the country's population issues. While some observers express alarm at the rapid rate of population growth, others applaud it as a means to solve what they claim is becoming a severe problem of labor shortage in the agricultural sector. Fertility in Sudan declined primarily because of increasing age at marriage which was due to increasing school attendance and male migration. However, the slow pace of fertility decline is mainly due to women's low educational level.

2.5 Future prospects

The high fertility sustained over the 1960s and 1970s in North Africa has produced a young age structure and has strengthened the future momentum of population growth. Nevertheless, the potential for structural changes in these countries is great because of modernization efforts, internal social change, political instability, peace in the Middle East, and the rise of religious fundamentalism. Therefore, there is considerable uncertainty about future fertility levels. The strong population growth momentum will have a great effect on the future demographic situation in countries of North Africa. Potential mothers for several decades to come have already been born. Therefore, the recent decline in fertility in North Africa will not have its full demographic impact for several years. With sustained high fertility the age composition of the population will be dominated by the young, those who are age 15 or younger. The social consequences of this young age

structure are inevitable, particularly added pressure on services and increasing demand for education.

The decline in fertility is not uniform within the countries. Most of the decline is in urban areas. Due to differences in desired family size, contraceptive use, and women's educational levels, the potential for further decline in fertility varies considerably by place of residence. Fertility differences by women's educational level are enormous. Findings from the WFS and the DHS show large fertility declines in response to an increase of only a few years in women's education.

Urban areas in North Africa will continue to play a leading role in fertility change. However, the greatest future demographic challenge for governments in North Africa is in rural areas where fertility is the highest and women's education is the lowest. Government activities in rural areas and the official stand on population policies will play a crucial role in modulating reproductive behavior and shaping the future pattern of rural fertility. Population policies and social programs influence reproductive decisions of couples in various ways. For example, the use of modern contraceptive methods is determined to a large extent by each government's stand on population issues. Government social policies and programs in many countries have successfully helped couples to achieve their fertility and health aspirations, primarily because these programs have gained social acceptance and direct government support. In other countries couples have failed to achieve some of these aspirations not because they are helpless victims of their own behavior, but because of a lack of government and public support and social obstacles.

The downward trend in fertility in urban areas is irreversible, particularly in Egypt, Tunisia, and Morocco. In the 1980s Tunisia's population targets were to reach an annual growth rate of 1.8 percent by 2001 and 1.1 percent by 2021 primarily through increases in contraceptive use and a social program to improve education and the status of women (Sayed, 1993). Fertility in Tunisia is likely to reach replacement level before any other country in the region. The government in Egypt has set a national goal of 2 children per couple by the year 2015. Fertility has been projected to decline from 3.9 in 1992 to 2.9 in 2005 to 2.1 in 2015 (Khalifa, 1994). To achieve replacement fertility contraceptive use must reach a high level of about 74 percent. However, the main challenge for realizing these national goals lies in rural areas, particularly in upper Egypt, where fertility is high and the potential for decline is the greatest.

Future fertility trends are associated with substantial uncertainties in Algeria, Libya, and Sudan. With the spread of pronatalistic attitudes and

programs, fertility in Algeria and Sudan may increase, particularly in rural areas. Fertility increases are realistic possibilities in many Arab countries. For example, fertility in Egypt increased in the late 1970s and mid-1980s, before it declined in the late 1980s. Another possible scenario is that fertility in these countries will follow a downward pattern in response to social development, improvements in women's education, and increased contraception use. However, replacement fertility will be very difficult to achieve, particularly in rural areas. In Libya, the current unabated high fertility level is unlikely to continue into the future. This country's changing economy, rapid urbanization, and improvements in women's status and education are likely to bring about a moderate decline in fertility.

3. Mortality

Unlike fertility and family planning, mortality involves fewer controversial issues, probably because of its lower sensitivity to cultural and religious factors. Nevertheless, health and mortality are closely linked to social development and the quality of life. Social development activities and services are often organized by place of residence. Rural residents have poor health and high mortality levels primarily because they do not have access to medical services. Mortality is directly linked to the disease environment. Many diseases, such as malaria and tuberculosis, are influenced by ecological zones and local climate conditions. Environmental hazards at the global and local levels, such as ozone-layer depletion and air pollution, may also directly affect health and mortality. Therefore, mortality and health are more likely to be sensitive to environmental degradation than fertility (Lutz, 1994a). It is important to consider these aspects when looking at the role of mortality in future population trends.

Mortality in the countries of North Africa has improved quite rapidly in the past three decades (*Table 5* and *Figure 4*). The most rapid decline has been in the four Maghreb countries (Algeria, Libya, Morocco, and Tunisia). During the period from 1950–1955 to 1990–1995 life expectancy at birth for females increased by about 24.1 years in Algeria and 23.6 years in Tunisia; for males life expectancy increased by 23.9 and 22.8 years, respectively. In Egypt life expectancy at birth increased by 6.9 years for males and females between 1976 and 1986; thereafter (1986–1991), females gained slightly more years of life than males. With improvements in women's status and educational

Table 5. Life expectancy at birth by sex in North Africa.

	Algeria		Egypt		Libya[b]		Morocco[b]		Sudan		Tunisia	
Period	F	M	F	M	F	M	F	M	F	M	F	M
1950–55	44.2	42.1	43.6	41.2	43.9	41.9	43.9	41.9	39.1	36.3	45.1	44.1
1955–60	46.8	44.7	46.1	43.7	46.6	44.3	46.6	44.3	40.1	37.3	47.6	46.6
1960–65	49.8	47.3	48.6	46.2	49.2	46.7	49.2	46.7	41.1	38.3	50.1	49.1
1965–70	52.5	50.4	51.0	48.5	51.8	49.0	51.8	49.0	43.1	40.3	52.6	51.6
1970–75	55.5	53.5	53.4	50.8	54.5	51.4	54.5	51.4	45.1	42.3	56.1	55.1
1975–80	58.5	56.5	55.3	52.9	57.5	54.1	57.5	54.1	48.1	45.3	60.6	59.6
1980–85	62.0	60.0	57.8	55.3	60.0	56.6	60.0	56.6	50.6	47.8	63.6	62.6
1985–90	66.0	64.0	62.3	59.8	62.5	59.1	62.5	59.1	52.4	49.6	66.4	64.9
1990–95[a]	68.3	66.0	64.8	62.4	65.0	61.6	65.0	61.6	54.4	51.6	68.7	66.9

[a]UN (1994) estimates for 1990–1995, medium variant projections.
[b]The 1992 and 1994 revision of the UN World Prospects (UN, 1992 and 1994) provide exactly the same figures on life expectancy at birth by sex for Libya and Morocco between 1950–1955 and 1990–1995. These data were thought problematic by the authors and were not analyzed in the text nor plotted on *Figure 4*.
Source: UN (1993:Table 7).

levels, the spread of family-planning programs, and declining fertility rates, women's life expectancy is likely to continue to improve.

Mortality improvement in Egypt between 1976 and 1986 was greater in the rural population than in the urban population. Life expectancy at birth increased by 8.2 and 7.4 years for rural males and females and by 5.0 and 5.8 years for their urban counterparts. Over this period the rural population gained three more years of life than the urban population. Cities may be unhealthy to live in; however, the proximity of rural areas to urban centers may facilitate the rural inhabitants' access to modern health facilities. Therefore, it is possible that these improvements in mortality are distorted somewhat by the classification of death in a place other than the usual place of residence.

Mortality in Sudan has declined slowly, and its level is still high. Life expectancy at birth has improved by about 7.3 years for males and females over the period from 1970–1975 to 1985–1990. Infectious diseases, particularly malaria, are still widespread in Sudan; therefore, this country's small decline in mortality is not unexpected. Health improvements in Sudan are hampered by several obstacles. Political and social development efforts over a considerable period of time are needed to repair the damage caused by three decades of civil war and frequent famines and droughts.

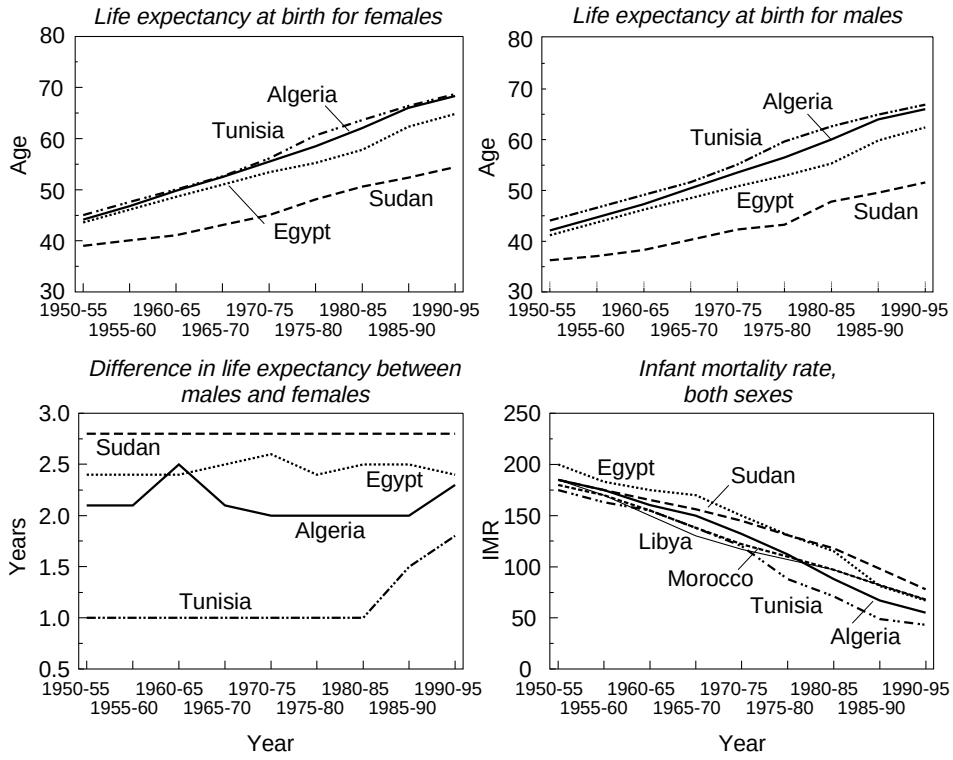

Figure 4. Trends in life expectancy at birth and infant mortality rate in North Africa.

Infants and the elderly are at high risk of death. Therefore, death rates are usually higher at infancy and old age than at other ages. As in other regions, age-specific mortality rates in North Africa diminish rapidly to age 4 then slowly to ages 5–9. Thereafter, mortality stays at a very low level to the 45–49 age group. Mortality rates are very low, usually below 10 per 1,000 population, for children aged 5–9 and 10–14 and for adults aged 15–49. The level then increases at an accelerating rate. Starting approximately at the 50–54 age group for males and 55–59 age group for females, mortality rates increase to levels above 10 per 1,000 population. Thereafter the rates increase to high double digits in the 70–74 age group and to three digits, in most cases exceeding the infant mortality rate, in the open-end age intervals (75+ and 80+).

Table 6. Infant mortality rates in North Africa.

Period	Algeria	Egypt	Libya	Morocco	Sudan	Tunisia
1950–1955	185	200	185	180	185	175
1955–1960	175	183	170	170	170	163
1960–1965	160	175	150	155	150	155
1965–1970	150	170	130	138	130	138
1970–1975	132	150	117	122	110	120
1975–1980	112	131	107	110	97	88
1980–1985	88	115	97	97	92	71
1985–1990	67	81	82	82	85	49
1990–1995[a]	55	67	68	68	78	43

[a]UN (1994) estimates for 1990–1995, medium variant projections.
Source: UNECA (1992:Table 13).

Infants are highly vulnerable to the risk of death. Infant mortality is a very sensitive indicator of social development. As the standard of living goes up, so does the average level of health; in fact, the health of babies improves faster and earlier than the health of adults (Weeks, 1994). Infant mortality was high and declined slowly in all countries in North Africa during the 1950s and 1960s. Since the 1970s it has declined more rapidly (*Table 6*). The trend of infant mortality rates shows a rapid downward pattern.

Pregnant and postpartum women are another high-risk group. In 1986 the WHO estimated maternal mortality in Africa to be 640 per 100,000 live births. Maternal mortality is considered a major public-health issue in all North African countries, particularly in rural areas. Recent studies indicate that the rate of maternal mortality in Egypt was high during the 1960s and 1970s, but it declined to 320 per 100,000 live births in 1986 and to 266 in 1991 (Makhlouf *et al.*, 1994). The maternal mortality rate was 332 in Morocco in 1992 and 552 in Sudan in the 1983–1989 period. With increasing age at marriage and increased use of contraceptives, maternal mortality is likely to decline further in the future.

Gender differences in mortality have been well established worldwide. Generally, women live longer than men primarily because of biological and social factors. Higher rates of heart disease for men combined with men's higher risk behavior account for most of the differences in the gender gap (Weeks, 1994). Data from North Africa show very small differences in life expectancy at birth by sex (*Table 5*). For the most part the gender difference ranges between 1 and 2.8 years over the entire period from 1950 to 1990. The gender difference in life expectancy at birth in Egypt indicates that

women outlived men by about 6 years between 1936 and 1949 and by about 2.5 years from the 1950s to the 1980s. In 1991 this difference increased to 3.4 years.

Egypt is the only country in North Africa for which gender mortality by place of residence (urban/rural) is available. The gender difference in life expectancy at birth in urban areas was 2.3 years in 1976; it increased to about 3 years in 1986. By contrast, the difference in rural areas was about 3.1 in 1976 and declined to 2.3 in 1986. These results suggest that the gender gap is widening in urban areas and narrowing in rural ones.

The mortality decline in each country in North Africa is impressive. All governments in the region have implemented maternal- and child-health programs based on simple, low-cost health technology. For example, immunization and oral rehydration therapy have become widespread. The demographic impact of these health programs has not yet been fully assessed. However, these programs are likely to lead to a substantial decline in infant and child mortality. Infant mortality may decline to below 20 deaths per 1,000 live births in Tunisia and Egypt and to below 40 in Morocco, Algeria, and Libya. In Sudan infant mortality is likely to fluctuate at a high level for the near future primarily because of poor health conditions and poverty.

4. Education

4.1 Education and development

Education is an important factor in development. Future educational achievements of a given population will be decisive in determining that population's chances of developing and prospering. Schumacher (1973) summarizes the role of education in the following way:

> [D]evelopment does not start with goods; it starts with people and their education, organization and discipline. Without these three, all resources remain latent, untapped, potential. Here lies the reason why development cannot be an act of creation, why it cannot be ordered, bought, comprehensively planned: why it requires a process of evolution. Education does not "jump".

It does not "jump" because its pattern of change is a slow one, with the long momentum characteristic of demographic changes. Each person who enters adulthood with a certain level of education will remain a part of the adult population for, on average, four to six decades. During this time,

each person's level of schooling influences the educational achievement of the adult population.

As pointed out in a recent United Nations Industrial Development Organization (UNIDO) study, education increases human capital and the quality of life (Forstner and Ballance, 1990). With higher education, or higher human capital, people's "well-being is enhanced by gains in labor productivity, and by increases in entrepreneurial efficiency in acquiring information, and in adjusting to the disequilibrium inherent in the process of modernization as it affects farm and non-farm production, household production" (Schultz, 1979:343). Formal education is only a part of human capital as "[t]he quality of population in a country is usually taken to mean its state of health, its nutritional standards, and the level of skills and competencies" (Blaug, 1979:361). Education directly increases skills and competencies, but it can also improve people's awareness of the need for better health and diets and is therefore an essential part of increasing human capital.

Growth model studies by economists give a theoretical basis for these observations (Grossman and Helpman, 1991). These studies emphasize the role of human capital in the development of new technologies, innovations, and patents, which have been identified as the long-term engines of economic growth. An economy that has very little human capital in the form of well-educated and skilled individuals will need to use all of this capital in the production sector; therefore, few will be available to develop new technologies. Yet an active research and development sector is what drives the economic growth of a country, including its comparative advantage in international world markets. Indeed, extreme proponents of the value of human capital (e.g., Simon, 1981) argue that it is the "ultimate resource" that determines the level of welfare in a country, and the globe as a whole.

Demographic research has shown that education is one of the most important links between population growth and development (Coale and Hoover, 1958). Rapid population growth implies a young age structure requiring large educational outlays. These outlays reduce the resources available for other investments that could directly benefit economic growth. Even if educational outlays are regarded as investments, the fact that there is a time lag between the initial investment and the increased productivity of the educated worker implies that there are costs to economic growth.

Some authors (e.g., Todaro, 1981) argue that the distribution of expenditure between basic and higher education favors tertiary education in many countries. This situation results in increased inequality, as tertiary education for a few is expanded at the cost of basic education for many, and in

Table 7. Distribution of student population in the countries of North Africa.

	First level			Second level		
	Total	% female	Sex ratio	Total	% female	Sex ratio
Algeria						
1980	3,118,827	41.92	1.39	1,028,294	38.53	1.60
1985	3,481,288	43.55	1.30	1,823,392	41.54	1.41
1987	3,801,651	44.26	1.26	2,082,646	41.65	1.40
1988	3,911,388	44.52	1.25	2,111,292	42.13	1.37
1989	4,027,612	44.66	1.24	2,162,469	42.62	1.35
1990	4,189,152	44.83	1.23	2,175,580	43.36	1.31
1991	4,357,352	45.12	1.22	2,232,780	43.98	1.27
1992	4,436,363	45.35	1.21	2,305,198	44.57	1.24
Egypt						
1980	4,662,816	40.23	1.49	2,929,168	36.92	1.71
1985	6,214,250	43.20	1.31	3,826,601	39.57	1.53
1987	7,034,617	42.77	1.34	4,130,812	40.80	1.45
1988	7,343,716	44.18	1.26	4,180,754	41.35	1.42
1989	6,578,126	44.61	1.24	5,286,776	42.50	1.35
1990	6,964,306	44.35	1.25	5,507,257	43.24	1.31
1991	6,541,725	44.98	1.22	5,284,174	44.58	1.24
Libya						
1980	662,843	47.46	1.11	296,197	40.16	1.49
1981						
1982						
1985	1,011,952	47.00	1.13	143,113	47.27	1.12
1991	1,238,986	47.91	1.09	215,508	56.31	0.78

inefficiency, because most of the costs of tertiary education are borne by the society while most of the benefits accrue to the individual. This theory is supported by the situation of many developing countries in the early 1970s. This situation occurred in Egypt, where an education explosion at the secondary and university levels had created a mismatch between the educational profile of the labor force and the structure of employment opportunities generated by rapid industrial growth. The result was high unemployment rates among graduates with consequent economic and social tensions.

This part of the report provides a succinct description of the educational systems in the countries of North Africa. It describes each country's system and structure. It also presents the role of the system in improving educational attainment and eradicating illiteracy. The analyses highlight differences in educational attainment by region and sex (*Table 7*). Disparities

Table 7. Continued.

	General education[a]			Third level		
	Total	% female	Sex ratio	Total	% female	Sex ratio
Algeria						
1980	4,147,121	41.08	1.43	79,351	26.48	2.78
1985	5,304,680	42.86	1.33	132,057	31.47	2.18
1987	5,884,297	43.34	1.31	180,755	33.54	1.98
1988	6,022,680	43.68	1.29			
1989	6,190,081	43.95	1.28			
1990	6,364,732	44.33	1.26			
1991	6,590,132	44.73	1.24			
1992	6,741,561	45.08	1.22			
Egypt						
1980	7,591,984	38.95	1.57	715,701	31.52	2.17
1985	10,040,851	41.82	1.39	854,584	29.78	2.36
1987	11,165,429	42.04	1.38	875,033	32.69	2.06
1988	11,524,470	43.15	1.32	761,539	33.46	1.99
1989	11,864,902	43.67	1.29	733,275	34.04	1.94
1990	12,471,563	43.86	1.28	708,417	34.54	1.90
1991	11,825,899	44.80	1.23			
Libya						
1980	959,040	45.21	1.21	20,166	25.27	2.96
1981				23,767	25.56	2.91
1982				27,535	25.68	2.89
1985	1,155,065	47.03	1.13			
1991	1,454,494	49.15	1.03	72,899	45.73	1.19

[a] General education refers to first and second levels together.

exist in many countries because education services are unequally distributed and of unequal quality by place of residence (rural/urban) and administrative units. Therefore, educational systems may have differential impacts on various aspects of development and social change. Their effect on fertility and migration in urban areas, for example, may be different from their effect on these components in rural areas. Such differential impacts of education are a subject of separate research. Here we focus on gender differences and differences by place of residence.

4.2 Educational systems and policies in North Africa

Educational systems in North Africa are hierarchical. At the bottom level primary schools provide basic knowledge on various subjects, and at the top

Table 7. Continued.

	First level			Second level		
	Total	% female	Sex ratio	Total	% female	Sex ratio
Morocco						
1980	2,172,289	37.01	1.70	797,110	37.72	1.65
1985	2,279,887	38.21	1.62	1,201,858	39.50	1.53
1986	2,227,960	38.37	1.61	1,280,701	39.40	1.54
1987	2,176,847	38.63	1.59	1,347,202	39.70	1.52
1988	2,110,719	38.93	1.57	1,349,792	39.66	1.52
1989	2,163,185	39.43	1.54	1,378,469	40.13	1.49
1990	2,483,691	39.84	1.51	1,,123,531	40.84	1.45
1991	2,578,566	40.19	1.49	1,168,918	40.58	1.46
1992	2,727,833	40.54	1.47	1,207,743	41.01	1.44
Sudan						
1980	1,464,227	40.37	1.48	384,194	36.89	1.71
1985	1,738,341	40.44	1.47	556,587	42.29	1.36
1986						
1987						
1989						
1990	2,042,743	42.79	1.34	731,624	43.48	1.30
1991	2,168,180	43.01	1.33	718,298	44.17	1.26
Tunisia						
1980	1,054,027	41.58	1.41	293,351	36.50	1.74
1985	1,291,490	44.51	1.25	457,630	40.12	1.49
1987	1,345,921	44.73	1.24	385,680	42.94	1.33
1988	1,333,490	45.13	1.22	455,708	42.66	1.34
1989	1,376,519	45.48	1.20	546,953	42.54	1.35
1990	1,405,665	45.81	1.18	564,540	43.12	1.32
1991	1,426,215	46.07	1.17	589,674	44.21	1.26
1992	1,440,960	46.39	1.16	639,403	44.96	1.22

universities and higher education provide specialized training. These systems have several potential functions, and they fulfill noneconomic needs, both societal and personal. They help an individual develop his or her personality, build his or her career, and obtain better jobs. Education enhances the capacity to accept new ideas and values and changes a child's perception of life and his or her role in society. In fact, educational systems prepare children to have constructive roles in society. For nations and states, educational systems are important for human resources development, transfer of knowledge, and diffusion of technological innovations (Noor, 1981). Societies

Table 7. Continued.

	General education			Third level		
	Total	% female	Sex ratio	Total	% female	Sex ratio
Morocco						
1980	2,969,399	37.20	1.69			
1985	3,481,745	38.66	1.59	181,087	32.33	2.09
1986	3,508,661	38.75	1.58			
1987	3,524,049	39.04	1.56	213,570	33.64	1.97
1988	3,460,511	39.21	1.55	232,071	35.11	1.85
1989	3,541,654	39.70	1.52	239,923	36.32	1.75
1990	3,607,222	40.15	1.49	221,217	36.17	1.76
1991	3,747,484	40.31	1.48			
1992	3,935,576	40.68	1.46			
Sudan						
1980	1,848,421	39.65	1.52	28,788	27.06	2.70
1985	2,294,928	40.89	1.45	41,594	35.64	1.81
1986				39,843	37.43	1.67
1987				34,647	38.28	1.61
1989				60,134	40.18	1.49
1990	2,774,367	42.97	1.33			
1991	2,886,478	43.30	1.31			
Tunisia						
1980	1,347,378	40.47	1.47	31,827	29.65	2.37
1985	1,749,120	43.36	1.31	41,594	35.64	1.81
1987	1,731,601	44.33	1.26	43,797	37.23	1.69
1988	1,789,198	44.50	1.25	54,466	37.81	1.64
1989	1,923,472	44.64	1.24	62,658	38.29	1.61
1990	1,970,205	45.04	1.22	68,535	39.38	1.54
1991	2,015,889	45.53	1.20	76,097	40.52	1.47
1992	2,080,363	45.95	1.18	87,780	41.15	1.43

Source: UNESCO (1992, 1994:Tables 3.4, 3.8, and 3.12).

are greatly empowered when their members (men and women) acquire education and knowledge.

Educational systems also provide statistics through a process in which schools report to local government units which, in turn, report to the national government. These data give information on enrollment, graduates, teachers, classrooms, and so on. Usually the data are published in national reports and demographic yearbooks. In addition censuses and national surveys, such as the DHS, often include data on the educational characteristics of the population measured by level and/or completed years of schooling. The United

Nations Educational, Scientific and Cultural Organization (UNESCO) publishes statistics gathered from official replies to UNESCO questionnaires and special surveys and from official reports and publications. Analyses in this section are based on data compiled from these different sources. It should be noted that education data published in census volumes and national statistical yearbooks are difficult to compare because of variations in the population covered, the definitions employed, and the completeness and accuracy of reporting. However, we found few discrepancies between UNESCO statistics and education statistics published in the statistical yearbooks of the countries in North Africa.[4]

Algeria

The 1976 reforms have proved to be a milestone in the history of education in Algeria. These reforms set the educational system in Algeria on the principles of socialism that were strongly advocated by the government during the 1970s. The mission of the system is to prepare children and citizens for productive active life, to help them acquire scientific knowledge, to respond to popular demands for justice and progress, and to raise the individual's consciousness of the homeland (National Board of Statistics, Algeria, 1991). The school charter states that all Algerians have the right to an education; education is compulsory for all children between 6 and 16 years old; it is free for all citizens; and lessons are in Arabic. These reforms, coupled with a good economy during the 1970s, have enabled Algeria to expand its educational system substantially. The number of pupils and enrollment rates have increased significantly.

The system of education in Algeria, which is under the authority and guidance of the Ministry of Higher Education and Scientific Research, is divided into three levels: fundamental, secondary, and higher education. Fundamental education extends over nine years in three stages of schooling: the first stage from year 1 to year 3, the second stage from year 4 to year 6, and the third stage from year 7 to year 9. The first and second stages are equivalent to first-level education defined by UNESCO. The third stage is called intermediate education. Students who successfully complete the third stage of fundamental education are eligible to compete for entrance into secondary schools. Intermediate education and secondary education are equivalent to UNESCO's second-level education. There are three types of secondary schools in Algeria: general secondary schools, which last a three-year period; specialized secondary schools, also last a three-year period; and

technological and professional secondary schools, which last between one and four years. Students who successfully complete secondary education compete for entrance into the institutes of higher education (universities, high schools, and higher technological institutes); this is the third-level of education defined by UNESCO.

The distribution of the student population by level of education indicates that the system of education in Algeria is broadly based. Of all students in general education, those in fundamental education make up about 66 percent (23 percent in intermediate schools and 11 percent in secondary schools).[5] Students in higher education (universities and institutions of higher education) constitute between 2.7 percent and 3.5 percent of all students in Algeria. The student population has grown rapidly. The number of students enrolled in schools in general education has increased from slightly more than 4 million in 1980 to about 6.7 million in 1992 (see *Table 7*). In fact, the student population in 1990 was more than three times its size in 1970. Students made up 14.7 percent of the population in 1970 and 26.8 percent in 1987. At the first level, the number of pupils has increased from about 1.9 million in 1970 to 3.1 million in 1980 and 4.4 million in 1992 (*Table 7*). The number of students in secondary schools and institutions of higher education has also grown rapidly.

Associated with the growth of the student population in Algeria are changes in the sex composition. There were only 363 female students out of every 1,000 students at all levels of education in 1970, compared with 431 in 1987 and 442 in 1990. Changes in the sex composition of students are interesting when we consider each level of education separately. At the level of fundamental education, the ratio of male to female students has declined from 1.67 in 1970 to 1.21 in 1992. The sex composition of the student population has also changed at the secondary level; the sex ratio declined from 2.50 in 1970 to 1.24 in 1992. The most profound change in the sex composition has occurred in the institutions of higher education where the sex ratio has declined from about 4.00 in 1970 to 1.98 in 1987 and to 1.49 in 1992. These changes in the sex composition of the student population indicate a significant increase in the number of female students at all levels of education. A direct consequence of this is the decline in the gender gap in education.

Gender differences in education could be further studied by examining age-specific enrollment rates. These are the proportion of students enrolled in all levels of education in each age group. *Table 8* shows that enrollment rates at each age are higher for males than for females. While these rates

Table 8. Age-specific enrollment rates in Algeria, Libya, and Sudan by sex.

Age	Males	Females	Total	Difference (M-F)
Algeria 1987				
5–6	0.5550	0.4810	0.5188	0.0740
7–9	0.9999	0.8614	0.9321	0.1385
10–12	0.9498	0.7550	0.8544	0.1948
13–15	0.8056	0.5866	0.6997	0.2190
16–18	0.4335	0.3147	0.3746	0.1188
19–21	0.1857	0.1217	0.1538	0.0640
22–24	0.0591	0.0256	0.0425	0.0335
Libya 1984				
6	0.4636	0.4393	0.4516	0.0243
7–9	0.9622	0.9300	0.9464	0.0322
10–12	0.9794	0.9193	0.9498	0.0601
13–15	0.9645	0.7624	0.8658	0.2021
16–18	0.8012	0.4912	0.6492	0.3100
19–21	0.4178	0.2165	0.3191	0.2013
22–24	0.1782	0.0584	0.1201	0.1198
Sudan 1983				
7–9	0.3450	0.2985	0.3227	0.0465
10–12	0.5008	0.4184	0.4620	0.0824
13–15	0.4258	0.3491	0.3898	0.0767
16–18	0.2859	0.1985	0.2430	0.0874
19–21	0.1760	0.0831	0.1284	0.0929
22–24	0.0872	0.0414	0.0640	0.0458

Sources: National Board of Statistics, Algeria (1991); Department of Statistics and Census, Libya (1984); Department of Statistics, Sudan (1989).

reach a peak at ages 7–9, the gender gap (the difference between them) reaches its peak at ages 10–12. This is most likely because more girls than boys who complete primary education do not proceed to intermediate and higher levels of schooling. Also, it may be possible that there was an undercount of the female student population in the 1987 census.

One outcome of the educational progress in Algeria is declining gender disparities. Another outcome is that illiteracy rates declined from 73.6 percent in 1970 to 50.4 percent in 1987 among people age 15 or older. During this same period illiteracy rates declined from 58.2 to 38.6 for males and from 87.4 to 64.2 for females. Illiteracy rates by place of residence in 1970 were 42.0 percent and 74.2 percent for urban males and females, respectively; for their counterparts in rural areas these rates were 66.5 percent and 94 percent, respectively. In 1987 the rates were 29.5 percent and 56.2 percent

for urban males and urban females, respectively, and 55.8 percent and 87.2 percent for rural males and rural females, respectively. It is apparent that urban men have the highest literacy rates, followed by rural men, urban women, and rural women. This order indicates that women in both urban and rural areas are the most disadvantaged groups in Algeria. Therefore, more must be done to narrow the gender gap, to reduce illiteracy among rural and urban women, and to encourage women to proceed to secondary and higher levels of education.

Egypt

Egypt leads in educational attainment, not only among the countries of North Africa, but also in the Arab world. The history of formal education in Egypt goes back more than a thousand years when the *Al-Azhar* started to provide religious instructions for children and adults.[6] Formal education started in Egypt well before the colonial period. In this respect Egypt is unique among the countries in the region. The most well-known educational policies were introduced during Nasser's regime (1952–1970) when the July revolution introduced major reforms in Egypt. The constitution stipulates that all Egyptians have a right to education, and it must be provided free in government schools at all levels. According to the constitution, the fundamental objectives of education are to build an Egyptian character capable of facing the future, to establish a productive society, to effect comprehensive development, and to prepare generations of scientists (Soliman, 1994).

The current system of education in Egypt consists of three levels: basic, secondary, and universities and higher institutes. At the basic level education is compulsory. According to education law number 139, enacted in 1981, all six-year-old children must attend grade 1 in primary schools. Basic education runs for an eight-year period divided into five years of primary education (*Ibtida'ai*) and three years of preparatory education (*Aidadi*). Secondary education (*Thanawi*) consists of general, industrial, agricultural, and commercial schools. The duration of secondary general education is three years. Each of the remaining three types of secondary education offers the possibility of either a three- or five-year curriculum. Higher-level education is provided in 11 universities in Egypt and in a large number of institutions of higher education (both private and public) offering two- and five-year courses in various specializations. The Ministry of Education, which organizes and oversees the educational system, the *Al-Azhar*, and the private sector provide educational services at all levels. Most students enroll in public schools.

For example, in 1990–1991, 89.1 percent of all students in general education were in public-sector schools. The remaining students were in the *Al-Azhar* (6.7 percent) and the private-sector (4.2 percent) schools.

The principal objective of the educational policy is to expand educational services to achieve universal primary education and eradicate illiteracy. During the Nasser and Sadat regimes, the policy favored expanding higher education (Hansen, 1991). These policies have undeniably led to a tremendous increase in the number of students. Nonetheless, the overall educational attainment in Egypt is low, and illiteracy rates are still high. Also, there are substantial disparities by province and sex. In this section we attempt to explain this paradox.

Education data indicate that the number of students in general education in Egypt increased from about 7.6 million in 1980 to 12.5 million in 1990 (*Table 7*). At the first level (primary education) the number of pupils increased from about 4.7 million in 1980 to 6.9 million in 1990. Quite recently Egypt achieved nearly universal primary education. The gross enrollment rate in primary schools increased from 90.0 percent in 1986–1987 to 97.2 percent in 1990–1991. At the second level (preparatory and secondary schools) the number of students also increased substantially from about 2.9 million in 1980 to about 5.5 million in 1990. Recently, total enrollment in the first and second levels dropped. At the third level total enrollment, according to UNESCO, reached a peak in 1987 and has declined since (*Table 7*). The recent decline in the number of students in higher education is a reverse of the rising trend of the 1960s and 1970s. Given the current economic and employment situations this downward trend in higher education is likely to continue in the future.

Recently, the government adopted a policy of expanding technical education to train the human resources needed in different economic sectors, such as textile, electronics, petrochemicals, mechanics, animal husbandry, and banking. The overall strategy is to expand technical education, improve its quality, and establish new specializations. Due to high unemployment rates among university graduates, students have increasingly become interested in vocations that guarantee employment. Therefore, technical secondary schools, particularly three-year industrial schools, have attracted many young adults. Technical secondary schools absorb about 62 percent of the graduates from preparatory schools, compared with 32 percent from general secondary schools (Soliman, 1994). The number of students in technical secondary schools increased from less than 1 million in 1988–1989 to about 1.4 million in 1992–1993.

Table 9. Percentage illiterate by sex (ages 10+) in Egypt.

Census year	Males	Females	Total
1937	76.0	94.0	85.0
1947	65.0	84.0	75.0
1960	56.0	83.0	71.0
1966	52.0	79.0	65.0
1976	42.6	72.5	57.2
1986	37.8	61.8	49.4

Source: Central Agency for Public Mobilization and Statistics (1993).

These expansions in education have brought about considerable changes in the sex composition of the student population. The gender gap in education has narrowed across all levels of education in Egypt. The percentage of females in primary schools (first level according to UNESCO) and preparatory and secondary schools (second level according to UNESCO) has increased (*Table 7*). Consequently, the sex ratios have declined. For example, the UNESCO statistics show a decline in the sex ratio from 1.49 in 1980 to 1.22 in 1991 at the first level, and from 1.71 in 1980 to 1.24 in 1991 at the second level. These changes in the sex composition of the student population are also true for the third level.

Another important aspect of education in Egypt is that it is regionally unbalanced, and the regional disparities are quite large. For example, in 1990–1991 the governorate of Demiattia had a gross primary enrollment rate of 118.3 percent compared with 75.9 percent in Beni Suef. However, it is not known how regional disparities are distorted by differences in grade repetition rates, which is widespread in Egypt. For example, in 1991–1992 the percentage of students repeating grade 5 in primary schools was 15 percent for males and 12.2 percent for females. Grade repetition rates in 1991–1992 were very high in the final grades of preparatory (20.2 percent for males and 15.3 percent for females) and secondary schools (22.3 percent for males and 20.1 percent for females). As a result of these high repetition rates the age of the student population at each level of education is likely to span beyond standard age limits.

In spite of the rapid expansion in education, illiteracy in Egypt is still high but declining moderately. Censuses taken between 1937 and 1986 give declining illiteracy rates (*Table 9*). These rates are higher for females than for males, and higher in rural areas than in urban areas. National sample surveys also show higher illiteracy for women than for men. For example, the 1992 DHS for Egypt shows that only 22.5 percent of males from ages 5 to

Table 10. Percentage of individuals with no schooling and median years of education by sex and residence in Egypt.

	% no schooling			Median years of education		
Place of residence	Females	Males	Gap	Males	Females	Gap
Urban governorates	23.9	13.6	10.3	6.9	5.7	1.2
Lower Egypt	40.2	22.9	17.3	5.2	2.2	3.0
Urban	26.3	14.7	11.6	6.6	4.6	2.0
Rural	46.0	26.5	19.5	4.5	1.0	3.5
Upper Egypt	52.7	28.6	24.1	4.2	0.0	4.2
Urban	30.0	18.5	11.5	6.4	4.2	2.0
Rural	63.3	33.2	30.1	3.2	0.0	3.2
Total urban	26.0	15.0	11.0	6.7	5.0	1.7
Total rural	53.7	29.4	24.3	4.0	0.0	4.0
Total Egypt	40.7	22.5	18.2	5.3	2.3	3.0

Source: El-Zanaty *et al.* (1993: Tables 2.4.1 and 2.4.2).

65 and over in the sample have no schooling, compared with 40.7 percent of females (El-Zanaty *et al.*, 1993). Another important finding is that women's education lasts for a shorter period than men's. On average, the median years of schooling is 2.3 for women and 5.3 for men. Gender differences in education are larger than differences between urban and rural areas (*Table 10*). Women in rural upper Egypt are at the bottom of the educational system.

One important factor that helps to explain the inconsistency between rapid education expansion and high illiteracy rates in Egypt is high population growth. The population in Egypt grew from 26.1 million in 1960 to 36.6 million in 1976 and to 48.2 million in 1986. The school-age population (5–24-year olds) increased from 10.9 million in 1960 to 16.7 million in 1976 and to 21.2 million in 1986. This rapid growth increases demands on educational services, but on the supply side, expenditure on education is limited because of scarce financial resources. Total educational expenditure as a percentage of GNP was 4.1 percent in 1960, 5.7 percent in 1981, and 3.8 percent in 1990 (UNESCO, 1994). Actual funds allocated by the government to meet education needs are usually far below the amounts required. In addition, education accounts for about 2 percent of total household expenditure in Cairo and less than 1 percent in the rural areas in upper and lower Egypt (Soliman, 1994). Financial difficulties, coupled with a policy of free education, have led to inefficiencies in the educational system. There is a shortage of primary

and secondary schools, and many of the existing ones are not adequate for teaching and training. The government's long-standing policy of guaranteed employment for all university graduates has also created inefficiencies in the labor market.

Libya

Formal education in Libya is organized at four levels of schooling: primary, preparatory, secondary, and universities and institutions of higher education. Primary and preparatory schools are compulsory for all children aged 6 to 14. At the primary level (first level as defined by UNESCO) children enter the first grade when they are 6, and on successful completion of grade 6, approximately at age 11, they proceed to grade 7, which is the first grade at the preparatory level. Preparatory classes cover a three-year period to grade 9. The third level, secondary education, lasts for three years and corresponds to ages 15, 16, and 17 (Libya's preparatory and secondary education equals second-level education of UNESCO). However, the 1984 census results show that the age span is between ages 6 and 14 for primary school students, 12 and 19 for preparatory school students, 15 and 24 for secondary school students, and 19 and 24 years for students at the university level (third level according to UNESCO). These are the age and population groups for which one would expect the fewest reporting errors.

Education in Libya expanded rapidly between 1973 and 1984. During this period the size of the student population doubled. Girls in the student population increased by 130 percent, compared with 80 percent for boys (*Table 11*). The increases were dramatic at the preparatory (433 percent), secondary (783 percent), and university (537 percent) levels. Most of these increases were in the urban population (*Table 12*). The 1984 student population in urban areas was 2.5 times larger than the 1973 student population; in contrast, the student population in rural areas increased only 1.2 times over this period. Consequently, the urban/rural student population ratio changed from 1.6 in 1973 to 3.3 in 1984. These results are not surprising because the population became more urban, due to both high natural increase in urban areas and rural/urban migration. Approximately 75 percent of the population lived in urban areas in 1984, in contrast to about 58 percent in 1973. Moreover, only 0.1 percent of all families in Libya were nomadic or semi-nomadic in 1984 versus 3.8 percent in 1973. The rapid rate of urban population growth, the high income generated primarily from the oil boom

Table 11. Student population and enrollment rates by level of education and sex in Libya.

	Student population			Gross enrollment rates, 1984		
Sex	1973	1984	% change	Urban	Rural	All
Primary	434,606	674,180	55.1	1.06	1.03	1.05
Males	250,259	352,021	40.7	1.08	1.08	1.08
Females	184,347	322,159	74.8	1.03	0.97	1.02
Preparatory	80,073	251,831	214.5	0.94	0.82	0.91
Males	60,297	146,420	142.8	1.04	1.01	1.03
Females	19,776	105,411	433.0	0.83	0.62	0.77
Secondary	26,500	139,658	427.0	0.61	0.52	0.59
Males	20,674	88,236	326.8	0.74	0.71	0.73
Females	5,826	51,422	782.6	0.49	0.32	0.45
University	9,802	30,828	214.5	0.10	0.05	0.09
Males	8,669	23,613	172.4	0.15	0.09	0.13
Females	1,133	7,215	536.8	0.05	0.01	0.04
All levels	550,981	1,096,497	99.0	0.71	0.66	0.70
Males	339,899	610,290	79.6	0.77	0.75	0.76
Females	211,082	486,207	130.3	0.65	0.57	0.63

Source: Department of Statistics and Census, Libya (1984).

during the 1970s, and the small population base are among the factors that have contributed significantly to the expansion of education in Libya.

Absolute numbers of the student population are of limited use unless they can be related to the school-age population. Enrollment rate – that is, the rate of the student population to total population between ages 6 and 24 – is a useful measure. The overall enrollment rate in Libya increased by 5.8 percentage points – from 64.1 percent in 1973 to 69.9 percent in 1984. During the same period the enrollment rate increased by 7.8 percentage points (from 58.1 percent to 65.9 percent) in rural areas and 2.8 points (from 68.4 percent to 71.2 percent) in urban areas. Probably due to increasing urbanization, expanding education in urban areas, and rural/urban migration, more class space became available in the rural areas, particularly for females left behind in villages. Interestingly, enrollment rates for males in urban and rural areas did not change significantly between 1973 and 1984. By contrast, the enrollment rate increased by 17.7 percentage points for rural women and 5.7 percentage points for urban women during the same period. Thus, women in Libya have achieved substantial gains in education.

The oil-driven economy has empowered Libya to achieve universal primary education in a very short period. The 1984 gross enrollment rate at the

Table 12. Student population and total population between ages 6 and 24 and enrollment rates by residence and sex in Libya.

	1973			1984		
Sex	Students	Total	Rate	Students	Total	Rate
Urban	340,113	497,458	0.684	838,296	1,177,083	0.712
Males	195,420	254,913	0.767	459,978	598,328	0.769
Females	144,693	242,545	0.597	378,318	578,755	0.654
Rural	207,425	356,756	0.581	258,201	391,888	0.659
Males	141,361	186,796	0.757	150,312	201,105	0.747
Females	66,064	169,960	0.389	107,889	190,783	0.566
All areas	547,538	854,214	0.641	1,096,497	1,568,971	0.699
Males	336,781	441,709	0.762	610,290	799,433	0.763
Females	210,757	412,505	0.511	486,207	769,538	0.632

Source: Department of Statistics and Census, Libya (1984).

primary level – that is, the rate of students in primary schools to children in the total population between ages 6 and 11 – exceeded 1 for boys in urban and rural areas. Girls have achieved a gross enrollment rate of 1.03 in urban areas and 0.97 in rural areas. The comprehensiveness of primary education can further be supported by examining age-specific enrollment rates. These rates are high, 90 percent or more for girls and boys from age 7 to 11 in urban and rural areas (*Table 13*). The age pattern of primary enrollment rates shows a high plateau between ages 7 and 11. At age 6 the ratio is low primarily because not all children enter school at age 6. Because of this factor and because of grade repetition, some students reach age 14 while they are in primary schools.

At the preparatory and secondary levels the number of female students increased by 5 and 8.8 times their 1973 size; the increase for males was only 2.4 and 4.3, respectively. However, the gross enrollment rate for females is far below that for males, particularly in rural areas. These differences are clearly reflected in the age-specific ratios for preparatory and secondary education. At the university level the enrollment rates are lower for females than for males and are the lowest for females in rural areas. Social factors such as early marriage may have discouraged some girls from continuing their education.

Several important outcomes have resulted from the rapid expansion of education in Libya. Illiteracy has declined substantially, and the gender gap has narrowed significantly. The illiteracy rate among people age 10 or older has declined by about 18.5 percentage points: from 50.9 percent in 1973 to

Table 13. Age-specific enrollment rates by sex and place of residence in Libya and Sudan.

	Urban			Rural		
Age	Males	Females	Difference	Males	Females	Difference
Libya 1984						
6	0.4652	0.4459	0.0193	0.4591	0.4199	0.0392
7–9	0.9663	0.9459	0.0204	0.9503	0.8829	0.0674
10–12	0.9819	0.9378	0.0441	0.9720	0.8632	0.1088
13–15	0.9682	0.7959	0.1723	0.9531	0.6595	0.2936
16–18	0.8059	0.5336	0.2723	0.7870	0.3634	0.4236
19–21	0.4275	0.2415	0.1860	0.3886	0.1383	0.2503
22–24	0.1904	0.0668	0.1236	0.1422	0.0324	0.1098
Sudan 1983						
7–9	0.5717	0.5594	0.0123	0.2879	0.2304	0.0575
10–12	0.8118	0.7666	0.0452	0.4249	0.3254	0.0995
13–15	0.7082	0.6727	0.0355	0.3470	0.2492	0.0978
16–18	0.5073	0.4768	0.0305	0.2075	0.1093	0.0982
19–21	0.3000	0.2405	0.0595	0.1195	0.0325	0.0870
22–24	0.1360	0.1102	0.0258	0.0589	0.0159	0.0430

Source: Department of Statistics and Census, Libya (1984); Department of Statistics, Sudan (1989).

32.4 percent in 1984. Women's education increased impressively during the 1973–1984 period. Illiteracy among females age 10 or older declined from 72.7 percent in 1973 to 47.1 percent in 1984; for males the decline was from 30.9 percent to 18.4 percent. This drop of about 26 percentage points in less than 15 years is a remarkable achievement in women's education. Consequently, the gender gap in education in Libya has narrowed substantially. This gap, when measured in percentage point differences between enrollment rates for boys and girls, declined from 36.8 in 1973 to 18.1 in 1984 in rural areas, and from 17 in 1973 to 11.5 in 1984 in urban areas.

Although the gender gap has decreased, still fewer girls than boys continue to climb the upper rungs of the education ladder. Nevertheless, Libya has accomplished a great deal by putting the majority of its young generations in schools. The educational success in Libya is likely to continue as young generations move up the age pyramid. However, the real challenge is to maintain this achievement by reducing school dropout rates and encouraging students, particularly females, to continue their education at the higher levels.

Morocco

Before independence, education in Morocco was organized under the Direction of Public Instructions. A National Ministry of Education was established in 1955, and in 1959 the structure of education in Morocco was laid down in five divisions: preschool, primary, secondary, professional formation, and higher education. Primary education is compulsory for all children between ages 7 and 13 (Direction of Statistics, 1990). Until 1990 it was provided in five-year schools; in 1990 this was changed to six-year schools. Progress in primary education was undeniably made between 1960 and 1990. Primary school enrollment more than doubled, and the rate of enrollment for 7-year-old children grew from 13 percent in 1960 to 67 percent in 1990. The percentage of girls in the total student population at this level increased slightly from 37.01 percent in 1980 to 40.54 percent in 1992. Consequently, the sex ratio of students in primary schools declined from 1.70 to 1.47 over the period (*Table 7*).

National sample surveys show substantial sex differences in enrollment rates in primary schools. For example, the DHS for Morocco shows enrollment rates in primary education (ages 5–9) of 71.4 for boys and 54.8 for girls (Azelmat *et al.*, 1992). The enrollment rates for the 10–14 age group are 61.4 for boys and 44.0 for girls. These sex differences are due to the fact that very few educational opportunities are available to girls in rural areas. The DHS shows that only 14.3 percent of the females in rural areas have received a primary education in contrast to 31.3 percent of the urban females; the percentages for males are 32 and 38.8, respectively.

Students who successfully complete their primary education proceed to the secondary and professional formation levels. Secondary education lasts seven years and is divided into two cycles: the first cycle is four years; the second cycle is three years. The second cycle is condensed and students graduate with degrees in literature, science, or technology. At the secondary level, students may take instructions in Arabic, French, or both.

The student population in secondary schools grew slowly from about 1.2 million in 1985–1986 to 1.4 million in 1989–1990. Girls make up between 39 percent and 40 percent of the total student population in secondary schools. The sex ratio of secondary school students declined slightly from 1.52 in 1985–1986 to 1.47 in 1989–1990.

Professional formation, which was introduced in Morocco in 1984, is equivalent to a general technical education in many other countries in the Arab world. Its main objective is to provide students with economic and

social development skills and to promote employment. Professional education consists of three cycles. The first cycle is technical and is accessible to students who successfully complete seven years in secondary schools. Graduates from this cycle obtain a technical diploma. The second cycle is called "qualification" and is accessible to students who complete grade 4, 5, or 6 of secondary education. Graduates from this cycle obtain a certificate of professional qualification. The third cycle is called "specialization" and is accessible to students with certificates from primary education and those who complete grade 3 of secondary education. Students in this cycle acquire essential trade, construction, or agricultural skills. Students in professional formation make up only 2 percent of all students in general education. However, female students have increased from about 19,000 to 27,000. Consequently the sex ratio of students in the professional formation level has declined from about 2.6 to about 1.5.

Morocco has 11 universities and a large number of specialized institutions of higher education. Total enrollment in higher education is 4 percent to 5 percent of the total student population in Morocco. The sex ratio of students in higher education declined from about 2.07 in 1985–1986 to 1.75 in 1989–1990.

Morocco has made substantial progress in education since its independence. The share of the state budget allocated to education increased from 17 percent in 1961 to 23 percent in 1988. The number of students enrolled in various educational levels has more than doubled. The number of women in technical schools and higher education has increased, which is a sign of the social change and progress in women's educational opportunities in Morocco. However, the rate of enrollment among females is lower than the national average, especially in rural areas. Illiteracy is widespread; according to the 1982 census, 69.7 percent of the population age 15 or older is illiterate (56.3 percent for males and 82.5 percent for females). Illiteracy rates are higher in rural areas (74.5 percent for males and 97.2 percent for females) than in urban areas (34.9 percent for males and 64.8 percent for females). School dropout rates are considerably high and vary tremendously from one province to another (ranging from 24 percent to 98.7 percent).

Sudan

Sudan has made reasonable progress in the field of education. When it gained independence in 1956 the total population of Sudan was 10.3 million, of which about 2 percent were students. The large majority (86 percent) of

the population age 5 or older was illiterate. Immediately after independence a policy was introduced to nationalize jobs and to train personnel for the rapidly expanding public and private sectors. Seventeen years later, in 1973, the population of Sudan reached 14.1 million and the number of students increased to 1.2 million (8.5 percent). In 1983 the population at 20.5 million was double its 1956 size, and the number of students was about 2.1 million (10.2 percent). Despite these substantial achievements, most of the population remained illiterate. The illiteracy rate for the population age 10 or older was 68.7 percent in 1973 and 64.0 percent in 1983. There is still much to be done to improve the overall education level in Sudan.

Formal education in Sudan was introduced by the British during the 1920s. Since then several structural reforms have been introduced. The four-year curriculum for the primary, intermediate, and secondary schools inherited from the colonial era was changed in 1970 to a six-year curriculum for primary schools and a three-year curriculum for intermediate and secondary levels. Further reform was introduced in 1991 when the primary and intermediate levels of education were amalgamated into one eight-year level called "basic education." Several other changes were also introduced. Arabic replaced English as the medium of instruction in secondary schools in 1970 and in universities and institutions of higher education in 1991. The 1991 reform shortened the duration of general education (from 12 to 11 years) and broadened its base at the primary level. Also, the number of universities and higher education institutes has quadrupled since 1990.

These reforms were brought about by politically unstable governments in Sudan. One drawback of the 1991 reforms is that education has expanded quantitatively at the expense of quality. The overall standard of education at the university level has deteriorated because of lack of staff and Arabic textbooks. Education has become a burden on parents. With increasing poverty and low household income more children are likely to end up working on the streets instead of attending schools. This situation has a negative impact on the overall educational attainment of the population. Each level of education in the system serves as a preparatory stage for the next level. Therefore, students hope to move up through the system. However, because of filter examinations and limited class spaces, few students move up to the top level. Only gifted students, those who have achieved high scores on final exams, proceed to secondary schools and universities. This rigid system has led to a large number of girls and boys who proceed to adulthood without secondary and tertiary education. Class space is also limited at the primary level. Therefore, a large number of children end up with no formal

education. Unmet educational needs will undoubtedly slow the progress toward achieving widespread primary education. Several other factors deter the attainment of universal primary education in Sudan. The country is vast and sparsely populated, and has limited financial resources. These constraints are likely to affect future education expansions.

Sudan's enrollment rate of 46.2 percent in primary schools is substantially below the average in other countries of North Africa. Regional disparities are substantial in the primary (first level according to UNESCO), intermediate, and secondary (second level according to UNESCO) schools (*Table 14*). Southern Sudan is far behind the other regions in the country. Intake in primary education in the southern region is about one-third of the northern region, and half the average for Sudan. Less than half of the 7-year-old population in Kordofan, Darfur, and the eastern regions enters primary schools. Also, because of space limitations and other factors, dropout rates from primary schools are high in these regions. Total enrollment is, therefore, very low in primary schools, and subsequently in intermediate and secondary schools.

Regional disparities by gender are also pronounced. The regions with low educational levels have the highest gender difference. Intake in primary schools for females is about half that for males in Kordofan, Darfur, and the southern regions, and about 7.3 to 12.1 percentage points lower than that for males in Khartoum, central, and eastern regions. These gender differences are reflected somewhat at the primary, intermediate, and secondary levels. Only in the northern region do females have intake and enrollment rates comparable to males. Another observation derived from *Table 14* is that in all regions, except Khartoum, enrollment rates for females are lower than the rates for males at all levels of education; this is probably due to the higher dropout rates among females than among males. In Khartoum, females in intermediate and secondary schools have higher enrollment rates than males. There are considerable gender differences at the tertiary level. For example, females attending the two largest universities of Khartoum and the Khartoum Branch of the Cairo University comprise 26.6 percent and 39.4 percent, respectively, of the total student population.

Enrollment rates by age calculated from the 1983 census results show that there are considerable gender differences (*Table 8*). At each age group males have higher enrollment rates than females, particularly for the 16–18 and 19–21 age groups. When we control for place of residence (rural/urban) the gender differences in education become more significant in rural areas than in urban areas (*Table 13*). Because of more access to educational

Table 14. Intake and enrollment rates by region and sex in Sudan in 1982–1983.[a]

Level of education	Northern	Khartoum	Central	Eastern	Kordofan	Darfur	Southern	Sudan
Intake in primary	86.3	69.0	68.7	44.4	39.6	35.2	29.7	55.8
Males	88.8	73.9	73.7	47.8	50.5	47.0	38.2	48.3
Females	84.2	61.8	63.6	40.5	27.9	22.8	20.6	40.4
Primary	84.4	80.7	68.8	39.6	39.3	32.6	18.8	46.2
Males	84.6	85.4	73.8	42.2	49.2	42.5	25.2	52.3
Females	84.2	76.3	63.4	36.5	28.1	21.6	11.9	39.5
Intermediate	57.6	65.5	35.1	21.2	19.1	15.4	8.3	26.3
Males	61.4	62.2	40.0	23.1	23.1	19.6	12.1	29.6
Females	53.7	69.4	30.0	16.8	15.0	10.8	4.2	22.9
Secondary	32.7	34.5	19.0	12.3	10.0	6.4	4.0	13.9
Males	39.8	33.9	24.4	14.4	14.4	9.9	6.1	17.1
Females	26.3	35.3	13.7	9.9	6.3	3.1	1.8	10.6

[a]Intake in primary as a percentage of the population at age 7. Enrollment rates refer to those enrolled in primary, intermediate, and secondary schools as a percentage of those aged 7–12, 13–15, and 16–18, respectively.
Source: Department of Statistics, Sudan (1985).

services, urban females are better educated than rural males. Rural males and females, therefore, should be targeted for educational and development services. If comprehensive primary education is to be achieved in Sudan much must be done to reduce regional (rural/urban) and gender disparities. There is need for many more schools in the relatively disadvantaged regions and in the rural areas of Sudan. Unless political stability is achieved in the country, it is hard to conceive of any progress in education in these regions. Furthermore, cultural barriers to women's education, particularly in rural areas, have to be ameliorated somewhat through programs specifically designed to address this issue. For example, the government could introduce multi-objective schools and community centers for women and encourage girls to work as teachers in their communities.

Tunisia

After independence, Tunisia seriously considered the importance of demographic parameters in the process of development. In addition to introducing measures concerning health, employment, social security, regional development, and family planning, the government completely reformed the educational system. The "schooling plan" (*Plan de Scolarisation*) was adopted in 1958. The immediate consequence was the massive enrollment of girls in schools, the effects of which were evident in many ways, but mostly in the success of the family-planning program.

The system of education in Tunisia is based on three levels of schooling: primary, secondary, and higher education. Primary education (first level as defined by UNESCO) starts at age 6 and continues for six years. A few primary schools extend to eight years. After successful completion of primary education the great majority of students proceeds to secondary education (second level for UNESCO) which consists of three- and four-year stages. Those who pass the final secondary exams compete for places in the institutes of higher education (UNESCO's third level).

Education in Tunisia is compulsory for the first 11 years for all persons between ages 6 and 16. Total enrollment in primary education in Tunisia increased from about 1.1 million in 1980 to 1.4 million in 1992 (Institute of National Statistics, 1990).

The educational system underwent some drastic austerity measures after the implementation of the adjustment program in 1986 – between 1985 and 1987, the number of children enrolled in secondary school decreased by 8 percent and stagnated in the other school levels (*Table 7*). However, the

late 1980s witnessed some major improvements in school enrollment levels for both sexes. The proportion of children aged 6 to 11 enrolled in primary schools was 100 percent for boys and 92 percent for girls in 1990. Enrollment in secondary schools increased considerably in the late 1980s. Whereas 45 percent of the children aged 12 to 17 were enrolled in school in 1980, 63 percent were enrolled in 1990. The gender gap at this level is still substantial; there is a difference of more than 15 percentage points between male and female adolescents attending school. Of the young people in the 18–23 age group, only 18 percent remained in school. The number of women receiving tertiary education doubled in the 1980s.

These improvements are not yet reflected in the educational status of the whole population. According to the DHS, 57 percent of the women have never received any form of education, 31 percent have had some primary education, and 12 percent have reached the secondary or tertiary levels (Aloui *et al.* 1988). The proportion of women with some schooling (primary, secondary, tertiary or higher) doubled between 1978 and 1988. The level of schooling is also reflected in the literacy rates of women: 61 percent of women were classified as illiterate, whereas 39 percent were able to read a newspaper or to write a letter.

There are significant differences in educational levels depending on region, place of residence, and age category. The younger the woman, the more likely she has received an education (the proportion of women between ages 15 and 19 without any schooling is 35.4). The proportion of women with no schooling is 80 percent in rural areas, nearly double the proportion of women in urban areas (40.5 percent). The northwest and the central west have the highest proportion of women without any schooling. Of the women living in urban areas 89.5 percent have attended school, but only 20.1 percent of rural women have attended school. Women attaining the higher levels of education (secondary level or higher) are concentrated in urban areas where they represent 95.1 percent of all women with secondary or higher education.

5. Scenario Assumptions for the Next 50 Years

Multistate population projections by education require assumptions not only on the future course of fertility and mortality, but also on the future transitions between educational states. The question is, How would fertility and mortality evolve in the future given current and future changes in educational attainment? It is well documented that education is one of the most

powerful factors that affect demographic behavior (fertility, mortality, and migration). The literature is replete with studies on the retrospective interactions of education with fertility, mortality, and migration, and almost devoid of prospective views on these interactions. As well, numerous calculations have been done on future school enrollment rates but not on their impacts on the resulting population. In fact, forecasts of future interactions of education with demographic behavior are rare. The importance of considering these forecasts stems from education momentum, which is linked to a population's growth momentum. This latter component is well known in demographic analyses, but rarely linked to non-demographic factors such as education. The inclusion of education in demographic analyses adds two closely linked elements. The first requires that consideration be given to the young age structure, resulting primarily from past high fertility and declining mortality levels, that pushes the momentum of population growth in the countries of North Africa. The second element takes into account the fact that through the years students move up the education scale. Therefore, the educational attainment of the population changes as younger and more educated cohorts move up the age and education scales. A stagnation in school enrollment, caused by financial, socioeconomic, or political problems, may still be associated with increasing average education. Also, the future impacts of past high levels of illiteracy are as inescapable as the future impacts of past high fertility and mortality levels. The current illiterate generations did not attend schools in the past and the future illiterate generations would be those that are not able to attend schools today. Even if school enrollment is high, it is very difficult to educate the uneducated adult population groups.

Future uncertainties are substantial in each of the six countries of North Africa. Each country provides its own laboratory for demographic and social behavior. The development of women's status, fertility, mortality, and education has been very diverse in these countries. The levels of these factors and the rate by which they have changed vary from country to country. Moreover, the political and economic situations differ from one country to the next. Also, the governments in these countries have different social policies and programs, particularly in the fields of education and health – two crucial components that shape future demographic patterns.

Given these issues, we established our assumptions on substantive knowledge on fertility, mortality, and education, as described in the previous sections of this report. We also used age- and sex-specific population data available from the last census of each country as a basis for the projection.

Table 15. The International Standard Classification of Education used by UNESCO.

State	Definition
1 No schooling	Those who have never attended school or have completed less than one year of primary school education.
2 Primary education	Those who have completed the final grade at the first level of education or have completed at least one year of primary education.
3 Secondary education	Those who have completed the final grade at the second level of education or have entered secondary schools but have not completed the final grade.
4 Tertiary education	Those who have undertaken third-level studies (ISCED 5, 6, or 7) regardless of whether they have completed the course.

Consequently, the base year is not the same in all the countries: Morocco, 1982; Sudan, 1983; Tunisia, 1984; Libya, 1984; Egypt, 1986; and Algeria, 1987. The end year of the projection depends on the base year, so it also varies from country to country. It is important to note that these censuses were taken within a five-year period (1982–1987) and the projections are to the 2032–2037 period. When available, more recent data on fertility and mortality were incorporated into the projections, for instance, in the case of mortality and fertility rates for Egypt (1991), Sudan (1988), Tunisia (1989), and Morocco (1992). These new data improved the base for the projections. We divided the base year population in each country into four states: no schooling, primary education, secondary education, and tertiary education. The definition of these four states is based on the International Standard Classification of Education (ISCED) used by UNESCO (*Table 15*).

5.1 Base year parameters

The base year parameters for education are transition rates: from no schooling to primary, from primary to secondary, and from secondary to tertiary. The calculation of these transition rates is rather problematic because the five-year age intervals usually used for grouping demographic data do not correspond exactly to schooling intervals. Due to early entry, grade repetition, and school dropout, the duration of each level of education is substantially shorter than the age span of students. Schooling intervals vary from country to country and are not in five-year periods. To eliminate some of

these difficulties we based the transition rates on the hierarchical nature of the educational systems. The transition rates from no schooling to primary education are higher than those from primary schools to secondary schools which are, in turn, higher than those from secondary schools to the tertiary level. Another aspect of the base year transition rates is that they are higher for males than for females (*Tables 16–21*) because the data show substantial gender gaps in education.

In the base year the overall total fertility rate for each country is lower than the rate for women with no schooling (*Tables 16–21*) and the fertility rates are lower at higher educational levels. We assumed that this pattern would continue throughout the projection period for each country. This pattern of fertility by education has been well established by data from censuses and national sample surveys of countries in North Africa. To account for the high sensitivity of fertility to slight increases in women's education in these countries, we assumed a one-child difference between women with no education and women with a primary education, and a smaller difference between the remaining educational groups.

Unfortunately we must assume the same mortality level for the four states primarily because accurate mortality data by level of education are not available. This assumption is rather unrealistic because higher education often results in better health and personal hygiene and higher income. But the assumption of any specific percentage difference of mortality in different educational groups would have been completely arbitrary and therefore impossible to justify.

No international migration has been assumed in these scenarios. This is partly because of the lack of reliable data, but also because significant international migration would obscure the analysis of educational change and the impact of alternative fertility and mortality patterns. International migration is discussed separately in Section 7.

5.2 Scenario assumptions

We defined three scenarios for each state in each of the six countries in North Africa. Each scenario combines low, central, and high assumptions on fertility, mortality, and education. The base year parameters of each country remain the same in all three scenarios. The assumptions for the scenarios were obtained by following three simple rules. These rules were used to determine the directions of change:

Table 16. Base year parameters and scenario assumptions for Algeria in 2037.

	Base year 1987	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	5.2	2.1	3.5	4.8
No schooling	5.7	2.9	4.8	5.7
Primary education	4.7	2.2	3.9	4.7
Secondary education	4.2	2.0	2.6	4.2
Tertiary education	3.3	1.6	1.9	3.3
Life expectancy (in years)				
Male	68.3	83.5	75.7	65.8
Female	68.7	84.0	76.1	66.2
Education transition (in %)				
From no schooling to primary				
Male	93.0	100.0 (2007–	100.0[a]	93.0
Female	79.0	100.0 2012)	100.0[a]	79.0
From primary to secondary				
Male	61.0	80.0	66.0[a]	55.0
Female	46.0	80.0	65.0[a]	38.3
From secondary to tertiary				
Male	18.0	30.0	21.0[a]	18.0
Female	10.0	30.0	17.0[a]	10.0

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2012.

1. Primary education increases before secondary, and secondary education increases before tertiary. This rule is necessarily true because of the hierarchical nature of education: a person must complete primary school before attending secondary school, and secondary school before being admitted to the tertiary level. The percentage of an age group with primary education is greater than the age group with secondary education which, in turn, is greater than the age group with tertiary education because the latter groups are subpopulations of the former groups. Since this is true for each age group, it is also true for the adult population as a whole. At any point in time, the proportion of adults with at least primary education is larger than or equal to the proportion with at least secondary education, and the proportion of adults with at least secondary education is larger than or equal to the proportion with tertiary

Table 17. Base year parameters and scenario assumptions for Egypt in 2036.

	Base year 1986	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	5.6	1.8	2.6	3.4
No schooling	6.1	2.4	3.6	4.2
Primary education	5.1	2.0	3.1	3.6
Secondary education	4.5	1.7	2.2	2.9
Tertiary education	3.6	1.5	1.7	2.0
Life expectancy (in years)				
Male	59.7	76.1	70.9	65.6
Female	61.9	78.5	73.3	68.0
Education transition (in %)				
From no schooling to primary				
Male	95.9	100.0 (1991–1996)	100.0 (1991–1996)	89.6
Female	86.3			63.0
From primary to secondary				
Male	64.0	90.0	73.5[a]	52.3
Female	45.6	90.0	64.3[a]	32.4
From secondary to tertiary				
Male	28.2	50.0	29.8[a]	28.2
Female	16.0	50.0	21.7[a]	16.0

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2011.

education. Moreover, because it takes a number of years to complete each level, the increase in the secondary lags behind that in the primary level, and the increase in the tertiary level lags behind that in the secondary level. The time lag is equal to the number of years it takes to pass from one level of education to the next.

2. In any given educational level, boys tend to precede girls. This rule is based on the data that show that at low levels of general education girls lag far behind boys and on observations from historical data on each educational level. The data also indicate that at high or university levels of education, the educational gender gap disappears.
3. Fertility is lower among women with higher education. Moreover, when the general level of education of women is very low, the differential of fertility by level of education is small. In a period when educational

Table 18. Base year parameters and scenario assumptions for Libya in 2034.

	Base year 1984	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	6.8	2.3	3.6	4.9
No schooling	7.3	3.3	5.2	6.5
Primary education	6.3	2.8	4.3	5.6
Secondary education	5.6	2.2	3.5	4.5
Tertiary education	4.5	1.6	2.3	3.4
Life expectancy (in years)				
Male	56.7	73.5	66.2	59.0
Female	60.1	76.9	69.6	62.4
Education transition (in %)				
From no schooling to primary				
Male	100.0	100.0	100.0[a]	86.3
Female	100.0	100.0	100.0[a]	75.0
From primary to secondary				
Male	89.5	93.0	79.3[a]	78.3
Female	72.0	93.0	76.0[a]	58.3
From secondary to tertiary				
Male	30.6	45.0	30.5[a]	32.5
Female	23.0	45.0	45.0[a]	27.5

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2014.

levels are increasing, women with higher education tend to take the lead in reducing their fertility, and a fertility gap appears. The extent of the gap depends on factors such as the country's level of development and family-planning programs (Freedman, 1987). At levels of very high average education and very low fertility, the fertility gap diminishes or disappears. Thus, fertility differentials by level of education are greatest during the middle phase of a secular fertility decline. There is a long time lag between beginning efforts to educate the youth and the effects of having an educated adult population; this long time lag is easy to explain. In Europe, the transformation from an illiterate to a literate society during the industrialization process usually took at least 50 years, and sometimes more than 75 years. Research on education diffusion developed by Goujon and Wils (forthcoming) shows that

Table 19. Base year parameters and scenario assumptions for Morocco in 2032.

	Base year 1982	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	6.0	1.7	2.6	3.7
No schooling	6.4	1.9	2.8	3.9
Primary education	5.3	1.7	2.4	3.4
Secondary education	4.7	1.5	2.2	2.9
Tertiary education	3.7	1.3	1.7	2.0
Life expectancy (in years)				
Male	54.6	73.1	64.9	56.6
Female	58.6	77.1	68.9	60.6
Education transition (in %)				
From no schooling to primary				
Male	74.0	90.0	69.8[a]	60.0
Female	47.0	90.0	58.5[a]	40.0
From primary to secondary				
Male	28.0	70.0	52.8[a]	45.0
Female	18.0	70.0	42.3[a]	30.0
From secondary to tertiary				
Male	5.0	40.0	24.6[a]	20.0
Female	4.0	40.0	18.5[a]	10.0

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2012.

the time lag is considerably longer than a generation, and closer to the length of an adult lifetime (i.e., 40–50 years rather than 15–20). Their work also shows that, because in most developing countries the present young generations are very large in relation to the adult population, the change from an "uneducated adult population" to an "educated adult population" is nonlinear and can happen quite suddenly, when the large young cohorts become adults. The nonlinear increase of average educational levels also means that the associated fertility levels decrease in a nonlinear fashion – in fact, fertility can drop at a faster rate than expected once a large cohort of relatively well-educated young women enters childbearing age. This could, in part, explain some of the sudden fertility changes observed in some countries (Mauritius, Thailand, Asian Tigers, Jamaica). Thus, it is possible that fertility will fall faster than

Table 20. Base year parameters and scenario assumptions for Sudan in 2033.

	Base year 1983	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	6.9	2.5	4.0	5.5
No schooling	7.1	2.8	4.1	5.7
Primary education	6.1	2.4	3.6	4.8
Secondary education	5.4	1.9	2.9	4.1
Tertiary education	4.3	1.6	2.3	3.2
Life expectancy (in years)				
Male	44.5	64.2	56.4	46.9
Female	45.7	67.0	59.5	49.7
Education transition (in %)				
From no schooling to primary				
Male	42.8	90.0	41.7 (1993–	40.3
Female	32.0	90.0	33.3 1998)	32.2
From primary to secondary				
Male	29.8	50.0	30.0[a]	28.5
Female	20.8	50.0	25.5[a]	24.3
From secondary to tertiary				
Male	11.0	30.0	13.5[a]	13.5
Female	5.0	30.0	8.0[a]	8.0

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2013.

expected in aggregate projections, and that populations will grow more slowly than currently expected. The larger the education effort of the past the larger the drop in fertility will be.

Scenario 1 (Low Scenario)

This scenario combines low fertility, low mortality, and high education. High education means the highest transition rates we would expect each country to achieve by the end of the projection period. Therefore, the transition rates range between 90 and 100 from no schooling to primary, between 50 and 90 from primary to secondary, and between 30 and 50 from secondary to tertiary education. We assume that all males and females of Algeria, Egypt, Libya, and Tunisia receive a primary education at a specified future date.

Table 21. Base year parameters and scenario assumptions for Tunisia in 2034.

	Base year 1984	Scenario 1	Scenario 2	Scenario 3
TFR				
Total population	4.5	1.8	2.2	3.1
No schooling	5.0	2.6	3.0	3.9
Primary education	4.0	2.1	2.5	3.1
Secondary education	3.6	1.6	2.0	2.4
Tertiary education	2.9	1.3	1.6	1.9
Life expectancy (in years)				
Male	62.3	79.3	74.0	68.7
Female	63.4	80.8	75.5	70.2
Education transition (in %)				
From no schooling to primary				
Male	100.0	100.0	100.0[a]	93.4
Female	87.0	100.0 (1994–1999)	100.0 (2009–2014)	72.8
From primary to secondary				
Male	59.8	90.0	73.3[a]	55.3
Female	40.2	90.0	71.2[a]	33.7
From secondary to tertiary				
Male	17.0	50.0	22.5[a]	15.5
Female	10.0	50.0	21.5[a]	8.0

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UNESCO scenario up to 2014–2019.

These four countries have already achieved high levels of primary education; therefore we expect these high levels to be maintained in the future. Because widespread primary education would mean substantial efforts for Morocco and Sudan, we decided to lower the target to 90 percent of children receiving primary education. With increasing educational levels we assume that the gender gap disappears in all six countries. Therefore the transition rates for females are the same as the rates for males at all levels by the end of the period. This is not unexpected, as some countries (Libya, Tunisia, and Egypt) have already reached parity in primary enrollment.

Consistent with high education we assume that fertility and mortality reach low levels by the end of the projection period. Low fertility means the lowest level of total fertility rate that women at a particular educational level

would achieve. At the national level TFR is assumed to reach a low level of below 2 in Egypt, Morocco, and Tunisia and between 2.1 and 2.5 in the remaining three countries. Women who attain secondary and tertiary levels of education are assumed to achieve TFR of 2 or less, except for women with secondary education in Libya who achieve a TFR of 2.2. The TFR of women without schooling or primary education is assumed to be more than or equal to the national average. Also, we assume that the fertility differentials between educational levels are reduced; the difference of about 2 children between no schooling and tertiary education in the base year is assumed to decline to between 0.9 and 1.7. These assumptions reflect a smaller fertility difference between educational groups in the projection year than in the base year, which is consistent with increasing women's education. Another aspect is that below replacement fertility is omnipresent. In view of increasing urbanization and high sensitivity of fertility to women's education in North Africa, the assumption of replacement fertility is not unexpected, particularly for women with secondary and higher levels of education.

The assumption of low mortality means an increase in life expectancy at birth by from 1.6 to 2.2 years every five years for males and females. This assumption foresees rapid health improvements, particularly in the countries where mortality is currently high. In Sudan, for example, even though we assume that males and females achieve the highest rate of change, their life expectancy at birth remains below that of their counterparts in other countries; this is primarily due to the initial high mortality levels in the country.

Scenario 2 (Central Scenario)

In this scenario we assign central assumptions to fertility, mortality, and education. Central refers not to the arithmetic mean, but rather to the value in the middle of the low and high extremes. Transition rates for the central scenario are based on future enrollment rates as projected by UNESCO to the year 2015 (UNESCO, 1993). Using annual enrollment data by level of education, age group, and sex for the 1960–1993 period and the medium variant of the 1992 Population Revision of the UN Population Division, the Division of Statistics of UNESCO prepared enrollment trends and projections to the year 2025. We followed the UNESCO projections until 2015 and then kept them constant until the end of the period. For transition rates from no schooling to primary education we assume that each country achieves the UNESCO target results by the date indicated in *Tables 16–21*

and then maintains these results until the end year of the projection (*Tables 16–21*). With the exception of Libya and Egypt, these dates are different from those in scenario 1 to allow for a difference in the attainment of primary education between the two scenario. The strategy is to keep these transition rates lower than those in scenario 1, which assumes high education. The transition rates from primary education to secondary education and from secondary to tertiary are also based on the UNESCO scenario. We assume that more females receive a secondary or tertiary education in this scenario than in the base year, so as to narrow the observed gender gap. Unlike scenario 1, this scenario allows for minor differences in the transition rates for males and females.

At the national level we assume central fertility rates to be between 3.5 and 4 for Sudan, Algeria, and Libya, and between 2.2 and 2.6 for Tunisia, Morocco, and Egypt. Comparing this assumption with the base year it is evident that we project more rapid fertility decline in the latter group of countries than the former group. In particular, we project a decline of fertility in Morocco from 6.0 in 1982 to 2.6 in 2032; this latter fertility rate is also projected for Tunisia and Egypt. We assume the total fertility rate for women with tertiary education to be 2.3 in Libya and Sudan and to be less than 2 in the remaining four countries. For women with secondary education we assume that the TFR remains above 2 (2.2 to 3.5) in all countries except Tunisia, for which we assume a TFR of 2. These assumptions indicate that not all women with secondary and tertiary levels of education would achieve a fertility level of 2 or less. With regard to women with no schooling and those with primary education we assume that fertility declines to levels higher than the national average in all countries except Sudan, where we assume that the TFR declines to 4.1 and 3.6, respectively.

We assume that mortality for males and females declines by between 0.75 and 1.4 years every five years. Males and females achieve moderate gains between 7.5 years and 13.5 years by the end of the projection period. Under this assumption life expectancy at birth reaches between 56.4 and 75.7 for males and 59.5 and 76.1 for females.

Scenario 3 (High Scenario)

This scenario considers high assumptions for fertility and mortality and low assumptions for education. We assume that the transition rates fall back to the levels prevalent during the 1980s. For Algeria, Egypt, and Tunisia we assume that these transition rates are the same as or lower than the base

Color plate: Algeria

Color plate: Egypt

Color plate: Libya

Color plate: Morocco

Color plate: Sudan

Color plate: Tunisia

year. For Libya, Morocco, and the Sudan we assume that the transition rates from no schooling to secondary education are lower than the rates in the base year. Also, for the same countries we assume that the rates from primary to secondary education and from secondary to tertiary education are higher than the corresponding rates in the base year. Together, these assumptions make up the low-education scenario – the worst situation in our forecasts.

With low-education assumptions, we assume that fertility is high, but lower than the base year, at the national level. We apply this assumption to all states and all countries except Algeria, where we assume fertility to be equivalent to the base year level.

We assume that mortality declines slightly, by less than 0.75 years every five years in all countries except Algeria, where we assume mortality increases by 0.25 years every five years for males and females, resulting in life expectancies at birth that are lower than those in the base year.

6. Analyses of Projection Results

Starting at the 1982–1987 period, the projection scenarios were carried out over a 50-year period, until 2032–2037, for the six countries. Each country was considered separately, in five-year steps, using the Population-Development-Environment software program developed recently at IIASA. This program has been used to produce population projections of the island of Mauritius (Lutz, 1994c) and the Yucatán Peninsula. The three scenarios combine high, central, and low assumptions for fertility, mortality, and education. *Tables 22* and *23* show the base year values and results from the three scenarios. These tables list the total population size by country, the mean age of the population, percentages of the 0–14 age group and the 60+ age group (*Table 22*), and the percentages of males, females, and total population by level of education (*Table 23*). (See Color Plates for selected multistate age pyramids of projection results.)

6.1 Population size

Rapid population growth is certain in North Africa. The high, central, and low scenarios show a total population of 374, 350, and 305 million persons, respectively, by 2032–2037, compared with a total population of about 122 million persons in the base period. Under the low scenario, the four Maghreb countries (Algeria, Libya, Tunisia, and Morocco) grow from about 53 million

Table 22. Scenario results under high, central, and low assumptions for fertility, mortality, and education.

Country	Base year	Population (in 1,000)	End year	Population (in 1,000) at end year Scenario 1	Scenario 2	Scenario 3
Algeria	1987	22,601	2037	63,376	74,128	83,385
Egypt	1986	48,056	2036	106,509	125,613	132,593
Libya	1984	3,231	2034	11,256	12,649	14,108
Morocco	1982	20,450	2032	55,934	61,113	63,083
Sudan	1983	20,567	2033	53,040	60,412	64,377
Tunisia	1984	6,975	2034	14,873	15,536	16,742
Region total	1982–1987	121,880	2032–2037	304,988	349,451	374,288

Country	Base year	Mean age	End year	Mean age at end year Scenario 1	Scenario 2	Scenario 3
Algeria	1987	22.6	2037	34.0	29.7	26.3
Egypt	1986	24.2	2036	35.0	31.2	28.9
Libya	1984	21.2	2034	30.3	27.1	24.5
Morocco	1982	23.5	2032	32.9	29.8	27.4
Sudan	1983	22.3	2033	31.7	28.0	25.4
Tunisia	1984	24.5	2034	36.5	34.3	31.4

Country	Base year	Ratio	End year	Percentage of 0–14 age group in total population Scenario 1	Scenario 2	Scenario 3
Algeria	1987	44.0	2037	23.5	31.5	37.9
Egypt	1986	40.1	2036	21.0	27.1	31.8
Libya	1984	49.9	2034	27.3	34.7	40.3
Morocco	1982	42.2	2032	23.2	28.8	34.0
Sudan	1983	44.1	2033	26.4	33.8	39.1
Tunisia	1984	39.6	2034	20.1	23.6	28.9

Country	Base year	Ratio	End year	Percentage of 60+ age group in total population Scenario 1	Scenario 2	Scenario 3
Algeria	1987	5.7	2037	14.8	11.3	8.4
Egypt	1986	5.7	2036	14.2	11.1	9.1
Libya	1984	5.5	2034	9.9	7.9	6.2
Morocco	1982	6.1	2032	12.5	9.9	8.0
Sudan	1983	4.0	2033	11.9	9.2	7.1
Tunisia	1984	6.7	2034	17.3	15.1	12.5

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.

Table 23a. Population by level of education in Algeria.

		2037		
	1987	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	40.9	12.9	17.0	24.5
Primary education	38.7	41.7	47.2	47.7
Secondary education	16.5	40.9	33.0	25.9
Tertiary education	3.9	4.5	2.8	1.9
Female				
No schooling	59.6	18.5	23.6	38.2
Primary education	26.9	45.8	45.9	45.9
Secondary education	10.8	32.4	28.6	15.1
Tertiary education	2.7	3.3	1.9	0.8
Total				
No schooling	50.1	15.7	20.3	31.3
Primary education	32.9	43.8	46.6	46.8
Secondary education	13.7	36.6	30.8	20.5
Tertiary education	3.3	3.9	2.3	1.4

Table 23b. Population by level of education in Egypt.

		2036		
	1986	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	44.8	12.0	14.1	21.1
Primary education	32.3	33.6	41.2	46.2
Secondary education	19.6	42.9	38.2	28.0
Tertiary education	3.3	11.5	6.5	4.7
Female				
No schooling	62.6	14.8	16.4	32.0
Primary education	25.3	37.2	48.3	49.2
Secondary education	11.1	39.0	31.8	17.2
Tertiary education	1.0	9.0	3.5	1.6
Total				
No schooling	53.4	13.4	15.3	26.6
Primary education	28.9	35.4	44.7	47.7
Secondary education	15.5	41.0	35.0	22.6
Tertiary education	2.2	10.2	5.0	3.1

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.

Table 23c. Population by level of education in Libya.

		2034		
	1984	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	45.8	12.5	16.5	22.3
Primary education	45.0	25.2	35.6	29.5
Secondary education	7.6	52.2	42.6	42.4
Tertiary education	1.6	10.1	5.3	5.8
Female				
No schooling	57.3	14.1	17.5	25.9
Primary education	37.6	31.2	41.2	40.6
Secondary education	4.4	46.5	34.1	30.2
Tertiary education	0.7	8.2	7.2	3.3
Total				
No schooling	51.4	13.3	17.0	24.1
Primary education	41.4	28.2	38.4	35.1
Secondary education	6.1	49.3	38.3	36.2
Tertiary education	1.1	9.2	6.3	4.6

Table 23d. Population by level of education in Morocco.

		2032		
	1982	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	59.8	37.2	47.7	54.9
Primary education	26.8	41.8	38.4	35.0
Secondary education	12.1	19.0	13.1	9.6
Tertiary education	1.3	2.0	0.8	0.5
Female				
No schooling	72.0	46.5	60.5	70.3
Primary education	19.8	37.4	31.7	25.1
Secondary education	7.5	14.7	7.5	4.5
Tertiary education	0.7	1.4	0.3	0.1
Total				
No schooling	65.9	41.9	54.2	62.8
Primary education	23.3	39.6	35.0	29.9
Secondary education	9.8	16.8	10.3	7.0
Tertiary education	1.0	1.7	0.5	0.3

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.

Table 23e. Population by level of education in Sudan.

		2033		
	1983	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	73.8	49.3	72.1	73.9
Primary education	19.6	40.7	23.7	22.4
Secondary education	6.1	9.4	4.1	3.6
Tertiary education	0.5	0.6	0.1	0.1
Female				
No schooling	82.5	53.6	78.7	79.9
Primary education	13.9	38.1	18.7	17.8
Secondary education	3.4	7.9	2.5	2.3
Tertiary education	0.2	0.4	0.1	0.0
Total				
No schooling	78.0	51.5	75.4	77.0
Primary education	16.8	39.3	21.2	20.0
Secondary education	4.8	8.7	3.3	2.9
Tertiary education	0.4	0.5	0.1	0.1

Table 23f. Population by level of education in Tunisia.

		2034		
	1984	Scenario 1	Scenario 2	Scenario 3
Male				
No schooling	42.3	10.5	11.8	17.5
Primary education	39.2	37.8	45.4	51.7
Secondary education	16.2	43.9	40.2	29.4
Tertiary education	2.3	7.8	2.6	1.4
Female				
No schooling	57.8	15.3	17.2	34.1
Primary education	32.7	40.9	47.9	51.1
Secondary education	8.7	37.4	33.4	14.4
Tertiary education	0.8	6.4	1.5	0.4
Total				
No schooling	49.9	12.9	14.6	25.8
Primary education	36.0	39.4	46.6	51.4
Secondary education	12.5	40.7	36.8	21.9
Tertiary education	1.6	7.0	2.0	0.9

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.

Table 24. Average annual rate of population growth over projection period (in percent).

		Growth during projection period		
	Base year[a]	Scenario 1	Scenario 2	Scenario 3
Algeria	2.6 (1985–1990)	2.1	2.4	2.6
Egypt	2.5 (1985–1990)	1.6	1.9	2.1
Libya	4.4 (1980–1985)	2.5	2.8	3.0
Morocco	2.4 (1980–1985)	2.0	2.2	2.3
Sudan	2.8 (1980–1985)	1.9	2.2	2.3
Tunisia	2.6 (1980–1985)	1.5	1.6	1.8

Scenario 1: low fertility/low mortality/high education.
Scenario 2: central fertility/central mortality/central education.
Scenario 3: high fertility/high mortality/low education.
[a]UN (1994).

to at least 145 million – 5 million more than the estimated population size of North Africa in 1990. Because of their proximity to Europe, the Maghreb countries (and their rapid population increases) are of special interest to the European Union. It is interesting to note that the combined population of Algeria and Morocco, countries that currently have the largest number of immigrants to Europe, grows to, at least, about 119 million, 2.8 times its size in the base year. By contrast, the population of Libya grows to 11–14 million and that of Tunisia to 15–17 million by the end of the period. Egypt continues to rank first in population size. The low scenario for Egypt gives a total population of about 107 million, in contrast to 126 million under the central scenario and 133 million under the high scenario (*Table 22*). The central and high scenarios show that the population of Sudan triples over a 50-year period. Even under low-scenario assumptions the population of Sudan grows to about 53 million.

Although the population of the region continues to increase over the next 40 years, it grows at a slower pace than in the past (*Table 24*). Even under the extreme scenario of high fertility combined with high mortality, the average annual rate of population growth in 2032–2037 would be equal to (for Algeria) or below (all other countries) the annual rate of growth in 1980–1985 or 1985–1990. The decrease is quite dramatic in the case of Libya, where the population that had grown at a rate of 4.4 percent per year in the early 1980s only grows at a rate of 3.0 percent in the 2030s under the high-fertility/high-mortality scenario. The three scenarios show little difference in the annual rate of growth, which at the maximum is 0.5 percentage points in the case

of Algeria between the high-fertility/high-mortality scenario and the low-fertility/low-mortality scenario. In the central scenario, which follows the school enrollment projections of UNESCO for the near future, the population growth is systematically lower when education is available to more and more people. Ranked according to transition rates (all levels) and percentage point differences of annual growth rates between 1982–1987 and 2032–2037, we found the highest to the lowest to be as follows: Libya, Tunisia, Egypt, Algeria, and Morocco. Only Sudan does not fit into this picture because even under the central scenario we assume that fertility and mortality rates remain quite high and that the impact of education is limited.

6.2 Age structure

The age pyramids given in the Color Plates show the age structures of the populations in the countries of North Africa. *Table 22* presents the percentages of the youngest and oldest age groups in the populations. The pattern for the young age group continues to dominate the age structure of the populations of Algeria, Libya, Morocco, and Sudan. The high and central scenarios show that at the end of the projection period between 29 percent and 40 percent of the total population are in the 0–14 age group in these countries. Only under low-fertility, low-mortality, and high-education assumptions (low scenario) do these percentages fall to 23–27 percent. By contrast, Egypt and Tunisia, the two countries that are currently experiencing rapid declines in fertility, have different age structures. For Egypt, the high scenario shows that the percentage of the 0–14 age group in the total population (40.1 percent) decreases by about 8 percentage points, compared with 13 and 19 percentage points under the central and low scenarios, respectively. For Tunisia the high scenario shows that the proportion in the 0–14 age group decreases by about 11 percentage points (from 39.6 to 28.9), compared with 16 and 19.5 percentage points for the central and low scenarios, respectively.

The scenarios also show that the 60+ proportion in the total population increases such that the countries experience a slightly different aging process. The two extreme cases are Libya and Tunisia. Under high-scenario assumptions the 60+ proportion in the total population increases slightly to 6.2 percent in Libya and almost doubles to 12.5 percent in Tunisia. The base year parameters, as well as the high, central, and low scenarios, show that the youngest mean age is in Libya and the oldest is in Tunisia.

6.3 Educational composition

Given past demographic and educational trends, these projections provide a picture of possible future educational attainments of the populations in North Africa. *Table 23* gives the percentage of males, females, and total population by level of education in the base year and end year of the projection period for the six countries in North Africa. The results of the three scenarios are astounding.

All three scenarios show a substantial decline in the percentage of the population with no schooling in all countries except Morocco and the Sudan, where an appreciable decline is envisaged only under low-scenario assumptions. Even with low education, high fertility, and high mortality (high scenario), the percentage of the population with no schooling is not more than half the percentage in the base year in Egypt, Tunisia, and Libya. The central and low scenarios give further substantial reductions for these three countries. At the primary level, women realize considerable gains in education.

Another important result from these projection scenarios is that at all levels of education in all countries except Libya, the gender disparities in education narrows considerably, because educational attainment increases more for women than for men. The educational gaps between men and women are smaller under the central and low scenarios than in the base year or under the high scenario. At the primary level, the central and low scenarios for Tunisia, Egypt, and Libya give higher percentages for females than for males.

Another interesting point when we look across scenarios is that education in a given population can spread quickly when low fertility rates and high rates of educational enrollment are combined. This situation is evident when we consider fertility differentials by educational level. The central scenario for Tunisia and Egypt illustrates this point. The TFR decreases from 5.6 to 2.6 by the year 2036 for Egypt (*Table 17*) and from 4.5 to 2.2 by 2034 for Tunisia (*Table 21*). This fertility decline is associated with substantial educational achievement: full intake for boys and girls in primary school, secondary school enrollment above 70 percent, and tertiary education above 20 percent. These assumptions allow the two countries to reach an advantageous demographic and educational situation by the end of the projection period. In the two countries, about 40 percent of the total population and 35 percent of the female population have at least a secondary education under the central scenario. Of those individuals in the working-age group (ages 20

to 60), the percentage of the population with at least a secondary degree is above 50 percent (46 percent for women). In Egypt less than 1 percent of the population in the working-age group is without any schooling (1 percent of women) and in Tunisia this rate is 2 percent for the total population and 4 percent for women of working age. The age structure shows that the two countries have the lowest percentage of young people and conversely the highest proportion of people over age 60.

However, progress is slower when we consider – still under the central scenario – the other combinations of (a) high fertility and high education (Libya and Algeria), (b) low fertility and low education (Morocco), and (c) high fertility and low education (Sudan). The central scenario for Libya shows what happens when the diffusion of education in the population is not followed by a proportional fertility decline. In 1984, Libya had the most widespread educational system of the region but a TFR of 6.8 and a fertility rate of 4.5 for women with a tertiary education. If we extend this trend of high fertility levels to all educational categories and at the same time apply a global decline to the TFR until it reaches 3.6 in 2034, the population continues to have the age structure of a developing country with a large young age group (35 percent) and a very small elderly age group (8 percent). However, the working-age population is very educated: 67 percent of the 20–60-year-old population has received an education and 60 percent of working-age women have at least some secondary education.

Algeria is an intermediate case where school enrollments are relatively high – not as high as in Libya, but close to those of Egypt and Tunisia. The situation in Algeria in 2037 is very different from that in Libya, Egypt, and Tunisia. Under the central scenario, the age pyramid remains very large at the base until the end of the projection period (32 percent in the 0–14 age group). The majority of the working-age population has primary or secondary qualifications (90 percent in the total population and 87 percent in the female population) although 7 percent still has no education (11 percent for women); and 0.7 percent has some tertiary education.

Morocco and Sudan were the two countries with the highest proportion of people without any education in 1982 and 1983 (66 percent and 78 percent, respectively). This handicap is difficult to overcome. Under the central scenario, by 2030 most countries in the region are able to eliminate illiteracy (which we consider, for simplification purposes, similar to the level of no education) with the exception of Morocco and Sudan. The UNESCO projections of enrollment rates for these two countries are rather pessimistic: the total enrollment rate for all levels increase, at best, a few percentage

points (Morocco) or decrease (Sudan). This explains the educational composition of the population at the end of the projection period under the central scenario. In Morocco, 49 percent of the 20–60 age group would have had no education (for Sudan the figure is 72 percent) with a large gender discrepancy: 57 percent of the women (76 percent in Sudan). The low scenario (low-fertility/low-mortality/high-education) shows a brighter future. We can see from the age pyramids that the population receives access to educational development but, because of the time lag between school age and working age, the majority of the 20–60-year-old population is still uneducated (53 percent in Sudan and 40 percent in Morocco). This result shows that the momentum of education adds to the population momentum.

The three scenarios for Tunisia offer an interesting example of diverse population composition. Although the three scenarios give very similar total population results (15.5 million, 16.7 million, and 14.9 million in 2034, respectively, for the central, high, and low scenarios, *Table 22*), the age and educational structures are quite different under each scenario (see Color Plates for age pyramids). Under the low scenario (low-fertility/low-mortality/high-education) the educational progress of the population is spectacular and the proportion of people without an education is about 13 percent for both sexes and can only be found in the 60+ age group. Already 40 percent of the population has some secondary or tertiary education. At the other extreme, in 2034 the high scenario (high-fertility/high-mortality/low-education) shows 26 percent of the total population without any education, hiding a large male–female differential of 16 percentage points.

7. Outlook

7.1 Probabilistic population projections of North Africa to 2100

In this section, we aggregate the projection results obtained for Algeria, Egypt, Libya, Morocco, Sudan, and Tunisia and compare them to the regional probabilistic projections for North Africa produced in the process of preparing the 1996 revised edition of *The Future Population of the World* (Lutz, 1996). North Africa was one of the 13 regions included in this first set of probabilistic world population projections up to the year 2100. The approach is based on expert judgment about trends and uncertainties of future fertility, mortality, and migration in all world regions. For each demographic component, a group of experts defined three alternative future paths: low,

central, and high. A standard normal distribution was fitted to these assumptions, with the central assumption giving the most likely case (mean) and the low and high assumptions giving the 90 percent range of all possible cases. Drawing randomly from these distributions, 4,000 simulations were performed to determine uncertainty distributions of the future population size and age structure of the world.

The starting year of these projections was 1995; the population estimates were based on the 1995 population data sheet of the Population Reference Bureau (PRB). Age structures were derived from the 1994 UN assessment and adjusted to correspond with the 1995 PRB data. Mortality and fertility information were also derived from these sources; migration data were taken from Zlotnik (1994). For the region of North Africa several assumptions were made. Total fertility was estimated to decline from 4.35 in 1995 to 3.92 in 2000, 2.00 in 2030–2035, and 1.54 in 2080–2085 in the low case; to 4.13 in 2000, 3.00 in 2030–2035, and 2.04 in 2080–2085 in the central case; and to 4.35 in 2000, 4.00 in 2030–2035, and 2.54 in 2080–2085 in the high case. Life expectancy, which was 62.7 years for men and 65.3 years for women in North Africa in 1995, was assumed to increase by 0.5 years per decade in the low case; by 2.25 years, in the central case; and by 4 years, in the high case. After 2035 increases per decade were assumed to be half these amounts. For migration the low case assumed no net-migration: the central case assumed a net loss of 237,500 persons per year; and the high case, a net loss of 475,000 per year. [For a justification of these assumptions and the specific age patterns, see Lutz (1996), which also gives a detailed comparison to the UN projections].

The results show that in the most likely case the population of the region increases from 162 million in 1995 to 277 million in 2020, 440 million in 2050, and 630 million by the end of the next century (*Table 25*). Hence, the population is likely to increase by almost a factor of four. It is interesting to note that the same figure of 277 million for 2020 was obtained through the projections by educational states presented in Section 6 if we add the population results of the six countries during the 2018–2022 period for the central scenario (central fertility/central mortality/central education). Calculated on the basis of the 1950 population, the total population of the region increases by an incredible factor of 12 over just one and a half centuries. This is the most likely case. The uncertainty distribution of this increase is depicted in *Figure 5*. The figure shows that by 2020 the uncertainty range is still narrow: the 95 percent confidence interval ranges from 254 million to 300 million. The aggregated figures obtained through the high, central, and low

Table 25. Mean, median, and 95 percent confidence intervals for North Africa in 1995, 2020, 2050, and 2100.

	Population (in millions)	0–14 age group (in %)	60+ age group (in %)
1995	162	38.8	5.9
2020			
Mean	277	33.9	7.9
Median	277	34.0	7.9
2.5	254	30.0	7.2
97.5	300	37.5	8.7
2050			
Mean	440	27.0	13.6
Median	439	27.3	13.3
2.5	309	18.6	9.4
97.5	583	34.2	19.2
2100			
Mean	630	18.7	24.0
Median	598	19.0	23.0
2.5	228	11.5	15.2
97.5	1,202	25.1	37.4

Table 26. Aggregated results of the projections for six countries in North Africa, 2018–2022.

	Central	Low	High
Population (in millions)	277	259	282
0–14 (in %)	33.9	29.8	36.1
60+ (in %)	7.7	8.7	6.9

scenarios mentioned in Section 6 fall within this range. The central scenario gives exactly the mean of the probabilistic projection (277 million). The populations resulting from the high (282 million) and the low (259 million) scenarios are very close to the lower and upper bounds of the 95 percent confidence intervals of these probabilistic projections (*Table 26*). By 2050 the span of the 95 percent confidence interval increases from 309 million to 583 million, and by 2100 the uncertainty range is extremely wide, ranging from a low 228 million (which is still higher than today's population) to an incredible 1.2 billion – a range of 1 billion people. But this range includes some rather unlikely cases. Looking at the most likely case, i.e., the

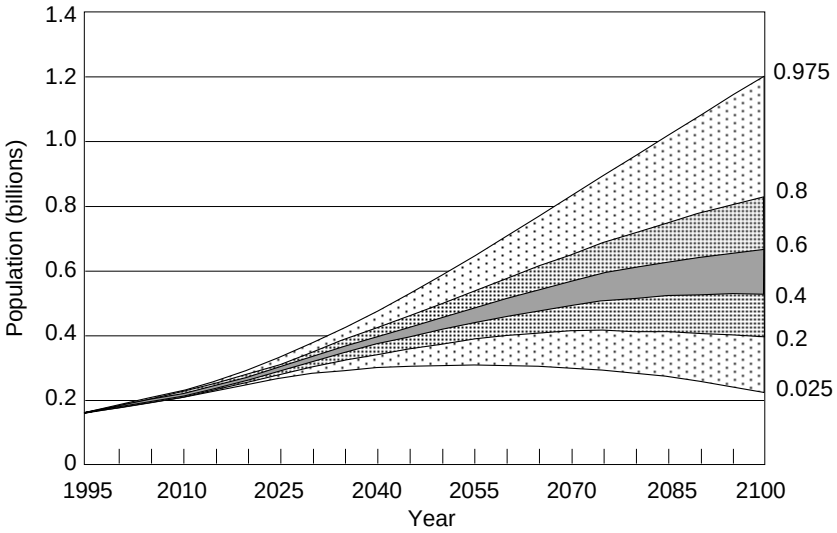

Figure 5. Future population size in North Africa. Figures on the right-hand side refer to the probability that the population size will lie below the line indicated.

range between the 0.2 and the 0.8 fractiles, the uncertainty range in 2100 diminishes to somewhat more than 400 million people.

The probability distributions given for the percentage of the population below age 15 and above age 60 clearly indicate that significant population aging in the region is virtually certain. This phenomenon, however, happens slowly; the momentum is high and the region maintains a very young age structure at least for another 30 years. The probabilistic projections show that in 97.5 percent of all cases, the proportion of the population that is below age 15 declines only from 39 percent today to 38 percent in 2020. The lower confidence limit is not even eight percentage points lower. In the same manner, the proportion above age 60 increases very slowly from 6 percent today to almost 9 percent in 2020. This process of slow population aging is also shown through the high, central, and low scenarios discussed earlier. The central scenario for 2020 reproduces, very closely, the mean of the probabilistic projection with 33.9 percent of the population in the 0–14 age group and 7.7 percent in the 60+ age group. The low and high scenarios reflect, as well, the lower and upper confidence limit of the probabilistic projection. Population aging is more pronounced at the end of the next

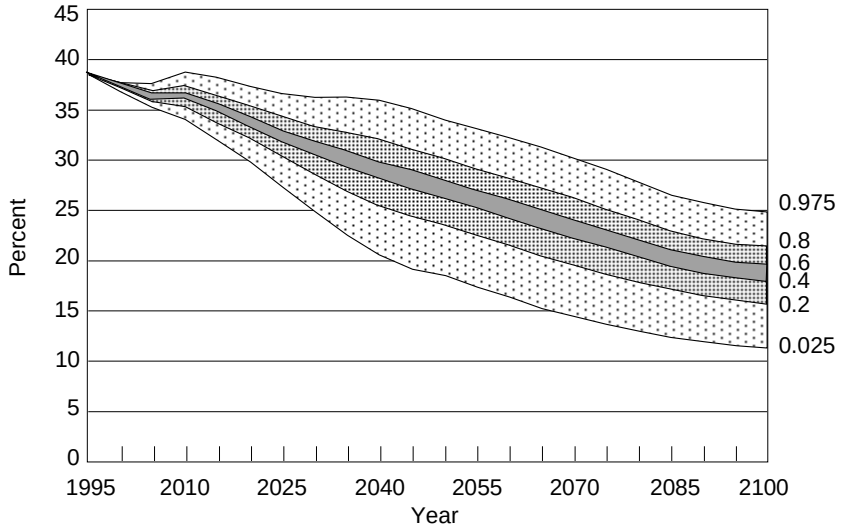

Figure 6. Proportion of the population in North Africa below age 15. Figures on the right-hand side refer to the probability that the percentage of the 0–14 age group will lie below the line indicated.

century. *Figure 6* shows that in 97.5 percent of all cases the proportion of the population that is below age 15 declines from close to 40 percent today to below 25 percent by the end of the 21st century. The proportion above age 60, illustrated in *Figure 7*, increases in 97.5 percent of all cases from around 5 percent today to above 35 percent. In the most likely case it increases to above 20 percent.

It is interesting to note that the uncertainty ranges of the young population and the elderly population show very different developments over time. For the population below age 15 uncertainty about population size increases quickly because it is immediately affected by the uncertainty of future fertility rates. The number of elderly, on the other hand, is not affected by alternative fertility rates before the middle of the next century, but it is affected by mortality uncertainty, which evolves more slowly. By the end of the next century, however, the uncertainty range of the elderly population (15–37 percent) is much greater than that of the young population (12–25 percent) because of the combined effect of fertility and mortality on the young population. Alternative migration assumptions also affect the elderly to a greater extent than the young.

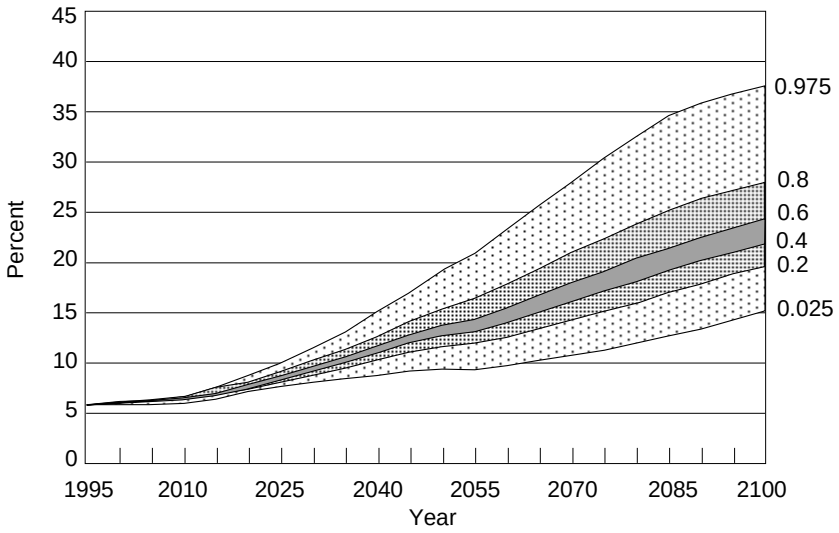

Figure 7. Proportion of the population in North Africa above age 60. Figures on the right-hand side refer to the probability that the percentage of the 60+ age group will lie above the line indicated.

7.2 Possible future migration from North Africa to Europe

The issue of international migration across the Mediterranean has not been addressed explicitly at the individual country level because of the lack of reliable data. Furthermore, the objective of this study is to look primarily at the long-term implications of alternative fertility, mortality, and education patterns. The migration dimension makes the analysis more complex and the interpretation of results more difficult. Nevertheless, there is no doubt that future large-scale migration would have significant effects on both the sending countries and the receiving countries; most of the latter countries are in Southern and Western Europe. In this section we numerically address the migration issue.

Available data on past migration streams show that migration from North Africa was directed mostly to France and Germany (Zlotnik, 1994). The flow to France peaked in the 1970–1974 period, when between 70,000 and 80,000 immigrants from the region entered France each year. The number of immigrants declined during the late 1970s, increased again during the early 1980s, and has been in a steep decline in recent years. During the late 1980s annual immigration from the region to France had declined to

about 20,000. Also during this time there was considerable out-migration from France to the Maghreb during the 1980s, so it is not clear whether net-migration was positive during this entire period. According to census statistics, in the early 1990s Belgium, France, Germany, the Netherlands, and Sweden together hosted about 951,000 Moroccans, 631,000 Algerians, and 242,000 Tunisians (OECD, 1992). In Italy at this time there were 146,000 individuals from North Africa (including 78,000 Moroccans, 41,000 Tunisians, and 20,000 Egyptians). Spain also saw increases in the number of immigrants from North Africa recently, but the absolute number is still rather small.

The IIASA world population projections discussed in Section 7.1 (see also Lutz, 1994b, 1996) make several assumptions about possible future migration streams. In the high-migration scenario 477,000 North Africans are assumed to leave the region every year. Of these, 275,000 are assumed to move to Western Europe and 90,000 to North America. It is assumed that the rest moves to other world regions (mostly to countries in West and Central Asia). The low-migration scenario assumes no new migration between any regions, and the central (and most likely) scenario assumes half of the annual stream assumed under the high scenario. Hence, in the central scenario an annual net-migration of about 140,000 is assumed between North Africa and Western Europe. For Western Europe this is 28 percent of its total assumed net-migration gain. These assumptions were defined by a group of experts based on a study of past trends and discussions about possible alternative future migration patterns under different geopolitical scenarios.

Table 27 shows the effects of the alternative migration assumptions on total population size and the mean age of the population in the North African region, combined with central fertility and mortality assumptions. From the table it can be seen that even the very high levels of out-migration assumed under the high scenario have only a moderate effect on reducing total population growth in the short and medium term. Over the next 15 years (i.e., to 2010) the most extreme assumptions range from a total population of 231 million to 224 million, hence a difference of only 7 million or 3 percent of the total population. In the long term the total population of the region doubles or perhaps triples by the middle of the next century and increases by a factor of 3.5 by the end of the next century. In the low extreme, the case of no out-migration, the population almost triples by the end of the next century. Hence, the range between the high extreme and the low extreme, which is assumed to cover about 90 percent of all possible

Table 27. Alternative migration scenarios for North Africa under central fertility and mortality assumptions combined with low and high migration.

	Total population (in millions)			Mean age of population (in years)	
	Low migration	Central migration	High migration	Low migration	High migration
1995	162	162	162	24.6	24.6
2010	231	228	224	26.0	26.0
2020	284	277	271	27.4	27.4
2030	340	331	321	29.0	29.0
2050	457	439	421	32.1	32.1
2100	645	607	569	39.4	39.6

future migration streams, is 36 million migrants by the middle of the next century and 76 million by the end of the next century.

Table 27 also shows that there is virtually no effect of alternative migration assumptions on the speed of population aging. The mean age of the population will still increase from today's 24.6 years to 32.1 by the middle of the next century, and to more than 39 years by the end of the next century. At that time the high-migration scenario shows a somewhat higher mean age of the population because migrants tend to be younger.

The total population size and the speed of population aging in the region are affected not only by the numbers considered in the alternative migration scenarios but also by the amount of education the out-migrants have received. However, there is too little information about the structure of migrants to include this dimension explicitly in the alternative migration scenarios. Two other crucial issues are the kind of ties the migrants retain with their country of origin and whether they send remittances home. Also, looking only at net-migration may hide some very important factors such as persons returning after having received an education abroad or with new technologies or new life-styles that may exert some influence on the living conditions in the home country. These issues are not examined in this study, but should be the topic of further in-depth studies.

Finally one might ask, What effect would alternative migration streams from North Africa to Western Europe have on the receiving countries? This question has been discussed in the literature. Lutz and Prinz (1992) and Lutz (1994b) have extensively analyzed the demographic consequences of alternative immigration and integration scenarios. In short, even massive

immigration to Western Europe cannot reverse or stop the strong and very pronounced aging process that will be experienced over the coming decades. Under the central scenario the proportion of the population above age 60 increases from today's 19 percent to 35 percent in the year 2050. Under the high-migration scenarios (assuming an annual gain of 1 million, of which 275,000 would come from North Africa), this proportion in 2050 is only one percentage point lower, i.e., 34 percent; under the low-migration scenario 36 percent of the population in Western Europe is above age 60. This marginal difference in the speed of aging, however, is associated with a total population size that in 2050 is 505 million (high migration) instead of 433 million (low migration), i.e., a 17 percent difference.

8. Conclusion: Population, Education, and Sustainable Development

In concluding this report we return to the initial question of why we study population and education in the context of long-term national development. Both aspects clearly deserve individual attention. It is interesting and relevant to study population and education as complex and important societal phenomena in themselves. In the first part of this study we provided comprehensive surveys of recent population and education trends in the six countries of North Africa and also discussed our assumptions about likely future trends of these two important variables.

In the second part of the study we went beyond the sectoral analysis of population and education and entered new territory by looking at interactions and combined effects of population and education. Because these two phenomena – which in the past have generally been treated as separate issues – follow similar laws of change, this effort proved highly successful. To our knowledge this is the first attempt at systematic, international population and education projections. This combined analysis of education and population makes a significant contribution to our knowledge about both variables.

The educational composition of the population is the most important variable through which educational efforts benefit society. Educational expenditures, numbers of teachers, and enrollment rates are only intermediate variables that influence the educational composition of the population. The results of educational efforts, rather than the efforts themselves, determine the human capital of a society. It is amazing how little analysis has been

undertaken to study the results of educational efforts. This neglect has probably been due to methodological problems inherent in the fact that educational change of the population is a very slow and long-term process. Actually it is only the *union* with population projections that allows us to conduct these longer-term projections of the educational composition of the population by age in a methodologically accurate manner. In this sense, the combination of education and population projections adds significantly to the analysis of education itself. It is the only way in which the future consequences of current educational efforts can be evaluated.

Also, the population projection itself benefits from the inclusion of the educational dimension because all three components of population change (fertility, mortality, and migration) vary significantly with education. The explicit consideration of educational fertility differentials makes a major difference to the projection of total population size and the population's age structure if the educational composition of the population changes over time. Given that the fertility rate of women in the highest educational group is lower than the average fertility level, an increase in the relative size of the group of highly educated women in the childbearing ages (which is evident in most countries because of educational efforts in the past) will in itself result in a decline of the fertility of the total population, even if fertility rates within each educational status are assumed to remain constant. Hence, given that a population's educational composition is one of the most important structural components, next to age and sex, making it explicit in the process can only add to the validity of the population projection in the same way that the cohort-component model adds to a simple exponential growth model that disregards age structure.

The results of the educational population projections presented in this report have been very encouraging in a more practical way. They have shown that such projections are indeed feasible in terms of data and methodology. The multistate population projection methodology is readily available and educational composition by age is usually provided by censuses. Data on current enrollment ratios are also available for most countries, and assumptions on future rates must be derived somewhat intuitively in any case. Given the overriding importance of the educational composition of the population – in addition to its size and age structure – for increased productivity, social development, and government planning, we recommend that such projections be conducted for all countries of the world.

In the context of the global discussion of the concept of sustainable development, both population and education are frequently mentioned as two

of the most important variables (if not the most important variables), but they are usually seen as independent forces. On the one hand, population is usually discussed under a carrying-capacity approach that only considers the number of people but does not look at the educational level of individuals or their skills in coping with problems. Education, on the other hand, is seen by many as the key to coping with present and anticipated future problems (ecological and others), but is often considered an element that is restricted to the minds of people, disregarding the social mechanisms of dissemination of education and the slow replacement of generations with different levels and types of education. Obviously both of these unrelated, and in some cases even contradictory, views describe some relevant aspects in a country's struggle toward sustainable development. The present study shows that these views need not be unrelated (or even contradictory) but can be described and even projected jointly. We think that the consideration of population and education in a joint analysis provides opportunities for improving the plans for sustainable development.

Notes

[1] In World Fertility Surveys place of current residence is divided into three categories: rural, other urban, and major urban. The basic definition of rural versus urban is left to the discretion of individual countries. Countries use various criteria based on population size, sewerage, electricity, and so on to differentiate between rural and urban areas. Further division of urban areas into "other urban" and "major urban" is based on a set of rules; for example, cities with a population of more than 1 million are classified as major urban and national capitals regardless of population size are classified as major urban (UN, 1987:190).

[2] In Egypt the governorates of Cairo, Alexandria, Port Said, Ismailia, Suez, frontier governorates, and capitals of other governorates as well as district capitals (Markaz) are considered urban.

[3] SMAM is the mean age at first marriage of women who marry by age 50, and is estimated by adding the proportion currently single at successive ages as though they referred to a single real cohort of women.

[4] We compared UNESCO statistics on students by gender with statistics published in the statistical yearbooks of countries in North Africa. It is important to note that UNESCO defines three levels of education; the first level covers primary education in public and private schools, including primary classes attached to secondary schools; the second level covers general education, teacher-training, and technical- and vocational-training in public and private schools; the third level covers universities and equivalent degree-granting institutions and other third-level institutions such as teacher-training colleges and technical colleges

(UNESCO, 1994). Each country in North Africa has its own definition of educational levels. For the sake of comparison in the text we give the UNESCO level that corresponds to the national level(s).

[5] General education refers to preuniversity level, including first and second level and excluding preschool education.

[6] The *Al-Azhar* is the oldest institute for teaching courses on Islamic studies in the Arab countries.

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