

$$P_{i,s,g}^{m+1} = P_{i,s,g}^m + N_{i,s,g}^m - D_{i,s,g}^m$$

For $m = 1, 2, \dots, 122$ it being $m = 1$ the first period corresponds to 1 January 1971 and $m = 122$ the second to last period that corresponds to 1 February 1981, for the Intercensus period from 1971 to 1981.

For $m = 1, 2, \dots, 120$ it being $m = 1$ the first period that corresponds to 1 March 1981 and $m = 120$ the second to last period that corresponds to 1 February 1991, for the Intercensus period from 1981 to 1991.

And for $m = 1, 2, \dots, 128$ it being $m = 1$ the first period corresponding to 1 March 1991 and $m = 128$ the second to last period corresponding to 1 October 2001, for the Intercensus period from 1991 to 2001.

Where:

$P_{i,s,g}^m$ is the population resident in the province i , of sex s and year of birth g on the first day of the month m . We will consider the first population coinciding with the census at the beginning of the period, i.e., $P_{i,s,g}^1 = P_{i,s,g}^{Censo\ inic}$, so that the first population to be estimated is $P_{i,s,g}^2$.

$N_{i,s,g}^m$ are the births to women resident in the province i , of sex s and year of birth g occurring throughout the month m .

$D_{i,s,g}^m$ are the deaths of residents in the province i , of sex s and year of birth g occurring throughout the month m .

3.2 2001-2011 PERIOD

An account of the demographic events occurring (births, deaths, migrations and acquisitions of Spanish nationality) between 1 November 2001 and 31 December 2011¹³ establishes the population for each sex, year of birth, country of nationality and country of birth, resident in Spain, in each Autonomous Community and in each province (islands, in the island provinces) at 1 January 2012, using the population figures for each of those breakdowns provided by the 2001 Population Census. To this end, we proceed, successively, according to the following equations:

$$P_{h,s,g,España,j}^{m+1} = P_{h,s,g,España,j}^m + N_{h,s,España,j}^m - D_{h,s,g,España,j}^m + I_{h,s,g,España,j}^m - E_{h,s,g,España,j}^m + I_{h,s,g,España,j}^m - E_{h,s,g,España,j}^m + \sum_i Nac_{h,s,g,i,j}^m$$

If $i \neq España$

¹³ Although the reference date for the 2011 Census is 1 November, 2011, it was decided to estimate the populations for two more months, within the scope of the Intercensal Estimates for the decade 2001-2011, in order to reach the reference date of 1 January, 2012 and thus fix this population.

$$P_{h,s,g,i,j}^{m+1} = P_{h,s,g,i,j}^m + N_{h,s,i,j}^m - D_{h,s,g,i,j}^m + I_{h,s,g,i,j}^m - E_{h,s,g,i,j}^m + Ii_{h,s,g,i,j}^m - Ei_{h,s,g,i,j}^m - Nac_{h,s,g,i,j}^m$$

Where:

$P_{h,s,g,i,j}^m$ is the population resident in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j on the first day of the month m . We will consider the first population coinciding with the census at the beginning of the period, i.e., $P_{h,s,g,i,j}^1 = P_{h,s,g,i,j}^{Censo\ inic}$, so that the first population to be estimated is $P_{h,s,g,i,j}^2$.

$N_{h,s,i,j}^m$ are the births to women residence in the province (island, in the case of the island provinces) h , of sex s , country of nationality i and country of birth j occurring throughout the month m .

$D_{h,s,g,i,j}^m$ are the deaths of persons resident in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$I_{h,s,g,i,j}^m$ are the immigrations from abroad in province (island, in the case of the island provinces) h , of persons of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$E_{h,s,g,i,j}^m$ are the emigrations abroad of persons residents in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$Ii_{h,s,g,i,j}^m$ are the immigrations from the rest of Spain in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$Ei_{h,s,g,i,j}^m$ are the emigrations with destinations in the rest of Spain in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$Nac_{h,s,g,i,j}^m$ are the acquisitions of Spanish nationality of persons resident in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

For $m = 1, 2, \dots, 120$ being $m = 1$ the first period corresponding to November 2001 and $m = 120$ the second to last period corresponding to October 2011, for the Intercensus period from 2001 to 2011.

3.3 2011-2021 PERIOD

The accounting of demographic events described for the previous periods is already systematically collected for this period in the operation Population Figures.

Population Figures Statistical operation

The Population Figures operation began to be published in June 2013, with data from 1 July, 2012 (in addition to including the entire previous intercensal series up to 1 January, 2012). It is published for the last time in December 2022, at which time the 2021 Census is already published. From then on, the Population Figures operation will be replaced by the Population Continuous Statistics, which will contain all the intercensal estimates until 1 January, 2021, and from then on, the provisional population estimate, which will become definitive when a new census is published, starting in 2023 on an annual basis.

Population figures were calculated as of 1 January and 1 July of each year, disaggregated by sex, year of birth, age, nationality and country of birth. They were derived from the Population Figures at the beginning of the previous six-month period (or the results of the Intercensal Population Estimates as of 1 January, 2012, in the starting year) and the demographic phenomena that occurred during that six-month period. These demographic phenomena were obtained, as mentioned above, from previously elaborated statistical operations, such as the Vital Statistics on Births and Deaths, the Migration Statistics and the Statistics on the Acquisition of Spanish Nationality of Residents.

Thus, to obtain the population on 1 July of year t , the population on 1 January of year t was taken as the starting point and the demographic phenomena that occurred in the first half of that year were applied; to obtain the population on 1 January of year $t+1$, the population on 1 July of the previous year (t) was taken as the starting point and the demographic phenomena that occurred in the second half of year t were applied.

The calculation method was the component method described in the previous section, with the difference that the calculations were made semi-annually instead of monthly, and they started on 1 January, 2012 (as an extrapolation of the 2011 Census).

This guaranteed the total consistency of the information on demographic flows and population stocks at all territorial levels considered, as well as compliance with the compensating equation, which states that the final population of a period is formed by the initial population, after applying (adding or subtracting, as the case may be) the demographic phenomena that occurred during that period.

From the figures resulting from this process, the figures by age are derived under the hypothesis of uniform distribution of the incidence of each phenomenon in each generation among the exact ages that the individuals of each generation will have at some time during the year.

Correction of the population aged 100 and older

In June 2017, a correction was applied on the Population Figures as of 1 January, 2016 for ages 100 and over, based on improvements in the links of the census with the historical death files and with various administrative records. The Population Figures published thereafter contained this correction, which was integrated with

the calculation process and applied to the population that became 100 years old in each period. This implied the need to introduce a small adjustment item to explain the increase in population as the sum of its components (births, deaths, immigration, emigration and adjustment).

From the intercensal period 2012 - 2021, the populations aged 100 years and over for the period 2012 to 2015, both ends on 1 July, remained uncorrected. For this reason, in the context of calculating the Intercensal Population Estimates, these populations have first been corrected.

For this purpose, the prospective probabilities of passage corresponding to the 2016 mortality tables were calculated and applied to the populations of the previous period, differentiating males and females, linking them backwards so that they gradually reached the population values of 2012.

4 Adjustment to population Censuses. Final Result

As a result of the accounting of demographic events occurring after the first census of each period (already integrated in the operation Population Figures for the intercensal period 2011-2021), resident population figures are obtained in Spain, in each autonomous community and in each province (and island, in the island provinces) on the reference date of the second census of said intercensal period, with a certain degree of disaggregation in each period.

Said figures differ from those provided by the 2011 Population Census, with the difference being attributable either to overestimation or underestimation errors of the respective or to errors in the measurements of the demographic events occurring in the period between the reference dates thereof. Because of the impossibility to determine the cause of such difference, a population stocks adjustment, derivatives for every Intercensus period to the Census results of 1981, 1991, 2001, 2011 and 2021 respectively, is carried out through a uniform distribution of said difference for each breakdown level considered, in each reference date of the four Intercensus periods.

Each intercensal period has a different number of months (or semester) to estimate, depending on the census reference date implicit in each section, which implies a different adjustment process for each period.

Although in some periods the calculation of intercensal populations is made by month, the published series has as reference dates 1 January and 1 July of each year.

4.1 1971-1981 PERIOD

It is determined by:

$P_{i,s,g}^{1-3-1981}$ the population figure of resident population in province i , of sex s , and year of birth g on 1 March 1981, according to the result described in section 3 of this document.

$\hat{P}_{i,s,g}^{1-3-1981}$ the population figure according to the 1981 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{P}_{i,s,g}^{1-3-1981} - P_{i,s,g}^{1-3-1981}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from January 1971 to February 1981, yielding the following:

– For $g \leq 1970$:

$$d_{i,s,g}^{m+1} = \frac{m}{122} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 122$$

– For $g = 1971, 1972, \dots, 1981$:

$$d_{i,s,g}^{m+1} = \frac{m - (12(g - 1971))}{122 - (12(g - 1971))} D_{i,s,g}, \text{ for } m = 122 - 12(g - 1971), \dots, 122$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 3, is replaced by

$$P_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$$

4.2 1981-1991 PERIOD

It is determined by:

$P_{i,s,g}^{1-3-1991}$ the population figure of resident population in province i , of sex s , and year of birth g on 1 March 1991, according to the result described in section 3 of this document.

$\hat{P}_{i,s,g}^{1-3-1991}$ the population figure according to the 1991 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{P}_{i,s,g}^{1-3-1991} - P_{i,s,g}^{1-3-1991}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from March 1981 to February 1991 (120 months), yielding the following:

– For $g \leq 1981$

$$d_{i,s,g}^{m+1} = \frac{m}{120} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 120$$

– For $g = 1982, 1983, \dots, 1991$:

$$d_{i,s,g}^{m+1} = \frac{m-(12(g-1982)+10)}{120-(12(g-1982)+10)} D_{i,s,g}, \text{ for } m = 120 - (12(g - 1982) + 10), \dots, 120$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 3, is replaced by

$$P_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$$

4.3 1991-2001 PERIOD

It is determined by:

$P_{i,s,g}^{1-11-2001}$ the figure of resident population in province i , of sex s , and year of birth g on 1 November 2001, according to the result described in section 3 of this document.

$\hat{P}_{i,s,g}^{1-11-2001}$ the population figure according to the 2001 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{P}_{i,s,g}^{1-11-2001} - P_{i,s,g}^{1-11-2001}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from March 1991 to October 2001, (128 months), yielding the following:

– For $g \leq 1991$:

$$d_{i,s,g}^{m+1} = \frac{m}{128} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 128$$

– For $g = 1992, 1993, \dots, 2001$:

$$d_{i,s,g}^{m+1} = \frac{m-(12(g-1992)+10)}{128-(12(g-1992)+10)} D_{i,s,g}, \text{ for } m = 128 - (12(g - 1992) + 10), \dots, 128$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 3, is replaced by

$$P_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$$

4.4 2001-2011 PERIOD

It is determined by:

$P_{h,s,g,i,j}^{1-11-2011}$ the figure for the population resident in province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j on 1 November 2011, according to the calculation described in section 3 of this document.

$\hat{P}_{h,s,g,i,j}^{1-11-2011}$ the population figure according to the 2001 Population Census.

The difference is then:

$$D_{h,s,g,i,j} = \hat{P}_{h,s,g,i,j}^{1-11-2011} - P_{h,s,g,i,j}^{1-11-2011}$$

The difference $D_{h,s,g,i,j}$ is distributed uniformly in each month of the period from March 1981 to February 1991 (120 months), yielding the following:

– For $g \leq 2001$:

$$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{120} \text{ and the figure } P_{h,s,g,i,j}^{m+1} \text{ resulting from point 3, is replaced by } P_{h,s,g,i,j}^{m+1} + m \cdot d_{h,s,g,i,j}^m, \text{ for } m = 1, \dots, 120.$$

– For $g = 2002, 2003, \dots, 2011$:

$$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{120 - (12 \cdot (g - 2002) + 2)} \text{ and the figure } P_{h,s,g,i,j}^{m+1} \text{ resulting from point 3, is replaced by } P_{h,s,g,i,j}^{m+1} + (m - (12 \cdot (g - 2002) + 2)) \cdot d_{h,s,g,i,j}^m, \text{ for } m = 120 - (12 \cdot (g - 2002) + 2), \dots, 120.$$

Note: the 2001-2011 intercensal estimates are extrapolated forward using the same method, to end two months beyond the 2011 census and thus arrive at the reference date of 1 January, 2012. For this purpose, the 2011 census is used as a starting point and the demographic phenomena corresponding to the months of November and December 2011 are applied. This is why it is sometimes said that the next intercensal period is 2012-2021, instead of 2011-2021.

Lastly, with the population figures, according to year of birth, obtained for each date, province and population group, the figures have been derived by age, under the hypothesis of uniform distribution of the birthday of the individuals of each generation throughout the year.

4.5 2012-2021 PERIOD

It is determined by:

$P_{h,s,g,i,j}^{1-1-2021}$ the figure for the population resident in province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j on 1 January 2021, according to the calculation described in section 3 of this document.

$\hat{P}_{h,s,g,i,j}^{1-1-2021}$ the population figure according to the 2021 Population Census.

The difference is then:

$$D_{h,s,g,i,j} = \hat{P}_{h,s,g,i,j}^{1-1-2021} - P_{h,s,g,i,j}^{1-1-2021}$$

The difference $D_{h,s,g,i,j}$ is distributed uniformly over each six-month period from 1 January, 2012 to 1 January, 2021 (18 six-month periods), yielding the following:

- For $g \leq 2011$:

$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{18}$, and the figure $P_{h,s,g,i,j}^{m+1}$ resulting from point 3, is replaced by $P_{h,s,g,i,j}^{m+1} + m \cdot d_{h,s,g,i,j}^m$, for $m = 1, \dots, 18$, where now m refers to semesters instead of months, but is left as m for uniformity in notation.

- For $g = 2012, 2013, \dots, 2020$:

$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{(2021-g)*2}$ and the figure $P_{h,s,g,i,j}^{m+1}$ resulting from point 3, is replaced by $P_{h,s,g,i,j}^{m+1} + m \cdot d_{h,s,g,i,j}^m$, for $m = (t - g) * 2$, if it is January and $m = ((t - g) * 2) + 1$, if it is July, where t is each year of the estimated period, $t = 2012, \dots, 2020$.

In addition, as of 1 July, 2012, these results have been rounded off to offer the entire series as of that date without decimals.

Lastly, with the population figures, according to year of birth, obtained for each date, province and population group, the figures have been derived by age, under the hypothesis of uniform distribution of the birthday of the individuals of each generation throughout the year.