university of groningen

faculty of spatial sciences

# Population projection of Stad & Lande

## A disquisition of demographic scenarios to 2053


**Abstract**

Population projections are most often focused on the national level and scarcely use a subnational perspective. This research is an exception to the rule whereby the province of Groningen in the Netherlands was taken as the research region. The province is divided into two parts: the urban municipality of Groningen and the other rural municipalities. Separate population projections were performed for both regions using the cohort component method. The future development of the components of demographic change (fertility, mortality, internal migration, and international migration) is based on various methods including convergence and OLS simple regression. Based on these results, three different scenarios have been created: minimum, realistic, and maximum. The results show that the unique population structure (many young adults) of the municipality of Groningen will be maintained in the future. The dependency ratios will increase but only modestly. The opposite is the case in the other municipalities, where there will be a strong ageing population. The youth dependency ratio will remain stable, while the old-age dependency will increase sharply over the next two decades, and ultimately stabiles in the middle of the century. Both regions taken as a collective indicate that the province of Groningen as a whole will retain the relatively large share of young adults and that the share of elderly people will increase sharply in the future.



**Student**: Ewoud Jansma (S4451961)

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**Thesis supervisor**: Prof. dr. Leo van Wissen



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## 1. Introduction

The population of the Netherlands has increased rapidly over the past two centuries from two million to almost eighteen million (Sonsbeek et al., 2023). Over the past two centuries, the death rate decreased, followed by the fertility rate. This process, in which a country shifts from high birth and high death rates to low birth and low death rates, is referred to as 'demographic transition' (Weeks, 2020). This process is accompanied, among other changes, by an 'age transition': increasing life expectancy combined with the decreasing birth rate results in a shift from a predominantly younger to a predominantly older population. Today in the Netherlands, birth and death numbers are virtually equal. In every province in the Netherlands, the fertility rate in 2022 was 1.49, or well below the replacement level of 2.1 children per woman (CBS StatLine, 2023a). Yet the population of the Netherlands is still growing. This is mainly caused by high immigration numbers. Although the population is growing at a national level, there are at the same time large differences in demographic developments within the regions of the Netherlands.

Young adults are increasingly moving from the edges of the Netherlands to the Randstad or cities beyond for work or study (CBS, 2016). Furthermore, many people in their thirties continue to live in these urban areas and have children in these places. This outflow has an amplifying effect on the ageing population at the border regions (*randgemeenten*) of the Netherlands. In border municipalities such as Westerwolde (Groningen), Gulpen-Wittem (Limburg), and Sluis (Zeeland), more than a quarter of the population consists of people over the age of 65 years (CBS, n.d.[a]). Moreover, the population is shrinking on the edges of the Netherlands (CBS, n.d.[b]). This concerns large parts of the north (Drenthe, Friesland, and Groningen), the Achterhoek, South Limburg, and Zeeland. On the other hand, population growth is taking place in and around large cities in the Randstad and cities such as Amersfoort, Arnhem, Eindhoven, Groningen, Haarlem, and Zwolle.

An ageing population has implications for resource allocation. When people reach retirement age they are considered as 'dependent', less productive or non-productive, and recipients of pensions and other state support (Gould, 2015). Ageing will cause a decline in labour supply and a decline in economic growth, while government expenditure and healthcare demand will rise at the same time (Sonsbeek et al., 2023). Every individual of working-age (typically those aged 15 to 64) must support more dependents if the relative share of people over the age of 65 years increases (Weeks, 2020). Population projections can help to anticipate these issues.

A population projection is a calculation of the expected number of individuals, classified by age and sex, at various time intervals after a census or other initial reference point (Keyfitz, 1977). The Central Bureau of Statistics (CBS) carries out three long-term projections: the Population Forecast, the Key Population Forecast, and the Household Forecast (CBS, n.d.[c]). The Population Forecast concerns the size and composition of the Dutch population until 2070, the Key Population Forecast only concerns the population and population flows (births, deaths, immigration, and emigration) by age and sex and the Household Forecast reports the development of the number of households by type and of the number of inhabitants by household position. In addition, the CBS makes a Regional Forecast of the number of inhabitants and households per municipality for the medium term in collaboration with the Netherlands Environmental Assessment Agency (PBL). Finally, CBS has also written a recent report in collaboration with the Netherlands Interdisciplinary Demographic Institute (NIDI) on the consequences of demographic changes on education, work, care, and housing (Beer et al., 2021).

Although these population projections help provide insight into the expected demographic trends in broad terms, the focus is often placed on the national level and the national context. Relatively little attention is paid to specific regions. The Regional Forecast and the Household Forecast, as already mentioned, do attend to regional diversity in demographic developments. However, it is relatively limited in analytical approach: general trends are explained descriptively, but different scenarios are not discussed in depth. This thesis aims to contribute to current knowledge by adopting a regional perspective when analysing future demographic scenarios.

The province of Groningen is an excellent candidate. Groningen is interesting because the province can be divided into two separate regions in terms of demographic composition and development: the municipality of Groningen and the other municipalities. The municipality of Groningen contains the city of Groningen, giving it by far the largest total population of all municipalities in the province. In 2022, the population size was 234,950, or 40% of the total population of the province (CBS StatLine, 2023b). The other municipalities have populations between 12,196 (Pekela) and 64,306 (Westerkwartier) and together represent the remaining 60% of the total population of the province. The relative share of those aged 65 years and older in the other municipalities varies from 39% (Westerkwartier) to 49% (Westerwolde), while the share is significantly lower in the municipality of Groningen: 22.9%. The other municipalities have relatively homogeneous populations, with an average of 88% of the population having no migration background. The municipality of Groningen, on the other hand, is more diverse: 26%

of its residents have a migration background. Furthermore, the municipality of Groningen saw an increase in population size every year from 2015 to 2022, while all other municipalities experienced a population decline in at least one year in the same period. Finally, as a student city, the city of Groningen attracts many young people to come and study there from large parts of the Northern Netherlands. However, a large proportion of young people leave for work in the major cities of the Randstad after completing their studies (CBS, 2017).

In addition to current challenges, the two regions of the province of Groningen also face several future challenges. The Dispersal Law (*spreidingswet*), a law that obliges each municipality to accommodate a certain number of refugees, was approved by the Senate (*Eerste Kamer*) and can have enormous consequences for the municipality of Westerwolde. The municipality only has to accommodate 131 asylum seekers instead of the more than 2,000 people who are currently being accommodated after the introduction of the law (NOS, 2024). Furthermore, Dutch universities are taking measures to control the influx of foreign students (Puylaert, 2024). This will have implications for the influx of foreign students to the municipality of Groningen. For example, in the academic year of 2021-2022, approximately a quarter of first-year students in higher education were international and the share at universities was even almost 40% (CBS, 2022a). In the case of the University of Groningen, the total share of international students of the entire student body is 27% (RUG, 2023). In addition, it is very likely that the next cabinet, in which the largest party is committed to reducing immigration figures, will implement policy measures that will severely limit the immigration flow from the Netherlands as a whole.

In short, the province of Groningen is confronted with various demographic challenges that differ per region. Due to the contrast between the two regions, it is necessary to make a distinction when analysing future demographic scenarios for the province of Groningen. This will provide a more accurate picture of expected demographic outcomes for the two divergent regions and provide more appropriate policy recommendations. The main question of the thesis is: *What are the possible demographic future scenarios that the province of Groningen can expect until 2053?* The operationalisation of the main question is logically split into two, creating two separate populations projection of the two distinct regions of the province of Groningen. The synthesis of both population projections provides the answer to the main question.

The thesis continues with a discussion of the relevant literature on population projections. The subsequent segment highlights which data is put into use, and which method and assumptions are applied. The results section is divided into two parts, where the first part focuses on historical trends and the second part focuses on possible future scenarios. The findings are summarised in the conclusion and the thesis ends with a discussion. The discussion reflects on the additions and limitations of the research. In addition, suggestions are made for further research, and policy measures are recommended that can assist the province and municipalities.

## 2. Theoretical framework

The development of a population in a specific period of a given geographical area depends on three key determinants: the number of births, deaths, and the net number of migrants (the inflow minus the outflow of individuals). This principle is made clear in the 'demographic balancing equation' below:[1]

$$N[t+n] = N[t] + B[t,t+n] - D[t,t+n] + I[t,t+n] - O[t,t+n]$$

where $n$ specifies the length of the projection interval, $N[t+n]$ concerns the population size at the end of the projection interval, $N[t]$ indicates the population size at the start of the projection interval, $B[t,t+n]$ refers to the number of births that take place within the projection interval, $D[t,t+n]$ indicates the number of deaths within the projection interval and finally $I[t,t+n]$ *concerns* the in-migration and $O[t,t+n]$ the out-migration within the projection interval.

Typically, population projections use the sex- and age-specific population numbers at a specific point in time as the starting population. From this, the population is calculated for the future, whereby estimates are made for future developments in fertility, migration, and mortality (Vanella et al., 2020). However, the three drivers of demographic change do vary in terms of their predictability (Petropoulos et al., 2022). Mortality, a biological process moderated by medical technology, is the most predictable. Fertility, which is determined by both biological and behavioural factors, is in the middle, and migration, a social and behavioural process, is the least predictable. Recent examples of this are the decline in the immigration rate of the Netherlands due to the COVID-19 pandemic or its sharp increase due to the inflow of Ukrainian refugees (Stoeldraijer et al., 2023).

Several approaches can be used to predict the components of demographic growth. These can be placed into three main categories: expectation, explanation, and extrapolation (Booth, 2006). The expectation approach uses subjective opinions of experts and in the context of mortality, for example, a certain mortality target is set (Petropoulos et al., 2022). Often, expert judgment is based on a combination of current mortality rates, historical mortality trends, and a variety of lifestyle, medical, technological, and socioeconomic factors that could cause mortality rates to change in the future Smith et al., 2013). An advantage of this approach is that many different relevant information can be included in the prediction (Petropoulos et al., 2022).

[1] The demographic balancing equation is stated in different ways, but they all boil down to the same principle. The current comparison is a synthesis of Preston et al. (2001) and the UN (2022).

On the other hand, the subjective nature of the approach means that it can only deliver scenario-based predictions as a result.

The explanatory approach attempts to explain demographic processes using structural models based on theories that relate demographic units to other variables (Booth, 2006). The advantage of this approach is that feedback mechanisms and limiting factors can be taken into account. However, the risk of model misspecification is high due to a lack of robust theoretical foundations. The use of structural models is considered the ideal, yet it has generally not produced more accurate predictions. The ability to capture turning points or structural changes, the theoretical advantage of the approach, has not often been realised.

Finally, the most common approach in demographic projections is the extrapolation approach (Booth, 2006). Extrapolative methods assume that the future will be, to some extent, a continuation of the past. In the case of mortality projections, the method is considered more objective and user-friendly and is likely to provide better prediction accuracy than the other two approaches (Petropoulos et al., 2022). However, when long-term trends are lacking or there is no solid basis for predicting turning points, extrapolative methods will be risky (Smith et al., 2013). Furthermore, historical trends may not be the most reliable guide to the future, especially because changes in trends or structural changes can be missed.

It is noteworthy that the differentiation between the three approaches is not always clear and cut in practice (Booth, 2006). The subjective opinions of experts can be included in extrapolative methods, exogenous variables can be applied to extrapolative methods, and structural models can involve extrapolation. Moreover, the approach used per individual component of population change may also differ in a population projection. Historical trends of these components help to gain insight into the underlying dynamics and are necessary to assist assumptions. It is therefore necessary to discuss these components individually and, where possible, relate them to the context of the province of Groningen.

## 2.1. Births

In the case of estimating births, the total fertility rate (TFR) is taken as the basis. The TFR is the average number of children a woman would have if she reached the end of reproductive age and experienced a specific range of age-specific fertility rates at each age (Preston et al., 2001). In other words, it indicates what would happen in the future if all women throughout their lives had children at the same rate as women at that particular point in time (Weeks, 2020). The complexity of predicting the TFR arises from the structural changes in the level of the fertility rate ('quantum'), the changing age patterns ('tempo'), and the interaction between the two (Booth, 2006).

The TFR of the Netherlands has been below the replacement level of 2.1 since the baby boom (Sonsbeek et al., 2023). After a very short increase in the period 2000 to 2010, a further downward trend has started in the fertility rate (Duin & Feijten, 2023). In 2022, the fertility rate was 1.49, and preliminary figures for 2023 indicate a further decline to 1.43 (Stoeldraijer et al., 2023). Initially, the decline in the fertility rate was sought in economic developments (Wijk & Chkalova, 2020). During and just after the economic recession, fewer children were born than in boom times. However, this decline appears to have continued even though the economy of the Netherlands was again in a favourable position for a number of years in 2018.

The decline in the fertility rate is linked to several factors. Wijk & Chkalova (2023) indicate that the increasing flexibility of the labour market and increased education participation between 2010 and 2017 have resulted in a decline in fertility. However, the effect of the two types of developments is very small and, the decline in the number of births was almost entirely concentrated among women under the age of 33. Duin & Feijten (2023) found the same phenomenon, that the fertility decline was strongest among women under the age of 30, and added that the decline was strongest among women with the lowest education levels ('no starting qualifications'). The analysis was largely limited to Dutch-born women, but Riele & Loozen (2017) also state that women with a migration background are having children increasingly later.

The Netherlands does not appear to be the only country in which there is a trend towards postponing family formation in the age group under 30. Hellstrand et al. (2021) point out that the recent fertility decline in the Nordic countries (Denmark, Finland, Iceland, and Sweden) since 2010 is a postponement trend in family formation. England has experienced a decline in fertility rates over the same period that also appears to be mainly due to declines in first births (Ermish, 2021). The decline was similar to the Netherlands, with the decline being greater among women without a university degree than women with a university degree.

There are clear differences in the fertility rate within the various municipalities of Groningen. The total fertility rates of the other municipalities are between 1.58 (Midden-Groningen) and 1.97 (Westerkwartier), which is below the replacement level, but is still clearly higher than the very low fertility rate of the municipality of Groningen, which is 1.15 (CBS StatLine, 2023b). Although a separate analysis of this difference has not been conducted, it is known that small municipalities have higher fertility rates than large cities in the Netherlands (Beer & Deerenberg, 2007).

Furthermore, people who are in education are less likely to have a child compared to people who have completed their education and entered the labour market (Wijk & Chkalova, 2020). This may also partly explain why the fertility rate of the municipality of Groningen is so low compared to the other municipalities.

### 2.2. Deaths

Similar to estimating the number of births, a separate criterion is used when estimating the number of deaths: life expectancy. Life expectancy refers to the average age at death for a hypothetical group of people born in a given year and exposed to the risks of death experienced by people of all ages in that year (Weeks, 2020).

Life expectancy in the Netherlands has increased over the past century due to a strong reduction in mortality in the early stages of life, followed by improvements in survival rates at older ages. In the mid-twentieth century, life expectancy at birth was just over 70 years, and in 2018 this figure increased further to just over 80 years (Stoeldraijer, 2020). However, there is a clear difference between the two sexes, with women having more favourable life expectancies over the decades. In 2018, this difference was 3.1 years (80.2 years for men compared to 83.3 years for women). The speed at which life expectancy has increased recently up to 2018 varies per period.

In the decade before 2002 and the period 2012 to 2018, there was a steady increase in life expectancy (Stoeldraijer, 2020). Between 2002 and 2012, the increase in life expectancy accelerated by 2.6 years. The accelerated increase that took place is related to the increase in healthcare for the elderly and the availability of larger healthcare budgets. The COVID-19 pandemic brought a clear break in the increasing life expectancy and almost four after the start of the pandemic, life expectancy is still lower than before (CBS, 2024a). The provisional figures for 2023 show a life expectancy at birth for men of 80.3 years and 83.3 years for women.

Further increases in life expectancy are becoming increasingly dependent on improving survival at old-ages because much has already been achieved at younger ages and the options for reducing mortality are more limited (Stoeldraijer, 2020). For example, approximately 70% of the contribution to the increase in life expectancy in the period 2012 to 2018 was due to lower mortality risks in the age categories from 65 in the case of men and approximately 40% in the case of women.

The province of Groningen has a relatively low life expectancy compared to the national average (RIVM StatLine, 2023). Additionally, there are large differences within the province, with municipalities in the east of Groningen having a lower life expectancy at birth from 79.5

years (Oldambt) to 80.3 years (Pekela and Veendam) in the period 2018-2021. The municipality of Westerwolde is an exception with a life expectancy of 81.2 at birth, which is more in line with that of the municipalities of Groningen and Midden-Groningen. The western municipalities of Westerkwartier and Het Hogeland have the highest life expectancies of 81.9 and 81.6 years respectively. In this case, there is no clear dichotomy '*Stad & Lande*'.

Furthermore, there are clear differences per Groningen municipality in the average health status of their residents. In recent years, diseases associated with obesity have become an increasingly important public health issue in the Netherlands (Stoeldraijer, 2020). Being overweight increases the risk of diseases such as cancer, heart disease, and diabetes. The figures regarding obesity vary across the provinces, as do the subjective health figures. The municipality of Groningen has the lowest obesity figures and the best subjective health figures (Sociaal Planbureau Groningen, n.d.). About 40% of adults are overweight and four in five adults report being in good health. This may be influenced by the youthful age composition of the city. For example, obesity rates for those between the ages of 19 and 35 are much lower than other age categories in the province. The western municipalities follow the municipality of Groningen with comparable figures and the municipalities in the east have the worst figures. In these municipalities, the proportion of adults who are overweight is 53% to 74% and the percentages who indicated that they were in good health in these municipalities were between 68% and 74%.

## 2.3. Migration

Migration is, as has already been stated, the most difficult component of population development. At the same time, it has been a very important factor in the development of the population of the Netherlands in recent years. Between 2017 and 2020, the population grew by half a million additional inhabitants and 90% of this increase was the result of immigration (CBS, 2022b). The number of immigrants was 1.2 million and the number of emigrants amounted to 770 thousand in the period. In 2023, the population grew by 140 thousand inhabitants to 17.9 million (CBS, 2024b). This growth was achieved solely by immigrants, as more people died than were born. The number of immigrants was 337 thousand and the number of emigrants was 193 thousand.

When looking at the international migration (immigration) to the Netherlands, a number of trends can be deduced per country of birth of immigrants. The net migration (the difference between the annual immigration and emigration figures) of countries that have joined the European Union since the turn of the millennium shows an upward effect after these countries have joined (CBS, 2022b). In contrast, the migration balances of the countries with the largest groups of origin in the Netherlands (Indonesia, Morocco, the Dutch Caribbean, Suriname, and Turkey) show very unstable patterns. In the period 1995-2000 there was a high net migration from these countries, followed by a low point in the period 2005-2006 in which even more people left for Suriname and Turkey than settled in the Netherlands. After 2007, migration balances were relatively stable and there has been an increasing trend since 2015.

Finally, there are the countries that are included in refugee groups. The migration balances of the refugee countries Afghanistan, Eritrea, Iraq, Iran, Somalia, and Syria fluctuate even more, with small peaks in the late 1990s and the late 2000s (CBS, 2022b). However, the period around 2016 was an exception due to the ongoing civil war in Syria, in which more than 25 thousand Syrians settled in the Netherlands. Due to the invasion of Russia in February 2022, the influx of Ukrainians has been very decisive in the population development of the past two years. The provisional figures from the CBS (2024b) show that one-third of the net migration came from the region 'Former Soviet Union' (which includes Ukraine) in the past two years: 368 thousand.

The numbers of immigrants and emigrants vary within the province of Groningen. In 2022, the municipality of Westerwolde (which includes Ter Apel) received by far the most immigrants: 15,443 (CBS StatLine, 2023c). The municipality of Groningen follows with 9,235 immigrants and the other municipalities receive considerably lower numbers, ranging from 192 (Veendam), and to 944 (Central Groningen). The numbers of emigrants again reflect the dichotomous character of the province, with the municipality of Groningen having the highest numbers (4,860) and the other municipalities having an average of 178 emigrants. Moreover, every municipality had a positive migration balance in 2022, meaning that more people immigrated to the municipalities than emigrated from them.

What makes subnational population projections extra difficult is that internal migration flows must also be taken into account in addition to international migration flows. In the introduction, we discussed the fact that the municipality of Groningen attracts many young people from large parts of the Northern Netherlands to study there and that a large number of these young people then leave for the large cities of the Randstad for work (CBS, 2017). However, a clear caveat must be made.

The cohort analysis by the Sociaal Planbureau Groningen (2020) shows that although many young people aged 17 to 25 leave the other municipalities, the majority of them continue to live in the region, and some later returned to the region as young adults. The municipality of Groningen is experiencing a large influx of young people who study there and leave again from the age of about 22 after completing their studies. Nevertheless, the municipality of Groningen retains a larger cohort group than the original cohort size. The trends differ in the other municipalities. In the east of Groningen, the vast majority of young people remain and a minimal decrease in the size of the cohorts can be seen. In the rest of Groningen, relatively many young people are leaving, in the municipalities of Westerkwartier and Midden-Groningen there is a recovery in the size of the cohorts after a number of years and this is less the case in the remaining municipalities. Moreover, the trends and proportions are relatively stable over time.

### 2.4. Conceptual model

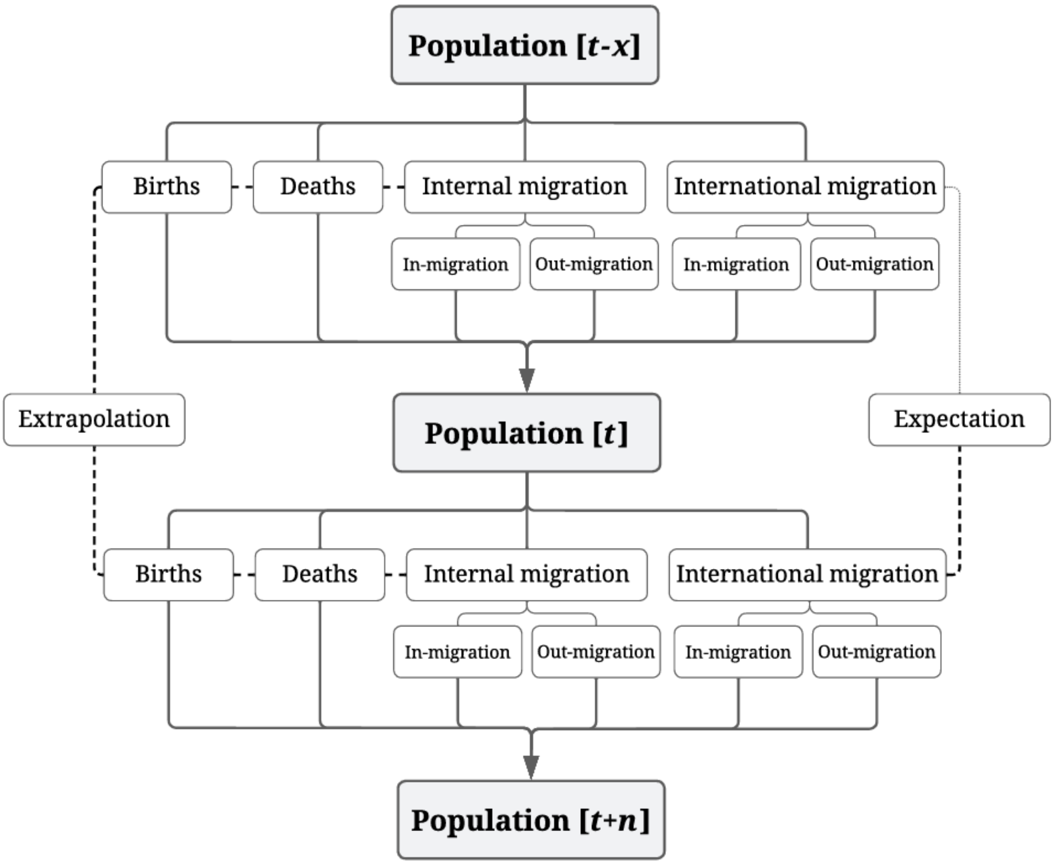
Based on the literature, several generalities can be deduced in the expected future development of the drivers of demographic change. First of all, the TFR is used for predicting the number of births. The trends in the TFR of the Netherlands are fairly stable and have shown a decline in recent years that can be attributed to a postponement trend in family formation. In addition, the province shows a clearly dichotomous character in terms of fertility rates, with the municipality of Groningen having the lowest fertility rate, while the other municipalities have higher fertility rates. The historical trends help provide a guideline for future developments. The trends do not show strong fluctuations and therefore extrapolation is possible, taking into account the postponement trend.

In the case of mortality, life expectancy is used to estimate the number of deaths. Life expectancy in the Netherlands showed a clear upward trend, which was interrupted by the COVID-19 pandemic, and then rose steadily again. Moreover, further increases in life expectancy become increasingly dependent on promoting survival into old-age. The mortality and health figures of the municipalities in the province of Groningen show a more mixed picture. The historical trends are fairly linear except for the COVID-19 years. An extrapolation is possible when the sharp break in the growing importance of mortality probabilities at older ages and the decreasing importance of mortality probabilities at younger ages are taken into account.

Finally, there is the migration component that must be divided into international and internal migration. The first shows highly fluctuating figures, making the future migration balance very difficult to extrapolate. At the same time, there are clear signals from politicians to reduce immigration and universities also want to limit the foreign influx. This means that resorting to an expectation approach is the most applicable in this scenario. The internal migration figures show a more stable pattern and also fit the dichotomous nature of the province of Groningen. The municipality of Groningen is experiencing an influx of young people who largely leave at a later age. The other municipalities experience an outflow and then see, to varying degrees, a return of these young people when they are young adults.

The findings from the literature lead to the conceptual model below (see Figure 2.1). The conceptual model is an adaptation of the demographic equilibrium model. It starts with the historical population denoted as 'Population [*t*-*x*]'. This refers to the size of the population *x* number of years before point *t*. 'Population [*t*]' refers to the starting population of the population projection. Population [*t*] is the result of the number of births, deaths, and (internal and international) migration in the *x* number of years leading up to time *t*. The same logic is applied to convert the starting population (Population [*t*]) to the population at the end of the interval *n*: Population [*t*+*n*]. The difference lies between the fact that the historical numbers are known and the future numbers have to be projected. The historical trends inform future developments for births, deaths, and internal migration to a great degree. Hence, extrapolation can be applied in this scenario. In the case of international migration, this is not possible and expectations will have to be set. These will be informed to a small extent by historical trends.

**Figure 2.1**: Conceptual framework for subnational population projections



The underlying principle of the conceptual model is applied in the same way for two distinct regions of the province of Groningen. This means that Population in the conceptual model can refer to the population of the municipality of Groningen as the other municipalities. Furthermore, the population of the whole province of Groningen is calculated by adding the two projections municipality of Groningen to the other municipalities of the province of Groningen.

## 3. Data, methods and assumptions

The data of the CBS form the basis of this research. The open data of the CBS are made available via StatLine. The advantage of this statistical information is that it can be used freely by the public, does not contain any privacy-sensitive information, and is therefore free from possible ethical considerations. The data required largely depends on the method being used.

The 'cohort component' method is applied to this thesis. It is the most commonly used method for population projections that takes the age distribution into account (Preston et al., 2001; UN, 2022). The method involves segmenting the population into different subpopulations exposed to varying 'risks' of fertility, mortality, and migration, and separately calculating the changes over time in each group. The cohort component method provides a framework to analyse the three major demographic components of population change and implements it in a manner that preserves the demographic balancing equation (UN, 2022).

The cohort-component model requires large amounts of input data due to its highly disaggregated nature (Smith et al., 2013). A series of age-specific fertility rates are required for each projection interval, and sex- and age-specific rates are also required for mortality, in-migration, and out-migration for both internal migration and international migration (Preston et al., 2001). The cohort-component model requires that assumptions be made regarding future rates of these drivers of demographic change (Smith et al., 2013). The historic trends inform the assumptions and therefore several datasets from CBS StatLine are used to create a suitable population projection. The specific assumptions are only discussed after discussing the data and method.

### 3.1. Data

In order to have an appropriate starting population, accurate sex- and age-specific population numbers are needed per municipality. This data is taken from the dataset "Bevolking op 1 januari en gemiddeld; geslacht, leeftijd en regio" which contains the relevant numbers concerning the population on January 1 and the average population from 1988 to 2023 (CBS StatLine, 2023d). The ages are shown as single years and are aggregated to five years in size. This is needed because the age intervals of the population estimates must be the same as the age intervals used in rates of demographic change must be the same as those used in the population estimates (Preston et al., 2001). The latter are exclusively available in age increments of five years. Furthermore, the data is also used to assist the different age-specific rate calculations. Since the average population data is incomplete, its alternative is calculated by the following formula:

$$_5\overline{N}_x = \frac{_5N_x(t) + {_5N_x}(t+1)}{2}$$

where $x$ denotes the age, 5 indicates the length of the age interval, $_5\overline{N}_x$ indicates the mid-year number of people aged $x$ to $x + 5$, $_5N_x(t)$ denotes the number of people aged $x$ to $x + 5$ living at the start of the time interval, while $_5N_x(t+1)$ represents the population at the end of the projection interval.

To facilitate estimates of the number of births, age-specific fertility rates per municipality are required. The dataset "Geboorte; kerncijfers vruchtbaarheid, leeftijd moeder, regio" contains data on live births among the population of the Netherlands from 1988 to 2022 (CBS StatLine, 2023a). The dataset shows the number of live births by age of the mother per municipality. The age is divided into seven different age categories: under 20 years, 20 to 25 years, 25 to 30 years, 30 to 35 years, 35 to 40 years, 40 to 45 years, and 45 years or older. The number of live births by age of the mother must be converted into age-specific fertility rates. The data from the sex- and age-specific population figures are used to calculate these. The youngest and oldest age categories are limited by a five-year break, as is the case with the other age categories.[2] The following method is used to calculate age-specific fertility rates for age groups five years in size:

$$_5F_x = \frac{_5B_x}{_5\overline{N}_x^F}$$

where $_5F_x$ represents the age-specific fertility rate for age interval $x$ to $x + 5$, $_5B_x$ concerns the number of births for women aged $x$ to $x + 5$ during the year and $_5\overline{N}_x^F$ indicates the mid-year number of women aged $x$ to $x + 5$. In essence, the number of births per five-year age category of the mother is divided by the number of women in that age category based on the average, operationalised by the mid-year, population.

For mortality, survival probabilities are required for each subgroup (Preston et al., 2001). The survival probabilities have to be calculated by single decrement life tables. To guarantee compatibility with CBS data, the same method is applied that CBS uses for calculating period life tables (Van der Meulen & Janssen, 2007). The construction of a period life table needs two basic constituents: the population on January 1 for each age category by sex ($_5N_x^M$ for males and $_5N_x^F$ for females) and the number of deaths occurring in these age categories by sex ($_5D_x^M$ for males and $_5D_x^F$ for females). The dataset "Overledenen; geslacht, leeftijd, burgerlijke staat,

[2] This approach is in line with how Preston et al. (2001) operationalise the fertile ages of women but differs from, for example, Smith et al. (2013) where the age category 15-44 is applied.

regio" has the relevant data running from 1988 to 2022 (CBS StatLine, 2023e). This includes the number of deaths by age, sex, and municipality. The age is divided into different age categories and most are five years in size (e.g. 5 to 10 years). Exceptions are the first two age categories (0 years and 1 to 5 years) and the last age category (95 years or older). The first age categories are merged into one and the last age category is kept as open-ended.

In the case of migration, the sex- and age-specific internal and international migration rates per municipality are a requisite. The CBS makes a distinction between internal and international migration. The latter refers to all the movements that cross the national border, while the first alludes to movements within the national borders. The dataset "Verhuisde personen; geslacht, leeftijd en regio per maand" encompasses the number of individuals by age and sex that moved within the Netherlands from 2010 to February 2024 (CBS StatLine, 2024). The age is indicated as both single years and five years in size. The appropriate indicator is 'People moved between municipalities', which consists of in-migration 'Settled in the municipality' and out-migration 'Left the municipality'. The latter is used in combination with the sex- and age-specific average population to calculate the internal out-migration (${}_5O_x$).

The CBS defines an immigrant as a person who has settled in the Netherlands from abroad and expects to stay for at least four months (CBS StatLine, 2023f). The definition of an emigrant differs a bit: a person who goes abroad to settle abroad and the expected duration of stay is at least eight months. The dataset "Immi- en emigratie; geslacht, leeftijd, nationaliteit, regio" includes sex- and age-specific international migration numbers from 2010 to 2022. The data is the most incomplete compared to the other datasets: the age categories stop at the age category 50 years or older. Furthermore, administrative corrections are also included in the migration figures. These may be cases in which it was expected that someone had left the Netherlands, been removed from the population register, but subsequently never left the country, and was therefore added back to the population register. In contrast to internal migration, both sex- and age-specific out-migration (${}_5O'_x$) and in-migration (${}_5I'_x$) are calculated.[3]

Finally, several datasets of the CBS are used to support the assumptions regarding the components of demographic change. These include data about the forecasted age-specific fertility rates (CBS StatLine, 2023g), the sex- and age-specific life expectancy (CBS StatLine, 2023h), international migration (CBS StatLine, 2023i), and population size on January 1 (CBS StatLine, 2023j) comprising all at the national level spanning each year from 2023 through

[3] The addition of an apostrophe indicates that it refers to international migration in opposition to internal migration.

2070. In addition, two extra datasets are used. First, the dataset "Levensverwachting; geslacht, leeftijd (per jaar en periode van vijf jaren)" contains the life expectancy differentiated by age and sex for the Netherlands from 1861 to 2022 (CBS StatLine, 2023k). Second, the dataset "Immi- en emigratie; leeftijd (31 dec.), burg staat, geboorteland; 1995-2022" consists of the sex- and age-specific immigration and emigration numbers from 1995 to 2022 for the Netherlands (CBS StatLine, 2023l).

### 3.2. The cohort-component model

The cohort-component model is a discrete-time model of population development (Preston et al., 2001). This means that population size and characteristics are calculated only at select points in time, separated by long time intervals. The projection period of this thesis is the same size in length as the age intervals used: five years in size. For each projection interval, a separate projection is performed consisting of the same steps.

First, the population of each group divided by age category and sex is projected at the beginning to the end of the projection interval. The survivorship ratios are applied to calculate this number. The formula for any group, except for the youngest and oldest, is:

$$ {}_5N_x(t+5) = {}_5N_{x-5}(t) \cdot \frac{{}_5L_x}{{}_5L_{x-5}} $$

where $x$ denotes the age, 5 refers both the length of the projection and age interval, $t$ is the beginning of the time interval, ${}_5N_x(t+5)$ represents the population at the end of the projection interval, ${}_5N_{x-5}(t)$ is the population at the beginning of the time interval and ${}_5L_x \,/\, {}_5L_{x-5}$ refers to the proportion of the persons aged *x – 5* to x that will be alive 5 years later in the population subject to the appropriate life table. Alternatively, the last part could also have been written as ${}_5S_x$, which signifies the same meaning as the survival ratio.

The formula for the oldest open-ended age group combines the survivors from two previous age groups:

$$ {}_\infty N_x(t+5) = \left({}_5N_{x-5}(t) \cdot \frac{{}_5L_x}{{}_5L_{x-5}}\right) + \left({}_\infty N_{x-5}(t) \cdot \frac{T_{x+5}}{T_x}\right) $$

The first part of this formula is the same as in the previous formula. It gives the number of people surviving to the next open-ended age group. The second part produces the number of survivors who are already in the open-ended age group at the start of the population interval. The survivorship ratio information is deduced from the life table. In the formula, it's denoted as $T_{x+5}$ / $T_x$ which means the number of person-years lived above $x$ + 5 divided by the number of person-years lived above age $x$.

The youngest age group also needs a distinct calculation. First, the total number of births must be calculated using the following formula:

$$B[t, t+5] = \sum_{x=\alpha}^{\beta-5} 5 \cdot {}_5F_x \cdot \left( \frac{{}_5N_x^F(t) + {}_5N_{x-5}^F(t) \cdot \frac{{}_5L_x^F}{{}_5L_{x-5}^F}}{2} \right)$$

The first part summarises the age-specific fertility rates over five years, where α and β are the lower and upper limits of the childbearing age. The second part multiplies it by the average number of women who lived in the different age groups.

The previous formulas could be applied separately to both males and females. However, sex-specific formulas are required to be explicitly depicted for the youngest age group for men and women. First, the number of women born must be distinguished from the number of men born. It must then be calculated how many of them survive until the next projection interval. Using the following formula, the number of female births is calculated:

$${}_5N_0^F(t+5) = B[t, t+5] \cdot \frac{1}{1 + SRB} \cdot \frac{{}_5L_0^F}{5 \cdot l_0}$$

where $B[t, t+5]$ refers to the total amount of births occurring between the beginning and end of the projection interval, $SRB$ refers to the ratio of male to female births (i.e. the sex ratio at birth), and ${}_5L_0^F$ / $(5 \cdot l_0)$ indicates the survival ratio where the newborn females are subjected to. Additionally, the assumption that the SRB does not differ with regard to the age of the mother is rarely problematic (Preston et al., 2001). The slightly adjusted formula can be applied to calculate the amount of male births:

$${}_5N_0^M(t+5) = B[t, t+5] \cdot \frac{SRB}{1 + SRB} \cdot \frac{{}_5L_0^M}{5 \cdot l_0}$$

Given the premise that Groningen is not a closed population, the last step is to add the migration component. Groningen needs to contend with both internal and international migration, these figures must be taken into account in every demographic calculation. Adding the net number of migrants into two separate quantities provides a convenient solution (Preston et al., 2001). As a result, half are exposed to the same fertility, mortality, and migration risks as the general population, while the other half remains ‘protected’.

Projecting the population five years forward needs to be adjusted to account for both internal and international migration by the following method:

$$
\begin{aligned}
{}_5N_x(t+5) = & \left[\left({}_5N_{x-5}(t)\cdot\left(1+\left(2.5\cdot\frac{{}_5V_x}{2}\right)\right)+\frac{{}_5V_x'[t,t+5]}{2}\right)\cdot\frac{{}_5L_x}{{}_5L_{x-5}}\right] \\
& + {}_5N_{x-5}(t)\cdot\left(1+\left(2.5\cdot\frac{{}_5V_x}{2}\right)\right)+\frac{{}_5V_x'[t,t+5]}{2}
\end{aligned}
$$

The praxis of projecting the population five years forward now includes the addition of ${}_5V_x$ and ${}_5V_x'[t,t+5]$. The first refers to the net migration rate, which is multiplied every two and a half years by the population group. The multiplication leads to a number of internal migrants settling in the region or leaving if the number is negative. The latter denotes the net number of international migrants flowing in or out of the region between $t$ and $t+5$. Similar adjustments are made for the calculation of the number of survivors in the open-ended age group and the number of male and female births.

To readily perform the multitude of calculations, matrix algebra is used. The mechanics of the cohort component model are concisely displayed in the following matrix notation:

$$
\begin{aligned}
\begin{pmatrix} N^F(t+5) \\ N^M(t+5) \end{pmatrix} = & \begin{pmatrix} F^F+S^F & 0 \\ F^M & S^M \end{pmatrix}\cdot\begin{pmatrix} N^F(t) \\ N^M(t) \end{pmatrix} + \begin{pmatrix} F^F+S^F & 0 \\ F^M & S^M \end{pmatrix} \\
& \cdot\begin{pmatrix} \left(1+\left(2.5\cdot\frac{V^F}{2}\right)\right)+\frac{V'^F[t,t+5]}{2} \\ \left(1+\left(2.5\cdot\frac{V^M}{2}\right)\right)+\frac{V'^M[t,t+5]}{2} \end{pmatrix} + \begin{matrix} \left(1+\left(2.5\cdot\frac{V^F}{2}\right)\right)+\frac{V'^F[t,t+5]}{2} \\ \left(1+\left(2.5\cdot\frac{V^M}{2}\right)\right)+\frac{V'^M[t,t+5]}{2} \end{matrix}
\end{aligned}
$$

where $N^F(t+5)$ refers to the column vector of the female population by age group at the end of the projection interval, $N^M(t+5)$ denotes the column vector of the male population by age group at the end of the projection interval, $F^F$ represents the fertility matrix for female births, $S^F$ refers to the survival matrix for females, 0 is a zero matrix, $F^M$ is the fertility matrix for male births, $S^F$ represents the survival matrix for males, $N^F(t)$ denotes the column vector of the female population by age group at the start of the projection interval, $N^M(t)$ refers to the column vector of the male population by age group at the start of the projection interval, $V^F$ and $V^M$ indicates the net migration rate for females and males respectively, and lastly

$V^{\prime F}[t, t+5] + V^{\prime M}[t, t+5]$ describes the net number of internal and international female and male migrants between $t$ and $t+5$ respectively.

### 3.3. Assumptions and operationalisation

The mechanics of the cohort component model are invariant across projection intervals. It needs a starting population as its input in combination with assumptions about the development of fertility, mortality, and migration. The starting population that will be used is straightforward: the population of both geographical areas is divided into sex and age groups of five years in size (with 95+ as the open-ended age category) as of January 1, 2023. On the other hand, the assumptions regarding the development of the components of demographic changes are more difficult.

The Population Forecast of the CBS for 2023 to 2070 functions as a guideline for the assumptions (Stoeldraijer et al., 2023). In the case of fertility, the literature indicates that the declining fertility rate is probably a (new) postponement trend of family formation. The Population Forecast of the CBS assumes that the postponement among today's young women will still partly be made up (Stoeldraijer et al., 2023). Additionally, the CBS assumes that a smaller part of the postponement is made up for older women because they are already at ages where fecundity is clearly waning.

The fertility estimates of the CBS concern the Netherlands as a whole (CBS StatLine, 2023g). However, there is great regional variation. The estimates must therefore be adjusted to the context of both the municipality of Groningen and the other municipalities of the province of Groningen. This is done using a simple linear regression in which the age-specific fertility rates of the municipality of Groningen or the other municipalities serve as the dependent variable and the national age-specific fertility rates are the independent variable. The future values of the age-specific fertility rates of the municipality of Groningen or the other municipalities are then predicted by multiplying the parameter of the independent variable by the forecasted national values and adding the constant. This simple linear regression takes the following form:

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t$$

where $Y_t$ denotes the age-specific fertility rates of the municipality of Groningen or the other municipalities at time $t$, $\beta_0$ is the constant parameter, $\beta_1$ indicates the estimated parameter of the national average age-specific fertility rates, which itself is denoted as $X_t$, and lastly $\varepsilon_t$ is the error term.

The essence of the approach is that the historical values are used to estimate the ratio and this ratio is then applied to the national forecasted values to predict regional age-specific fertility rates. The values of $\beta_0$ and $\beta_1$ determine whether the regional trend is divergent or convergent with respect to the national trend. For example, when the estimated parameters are $\beta_0 > 0$ and $\beta_1 > 1$, in this situation, divergence occurs whereby the national trend continues to increase compared to the regional trend. However, in the case of $\beta_0 < 0$ and $\beta_1 > 1$, the regional trend initially converges to the national trend until the regional line crosses the national line, at which point it diverges.[4]

Additionally, an alternative scenario will be created in which the values for the two Groningen values move towards the general Dutch trend with a linear convergence, with the deviation decreasing by one-thirtieth every year. Furthermore, to distinguish the number of male births from female births, a value for the SRB must be determined. The SRB will be the average ratio of male births compared to female births from 1988 to 2022 (CBS StatLine, 2023a). It is expected that this ratio will remain constant throughout the different projection intervals.

In the case of mortality, the literature shows that life expectancy has increased steadily over the past decades with women having more favourable life expectancies compared to men. The COVID-19 pandemic brought a clear break in the increasing life expectancy and life expectancy is still lower than before the pandemic. The Population Forecast of the CBS uses an extrapolating technique that applies weights for the last in later years to adjust for the slowly increasing life expectancy after the COVID-19 pandemic (Stoeldraijer et al., 2023). Furthermore, it uses more stable trends in other Western European countries to correct for temporary accelerations and decelerations that occur in the national trends of the Netherlands and it also takes into account the effect of smoking behaviour on mortality.

To modify the national trends into the regional trends for the province of Groningen, the same method is used for the fertility rate. For mortality, the probability of dying per sex and age is taken (CBS StatLine, 2023h). These figures are then, again, used in a simple linear regression where the derived constant and parameter are used to predict the future probabilities of dying per sex and age group for the municipality of Groningen and for the other municipalities. The survival ratios are subsequently adjusted per age and sex, as appropriate. In addition, a convergent alternative scenario is again used, in which the values of both the municipality of Groningen and the other municipalities will converge with the national average.

[4] The results of the series of OLS regressions are shown in Appendix B.

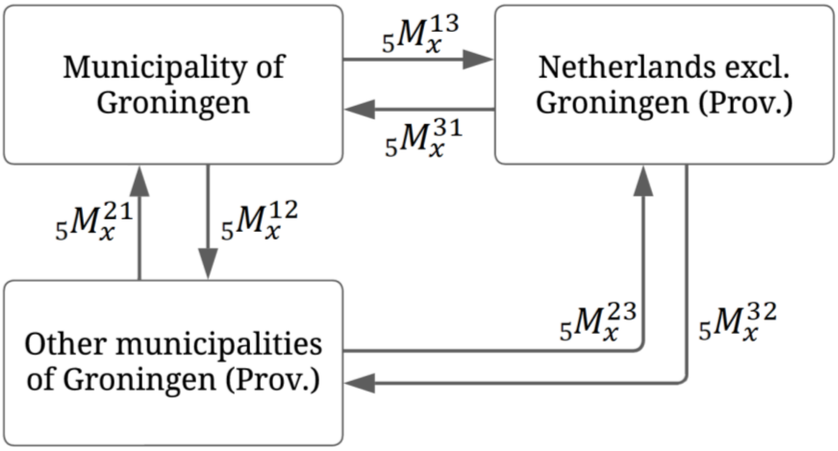
The assumptions for migration need the most attention. An important factor distinguishing the assumptions of internal migration from international migration is that there are only forecasted numbers for international migration (CBS StatLine, 2023i). The same numbers are not available in the case of internal migration. The limited data regarding internal migration provides little room for the application of advanced statistical methods. For this reason, the annual average internal net migration rate specified per sex and age category is taken from the observed time series spanning from 2010 to 2022. These rates are then assumed to stay constant throughout the entire period of analysis. This contrasts with an alternative scenario where, rather than considering the entire period, the average rates from the last five years of the available data series are assumed to be constant: from 2018 to 2022.

Implementing a multistate model would be a more professional alternative. Ideally, a multi-state model would be used to calculate the internal migration probabilities to and from the relevant regions in this study. The three regions represent the three different possible states: the municipality of Groningen, the other municipalities of the province of Groningen, and the Netherlands excluding the province of Groningen. This means that six different transitions would have to be calculated. Additionally, the transition rates needed to be specified by sex and age. The transition rates from state $i$ and $j$ between ages $x$ to $x + 5$ are expressed as (Muniz, 2020):

$$ {}_5M_x^{ij} = \frac{{}_5D_x^{ij}}{{}_5\bar{N}_x^{i}} $$

where ${}_nD_x^{ij}$ refers to the total amount moves between states $i$ and $j$ from the age $x$ to $x + 5$, and ${}_5\bar{N}_x^{i}$ denotes the mid-year number of people aged $x$ to $x + 5$. Figure 3.1 shows the different transitions between the different regions of the Netherlands: (1) the municipality of Groningen, (2) the other municipalities of the province of Groningen, and (3) the Netherlands excluding the province of Groningen.

**Figure 3.1**: Overview of the multistate model of internal migration




Unfortunately, only total numbers are available for migration flows between the different municipalities (CBS StatLine, 2023m). Furthermore, internal in- and out-migration figures per municipality do not provide a solution, as this also includes inter-municipal migration from municipalities that belong to the same created region. This would most likely produce inaccurate results.

Pertaining to international migration, the literature indicates that international migration is very volatile and thus very unpredictable. In addition, the future is even more uncertain because of the political will to better control and reduce immigration, while universities want to reduce the influx of international students. Due to the above reasons, several scenarios are implemented. Firstly, the average sex- and age-specific national share of immigrants and emigrants from the municipality of Groningen and the other municipalities are calculated. Followingly, this share is assumed to stay constant in the future. However, weights are used to calculate the share in the case of the other municipality. The share in the period 2010-2017 has a weight twice that of the other period. This is done because recent years have had extraordinarily high migration rates that significantly increase the annual average. The shares can then be multiplied, with the sex- and age-specific number of immigrants and emigrants that are forecasted by the CBS (CBS StatLine, 2023i).

Secondly, the report of the State Committee Demographic Developments 2050 states that moderate growth in the population size of the Netherlands, resulting in 19 to 20 million people in 2050, will provide better outcomes for sufficient growth in prosperity in a broad sense (Staatscommissie, 2024). Various calculations have been made in the report with varying net migration balances. Based on these calculations, an annual average net migration balance of 60,000 will result in approximately 19.5 million inhabitants in the Netherlands in 2050. This target figure is included as an alternative scenario to compare with the CBS forecasts. This is done by reducing the CBS forecast of the net migration to the Netherlands to an annual number of 60,000 and assuming the relative proportions of age categories and sex are maintained. To illustrate the approach with an example, if the forecasted number of the CBS is, for instance, 90,000 in a certain year, a factor of 0.67 is applied in that specific year.

Finally, a correction must be made for the open-ended age category used in the international migration dataset (CBS StatLine, 2023f). The open-ended age category, as already stated, stops at 50 years or older, while migration rates fluctuate at every age category. For this reason, national data are used to reshape regional migration rates from 50 years onwards (CBS StatLine, 2023l). The result of this is that the age categories from fifty will not have an average rate, but will vary according to the national average.

# 4. Results

The results section is divided into six segments: fertility, mortality, international migration, internal migration, population and structure, and dependency ratios. First, the historical development of the specific subject is discussed, and then the expected future development of the subject. The discussion of the projected population size, population structure, and dependency ratios are all dependent upon the conditions put forward by the future development of fertility, mortality, internal migration, and international migration. Therefore, in this discussion, a variety of combinations are selected that result in the minimum and maximum results to indicate the lower and upper bound. Additionally, a middle path is outlined based on the combination of scenarios that are considered most realistic. Lastly, a comparison is made between the middle path and population projections produced by other research institutions.

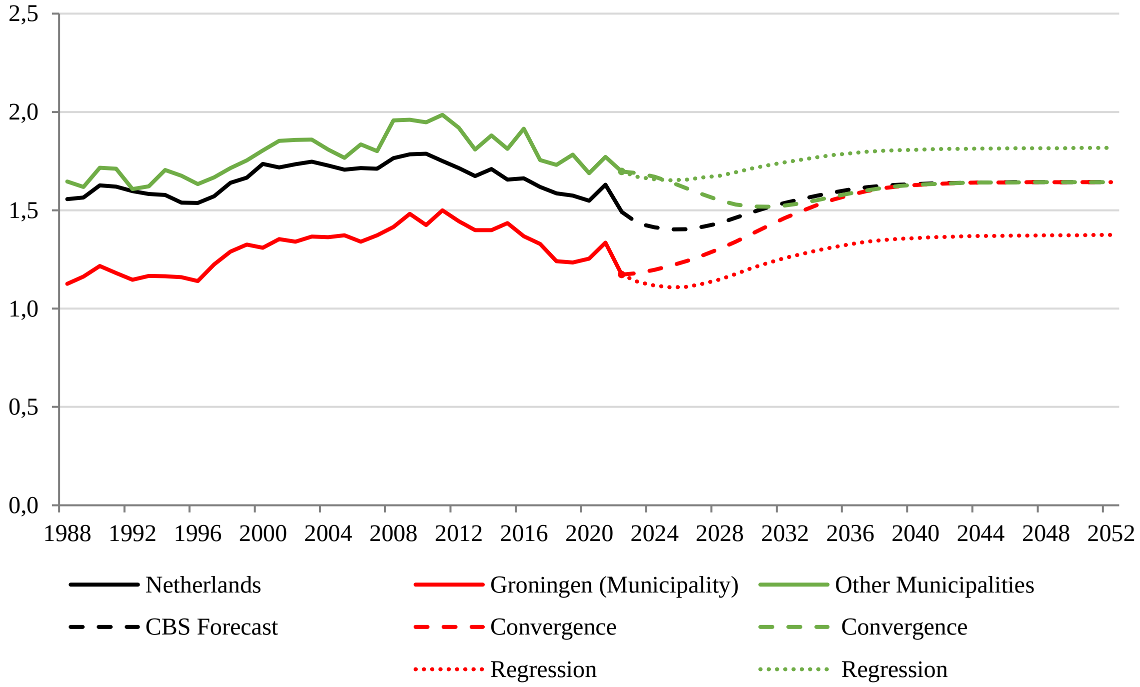
## 4.1. Fertility

Figure 4.1 shows the total fertility rate (TFR) of the Netherlands, the municipality of Groningen, and the other municipalities of the province of Groningen. It can be seen that the relative proportions in the level of the TFR between the Netherlands, the municipality of Groningen, and the other municipalities are fairly stable in the period 1988 to 2022. All show the same pattern: a steady increase that continues until approximately 2010 and then a downward trend that is briefly interrupted by a small peak in 2021. The TFR of the other municipalities of the province of Groningen was above the national average and reached its peak of 1.99 in 2012. The TFR of the municipality of Groningen, on the other hand, was far below the national average. The TFR was 1.13 in 1988, rose to 1.50 in 2011, and then fell to 1.17 in 2022.

When considering future prospects, it can be seen that convergence with the projected TFR of the Netherlands has opposite effects on the TFR of the municipality of Groningen and the other municipalities. In the case of the other municipalities of the province of Groningen, convergence means that the decline in the TFR will continue to 1.52 in 2030. However, a converging TFR means a strong increase for the municipality of Groningen. In this scenario, the TFR increases rapidly from 1.17 in 2022 to 1.64 in 2042, or an increase of more than 40%. However, this is extremely unlikely given the special composition of the student city population. In the last decade, the TFR of both regions will be at almost the same level as that of the Netherlands at a stable level of 1.64.

The alternative scenario is based on extrapolation of historical trends. In this scenario, the relative proportions in the level of the TFR between the Netherlands, the municipality of Groningen, and the other municipalities will be maintained in the future. In this scenario, both regions of the province of Groningen will see a decline in their TFR that will continue until 2025. Adhering to the conditions put forward by the regression, the municipality of Groningen will have a TFR that is even lower than the lowest observed figure of 1.13 in 1988, while the TFR of the other municipalities will be half a child per woman higher: 1.65. After this downward trend, the TFR of both regions will increase until 2024, with the municipality of Groningen and other municipalities reaching a stable level of 1.37 and 1.82 respectively.

**Figure 4.1**: The historic and projected total fertility rate (TFR) of the Netherlands and the subregions of the province of Groningen, 1988-2052



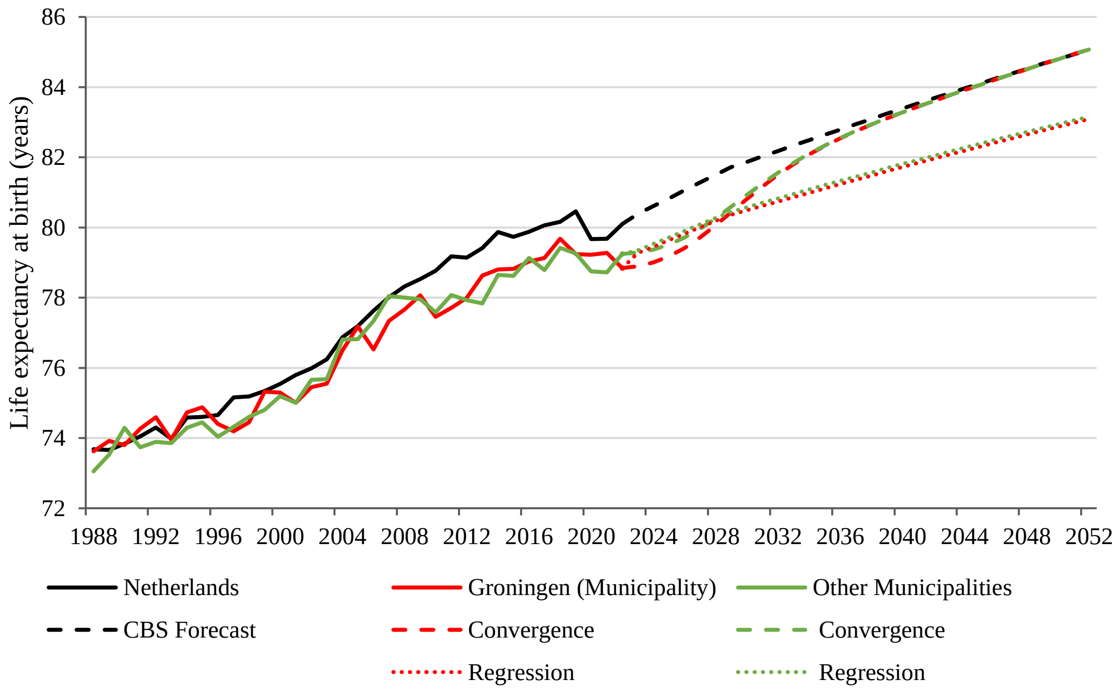

**Source**: CBS StatLine (2023a; 2023d; 2023g).

### 4.2. Mortality

Life expectancy in the Netherlands has increased in recent times for both men and women (see Figures 4.2 and 4.3 respectively). Life expectancy at birth for men was initially just under 74 years in the Netherlands and in the province of Groningen in 1988. In the following decades, life expectancy increases for all, especially at the beginning of the new millennium. The increase levelled off around 2010 and a decline occurred during the COVID-19 pandemic years. With a few exceptions, life expectancy in the Netherlands has been consistently higher than in both Groningen regions since 1966. The greatest distance has been observed in the past decade. In 2019, Dutch males had on average a life expectancy at birth of 80.46 years, while this figure was approximately 1.22 years lower in the municipality of Groningen (79.24 years) and the other municipalities of the province of Groningen (79.26 years). The development of male life expectancy in the two regions of the province of Groningen was very variable and correlated almost perfectly.

The historical trends inform the future scenarios and since the municipality of Groningen and the other municipalities of the province of Groningen have almost identical histories in terms of life expectancy at birth, the future scenarios yield almost identical values. The scenario based on convergence shows that the life expectancy at birth will increase from 78.84 years in the municipality of Groningen and 79.25 years in the other municipalities in 2022, to the same life expectancy at birth of 82.93 years in 2038. In the following years, life expectancy in the two regions of Groningen will increase by 0.15 years or almost 2 months annually. This will ultimately reach the same level as the national average of 85 years in 2052.

**Figure 4.2**: The historic and projected male life expectancy at birth of the Netherlands and the subregions of the province of Groningen, 1988-2052

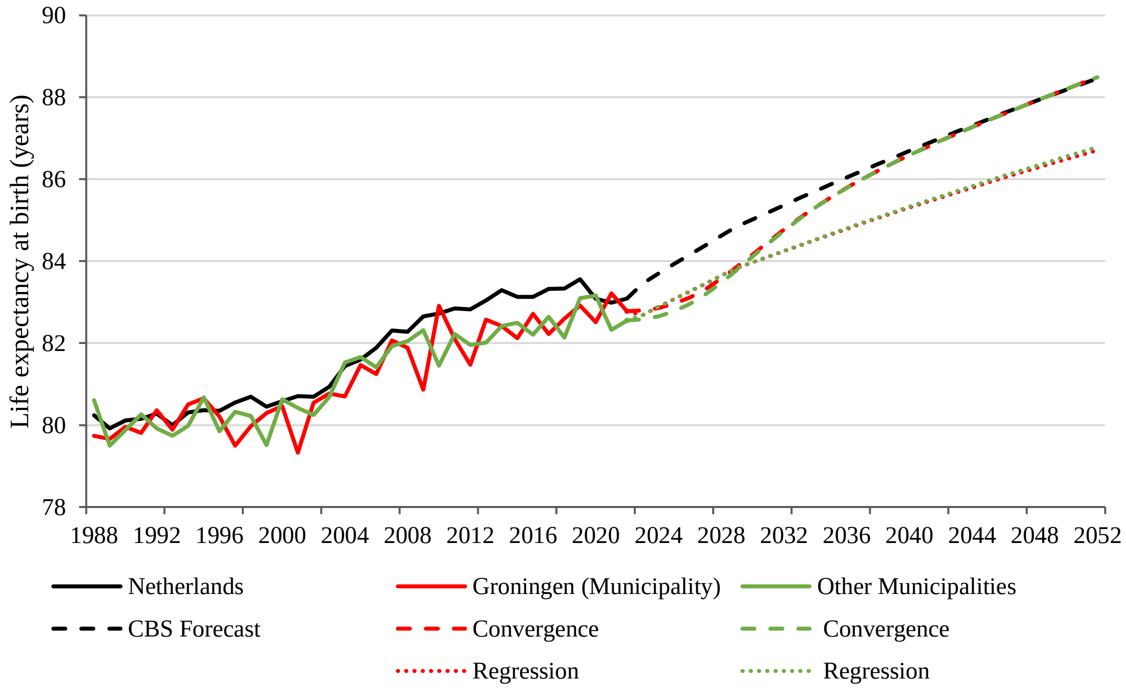



**Source**: CBS StatLine (2023d; 2023e; 2023h; 2023k).

The scenario based on regression yields noticeable differences compared to the convergence scenario. Based on the conditions assumed by the regression technique, the relative proportions between the Netherlands, the municipality of Groningen, and the other municipalities will be maintained in the future. The difference in life expectancy at birth for men between the municipality of Groningen and the other municipalities is barely noticeable: 0.08 years in favour of the latter. The differences between the two regions of the province of Groningen and the Netherlands are clearly visible. In 2025, life expectancy in the Netherlands will be at a level of 80.83 years for males, or more than one year higher in the municipality of Groningen and the other municipalities. However, the distance grows in the subsequent years. In 2036 the difference is one and a half years and at the end of the projection period, the difference has grown to a distance of almost two years. The result is a life expectancy at birth for men of 83.09 years for the municipality of Groningen and 83.15 years for the other municipalities of the province of Groningen.

Life expectancy at birth for women in the Netherlands has increased less rapidly in the period 1988 to 2022 than that of men in the same period (see Figure 4.3). Nevertheless, women have more favourable life expectations than men throughout the entire period. The difference between the sexes is so pronounced that in 1988 women had even more favourable life expectations at birth than the male life expectancy at birth in 2022. In 1988, life expectancy at birth for women was 79.64 years in the municipality of Groningen, 80.61 years in the other municipalities of the province of Groningen, and the national average was 80.24 years.

**Figure 4.3**: The historic and projected female life expectancy at birth of the Netherlands and the subregions of the province of Groningen, 1988-2052




**Source**: CBS StatLine (2023d; 2023e; 2023h; 2023k).

The life expectancy of the municipality of Groningen and the other municipalities hardly increased up to the turn of the millennium. Similar to men, life expectancy at birth for women increased sharply in the following ten years. The increase levelled off in the following years and in 2019 women in the municipality of Groningen had a life expectancy at birth of approximately 83 years. Life expectancy dropped in the COVID-19 years and did not fully recover to the pre-pandemic levels by 2022. During this entire period, the life expectancies of women in the municipality of Groningen and the other municipalities were on average more than five months lower compared to the national average.

The perspective on the future life expectancy for women shows similar results to that for men. Because of the almost identical values in the past, there is almost a perfect correlation in the future scenarios. The scenario based on the simple linear regression shows a slow increase in the future life expectancy of women. Only in 2026 will the life expectancy of both regions have recovered from the negative consequences of the COVID-19 pandemic. In 2038, in the middle of the projection period, life expectancy will have increased to 85 years in both regions of Groningen. The final life expectancy in 2052 is 86.71 years for the municipality of Groningen and 86.79 years for other municipalities of the province of Groningen. The national average is almost two years higher and stands at 88.46 years.

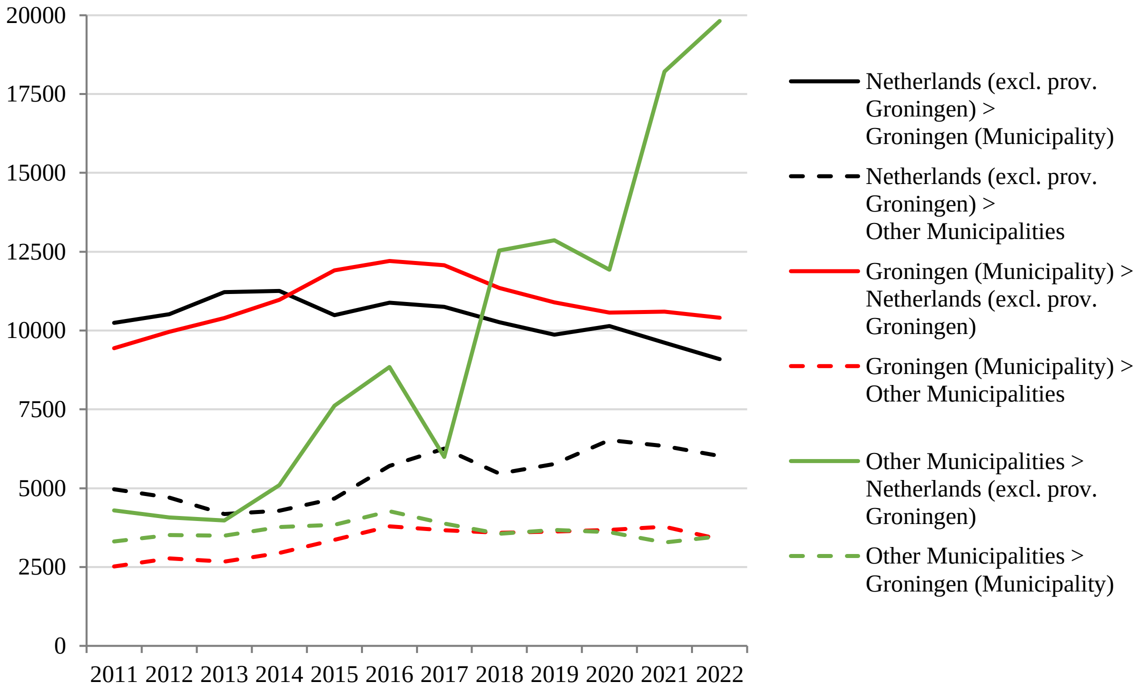
The scenario based on convergence paints a different picture but here too the values of the two regions of the province of Groningen are virtually impossible to separate. In 2027, the national average life expectancy of women at birth of 84.39 years will be more than a year higher than in the municipality of Groningen and the other municipalities. This difference decreases as time goes on and in 2035 the two regions of the province of Groningen will have a life expectancy at birth of 85.56 years. In the last decade of the forecast, the differences are no longer noticeable and all will reach a life expectancy at birth of 88 years and six months in 2052.

### 4.3. Internal migration

Figure 4.4 shows the migration flows between the municipality of Groningen, the other municipalities of the province of Groningen, and the rest of the Netherlands. What is immediately striking, is the flow of internal migrants from the other municipalities to the rest of the Netherlands. Yet there is no mass exodus from this region of Groningen as the graph would suggest. The high outflow is almost entirely caused by the municipality of Westerwolde in later years (CBS StatLine, 2024). Ter Apel is located in this municipality and all the asylum seekers who enter the municipality are registered in the Dutch registration system (*Basisregistratie Personen*: BRP) (RTV Noord, 2019). These foreigners are therefore included in the internal migration figures, despite the fact that their stay may be very short.

The internal migration flow from the rest of the Netherlands to the municipality of Groningen has decreased in the past 10 years, while the numbers to the other municipalities have increased. Nevertheless, more people from the rest of the Netherlands have settled in the municipality of Groningen than in the other municipalities in 2022: 9,093 and 6,021 respectively. Initially, more people moved to the municipality of Groningen from the rest of the Netherlands than the other way around, but this trend reversed after 2014. In 2022, the difference grew to 1,314 people to the disadvantage of the municipality of Groningen. The same pattern can be observed in the case of the other municipalities. First more people left from the other municipalities for the municipality of Groningen. In 2011, 3,310 people moved from other municipalities to the municipality of Groningen and only 2,518 vice versa. The flows converged in 2018 and in 2021 more people (498) settled in the other municipalities than the other way around.

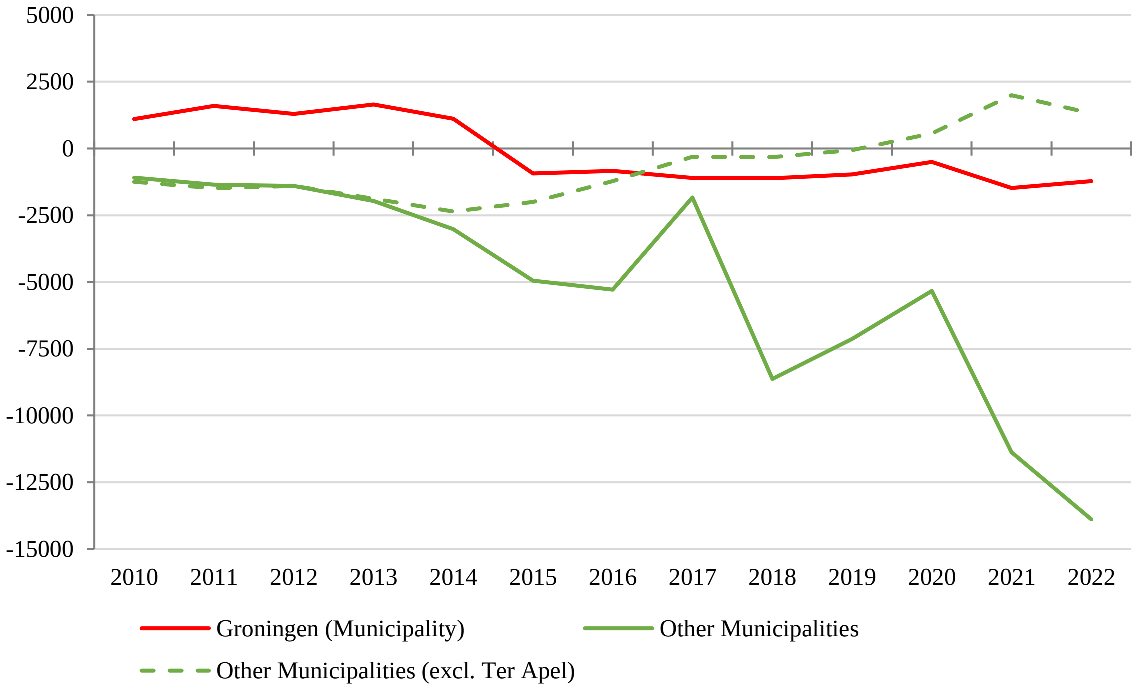
**Figure 4.4**: The internal out- and in-migration flow between the Netherlands and the subregions of the province of Groningen, 2011-2022




**Source**: CBS StatLine (2023m).

The difference between the inflow and outflow from the municipality of Groningen and the other municipalities is shown in Figure 4.5. In addition, the net internal migration numbers of the other municipalities have been added without the municipality of Westerwolde (and its predecessor Vlagtwedde) where Ter Apel is located. It can be observed that until 2014 there were hardly any differences between the other municipalities in the numbers of internal net migration. From 2010 to 2014, an average of 1,800 people per year left the other municipalities to reside elsewhere in the Netherlands. Since 2014, there has been a considerable diverging trend if the municipalities between the other municipalities including and excluding the municipality where Ter Apel is located. It can be seen that from 2014 onwards, the other municipalities, excluding the municipalities of Westerwolde and Vlagtwedde, have had a decreasing outflow of net internal migration figures and even positive figures in the period 2020-2022. This differs considerably from the other municipalities as a collective: this trend shows that an average of 5,824 have left this particular region of Groningen region from 2014 onwards. Additionally, it can be observed that the municipality of Groningen had a positive net internal migration balance in the period 2010-2014. In 2013, 1,648 more people settled in the municipality than left the municipality. However, this high positive internal migration balance turned into a negative balance in later years. In the period 2015 to 2022, no fewer than 8,175 people left the municipality in total.

**Figure 4.5**: Net number of internal migrants of the municipality of Groningen and other municipalities, 2010-2022 & 2018-2022




**Source**: CBS StatLine (2023d; 2024).

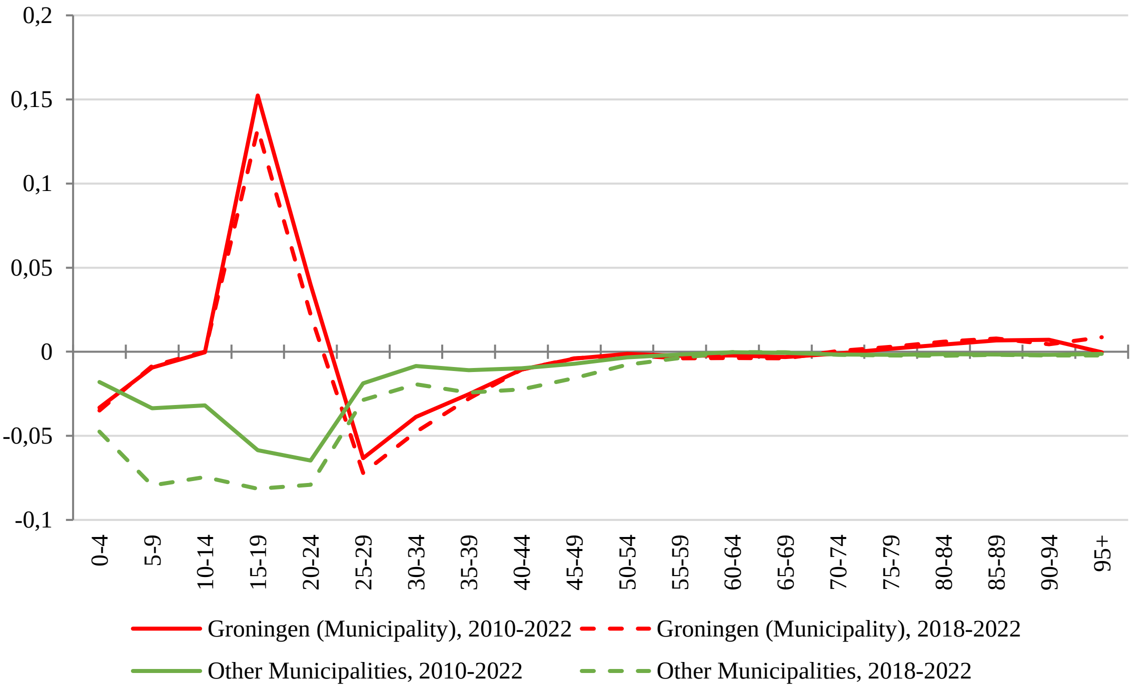
The two different future scenarios are determined by the years from which the annual averages of the data series are taken. Figure 4.7 shows the differences in the assumed constant internal migration rates per age category.[5] In the case of the municipality of Groningen, the differences between the two assumed constants are hardly noticeable. The exceptions are the age categories from 15 years to 40 years, with the annual average of the last five years showing lower internal migration rates. This shows that fewer adolescents and adults have settled in the municipality

[5] The differences in the net migration rates by sex are not shown in Figure 4.7. However, the sex difference is taken into account in the projecting of the populations of the municipality of Groningen and other municipalities.

of Groningen in the past five years than in the previous thirteen years. However, the age pattern remains the same, with relatively many adolescents moving into the municipality, while relatively many in the ages where they have finished their education (25 to 39-year-olds) are leaving the municipality. In addition, many children leave the municipality.

The differences are more evident in the case of the other municipalities. The net internal migration rates at all ages are lower in the past five years than in the period 2011-2022. Despite that the differences between the annual averages of the two different periods are noticeable, it can also be observed that the age-specific pattern in the net internal migration rate remains the same. In almost all age categories, net internal migration is below zero, which indicates that in every age category, more people are leaving the other municipalities than are settling there from another part of the Netherlands. The net internal migration rate is extremely low, especially in the youngest age categories, and to a lesser extent in the ages 25 to 50 years old.

**Figure 4.6**: Age-specific internal net migration rates of the municipality of Groningen and other municipalities of the province of Groningen, 2010-2022 & 2018-2022

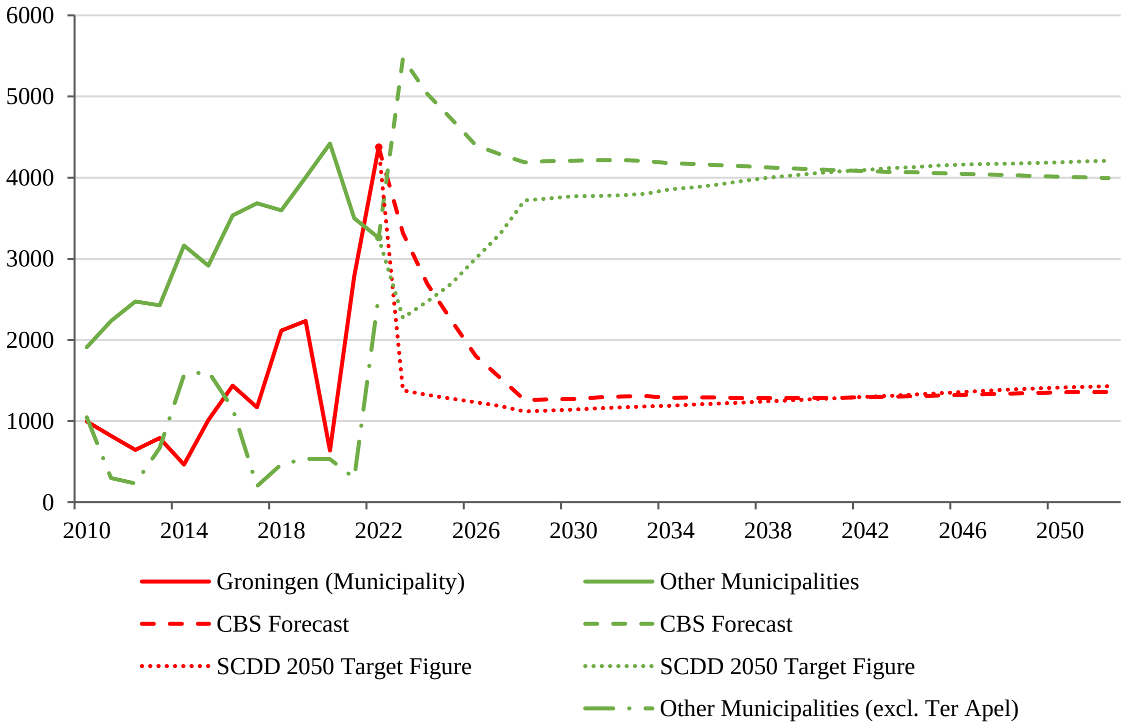



**Source**: CBS StatLine (2023d; 2024).

### 4.4. International migration

Figure 4.7 depicts the net international migration of the Netherlands, the municipality of Groningen, and the other municipalities of the province of Groningen. The net international migration numbers fluctuate very strongly in the case of the municipality of Groningen. Initially, net international migration fell from 994 in 2010 to 464 in 2014. In subsequent years there has been an increasing trend. However, the year 2020 was an important exception. The net international migration this year was 637. After this, the net international migration numbers skyrocketed to 2,791 in 2021 and 4,375 in 2022. The dip was most likely caused by the COVID-19 pandemic and the peak that follows is probably a catch-up of international migration movements to the Netherlands by international students from abroad. The historical trend for the other municipalities exhibits pronounced differences with the municipality of Groningen. The net international migration of the other municipalities was almost twice as high (1,910) compared to the municipality of Groningen in 2010 (994). In the following years, it steadily increased and even reached a peak in 2020 of 4,420 or an increase of 131% compared to 2010. However, excluding the municipality in which Ter Apel is located results in a significant alteration of the trend. In this case, the number of net migrants fluctuates widely with a minimum of 198 in 2017 and the highest level of 2,548 in 2022.

**Figure 4.7**: The historic and projected net international migration of the Netherlands and the subregions of the province of Groningen, 2010-2052




**Source**: CBS StatLine (2023f; 2023i; 2023l).

The two future scenarios illustrate different trends. Both the adjusted CBS forecast and the target figure of the State Committee Demographic Developments 2050 (denoted as SCDD 2050 in Figure 4.8) present a decrease in the net international migration regarding the municipality of Groningen. The scenario based on the SCDD 2050 proposes a steep decline to a stable number of net international migrants around 1,100 annually. The CBS forecast displays a smoother decline of an average of 525 international migrants per year. The decline stabilises in 2028 at the same level as in the SCDD 2050 scenario. In the case of the other municipalities, the net international migration rate will sharply increase to 5,471 in 2023 in accordance with the conditions outlined by the adjusted CBS forecast. In the following years, it will gradually decrease to around the annual number of 4,200 to 4,000 net international migrants in the period 2028-2052. The SCDD 2050 target figure suggests a sharp decline to 2,272 in 2023. Subsequently, there will be a strong increase of approximately 300 net international migrants per year until 2028. Afterward, the increase in net international migration will persist but its increase will be less pronounced. In 2042, the SCDD 2050 assumes a higher number of net international migrants than the adjusted CBS forecast and in the end, this has grown to an annual difference of around 200 net international migrants.

Table 4.1 below summarises the results of the different trajectories that the components of demographic change may undergo in the future. The table shows for both parts of the province of Groningen which scenario leads to the lowest and highest value with regard to each demographic component. In the case of the municipality of Groningen, the scenario based on regression for fertility and mortality in combination with internal migration rates based on recent years (2018-2022) and international migration based on the target figure set by the State Committee Demographic Developments 2050 results in the lowest fertility rates, lowest life expectancy, lowest internal and international migration numbers. On the other hand, fertility and mortality based on a convergence scenario combined with the standard constant of internal migration rates (based on the annual average of the period 2010-2022) and the adjusted CBS forecast of migration figures lead to the highest numbers. The only difference between the municipality of Groningen and the other municipalities is that fertility based on convergence leads to lower fertility rates, while regression shows higher fertility rates in the case of the other municipalities.

**Table 4.1**: Summary of results for the various demographic component trajectories per region of the province of Groningen

| | *Municipality of Groningen* | | *Other municipalities* | |
|---|---|---|---|---|
| **Component** | **Low** | **High** | **Low** | **High** |
| Fertility | Regression | Convergence | Convergence | Regression |
| Mortality | Regression | Convergence | Regression | Convergence |
| Internal migration | Recent constant | Standard constant | Recent constant | Standard constant |
| International migration | SCDD 2050 | CBS Forecast | SCDD 2050 | CBS Forecast |

This overview informs us in creating the expected upper and lower bounds. In addition, a realistic middle ground is created for both regions. For both regions, a combination of mortality rates is made based on the average proposed by the regression and convergence scenario, and the same applies to the two international migration scenarios. For fertility, the regression-based scenario is used because the historical time series has displayed very consistent relative proportions between the national average, the municipality of Groningen, and the other municipalities. Lastly, the standard constant for net internal migration rates is utilised.

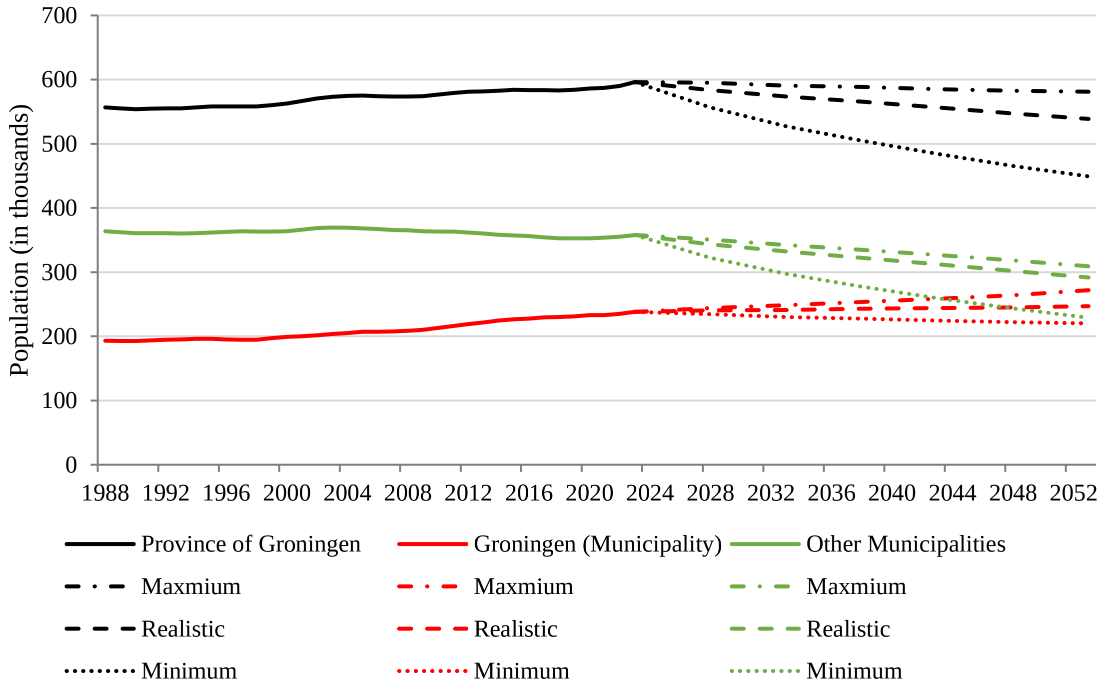
### 4.5. Population and structure

When discussing the results of the population projections, it is important to have a clear picture of the different combinations of scenarios presented. The minimum scenario represents the lowest fertility rates, lowest life expectancy, and lowest international migration rates, while the maximum scenario represents the opposite. The realistic scenario applies the extrapolated fertility rates in combination with the average of the mortality rates and international migration figures of the two different scenarios.

Figure 4.8 shows the total population size of the province of Groningen, the municipality of Groningen, and the other municipalities of the province of Groningen. During the period 1988-2008, both the population size of the municipality of Groningen and the other municipalities were fairly stable at a level of approximately 365 thousand inhabitants. In the following years, the population size of the other municipalities fell by 10 thousand to 355 thousand inhabitants in 2022. The municipality of Groningen, on the other hand, saw an increase in its population size in the same time series of 16,711 inhabitants, or an increase of 2.91% in fifteen years. This has caused the population of the two regions to converge. Because growth in the municipality of Groningen was stronger than in the other municipalities, the general population of the province also increased throughout the period from 556,757 in 1988 to 590,170 in 2022.

When looking into the future, it is visible that the convergence of the two regions in terms of population size will continue, no matter which scenario. In the maximum scenario, the population of the municipality of Groningen continues to grow from 238 thousand in 2022 to 272 thousand in 2052. This differs from the other municipalities, which fall from 358 thousand in 2023 to 309 thousand in 2053. The first experiences an increase of 34 thousand inhabitants, while the latter sees a decrease of 49 thousand inhabitants. The province's population will experience a small decline of 500 people annually in this scenario.

**Figure 4.8**: The historic and projected total population at the start of the year of the province of Groningen and its subregions, 1988-2052

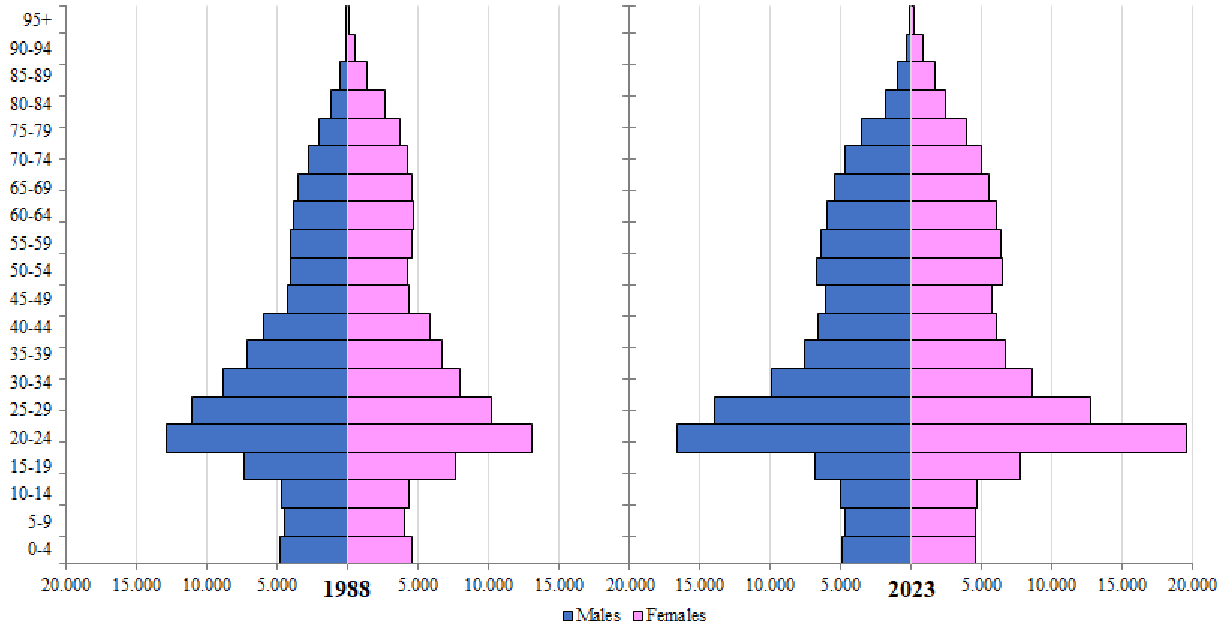



**Source**: CBS StatLine (2023a-m; 2024).

The minimum and realistic scenarios do not differ much from each other in the case of the municipality of Groningen, while the distance between the scenarios in the case of the other municipalities is quite significant. In the case of the other municipalities, the population decreases to 292 thousand in the realistic scenario and to 229 thousand in the minimum scenario in 2050. The difference between the two scenarios is less pronounced in the case of the municipality of Groningen. In the minimum scenario, the population will decrease from 238 thousand in 2023 to 220 thousand in 2053. In the realistic scenario, this amounts to a growth of 9,000 to 247 inhabitants in 2053. In the case of the province of Groningen as a whole, both scenarios lead to a decline in the population. The decrease is more prominent in the minimum scenario when compared to the realistic scenario: 449 and 539 thousand inhabitants in 2053 respectively.

To analyse the population structure, a population pyramid is used as a graphical representation. Population pyramids provide a representation of the sex and age distribution of the population. Figure 4.9 depicts the population structure of the municipality of Groningen in 1988 on the left-hand side and the right-hand side shows the same for 2023. Both indicate the same unique structure of relatively many young adults. The largest age groups are the 20 to 24-year-olds and the 25 to 29-year-olds. The two age groups comprised almost a quarter of the total population in 1988. In 2023 their share increased to just above a quarter (26%). The share of the youth (below 15 years) is relatively small, especially in 2023. Although their absolute share has shrunk, their absolute number actually increased from 26,922 in 1988 to 28,475 in 2023. The proportion of older adults and elderly was less voluminous in 1988 compared to 2023. It is also worth noting that there were relatively many women in the age groups above 50 years at that time: 58.01%.

**Figure 4.9**: Population structure of the municipality of Groningen, 1988 and 2023

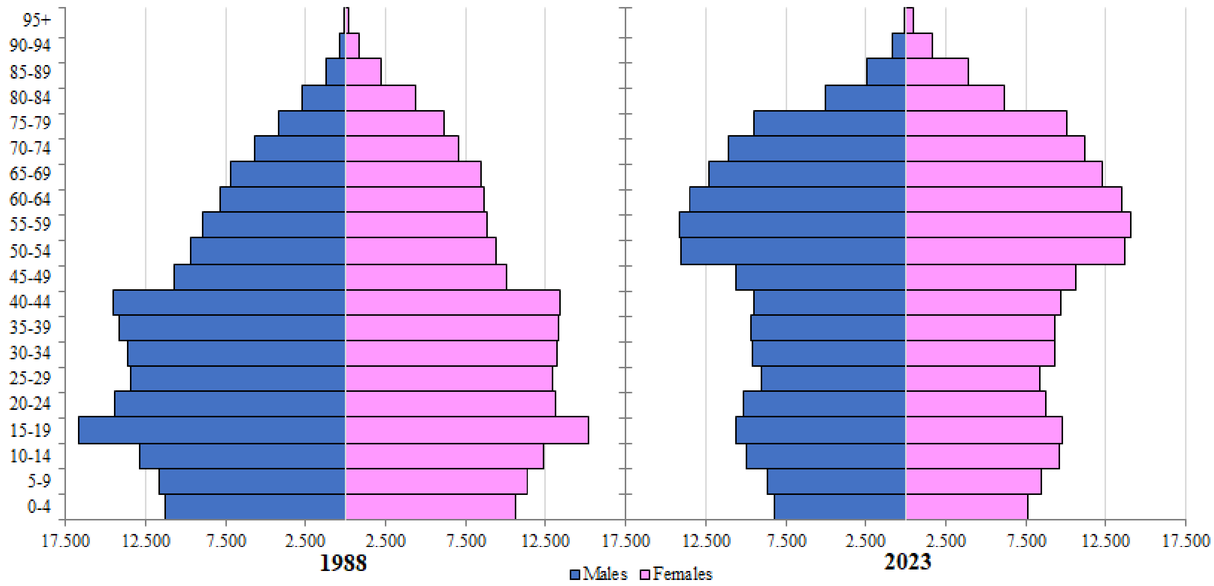



**Source**: CBS StatLine (2023d).

The difference between the two points in time is much more pronounced in the case of the other municipalities (see Figure 4.10). The left side shows that the population of the other municipalities was predominantly young. The large proportion of young people under 19 is particularly remarkable between the other municipalities and the municipality of Groningen. In absolute numbers, this group was 2.5 times larger in the other municipalities (102 thousand) than in the municipality of Groningen (41 thousand). However, it is clear that the other municipalities of the province of Groningen did not retain their original population structure in 2023. The region of the province of Groningen transformed from a youthful population to an old population. The relative share over the age of 50 doubled from 28.67% in 1988 to 47.50% in 2023. The other age groups are more balanced.

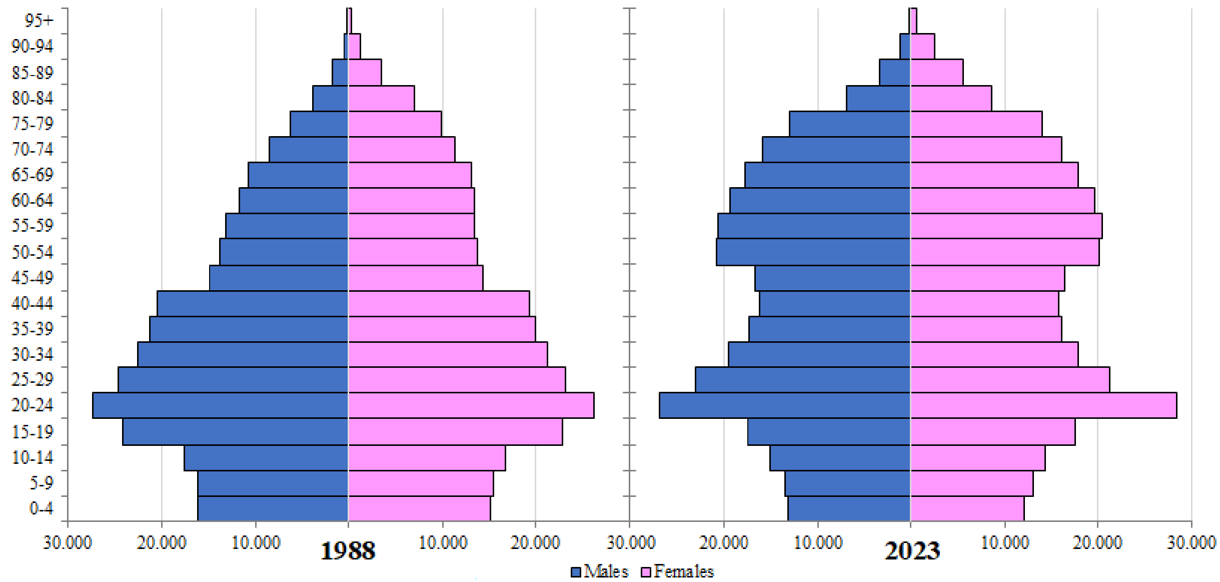
Figure 4.10 shows the province of Groningen as a whole. The population pyramid of 1988 shows the large size of the boomer generation, which all had reached their working-age at that point in time. The generations before and after are clearly smaller in size. The population structure of 2023 reflects the unique structure of both regions of the province of Groningen: it has a relatively high proportion of young adults (20-29 years old) and people aged over 50 years. In short, the province retained a high share of student-age residents, while at the same time, the boomer generation grew older, and accordingly, moved up some steps in the population pyramid.

**Figure 4.10**: Population structure of the other municipalities of the province of Groningen, 1988 and 2023




**Source**: CBS StatLine (2023d).

**Figure 4.11**: Population structure of the province of Groningen, 1988 and 2023

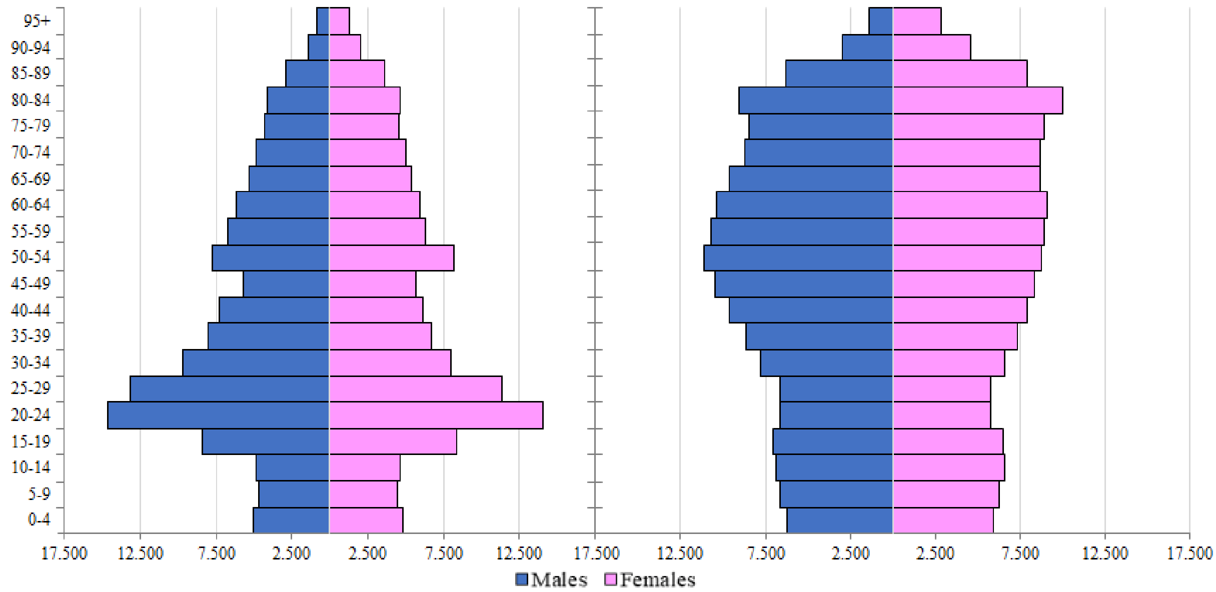



**Source**: CBS StatLine (2023d).

The municipality of Groningen will retain its unique population structure in 2053 (see Figure 4.11). The population diagram shows the conditions assumed in the realistic scenario, which includes low fertility. As a result, the municipality of Groningen continues to have a relatively small proportion of residents under the age of 15. The share of young adults remains large, but the relative share of young adults falls below a quarter to 21.56% in 2053. The proportion of older adults and elderly will grow compared to 2023. This unique population structure, a narrow base of the population pyramids in combination with many young adults and a gradually decreasing share in older age groups, resembles the shape of a Christmas tree.[6]

The population structure of the other municipalities is shown on the right side of Figure 4.12. In the next thirty years, the relatively large group of people over 50 years old will be exposed to both decreasing mortality risks in a temporal perspective and increasing mortality risks in terms of their increasing age. As they get older, more of them will die. Relatively many women are present in the oldest age group because of their better survival odds. This differs from the working-age in which relatively many men are present. This is mainly due to more male international immigrants coming to the region (about 55%). Exactly the opposite applies to the municipality of Groningen, where male immigrants represent only 45%. Finally, the share of those aged under 20 years old is relatively small in 2053 compared to 1988: 17.37% and 28.11% respectively.

**Figure 4.12**: Projected population structure of the municipality of Groningen (left) and other municipalities of the province of Groningen (right), 2053



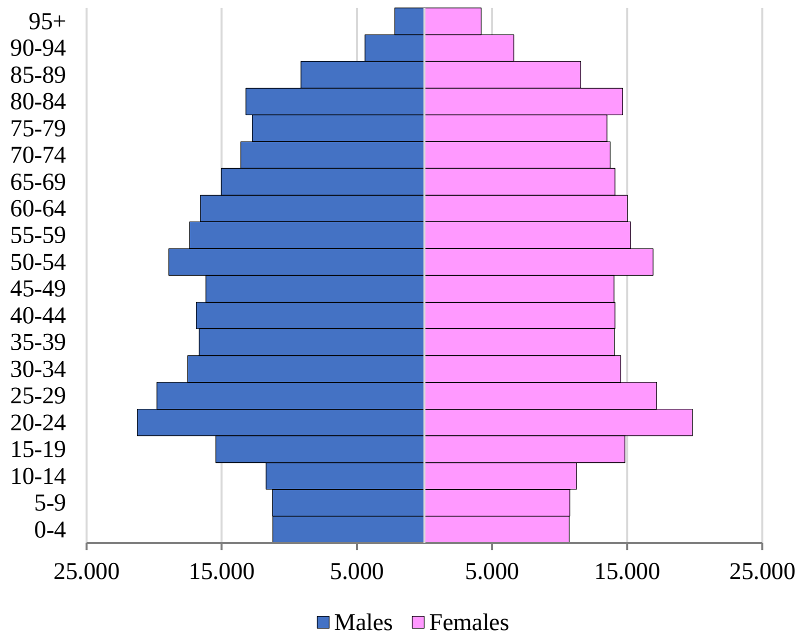

**Source**: CBS StatLine (2023a-m; 2024).

The combination of the two population diagrams leads to the realistic scenario of the population of the province of Groningen as a whole in 2053 (see Figure 4.13). This future scenario shows that the proportion of people over the age of 80 has increased significantly. The difference is the greatest when compared to 1988. In 1988, 18,534 persons, or 3.33% of the total population

[6] The population structures under the conditions proposed by the alternative scenarios can all be consulted in the appendix.

were over the age of eighty in the province of Groningen. In 2053 this will increase to 66,027 or 12.05% of the total population. This is three and a half times higher when compared to 2023. In addition, the continued presence of a relatively high proportion of young adults is noteworthy.

**Figure 4.13**: Projected population structure of the province of Groningen, 2053



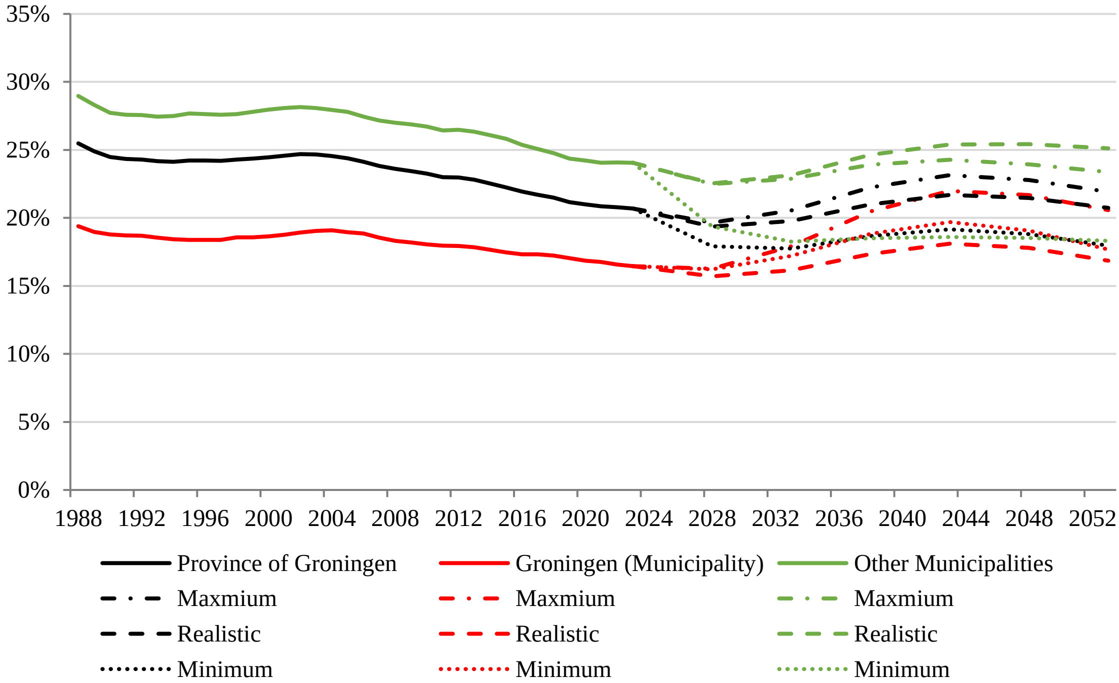

**Source**: CBS StatLine (2023a-m; 2024).

### 4.6. Dependency ratios

Population pyramids are useful for visually presenting a global perspective of the structure of a population. However, it is difficult to measure the implications of the structure based on this overview. This is why the dependency ratios are examined. The dependency ratios measure the ratio of dependents to the working-age population (15 up to 65 years old).

First, an overview is given of the youth dependency ratio, which concerns the ratio between the population under 15 years and the working-age population (see Figure 4.14). The youth dependency was highest in the other municipalities of the province of Groningen in 1988: 28.97%. This number remained virtually unchanged until the beginning of the twenty-first century and was 28.08% in 2003. This was followed by a sharp decline to 24.05% in 2023. This percentage implies that there were approximately four people in the working-age population for every person under the age of 15. The municipality of Groningen shows almost an identical trend but starts at a lower point. In 1988 the youth dependency ratio was 19.4%. After a brief peak in 2004 of 19.09%, the youth dependency ratio of the municipality of Groningen also fell to the lowest point of 16.45% in 2023. The youth dependency ratio of the province of Groningen was 25.48% in 1988. As the population size of the other municipalities decreased and that of the municipality of Groningen increased, the youth dependency of the entire province increasingly moved between the two subregions and ended at 20.69% in 2023. This is equivalent to approximately five people in the working-age population for every person under the age of 15.

**Figure 4.14**: The historic and projected youth dependency ratio of the province of Groningen and its subregions, 1988-2052




**Source**: CBS StatLine (2023a-m; 2024).

The realistic and maximum scenario do not mean very different results in the case of the other municipalities. In both scenarios, the youth dependency ratio decreases in the first five years. In the maximum scenario, it increases until 2043, reaching a peak of 24.28% after which it gradually decreases again to 23.37% in 2053. In the realistic scenario, the ratio increases sharply and ends in 2053 at a level of 25.11%. The minimum scenario paints a completely different story, with the youth dependency ratio declining sharply and stabilising at a level of 18.5% in the second half of the projection period.

The municipality of Groningen shows clear differences in the different scenarios. The maximum scenario outlines a strong increase of 33.68% from 16.45% in 2023 to 21.99% in 2043. Subsequently, the youth dependency ratio decreases to 20.59% at the end of the projection period. The minimum and realistic scenarios show lower results. Initially, the youth dependency ratio increases, but not as strongly as in the maximum scenario, to 18.12% in the realistic scenario and to 19.70% in the minimum scenario in 2043. In 2053 the two scenarios reach approximately 17%. This means that for every person under 15 years old, there will be about six persons of working-age.

The accumulation of the different scenarios per subregion leads to a perspective on the future youth dependency ratio of the province as a whole. At first, both the maximum and realistic scenario show a brief decrease in 2028 below 20%, but then it is converted into an increase in the youth dependency ratio. The decrease in the minimum scenario is rather strong and levels off at around 18% in 2033. The youth dependency ratio reaches the highest level in the maximum scenario (21.92%), the realistic scenario is in the middle (20.75%) and the minimum scenario shows by far the lowest figures (17.79%).

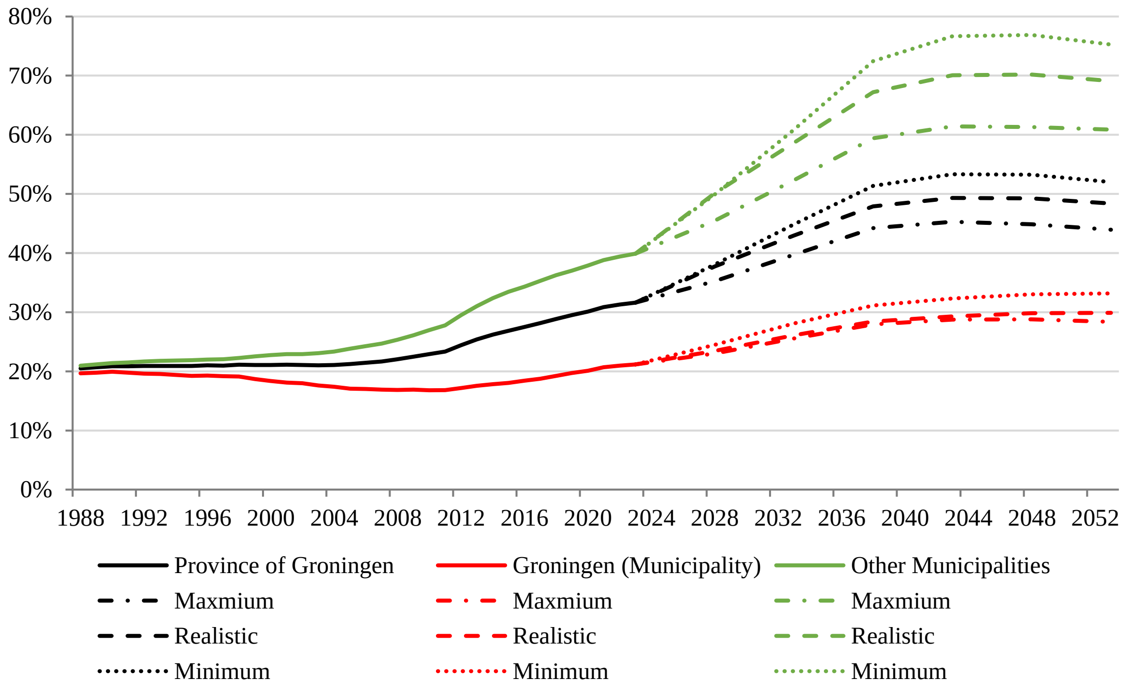
Figure 4.15, gives an overview of the old-age dependency ratio, which refers to the ratio between the population aged over 65 years and the working-age population. The graph shows that all almost regions start from an identical starting point of 20%. In the first two decades after this, the old-age dependency ratio of the other municipalities gradually increases, while that of the municipality of Groningen decreases. This divergent trend will be reinforced after 2012, with the old-age dependency ratio of the other municipalities increasing sharply by more than 10 percentage points to 39.89% in 2023. Although the old-age dependency ratio of the municipality of Groningen also increases, the increase is much less strong and also ends at a lower level in 2023: 21.16%. The old-age dependency ratio of the province of Groningen hardly increased during the first two decades after 1988, but also increased at a relatively high pace from 2012 onwards. The old-age dependency age ratio of the province of Groningen was 31.61% in 2023. This means that for every person aged sixty-five or older, approximately three are living in the working-age population.

Shifting the attention from the past to the future, it can be noticed that the trend for the other municipalities will continue and even strengthen. In the minimum scenario, the increase is the strongest and a level of 76.88% is reached in 2048. In the last five years, the old-age dependency ratio decreases minimally and ends at 75.28% in 2053. This means that for every three persons in the working-age population, there will be two persons 65 years or older. The increase is less strong in the realistic scenario. In the realistic scenario, the old age dependency ratio peaks at 70.06% in 2043 and ends at 69.07% in 2053. The maximum scenario proposes a smaller increase from 39.89% in 2023 to 60.09% in 2053.

In the case of the municipality of Groningen, there is not much divergence between the different scenarios. In the minimum scenario, the old age dependency increases more strongly, reaching 33.17% in 2053. In the realistic and maximum scenario, the increasing trend in the old-age dependency ratio will continue to around 28% in 2038. In the following fifteen years, this ratio will remain very stable, which means that in 2053 for every three people over the age of 65, there will be 10 people present in the working-age population.

Finally, it can be observed that the old-age dependency ratio of the province of Groningen will continue to increase. In 2038, the increase levels off and reaches a level of approximately 48%. The old-age dependency ratio ends at lower levels at the end of the projection period in the case of the realistic and maximum scenarios: 48.36% and 43.94% respectively. The old-age dependency ratio ends up the highest in the minimum scenario: 52.02%.

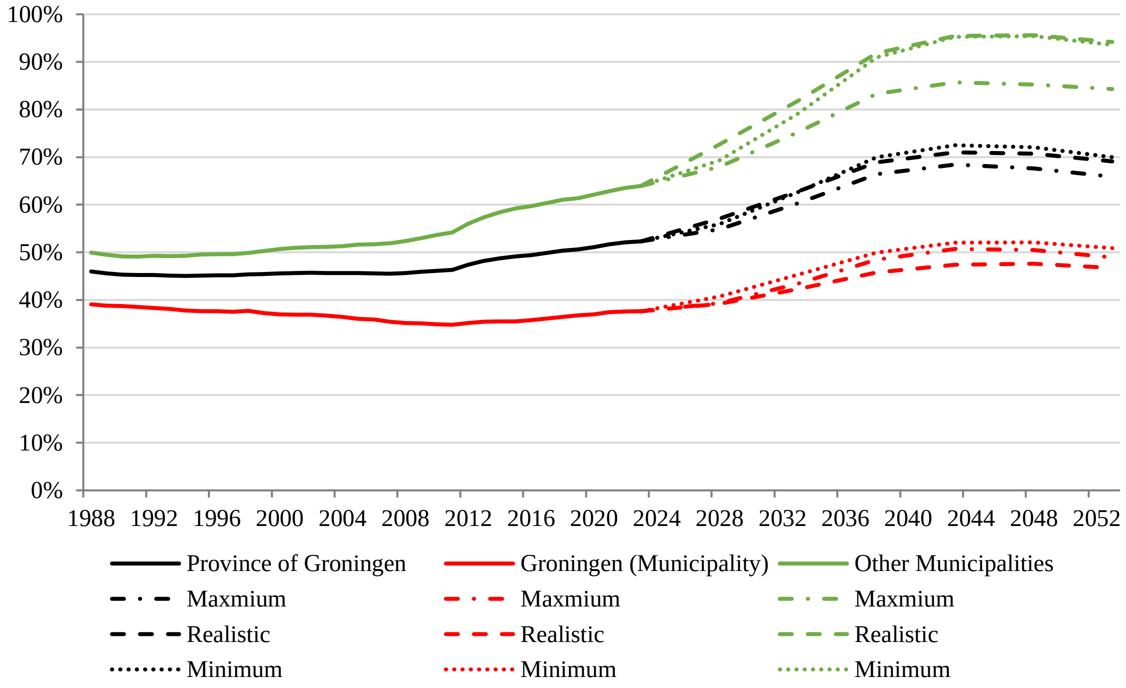
**Figure 4.15**: The historic and projected old-age dependency ratio of the province of Groningen and its subregions, 1988-2052




**Source**: CBS StatLine (2023a-m; 2024).

The summation of the youth and old-age dependency ratio leads to the total dependency ratio that is shown graphically in Figure 4.16. This measures the full ratio of the dependent-age population (the young plus the old) to the working-age population. From 1988 to 2011, the total dependency ratio of the other municipalities gradually increased, it gradually decreased in the municipality of Groningen and that of the province as a whole was fairly stable. The total dependency ratio of the municipality of Groningen increased after 2011 from 34.78% to 37.62% in 2023. The total dependency ratio of the other municipalities increased sharply from 54.19% to 63.94% in the same period. It increased with a growth factor of 1.18 compared to 1.08 in the case of the municipality of Groningen. Furthermore, the province's total dependency ratio also increased, but this growth was moderate and reached a level of 52.30% in 2023. This means that for every dependent there are two people in the working-age population.

**Figure 4.16**: The historic and projected total dependency ratio of the province of Groningen and its subregions, 1988-2052




**Source**: CBS StatLine (2023a-m).

The future shows different results for the subregions of the province of Groningen, but an increase in the total dependency ratio can be observed in every scenario. There is virtually no difference in the future trend to note from the minimal and realistic scenario. Both increase until 2048 and then reach the highest level of approximately 95%. The maximum scenario states that the total dependency ratio will reach a peak of 85.70% in 2043, or 10 percentage points lower. The municipality of Groningen shows smaller differences between the different future scenarios. In the minimum scenario, the total dependency of the municipality of Groningen reaches the highest value of 50.71% in 2043. Yet the values of the realistic and minimum scenarios are not far from this: 47.41% and 52.03% respectively. The total dependency of the municipality of Groningen then decreases in every scenario and all reach a value of approximately 50%.

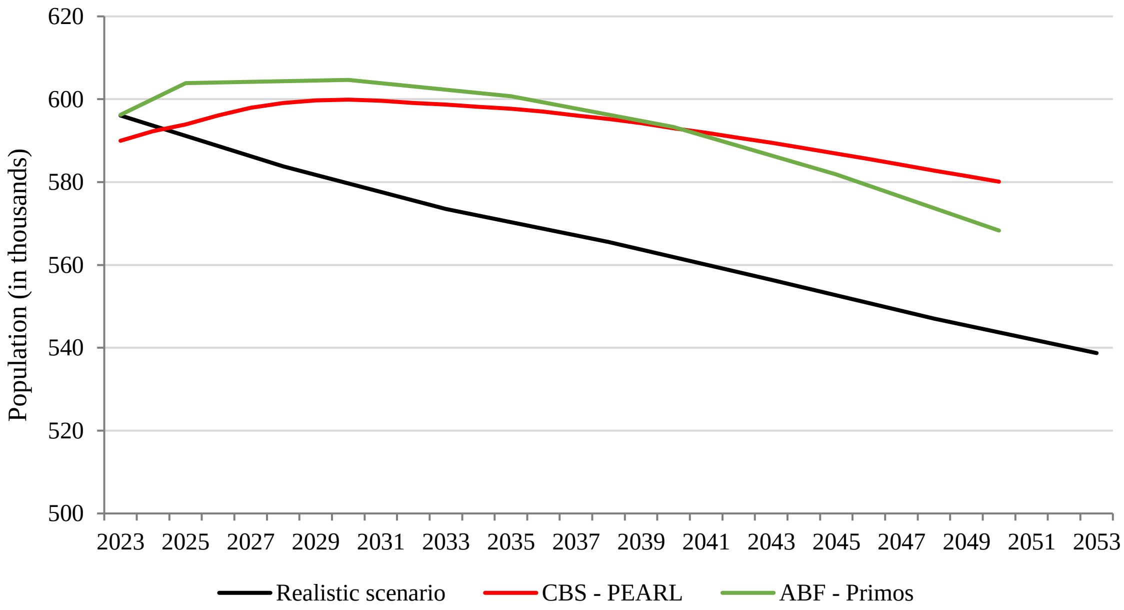
Lastly, the total dependency ratio of the province of Groningen will increase, no matter which scenario. The conditions set by the minimum scenario will see the greatest increase from 52.30% in 2023 to 69.99% in 2053. However, the differences are not large between the other two scenarios. In the maximum scenario, the total dependency ratio reaches a level of 65.85%

in 2053. In the realistic scenario, this figure is closer to the minimum scenario: 69.11%. This implies that for every seven dependents there are ten people in the working-age population.

### 4.7. Comparison with other population projections

Comparing the population projection results of this thesis with population projections made by other research institutions is insightful and may identify possible inconsistencies in the results. The results of the realistic scenario are compared with the results of the model of the CBS (Projecting population Events At the Regional Level; PEARL) and of ABF Research (Primos). Unfortunately, both have complementary shortcomings. First of all, CBS does not disaggregate population numbers by age, while it gives the aggregate data by municipal level (CBS, 2023n).[7] In contrast, ABF Research disaggregates by age, but not by municipality level (ABF, n.d.). Therefore, only comparisons at the provincial level are made.

**Figure 4.17**: Population projections of the province of Groningen, 2023-2053



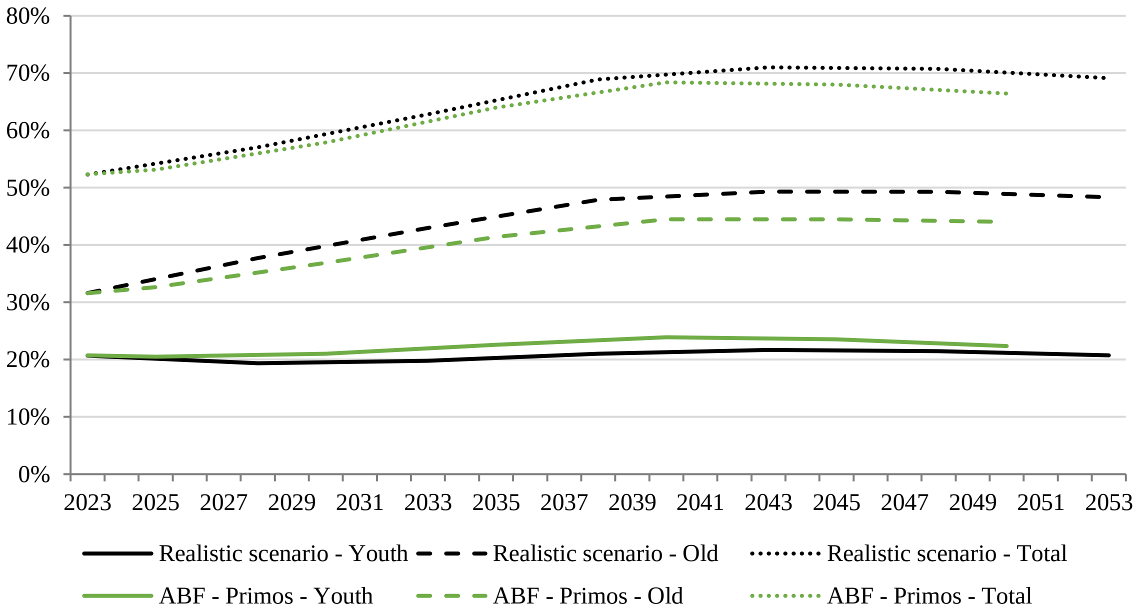

**Source**: CBS StatLine (2023a-n; ABF Research, n.d.).

Figure 4.17 shows the various population projections for the province of Groningen. The realistic scenario proposes a decline in the number of inhabitants from the beginning of the projection period, while the other population projection models expect population growth in the first ten years. The PEARL model assumes that the population will continue to grow to 600 thousand in 2030, after which there will be a steady population decline of approximately one thousand inhabitants per year. ABF Research's Primos model expects a relatively strong

[7] The detailed information, including numbers per age group, is not included in the data. Probably due to its insufficient reliability as stated in the erratum (CBS, 2023n).

increase over the next three years. From 2030 onwards, according to the Primos model, the population size of the province of Groningen will decrease. This decrease is relatively strong compared to the other population projections, but not so strong that it falls below the expectations of the realistic scenario. In 2050, the PEARL model depicts the highest population number (580 thousand), followed by the Primos model (568 thousand), and the realistic scenario shows the lowest population number (544 thousand) for the province of Groningen.

**Figure 4.18**: Projected dependency ratios of the province of Groningen, 2023-2053




**Source**: CBS StatLine (2023a-n; ABF Research, n.d.).

Figure 4.18 focuses on the development of the dependency ratios and compares the results of the realistic scenario with the results of the Primos model. Although the two models showed different total population numbers, the relative population numbers are quite similar. The Primos model estimates the youth dependency ratio to be slightly higher than the realistic scenario. However, this difference amounts to approximately just under 1.5 percentage points over the projection period. The differences in the old-age dependency ratios, on the other hand, are larger. The realistic scenario expects a faster increase in the old age dependency ratio than the Primos model. The difference grows steadily from 1.39 percentage points in 2025 to 4.54 in 2048. Because the realistic scenario estimates the youth dependency values to be lower than the Primos model and the old-age dependency ratio to be higher, the total dependency ratios do not deviate far from each other. The Pearl model shows that the old age dependency is 3.65 percentage points lower than that of the realistic scenario in 2050: 66.44% and 70.09% respectively.

## 5. Conclusion

This research examined the possible demographic future scenarios that the province of Groningen can expect until 2053. For this purpose, the province has been divided into two subregions: the municipality of Groningen and the other municipalities of the province of Groningen. This was done because of the different demographic characteristics of both Groningen regions. Separate population forecasts were then created for the two regions.

The population forecasts are built on future developments in the components of demographic change: fertility, mortality, internal migration, and international migration. Two different methods were used for future developments in fertility and mortality: extrapolation based on a simple linear regression with the forecasted national values and convergence with the relevant values. For internal migration, two constants based on the historical time series were assumed. This was done because the lack of data leaves little room for manoeuvring for more advanced statistical methods. Finally, a constant relationship with the forecasted national values has again been assumed for international migration, while a target figure of the State Committee Demographic Developments 2050 has been applied as an alternative.

The components of demographic change have been analysed separately, both their recent-historical development and future development under the different conditions suggested by convergence, simple linear regression, and other assumptions. Based on these results, three different scenarios have been created. The minimum scenario represents the lowest fertility rates, the lowest life expectancy, the lowest internal migration rates, and the lowest international migration rates. The maximum scenario represents the inverse. The realistic scenario applies the extrapolated fertility rates, because of their historical relative consistency proportions, in combination with the standard constant for net internal migration rates, and the average of the mortality rates and international migration figures of the two different scenarios.

The three scenarios have been applied within the framework of the cohort component model. The unique population structure of the municipality of Groningen – a relatively large proportion of young adults (20-29 years old), a decreasing proportion of older adults, and a minimal proportion of youth – will be maintained in the future. The different scenarios show little variation. In every scenario the youth, old-age, and logically also the total dependency increases. Yet these are relatively small increases from an average of 1.92 percentage points in the case of the youth dependency ratio to an average of 18.37% in 2053. In the case of the old-age dependency ratio, it increases by an average of 9.31 percentage points to a level of an average of 27.92%. The only exception can be noted in the convergence scenario, which shows a strong increase in the youth dependency ratio which is 2.5 percentage points higher than the other two scenarios. The total dependency ratio will reach a maximum of 52.09% in the minimum scenario. This means that there will be two people in the working-age population for every person of dependent age.

The future will bring more changes to the population structure of the other municipalities of the province of Groningen. In 1988, this region was characterised by a relatively young population, while in 2023 it was characterised by relatively many people over the age of 50. In the future, this trend will continue and under conditions set by the realistic scenario, the share of people aged 80 years or older will have grown to one in seven. According to the conditions set by the realistic scenario, the share of share of elderly people compared to the working-age population will reach 69.07% in 2053. The other two scenarios show results slightly above and below this value. Nevertheless, this means that for every seven people aged 65 and over, there will be 10 people in the working-age population. The youth dependency ratio will be fairly stable in the other municipalities in the case of the realistic and maximum scenario and end at around 24.24% in 2053. However, the minimum scenario shows a strong decline and therefore ends significantly lower at 18.32% in 2053. Finally, the total dependency will end up somewhere between 84.27% and 93.61% range.

When the two subregions of the province are considered collectively, the main question of this research can be answered. The province of Groningen will retain a relatively large share of young adults in 2053. In addition, the share of youth (15 years or younger) will increase slightly in the coming decades. As a result, the youth dependency ratio will increase steadily from 20.69% in 2023 to a maximum of 23.15% in 2038, after which it will gradually decrease again to approximately 20% in 2053. At the same time, the large age group of 50 years and over will continue to grow older. As a result, the old-age dependency ratio will keep increasing and will reach a maximum of approximately 49.31% in 2043. This figure will stabilise and end in 2053 at a level of approximately 48.11%. The young and old-age dependency ratios taken together result in a total dependency in 2053 that is between 65.85% due to the conditions assumed by the maximum scenario and 69.99% due to the circumstances indicated in the realistic scenario.

Finally, comparisons with the population projections of the PEARL model and Primos model showed that the population of the province of Groningen will continue to grow in the next ten years, while the realistic model assumes a steady population decline. The realistic scenario states that the population size of the province will be 544 thousand in 2050. According to the PEARL model, this will be higher with 36 thousand additional inhabitants and the number of additional estimated inhabitants is 24 thousand higher in the case of the Primos model. Although the expected number of inhabitants of the province varies, the projected dependency ratios of the realistic scenario and the Primos model correspond fairly well.

## 6. Discussion

Population projections are most often focused on the national level and scarcely use a subnational perspective. This research has contributed by taking a regional perspective when analysing future demographic scenarios. This was performed for the province of Groningen. The province is divided into two parts: the municipality of Groningen and the other municipalities. This method was used because of the dichotomous nature of the province in terms of its demographic characteristics. This division leads to more precise results for the province of Groningen that can help describe upcoming population issues in more detail.

The analysis has shown that the municipality of Groningen will retain its unique population structure. Although the youth and old-age dependency ratio will increase, the increase is relatively limited, especially compared to the other municipalities. In the case of the other municipalities of the province of Groningen, the increase in the youth dependency ratio will be fairly limited or even stable. On the other hand, the old-age dependency ratio will increase sharply from 38.89% in 2023 to about 62% in 2053. The increase will only stabilise in the middle of the twenty-first century. This implies a considerable task for the province, which will only become more prominent in the next two decades.

Ageing poses a problem when it comes to public services, especially with regard to health and social care. The large number of baby boomers who are ageing will most definitely increase healthcare costs. However, it should be noted that the impact is not as large as models based on a simple extrapolation of a crude age-expenditure curve will suggest (Howdon & Rice, 2018). It is not age in itself, but the time until death, especially the last year of life, that is a strong driver for health care expenditure.

Population decline is, to a certain extent, problem to the obstacle of an aging population. It is already an obstacle that certain parts of the province of Groningen are struggling with and the problem will only worsen in the future. Research by the Sociaal Planbureau Groningen (2016) shows that residents of the countryside, and in particular the shrinking areas in Groningen, experienced a decline in the quality of life. The decline in the quality of life relates to a variety of issues, including the closure of facilities, vacancy and overdue maintenance of buildings and gardens, and the decline in social contacts. In the future, population decline in the other municipalities will continue and this will have a strong influence on the quality of life in the region. Although the municipality of Groningen will probably escape the problem of population decline in the future, the interconnectedness between the two regions of the province of Groningen should be taken into account. The population decline in the other municipalies will be accompanied by a decreasing inflow of young people studying to the municipality of Groningen. When this scenario is combined with a future perspective in which Dutch universities are ‘de-internationalised’, this could also have far-reaching consequences for the municipality of Groningen and its population.

Increasing the number of births will not provide a solution in the short term. Government efforts that focus directly on increasing the number of children often have no or only very temporary effect (Staatscommissie, 2024). Moreover, a successful outcome would primarily lead to an increase in the youth dependency ratio and indirectly slow down the labour force participation of men and women. Efforts to increase immigration are contentious. Additionally, the recent election results indicate little appetite from the population of the province of Groningen (mostly in the other municipalities) for higher immigration figures. Efforts in the field of internal migration therefore seem to be a more suitable alternative for exerting influence as a government body.

Attempts to limit the internal migration outflow can be beneficial for the other municipalities as well as the municipality of Groningen. Both regions have more people leaving the region than settling in the region. However, there is a possibility that the other municipalities of the province of Groningen attract more people from other regions of the Netherlands than leave the region. The analysis of the net internal migration numbers showed that more people settle in the other municipalities than leave the region when the municipality with Ter Apel is not included in the figures. However, this conclusion cannot be definitively drawn because the internal migration numbers are not available by migration background.

The various scenarios set out in this thesis cannot be taken as gospel. There are important limitations to population projections in general: the future is simply uncertain. An additional conflict at Europe’s borders could result in a new influx of immigrants. In addition, an uncertain future, for example, a very unstable and precarious economic situation, can have a negative impact on the number of children being born. Finally, medical breakthroughs can improve life expectancy at a later age and thus make old-age dependency higher than expected.

In addition, there are barriers specific to this research. Most centre around the migration component. First of all, a multistate model was not applied in the case of internal migration due to missing necessary data. This would be desirable since the internal migration flows between the municipality of Groningen, the other municipalities of the province of Groningen, and the rest of the Netherlands are interlinked. In addition, the availability regarding internal and international migration was limited in time scope. This meant that only a small time series could be analysed and the application of more advanced statistical methods was not feasible.

Furthermore, the association between international migration and internal migration is not controlled for in this study. In the case of the other municipalities of the province of Groningen, a significant part of the internal migration outflow appeared to be determined by the international inflow to the municipality of Westerwolde. Many of these immigrants leave this municipality to settle elsewhere, making the internal migration outflow misleadingly high. Future research should create a solid working framework that checks the coherence of international migration flows and internal migration flows. Ideally, this is done within the framework of a multi-state model, in which all areas of the Netherlands are interconnected.

In addition, the population is not divided by migration background or education level. The data for this was simply not available. Including these variables in subsequent research would likely lead to more precise results. Finally, subsequent research can adjust the dependency ratios by moving the retirement age as the upper limit of the working-age population as opposed to the commonly used age of 65 years as used in this study. The same applies to the lower limit when the age at which young people perform their first job differs significantly from 15 years. This could potentially provide more realistic insights into the actual dependency ratio within a given geographic area.

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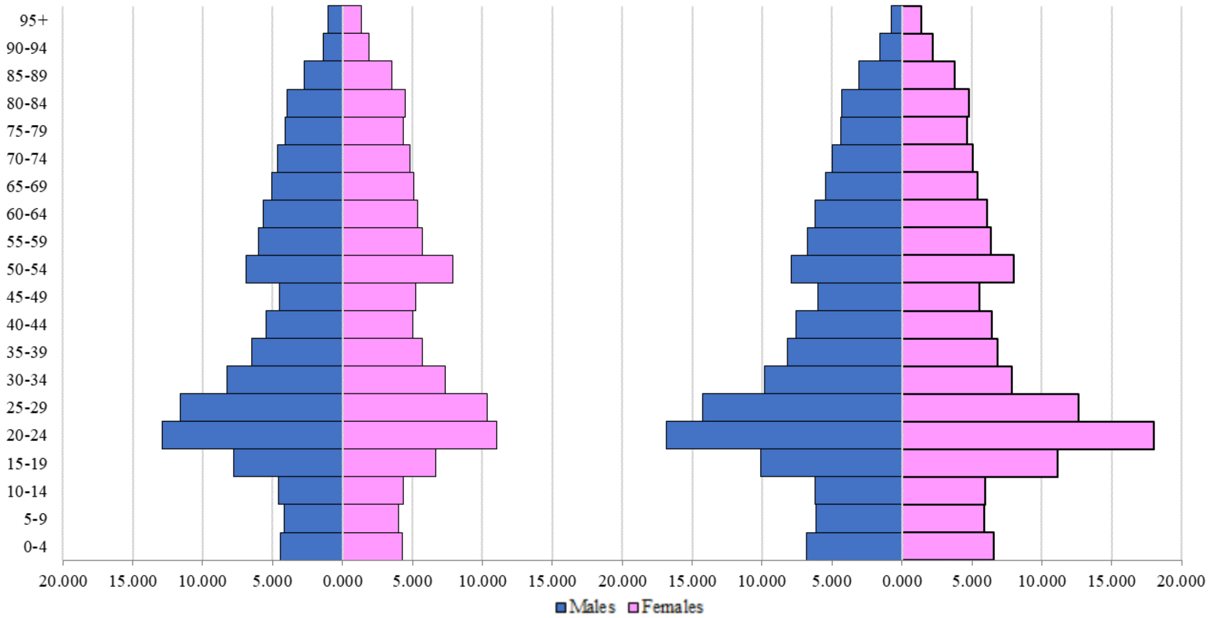
# 8. Appendix

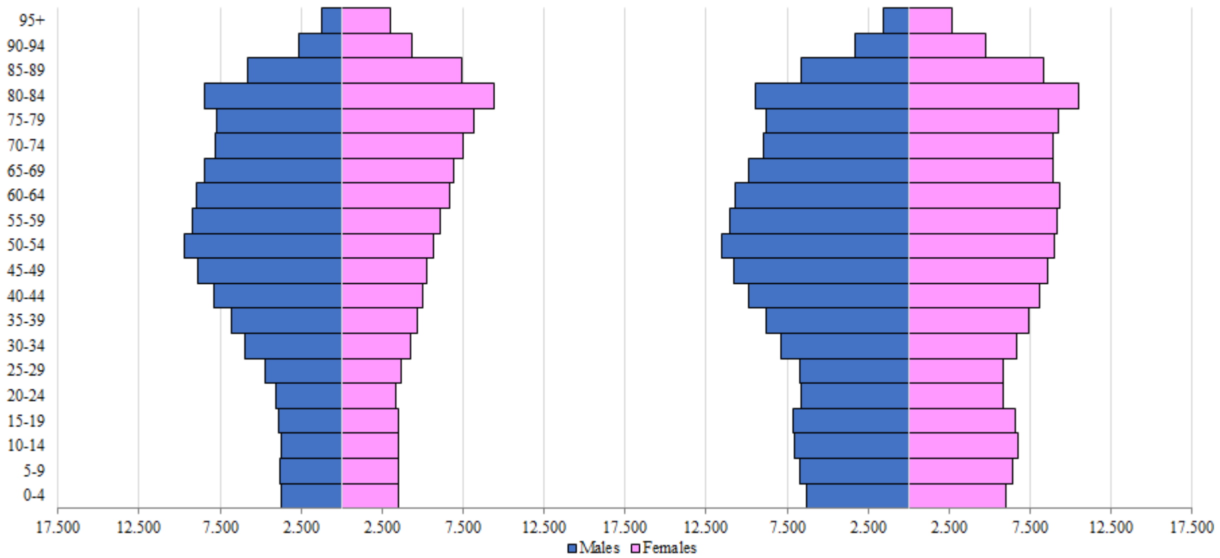
**Appendix A**: Additional figures

**Figure A.1**: Projected population structure of the municipality of Groningen under conditions set by the minimum (left) and maximum (right) scenario, 2053



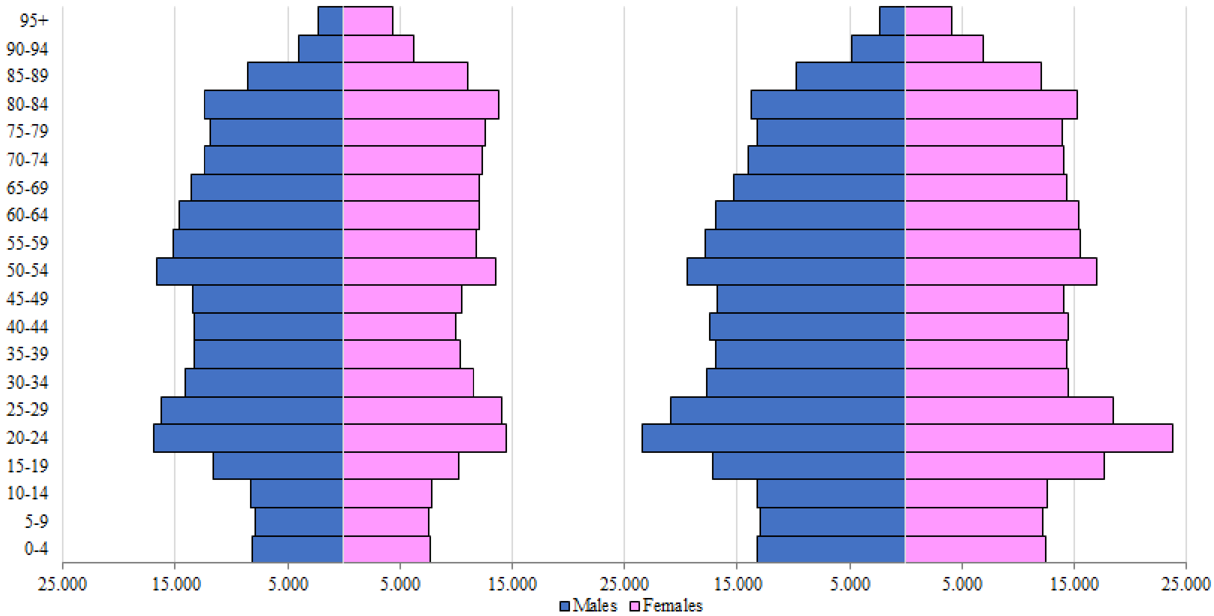

**Source**: CBS StatLine (2023a-m; 2024).

**Figure A.2**: Projected population structure of other municipalities of the province of Groningen under conditions set by the minimum (left) and maximum (right) scenario, 2053




**Source**: CBS StatLine (2023a-m; 2024).

**Figure A.3**: Projected population structure of the province of Groningen under conditions set by the minimum (left) and maximum (right) scenario, 2053




**Source**: CBS StatLine (2023a-m; 2024).

## **Appendix B**: Ordinary Least Squares regression (OLS) results

**Table B.1**: Regression results for the age-specific fertility rates

| Age Category | Parameters | Municipality of Groningen | Other municipalities |
|---|---|---|---|
| 15-19 | $\beta_1$ (Regression coefficient) | 1.078076*** | 0.6132261*** |
| | $\beta_0$ (Intercept) | -0.0000268 | 0.0018076** |
| 20-24 | $\beta_1$ (Regression coefficient) | 0.6036969*** | 0.5489843** |
| | $\beta_0$ (Intercept) | -0.0062589*** | 0.0290159*** |
| 25-29 | $\beta_1$ (Regression coefficient) | 0.8356307*** | 0.3680679** |
| | $\beta_0$ (Intercept) | -0.0289006*** | 0.0939095*** |
| 30-34 | $\beta_1$ (Regression coefficient) | 1.148864*** | 0.9446489*** |
| | $\beta_0$ (Intercept) | -0.0368744* | 0.0016274 |
| 30-34 | $\beta_1$ (Regression coefficient) | 1.04046*** | 0.6098588*** |
| | $\beta_0$ (Intercept) | 0.0061302* | 0.0101931*** |
| 40-44 | $\beta_1$ (Regression coefficient) | 1.129657*** | 0.5496678*** |
| | $\beta_0$ (Intercept) | 0.001783 | 0.0015407** |
| 45-49 | $\beta_1$ (Regression coefficient) | 1.207036** | 0.3903032* |
| | $\beta_0$ (Intercept) | -0.0000057 | 0.000081 |

**Note**: Significance levels *** p<0.001, ** p<0.01, * p<0.05.
**Source**: CBS StatLine (2023a; 2023d; 2023g).

**Table B.2**: Regression results for the male age-specific probabilities of dying

| Age Category | Parameters | Municipality of Groningen | Other municipalities |
|---|---|---|---|
| 0-1 | $\beta_1$ (Regression coefficient) | 0.8572858*** | 0.7195685* |
| | $\beta_0$ (Intercept) | 0.0014211** | 0.0020848 |
| 1-4 | $\beta_1$ (Regression coefficient) | 1.211729*** | 0.7932184** |
| | $\beta_0$ (Intercept) | -0.0000449 | 0.0005845 |
| 5-9 | $\beta_1$ (Regression coefficient) | 0.4126211 | 0.9471148* |
| | $\beta_0$ (Intercept) | 0.0004066** | 0.0001678 |
| 10-14 | $\beta_1$ (Regression coefficient) | 0.3808009 | 2.426264*** |
| | $\beta_0$ (Intercept) | 0.0003744 | -0.0007182* |
| 15-19 | $\beta_1$ (Regression coefficient) | 0.1784017 | 0.9835282** |
| | $\beta_0$ (Intercept) | 0.0008142 | 0.0001753 |
| 20-24 | $\beta_1$ (Regression coefficient) | 0.3172223 | 0.4260742 |
| | $\beta_0$ (Intercept) | 0.0010048 | 0.0022088 |
| 25-29 | $\beta_1$ (Regression coefficient) | 0.6221926* | 0 .3082147 |
| | $\beta_0$ (Intercept) | 0.0005824 | 0.0019834* |
| 30-34 | $\beta_1$ (Regression coefficient) | 1.43854*** | 0.2882927 |
| | $\beta_0$ (Intercept) | -0.001063 | 0.0027014* |
| 35-39 | $\beta_1$ (Regression coefficient) | 1.42511*** | 0.1564027 |
| | $\beta_0$ (Intercept) | -0.0015105 | 0.0043465*** |
| 40-44 | $\beta_1$ (Regression coefficient) | 0.7996837* | 0.8873646*** |
| | $\beta_0$ (Intercept) | 0.0038139 | 0.000863 |
| 45-49 | $\beta_1$ (Regression coefficient) | 0.7756061*** | 0.8104157*** |
| | $\beta_0$ (Intercept) | 0.0045864 | 0.0024921 |
| 50-54 | $\beta_1$ (Regression coefficient) | 0.97986 | 1.081904*** |
| | $\beta_0$ (Intercept) | 0.0028603 | -0.000106 |
| 55-59 | $\beta_1$ (Regression coefficient) | 0.7684937*** | 1.142129*** |
| | $\beta_0$ (Intercept) | 0.0103956* | -0.0012308 |
| 60-64 | $\beta_1$ (Regression coefficient) | 0.7960041*** | 1.071424*** |
| | $\beta_0$ (Intercept) | 0.013181* | 0.0010305 |
| 65-69 | $\beta_1$ (Regression coefficient) | 0.9356527*** | 1.007286*** |
| | $\beta_0$ (Intercept) | 0.0097488 | 0.0042162 |
| 70-74 | $\beta_1$ (Regression coefficient) | 0.8599648*** | 0.8613687*** |
| | $\beta_0$ (Intercept) | 0.02681** | 0.0234048** |
| 75-79 | $\beta_1$ (Regression coefficient) | 0.8943996*** | 0.8574034*** |
| | $\beta_0$ (Intercept) | 0.0336508** | 0.0401452** |
| 80-84 | $\beta_1$ (Regression coefficient) | 0.8192155*** | 0.8782407*** |
| | $\beta_0$ (Intercept) | 0.0681192** | 0.0461985* |
| 85-89 | $\beta_1$ (Regression coefficient) | 0.6640287*** | 0.7619995*** |
| | $\beta_0$ (Intercept) | 0.1918547* | 0.1447253** |
| 90-94 | $\beta_1$ (Regression coefficient) | 1.21448** | 0.8675459** |
| | $\beta_0$ (Intercept) | -0.1258727 | 0.1380191 |
| 95+ | $\beta_1$ (Regression coefficient) | 2.137769* | 1.441911* |
| | $\beta_0$ (Intercept) | -1.091576 | -0.3825191 |

**Note**: Significance levels *** p<0.001, ** p<0.01, * p<0.05.
**Source**: CBS StatLine (2023d; 2023e; 2023h; 2023k).

**Table B.3**: Regression results for the female age-specific probabilities of dying

| Age Category | Parameters | Municipality of Groningen | Other municipalities |
|---|---|---|---|
| 0-1 | $\beta_1$ (Regression coefficient) | 1.260329** | 1.504084*** |
| | $\beta_0$ (Intercept) | -0.0006427 | -0.0009716 |
| 1-4 | $\beta_1$ (Regression coefficient) | 0.7075405 | 0.9963273** |
| | $\beta_0$ (Intercept) | 0.0008836 | 0.0000728 |
| 5-9 | $\beta_1$ (Regression coefficient) | 0.5946053 | 1.067861 |
| | $\beta_0$ (Intercept) | 0.0001269 | -0.0000531 |
| 10-14 | $\beta_1$ (Regression coefficient) | -0.6677075 | 0.3013989 |
| | $\beta_0$ (Intercept) | 0.000914* | 0.0004481 |
| 15-19 | $\beta_1$ (Regression coefficient) | 1.168831* | 0.5872475 |
| | $\beta_0$ (Intercept) | -0.0002604 | 0.0002856 |
| 20-24 | $\beta_1$ (Regression coefficient) | 0.6770948* | 0.5488493 |
| | $\beta_0$ (Intercept) | 0.0001147 | 0.0007014 |
| 25-29 | $\beta_1$ (Regression coefficient) | 1.123006** | 0.1837801 |
| | $\beta_0$ (Intercept) | -0.0003386 | 0.0008064 |
| 30-34 | $\beta_1$ (Regression coefficient) | 1.031466 | 0.9341975 |
| | $\beta_0$ (Intercept) | 0.0003077 | 0.0004785 |
| 35-39 | $\beta_1$ (Regression coefficient) | 1.360374** | 1.446448*** |
| | $\beta_0$ (Intercept) | -0.0009203 | -0.000895 |
| 40-44 | $\beta_1$ (Regression coefficient) | 1.049492** | 1.337094*** |
| | $\beta_0$ (Intercept) | -0.0000444 | -0.0012647 |
| 45-49 | $\beta_1$ (Regression coefficient) | 1.307493*** | 0.9609629*** |
| | $\beta_0$ (Intercept) | -0.0015704 | 0.0015442 |
| 50-54 | $\beta_1$ (Regression coefficient) | 0.5772249 | 0.7748004*** |
| | $\beta_0$ (Intercept) | 0.0065621 | 0.003906 |
| 55-59 | $\beta_1$ (Regression coefficient) | 1.115488** | 0.8961223*** |
| | $\beta_0$ (Intercept) | 0.000619 | 0.003814 |
| 60-64 | $\beta_1$ (Regression coefficient) | 0.9804668** | 0.9006709*** |
| | $\beta_0$ (Intercept) | 0.0043367 | 0.0056825 |
| 65-69 | $\beta_1$ (Regression coefficient) | 1.089188*** | 0.542244** |
| | $\beta_0$ (Intercept) | -0.0010773 | 0.0255621** |
| 70-74 | $\beta_1$ (Regression coefficient) | 0.4282051* | 0.8199131*** |
| | $\beta_0$ (Intercept) | 0.0529541*** | 0.0177274 |
| 75-79 | $\beta_1$ (Regression coefficient) | 0.7952084*** | 0.7055604*** |
| | $\beta_0$ (Intercept) | 0.0309714* | 0.046857*** |
| 80-84 | $\beta_1$ (Regression coefficient) | 0.8282385*** | 0.6802242*** |
| | $\beta_0$ (Intercept) | 0.0442234 | 0.081283*** |
| 85-89 | $\beta_1$ (Regression coefficient) | 0.7267862*** | 0.8420203*** |
| | $\beta_0$ (Intercept) | 0.1126988 | 0.0677355 |
| 90-94 | $\beta_1$ (Regression coefficient) | 0.5372635* | 1.289562*** |
| | $\beta_0$ (Intercept) | 0.3250284* | -0.1702663 |
| 95+ | $\beta_1$ (Regression coefficient) | 2.573654*** | 1.956086*** |
| | $\beta_0$ (Intercept) | -1.314139* | -0.8105344* |

**Note**: Significance levels *** p<0.001, ** p<0.01, * p<0.05.
**Source**: CBS StatLine (2023d; 2023e; 2023h; 2023k).