Regional Population Projections for Japan: 2010-2040
Overview of the Method
(Released in March 2013)

Introduction

We publicized the new population projection by region in March 2012. We projected population by age, sex and municipalities of Japan, except the municipalities in Fukushima Prefecture. Because of the Fukushima Daiichi nuclear disaster triggered by the 3/11 Great East Japan Earthquake in 2011, it was not admitted, if not impossible, to foresee the future geographical pattern of residents in Fukushima Prefecture. We decided to make use of the prefectural total population over municipalities as the single projection unit for Fukushima Prefecture.

The National Institute of Population and Social Security Research has conducted population projections of all Japan, prefectures and municipalities. However, the impacts of the Great East Japan Earthquake on reproduction and migration behaviors were extensively outspread over municipalities. Following the release of the population projection for Japan based on the 2010 Population Census, we conducted population projections for municipalities first in this time and the future populations by prefectures were obtained by totals of municipalities belonging to the corresponding prefecture. Note that the sum of populations over individual regions by age and sex reported here is consistent with the medium-variant fertility and medium-variant mortality projection results of the national projections (published in January 2011).

This paper summarizes the projection method and its implementation (i.e. assumption settings), and major results. We acknowledge that we utilized statistical tables made by the secondary use of questionnaire information collected for *Population Census of Japan* and *Vital Statistics of Japan* under Article 32 and Article 33 of the Statistics Act No. 53 of May 23, 2007.

An Overview of the Projection Method

1. Projection horizon and interval

The projection was conducted every five years for 30 years, starting from 2010 and ending in 2040.

2. Target municipalities and prefectures of the projection

The geographical units applied to the projection were comprised of 1,799 municipalities (23 Tokyo special wards, 128 wards in 12 major cities, 764 cities, 715 towns and 169 villages) by the

boundaries as of March 1st of 2013 and 1 prefecture (Fukushima). As noted above, the projection by municipality was not conducted but only prefectural population was projected for Fukushima Prefecture, because the future geographical pattern of population over municipalities in Fukushima Prefecture is too uncertain to make a projection as a consequence of the Fukushima Daiichi nuclear disaster triggered by the Great East Japan Earthquake. The 12 major cities in which their wards were taken as the unit of the projection were identified by the availability of data required for the projection as cities of Sapporo (Hokkaido), Sendai (Miyagi) Chiba (Chiba), Yokohama (Kanagawa), Kawasaki (Kanagawa), Nagoya (Aichi), Kyoto (Kyoto), Osaka (Osaka), Kobe (Hyogo), Hiroshima (Hiroshima), Kitakyusyu (Fukuoka) and Fukuoka (Fukuoka) where the name of the belonging prefecture is in parentheses.

3. The Method

A variant of a cohort component method was used for the projections. The cohort component method calculates future population by applying future vital rates to an age-specific population in a certain year. In the implementation of this method for the projection of the population of age 5 and above, survivorship rates and net migration rates are required. The cohort component method requires future age-specific fertility rates and future sex ratios at birth in addition to survivorship and net-migration rates for the projection of the population of age 0-4. However, because annual fertility rates by municipality fluctuate unstably, we accommodated a child-woman ratio and a sex ratio of the population of age 0-4. Hence, our projection requires setting: 1) initial populations, 2) future survivorship rates, 3) future net migration rates, 4) future child-woman ratios and 5) future sex ratios of age 0-4 populations.

Note that initially calculated results for populations in each municipality and Fukushima Prefecture by the cohort component method were adjusted so that the sums of population by age and sex over regions would conform to the national projection result (medium fertility and medium mortality). These adjusted results consistent with the national projection result (medium fertility and medium mortality) were reported in this paper. The flowchart for this projection is summarized in Figure 1.

4. Initial Population

The initial population used as the base of the projection was the population - total population including Japanese nationals and foreigners - by 5-year age group, sex and municipality as of October 1, 2010, according to the Final Report of the 2010 population census of Japan by the Statistics Bureau, Ministry of Internal Affairs and Communications. Note that the projection was conducted by the prefecture as a single projection unit for Fukushima Prefecture and the prefectural population in the census was used as the base for Fukushima.

For the municipalities which were consolidated after the date of the 2010 population census survey, initial population data were merged so as to agree with the boundary as of March 1, 2013, that defined the target municipalities of this projection. The population of unknown age was proportionately distributed to every 5-year age group by sex within each prefecture, and included in the initial population.

5. Setting Future Age-specific Survivorship Rates

In order to reflect the future trend of the national projection's survivorship-rate assumptions (medium mortality) on regional variation in mortality, we employ relative disparities of survivorship rates from the national levels by age group, sex and region, and used them to set the future survivorship rates for each region. Note that throughout the paper, we call ratios of measures at each region relating to the national mean relative disparities, or often simply disparities.

For ages of 55-59→60-64 and below, because regional differentials in mortality among municipalities are limited, we set future survivorship rates by prefecture and applied them to municipalities within each prefecture. Specifically, the life table for 2010 was constructed for each prefecture. Combined with life tables from *Prefectural Life Tables 2005* (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare), the survivorship ratios by age group, sex and prefecture for the period of 2005-2010 were calculated. Then, the relative disparity of the survivorship rates from the national level (medium mortality) was calculated by age group and sex for each prefecture. These relative disparities were assumed to diminish linearly such that the relative disparities compared with the national levels of the period from 2035 to 2040 would reach half the corresponding levels of relative disparity in the period from 2005 to 2010.

For ages of 60-64→65-69 and above, because municipal differentials in mortality among each prefecture are sizeable to an extent that they significantly affect to the result of population projections, we utilized relative disparities of municipalities from the belonging prefecture's survivorship rates. Specifically, the survivorship ratios by age group, sex and municipality for the period of 2000-2005 were calculated by ${}_nL_x$ functions in *Municipal Life Tables 2000* and *Municipal Life Tables 2005* (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare). In the same time, the survivorship rates of prefectures to which each municipality belonged were calculated based on *Prefectural Life Tables 2000* and *Prefectural Life Tables 2005*. Then, the relative disparities of the municipal survivorship rates from the host prefecture were computed by these figures. Similar to the method employed to set survivorship rates for ages of 55-59→60-64 and below, we set future municipal survivorship rates assuming the relative disparities are kept constant from 2000-2005 to 2035-2040.

Finally, we took the effect of the Great East Japan Earthquake on the survivorship rates for 2010~2015 into account. Specifically, the number of cohort deaths caused by the Great East Japan Earthquake reported in *Vital Statistics of Japan 2011* (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare) was used to calculate extra death rates in Iwate, Miyagi and Fukushima Prefectures. Because the survivorship rates set above were meant as if the disaster would not happen, the extra death rates were subtracted from the survivorship rates in the municipalities concerned in Iwate and Miyagi Prefectures and in Fukushima Prefecture.

6. Setting Future Net Migration Rates by Age and Sex

The net migration rate refers to an excess rate of in- migrants over out-migrants to the regional population. Specific patterns and regularities behind them are not easily conceived for the time series of regional net migration rates by age and sex, given that the socio-economic conditions of the nation and each region at each period considerably affect the migration behaviors. Hence, concerning the consistency in the final projection results with the results for the national projection, we decided to reflect the general trend of the whole nation. According to *Report on Internal Migration in Japan Derived From the Basic Resident Registers*, the regional variation in the number of the net migration has been on a downward trend after 2007. Thus, in principle, we assumed that the intercensal estimates of net migration rates by age group, sex and municipality observed between the 2005 census and 2010 census would continue to decline until the period of 2015-2020. After the period of 2015-2020, we assumed that the reduced rates remained constant until 2035-2040.

There are three types of exceptional regions. First, for some municipalities in Iwate, Miyagi and Fukushima prefectures and in the Kanto region (including Tokyo, Kanagawa, Saitama, Gunma, Tochigi, Ibaraki and Chiba prefectures) where the Great East Japan Earthquake in 2011 caused severe damages, the patterns in the net migration were altered after the survey of population census 2010. We set net migration rates reflecting the latest figures. Second, for municipalities where the patterns of the net migration had changed for 2005-2010 compared to the patterns in the past, we made net migration assumptions consistent with the past patterns observed in censuses before 2005 and local conditions around the municipality concerned. Other than these, for municipalities of small population sizes so that the net migration rates unstably fluctuated, we aggregated the number of the net migrants through five periods from 1985-1990 to 2005-2010 to set the future net migration rates in terms of long-run average levels in the region.

7. Setting Future Child-Woman Ratios

The child-woman ratio refers to the average number of age 0-4 population per age 15-49 women in a region. We utilized age and sex specific population of the national projection result (medium fertility and medium mortality scenario) to set the future child-woman ratios. Specifically, because there are apparent municipal differentials in the child-woman ratios, we calculate relative disparities of the municipal child-woman ratio to the national ratios in 2010 and we set the future municipal child-woman ratios assuming that the relative disparities kept constant from 2010 to 2040. A similar method was employed for Fukushima prefecture.

There are a few municipalities where the child-woman ratios in 2010 were distorted from the past patterns and developments of the ratios. For these municipalities, we calculated average child-woman ratios of 1995, 2000 and 2005, and set the future ratios keeping the average ratios constant for 2015-2040.

8. Setting Future Sex Ratios of Age 0-4 Population

Sums of male and female population of age 0-4 were projected based on the assumptions on the future child-woman ratios set in 7. above. We need sex ratios of age 0-4 population to divide them into male and female.

For the sake of simplicity, given the limited variation in the sex ratio of the youngest population, we calculate the sex ratios of the age 0-4 population from the national projection result (medium fertility and medium mortality scenario) over the projection horizon. We applied the sex ratios of the level at the national average to all municipalities.

Figure　Procedure of Regional Population Projection by the Cohort Component Method