Planning for a sustainable Arctic: Regional development in the Yamalo-Nenets Autonomous Okrug (Russia)

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Introduction

In the framework of regional sustainable development (RSD), reconciling economic, social, and ecological goals and activities is one of the top priorities for policy-makers involved in regional planning (Coelho et al. 2010). Public regulators who define the "rules of the game" for public and private companies need to interpret and operationalize sustainable development (SD) before it can enter policy practice. A typical approach is to develop a system of sustainability indicators that can determine whether the past growth of an economy has been sustainable. Regional planners can design SD indicators that account for regional specificity to inform future policy choices (Van Zeijl-Rozema et al. 2011). For instance, a region's location, size, or available factors of production could have an impact on the community's values, concerns, and options for the future (Gustavson et al. 1999; Coelho et al. 2010). The special properties of the Arctic regions, such as remoteness from the centers of production and consumption, ultra-small population, and resource abundance coupled with the fragile Arctic nature require adequate treatment when developing and analyzing pathways toward sustainable development.

Previous studies have shown that Russia's centralized political system, primacy of economic goals, and securitization of the policy agenda have undermined the capacity of local governments and societal actors to promote sustainability goals in the Russian Arctic (Orttung 2015; Palosaari and Tynkkynen 2015). Building upon these insights, our chapter takes a more "technical" approach and examines how data availability and quality can set limitations on promoting RSD in the Arctic. Specifically, we explore the resource curse hypothesis by studying the correlations between the social, economic, and environmental indicators and the accelerating hydrocarbon export from the Yamalo-Nenets Autonomous Okrug (YNAO) during 2005–15. Our results show that statistical data conventionally used for regional benchmarking does not allow for locating sustainability in the context of ongoing Arctic industrial development unambiguously. We conclude by presenting our considerations in relation to data and indicators for RSD in the Arctic.

Yamal: a resource-abundant Arctic province

The Yamal-Nenets Autonomous Okrug (district) (YNAO) is located in northwest Siberia, stretching from the Ural Mountains northwards into the Kara Sea (Figure 4.1). YNAO was formed as an independent subject of the Russian Federation (RF) in 1991, administrated within the Tyumen Oblast, which also includes the Khanty-Mansi Autonomous Okrug. YNAO has the second largest per capita GRP in the Russian Federation, preceded only by the Nenets AO (ranked #1), and followed by the Khanty-Mansi AO (#3), Sakhalin (#4), and Chukotka AO (#5) (see also Tabata and Tabata, this volume). The Arctic location of YNAO has implications both for the natural environment and its social characteristics. Covering a large territory of 750,600 square kilometers, YNAO encompasses the largest wetland in the world with around 48,000 rivers and 3000–5000 lakes (Encyclopedia of the Arctic, 2005). Much of the terrain is considered moderately to extremely unstable for infrastructure development due to permafrost (Nutall 2005). The region is very scarcely populated, with an averageof 0.7 persons/square kilometer.

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Figure 4.1 Yamal-Nenets Autonomous Okrug

In the sixteenth century, Yamal was known as a resource-rich region for its wealth of marine mammals and furs; now, it is the location of Russia's largest known gas reserves. Already in the 1960s, several large gas fields had been discovered in the Tazovskiy and Nadymskiy Districts, and in the early 1980s, Bovanenkovo, Tambeyskoe, Kharasaveyskoe, and several other major gas fields were discovered in Yamal, making the region a prime target for future development (see Motomura, this volume). Proven Yamal gas reserves amount to 13.5 trillion cubic meters on land, and additional deposits on the Kara Sea shelf are estimated at 50 trillion cubic meters (Gubarkov 2008, in Walker et al. 2010, p. 213). Production from the YNAO fields led by the Russian state-owned gas company Gazprom started in the mid-1980s; a Yamal-Europe pipeline that allows delivery of gas from the Bovanenkovo field in the Yamal peninsula to the West European markets was launched in December 2008. At the same time, Gazprom announced its interest in constructing a liquefied natural gas (LNG) plant in the Yamal peninsula (Miller 2009). Yet, Gazprom did not continue with this undertaking. Instead, in 2013, Novatek, Russia's largest private natural gas producer, moved ahead with the Yamal LNG project with a production capacity of 16.5 cubic meters per year, expected to go online in 2017.

Table 4.1 Natural resource extraction in YNAO 2005–15

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Resource extraction (mln rub)	364,787	459,580	464,564	559,252	498,136	558,134	671,459	890,918	1,054,857	1,146,823	1,352,971
USD equivalent (mln)	12,710	16,909	18,168	22,541	15,724	18,384	22,878	28,675	33,151	30,203	22,304
Annual Europe Brent spot price, USD/barrel	54.57	65.16	72.44	96.94	61.74	79.61	111.26	111.63	108.56	98.97	52.32

Source: Authors based on Rosstat, RF Central Bank, EIA.

Table 4.1 indicates that between 2005 and 2015, resource extraction in YNAO increased more than threefold in terms of gross value. Yet, the impact on the regional budget has been indirect, stemming primarily from corporate and personal taxes (Table 4.2). In 2016, for instance, the largest source of income to the regional budget was corporate property taxes (46.9 percent). Coupled with a high-income population, personal income taxes amounted to 25.9 percent and exceeded the share of corporate income taxes (21.5 percent). The main areas receiving budgetary expenditures are social policy (healthcare, education, housing, social payments) and the local economy, which is in line with the regional development strategy (YNAO, 2016). In total, less than 20 percent of the regional budget was allocated to alleviate the key negative consequences of extensive resource extraction; for instance, the monetary value of extracted resources amounted to ca. 40 USD per capita, yet budget spending on environmental protection was around 14 USD per capita. It should be emphasized that the mineral extraction tax (MET) and fees for using natural resources together add up to less than 1 percent of the YNAO's budget. The reason for this is that, in Russia, mineral resource bases are owned by the state, and the fees for natural resource use have been very low. Also, after the introduction of the fixed federal MET in 2002, which tied the tax to the amount of minerals extracted, the regional share of MET on oil and gas declined dramatically (Alexeev and Chernyavskiy 2015), also in YNAO.

Table 4.2. Structure of the YNAO regional budget, 2016 and 2017 (plan) in Russian rubles (mln)

	2016		2017 (planned)	
	RUB	%	RUB	%
Corporate income tax	23,807	21.58	29,507	24.26
Personal income tax	28,626	25.94	30,783	25.31
Corporate property tax	51,713	46.87	54,746	45.01
Transport tax	901	0.82	874	0.72
Mineral extraction tax	467	0.42	421	0.35
Fees for use of natural resources	598	0.54	625	0.51
Other	4,224	3.83	4,687	3.84
TOTAL INCOME	110,336	100	121,643	100
Public administration	4,131	3.26	4,227	3.16
National security and law enforcement	1,667	1.31	1,801	1.35
Agriculture and fisheries	1,977	1.56	2,212	1.65
Transport and road funds*	7,310	5.77	7,410	5.54
Reproduction of mineral resource base*	192	0.15	196	0.15
Housing and utilities	17,271	13.62	19,866	14.86
Environmental protection*	418	0.33	584	0.44
Education	23,681	18.68	23,584	17.64
Social policy (payments)	15,301	12.07	18,965	14.18
Health care*	15,550	12.26	12,302	9.20
Other	39,305	30.99	42,584	31.83
TOTAL EXPENDITURE	126,803	100	133,731	100

Source: Authors based on YNAO Financial and Economic Analysis (Department of Finance of YNAO, 2017). Expenditure directed to alleviation of potential negative consequences of resource extraction are marked with an asterisk.

The population of the YNAO consists of three main groups. First, the indigenous peoples who constitute around 10 percent of the population include the Nenets, Khanty, Selkup, Mansi, Komi, and individual representatives of other Northern peoples. These groups largely pursue traditional lifestyles based on fishing and reindeer herding in the tundra. Second, non-indigenous "newcomers," mostly Russian-speakers who either were born in the region or moved there for permanent residency, are usually employed in various tasks in the urbanized centers. Finally, there are a number of non-permanent residents, such as duty-shift workers, who are temporarily employed in the region, mostly in the extractive and construction sectors. Table 4.3 demonstrates that, since the beginning of active hydrocarbon development in Yamal in the mid-1980s, the population has increased in total due to active workforce migration to the new production sites, as well as among most indigenous peoples. During the period of 2005–15, the population did not experience major changes, remaining within the range of 525–540,000 people.

Table 4.3 Population dynamics among the main Northern Indigenous peoples and Russian groups in YNAO

Ethnic group	1959	1970	1979	1989	2002	2010
Nenets	13977	17538	17404	20917	26435	29772
Khanty	5519	6513	6466	7247	8760	9489
Selkup	1245	171	1611	1530	1797	1988
Mansi	94	85	116	216	172	166
Komi	4866	5445	5642	5746	6177	5141
Russian	27789	37518	93750	292808	298359	312019
Other	8844	12707	33895	166380	165306	164329
TOTAL	62334	79977	158884	494844	507006	522904

Source: Authors, based on population census data. NB: population structure by ethnic group at the regional level is only available from census data and may deviate from the total regional population numbers provided by the Federal Statistical Services.

Climate change is having a more noticeable effect in the Arctic than in other parts of the world, resulting in accelerated permafrost thaw and massive thermokarst erosion (Kumpula et al., 2011). The land use changes stem from the development of the hydrocarbon industry in the sensitive Arctic environment; the multiple sources of environmental degradation include surface disturbances and increases of traffic, contamination, and waste from both production facilities and the increased population (Kumpula et al., 2011). The impact of the hydrocarbon industry, in particular the flaring of excess natural gas during oil extraction in the Russian Arctic which leads to a rapid increase of black carbon concentrations in the atmosphere and on surface snow, is detrimental in terms of Arctic air pollution and climate change (Stohl et al. 2013; Arnold et al. 2016).

Summing up, four major drivers of change can be identified in YNAO: the gas-development boom, an unusually sensitive permafrost environment, the steady growth of both indigenous and "newcomer" populations, and rapid climate change (Walker et al. 2010). Accelerating environmental change in the Arctic as a result of increased human activity in a fragile natural environment has been further complicated by the regional demographics. According to Forbes et al. (2009), half of the indigenous Nenets population still practices reindeer herding as a nomadic way of life. The intensive Arctic industrial development, particularly in the energy and maritime sectors, has restricted indigenous peoples from carrying on with their livelihoods (Stammler 2005). Since the traditional lifestyles pursued by many Arctic indigenous peoples depend on reindeer herding, tensions over land ownership and use have arisen when pasture areas are occupied by energy infrastructure. Creating a sustainable future for YNAO, as well as the other Arctic regions, must thus be grounded in a thorough understanding of the regional characteristics.

Sustainable development in resource-rich regions

The classical definition of sustainable development (SD) was given in the report Our Common Future (Brundtland report) published by the World Commission on Environment and Development (WCED) in 1987: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 41). This conceptualization supports strong economic and social development, while stressing the importance of protecting the environment. Research on SD is multidisciplinary and diverse; one strand of it has concentrated on regional sustainable development (RSD). RSD differs from regional development in that it suggests that the alleviation of regional disparities shall incorporate ecological concerns (Haughton and Counsell 2004). Eventually, in RSD, the goal of policy interventions is to promote balanced regional development that accounts for the environment, the economy, and society, relying on the tripartite notion of sustainability derived from the 1987 Brundtland report.

Within the wide body of RSD literature, contributions that have sought to understand the relationship between natural resource endowment and socio-economic development are particularly relevant to the study of RSD in the Arctic, since natural resource endowment is one of the key characteristics of the Arctic political economy (Gritsenko 2017). The unrolling of massive resource extraction projects in the Arctic has raised major controversies with regard to RSD (Wilson and Stammler 2016; Gritsenko, 2017). Whereas some actors have pointed to potentially devastating ecological effects, others feel that a strong focus on environmental concerns could impede human development.

In addition, the Arctic regions can be prone to "resource curse," a condition denoting the surprisingly poor performance of resource-rich regions, thereby casting doubt on the contribution of extractive industries to regional development (Auty 1990, 2002; Davis 1995; Atkinson and Hamilton, 2003). First, the Arctic is resource abundant: according to the US Geological Survey, an estimated 13 percent of the world's undiscovered oil and 30 percent of gas resources are located beyond the Arctic Circle (USGS 2008). Second, Arctic regions are resource dependent, as regional economic development has been a function of extractive activities (Pearce et al. 2012). Finally, while many types of economic activity are costly or do not yield an immediate competitive advantage due to natural conditions in the Arctic, SD in local Arctic economies has been politically interpreted as sustainable development of Arctic natural resources (Canuel 2016).

Bridge (2008) suggested that resource curse literature could be divided into four categories of argument: micro-economic (production function of firms), macro-economic ("Dutch disease"), empirical correlation between economic growth and resource export, and political (rent-seeking and corrupt political regimes). Scholars have demonstrated how natural capital assets that could be extracted and exported to provide higher levels of socio-economic well-being have acted as obstacles to economic growth (Sachs and Warner 2001), human welfare (Bulte et al. 2005), and good governance (Ross 2001), thereby confirming the problematic relationship between natural resources and various measures of societal development. It should be noted that the "Dutch disease" type of argument, which highlights the roles of state-level institutions (resource ownership, exchange rate, industrial policy), can only be made at the national level. Yet, resource curse as the effect of resource extraction on the socio-economic development in extractive regions can be additionally considered at the sub- and supra-national levels.

Research concentrating on the regional rather than national level has added another interesting angle to the resource curse debate, in particular by probing the relationship between economic growth and resource extraction. A study by Alexeev and Chernyavskiy (2015) on the impact of natural resource wealth on economic growth in Russia's regions is of particular interest in this respect. This paper concentrated on the degree to which the federal government has been able to tax away the natural resource rents. Comparing non-hydrocarbon mineral and hydrocarbon resources, they concluded that the lack of positive economic effect on regional growth during 2002–11 could be attributed to fiscal policy; in other words, the Russian federal government was taxing away the regional oil rents. Similar findings have been presented by Fleming et al. (2015), whose analysis of the effects of extractive industries across regions in Australia showed that, while most regions experienced a "resource blessing," some experienced a "resource curse," in particular regarding the non-extractive employment rates, as well as by Dube and Polese (2015), whose study of 135 Canadian areas found no universal "resource curse" pattern.

Apart from quantitative resource-curse studies that have sought a correlation between resource-based development and economic growth, there have also been more granular qualitative studies that have examined the structural and attitudinal consequences of resource-driven local economies. Within the latter category, there are currently only a handful of in-depth accounts investigating resource curse in Russian regions. Tynkkynen (2007) argued that, at the local level, natural resource abundance can lead to resource-fatalism and low levels of local entrepreneurial activity. Suutarinen (2015) provided evidence for local resource curse in one Russian Arctic mining community. Both studies indicated that indirect rather than direct implications of reliance on natural resources undermined the long-term potential for sustainable development manifested through a lack of belief in alternative development paths among policy-makers and local citizens.

Regional development in YNAO and the "Resource Curse" argument

One of the common approaches to analyzing SD in resource-rich regions has carried the assumption that balanced and responsible use of hydrocarbon resources is acceptable if it enhances human development. This approach informed our research design, which used correlation analysis to test for relationships between the gross value of natural resource extraction (Table 4.1) and the groups of indicators characterizing economic, social, and environmental development in YNAO.

As discussed in the introduction, data quality is a critical issue. In other words, accuracy, transparency, frequency, consistency, and availability of data are central to measuring and steering SD policy and planning. In accordance with the Federal Law on Strategic Planning in the Russian Federation (N 172-FZ, 2014), the development of planning documents at all levels of government shall include a system of indicators to support evidence-based decision-making. Such indicators have conventionally been developed on the basis of statistics provided by the Federal Service for State Statistics (Rosstat), which became a part of the Ministry of Economic Development in April 2017. For this reason, this research was based on data retrieved from the Rosstat website (www.gks.ru). The Rosstat data have a number of limitations, however. In 2007, a statistical law was enacted in the Russian Federation to provide a legal framework for comprehensive statistical accounting similar to the OECD countries, which improved data quality, but provoked changes in methodologies. This has resulted in a lack of comprehensive indicators available at the regional level for longer periods. These limitations suggested correlation analysis as an appropriate tool to reveal mutual relationships between variables in application to short (10 years) time-series. We used two primary measures of correlation: Pearson's correlation (r), which measures linear (monotone) trends; and Spearman's correlation (s), which measures increasing and decreasing trends, i.e., nonlinear interdependences between variables. The statistical analysis was performed using SPSS 3.2 software.

Economic indicators

Table 4.4 Correlation Results for the Economic Indicators, 2005–15

Indicator	r	s
GRP (mln rub)	0.994**	0.998**
GRP per capita (thousand rub)	0.994**	0.988**
Manufacturing	0.930**	0.964**
Electricity, gas, and water production and distribution	0.722*	0.964**
Railway transportation (cargo)	0.915**	0.794**
Railway transportation (passenger)	0.074	0.091
Automobile transportation (cargo)	0.170	0.309
Cargo turnover (auto, total)	0.476	0.600
Roads with hard cover (% of total)	-0.729*	-0.729*
Roads with improved cover (% of total)	-0.743*	0.848**
Road density (hard cover)	0.973**	0.951**
Amount of public buses per 100,000 people	-0.824**	-0.782**
Investment in fixed assets	0.956**	1.000**
Investment in fixed assets per capita	0.953**	1.000**

Source: Authors based on Rosstat. *, ** significant at 5 percent and 1 percent levels, respectively (two-tailed)

Table 4.4 demonstrates that the key macro-economic indicators – gross regional product (GRP) and per capita GRP – were positively correlated with the gross value of natural resource extraction. Manufacturing and production of utilities (electricity, gas, and water) were also positively correlated with resource extraction, as was previously shown by Bradshaw (2006). Capital investment has exhibited the same positive correlation, both in absolute terms and per capita, in line with the neoclassical growth model and opposite to the resource curse proposition of divestment in non-extractive sectors. Capital investments are capable of boosting not only industrial development, but also other factors of production, and, as a result, micro-economic indicators (Bradshaw, 2006, 742-743). Among the current major infrastructure development projects in YNAO are the construction of the Yamal LNG production facility and the port of Sabetta (Gritsenko and Efimova 2017). When it comes to land transport infrastructure, railway transportation was positively correlated, while automobile road transportation was unrelated to the gross value of natural resource extraction. A negative correlation was found between the network of roads and the volumes of resource extraction, which may be related to the "centralizing" effects of extractive industries (Watts 2004) and the lack of incentive to maintain roads that are not commonly used for resource transportation.

Social situation

Table 4.5 Correlation Results for Social Indicators, 2005–15

Indicator	r	s
Population	-0.166	-0.28
Workforce population	0.05	0.328
Unemployment	-0.519	-0.394
Retail trading per capita	0.988**	0.988**
Number of crimes registered per 100,000	-0.630	-0.389**
Number of qualified workers per 10,000 of employed population	0.646*	0.646*
Mortality rate (per 1000)	-0.745*	-0.817**
Average per capita income	0.959**	0.964**
Housing fund (total area of residential premises, million sq. M.)	0.850**	0.874**
The total area of residential premises, sq. meter per inhabitant	0.916**	0.900**
Traffic incident victims (per 1000)	-0.646*	-0.426
Traffic incidents	-0.552	-0.600
Car ownership per 1000 population	0.983**	0.964**

Source: Authors based on Rosstat. *, ** significant at 5 percent and 1percent levels, respectively (two-tailed)

Since economic growth is a poor indicator of welfare (Bulte et al., 2005), Table 4.5 includes measures of socio-economic well-being known as quality of life indicators (Hajkowicz et al. 2011). We observed that different indicators were related to the increase in extractive activities positively (monthly per capita income, purchasing per capita, car ownership, and housing) and negatively (mortality rate, number of road accidents, and crime), marking improvements in life quality. At the same time, total population, workforce dynamics, and employment indicators showed no statistically significant correlations, most probably due to the low labor intensity of the hydrocarbon sector and relative stability of the YNAO population.

Along with life quality, social justice (captured through measures of wealth distribution and inequality) constitutes an inherent part of sustainable development (Langhelle 2000). Table 4.6 indicates that in YNAO, citizens earned more than the average in Russia. In addition, the percentage of the population that were low-income (those earning less than 14,000 rubles) was significantly lower than the federal average (5.5 percent vs. 26.4 percent), which can be related to the specificity of YNAO's demographics and the prevalence of working-age population. The Gini coefficient for YNAO, a standard measure of economic inequality, was slightly higher than the federal coefficient, which can be attributed to the large number of high earners employed in the extractive industries.

Table 4.6 Distribution of population (percentage) according to their monthly income (in rubles), 2015

	< 5000	5000.1–7000	7000.1-10,000	10,000.1-14,000	14,000.1-19,000	19,000.1–27,000	27,000.1–45,000	>45,000	Gini
YNAO	0.2	0.5	1.5	3.4	5.8	11.0	23.2	54.5	0.422
Russian Federation	2.4	3.8	8.0	12.2	14.4	18.1	22.5	18.6	0.413

Source: Authors based on Rosstat (www.gks.ru/bgd/regl/b16_14p/Main.htm)

Environmental situation

Table 4.7 Correlation Results for the Environmental Indicators, 2005–15

Indicator	r	s
Emissions of pollutant substances to air, deriving from stationary sources	-0.822**	0.661*
Freshwater consumption	0.647*	0.498
Waste water release	-0.857**	-0.855**
Capture of air emissions from stationary sources	-0.273	-0.025
Investment into water protection	0.315	0.391
Investment into land protection	0.574	0.182
Investment into waste protection	0.198	0.182
Fixed asset investment into environmental protection	0.517	0.473

Source: Authors based on Rosstat. *, ** significant at 5 percent and 1percent levels, respectively (two-tailed)

While the extraction of natural resources obviously constitutes a negative disturbance for the environment, the more important question is how the increase in extractive activities affects key environmental indicators. Table

4.7 demonstrates that emissions to air and water were negatively correlated to the rates of resource extraction, while freshwater exploitation showed a positive correlation with Pearson's criterion. Air emission abatement and investments in fixed assets directed to protecting the environment and the rational use of natural resources did not yield statistical significance. As a result, available pollution data tell little about the actual environmental situation in the region, as they do not include methane emissions or measures for energy efficiency in hydrocarbon extraction and transport. In turn, investment data may lead us astray, as the absolute amount of investment in environmental protection (Table 4.2) was not on par with the magnitude of ongoing and potential future environmental change in the region. Moreover, public health indicators, which are routinely used to assess the environmental quality at the national level, could not be included in the analysis due to missing values in the regional data.

The role of data in planning sustainable Arctic regions

The aim of this chapter was to locate local sustainability in the Arctic within the context of ongoing industrial development by exploring the dynamics of social, economic, and ecological indicators vis-a-vis the accelerating hydrocarbon exports in YNAO. We found no evidence of systematic negative associations between economic growth, quality of life, and the gross value of minerals production. Instead, extractive activity showed a positive impact on GRP, incomes, manufacturing and retail sectors, development of transport infrastructure and housing, education, and social services in this remote Arctic region. However, no positive association between the environment and resource development was observed – either in terms of factual environmental effects or in terms of environmental investment. Neither were there negative dynamics, which allows us to conclude that, while accelerating resource extraction has added to increasing pressure and risks on the environment, there has been no systematic policy for addressing the issue. While our methodology did not establish causality between tested variables, the analysis suggests that resource curse as a negative influence of oil and gas extraction activities on regional socio-economic performance cannot be established on the basis of the data scrutinized for YNAO.

There are a number of issues, however, that could not be addressed due to the limitations of the approach, which derived key indicators from the readily available statistical data. In our analysis, the dynamics of macroeconomic indicators was contrary to the predictions of resource curse. Yet, YNAO heavily relies on natural resource extraction: as of 2016, 94.4 percent of the total volume of industrial products took place in the oil and gas industry, while manufacture of machinery, vehicles, and equipment made up 3.6 percent. Economies dependent on oil and gas exports tend to allocate high capital spending on large-scale projects, which in turn propel non-carbon sectors such as construction, transport, and business tourism (Stevens et al. 2015). Yet, whether these sectors can sustain their productivity "after oil and gas" is difficult to predict. The specialization on resource extraction has allowed YNAO to realize its competitive advantage, which has come at the price of not investing (or underinvesting) in other activities, while the actual longevity of their resource advantage is unclear.

The number of deteriorating Russian mono-cities, especially in the Arctic region, points to the fact that, not only may resource-based development not be sustainable in the long term, but also the sectors that have flourished in association with it may collapse, undermining the future ability of the region to balance economic, social, and environmental goals. Tynkkynen (2007) used the concept of "resource fatalism" to describe the negative socio-cultural consequences of resource specialization. Stevens et al. (2015) suggested that, in order to assess the success of resource-based diversification, measurements shall account for the share of non-hydrocarbon sector output that is globally competitive. In YNAO, reindeer herding, fisheries, and tourism would be suitable candidates for diversification, yet the consequences of refocusing the regional economy away from gas production should be studied separately and would require the input of novel data currently not available within the existing framework of statistical accounting.

Similar arguments can be used to question the results obtained for social welfare indicators. The word “sustainable” has a connotation of long lasting, and the definition of SD equally emphasizes intra- and intergenerational justice. In particular, the lack of systematic attention to the environmental side of SD could negatively affect the regional dynamics in the years to come. In 2014, a report issued by YNAO’s government showed that in the structure of the general morbidity of the population, respiratory diseases occupied the first place – which is related to air pollution, in particular in urban centers (where the majority of YNAO population resides) (YNAO, 2014). The quality of drinking water was also identified as one of the main environmental factors affecting the health of the population. The report suggested that surface sources of the drinking water supply within the territory of the YNAO were characterized by a high level of chemical and microbiological contamination, in particular by petroleum products, iron, manganese, and zinc, thus leading to a shortage of quality drinking water. Those data that link environmental change with human welfare are paramount to establishing a robust system of RSD indicators to support policy decisions.

Finally, the quality of available environmental statistics, including transparency, frequency, and availability, is currently insufficient to prevent environmental setbacks. Data that both document the magnitude of environmental change and incorporate a broad spectrum of anthropogenic impacts on the environment are required instead. For instance, in YNAO, GHG emissions associated with permafrost thaw and hydrocarbon extraction would be an example of an environmental indicator that is both directly and indirectly linked to the main industrial activity. Summing up, besides the fact that metrics come with their underlying biases and limitations, there has been the persistent problem of incomplete and missing data, in particular at the sub-national level. Working with available rather than with optimal data requires the use of numerous assumptions and proxy-terms, which may impede our capacity to provide information useful for decision-making.

Recent developments have lent to optimism with regard to the future potential of translating sustainability values and norms into comprehensive and actionable indicators. First, data and information on complex phenomena such as climate change have increased with the introduction of new measurement technologies and the proliferation of citizen participatory science. Second, there have been considerable efforts to strengthen data sharing, which resulted (along with other initiatives) in the establishment of the Arctic Data Committee (April 2014) to facilitate open Arctic data and the launch of the Arctic Data Center (March 2016) to preserve and open data from research conducted under the National Science Foundation (NSF) awarded grants to partner with the Arctic research communities globally. Pulling together various types of data from different sources and applying big data analytics can enhance predictive algorithms and assist in understanding complex phenomena such as Arctic climate change. Eventually, planning for SD can be decoupled from the limitations of the data collected by national statistical services to establish an explicit system of indicators that genuinely account for short- and long-term effects of the encounters between “large-scale industries” and “small-scale societies.”

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Annex I

Population census data for YNAO.

Data source	URL (Last accessed 24.4.2017)
Population census 1959	http://demoscope.ru/weekly/ssp/rus_nac_59.php?reg=70
Population census 1970	http://demoscope.ru/weekly/ssp/rus_nac_70.php?reg=68
Population census 1979	http://demoscope.ru/weekly/ssp/rus_nac_79.php?reg=68
Population census 1989	http://demoscope.ru/weekly/ssp/rus_nac_89_gs.php?reg=66
Population census 2002	www.perepis2002.ru/index.html?id=17
Population census 2010	www.gks.ru/free_doc/new_site/perepis2010/croc/results2.html