1. Background

At the time of Bangladesh's independence in 1971 the size of the population was around 70 million people. After 29 years of the independence of Bangladesh, the country's population was almost double, approximately 129.3 million people (NIPORT et al. 2001). Bangladesh is a developing country with enormous potentiality and has comparable population trends as South Asian countries. Bangladesh has a medium Total Fertility Rate, a moderate life expectancy and it is an emigration country (Streatfield and Karar 2008).

Bangladesh, a small country of 147,570 square kilometers and more than 120 million people, gained independence on March 26, 1971 after a war of liberation from Pakistan. For administrative purposes, the country is divided into 6 divisions, 64 districts, and 490 *thanas* (subdistricts) (Bangladesh Bureau of Statistics (BBS) 1997). Muslims constitute almost 90 percent of the population of Bangladesh, Hindus constitute about 10 percent, and others constitute less than 1 percent. The national language of Bangladesh is Bangla, which is spoken and understood by all (Bangladesh Bureau of Statistics (BBS) 1997).

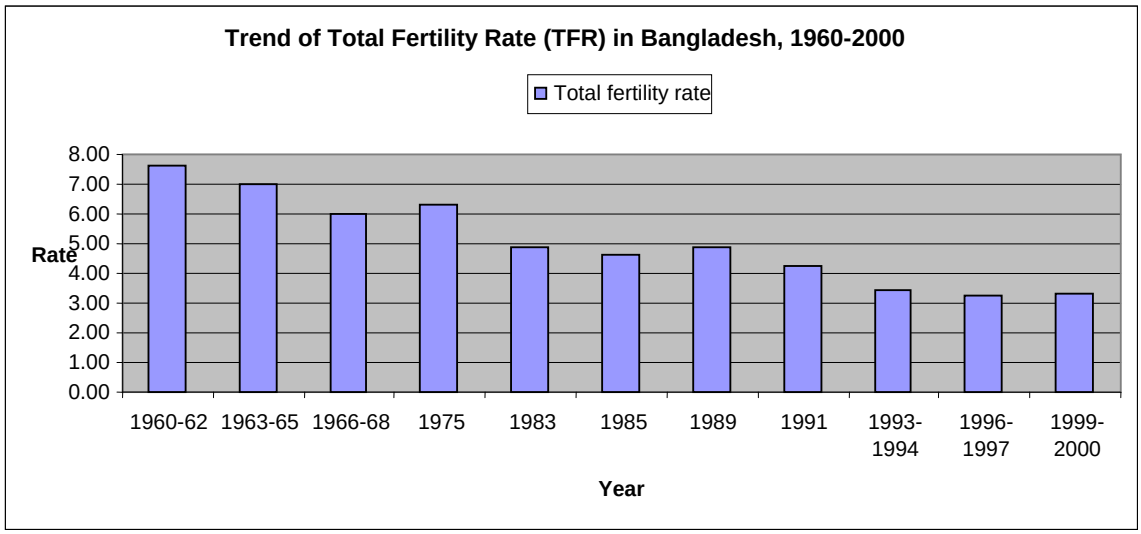
Agriculture is the most important sector of the nation's economy. It accounts for 30 percent of the gross domestic product (GDP) and employs 64 percent of the workforce (Bangladesh Bureau of Statistics (BBS) 1997). Jute is the main nonfood crop and the main cash crop of Bangladesh. Less than 20 percent of the cropped land area is used for crops other than jute and rice (Bangladesh Bureau of Statistics (BBS) 1997). Industry, although small, is increasing in importance as a result of foreign investments. Prospects for mineral resources, gas, coal, and oil appear to be bright.

Fertility

The decline of the level of fertility was initiated in the mid-seventies (Anon 2000). However, the Crude Birth Rate (CBR) was 50 or higher per thousand populations until 1961. And it was 47 per thousand populations in 1976 that declined to 38.9 in 1986 and 19.9 in 1998 (2000).

Figure1 displays that the total fertility rate declined from above 7 from early 60s to 3.3 in the late 90s. The level of fertility declined from 6.3 to 4.3 during the period1975-91. Among other reasons, this decline mostly as a result of continuous support for the family planning programs. After 1991, the rapid rate of fertility decline has become stagnant at 3.3 until 2000. Three successive BDH surveys have shown total fertility rates (TFR) as 3.4 in 1993-1994, 3.3 in 1996-1997 and 3.3 in 1999-2000 (NIPORT, Mitra and Associates, & ORC Macro 2001). Over the last 25 years, there has been a decline of 48% in TFR. It means a decline of 1.9% per year (Snow 2003).

Figure 1: Trends of TFR in Bangladesh, 1960-2000



Mortality

The Crude Death Rate (CDR)

The death rate was consistent trend of high mortality, around 45 per thousand populations, until 1921. The mortality rate started to decline in 1921 and it was declined to about 40 per thousand during 1921-51 period. However, the fastest decline in the level of mortality was observed in 1951-61 period to 30 per thousand population and further declined to 19.4 in 1961-74, to 8.6 in 1994 and to 4.9 in 2000 (2000).

In other words, the level of overall mortality has declined to a level, close to a potential minimum. The reduction of mortality can be materialized through declines in the levels of infant and child mortality rates as well as in the level of maternal mortality rate (2000).

Life expectancy at birth

Table 1: Life expectancy at birth in Bangladesh, 1970-2000

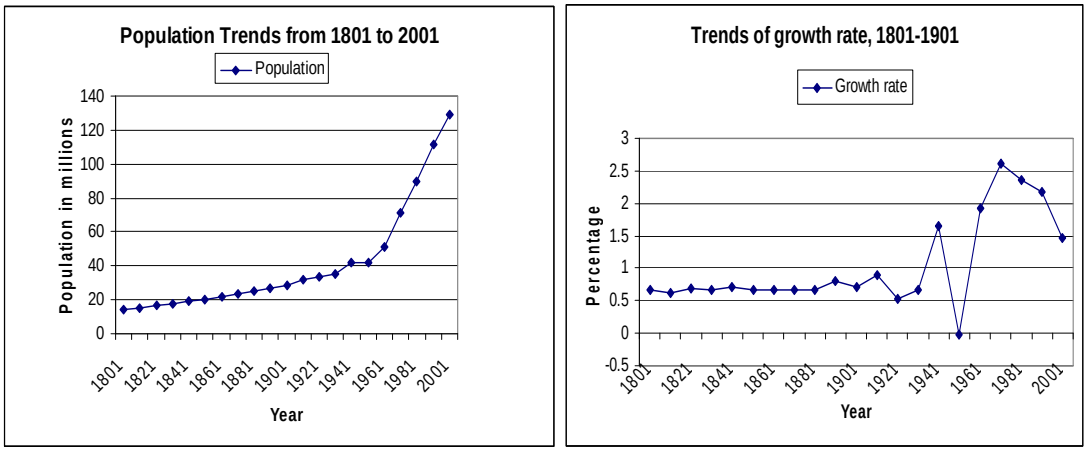
Period	Both sexes combined	Male	Female	Differences in male life expectancy at birth	Differences in female life expectancy at birth
1970-1975	44.6	44.2	45.1		
1975-1980	46.1	45.7	46.8	1.5	1.7
1980-1985	49.4	48.9	50.2	3.2	3.4
1985-1990	52.4	51.9	53.2	3.0	3.0
1990-1995	55.7	55.0	56.5	3.1	3.3
1995-2000	59.5	58.7	60.4	3.7	3.9

The above table denotes that the life expectancy at birth in both sexes is increasing since 1970. The life expectancy of both sexes has increased around 3 year in each five years interval since 80s.

Total Population

The population of Bangladesh was first estimated in 1801 and it was around 14.5 millions (2000). The size of population was around double by next 100 years. The growth rate of 1801-1901 periods was less than 0.7 percent per year. However, the same size of increase in population was observed during approximately the next fifty years. Since then, the increase in population was very rapid. During 1951-74 period, the population increased by about 29 million, in a period of only 23 years. However, it was more rapid during the next 27 years; an increase of about 60 millions was evident during 1974-2001.

Figure 2: Trends of population and growth rate in Bangladesh, 1801-2001



The main objective of this study is to make a population projection of Bangladesh based on assumptions for fertility, mortality and migration. These assumptions are based on past trends and expert opinions about the future population trends of Bangladesh. The research questions are as following:

1. What are the trends in fertility, mortality, migration, population size and age structure over the past years of Bangladesh?
2. Which assumptions can be made for fertility, mortality and migration based on the past trends and expert opinions?
3. How would the population increase between 2000 and 2040?
4. How would the population increase between 2000 and 2040 when rates are used which are based on the assumptions for fertility, mortality and migration?
5. How do the population projections look in comparison with others?

2. Methodology

A population projection tries to determine what the future population will be like (Hinde 1998). It is a very important demographic technique which shows the future development of a population based on certain assumptions about the future of fertility, mortality and migration. According to Preston et al. (2000) governments and private businesses are very much interested on population projections, because these can be used to anticipate on a variety of demands. For example: the labour market, education and health centres (Preston et al. 2001).

Two methods have been broadly used for population projection. First, the mathematical method where future population trend is described by some simple mathematical formula. Second, the component method in which the components of population change are taken into account (Hinde 1998).

Among component methods, the cohort component method is widely used. In this report, the cohort component method is used for making the population projection. This method divides the population into different subgroups like age and sex who are differentially exposed to the 'risks' of fertility, mortality and migration (Preston, Heuveline, & Guillot 2001).

For this study the population projections of Bangladesh has been made with the base or starting year of 2000. The projection is for the period 2000-2040. Data have been collected from several sources like Bangladesh Bureau of Statistics (BBS), World Health Organization (WHO) and UN Population Information (POPIN) because of unavailability of data from a single source.

3. Assumptions

Assumptions of Fertility:

Fertility would continue to decline

- Based in the past trends and the national programs and policies on fertility reduction, it is fair to assume that the level of fertility would continue to decline in Bangladesh.
- Historical analysis indicates that economic growth, women's education and urbanization would contribute to the process of fertility decline in Bangladesh.
- Improved health status and decline of infant mortality would also facilitate reduction in fertility in Bangladesh.

The pace of fertility decline would be slow and at one stage it might be stable

Fertility would remain constant at the level of 2.1 or 1.7 for a while

- Historical trends suggest that fertility decline after it has replacement level is very slow or minimal
- Son preference is a believe in rural Bangladesh. And considering the fact that most of the people in Bangladesh live rural areas and it dose not seem plausible that fertility would continue to decline after 1.7. For this to happen, it would require change in the social structure and the gender roles and relations.

There will not be any postponement in marriage and child bearing

- This is rather an unrealistic assumption as the current age at marriage, age at first birth and spacing of successive births is quite low and there is a clear evidence that these indicators are increasing though a very low pace. However, this assumption is made for the simplicity of the calculations.

The current sex ratio at birth of 105 is assumed to remain constant

On the basis of trend extrapolation and expert's opinions, two trends of TFR will be assumed. Because trend extrapolation of TFR, experts' opinions and the reality of Bangladesh are not the same. The first trend of TFR can be called 'optimistic view or perspective' and the projection based on 'optimistic view' is named 'Projection I'. The second trend of TFR can be called 'moderate view or perspective' and the projection based on this view is named 'Projection II'. The assumption on TFR is as follows:

Table 2: Assumed TFR for two different projections

	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Projection I	3.3	2.9	2.5	2.1	1.7	1.7	1.7	1.7	1.7
Projection II	3.3	2.9	2.5	2.5	2.5	2.1	2.1	2.1	2.1

Sourse: Data analysis

Assumption of Mortality

On the basis of trend extrapolation and expert's opinions, two trends of life expectancy will be assumed. The assumed life expectancy at birth for female and male is as follows:

Table 3: Assumed life expectancy at birth for female

	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Projection I	61.5	64.6	67.7	70.8	73.9	77.0	80.1	83.2	86.3
Projection II	61.5	63.4	65.3	67.1	69.0	70.9	72.8	74.6	76.5

Source: Data analysis

Table 4: Assumed life expectancy at birth for male

	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Projection I	60.7	63.7	66.6	69.6	72.5	75.5	78.4	81.4	84.3
Projection II	60.7	62.3	63.9	65.6	67.2	68.8	70.5	72.1	73.7

Source: Data analysis

Assumptions on migration:

POPIN data mentions that the net migrant (1995-2000) of Bangladesh is around 110 thousand (emigrants) which is only 0.0851 percent of total population. Considering the population size and abnormalities among data, it can be assumed that migration will not be considered in this projection.

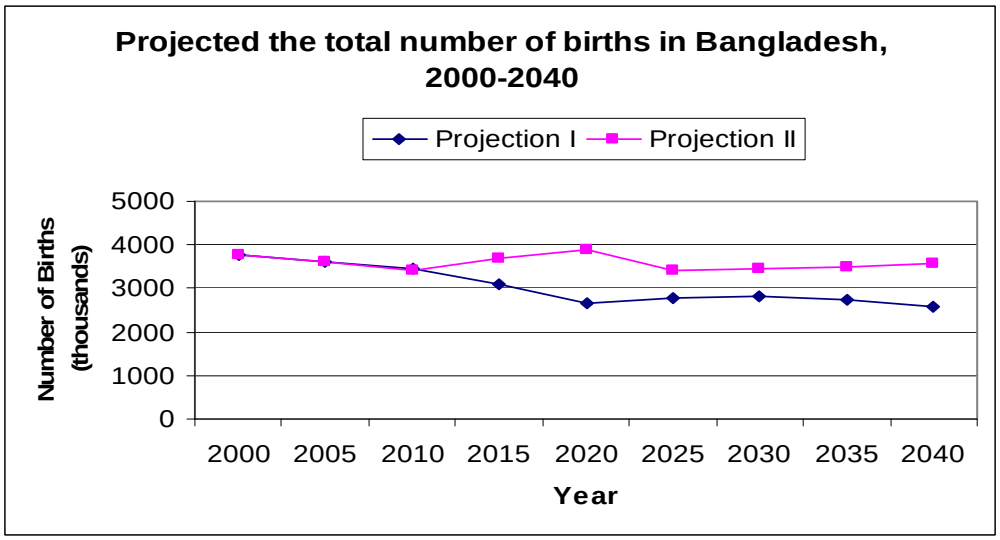
4. Projection Results

Total number of births

The total number of births of Bangladesh for both projections can be seen in figure 3. For the first projection a TFR of 1.7 births per woman has been used from 2020 to 2040 and for the second projection a TFR of 2.1 births per woman has been used from 2025 to 2040. This difference in the TFR leads to differences (0.978 millions) in

the number of births in 2040. The number of births in both projections is almost decreasing. In the period 2000-2020 respectively 16.6 million babies (projection 1) and 18.4 million babies (projection 2) will be born according to the projections. In the period 2020-2040 respectively 13.6 million babies (projection 1) and 17.8 million babies (projection 2) will be born.

Figure 3: Projected total number of births in Bangladesh, 2000-2040

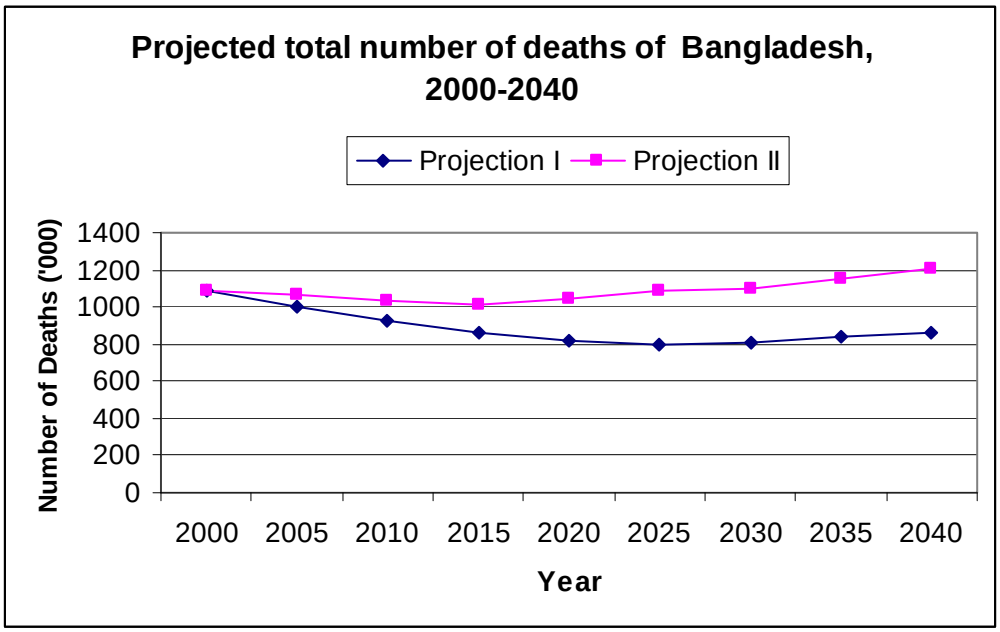


Source: Data analysis

Total number of deaths

Figure 4 shows the total number of deaths of Bangladesh for both projections. In the both projections, an increasing life expectancy at birth is used. In projection one, the expected life expectancy at birth in 2040 for female is 86.3 years and for male are 84.3 respectively. And the assumed life expectancy at birth for projection two in 2040 for female is 76.5 and for male are 73.7 respectively. The total number of deaths for the first projection is lower than the total number of deaths for the second projection. This is caused by the still increasing life expectancy at birth in the first projection which leads to decreasing mortality rates. In the first projection the number of deaths is decreasing from about 1.09 million deaths in the period 1995-2000 till about 0.86 million in the period 2035-2040. In the second projection the number of deaths is increasing from about 1.09 million in the period 1995-2000 till about 1.21 million in the period 2035-2040.

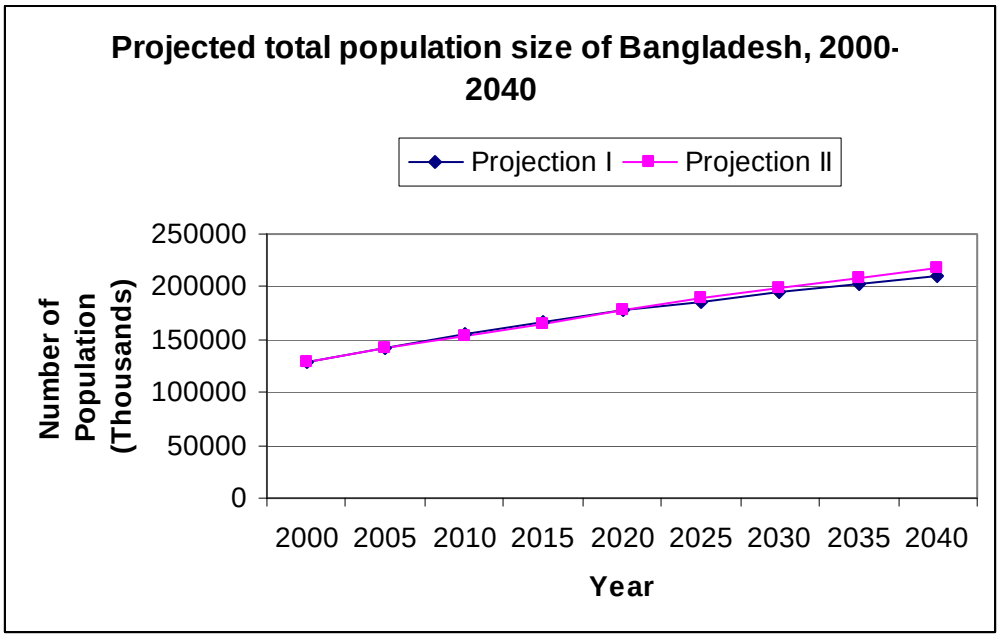
Figure 4: Projected total number of deaths in Bangladesh, 2000-2040



Population change:

The projected total population size of Bangladesh over time can be seen in figure 5. From the figure becomes clear that the population size in the first projection is slower increasing than the population size in the second projection. In 2025 the projected total population size of Bangladesh will be respectively around 186.3 million people (projection 1) and 190.1 million people (projection 2). In 2040 the projected population size is increased till respectively 210.4 million people (projection 1) and 218.1 million people (projection 2). The difference between population sizes of two projections is 7.7 millions.

Figure 5: Projected total population size in Bangladesh, 2000-2040



Source: Data analysis

Table 5 shows the projected change of the population size of Bangladesh over time. The change of the population size in projection two is high. There is a decreasing trend of population change in both projections. Population change occurred in projection one is faster than projection two. It is almost 50 percent change in projection one of 2040 compared with same projection of 2000.

Table 5: Projected population change in Bangladesh in 5-years periods, 2000-2040

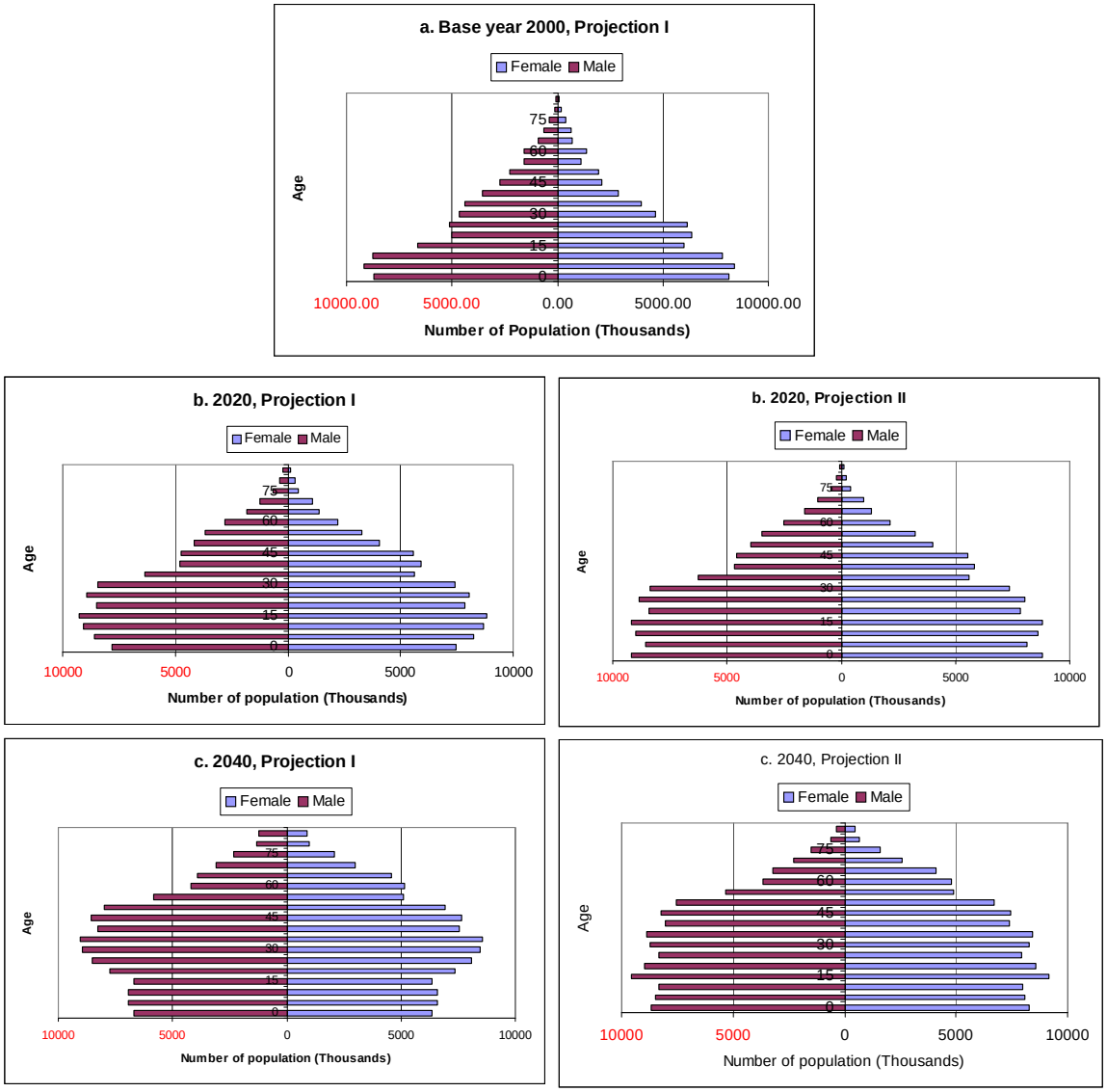
Projected population change of Bangladesh in 5-year periods, 2000-2040								
Year	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Projection I	13220	13038	12127	10493	8257	8487	8227	7442
Projection II	12828	12293	11129	11997	12677	9611	9314	9050

Source: Data analysis

Age Distribution

The age distribution of the Bangladesh population is changing very much in both projections. Figure 6 shows population pyramids of the Bangladeshi population for different years. Figure 6a shows the base year age distribution in 2000. In 2000, the younger age groups are relative big comparing to the other age groups and it is similar with young age population pyramid. The shape of the population pyramids is changing in the future, as can be seen in the figures 6b-c. In 2020, both projections lead bigger age group of 15 to 35. In 2040, the age distributed population pyramid of projection two looks like pyramid of middle aged people or mature pyramid. There is also a sign of bigger old age population in 2040. Evening up of numbers in younger and middle age groups can denote the replacement level fertility.

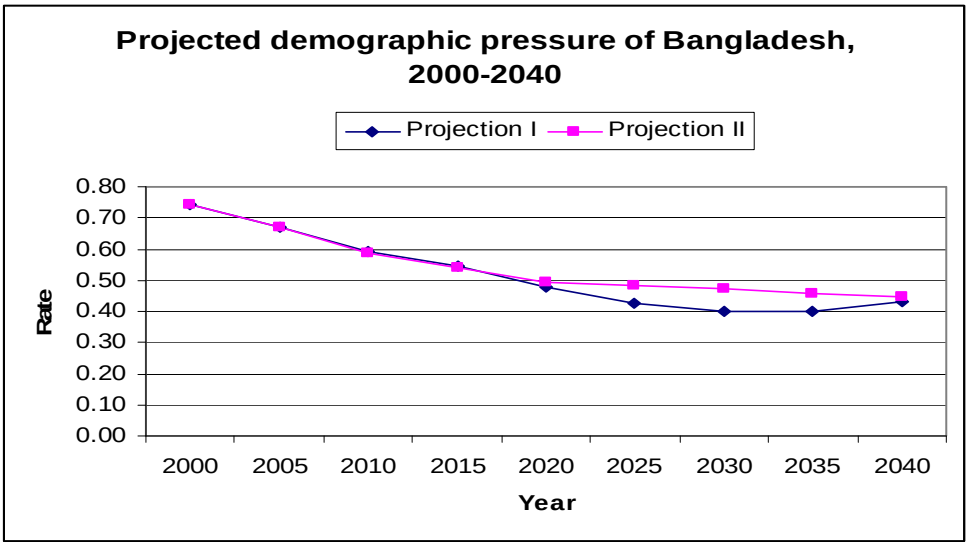
Figure 6: Population pyramid of Bangladesh, 2000, 2020 & 2040



Demographic pressure

As also can be derived from the population pyramids of figure 6 will the demographic pressure be decreasing in the future, according to both projections. Figure 7 shows the projected demographic pressure of Bangladesh over 40 years. The demographic pressure rate is the number of people aged 0-14 years and 65 years or older over the number of people aged 15-64 years. The base year (2000) demographic pressure was 0.74. From figure 5.5 becomes clear that the demographic pressure rate of both projections is almost similar and decreases until 2015. After 2015 the demographic pressure rate of projection one decreases faster than that of two. In 2040, the demographic pressure rate of projection one increases a little bit (0.43) compared with last two years and shows almost similar to the number of demographic pressure rate of projection two.

Figure 7: Projected demographic pressure in Bangladesh, 2000-2004



Source: Data analysis

5. Conclusions:

Population projection is a very important demographic technique to show the future development of a population. Fertility, mortality and migration are the core components of making assumptions of population projection. Valid assumptions about the future can be made through combining two sources of information: a country's past trends and expert opinions about the future trends (Wissen 2006).

Based on the past trends of, and expert opinions about Bangladesh, some assumptions were made which leaded to two projections. In projection I (optimistic perspective), TFR of 3.3 was used as starting TFR and assumed to be constant on 1.7 from 2020 as well as the life expectancy at birth constantly increased with maximum proportion (based on polynomial extrapolation and expert's opinions). In projection II (moderate perspectives), replacement level fertility would be achieved on 2025 (TFR of 2.1) and remained constant until 2040. In both projections, migration data did not used because of its abnormalities.

From the projections it became clear that the Bangladeshi population will increase further in the future to respectively 210 million (projection 1) and 218 million (projection 2) in 2040. These numbers almost correspond with the projections of the UN (219 million). It is difficult to answer which projection is the right one, because we do not know what will happen in the future. "Population projections are just calculations which show the future development of a population when certain assumptions are made about the future course of fertility, mortality and migration" (Preston, Heuveline, & Guillot 2001).

The population size is still increasing, but no longer as fast as in the last century. Actually, the change in population size is becoming lower. In projection I from more than 13 million persons increase per five-year period in 2000 to around 7.4 million persons decrease per five-year period at the end of the projection period. In the

second projection the decline of the population change is much bigger, from about 12.8 millions in 2000 to around 9.0 millions decrease per five-year period in 2040.

Another point that can be made based on the projections is that the demographic pressure rate will decrease in the future. In 2007 the demographic pressure rate was 0.74. That means that there are 74 people in non-working age groups for every 100 working age people. In 2040 this will be around 0.43 or 0.45 depending on the assumptions used for the projection. This low rate of demographic pressure became also clear from the projection of the UN.

In 2040 there will be more people in working age groups than people in non-working age groups. This could lead to economical and social benefit. Bangladesh government can take the opportunity to convert this huge population as human recourses and accelerate the progress to become a high-middle income country. That is why, population projection is very important to get a picture of the future population and the coming problems and opportunities that could occur as a result of this future population.

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