

POPULATION PROJECTIONS WORKING GROUP

Variant projections for sub-national population projections**1. Introduction**

- 1.1. This paper and Excel workbook provide PPWG with a summary of the investigation carried out by the General Register Office for Scotland (GROS) on the feasibility of producing additional variant population projections for Scottish areas.
- 1.2. The main purpose of this work is to provide users with further information on the future population of Scottish areas by developing additional variants showing alternative projections for the population of these areas, as requested by councils in response to the consultation in November 2009.
- 1.3. PPWG are invited to:
 - Comment on the methods for producing these variants and the results.
 - Give an indication of demand and use of these variants
 - Note that the production of these additional variants is subject to sufficient IT input to improve the format of the outputs from the GROS system, and statistical resource.

2. Background

- 2.1. GROS publishes population projections at national and local authority (council and NHS board area) level every two years. In addition, projections are published biennially for Strategic Development Plan Areas and National Parks.
- 2.2. Variant projections are produced to give users an indication of the inherent uncertainty of demographic behaviour, especially for long-term projections. They are not intended to represent upper or lower limits but to illustrate plausible alternative scenarios of future demographic behaviour.
- 2.3. The Office for National Statistics (ONS) produces over 20 variant projections at national level. These variant projections are based on alternative assumptions of future fertility, mortality and migration.
- 2.4. For the latest set of Scottish sub-national projections (2008-based projections), two variant projections were published – high and low migration variants. This was the first time a low migration variant projection had been produced for sub-national areas. There is a growing demand for further variants providing more in-depth analysis on the future population of Scottish areas.
- 2.5. For English and Northern Irish sub-national population projections no variant projections were published.
- 2.6. For the Welsh 2008-based sub-national projections a no migration (natural change only) variant, and also higher and lower population projections were produced. The higher variant projection assumes higher fertility and lower mortality rates than the

principal projection, and the lower projection is the reverse. These variant projections are not constrained, and are not variants which ONS produce.

- 2.7. GROS projections are produced mainly using an in-house Excel based projection system. There are two parts to this system – the migration system and the main projection system. The inputs for the main system include: average births and deaths for each area; the base year population by council area; Scotland's projected births, population, age-specific mortality and fertility rates from the National Population Projections; and the projected migration for each council and NHS board area from the migration phase of the system.

3. Objective

- 3.1. To assess the feasibility of producing further variants for the sub-national population projections.
- 3.2. Investigate methods for producing variants at this level.

4. Work description

- 4.1. Using the GROS projection system a range of variants were produced, namely:
 - High and low fertility variants.
 - High and low life expectancy variants.
 - Zero migration (natural change only) variant.
- 4.2. Alternative migration, fertility, and mortality assumptions were used to produce these variants. The variants produced were constrained to the variant national population projection figures produced by ONS.
- 4.3. For the fertility variants, the input figures were changed to reflect the corresponding assumptions for the national fertility variants. This involved changing the age-specific fertility rates, and the projected births and population figures for Scotland. These changes were then projected through each area by the local scaling factors. The local scaling factors were not changed as further information was not available at this level, and this would also affect the constraining to the national figures.
- 4.4. To calculate the local scaling factors, first the expected births and deaths are calculated as the number of births and deaths that would be observed in each area if the Scotland level age-specific fertility and mortality factors applied. Then the number of births and deaths that we would expect if we simply scaled the average births and deaths across Scotland from the last five years to match the projected births and deaths for 2008/09 are calculated. These figures are then divided by the number of expected births and deaths mentioned above and the result is the scaling factor. A scaling factor of less than one means fewer births or deaths than if Scotland level rates applied whilst a factor of greater than one implies more births or deaths. Separate scaling factors are calculated for: fertility, mortality of males aged 0-59, mortality of males aged 60-79, mortality of males aged 80+, mortality of females aged 0-59, mortality of females aged 60-79, mortality of females aged 80+. However, for smaller areas it is not always appropriate to calculate separate mortality scaling factors for each age group

and in these cases a single factor for males and a single factor for females is used.

- 4.5. For the life expectancy variants, the Scotland level age-specific mortality rates, births, and population figures from the corresponding variants produced by ONS were inputted. This change was filtered through all areas, with local scaling factors being considered.
- 4.6. For the zero migration variant it was possible to select a 'natural increase' option on the projection system so that migration figures were not used for the projection. This led to zero in-migration and zero out-migration for the projection period, not just a net migration of zero. Fertility and mortality rate assumptions were left unchanged but the total number of births and population figures were changed to the corresponding values from the national zero migration variant projection. The system was run using zero for every migration figure and the results were compared with the 'natural increase' option projected figures.

5. Results

- 5.1. The results from the variant projections were analysed using population pyramids and scroll charts of projected population, births, and deaths. For each variant the projected figures look reasonable compared with the principal projection and the pattern of the variant projections for Scotland. Feedback is sought from PPWG members and others.
- 5.2. Both methods for producing a zero migration projection gave the same results.
- 5.3. Looking at the percentage difference between the projected population for 2033 for the principal projection and the variant projections the difference varies depending on the base population, the assumptions for each area and the local scaling factors. By ranking the difference from the principal projection it was easier to identify which areas were most affected by each variant.
- 5.4. The difference between the high and low fertility variants and the principal projection is dependent on the proportion of women of childbearing age and the local fertility scaling factors. For areas with a low proportion of women of childbearing age, the fertility variant projected populations are relatively close to the principal projection. This is the case for EileanSiar and the Orkney Islands. For areas where a larger proportion of the population falls into this category, the effect of the fertility variants is more significant, as is the case for West Dunbartonshire and West Lothian. However, for areas such as City of Edinburgh where the local fertility scaling factor is low (0.7) and the proportion of women of childbearing age is high due to the high student population, the effect of changing the fertility assumptions is low.
- 5.5. Changing life expectancy also has differing effects on the projected population for each area of Scotland. Areas which have a high proportion of older aged people and less migration tend to be more affected by the changes in life expectancy assumptions. For example, the projected population of EileanSiar and Dumfries & Galloway varies significantly from the principal projection for these areas.

- 5.6. The biggest variance from the principal projected population for almost all areas is for the high and low migration variants. The difference from the principal projection is dependent on the migration assumptions for the area.
- 5.7. For most council areas the projected populations for the variants followed a similar pattern to Scotland with the high migration variant projecting the highest population for 2033, then the high fertility, high life expectancy, the principal projection, and below this the low life expectancy, low fertility and then low migration variant. The zero migration variant gave the lowest projected population for Scotland compared with the other variants mentioned. The results for the zero migration variant differ significantly across the council areas depending on the migration assumptions for the principal projection. For example, for Inverclyde council area where the projected long-term net migration assumption is -400, the zero migration assumption led to a higher projected population for 2033 than the principal projection. In contrast, for East Lothian where the projected long-term net migration assumption is +850, the zero migration assumption leads to a lower projected population for 2033 than the principal projection.
- 5.8. Comparing the projected births for each variant, for most council areas the highest number of projected births was for the high fertility variant, then high migration variant. For the principal and life expectancy variants similar numbers of births were projected. The least number of births were projected for the low fertility variant for most areas, and the low migration variant usually had the second fewest number of projected births. Again the position of the zero migration variant is dependent on the migration assumptions for the principal and other migration variants.
- 5.9. Looking at the projected deaths for each area and Scotland, similar figures were projected for the principal projection and the fertility and migration variants. The high life expectancy variant projected less deaths and the low life expectancy variant projected more deaths over the projection period, as you would expect. Once again, the position of the zero migration variant changes between areas. For smaller council areas, the projected figures do not follow such a smooth trend as in larger areas.

6. Conclusion

- 6.1. It does seem feasible to produce variant projections at sub-national level. The results for the variants for all areas look reasonable when compared with the principal projection, but feedback is sought from PPWG.
- 6.2. The current projection system can be used to create these alternative scenarios, and they are constrained to the variants from the national population projections allowing potentially useful comparisons.

7. Recommendations

- 7.1. If both statistical and IT resources allow, producing the additional five variants investigated would be a useful way to provide users with further information on the future population of Scottish areas. The value added from these variants would be to highlight the uncertainty of demographic behaviour and provide alternative scenarios for each area.