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Background assessment of sulphur dioxide in the air in the Shchuchinsk-Borovskoye resort area

Balgabay Maikanov, Laura Auteleyeva*, Asylkhan Kabievich Inirbayev, Aikumys Nurgalievna Zhumakayeva and Aslan Abdykanovich Bainiyazov

NJSC "S. Seifullin Kazakh Agrotechnical University" Department of Veterinary Sanitation, Faculty of "Veterinary Science and Technology of Animal Husbandry", Nur-Sultan, 010011, Republic of Kazakhstan

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ABSTRACT

Studies on the content of sulphur dioxide (SO_2) in the atmospheric air were conducted in the Shchuchinsk-Borovskoye resort zone of the Republic of Kazakhstan. The research results showed that the highest excess of SO_2 concentration was in the warm period. The average SO_2 concentration in the warm period exceeds 2-6 MAC The indicators of the standard index and the highest repeatability of the warm period are characterized by a high level of SO_2 pollution in the atmospheric air.

***Key words**: Shchuchinsk-Borovskoye resort area, Atmospheric air, Anthropogenic impact.*

Introduction

In the Republic of Kazakhstan, the Shchuchinsk-Borovskoye resort zone belongs to the State National Natural Park "Burabay", which is a nature protection state institution that is the part of the system of specially protected natural territories of national significance and is under the authority of the Office of the President of the Republic of Kazakhstan (Department of Presidential Affairs "Burabay State National Natural Park", 2019). Currently, air pollution has become one of the leading problems for health and climate change in the world (Dockery *et al.,* 1993; Pope *et al.,* 2002; Simoni *et al.,* 2015; Patz *et al.,* 2014).

Air quality is directly related to human health and socio-economic development (Yongli 2019). This is reflected in the work of many scientists who study atmospheric air and its components, such as aerosols and other pollutants. They are ubiquitous in the atmosphere with different impacts on the climate system (Ramanathan *et al.,* 2001), human health (Kampa and Castanas, 2008). According to the studies of atmospheric air in Asian countries, such as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, scientists have concluded that along with the growth of urbanization, industrialization and population growth, there is increasing air pollution with various harmful substances, and recommend the creation of long-term monitoring stations in the region; it was also found that in the Republic of Kazakhstan during fifteen years in all cities there was an increase in the aerosol load at a rate from 0.0004 $year^{-1}$ (Astana) to 0.0033 $year^{-1}$ (Oral) (Rupakhetia *et al.,* 2019).

Material and Methodology

Studies of atmospheric air indicators were conducted in 2018. A total of 162 air samples were collected and examined. Concentrations of pollutants in the atmospheric air in the Shchuchinsk-

Borovskoye resort area were carried out at 4 stationary posts: checkpoint #1 – Akylbay village, checkpoint #2 – Burabay village; checkpoint t#3 – Zhekebatyr sanatorium, checkpoint #4 – Republican Training and Health Center "Baldauren" and at the central point, the most visited cultural and historical place by tourists (Abylay Khan meadow). The selection was carried out using GANK-4 gas analyzer, in accordance with the method of performing air sampling and research, ÌÂÈ KZ 07.00.01612/1-2013. Vehicles were counted at checkpoints at the entrance to the resort area and at Abylay Khan meadow. In accordance with generally accepted methods of calculating vehicles, the analysis was performed during the cold, transition and warm periods of the year.

Results and Discussion

The results of the annual SO_2 concentration at four checkpoints of the Shchuchinsk-Borovskoye resort zone and Abylay Khan meadow are shown in Table 1.

It was found that the average concentration of SO_2 in the cold period exceeds the maximum allowable index by 2-6 MAC at checkpoint #3 (3.17±0.015), checkpoint #2 (2.95±0.0262 mg/m3), at checkpoint #1 (2.84±0.0003), at Abylai Khan meadow – (2.3±0.0067 mg/m3), checkpoint #4 (2.5±0.0010).

According to WHO, in the past two years, the database is now covering 3,000 cities in 103 countries – has nearly doubled, with more cities measuring air pollution levels and recognizing the associated health impacts. As urban air quality declines, the risk of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases, including asthma, increases for the people who live in them (WHO, 2017).

Data on exceedance may be correlated with the number of vehicles entering and their total emissions (Table 2). During the cold period, the following number of vehicles entered the resort area through all checkpoints: 7,493, including passenger cars – 6,033, buses – 1,081, trucks – 379.

According to the method, calculations were made of the amount of harmful substances entering the atmosphere as part of car exhaust gases. The total emission of SO_2 into the atmosphere from the exhaust gases of motor vehicles during the cold period was 0.0198 tons.

Other studied parameters did not exceed the maximum allowable concentration: carbon soot (0.015±0.003 to 0.03±0.005), NH_3 (0.03±0.004 to 0.025±0.004), CO_2 (86.12±0.013 to 0.02±0), NO_2 (0.042±0.0008 to 0.011±0.004), cement dust (0.05±0.003 to 0.0217±0.0003) H_2S (0.0127±0.0002 to 0.001±0.0005).

The main contribution to SO_2 exposure in the study area is made by the population, as well as by industrial and vehicle pollution, of which vehicle pollution is the most important regardless of race and age. The study allows decision-makers to identify the source of vehicle pollution, which leads to a

Table 1. Concentration of sulphur dioxide (mg/m3) in the atmospheric air of the Shchuchinsk-Borovskoye zone for 2018

No	Name	Periods		
		Cold	Transition	Warm
1	Checkpoint 1	2.84±0.0003	0.0233±0.0017	3.1967±0.006
2	Checkpoint 2	2.95±0.0262	0.05±0	1.12±0.0029
3	Checkpoint 3	3.17±0.015	0.063±0.0017	2.2267±0.0083
4	Checkpoint 4	2.5±0.0010	0.07±0	1.6±0.00221
5	Abylay Khan meadow	2.3±0.0067	0.02±0.003	0.9967±0.006

Table 2. Number of vehicles for 2018

No	Categories of vehicles	Periods		
		Cold	Transition	Warm
1	Passenger cars	6,033	3,582	12,075
2	Buses	1,081	393	714
3	Trucks	379	147	429
	Total	7,493	4,122	13,218

Table 3. Indicators of the standard index (SI) and the highest repeatability (HR) for SO_2 for 2018

Indicators \ Place of measurement	Checkpoint #1	Checkpoint #2	Checkpoint #3	Checkpoint #4	Abylay Khan meadow
SI	6.4	6.4	6.4	3.38	4.62
HR	50%	66%	100%	50%	66%

wide range of high-risk exposures, and sheds light on understanding the spatial distribution of the population exposed to each source by demographic characteristics. Implementing a strategy for sustainable reduction of air pollution in the area of the case study will prevent the health risks associated with breathing in polluted air. Strategies that reduce the risk of exposure to air pollution should be implemented, such as vehicle exhaust emission limits and legislation on ambient air quality and / or enforcement practices (Dong *et al.,* 2020).

During the transition period, it was found that the SO_2 concentration does not exceed the maximum allowable index at all the studied points. The concentration ranges from 0.02±0.003 to 0.05±0.01 mg/m^3.

During the cold period, the following number of vehicles entered the resort area through all checkpoints: 4,122, including passenger cars – 3,582, buses – 393, trucks – 147. The total emission of SO_2 into the atmosphere from the exhaust gases of motor vehicles during the cold period was 0.009 tons. Other studied parameters did not exceed the maximum allowable concentration: carbon soot (0.014±0.003 to 0.03±0.005), NH_3 (0.002±0.002 to 0.0003±0.001), CO2 (80.4±0.0577 to 62.63±1.44), NO_2 (0.05±00.011 to 0.0267±0.0017), cement dust (0.05±0.006 to 0.02±0.002), H_2S (0.001±0 to 0.001±0.001).

The average SO_2 concentration in the warm period exceeds 2-6 MAC and is checkpoint #1 (3.1967±0.006 mg/m^3), checkpoint #2 (1.12±0.0029 mg/m3); checkpoint #3 (2.2267±0.0083 mg/m^3), checkpoint #4 (1.6±0.00221 mg/m^3), Abylay Khan meadow (0.9967±0.006 mg/m^3).

During the study period, the following number of vehicles entered the resort area through all checkpoints: 13,218, of them passenger cars – 12,075, buses – 714, cargo – 429. The total emission of SO_2 into the atmosphere from vehicles was 0.1069 tons. Other studied parameters did not exceed the maximum allowable concentration: carbon soot (0.08±0.0002 to 0.0127±0.006), NH_3 (0.02±0.003 to 0.0003±0.002), CO_2 (0.05±0.003 to 0.1267±0.0073), NO_2 (0.04±0 to 0.08±0.166), cement dust (0.02±0.0015 to 0.02±0.006), H_2S (0.001±0.002 to 0.001±0.001).

Taking into account the concentration of SO_2 during the warm period at checkpoint #1, checkpoint #2 and checkpoint #3, a default index **is** equal to 6.4, which refers to high levels of air pollution. The standard index at checkpoint #4 was 3.38 and indicates an increased level of pollution.

The highest repeatability for sulphur dioxide at checkpoint #1 and checkpoint #4 was 50%. At checkpoint #2 it was 66%, and at checkpoint #3 it was equal to 100%. Sulphur dioxide (SO_2) is a common air pollutant released from both anthropogenic and natural sources, and it has long been known to cause adverse effects on respiratory health. SO_2 has been set as a chemical indicator for National Ambient Air Quality Standards for gaseous sulphur oxides under the U.S. Clean Air Act. (Johns *et al.,* 2011; CCAC 2019).

Conclusion

The highest concentration of SO_2 in the Shchuchinsk-Borovskoye resort area was found in the cold and warm periods. Here, the concentration was higher than the maximum allowable concentration of up to 6 MAC. These results are confirmed with a large number of vehicles entering during the cold period (7,493), warm period (13,218) and total exhaust emissions (0.019;0.1069 tons). The indicators of the standard index and the highest repeatability were established, which suggests an increased level of pollution.

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