Curaçao Population Projections 2015-2050

Methodological considerations, results and comparison of five projection variants

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Introduction

Population growth in Curaçao has followed a rather turbulent path in the past three decades. While the fertility level declined and the life expectancy increased between the mid-1980s and 2015, migration has proven to be the dominant driving force behind population change in Curaçao during this period, and will likely continue this role in the future. Two emigration waves during the 1980s and 1990s, which were followed by an extended period of population growth, due to a high level of immigration, have severely altered the population size, but also caused changes in the age composition of the population. Rapid aging and at the same time dejuvenation of the population are some of the results of these developments.

Population projections for the small island state of Curaçao therefore rely heavily on migration assumptions. Population projections (for most countries in the world) by major agencies, like the United Nations and the US Census Bureau, usually assume merely one migration scenario per country. This approach is too limited for countries like Curaçao which depend greatly on migration developments, which are strongly fluctuating, for future population growth. This article argues that population projections for populations depending predominantly on migration for population growth (e.g. small island states) benefit from more than one migration scenario, in fact, need more than one migration scenario. By presenting the Curaçao Central Bureau of Statistics (CBS) 2015-2050 population projections, which include four different migration scenarios, this argument will be supported. These projections show how the different migration scenarios lead to various scenarios of population growth and have varying effects on the pace of population aging and dejuvenation of the population in Curaçao.

In the first part of this article the CBS 2015-2050 population projections methodology including the different fertility, mortality and migration assumptions and the rationale behind these assumptions are presented and discussed. The results of five projection variants and a comparison of these results are presented in the second part of the article. Finally, an argument is made for future improvements on the migration assumptions methodology. A list of definitions of the used concepts is found in the appendix.

Methodology

Cohort component method

For the CBS population projections the cohort component method has been used, because this is nowadays nearly the only method used for population projections, 'representing a rare consensus for the social sciences' (Preston, Heuveline, & Guillot, 2001). In this approach the population is segmented into different subgroups, in this case birth cohorts. Each subgroup is exposed to age-specific "risks" of fertility, mortality and migration. By applying these risks, population changes over time for each subgroup are calculated. This is done separately for males and females. It is a model in which the different components of population change are dynamically linked to one another (Preston, Heuveline, & Guillot, 2001). The Curaçao projections are carried out over discrete time intervals, i.e. 5-year intervals, for 5-year age groups. The baseline population for these projections is the CBS estimated population at the 1st of January 2015.

Projection assumptions

In their 'World Population Prospects, The 2012 Revision' (United Nations, 2014), the United Nations made fertility and mortality assumptions for each country separately, based on historical estimates dating back to 1950. For instance, for Curaçao, historical data obtained from the CBS, i.e. census data and population registry data, was checked, validated for inconsistencies and analyzed by the UN. Then, a probabilistic projection model was used to project fertility and mortality developments for Curaçao in the future, by making use of historical trends within the country and the experiences of similar countries concerning fertility and mortality. This projection model is grounded on demographic theories of fertility transition and mortality transition[1]. Because of the use of validated and consistent historical data, as well as a sound theoretical model, the resulting projected fertility and mortality trajectories, made by the UN, have been partly adopted as assumptions in the CBS population projections.

The importance of the migration assumptions called for a different approach. The total fertility rate and life expectancy at birth, indicators used as a measure of a population's level of fertility and mortality respectively, usually follow a relatively stable (compared to migration) and similar path across populations. Projecting fertility and mortality levels in the future is therefore a less complicated exercise than projecting migration levels, which is the least predictable component of population growth. Migration is dependent on many variables, which may be endogenous (in the country of settlement) as well as exogenous (in the country of departure), and include job opportunities, wages, migration policies, migrant networks and educational opportunities or constraints, for example. Changes in any of these variables can have large effects on international migration flows. Because the projection of migration is such a complex and time consuming task, for which there was a lack of capacity during this study, the migration assumptions have been generated by projecting different migration trends of the past two decades to the future.

Fertility assumptions

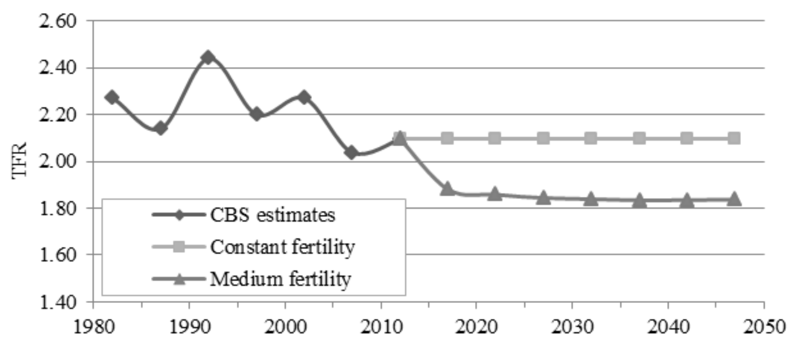
Two sets of fertility assumptions have been selected for the CBS population projections:

1. Medium fertility assumption (adopted from the UN WPP 2012 (United Nations, 2014)):
    a. The total fertility rate (TFR) will marginally decline from 1.88 children per woman in the interval 2015-2019 to 1.84 children per woman in the interval 2045-2049. However,

[1] Most countries (populations) worldwide undergo a transition in fertility levels as well as in mortality levels; the fertility transition is characterized by a reduction in fertility to below replacement level (2.1 children per woman) and a delay in the age at initiation in childbearing. The mortality transition is characterized by a rise in life expectancy (declining mortality rates) through processes of improved hygiene and nutrition, social and economic development and mass immunization among others.

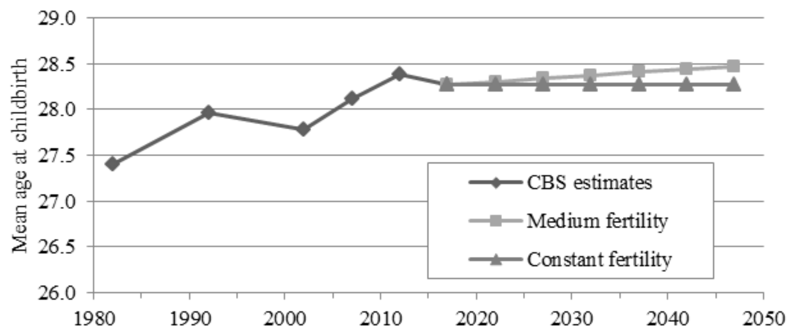
a more significant decline is expected from 2.10 children per woman in 2010-2014 (CBS estimate) to 1.88 in 2015-2019 (Figure 1).

Figure 1. Total fertility rate, estimates and assumptions, 1980-2050



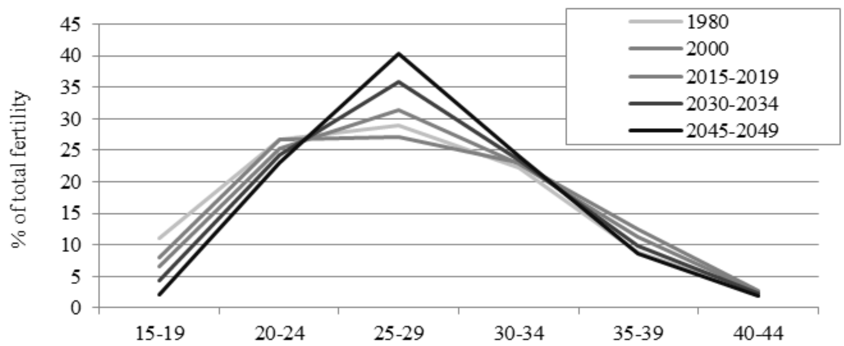
b. The mean age at childbirth (MACB) increases slightly from 28.3 in the 2015-2019 interval to 28.5 in the 2045-2049 interval (Figure 2).

Figure 2. Mean age at childbirth, estimates and assumptions, 1980-2050



c. Age-specific fertility rates (ASFRs) will decrease for the younger ages and the older ages and center more in the 25-29 age group (Figure 3).

Figure 3. Age specific fertility in percentages of total fertility, estimates and assumptions, 1980-2050



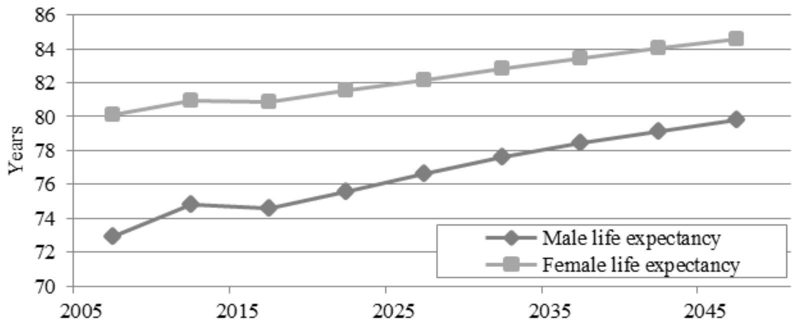
2. Constant fertility assumption: the fertility schedule will remain constant at the 2010-2014 fertility level of 2.1 children per woman (Figure 1). No changes in TFR, MACB and ASFR will occur during the entire projection period (Figure 2).

The medium fertility assumption has been utilized in all projection variants, except in the constant fertility variant.

Mortality assumptions

All projection variants utilize the same mortality assumption, which is adopted from the UN WPP 2012 (United Nations, 2014), and referred to as the 'normal' mortality assumption: it is assumed that female life expectancy at birth will increase from 80.8 years in the 2015-2019 interval to 84.6 years in 2045-2049. Male life expectancy at birth is expected to increase from 74.6 years to 79.8 years over the same period. The difference in life expectancy at birth between females and males is thus expected to decline from 6.2 years to 4.8 years (Figure 4). The narrowing gender gap in life expectancy is observed in high-income countries and is assumed to occur in the future in other countries with a female life

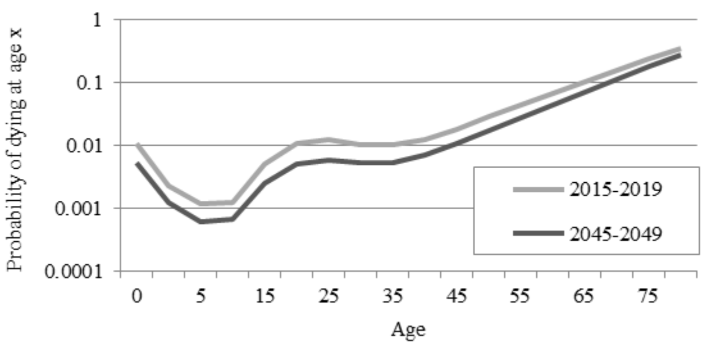
Figure 4. Life expectancy at birth, estimates and assumptions, 2005-2050



expectancy above 75 years.

Improvements in mortality, i.e. declining mortality rates or declining probabilities of dying, are expected in all age groups, male as well as female. Males aged 0 to 40 years are expected to experience the largest improvements in mortality, especially between ages 15 and 35 (Figure 5). For females the largest improvements are expected at the youngest ages, especially for infants, under age 1, and from age 1 up to age 20 years (Figure 6).

Figure 5. Probability of dying, males, 2015-2019 – 2045-2049

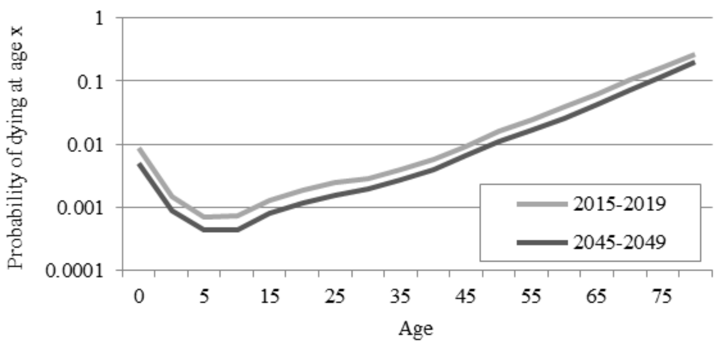


Migration assumptions

For the 2015-2050 projections four different migration variants have been generated by the CBS. The two major emigration waves and the continuous positive net migration after these emigration episodes, in Curaçaos' recent past, have induced the need for various future migration scenarios. The following migration assumptions were made:

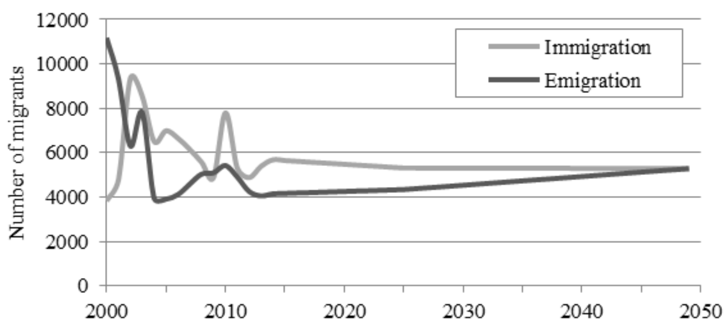
1. Standard migration assumption:
    a. Immigration and emigration levels in 2025 are fixed at the average levels of registered immigration and emigration over the 2011-2014 period. In the long-term, in 2050, both immigration and emigration levels are fixed at the average level of registered immigration over the 2005-2014 period. That means that net migration will be zero in

Figure 6. Probability of dying, females, 2015-2019 – 2045-2049



2050. A linear trend is assumed between 2015 and 2025 and between 2025 and 2050 (Figure 7).

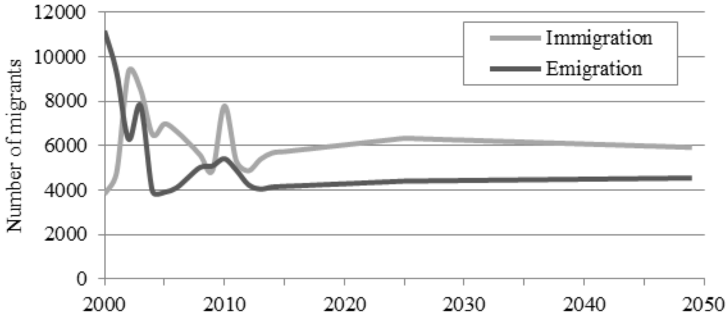
Figure 7. Immigration and emigration, standard migration assumption, 2000-2050



    b. The average age distribution of registered immigration as well as emigration of the period 2010-2014, differentiated by sex, has been applied to immigration and emigration levels for each of the 5-year projection periods. The age distribution has been held constant over the entire projection period.
2. High immigration assumption:

a. Immigration and emigration levels in 2025 are fixed at the average levels of registered immigration and emigration over the 2005-2008 period, which was characterized by the high level of immigration and the resulting high positive net migration. For 2050 immigration and emigration levels are fixed at the average levels of registered immigration and emigration over the 2005-2014 period. Net migration will remain positive towards 2050. Migration levels are assumed to grow or decline in a linear trend (Figure 8).

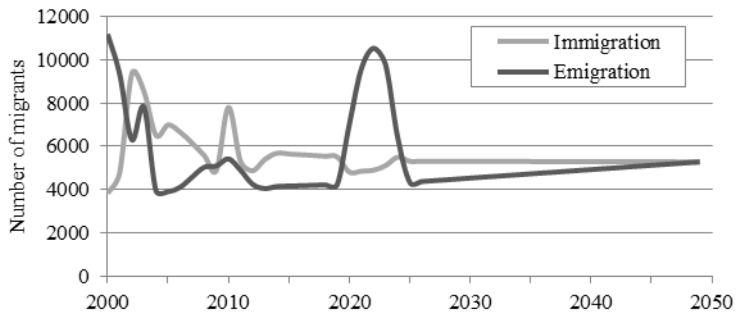
Figure 8. Immigration and emigration, high immigration assumption, 2000-2050



b. For the period 2015-2025 the average age distribution of immigration as well as emigration of the period 2005-2008, differentiated by sex, has been applied to the projected immigration and emigration levels. For the remaining projection period, 2025-2050, the age distribution is equal to age distribution as used in the standard migration assumption.

3. Emigration wave assumption:
   a. Immigration and emigration levels will follow the same path as in the standard migration variant, however, between 2020 and 2025 an emigration wave, equal in size and scope as the emigration wave that took place from 1998 to 2001 in Curaçao, will occur. It is assumed that similar migration rates will occur during the emigration wave as measured during the 1998-2001 emigration wave (Figure 9).
   b. The same age distribution applies as in the standard migration variant, with

Figure 9. Immigration and emigration level, emigration wave assumption, 2000-2050



exception of the 2020-2024 emigration wave period, in which the average age distribution of the 1998-2001 period has been applied to the migration levels.

4. Zero-migration assumption: in this projection variant it is assumed that no international migration takes place in Curaçao during the entire projection period. This variant merely serves as a reference frame to estimate the effects of migration in the other non-zero migration scenarios.

Table 1 gives a schematic overview of the different projection variants and the combination of assumptions used for each variant.

Table 1. Projection variants by fertility, mortality and migration assumptions

Projection variant	Assumptions		
	Fertility	Mortality	Migration
Standard migration	Medium	Normal	Standard
Constant fertility	Constant as of 2015-2020	Normal	Standard
High immigration	Medium	Normal	High immigration
Emigration wave	Medium	Normal	Emigration wave
Zero-migration	Medium	Normal	Zero-migration

Data sources

Population estimates based on the Curaçao population register data and census data are the basic data source for this study. Births, deaths and migration time series from the population register from 1950 to 2015, combined with population data from the six censuses held in Curaçao between 1960 and 2011, were the input for the United Nations' WPP 2012. The vital statistics time series, by age and sex, from 1998 to 2014 were used for the migration assumptions generated by the CBS.

Results

Figure 10 and Table 2 give an overview of the total population size for each projection variant.

Figure 10. Total population by variant, 1950-2050

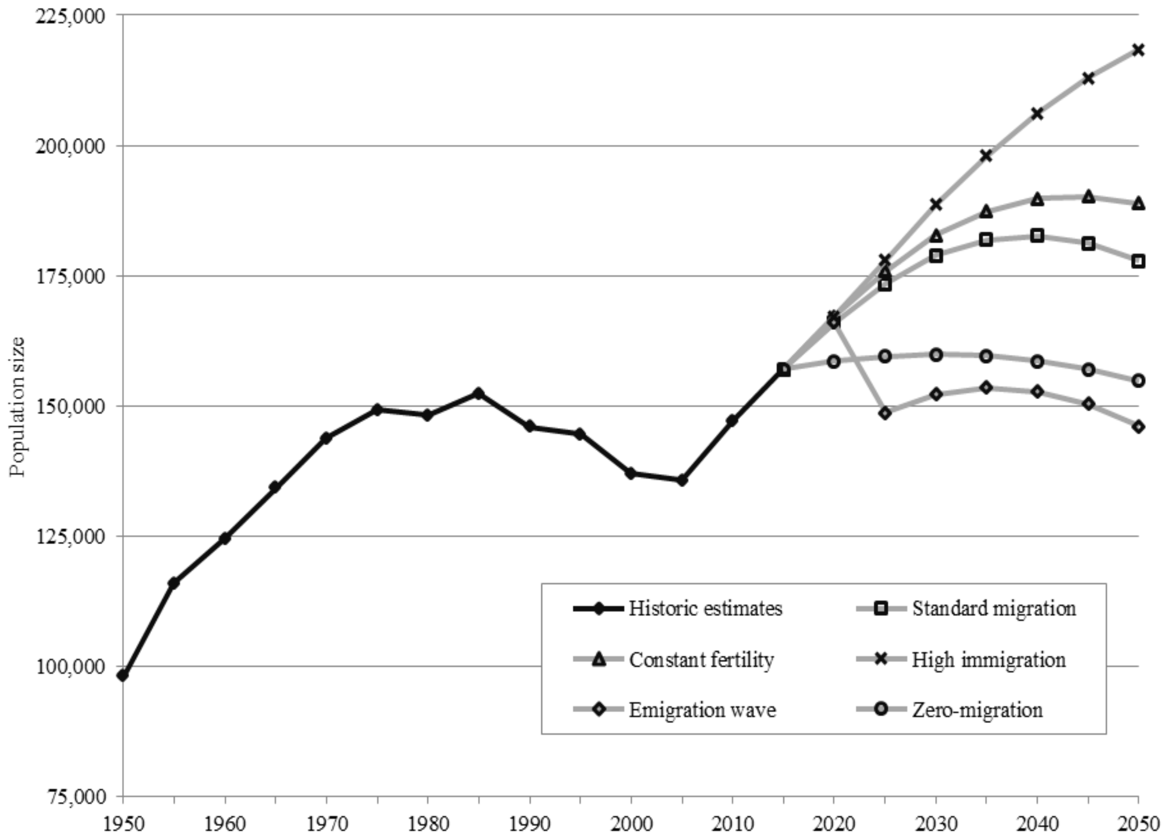
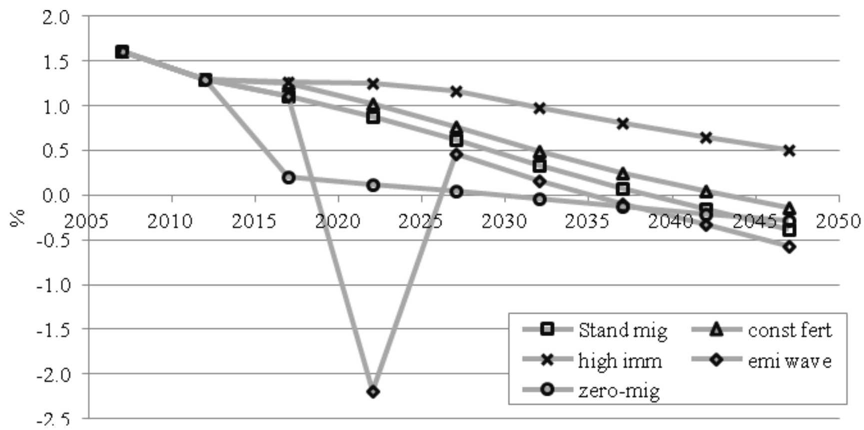


Table 2. Total population by variant, 1950-2050								
Projection variant	2015	2020	2025	2030	2035	2040	2045	2050
Standard migration	156,971	165,983	173,409	178,834	181,885	182,626	181,261	177,878
Constant fertility	156,971	167,151	175,907	182,780	187,375	189,740	190,150	188,877
High immigration	156,971	167,184	177,948	188,588	198,000	206,134	212,967	218,468
Emigration wave	156,971	165,983	148,755	152,242	153,504	152,801	150,346	146,170
Zero-migration	156,971	158,589	159,507	159,926	159,623	158,607	156,974	154,793

Future population growth in Curaçao will be largest for the high immigration variant which yields a population size of almost 220,000 persons in 2050. Mass emigration (emigration wave) in the near future will lead to a population decline, which may cause the population size to reduce to about 146,000 persons in 2050. The standard migration and constant fertility scenarios project a population size of around 178,000 and 189,000 persons respectively. Without international migration the population size will slowly start to decrease to reach a little fewer than 155,000 persons in 2050.

Figure 11. Population growth rate



The population growth rate is expected to decline and eventually become negative in all variants, except the high immigration variant (Figure 11). The rate of natural increase ((births – deaths) * 1000 population) is expected to drop below zero in all variants, meaning that eventually deaths will exceed births, no matter the migration scenario (Figure 12). An emigration wave will accelerate this process because less births are expected to take place in the future. The constant fertility variant will delay the decrease in the rate of natural increase the longest, but eventually the rate will drop below zero as well.

All projection variants show that population aging is irreversible and has a big impact on the population. High positive net migration slows the aging process whereas an emigration wave speeds up the aging process. As life expectancy is set to increase further towards 2050, the median age of the population is expected to be between 46 (high immigration) and 52 (emigration wave) years in 2050, compared to 41 years in 2015. The population aged 65 years or older is estimated to make up between 24 percent (high immigration variant) and 30 percent (emigration wave variant) of the Curaçaoan population in 2050 (Figure 13). This means an increase of at least 8 percentage points from a level of 15 percent in 2015.

Figure 12. Rate of natural increase

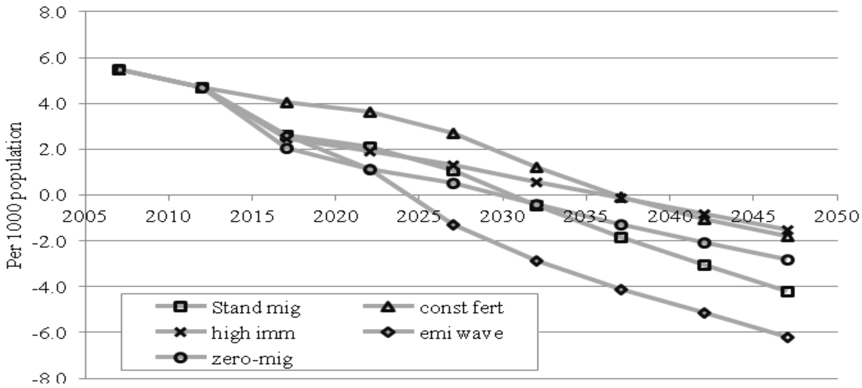
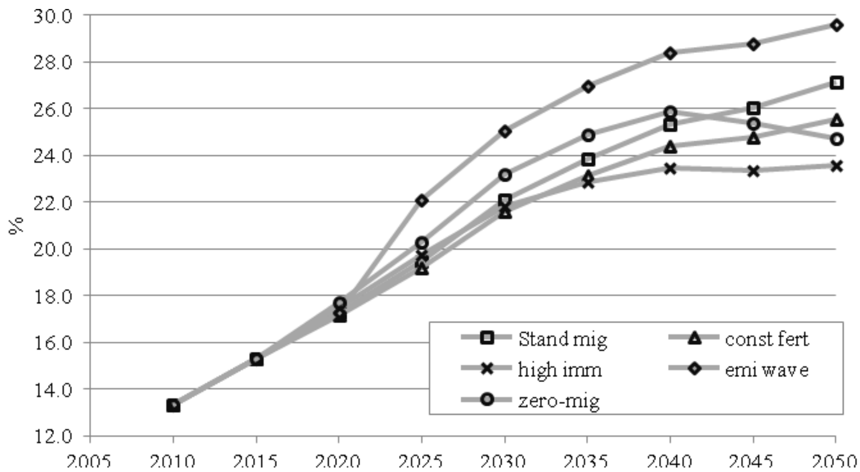
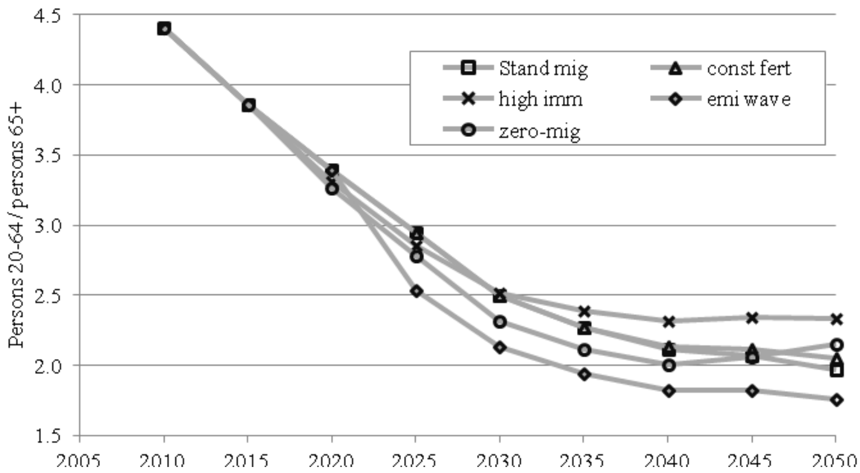


Figure 13. Percentage population 65+



It is expected that in 2050 every elderly person will be economically dependent on half the number of working-age persons (about 2 persons) compared to 2015 (about 4 persons) (Figure 14). Again, an emigration wave will only accelerate the aging process and cause the old-age support ratio to drop even faster than in the other projection variants.

Figure 14. Old-age support ratio



At the same time, due to a declining fertility rate, the proportion of youth in the population is expected to decline from 19 percent in 2015 to somewhere between 14 and 17 percent in 2050. If the fertility rate remains constant at the 2015 level, the 'dejuvenation' of the population will be less severe than in the case of an emigration wave, which, of all projection variants, will cause the largest decline in the share of youth in the population. In the constant fertility variant the proportion of youth will remain stable at around 19 percent up to 2030, but eventually will drop to 17 percent in 2050.

Figure 15. Population by age and sex in 2050, high immigration and emigration wave variant

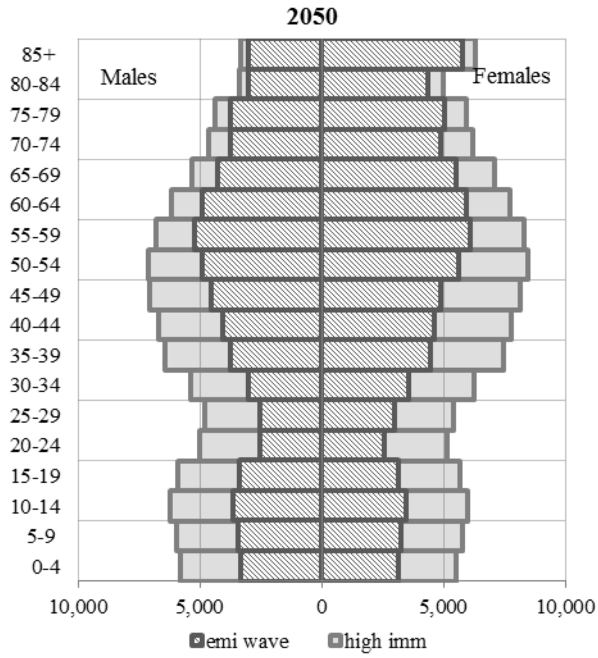
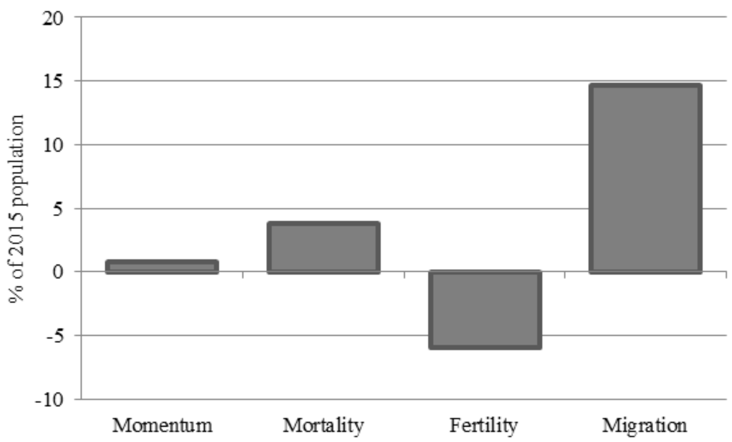


Figure 15 shows the population pyramids for the year 2050 for the two most deviating variants: the high immigration variant and the emigration wave variant. Clearly the impact of the two different migration scenarios on the age structure of the population is displayed here. The emigration wave pyramid shows a more advanced aged population compared to the high immigration pyramid: it displays proportionately less youth and proportionately more elderly persons. Furthermore, the considerable difference in total population size is evident from the graph.

A method to measure the contribution of each of the components of population growth (fertility, mortality, migration and the initial age structure of the population) to future population growth is the decomposition method[2], as proposed by Bongaarts and Bulatao (1999). Decomposition of the standard migration variant shows that future population growth is mainly driven by migration, which accounts for about 15 percent growth of the population between 2015 and 2050 (Figure 16). The increasing life expectancy adds almost 4 percent to the 2015 population and the age structure of the baseline population (momentum) accounts for about one percent of the population growth. Fertility decline, on the other hand, reduces the population by six percent between 2015 and 2050. Altogether, a population growth of 13 percent is expected in the standard migration variant.

Figure 16. Contribution to population growth by component, as percentage of the 2015 population



4. Conclusion

This article started by pointing out the importance of using multiple migration scenarios for population projections for (small island) states that predominantly depend on migration for population growth. It was stated that population projections by international agencies, like the UN and the US Census Bureau, lack different migration scenarios for these kind of countries. This article has emphasized the impact of the use of multiple migration scenarios on population development by applying them in the CBS 2015-2050 population projections for Curaçao. The different projection variants not only indicate large differences in future population size, but also provide evidence of

[2] A detailed description and an application of the method can be found in the technical paper 'Demographic components of future population growth' (Andreev, Kantorová, & Bongaarts, 2013)

varying effects on the pace of population aging and dejuvenation of the population in Curaçao. Additionally, decomposition of the projected population growth in the standard migration variant, stresses the proportionately large contribution of migration to population growth. While the point of the importance of multiple migration scenarios is made, a subordinate amount of attention is given to the methodology of projecting future migration scenarios. The complexity of the process of international migration actually calls for a more sophisticated approach than the method that was used for this study. Researching the relationship between migration in Curaçao and labour market developments or migration policies for example, would render valuable information which can then be assessed for a more theoretically based and data-driven projection methodology of future migration.

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Appendix

Definitions

Age-specific fertility rate: number of births in period 0 to T to women aged x to $x + n$ divided by the average number of women aged x to $x + n$ in period 0 to T

Life expectancy: the average number of additional years that a survivor to age x can expect to live beyond that age.

Mean age at childbearing: the average age at childbearing of all women who gave birth in a given period.

Old-age support ratio: the number of persons of working age (20-64) per elderly person (65+). This definition is adopted from the OECD (OECD/IDB/The World Bank, 2014) and differs from old-age dependency ratio by the working age range, which starts at 20 instead of 15 years.

Population growth rate: represents the mean annual rate of population change, expressed in percentage, and is calculated as $\ln[N(T)/N(0)]/T$

Probability of dying: the probability of death between age x and x + n is defined as the ratio of deaths between ages x and x + n to the number of survivors at exact age x.

Rate of natural increase: the number of persons added by natural growth (births minus deaths) to the population in a given period per 1,000 persons in the population during that period.

Total fertility rate (TFR): the average number of children a woman would bear if she survived through the end of the reproductive age span and experienced, at each age, a particular set of age-specific fertility rates.