POPULATION PROJECTIONS FOR CAMBODIA, 2008-2030

INTRODUCTION

1. Population projections are usually conducted after the results of a population and housing census are published. The projection is the most important analytical operation conducted with the census data. First, the census population is obsolete by the following day of the census, and the projection provides the current population size which is, by itself important, but also makes available denominators for most population-based indicators during inter-censal periods. Second, a population projection does not involve only an estimation of the future population, but also an evaluation of the census coverage and quality of some data. The standard practice is to adjust the population in terms of reducing problems of under enumeration, both affecting the entire population or some specific groups, and also to evaluate and adjust the demographic variables used in the exercise.

2. This report includes three sets of population projections by age and sex: national, urban-rural and provincial. For the three sets, the cohort component method was utilized. It involves calculating the future size of cohorts, taking into account effects of the population components, that is, mortality, fertility and migration. Its principle is to advance though time, in five-year increments, five-year cohorts from a base population, in this case the 2008 adjusted census. Hence, in its most basic form, this method provides the population by sex and five-year age groups for the end of each quinquenium of the projection period. Nevertheless, for these projections the results are provided for single ages and continuous years. For the national projection, the period covered is from 2008 to 2050 and for the urban-rural and provincial projections from 2008 to 2030.

3. A common practice in population projections is to prepare, at least for the national projection, three *hypotheses* or *scenarios* regarding the magnitude of population increase. They differentiate each other mainly in the behavior of the components, especially fertility. The *most likely hypothesis* or *middle scenario* is the one constructed with the most likely future behavior of the components (sometimes just fertility is used). Two more scenarios are constructed, one that recommends a more rapid population growth that that assumed in the most likely scenario, and another where a slower population growth is proposed. For these projections, only one scenario is proposed. Although three or more hypotheses may have analytical interest, policy makers, administrators of programs and planners typically utilize only the most recommended projection. In other words, they need one figure and not three or four.

4. It is important to clarify here, at the beginning of this document, that a population projection is not a clairvoyant or fortuneteller exercise nor a complex scientific recipe to foresee the future. When conducting a projection the purpose is not to predict the population numbers for future years or decades, but to provide the size that population will have if certain assumption regarding mortality, fertility and migration levels and trends take place in the future.

5. In this sense, a population projection is more a prospective exercise than a prediction. What is important is not to guess the exact number of children, young adults or elders that will be living in a territory in 10 or 20 more years. What is relevant to know is whether or not the number of schools, classrooms and teachers will have to increase by a given percentage to reach full education coverage in the future, the economy will have to generate jobs at a certain rate to reach low levels of unemployment, and a given quantity of new residential dwelling will have to be constructed to avoid housing shortages (if the trends in the demographic components come about as proposed in the projection exercise). In other words, projections are not instruments to predict the future but to construct the future[1]

POPULATION PROJECTION AT THE NATIONAL LEVEL

6. As mentioned above, the method used to prepare these population projections is the cohort component method. This projection was conducted using the software Rural-Urban Projections (RUP), developed by the U.S. Bureau of the Census. One of the main advantages of this program is that it allows performing projections by single years of age (instead of five-years as the conventional approach). Data for special age groups that do not fall into conventional five-year age groups can be obtained with this feature. It also makes it possible to follow population cohorts that may be smaller or larger than adjacent cohorts due to past demographic events. In addition, the projection is executed year by year. By using this feature it is possible to add information on demographic events for a particular year without forcing the effect over a five-year period. It also provides users with estimates for each year without having to interpolate between data for intermediate years. Input data for the population and components can be provided in either single years or five-year age groups. The age grouping of each item is independent, so it is possible to input five-year data for some items and single-year data for others. The program converts all data set to single years of age before executing the projection. This flexibility has the advantage of allowing a demographer to develop a projection model that accurately captures the demographic situation of a country and makes maximum use of available data in a way that is as close as possible to its original form. The program provides outputs on diverse demographic measures for any given year within the projection period such as population by age and sex (single years, 5-years age groups, and special age groups), summary measures, summary vital rates, life tables, migration rates, number of births and death, etc.

7. The statistics on birth and death provided by the vital registration system of Cambodia are not complete and it is not possible to use them to estimate fertility or mortality levels. Thus, for this projection, these data were obtained mainly from the 2008 census. During the past 50 years technical demographers have developed reliable methods for estimating mortality and fertility from census data. They are the so called *indirect methods*, which are extensively utilized in this type of work.

[1] Romaniuc, A. 1990. *Population projection and prediction, simulation and prospective analysis*, Population Bulletin of the United Nations No. 29, pp. 16- 31.

8. The NIS prepared a report on the estimates of mortality and fertility based on the 2008 Census[2]. In the case of fertility, the data usually utilized to measure this variable is the number of children born in the past 12 months and also the number of children ever born. Several indirect methods were utilized to estimate Total Fertility Rates (TFR) and other fertility indicators. Based on the plausibility of the results, the robustness of the methods and other methodological considerations it was decided to accept a TFR of 3.1 children per woman as the fertility level provided by the 2008 Census. This value is the average between the fertility rates estimated with the Arriaga one-census and two-census method. The former gave a TFR of 2.7 and the latter of 3.4 (based on data from the 2008 and 1998 censuses)[3]. The data indicates a substantial decline during the inter-censal period: from 5.3 to 3.1 children per woman. Data from the 2000 and 2005 Cambodian Demographic and Health Survey also indicates a substantial decline in fertility during 1998-2008. It is important to mention that the application of the several indirect method of fertility estimate indicate a substantial under-reporting of births in the census questions of births during the past 12 months.

9. In order to gain a more reliable projection of TFR it is important to examine past fertility trends. **Table 1** shows the fertility trend in Cambodia according to several sources and dates (expressed in TFRs), including those presented in the NIS report on mortality and fertility previously cited. The data was plotted in a graph and several trend lines were tested using the EXCEL *trend line* command. The best fitting curve was a linear equation. This exercise is presented in **Figure 1,** including the respective equation. **Table 2** shows the observed TFRs and those estimated using the equation. The main advantage of this approach is that several independent sources are used and, therefore, the estimated past fertility trend represent an *average* among the different fertility indicators measured by different data collection instruments that may have over- and under-estimate TFRs. It was decided to use the TFR estimated with the equation (**Table 2)** since it capture a trend, which is more appropriate for a projection. Anyways, the TFR estimated with the equation is almost the same as that considered as the best estimate in the NIS report on fertility and mortality (3.01 against 3.05), which is the average of the fertility estimated with the Brass method and the Arriaga method for two censuses (see **Table 1**).

10. **Table 3** shows the estimates of TFR, using the previous equations, for some selected years. The year 2005.67 is the midyear of the quinquenium previous to the census (the months are expressed in decimal terms). The census was taken on 3 March 2008. Since the beginning of the year 62 day has passed; thus, the date expressed in decimal terms is 2008.17 (62/365=0.17). The quinquenium previous to the census goes from 2003.17 to 2008.17. The mid-date of this quinquenium is 2005.67. This value is necessary to adjust the number of the population 0-4 years old. The other four values will be used to project fertility using a logistic curve as it is explained further.

[2] National Institute of Statistics, 2010. *Report 1, Fertility and Mortality in Cambodia*, General Population Census of Cambodia 2008, Analysis of Census Results, Phnom Penh.

[3] For an explanation of these methods see Arriaga, E. 1994. *Population Analysis with Microcomputers*, US Bureau of the Census, New York.

11. Mortality was calculated using the question on number of persons who have died in the household during the past 12 months. The age-specific mortality rates (ASMR) were used to compute a life table but the respective life expectancies at births gave impossible values: 91.2 years for males and 116.8 years for females. In order to evaluate the completeness of the enumeration of deaths the Preston-Coale and the Brass Balance Equation methods were used. The worksheets PRECOA and GRBAL from the package PAS were used for these calculations[4]. The under-enumeration indicated by these exercises is extremely large: 88.2% using the former method and 87.6 using the latter. It is true that when these methods are applied to a population with the demographic dynamics of Cambodia several assumptions are violated, but even though, under-enumeration is unacceptable.

12. It is important to mention that, in spite of the fact that the data on the deaths in the past 12 months is useless to estimate the level of fertility, it may provide a realistic age pattern of mortality. For this reason, the data was used to assess to which table model pattern does the mortality pattern of Cambodia fits better. The program COMPAR from the package MORTPAK was utilized[5]. The results indicate that the Cambodian mortality pattern fits quite well with the North pattern of the Coale-Demeny life table models. Of course this evaluation assumes that the age-sex pattern provided by the 2008 census mortality data is true. The selection of the model will be quite useful for future analyses. The report on fertility and mortality, previously cited, did not evaluate the data on adult mortality.

13. An approach frequently utilized in the absence of reliable estimates of adult mortality is to obtain a reliable estimate of infant mortality. This IMR is used to identify the level of mortality of a model life table that is believed to describe better the mortality age sex pattern of the population. This is precisely the approach used here. A good estimate of IMR was secured and used to select the level of mortality of a Coale-Demeny North model life table.

14. The previous mentioned NIS report estimated infant and child mortality using the data on children ever born and children surviving by age of women. This data is used to estimate early-age mortality with an *indirect technique*[6]. However, considering recent and past estimates of early-age mortality form other sources, the values obtained with this method indicate unrealistically low values. For example, the estimate of infant mortality rate (IMR) was 26 deaths per 1,000 births. The estimate from the 2005 Cambodian Demographic and Health Survey is 62 deaths per 1,000 births[7]. This is not the place to analyze why the method produced such results, but it would be convenient to conduct an in-depth analysis on this issue.

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[4] Arriaga, Ibid.

[5] United Nations, 1988. *MortPak-The United Nations Software Package for Mortality Measurement*, United Nations, New York.

[6] The reader interested in indirect technique of mortality and fertility estimation can see: United Nations, 1983. *Manual X - Indirect Techniques for Demographic Estimation,* United Nations, New York.

[7] National Institute of Statistics, op. cit., 2010

15. As a solution, the number of infant's deaths (under one year) from the data on deaths in the past 12 month in the household and the number of birth during the past 12 months were used to estimate infant mortality directly. As mentioned above, the evaluation of this information indicated a substantial under-reporting of deaths and births, but the respective result, presented in **Table 4**, indicate a more realistic value than that obtained by applying an indirect method to the data on children ever born and children surviving. In any case, the results of **Table 4** should be interpreted with caution and, as explained above, they were used with other independent information. In addition, it is likely that children born in the past 12 months and those who died in the past 12 months are both underestimated. Such under-reporting compensates each other resulting in a relatively credible and reliable estimate of IMR. This argument to justify the use of this approach was given in the report on fertility and mortality published by the NIS and cited above.

16. **Table 4** shows several estimates of IMR, including the one from the 2008 Census previously discussed. These values were plotted in **Figure 2**. A declining trend is clear, initially rapid and then slowing down. Several trend lines were tested using the Excel *trend line* command. The best fitting curve was a third degree polynomial function. Therefore, an equation was established as in the case of fertility to analyze past trends. Estimates obtained from this equation are presented in **Table 5**. These rates, together with those of fertility presented in **Table 3**, will be used to estimate the under-enumeration of the population 0-4 years old and to project life expectancy at births.

17. Note that the estimates of IMR are not disaggregated by sex in **Tables 4** and **5.** Unfortunately, most of the secondary sources did not provide this information. The estimate of IMR obtained from the 2008 census data is not presented by sex either. These data were carefully evaluated and unfortunately they indicate an unrealistically high male IMR as compared with the female rates. In spite of the fact that the IMR for both sexes was credible and consistent with other sources, the IMR by sex was unreliable. The problem was solved by using life table models, in particular the Coale-Demeny North model, which, as mentioned above, seems to be the most adequate to describe the age-sex mortality pattern of Cambodia. The IMR permitted to identify the level of the mortality model for both sexes and this level was, in turn, used to identify the male and female model life table corresponding to such level[8]. In other words, the level of the male and female model life table corresponds to the both sexes level, indicated by the IMR. Hence, the disaggregation by sex of the IMR, and the life tables that were derived from them, followed the North model pattern of sex differentials. **Table 6** shows the IMRs and the corresponding life expectancies at birth (E(0)). Operationally, the number of the life tables that indicates their level is not used. It is the E(0)s that are usually employed (actually, any life table function indicate an unequivocally level of mortality).

[8] Model life tables have numbers according to their implicit level of mortality. Having an IMR, which correspond to the probability of dying before the first birthday (or any other life table function), it is possible to identify the level (number) of the life table that correspond to such IMR. Since the level of model life tables is expressed in integer numbers, most of the time it is necessary to interpolate between levels.

18. The E(0)s corresponding to year 2005.67, presented in **Table 6** were used to construct a complete life table for that date, which is the exact date that correspond to the middle of the quinquenium prior to the census date (**Table 7**). This was done using the program MATCH from the package MORTPAK cited earlier. As suggested before, a life table for this date is necessary to adjust the population 0-4 years, which is the next step. The IMRs and the corresponding E(0)s for 2007 presented in **Table 6** are to prepare the life table for the initial year of the projection period, which is a further operation.

19. In this projection international migration is not considered. The assumption here in this regard is that it is improbable that international migration will become a major component of the population dynamic of the country. This is only an assumption. Emigration and immigration may take place during the future 20 years, but probably its level will be low and hence unlikely to impact on the population size and structure. This hypothesis does not mean that in the near future emigration or immigration will not occur; however there is no evidence for proposing a hypothesis regarding volume and trend of international migration. The usual practice in this case it is to assume that it will be negligible.

20. **Table 8** shows the procedure to estimate the under-enumeration of the population 0-4 years, which is usually the age group that experiences the largest undercount. The operation is based on estimated the number of births using the number of women rejuvenated to the middle of the quinquenium previous to the census and the age-specific fertility rates corresponding to the same date (year 2005.67). To move the women population the program MOVEPOP from the package PAS, previously cited, was utilized. The number of births is multiplied by five to obtain the number of births during the quinquenium and disaggregated by sex assuming a sex ratio at birth of 105. To these numbers of births, the survival rates of the 2005.67 life tables are applied and the population 0-4 years by sex is estimated. Calculations can be followed in **Table 8**. The experience indicates that this estimate is more precise than the census count for this age group. The total under enumeration is 12.9%; for males it is 12.2% and for females 13.6%. These estimates are larger than that calculated from the Post-enumeration Survey: 2.8%[9], which is an expected result.
21. **Table 9** shows three populations. The first one is the 2008 census enumerated population and the second one is the adjusted population. The age group 0-4 was adjusted using the percentages estimated in **Table 8** while the other age groups were adjusted using the percentage estimated by the post-enumeration survey. The third population is the adjusted population moved to 1 July 2008, which is the middle of the year. All the projected values will refer to the middle of the respective years. The program MOVEPOP from PAS was used to perform this operation. **Figure 3** shows the pyramid corresponding to the base population. The dent at age 30-34 corresponds to the demographic dynamic resulting from the Khmer Rouge period. The first two bars indicate the recent decline in fertility.

[9]Report on Post Enumeration Survey, October 2009

22. To project life expectancy, a logistic function was used. The program used was E0LGST from the software PAS cited earlier. The lower asymptote for both males and females was 25 years and the upper asymptote for males was 80 years and 85 years for females. Two intermediate points were used to establish the logistic. The first intermediate point was the life expectancy estimated from the 2008 Census, corresponding to year 2007. These values are presented in **Table 10**. The second intermediate point was the life expectancy at birth corresponding to the infant mortality rate posited by Cambodia for year 2015 within the context of the Millennium Development Goals (an infant mortality of 50 per 1,000 births for males and 43 for females)[10]. Some readers may consider this goal as too optimistic considering the poor gains in mortality reduction exhibited by the country during the past two decades. However, if recent gains in infant mortality continue in the near future, the goal is not as optimistic as it may seem. Less reasonable would have been to use only the four intermediate values (1990, 1995, 2000 and 2005; see **Figure 2**), both using a logistic function or the third degree polynomial function. Initially, it was considered to use these values and one of those functions to project the level of mortality. However, both functions would have established an unrealistically trends in mortality levels for the projection period.

23. **Table 11** shows the *initial life table* for the national projection, which correspond to year 2007. In the projection exercise this table will establish the age-sex composition of mortality. Specifically, the age-specific mortality rates are imputed in RUP. It is assumed that this structure will remain constant until the end of the projection period.

24. **Table 12** shows the estimated and projected fertility level expressed in TFR. The projection was also done using a logistic trend. The program TFRLGTS from PAS was used to project. As upper asymptote, a TFR of 7 children per woman was selected and as a lower asymptote a value of 2 children per woman. 5 intermediate values were selected: TFR for years 1990, 1995, 2000, 2005 and 2007. The worksheet TFRLGST from PAS was used to project TFR according to a logistic function.

25. The age-specific fertility rates (ASFR) that will establish the future age structure of fertility are presented in **Table 13**. The first column shows the ASFR estimated from the 2008 Census and correspond to year 2007. This will be the set of ASFR for the initial year of the projection. It is assumed that the implicit structure of this schedule of ASFR, as fertility continue to decline, will approach an age structure corresponding to the Asian Model of the UN fertility models[11]. This structure, presented in column 2 in **Table 13**, corresponds to a TFR of 2.0 children per woman and it indicates a pattern with births more concentrated in ages 20 to 30 (see **Figure 4**). The last column indicates the ASFR expected for the last year of the projection period (2050).

26. With all these information the projection was conducted using RUP. A summary of the results is presented in **Table 14**. The main results are presented in **Appendix A1** and **A2**. The first

[10] Millennium Development Goals, October 2005

[11] United Nations, 1973. *World Population Prospects as Assessed in 1973*, Population Studies No. 60, United Nations, New York

appendix shows the projected population by age groups and sex for each year of the projection period (2008-2050). The second appendix shows the same information but the population is presented by single age group. It is important to note that the program RUP provide the population by single years of age. However, in this case, it was preferred to obtain the projection by single ages by splitting the 5-years age groups in the original projection using the Beers[12] formulas. It was considered that this method provides more regular and reliable results[13].

27. There are two main issues that are relevant to mention regarding the future population trends in Cambodia:
    - In spite of a substantial fertility decline that is expected for the next decades, population will continue to experience a substantial growth. This is very clear in **Table 14**. During the entire projection period the population will continue to grow. This growth will take place even after fertility reaches a *replacement level*, which is a TFR of a little more than 2 children per woman. Each couple has only 2 children, replacing themselves[14]. This level is to be reached around year 2025. The reason of this continuous growth is the *population momentum* that the population of Cambodia is experiencing. Past high fertility rates resulted in large cohorts of women in reproductive age that, in spite of having reduced their fertility, as a cohort, are producing large number of children. In other words, the number of children per woman has, and will continue, to decrease but, because the number of woman in reproductive age is increasing, the number of births will no decline or will experience only a limited decline. Obviously, the rate of population growth is declining. By the middle of the 2020 it will be near 1% and by the end of that decade it will be les that 1%. At the end of the projection period it will be only 0.55%. Although these numbers appear to indicate a substantial relieve of the population pressure that the country will experience in the future, absolute numbers are not very small. For example, between 2010 and 2015 the population with expand by more than 1 million people and between 2010 and 2020 by more than 2 million.
    - Substantial changes are also expected in the population's age composition. The population of Cambodia will experience an important process of ageing. This does not mean that old-age people will predominate in the population or will reach a very high percentage; this means that the proportion of children will decline and the proportion of middle age people will increase substantially and also the elderly will experience an increase. This is clearly indicated by the median population[15] in **Table 14**. While in 2008 it was 22.0 years, in

[12] Beers, H. S. 1945. "Six-Term Formula for Routine Actuarial Interpolation," *The Record of the American Institute of Actuaries*, 34 Part I (69): 59-60.

[13] The decision taken here of using the Beers interpolation formulas to obtain single age population instead of the results provided directly by RUP can be argued. However, this is not the place for a complex methodological discussion.

[14] Replacement level fertility corresponds to a TFR of approximately 2.1 children per woman. It is " higher than 2.0 (one child for each parent) because there are slightly more males than females born and not all females survive to their childbearing years" from Population Reference Bureau, 2000. *Population Handbook*, Washington, p. 19.

[15] "The median age of a population is the age that divides a population into two numerically equal groups; that is , half of the people are younger than this age and half are older" Population Reference Bureau, op. cit. 2000, p. 59. Although different it can be interpreted as the mean or average age.

2020 it will be 26.7 years and 30.8 years in 2030. By the end of the projection period it will be 36.1 years.

28. Further analyses should study the differential growth of functional age groups such as the working age population, the school age population, young adults, the elderly, etc. These analyses will provide important insights on the future supply of labor, demand of education and health, demand of housing, and the like. Studies on the future age composition of the population are essential for development planning and policy making.

29. In this regard, it is important to mention here that the expected changes in the age structure of Cambodia, as a result of fertility decline, suggest a potential *demographic bonus*; that is, a population composition that positively affects socioeconomic development. There are several mechanisms to this relationship: fertility decline, which increase female labor force participation and facilitates improving family nutrition and health; smaller family size reduces households' dependency ratios and increase incentives to invest in children; and the working-age population increases relative to the younger and older dependents. In summary, the lower dependency ratio helps to speed socio-economic development. Relevant to the demographic bonus is the concept of *demographic window of opportunity*. This window *opens* as the number of young children start declining, and *closes* as the proportion of older people starts its rapid growth. The demographic window open only once in the transition from a young to an old population. The opportunity that it offers can be realized if countries have made the appropriate investments in health, education and employment opportunity for a new and enabled labor force. Is this skilled workforce the engine of development when the window closes. In other words, the *demographic bonus* has no effect in socio-economic development in a context of low female participation rates, rampant unemployment or low investments in health and education[16].

URBAN-RURAL POPULATION PROJECTION

30. The projection of urban and rural areas has a great importance for development planning and policy making. There is a number of variables that differentiate the population of these two areas such as the type of insertion in the productive system of the country, the standard of living, the access to services, type of households, customs, etc.

31. Definitions of what is urban and rural vary from country to country, but population size is the main criterion, often combined with additional criteria such as population density and the percentage of the labor force in agricultural employment. Cambodia is not an exception. As a

[16] For a clear description of the *demographic bonus* see: Xizhe Peng and Yuan Cheng, 2005. *Harvesting the demographic bonus*, Asian Population Studies 1, pp. 189-205.

result of a recent study, communes with the following characteristics are considered as urban[17]: (i) population density exceeding 200 per km^2, (ii) Percentage of the male employment in agriculture bellow 50% and (iii) total population of the commune exceeding 2,000.

32. **Table 15** shows the urban and rural populations adjusted to the national base population (corresponding to 1 July 2008). This adjustment was done using the PAS worksheet CTBL32 cited above. These are the base or initial populations for the urban and rural projections.

33. The urban population was projected first. It was done by using the component method and the RUP program. The rural population was projected using a different approach but equivalent to the component method. This method will be described latter.

34. **Table 16** shows the initial life table used in the projection of the urban population. The life expectancy for 2007 was obtained using the infant mortality estimated in the mortality and fertility report previously cited: 34 deaths per 1,000 births. Then, using the MORTPAK program COMPAR, also cited above, and with the North mortality model, the corresponding life expectancies at birth by sex were estimated (67.50 years for males and 69,80 years for females).

35. **Table 17** shows the estimated and projected life expectancy at births for urban areas. It was assumed that mortality will experience a logistic trend in the future. To establish the logistic trend at least one more value was necessary. This value was calculated on the basis of the life expectancy at birth corresponding to the infant mortality expected for 2015 in the Millennium Development Goals. According to previous calculations, infant mortality should decline by approximately 5% between 2007 and 2015. This decline was applied to the urban infant mortality rate (by sex) estimated for 2007 and then, using the result, life expectancy at birth was estimated. The values for 2015 were 70.84 years for males and 73.28 years for females. The upper asymptotes used to establish the logistic were 80 for males and 85 for females; the lower asymptotes were 20 years for both males and females. Although less information was used to establish this trend as compare to the national population, this projected mortality is plausible and probable.

36. The estimate of urban fertility is presented in **Table 18**. It was also assumed that fertility in the future will follow a logistic trend. In this case four intermediate values were used to establish the logistic curve: 3.1, 2.8 and 2.2. They correspond to the TFR estimated in the 2000 and 2005 Cambodian Demographic and Health Survey and the 2008 Census, respectively[18]. TFRs of 6.0 and 1.8 were used as the upper and lower asymptote, respectively. Notice that the replacement fertility level, discussed above, has already been reached in urban areas. It is expected a below-replacement fertility by 2015. Fertility has declined very rapid in Cambodia, especially in urban

[17] National Institute of Statistics, 2009. *Report 2, Spatial Distribution and Growth of Population in Cambodia*, General Population Census of Cambodia 2008, Phnom Penh.

[18] National Institute of Statistics, op. cit., 2010

areas. This trend is certainly reliable since in has been documented by independent estimates and measures[19]. A major undertaking now is to provide substantiated explanations. Anyway, the trend proposed here is quite likely since once fertility has reached such low levels, an increase is unlikely as it is a larger further decline.

37. The age-structure of fertility, measured by the ASFR, used by the initial year of the projection period was that estimated using the 2008 Census data and that for the end of the projection period, the distribution corresponding to the Asian low fertility model (TFR=2) of the United Nations. The respective data is presented in **Table 19**. The program RUP requires ASFR for the initial year of the projection and it is convenient to include those expected for the last years, which will permit to establish a trend.

38. One of the most important components of the demographic dynamic of urban populations is migration. In the case of the overall urban population, it is usually rural out-migration. **Table 20** shows the annual net migration in urban and rural areas. Net migration is the difference between in-migrants and out-migrants. A positive value indicates that the area is gaining population by migration and a negative value that the area is losing population. In this case, urban areas are gaining and rural are losing. There is some urban to rural migration but rural to urban is much larger. The numbers presented in **Table 20** correspond to the absolute number of net migrants and refer to annual values. Specifically, the figures correspond to the average annual migrants during the 5 years prior to the census. Note that annual number of migrants is being used and not migration rates. The reason is that it is easier to process absolute numbers than rates in population projections when a program such as RUP is being used. Also note that *number of net migrants* or *net migrant* is an abstract idea. It does not correspond to persons, but to the result of an arithmetic operation. Some demographers feel uncomfortable working with such an intangible concept and, in fact, absolute net migrant is not an appropriate concept for migration analysis. However, it is quite operational for population projections.

39. A rapid look at the distribution of net migrants by age indicates that migration take place mainly between ages 15 and 30 years, suggesting that the main reasons for migration are work-related. Notice also that female migrants outnumber male migrants and the number is particularly large in the age group 20-24. Many rural young, single females leave rural areas, most likely, in search of urban employment. It would be important to know whether this is an individual decision or a family economic strategy. A second major issue here is the degree of vulnerability of these women migrants in the urban context. Much research is needed in this area. It is relevant to notice, however, that also some family migration take place as suggested by the number of net children migrants. This aspect of migration also represents a social challenge.

40. Regarding the projection of urban net migration, it is assumed that the number of net migrants by age groups and sex will continue being the same during the entire projection period. This mean that, although numbers will remain constant, migration rates will decline since the population size

[19] Ibid, Table 3

is increasing. This trend is likely to occur because urban investments have been an important part of Cambodia's recent economic development and cities appear to have provided employment opportunities. Although this trend may continue, it is likely that the pace of migration declines somewhat in the future. However, this slow down is not expected to be substantial as it is indicated further by the urban rate of growth.

41. As mentioned above, the projection of the urban population was conducted using the cohort component method and the program utilized was RUP. The results of this projection and the projection of the rural population are presented as a summary in **Table 21** and the complete results in **Appendices B1** and **B2**. Before going over the results, the projection of the rural population is described.

42. One of the important features of the program RUP is its capacity to project a third area when two areas are calculated. For example, if the urban and rural populations have been projected independently, a RUP sub-program call RUPAGG can aggregate or sum these two projections and get a new one, which should be the national projection. It can also obtain a projection by difference or as a complement; that is, having the national projection and the urban projection, RUPAGG can produce the rural projection. This program was used here to project the rural population. In other words, the rural population was projected as a difference between the national projection and the urban projection

43. The output of RUPAGG is not only the population by age and sex but also the implicit values of the components: mortality, fertility and migration indicators. **Table 22** shows the TFR estimated for 2007 and that calculated by RUPAGG for the next year (2008). The values are quite consistent. The table also shows the TFR and the life expectancies at birth projected for rural areas. They seem quite plausible and consistent, considering the national and urban projections, indicating that the use of the program is appropriate.

44. There is an important aspect in these projections that it is convenient to examine. According to this exercise, the urban population will grow more rapid than the rural one. Between 2008 and 2030 the urban population will double while the rural population will grow by only 14.2%. By the end of the projection period urban areas will be experiencing an annual growth of 2.22% while rural areas of only 0.25%. In general the growth in urban areas will be caused mainly by migration. For example, in year 2030, 46% of the urban growth will be caused by natural increase (difference between births and deaths) and 54% by net migration[20]. The trend projected here is quite plausible since this has been the experience of most developing countries during the second half of the past century and the first decade of de present century[21].

[20] In 2008, 40% of the urban growth can be attributed to natural increase and 60% to net migration. The differences can be explained by the relative decline or rural out-migration.

[21] See, for example, Weeks, J. R. 2002. *Population, an Introduction to Concepts and Issues* (eighth edition), Wadsworth.

POPULATION PROJECTIONS BY PROVINCES

45. Conducting population projections by sub-areas, such as provinces, is important because the different sub-areas of a country usually have dissimilar densities, unequal levels of development, diverse forms of insertion in the national economy, different natural resources and assorted problems that may range from those related to the environment to natural disasters. Regional planning is directed, precisely, to the design of plans and programs that consider the specific characteristics of a region, zone, area or its administrative equivalent. Ideally, regional planning should harmonize national with local development, that is, generate national development through the progress in the different parts of the country. The magnitude of the population in different geographic or administrative units, its structure and demographic dynamic are essential inputs to regional planning exercises.

46. It is important to point out that the results of the projection of the population of sub-areas are less reliable, or more uncertain, than those obtained in a national projection. This is mainly the result of the difficulties associated with projecting internal migration. In fact, this is often an important component of population growth or decline among the subdivisions of a country. Therefore, a major issue concerning population projections among regions, provinces or districts is the projection of internal migration.

47. Cambodia is divided into 24 provinces. **Table 23** shows the base populations for the provincial projections that is, the population of the provinces for the middle of the year 2008. In other words, it shows the sum of the provincial populations conciliated with the national base population. The operation, as in the case of the urban-rural migration was done with the PAS worksheet CTBL32.

48. The projection of the level of fertility (TFR) was done using a logistic function. Four TFRs were used as intermediate points to establish the logistics. The sources were the 1998 Census, the 2000 and 2005 DHS and the 2008 Census[22]. The respective reference dates for the TFRs are years 1995, 1997, 2003 and 2007[23]. As upper asymptotes a TFR of 7 was used and as a lower asymptotes a TFR of 2. The only exception was Phnom Penh. Considering its lower fertility level and past trends the two asymptotes utilized were TFRs of 5.5 and 1.60. The results of this exercise are presented in **Table 24**.

49. The set of panels in **Table 25** shows the projection of the ASFR for the end of the projection period. As mentioned earlier, as fertility decline, the age schedule changes. In this case, as in the other projections, it was also assumed that the pattern of fertility by 2030 in all districts will be that corresponding to the lowest level of the Asian Model age structure of the UN fertility models. The first column in the panels in **Table 25** shows the ASFRs according to the 2008 Census

[22] See National Institute of Statistics, op. cit. 2010, p.22.

[23] As suggested previously, the date of fertility, and in particular TFR, measured by a census or survey corresponds to one or more years previous to the date of the census or survey.

estimates, the second column indicates the fertility model (expressed in proportions) and the third column shows the ASFR corresponding to the TFR projected for year 2030.

50. **Table 26** shows the estimate of infant mortality and the projection of life expectancy at birth for each province. The first three columns show the births and the deaths according to the 2008 Census (questions on deaths and births during the past 12 month) and the respective IMR. The fourth column shows the IMRs adjusted by a factor suggested in the mortality and fertility report. This factor is the ratio 60/58[24]. The following two columns show the life expectancy at births corresponding to the IMR (according to the Coale-Demeany North model life table) and the next two columns the life expectancy at birth corresponding to the decline in infant mortality expected to 2015 according to the Millennium Development Goals. The projection of the life expectancies at births in the provinces was done using a logistic with these two values (for years 2007 and 2015) as the intermediate points and an upper asymptote of 85 years and a lower asymptote of 25 years. The only exception was Ratanak Kiri. The estimated infant mortality and subsequent life expectancy at birth are too low. There appear to be a serious overestimate of infant mortality. Therefore, for this province the mortality values of the neighbor province of Mondul Kiri were used (life table and projected life expectancy at birth).

51. The life tables corresponding to the life expectancies at births for each province are presented in **Table 27**. They were calculated from the life expectancies at birth using the program COMPAR from the software MORTPAK cited earlier. It is relevant to remember that these life tables establish the pattern of mortality during the projection period.

52. Some explanation of the estimates of internal migration was given in the section urban-rural projections. It was measured using the questions on previous residence and duration of stay in the present place of residence. The number of in-migrants and out-migrants during the five years prior to the census by age groups and sex was tabulated for each province. Net migration was calculated and the input used for the initial projection year was the average annual net migration during the five years previous to the census (see **Table 28**). It was assumed that the number of net migrants by age groups and sex will continue being the same during the entire projection period. This was the approach used in urban-rural projection. Although numbers will remain constant, migration rates will decline since the population size is increasing. This trend is likely to occur because provinces that attract population because better economic conditions, more jobs or resources are likely to lose their comparative advantages because of the population pressure caused by in-migration over employment or resources. Similarly, provinces that tend to lose population tend to experience a decline in the pace or out-movements. These propositions do not mean that several factors may change during the projection period and some districts that are losing population become poles of attraction or districts that are gaining population continue doing so and even increase their capacity to absorb people. However, because evidence on those

[24] For an explanation of this correction factor see National Institute of Statistics, op. cit. 2010, p. 31.

trends is not available, it is not convenient to assume erratic tendencies. The usual approach is to assume a slow decline in the recently observed trends.

53. Hence, using the previously presented projected data on mortality, fertility and net migration, the population of each province was projected. As in the previous projections, the cohort-component method was used and the software RUP was the program that was utilized.

54. In order to ensure internal consistency between the sum of the provincial projections and the national projection, a final prorating step needs to be conducted. This procedure involves adjusting the sum of the provincial age-sex-specific population to conform to the national level projection. It is the same operation done to conciliate the census provincial populations with the national base population. It was done with the PAS worksheet CTBL32.

55. The results of the provincial projections, already conciliated with the national projections, are presented in **Table 29** and **Appendices C1** and **C2**. The first appendix shows the population by age groups and sex and the second one the population by sex and single years of age. The projection by single ages was obtained by splitting the 5-years age groups in the original projection using the Beers formulas previously cited.

56. Particularly interesting are some results presented in **Table 29**. All provinces will continue exhibiting some growth. The exceptions are two: Kampong Cham and to a lesser extent Prey Veng. The prevalence of positive rate of growth in most provinces is the result of past high fertility rates, which enlarged substantially the female population in reproductive age. In spite of fertility decline the number of births which continue to surpass the number of deaths and, in some cases, the large number of out-migrants. However, most provinces the rate of growth is expected to diminish. The largest growth is to be observed in Pailin, Oddar Meanchey, Kep and Phnom Penh, although only in Kep the rates will experience a growth.

57. Another important issue is to examine whether or not the assumed demographic dynamic will result in a redistribution of the population and how significant this will be. In spite of substantial differences in the rate of growth, a redistribution of the population from the beginning of the present decade to the end of the next will not be substantial. The main reason of this feature is the limited time span of the projection period and the fact that, at present, the districts do not exhibit major population concentrations. For example, except for Phnom Penh, no other district contains more than 10% of the population.

58. There are other issues that deserve further analyses. An important one is the analysis of the age composition of the population in the provinces. According to **Table 29**, the age structure in the different provinces is indicating a slow process of ageing as indicated by the median age. The impact of these changes in the socio-economic structure of the provinces is a quite important issue for planners and policy makers. As mentioned above, the size of the labor force to be absorbed by the labor market, school and health services needs as well as housing demand are quite important issues for the regional governments.