



# Exploring the Future Population and Educational Dynamics in the Arctic: 2015 to 2050

ANASTASIA EMELYANOVA,  
Dr. of Health Sciences, Postdoctoral Researcher  
Thule Institute & University of Arctic, University of Oulu

## Conflict of Interest statement

There is just one author and there is no conflict of interest

## Abstract

*The Arctic is a geographical space surrounding the North Pole. It encompasses dozens of sub-national entities north of eight Arctic countries: Russia, Canada, Denmark, the United States, Iceland, Norway, Sweden, and Finland. It is 20 million square kilometers land coverage settled with only 10 million people (2015). In the desire to learn more about the Arctic overall profile in population change, we aimed at producing cross-regional dataset covering all parts of the Arctic, and using it as a baseline for the cohort-component population projection. In this way, we model the future changes in the age, sex, and educational structure of sub-national populations, the latter reflecting the regional human capital. The projections are based on three alternative scenarios, taking into account regional characteristics (“Medium development”, “Arctic Boost”, and “Arctic Dip”). The results might be informative for those interested in the future dynamics of the Arctic population from 2015 forward to 2050.*

**Keywords:** population projections, education forward dynamics, the Arctic, sub-national

## 1 Introduction

The Arctic region covers more than 10% of the planet's total land area but is one of the least populated places due to remoteness and rough climate. It encompasses the lands located to the north of 60° N latitude (Figure 1). On basis of health and demographic data, we explore population dynamics dividing the Arctic into four internal regions. They consist of 25 sub-national entities: (1) North American Arctic: Alaska in the United States (US) and Canadian Yukon, Northwest Territories (NWT), and Nunavut, (2) North Atlantic Arctic: the Danish Faroe Islands and Greenland, and Iceland. In (3) Fennoscandian Arctic, Norrbotten and Vesterboten of Sweden are included as well as three regions of Norway – Nordland, Troms, and Finnmark – and three regions of Finland – Lapland, Kainuu, and North Ostrobothnia (Oulu). (4) The Russian Arctic includes 11 subjects: Karelia, Komi, Arkhangelsk, Murmansk, Nenets and Yamalo-Nenets areas, Sakha Yakutia, Magadan, Kamchatka, Khanty-Mansi and Chukotka.



**Figure 1.**  
*Coverage of the Arctic Area*

In many parts of the Arctic, population change has been affected with a rapid environmental and socioeconomic transformation. Mineral industries, fisheries, transportation, technology development, and boosting tourism have been pushing human migration and affecting Arctic ecosystems. It came together with climate change that leads to the loss of sea ice, erosion and contamination of coastal lands due to e.g. thawing permafrost and global transport of chemicals. Under internal and external factors, the Arctic communities experienced a marked population growth. In 1945 the population of Alaska in the US was 100,000 and has grown sevenfold by 2015. In Greenland, the increase has been more than fivefold, and a fourfold increase occurred in Iceland during

the same period. At present, only Alaska, Iceland, and the Canadian Arctic have continued to experience population growth due to still positive net migration and natural population increases (more births than deaths) (Larsen & Fondahl, 2015).

However, population living in the northern parts of Sweden, Finland and Arctic Russia has declined up to 10% in the last decades due to accelerated out-migration and natural population decline. In particular, starting in the 1990s, the profound growth seen in Greenland and the Faroe Islands has reversed to a declining population trend (Gløersen, Dubois, Copus, & Schürmann, 2006). Education plays a role in affecting the population structure. For instance, there has been out-migration of youth, in particular young females, from the North Atlantic Arctic who choose to study and work outside their native lands (Hansen, Rasmussen, Olsen, Roto, & Fredricsson, 2012).

In this study, we take into account the known characteristics of the region's population discussed in the number of publications on human development in the Arctic, including the demographic and health transitions as well as societal drivers of change (Andrew, 2014; Einarsson, Nymand Larsen, Nilsson, & Young, 2004; Hansen et al., 2012; Larsen & Fondahl, 2015; Larsen, Schweitzer, & Fondahl, 2010; Megatrends, 2011; Young, Rawat, Dallmann, Chatwood, & Bjerregaard, 2012). The key features are also described in Section 2. Our three main scenarios resulted out of the literature analysis and named "Medium", "Arctic Boost" and "Arctic Dip" (Section 3), help to explore the changes in the size and the structure of the population in the overall Arctic, its constituting sub-national entities, and to compare the effect of scenarios to the country-level situation (national average) for the timeline 2015 to 2050 (see Results in Section 4).

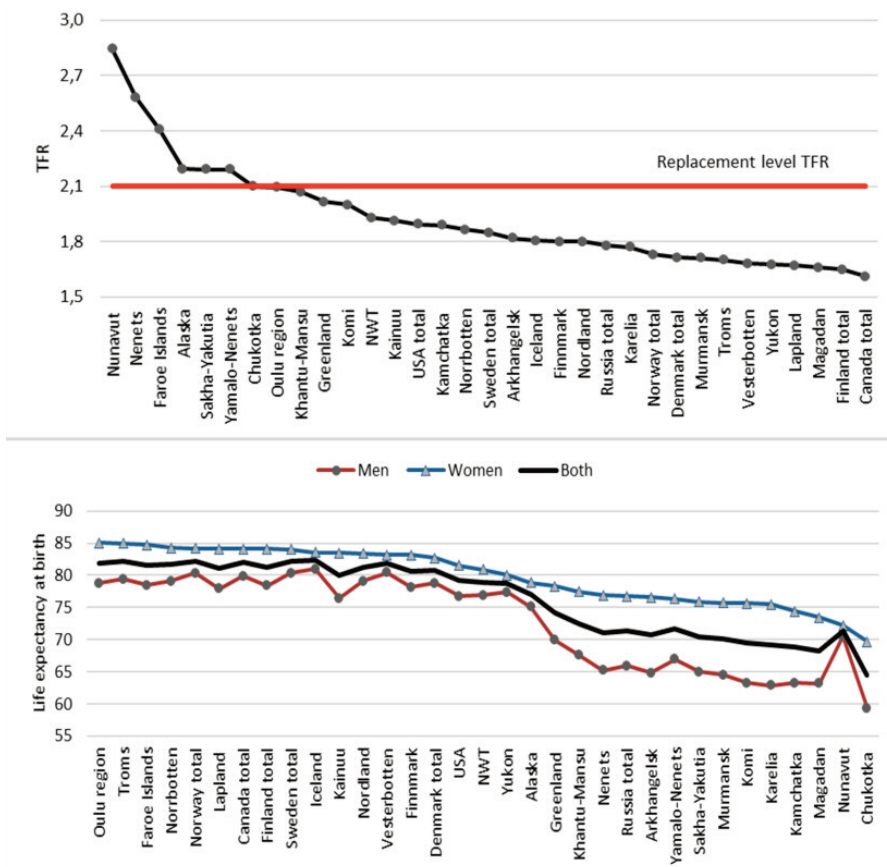
## **2 Demographic and education outlook of the Arctic population**

Section 2 outlines regional fertility, mortality, migration, and ethnic patterns as principal determinants of population change in the Arctic, in a summary way. It also discusses what kind of education trends and gaps are there in the region.

In fertility indicators, the Arctic has undergone a decline at the turn of the century, however, dynamics will not likely cause a major population loss. Still, fertility has been above the national average in several Arctic territories and showing one of the highest fertility rates in Europe. In 2015, the Total Fertility Rate (TFR) above the replacement level was encountered in one quarter of regions and countries under study (eight areas out of 33). The highest TFRs have been found in Canadian Nunavut (2.8), Nenets area of Russia (2.6), and the Faroe Islands (2.4). Alaska, Sakha Yakutia, Yamalo-Nenets, Chukotka, and North Ostrobothnia have fertility levels around replacement (2.0–2.2). The remaining areas have fertility levels below replacement, marking at the lowest 1.7 in the Russian region of Magadan, Canadian Yukon, and northernmost areas in Scandinavia. On average, Northern Fennoscandia and Russian Arctic's fertility have been lower than in the North American and North Atlantic parts of the Arctic.

There is a significantly varying pattern of longevity due to large differences in mortality between sexes and regions. The average Life Expectancy (LE) at birth for both sexes in the Arctic provinces was 75.4 years in 2015 (male 71.7 and female 79.2). Calculating the average of the eight Arctic countries instead of just their northern provinces, LE was five years higher: 80.1 years for both sexes (male 77.7 and female 82.6). This hints on the still existing longevity gap between the nation-wide and north-specific indication of life expectancy.

Inside the Arctic, there is an enormous gap of more than 20 years in male and female LEs between the area with the lowest indication – Russian Chukotka – and the leading areas such as the Faroe Islands, Iceland, and Norwegian Troms. In general, the Arctic areas in Siberian Russia have the lowest indication of LE (Chukotka, Magadan, Kamchatka). Nunavut and Greenland have a relatively low LE, more than 10 years of difference in male LE with Canada or Denmark, in part due to history of local population in the colonial times (Larsen & Fondahl, 2015). Figure 2 illustrates the above discussed patterns in the TFR and LE (2015).



**Figure 2.** Total Fertility Rate (TFR) and Life Expectancy at Birth in the Arctic Constituting Regions and Countries, 2015

The migration processes count for high impact on population size, composition, and human capital characteristics of the Arctic population (such as education, health, income) because of relatively small size of populations located across the North. The migration turnover has been at a higher rate in the Arctic regions than the rest of their countries, with more people moving to, from, and within the North. The character of regional migration might remind of a cycle of booms and busts that have been historically associated with large-scale industrial projects, such as pipeline constructions, oil exploration and mining, military activities, and financial recession periods. At times many Arctic settlements have experienced migration in-flows larger than the natural rate of increase (births/deaths) (Hamilton & Mitiguy, 2009; Hamilton & Rasmussen, 2010; Heleniak, 2014a).

The ethnic composition greatly affects demographic indicators of birth, death, mobility and others such as urban-rural residence and household structure in the Arctic. Previous research documents poorer outcomes for Indigenous people compared with benchmark populations (Anderson et al., 2016), illustrating the earlier stages of demographic and epidemiological transitions of Indigenous populations. In fact, the health of people living in rural, remote Indigenous communities in the Arctic is poorer than that of their urban and non-Indigenous counterparts. The Indigenous population has a much younger age structure, higher fertility and mortality, and a less balanced sex ratio. Across the Arctic, Native Greenlanders in Greenland and Indigenous people in Canadian Nunavut make as large as 86% of the total respective region's population, 50% in NWT, 20% in Alaska and Yukon, 15% in Arctic Norway, and as little as 3–6% in the Russian Arctic (except for 30% in Chukotka).

The educational structure is an important driver of population development and a variable of human capital. The results of some studies imply that improvements in educational attainment are the key to explaining productivity and income growth and that a substantial portion of the demographic dividend is an education dividend (Crespo Cuaresma, Lutz, & Sanderson, 2014; Cuaresma & Mishra, 2011; Lutz, Butz, & KC, 2014; Lutz & KC, 2011). In the Arctic, number of people with upper and post-secondary educational attainment has been steadily increasing. New technologies provide more opportunities for distant learning for many remote and rural residents, a trend that is incorporated into our education scenarios. From the quality perspective, there is a growing recognition of the importance of Indigenous and local knowledge at all levels. Curricula are changing from a purely needs perspective of the Arctic industries towards preparing students to address all future challenges – adaptation to climate change, health threats, development needs of mixed economies – both globally and with a greater focus on content that speaks to local needs and conditions. Alongside the recent progress made in some areas, there are still various long-term challenges and inequalities in the Arctic education e.g. high drop-out rates of males and Indigenous students, skewed access to education and its quality due to distance and lack of teachers, education outcomes below the national level, brain drain and many others (more in detail in Larsen & Fondahl, 2015).

## 3 Data, methods and scenarios

### 3.1 Data characteristics and limitations

Tables with various national and regional population data have been retrieved from the national statistical databanks of the Arctic states. The Russian Federation Federal State Statistics Service and the Unified Interdepartmental Statistical Information System are the main data supplier of population accounts and components of population change in Russia (Fedstat, 2017; Rosstat, 2017). For the Nordic countries, national and sub-national statistical agencies publish time series on various population events (Statistics Denmark, 2017; Statistics Faroe Islands, 2017; Statistics Finland, 2017; Statistics Greenland, 2017; Statistics Iceland, 2017; Statistics Norway, 2017; Statistics Sweden, 2017).

Canada's national statistical agency and the Canadian Human Mortality Database (CHMD) are the other main sources of regional and national population data (Department of Demography, Université de Montréal, 2017; Statistics Canada, 2017). The CHMD life tables is the main source for mortality data as available for longer time series (1950 to 2010–2011) and by sex. When projecting the US and Alaska's populations, baseline data is assumed on the basis of population estimates and further data from local statistics as well as census data of the US (Alaska Department of Labor and Workforce Development, 2017; US Census Bureau, 2017).

The population of the Arctic is projected according to the ISCED levels of educational attainment (International Standard Classification of Education ISCED 2011, 2012). The levels have been aggregated and visualized by four larger groups in Section 4: Total, None to lower secondary, Upper secondary, and Post-secondary. The full list of educational levels, codes, data suppliers and resulted projections according to the national systems of education can be inquired from the author.

It is important to note that while acknowledging differences in health status and demographics between Indigenous and non-Indigenous populations in the Arctic (briefed in Section 2), the computation of projections in this study is restricted to only the total populations living in the sub-national entities. This is in light of such restrictions as the proportion of Indigenous people is estimated to be about 10% of total population living in the Arctic (Nordregio, 2013); the different ways in which Arctic countries categorize native peoples (hence, difficult to establish vital statistics trends by ethnicity), and also baseline educational distribution of regional population was mainly available without ethnic distinction. The similar data limitation goes to the quality of education, to which there is lack of comparative assessment data. The quality across educational levels is not examined in our quantitative model even though the quality might largely vary across national educational systems and programs.

Finally, the starting point of projections – Arctic data on population by education – is collected for various years in the period 2010 to 2015 depending on available census or survey waves. Only Denmark, Greenland, Norway, Sweden and the US have pro-



vided data for the year 2015 by the time of data collection. For reasons of simplicity, the education distribution of other territories with data from earlier years 2011 or above was assumed as of the baseline year 2015 and should be regarded with such warning. The accompanying demographic components – life expectancy, fertility and migration rates – have been forecasted until 2015 where actual data for 2015 has not yet been released by national statistical databases. One more data limitation to bear in mind is related to Sweden, Norway and their Arctic territories, where data for the usual age group 15–19 is published for the age group 16 to 19. In projections, this age group is regarded as 15–19.

### *3.2 Methods and scenarios*

The population distribution is projected in 5-year periods starting from 2015 until 2050. The latest data on demographic patterns in the respective territories (2000–2015) is taken into account while implementing assumptions. The assumptions are applied to the multi-state cohort component model to project the population at the national and sub-national levels. Excel Microsoft Office Professional Plus 2016 software is used for the majority of computations in addition to minor computing with R.

The optimization procedures to find education specific survival ratios, life tables and TFRs by educational level were inspired from earlier projections stratified by education (KC, Potančoková, Bauer, Goujon, & Striessnig, 2013, 2014) but included methodological alterations to build scenarios and for the part of mortality package. In order to find education specific survival ratios, life tables by educational level have been constructed applying the Relational Brass logit mortality model (Brass, 1975; United States National Academy of Sciences, 1983) by year, region, age, and sex. LE at age 15 was extracted from life tables we computed at the earlier stage of the analysis for the three mortality scenarios. It was subjected to the difference in LE by sex between the lowest and highest educational levels – 6 years for males and 4 years for females. The difference between specific levels varied depending on the territory under study and its classification of educational system to which data was available.

The multiple field matrices were applied to optimize the choice of LE at age 15 (e15) for each educational category, keeping the chosen differentials constant. We calculated the inverse of a square matrix for both sexes, followed by finding the matrix product of two arrays or so-called representing matrices. This generated a final set of e15 of educational levels whose averages were equal to e15 of a total population. Having e15 defined for educational level, territory, sex, and scenario, the Brass logit model was applied again based on mortality schedules of earlier forecasted life tables of a total population, and produced a new set of life tables and respectively survivorship contrasted by educational categories. The weights of population in each educational category helped to proportionate the remaining residuals of deaths to complete the number of people after survival, aggregated over attainment levels to be equal to the total number of people in the projection, forecasted in the first round (without education distinction).

The narrative background for scenarios is based on the views of the Arctic Monitoring and Assessment Programme (an Arctic Council Working Group) to the future socioeconomic development of the Arctic region (e.g. Andrew, 2014). We develop three umbrella scenarios, which takes into account both pan-Arctic and specific regional trends (Table 1).

**Table 1.** *Scenarios of the Projections*

Component	UMBRELLA SCENARIOS		
	1.MEDIUM	2.ARTIC BOOST	3.ARTIC DIP
<b>FERTILITY</b>	<p><b>Arctic Fertility</b> – forecasted with a continuing downward trend, where the TFR will go down 0.2 points by 2030 as the average of Arctic areas where decline happened throughout 2000–2015. Further decline is slowing down -0.1 by 2050</p>		<p><b>UN Fertility</b> setting on 2030 and 2050 “medium” forecasts in TFRs of the UN World Population Prospects: The 2015 Revision (United Nations, 2015)</p>
<b>MORTALITY</b>	<p><b>Arctic &amp; Fast improvement</b> setting on the Arctic forerunner Faroe Islands (84.5 years female life expectancy (LE) in 2014–2015) with a 1.24% growth in LE per each 5-year period (based on Faroe Islands empirical data in 1990–2014)</p>	<p><b>Global Convergence assumption</b> Setting Arctic countries on the global forerunner Japan, assumed to experience a constant increase of 2 years in LE per decade. Sub-national areas to follow the dynamics of the respective country</p>	<p><b>UN Mortality</b> setting on 2030/2050 “medium” forecasts in LE of the 2015 Revision of World Population Prospects. Arctic sub-national areas follow the dynamics of the respective country</p>
<b>MIGRATION</b>	<p><b>Levelled-off Convergence</b> Baseline migration towards equilibrium in 2050 so that each region’s immigration and emigration probabilities converge to their average, net migration reaches zero by 2050</p>	<p><b>In-Migration Ups</b> 100% probabilities of immigration move up at a 10% probability pace by 5-year period until 2030, after that the growth in number of incomers is set at 5% reaching 150% of that in baseline year by 2050</p>	<p><b>Prevailing Out-Migration</b> 100% probabilities of out-migration move up at a 10% pace in each 5-year period until 2030, with 5% from 2035 to 2050, overall reaching 150% of the baseline number of outcomers by 2050.</p>
<b>EDUCATION</b>	<p><b>Moderate Progression</b> EAPRs for the levels below Bachelor are set on 20% growth to reach by 2070 from the 2020 year data, calculated using a logit model, and 10% increase for the Master and Doctoral graduates share</p>	<p><b>Fast Progression</b> EAPRs for the levels below Bachelor are set on 40% growth to reach by 2070 from the 2020 year data, calculated using a logit model, and 20% increase for the Master and Doctoral graduates share</p>	<p><b>Stalled Progression</b> EAPRs for the levels below Bachelor are set on 5% growth to reach by 2070 from the 2020 year data, calculated using a logit model, and 0% increase for the Master and Doctoral graduates share</p>



1. The “Medium” scenario projects a continuation of trends in the individual Arctic territories from the recent past and assumes moderate changes in education progression. Scenarios two and three consider migration as a larger cause of demographic change.
2. The “Arctic Boost” scenario accounts for the vision on future growth in the Arctic that, according to experts, will come from immigration (Larsen & Fondahl, 2015). It implies a growth in the number of newcomers driven by further changes in climate and technological developments, which makes the region more tangible for new industries, resources exploration, and infrastructure development. It also implicates faster education progression between educational levels and an increase in the number of people with the highest qualifications who contribute to the boost, coming both from the outside and encouraged by the growth in the number and study opportunities at the domestic educational institutions.

The attractive prospects of the Arctic development suggest the number of in-migrants to the region may change upwards; however, the context is complex and variations can be large across the constituting regions. Here, we assume net-migration to be positive (more people coming into a region than leaving) but at the region’s specific pace. In the comprehensive analysis of migration in the Arctic, several experts suggest that a ‘huge’ influx of people to the Arctic in the foreseeable future is not very likely (Andrew, 2014; Heleniak, 2014b). Hence, our assumptions lead to a moderate pattern of increase and the growing number of total in-migrants is not large in absolute terms.

To note, the Arctic has never performed a consistent trend of prevailing in-migration experienced by all constituting territories. On the opposite, some Arctic regions have experienced a large exodus of peoples, in particular, some areas in the Russian Arctic and Greenland. Hypothetically assuming that all Arctic territories will have positive migration, or as in the next scenario “Arctic Dip” – negative migration, serves the research curiosity of what would happen to the overall population if the development boom in newcomers or out-comers becomes reality everywhere in the studied territories.

3. The “Arctic Dip” scenario is interesting as, even though the stakes are high, should there be continuing economic downturns and aggravated global recessions, the “boom” of Arctic projects may never come. Possible policy mechanisms sanctioning against resource-dominated development of the region coupled with financial crisis and reinforced environmental protection actions against large-scale industrial plans imply that a growing number of current residents may retain ties to places outside the Arctic to where they could move. Furthermore, increasing risks of “climigration” – climate change driven migration – will make either planned or unplanned movements unavoidable in the near future for many coastal Arctic residents under impact, possibly away to the South (Hamilton, Saito, Loring, Lammers, & Huntington, 2016). The climate change outcomes most affecting the Arctic include sporadic extreme weather events, long-term deterioration of the residing area, reduced access to sea ice as a source of drinking water, further environmental contamination, and broader the issues of retaining local traditional food supply and methods of food conservation possibly not secured

anymore in the Arctic (Beaumier & Ford, 2010; Bronen & Chapin, 2013; Ford, Smit, & Wandel, 2006; Gerlach, Loring, Turner, & Atkinson, 2011).

These factors can decrease the attractiveness of the Arctic to be home for future cohorts of newcomers. Hence, it entails accelerating out-migration as a driver of future population decline combined with a number of larger constraints to development in the region. Progression of population groups to higher levels of education is slower and stalled at the baseline level for the MA and PhD levels and presumably many qualified students and professionals might opt to go elsewhere to pursue further education and careers.

Education scenarios are defined as the transition from lower to higher educational levels. At first, the Education Attainment Progression Ratio (EAPR) (Yucesahin & K. C., 2015) is computed from the baseline population distribution by education categories, finding out the proportion of the population who progressed from a lower level to the next higher level. For instance, if 20% of people in a certain age group have completed at least Bachelor degree level and 80% have completed upper secondary, 25% of upper secondary graduates have graduated with the Bachelor diploma. Next, finding logits of EAPR for each age group has been done that allowed finding intercept and slope to predict EAPRs for the first projection period (2015–2020). From 2020 to 2070, EAPRs for each education level follows the scenario stated in the Education row of Table 1.

The resulted population distributions have been smoothed for those regions that showed education related distortions in the middle age groups. The smoothing within those age intervals was done by sex and education level, the small residuals to total population being proportionally adjusted. The Arriaga's strong and light smoothing formulas have been applied depending on the better suitability for the age groups 20–25 through 65–69 (formulas as in: United States Census Bureau, n.d.). These smoothing techniques were chosen as preserving the original population totals.

## 4 Results and discussion

### 4.1 *Is population going to grow in the Arctic?*

The results at the pan-Arctic level are informative to portrait the total level of change (i.e. growth vs. decline) under three scenarios developed for the future of the region. In 2015, 10.08 million people was a starting number of Arctic residents. The Medium scenario predicts 5% growth and 10.59 million people in 2050. There is a difference of approximately 1 million people between the side scenarios and the Medium scenario. It shows a variation up to 15% population increase from 2015 to 2050 in case of the Arctic vigorous development (Arctic Boost), and 5% decline in compliance with the Arctic Dip pathway. Based on all scenario variations, the conclusion is that, following many decades of intense growth, the population in the Arctic will likely remain in a status-quo and are no big changes foreseen.

Disaggregating the Arctic into compounding areas allows examining some features

of the Arctic diversity. In particular, this becomes clear that in general there will be a continuing population decline in some of the Arctic areas offset by growth in other areas. The territory-specific dynamics depend on the followed scenario (Table 2).

**Table 2.** *Population Change for the Arctic Territories, 2015 and 2050, Three Scenarios*

Arctic states and their provinces	Medium		Arctic Boost		Arctic Dip		
	2015	2050	% of change†	2050	% of change	2050	% of change
<b>The Arctic, mln</b>	10,08	10,59	5,1	11,63	15,4	9,59	-4,9
If “mln” (million) not stated then numbers are given in thousands							
<b>NAA, mln ‡</b>	0,85	0,99	16,8	1,10	29,6	0,91	7,2
<b>Canada, mln §</b>	35,85	35,85	0,0	37,78	5,4	36,22	1,0
Nunavut	36532	68207	86,7	73756	101,9	67319	84,3
NWT	44244	50917	15,1	57284	29,5	47432	7,2
Yukon	37393	39411	5,4	44710	19,6	37260	-0,4
<b>United States, mln</b>	321,87	342,92	6,5	346,71	7,7	352,25	9,4
Alaska	729162	830993	14,0	922677	26,5	756013	3,7
<b>NAA2, mln</b>	0,42	0,50	18,1	0,52	24,1	0,48	15,1
<b>Denmark, mln</b>	5,66	5,79	2,4	6,01	6,2	5,87	3,8
Faroe Islands	48346	63306	30,9	66815	38,2	62148	28,5
Greenland	55847	60137	7,7	64333	15,2	53918	-3,5
<b>Iceland, mln</b>	0,32	0,37	18,0	0,39	23,5	0,37	16,3
<b>FA, mln</b>	1,66	1,72	3,9	1,89	13,9	1,62	-2,1
<b>Finland, mln</b>	5,49	5,51	-5,3	5,82	6,1	4,90	-10,6
Kainuu	75324	62168	-17,5	67997	-9,7	56702	-24,7
Lapland	180858	155830	-13,8	172971	-4,4	141067	-22,0
North Ostrobothnia	410054	471060	14,9	522284	27,4	434958	6,1
<b>Norway, mln</b>	5,15	5,51	6,9	6,00	16,4	5,26	2,2
Finnmark	75111	74382	-1,0	81675	8,7	69874	-7,0
Nordland	239447	235348	-1,7	251340	5,0	227693	-4,9
Troms	162514	167794	3,2	182986	12,6	163483	0,6
<b>Sweden, mln</b>	9,85	11,12	12,9	11,73	19,0	11,62	18,0
Norrbottn	249733	267559	7,1	292441	17,1	255471	2,3
Vesterbotten	263378	286999	9,0	315195	19,7	271946	3,3
<b>RA, mln</b>	7,15	7,39	3,3	8,12	13,6	6,58	-8,0
<b>Russia, mln</b>	142,82	136,72	-4,3	146,45	2,5	125,63	-12,0
Arkhangelsk	1227625	1112543	-9,4	1193764	-2,8	1003832	-18,2
Chukotka	50523	50392	-0,3	60028	18,8	42247	-16,4
Kamchatka	322047	313252	-2,7	344358	6,9	280107	-13,0
Karelia	643298	568265	-11,7	616039	-4,2	511732	-20,5
Khantu-Mansu	1532129	1834849	19,8	2038970	33,1	1635412	6,7
Komi Republic	901004	863734	-4,1	940352	4,4	768859	-14,7
Magadan	156995	128686	-18,0	140810	-10,3	110485	-29,6
Murmansk	795259	735446	-7,5	820637	3,2	659634	-17,1
Nenets	42090	56426	34,1	62038	47,4	59882	42,3
Sakha Yakutia	958491	1159205	20,9	1257433	31,2	1034861	8,0
Yamalo-Nenets	522886	564354	7,9	649488	24,2	470760	-10,0

† Percent of change to the baseline 2015 population: negative % indicates population decline

‡ NAA - North American Arctic, NAA2 - North Atlantic Arctic, FA - Fennoscandian Arctic, RA - Russian Arctic

§ An aggregate level population (countries, larger Arctic areas such as the Russian Arctic etc.) is given in million

Out of 26 territories (25 sub-national entities and one country Iceland), 11 areas would undergo population decline to its baseline number, according to the Medium scenario. The majority of losses belong to the Finnish, Norwegian, and Russian northern areas. Under the highest alert of depopulation are five regions who still keep declining under optimistic Arctic Boost scenario: Finnish areas of Kainuu and Lapland, and Russian Arkhangelsk, Murmansk and Magadan regions. These five areas require rather immediate policy response supportive to natural population growth and reversing out-migration.

One-third of the studied provinces (10 of 26) keep increasing their total population even alongside the pessimistic Arctic Dip scenario. Many of growing jurisdictions are settled with Indigenous people (Canadian Nunavut and NWT, Khantu-Mansu, Sakha Yakutia, and Nenets areas in Russia), or having higher fertility comparing to its neighbors (Finnish Oulu in comparison to Lapland and Kainuu), or experiencing population growth due to one of the highest life expectancies in the world (Faroe Islands, Iceland, Swedish Arctic).

With regard to the age structure, under Medium and Arctic Dip scenarios, the population of children (0 to 14 years old) will shrink in most of the areas, except for Nunavut, Faroe Islands, Finnish Oulu, Swedish Norrbotten, Nenets, Sakha Yakutia, Yamalo-Nenets, and Khantu-Mansu areas in Russia, with a large share of indigenous residents there and higher fertility. Applying the Arctic Boost scenario results in around half of the Arctic regions enjoying the growth of children (15 areas out of 26). The situation with population in the age group 15–59 is more worrying. The majority of regions would move toward a significant loss of working age population (23 areas under Arctic Dip scenario, 18 areas under Medium). The elderly population (60+ years old) will increase by approximately 60% in all scenarios, being true for all the studied regions. The old-age dependency ratio (% of working-age population) will grow in all regions in the same period. Median age will increase by on average four years from 2015 to 2050, at the fastest speed increasing in Iceland, Yukon, NWT, and Troms.

#### *4.2 What are the educational dynamics?*

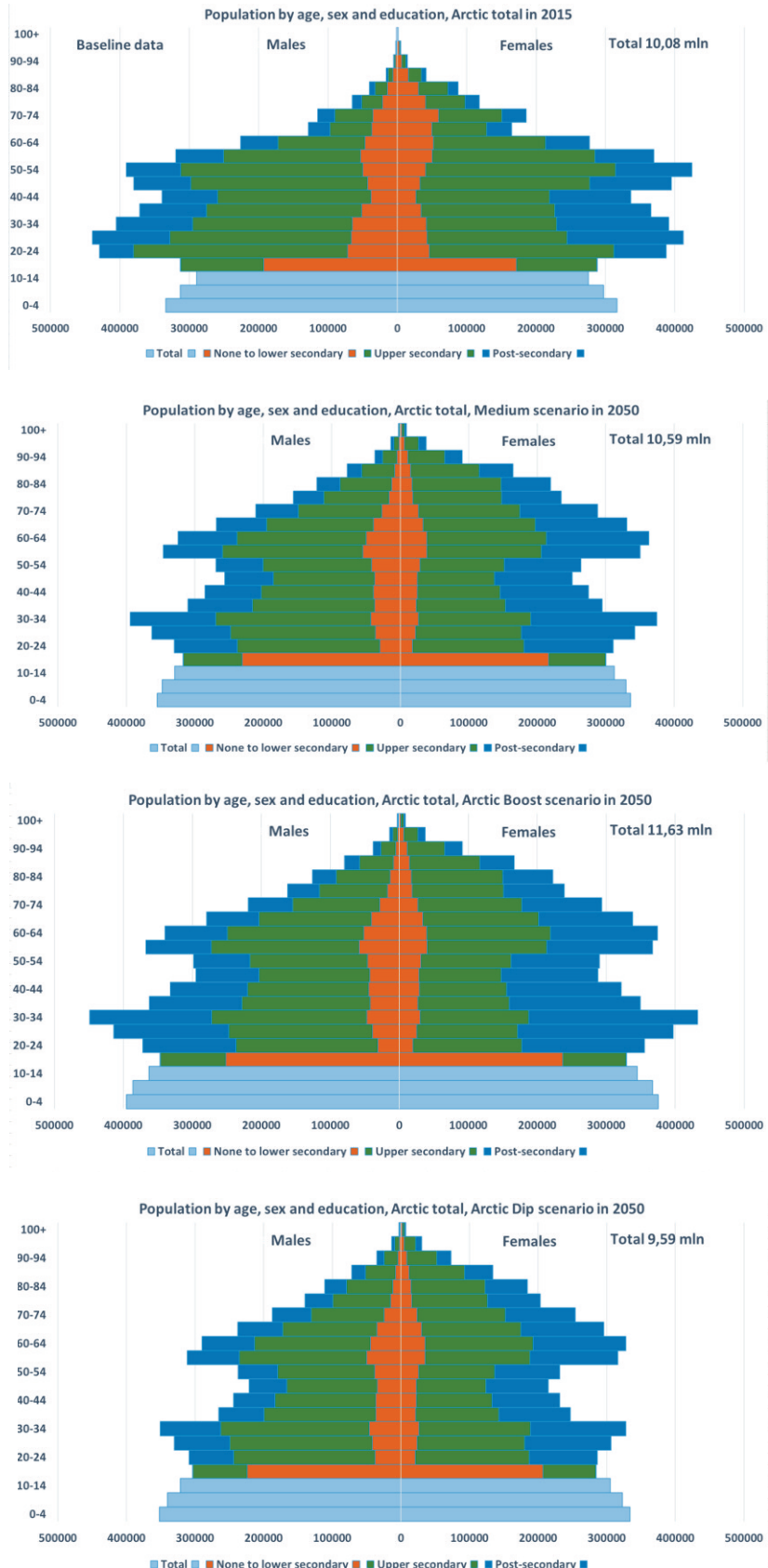
The educational structure of the present and upcoming Arctic population confirms a profound internal variation similarly to the above discussed demographic situation with growth and decline. It is satisfactory to know that in the region, post-secondary education attainment has been on increase (Larsen & Fondahl, 2015) and will likely continue development in that direction. Table 3 and Figure 3 inform with data on what share of population older than 15 years old (P15+) would be in one of three major educational categories: primary to lower secondary (including no education or not known education), upper secondary, and post-secondary, by scenario, sex, and for the years 2015 and 2050. The shares of three educational levels make 100%, and regard to the overall number of P15+ for the area and sex specific category.

**Table 3.** *Arctic Population by Sex, Major Education Categories and Three Scenarios, 2015 and 2050, Total Arctic and its Four Aggregate Areas, in million (mln) and % in Male and Female Population Aged 15+*

Area	Male				Female			
	Male population 15+, mln	Primary to Lower secondary, % in P15+†	Upper secondary, % in P15+	Post-secondary, % in P15+	Female population 15+, mln	Primary to Lower secondary, % in P15+	Upper secondary, % in P15+	Post-secondary, % in P15+
At – Arctic total NAA – North American Arctic NAA2 – North Atlantic Arctic FA – Fennoscandian Arctic RA – Russian Arctic								
<b>Baseline 2015</b>								
At	3,99	26,4	49,9	23,7	4,26	24,4	45,8	29,8
NAA	0,35	27,8	30,8	41,4	0,32	27,0	30,0	43,1
NAA2	0,17	45,0	32,8	22,2	0,16	49,2	28,4	22,4
FA	0,69	28,4	48,3	23,4	0,68	25,3	41,7	33,0
RA	2,78	19,3	62,7	18,0	3,10	16,0	59,2	24,7
<b>Medium 2050</b>								
At	4,08	23,4	49,5	27,0	4,50	18,2	42,5	39,2
NAA	0,41	24,9	38,1	37,0	0,39	21,8	33,7	44,5
NAA2	0,21	42,7	39,6	17,8	0,21	32,5	43,9	23,6
FA	0,73	23,0	50,9	26,1	0,72	17,5	39,6	42,9
RA	2,74	18,0	55,4	26,6	3,18	13,6	47,5	38,9
<b>Arctic Boost 2050</b>								
At	4,50	22,7	47,0	30,4	4,90	17,9	40,0	42,1
NAA	0,45	23,7	36,1	40,2	0,44	20,8	31,9	47,3
NAA2	0,22	40,0	39,4	20,6	0,21	31,1	42,7	26,2
FA	0,79	22,3	48,7	29,0	0,78	17,4	37,6	44,9
RA	3,03	17,9	51,7	30,5	3,47	13,6	43,9	42,5
<b>Arctic Dip 2050</b>								
At	3,66	25,5	50,4	24,2	3,95	19,7	43,8	36,5
NAA	0,37	27,0	39,2	33,8	0,35	23,6	35,2	41,2
NAA2	0,20	45,5	38,9	15,6	0,19	34,7	44,2	21,1
FA	0,68	25,0	51,2	23,8	0,66	19,2	40,7	40,2
RA	2,41	19,8	56,9	23,3	2,75	14,5	49,2	36,3

† P15+ is a total population by respective sex, aged 15 years and above

**Figure 3.**  
*Age, Sex, and Education Pyramid for the Arctic Total, 2015 (Baseline scenario) and 2050 (Medium, Arctic Boost, Arctic Dip Scenarios)*





Post-secondary education may not be growing equally for males and females. Women have been more educated in the Arctic already at the baseline year 2015. Their share was higher than that of men in the post-secondary category at the pan-Arctic level. For instance, in Fennoscandia, 23% of male population has passed to the post-secondary category versus 33% of that achievement in females. Noticeably, there was rather a gender equality with attaining post-secondary education in the North Atlantic and North American Arctic areas. However, projecting forward, all three scenarios indicate a growing gender gap. The North Atlantic and North American Arctic seem no longer gender equal in 2050: there will likely be a higher share of female individuals with college/university degrees over males than that in the previous decades. Fennoscandia shows almost a double difference between sexes at the end of the projection horizon to the shares found in 2015.

According to some theories, there is the relationship between investment in human capital development and post-secondary education, economic development, productivity growth, and innovation (e.g. Lutz, Cuaresma, & Sanderson, 2008). As seen in Table 3, fewer than half of residents in the North American Arctic ( $\approx 40\%$  in 2015) has attained post-secondary education that is a leading and twice higher share to that in other aggregate regions. However, it is important to note that educational achievements of the Arctic aggregate regions hide the next level heterogeneity for its compounding areas. For instance, the constituting parts of the North American Arctic – Alaska and Yukon – perform significantly better than the NWT, with Nunavut sitting at the very bottom of this aggregate region, given the long-term trend of the high school dropout rate in that territory, around 50% in the baseline period (Government of Canada, 2013). Hence, Appendix 1 provides more data for the national and sub-national level of population projections by sex, education, each territory, and scenario.

### *4.3 How different the Arctic vs. country-wide?*

When exploring the dynamics of Arctic population, it is striking to realize that among the total population of a country, the share of people living in the parts extending into the Arctic is invariably tiny. The lowest shares include those living primarily in the Russian (Siberian) and Canadian northernmost regions, and Alaska ( $<0.1\%$  of respective country's total population). The negligible number of people contrasts sharply with the colossal part of the country's land mass they occupy. This characterizes the Arctic as in many cases a place of pristine wilderness without a human trace. The existing settlements are divided into highly urbanized cities and, on the other hand, highly dispersed small communities and villages situated across the region. Of the more populated areas are the ones in the Fennoscandian Arctic, with Oulu region being most populated among three Arctic territories of Finland, 7.5% of national population in 2015.

Table 4 displays the changes in population size according to the three scenarios for the years 2015, 2030 and 2050, as a percent in respective country's total population. The colour shading is set to visualize the gradient with which each region has a share

in total population of their respective country. The red colour signifies the minimal share while blue is of larger percent in total population of the country. In addition, without a colour, it informs on the aggregate north of each country.

**Table 4.** *Arctic Population by Aggregate Regions and Areas, % in Respective Country's Total Population, 2015, 2030 and 2050†*

	Medium			Arctic Boost		Arctic Dip	
	2015	2030	2050	2030	2050	2030	2050
<b>Danish Arctic</b>	1,84	1,96	2,13	1,96	2,18	1,93	1,98
Greenland	0,85	0,94	1,09	0,94	1,11	0,94	1,06
Faroe Islands	0,99	1,02	1,04	1,02	1,07	0,99	0,92
<b>Finnish Arctic</b>	12,14	12,45	13,26	12,43	13,11	12,38	12,90
Kainuu	1,37	1,28	1,20	1,28	1,17	1,28	1,16
Lapland	3,30	3,15	3,00	3,15	2,97	3,13	2,88
North Ostrobothnia	7,47	8,01	9,06	8,00	8,97	7,98	8,87
<b>Norwegian Arctic</b>	9,26	8,96	8,67	8,97	8,60	9,03	8,76
Finnmark	1,46	1,43	1,35	1,43	1,36	1,42	1,33
Nordland	4,65	4,41	4,27	4,40	4,19	4,42	4,33
Troms	3,15	3,13	3,05	3,14	3,05	3,19	3,11
<b>Swedish Arctic</b>	5,21	5,08	4,98	5,11	5,18	5,00	4,54
Norrbottnen	2,54	2,46	2,41	2,47	2,49	2,42	2,20
Vesterbottnen	2,67	2,62	2,58	2,63	2,69	2,58	2,34
<b>Canadian Arctic</b>	0,33	0,37	0,44	0,37	0,47	0,37	0,42
Nunavut	0,10	0,13	0,19	0,13	0,20	0,13	0,19
NWT	0,12	0,13	0,14	0,13	0,15	0,13	0,13
Yukon	0,10	0,11	0,11	0,11	0,12	0,11	0,10
Alaska	0,23	0,24	0,24	0,24	0,27	0,23	0,21
<b>Russian Arctic</b>	5,01	5,22	5,40	5,24	5,55	5,19	5,24
Arkhangelsk	0,86	0,84	0,81	0,84	0,82	0,84	0,80
Chukotka	0,04	0,04	0,04	0,04	0,04	0,04	0,03
Kamchatka	0,23	0,23	0,23	0,23	0,24	0,23	0,22
Karelia	0,45	0,43	0,42	0,43	0,42	0,43	0,41
Khantu-Mansu	1,07	1,20	1,34	1,21	1,39	1,20	1,30
Komi Republic	0,63	0,63	0,63	0,64	0,64	0,63	0,61
Magadan region	0,11	0,10	0,09	0,10	0,10	0,10	0,09
Murmansk	0,56	0,56	0,54	0,56	0,56	0,56	0,53
Nenets	0,03	0,03	0,04	0,03	0,04	0,04	0,05
Sakha-Yakutia	0,67	0,75	0,85	0,75	0,86	0,74	0,82
Yamalo-Nenets	0,37	0,39	0,41	0,40	0,44	0,39	0,37

† Graded colouring goes from the minimal share (red scales), via midpoint (grey) to the maximum (blue)

The more Indigenous people in the population structure of the particular area, the less similar the patterns look compared to the overall respective country. As an example, the large share of Inuit people living in Nunavut (86%) makes its population structure overwhelmingly different from Canada (Figure 4). In fact, Nunavut is the youngest region with the highest fertility of both Canada and the Arctic overall. In contrast, Arctic areas with a minimal share of Indigenous people look alike to the national population pyramid. Arkhangelsk region is such an example in Russia (Figure 5). However, the phenomenon discussed in this paragraph might very well wear off in time, as the cases are for Chukotka, Yamalo-Nenets and some other regions in Russia, richly settled with Indigenous communities. Their population pyramids were different in 2015 but remind more of the national pattern in 2050, due to faster demographic transition and catching up to the national indices of mortality, longevity, and fertility.



**Figure 4.**

*Age, Sex, and Education Pyramid for Canada Total and its Nunavut Territory, 2015 and 2050, Medium Scenario*

Figure 4. *cont.*

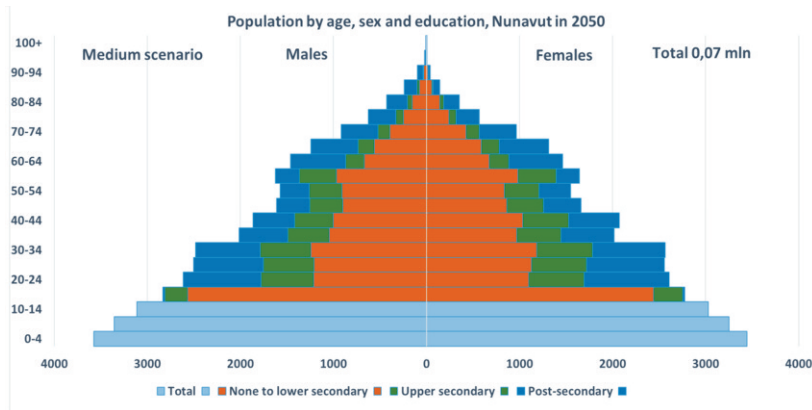
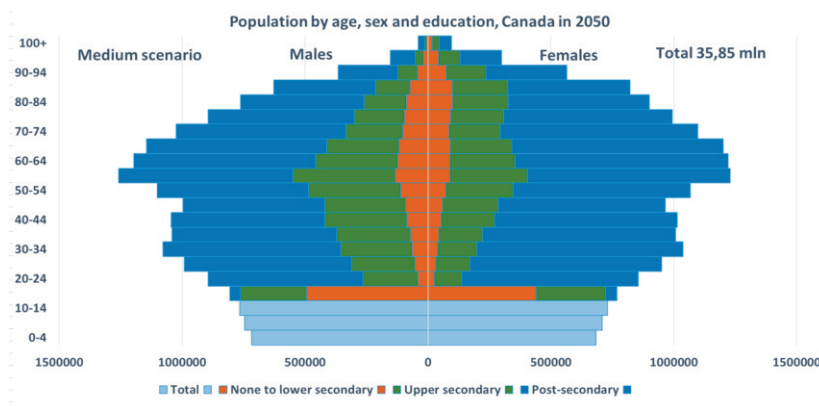
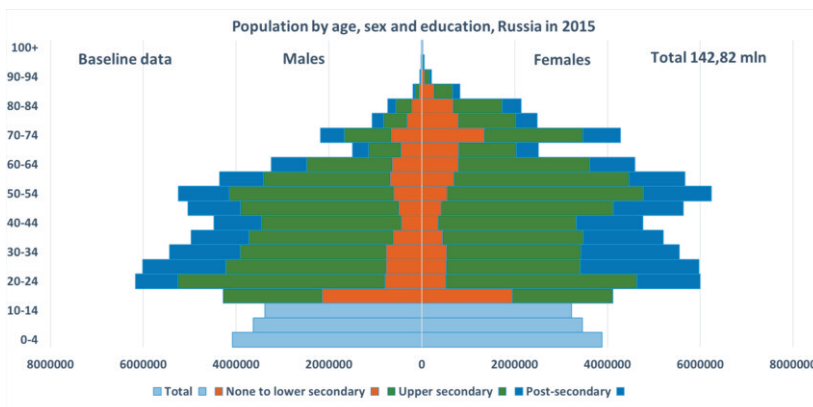
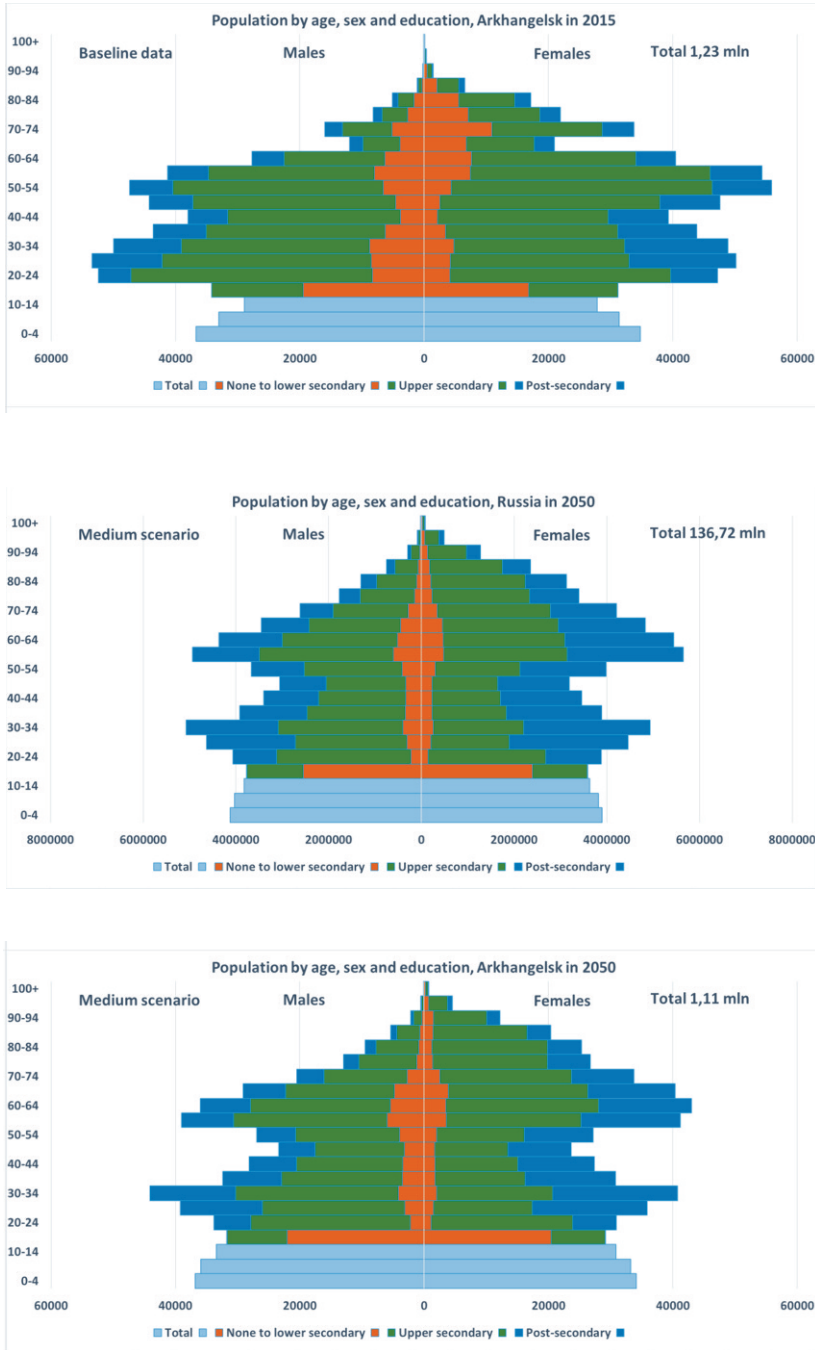


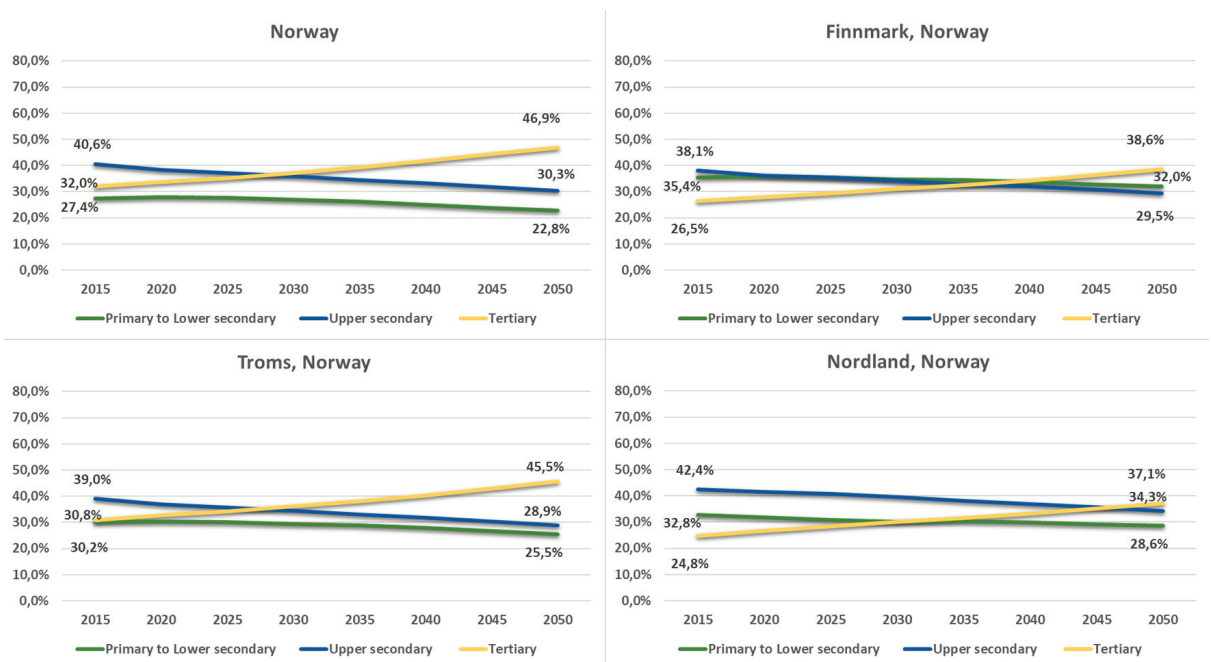
Figure 5.





**Figure 5.**  
*Age, Sex, and Education Pyramid for Russia Total and Arkhangelsk Region in 2015 and 2050, Medium Scenario*

Figures 6 further assesses the education composition of the adult population on the example of Norway. It portrays that the post-secondary level education completion rates in the Arctic territories are to a various degree lower than that of their respective country average. In particular, the share of people attained primary to lower secondary education are higher in some areas of the North, while the share of graduates with college and university diploma is lower (e.g. 38.6% tertiary level attainment in Finnmark vs. 46.9% in Norway on average). However, the Arctic- vs. country-wide difference is not large in Fennoscandia, Yukon, and most of the Russian Arctic areas.



**Figure 6.** *Educational Development in Norway and its Arctic Areas, 2015-2050, Medium Scenario*

## 5 Conclusions

In the course of this exercise, we followed three scenarios based on the knowledge about the past and expectations about the future of the population in the Arctic. Under three storylines, we developed the set of assumptions for fertility, mortality, and migration. In education, as imagined a rapid transformation will take place under Arctic Boost scenario with more homogeneous and higher level of education across the Arctic,



whereas, under the Arctic Dip scenario, the Arctic would continue to diverge being a society with lower level of education and, possibly assumed, human capital. The Medium scenario is the midpoint between the two. We combined the sets of assumptions and the produced dataset on the population distribution by educational levels in the baseline year 2015 (circa) and projected the population for the majority of geographical administrative areas (25) comparing to all Arctic countries (8), and using the multi-state population projection method for the period 2015–2050.

We found the Arctic to likely keep a status quo in the future number of inhabitants, varying between 9.6 (Arctic Dip) and 11.6 (Arctic Boost) million people in 2050, yet representing only a tiny share in their countries' totals. Inside the region, the population of the North Atlantic and North American Arctic will grow faster than in the territories of the Russian and Fennoscandian Arctic. Population growth is forecasted to happen everywhere in the North American and North Atlantic Arctic regions but to a various extent. Population will also likely grow also in Oulu, Troms, Norrbotten and Västerbotten of the Fennoscandian region; and Khanty-Mansi, Sakha Yakutia and Nenets areas in Russia, with the rest of the Arctic provinces expected to shrink or, in case of the optimistic Arctic Boost scenario, to increase negligibly.

Assessing the human capital related – educational – prospects, gender gap has been already substantial and will increase more toward feminization of education, signifying less female than male graduates in the primary educational segment and more females than males in the post-secondary educational segment in the trajectory 2015 to 2050.

For the future analysis, there is a need to develop population forecast models relevant for remote and sparsely populated areas in the Arctic. They need to consider the components of high relevance for the Arctic. For instance, 'Indigenoussness' might have a strong effect on the future population structure, with both younger, less educated populations showing slower dynamics of educational progress than in the areas with a minor share of Indigenous people. The same goes to the highly urbanized centers with colleges and universities versus remote rural settings with only a few hundreds of inhabitants and little opportunities to study. It is a future task for the statistical agencies and survey providers to collect and openly publish data on population distribution by education adding, when possible, dimensions of ethnicity and locality for the Arctic territories.

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