

Brief information about the project

Name of the project	AP27510649 «Investigation of the Physical and Chemical Properties and Biological Activity of PM _{2.5} in Almaty's Air: A Comprehensive Approach to Assessing Environmental Risks»
Relevance	Air quality in the cities of Kazakhstan, especially in Almaty, presents a serious environmental concern. High levels of fine particulate matter (PM_{2.5}), especially during the heating season, exceed WHO standards by 5–7 times and are linked to coal burning, vehicle emissions, and unfavorable meteorological conditions. PM_{2.5} not only penetrates into the respiratory system, contributing to chronic diseases, but also serve as a carrier for toxic compounds such as polycyclic aromatic hydrocarbons (PAHs), several of which are known carcinogens. Despite significant health risks, Kazakhstan lacks systematic monitoring of PAHs and their oxidative potential (OP), which is a key indicator of the toxicological activity of particulate matter. Furthermore, the morphology and elemental composition of PM_{2.5} remain underexplored, limiting the accuracy of source identification. Considering the region's specific climatic, geographic, and anthropogenic features, comprehensive studies of PM_{2.5}, including the analysis of PAHs, OP, and morphological composition, are urgently needed to inform targeted air quality management and public health protection strategies.
Purpose	To comprehensively study the chemical composition of fine particulate matter (PM _{2.5}), including PAHs concentrations, qualitative analysis of chemical elements, and determination of morphological characteristics and oxidative potential. The project will identify key pollution sources, analyze seasonal variations, and assess the carcinogenic risk of PAHs exposure to public health. Additionally, it aims to develop scientifically grounded recommendations to reduce the carcinogenic risk and oxidative potential of air pollutants.
Objectives	1. Sampling of ambient air PM_{2.5} in Almaty 2. Investigation of daily and annual average concentrations of PAHs bound to PM_{2.5} and analysis of their temporal variations 3. Identification of emission sources of PAHs using diagnostic ratios of pollutants concentrations 4. Assessment of potential health risks associated with exposure to PAHs 5. Determination of morphological features and elemental composition of PM_{2.5} for source identification 6. Assessment of the oxidative potential of PM_{2.5} Preparation and publication of articles in peer-reviewed scientific journals

Expected and achieved results	Expected results: 2025 Sampling of fine particulate matter (PM_{2.5}) in Almaty. Commencement of work on determining concentrations of polycyclic aromatic hydrocarbons (PAHs) and assessing their temporal variations. 2026 PAH concentrations in PM_{2.5} samples are determined. Seasonal variations in concentrations are assessed. Diagnostic ratios for identifying PAH emission sources are calculated. Carcinogenic and non-carcinogenic health risks from PAH exposure are calculated. 2027 Morphological characteristics and chemical composition of PM_{2.5} are determined, particle sources are established, and data on their oxidative potential (OP) are obtained. The project will result in the publication of: - at least 2 (two) articles and (or) reviews in peer-reviewed scientific publications in the scientific direction of the project, indexed in Science Citation Index Expanded and included in the 1st (first), 2nd (second) or 3rd (third) quartile of the impact factor in the Web of Science database and (or) having a CiteScore percentile of at least 50 (fifty) in the Scopus database; - at least 2 (two) articles or review in a peer-reviewed foreign or domestic publication recommended from lists 1 and 2 of the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (SHEQAC). - or at least 1 (one) article or review in a peer-reviewed scientific publication indexed in Science Citation Index Expanded and included in the 1st (first) quartile by impact factor in the Web of Science database and (or) having a percentile by CiteScore in the Scopus database not less than 80 (eighty). - at least 1 (one) article or review in a peer-reviewed foreign or domestic publication recommended from lists 1 and 2 of the SHEQAC. One master's student and one bachelor's degree student will graduate as part of the project. Achieved results: • Since January 2025 to January 2026, PM_{2.5} sampling has been conducted using quartz filters. • Average daily concentrations ranged from 0.7 to 115 µg/m³. Average monthly concentrations ranged from 21 to 66 µg/m³. Peaks were recorded during the
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	winter months (December 2025 — 64 µg/m³, January 2026 — 66 µg/m³), as well as in July (54 µg/m³). • Of the 104 days, 93 (89%) saw average daily concentrations exceeding the World Health Organization recommendations (15 µg/m³). In January, February, July, September, October, December, and January 2026, exceedances were recorded in 100% of cases. The lowest proportion of exceedances was observed in March (57%). • Work continues on determining the concentrations of polycyclic aromatic hydrocarbons (PAHs), including assessing their temporal variations, calculating diagnostic ratios to identify PAH emission sources, and evaluating both carcinogenic and non-carcinogenic health risks from PAH exposure. • As part of the project implementation, Master's student A.E. Kashtanov completed a dissertation titled "Investigation of temporal variations in concentrations, source identification, and assessment of risks associated with polycyclic aromatic hydrocarbons on PM_{2.5} in the air of cities in Kazakhstan." Research results were presented at the 25th European Meeting on Environmental Chemistry (EMEC25, Chania, Crete, Greece, November 23-25, 2025, oral presentation); at the II International Student Scientific Conference "ECOLOGY AND SUSTAINABLE DEVELOPMENT" (March 31, 2025, Narxoz University, Almaty, oral presentation); at the international school "Farabi Summer School on Applied Chemistry" (June 9-14, 2025, Almaty, practical session); and at the "Chem in STEM" event organized by American Space & Makerspace Almaty and the Society of Petroleum Engineers (SPE) (July 10, 2025, Almaty, excursion and oral presentation).
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	Anara Omarova – Project Leader, PhD, Leading Researcher. Scopus ID: 57271406600. ResearcherID: P-5606-2017 ORCID ID: : 0000-0002-3990-1952 Nassiba Baimatova – Leading Researcher, PhD, Associate Professor. Scopus ID: 55207389900. ResearcherID: M-8856-2017 ORCID ID: 0000-0002-0631-3425 Olga Ibragimova – PhD, Leading Researcher. Scopus ID: 57216646818. ResearcherID: O-4098-2017 ORCID ID: 0000-0001-5868-6648 Kazbek Tursun - Ms, Researcher ORCID: 0000-0002-5000-7978 SCOPUS ID: 58192473800 Resercher ID: HIU-0082-2022 Eldana Bakhytzhan - PhD, Researcher

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Usage	<u>Potential Users of the Project Outcomes</u> • Authorized health organizations, which can utilize the data to develop programs aimed at reducing the impact of PAHs and PM_{2.5} on public health. • The Ministry of Ecology and Natural Resources of the Republic of Kazakhstan, which can leverage the project results to formulate and implement effective measures to improve air quality and reduce pollutant emissions. • Scientific and research groups, which will gain access to an expanded database for further studies on the impact of PAHs on human health and ecosystems, as well as for analyzing climatic factors affecting air pollution.
Priority compared to real-world alternatives	This project is the first comprehensive study of PM _{2.5} in Almaty, simultaneously covering PAH concentrations, oxidative potential, morphology, and the elemental composition of particles.
List of publications with links to them	At the stage of submission and experimental work.
Patents	Not provided for in the calendar plan