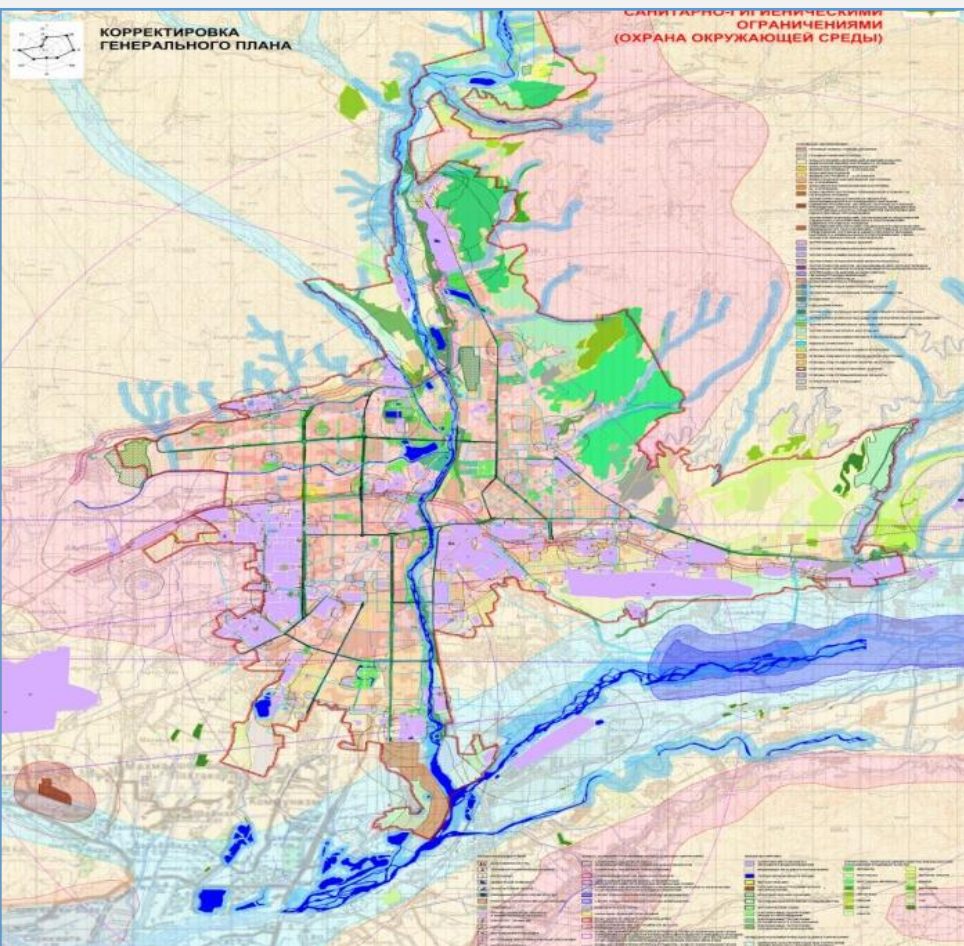


Regional Environmental Center for Central Asia, Country Office in Tajikistan

Overview of Nature-based Solutions and Their Potential to Support Improved Air Quality and Healthy Cities in Tajikistan and Dushanbe

Results of a desk study for UNEP



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List of Acronyms and abbreviations

CA – Central Asia

CHP - Combined Heat and Power Plant

CIS - Commonwealth of Independent States

EMEP - the co-operative program for monitoring and evaluation of the long-range transmission of air pollutants in Europe

F&L - Fuels and lubricants

GAI - City traffic police

GHG - Greenhouse gases

GIS - Geoinformation System

HCFCs - Hydrochlorofluorocarbons

HPP - hydroelectric power plant

LJSHC - Limited Joint Stock Holding Company

MM - mass media

MPC- maximum permissible concentration

NAS - National Academy of Sciences

NASA - National Agency

ODS - Ozone Depleting Substances

PM - Heavy Particles

PM - Particular Matter

SDS - Sand and dust storms

TALCO - State Unitary Enterprise "Tajik Aluminum Company"

TPP - Thermal Power Plant

UN - United Nations

UNDP - United Nations Development Program

UNFCCC - United Nations Framework Convention on Climate Change

Introduction

Nature-based solutions, combined with participatory and empowering approaches, can contribute to economic recovery and environmental improvements, while increasing resilience to future pandemics and other impacts on human health and well-being. Improved capacity is also needed to effectively plan and develop tailor-made approaches to nature-based solutions to mitigate urban air pollution and promote healthier urban lifestyles. Along with air quality monitoring, the basis for decision-making and citizen engagement in local solutions and improvements can be strengthening capacities to implement and use low-cost solutions that can be easily supported.

In this regard, on behalf of UNEP, the Regional Environmental Center for Central Asia (CAREC) conducted a desk study on nature-based solutions and their potential to increase resilience to COVID-19 and air pollution in cities, and to support healthy lifestyle in cities, in Bishkek city, Kyrgyzstan. The approach was based on a desk study and review of existing and potential nature-based solutions in Bishkek and Dushanbe (in terms of their potential to improve urban air quality), a review of existing research and data on COVID-19 and air pollution in Kyrgyzstan, and a review of air quality and air quality monitoring and management practices.

This report was prepared by the CAREC Country Office in Dushanbe for the United Nations Environment Programme (UNEP) as part of the project to support UNEP in preparing Common Country Assessments for Kyrgyzstan and Tajikistan. The desk study was carried out by the consultants of the CAREC Country Office in Tajikistan Dr. M.S. Saidov, Dr. S.M. Saidov, Abdulov Ch., Muhabatshozoda Ch., under the guidance of the Director of the CAREC Country office in Tajikistan Ms.Zebiniso Muminzoda and UNEP expert Katherine Hall.

1. Background

1.1. Nature-based solutions supporting healthy urban living

Although a healthy lifestyle is an individual system of behavior, but to a large extent depends on a set of environmental conditions and life activities of the city population (condition of the air, water, soil, vegetation, etc.), determined by impact of the natural and anthropogenic (industrial, social and domestic) factors.

Air pollution by carcinogens and other harmful substances, soil contamination, abrupt changes in atmospheric conditions, increased heliocosmic, radiation, magnetic and other radiations are primary risk factors. As a result of human activity, there is constant pollution of the atmosphere, soil and natural waters, which adversely affects human health.

In some cases, there is pollution by gaseous substances, in others by suspended solids. Gaseous impurities include oxides of carbon, nitrogen, sulfur and hydrocarbons. The most common solid impurities are dust and soot particles. Soot is produced by combustion of oil, diesel fuel, wood, and other combustible materials. It can accumulate in the lungs, disrupting their function. Inhaling tiny particles of soot can cause coronary heart disease, asthma, bronchitis, and many other respiratory diseases¹.

Ecology is rapidly expanding among the population. More and more often, citizens and activists are calling for environment. Of course, human enthusiasm is not enough to build an ecological system. We need support from the government, funding from patrons, and a reasonable approach by specialists. The approach to nature-based solutions supporting healthy urban living needs to be comprehensive. It should include long-term and planned activities aimed at all areas of society. To drastically improve the ecological situation, both on the earth as a whole and in a particular country or city, it is necessary to implement the following measures:

Legal. They include the creation of environmental protection laws. International agreements are also important.

Technological. The use of new technologies in the mining, metallurgical and transport industries will minimize environmental pollution. The main objective is to create environmentally friendly energy sources.

Organizational. They consist in an even distribution of traffic streams to avoid its long accumulation in one place. Widening of streets for better ventilation. Creation of green parks and public water bodies. Creation of green areas in the city will help reduce the air temperature by 2-8°C in the hot summer season - this is especially important for Dushanbe, where the summer temperature does not drop below 40°C.

Trees help purify water and air from pollution, prevent flooding and soil erosion, fence off houses from nearby roads and industrial areas, and trees reduce noise levels. Research confirms that green spaces and trees in cities not only improve the quality of citizens' life, but also seriously affect their state of mind and well-being. They make people happier and healthier, because green spaces are a favorite place for relaxation and inspiration.

Architectural. It is advisable to plant greenery in large and small settlements, to divide their territory into zones using plantations. Planting around enterprises and along roads is also important.

¹ Impact of air pollution on human health and living conditions. <https://uvghost.ru/vliyanie-zagryazneniya-vozduha-na-zdorove-i-usloviya-zhizni-lyudei-atmosfernyi.html>

1.2. COVID-19 and air pollution

1.2.1. Link between COVID-19 and air pollution

There have been many studies on the link between COVID-19 and air pollution, despite the novelty of the virus and the short research time frame. The focus of these multiple studies has been to examine the relationship between long-term or short-term exposure to air pollution and how it affects or correlates with COVID-19 health effects, as well as studies of air pollution and whether it can act as a COVID-19 vector through the environment. Ongoing research based on the original evidence will be needed to further explore this connection. The original study examined the correlation between PM_{2.5} and COVID-19 disease severity in the United States and found an increase of 1 µg/m³ in the long-term average PM_{2.5} is associated with a statistically significant 11% increase in the county's COVID-19 mortality rate². Researchers of the Imperial College London conducted a comprehensive review and analysis of the existing studies on the link between air pollution and COVID-19, examining whether air pollution increases the likelihood of COVID-19 infection and whether it negatively affects health outcomes if infected.

The review showed that people with long-term exposure to contaminated air were at increased risk of hospitalization for COVID-19 infection. Besides, the review showed that long-term exposure to air pollution was associated with disposition to worse COVID-19 outcomes, possibly because of the link between air pollution and lung and heart diseases, as they are associated with increased vulnerability to adverse COVID-19 outcomes. The review also noted that exposure to air pollution can increase the likelihood of COVID-19 infection in contact with the virus.

Regarding the role of air pollution in contributing to COVID-19 transmission, the review noted that particulate matter does not play an important role in the COVID-19 transmission in the environment, which contradicts the conclusions proposed in earlier studies. Finally, the review concludes that there is currently no final evidence for a link between short-term exposure to air pollution and COVID-19, but this requires further study. The researchers concluded that the role air pollution plays in infectious diseases is generally overlooked. There is increasing evidence showing that efforts to tackle air pollution will reduce the population's vulnerability to COVID-19. More research is needed to better understand the link between COVID-19 and air quality³.

To summarize, COVID-19 health outcomes (hospitalizations, mortality, and morbidity) are worse in populations that are exposed to long-term air pollution. This may be due to various and potentially interacting factors directly related to air pollution, and/or because prolonged exposure to air pollution is associated with lung and heart disease, which are known to be associated with worse outcomes of COVID-19 infection. More research is needed for further study. In any case, there is reason to believe that the population already suffering from air pollution is suffering from the more serious effects of COVID-19 infection. For policymakers, this is a strong indication that any effort to reduce the burden of air pollution is also likely to yield impressive benefits related to COVID-19 treatment. This can be achieved by switching to alternative renewable energy systems that do not burn fossil fuels and by strengthening energy efficiency measures, switching to green transportation, and ensuring environmentally friendly waste management⁴.

² Xiao Wu, Rachel C. Nethery K., Sabat, M. B., Brown, D., and Dominici, F. Air pollution and mortality from COVID-19 in the United States: strengths and weaknesses of environmental regression analysis. *Advances in Science*, 6 (45), eabd4049. 2020.

³ Walton H., Evangelopoulos D., Kasdagli M., Selley L., Dajnak D., and Katsouyanni K. Investigating links between air pollution, COVID-19 and lower respiratory infectious diseases. Environmental Research Group. Imperial College London 2021

⁴ Kowalski P.A., Szwagrzyk M., Konior A., Madej J, Demir C, Lacionova E, Rozestaniec K (September 2021). Air quality monitoring data for analysis of the pace and intensity of the coronavirus (COVID-19) spread in Central and Eastern Europe and the Balkans. United Nations Development Futures Series. UNDP Global Policy Network Brief.

1.2.2. Review of the existing studies and available data on COVID-19 in Dushanbe and studies/reports on the relationship between COVID-19 and air pollution in Dushanbe

No study has been conducted to investigate the links between particulate matter, nitric oxide, and COVID-19 incidence in Tajikistan. This conclusion is based on the lack of information in the media, scientific publications and final annual conferences of the ministries, departments and scientific organizations specializing in this area.

1.2.3. Relevant stakeholders for NbS

Table 1. Identification of relevant stakeholders for promotion of nature-based solutions at the city level in Tajikistan

Name of Organization ⁵	Functions of the organization
Executive Office President of the Republic of Tajikistan	Monitors compliance with laws, programs, and plans relating to the environment and climate change at the state level.
Majlisi Oli (Parliament)	Plays a key role in the formation and improvement of legislation and bringing it in line with international agreements, including those related to climate change.
Local executive bodies	Empowered to monitor environmental protection, development and implementation of action plans in this area at the local level.
Environmental Protection Committee under the Government of the Republic of Tajikistan	<p>Conducts the state policy in the field of hydrometeorology, rational use of natural resources, organizes and conducts environmental monitoring, comprehensive forecasting and environmental studies. The Committee analyzes and makes proposals to improve the regulatory framework for environmental protection and the development of relevant by-laws, determines the main activities in the field of environmental protection, the study, reproduction, use of natural resources, preventing the effects of climate change.</p> <p>The Committee has the Department of state control of use and protection of atmospheric air, monitoring service, analytical control and environmental impact assessment.</p>

⁵ Environmental Performance Reviews. Tajikistan. Third review of the project. UN New York and Geneva, 2017. Source: <http://pdf.knigi-x.ru/21biologiya/152663-1-obzori-rezultativnosti-ekologicheskoy-deyatelnosti-tadzhikistan-tretiy-obzor-proekt-organizaci.php>

<p>State Agency for Hydrometeorology under the Environmental Protection Committee.</p>	<p>This is a national agency responsible for coordinating climate change issues in Tajikistan. The Agency provides relevant ministries and departments, local public authorities, as well as other institutions and organizations with hydrometeorological information and other information on the environment condition. The Agency's divisions measure the air pollution on a daily basis, a separate component of which is air pollution by the SDS.</p> <p>The Agency has the Climate Change Center.</p>
<p>Ministry of Health and Social Protection of the Republic of Tajikistan</p>	<p>It is the central executive body responsible for implementation of the state policy in health and social protection of the population. Among other tasks, the Ministry approves sanitary norms, rules and hygienic standards.</p>
<p>Ministry of Industry and New Technologies of the Republic of Tajikistan.</p>	<p>The Ministry carries out the functions of conducting state policy and legal regulation in the fields of industry, the fuel complex and the development of new technologies, including the defense industry, mechanical engineering, metal processing, building materials, coal, food and processing industries.</p>
<p>Ministry of Internal Affairs of the Republic of Tajikistan</p>	<p>Ensuring environmental safety is one of the tasks of the Ministry of Internal Affairs. The environmental police is part of the Department of Public Order Protection of the Ministry of Internal Affairs and is financed from the Ministry's budget. The tasks of the environmental police include control of air pollution from vehicle emissions, as well as the fight against illegal import, export and transit of environmentally hazardous goods, flora and fauna listed in the Red Book, toxic chemicals and illegal waste.</p>
<p>Committee for Emergency Situations and Civil Defense under the Government of the Republic of Tajikistan.</p>	<p>The Committee is responsible for policy in the field of preparation and protection of the population and economic facilities from the consequences of natural and man-made emergencies, as well as in the event of military action.</p>
<p>Statistics Agency under President of the Republic of Tajikistan</p>	<p>Collects and disseminates statistical information, guided by the principles of objective and comprehensive study of socio-economic and environmental processes occurring in the republic.</p>
<p>National Academy of Sciences of Tajikistan</p>	<p>Participates in the development of the strategy and tactics of environmental policy on the territory of the RT. The NAS includes 15 research institutes, including those on climatology, glaciology, hydrology, hydropower, biodiversity, and water conservation and rational use. For more than 30 years, the laboratory of Atmospheric Physics of the Physics and Technical Institute of the NAS has been studying the elemental composition of PM brought in from outside.</p>
<p>Environmental services, centers and organizations in Dushanbe, Khujand and other settlements:</p>	<p>Implementation of environmental initiatives aimed at environmental protection, green economy, sustainable</p>

Public ecological organization of the RT "Civil Initiatives Support Foundation"; Little Earth; Youth Ecological Center.

development, development and implementation of the natural resource management programs.

1.3. Potential for integrating nature-based solutions into urban planning to improve air quality and healthy lifestyle in Dushanbe

The potential for integrating nature-based solutions in Dushanbe largely depends on the existing legal framework. Laws, regulations and plans govern the future development of the city. In the past (during the USSR period), they were not specifically developed to facilitate the inclusion of the nature-based solutions. However, within the framework of existing plans, there are several opportunities for introducing the nature-based solutions into urban planning.

One of the important documents that could increase the potential for integrating the nature-based solutions into urban planning to improve air quality and a healthy lifestyle in Dushanbe is the "Revised Master Plan of Dushanbe City (Concept of Socio-Economic and Territorial Development of Dushanbe) of 2010"⁶. Due to growth of the population of Dushanbe City by almost one and a half to two times, the revised development master plan is focusing on issues of transport services (sharp increase in motorization), engineering protection of the territory, engineering infrastructure, as well as the ecological state of urban infrastructure.

Conclusions of the report on the Concept of Socio-Economic and Territorial Development of Dushanbe City⁷.

1. Fifty seven per cent (7,415 ha) of Dushanbe city are territories within which new housing construction, the placement of health care facilities and the organization of recreational functions (production and communal areas, sanitary protection zones and sanitary breaks, etc.) are prohibited.

2. Twenty eight per cent (3,605 ha) of the city territory make the natural and ecological frame of the city, within which no capital construction is recommended⁸.

3. Given the mutual overlap of these two zones, 75% (9,758 ha) of the city is currently unfavorable for residence, treatment and recreation of the population. Taking into account the zone of most uncomfortable states of the thermal regime and the ventilation regime, this area (considering the mutual overlapping of borders) increases to 11,950 ha, that is, it makes up 92% of the total city territory within the current city boundaries⁹.

4. Territorial resources of capital construction within the modern boundaries of the city are practically exhausted.

5. The territorial development of the city in the northern direction is "blocked" by the negative impact on the environment of the cement plant (asbestos-cement plant) and further - by the territories of the Varzob recreation zone.

6. Adjustment of the master plan of the Republic of Tajikistan. Dushanbe City. The concept of socio-economic and territorial development of Dushanbe city. 2010

Source: <https://ru.wikipedia.org/wiki/%D0%94%D1%83%D1%88%D0%B0%D0%BD%D0%B1%D0%B5>

7. As above

8. As above

9. As above

6. The territorial development of the city in the eastern direction along the Kafirnigan River is impossible due to the sanitary and hygienic requirements for the protection of the city water intake for household and drinking purposes and the restrictions on the sanitary gap along the standard take-off and landing routes of aircraft of Dushanbe airport.

7. The territorial development of the city in the western direction is limited by the clear zone along the standard take-off and landing airline routes of Aini airfield.

8. There are limited opportunities for reconstruction of residential buildings and placement of new residential buildings in the central districts of the city due to the clear zone regime along the standard take-off and landing airline routes of the Dushanbe airport and the Aini airfield.

9. The territorial development of the city in the southwest direction is limited by the protected zones of the Hissar Astronomical Observatory.

10. The territorial development of the city on the southern exposure Adyr slopes is limited by a combination of bad engineering and geological conditions, insufficient or uncomfortable parameters of one of the climate-forming factors, or a combination of the most uncomfortable conditions of the thermal regime and ventilation regime, as well as dehydration of the territories.

11. Territorial development in the southern direction seems to be the most favorable in terms of comfort in relation to the person in the open area and the dwelling microclimate taking into account typological daily cycles and phases of development of the mountain-valley circulation, with relatively good environmental and sanitary and hygienic conditions (Fig. 1).

Thus, based on the above data by authors of the Concept of Socio-Economic and Territorial Development of Dushanbe city, we can conclude that today, Dushanbe has almost exhausted all its possible potential of integrating nature-based solutions in the city planning to improve air quality and healthy lifestyle in Dushanbe. Only further territorial development of Dushanbe city in a southern direction will increase the potential for integrating nature-based solutions into the city planning to improve air quality and a healthy lifestyle in Dushanbe.

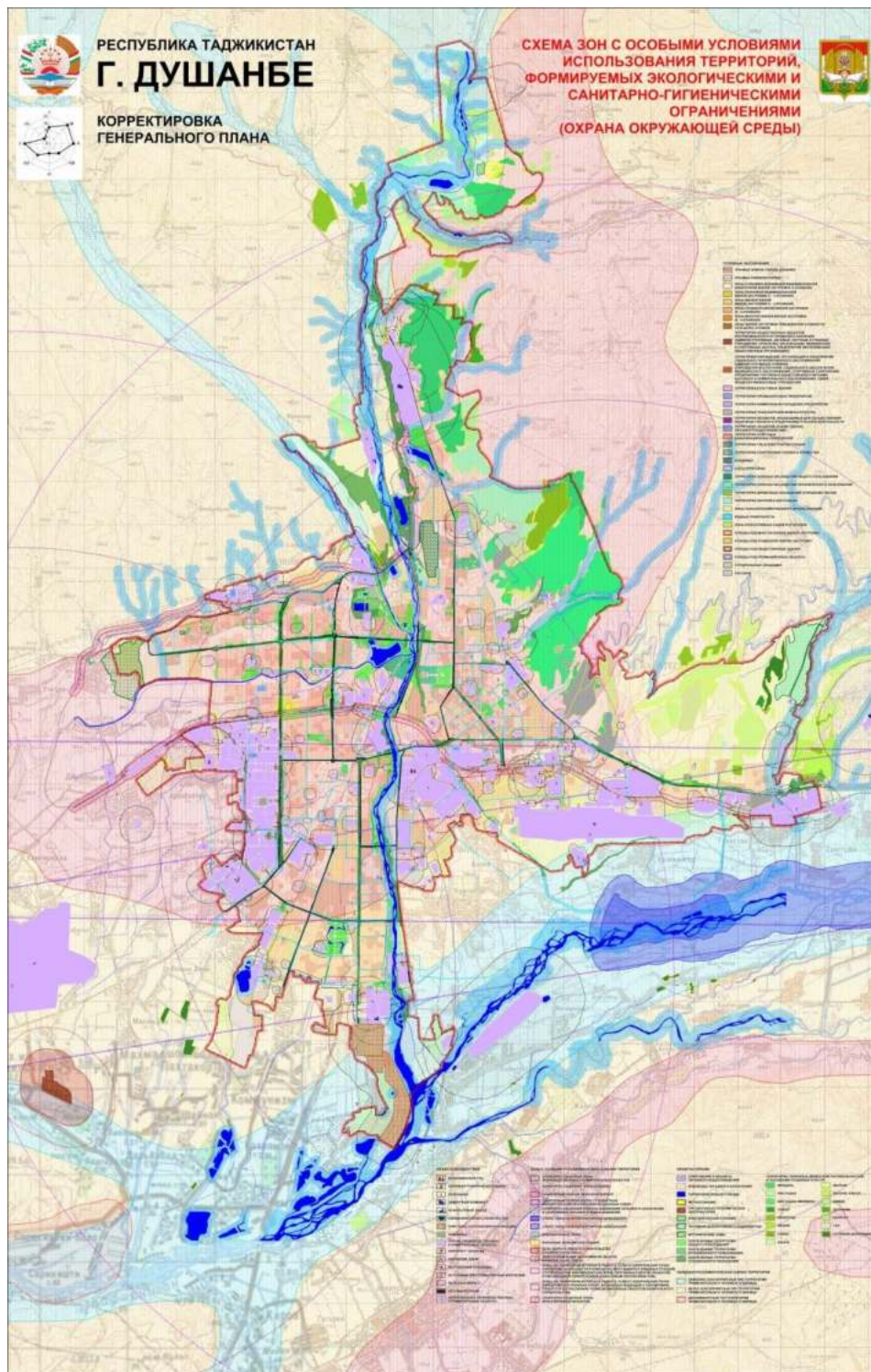


Figure 1. Master plan for the development of Dushanbe city
(Source: 10)

The main steps and actions of the Government to implement the nature-based solutions and actions are included in the National Program for the Formation of Healthy Lifestyle in the Republic of Tajikistan for 2011 - 2020 (Resolution of the Republic of Tajikistan Government dated 30 October 2010 No.560) and the Draft National Program for the Formation of Healthy Lifestyle in the

10. As above

Republic of Tajikistan for 2021-2025. The documents stipulate development of measures aimed at improving the mechanism of disease prevention and promoting a healthy lifestyle among the population, integrating nature-based solutions into the city planning to improve air quality and healthy lifestyle in Dushanbe and other cities of the country based on partnership with society and increasing responsibility for own and others' health. The country has great natural and human resources capacity for this.

As part of the Program, a number of significant activities in the area of landscaping and gardening have been completed. In particular, for the purpose of green planting and landscaping the avenues, cultural and entertainment parks, villages and makhallas, enterprises and organizations in Dushanbe city, 226.3 thousand seedlings and shrubs, and 14.2 million perennial seasonal flowers and lawns were planted on an area of 254.4 thousand square meters¹¹.

Despite the achievements, the system of public green areas is underdeveloped in the peripheral parts of cities. As a negative trend, local experts note the use of conifers that do not provide shade, as well as deciduous trees of European species, not adapted to Tajikistan's climate, instead of local broadleaf trees, to replace plantings and in new green areas of cities, especially in Dushanbe.

In addition, there are opportunities to integrate nature-based solutions into existing buildings and infrastructure. Green walls or so-called outdoor living walls are an example of this, as are x, y z. The indisputable advantages of green roofs:

- Eliminate release of volatile substances and compounds from bituminous roofing materials, which are hazardous to human health;
- Reduce air pollution (plants on the roof can capture from the air streams over the surface of the roof up to 50% of dust and reduce concentration of harmful microorganisms);
- Provide a supply of oxygen (a lawn of 150 square meters produces oxygen in a year sufficient for a hundred! people to breathe);
- Reduce the general noise background in the house to 10 dB;
- Increase air humidity due to the slow evaporation of moisture from the soil, which has a beneficial effect on human health; contribute to reducing the respiratory disease incidence; an increase in the percentage of green spaces in the metropolis¹².

¹¹ Plan of activities for planting trees and shrubs, seasonal and perennial flowers in autumn 2021 and spring 2022. Source: <https://khovar.tj/rus/2021/10/v-dushanbe-utverzhdyon-plan-meropriyatij-po-posadke-sezonnyh-i-mnogoletnih-rastenij-na-period-oseni-2021-goda-i-vesny-2022-goda/>

¹² Greening the roof of the house: advantages. Source: <http://recl.ru/ozelenenie-krysh-domov-svoimi-rukami>

2. Nature-based Solutions in Dushanbe and Tajikistan

2.1. Review of the nature-based solutions and projects implemented in Dushanbe and Tajikistan (including green infrastructure projects)

Green spaces of the city are part of the complex green zone - a single system of interconnected elements of the city landscape and the adjacent area, providing a comprehensive solution to issues of landscaping and renewal of the territory, nature protection and recreation and aimed at improving working conditions, life and recreation of the population. The green spaces in a modern city mainly perform the sanitary and hygienic, recreational, structural planning and decorative and artistic functions. Green plants play an important role in enriching the environment with oxygen and absorbing the produced carbon dioxide. The spread or movement of dust is impeded not only by trees and shrubs, but also by lawns, which inhibit the forward movement of dust driven by the wind from different places.

In Dushanbe, significant efforts are being made to improve the urban ecology. The State Environmental Program for 2009-2019 (Government Decree No. 123 of 2009) was one of the first strategic documents of its kind and its implementation proved to be quite effective thanks to the support of donors, public efforts, and private and public initiative. The program includes a section on air protection, emphasizing the need for improved data collection and analysis, as well as stronger control of emissions from stationary and mobile sources, as well as the development of regional air quality regulations and standards.

The plan for the implementation of this program (Government Resolution No. 602 of 2009) includes such activities as:

- organization of transport environmental posts and vehicle maintenance stations at customs posts and highways;
- rehabilitation and reconstruction of dust collection facilities and devices for the neutralization of industrial waste;
- organization of mobile ecological diagnostic laboratories;
- organization of environmental monitoring in the TALCO influence zone. Under this Program, an environmental management system in accordance with ISO 14000 was introduced at TALCO enterprises. Environmental monitoring is conducted in the vicinity of TALCO;
- restoration of aerometeorological stations in Dushanbe and Khorog.
- To improve environment in the capital, 50,206 different trees have been planted: conifers - 17,765, various shrubs - 10,865, fruit trees - 3,014, flower beds and green lawns.

2.2. Inventory of existing nature-based solutions in Dushanbe and Tajikistan Summary of nature-based solutions in Dushanbe

There are more than 15 parks and squares in Dushanbe city: Botanic Garden of the National Academy of Sciences of Tajikistan, City Garden "Bogi Rudaki", Park for Recreation and Leisure named after S. Aini, City Park of Shokhmansur District, "Javoni" Park "Buston" square, "Victory" Park, City Entertainment Park "Bogi Poytakht", "Dolphin" Aquapark and hundreds of other sports complexes, some of which are green.¹³

13. Plan of activities for planting trees and shrubs, seasonal and perennial flowers in autumn 2021 and spring 2022. Source: <https://khover.tj/rus/2021/10/v-dushanbe-utverzhdyon-plan-meropriyatij-po-posadke-sezonnih-i-mnogoletnih-rastenij-na-period-oseni-2021-goda-i-vesny-2022-goda/>

The total area of public green areas within the modern city line is 284 ha (2.2% of the total area of the city), and the limited use green areas make about 90 ha (0.7% of the total area of the city), and the special green areas - 340 ha (2.6% of the total area of the city)¹⁴. The total area of specially protected natural areas within the city makes 78 ha (0.6% of the total area of the city) - two botanical gardens of 39 ha (in northern part of the city) and 84 ha ("Hissar" in the northwestern part of town) - partially on the lands adjacent to the city. The area of ornamental gardening nursery is 98 ha, experimental forest station - 4 ha¹⁵.

At the same time, a very significant positive environmental effect has a long-standing practice of planting almond, pistachio, apple, and other tree crops on adyr slopes, organizing parks and squares, landscaping streets and neighborhoods. In the materials for assessing the current state, these territories are identified as functional zones (green areas of general use, limited use, special purpose, specially protected natural areas), tree plantations are delimited by the species composition of plantations. This practice has been in place for more than a decade¹⁶. So, according to "Khover" NIAT with reference to the Information Department of Office of Dushanbe City Chairman, by Decree of Dushanbe City Chairman Rustami Emomali, dated 20 October 2021, as part of annual events for greening the city, an action plan for planting seasonal and perennial plants for the period from autumn 2021 to spring 2022 has been approved.¹⁷

The total area of tree, fruit, stone fruit plantations on adyr slopes (and partly in the "body" of the development) as special green areas (in addition to those registered above 340 ha) within the modern city borderline is 1,588 ha, that is, more than 12% of the total city area. Including: 293 ha (outside the public and limited use green areas) are planted with apple trees, 2 ha - with apple, cherry and cherry plums, 2 ha -with cherry trees, 8 ha -with cherry plums, 1 hectare -with plums, 238 ha - pistachios, and almonds make 366 ha, pistachios and almonds - 497 ha, grapes - 93 ha, pomegranates - 4 ha, jids - 16 ha, mulberry trees - 27 ha, plane trees and willows - 2 ha, elm - 35 ha, osier - 4 ha¹⁸. The total area of water bodies and water protection zones within the modern city lines is 1,379 ha¹⁹. Due to the scale of graphic materials of the city master plan (1:10000 - 1:25000) and the detailed topographic basis provided for the master plan, it is not possible to determine the boundaries and area of the coastal protective strips. Such calculations are made taking into account the relief of the coastal area and land use in development of the "Scheme of complex use and protection of water bodies" and are taken into account at the stage of design planning.

Thus, the total area of the city green fund is currently 2,478 hectares (19% of the total area of the city, i.e., one fifth of it), and together with streams, reservoirs and their water protection zones (the basis of the natural and ecological framework of the city) - 3,605 hectares (taking into account the mutual overlap of areas), or almost 28% of the total city area within the modern city lines²⁰. An important part of integrating the nature-based solutions into the city planning to improve air quality and a healthy lifestyle in Dushanbe may be expansion of streets and avenues and their greening, which will allow the PM accumulated in the ground layers to be quickly blown out.

For Dushanbe, the landscape gardening of roofs and walls, is still a new, undeveloped area. Due to their design, the existing buildings of the Soviet period, do not allow exercising such practice. But now, according to the 2010 Dushanbe city Reconstruction Master Plan, by 2050, in Dushanbe city, all multi-storey buildings (2, 3, 4, 5 and 6 stores) will be demolished. In their

14. As above

15. As above

16. As above

17. As above

18. As above

19. As above

20. As above

place, it is planned to build high-rise buildings, in which design the architects provide for conditions for the roof landscape gardening. Today, more than a dozen of such buildings have been built in the city, with some of them already having greenhouses of the ornamental plants (the Sultoni Kabir shopping center, the Golden Domes residential complex and a number of other buildings)²¹.

In this regards, it should be noted that the RT Ministry of Health and Social Protection, together with the relevant ministries and departments and local executive bodies of state power, was instructed to develop and submit to the RT Government a draft National Program for formation of a healthy lifestyle in the Republic of Tajikistan for 2021-2025, and take necessary measures to improve the healthy lifestyle promotion among the population based on partnership with society and increasing people's responsibility for their own health and those around them²².

The document provides for development of measures aimed at improving the healthy lifestyle promotion among the population, integrating the nature-based solutions into city planning to improve air quality and healthy lifestyle in Dushanbe and other cities of the country based on partnership with society and increasing responsibility for own health and those around them. The country has great potential in natural and human resources for this²³. Under the Program, a number of significant activities on the landscaping and gardening were implemented. In particular, for the purpose of landscaping and landscaping avenues, cultural and entertainment parks, villages and makhallas, enterprises and organizations of Dushanbe City, only in 2020, 226.3 thousand seedlings and shrubs, 14.2 million perennial seasonal flowers were planted, and 254.4 thousand square meters were covered with lawns²⁴.

Despite the achievements, the public green areas system is underdeveloped in the peripheral parts of cities. As a negative trend, local experts note the use of conifers that do not provide shade, as well as deciduous trees of European species, not adapted to Tajikistan's climate, instead of local broadleaf trees, to replace plantings and in new green areas of cities, especially in Dushanbe.

21 . Adjustment of the Master Plan of the Republic of Tajikistan. Dushanbe City. The Concept of Socio-Economic and Territorial Development of Dushanbe city. 2010

Source: <https://ru.wikipedia.org/wiki/%D0%94%D1%83%D1%88%D0%B0%D0%BD%D0%B1%D0%B5>

22. National program for the formation of a healthy lifestyle in the Republic of Tajikistan for the period 2011-2020 dated 30 October 2010, No. 560. Source: http://www.adlia.tj/show_doc.fwx?rgn=15925

23 . As above

24. Plan of activities for planting trees and shrubs, seasonal and perennial flowers in autumn 2021 and spring 2022. Source: <https://khovar.tj/rus/2021/10/v-dushanbe-utverzhdyon-plan-meropriyatij-po-posadke-sezonnih-i-mnogoletnih-rastenij-na-period-oseni-2021-goda-i-vesny-2022-goda/>

2.3. Recommendations for the nature-based solutions to improve air quality and healthy lifestyle in Dushanbe.

1. Planting of new trees and roof gardens. All greening activities should be implemented in accordance with the revised Master Plan of Dushanbe city;
2. In accordance with the procedure established by the RT legislation, approve the boundaries of all public green spaces: city parks, gardens, public gardens, groves, boulevards and other landscaped areas.
3. In the design of new construction projects, it is mandatory to provide for landscaping and irrigation system, and where necessary, to provide an alternative method of irrigation.
4. Develop standards for street gardening, a plan for the development of an irrigation system, introduction of the new landscaping methods.
5. Adopt a new procedure for planting trees and shrubs in the city, including in yards of the apartment buildings, according to which annually, the district administrations will collect proposals from local residents, and form a public opinion on the landscaping of specific areas.
6. Develop the Program to overhaul main canals, restore and expand the urban irrigation network, restore and build new artesian wells and irrigation water pipelines, introduce "drip irrigation" and "sprinkling" to reduce the share of auto irrigation in the served green areas.
7. Formation of protected zones outside and within Dushanbe, constituting a single whole and developing a system of special protected areas of the natural complex;
8. Organization and improvement of water protection strips of the Dushanbinka, Luchob, and Kafirnigan rivers, carrying out activities to restore floodplains as elements of the city ecosystem;
9. Preservation of all existing water bodies; construction of new water bodies in suitable areas of natural complexes and mixed purpose areas with a high proportion of landscaping.
10. Introduction of green walls and roofs in the new high-rise buildings in the city.

3. Air quality

3.1. Air pollution in Dushanbe and Tajikistan

3.1.1. Overview of the current situation (context, trends, perspectives)

A 2016 study by the British consulting company Mercer on the quality of life, Dushanbe ranked 215th among 223 cities in the world²⁵. The air state was an important indicator in the cities ranking. On this indicator, the capital of Tajikistan was among 20 worst cities in the Asia-Pacific region. The World's Air Pollution Index, which assesses air pollution in 2,000 cities in 134 countries, also assessed the air in Dushanbe as "polluted and dangerous to health"²⁶

The main anthropogenic sources of environmental pollution include industrial and municipal facilities. In the beginning of 2019, the main industrial stationary sources of emission of chemical pollutants into the atmosphere in Dushanbe were CHP-2, Dushanbe Cement Plant, other industrial enterprises of the city, boiler houses, and small factory workshops that process and burn various types of waste. Many enterprises in the capital use coal as raw material for energy generation. For example, there are 24 enterprises in the city that produce heat by burning coal fuel. The largest of these is Dushanbe CHP-2 managed by the state energy company "Barki Tojik", which produced, for example, in 2018, 671.2 Gcal of heat or 82% of total heat production in the republic^{27, 28}.

Coal is also used by 434 manufacturing companies. Relative to other regions of the country, Dushanbe has an accelerated development of the furniture industry, which emits harmful substances into air in the city: solvents, formaldehyde, carbon monoxide, ammonia, etc.

The main air pollutant in Dushanbe is particulate matter - PM_{2.5}, PM₁₀ which accounted for 93% of the total volume of harmful emissions from stationary sources in the capital³¹. The PM concentration is a frequently used measure of air pollution. PM is a complex mixture of solid and liquid organic and inorganic substances present in suspension in the air. Air quality is usually evaluated in daily or annual levels of PM₁₀ concentrations in one cubic meter of air. The amount of pollutants discharged from stationary sources in 1991-2018, on average in Tajikistan decreased by almost 200 thousand tons. However, during the same period, for Dushanbe the volume of harmful emissions increased, accounting for 86% of the country total emissions in 2018³².

In 2018, the amount of dirty air emissions in Dushanbe exceeded the amount of emissions in the city in 1991, when Dushanbe was one of the top ten dirty cities in the USSR³³. The volume of pollutants in Dushanbe is more rapidly growing compared to other cities of Tajikistan. Only within one year (2017-2018), the volume of emissions of air pollutants in the city increased by 2.6

25 How air pollution has lowered Dushanbe's ranking, 2017. Source: <http://news.tajweek.tj/view/kak-zagryaznenie-vozduha-snjizilo-rejting-dushanbe/>; <https://livingasia.online/2017/03/29/air-in-dushanbe/>

26. As above

27 Statistical Yearbook of the Republic of Tajikistan 2020. Statistics Agency under President of PT. <https://www.stat.tj/ru>

28 How to improve air quality in the capital of Tajikistan? Source: <https://cabar.asia/ru/kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana/>; <https://stanradar.com/news/full/40083-kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana.html>

29. Environmental Protection in the Republic of Tajikistan (2019).. Statistics Agency under President of the Republic of Tajikistan (statistical book). Source: <https://stat.tj/ru/news/publications/environmental-protection-in-the-republic-of-tajikistan> (Опубликовано: 06.12.2019)

30 How to improve air quality in the capital of Tajikistan? Source: <https://cabar.asia/ru/kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana/>; <https://stanradar.com/news/full/40083-kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana.html>

31 Statistical Yearbook of the Republic of Tajikistan 2020. Statistics Agency under President of PT. <https://www.stat.tj/ru>

32. As above

33 How to improve air quality in the capital of Tajikistan? Source: <https://cabar.asia/ru/kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana/>; <https://stanradar.com/news/full/40083-kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadzhikistana.html>

times, compared to 2016 – by 55 times, to 2015 – by 88 times³⁴. The amount of harmful emissions from stationary sources in Dushanbe in 2018 exceeds the amount of emissions in such large industrial areas of Tajikistan as the RRS and Sughd Region³⁵

In addition to Dushanbe CHP-2, a major air polluter in the capital (carbon dioxide, smog, etc.) is the Dushanbe Cement Plant, built on the main street of Dushanbe in 1941. The cement plant, which previously used natural gas as fuel, was converted to coal in 2013. In the coming years, on the territory of the Ismoili Somoni district of Dushanbe, a new enterprise, JSC Tajikcement will be launched, with the production capacity of 3,300 tons of cement per day, and 1.2 million tons of cement per year (4 times more than the cement production at the Dushanbe cement plant in 2018). The raw material for energy production will remain coal, with its possible replacement by gas fuel³⁶.

Dushanbe is a cleaner city compared to other cities in the world. According to experts, the air quality complies with accepted norms, but traffic jams and construction work in the capital caused local excess pollution, which can be detrimental to public health. **The vehicles share in air pollution has increased from 68.7% in 2009 ³⁷ to about 80% by 2015, due to decline in the industrial production and increase in the number of passenger cars.**

Although Tajikistan includes unleaded gasoline in its definition of fuel standards, the leaded fuel is still used. Some vehicles in Dushanbe, such as buses, already use natural gas. Due to poor fuel quality and poorly regulated engines, the average fuel consumption in urbanized areas is considered to be high³⁸. By 2018, the air pollution slightly decreased and stopped at a level slightly above the 2009 level, and according to the Environmental Protection Committee, in 2018, it made just over 70% of all harmful emissions into air.³⁹

Air pollution in Dushanbe is noticeable with the onset of the heating season, which lasts from October to March. During this period, coal/wood/low-quality fuel is burned in individual (single-family) houses. The central heating and power plant also operate on coal, which contributes to the deterioration of air quality in the city. The only good thing at this time of year is that it is illegal by law to burn the fallen tree leaves.

However, the highest PM2.5 levels in 2019 were observed during dust storms in summer and fall. In Tajikistan, the number of sand and dust storms (popularly known as the “Afghanis”) has increased at least tenfold over the past 30 years. The increased frequency of dust storms was caused by desertification. In the early 1990s, people destroyed 70 percent of the country's forested area - that's 700,000 hectares. Scientists say that along the dust storms path - from Ayvaj to Dushanbe - the forest strips are almost totally destroyed. It is the trees standing in the path of the wind that filter air from dust.⁴⁰. On these days, the average PM2.5 concentration rose to 475

34 . As above

35. As above

36 . As above

37 . Ministry of Agriculture and Nature Protection Air Quality Monitoring in the Republic of Tajikistan Dushanbe 2007. (presentation). Source: <http://www.myshared.ru/slide/635007/>

38. What air do we breathe? Source: <http://www.toptj.com/News/2016/09/20/kakim-vozdukhom-my-dyshim;https://asiaplustj.info/news/tajikistan/society/20160920/231081>

39 Is Dushanbe a city for people or cars? <http://ekois.net/dushanbe-gorod-dlya-lyudej-ili-avtomobilej/>. Category: Central Asia, city ecology

40 Abdullayev S.F. Comprehensive studies of dust and gas impurities in arid zones and their impact on the regional climatic regime of southeastern Central Asia. Dissertation for the degree of Doctor of Physical and Mathematical Sciences, Dushanbe - 2014
Source: <https://www.dissercat.com/content/kompleksnye-issledovaniya-pylevykh-i-gazovykh-primesei-v-aridnykh-zonakh-i-ikh-vliyanie-na>

mg/m³ and the maximum value per hour rose to 838 mg/m³. This is 33.5 times higher than the permissible level⁴¹.

In addition to the above factors, city's environmental problems are caused by the low percentage of implementation of the environmental measures laid down in the previous city master plan (1982). Especially harmful enterprises (cement plant, etc.), the airport, sewage treatment facilities were not moved from the city. The public green areas are insufficient in the peripheral parts of the city. There are just fragmented special landscaped areas.

Based on the commitments undertaken by Tajikistan to reduce greenhouse gas emissions, a number of regulatory and policy measures have been taken, which can be the ground for development of the MRV Concept and subsequently the development of a special Law. The fundamental country development document is the National Development Strategy of Tajikistan to 2030, adopted in 2016. The Strategy outlines the general economic development directions, which, when implemented, can contribute to reduction of the GHG emissions, which include: the use of non-traditional (renewable) energy sources; minimization of the negative impact of vehicles on the environment and human health; encouraging the development of "green employment", expansion and state support of the environmental entrepreneurship and the environmental services market.

3.1.2. Overview. PM2.5 (and other contaminants)

PM 2.5 (PM - abbreviation for Particular Matter - particulate matter) is an air pollutant, which includes solid microparticles and tiny droplets of liquids. They easily penetrate the biological barriers and therefore pose the greatest threat to the human body. PM 2.5 are particles with a diameter of less than 2.5 micrometers (µm). A micrometer or micron is one millionth of a meter. For example, the thickness of human hair averages 70 micrometers. It turns out that 30 particles of PM 2.5 will fit on the section of a single hair. Fine dust flies from car engines, factories and plants. There is also dust of natural origin: dust from soil not covered by vegetation. For example, dust storms, from time to time brought into Dushanbe from Afghanistan and the drying Aral Sea⁴².

Why are PM 2.5 dangerous? Especially particles brought in by dust storms. PM 2.5 particles are very light, so they can fly in the air for days and weeks. When you breathe, large particles of dust get into your nose, mouth, and throat. PM 2.5 is so small that it penetrates deep into the lungs and settles there. The World Health Organization and the International Agency for Research on Cancer have classified PM 2.5 in the first category of danger. However, no maximum permissible concentration of airborne particles has been established. The higher concentration is, the worse is for health. The consequences do not appear immediately. PM 2.5 particles accumulate in the lungs over the years and are not excreted back. Consequences are cardiovascular diseases, toxic poisoning, allergic reactions, bacterial and fungal infections, fibrosis, cancer, and other diseases. PM 2.5 kills more people than coronavirus. Environmentalist Farrukh Kasymov in his presentation "Air Quality in Central Asia" showed the direct link of deaths with air pollution⁴³.

Who is polluting the air? Representative of the Environmental Protection Committee Murod Ergashev explains that the air pollutant PM 2.5 enters the atmosphere from vehicles, from

41. As above

42. Tajikistan Dushanbe's polluted air is more dangerous than the coronavirus. Source: <https://asiaplustj.info/ru/news/tajikistan/security/20210607/gryaznii-vozduh-dushanbe-opasnee-koronavirusa>; <https://asia-times.org/11337-tadzhikistan-gryaznyy-vozduh-dushanbe-opasnee-koronavirusa.html>

43 . As above

use of coal at CHP, the cement and ceramic production, and use of chemicals in agriculture. Thus, according to environmentalists, the share of vehicles makes up to 80% of all emissions⁴⁴. Saidusmon Sudurov, head of the state supervision of use and protection of atmospheric air of the Environmental Protection Committee, at the press conference on results of 2020, reported that approximately 344 thousand tons of dust and other air pollutants, especially cars, are emitted into atmosphere annually.⁴⁵

As well known, Dushanbe is located in the arid zone of the Hissar Valley, where anthropogenic emissions are often added to natural dust. Currently, the city is covered by construction of tall residential buildings, causing air pollution with many small and large streams of suspended substances arising when the earth is dug at the depth of several meters, where age-old waste is stored. Cement dust, emissions from incinerated construction debris, and many gas impurities emitted by various construction units as well as vehicles and CHP plants enter the atmosphere.

Figure 2 shows the average hourly values of daily variation of PM1, PM2.5 and PM10 concentrations in the atmosphere of Dushanbe city⁴⁶. The hourly average PM1 values indicate that the submicron aerosol fraction dominates in the atmosphere of Dushanbe during the cold period, which is associated with the heating season, and in this sample, low values during the summer period are not given. Like PM1, hourly mean values of PM2.5 indicate that in Dushanbe atmosphere, the submicron aerosol fraction also dominates in the cold period, which also seems to be associated with the heating season. Hourly mean values of PM10 indicate that Dushanbe atmosphere is dominated by coarse aerosol fraction in the warm period, which is associated with dust intrusions from March to November. In this sample, low values in winter are not shown⁴⁷ (Table 2).

44 . As above

45. As above

46 Inson wa tabiat. Hourly average variations of Pm1, Pm2.5 and Pm10 in the atmosphere of Dushanbe. Samiev S.B., Abdullaev S.F., Agency on Hydrometeorology of the Republic of Tajikistan. Source: <http://environment.tj/srednechasovye-variatsii-pm1-pm2-5-i-pm10-v-atmosfere-g-dushanbe/>

47 . As above

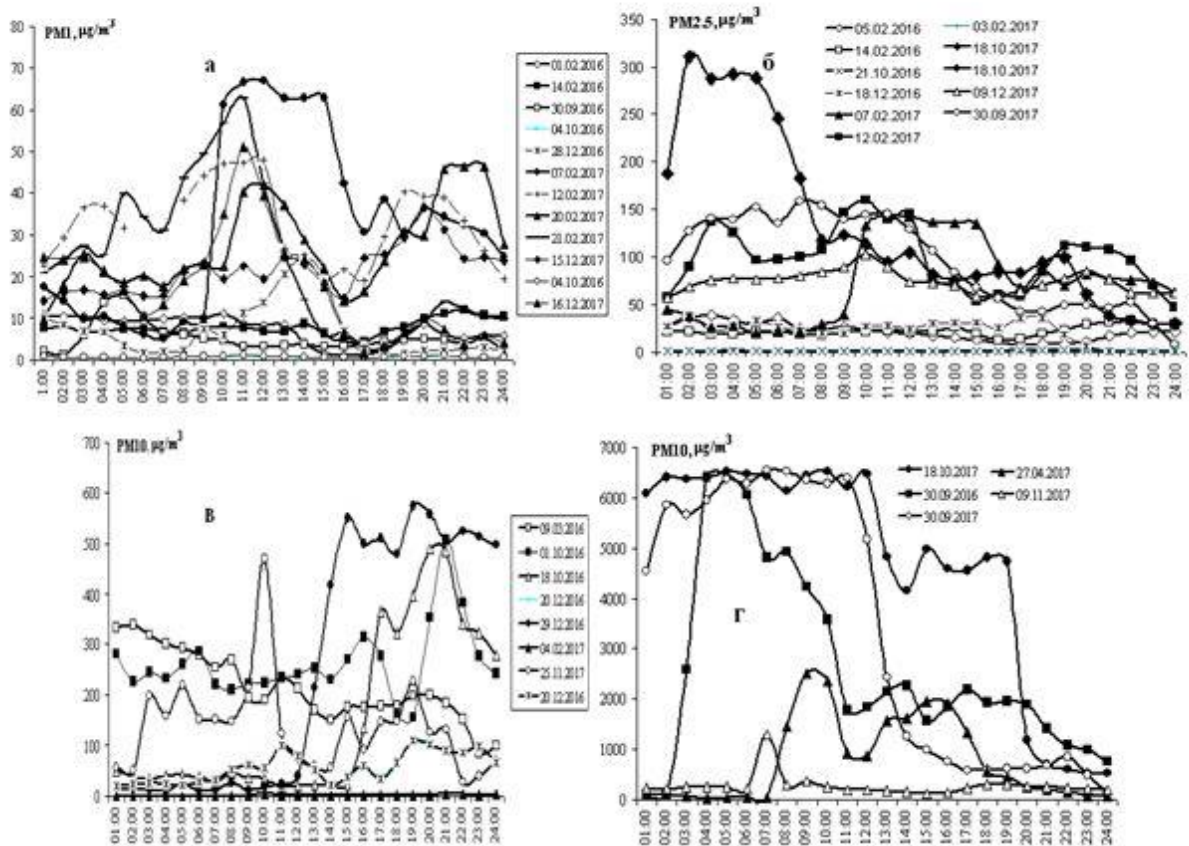


Figure 2. Hourly mean values of daily variation of PM1, PM2.5 and PM10 concentrations in Dushanbe atmosphere

Source: 48.

Figure 3 shows the hourly mean values of daily variations of concentration of PM1, PM2.5 and PM10 in the relatively clean atmosphere of Dushanbe city⁴⁹. The variation in the hourly mean concentration in a relatively clean atmosphere indicates the presence of two daytime maxima at 10-11 am and nighttime at 08-09 pm, which may be caused by streams movements at this time.

In Dushanbe, the average annual level of PM2.5 is about 0.013 mg/m³. Thus, the average annual level of PM2.5 in 2018 was 0.015 mg/m³, in 2019 - 0.012 mg/m³, and in 2020 - 0.013 mg/m³, with standard -0.035 mg/m³ ⁵⁰. While according to the online monitor of the US Embassy in Dushanbe, as of 05.05.2020, the AQI was 137 (unhealthy for sensitive groups). By this indicator, Tajikistan ranked first among the CIS and CA countries as of 05.05.2020⁵¹.

Air quality data from the US Embassy monitor showed that air quality in Dushanbe was mostly moderate (50-100 AQI) beyond the heating season on 17 May - 16 June 16 2019. During this period, there was a moderate health problem for a small number of people sensitive to air pollution. However, during this favorable period for air quality, the AQI value for several days showed more

48. As above

49. As above

50. Tajikistan. Dushanbe's polluted air is more dangerous than the coronavirus. Source: <https://asiaplustj.info/ru/news/tajikistan/security/20210607/gryaznii-vozduh-dushanbe-opasnee-koronavirusa;> <https://asia-times.org/11337-tadhikistan-gryaznyy-vozduh-dushanbe-opasnee-koronavirusa.html>

51. Press Release on Air Quality Monitoring at the U.S. Embassy in Dushanbe. US Embassy <https://tj.usembassy.gov/ru/pr-06202019-ru/>

than 150 units (unhealthy for sensitive groups). For two days on 23-24 May 2019, there was a dramatic deterioration in air quality to 300 AQI - hazardous to health - mostly at night. The monitor data show that the air quality in Dushanbe sharply deteriorates in the autumn-winter period of the year, and this is most likely due to the heating season.⁵²

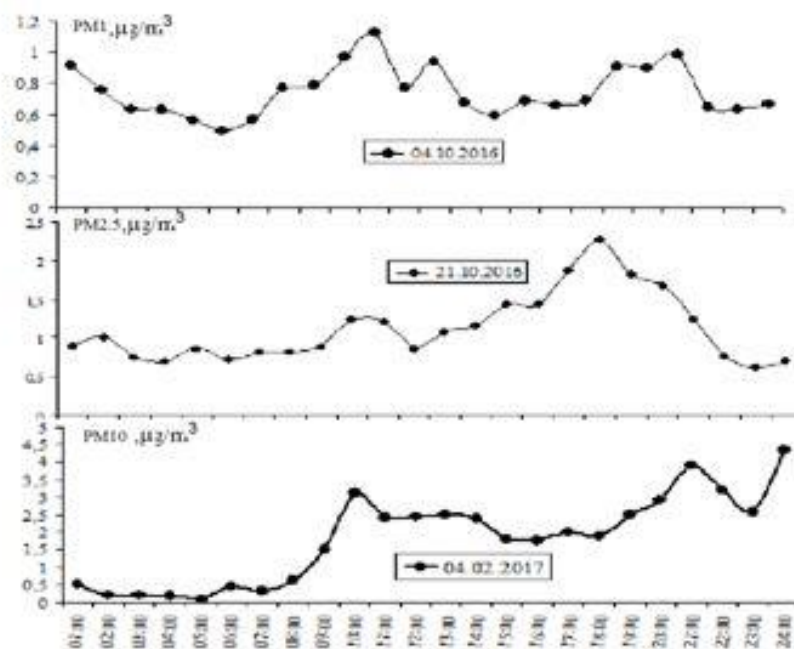


Figure 3. Hourly mean variations of PM1, PM2.5 and PM10 concentrations in a relatively clean atmosphere

Source: 53

Table 2. Trends in emissions changes, 2000, 2005–2013

	2000	2005	2006	2007	2008	2009	2010	2011	2012
SO ₂	20	31	34	36 39	39	41	43	47	50
NO _x	31	49	53	57	62	64	68	73	79
NH ₃	19	30	32	34	37	39	41	44	47
Non-methane Volatile Organic Compounds	14	23	25	26	29	30	32	34	36
CO	360	575	615	663	715	742	791	849	913
PM _{2.5}	12	19	20	21	23	24	26	27	30
PM ₁₀	23	37	40	43	46	48	51	55	59

Sources: 54.

52. As above

53 Inson wa tabiat. Hourly average variations of Pm1, Pm2.5 and Pm10 in the atmosphere of Dushanbe. Samiev S.B., Abdullaev S.F., Agency on Hydrometeorology of the Republic of Tajikistan. Source: <http://environment.tj/srednechasovye-variatsii-pm1-pm2-5-i-pm10-v-atmosfere-g-dushanbe/>

54. Transboundary air pollution by major pollutants (S, N, O₃) and PM in Tajikistan, EMEP, 2015. Environmental Performance Reviews. Tajikistan Draft third review. UN New York and Geneva, 2017. Source: <http://pdf.knigi-x.ru/21biologiya/152663-1-obzori-rezultativnosti-ekologicheskoy-deyatelnosti-tadzhikistan-tretiy-obzor-proekt-organizaci.php>

3.1.3. Major sources of air pollution

The main sources of air pollution in Dushanbe can be grouped as follows:

1. Air pollution in Dushanbe city by vehicles.
2. Air pollution from sand and dust storms.
3. Emissions of pollutants into the atmosphere in Dushanbe from stationary sources.
4. Air pollution in Dushanbe city with household and industrial waste.

1. Air pollution in Dushanbe city by vehicles.

Dushanbe ranks first in the country (44.1%) in terms of the number of passengers transported by road (public, departmental, individual). The total emissions of harmful substances from motor vehicles in 2018, in Tajikistan as a whole amounted to 561 thous. tons, with the largest volume coming to CO₂ emissions - 380.4 thous. tons, and the nitrogen oxide emissions - 108.6 thous. tons⁵⁵. The main source of these emissions (90% and 97%, respectively)⁵⁶ is passenger cars. In mid-March 2019, the authorities of Dushanbe city intended to consider banning the use of passenger cars (taxis) manufactured before 2014 as less serviceable. However, this decision was subsequently cancelled. Catalysts for cleaning harmful emissions are installed only on new cars.

The Law on Environmental Safety of Motor Vehicles adopted in 2015, provides for a wide range of measures to mitigate the environmental impact of motor vehicles. However, the mechanism for the implementation of this law between various government bodies has not been introduced. One of the causes of air pollution in Dushanbe from motor vehicles is the fact that there is little environmental control of harmful emissions by traffic police.

2. Air pollution from sand and dust storms

The air quality in Dushanbe is significantly affected by the dust haze brought by sand and dust storms (SDS) from Afghanistan, Uzbekistan, Turkmenistan, the Arabian Peninsula and even North Africa, and more recently from Aralkum. Dust haze usually occurs when high winds lift large amounts of sand and dust from exposed dry soils into the atmosphere⁵⁷.

The arid zone of Tajikistan is constantly exposed to dust particles of the submicron fraction formed as a result of SDS. Increased dust emissions can cause a significant deterioration of human and animal health. Global climate change and the expansion of desert zones create favorable conditions to sites formation, development and frequent distribution of SDS. Despite its relevance, this issue has not been comprehensively studied, although it is one of the significant factors affecting the environmental, social and economic spheres of the country's development, especially healthcare.

55 How to improve air quality in the capital of Tajikistan? Source: <https://cabar.asia/ru/kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadjikistana>; <https://stanradar.com/news/full/40083-kak-mozhno-uluchshit-kachestvo-vozduha-v-stolitse-tadjikistana.html>

56. As above

57. Abdullaev S.F. Comprehensive studies of dust and gas impurities in arid zones and their impact on the regional climatic regime of southeastern Central Asia. Dissertation for the degree of Doctor of Physical and Mathematical Sciences, Dushanbe - 2014

Source: <https://www.dissercat.com/content/kompleksnye-issledovaniya-pylevykh-i-gazovykh-primesei-v-aridnykh-zonakh-i-ikh-vliyaniya-na>

Depending on the weather, dust over Dushanbe city and the entire Southwestern Tajikistan can remain suspended from 3-4 days to one week, or even more.⁵⁸

The Atmospheric Physics Laboratory of the Physicotechnical Institute of the National Academy of Sciences is engaged in the study of nature and elemental composition of dust storms brought in from outside. As a result of research carried out by scientists of this institute, traces of radioactive man-made isotopes were found in the sand and dust collected in the arid zone of Tajikistan. This became the basis for further study by this Institute of elemental composition of the dusty haze spreading from the south to the central part of the country⁵⁹.

The results showed that in all distributions for dusty haze samples, there is a 5-10 fold increase in the content of isotopes compared to soil samples from areas located along the path of the dusty haze, indicating that the dusty haze is enriched with radioactive isotopes from neighboring countries (China, Pakistan, India). The danger of the situation in this case is that radioactive isotopes, through the lush grass of the foothills, can enter the human and animal bodies, causing serious diseases.⁶⁰

The study of dynamics in the concentration of some heavy metals and radioactive isotopes in soil and dust aerosol samples in the south of Tajikistan showed that an increase in their concentration is observed in the north. This is probably due to the influence of radionuclide migration. Wind-carried contaminated dust and hazardous substances can enter the soil and, during heavy rainfall, seep into surface and even groundwater, affecting the population health.

In the transfer of heavy metals and radioactive contamination, atmospheric processes play an important role, in particular, dust storms and dust haze, which transport solid particles over long distances from the dust release site. In invasion of (natural) dusty haze from the southwestern border of the country, an increased concentration of elements was found in the dust haze aerosol relative to their concentration in the soils of the dust haze distribution zones: Sc, Zn, Ni, Cu, Ca, Sr и Ge⁶¹. High migration in air is observed for the elements: Co, Zn, Rb, As and Sr, which is evidence of accumulation of very toxic elements in the atmosphere. Alarming is the high content of such toxic elements as Zn, As and Sb, which is up to ten times higher than the clarke (the average element content in the earth's crust)⁶².

3. Emissions of pollutants into the atmosphere from stationary sources in Dushanbe

In the beginning of 2019, the main industrial stationary sources of the chemical pollutants emissions into the atmosphere in Dushanbe include CHP-2, Dushanbe cement plant, other industrial enterprises of the city, boiler houses, as well as small factory workshops that process and incinerate various types of waste. The main air pollutant in Dushanbe is particulate matter - PM, which makes 93% of the total volume of harmful emissions from stationary sources in the capital⁶³. The concentration of PM in air is a commonly used indicator of air pollution levels. PM is a complex mixture of solid and liquid organic and inorganic substances present in suspension in the air. Air quality is usually evaluated in daily or annual levels of PM10 concentrations in one cubic meter of air.

58. As above

59. As above

60. As above

61. As above

62. As above

63. Environmental Protection in the Republic of Tajikistan (2019). Statistics Agency under President of the Republic of Tajikistan (statistical book). Source: <https://stat.tj/ru/news/publications/environmental-protection-in-the-republic-of-tajikistan> (Опубликовано: 06.12.2019)

For the period 1991-2018, the amount of pollutants emitted from stationary sources on average in Tajikistan, decreased by almost 200 thous. tons. However, in Dushanbe, over the same period, the volume of harmful emissions increased, amounting to 86% of the total emissions in the county in 2018. The amount of dirty air emissions in Dushanbe in 2018 exceeded the amount of emissions in the city compared to 1991, when Dushanbe was one of the top ten dirty cities in the USSR⁶⁴. The volume of pollutants in Dushanbe is growing at an accelerated rate compared to other cities of the Republic of Tajikistan. Only within one year (2017-2018), the amount of pollutants released into the city's atmosphere increased 2.6-fold, relative to 2016 – by 55 times, and by 88 times in 2015. The amount of harmful emissions from stationary sources in Dushanbe city in 2018 exceeds the volume of emissions in such large industrial zones of Tajikistan as the Districts of Republican Subordination and the Sughd Region⁶⁵ (Fig. 4, 5).

The amount of pollutants emanating from stationary sources

(thousand tons / year)

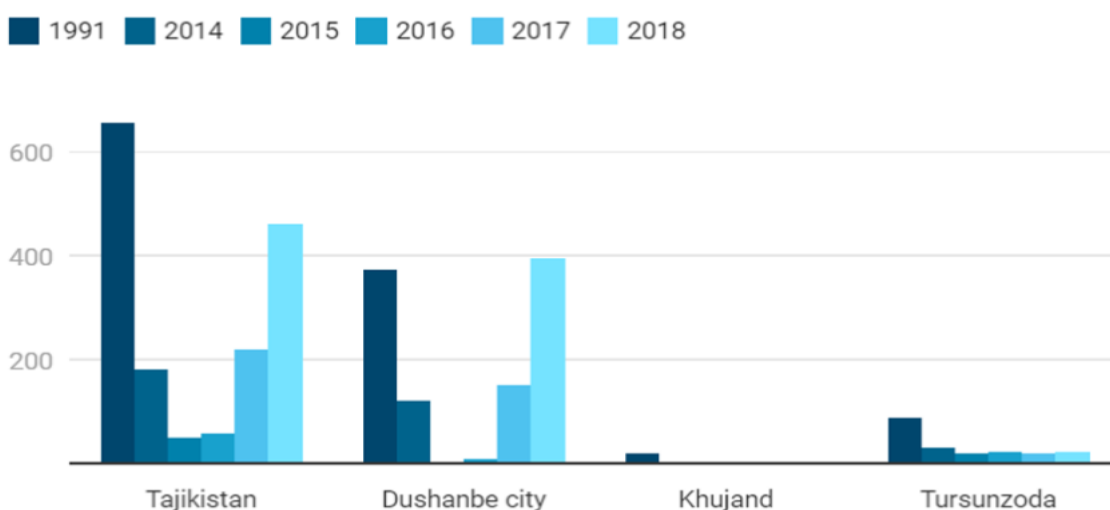


Chart: CABAR.Asia ·

Source: Environmental Protection in the Republic of Tajikistan (2019). Agency on Statistics under the Pres of the Republic of Tajikistan

· [Get the data](#) · Created with [Datawrapper](#)

Figure 4. The amount of pollutants emitted from stationary sources

(Sources: 66)

64 . As above

65. As above

66. Statistical Yearbook of the Republic of Tajikistan. 2020. Statistics Agency under President of PT. <https://www.stat.tj/ru>

Emissions of harmful substances to atmosphere air from stationary sources

(thousand tons / year)

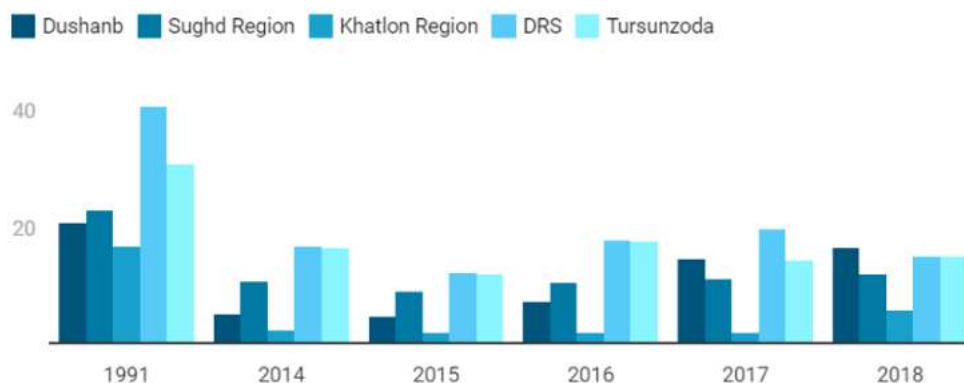


Chart: CABAR.asia • Source: Environmental Protection in the Republic of Tajikistan (2019). Agency on Statistics under the President of the Republic of Tajikistan • Get the data • Created with Datawrapper

Figure 5. Emission of harmful substances into the atmosphere from stationary sources

Sources⁶⁷

The second stage of CHP-2 with capacity of 300 MW was commissioned in September 2014; the plant's contractor is the Chinese company TVEA. The total plant capacity of 400 MW of electricity was reached in December 2016. For the production of these types of energy, CHP-2 used 831 thousand tons of coal (coal from the Fan-Yagnob and Ziddy deposits)⁶⁸. In the coming years, the country plans to increase the coal production by mining, which will accordingly lead to an increase in the coal production cost. The cost of imported fuels and lubricants for transportation of coal by road will increase, which will lead to an increase in the cost of power generation at CHP plants and a decrease in environmental protection expenses. One of the key air purity indicator is the increase of carbon dioxide (CO₂) in air, which accompanies the coal combustion in generating electricity and heat, and industrial production. Among the most hazardous air emissions are particulate matter (PM), sulfur dioxide, nitrogen oxides, carbon monoxide, mercury, arsenic, inorganic dust, and soot.

Some of these pollutants interact in the atmosphere to form ozone and fine particulate matter. The effect of sulfur oxide on human health can be expressed both in the direct effect of this gas on the body, and through the interaction of CO₂ with the smallest particles of PM_{2.5} dust. The coal combustion is accompanied by emissions of benzopyrene, which is a hazard class 1 substance that tends to accumulate in soil and water. This pollutant is not measured by automatic air monitoring systems in Dushanbe.

In addition to Dushanbe CHP-2, a major air polluter in the capital (carbon dioxide, smog, etc.) is the Dushanbe cement plant, built in the Ismoili Somoni district of Dushanbe City in 1941. The cement plant, which previously used natural gas as fuel, was converted to coal in 2013. In the coming years, in Ismoili Somoni district of Dushanbe, a new enterprise JSC "Tajikcement", with the production capacity of 3,300 tons of cement per day, 1.2 million tons of cement per year (4

67. As above

68. As above

times more than the cement production of Dushanbe cement plant in 2018)⁶⁹. The raw material for energy production will remain coal fuel, with its possible replacement by gas fuel.

In addition to large air pollutants (CHP, Cement Plant) in Dushanbe, there are more than 20 coal-fired boiler houses, 6 small private enterprises recycling plastic, 1 small enterprise recycling tires⁷⁰. It is impossible to say unequivocally whether they have official licenses, permits to conduct dirty business. Most often, these enterprises, which are sources of harmful emissions, are poorly monitored by the authorized bodies.

4. Air pollution in Dushanbe with household and industrial waste.

The waste contains methane and nitrous oxide emissions (greenhouse gases). Dushanbe does not have a waste recycling system. Methane generated in landfills is not recycled and is completely released into the atmosphere. In addition to environmental degradation, waste contributes to methane and nitrous oxide emissions as a result of:

- Anaerobic decomposition of the organic fraction of solid urban (domestic) waste dumps;
- Treatment and discharge of domestic wastewater to the city's centralized sewage treatment facilities;
- Industrial wastewater treatment and discharge.

Of the total amount of pollutants that entered Tajikistan's wastewater treatment plants in 2018, the vast majority (90%) are emissions from Dushanbe wastewater treatment plant. These are mainly particulate matter (98% of total emissions) and carbon monoxide⁷¹.

Tajikistan has no national waste management strategy or action plan. Such a strategy is under development. The country also lacks waste management plans for regions, cities, and individual waste generators. National data on collected solid household waste (SHW) are reported in cubic meters, but individual operators prefer to collect data on waste in tons. The data on SHW collection is incomplete, available only for Dushanbe and Khujand.

SHW is transported to specially designated sites, where basic measures are not taken to prevent the spread of pollutants. In 2016, the Environmental Protection Committee reported 69 landfills used to dispose of household waste. According to other information sources, there are 79 of them⁷². The existing landfills in regional centers are overfilled, and there is an urgent need to start building a national network of solid waste landfills. Separate waste collection is not yet practiced, although some progress has been made since beginning of the fluorescent lamps production. In general, the country lacks infrastructure for waste processing, with the exception of metal scrap and waste paper.

Little information is available on industrial waste as there is no regular reporting. Industrial enterprises and organizations, on the basis of contracts with road maintenance departments, take their waste to municipal landfills, where this waste is disposed of together with household waste. The Environmental Protection Committee has begun working on an inventory of industrial waste disposal sites. The concept of hazardous waste is reduced to radioactive waste and pesticides. These types of waste are currently being prioritized. It is expected that once the situation in this

69. As above

70. As above

71. As above

72. "Garbage Mountains", Tilav Rasul-Zade, 04.09.19, Fergana news agency. Source: <https://cabar.asia/en/bury-and-forget-how-people-struggle-with-growth-of-landfills-in-tajikistan>

area improves, progress will be made in developing a methodology for other hazardous waste management⁷³.

Due to the fact that the state has no money for recycling, garbage is usually trampled and covered with sand, forming a "layer cake" of garbage and sand. For example, about 700-800 tons of garbage are brought to Dushanbe solid waste dump every day, and this figure is increasing every year⁷⁴. Since in Dushanbe, as well as in Tajikistan as a whole, there is no generally accepted practice of separate waste collection, it is impossible to sort recyclables in landfills. The buried waste becomes unusable.

Over the years, it rots and releases leachate - a toxic liquid that gets into the groundwater and, consequently, into the drinking water system. The Environmental Protection Committee in Dushanbe claims that leachate at the Dushanbe landfill is pumped out and then deposited in two pools before being discharged into the sewage system. Even assuming that the drainage system at the Dushanbe city landfill works properly, we can be sure of other landfills in Tajikistan.

Landfills also produce landfill gas, which adversely affects people living nearby⁷⁵. Landfill gas contributes to global warming at least 25 times more than CO₂ emissions⁷⁶, and is highly flammable, which is why fires occur so often on landfills. The smoke from burning waste not only has an unpleasant odor, but also poses danger to people and animals within radius of several kilometers from the fire site. If we compare the area around Dushanbe landfill in 2009 and 2021. The larger the landfill area is, the farther people should live from it, but in reality the situation is completely different - the polygons are grassed, and houses are being built closer and closer to landfills, usually less than 700 meters away. This shows that safe waste management is not a priority for citizens themselves. Due to city population growth, settlers with less income have no choice of housing in greener areas.

3.1.4. Geographic and topographic context

Dushanbe⁷⁷ is located at 38° north latitude and 68° east longitude in the densely populated and fertile Hissar valley, at an altitude of 750-930 meters above sea level. The area is 125 km². The Varzob (Dushanbinka or Dushanbe-Darya) river runs through the city from north to south, feeding an artificial lake in the downtown, and the Kafirnigan river runs from east to west. To the north of the city is Varzob gorge - there are numerous recreation centers. From the north and north-east and north-west, Dushanbe is bounded by the Hissar mountain ridge, from the south and south-west by the systems Karshitau and Babatag ridges, and from the south and south-east by the Rangon mountain range.

Dushanbe has a separate administrative status and is divided into four districts. It is surrounded by mountain ranges to the north, east and south, with the only exit to the west into the Hissar Valley.

73 Environmental Performance Reviews. Tajikistan The third review. Draft. UN New York and Geneva, 2017. Source: <http://pdf.knigi-x.ru/21biologiya/152663-1-obzori-rezultativnosti-ekologicheskoy-deyatelnosti-tadzhikistan-tretiy-obzor-proekt-organizaci.php>

74 . "Waste Management in Dushanbe City", 22.05.2020. The Committee for Environmental protection under the Government of the Republic of Tajikistan. Source <http://tajnature.tj/?p=11251>

75 Assessment of human exposure to landfill gas. Balakhchina Taira Kaadyr-Oolovna, Scientific Dialogue, no. 2, 2012, pp. 41-

57. <https://cyberleninka.ru/article/n/otsenka-vozdeystviya-svalochnogo-gaza-s-poligonov-tverdyh-bytovykh-othodov-na-cheloveka>
76 Global Methane Emissions and Mitigation Opportunities", Global Methane Initiative, <https://www.globalmethane.org/documents/gmi-mitigation-factsheet.pdf>

77. Environmental Performance Reviews. Tajikistan. Third review. Draft. UN New York and Geneva, 2017. Source: <http://pdf.knigi-x.ru/21biologiya/152663-1-obzori-rezultativnosti-ekologicheskoy-deyatelnosti-tadzhikistan-tretiy-obzor-proekt-organizaci.php>

The wind direction is mainly north-south along the Varzob River valley. According to the RT Agency for Hydrometeorology, the wind immobility is about 38%. For these reasons, the degree of dispersion of toxic substances in the atmosphere of Dushanbe is low, most of them settle within the city. Even with small emissions, harmful substances can accumulate in the air to high concentrations⁷⁸.

The climate is subtropical inland, to some extent mitigated by the mountainous position of the city. Summer in Dushanbe is long and hot, with rare precipitation. Winter is relatively short, due to the flow of humid air in winter, winter is accompanied by abundant rainfall, which is remotely reminiscent of the Mediterranean climate. Spring is rainy and relatively prolonged, with frequent thunderstorms. Early fall is relatively dry, but then autumn becomes rainy and wet. Dry (June-October) and wet (December-May) seasons are pronounced. The average temperature in January is 1°C, in July - 28°C. Temperature in the valleys in January ranges from 0°C to 2°C, in the highlands fall to - 28°C, in July temperature in the valleys ranges from 23°C to 30°C, in the mountains - from 4°C to 15°C. Maximum precipitation is in winter and spring, in summer and autumn it rains rarely⁷⁹.

3.1.5. *The air pollution effect on health*

The impact of air pollution on the human body. The physiological effects of air pollutants on the human body are different. Carbon monoxide is firmly combined with blood hemoglobin, which interferes with the normal supply of organs and tissues with oxygen, as a result, the mental activity processes are weakened, reflexes slow down, drowsiness occurs, loss of consciousness and death from suffocation are possible. Silicon dioxide (SiO₂) in dust causes a serious lung disease called silicosis. Sulfur dioxide combines with moisture to form sulfuric acid, which destroys lung tissue.

Nitrogen oxides irritate and corrode the mucous membranes of eyes and lungs, increase susceptibility to infectious diseases, and cause bronchitis and pneumonia. If the air contains nitrogen oxides and sulfur dioxide together, there is a synergistic effect, i.e., an increase in the toxicity of the entire gaseous mixture. Particles less than 5 microns in size are able to penetrate the lymph nodes, linger in the lung alveoli, clog the mucous membranes. Emissions that are insignificant in volume, such as compounds of lead, cadmium, mercury, arsenic, cobalt, phosphorus, etc., can have an impact extended over time. They have a carcinogenic effect, cause defects in newborns, reduce immunity, depress the hematopoietic and nervous systems, etc.

Not only exposure to PM, but also exposure to ozone, nitrogen dioxide, and sulfur dioxide poses serious health risks. Ozone is produced by reaction with sunlight of pollutants such as nitric oxide emitted into the air from cars and industries, and volatile organic compounds emitted from vehicles and industry. The highest levels of ozone pollution are found in sunny weather. Harmful air emissions cause the following diseases (WHO data)⁸⁰:

- Asthma, lung diseases - sulfur dioxide, particulate matter, ozone;
- Heart disease - carbon monoxide, contaminated particles;
- Elderly people and children - ozone, contaminated particles.

The wind carries PM_{2.5} particles everywhere, and people breathe them every day. Why are PM_{2.5} dangerous? PM_{2.5} particles are very light, so they can fly in the air for days and weeks. Sand and dust storms are one of the poorly studied vectors of PM_{2.5} in Tajikistan. When you breathe, large particles of dust get into your nose, mouth, and throat. PM_{2.5} is so small that it

78 . As above

79 . As above

80 UN: Sand and dust storms are a problem for human health and well-being. Source: <https://news.un.org/ru/story/2018/07/1334462>

penetrates deep into the lungs and settles there. The World Health Organization and the International Agency for Research on Cancer classified PM2.5 as the first danger category. However, no maximum permissible concentration of airborne particles has been established. The higher their concentration is, the worse it is for health⁸¹.

The structure of morbidity in Tajikistan shows that more than 29% of diseases are associated with the respiratory system (Fig. 6), which, in turn, depend on the SDS impact, especially in the southern regions of the country and in Dushanbe city. But, despite this, the SDS impact on health of the population, especially children, the elderly and women in the health care system of Tajikistan, has not been fully studied.

Particles raised by SDS cause or exacerbate the following health problems: coughing and wheezing, asthma and bronchitis, and cardiovascular diseases. Specific impact and harm from SDS have yet to be fully studied, taking into account the gender dimension due to the vulnerability of women and children to SDS.

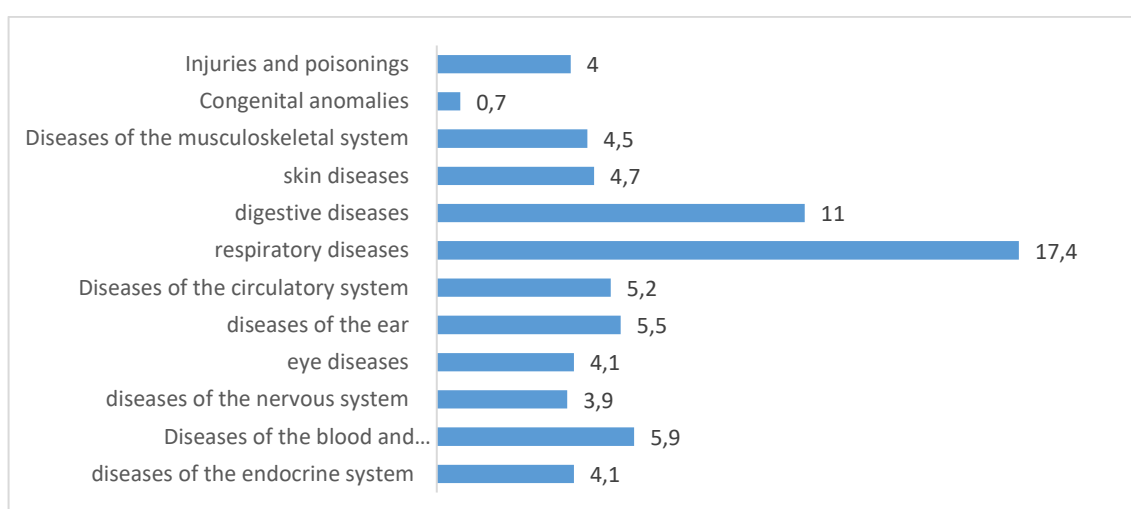


Figure 6. Morbidity in the Republic of Tajikistan by main types of diseases

(Source: 82)

In the transfer of heavy metals and radioactive contamination, atmospheric processes play an important role, in particular, dust storms and dust haze, which transfer solid particles over long distances from the dust release site. During the invasion of dusty haze (natural) from the southwestern border of the country, an increased concentration of elements of the dust haze aerosol was found relative to their concentration in soils in the dust haze zones: Sc, Zn, Ni, Cu, Ca, Sr, and Ge⁸³. Strong atmospheric migration is observed for the elements Co, Zn, Rb, As and Sr, which is evidence of accumulation of very toxic elements in the atmosphere.⁸⁴ Alarming is the high content of toxic elements such as Zn, As and Sb, which is up to ten times higher than the Clarke (the average content of an element in the earth's crust)⁸⁵.

81 As above

82 . Statistical Yearbook of the Republic of Tajikistan 2020. Statistics Agency under President of PT. <https://www.stat.tj/ru>

83. Abdullaev S.F. Comprehensive studies of dust and gas impurities in arid zones and their impact on the regional climatic regime of southeastern Central Asia. Dissertation for the degree of Doctor of Physical and Mathematical Sciences, Dushanbe - 2014

Source: <https://www.dissercat.com/content/kompleksnye-issledovaniya-pylevykh-i-gazovykh-primesei-v-aridnykh-zonakh-i-ikh-vliyanie-na>

84 . As above

85. As above

Air quality is an important environmental factor affecting public health in Tajikistan, but this fact has not yet been sufficiently recognized. The Agency for Hydrometeorology, part of the Environmental Protection Committee, monitors atmospheric air quality, but health aspects are not included in the monitoring scope/parameters and schemes. In addition, outdated regulations are used. But in spite of this, statistical analysis enables to reliably establish the relationship between the level of air pollution by SDS and diseases of the upper respiratory tract, heart failure, bronchitis, asthma, pneumonia, emphysema, as well as eye diseases. A sharp increase in the concentration of impurities, which persists for several days, increases the mortality of the elderly from respiratory and cardiovascular diseases.

3.1.6. Environmental consequences of air pollution

Air pollution has significant environmental impacts, including contributing to the greenhouse effect, climate change and acid rain. It also affects the plant health.

Climate change is the result of the greenhouse effect due to excessive greenhouse gases in the earth's atmosphere caused by the anthropogenic activities, including the fossil fuels burning. It is well known that combustion reaction products cause air pollution at ground level, and some greenhouse gases also cause air pollution. Some air pollutants contribute to global warming by trapping heat in the atmosphere, while others can form the reflective particles with cooling effect.

The greenhouse effect caused an unprecedented rise in the Earth's average temperature, with serious consequences for the whole creation on Earth. The climate change impacts include more frequent extreme weather events (such as droughts, floods, and storms) and massive loss of biodiversity. The social and economic consequences are extensive and have a detrimental effect on human health and food security⁸⁶.

Acid rain occurs when emissions of sulfur dioxide and nitrogen oxides caused by burning fossil fuels react with water, oxygen and other chemicals in the atmosphere to form sulfuric and nitric acids, which mix with water and fall to the ground as rain. Sulfur dioxide and nitrogen oxides also cause air pollution at the ground level.

At present, the negative impact of air pollution on vegetation is obvious. The air is never clean. Atmospheric air is an amazing mixture of gases and vapors, as well as microscopic particles of various origins. Of course, not every component of atmospheric air is a pollutant. These should include those components of the atmosphere that have an adverse effect on plants. The effects of some substances on plants can be perceptible, but leading to physiological disturbances, and in some cases to the complete withering away and death of the plant. Almost all atmospheric emissions have negative impact on plants, but the so-called priority pollutants requires special consideration:

- sulfur oxides from fossil fuel combustion and metal smelting;
- small particles of heavy metals;
- hydrocarbons and carbon monoxide contained in vehicle exhaust gases;
- fluorine compounds formed during the production of aluminum and phosphates;

It is these compounds that do the most harm to vegetation, but the list of pollutants is not limited to them. Chlorides, ammonia, nitrogen oxides, pesticides, dust, ethylene, and combinations of all of these substances can harm vegetation. Among the above pollutants, emissions to the

⁸⁶ IPCC, 2019: Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, etc (Eds.)].

atmosphere, as well as hydrocarbons and carbon monoxide, pose the greatest hazard to plants growing within the city⁸⁷.

3.2. Air quality monitoring in Dushanbe and Tajikistan

3.2.1. State monitoring

In all countries, the state and level of environmental pollution is monitored by a specialized service. In Tajikistan, such monitoring is carried out by the Environmental Monitoring Department (EMD) of the Agency for Hydrometeorology. In 1972, a specialized environmental monitoring and surveillance department was established in Tajikistan under the Agency for Hydrometeorology. Since then, the republic has been monitoring the state of the atmosphere, surface water, soil, and radiometric exposure. The department monitors the environment, observes air pollution, surface water, soil, and radiation levels. This department, providing all state bodies, institutions and organizations, legal entities and individuals with constant, operational information and forecasts, summarizes the results in the form of reports and yearbooks.

Until 1990, air pollution was monitored in 7 cities of Tajikistan and 21 observation points to determine 21 types of pollutants, including heavy metals. At that time, there were 7 environmental pollution observation points (EPPs) in Dushanbe, 3 EPPs in Tursunzade, 3 EPPs in Bokhtar, 2 EPPs in Yavan, 1 EPP in Kulyab, 3 EPPs in Khujand, and 1 EPP in Sarband. To study more details of air pollution, route and episodic observations were carried out using the mobile laboratory "Atmosphere-2". All sampling stations, with the exception of the one installed at the Agency for Hydrometeorology, are manual.

In 1993-1997, the number of observation points decreased. At present, the air pollution in cities and districts of the republic is studied according to a compressed program with the help of 5 stationary observation points: in Dushanbe - 1 (EPP), Bokhtar (Kurgan-Tyube) - 1 (EPP), Tursunzade-1 (EPP), Khujand - 1 (EPP), Spitamen - 1 (EPP). As can be seen from the above, there is only one stationary air quality monitoring station in each settlement, and a mobile air quality monitoring station in Dushanbe City.

In 2014, with the support of the Agency's management through the Central Asia Hydrometeorology project, component "C", a mobile laboratory for monitoring the air pollution was purchased. Since 2015, the route monitoring has been performed regularly in Dushanbe city and periodically in Tursunzade and Yavan using a mobile laboratory to determine the air pollution level.

Information about monitoring observations is published daily on the website of the Agency for Hydrometeorology (www.meteo.tj). Monitoring of the state of atmospheric air in some cities, for example, Spitamen and Khujand, was carried out on an irregular basis and without strict adherence to the requirements for the frequency of measurements, for example, three times a day for manual measurements. The irregular monitoring and lack of air quality observations at some of the stations that used to function is also due to lack of fuel to make measurement trips. In addition, some of these cities make sporadic measurements at several points, while according to official reports, each of them has only one stationary air observation post.

Only one of the air quality monitoring stations located on the territory under jurisdiction of the head office of the Agency for Hydrometeorology in Dushanbe operates in an automatic mode; data from the rest are collected manually. Air quality monitoring posts are mainly located on the

87 . Effects of atmospheric pollution on plants. Environmental Performance Reviews. Tajikistan. Third review. Draft. UN New York and Geneva, 2017. Source: <http://pdf.knigi-x.ru/21biologiya/152663-1-obzori-rezultativnosti-ekologicheskoy-deyatelnosti-tadzhikistan-tretiy-obzor-proekt-organizaci.php>

territory of hydrometeorological centers far from stationary industrial sources of pollution. On some days, there are exceedances of MPC, mainly for nitrogen dioxide and dust.

The current location of air quality monitoring posts and their limited number do not allow using the data of the Agency for Hydrometeorology for assessing pollution from stationary sources; rather, these data show pollution from vehicles and construction activities, while current economic developments are creating new stationary pollution sources, such as metal, brick and cement manufacturing, coal mining and coal-fired power plants. The air pollution monitoring system of the Agency for Hydrometeorology and analytical control laboratories does not adequately monitor these stationary sources.

Four pollutants are monitored at the sources, including nitrogen oxides, carbon monoxide and hydrogen fluoride. At the boundaries of the sanitary protection zones of enterprises, as a rule, nine parameters are controlled. The level of air pollution from most other stationary sources is measured using the mobile monitoring devices on a limited number of parameters.

In particular, the information bulletin of the Khatlon Oblast Environmental Protection Department, for the first half of 2015 contains only data on exceeding MPC for dust (PM10) in emissions from stationary sources. Concentrations of carbon monoxide and dioxide, nitrogen oxide and dioxide, sulfur dioxide, hydrogen fluoride, phenol and formaldehyde are measured at the border of the sanitary protection zone of TALCO plant. In general, monitoring on 15 sites is focused on the air pollution resulting from the this enterprise's activities (Table 7).

According to the Environmental Protection Committee, about 60 sites are carrying out the environmental control at the plant. Enterprises do not submit their monitoring data to the Environmental Protection Committee on a regular basis; however, the data are available during audits. At the same time, enterprises submit quarterly data on payment for environmental pollution to the Committee, which allows us to check the reported volumes of emissions for compliance with the limits set in the permitting documents.

In addition to enterprise control data, business entities must submit a number of statistical reports to the Statistics Agency. The Agency collects and processes statistical data in accordance with the annual statistical work program. The annual program, approved by Government Resolution No. 613 of 2015, provides for submission of the report "On the protection of atmospheric air (annual reporting forms 2-tp (air) and 2-atmosphere)" by enterprises.

Statistics on air emissions from individual stationary sources are not made public, but the public has access to aggregate air pollution data broken down by individual pollutant and region, as well as the amount of funding for air pollution prevention and reduction measures. The Environmental Protection Committee collects information and data from its territorial bodies on a monthly basis on 18 reporting forms. In addition, every month, the Agency for Hydrometeorology informs the Committee of the results of observations as part of the environmental pollution monitoring.

Table 3. Controlled pollutants and published data on air pollution

	Controlled pollutants	Published data on controlled
Dushanbe	SO ₂ , CO, CHO ₂ , NO, NO ₂ , dust	SO ₂ , CO, CHO ₂ , NO, NO ₂ , dust
Khudjand	SO ₂ , CO, NO, NO ₂ , dust	SO ₂ , NO ₂ , dust
Bokhtar	SO ₂ , CO, NO, NO ₂ , dust	SO ₂ , NO ₂
Spitamen	SO ₂ , CO, NO, NO ₂ , HF, dust	
Tursunzade	SO ₂ , CO, CHO ₂ , NO, NO ₂ , dust	SO ₂ , NO ₂ , HF, dust

Source: 88

Tajikistan has no environmental pollution databases. According to information received from the Environmental Protection Committee, there are no databases on air pollution. The monitoring data is largely collected and processed manually. For example, graphs are drawn, and data is entered from hard copies of reports into a computer. Information from monitoring stations is transmitted by text messages via a mobile phone or e-mail. This is due to both lack of computer equipment and regular power outages. The Statistics Agency manually collects and processes the basic statistical data, with exception of the air pollution information, i.e. enters them into computer from hardcopy reports.

Currently, the environmental monitoring systems under jurisdiction of the Agency for Hydrometeorology and analytical laboratories of the Environmental Protection Committee and the State Sanitary and Epidemiological Surveillance Service of the Ministry of Health and Social Protection, as well as the Agency for Forestry and Tajikgeology, define only a limited number of basic environmental indicators included in the Guidelines on the Application of environmental indicators in Eastern Europe, the Caucasus and Central Asia. For lack of reliable monitoring systems that would enable the use of recommended environmental indicators, no significant progress has been made in practical implementation of the Guidelines.

For example, despite the existing networks for monitoring such environmental indicators as emissions of pollutants into the atmospheric air and air quality in urban settlements, their function is limited for lack of financial, technical and human resources. For example, they generally do not determine the content of PM_{2.5} and ground-level ozone (O₃) in the ambient air in urban settlements where monitoring is carried out, while monitoring of air emissions from most stationary sources is limited to nitrogen oxides, carbon monoxide, hydrogen fluoride, and sometimes even only dust particles.

A relatively better picture is observed in terms of establishing and tracking recommended environmental indicators for ODS consumption and greenhouse gas emissions in relation to their regulation and international support under the Montreal Protocol to Vienna Convention for the Protection of the Ozone Layer and the United Nations Framework Convention on Climate Change (UNFCCC). Despite the fact that the Agency for Hydrometeorology and the Center for Analytical Control of the Environmental Protection Committee take samples for environmental monitoring on a very large territory covering Dushanbe city and districts of republican subordination, and monitor even outside of these territories, these data are not published or publicly available and shared. Only aggregated data are available to the public or other government agencies, more or less structured for comparisons at the countries, regions and settlements levels.

Much of the monitoring data and environmental enforcement data are inconsistent or not comparable because data sources often change or are not compatible with each other. Restricted data and information are not stored electronically, and only hard copies are available. Often, the environmental information is available only to a very limited number of government officials and, since almost all information flows are vertical, no horizontal provision of data to other government agencies at the same government level is practiced.

88 Agency for Hydrometeorology, Environmental Protection Committee under Government of the Republic of Tajikistan. meteo.
<http://www.meteo.tj/>

Air quality monitoring in Dushanbe.

Air quality monitoring in Dushanbe is based on the indicators of two permanent automatic stationary posts and two mobile laboratories. Automated air quality stations operate around the clock, measuring the most important pollutants (carbon monoxide, nitrogen oxides, sulfur dioxide, formaldehyde, suspended solids). The Agency for Hydrometeorology collects daily meteorological data (freely accessible on the website), prepares environmental bulletins (for fee).

One of the mobile laboratories, which is under the Agency for Hydrometeorology, conducts the route monitoring and visits upon request. The second one, which is at the disposal of the Environmental Protection Committee under the RT Government, makes visits in accordance with the developed visits plan. Such visits require additional financial resources, therefore, are not always possible to carry out. In addition to the existing instruments for measuring air pollution in Dushanbe, the head of the Environmental Protection Committee under the RT Government Bahodur Sheralizoda, announced the Committee's decision to install equipment to check the air pollution in Dushanbe. According to the plan, they will be installed in the Aini park, on the Druzhba Narodov street, in the territory of Kalinin settlement, near "Textilkombinat" and near "Sakhovat" market.

The Environmental Police, which is subordinate to the Ministry of Internal Affairs, is responsible for regular inspections of vehicles for exhaust fumes. Periodic vehicles inspections are carried out by a private company and supervised by the State Automobile Inspectorate, which belongs to the same ministry. The Analytical Control Center measures pollution from stationary sources. The center has its own mobile equipment for measuring the ambient air pollution level near industrial enterprises. Readings are taken at about 60 plants, in most of them twice a year, with exception of TALCO, where measurements are taken every two weeks. The data are then transferred to the Department of State Control of the Use and Protection of Atmospheric Air of the Environmental Protection Committee and are used during inspections, as well as for collecting the air pollution information.

The Ministry of Transport is engaged in development of the country's road and other infrastructure, taking into account the air pollution aspects.

The Ministry of Industry and New Technologies develops and implements state policy in the industrial sector. The Ministry is responsible for the creation and implementation of research and development programs, and for implementation of the innovative projects focused on the creation of energy-saving technologies and "green" products in order to reduce air pollution and prevent climate change.

The Ministry of Health and Social Protection of the Population deals with the risks of climate change and the impact of air pollution on human health

The Statistics Agency publishes aggregate data on air emissions from stationary and mobile sources.

The National Academy of Sciences provides scientific support for the implementation of atmospheric air protection policies.

Local government agencies are responsible for planning, financing, and implementing local air protection programs, as well as maintaining records of facilities affecting the air quality.

3.2.2. Non-governmental monitoring

The air quality index in Dushanbe can be seen in the public domain according to the air monitor installed by the US Embassy in 2018. The monitor is designed to measure the content of particulate matter in air at the US Embassy located in the Zarafshan district of Dushanbe city. An air quality monitor measures particles with diameter of less than 2.5 micrometers (PM 2.5). This indicator is considered as most hazardous to health, therefore, it is the air quality standard recognized by the US Environmental Protection Agency (EPA). Online air quality data are publicly available on the dedicated air website airnow.gov, which is a partner of the US Environmental Protection Agency.

The US EPA has developed a formula to convert PM_{2.5} values to the Air Quality Index (AQI) which can inform the health-related decisions. For example, an AQI value of 50 represents good air quality, 50-100 represents acceptable air quality, which can be a moderate health problem for people most sensitive to air pollution (people with heart disease, lung disease, children, the elderly), 101-150 – bad for sensitive groups, 200-300 - harmful to health. An AQI more than 300 represents hazardous air quality. All of these air quality values are color-coded to ease perception⁸⁹.

In addition, the Youth Group on Protection of Environment (YGPE) monitored air quality with low-cost sensors. YPGE installed 11 low-cost PM_{2.5} sensors in 8 cities in Tajikistan during the year ended July 2021.

3.2.3. Recommendations to improve air quality monitoring

The problem of environmental pollution, especially of the Earth's air shell, is becoming more and more critical as time goes on. The problem can be addressed through development and improvement of the environmental monitoring systems with application of advanced organizational and technological methods. The main areas of methodological support are analyses of dust pollution and the presence of pollutants in the air.

1. Radical modernization of the observation network and laboratory equipment;
2. Transition from a shortened air sampling and analysis program to a full program;
3. Organization of a subsystem for monitoring concentrations of fine dust, PM₁₀ and PM_{2.5} fractions;
4. Introduction of advanced equipment and technologies in regional monitoring centers;
5. Development of a network of GAS stations, background monitoring as reference points for reconstruction of the air pollution characteristics on the territory of Tajikistan.
6. Conducting regular observations of the atmospheric air pollution and optimizing them by increasing the frequency of observations;
7. Step-by-step introduction of the automated systems for continuous measurement of the main pollutants in the air of settlements.

89. Press Release on Air Quality Monitoring at the U.S. Embassy in Dushanbe. US Embassy <https://tj.usembassy.gov/ru/pr-06202019-ru/>

3.3. Air Quality Management in Dushanbe and Tajikistan

3.3.1. Relevant legislation

The Republic of Tajikistan has laws and resolutions defining regulations in the field of atmospheric air protection.

Goals and objectives of the Law “On Atmospheric Air Protection” dated 16.10.09, No. 557 include: regulation of public relations in this area in order to ensure safe environment for humans, flora and fauna, maintain cleanliness and improve the state of atmospheric air, establish state control over the use of the air basin of cities and industrial centers, other settlements, sources of air pollution, as well as strengthening the rule of law in these relations in the interests of present and future generations of people⁹⁰.

The legislation of the Republic of Tajikistan “On Atmospheric Air Protection” is based on the Constitution of the Republic of Tajikistan and consists of the Law, other regulatory legal acts of the Republic of Tajikistan, as well as international legal acts recognized by Tajikistan. In accordance with Article 3 of this Law “On the Atmospheric Air Protection”, the main principles of the atmospheric air protection are to ensure the cleanliness of atmospheric air from various pollutants and to maintain it on the basis of evidence-based norms and standards:

State administration in the field of atmospheric air protection is performed by the Government of the Republic of Tajikistan, as well as by authorized state bodies. The authorized state bodies for the protection of atmospheric air in the country include the Environmental Protection Committee, the RT Ministry of Health. The competence of authorized state bodies on atmospheric air protection is determined by the Nature Protection Law of the Republic of Tajikistan⁹¹.

3.3.2. Key actors and government agencies

Source: ⁹².

<p>To ensure the unity of legislative regulation of relations in the field of atmospheric air</p> <p>Majlisi Oli of the Republic of Tajikistan</p>	<ul style="list-style-type: none"> • determines the main directions of state policy on atmospheric air protection; • declares the environmental emergencies areas and ensures their legal resolution; • approves the state environmental programs, including protection of atmospheric air from pollution, ensuring public safety, and preventing and eliminating the consequences of atmospheric air pollution; • addresses other issues in the field of atmospheric air protection in accordance with the Constitution of the Republic of Tajikistan and this Law.
<p>The Government of the Republic of Tajikistan in the field of atmospheric air protection</p>	<ul style="list-style-type: none"> • ensures the development and implementation of state and interstate environmental programs, the most important complex inter-branch and territorial programs; • plans the national events, approves republican complex target programs, ensures their financing and material and technical support; • establishes standards for maximum permissible concentrations of pollutants in the air and levels of harmful physical and other effects on

⁹⁰ Law of the Republic of Tajikistan “On Atmospheric Air Protection” dated 16.10.09, No. 557. Source: http://www.adlia.tj/show_doc.fwx?rgn=14929

⁹¹ . As above

⁹² As above

	<p>it, the procedure for charging fees for emissions and charges for harmful, substances and other harmful effects on the environment;</p> <ul style="list-style-type: none"> • makes decision to suspend or apply to court to terminate operations of enterprises, institutions and organizations, regardless of ownership and subordination, if they violate the atmospheric air protection law; • establishes a unified procedure for maintaining state record of harmful effects on the atmospheric air, monitoring the state of atmospheric air, creates a republican database and a unified information system; • directs, coordinates and facilitates scientific research in the field of atmospheric air protection.
<p>Local authorities in the field of regulation of relations on the protection of atmospheric air are in charge of</p>	<ul style="list-style-type: none"> • determination of the main directions for the atmospheric air protection and approval of programs for the air protection from harmful influences in the subordinate territories; • accounting for facilities affecting the state of atmospheric air; • planning, financing, and logistical support for the implementation of programs to protect the atmosphere; • coordination of activities of management bodies of enterprises, organizations, institutions, regardless of the form of ownership and subordination, as well as environmental services in the field of atmospheric air protection; • considering other issues of atmospheric air protection within its competence.
<p>Environmental Protection Committee under the Government of the Republic of Tajikistan</p>	<ul style="list-style-type: none"> • Conducts the state policy in the field of hydrometeorology, rational use of natural resources, organizes and conducts environmental monitoring, comprehensive forecasting and environmental studies. The Committee analyzes and makes proposals to improve the regulatory framework for environmental protection and the development of relevant by-laws, determines the main activities in the field of environmental protection, study, reproduction, use of natural resources, preventing the climate change effects. The Committee has the department for State Control over the Use and Protection of Atmospheric Air, services for monitoring, analytical control and environmental impact assessment, inspections, departments for processing and providing the environmental information.
<p>State Agency for Hydrometeorology under the Environmental Protection Committee.</p>	<ul style="list-style-type: none"> • It is a national agency responsible for coordinating the climate change issues in Tajikistan. The Agency for Hydrometeorology provides the relevant ministries and departments, local government authorities, as well as other agencies and organizations with hydrometeorological information and other information on the state of the environment. On a daily basis, units of the Agency for Hydrometeorology measure the air pollution, a separate component of which is atmospheric pollution by SDS.

3.3.3. Air pollution stakeholders

Executive Office of President of the Republic of Tajikistan.	Pursues the state policy in the field of nature protection, environmental safety and nature management. Development and implementation of state and interstate environmental programs, the most important integrated intersectoral and territorial programs in the field of atmospheric air protection.
Majlisi Oli (Parliament)	In order to ensure the unity of legislative regulation of relations in the field of atmospheric air. Determination of the main directions of state policy in the field of atmospheric air protection.
Local executive bodies	In order to develop and implement measures for environmental protection and the development of environmental protection measures aimed at supporting a healthy lifestyle of citizens
The Environmental Protection Committee under the Government of the Republic of Tajikistan; State Agency for Hydrometeorology	In order to develop norms and standards for air quality and emissions from stationary and mobile sources, the procedure for issuing permits, economic incentives in the field of atmospheric air protection, and issues of monitoring, inventory and reporting
Ministry of Health and Social Protection of RT	To form a unified state policy in health protection and promotion; taking measures to protect the health of citizens, studying the air pollution problems and developing measures to solve them.
Ministry of Communications and Transport of RT	Improvement of mechanism for the implementation of state control over the protection of atmospheric air from emissions of pollutants by vehicles.
Ministry of Industry and New Technologies of RT	Improvement of state control over protection of atmospheric air from emissions of pollutants by industrial enterprises
Ministry of Internal Affairs of the RT	Monitoring emissions of pollutants into the air by motor vehicles
Ministry of Agriculture	For the sustainable use of forests to prevent the effects of the climate change and emissions from forest fires
Statistics Agency under President of the RT	Collecting environmental data, publication of a statistical bulletin on the environment;
National Academy of Sciences of Tajikistan	To implement the research and development that support activities to improve human capacity, project development and implementation of new technologies
Public environmental organizations. The youth environmental centers.	In implement projects on civil monitoring, gardening, environmental education, creation of the dialogue platforms

3.3.4. Accessibility, availability and applicability of air quality data

The Agency⁹³ publishes ten-day and monthly eco-bulletins explaining the air pollution level in Dushanbe and other large cities of the country. Besides, whenever possible, annual reviews on the state of atmospheric air pollution in the republic are being developed and prepared for publication. The same information is posted on Internet. Access to basic data (for a long period) is provided upon official request. Short-term data can be accessed through the Agency's website (meteo.tj), as well as upon official request. Every day, Hydromet publishes an Environmental Review on air pollution in large cities of the country (ekolonicheskij-obzor).

Provision of hydrometeorological information, information on the state of the environment:

General Information: Weather forecast from one to three days in the Republic of Tajikistan without taking into account time and location - free of charge

Special hydrometeorological information: Hydrometeorological forecast, interviews about abnormal weather, past and present, operating and reference information (one item at a time), air temperature, soil temperature, air humidity, cloudiness, visibility, wind speed and direction, atmospheric pressure, precipitation, snow cover, sun shine, ice and frost phenomena, monitoring of surface water pollution and other information – for fee, on average 50 somoni (from one point) 94

Air pollution monitoring (from 1 point): Determination of formaldehyde, Determination of dust presence in the air (suspended particles), Determination of carbon dioxide SO₂, Determination of hydrogen fluoride HF, Determination of carbon oxide CO, Determination of nitrogen oxide NO – for fee, on average 25 somoni (from one point)⁹⁵. Special services: from 60,000 to 18,000 somoni. There are currently no mobile applications for air quality data in Tajikistan.

3.3.5. Recommendations for improving air quality management

1. Introduction of the carbon and fuel taxes from enterprises in Dushanbe, stationary and mobile sources of air pollution in the city, as a measure to combat CO₂ emissions.
2. Improving the vehicles inspection.
3. Transfer of Dushanbe CHP-2 and the Cement Plant to gas fuel.
4. Gradual transition of enterprises to the use of electricity produced by hydroelectric power plants in Tajikistan. Transition to energy-saving technologies.
5. Transfer of administrative and residential buildings of the city to the renewable energy sources, in particular, to environmentally safe solar energy, the cost of which is constantly decreasing. Implementation of insulation and energy efficiency in city buildings.
6. Policies and investments to support cleaner vehicles, import of the hybrid and electric-powered vehicles (electric cars). Promote the use of clean transport by reducing customs duties.

⁹³ Agency on Hydrometeorology, the Environmental Protection Committee under the Government of the Republic of Tajikistan. meteo. <http://www.meteo.tj/>

⁹⁴. As above

⁹⁵. As above

7. Removing priority focus on the urban high-speed transport, pedestrian and bicycle networks. Reducing congestion, improving access to public transport, trolleybuses.
8. Reform the vehicle taxation (purchase, registration and annual road taxes) so that taxes are based on specific CO₂ emissions.
9. Implementation of the advanced methods of household waste utilization and processing, including capturing methane emitted at waste disposal sites.
10. Development of an open and publicly available map of pollutant emissions into the atmospheric air in Dushanbe, public monitoring of the air quality.
11. The Republic of Tajikistan should become a Party to the Convention on Long-range Transboundary Air Pollution and its Protocols. Tajikistan's participation in the Convention will provide the country with better access to the information it needs to develop an air pollution monitoring strategy, a robust emissions inventory system, and an air quality management strategy.
12. Increasing the number of green solutions in the city, such as expanding city parks and green spaces, and creating green walls and roofs on existing buildings.

Appendix 1 Overview and National Capacities for the Air Quality Monitoring and Data Management in Tajikistan

Tajikhydromet overview

A. Mandate and Responsibilities of the Agency for Hydrometeorology:

The Agency for Hydrometeorology is a national agency responsible for coordinating the climate change issues in Tajikistan. The Agency provides the relevant ministries and departments, local public authorities, and other institutions and organizations with hydrometeorological information and other information on the state of the environment. On a daily basis, units of the Agency for Hydrometeorology measure the air pollution, a separate component of which is atmospheric pollution by SDS. Unfortunately, these measurements are only used for information and no further analysis is performed on them. The Agency has the Climate Change center.

B. Activities related to air quality management:

The Agency for Hydrometeorology monitors the state of air and posts this information on Internet on a daily basis. Since 2014, the Agency for Hydrometeorology has been responsible for collecting data and preparing a national GHG inventory, assessing vulnerability to climate change, disseminating information on implementation of the UNFCCC provisions, and is responsible for international cooperation (with the Intergovernmental Panel on Climate Change and the UNFCCC Secretariat).

Information about air quality is published daily on the website www.meteo.tj. Annual reports are not published online, but are available in hard copy.

In 2014, the National Ozone Center, a non-profit organization funded by UNEP, was established. The main purpose of the Center is to facilitate the implementation of Tajikistan's obligations under the Montreal Protocol and the provisions of the state strategic documents on ODS. The Center's activities include monitoring the ODS use, sharing information, preparing reports for UNEP, and educating and providing information to users of refrigerants.

Capacity review

A. Strengths of the organization:

1. Hydrometeorological support for the needs of the population, households and national defense;

2. Development and preparation of short-term and long-term hydrometeorological forecasts, as well as providing information about state of the natural environment and climate to government and public organizations and enterprises, especially information about emergency situations.

These and other tasks can be addressed through creation and development of a unified state system for monitoring the natural environment based on the automated observation devices, high-speed communication systems and modern information processing facilities.

The Agency represents interests of the Republic of Tajikistan in one of the US specialized agencies the World Meteorological Organization (WMO). Director of the Agency is a permanent

representative of the Republic of Tajikistan in WMO, the National Coordinator of the UN Framework Convention on Climate Change in Tajikistan.

B. Organizational challenges:

1. Poor funding of the area;
2. Lack of equipment, and outdated analytical tools that do not allow to properly perform the work;
3. Lack and outflow of highly qualified specialists due to low wages;
4. Insufficient number of mobile laboratories to monitor air pollution;
5. Lack of specialists in GIS;

C. Identification of key gaps and organizational needs in air quality monitoring and management:

1. Provide laboratories with new analytical tools, including for heavy metals analysis;
2. Expand the network of automated observation posts;
3. Improve the human resource capacity;
4. Train GIS specialists in modeling methods;
5. Organize work on the analysis of the primary data quality;
6. Introduce new methods for assessing the quality of atmospheric air.

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