

TECHNICAL NOTES

2020 CENSUS-BASED REGIONAL, PROVINCIAL/HIGHLY URBANIZED CITY, AND CITY/MUNICIPALITY LEVEL POPULATION PROJECTIONS

List of Abbreviations

ASDR	Age-Specific Death Rate
ASFR	Age-Specific Fertility Rate
CBPP	Census-Based Population Projections
CPH	Census of Population and Housing
CCM	Cohort-Component Method
CRVS	Civil Registration and Vital Statistics
DAPPS	Demographic Analysis and Population Projection System
IAWGPP	Interagency Working Group on Population Projections
IMR	Infant Mortality Rate
LEB	Life Expectancy at Birth
MortPak	Software Package for Mortality Measurement
NDHS	National Demographic and Health Survey
NMR	Net Migration Rate
PAS	Population Analysis System
TFR	Total Fertility Rate
USCB	United States Census Bureau

Overview

The 2020 Census-Based Regional Population Projections utilized the Cohort-Component Method, the same method used for the 2020 Census-based national population projections. This method projects the future population based on a baseline population, fertility, mortality, and migration. The methodology separately involves projecting fertility rates by age of women, life expectancy at birth (LEB) by sex, net number of international migrants, and net interregional migration rates. The sum of the

regional population projections was ensured conform to the national population projections under Scenario 2 where the national Total Fertility Rate (TFR) is assumed to gradually decline from 2.1 children in 2020 to 1.9 children in 2055.

The basic equation of the method states that the population at year t is equal to the population at year $(t-n)$ plus births in the interval $(t-n)$ to t minus deaths during the same time interval $(t-n, t)$ plus the net migrants from the international and interregional migration. The net migrants refer to the difference between in-migrants minus out-migrants. The components of population change are projected separately and applied recursively to the equation given below to produce a series of populations by sex and by age group in successive midyear.

$$P_{t+n} = P_t + B_{t+n} - D_{t+n} + M_{t+n}$$

Where:

P_{t+n}	= projected population at year $t+n$
P_t	= base population (population at year t)
B_{t+n}	= births at year $t+n$
D_{t+n}	= deaths at year $t+n$
M_{t+n}	= net migration at year $t+n$
t	= base year

Essentially, the equation accounts for the natural increase (births minus deaths) and net migration (immigrants minus emigrants) to determine the population at a later time. The methodology involves separately projecting the fertility rates by reproductive age of women, i.e., aged 15 to 49, life expectancies at birth (LEB), and net migration rates (NMR) of international and interregional migrants by five-year age groups, for each sex.

The base population and the components of population change are projected separately and applied recursively to the equation to produce a series of population projections in midyear based on reliable projection horizon years.

To calculate the CCM, several software applications were used to generate the baseline and projected inputs such as Population Analysis Spreadsheets (PAS), Demographic Analysis and Population Projections System (DAPPS), and Software Package for Mortality Measurement (MortPak) for the national and regional levels.

For the Provincial/highly urbanized city (HUC) and city/municipality level of population projections, non-CCM was adopted due to the lack of reliable data to be used as the basis for fertility, mortality, and migration from surveys and administrative sources at the lower geographic levels.

Based on the recommendations from the technical experts of the United States Census Bureau (USCB) and with the agreement of the Interagency Working Group on Population Projections, different projection horizons for each administrative level due to the decreasing reliability of estimates in more distant years for subnational projections. This information is provided in Table 1.

Table 1. Projection Horizons by Administrative Level

Administrative Level	Projection Horizon	Number of Years
1. National	2020 to 2055	35
2. Regional	2020 to 2035	15
3. Provincial/HUC	2020 to 2030	10
4. City/Municipality	2020 to 2030	10

In the 2020 CBPP, HUCs were treated similarly to provinces in compliance with the PSA Board Resolution No. 01 Series of 2017 – 143, *Enjoining Major Statistical Agencies and Other Data Producers to Generate Separate Data for Highly Urbanized Cities*. The recent changes in the composition of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) and the SOCCSKSARGEN were considered in the 2020 CBPP.

Methodology Used for the Regional, Provincial/HUC, and City/Municipality Level Population Projections

I. Regional Level Population Projections

a. Base Population

Consistent with the national population projections, the official census counts disaggregated by regions from the 2020 CPH were used as inputs for the base population at the regional level.

To ascertain the accuracy of age reporting and the completeness of census enumeration, the results of the 2020 CPH were assessed. Assessment procedures such as cohort analysis, estimates of the expected number of children aged zero to four years, as well as checks for age heaping were done for each of the regions. Table 2 provides a summary of the evaluation procedure.

Table 2. Summary of Evaluation of Age Reported in the 2020 CPH by Region

Assessment Procedure	Result
1. Cohort Analyses using the 2010, 2015, and 2020 census results Age Cohorts:	An increasing population of selected age cohort from one census to another was observed in some regions such as the National Capital Region (NCR) and the

Assessment Procedure	Result
<ul style="list-style-type: none"> • Age group 0 to 4 years • Age group 5 to 9 years • Age group 10 to 14 years 	<p>Cordillera Administrative Region (CAR) e.g., the population aged zero to four years in 2010 CPH increased in the 2015 POPCEN when they were counted in age group five to nine years.</p>
<p>2. Estimating the population aged 0 to 4 years based on the latest fertility data sources</p> <p>Methods and Data:</p> <ul style="list-style-type: none"> • Interpolated ASFRs from the 2017 National Demographic and Health Survey (NDHS) and 2022 NDHS results • ASFRs from the 2022 NDHS • Interpolated ASFRs from the 2022 NDHS at midyear (01 July 2022) • ASFRs from the 2020 CPH P/F Ratio • Interpolated ASFRs from the 2022 NDHS and 2020 CPH P/F Ratio • Average of ASFRs from the 2017 NDHS and 2022 NDHS • Interpolated ASFRs from the 2017 NDHS and 2020 CPH P/F Ratio 	<p>Using several variations of inputs to estimate the current population based on different fertility data sources, discrepancies were still observed between the expected/estimated and the enumerated population of children aged zero to four years in the 2020 CPH.</p>
<p>3. Age heaping using Whipple's and Myers' Indices</p>	<p>Evidence of age heaping based on Whipple's' Index was observed for BARMM when evaluated in single ages. However, the region's age-sex pyramid in five-year age groups is smooth.</p>
<p>4. Digit Preference on Age Reporting using the UN Age-Sex Accuracy Index</p>	<p>No evidence of highly inaccurate digit preference on age reporting was observed in all regions across the country.</p>

The results of the 2020 CPH counts for each region served as the base population forwarded to the midyear population as of 01 July 2020. To compensate for the growth rate value derived by applying the inputs of the 2020 ASDRs, 2020 ASFRs, and the 2020 net number of migrants to the population as of 01 May 2020 by sex and age

group, the midyear population counts for each region was again adjusted to conform with the approved national population projections.

b. Fertility

Regional fertility trends from 2013 to 2022 were examined using various sources such as NDHS results, CRVS, and fertility results derived from the 2020 CPH. The regions were ranked based on each of the data sources (Table 3).

Table 3. Total Fertility Rate Trends from Various Data Sources: 2013-2022

Region	Total Fertility Rate									
	2013 NDHS	2016 CRVS	2017 CRVS	2017 NDHS	2018 CRVS	2019 CRVS	2020 CRVS*	2020 CPH P/F RATIO	2021 CRVS	2022 NDHS
Philippines	3.04	2.36	2.30	2.67	2.23	2.20	2.10	2.27	1.76	1.95
NCR	2.34	2.10	2.07	1.93	2.06	2.05	1.96	2.25	1.49	1.17
CAR	2.89	2.18	2.09	2.55	2.16	2.09	2.03	1.75	1.74	2.05
Region I	2.81	2.22	2.14	2.63	2.06	2.04	1.96	2.12	1.64	1.94
Region II	3.16	2.25	2.16	3.08	2.11	2.02	1.96	1.62	1.68	2.12
Region III	2.77	2.25	2.22	2.45	2.19	2.14	2.05	2.23	1.74	1.86
Region IV-A	2.69	2.21	2.14	2.58	2.11	2.05	1.96	2.05	1.62	1.85
MIMAROPA	3.64	2.53	2.44	2.89	2.39	2.31	2.22	2.70	1.87	2.44
Region V	4.09	2.98	2.87	3.19	2.78	2.72	2.61	2.43	2.19	2.17
Region VI	3.83	2.26	2.16	3.02	2.05	2.04	1.93	2.13	1.59	2.24
Region VII	3.19	2.61	2.56	2.52	2.43	2.43	2.30	2.55	1.88	1.96
Region VIII	3.52	2.66	2.47	3.12	2.37	2.40	2.28	2.16	2.01	1.97
Region IX	3.49	2.63	2.42	3.63	2.48	2.43	2.29	2.31	1.97	2.56
Region X	3.45	2.68	2.66	3.11	2.57	2.58	2.45	2.66	2.15	2.14
Region XI	2.93	2.51	2.40	2.66	2.36	2.31	2.21	2.59	1.85	1.80
Region XII	3.17	2.56	2.51	3.40	2.46	2.47	2.36	2.13	2.14	2.53
Caraga	3.65	2.56	2.49	3.02	2.45	2.44	2.31	2.28	1.98	2.34
BARMM	4.19	2.00	2.20	3.07	1.85	1.82	1.71	2.78	1.60	3.09

* Based on the average 2018-2020 CRVS-adjusted registered births

The regional rank based on the TFR from the 2018-2020 CRVS and the TFR from the 2022 NDHS were the basis of the criteria for selecting the baseline TFR for each of the regions (Table 4).

Table 4. Criteria for Selecting the Baseline TFR

Criteria	Source of Baseline TFR
1. The difference in the regional rankings is three or less ($D \leq 3$)	2020 CRVS*

2. The difference in the regional rankings is three or less ($D \geq 4$)	Average TFR of the 2022 NDHS and the 2020 CRVS*
3. If the <i>resulting TFR derived from the selected source of baseline TFR</i> is below the TFR from the 2022 NDHS	TFR from the 2022 NDHS

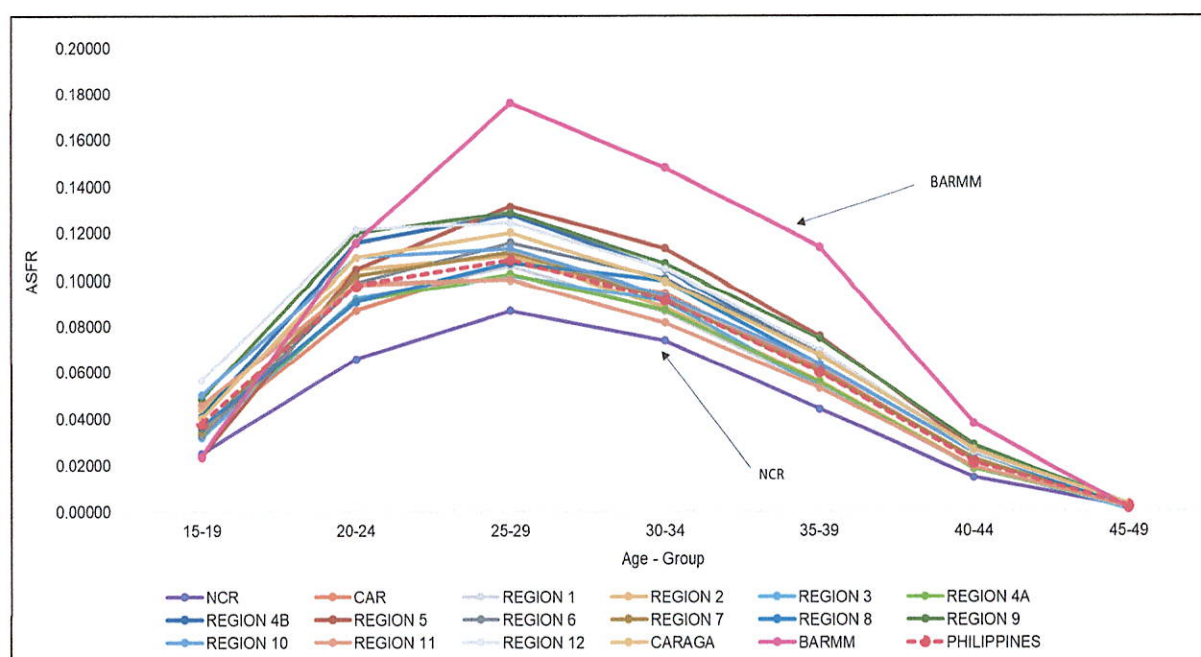
* Based on the average 2018-2020 CRVS-adjusted registered births

Adjustments to ASFRs for some regions were made due to irregular patterns while maintaining the baseline regional TFR. Table 5 indicates the baseline regional TFR selected, and Figure 1 shows the baseline regional ASFRs.

Table 5. Baseline Regional TFR: 2020

Region	Baseline TFR: 2020	Source
Philippines	2.10	CRVS 2020*
NCR	1.56	2022 NDHS and CRVS 2020*
CAR	2.05	2022 NDHS
Region I	1.96	CRVS 2020*
Region II	2.12	2022 NDHS
Region III	1.96	2022 NDHS and CRVS 2020*
Region IV-A	1.96	CRVS 2020*
MIMAROPA	2.44	2022 NDHS
Region V	2.39	2022 NDHS and CRVS 2020*
Region VI	2.24	2022 NDHS
Region VII	2.13	2022 NDHS and CRVS 2020*
Region VIII	2.12	2022 NDHS and CRVS 2020*
Region IX	2.56	2022 NDHS
Region X	2.29	2022 NDHS and CRVS 2020*
Region XI	2.00	2022 NDHS and CRVS 2020*
Region XII	2.53	2022 NDHS
Caraga	2.34	2022 NDHS
BARMM	3.09	2022 NDHS

* Based on the average 2018-2020 CRVS-adjusted registered births

Figure 1. Baseline Regional ASFRs: 2020

The projected regional TFRs for projection years 2021, 2022, and for every five-year projection period from 2025 to 2055 were ensured to be consistent with the projected national TFRs. Projecting the regional TFRs under Scenario 2 required regional baseline TFRs, baseline national TFR, and the projected national TFRs.

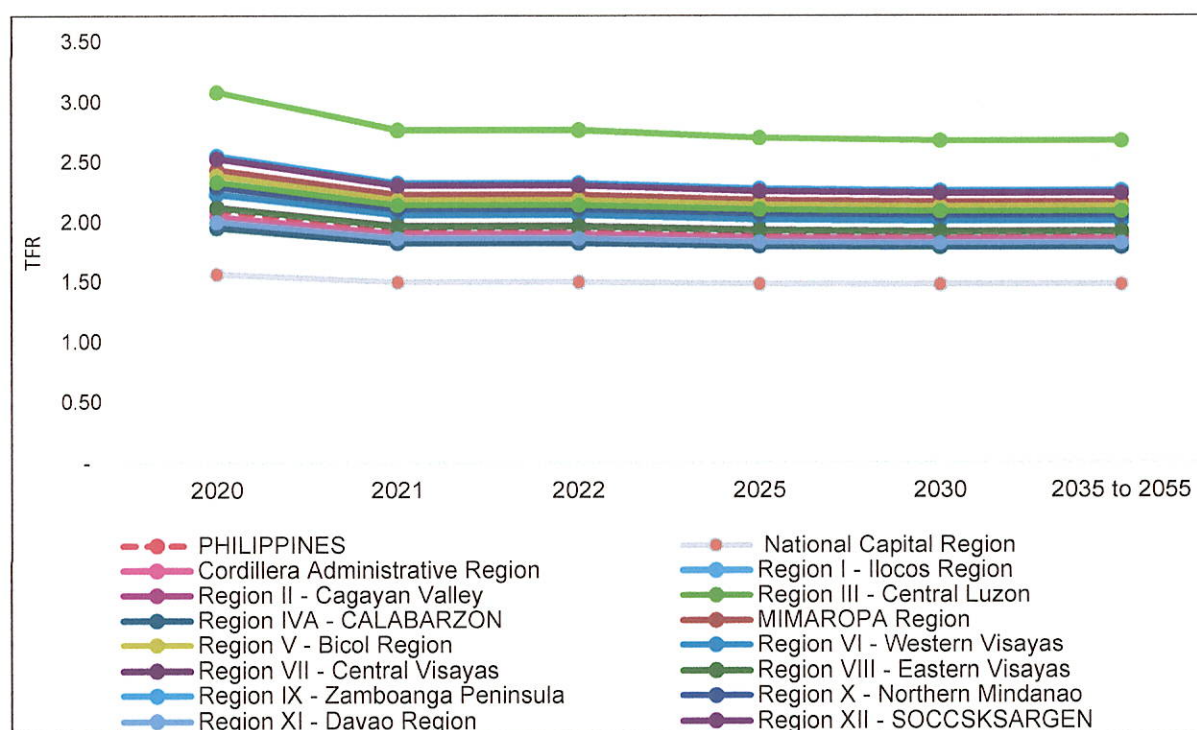
Similar to the previously approved methodology for the national population projections under Scenario 2, wherein the TFR will gradually decline from 2.1 in 2020 to 1.9 in 2021 until 2035, the regions will follow the same trend. Table 6 shows the baseline and projected regional TFRs from 2020 to 2050 and Figure 2 shows the pattern of TFR over the projection horizon.

Table 6. Baseline and Projected Regional TFRs: 2020-2050

Region	Baseline TFR: 2020	Projected Total Fertility Rates				
		2021	2022	2025	2030	2035 to 2050
Philippines	2.10	1.95	1.95	1.91	1.90	1.90
NCR	1.56	1.50	1.50	1.48	1.48	1.48
CAR	2.05	1.90	1.90	1.87	1.86	1.86
Region I	1.96	1.83	1.83	1.80	1.79	1.79
Region II	2.12	1.96	1.96	1.93	1.92	1.92
Region III	1.96	1.83	1.83	1.80	1.79	1.79
Region IV-A	1.96	1.83	1.83	1.80	1.79	1.79
MIMAROPA	2.44	2.23	2.23	2.18	2.17	2.16
Region V	2.39	2.19	2.19	2.15	2.13	2.13
Region VI	2.24	2.06	2.06	2.02	2.01	2.01

Region	Baseline TFR: 2020	Projected Total Fertility Rates				
		2021	2022	2025	2030	2035 to 2050
Region VII	2.13	1.97	1.97	1.93	1.92	1.92
Region VIII	2.12	1.97	1.97	1.93	1.92	1.92
Region IX	2.56	2.33	2.33	2.28	2.26	2.26
Region X	2.29	2.11	2.11	2.07	2.05	2.05
Region XI	2.00	1.87	1.87	1.84	1.83	1.82
Region XII	2.53	2.31	2.31	2.26	2.24	2.24
Caraga	2.34	2.14	2.14	2.10	2.09	2.09
BARMM	3.09	2.77	2.77	2.70	2.68	2.68

Figure 2. Baseline and Projected Regional TFR: 2020-2055



c. Mortality

The 2020 ASDRs from the national population projections were used as a model pattern of mortality along with the calculated level of infant mortality rate (IMR) per region to arrive at regional ASDRs and LEB by sex. The decision to use the 2020 ASDRs as spline of each region was informed by the assessment of CRVS data (adjusted for late registration and completeness) where findings indicated that estimates of ASDRs from the CRVS are erratic and inconsistent with the NDHS child mortality estimates.

Evaluation of the 2022 NDHS regional IMR estimates by sex showed that it was not robust due to small sample sizes and wide confidence intervals; hence, these cannot

be used as data inputs in projecting the baseline regional mortality rates. Instead, the following were used as data inputs:

1. National IMRs (both sexes, male, and female) for five years preceding the survey from the 2022 NDHS
2. National IMRs (both sexes, male, and female) for ten years preceding the survey from the 2013 NDHS
3. Average of IMRs (both sexes) per region from 2013, 2017, and 2022 NDHS

The 10-year IMR estimates by region from the 2013 NDHS were used instead of the five-year estimates because of the former's varying levels for both sexes, males, and females; whereas in the latter, IMR estimates in the 2013 NDHS were assumed to be implausible because the IMR for both sexes and males is the same (0.023), while the female IMR is 0.022.

With the calculated IMR per region and national 2020 ASDR from the national population projections, regional ASDRs, and baseline regional LEB were derived from the output life tables of the MATCH function of MortPak software. The baseline regional LEB were then used to project future regional LEB.

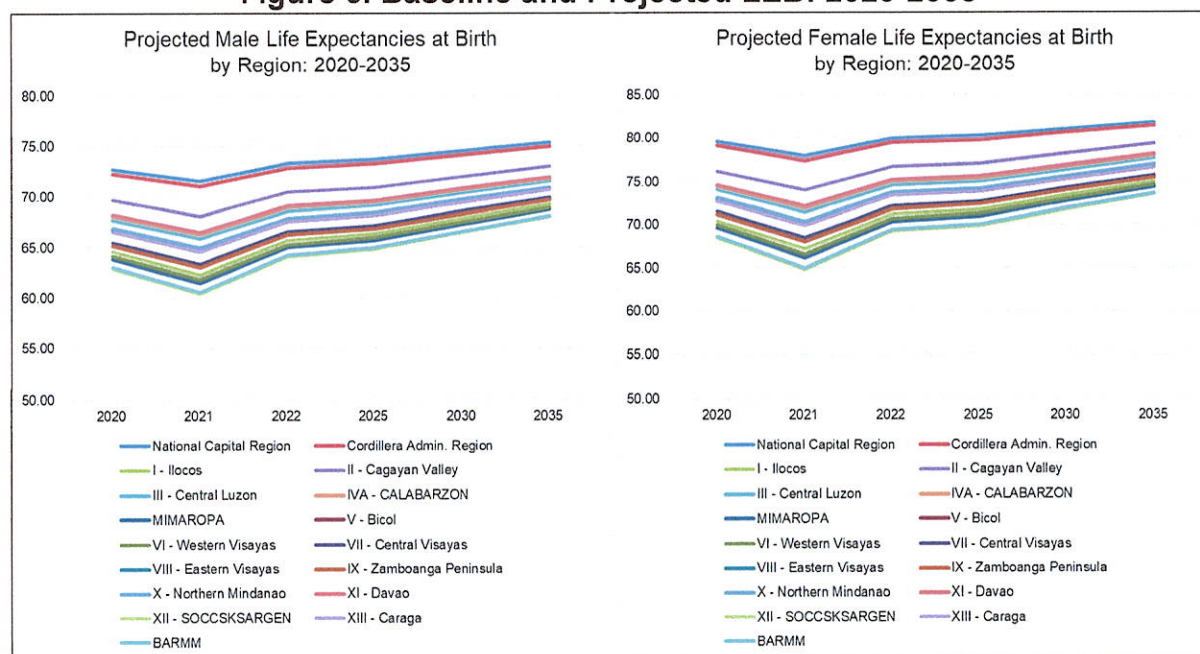
The projected regional LEB were used as input along with the baseline and projected national LEB estimates for 2020, 2021, 2022, 2025, 2030, and 2035 for population projections. Table 7 and Figure 3 summarize the baseline and endpoint LEB by sex for each region.

Table 7. Baseline and Endpoint Regional LEB (e_0) by Sex: 2020 and 2035

Region	Males		Females	
	2020 e_0	2035 e_0	2020 e_0	2035 e_0
Philippines	66.2	70.4	73.3	77.1
NCR	72.8	75.3	79.6	81.8
CAR	72.3	75.0	79.1	81.4
Region I	64.6	69.2	70.4	75.0
Region II	69.7	73.0	76.2	79.3
Region III	67.7	71.6	74.1	77.7
Region IV-A	68.1	71.8	74.4	77.9
MIMAROPA	63.8	68.7	69.6	74.3
Region V	66.6	70.7	72.7	76.7
Region VI	64.1	68.9	69.9	74.6
Region VII	65.5	69.9	71.5	75.7
Region VIII	66.7	70.8	72.9	76.8
Region IX	65.2	69.7	71.1	75.5
Region X	66.9	71.0	73.1	77.0
Region XI	68.2	72.0	74.6	78.1
Region XII	62.9	68.0	68.4	73.4

Region	Males		Females	
	2020 e_0	2035 e_0	2020 e_0	2035 e_0
Caraga	66.6	70.7	72.7	76.7
BARMM	63.0	68.1	68.6	73.6

Figure 3. Baseline and Projected LEB: 2020-2035



The mortality inputs used for the regional population projections were the regional ASDRs by sex for the year 2020, and the projected LEB by sex from 2021 to 2035.

d. Migration

Two migration inputs were used for the regional population projections.

1. Primary migration input – baseline and projected regional net number of international migrants by age group and sex
2. Secondary migration input – baseline and projected interregional NMRs by age group and sex

Primary migration was measured using the number of Filipino emigrants obtained from the Commission on Filipinos Overseas (CFO), while the number of immigrants was from the Bureau of Immigration (BI).

To derive the regional net number of international migrants by age group and sex from 2020 to 2035 as an input to be used for the primary migration in the projection of each region, the estimated 2020 net number of international migrants by age group and sex used in the generation of the national population projections were distributed to all regions following a proportionate allocation. The net number of international migrants for each region from 2020 to 2035 was obtained by:

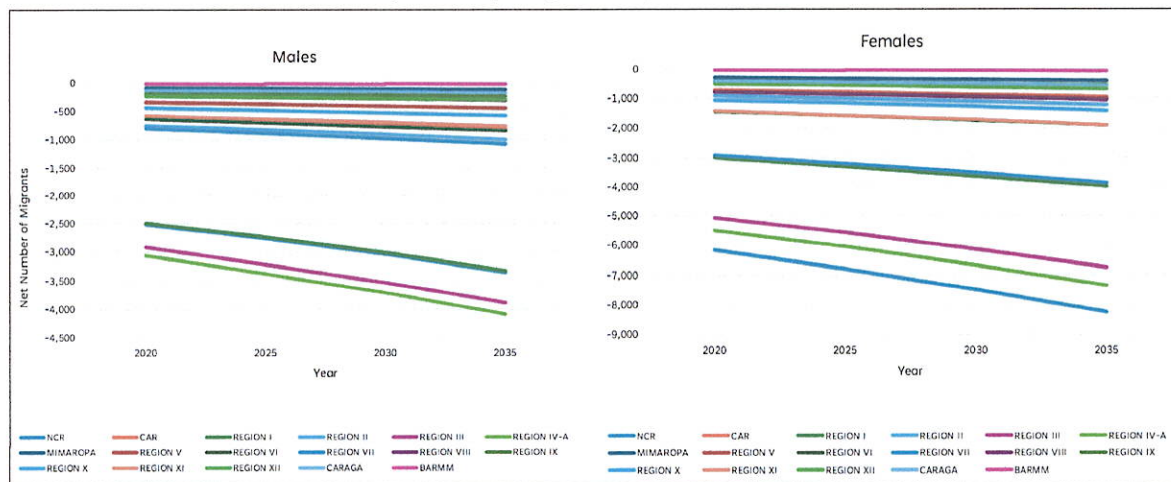
1. Estimating the proportion of immigrants and emigrants for every five-year projection period, and by sex from the total net migrants. The computed proportions are as follows:

Proportion of Immigrants to total net migrants:	0.13	Male: 0.75, Female: 0.25
Proportion of Emigrants to total net migrants:	1.13	Male: 0.39, Female: 0.61

2. Estimating the regional proportion to the net number of international migrants for the regional proportions and age-sex structure was based on the actual 2019 age-sex structure of the immigrants and emigrants.

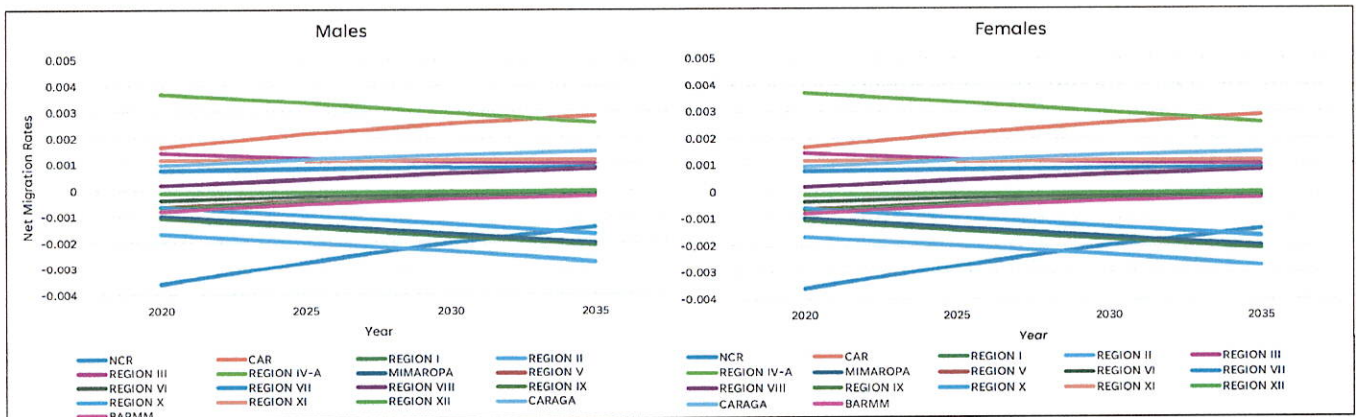
The resulting age-sex structure for the 2020 net number of international migrants was assumed to be consistent until 2035.

Figure 4. Baseline and Projected Net Number of International Migrants by Sex (Primary Migration): 2020-2035



Among the methodologies explored for the secondary migration inputs for the regional population projections, the methodology that stands out with the expected results was the utilization of the 2010 CBPP projected NMRs for 2020 to 2035. The projected NMRs during the 2010 CBPP round were for five-year periods (i.e., 2015-2020, 2020-2025, 2025-2030, and 2030-2035) and the annualized 2020, 2025, 2030, and 2035 NMRs were computed by dividing the NMRs by five.

**Figure 5. Baseline and Projected Interregional NMRs by Sex
(Secondary Migration): 2020-2035**



II. Provincial and Highly Urbanized City Level Population Projections

For the 2020 population projection round at the provincial and HUC level, a top-down approach was followed so that lower-level disaggregation outputs of population projections should sum up to the regional and national totals, considering that these figures are more reliable in terms of data and assumptions based on censuses, surveys, and administrative data than those at the lower geographic level. Therefore, the province and HUC levels of population projections should be adjusted to be consistent with the regional and national figures.

The 2020 CPH results for the province and HUC will serve as the base population. Provincial population projections will span from midyear 2020 to 2030, five years less than the regional population projections horizon as population projections' reliability tends to decrease in further years. HUCs were also treated as provinces in the 2020 CBPP in compliance with the PSA Board Resolution No. 01, Series of 2017 – 143, *Enjoining Major Statistical Agencies and Other Data Producers to Generate Separate Data for Highly Urbanized Cities*.

Two provincial census counts by sex were needed to serve as inputs in projecting the population at the provincial and HUC levels. Three options were evaluated using the results of various censuses of the population, and the provincial/HUC counts from the 2010 and 2020 CPH were selected.

Evaluation of the trends in the projected populations from 2025 to 2030 provided similar patterns of trajectories in most provinces. Further analysis showed that the 2010 and 2020 CPH provincial/HUC counts as inputs yielded the least number of provinces/HUCs with decreasing population projections. Hence, this option was ultimately used as the final input in calculating the provincial population projections.

Methodology

Using the 2010 and 2020 CPH results at the province/HUC level, the proportions of the province/HUC that constitute the regional population were calculated. The province/HUC proportions, together with the reference dates for the conduct of the censuses were used to derive the logistic growth rates¹. Below is the procedure and formula used to generate the provincial/HUC level of population projections.

1. Generate the total provincial/HUC population projections by sex from 2020-2030

- a. The provincial/HUC growth rate by sex was estimated using the logistic growth rate with the following formula:

$$GR_t = \frac{\ln \left\{ \frac{\left(\frac{1-PR_{2020}}{PR_{2020}} \right)}{\left(\frac{1-PR_{2020}}{PR_{2010}} \right)} \right\}}{-10}$$

where:

GR_t = logistic growth rate for each province/HUC at time t

PR_{2020} = proportion of the province/HUC to the regional population in 2020

PR_{2010} = proportion of the province/HUC to the regional population in 2010

\ln = natural logarithm

Data inputs:

1. Census population counts of province/HUC by sex from 2010 and 2020 CPH
 2. Projected regional population by sex for 2020-2030
- b. Projection of the province/HUC proportions to one or more future dates uses the calculated logistic growth rates:

$$PR_t = \frac{1}{1 + \left[\frac{1 - PR_{2020}}{PR_{2020}} \right] e^{-(t-2020)GR_t}}$$

¹ The SALGST workbook projects the total populations of subnational areas using a logistic function and controls projected subnational populations to a national or next level higher subnational projected population series. The resulting projections are consistent with the national or the next higher subnational totals.

where:

PR_t = projected proportion of the province/HUC to the regional population at time t

PR_{2020} = base proportion of province/HUC to regional population in 2020

GR_t = logistic growth rate of the province/HUC at time t

t = future year for projected population

Note: PR_t adjusted such that the sum of the projected proportions is equal to 1

- c. The total provincial/HUC population projection by sex is obtained by multiplying the regional population projection by the projected proportion of the province/HUC to the regional population projection, which is given as follows:

$$P_t = P_{r,t} * PR_t$$

where:

P_t = total population projection of province/HUC at time t

$P_{r,t}$ = total population projection of the region at time t

PR_t = projected proportion of province/HUC to the region at time t

2. Generate the total provincial/HUC population projections by age-sex from 2020-2030

The age-group distribution of province/HUC population projections by sex was estimated using the two-way raking process (also known as iterative proportional fitting and contingency table adjustment) to distribute the projected total populations of the provinces/HUCs into age groups by sex.

Data Inputs:

1. 2020 CBPP regional total population projections by age-sex distribution
2. 2020 CPH population counts by age-sex distribution at the province/HUC level
3. Total province/HUC population projections by sex from 2020-2030 as generated in step 1c

III. City/Municipality Level Population Projections

The city/municipality level population projections will also be adjusted to be consistent with the provincial-level totals. Note that since the population projections for highly urbanized cities were already generated as part of the province, the summary of the remaining cities and municipalities within the province will be included in this city/municipality level population projections, excluding HUC.

The 2020 CPH results for the city/municipality within the province, excluding HUC, will serve as the base population. The city/municipality level population projections will span from midyear 2020 to 2030, similar to the provincial/HUC level population projections.

Methodology

Similar to the province/HUC level, the 2010 and 2020 CPH results of population counts at the city and/or municipality level were utilized. The proportions of the city/municipality as the share of the provincial population were calculated. The logistic growth rates were derived using the city/municipality proportions and the reference dates of the censuses. To compute the logistic growth rate and the natural logarithm, the same formula with the province/HUC was used, replacing it with the city/municipality inputs.

To distribute the derived totals for the city/municipality level population estimates into the age-sex distribution, unlike the province/HUC, which derived the age-sex distribution using the PAS worksheet, the city/municipality level estimates did not use this worksheet due to the limitations on the number of cities/municipalities within the province that can be included in the PAS worksheet to operate the program.

Instead, an interpolation process was used to distribute the projected total populations of the cities/municipalities into five-year age groups until 85 years and over. These processes were performed for each projection year until 2030 by sex. To describe the procedure to derive the city/municipality estimates, below are the steps undertaken.

Steps:

1. Compute the proportion of males and females based on the 2020 CPH by city/municipality and five-year age group.
2. Multiply the computed proportions with the total city/municipality population projections to get the initial male and female population. In this step, the totals will conform to the total projected population of the province but do not conform yet to the age-sex distribution of the province. For example, the sum of the age group zero to four years of all cities and municipalities within a province is not equal to the age group zero to four years of that province.
3. Recompute for the adjustment to conform with the approved province-level population projections by age-sex distribution, using the totals of computed age-sex distribution at the city/municipality level versus the province-level population projections by age-sex distribution from the 2020 CBPP.