ENVIRONMENTAL PUBLIC HEALTH SURVEILLANCE

2022 REPORT

Ulaanbaatar, Mongolia

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CONTENTS

PREFACE

In 2018, the United Nations General Assembly held the Third High-level Meeting on the prevention and control of noncommunicable diseases (NCDs) and defined that air pollution is a risk factor for NCDs and the second leading cause of death. Improvements in air quality can contribute greatly to health protection and reduce the burden of NCDs, and have been identified as having multiple benefits for other sectors of society .

The Environmental Public Health Surveillance System (EPHSS) of Mongolia developed by the National Center for Public Health (NCPH) is a meticulously designed and data-driven framework that aims to serve as the vigilant custodian of public health by monitoring and assessing the relationship between environmental factors and human health affected by NCD's.

The EPHSS is a sophisticated composition of cutting-edge technologies, including remote sensing, geographic information systems (GIS), big data analytics, and real-time data streams from many environmental sensors. These technologies converge to form a digital ecosystem capable of capturing, processing, and disseminating information to the public, healthcare professionals, and policymakers about environmental health risks that can inform the development of public health policies and regulations aimed to reduce environmental hazards, allocate resources efficiently, and safeguard the well-being of communities.

The EPHSS diligently collects information on air and water quality, temperature fluctuations, pollution levels, disease outbreaks, and other critical parameters. This data is curated, cleansed, and integrated, resulting in a robust knowledge repository that employs advanced analytical methods, including epidemiological studies, statistical modeling, and data visualization, to identify trends, patterns, and potential associations between environmental exposures and health effects.

This system also aims to serve as a platform for ongoing research and innovation in the field of environmental public health in Mongolia, contributing to our understanding of how environmental factors affect human health. One such priority at the NCPH is to research the causes of cardiovascular diseases, cancer, diabetes and chronic respiratory diseases which present a 16.2% risk of premature death among 30-70 year olds in Mongolia.

This compilation presented to you is the 4th booklet of "Environmental Public Health Surveillance Indicators" and will be further improved and refined as a result of interdisciplinary cooperation. This report presents findings that are based on reported and available data during the years 2018 to to 2022. The impact of Covid-19 cannot be fully accounted for due to unprecedented measures taken to protect the vulnerable population and further spread of the disease. The effects of Covid-19 on mortality during the years 2019-2021 are still under investigation, and as such, cannot be fully accounted for in these findings.

As of January 2023, NCPH partnered with the information technology specialists at "Robot Systems" LLC to improve the environmental health surveillance program to study the main indicators of environmental pollution in relation with the disease and mortality in Mongolia. The objective of this partnership is to meet the need to create an electronic environment for organizing response measures, and to lay the foundation for the implementation of the environmental public health surveillance program.

ACKNOWLEDGEMENTS

In accordance with Resolution No. 259 of the Government of Mongolia of 2017, the National Center for Public Health prepares and delivers the report to decision makers and policy makers at all levels integrating the environmental and health indicators collected at the national level.

We would like to express our gratitude to the management and staff of the Department of Meteorological and Environmental Analysis of the Ministry of Environment and Tourism, Sectoral Inspection Department, the Health Development Center, and the Trauma and Orthopedic National Center of the Ministry of Health for their cooperation in bringing the compilation to your hands.

Also, we would like to express our gratitude to E. Myagmarsuren, the Executive Director of "Robot Systems" LLC, programmer A. Amarzaya, and the colleagues of the Company, who helped to improve the environmental surveillance program and open up information, and wish them great success in their future work.

List of Tables

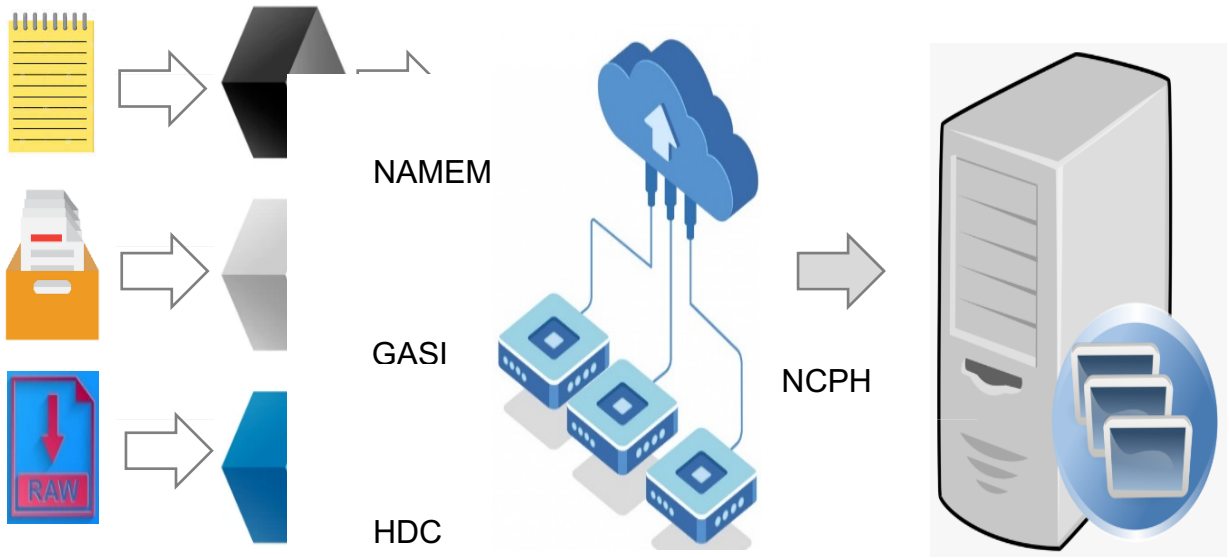
List of Figures

Abbreviations

mcg/m^3	Microgram per cubic meter ($\mu g/m^3$), parts per billion (PPB)
MED	Medicine
AQS	Mongolian Air Quality Standard
AQG	WHO Air Quality Guidelines
AQMM	Air quality monitor measurements
MET	Ministry of Environment and Tourism
BGD	Bayangol District
BZD	Bayanzurkh District
BND	Baganuur District
NTORC	National Trauma and Orthopedic Research Center
WHO	World Health Organization
GASI	General Authority of Special Inspection
UNO	United Nations Organization
PH	Public Health
NCPH	National Center for Public Health
OEHIA	Office of Environmental Health and Impact Assessment
SKD	Songinokhairkhan District
SBD	Sukhbaatar District
UB	Ulaanbaatar
WA	Water Authority
WCIA	Water Canal and Irrigation Administration
NSO	National Statistic Organization
NCD	Noncommunicable disease
YLCEAL	Years of life calculated with employment ability loss
KUD	Khan-Uul District
NAMEM	National Agency Meteorology and the Environmental Monitoring
CHD	Chingeltei District
RES	Researcher
ARES	Assistant Researcher
HDC	Health Development Center
RESI	Research Intern
MOH	Ministry of Health
SS	Scientific Secretary

METHODOLOGY

Determining environmental indicators and making conclusions based on health metrics and parameters has limitations, and developing and selecting good and effective indicators is a difficult task, and one that requires continuous improvement. We conducted this surveillance study using the 1999 World Health Organization guidelines for developing environmental health indicators. The purpose of the environmental health surveillance system aims to use the current and numerical data of the following 3 organizations as basic information, to enter it into the electronic program of environmental surveillance /www.tandalt.mn/, to analyze it, and to issue regular reports.



Scheme 1. Information flow to the NCPH environmental public health surveillance system

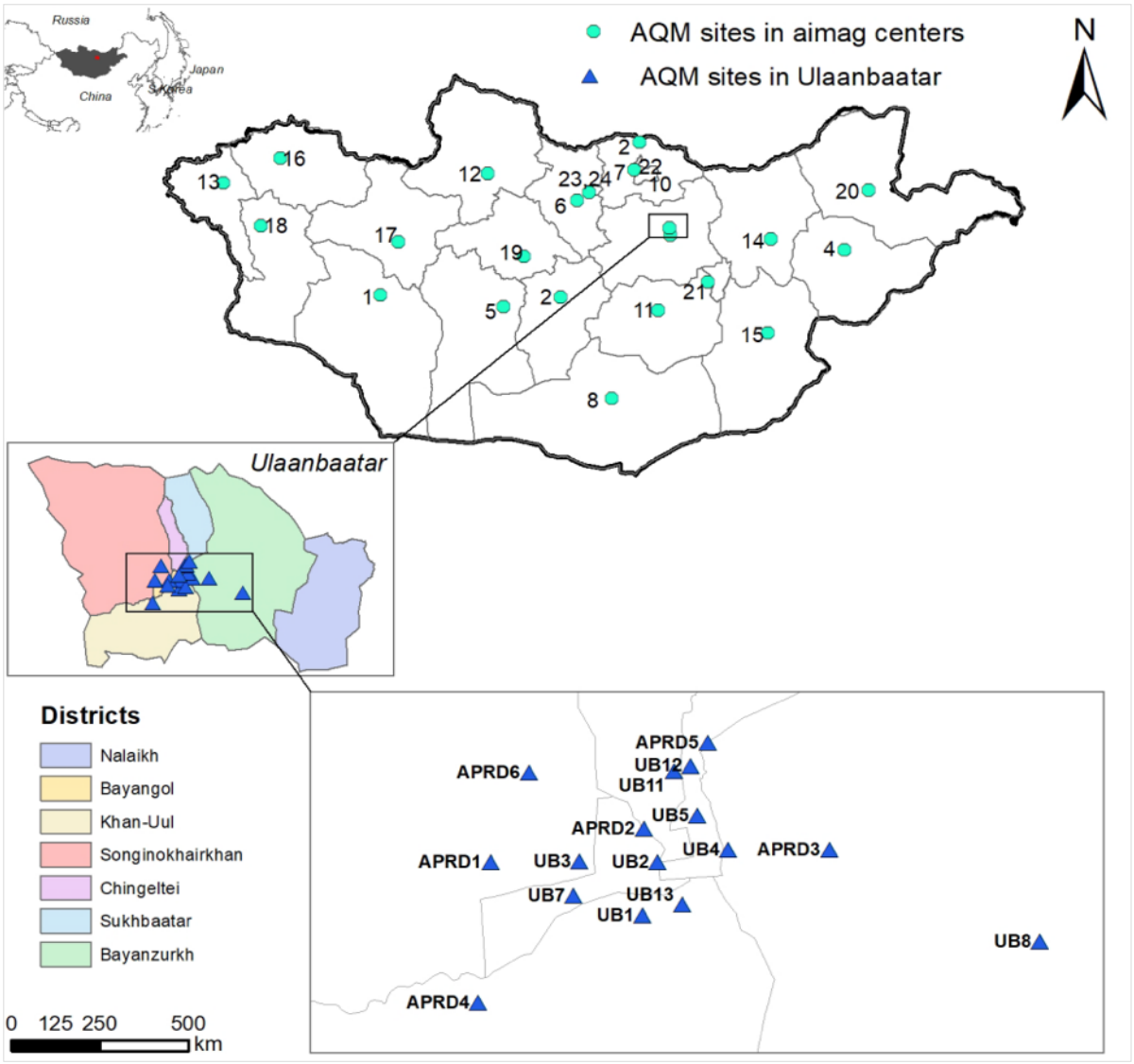


Figure 1. Location of air quality monitors

Hazardous Environmental Exposure Risk Indicators

Air Pollution

Across Ulaanbaatar city and 21 Aimag centers, the 4 indicators of air pollution that are reported daily are as follows:

- Coarse particles $\leq 10\,\mu$m (PM10)
- Fine particles $\leq 2.5\,\mu$m (PM2.5)
- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2)

The data for these 4 parameters is collected and reported by "'Weather, air quality and surface water quality indicators used for drinking water' that is regularly issued by NAMEM under the MET. A total of 9 indicators are selected to measure air pollution in Mongolia, but not all indicators can be obtained for Ulaanbaatar city and all 21 Aimags. Therefore, 4 indicators commonly measured by cities and Aimags are included in this

report (Figure 1). Air quality parameters are shown in Table 1 in comparison with Air Quality Standard (AQS) MNS 4585:2016 and WHO air quality guidelines (AQG).

Table 1. Air Pollutant Tolerance Levels and Comparisons

Name of parameters	Average measurement time	Measuring unit	MNS 4585:2016	WHO, 2021
Sulphur dioxide (SO_2)	10 minute average 20 minute average 24 hour average Annual average	mcg/m^3	- 450 50 20	500 - 40 20
Carbon monoxide (CO)	15 minute average 20 minute average 1 hour average 8 hour average 24 hour average	mcg/m^3	 60000 30000 10000	100000 35000 10000 4000
PM10	24 hour average Annual average	mcg/m^3	100 50	45 15
PM2.5	24 hour average Annual average	mcg/m^3	50 25	15 5
Nitrogen dioxide (NO_2)	20 minute average 1 hour average 24 hour average Annual average	mcg/m^3	200 - 50 40	- 200 25 10
Ozone (O_3)	8 hour average	mcg/m^3	100	100

** WHO updated air quality guideline for 2021*

Air quality indicator data collection. There are air quality monitors at 15 locations in Ulaanbaatar city and 26 locations in Aimags (Table 2).

Table 2. Pollutants measured by air quality monitors (AQM) and locations

#	Pollutants	Name of monitors
1	Sulphur dioxide, SO_2	Ulaanbaatar city AQM, 26 points in Aimags
2	Nitrogen dioxide, NO_2	Ulaanbaatar city AQM, 26 points in Aimags
3	PM10	Ulaanbaatar city AQM, 14 points in Aimags
4	PM2.5	UB-2, UB-3, UB-4, UB-11, UB-12, UB-13,5 points in Aimags
5	Carbon monoxide, CO	Ulaanbaatar city AQM, 4 points in Aimags
6	Ozone, O_3	UB-4, UB-5,

Drinking Water Contamination

Yearly reports on water quality are available for all UB districts, and for most districts in all 21 Aimags. The following 6 pollutant indicators are determined in drinking water:

- Ammonium (NH_4)
- Nitrite (NO_2)
- Nitrate (NO_3)
- Total number of bacteria
- Escherichia coli count
- The number of pathogens in the intestinal group

It is stipulated that “Monitoring and analysis of water quality and safety of centralized water supply shall be conducted by external monitoring and evaluation at least once a year" in 6.3 of “Environment. Health protection. Security. Drinking water. Hygiene requirements, quality, and safety assessment. MNS 0900:2018 Standard. Therefore, the General Agency of Specialized Inspection measures 6 indicators of drinking water pollutants once a year.

Soil Contamination

Following 4 indicators of soil pollution were determined in Ulaanbaatar city and in the center of 21 Aimags once per year:

- Total number of bacteria
- Coli titer
- Perfringes titre
- Escherichia coli count

It is stipulated that “The competent inspection organization shall take soil samples twice a year, analyze them in an accredited laboratory, and issue a sanitary opinion" in 6.4 of MNS 3297:2019 Standard “Environment protection. Soil. Assessment of the safety indicators of soil hygiene and pollution in cities and towns” and therefore the General Agency of Specialized Inspection collects information twice a year, in spring and autumn.

Public Health Outcomes and Disease

Information on morbidity and mortality of the population can be reported, daily, for Ulaanbaatar city and 21 Aimags. This information is based on the "Population Morbidity and Mortality Report" of the Health Development Center under the MOH. Environmental health indicators are considered in relation to each other and their interrelationships are presented (Table 3).

Table 3. Environmental hazard indicators integrated into surveillance systems and health effects

Environmental indicators	Health indicators	Effect
A. 4 indicators of air pollution	**D.** 5 selected health indicators	AD
B. 6 indicators of drinking water pollution	**D.** 6 selected health indicators	BD
C. 4 indicators of soil pollution	**D.** 6 selected health indicators	CD

Air Pollution Public Health Indicators

(AD). The following 5 indicators of morbidity and mortality of the population related to air pollution were selected for surveillance:

Article 3.9.1 of the Sustainable Development Goals stipulates that indoor and outdoor air pollution should be measured by mortality from the following diseases[1], which are

[1] Source: *http://sdg.gov.mn/Goal/?id=3*

reported here and in the Findings using the alphanumeric International Classification of Diseases 10th Revision (ICD-10), written as follows [α#]:

- Acute respiratory infections in children aged 0-5 years [J20-J22]
- Hypertension in the population over 25 years of age [I11-I15]
- Heart attacks in the population over 25 years of age [I20-I25]
- Chronic obstructive pulmonary disease in the population over 25 years of age [J44-J45]
- Lung cancer in the population over 25 years of age [C34]

Water and Soil Pollution Public Health Indicators

(BC, CD). Morbidity and mortality related to drinking water and soil contamination were studied with the cases of infectious diseases of the enteric group.

Article 3.9.2 of the Sustainable Development Goals stipulates that water, sanitation and hygiene condition that doesn't meet the requirement should be measured with the incidence of infectious diseases in the intestinal group of the population (A00-04, and A06-A09 in ICD10 category)[2].

Intestinal infectious diseases are grouped into dysentery, salmonellosis, diarrhea, hand, foot and mouth disease, and acute hepatitis A.

The Environmental Health Indicators 2022 compilation is reported on the following 3 main areas:

- Levels of air pollution for 2022, the highest polluted day in Ulaanbaatar city and in 21 Aimags, and a yearly comparison of monthly averages for 5 selected health criteria.
- Water quality reports for 2022, and a yearly comparison of 1 health indicator for Ulaanbaatar city and (21) Aimags and Soums,
- 2022 level of soil pollution, the selected 1 health indicator by Ulaanbaatar city and (21) Aimags and Soums, compared to prior years;

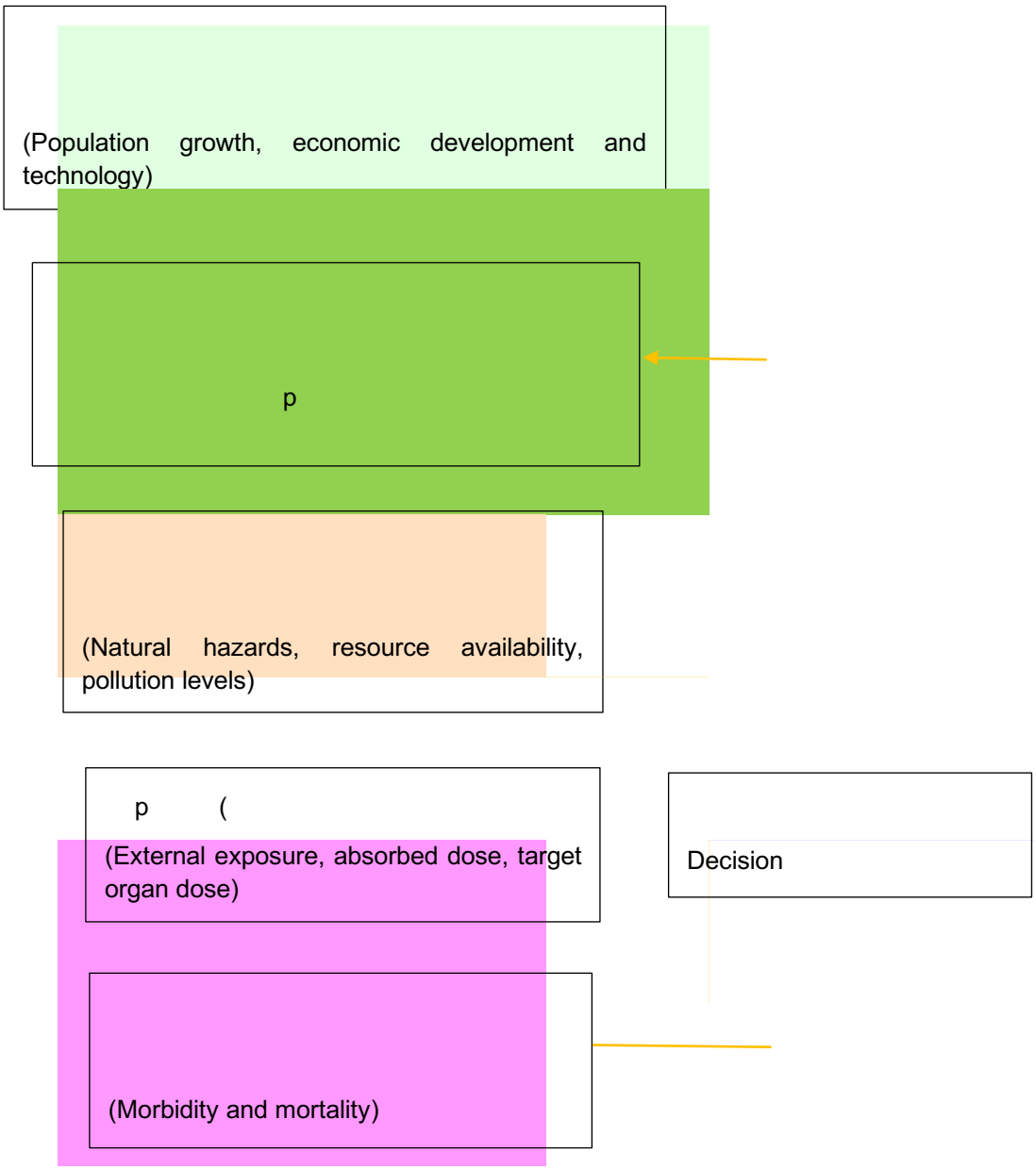
Reporting of Environmental Public Health Findings

DPSE$_1$E$_2$A Exposure-Disease Framework

The environmental health surveillance report was defined using the "DPSEEA framework" model according to WHO's Environmental Health Indicator Development Methodology, where DPSEEA represents "Driving force, Pressure, State, Exposure, Effect, and Action". The DPSEEA model is designed to identify environmental health problems from their root causes to their effects on human health and to support decision-making about interventions to reduce the burden of disease.

[2] Source: http://sdg.gov.mn/Goal/?id=3

- **D** – Driving force covers how the country's socio-economic factors, such as population growth, economic development, and technological progress, affect the environment. The most important of these is ***population growth***.
- **P** - Pressures on the environment can occur due to human activities or from all economic sectors such as mining and quarrying, energy and other manufacturing and service sectors, transport, tourism, agriculture and forestry. Pressures caused by human activities occur at all stages such as extraction, processing, distribution, final use, and waste generation of any resource.
- **S** – The state is changed due to influence of D and P. The frequency and number of natural disasters, the availability of natural resources, and the level of environmental pollution are expressed by such changes. These changes in environmental conditions may vary from region to region. Many changes are intense and localized, often concentrated near sources of stress (eg, living environment degradation, urban air pollution, contamination of local water supplies). Other desertification, ocean pollution, and climate change are more widespread globally and contribute to regional and global environmental change. Because of the direct effects of environmental degradation, almost all of these changes have a wide range of secondary effects.
- **E1 -** Health risks may arise when people are exposed to these environmental hazards. E1, or the exposure, represents the intersection between hazards caused from humans and the environment. Humans are exposed to environmental pollution through inhalation, ingestion, and skin absorption, and it depends on the duration and intensity of exposure.
- **E2 -** Exposure to environmental hazards can cause a wide variety of adverse effects on human health. They can vary in type, intensity, and magnitude depending on the type of hazard to which people are exposed, the level of exposure, and how many people are exposed. Consequences can manifest as the type of pathology and diseases, and in the most severe cases, the result is the untimely death.
- **A –**Appropriate measures should be taken to prevent and reduce exposure to environmental hazards.



Scheme 2. Schematic of the DPSEEA framework

FINDINGS

Surveillance finding are presented herein according to the DPSEEA framework of reporting for Ulaanbaatar city and rural areas nationwide.

D - Driving forces

Environmental health is influenced by socioeconomic and developmental factors such as population's social status, density, urbanization, migration, population growth, and technological advancement.

Population and growth. Mongolia's population reached 3.4575 million in 2022, and increased by 1.4% comparing to the data of previous year. 69.1% of Mongolia's population lives in urban areas and 30.9% in rural areas. 1691.8 thousand people or 48.9% of the total population live in Ulaanbaatar. The population growth rate is 1.4 as of 2022, which is decreased with 0.2% from the previous year.

Poverty. Poverty is a major determinant of health. Inadequate income is a factor in poor nutrition, poor access to housing conditions, health and other services, and low educational attainment. The poverty coverage index or the poverty level includes the share of the population with consumption below the poverty line in the total population.

As of 2022, the poverty coverage index is high in the Eastern (34), Western (30.2) and Khangai (38.5) Aimags, and the lowest in the Central region (26.3) and Ulaanbaatar (23.4)[3].

Population density. In underdeveloped countries, high population density leads to rapid urbanization and puts a strong pressure on local water sanitation, hygiene and health systems.In Mongolia, 2.2 people per 1 km^2 area in 2022 is the same level as the previous year, and in Ulaanbaatar city, it is 360.0 which increased by 12 people comparing to the previous year (Table 4).

Table 4. Population density of Mongolia, 2019-2021

Territory	2019	2020	2021	2022
Western region	1.0	1.0	1.0	1.
Khangai region	1.6	1.6	1.6	1.6
Central region	1.1	1.1	1.1	1.1
Eastern region	0.8	0.8	0.8	0.8
Ulaanbaatar city	312.6	329.8	348.8	360
Mongolia	2.1	2.1	2.2	2.2

Source: National Statistics Committee, 2022

Urbanization. The rapid development of urbanization without planning and control creates serious public health problems, such as poor services in inappropriate areas, construction of unplanned housing estates, congestion in service facilities, and as a result, exacerbates air, soil and water pollution, and loss of drinking water quality and safety. The population of Mongolia reached 3,457,548 in 2022, an increase of 47,609

[3] National Statistics Committee, 1212.mn

people from 2021, and 1,691,766 people live in Ulaanbaatar, which is an increase of 52,594 people from 2021.

Population migration. Internal population migration in Mongolia, including migration from rural areas to cities, continues unabated. Nationwide, 54,824 people migrated in 2022, an increase of 1.2 times compared to the same period in the previous year. 37,602 people migrated to Ulaanbaatar in 2022, an increase from the previous year.

Table 5. Migration, 2019-2022

Regions	2019	2020	2021	2022
Western	2036	3824	2059	1589
Khangai	5438	5766	5516	5121
Central	9404	7551	8628	8306
Eastern	2115	2907	2125	2206
Ulaanbaatar	12373	39515	25695	37602
Mongolia	31366	59563	44023	54824

Source: National Statistics Committee, 2022

Average life expectancy. The health status of a country's population is measured by life expectancy. The average life expectancy of the population of Mongolia in 2022 was 71.0 years, 67.1 for men and 76.5 for women, unchanged from the previous year.

The difference in life expectancy between men and women in our country is one of the countries with the highest difference compared to the world average. The average life expectancy calculated with the birth rate of the population by Aimags is the highest in Dundgov Aimag, and it is 0.5-2.5 years lower than the national average in Uvs, Dornod, Khuvsgul and Darkhan-uul Aimags.

Age structure. The age structure of the country's population can be seen by the percentage of the population under 16 and over 65 years of age. This indicator provides information on population trends, population growth, and how the demand for health promotion will be affected.

In general, it is believed that an increase in the proportion of the population in this range indicates that that it may increase in the demand for health services. The population under the age of 6 and over the age of 65 accounted for 35.6% of the total population in 2019, 36.2% in 2020, and 36.6% in 2021 and 2022, respectively.

Infant mortality. (SDG 3.2.2) Infant mortality rate is 7.8 in 2022, decreased with 0.4% from 2021.

Table 6. Infant mortality, per 1,000 live births, 2019-2022

Regions	2019	2020	2021	2022
Average in Aimags	8.3	7.8	8.6	7.7
Ulaanbaatar	8.0	8.0	7.9	7.8
Mongolia	8.6	7.3	8.2	7.8

Source: Health Development Center, 2022

P- Pressure on the Environment

Anthropogenic pressure. Pressure on the environment can arise from all sectors of the economy, including mining, quarrying and other manufacturing and service sectors, transportation, tourism and agriculture. As of March 2022, there are a total of 3,027 licenses in our country, and 6,107,961.88 hectares or 3.9% of the total territory have mineral licenses.

The total affected area in 2021 is 6307.4 thousand ha, of which mineral extraction accounts for 0.18%, and pastures and other grassy areas account for 93.6% (Table 7).

Table 7. Damaged area, by main category, national total, 2019-2021, thousand hectares

Type	2019	2020	2021
Total damaged area	7815.7	5559.2	6307.4
Cultivation area	139.2	86.6	112.5
Pasture and other grassland areas	7030.2	5255.6	5907.1
Urban area and other settlements	49.9	44.2	44.5
Land with forest reserve	570.8	136.6	229.1
Land with water reservoir	1.8	0.2	1.4
Excavated and damaged area	23.9	36.1	12.7
Due to geological exploration	0.0	8.1	0.1
Due to mineral extraction	23.3	27.1	11.3
Due to defense and security operations	0.1	0.0	0.1
Due to construction, engineering, pipeline establishment and maintenance work	0.2	0.0	0.0
Due to road, transport, communication construction, repair and maintenance	0.2	0.9	1.1

Source: *National Statistics Committee, 2021*

S - State of the Environment

Natural disasters. The number of reported disasters in Mongolia was 5123 in 2019, 3977 in 2020, 4053 in 2021, and 4299 in 2022. While the frequency of object fires had the highest occurrence of all disasters in 2022, the area of burned forests and grasslands occupied a larger area compared to previous years. There were 91 strong snow and dust storms, 35 heavy rains and floods, and 39 earthquakes (Table 8).

Table 8. Disasters and losses, 2019-2022

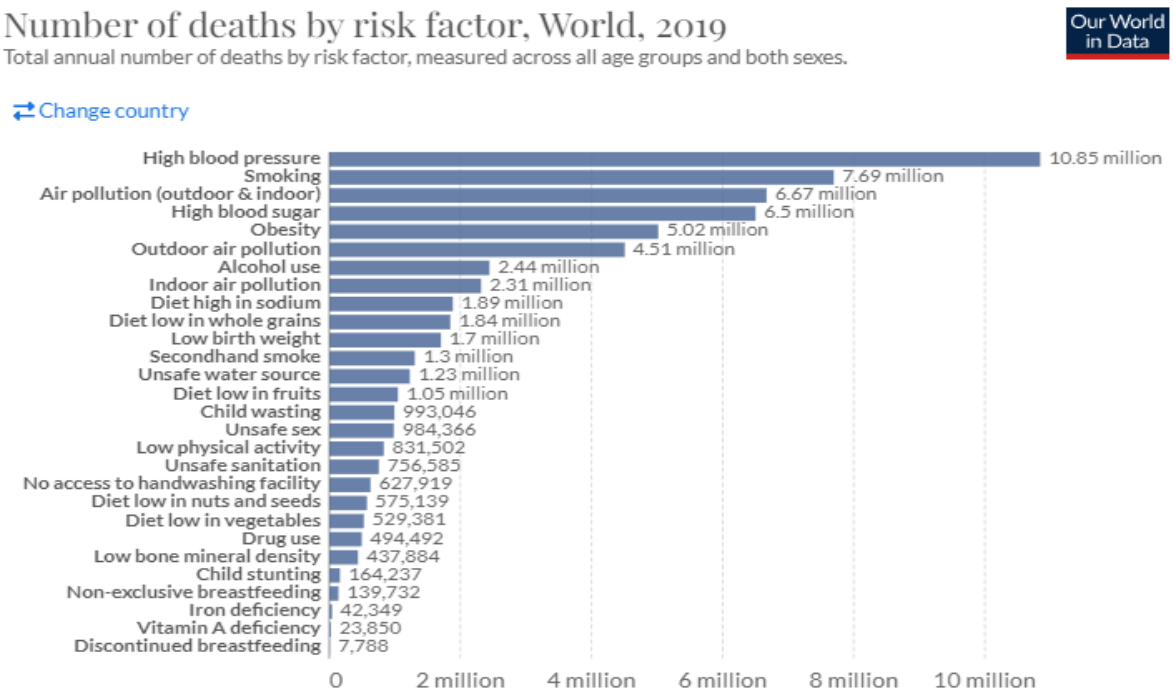
Disasters and losses	2019	2020	2021	2022
Number of occurrences of disasters	5.123	3.977	4.053	4299
Forest and steppe fires /number/	121	147	65	179
Burnt forests and steppe / million ha/	0.3	20.64	20.64	26.3
Object fire /number/	4.301	3.036	2.671	3.075
Heavy snow and dust storm /number/	56	51	91	56
Danger of heavy rains and floods /number/	35		72	35
Earthquake /number/	39	56	295	39
Exterminated and destroyed livestock and animals /thousands of heads/			163.7	8.553
People who died due to disaster /number/	207	243	319	247
The amount of damage caused by the disaster / billion tugrics /	35.8	31.32	25.8	33.2

Source: National Statistics Committee, 2022

E1- Air Pollution

Air pollution is the third leading risk factor for death, with approximately 7 million deaths each year due to air pollution (Figure 2).

Figure 2. Risk factors leading to mortality, globally, 2019



Source: World heart federation. Clean air, smart cities, healthy hearts: action on air pollution for cardiovascular health. 2019.

Air *Quality in Ulaanbaatar City*

Summary of average annual air quality index. The annual average concentration of outdoor air pollutants in Ulaanbaatar in 2022 compared to 2021 is as follows[4]:

PM2.5 decreased by 3 mcg/m^3, PM10 by 1 mcg/m^3, and sulfur dioxide (SO_2) by 3 mcg/m^3, and;
Nitrogen dioxide (NO_2) is increased with 4 mcg/m^3.

Table 9. Annual mean concentration of outdoor air pollutants in UB city, mcg/m^3

Air pollutants	Air quality guideline		Yearly average concentractions mcg/m^3				
	MNS 4585:2016	WHO	2018	2019	2020	2021	2022
PM2.5	25	5	74	60	49	44	41
PM10	50	15	136	124	90	89	88
NO_2	40	40	34	38	37	36	40
SO_2	20	20	25	29	47	66	63

Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). The annual mean NO_2 concentration during 2018-2022 is within the maximum allowable concentration specified by both Mongolian standards and WHO recommendations.

The daily average SO_2 concentration was 66 mcg/m^3 in 2021 and 63 mcg/m^3 in 2022, which is 3.1 times higher than the both Mongolian and WHO guidelines.

PM10. The daily average concentration of PM10 in 2018 was 136 mcg/m^3, which is 2.7 times higher than the Mongolian AQG. While it decreased to 88 mcg/m^3 in 2022, it is still 1.8 times higher than the Mongolian AQG and 6 times higher than the WHO AQG.

PM2.5. The annual average concentration of PM2.5 in 2018 was 74 mcg/m^3 or 2.96 times higher than Mongolia's standard. It decreased to 41 mcg/m^3 in 2022, but it is still 1.8 times higher than Mongolia's AQG and 9 times higher than WHO's AQG (Table 9). The decrease in PM2.5 over the 4-year period of record observed in all districts within Ulaanbaatar city, except for Sukhbaatar District, which remained the same.

Average monthly air quality index summary[5]. The average monthly concentration of air pollutants in 2018-2022 reached levels considered hazardous to human health during the months of the year with sub-zero temperatures (Oct-Feb). Among the coldest months of Dec-Feb with high/low averages temperatures of -10/-29 °C, January had the most extreme levels of "high pollution" posing the greatest risk of hazardous effects to human health.

[4] Тухайн жилийн өдөр бүр эсвэл сараар тооцсон үзүүлэлтийн дундаж агууламжийг хэлнэ.

[5] Means the average content of the total measurement value of the given parameter in a month.

24-Hour Average Air Quality Index

PM10. In 2022, the 24-hour average concentration of PM10 in Ulaanbaatar exceeded the MNS 4585:2016 AQS with 24.7% of the total 365 days, or in 90 days (Figure 3).

In 2022, the monthly average concentration of PM10 in November, January and February (3 months in the year) was slightly higher than the permissible AQS by MNS 4585:2016, When raw coal is used as primary fuel for decentralized household heating in October, November, December, January, February, March, April and May of 2018 (8 months of the year) and in October, November, December, January, February and May of 2019 (6 months of the year), the air pollution indicators greatly exceeded the AQS MNS 4585:2016.

The record shows 24-hour average PM10 was 242 mcg/m^3 in December 2018 and 236 mcg/m^3 in January, and decreased by 1.6-1.8 times reaching to 131 mcg/m^3 in December 2022 and 144 mcg/m^3 in January (Table 10).

Table 10. Monthly average concentration of outdoor air pollutants in UB city, 2022

Air pollution indicators	MNS 4585:2016 (24 hour average), mcg/m^3	Season and months of the year											
		Autumn			Winter			Spring			Summer		
		9	10	11	12	1	2	3	4	5	6	7	8
SO_2	50	12	45	85	145	162	130	73	48	15	10	7	7
NO_2	50	28	31	51	65	56	54	38	39	29	23	18	24
PM10	100	66	92	97	131	141	128	108	88	77	53	38	41
PM2.5	50	18	33	55	103	103	78	35	26	18	12	10	11

Source: National Agency Meteorology and the Environmental Monitoring

PM2.5. In 2022, the 24-hour average PM2.5 concentration in Ulaanbaatar exceeded the MNS 4585:2016 AQS with 24.7% of the total 365 days, or in 90 days (Figure 4). A comparison of 24-hour average PM2.5 levels during the coldest months Dec-Jan for 2018 and 2022 winters indicate the effect of the 2019 ban on raw coal in as home-burning fuel. Relative to 2018 levels, there was a 1.7 fold decrease in December of 2022 (182 mcg/m^3 in 2018 vs. 103 mcg/m^3 in 2022), and a 2.1 fold decrease in January (222 mcg/m^3 in 2018 vs. 103 mcg/m^3 in 2022).

Nitrogen dioxide. In 2022, the 24-hour average NO_2 concentration in Ulaanbaatar exceeded the MNS4585:2016 AQS during 24.7% of the year's 365 days, or for 90 days in total (Figure 5). During this winter period of Nov-Dec 2021 and Jan-Feb 2022, the monthly average concentration minorly exceeded the MNS4585:2016 AQS of 40 mcg/m^3 NO_2.

There was a 1.2 rate of increase in the NO_2 24-hour average index from 2018 to 2022 winters; 2018 and 2022 average NO_2 levels were 1.28 and 1.52 times higher than the AQS, respectively. The NO_2 record of measurement show 51 mcg/m^3 in Dec 2018 and 52 mcg/m^3 in Jan 2019, compared to 2021-22 winter, which recorded NO_2 levels of 66 mcg/m^3 in Dec 2021 and 56 mcg/m^3 in Jan 2022.

Sulfur dioxide. In 2022, the 24-hour average SO_2concentration of sulfur dioxide exceeded the MNS 4585:2016 AQS with 49.6% of the total 365 days or in 181 days (Figure 6).

During the winter period of Nov-Dec in 2022 and Jan to Feb in 2022, the monthly average SO_2 concentrations exceeded the AQS MNS 4585:2016, in which the maximum value in January 2022 exceeded the standard by 3 times.

The SO_2 index was 54 mcg/m^3 in December and 61 mcg/m^3 in January of 2018, and increased 2.5 times to 136 mcg/m^3 and 152 mcg/m^3 in 2022, respectively (Figure 6).

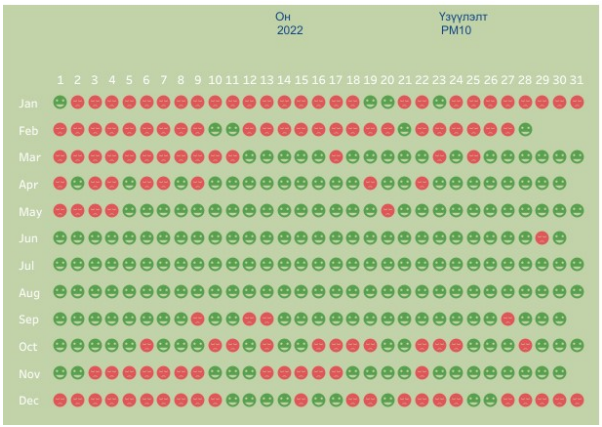


Figure 3. Days exceeding the PM10 AQS in UB city, 2022

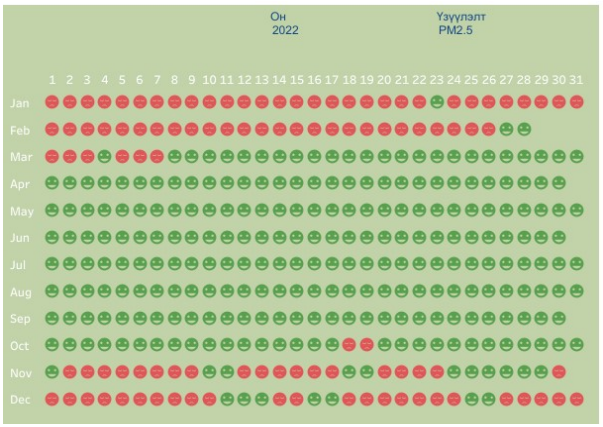


Figure 4. Days exceeding the PM2.5 AQS in UB city, 2022

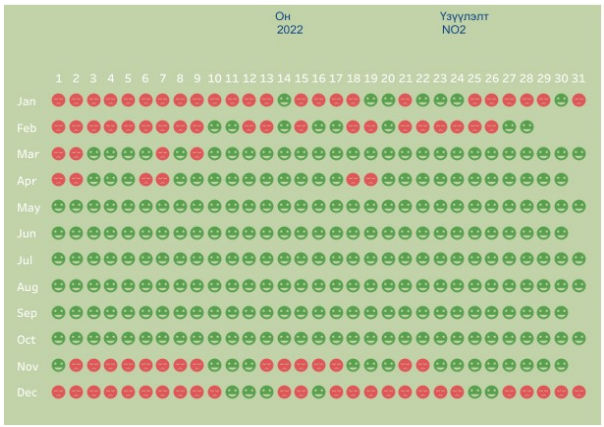


Figure 5. Days exceeding the NO_2 AQS in UB city, 2022

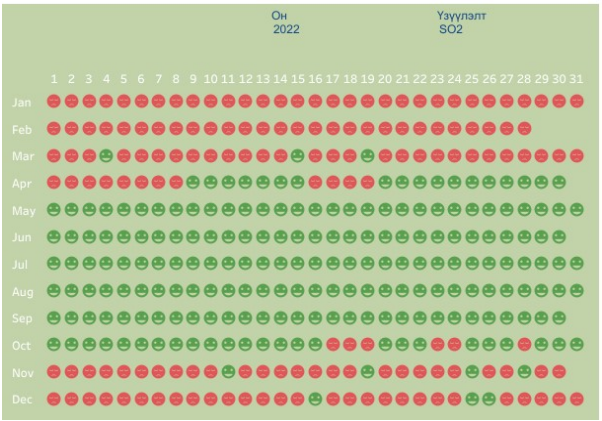


Figure 6. Days exceeding the SO_2 AQS in UB city, 2022

Annual comparison of January AQI. In the WHO Air Quality Guidelines, PM10 and PM2.5 are often compared using annual or 24-hour average values. The following reported findings represent the air quality in Ulaanbaatar during the most "highly polluted" month of January in terms of 24-hour average concentration, and a comparison of 4 indicators of air pollution in the external environment for 7 days relative to the MNS 4585:2016 AQS.

PM2.5. Weekly comparisons of PM2.5 for January show a decline in 24-hour average concentration during the 2018-2022 period of record. The lower and upper limits for the years 2018-2019 were 117 and 274 mcg/m^3 PM2.5, respectively, or 2.3-5.5 times higher than the standard; this decreased during the years 2020-2022 to a range of 85-122 mcg/m^3, which is still 1.7-2.4 times higher than MNS 4585:2016 AQS (Figure 7).

PM10. During the years 2018-2021, the lower and upper limits for maximum average PM10 concentrations observed over a 24-hour period was 110-316 mcg/m^3 PM10, which is 1.1-3.1 times higher than the standard, respectively. In 2022, the observed range was 119-174 mcg/m^3 PM10; despite the relative decline, the upper limit still exceeded the AQS by 1.1-1.7 times (Figure 8).

Sulfur dioxide. A comparison of the 2018 and 2022 years of record for ambient SO_2 concentrations in January show a triple fold increase in 24-hour average concentrations over this period. In January of 2018, the SO_2 concentration was the highest at 57 mcg/m^3 SO_2, and in 2022, it increased 3.2 times to 182 mcg/m^3 SO_2.

Nitrogen dioxide. The highest recorded 24-hour average ambient NO_2 concentration in 2018 was 56 mcg/m^3, compared with 70 mcg/m^3 in 2020. There was a relative decrease in the maximum NO_2 recorded values in January of 2022, in which NO_2 measured between 50-63 mcg/m^3, yet remained higher than the AQS (Figure 10).

Effect of Raw Coal vs. Modified Coal as Home-Burning Fuel

PM2.5. In 2020, the government implemented a ban on raw coal for home-burning fuel in Ulaanbaatar. The effect of coal type on air pollutant PM2.5 is evident through a comparative analysis of monthly averages during the five winter months of Nov-Mar for 2018-19 and 2021-22. For the 2018-19 winter season, all five winter months, Nov-Mar, had average monthly PM2.5 levels that exceeded the MNS 4585:2016 AQS of 25 mcg/m^3 PM2.5. During the 2021-22 winter, two years after the national ban on using raw coal as home-burning fuel, 2 months were more than the AQS, Dec 2021 and Jan 2022.

Sulfur dioxide. The findings show a marked difference before and after the raw coal ban through a comparative weekly analysis of 24-hour average concentrations SO_2 levels for January, the coldest month of the year. When raw coal was still in use during the years of record 2018-2019, ambient SO_2 concentration ranged 45-73 mcg/m^3; compared to 2020-2022 years of record after the change in home-burning coal, SO_2 levels increased 1.7-4 times to 80-295 mcg/m^3 relative to 2018-2019 (Figure 9).

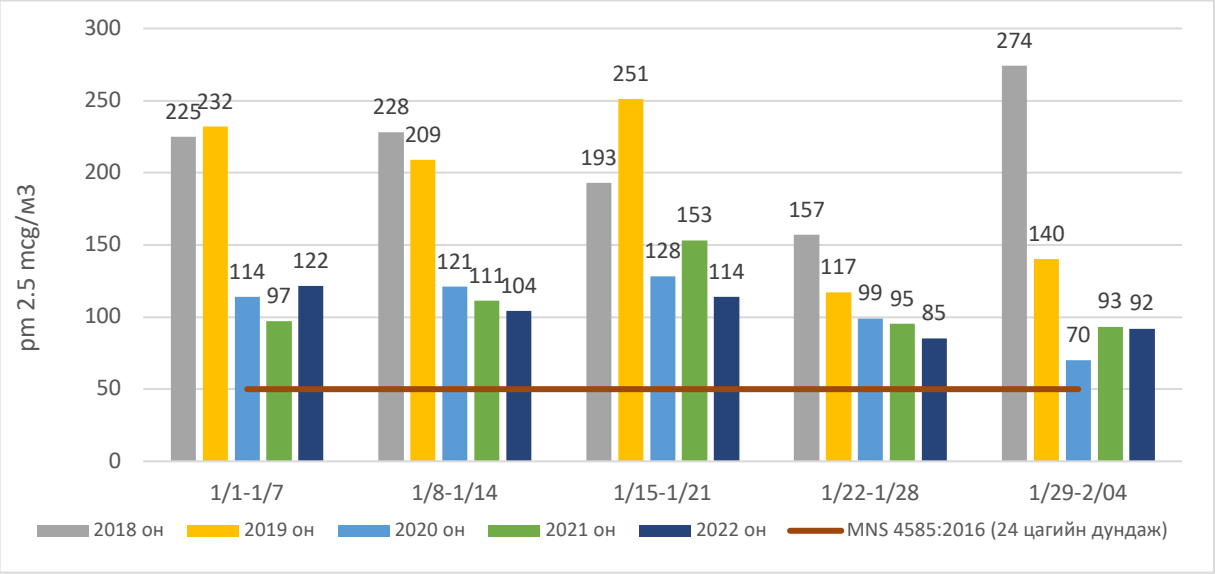


Figure 7. The average concentration of PM2.5 in UB city in January, 2018-2022

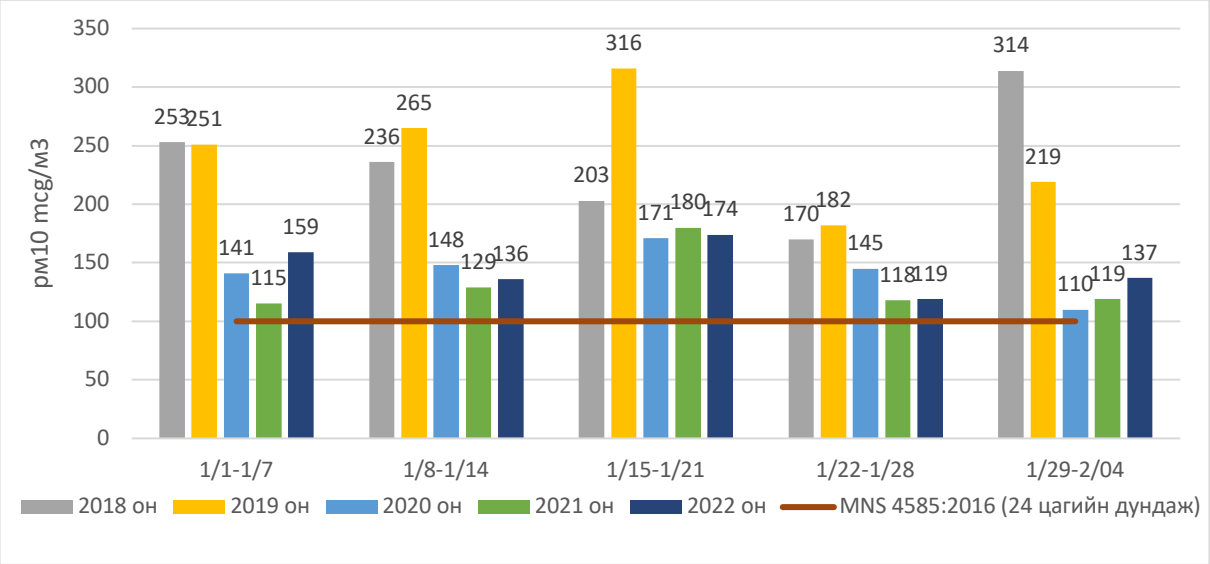


Figure 8. The average concentration of PM10 in UB city in January, 2018-2022

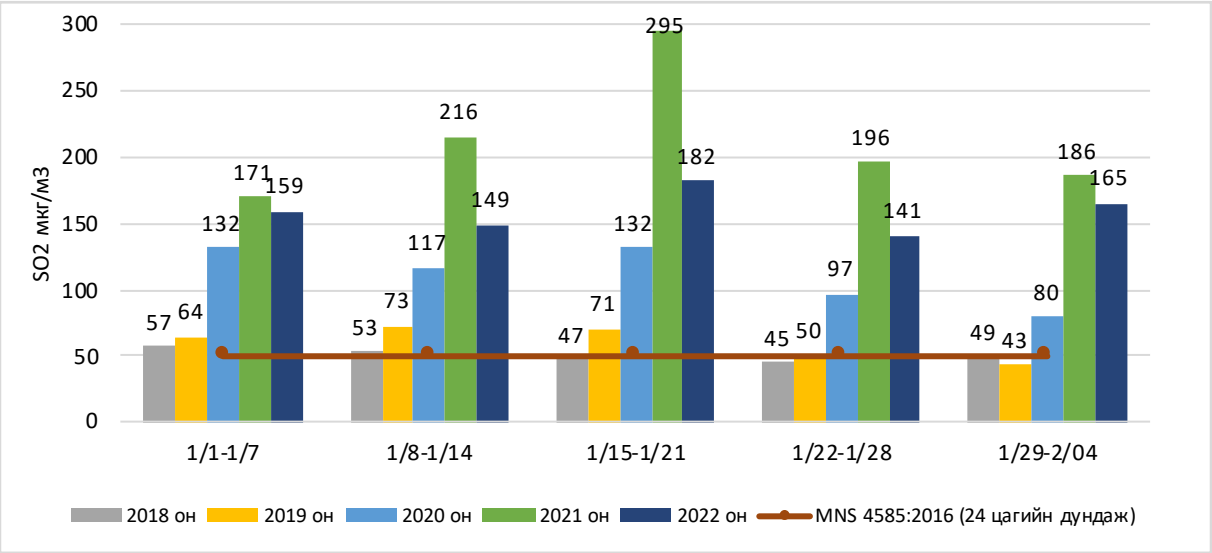


Figure 9. Average SO_2 concentration in UB city in January, 2018-2022

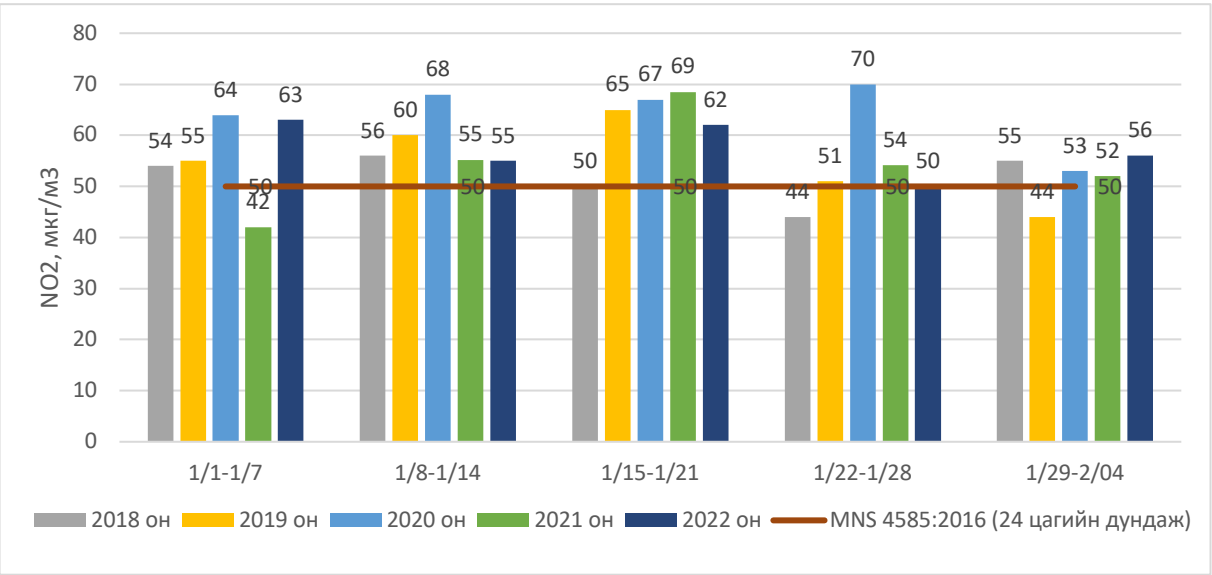


Figure 10. Average NO_2 concentration in UB city in January, 2018-2022

Air Quality in Rural Areas

If the air quality monitoring equipment of Aimag centers had damage or malfunctioned, the parameters of such Aimags are omitted. In the case where one Aimag center has more than one monitoring point, the concentration was averaged.

Average Annual Air Quality Indicators

PM2.5. In 15 Aimag centers, and the annual average PM2.5 concentration in 2022 is higher than the standard of Mongolia in Darkhan-Uul, Hovd, Bayan-ulgii, Umnogovi, Bayankhongor, Tuv, Selenge, Orkhon, Gobi-Altai, Khuvsgul, Bulgan, and Dornod (Figure 11).

PM10. The annual average PM10 in Selenge and Khuvsgul Aimags is between 66-74 mcg/m^3, or 1.3-1.5 times higher than the MNS 4585:2016 AQS (Figure 12).

Sulfur dioxide. In 2022, ambient SO_2 was monitored and reported for Aimag centers. The findings of comparative analysis show the annual average concentration of SO_2 is 1.2-2.5 times higher than the MNS 4585:2016 AQS in Umnogovi, Uvurkhangai, Gobi-Altai, Bayankhongor, and Orkhon Aimags (Figure 13).

Nitrogen dioxide. In 2022, NO_2 was measured in all Aimag centers, which found the annual average concentration of NO_2 in Orkhon Aimag was 1.6 times higher than the MNS 4585:2016 AQS, and is within the standard range for other Aimags (Figure 14).

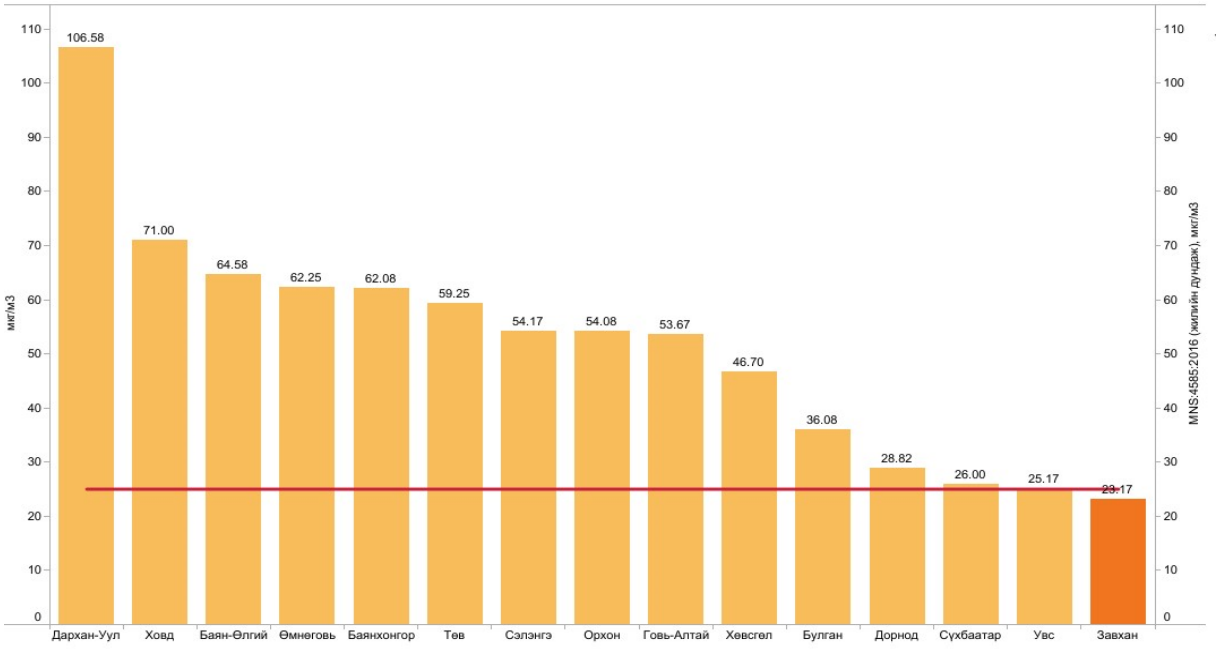


Figure 11. Annual average concentration of ambient PM2.5 by Aimags, 2022

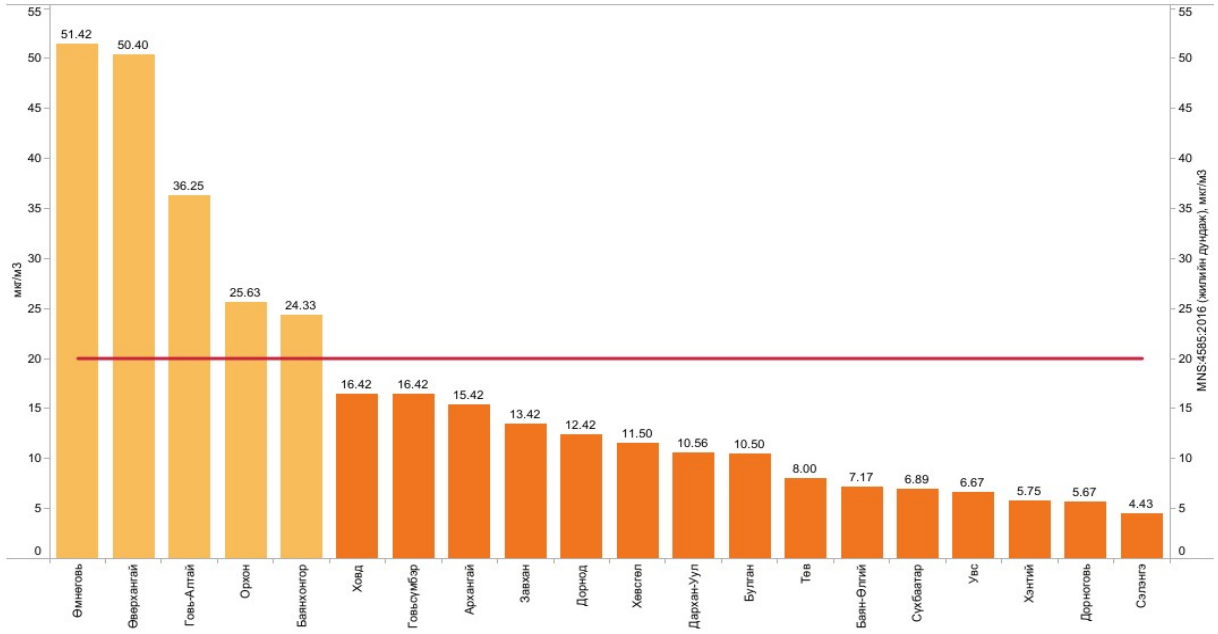


Figure 12. Annual average concentration of ambient air PM10, by Aimags,2022

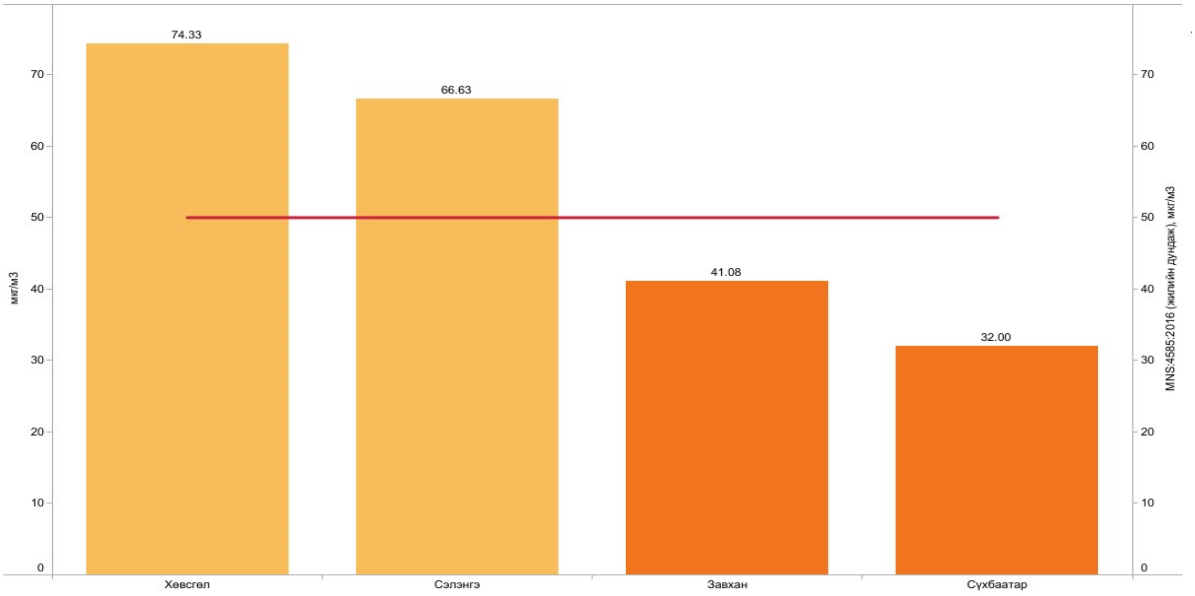


Figure 13. Annual average concentration of ambient air SO_2 by aimag, 2022

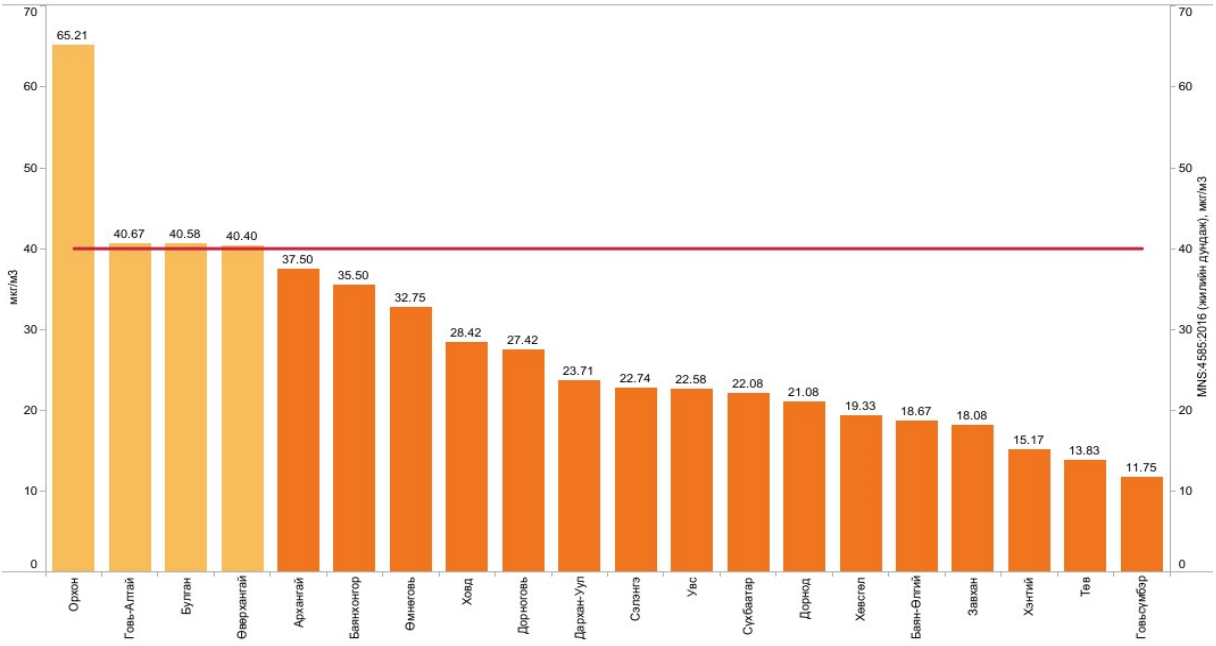


Figure 14. Annual average concentration of NO_2 in local area ambient air, 2022

Average Monthly Air Quality Index

PM2.5 and PM10 . In 2022, the monthly average concentration of PM2.5 in Ulaangom of Uvs Aimag, and Aimag centers of Zavkhan and Sukhbaatar Aimags exceeded the MNS 4585:2016 AQS only in January, and exceeded in all other Aimag centers in the November, December, January, and February (Table 11).

The monthly average concentration of PM10 exceeded AQS in Selenge Aimag in Nov-Jan, in Khuvsgol Aimag in Jan-Feb, and in Uvs Aimag in Sep-Jan (Table 12).

Sulfur dioxide. In 2022, the monthly average concentration of SO_2 exceeded MNS 4585:2016 AQS in Bayankhongor Aimag in Nov-Dec, in Gobi-Altai and Umnogov Aimags in Dec-Jan, and in Uvurkhangai Aimag in Oct-Feb. (Table 13).

Nitrogen dioxide. In 2021, the monthly average concentration of NO_2 exceeded MNS 4585:2016 AQS in Arkhangai Aimag during Dec-Jan, in Bulgan in Dec-Jan, in Govi-Altai during Dec-Jan, in Orkhon and Uvurkhangai Aimags during Oct-Dec and for Jan in Umnugovi Aimag (Table 14).

Table 11. Monthly average concentration of PM2.5 in local outdoor air, mcg/m^3, 2022

Location	Seasons and months											
	Autumn			Winter			Spring			Summer		
	9	10	11	12	1	2	3	4	5	6	7	8
Bayan-Ulgii	19	52	52	110	262	145	52	31	19	13	10	10
Bayankhongor	24	38	68	91	141	197	53	36	19	45	23	10
Bulgan	18	16	60	66	100	72	31	18	18	10	11	13
Govi-Altai	10	32	68	162	142	125	30	23	17	15	16	4
Darkhan-Uul	13	30	79	115	290	620	52	22	22	13	11	12
Dornod	9	32	62		65	63	25	21	14	11	7	8
Zavkhan	9	20	37	41	57	53	27	16	10	3	2	3
Orkhon	18	42	88	80	161	133	48	26	20	13	10	13
Umnugovi	7	38	80	93	220	168	49	26	26	23	14	3
Sukhbaatar	8	20	37	32	73	59	31	14	20	7	5	6
Selenge	14	42	61	95	169	127	58	26	23	15	11	12
Tuv	14	33	138	151	169	108	36	21	16	9	7	9
Uvs	24	38	39	34	43	37	32	15	11	8	9	12
Khovd	11	52	93	152	283	133	85	21	8	4	5	5
Khuvsgul	18	59			119	149	65	26	15	6	4	6

Note: A blank cell indicates that no measurement was performed during the month due to instrument failure. ***Source:*** *National Agency Meteorology and the Environmental Monitoring, 2022*

Table 12. Monthly average concentration of PM10 in local outdoor air, mcg/m3, 2022

Location	Quarters and months											
	Autumn			Winter			Spring			Summer		
	8	9	10	11	12	1	2	3	4	5	6	7
Zavkhan	35	38	48	60	43	42	50	57	48	32	21	19
Sukhbaatar	9	23			98	84	37	16		8	6	7
Selenge	17	53	76	118	207	149	74	35	28	18	13	14
Khuvsgul	3	7	38	80	93	220	168	49	26	26	23	14
Uvs	21	103	167	123	132	202	79	28	17	7	5	8

Note: A blank cell indicates that no measurement was performed during the month due to instrument failure. Source*: National Agency Meteorology and the Environmental Monitoring, 2022*

Table 13. Monthly average concentration of SO_2 in local outdoor air, mcg/m^3, 2022

Location	Quarters and months											
	Autumn			Winter			Spring			Summer		
	8	9	10	11	12	1	2	3	4	5	6	7
Arkhangai, Tsetserleg	6	19	46	42	30	24	6	3	5	2	1	1
Bayan-Ulgii, Ulgii	2	5	9	24	14	20	2	2	2	3	1	2
Bayankhongor, Bayankhongor	7	15	47	63	55	47	19	15	8	4	8	4
Bulgan, Bulgan	7	11	13	25	26	14	8	7	5	3	3	4
Govi-Altai, Altai	3	21	26	40	124	148	39	19	8	3	2	2
Govisumber, Choir	12	12	13	16	26	25	25	14	18	9	16	11
Darkhan-Uul, Darkhan	3	8	13	17	28	20	9	6	4	4	6	4
Dornogovi, Sainshand	3	6	11	7	13	9	6	3	4	2	2	2
Dornod, Choibalsan	4	11	27	26	31	35	4	3	2	2	2	2
Zavkhan, Uliastai	4	16	13	18	30	30	26	11	8	2	1	2
Orkhon, Erdenet	17	25	42	43	31	29	22	26	21	19	17	19
Uvurkhangai, Arvaikheer	5	27	107	110	122	60	45	20	6	2		
Umnugovi, Dalanzadgad	3	2	36	54	220	213	69	8	5	3	2	2
Sukhbaatar, Baruun-Urt	4	7	9	10	11	8				5	4	4
Selenge, Sukhbaatar	3	3	4	9	9	7	5	4	3	3	3	3
Tuv, Zuunmod	6	7	0		26	16	13	8	1	4	4	3
Uvs, Ulaangom	4	8	6	9	12	13	7	5	5	4	4	3
Khovd, Khovd	4	17	23	33	26	28	27	24	10	2	1	2
Khuvsgul, Murun	3	18	11	29	29	19	9	6	3	2	6	3
Khentii, Undurkhaan	3	3	7	15	11	6	8	4	3	3	3	3

Note: A blank cell indicates that no measurement was performed during the month due to instrument failure. Source: National Agency Meteorology and the Environmental Monitoring, 2022

Table 14. Monthly average concentration of NO_2 in local outdoor air, 2022

Location	Quarters and months											
	Autumn			Winter			Spring			Summer		
	8	9	10	11	12	1	2	3	4	5	6	7
Arkhangai, Tsetserleg	29	34	43	34	70	104	51	19	14	18	9	25
Bayan-Ulgii, Ulgii	19	24	30	37	41	23	10	6	8	9	5	12
Bayankhongor, Bayankhongor	27	32	49	52	50	53	40	27	21	25	28	22
Bulgan, Bulgan	25	29	42	66	120	88	40	22	18	14	11	12
Govi-Altai, Altai	11	30	33	51	116	126	46	25	18	12	9	11
Govisumber, Choir	10	15	16	18	15	12	12	11	10	8	6	8
Darkhan-Uul, Darkhan	23	24	23	27	32	34	24	20	19	19	17	19
Dornogovi, Sainshand	28	30	35	29	30	26	26	24	27	24	24	26
Dornod, Choibalsan	21	26	35	17	23	40	26	12	12	22	9	10
Zavkhan, Uliastai	4	11	12	11	54	48	31	14	8	13	7	4
Orkhon, Erdenet	44	58	135	136	65	62	57	54	53	41	39	42
Uvurkhangai, Arvaikheer	24	35	93	106	38	46	26	15	13	8		
Umnugovi, Dalanzadgad	21	30	33	44	61	45	43	27	22	23	24	20
Sukhbaatar, Baruun-Urt	23	21	23	21	25	26	24	21	21	19	20	21
Selenge, Sukhbaatar	19	22	29	28	31	26	19	22	20	19	17	21
Tuv, Zuunmod	9	16	25	23	16	9	22	12	6	11	10	7
Uvs, Ulaangom	19	24	27	21	26	20	24	25	24	20	19	22
Khovd, Khovd	15	24	27	44	42	46	45	35	29	13	10	11
Khuvsgul, Murun	22	23	21	24	24	22	18	16	17	20	10	15
Khentii, Undurkhaan	11	20	24	27	20	15	11	14	12	10	9	9

Note: A blank cell indicates that no measurement was performed during the month due to instrument failure. Source: National Agency Meteorology and the Environmental Monitoring, 2022

E2 - Population Mortality Associated with Air Pollution

Many scientists have estimated the impact of air pollution on NCD-related mortality[6]:

- Mortality due to lung cancer causes 40% (95% CI, 17– 56%)
- Mortality due to respiratory causes 29% (12–43%)
- Acute lower respiratory tract infection-cause mortality among children 33% (23% - 42%)
- Mortality due to chronic obstructive pulmonary disease (COPD) 19% (9% - 28%)
- Mortality due to cardiac ischemia 27% (19% - 42%)
- Mortality due to stroke 42% (14% - 54%).

Leading Causes of Mortality Nationwide

In recent years, diseases of the respiratory and circulatory organ systems in Mongolia have been observed as the main cause of morbidity and mortality of the entire population, and the fact that there is no significant decrease indicates that it is one of the pressing problems of the health sector.

Nationwide population mortality in 2021 reached 17.9 thousand, a decrease of 1950 (10.8%) people compared to the same period of the previous year. As of 2022, deaths caused by cardiovascular system disease are 17.5 per 10,000 population, by cancer are 12.8, by accidents and external causes are 10.1, by digestive system disorders are 3.7, and by respiratory system disorders are 2.7, which are the top 5 causes.

Cardiovascular disease. Mortality due to cardiovascular diseases accounted for 32.5% of all deaths in 2022, and the national average was 17.5 per 10,000 population, decreasing by 1.4 from 2021 (18.9). Mortality due to cardiovascular diseases has decreased in all Aimags except for five Aimags compared to the previous year. In 2022, Khuvsgul (20.9 per 10,000 population), Uvurkhangai (21.6), Dundgovi (20.7), Bulgan (26), Bayan-ulgii (21.7), Arkhangai (20.6), Tuv (20.8), and Govi-Altai (20.3) Aimags was more than national average (Figure 15

[6] Source: Allen et al, 2013, Hill et al, 2017

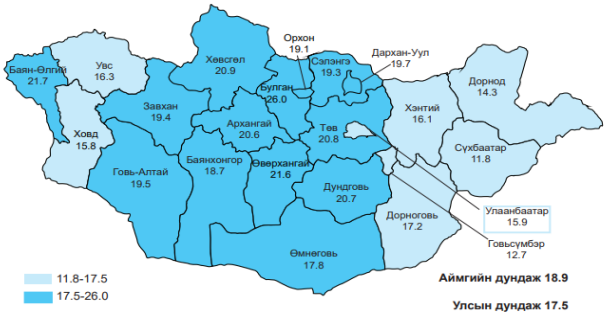


Figure 15. Mortality due to cardiovascular system diseases, per 10K pp, 2022

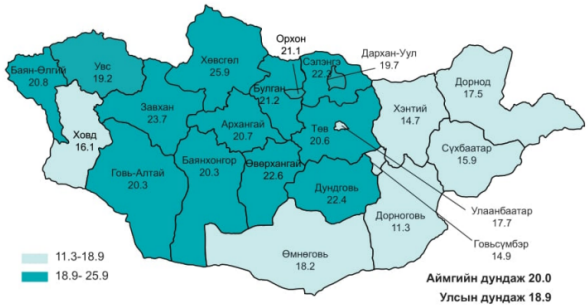


Figure 16. Mortality due to cardiovascular system diseases, per 10K pp, 2021

Source: Health Development Center: 2021,2022

In 2022, the majority of deaths due to cardiovascular diseases was caused by stroke (22.8%) and heart attack (44%). 91.9% of people who died from diseases of the cardiovascular system are over 45 years old. By the location, 42.5% of deaths due to diseases of the cardiovascular system were registered in Ulaanbaatar.

Diseases of the respiratory system. At the national level, in 2022, the death rate due to respiratory system diseases was registered as 2.7 per 10,000 population, which has decreased by 0.1 from the same period last year (2.8). All Aimags except 5 have a decrease in mortality. In 2022, Dornogovi (4.7 per 10,000 population), Tuv (3.2), Umnugovi (3.0), Selenge (3.3), Khuvsgul (2.9) Aimags and Ulaanbaatar city (3.3) have higher indicator than the national average (Figure 17, Figure 18). As of 2022, pneumonia-related deaths accounted for 50.3% of all respiratory system-related deaths, decreasing by 10.4% from the previous year.

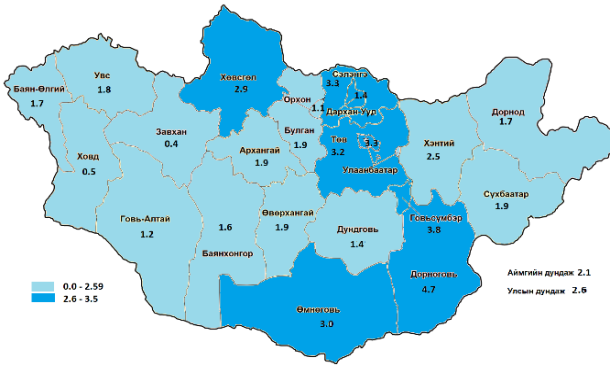


Figure 17. Mortality due to respiratory system diseases, per 10K pp, 2022

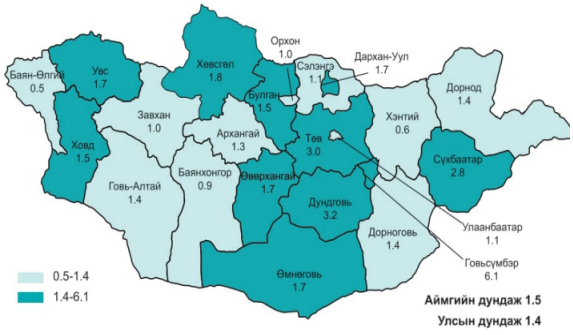


Figure 18. Mortality due to respiratory system diseases, per 10K pp , 2021

Source: Health Development Center: 2021,2022

Cancer-related disease. Mongolia leads the world in terms of cancer deaths. As of 2022, 23.7% of all deaths are caused by cancer. It is the second leading cause of the mortality.

In terms of cancer type, the majority of deaths are from liver and bile duct cancer, stomach cancer, and trachea (bronchial) and lung cancer.

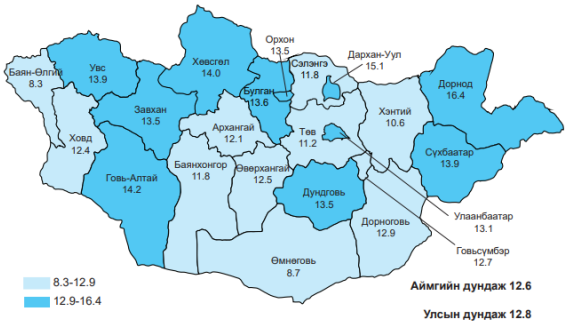


Figure 19. Lung cancer mortality, per 10K pp, 2022

Figure 20. Lung cancer mortality, per 10K pp, 2021

Source: Health Development Center: 2021,2022

Nationally, the lung cancer death rate in 2022 was 1.4 per 10,000 population, unchanged from the same period last year. All Aimags except 8 have an increase in mortality (Figure 19, Figure 20).

Yearly comparison by age group. At the national level, from 2018 to 2022, per 10,000 population, the mortality rate due to acute lower respiratory tract infections among children under 5 years of age increased by 0.01. Death due to influenza and pneumonia in children under the age of 5 decreased by 0.02 cases (Table 15).

For the population over 25 years of age mortality, cases of disease per 10,000 people in 2022 compared with 2021 as follows (Table 15):

⇑ Heart attack increased by 0.52,
⇑ Lung cancer increased by 0.47,
⇑ Chronic obstructive increased by 0.77
⇓ High blood pressure decreased by 0.27

Table 15. Population mortality of some diseases due to ambient air pollution, per 10,000 population, 2018-2022

Diseases	Year				
	2018	2019	2020	2021	2022
Mortality due to acute lower respiratory tract infections in children under 5 years of age [J20-J22]	0.0	0.0	0.01	0.0	0.01
Mortality due to influenza and pneumonia in children under 5 years of age [J10-J18]	1.93	2.37	1.85	2.97	1.91
Mortality due to hypertension in the population over 25 years of age [I11-I15]	0.47	0.38	0.48	1.01	0.74
Mortality due to heart attacks in the population over 25 years of age [I20-I25]	11.94	11.26	9.98	15.18	12.46
Mortality due to chronic obstructive pulmonary disease in the population over 25 years of age [J44-J45]	1.03	1.18	0.99	0.33	0.26
Mortality due to lung cancer in the population over 25 years of age [C34]	2.11	2.50	2.08	2.43	2.58

Note: The value of [α#] represents ICD-10. Source: Health Development Center 2022

Mortality of the Population of Ulaanbaatar

In these reported findings for 2022, the causes of death of the population of Ulaanbaatar city due to diseases related to blood circulation and the respiratory system have been studied and clarified.

Mortality due to diseases of the circulatory system among the population of Ulaanbaatar was 16.5 per 10,000 population in 2018 and 15.5 in 2019 and increased to 15.2 in 2020, to 18.1 in 2021, and to 15.9 in 2022. In Ulaanbaatar, the mortality rate due to diseases of the respiratory system was 2.6 per 10,000 population in 2018 and 2.7 in 2019 to 2.1 in 2020, and increased to 3.7 in 2021 and 3.3 in 2022 (Table 16). The number of deaths due to diseases of the respiratory and cardiovascular systems declined from 2018 until 2020, increased in 2021, and decreased in 2022. Cardiovascular disease related mortality registered 1.3-4.5 higher in rural areas than in urban areas, and respiratory disease related mortality was 0.4-1.2 higher in cities than in rural areas (Table 14).

Article 3.9.1 of the Sustainable Development Goals stipulates that air pollution in the outdoor environment should be measured by mortality from the following diseases, categorized according to ICD-10 [α#]:

- Acute lower respiratory tract infections in children up to 5 years of age [J20-J22]
- Hypertension in the population over 25 years of age [I11-I-15]
- Heart attacks in the population over 25 years of age [I20-I25]
- Chronic obstructive pulmonary disease in the population over 25 years of age [J44-J45]
- Lung cancer in the population over 25 years of age [C34]

In Ulaanbaatar city, during years 2018-2022, per 10,000 population, the death-rate deaths due to influenza and pneumonia in children under 5 years of age is increased by 0.6, and the number of deaths due to lung cancer by 0.3, respectively; the mortality rate declined by 0.5 for chronic obstructive pulmonary disease related deaths in the population over 25 years of age, the death-rate due to heart attack in the population over 25 years of age decreased by 1.4, respectively. During this period there was no change in mortality due to high blood pressure in the population over 25 years of age, and no change in mortality due to acute lower respiratory tract infections in children under 5 years of age (Table 17).

In Ulaanbaatar, the highest number of deaths due to influenza and pneumonia among children under the age of 5 was registered in October of 2018, in January of 2019, in January and February of 2020, in October and November of 2021, and in April of 2022, (Table 18).

Over the 2018-2022 period of record, months that reported the highest death rates due to hypertension in the population over 25 years of age are summarized as follows (Table 19):

- 2018: August and November
- 2019: June
- 2020: October and November
- 2021: October and November
- 2022: September and October

Mortality due to heart attack in the population over 25 years old was high in November, December, January, April, July and August of 2018-2019, in September, October, April and May of 2020, and in all months in 2021 and in 2022, it was the highest in January and decreased in all months compared to the previous year (Table 19).

The incidences of deaths due to chronic obstructive pulmonary disease among the population over 25 years old were high in Sep-Dec in 2018-2019, but in most months after 2020, the death rate has decreased every year (Table 20).

The highest mortality incidences due to lung cancer among the population over 25 years of age were registered in Mar-May of 2018 and 2019, in February and April of 2020, in Mar-Apr of 2021, and in May of 2022 (Table 20).

According to analysis from the 2022 Environmental Health Surveillance Program, when the average daily concentration of PM2.5 and PM10 increases, flu and pneumonia among children under 5 years old increased accordingly, and when the average daily concentration of SO_2 and NO_2 increases, the heart attack incidence rate among the population over 25 years old also increased (Figure 21, 22).

Table 16. Deaths due to respiratory and cardiovascular system diseases, per 10,000 population, 2018-2022, urban and rural

Disease	Year	Urban area	Countryside
Mortality due to diseases of the cardiovascular system	2018	16.5	20.9
	2019	15.5	18.9
	2020	15.2	16.5
	2021	18.1	20.0
	2022	15.9	18.9
Mortality due to diseases of the respiratory system	2018	2.6	2.2
	2019	2.7	2.3
	2020	2.1	1.7
	2021	3.7	2.4
	2022	3.3	2.1

Source: Health Development Center 2022

Table 17. Disease-related mortality attributable to ambient air pollution in UB city, per 10,000 population, 2018-2022

Disease	Year				
	2018	2019	2020	2021	2022
Mortality due to acute lower respiratory tract infections in children under 5 years of age [J20-J22]	0.0	0.0	0.0	0.0	0.0
Mortality due to influenza and pneumonia in children under 5 years of age [J10-J18]	1.9	2.4	1.8	4.4	2.5
Mortality due to hypertension in the population over 25 years of age [I11-I15)	0.5	0.4	0.5	1.2	0.5
Mortality due to heart attacks in the population over 25 years of age [I20-I25]	11.9	11.2	10.6	14.7	10.5
Mortality due to chronic obstructive pulmonary disease in the population over 25 years of age (J44-J45)	1.0	1.2	1.0	0.2	0.2
Mortality due to lung cancer in the population over 25 years of age [C34]	2.1	2.5	2.1	2.3	2.4

Source: Health Development Center 2022

Table 18. Mortality due to influenza and pneumonia among children under 5 years of age [J10-J18] in UB city, per 10,000 population, 2018-2022, by quarters and months

Year	Autumn			Winter			Spring			Summer		
	9	10	11	12	1	2	3	4	5	6	7	8
2018	0.15	0.25	0.11	0.14	0.12	0.15	0.15	0.16	0.27	0.15	0.15	0.15
2019	0.18	0.17	0.13	0.27	0.53	0.20	0.15	0.16	0.20	0.17	0.11	0.10
2020	0.14	0.26	0.14	0.14	0.29	0.25	0.10	0.11	0.17	0.10	0.10	0.05
2021	0.36	0.69	0.59	0.31	0.21	0.13	0.21	0.26	0.34	0.44	0.48	0.38
2022	0.20	0.24	0.09	0.22	0.19	0.22	0.26	0.27	0.21	0.16	0.21	0.22

Source: Health Development Center 2022

Table 19. Mortality due to hypertension and heart attack among the population over 25 years of age in UB city, per 10,000 population, by months, 2018-2022

Year	By quarters and months											
	Autumn			Winter			Spring			Summer		
	9	10	11	12	1	2	3	4	5	6	7	8
	Mortality due to hypertension in the population over 25 years of age [I11-I15]											
2018	0.01	0.04	0.07	0.05	0.02	0.01	0.05	0.02	0.02	0.04	0.05	0.07
2019	0.05	0.01		0.04	0.02	0.04	0.05	0.02		0.07	0.05	0.02
2020	0.06	0.11	0.02	0.05	0.04	0.04	0.02				0.06	0.08
2021	0.12	0.16	0.19	0.14	0.09	0.05	0.05	0.08	0.11	0.08	0.04	0.09
2022	0.07	0.07	0.04	0.05	0.02	0.04	0.06	0.04	0.04	0.05	0.06	0.05
	Mortality due to heart attacks in the population over 25 years of age [I20-I25]											
2018	0.97	0.95	1.10	1.05	0.98	0.98	1.02	0.70	0.94	1.01	1.16	1.08
2019	0.82	0.80	1.07	0.97	1.12	0.90	0.76	1.14	1.08	0.82	1.01	0.79
2020	1.05	1.08	0.92	0.73	0.85	0.84	0.77	1.05	1.01	0.73	0.78	0.85
2021	1.54	1.58	1.19	1.07	1.06	0.86	1.11	1.15	1.46	1.34	1.34	1.01
2022	0.79	0.75	0.85	0.82	1.05	0.96	1.06	0.86	0.73	0.86	0.87	0.93

Source: Health Development Center 2022

Table 20. Mortality due to chronic obstructive pulmonary diseases and lung cancer among the population over 25 years of age in UB city, per 10,000 population, by months, 2018-2022

Year	By quarters and months											
	Autumn			Winter			Spring			Summer		
	9	10	11	12	1	2	3	4	5	6	7	8
	Mortality due to chronic obstructive pulmonary disease in the population over 25 years of age [J44-J45]											
2018	0.10	0.10	0.15	0.16	0.09	0.06	0.10	0.07	0.10	0.05	0.02	0.04
2019	0.10	0.13	0.10	0.10	0.09	0.09	0.10	0.06	0.15	0.10	0.12	0.05
2020	0.06	0.07	0.06	0.07	0.13	0.13	0.08	0.08	0.05	0.13	0.06	0.05
2021	0.04	0.05	0.02	0.02	0.01		0.01	0.02	0.01		0.02	0.02
2022	0.02			0.01	0.02	0.01	0.04		0.04	0.05	0.01	0.01
	Mortality due to lung cancer in the population over 25 years of age [C34]											
2018	0.18	0.14	0.16	0.11	0.16	0.10	0.22	0.23	0.26	0.15	0.23	0.16
2019	0.18	0.25	0.25	0.13	0.15	0.22	0.26	0.34	0.20	0.13	0.20	0.20
2020	0.19	0.24	0.11	0.18	0.16	0.24	0.14	0.25	0.13	0.12	0.20	0.11
2021	0.16	0.13	0.25	0.18	0.18	0.18	0.26	0.25	0.16	0.24	0.19	0.15
2022	0.08	0.28	0.21	0.27	0.09	0.22	0.22	0.19	0.29	0.16	0.19	0.16

Source: Health Development Center 2022

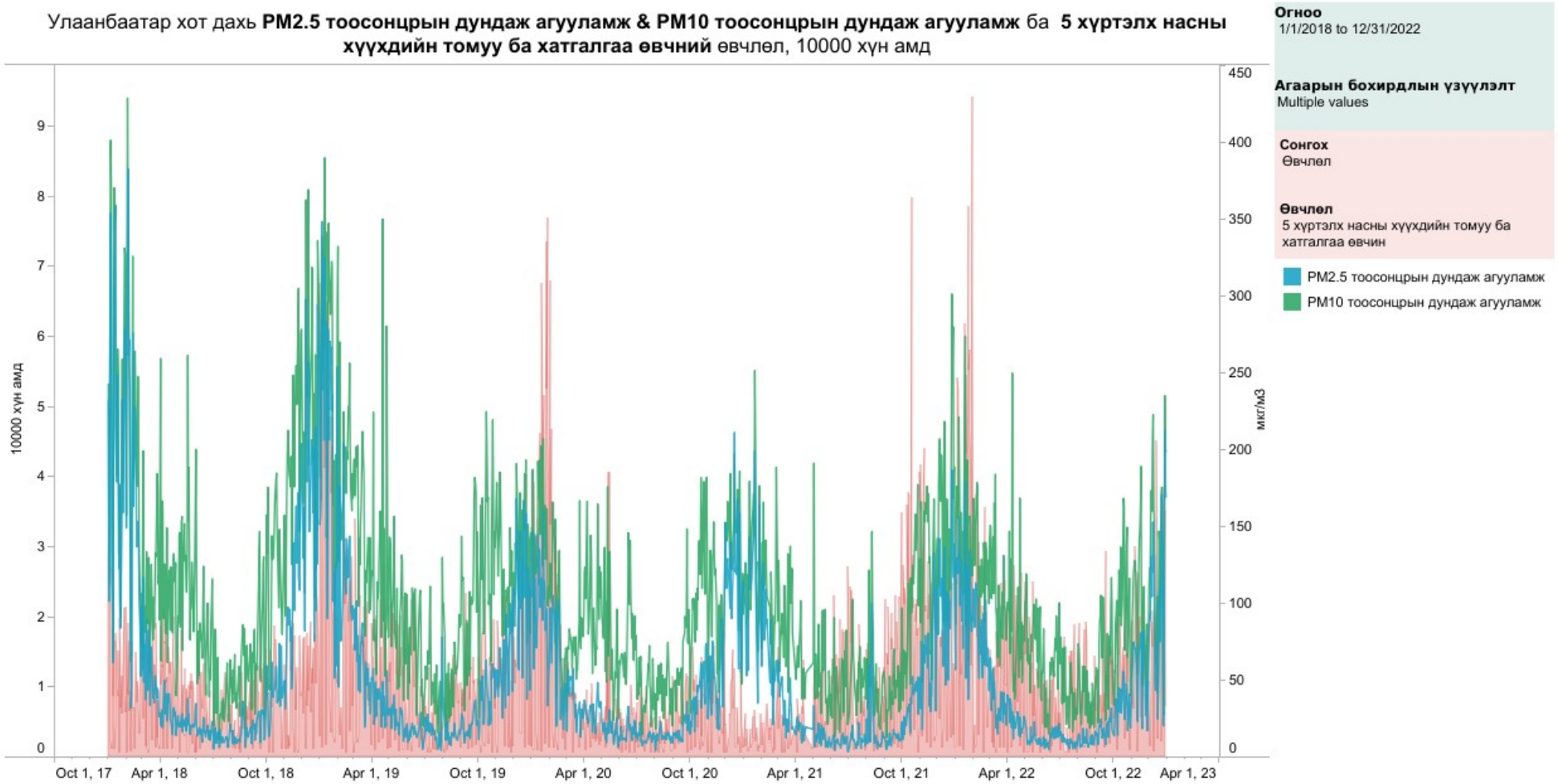


Figure 21. Daily average concentration of PM2.5 and PM10 in Ulaanbaatar city and flu and pneumonia among the children under 5 years of age, per 10,000 population, 2018-2022

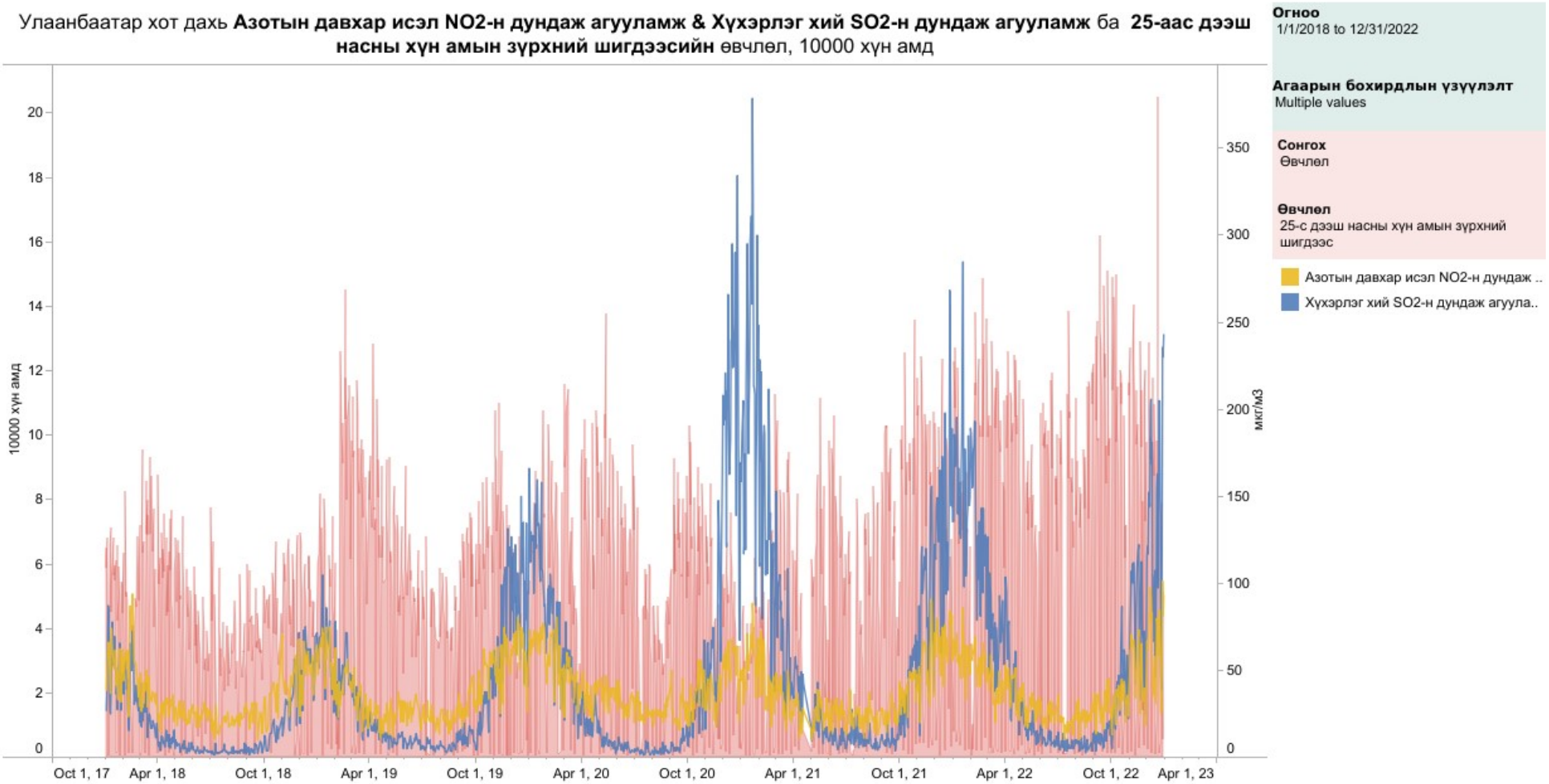
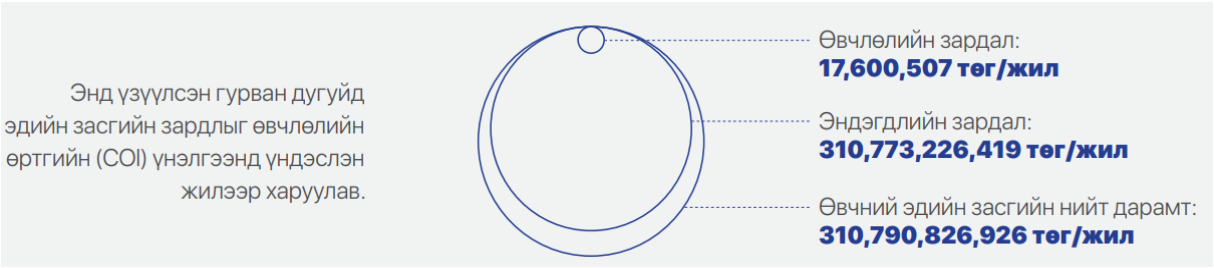


Figure 22. Daily average concentration of SO_2 and NO_2 in Ulaanbaatar city and the incidence of heart attacks among the population over 25 years old, per 10,000 population, 2018-2022

Within the framework of the project "Improving health and environmental sustainability through pollution reduction" implemented by the United Nations Development Program, the results of the first stage of economic benchmarking of indoor air pollution of "Investment Benchmark Calculation (AAP-HAP) and Institutional Situation Analysis" based on the monitoring data of the National Center of Public Health are as follows: Year of employment capability loss is 16859 YLD/year and death (number of years lost) is 2449 YLL/year.

Indoor air pollution burden to public health

Health-related economic losses



Source: United Nations Development Programme, Project: "Improving health and environmental sustainability through pollution reduction"

E1- drinking water contamination

Data provenance. The data reported here originate from the year 2021, when an independent nationwide survey of drinking water quality was undertaken by the Water Services Regulatory Commission of Mongolia (WSRC) in collaboration with the Mongolian Academy of Sciences water quality analysis laboratory. Groundwater wells and the number of people accessing the well for drinking water were identified and sampled for physiochemical characterization.

The results of the survey are drinking water quality analysis for 785 samples were collected from 102 Soums of 9 Aimags. The results of the sample analysis were assessedd by the GASI at the national level and compared to MNS 0900:2016 standard "Environment. Health Protection and Safety. Drinking water. Assessment of hygiene requirements, quality and safety".

Ammonia (NH_4)

Maximum permissible levels of ammonium in drinking water standards: 1.5 mg/l

Ammonia and ammonium salts in water are the main indicators of biological or human and animal excreta caused pollution. If ammonium is detected, solely, it indicates possible contamination with organic matter 7-10 days prior.

The average ammonium content of drinking water for the population of Mongolia was 0.25 ±0.34 mg/l in 2018-2019, 0.44 ±1.83 mg/l in 2000, and 0.4 ±0.1 mg/l in 2021.

In 2022, the distribution of ammonium content of drinking water was observed in 73 Soums of 9 Aimags, and the ammonium content was 0.06±0.1 mg/l which means that the content in all Soums was within the acceptable level specified in the standard.

Nitrite (NO_2)

Maximum permissible levels of nitrite in drinking water: 1.0 mg/l

If nitrites are detected in drinking water, it indicates that it may have been prior contamination with household waste.

The average nitrite content in drinking water used for the population of Mongolia was 0.04-1.0 mg/l in 2018-2019, 0.06 0.47 mg/l in 2020, and 0.04 ±0.8 mg/l in 2021.

In 2022, 785 drinking water locations in 102 Soums of 9 Aimags were tested, and the average nitrite concentration was 0.25 ±0.3 mg/l, and 5.6% of the total samples exceeded the standard permissible level. The nitrite content of Bugat, Altai, Tsengel, Ulaankhus, Nogoonnuur, Tolbo, Buyant, and Deluun Soums of Bayan-Olgii Aimag was 1.04-5.4 mg/l (Figure 23).

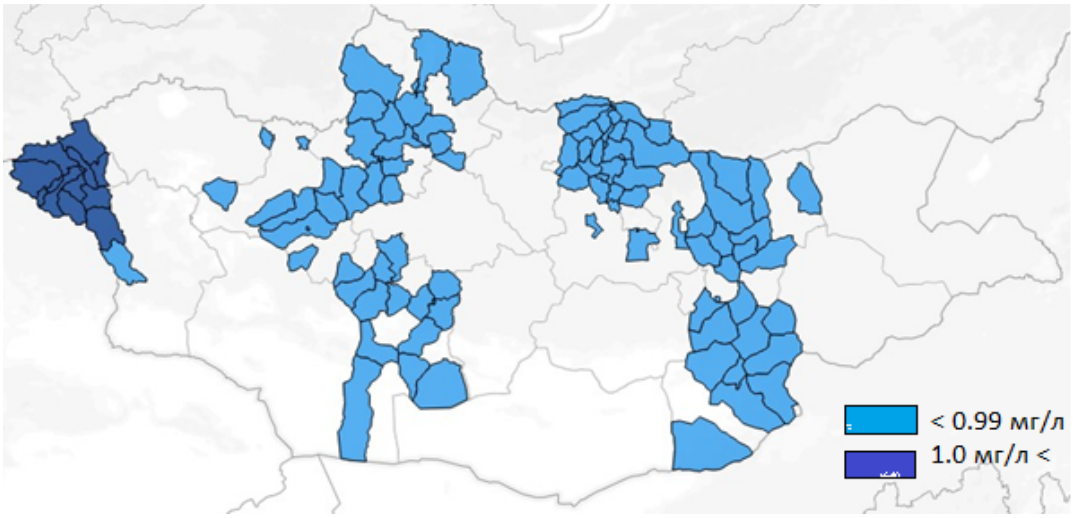


Figure 23. Prevalence of nitrite (NO_2) to drinking water, 2022, by Soums

Nitrate (NO_3)

Maximum permissible levels of nitrate in drinking water standards: 50 mg/l

If nitrates are detected in drinking water, it indicates that it may have been contaminated with organic matter many months or years ago. The longer the water has been contaminated with nitrogen compounds, the higher the nitrate concentration. It is one of the indicators of pollution because it is often found in water polluted by excreta and industrial waste.

The average nitrate content of drinking water used for drinking by the population of Mongolia was 1.7 ±2.8 mg/l in 2018-2019, 2.8 ±6.2 mg/l in 2020, and 4.9 ±3.2 mg/l in 2021.

In 2022, 785 drinking water locations in 102 Soums of 9 Aimags were analyzed, and the average nitrate content of drinking water was 6.56 ±3.2 mg/l, except for Bayangol Soum of Selenge Aimag and Binder Soum of Khentii Aimag, the values were within the acceptable level specified in the standard (Figure 24).

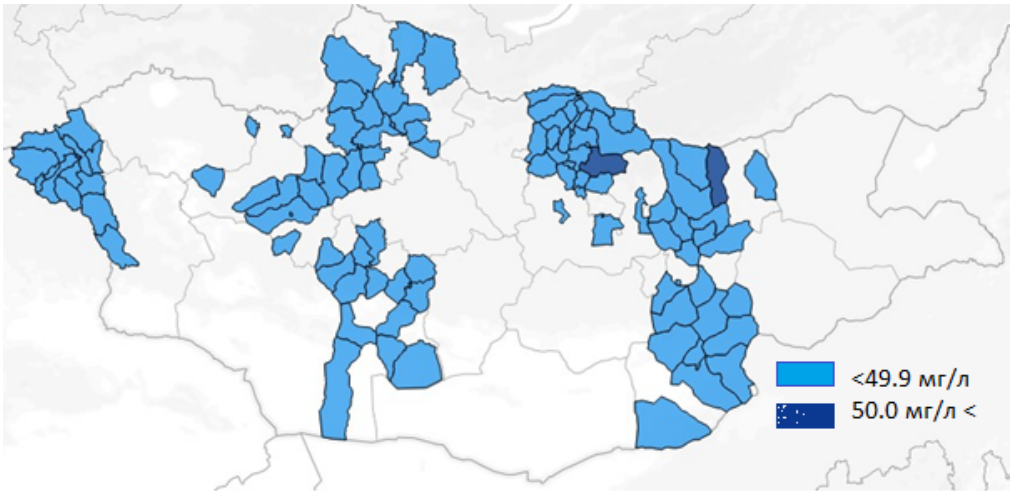


Figure 24. Prevalence of nitrate (NO_3) to drinking water, 2022, by Soums

Bacterial contamination

Maximum permissible levels of bacteria count in drinking water standards: <100 counts/ml. In 2019, the number of bacteria in drinking water was higher than the standard in 76 Soums (28.3%), in 35 Soums of 12 Aimags (18.8%) in 2020, in 26 Soums of 12 Aimags (12.2%) in 2021, and in 2022, 785 drinking water locations of 102 Soums in 9 Aimags were tested, and out of it, 23 Soums in 8 Aimags (7.9% of the total sample) had values higher than the permissible level specified in the standard (Table 21).

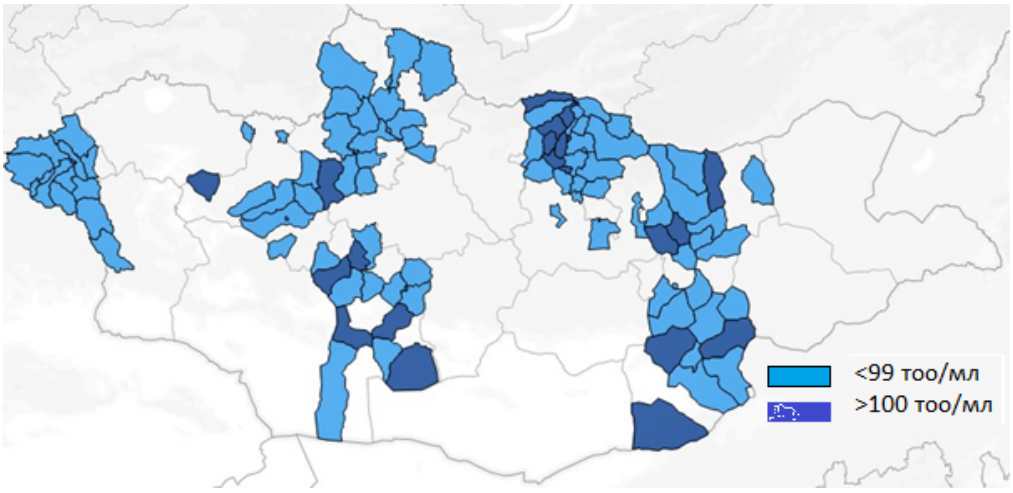


Figure 25. Bacterial coliform count in drinking water, Mongolia, 2022, by Soums

Table 21. Aimags and Soums with bacteria in drinking water exceeding the standard, 2022

Western region	Khangai region	Central region	Eastern region
Bayan-Ulgii: Ulgii **Zavkhan**: Tosontsengel and Urgamal Soums	**Bayankhongor** : Bayanlig, Bayantsagaan, Jinst, Zag, and Khureemaral Soums	**Dornogovi** - Urgun, Saikhandulaan and Khatanbulag Soums **Darkhan:** Darkhan Soum **Tuv:** Sumber Soum **Selenge:** Zuunburen, Orhon, Saikhan, Sant, Sukhbaatar, Tushig, and Khushaat Soums	**Khentii:** Binder, Delgerkhaan and Jargalthaan Soums

Escherichia coli (E. coli)

Maximum permissible levels of Escherichia coli in drinking water standards: 0 count/ml. In 2022, E.Coli was found in 23 water points of 11 Soums of 4 Aimags (2.9%) out of 785 drinking water locations in 102 Soums of 9 Aimags, which were involved to the test (Figure 26). In particular, E.Coli was found in more than 60 percent of water sampling locations in Urgamal Soum of Zavkhan Aimag and Darkhan of Darkhan-Uul Aimag were found (Table 23).

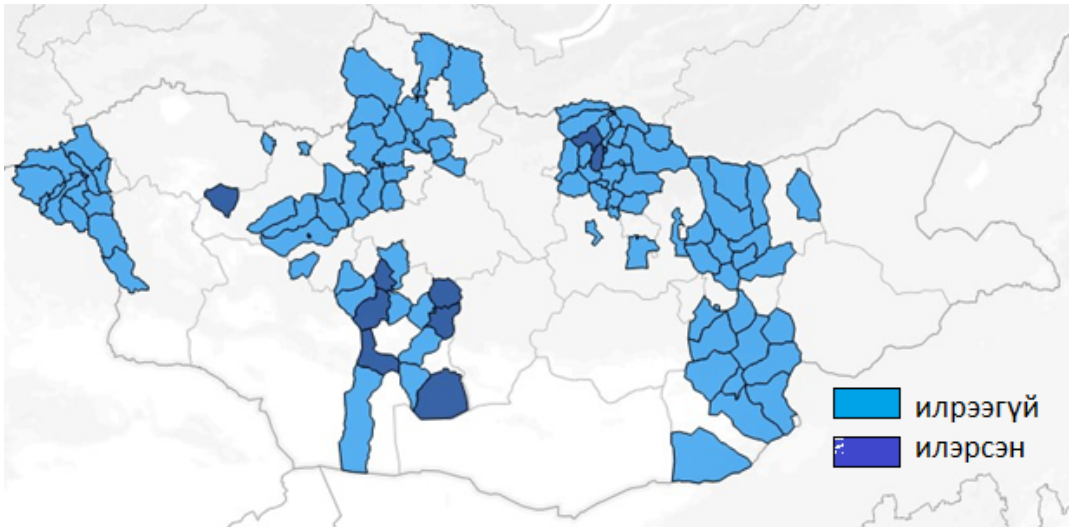


Figure 26. Enteric group bacteria in drinking water, Mongolia, 2022, by Soums

Table 22. Aimags and Soums where enteric group bacteria were found in drinking water, 2022

Western region	Khangai region	Central region	Eastern region
Bayan-Ulgii Aimag Ulgii Soum **Zavkhan Aimag** Uliastai and Urgamal Soums	**Bayankhongor** Aimag Bayanlig, Bayantsagaan, Buutsagaan, Zag, Ulziit and Erdenetsogt Soums	**Darkhan-Uul** Aimag Darkhan Soum **Selenge** Aimag Saikhan, Sukhbaatar and Khushaat Soums	-

E1- Soil contamination

Overview. Samples were taken from 74 points in Ulaanbaatar every year in May and October, and the level of soil pollution was determined according to MNS 3297:91 standard "Nature Protection. Soil. Assessment of safe indicators of urban soil hygiene and contamination".

By the hygiene assessment comparing contamination level of soil bacteriological analysis in 72 points of the residential area of the Capital city in 2022, it is more polluted in the spring and autumn seasons (Figure 27).

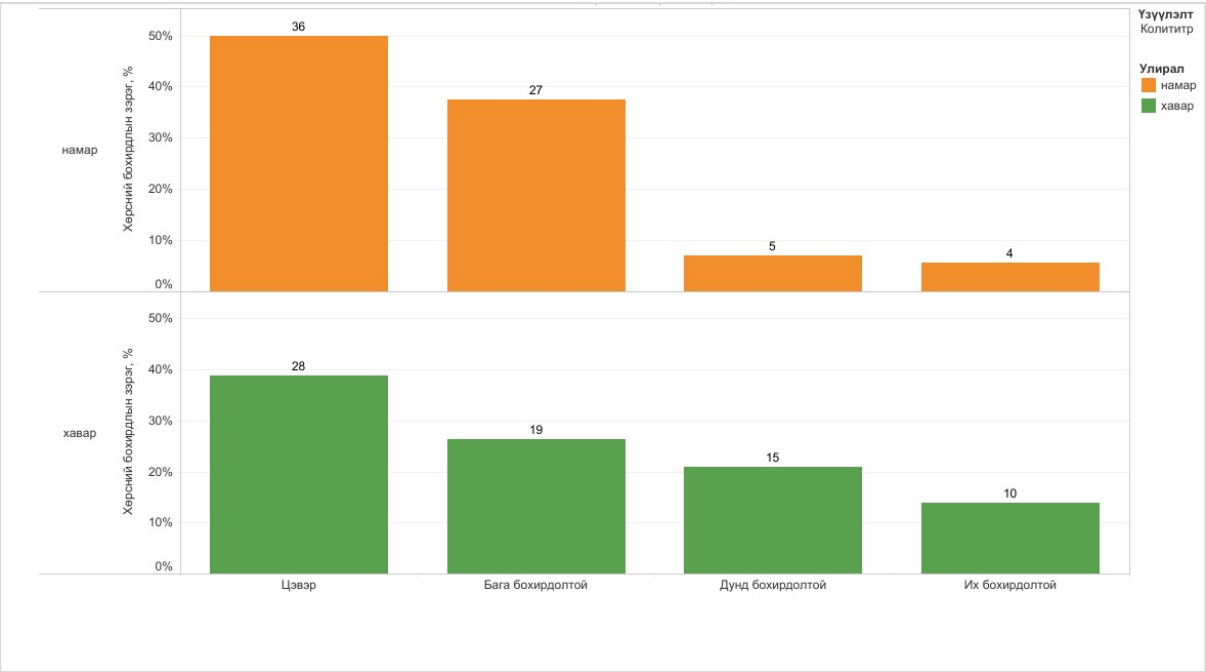


Figure 27. Soil pollution degree in Ulaanbaatar city in spring and autumn, 2027

A seasonal comparison of spring and autumn soil contamination is shown in Figures 28 and 29. Contamination measured by the perfringence-titer index of soil and total coliforms show the highest levels of bacterial contamination were recorded in the Nalaik district of Ulaanbaatar city.

Figure 28. Soil coli titer (a) and perfringence titer (b) of UB city, Spring 2022

Figure 29. Soil coli titer(a) and perfringence titer (b) of UB city, Autumn, 2022

E2 - Infectious intestinal disease

Article 3.9.2 of the Sustainable Development Goals stipulates that the measurement of inadequate water, sanitation and hygiene conditions shall be conducted by the incidence of infectious diseases in the intestinal group of the population.

Intestinal infectious diseases related to drinking water and soil pollution are grouped together as dysentery, salmonellosis, diarrhea, hand, foot and mouth disease, acute hepatitis A (A00, A01, A03, A04, A06-A09 by ICD10 classification).

A total of 3,962 cases of 6 types of intestinal infectious diseases were registered in 2022which is an increase of 2,899 cases compared to the same period of the previous year. 46.6% of all intestinal infections registered nationwide are hand, foot and mouth disease, 43.5% are dysentery, 5.7% are salmonellosis, 2.1% are diarrheal infections, 1.7% are bacterial food poisoning, and 0.4% are viral hepatitis A.

When comparing intestinal infectious diseases by regions, Ulaanbaatar city has 4.3 cases per 10,000 population, and the eastern region has 5.3 cases higher than the national average and the western and Khangay regions have 6.6 cases, respectively and central region has and 2.5 cases lower than the national average, respectively.

In 2022, 36.6 cases per 10,000 population of intestinal infectious diseases among children under 5 years of age were registered in 56 Soums of 15 Aimags (17.4% of total Soums) (Table 24, Figure 30).

79.2% of intestinal infectious diseases among children under 5 years of age were registered in Ulaanbaatar.

When the cases in 2022 were compared to those of previous year (18.5 per 10,000 population in 2021), the rate has doubled.

In 2022, for intestinal infectious diseases among children under 5 years of age the highest number of cases were registered in Mandakh of Dornogovi Aimag (125.8 per 10,000 population), Tsetserleg of Arkhangai Aimag (291), and Sergelen of Tuv Aimag (103.1), respectively (Figure 30). The number of bacteria in drinking water, bacteria of the intestinal group, and pathogens of the intestinal group are shown and compared with the intestinal group diseases among children under 5 years of age by geographical locations.

Intestinal infectious diseases among children under 5 years of age were registered the highest in July of 2018, August of 2019, February of 2020, December of 2021, and May of 2022, respectively (Figure 31).

Other bacteria-caused food poisoning, infectious gastroenteritis, diarrhea, and deaths. Other food poisoning caused by bacteria decreased with 0.2 (69) cases per 10,000 population in 2022 comparing to those in previous year by 0.1 (39) on average, and registered as follows; in Zavkhan (0.4), Orkhon (3.5), Tuv (0.3), Khuvsgul (0.7), and Ulaanbaatar (0.1). Infectious gastroenteritis and dysentery 0.2 (80), increased by 0.1 cases from 2019, and registered in Bayankhongor (0.6), Bulgan (1.1), Govi-Altai (8.3),

Dornogovi (0.3), Zav0khan (0.3), Orkhon (0.1), Uvs (0.4), Hovd (0.7) and in Khuvsgul (0.4) Aimags.

Deaths due to other food poisoning caused by bacteria were not registered nationwide, while 1 death due to infectious gastroenteritis and diarrhea occurred in Ulaanbaatar.

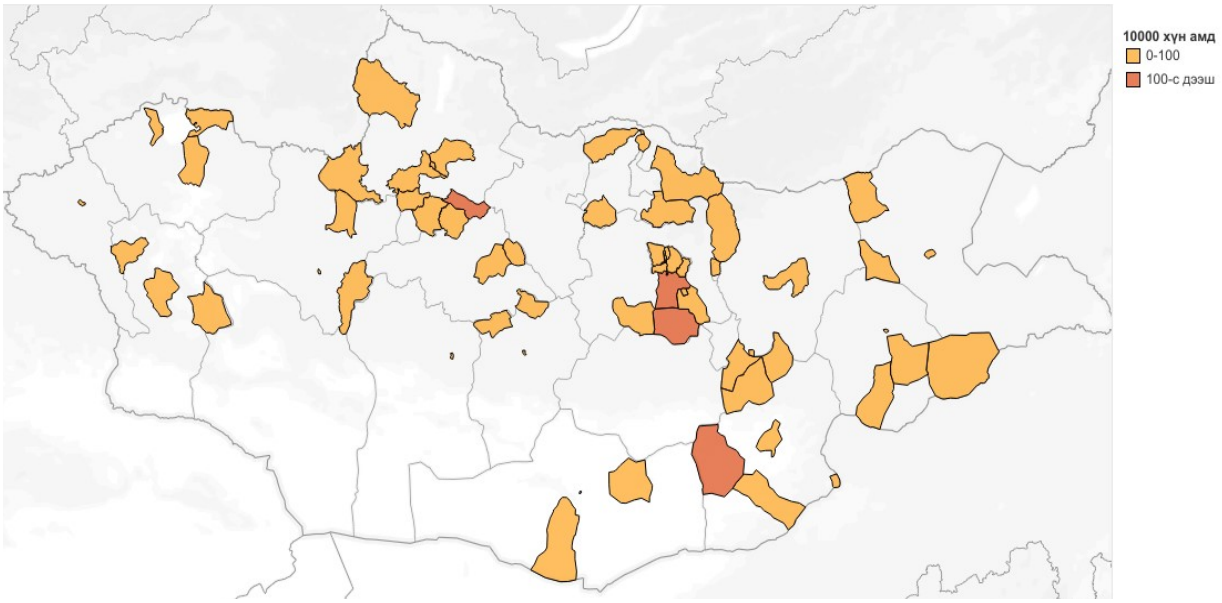


Figure 30. Intestinal infectious diseases of children under 5 years of age, by Soums, per 10,000 population, 2022

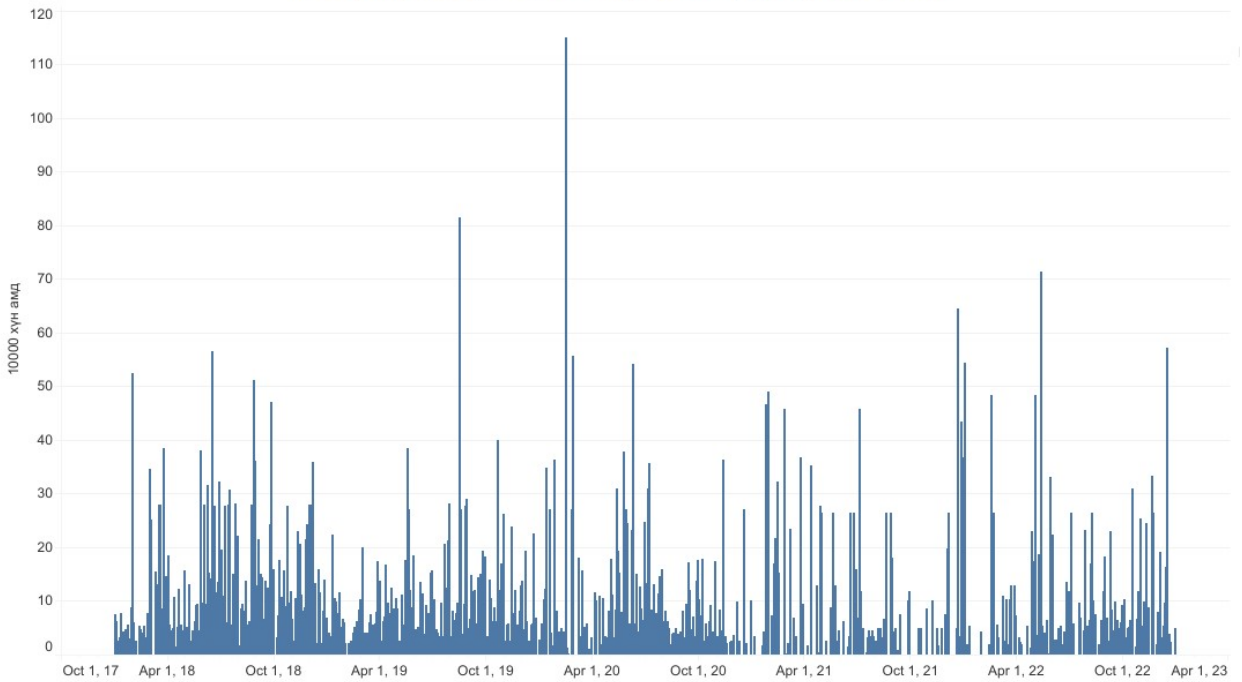


Figure 31. Daily registered intestinal infectious diseases of children under 5 years of age in Mongolia, per 10,000 population, 2018-2022

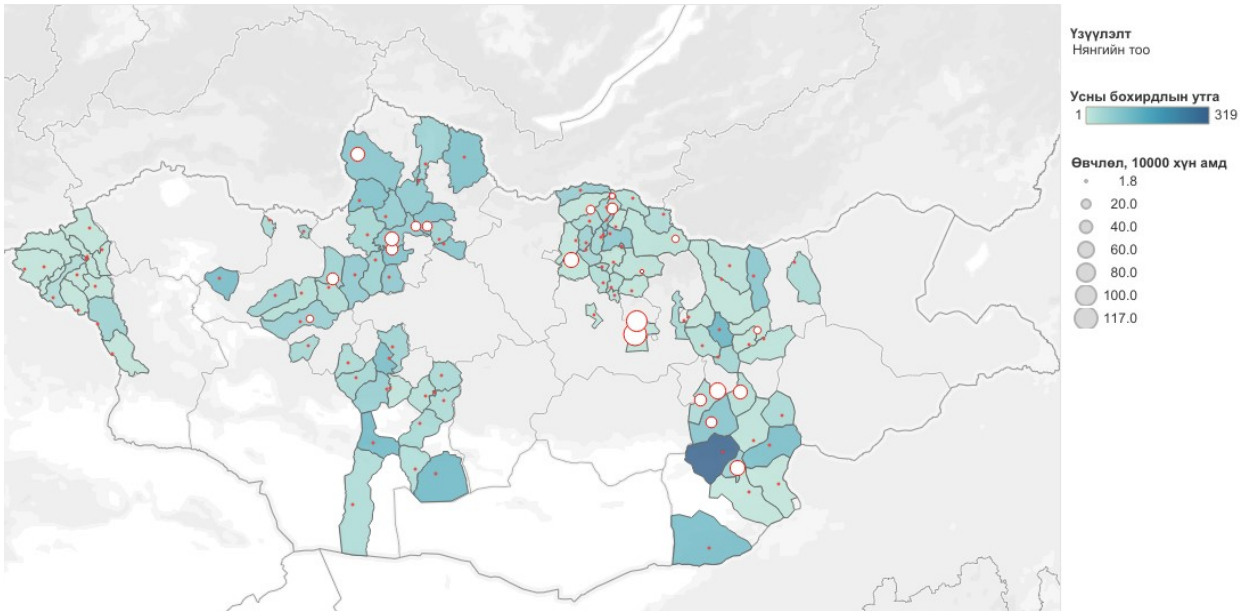


Figure 32. Number of bacteria in drinking water and intestinal infectious diseases in children under 5 years of age (per 10,000 population), by Districts and Soums, 2022

Table 23. Intestinal infectious diseases of children under 5 years of age, by Aimags, Soums and zones, per 10,000 population, 2022

Western region	Khangai region	Central region	Eastern region
• **Bayan-Ulgii–** Ulgii (1.8) • **Uvs –** Malchin (36.4), Tes (15.9), Ulaangom (19.9) • **Zavkhan-** Otgon (37), Telmen (30.7), Uliastai (11.6)	• **Arkhangai-** Battsengel (23.2), Jargalant (43.3), Ulziit (28.2), Tsetzerleg (291) • **Bayankhongor** – Bayankhongor (2.6), • **Khuvsgul** – Burentogtokh (45), Galt (18.1), Tunel (20.8), Murun (19.4), Ulaan-Uul (43.6), Tsetserleg (20.9), Shini-Ider (32.1) • **Uvurkhangai** - Arvaikheer (44.7), Bat-Ulzii (12.4), Kharkhorin (7.5)	• **Tuv** – Bayan (46.7), Bayan-Unjuul (42.4), Bayantsagaan (158.7), Zuunmod (90.5), Mungunmorit (42.2), Sergelen (103.1) • **Umnugovi** – Khurmen (59.9), Dalanzadgad (26.4), Tsogttsetsii (25.8) • **Selenge** – Mandal (3.5), Yeruu (12.9), Tsagaannuur (16.5), Sukhbaatar (8.7), Orkhontuul (52.2), Shaamar (23.5) • **Dornogovi –** Airag (26.4), Dalanjargalan (32.5), Zamiin-Uud (36.9), Ikhkhet (48.8), Mandakh (125.8), Sainshand (50.5), Khuvsgul (66.2) • **Ulaanbaatar city** - BZD (65.1), BGD (28.1), СХД (53.7), SBD (29.9), ХУД (35.8), ChD (38.5), BND (6.6) BKD (37.1), NAD (2.3)	• **Dornod** – Bayan-Uul (37.5), Khulunbuir (45.2), Kherlen (40.4) • **Khentii** – Kherlen (10.6), Bor-undur (57), • **Sukhbaatar** – Sukhbaatar (23.3), Baruun-Urt (30.0)

E2. Accidents and injuries

Road traffic fatalities continue to cause significant socioeconomic damage for developing countries. In 3.6.1 of SDG, the death rate due to road traffic accidents (the number of people who died due to road accidents per 10,000 people) is provided..

Death due to traffic accidents. Deaths caused by traffic accidents account for 13.8% of total deaths and are the 3rd leading cause of death due to accidents and injuries.

In 2022, there were 464 deaths registered due to traffic accidents, or **1.4 cases per 10,000 population** (Figure 33).

Men are 3.5 times more likely to die in traffic accidents than women.

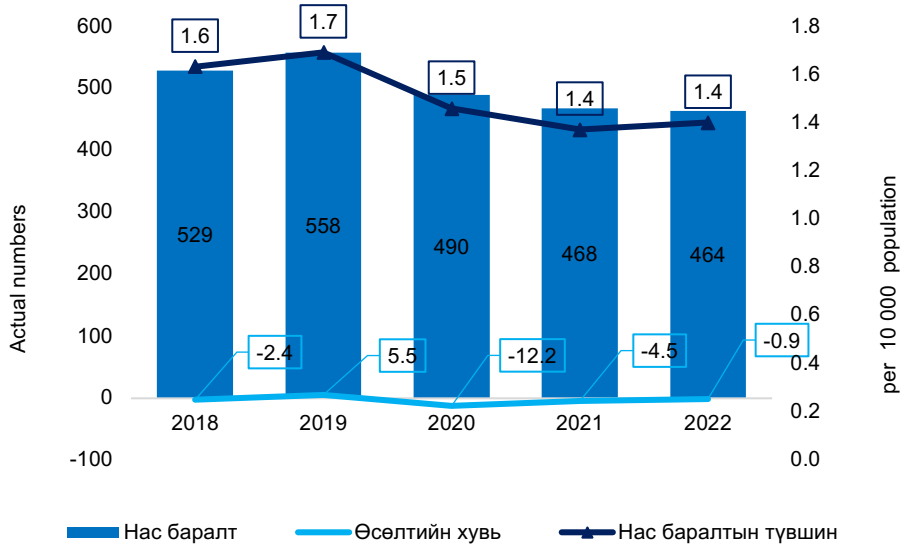


Figure 33. Deaths due to traffic accidents per 10,000 population

Other traffic accidents accounted for 52.6% of deaths due to traffic accidents, motorcycle passenger traffic accidents accounted for 24.7%, and pedestrian traffic accidents accounted for 22.3%.

The number of deaths caused by traffic accidents is registered the highest in Arkhangai /36/ and Tuv /35/ AImags, while the highest region in Khangai region. But in Govsumber Aimag, the number of deaths was less (Figure 34).

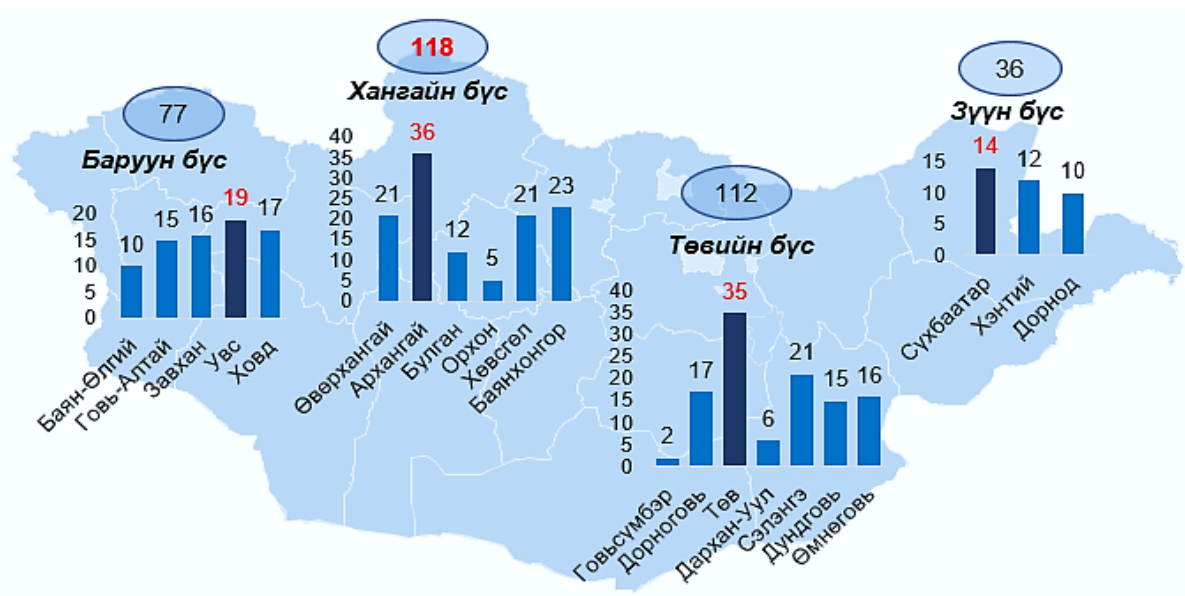


Figure 34. Actual number of deaths caused by traffic accidents, recorded by Aimags and zones

Incidences among children under 5 years of age

In 2022, 23,361 children aged 0-5 were injured in accidents in Mongolia. 89.9% of these cases were registered in the capital city. 620.5 out of 10,000 children between the ages of 0 and 5 were injured nationwide, and 1206.6 in the capital city. By the regions, the Central region had higher number and severity cases. For all registered Aimags, the number of cases per 10,000 children aged 0-5 is higher in Arkhangai Aimag (221.7) than in other Aimags (Figure 35).

Figure 35. Accidents and injuries of children under the age of 5 in 2022, per 10,000 population. Source: Department of Statistical Monitoring and Research of NTORC