REGINA

Remote communities & resource-based industries

How to make population projections for sparsely populated municipalities:

A User Manual for the Demographic Foresight Model

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Introduction

This working paper is developed as part of the interregional project REGINA. The REGINA project (Regional Innovation in the Nordic Arctic and Scotland with a special focus on regions with large-scale industries) is a 3-year project that focuses on developing a local smart specialisation strategy (L3S) model for implementation by remote and sparsely populated areas that depend heavily on resource based economies. Four municipalities from the Nordic-Arctic and North Atlantic region have participated in the project and each partner municipality has implemented the model. Broadly speaking, each LS3 aims to identify and develop the place-based strengths of each community, while mitigating potential risks and challenges. Three strategic planning tools developed by the REGINA project form the core components of the LS3 model:

1. **A demographic and labour market foresight Model (DFM):** that provides a quantitative means to assess the longer-term demographic implications of both negative "employment shocks" and alternative options for smart specialisation.
2. **A Social Impact Management Planning Tool (SIMP):** that aims at identifying, monitoring and managing social impacts of large-scale industries.
3. **A Local Benefit Analysis Toolbox (LBAT):** that supports the retention of local economic benefits through development of the local supply chains and growth of complimentary or spill-over opportunities presented by new industrial activities.

This working paper presents the demographic and labour market foresight model. Separate reports outline the results from our work with the social impact management planning tool and the local benefits analysis toolbox.

In this working paper, we present a specific tool to help local administrations understand the likely implications of a large-scale resource based investment (or disinvestment) upon the demographic situation and trends in their area. This is based upon the adaptation of demographic projection methods so that they can work for the small population of a sparsely populated community, and the addition of a foresight scenario capability to assess the population effects associated with a proposed development (or closure).

The structure of the report is as follows: The first section provides a brief description of population projection services provided by the national statistical agencies of the countries represented in the REGINA project (Sweden, Norway, Finland, Greenland and the UK [Scotland]), drawing attention to the aspects which local administrations (municipalities) may find insufficient for their local planning purposes. This is followed by a presentation of the structure and implementation of the REGINA Demographic Foresight Model (DFM), and a by a step-by-step guide to building a DFM for a municipality. The fourth section discusses the adaptation of the model to the needs and data availability of the municipalities which have participated in the REGINA project. The final section presents some reflections on how the quality and reliability of scenario analysis might be improved through wider consultation.

1. Demographic Projections and Foresight

Most national statistics agencies produce population *projections*, which are simply exercises in estimating future population trends on the assumption that the trajectory of the recent past (driven by fertility, mortality and migration) continues unchanged into the future. *Foresight* differs from projection in that future trends are estimated on the basis of assumptions about how mortality, fertility, and (especially) migration may change in the future. Foresight may take account of long-term trends, such as increasing life expectancy, or lifestyle choices relating to the age at which couples begin a family. They can also take account of more sudden, one-off changes, such as the opening or closing of a mine, and the associated tendency for in- or out-migration of workers and their families. It's in this connection that they provide important guidance to creating community strategies within the REGINA project.

This working paper describes a simple Demographic Foresight Model which has been adapted to suit the needs of relatively small and sparsely populated areas, such as the municipalities which have participated in the REGINA project. This is necessary because the projections produced by national statistical services can be less reliable for small populations, and in addition they do not allow the user to experiment with different foresight scenarios.

What the National Statistics Offices provide

In Sweden, official population projections are carried out at the national level. The approach is an unusual one, structured by "clusters" of housing types, rather than regions or municipalities. The reasoning is that numbers of inhabitants are rather small in many remote and rural areas, and statistically reliable estimates of the components of change are better made on the basis of grouping people (nationally) according to what kind of property they live in. The only way in which geographical differences can come through is on the basis of a 3-fold size of city classification (Franzen and Karlson 2010). Although projections for sub-national areas are available for purchase from Statistics Sweden, they are not available online, and the unconventional projection method should be kept in mind.

In Finland projections are estimated at the municipality level through to 2065, and available online. Fertility and mortality rates are not estimated for each municipality (because the populations are generally too small as the basis for reliable age/gender specific rates), but for groups of municipalities. These groups of municipalities are not contiguous regions, but are defined by their common demographic trends. The national projection is basically the sum of the municipality projections.

In Norway, the methodology is similar, except that calculations are carried out with data for 108 "projection regions" and then apportioned to constituent municipalities. Again, municipal projections (up to 2040) are available online.

In Greenland, only national projections are made available online, although sub-national projections seem to be available from the national statistics agency.

In Scotland, national projections are consistent between the 32 "Council Areas" and the Scottish total. However experimental projections have recently been produced for 110 "Sub-Council Areas" and even for the 4,000 data zones which are the smallest statistical unit in Scotland. These small area projections are constrained so that they sum to the Council Areas and to the national projections.

In all the above cases projecting the population involves dividing it into one year male/female age groups (cohorts), and applying annual fertility/mortality and migration rates stepwise, one year forward at a time. This single year cohort method works well for larger regions, where the numbers in any cohort are sufficiently large not to be distorted by random effects. However, applying this method to a municipality which has a population of only a few thousand people is much more vulnerable to the “small number problem” (hence the use of housing clusters in Sweden, groups of municipalities in Finland, and projection regions in Norway).

In the REGINA DFM the small number problem is ameliorated by using a five-year cohort model, and projecting forward five years at a time. Not only does this reduce the impact of random variation in the baseline age structure data, it makes for smaller, more manageable tables, without (arguably) a meaningful sacrifice in terms of accuracy.

2. The Structure and Data Requirements of the Regina Demographic Foresight Model (DFM)

Data requirements

The REGINA DFM is implemented in an Excel spreadsheet, and is therefore readily accessible to the majority of potential users. Its data requirements are as follows:

1. Base year (male and female) populations for five-year cohorts, from 0-4 up to 85-89, and then for all persons aged 90 and over.
2. Average annual fertility rates (per 1,000) for each female cohort from 15-19 up to 45-49.
3. Average annual mortality rates (per 1,000) for all cohorts, male and female.
4. Average annual migration rates – for each cohort, distinguishing males and females, and in-migration from out-migration.

It is important to emphasise that the fertility and mortality rates should **not** be estimated from births and deaths within the municipality for which you are making projections. The numbers here are likely to be too small for reliable rates to be calculated. Instead, it is better to use published rates, for the surrounding region, or even the country as a whole. This may seem strange, but the fact is that (age specific) fertility and mortality rates do not vary very much across developed countries, so any loss of local detail is more than outweighed by the benefits of having stable rates derived from large numbers.

By contrast, migration rates (in and out, by gender and age cohort) vary considerably between regions, and even between municipalities. It is therefore important to use local, or at least regional, sources for these.

The model also requires estimates of how fertility and mortality rates are likely to change in each successive projection period. These are of course “guestimates” – since none of us has objective data about the future. The best source for these will probably be the documentation of national or regional population projections, where such data are usually provided in the description of the assumptions. Another possibility is to base these assumptions on projecting forward recent trends.

It is very helpful to be able to "calibrate" the DFM by comparing it with official projections for the same area (where they exist). Such calibration is achieved by adjusting the rates of change of in and out migration (see below).

How the DFM calculates the projections

This is a very straightforward iterative sequence of simple calculations. After the baseline data and the fertility, mortality and migration rates are entered these are used as the basis for the projected population for the next five-year period. The sequence of calculations is as follows:

1. The initial estimate of the 0-4 population for the first projection period (five years after the baseline, i.e. t+5) is estimated by multiplying the number of females in the 15-49 age cohorts by the appropriate fertility rates.
2. Each of the other baseline cohorts is moved "down" one row, to represent them ageing 5 years. The 90+ age group in t+5 must be estimated in a slightly different way. First, the baseline 85-89 population is moved into the 90+ cohort for t+5. To this is added the number of persons who were 90+ in the baseline year, and are expected to survive until 95 or over in t+5.
3. All the new (t+5) cohorts (including 0-4) are adjusted for mortality, by applying the appropriate age/sex specific mortality rates.
4. Estimates of in-migrants and out-migrants are added and subtracted from each age group.
5. The same sequence is followed to generated the population distribution for the third time-period, and so on.
6. After the data have been entered and the projections have been calculated it is then possible to specify an "employment shock scenario". Further information on how these scenarios are structured, and what data is required is provided in Section 4 below.

All of these calculations are set up within the blank DFM "template". Some of the sheets necessary to make the calculations are "hidden" for the sake of clarity. The visible sheets are of two types – some for data input, and some for the presentation of the results, either in the form of tables, or in the form of graphs.

3. A guide to building a Demographic Foresight Model for your municipality

The following sequence explains the steps which are needed to generate a DFM from the blank spreadsheet “template”. It is important that the layout of the spreadsheet is not changed, for example by inserting or deleting rows or columns, or editing formulae. Such changes will prevent the model from calculating correctly. Sheets with Yellow tabs contain results of the model, whilst sheets with blue tabs are for the input of raw data. Raw data is required in the cells which are white. Yellow cells contain data calculated by the model.

Step 1: Enter the baseline data into the white cells on the “Base Year Population” sheet.

NORTOPIA

Base Year Population

Age Group	Males	Females	Persons
0 to 4	125	125	250
5 to 9	130	130	260
10 to 14	140	140	280
15 to 19	150	135	285
20 to 24	155	130	285
25 to 29	160	135	295
30 to 34	165	140	305
35 to 39	170	140	310
40 to 44	175	155	330
45 to 49	180	175	355
50 to 54	200	190	390
55 to 59	215	210	425
60 to 64	230	225	455
65 to 69	250	240	490
70 to 74	220	210	430
75 to 79	175	185	360
80 to 84	125	150	275
85 to 89	75	100	175
90 and over	15	30	45
Total	3,055	2,945	6,000

Step 2: Open the “Fertility” sheet and enter the annual fertility rates, (per 1,000 females) for the age categories of the base year (the white cells). The Total Fertility Rate (TFR) will be calculated and shown below the upper part of the table – it should be somewhere around 1.75-2.00. Now add the rates of change in fertility rates in the lower part of the table. Note that 0.00 indicates no change from the previous period – negative numbers indicate a reduction in fertility rate, and positive numbers indicate an increase. In other words, -0.01 means that the fertility rate has declined by 1% relative to the previous period, 0.02 indicates that the rate will increase by 2%, etc.

Fertility STORUMAN

Fertility Rates in Base Year

(Per 1,000 females, per annum)

Proportion of female babies: 0.48

Age Grou	2015	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039		2045-2049
15 to 19	4.0	4.0	3.9	3.9	3.8	3.8	3.8	3.7
20 to 24	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
25 to 29	100.0	100.8	101.5	102.3	103.1	103.9	104.7	105.5
30 to 34	130.0	131.0	132.0	133.0	134.1	135.1	136.1	137.2
35 to 39	75.0	75.8	76.5	77.3	78.0	78.8	79.6	80.4
40 to 44	20.0	20.2	20.4	20.6	20.8	21.0	21.2	21.4
45 to 49	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1
TFR	1.86	1.87	1.88	1.90	1.91	1.92	1.94	1.95

Fertility trend

(The number in each column shows the estimated proportionate change since the previous period)

Age Group		2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
15 to 19	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
20 to 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25 to 29	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
30 to 34	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
35 to 39	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
40 to 44	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
45 to 49	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Step 3: Move to the "Mortality" sheet and input the mortality rate data in the same way. This time, of course male and female are entered separately.

Mortality **NORTOPIA** (The numbers show the proportionate change since the previous 5 year period)

Mortality Rates in Base Year
(Per 1,000, per annum)

Age Group	Males	Females
0 to 4	1.00	1.00
5 to 9	0.05	0.05
10 to 14	0.05	0.05
15 to 19	0.25	0.25
20 to 24	0.50	0.50
25 to 29	0.70	0.70
30 to 34	0.70	0.70
35 to 39	0.70	0.70
40 to 44	1.00	1.00
45 to 49	1.50	1.50
50 to 54	2.00	2.00
55 to 59	2.50	2.50
60 to 64	5.00	5.00
65 to 69	10.00	10.00
70 to 74	20.00	15.00
75 to 79	30.00	25.00
80 to 84	50.00	45.00
85 to 89	125.00	100.00
90 and over	425.00	400.00

Mortality Trend
Males

Age Group	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
0 to 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 to 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 to 14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15 to 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20 to 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25 to 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30 to 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35 to 39	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
40 to 44	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
45 to 49	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
50 to 54	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
55 to 59	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
60 to 64	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
65 to 69	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
70 to 74	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
75 to 79	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
80 to 84	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
85 to 89	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
90 and over	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Life expectancy factor	0.18	0.20	0.22	0.24	0.26	0.29	0.32

Mortality Trend
Females

Age Group	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
0 to 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 to 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 to 14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15 to 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20 to 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25 to 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30 to 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35 to 39	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
40 to 44	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
45 to 49	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
50 to 54	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
55 to 59	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
60 to 64	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
65 to 69	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
70 to 74	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
75 to 79	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
80 to 84	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
85 to 89	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
90 and over	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Life expectancy factor	0.18	0.20	0.22	0.24	0.26	0.29	0.32

This is the estimated proportion of the 90+ age group surviving into the next five year period

The "Life Expectancy Factor" row at the bottom of the table is a way of handling the fact that the oldest age group is "open ended". What this means in practice is that the number of people in the "90 and over" cohort is mostly made up of people who, five years earlier were aged 85-89. However, we need to add in those who were 90-95 five years before and have survived to be over 95. The model estimates the number of these on the basis of the "Life Expectancy Factors" – which are basically probabilities. The spreadsheet above, for example has 0.18 in the 2015-2019 columns. This means that 18% of the people who were over 90 in 2015 are assumed to be still alive in 2019.

Step 4: Move to the Migration sheet and input the male and female in/out migration rates (again expressed per 1,000 persons). Note that all out-migration rates should be input as negative numbers. Net migration rates (base year) are calculated automatically. Leave the rates of change part of the sheet empty for the time being.

Estimated Migration Rates in Base Year (Per 1000)

Storuman	Males In	Fem. In	Males Out	Fem. Out	Net Mig
0 to 4	35	35	-20	-20	30
5 to 9	30	30	-25	-25	10
10 to 14	25	15	-25	-15	0
15 to 19	50	40	-45	-55	-10
20 to 24	120	110	-150	-180	-100
25 to 29	100	100	-100	-150	-50
30 to 34	75	75	-75	-100	-25
35 to 39	30	30	-30	-50	-20
40 to 44	25	25	-25	-25	0
45 to 49	25	25	-25	-25	0
50 to 54	25	25	-25	-25	0
55 to 59	20	20	-20	-20	0
60 to 64	25	25	-20	-20	10
65 to 69	30	30	-20	-20	20
70 to 74	15	15	-15	-15	0
75 to 79	5	5	-10	-10	-10
80 to 84	2	2	-5	-5	-6
85 to 89	1	1	-2	-2	-2
90 and over	0	0	-1	-1	-2

Step 5: If you have been able to acquire projections for your municipality from the national statistical agency, move to the "Official Projections" sheet and input the official projections there. Male and female numbers for each 5-year age group should be entered. The totals are calculated automatically.

Males	NORTOPIA							
Age Group	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	131	124	121	120	118	115	112
5 to 9	130	126	132	125	122	121	119	116
10 to 14	140	131	127	133	126	123	121	120
15 to 19	150	140	131	127	133	126	123	121
20 to 24	155	151	140	131	127	134	127	123
25 to 29	160	150	146	136	127	123	129	122
30 to 34	165	159	149	145	135	126	123	129
35 to 39	170	164	159	149	145	135	126	122
40 to 44	175	169	164	158	148	144	135	126
45 to 49	180	174	169	163	158	148	144	134
50 to 54	200	179	173	167	162	157	147	143
55 to 59	215	198	177	171	166	160	155	145
60 to 64	230	212	196	175	169	164	159	153
65 to 69	250	226	208	192	172	166	161	156
70 to 74	220	240	217	201	185	166	161	156
75 to 79	175	199	217	197	183	169	152	147
80 to 84	125	148	169	186	169	157	146	131
85 to 89	75	94	112	129	142	130	121	113
90 and ove	15	32	44	56	68	80	81	81
Total	3,055	3,023	2,954	2,862	2,756	2,646	2,543	2,452

Females	NORTOPIA							
Age Group	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	121	115	111	111	109	106	103
5 to 9	130	126	122	116	113	112	110	107
10 to 14	140	131	127	123	116	113	112	111
15 to 19	135	140	131	127	123	116	113	112
20 to 24	130	133	138	128	125	121	114	111
25 to 29	135	121	123	128	119	116	112	106
30 to 34	140	128	114	117	121	113	110	106
35 to 39	140	136	124	111	113	117	110	106
40 to 44	155	137	133	121	108	111	115	107
45 to 49	175	154	136	132	121	108	110	114
50 to 54	190	174	153	135	131	120	107	109
55 to 59	210	188	172	152	134	130	119	106
60 to 64	225	207	186	170	150	132	129	118
65 to 69	240	221	204	182	167	147	130	127
70 to 74	210	231	212	196	176	161	142	126
75 to 79	185	195	214	198	183	164	151	133
80 to 84	150	161	170	188	174	161	146	134
85 to 89	100	116	126	134	148	138	128	116
90 and over	30	56	72	82	92	105	107	107
Total	2,945	2,875	2,771	2,651	2,524	2,395	2,271	2,160

Persons	NORTOPIA							
Age Group	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	250	252	239	232	230	227	222	215
5 to 9	260	253	255	241	235	233	229	224
10 to 14	280	261	254	256	242	236	234	231
15 to 19	285	280	261	254	256	242	236	234
20 to 24	285	283	278	260	252	254	241	234
25 to 29	295	271	269	264	246	239	241	229
30 to 34	305	287	264	262	256	239	232	235
35 to 39	310	300	283	260	258	252	235	229
40 to 44	330	306	297	280	257	255	249	233
45 to 49	355	328	305	295	278	256	254	248
50 to 54	390	352	326	302	293	276	254	252
55 to 59	425	386	349	323	300	291	274	252
60 to 64	455	420	382	345	319	296	287	271
65 to 69	490	446	412	375	339	314	291	283
70 to 74	430	471	429	397	361	327	303	282
75 to 79	360	393	432	394	365	333	302	281
80 to 84	275	310	339	374	343	319	291	265
85 to 89	175	210	238	262	290	268	250	230
90 and over	45	88	115	138	159	185	188	188
Total	6,000	5,899	5,726	5,513	5,280	5,041	4,815	4,613

Step 6: Return to the "Migration" sheet. To the right of the "Predicted Percentage Change" part of the table you will see a section like the illustration on the right, which can be used to constrain the model to match the official projections. Follow the instructions in the white panel.

Using the change in migration rate to force the model to match the Official Projections: The objective is to make the model projection of total population exactly equal to the official projection for the same year. When this is achieved the figure in row 22 will be 100. Begin with the 2015-19 column (column j), and work through the periods until you reach the last year of official projections. If the figure in row 22 is less than 100 increase the percentage change in in-migration (row 15), by entering a positive number close to zero (such as 0.1). If it is more than 100, enter a negative number (such as -0.1). Adjust the number until, by trial and error the result in row 22 equals 100. Then move to the next period, and so on.

INMIGRATION

Predicted Percentage change compared with base year (In Migration)

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
0.00	0.00	0.00	0.00	0.00	0.00	0.00

OUTMIGRATION

Predicted Percentage change compared with base year

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
0.00	0.00	0.00	0.00	0.00	0.00	0.00

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
100.00	100.00	100.00	100.00	100.00	100.00	100.00

Step 7: The next section of the sheet uses a similar procedure to allow you to calculate how much migration would be required to keep the population stable. Again, follow the instructions in the white panel.

Using the change in migration rate to estimate the level of (annual) net migration required to maintain the population at the baseline level. The same procedure as described in the box to the left - except this time you are working in columns S to Y.

INMIGRATION

Required Percentage change compared with base year (In Migration)

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
0.22	0.364	0.429	0.453	0.458	0.424	0.362

OUTMIGRATION

Required Percentage change compared with base year

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
-0.22	-0.364	-0.429	-0.453	-0.458	-0.424	-0.362

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
100.00	100.00	100.00	100.00	100.00	100.00	100.00

Annual Net Migration Required to maintain Equilibrium

2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049
14.69	26.02	30.94	32.68	33.06	30.55	25.85

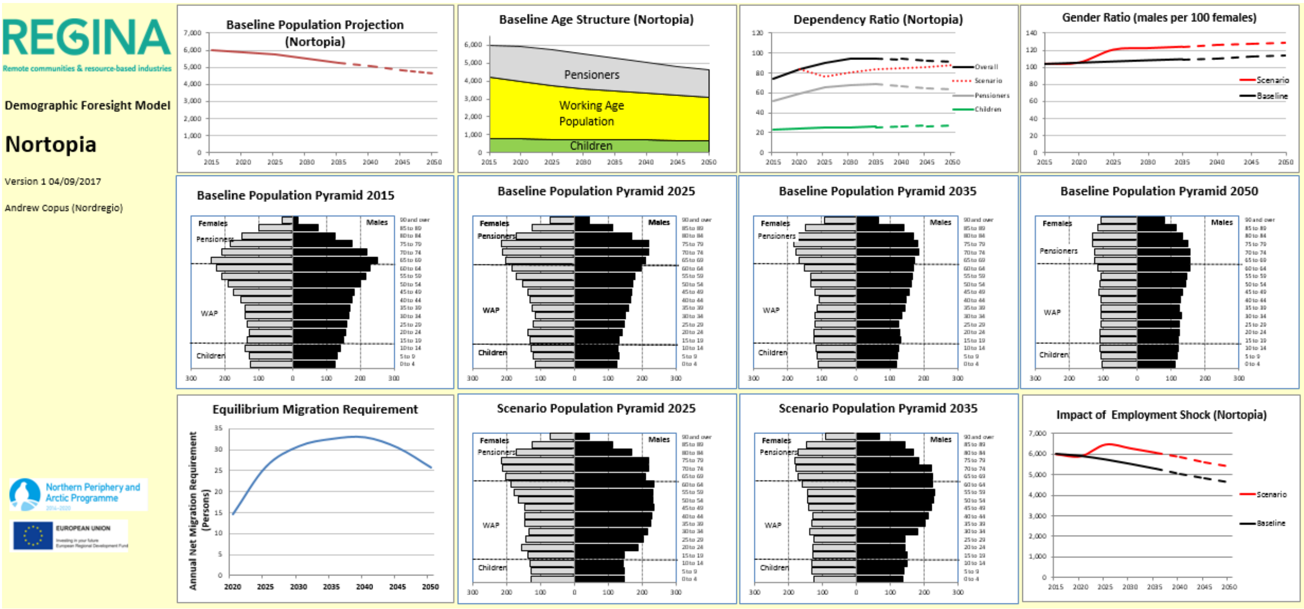
Step 8: Now take a look at the "Projections in Detail" sheet – all the projections should now be filled in. Have a quick look through them to check that they look reasonable. If they move around wildly, are blank, or negative this suggests you have made a mistake inputting the data. Go back and check!

Males	NORTOPIA (Baseline)							
Age G	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	131	124	121	120	118	115	112
5 to 9	130	126	132	125	122	121	119	116
10 to 14	140	131	127	133	126	123	121	120
15 to 19	150	140	131	127	133	126	123	121
20 to 2	155	151	140	131	127	134	127	123
25 to 2	160	150	146	136	127	123	129	122
30 to 3	165	159	149	145	135	126	123	129
35 to 3	170	164	159	149	145	135	126	122
40 to 4	175	169	164	158	148	144	135	126
45 to 4	180	174	169	163	158	148	144	134
50 to 54	200	179	173	167	162	157	147	143
55 to 59	215	198	177	171	166	160	155	145
60 to 6	230	212	196	175	169	164	159	153
65 to 6	250	226	208	192	172	166	161	156
70 to 74	220	240	217	201	185	166	161	156
75 to 79	175	199	217	197	183	169	152	147
80 to 8	125	148	169	186	169	157	146	131
85 to 8	75	94	112	129	142	130	121	113
90 and ov	15	32	44	56	68	80	81	81
Total	3,055	3,023	2,954	2,862	2,756	2,646	2,543	2,452

Females	NORTOPIA (Baseline)							
Age Gr	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	121	115	111	111	109	106	103
5 to 9	130	126	122	116	113	112	110	107
10 to 14	140	131	127	123	116	113	112	111
15 to 19	135	140	131	127	123	116	113	112
20 to 24	130	133	138	128	125	121	114	111
25 to 29	135	121	123	128	119	116	112	106
30 to 34	140	128	114	117	121	113	110	106
35 to 39	140	136	124	111	113	117	110	106
40 to 44	155	137	133	121	108	111	115	107
45 to 49	175	154	136	132	121	108	110	114
50 to 54	190	174	153	135	131	120	107	109
55 to 59	210	188	172	152	134	130	119	106
60 to 64	225	207	186	170	150	132	129	118
65 to 69	240	221	204	182	167	147	130	127
70 to 74	210	231	212	196	176	161	142	126
75 to 79	185	195	214	198	183	164	151	133
80 to 84	150	161	170	188	174	161	146	134
85 to 89	100	116	126	134	148	138	128	116
90 and ove	30	56	72	82	92	105	107	107
Total	2,945	2,875	2,771	2,651	2,524	2,395	2,271	2,160

Persons	NORTOPIA (Baseline)							
Age Gr	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	250	252	239	232	230	227	222	215
5 to 9	260	253	255	241	235	233	229	224
10 to 14	280	261	254	256	242	236	234	231
15 to 19	285	280	261	254	256	242	236	234
20 to 24	285	283	278	260	252	254	241	234
25 to 29	295	271	269	264	246	239	241	229
30 to 34	305	287	264	262	256	239	232	235
35 to 39	310	300	283	260	258	252	235	229
40 to 44	330	306	297	280	257	255	249	233
45 to 49	355	328	305	295	278	256	254	248
50 to 54	390	352	326	302	293	276	254	252
55 to 59	425	386	349	323	300	291	274	252
60 to 64	455	420	382	345	319	296	287	271
65 to 69	490	446	412	375	339	314	291	283
70 to 74	430	471	429	397	361	327	303	282
75 to 79	360	393	432	394	365	333	302	281
80 to 84	275	310	339	374	343	319	291	265
85 to 89	175	210	238	262	290	268	250	230
90 and ove	45	88	115	138	159	185	188	188
Total	6,000	5,899	5,726	5,513	5,280	5,041	4,815	4,613

Step 9: Finally, take a look at the "Dashboard" sheet. You should now see some helpful graphs of your projections. It may be necessary to re-scale the axes[1] of some of the graphs so that the lines show up. Again, if the graphs don't look right they may suggest where you have gone wrong.



[1] Double click on the area to the left of the axis (where the numbers are) and change the max and min values as appropriate.

4. Exploring the Demographic Impacts of an "Employment Shock"

The Employment Shock Scenario part of the DFM is designed to make the model more directly relevant to the planning process of municipalities in the Northern Periphery and Arctic, where it is not unusual to be confronted with a potentially sudden and substantial change in local employment prospects due to inward investment, - or disinvestment, - by large scale or multi-national companies engaged in resource industries.

It is perhaps worth pointing out at this point that the DFM is designed to deal with the *direct demographic* implications of the employment associated with the inward investment/disinvestment alone, not with *indirect or induced* multiplier effects upon the local economy. To assess the latter another kind of model (input-output, general equilibrium or social accounting matrix) would be required. This is beyond the scope of REGINA.

The Employment Shock Scenario module assumes that the operator has information about the likely employment impacts a particular inward investment or disinvestment. More specifically it is necessary to have an estimate of the number of jobs which will be created/lost, and their likely age/gender structure. It will then be necessary to make assumptions about the proportion of these jobs which will be taken up by in-migrants, (or in the case of redundancy, which will result in out-migration). Finally, it will be necessary to make some assumptions about how many household members are likely to migrate with the employees. These data and assumptions are inputs into the sheet called "Employment Shock" and the outcomes are shown both on the same sheet, and in the "Dashboard" sheet.

The procedure for setting up an employment shock scenario is as follows:

Step 1: Open the "Employment Shock" sheet. Enter the data for the number of jobs in the male and female age distribution blocks of cells (columns C to R), taking care to put them in the right period, and to distribute the total number of jobs between males and females and the age cohorts. Note that each job created/lost generates a single entry – or to put it another way, the creation or loss of a job is specified as a one-off event (as regards its demographic implications).

Job Opportunities (Nortopia)

Males	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2050	Females	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2050
0 to 4								0 to 4							
5 to 9								5 to 9							
10 to 14								10 to 14							
15 to 19		5						15 to 19		5					
20 to 24		30						20 to 24		12					
25 to 29		40						25 to 29		15					
30 to 34		45						30 to 34		15					
35 to 39		45						35 to 39		15					
40 to 44		45						40 to 44		10					
45 to 49		55						45 to 49		10					
50 to 54		50						50 to 54		10					
55 to 59		50						55 to 59		5					
60 to 64		35						60 to 64		3					
65 to 69								65 to 69							
70 to 74								70 to 74							
75 to 79								75 to 79							
80 to 84								80 to 84							
85 to 89								85 to 89							
90 and over								90 and over							
Total	0	400	0	0	0	0	0		0	100	0	0	0	0	0
	Total Jobs	500	Total direct Migration impact			450		Total indirect Migration impact		275			Direct+Indirect migration impact		725

Step 2: To the right of where you entered the number of jobs there is a block of white cells (in columns U-X) labelled "Migration probability. What is required here is assumptions about how likely the creation/loss of jobs will result in workers migrating into (or out of) the municipality. 1.00 would mean 100% probability that a job change will result in migration. 0.5 would mean that it is equally likely that the a newly created job will be filled by a person already living in the municipality, or (in the case of a job loss) that the redundant worker will not migrate out of the municipality. If the employment shock is negative (job losses), then the consequent out-migration probabilities should be entered as negative numbers.

Migration probability	Males	Females
0 to 4		
5 to 9		
10 to 14		
15 to 19	0.80	0.80
20 to 24	0.95	0.95
25 to 29	0.95	0.95
30 to 34	0.95	0.95
35 to 39	0.95	0.95
40 to 44	0.95	0.95
45 to 49	0.90	0.90
50 to 54	0.85	0.85
55 to 59	0.80	0.80
60 to 64	0.80	0.75
65 to 69		
70 to 74		
75 to 79		
80 to 84		
85 to 89		
90+		

Clearly there is no objective data source – these assumptions will have to be made on the basis of local knowledge, perhaps after consultation with local employers etc.

Step 3: Further still to the right (in columns AA-AU) you will find a table headed "Additional Indirect Migration Effects". This is where you enter assumptions about the probability of workers of different ages who migrate in or out as a result of the employment shock, *bringing with them, or taking with them* additional family members. For example, a person who migrates into the municipality to take up a job, who is in their mid-late twenties may bring a partner/spouse, a person in their thirties may also bring children. A migrant in their late teens is more likely to move alone.

In this table of probabilities, the rows represent the age groups of the employees, and the columns show the age groups of the household members who are likely to move with them. It will be helpful to give some examples of how this works:

- As already mentioned, employees under 20 are likely to migrate alone – so in this case row 7 should contain only zeros.
- Employees in the 20-24 age group (row 8) may bring similarly aged spouses with them – so the figure in the corresponding 20-24 column (AG) should have a non-zero number in it. Again 1.00 indicates 100% probability, 0.5 indicates a 50% probability. If the scenario involves job losses and out-migration the numbers should be negative.
- Employees in their late twenties or early thirties may also bring children with them. This would be represented by non-zero probabilities in the 0-4, 5-9, or 10-14 columns (AC-AE).

	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
1	Additional Indirect migration effects (households) - additional migrants per 100 "direct effect migrants" (Based on survey)																				
2			Household members (partners and children)																		
3		Total	0 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 to 84	85 to 89	90+
4	0 to 4																				
5	5 to 9																				
6	10 to 14																				
7	15 to 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	20 to 24	59	7	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	25 to 29	70	10	8	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0
10	30 to 34	80	10	10	8	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0
11	35 to 39	87	7	10	10	8	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0
12	40 to 44	84	0	8	10	10	4	0	0	0	52	0	0	0	0	0	0	0	0	0	0
13	45 to 49	51	0	0	7	7	3	0	0	0	0	34	0	0	0	0	0	0	0	0	0
14	50 to 54	39	0	0	0	5	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0
15	55 to 59	35	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0
16	60 to 64	35	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0
17	65 to 69																				
18	70 to 74																				
19	75 to 79																				
20	80 to 84																				
21	85 to 89																				
22	90+																				
23	Indirect by age		34	36	35	30	59	52	52	52	52	34	34	35	35	0	0	0	0	0	0

Obviously, the assumptions you enter in this table should be based upon local knowledge, and conversations with local employers may help to make these more realistic.

Step 4: At this stage the results of your scenario, in terms of the number of people who move into or out of the municipality as a result of the employment shock, are shown in the yellow cells on this same sheet (below the jobs table), in the Projections Summary sheet (see example below), and in the graphs on the Dashboard sheet. It is now possible to check whether your assumptions are realistic, and adjust them if the results do not seem convincing.

Males	NORTOPIA (Shock)							
Age G	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	131	147	140	135	129	123	119
5 to 9	130	126	147	149	141	137	130	124
10 to 14	140	131	142	148	150	142	137	131
15 to 19	150	140	148	142	148	150	142	137
20 to 2	155	151	187	148	143	149	150	143
25 to 2	160	150	203	181	144	138	144	145
30 to 3	165	159	214	203	180	143	138	143
35 to 3	170	164	224	214	202	180	143	137
40 to 4	175	169	229	223	213	201	179	142
45 to 4	180	174	235	228	222	212	200	178
50 to 54	200	179	230	233	226	221	211	199
55 to 59	215	198	231	228	231	224	219	209
60 to 6	230	212	233	228	225	229	222	216
65 to 6	250	226	208	229	224	221	225	218
70 to 74	220	240	217	201	221	217	214	217
75 to 79	175	199	217	197	183	202	198	196
80 to 8	125	148	169	186	169	157	174	171
85 to 8	75	94	112	129	142	130	121	135
90 and ov	15	32	44	56	68	80	81	81
Total	3,055	3,023	3,540	3,462	3,367	3,259	3,149	3,043
Difference between base projection and Schock Scenario								
	-	-	585	600	611	613	606	591

Females	NORTOPIA (Shock)							
Age Gr	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	125	121	129	129	125	119	113	110
5 to 9	130	126	127	130	131	126	120	114
10 to 14	140	131	131	128	131	131	127	121
15 to 19	135	140	138	131	128	131	131	127
20 to 24	130	133	156	135	129	126	128	129
25 to 29	135	121	145	144	126	119	116	119
30 to 34	140	128	136	137	137	119	113	110
35 to 39	140	136	146	132	133	133	116	110
40 to 44	155	137	147	142	129	130	130	113
45 to 49	175	154	148	147	142	128	129	129
50 to 54	190	174	165	147	146	141	127	129
55 to 59	210	188	177	163	146	144	140	126
60 to 64	225	207	189	175	161	144	143	138
65 to 69	240	221	204	185	172	158	142	140
70 to 74	210	231	212	196	179	166	153	137
75 to 79	185	195	214	198	183	167	156	143
80 to 84	150	161	170	188	174	161	148	138
85 to 89	100	116	126	134	148	138	128	118
90 and ove	30	56	72	82	92	105	107	107
Total	2,945	2,875	2,931	2,824	2,709	2,587	2,467	2,359
Difference between base projection and Schock Scenario								
	-	-	159	173	185	192	196	198

Persons	NORTOPIA (Shock)							
Age Gr	2015	2020	2025	2030	2035	2040	2045	2050
0 to 4	250	252	276	269	260	248	236	229
5 to 9	260	253	275	279	272	263	250	238
10 to 14	280	261	273	276	280	273	264	252
15 to 19	285	280	286	273	276	280	273	264
20 to 24	285	283	343	284	272	274	279	272
25 to 29	295	271	348	325	269	258	260	264
30 to 34	305	287	350	340	317	262	251	254
35 to 39	310	300	370	346	335	312	258	247
40 to 44	330	306	376	365	342	331	309	255
45 to 49	355	328	383	374	364	340	330	307
50 to 54	390	352	394	380	372	361	338	328
55 to 59	425	386	408	391	377	368	358	335
60 to 64	455	420	422	404	386	373	364	354
65 to 69	490	446	412	415	396	379	366	358
70 to 74	430	471	429	397	400	383	367	355
75 to 79	360	393	432	394	365	369	353	339
80 to 84	275	310	339	374	343	319	322	310
85 to 89	175	210	238	262	290	268	250	253
90 and ove	45	88	115	138	159	185	188	188
Total	6,000	5,899	6,470	6,286	6,076	5,846	5,617	5,402
Difference between base projection and Schock Scenario								
	-	-	745	773	795	805	802	789

5. Lessons Learned from the REGINA Municipalities

Storuman, (Sweden)

The main results for Storuman are shown in Figure 1.

According to Statistics Sweden Storuman's population is predicted to fall from approximately 6,000 in 2015 to about 5,200 by 2040. The Statistics Sweden projections end in 2040, but the REGINA model continues until 2050, predicting a further fall to around 4,800.

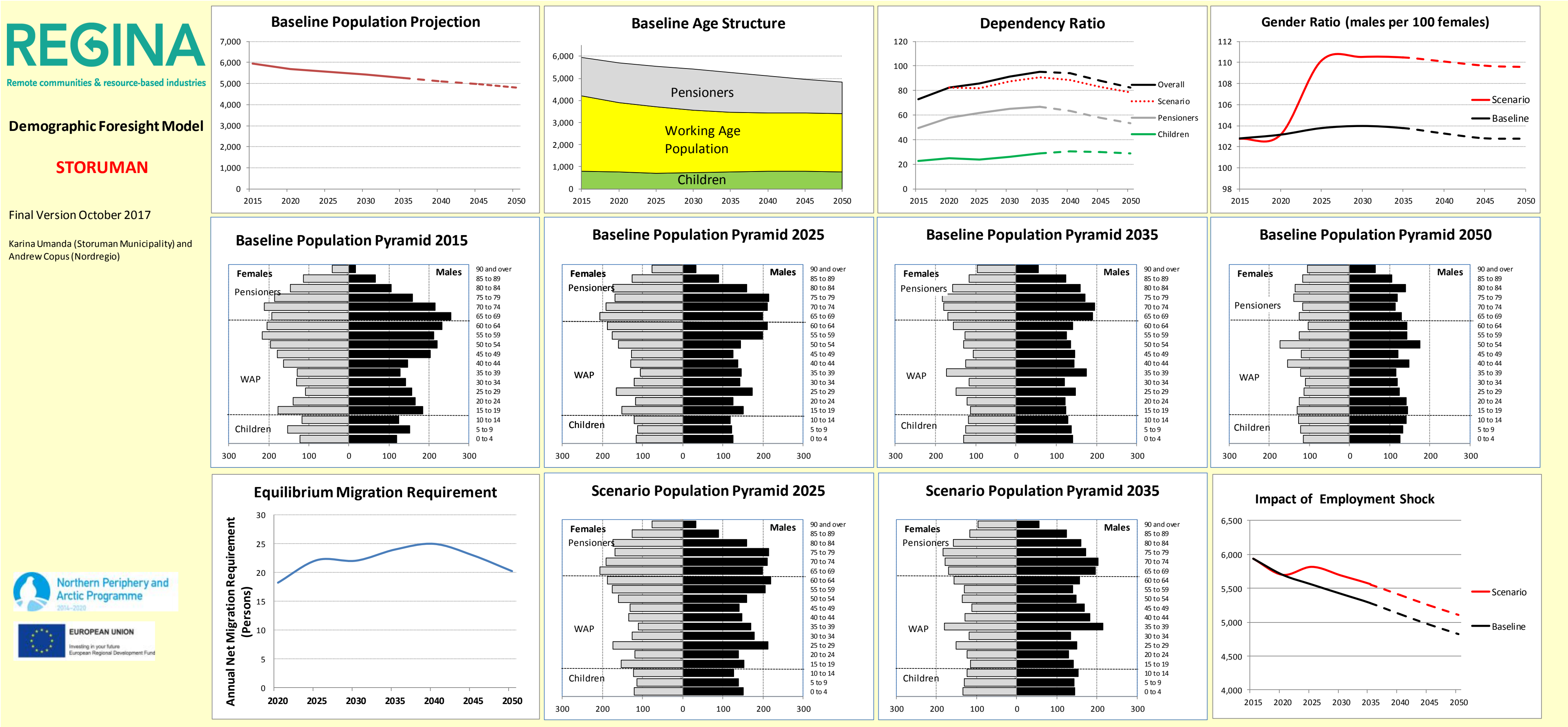
The population pyramid for Storuman in 2015 shows just how serious the issue of age structure and ageing is in this municipality. The largest cohorts are in the 45-70 age groups (perhaps associated with the post war years of relative prosperity?). The children cohorts are particularly small, indicating a substantial demographic sustainability challenge. The pyramids for 2025, 2035 and 2050 show that the "middle aged bulge" moves up and is dissipated, eventually leaving the "pyramid" narrow and more like a column in shape.

The age structure graph (top row, second from left) makes it clear that the decline in population is mainly a consequence of a shrinking working age population. The size of the children and pensioners age groups remain fairly stable. This results in a steady increase in dependency rates (third graph), so that by 2035 the number of children and pensioners is forecast to be almost equal to the working age population. The gender ratio (fourth graph) shows that for every 100 women there are about 103 men, and that this is set to increase slightly in the coming decades, but thereafter to fall to around 102 by 2035, and parity by 2050.

The Storuman employment shock scenario assumes the expansion of a local mine, which results in the creation of 130 jobs. This event is assumed to take place between 2020 and 2024. Of the 130 jobs, it is assumed that only 10% can be filled by local unemployed persons, and that there will therefore need to be 117 employees migrating into the municipality. Associated with these 117 workers are 140 household members – giving a total in-migration effect of 257 persons. However, since some of these migrants are women of fertile ages, the net effect on the total population, is greater at 261. Assuming (perhaps improbably) that the additional jobs are retained until 2035, the net additional population is predicted to increase to more than 280, as a third generation begins to be added to the migrant families. However, it is important to get this prediction in perspective – it takes place against a backdrop of long-term decline, so an increase of 130 jobs would by 2035 result in a municipal population total which would be roughly the same as that of 2015. Similarly, the dependency ratio would initially fall, but then by 2035 creep back up to 2015 levels. The gender ratio would increase so that there would be approximately 110 men for every 100 women.

Of course, the exact impact that the in-migration would have on the age structure and gender ratio would depend both on the age/gender profile of the new employees, and the extent to which the sustainability of the employment encouraged household members to settle in the municipality. Jobs which are perceived as short term would more likely result in weekly commuting, rather than the permanent resettlement of households.

Figure 1: The Main Results for Storuman Municipality (Sweden)



Sodankyla (Finland)

The main results for Sodankyla are shown in Figure 2.

According to Statistics Finland, Sodankyla's population is predicted to be relatively stable at approximately 8,800 between 2015 and 2035. The Statistics Finland projections end in 2035, but the REGINA model continues until 2050, predicting a small decline to around 8,500.

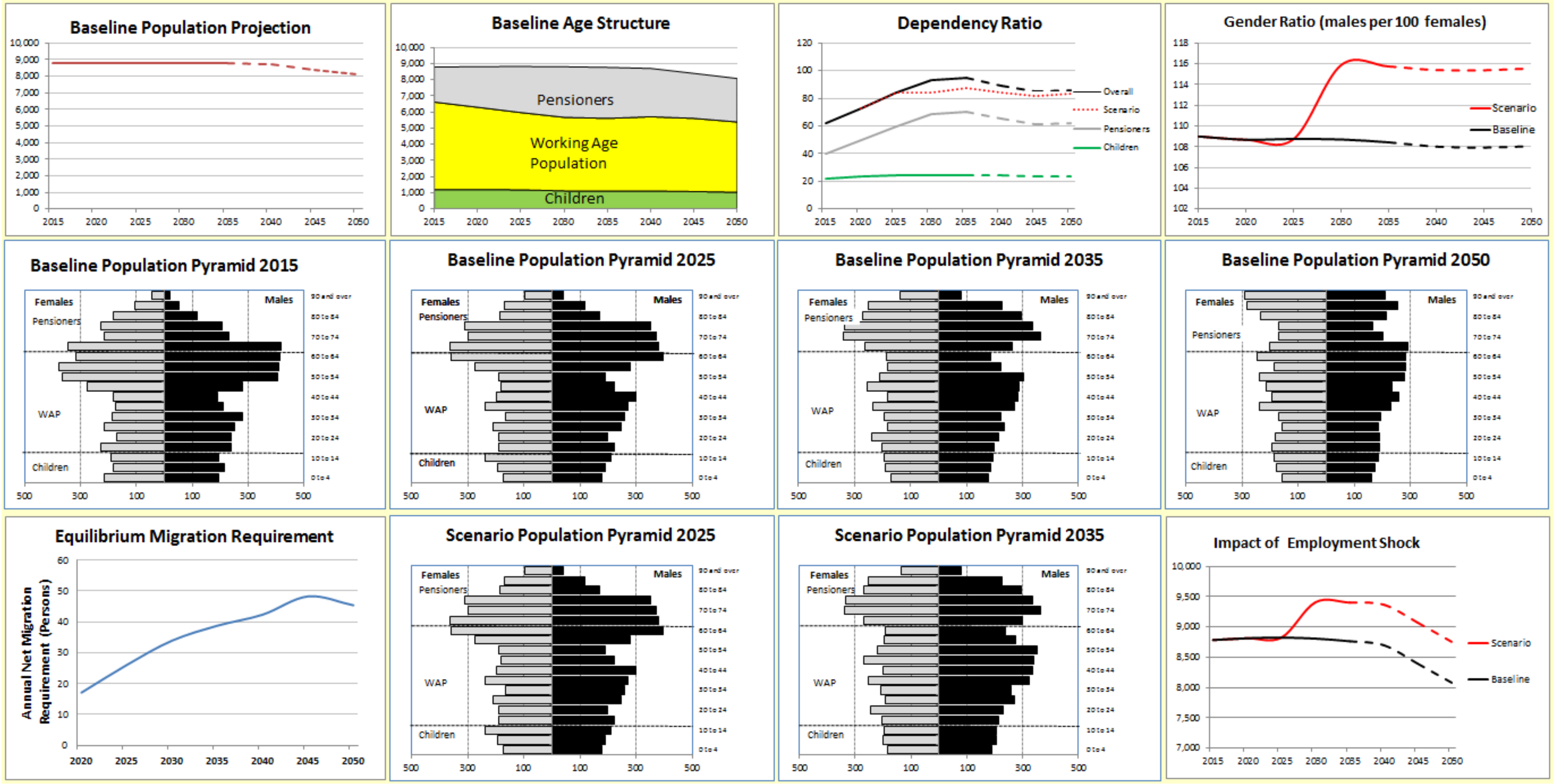
The population pyramid for Sodankyla in 2015 reveals a challenging age structure. The largest cohorts are in the 50-65 age groups. The cohorts aged 0-40 are all very similar in size, suggesting relative stability for four decades. The pyramids for 2025, 2035 and 2050 show that the "late middle aged bulge" moves up and is dissipated, eventually leaving the "pyramid" narrow and more like a column in shape.

The age structure graph (top row, second from left) makes it clear that the decline in population is mainly a consequence of a shrinking working age population. The size of the childrens age groups remains fairly stable, but the number of pensioners increases until about 2040, thereafter contracting slightly. This combination results in a steady increase in dependency rates (third graph), so that by 2035 the number of children and pensioners is forecast to be almost equal to the working age population. The gender ratio (fourth graph) shows that for every 100 women there are about 109 men, and that this will remain static in the coming decades.

The Sodankyla employment shock scenario assumes the expansion of a local mine, which results in the creation of 750 jobs. This event is assumed to take place between 2025 and 2029. Of the 750 jobs, it is assumed that only almost 370 will be taken up by workers migrating into the municipality. Associated with these 370 workers are almost 220 household members – giving a total in-migration effect of almost 590 persons. However, since some of these migrants are women of fertile ages, the net effect on the total population is greater at 600. Assuming (perhaps improbably) that the additional jobs are retained until 2035, the net additional population is predicted to increase to 675, as a third generation begins to be added to the migrant families. The dependency ratio would be reduced slightly due to the small increase in the working age population, whilst the gender ratio would increase significantly to more than 115 males per 100 females.

Of course, the exact impact that the in-migration would have on the age structure and gender ratio would depend both on the age/gender profile of the new employees, and the extent to which the sustainability of the employment encouraged household members to settle in the municipality. Jobs which are perceived as short term would more likely result in weekly commuting, rather than the permanent resettlement of households.

Figure 2: The Main Results for Sodankylä Municipality (Finland)



Brønnøy (Norway)

The main results for Brønnøy are shown in Figure 3.

According to Statistics Norway, Brønnøy's population is predicted increase from slightly less than 8,000 in 2015 to approximately 9,500 in 2040. The Statistics Norway projections end in 2040, but the REGINA model continues until 2050, predicting a continued increase to around 9,800.

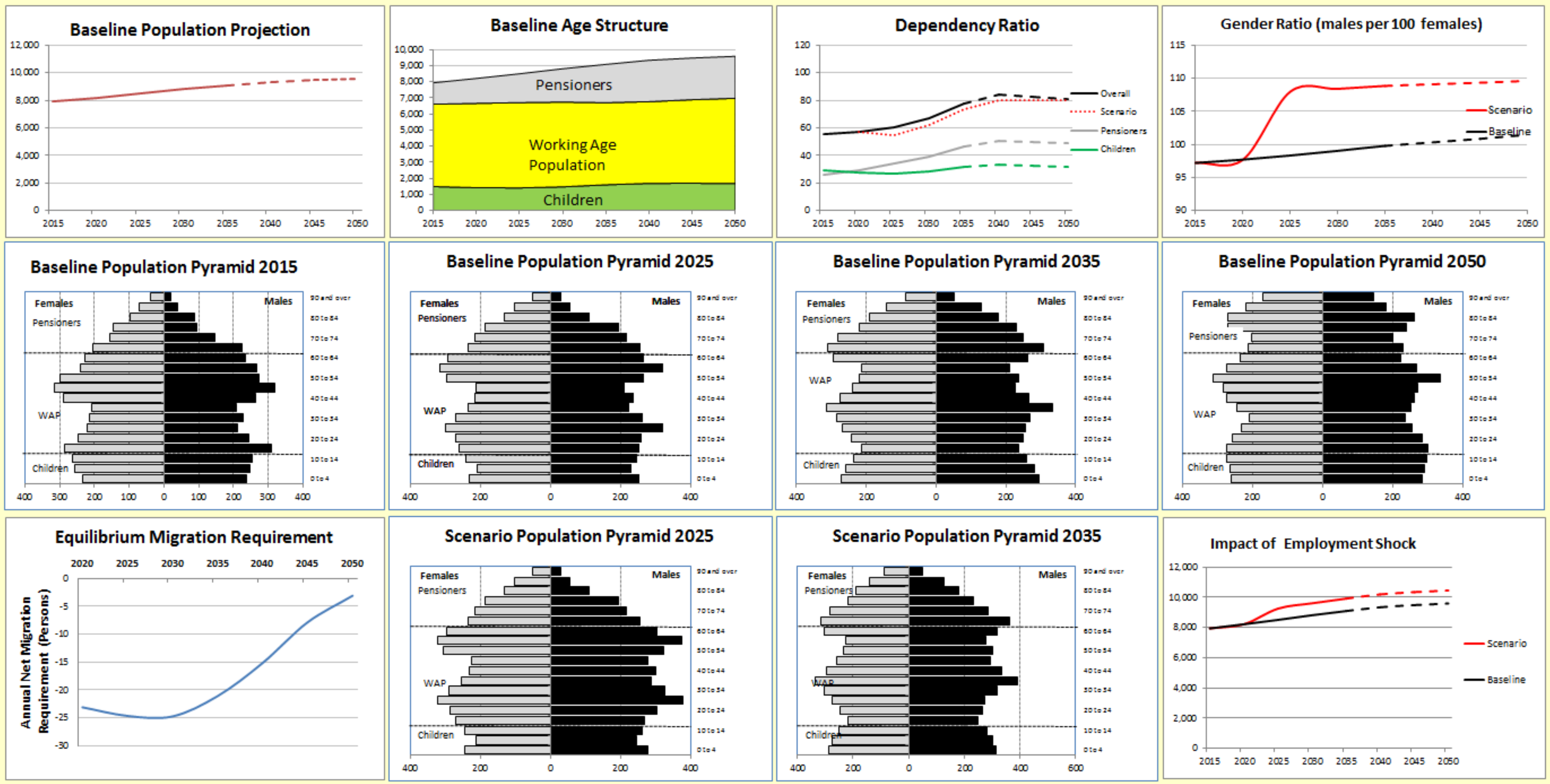
The population pyramid for Brønnøy in 2015 shows that the cohorts younger than 40 years old are smaller than those aged 40-60. The largest cohorts are in the 45-55 age groups. The cohorts aged 25-40 are particularly small, as are the three children cohorts.

The small child cohorts are also evident in 2025, but in 2035 they seem to have recovered. Generally speaking, the age structure of Brønnøy is less "top heavy" compared with the two preceding municipalities. Dependency rates are, in consequence, relatively lower, but rising quite steeply from 60 in 2015 to 80 in 2040. This is almost entirely due to the rising number of pensioners. The number of children rises much more slowly. Unlike the two former municipalities the gender ratio is in favour of females. In other word in 2015 there were only about 97 males for every 100 females. By2040 this is forecast to rise to about 99.

The Brønnøy employment shock scenario assumes the expansion of a limestone quarry, which results in the creation of 200 jobs. These 200 jobs comprise both direct and indirect/induced "multiplier effects" in related industries. This event is assumed to take place between 2020 and 2024. 85 of the jobs created are predicted to be filled by in-migrants to the municipality. Associated with these 85 workers are 70 household members – giving a total in-migration effect of 155 persons. However, since some of these migrants are women of fertile ages, the net effect on the total population is greater at 162. Assuming (perhaps improbably) that the additional jobs are retained until 2035, the net additional population is predicted to increase to more than 230, as a third generation begins to be added to the migrant families. Thus a relatively small number of additional jobs, of which a minority are predicted to be filled by in-migrants, would have a positive impact upon the municipal population which would have a small cumulative effect (assuming the additional jobs are retained). Furthermore the in-migration would have a the effect of very slightly reducing the dependency ratio, and shifting the gender ratio closer to parity.

Of course, the exact impact that the in-migration would have on the age structure and gender ratio would depend both on the age/gender profile of the new employees, and the extent to which the sustainability of the employment encouraged household members to settle in the municipality. Jobs which are perceived as short term would more likely result in weekly commuting, rather than the permanent resettlement of households.

Figure 3: The Main Results for Brønnøy Municipality (Norway)



Pentland Firth and Orkney Waters (Scotland)

The main results for the Pentland Firth and Orkney Waters (PFOW) area are shown in Figure 4.

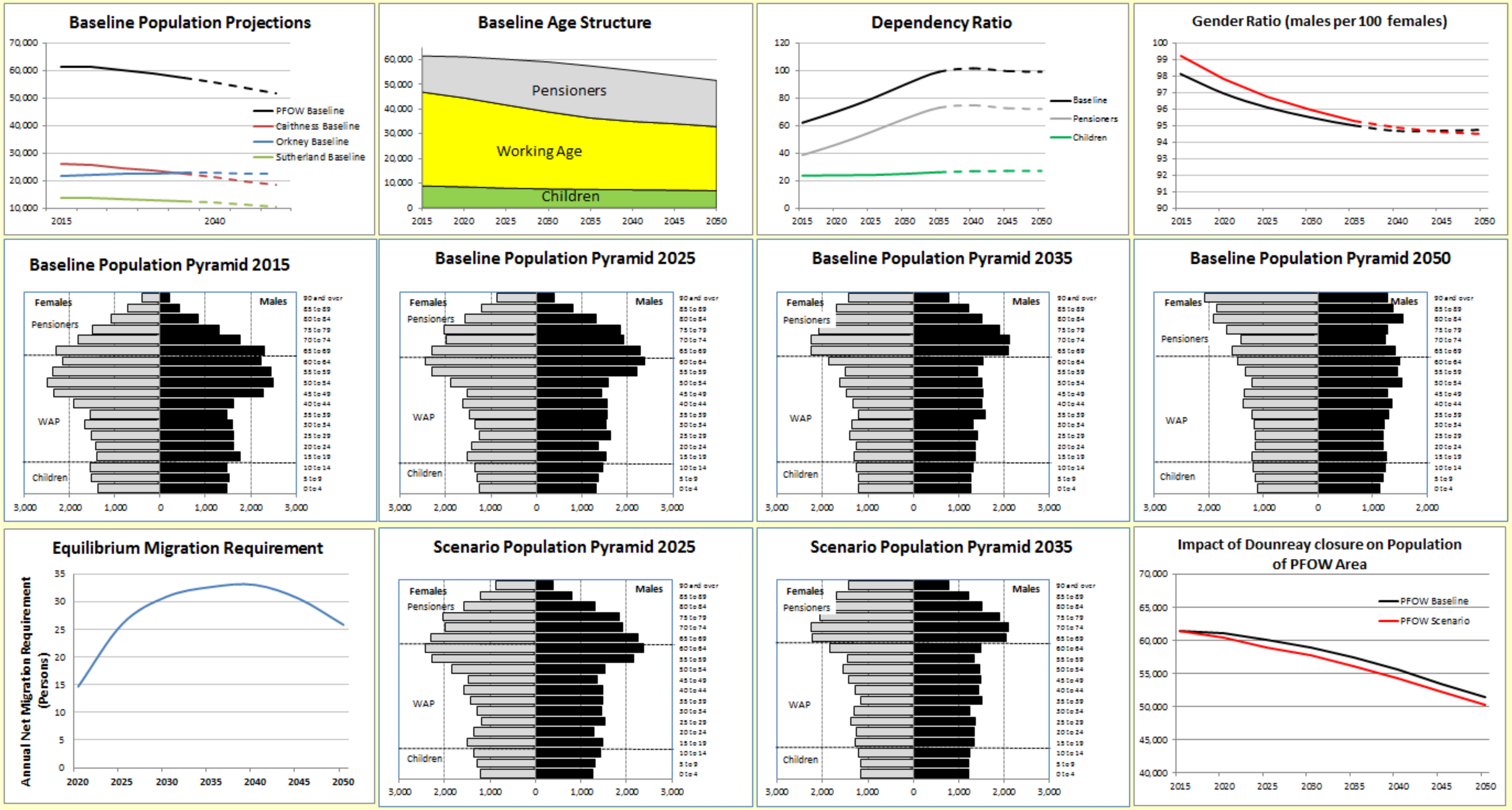
According to National Records Scotland, (NRS), the population of the PFOW area is predicted fall from slightly more than 61,000 in 2015 to approximately 57,000 in 2035. The NRS projections end in 2035, but the REGINA model continues until 2050, predicting a continued decrease to around 51,000. The overall decline across the PFOW area masks different trends in Orkney islands, where the population is set to increase, and in the mainland areas (Caithness and Sutherland) which are on the decline.

The population pyramid for the PFOW area in 2015 shows that the cohorts younger than 45 years old are consistently smaller than those aged 45-65. The progression to 2035 and 2050 can be summed up by saying that the larger cohorts in in the older age groups gradually pass away, leaving a very narrow age structure. Dependency rates rise form 60% in 2015 to around 100% in 2035. This change is mostly fuelled by the expansion of the pensioner part of the population. The number of children declines slowly between 1015 and 2050. As in Brønnøy the gender ratio is in favour of females. In 2015 there were approximately 98 males for every 100 females, the ratio is forecast to drop below 95 by 2050.

The PFOW employment shock scenario relates to the decommissioning of the Experimental Nuclear complex at Dounreay, which results in the loss of 1,500 jobs. This event is assumed to take place between 2015 and 2024. The job losses are estimated to result in the out-migration of about 630 workers. Together with this “direct migration impact” there is estimated to be an indirect effect as roughly 530 household members leave with the former employees. This results in a total out-migration effect of 1,160 persons. However, since some of these migrants are women of fertile ages, and the number of births is reduced, the net loss is greater, at more than 1,200. Assuming (perhaps improbably) that the additional jobs are retained until 2035, the loss of population is predicted to increase to more than 1,300. Thus, the loss of the out-migrating workers, together with their households, would be compounded by a reduced reproductive capacity. Both the gender ratio and the dependency rate would be slightly increased by the loss of jobs at Dounreay.

Of course, the exact impact that the out-migration would have on the age structure and gender ratio would depend both on the age/gender profile of the new employees, and contextual factors, such as the condition of the labour market in other parts of Scotland and the UK, which would impact upon the tendency to migrate.

Figure 4: The Main Results for Pentland Firth and Orkney Waters (Scotland)



6. How to improve your Demographic Foresight Model

Foresight, by definition, involves many assumptions and the validity of the predictions is very much affected by the quality of local expert knowledge. It is possible to achieve a forecast fairly quickly by making reasonable assumptions about future changes in fertility, mortality and migration rates. In simple projections, these are derived by continuing recent trends into the future. However, all of these parameters may well increase or decrease in coming decades, and these changes are likely to affect age groups differentially. For example, fertility rates for younger and older women are changing due to both cultural factors and improvements in medical science. Probably the aspect which is most sensitive to inputs of local knowledge is the employment shock scenario, where good judgements regarding the likely patterns of migration, both (direct and indirect) have substantial impacts on the outcome.

Various sources of information may be of value in improving the credibility of demographic foresight, including:

- Analyses of trends relating to fertility, mortality and migration, which may be available from your national statistical agency, or from couty or regional administrations.
- Expert local knowledge of local business organisations, housing organisations, employment agencies, and welfare providers.
- Surveys of local businesses.
- Focus groups which bring together a range of local organisations.
- The private sector companies involved in the employment changes modelled by the scenario.

A potentially even more effective approach could be to develop the scenario parameters in a workshop environment, through which different actors can experiment with the effects of varying the assumptions.

7. A Final Word

It is already widely recognised that in the context of fragile demographic situations, such as those of the Northern Periphery and Arctic, employment changes, whether positive or negative, have long-term and cumulative impacts upon the sustainability of local communities. The goal in this part of REGINA has been to provide a planning tool which will give municipal staff a means to assess the longer-term demographic impact of “Employment Shocks”, and to explore ways in which they can quantify and assess alternative smart specialisation options.

This document has presented a relatively simple spreadsheet-based demographic foresight model. This model has been adapted to the needs of relatively small municipalities, where conventional projection methods tend to be problematic due to the small numbers of persons involved. A key element is the use of 5-year cohorts and 5-year projection periods. The use of the Excel spreadsheet platform means that the model can be easily accessed, and adapted to reflect local needs and specific employment scenarios.

Detailed guidelines for implementing and adapting the model are followed by four examples, based upon four of the municipalities which have participated in the REGINA project. These represent both "shrinking" and "growing" demographic environments within the Northern Periphery and Arctic region. The scenarios illustrate the likely demographic consequences of both positive and negative employment shocks, and reveal the medium-long term cumulative effects upon the capacity of the population to reproduce. We trust that this model will prove to be a valuable learning tool, through which municipality staff may explore different development alternatives, and identify good practice within the context of the Local Smart Specialisation approach.