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DUST STORM AND ATMOSPHERE AIR POLLUTION IN UZBEKISTAN

Feruza I. Salomova[1], Nigora O. Ahmadalieva[2], Khosiyat A. Sadullaeva[3], Guzal F. Sherkuzieva[4], Nargiza F. Yarmukhamedova[5], Bakhritdin Q. Nurmatov[6]

1 DSc, Associate Professor, Head of the Department of Environmental Hygiene, Tashkent medical academy, Uzbekistan
E-mail: fsalomova@mail.ru

2 DSc, Associate Professor of the Department of Environmental Hygiene, Tashkent Medical Academy, Uzbekistan
E-mail: gig.dok.74@mail.ru

3 Candidate of Medical Sciences, Associate Professor of the Environmental Hygiene, Tashkent Medical Academy, Uzbekistan
E-mail: xosiyat.sadullaeva@tma.uz

4 Candidate of Medical Sciences, Associate Professor of the Department of Communal and Occupational Hygiene, Tashkent Medical Academy, Uzbekistan
E-mail: g.sherkuziyeva68@gmail.com

5 Assistant of the Department of Otolaryngology and Dentistry, Tashkent Medical Academy, Uzbekistan
E-mail: yanargiza@mail.ru

6 Head of the Scientific Center in collaboration with TTA-KU under the Interdepartmental Research Laboratory of Higher Education, Tashkent Medical Academy, Uzbekistan
E-mail: bnurmatov@tma.uz

ABSTRACT

Aim of the study: a hygienic assessment of the state of atmospheric air according to the Center for Hydrometeorological Service of the Republic of Uzbekistan and hygienic assessment of dust concentrations in the air based on laboratory control. **Materials and methods:** The Center of the Hydrometeorological Service of the Republic of Uzbekistan monitors air pollution in the cities of the Republic. The monitoring program covers 5 main pollutants: dust (suspended solids), carbon monoxide (carbon monoxide), nitrogen dioxide, sulfur dioxide, nitric oxide. The information obtained from 63 stationary observation posts allows us to judge the average level of air pollution in the republic as a whole and to calculate the atmospheric pollution index, which

gives an integral characteristic of the level of air pollution for the city over the year. **Conclusions:** An analysis of the data shows that over the studied period, an increased degree of atmospheric pollution index was observed only in Angren: 2014 - 5.12, 2016 - 5.32, 2017 - 5.30. In other cities of the republic, elevated API was not observed. It can be assumed that these indicators were achieved as a result of measures to reduce harmful atmospheric emissions through the construction and reconstruction of capture systems and dust and gas cleaning of individual workshops and industries, as well as work on the transfer of motor vehicles to alternative fuels. Dust storm observed on November 4, 2021 in the cities of the Republic of Uzbekistan polluted the atmosphere. On November 5, the amount of dust in the air was found to be 50 times the allowable concentration. On November 21, the amount of dust in the air decreased to the allowable concentration.

Key words: atmospheric air, monitoring of atmospheric air pollution, atmospheric pollution index, air protection measures.

INTRODUCTION

On November 4, 2021, a cold wind from the Ural and Volga rivers passed through Bukhara, Samarkand, Navoi and Jizzakh regions to the territory of Kazakhstan, adding sandstorms to the territory of the Republic of Uzbekistan and staying in the skies of Tashkent. (http://hydromet.uz/ru/taxonomy/term/218.

According to Uzhydromet, during the storm on November 4, the amount of dust in the atmosphere exceeded the allowable concentration by 5 times, and then increased to 30 times between 21:00 and 23:00 local time. (https://kun.uz/news/2021/11/05/toshkent-havosida-chang-miqdori-meyordagidan-30-barobargacha-ortganligi-malum-qilindi).

The dust storm in the air of Tashkent city and region was the first in its 150-year history. Such a dust storm was caused by the lack of conditions to trap dust in the areas where it was formed, including the fact that the area consisted mainly of hills and lack of vegetation.

Brief information. The air environment is one of the important factors that determine the state of health and functional state of the human body. The effects of the atmosphere on the human body begin in the fetal period and continue throughout life. It is known that a person breathes 16-20 times per minute and on average 12 liters of air pass through the lungs. In one day and night, 17,290 liters of air pass through. Therefore, in order to ensure that the air environment has the most favorable effect on the human body in any situation, it is necessary to achieve that the environment is in the most optimal or indifferent parameters that do not cause negative consequences even when exposed to the human body for a long time. The natural chemical composition of atmospheric air is nitrogen (78.08%), oxygen (20.95%), carbon dioxide (0.03%) and inert gases (around 1%). Atmospheric air also contains a certain amount of dust.

Dust is the presence of solid particles with a particle size of millimicrons (μm) in the air at a fraction of a few millimeters in diameter. The hygienic

importance of dust depends not only on the concentration of dust in the air, but also on its origin, size, and the nature of the dust particle. In terms of dust particle size (dust dispersion), large dispersion (dust particle size - 10 μm), medium dispersion (5-10 μm), small dispersion (0.25 - 0.5 μm) and ultra-small dispersion (less than 0.25 μm) is divided into dusts [6,7].

What is PM, and how does it get into the air?

PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

Particle pollution includes:

PM_{10} : inhalable particles, with diameters that are generally 10 micrometers and smaller; and

$PM_{2.5}$: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

How small is 2.5 micrometers? Think about a single hair from your head. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle (Figure 1.) https://www.airnow.gov/international/us-embassies-and-consulates/.

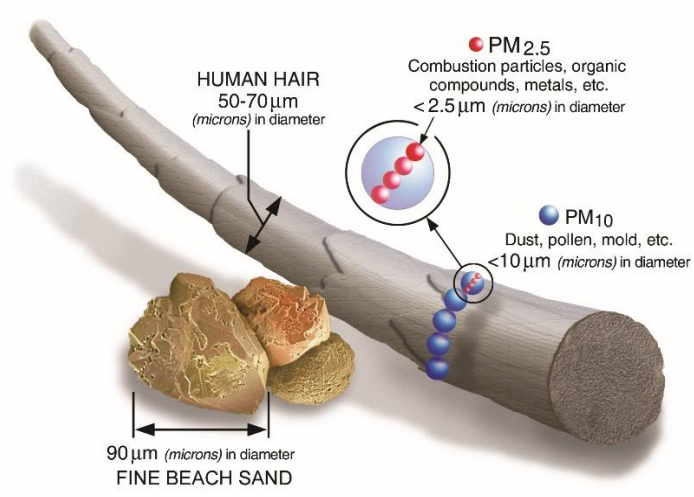

Figure 1. Human hair and dust particles

The World Health Organization (WHO) Permissible Dust Concentration is defined as follows (average 24-hour / average annual https://www.breeze-technologies.de/blog/new-2021-who-air-quality-guideline-limits/):

PM for 10 particles - 45μg / m3 -15 μg / m3;

PM for 2.5 particles - 15μg / m3 -5 μg / m3.

The chemical composition of the dust is also of great hygienic importance, as the dust can have a fibrogenic, irritating or itchy, toxic (toxic), allergenic effect on

the body. The damage of dust depends primarily on its dispersion, the size of the dust particles and their concentration in the respiratory tract (Figure 2) https://ane4bf-datap1.s3.eu-west-1.amazonaws.com/wmod8_gcos/s3fs-public/gcos-status_report_full_text-240_lr_compressed.pdf?FDdn12yqICpIxugb2V7hTQ9lTIcMRQFd.

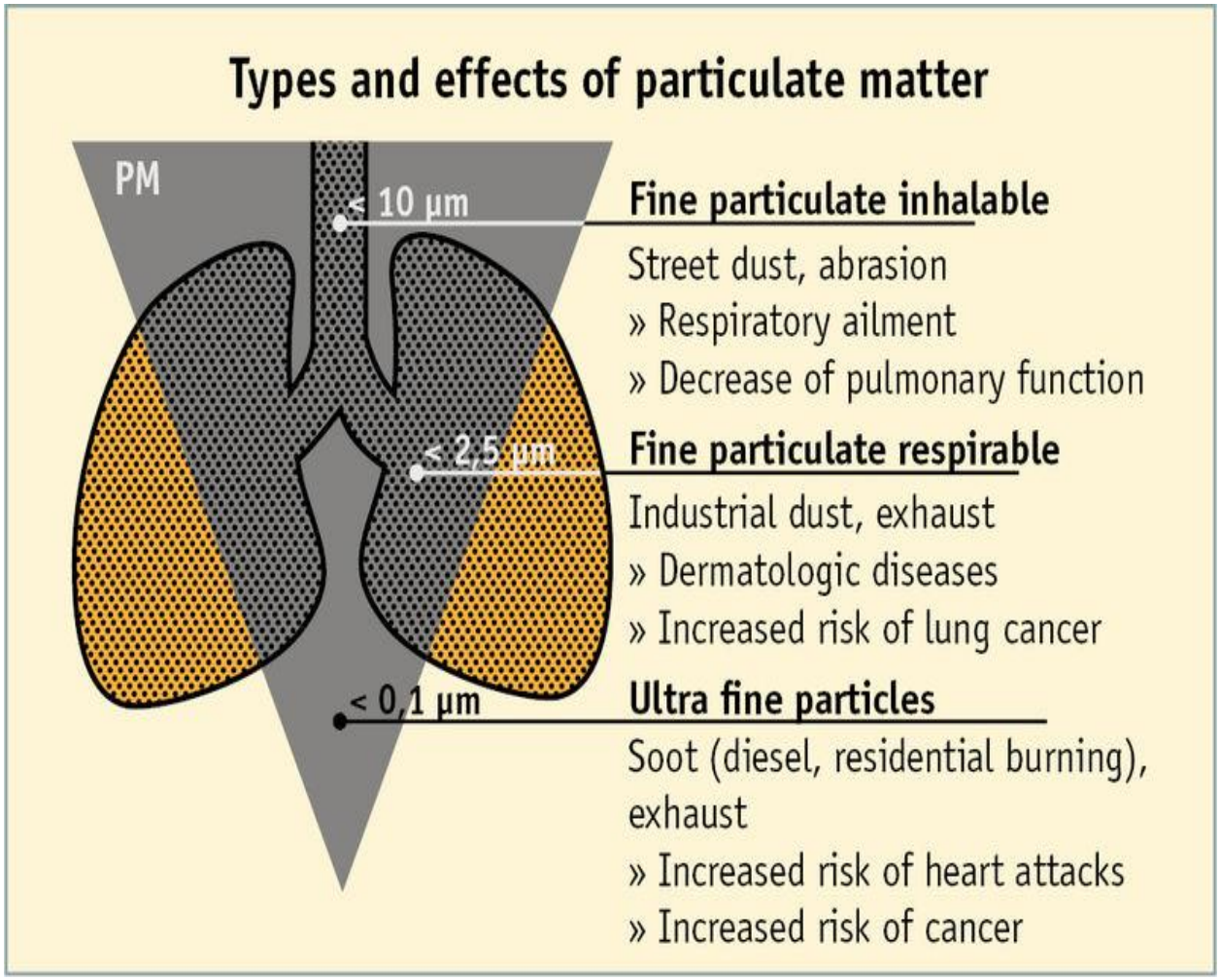

Figure 2. Effects of dust particles on the human body

Quartz or asbestos dusts are among the most harmful to humans. Then there is coal dust. But regardless of the type, dust can cause diseases of the lungs, such as pneumoconiosis, dust bronchitis. Underlying the origin of pneumoconiosis is the formation of connective tissue around the dust particles that have settled on the wall of the alveoli of the lungs. Only fine or small dispersed powders have the property of reaching the alveoli, so they are considered hazardous to medium and large dispersed powders.

Air pollution is determined by the influx of polluting substances from natural and man-made sources, as well as the physical-geographical and climatic conditions of the territory.

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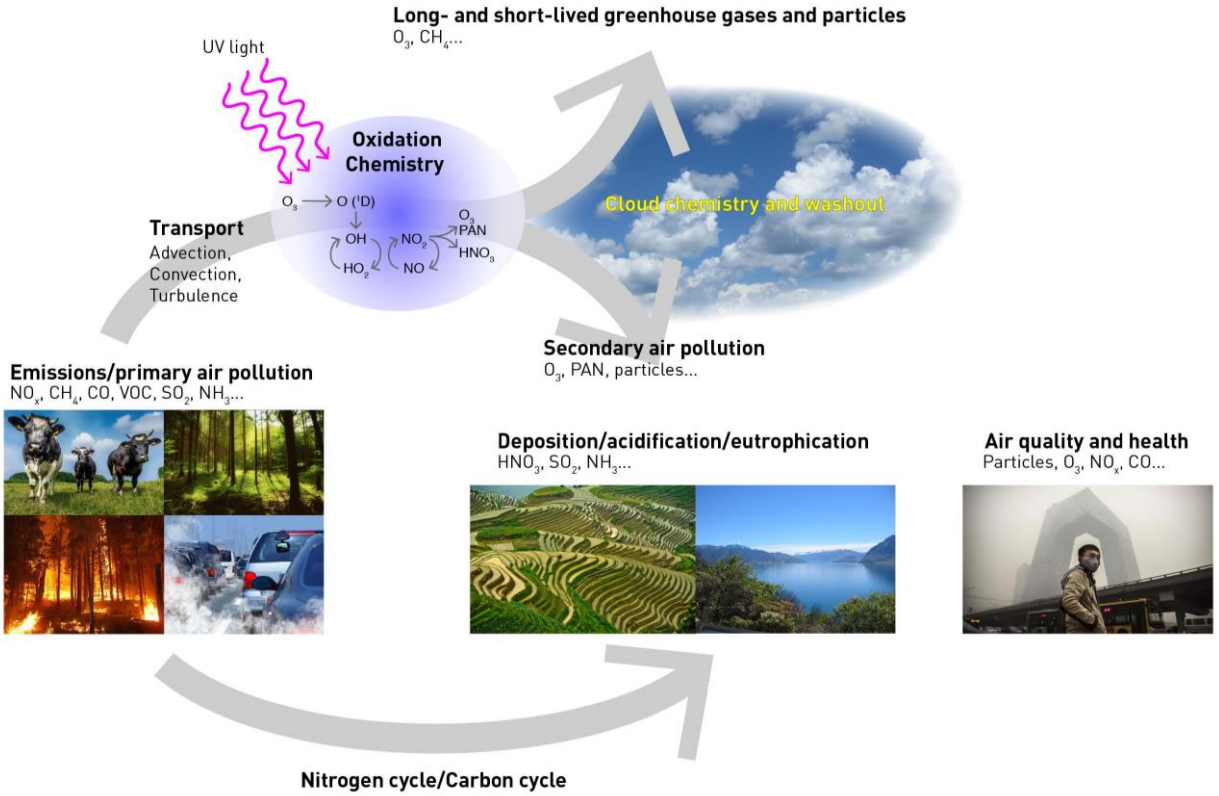

Figure 3. Physical and chemical processes that control the composition on of the atmosphere.

A significant part of Uzbekistan is a plain territory belonging to the Turan lowland, open to cold intrusions, which forms sharply continental climate features. Here, western, north-western intrusions of moist air from the temperate latitudes of the Atlantic Ocean are periodically observed, which also affects the formation of qualitative and quantitative characteristics of the atmosphere.

The Republic of Uzbekistan is located between the Amudarya and Syrdarya rivers, with an area of 447.4 thousand km2. It borders Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Afghanistan (Figure 4).

Figure 4. Geographical location of the Republic of Uzbekistan.

The main natural pollutants of the plain territory are natural sources of aerosol emissions into the atmosphere, such as the Karakum and Kyzyl Kum deserts with their frequent dust storms, as well as the Aral Sea zone from the shrunken part of the Aral Sea, from the surface of which large masses of saline dust rise and carry from the west to the east.

Sources of pollutants of anthropogenic origin are transport and enterprises of the leading industries of the Republic: oil and gas and refining, energy, metallurgical, construction, chemical and others [4].

In 1990, stationary industrial sources accounted for the largest share of air pollutants. With the acquisition of independence and the transition to a market economy, heavy industry enterprises were restructured, production declined, and a number of plants were closed. At the same time, there was a transition to new technologies and types of products necessary to maintain competitiveness and environmental standards.

The level of industrial air pollution has decreased. But the rapid increase in the number of cars has led to an increase in traffic congestion and increased air pollution in large cities. In many settlements, due to the deterioration of the public transport system, the car has become a more reliable means of transportation, and in areas with a high level of development, personal transport has also become a sign of social status. The contribution of mobile pollution sources, mainly automobiles, to the total air emissions is less than 50% in Kazakhstan and Turkmenistan, up to 70% in Uzbekistan and reaches almost 90% in Tajikistan and Kyrgyzstan [1, 5].

The main purpose of this study was to provide a hygienic assessment of the state of atmospheric air according to the Center for Hydrometeorological Service of the Republic of Uzbekistan (hereinafter - Uz Gidromet) and hygienic assessment of dust concentrations in the air on the basis of laboratory control.

Objectives and methods of research. Uz Hydromet has been monitoring air pollution in the cities of the Republic for many years. Observations are conducted in 25 cities and towns. In total, 63 stationary posts operate in the republic. The monitoring program covers 5 main pollutants: dust (suspended solids), carbon monoxide (carbon monoxide), nitrogen dioxide, sulfur dioxide, nitric oxide. Other parameters are added to the measurement programs depending on the composition of industrial emissions and the characteristics of the nearest cities and adjacent territories (ammonia, phenol, formaldehyde, ozone, chlorine, solid fluorides, hydrogen fluorides). Observation of the state of atmospheric air is carried out daily with a frequency of 3 times a day [2-3].

Assessment of air quality in the city is carried out according to the methodology set out in GD 52.04.186-89 (Guidance document. Guidelines for the control of atmospheric pollution), which is the fundamental guide for Hydromet systems in the CIS countries. The number of posts in the city (according to RD) depends on the population in the city, the area of the settlement, the terrain, and the degree of industrialization.

Sampling of air at mobile stations is performed by technicians using air intakes for specific programs. Samples are delivered to laboratories where they are analyzed by chemical methods.

According to the data of the UZ Hydromet, air pollution in the Republic of Uzbekistan is caused by emissions of harmful substances from stationary and mobile sources, as well as by the high (in most regions of the republic) climatic potential of air pollution [3].

The information obtained from 63 stationary observation posts allows us to judge the average level of air pollution in the republic as a whole and calculate the atmospheric pollution index (hereinafter - API), which gives an integral characteristic of the level of air pollution for the city for the year.

The complex atmospheric pollution index (hereinafter - API 5) is calculated for five substances with the highest normalized MPC values taking into account their hazard class. The OIA calculation does not include values for ozone, since this impurity is not monitored for all years and not in all cities, and for formaldehyde, because the method determines the amount of aldehydes (under the definition of “formaldehyde”, the concentrations of aldehydes are given without comparison MPC).

Air pollution is determined by the concentration of impurities. The degree of pollution is estimated by comparing actual concentrations with hygiene standards - the maximum allowable concentration of impurities in the air. There are 4 gradations of the degree of air pollution: from “low” to “very high” (table 1).

Table 1.

Assessment of the degree of air pollution

Air pollution	Air pollution	Rating
Low	API	0-4
Increased	API	5-6
High	API	7-13
Very high	API	14

One of the key indicators of climate change is the Air Quality Index (AQI) - the Air Quality Index (AQI), which is measured by calculating the amount of dust and other micro-elements in the air. This index helps you understand what time of day it is best to be active outdoors, or what time of day you should reduce outdoor activity or avoid going out. HSI is an index developed in the United States, which divides air quality into five categories: "good" (green - 0-50); "Average" (yellow - 50-100); "Unhealthy for vulnerable groups" (fire - 100-150); "Unhealthy" (red - 150-200); “Dangerous” (purple - 200-400) (www.aqicn.org).

So far, the U.S. Department of State has installed air quality monitors at more than 50 U.S. embassies and consulates around the world as part of the development of guidelines and recommendations for air quality measurement and monitoring. In particular, in May 2018, Tashkent will be equipped with an air quality monitor, which will check the air quality every hour and monitor the data online at www.aqicn.org.

The study of the chemical composition of the powder was carried out at a research center in collaboration with TTA-KU. To study the chemical composition of atmospheric dust, a rheometer reading was initially performed at 10 l / min (total air volume 3600 l) for 6 hours using a high volume air area sampler. The sample was tested in the laboratory for 4 different chemical compositions (lead, cadmium, copper and pH). The analysis used an international method called “Metal Analysis in Atomic Absorption Spectrometer” recommended by the Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health (NIOSH). Initially, 5 standard solutions and 1 background sample of the same composition were prepared for the inspection of the unknown substance. Standard solutions, background samples, and unknown solutions were prepared based on the recommendations given in the standard methods described above.

The results obtained and their discussion. An analysis of the data shows that over the studied period, an increase in the atmospheric pollution index was observed only in the city of Angren (table 2). The integrated pollution indicator was 5.12 in 2014, 5.32 in 2016 and 5.30 in 2017, which corresponds to the II degree, characterized by an increased level of atmospheric pollution, which leads to a deterioration in the living conditions of the population.

Table 2.

Indicators of the atmospheric pollution index (API) for cities of the Republic of Uzbekistan over the past 5 years

City	API				
	2013	2014	2015	2016	2017
Almalyk	4,05	4,10	4	4,12	4,23
Angren	4,72	5,12	4,71	5,32	5,30
Andijan	3,35	2,94	3,80	3,32	3,62
Bekabad	2,79	2,88	3,20	3,67	3,92
Bukhara	3,22	3,38	2,98	3,58	4,32
Gulistan	2,18	1,85	1,89	2,33	2,37
Denau	1,49	1,49	1,32	1,45	1,22
Kagan	0,60	0,80	0,97	1,2	1,21
Karshi	1,32	1,30	1,30	1,26	1,25
Kitab	1,17	1,15	1,17	1,13	1,13
Kokand	3,04	2,29	2,36	2,62	2,79
Margilan	1	1,23	1,20	1,28	1,43
Mubarek	0,32	0,33	0,33	0,34	0,35
Navoi	3,17	2,93	3,59	3,90	4,06
Namangan	1,72	1,93	2,26	3	2,95
Nukus	4,31	4,01	3,95	4,43	4,55
Samarkand	1,62	1,83	1,90	1,74	1,55
Sariasia	2,60	2	1,59	1,43	1,23
Tashkent	3,85	4,04	3,51	3,55	4,10
Urgench	1,82	1,9	2,02	2,11	1,24
Ferghana	3,57	3,84	4,10	4,52	4,38
Chirchik	2,69	2,95	3,61	3,61	3,41
Shakhrisabz	1,15	1,15	1,17	1,14	1,14
Yangiyul	0,54	0,54	0,57	0,43	0,41
Nurabad	0,68	-	-	-	1,41

Air quality monitoring has been carried out since November 26, 2018 using monitors installed at the US Consulate in Tashkent, and the results of the daily, monthly and annual reports of the Air Quality Index (HSI) are shown in Figure 5 (www.aqicn.org).

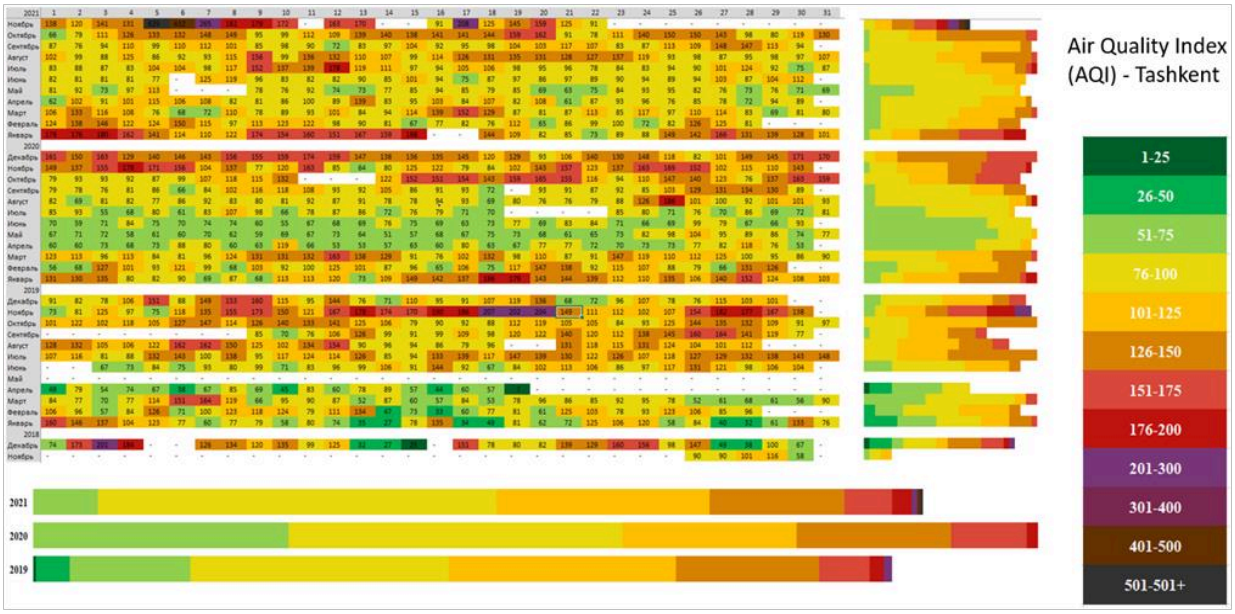

Figure 5. Daily, monthly and annual reporting indicators of the air quality index for the city of Tashkent from November 26, 2018.

The data shows that by 2021, the quality of urban air has declined compared to previous years. In particular, the number of "green" days based on the HSI classification has sharply decreased, and as of November 22, 2021, in 2021 it was only 23 days. This figure is much lower in Tashkent than in the neighboring capital. The air quality index in the Central Asian capitals is almost identical to that in Tashkent, the capital of Tajikistan, which borders Uzbekistan to the southeast, and Kabul, the capital of Afghanistan. However, despite the fact that the Turkmen capital Ashgabat, the Kazakh capital Nur-Sultan and the Kyrgyz capital Bishkek are located in the north and northwest of Tashkent, the air quality is several times higher than in Tashkent. Interestingly, if we look at the monthly report of HSI shown in Figure 1, we can see that the number of green days in April-July 2020 is significantly higher than in other months of the year. This was the result of quarantine and a series of restrictions imposed as a result of the coronavirus pandemic, with restrictions on the movement of vehicles and a temporary ban on the operation of a number of plants and factories contributing to improved air quality. Air quality in Tashkent is about “good” to “moderate” for about 6 months of the year, especially in spring and summer, which means that there is little or no danger to people. However, in the winter months, especially in November and December, air quality can be “unhealthy” and “unhealthy” for vulnerable groups. The air quality varies depending on the time of day and the worst performance is mainly observed in the morning when we all go to work and study https://aqicn.org/city/uzbekistan/tashkent/us-embassy/.

Air quality in Tashkent depends on a number of factors, but transport, industry, energy, production and heating systems play an important role in the level of air pollution we see every day. However, a dust storm on November 4 caused significant dust pollution in Tashkent. These days, observations of air pollution in Tashkent are carried out every hour from automated monitoring stations. Uzhydromet has published a list of cities with the highest dust levels (https://hydromet.uz/uz/node/1065). According to him, the amount of dust in the air in Tashkent exceeded the permissible concentration - 33 times, in Chirchik - 26 times, in Gulistan and Almalyk - 20 times, in Bekabad - 18 times, in Bukhara - 14 times, in Angren and Navoi - 8 times, in Samarkand - 4 times. In Sariosiya, Namangan, Urgench, Fergana, Kokand - about 2 times higher.

Specialists of the Center in collaboration with the Department of Environmental Hygiene of the Tashkent Medical Academy and Koryo University conducted research to study the amount of dust in the air, the dispersion and chemical composition of dust particles. The results of the study are shown in the following figures 6-7.

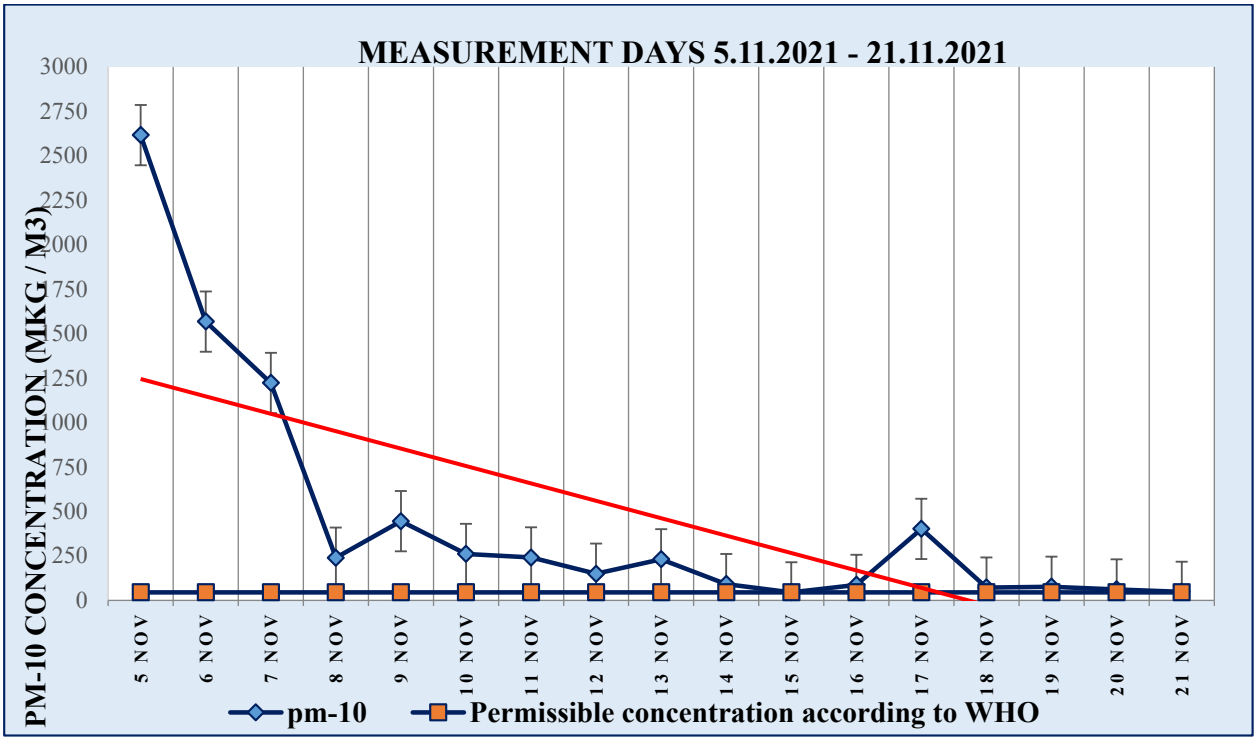

Figure 6. The amount of PM 10 diameter dust particles in the air

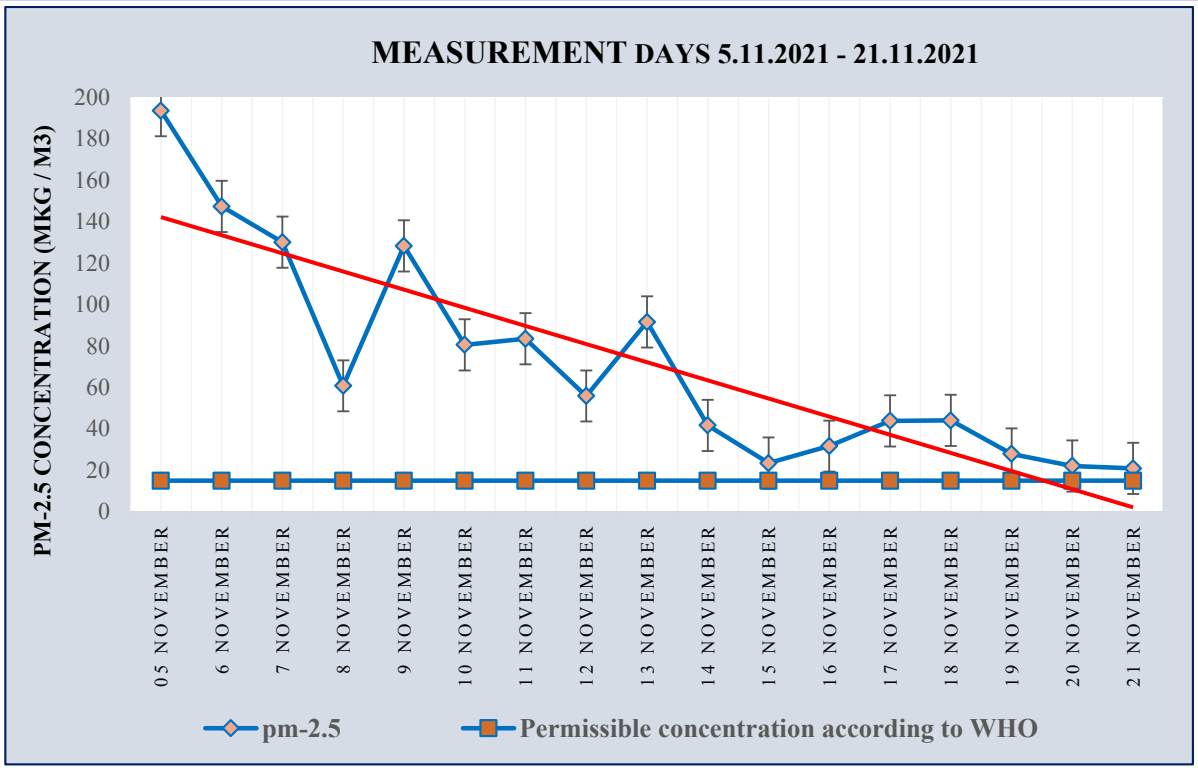

Figure 7. The amount of PM 2.5 diameter dust particles in the air

The results of the study showed that on November 5, the amount of PM 10 diameter dust particles in the air was 58 times higher than the allowable concentration (PM 2.5 -13). Despite the decrease in the amount of dust in the air since November 6, PM was found to be 10 - 35, PM 2.5 - 9.8 times, on November 7, PM 10 - 27.2, PM 2.5 - 8.7 times. According to the results of the inspection conducted on November 8, the amount of PM-10 in the air decreased by 10 times compared to November 4, and the amount of dust by 3 times. However, PM-10 showed that the amount of dust was 5.3 times higher than allowable concentration, and PM-2.5 was 4 times higher than allowable concentration. As the amount of dust in the air decreased, the dust settled to the ground. Due to the absence of precipitation, this dust is likely to rise into the air even when there is a low-speed wind, a study conducted on November 9 confirms. According to him, the results of the inspection showed that the amount of dust in the size of PM-10 was 9.9 times higher than the allowable concentration (November 8 -5.3), and the size of PM-2.5 - 8.6 times (November 8 - 4).

The results of the above study show that the amount of dust gradually decreases from day to day. It should be noted that the amount of PM-10-sized dust decreased faster than that of PM-2.5 and by November 21 had dropped to the amount of allowable concentration recommended by WHO.

At 6:10 am on November 17, dirty snow began to fall in Tashkent. At 10:30 the snow cover was 12 cm thick. According to Uzhydromet, the pH of the snow

was 9.6 - alkaline environment (pH of normal precipitation -7), electrical conductivity was 73.2. This indicates a low concentration of anions and cations and does not pose a health risk (https://hydromet.uz/ru/node/1118).

Scientists from the Ministry of Innovation have reported that the powder does not contain pesticides, salt and heavy metals. https://mininnovation.uz/ru/news/3638.

The results of the study of the chemical composition of dust particles in the air by experts from the Center in collaboration with the Department of Environmental Hygiene of TTA and Korea University showed that the dust has a weak alkaline environment and no lead (Pb), copper (Cu) and cadmium (Cd) were detected in heavy metals.

According to a number of scientists, against the background of climate change and a sharp decline in green vegetation around the world, there are cases of the release of harmful dust into the atmosphere. The use of three categories of data in the study of the health effects of dust is considered appropriate: the number of deaths due to dust, the number of hospitalizations, and the number of people with symptoms observed. (https://doi.org/10.1289/EHP7845)

According to the latest WHO data, about 7 million premature deaths are caused by air pollution and indoor air pollution. Today, air pollution is the most important global risk factor for health, second only to risk factors in the development of hypertension and eating disorders www.airvisual.com.

Atmospheric air pollution is dangerous to human health, as the dust can contain various toxic particles, plant dusts that cause allergic reactions, and others. In this case, in healthy people, the dust can cause inflammation of the upper respiratory tract, mucous membranes of the eyes and mouth, as well as reflexes in the throat, oral cavity, itching and coughing.

The total number of calls to the ambulance service in Tashkent on November 3 was 3433, and on November 4 this figure reached 4082. Of these, 678 were complaints directly related to shortness of breath (https://kun.uz/news/2021/11/05/toshkentda-678-kishi-nafas-qisishi-tufayli-tez-yordamga-murojaat-qildi-ssv-bunday-sharoitda-qanday-yol-tutish-boyicha-tavsiyalar-berdi).

Dust particles affect epithelial cells of the human airway and activate local macrophages, dendritic cells, and innate immune cells, as well as responses in different populations of specific immune cells such as T helper cells (Th1, Th2, Th17), T cytotoxic cells, and V cells (allergies) (https://pubmed.ncbi.nlm.nih.gov/24660118) [8].

Scientific studies by Italian scientists have found a link between air pollution and the spread of the coronavirus. Dust particles in the air have been found to cause the virus to spread over long distances. In addition, dust particles can cause inflammation to settle in human lung tissue, creating a favorable environment for Covid virus. In Italy, the number of cases has also increased as the concentration of dust particles in the air rises (**https://pubmed.ncbi.nlm.nih.gov/32580440**) [9].

Numerous scientific studies have been conducted on the health effects of PM10 and PM2.5. Numerous pieces of evidence confirm that the particles mainly have a negative effect on the respiratory and cardiovascular systems. There is growing evidence that the most harmful effects of particles depend on the size of the particle. The reduction in particle size increases their acidity and increases their ability to enter the lower respiratory tract. Effective air quality management is necessary to minimize health risks. As a means of expanding our knowledge of the severity of PM pollution, future research should focus on identifying and quantifying unknown organic and inorganic compounds present in ambient air particles (https://doi.org/10.1016/j.envint.2014.10.005) [10].

Assessing the sanitary condition of the air in populated areas of Uzbekistan, it should be noted that, despite the reduction in gross emissions of pollutants, it is not accompanied by stabilization and, especially, improvement in the quality of atmospheric air.

Precautions to avoid finely dispersed dust

Go out as little as possible, and only wear a medical mask once a day when it is absolutely necessary (to buy food, medicine, medical care, etc.).

Adults, pregnant women, young children and people suffering from chronic diseases, including bronchial asthma, allergic rhinitis, allergic conjunctivitis, cough with itchy throat, bronchitis, bronchial hyperreactivity and other chronic respiratory diseases, people with cardiovascular disease as much as possible it is recommended that they sit at home.

The following recommendations should be followed when returning home from the street:

- leave keys, glasses, telephone, bag, outerwear and shopping at the entrance;
- wash hands with soap and warm running water; not to touch the face until then;
- taking a shower (especially thorough washing of hair and face);
- wipe keys, glasses, telephone and bag thoroughly with a damp cloth;
- washing under running water (vegetables, wet fruits, greens, eggs, etc.) depending on the type of purchase; if the product is packaged, wipe the packaging surface thoroughly with a damp cloth;

• washing clothes worn on the street; topping outerwear (suit, cloak, coat, etc.) well without wearing a mask.

• frequent rinsing of the throat and nose with moist salt;

• drink more fluids (warm), if possible, green tea, namatak tincture;

• Limit fatty, fried, smoked, salty, salty, spicy foods; consumption of liquid vegetable dishes, milk and dairy products (yogurt, kefir, etc.), greens.

Dust cannot be completely eliminated, but its amount can be reduced. To do this, you need to prevent the accumulation of dust and clean the house and surfaces properly:

• one of the main - tight closing of doors and windows of houses, offices and cars;

• everything that can collect dust should be cleaned using a vacuum cleaner (carpet, carpets, upholstered furniture, soft toys, etc.); it is recommended to wrap upholstered furniture with a damp cloth before knocking.

• All surfaces where dust can collect (floors, cabinets, work surfaces, etc.) should be thoroughly wiped with a damp cloth several times a day; not to be overlooked are the corners, the bottom of the bed and cabinets; the fact that the wiping movements are directed from top to bottom ensures that the dust does not fall back on the cleaned surfaces.

• shoes should be left at the door and washed as soon as possible;

• proper and efficient use of exhaust ventilation installed in the house (kitchen);

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