

Examining the factors influencing air pollution in the extractive and energy industries in the sparsely populated regions of Russian Arctic

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Abstract NO₂ is high toxic air pollutant, due to its short lifetime it strongly correlates with local emission sources and is a good tracer of human activities over urban or industrial areas. The relationship between NO₂ concentration and major industries output among the regions shows the contribution of economic development to air pollution over time. Satellite observations provide information on NO₂ concentration on global scale, also where ground-based measurements or other information on air polluting emissions are not available. In this work, the NO₂ tropospheric columns derived from the TROPOMI satellite instrument are used to evaluate the spatial distribution of polluting emissions over the three areas of the Sakha Republic (Yakutia), the largest north-east region of Russia: diamond-extractive industrial hub of Aykhal and Unachny urban-type settlements, the coal-mining complex in the southern part of Yakutia, located in the territory of city of Negungry, Chulman and Serebryany Bor urban settlements and Yakutsk city, heat and energy generating center of the Yakutian division of the United Energy Systems of East of Russia. The territories dominated by anthropogenic NO₂ are revealed and the positive relation between NO₂ and coal consumption, industrialization, urbanization and cross-regional transportation are proved. The environmental policy measures influence on spatial NO₂ distribution is shown.

Key words: nitrogen dioxide, sparsely populated territories, Arctic, sustainable development, case study, ESG-strategy

Introduction

Recently, air pollution leads to the substantial economic and health losses and a cause of environmental degradation. Macro-economic context for the air-pollution is the lost work days due to diseases, agricultural crop yields, new jobs and competitiveness of sectors that are active in an international market in terms of clean-air policy realization (Vrontisi et al., 2016, Capros et al., 2013). Due to OCED (2019) Russia had 149 thousand people died from air-pollution with the total loss of 447,6 billion USD, or 12,5% of GNP in 2015.

The emerging economies can focus their efforts on the measures of decreasing economy-related air pollution, ranged from the fossil fuel substitution, improvement of industrial process efficiencies, to technology, components and energy-efficiency. Russia, as a northern oil and gas country with acceptance of the Paris Agreement in 2019 has manifested low-emission across industries and this leads to economic changes; in 2021 Russian Government announced the consolidated action plan to adapt Russian economy to the global

energy transition.

In the sparsely populated territories (SPTs) of the Russian Arctic and Far East air pollution is related to the heat and energy supply and mining industries, use of fossil fuels energy, such as coal, diesel and gas, and decentralized energy system. Generally, air pollution is higher in the mining regions due to severe climate conditions and energy-demanded economy (RF Analytical center, 2017). The low-emission goal realization is therefore lying in the primary industries actions, such as quantity of production, technological breaks, the mitigation strategies realization, which are, if any, a consequence of the consensus of the fuels and technologies availability and the pressure, put upon the companies by the consumers, policy and industrial product-chain. Warm winters lead to less fuel consumption and less emissions level. Knowing what factors influence most we can understand is the low-emission tendency sustainable or not.

Yakutia data analysis

a) NO₂ concentration over Yakutia

b) Aikhal and Udachny diamond extraction area

The average annual NO₂ concentration is high in the areas of the Jubileiny open pit and No. 8 and No. 14 of ALROSA diamond company. There is no clear NO₂ signal detected above Komsomolsk open pit, probably due to the lower mining activity. 2018 and 2019 years data show an increase in NO₂ concentration level of about 30% in 2019, and this indicates an increase in pollutant emissions. In addition, part of the difference can be attributed to differences in meteorological conditions.

c) South Yakutia coal mining center

Satellite observation data and statistical reports show a reduction in emissions in 2019 in the Neryungri region. We associate this reduction substitution of coal and diesel fuel to gas generation, the use of new technologies and a decrease in coal production at Yakutugol JSC. A decrease in electricity and heat generation at the Neryungri city district power plant is recorded in 2019, because some industrial consumers switched to gas generation. Another factor in reducing the average annual concentration of NO₂ might be Elgaugol LLC generating facilities modernization, declared in the annual report. The company since September 2019 has centralized power supply system, which replaced diesel generation to gas. Finally, the modernization of Denisovsky and Inaglinsky GOKs could also have an impact, the company reports indicate that collectors installed in 2019 now clean 99.9% of air pollutants from coal-fired generation.

d) Yakutsk city agglomeration

Specific emissions from the generating capacities of Yakutsk Power Plants - 1 and 2 for the period 2012-2018 decreased as a result of energy efficiency measures and repair work, which is confirmed by OMI data and government reports. At the same time, according to the 2018-2019 data, it did not change when Yakutsk Power Plant-2 started, and in 2020 it decreased, which is explained by the contribution of the transport sector.

Conclusion

The largest NO₂ enhancement was found as expected over the city of Yakutsk, where one third of the population of Yakutsk lives. The air polluting emissions in Yakutsk are due to mixed sources, such as transportation, energy production. Largest NO₂ pollution levels are related to the energy and extraction sectors. In particular, districts with a coal-based energy system such as Neryungri district show much larger NO₂ hotspots than for example the Mirninsky district, where the energy system is mostly based on hydropower. In addition, smaller NO₂ enhancements correspond to diamond mine sites such as Aykhal and Udachny.

The analysis of the year-to-year variability back to 2010 in Yakutsk and Neryungri reveal a reduction in the

fuel consumption in the recent years due to an increase in energy efficiency and substitution to gas supply that corresponds to a reduction in NO₂ levels.

The analysis of the first part of 2020 shows only a small effect of the COVID-19 pandemic on the socio-economic parameters (except for reduction in traffic emissions, consumer market and manufacture industry as well as on the NO₂ levels. The only clear reduction possibly related to COVID-19 has been observed in Yakutsk and it corresponds to a reduction in traffic emissions, as expected from the reduced commuter traffic during the lockdown. In general, it is challenging to quantify how much of the year-to-year variability is related to changes in emissions or meteorological conditions, especially when the signal or the change is small as here

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