Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

# ENVIRONMENTAL ASSESSMENT OF THE IMPACT OF DUST STORMS IN THE SOUTHERN ARAL SEA REGION

Renat G. Sultashov
Bibigul S. Tleumuratova
Zhalgasbay Zh. Kublanov
Karakalpak Research Institute of Natural Sciences, Karakalpak Branch of the Academy of Sciences of Uzbekistan, Nukus, Uzbekistan
Corresponding author: Zhalgasbay Zh. Kublanov, E-mail: kublanov90@list.ru

**Abstract**
This study presents the results of a comprehensive environmental assessment of the impacts of dust storms on the major environmental components of the Southern Aral Sea region. The assessment was based on field monitoring conducted during 2023–2026 at six representative sites within the Lower Amu Darya oasis, including Muynak Bay, the Telman waterbody, Lake Dautkul, the Kvadrat urban waterbody (Nukus), Lake Akshakol, and the Tuyamuyun Reservoir. A comparative analysis of near-surface ambient air quality, surface water quality, and soil conditions was carried out under both normal meteorological conditions and during dust storm events. The results showed that the concentration of $PM_{10}$ aerosol particles in the near-surface atmosphere increased by 5.4–9.3 times during dust storms, indicating a substantial deterioration in air quality. Surface waters and soils exhibited increased concentrations of chlorides, sulfates, and total dissolved solids, reflecting intensified secondary salinization and degradation of natural ecosystems. The spatial distribution of dust storm impacts displayed a pronounced latitudinal pattern, with the highest impact levels recorded in the northern part of Karakalpakstan adjacent to the Aralkum Desert and a gradual decrease toward the south. To quantitatively characterize the environmental consequences of dust storms, an integrated Dust Storm Impact Index was developed, incorporating changes in ambient air quality, surface water quality, and soil conditions. The proposed approach provides a practical framework for comparative environmental risk assessment across different territories and can be applied to improve environmental monitoring systems, model the consequences of salt-dust transport, and support the development of environmental management strategies under ongoing desertification in the Southern Aral Sea region.

**Keywords**: Dust storms; Southern Aral Sea region; environmental assessment; $PM_{10}$; ambient air quality; surface water quality; soil conditions; secondary salinization; environmental monitoring; environmental risk.

## Introduction

The Southern Aral Sea region, surrounded by vast desert areas, is highly vulnerable to dust storms, which represent one of the major natural factors adversely affecting environmental conditions, public health, regional climate, and economic activities [Molosnova et al., 1987; Valdberg et al., 1993; Mukasheva, 2015; Tleumuratova and Narymbetov, 2022; Urazymbetova et al., 2025]. The intensive transport of mineral and salt aerosols alters the physical and



Licensed under a Creative Commons Attribution 4.0 International License.

chemical properties of ambient air, surface waters, and soils, resulting in environmental degradation and increased ecological risks.

Air quality during dust storms. The deterioration of ambient air quality caused by elevated atmospheric aerosol concentrations is the best-documented environmental consequence of dust storms [Middleton and Kang, 2017; Middleton, 2019]. However, quantitative assessment of pollution in the near-surface atmospheric layer remains limited. Most previous studies have relied on remote sensing techniques, which effectively characterize the spatial distribution of aerosols but have limited capability for estimating pollutant concentrations near the ground surface [Groll et al., 2013; Rashki et al., 2015]. In the Southern Aral Sea region, this limitation is further aggravated by the low density of ground-based monitoring stations. Numerous studies have demonstrated a relationship between elevated aerosol concentrations during dust storms and increased morbidity [Aghababaeian et al., 2021]. Fine particulate matter containing microorganisms, heavy metals, and other contaminants can penetrate deep into the respiratory tract and bloodstream, contributing to respiratory diseases. During the COVID-19 pandemic, statistically significant associations were also reported between dust storm events and increased incidence of respiratory infections, which has been attributed to deteriorated air quality and the transport of biological aerosols [Broomandi et al., 2022].

Climatic conditions. Climate is another major component of the regional environment affected by dust storms. Atmospheric dust modifies the radiation and energy balance of the atmosphere, influences cloud formation and precipitation processes, and affects the cryosphere, thereby becoming an important driver of regional climate variability [Shao et al., 2011]. Previous studies have shown that atmospheric dust can alter atmospheric circulation, radiation balance, and temperature regimes, thereby affecting regional climatic processes [Shao et al., 2011]. In the Southern Aral Sea region, salt-dust storms originating from the Aralkum Desert decrease air temperature by 1–3°C, whereas sandstorms generated in the Karakum and Kyzylkum deserts increase air temperature by 6–8°C [Tleumuratova, 2018; Tleumuratova et al., 2024]. These temperature changes enhance climatic aridity, increase water deficits, degrade ecosystem stability, and elevate environmental risks.

Soil conditions. The influence of dust storms on soils remains controversial. Some studies suggest that wind-transported mineral particles may provide additional nutrients to agricultural soils [Field et al., 2010]. However, most researchers emphasize their adverse effects, including intensified wind erosion, soil degradation, and deterioration of agrochemical properties. In the Southern Aral Sea region, the dominant factor is the transport of salt-dust aerosols from the exposed Aral Sea bed. Their deposition promotes secondary salinization, deteriorates soil physical and chemical properties, and negatively affects vegetation development [Tleumuratova, 2018]. According to Razakov [1987], salt-dust deposition during dust storms reduces cotton yields by 5–15% and rice yields by 3–6%. Dust accumulation on leaf surfaces suppresses photosynthesis and gas exchange, while toxic substances associated with aerosols may accumulate in plants and subsequently enter food chains, increasing environmental and health risks.

Hydrochemical conditions. In addition to atmospheric air and soils, dust storms significantly affect surface waters. Deposition of dust and salt aerosols increases water mineralization, alters hydrochemical composition, and contributes to the degradation of aquatic ecosystems, particularly shallow closed water bodies within the Amu Darya delta. Atmospheric dust also influences the hydrological cycle by accelerating glacier melting through reduced surface albedo [Lau et al., 2010]. Previous studies indicate that salt-dust aerosols originating from the exposed Aral Sea bed can be transported over long distances and reach the glaciers of the Pamir-



*Licensed under a Creative Commons Attribution 4.0 International License.*

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

Alay and Tien Shan mountain systems, potentially affecting water resources throughout Central Asia [Groll et al., 2019]. Despite increasing research interest, the impact of dust storms on the quality of surface waters in the Southern Aral Sea region remains poorly investigated. Mathematical modeling has suggested that salt-dust transport from the dried Aral Sea bed may increase water salinity by 10–20 mg $L^{-1}$ [Tleumuratova and Kublanov, 2022; Tleumuratova and Kublanov, 2021]. However, field observations conducted during dust storm events are still scarce. Overall, previous studies have mainly focused on individual aspects of dust storm impacts, whereas comprehensive assessments of simultaneous changes in ambient air, surface water, and soil quality remain limited. The increasing frequency of dust storms in recent years highlights the need for integrated investigations of their environmental consequences. The present study reports the results of field monitoring conducted during 2023–2026 and provides a comprehensive assessment of the short-term impacts of dust storms on ambient air, surface waters, and soils in Karakalpakstan. The findings help fill the existing gap in experimental observations and provide a quantitative evaluation of dust storm impacts on regional environmental conditions.

## Materials and Methods

The study was conducted within the Lower Amu Darya oasis, the most densely populated and economically developed part of the Southern Aral Sea region, selected as the monitoring area (Fig. 1a). The investigated environmental components included near-surface ambient air, surface waters, and adjacent soils at six representative monitoring sites: Muynak Bay, the Telman waterbody (Chimbay District), Lake Dautkul, the Kvadrat urban waterbody (Nukus), Lake Akshakol, and the Tuyamuyun Reservoir (Fig. 1b).

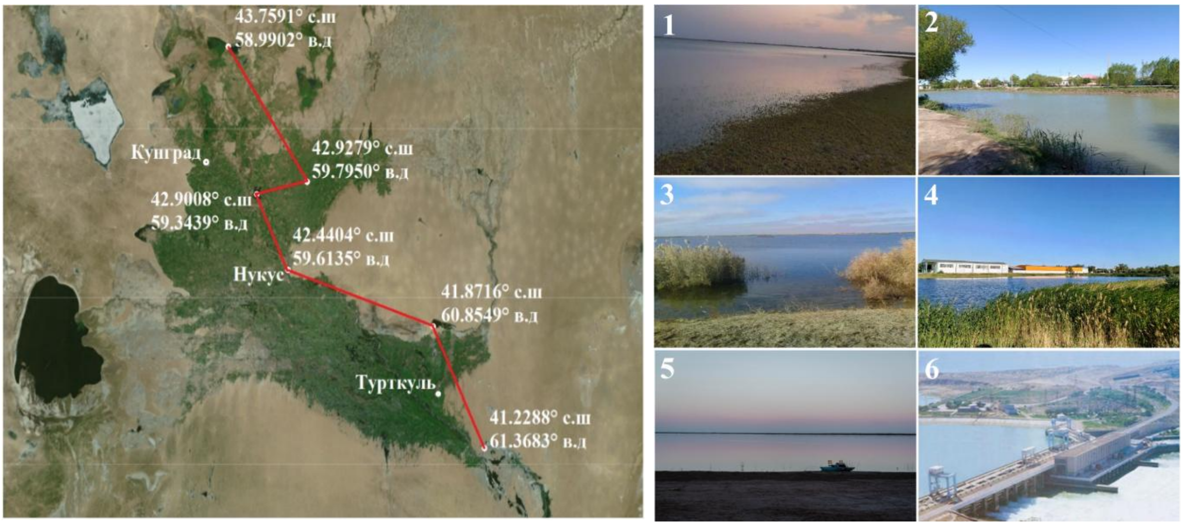


Figure 1. Study area and monitoring locations: (a) survey route and distribution of the monitoring sites; (b) representative study sites: 1—Muynak Bay; 2—Telman waterbody (Chimbay District); 3—Lake Dautkul; 4—Kvadrat urban waterbody (Nukus); 5—Lake Akshakol; 6—Tuyamuyun Reservoir.



*Licensed under a Creative Commons Attribution 4.0 International License.*

Dust concentration in the near-surface atmospheric layer was measured at the monitoring sites (Fig. 1) using an aerosol particle counter under both normal meteorological conditions and during dust storm events. Mean $PM_{10}$ concentrations were analyzed, as the instrument detects particles with an aerodynamic diameter of up to 10 μm. The measurement results were validated against data from automated meteorological stations and compared with previously published observations [Urazymbetova et al., 2025].

Water samples were collected from the surface layer (0–1 m). Water quality was assessed based on chloride ($Cl^-$), sulfate ($SO_4^{2-}$), and total dissolved solids (TDS) concentrations using the WHO Guidelines for Drinking-water Quality (350, 500, and 1000 mg $L^{-1}$, respectively) as reference values for evaluating mineralization [World Health Organization, 2022]. In addition, organoleptic characteristics, including turbidity, sediment formation, and odor, were evaluated. Soil samples were analyzed using the water extraction method according to Semendyaeva et al. [2011]. Chloride concentrations were determined by the Mohr argentometric method, whereas sulfate concentrations were measured using the standard arbitration method.

To provide an integrated assessment of dust storm impacts on the atmosphere, surface waters, and soils, an integral impact index was developed. For each parameter, the observed range of changes was divided into three equal intervals corresponding to low (1), moderate (2), and high (3) impact levels. Green, yellow, and red color classes were used to visualize the degree of environmental impact.

The integrated dust storm impact at each monitoring site was calculated as the sum of the indices characterizing the condition of the atmospheric air, surface waters, and soils:

$$I_{DS} = I_A + I_W + I_S \quad (1)$$

The results presented below characterize the impact of a single dust storm event on environmental conditions (EC). However, for practical applications in environmental monitoring and ecological risk assessment, estimating the cumulative seasonal impact of recurrent dust storms is of greater importance. Assuming that N dust storm events of comparable intensity occur during the warm season (April–October), and taking into account the cumulative accumulation of pollutants deposited on soils and water bodies, the seasonal change in environmental conditions can be expressed as follows:

$$\Delta E_i\,(S) = N\,\Delta E_i\,(R) \quad (2)$$

where $\Delta E_i(S)$ is the seasonal change in the concentration of the ith constituent in water or soil, and $\Delta E_i(R)$ is the change in the concentration of the i-th constituent caused by a single dust storm event. This model is not applicable to atmospheric air quality because atmospheric dispersion rapidly removes airborne particles, and dust concentrations typically return to background levels within 2–3 days after a dust storm.

**Results**

Ambient air quality is determined by the concentrations of atmospheric pollutants, including gaseous contaminants and aerosol particles, and their compliance with established air quality standards. Dust storms generally have little effect on the gaseous composition of the atmosphere but cause a sharp increase in the concentration of aerosol particles with diverse chemical compositions and particle-size distributions. Therefore, quantitative assessment of changes in



Licensed under a Creative Commons Attribution 4.0 International License.

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

aerosol concentrations represents one of the principal indicators for evaluating the impact of dust storms on ambient air quality.

Changes in Ambient Air Quality during Dust Storms. Table 1 presents the mean dust concentrations measured in the near-surface atmospheric layer (0–2 m) during 2023–2026 under normal meteorological conditions and during dust storm events. The magnitude of dust storm impact was assessed as the fold increase in $PM_{10}$ concentration relative to background conditions. The same approach was subsequently applied to evaluate changes in the quality of surface waters and soils.

Table 1 Variation in $PM_{10}$ concentration during dust storms

| Monitoring site | Normal calm conditions, mg m⁻³ | During dust storms, mg m⁻³ | Increase (times) |
|---|---|---|---|
| **Muynak Bay** | 0,255 | 2,36 | 9,3 |
| **Telman waterbody (Chimbay District)** | 0,236 | 2,02 | 8,6 |
| **Lake Dautkul** | 0,216 | 1,71 | 7,9 |
| **Kvadrat urban waterbody (Nukus)** | 0,214 | 1,55 | 7,2 |
| **Lake Akshakol** | 0,172 | 1,09 | 6,3 |
| **Tuyamuyun Reservoir** | 0,158 | 0,86 | 5,4 |

The results indicate that all monitoring sites are affected by dust storms originating from the Aralkum, Karakum, and Kyzylkum deserts, as well as the Ustyurt Plateau. The intensity of atmospheric pollution decreases from north to south, reflecting the predominance of northerly winds and the dominant contribution of dust transport from the Aralkum Desert.

It should be noted that the present study assessed only the mass concentration of $PM_{10}$, whereas the chemical and mineralogical composition of the aerosols was not analyzed. The highest environmental risk is expected in the Muynak and Kungrad districts, located closest to the Aralkum Desert and the Ustyurt Plateau, where airborne particles are likely enriched with salts and gypsum, thereby increasing their adverse impacts on the environment and human health.

Dust Storm-Induced Changes in Water Quality. According to Razakov and Kosnazarov [Razakov and Kosnazarov, 1998], the deposition of salt–dust aerosols in the Amu Darya Delta ranges from 1.5 to 6.0 t $ha^{-1}$, including 170–800 kg $ha^{-1}$ of soluble salts, whereas on the dried bed of the Aral Sea the deposition reaches 1,800 kg $ha^{-1}$. In the irrigated areas of Karakalpakstan, atmospheric deposition decreases to 150–300 kg $ha^{-1}$, while the contribution of aeolian transport to the salt balance declines from 6–26% in the Aralkum region to 1–1.5% at distances of 100–200 km from the source. Intensive salt–dust transport increases the mineralization of atmospheric precipitation to as much as 200 mg $L^{-1}$, thereby contributing to the development of secondary soil salinization.

The results of water quality monitoring (Table 2) showed that under normal meteorological conditions, moderate turbidity, sediment, and a slight odor were observed only in Muynak Bay and Lake Dautkul, whereas the remaining water bodies retained satisfactory organoleptic



*Licensed under a Creative Commons Attribution 4.0 International License.*

characteristics. During dust storm events, water quality deterioration was observed primarily in Muynak Bay, Lake Akshakol, and the urban water body "Kvadrat" (Nukus), where increases in turbidity, color intensity, and sediment accumulation were recorded. The smallest changes were detected in the Tuyamuyun Reservoir, which maintained clear water and the absence of any noticeable odor throughout the observation period.

Table 2 Results of Water Quality Monitoring

| **Monitoring Site** | **Cl** | | | **$SO_4$** | | | **Dry Residue** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Normal (Non-Dust Storm) Days, %** | **During Dust Storms, %** | **Increase Factor** | **Normal (Non-Dust Storm) Days, %** | **During Dust Storms, %** | **Increase Factor** | **Normal (Non-Dust Storm) Days, %** | **During Dust Storms, %** | **Increase Factor** |
| **Muynak Bay** | 0,92 | 5,8 | 6,3 | 0,98 | 6,3 | 6,4 | 2,8 | 19,6 | 7 |
| **Telman waterbody (Chimbay District)** | 0,371 | 1,89 | 5,1 | 0,432 | 2,6 | 6,0 | 0,8 | 4,5 | 5,6 |
| **Lake Dautkul** | 0,484 | 2,3 | 4,8 | 0,658 | 3,3 | 5,0 | 1,4 | 6,8 | 4,9 |
| **Kvadrat urban waterbody (Nukus)** | 0,318 | 1,523 | 4,8 | 0,532 | 2,1 | 3,9 | 0,8 | 2,4 | 3 |
| **Lake Akshakol** | 0,311 | 1,05 | 3,4 | 0,482 | 1,8 | 3,7 | 0,5 | 1,2 | 2,4 |
| **Tuyamuyun Reservoir** | 0,329 | 1,1 | 3,3 | 0,462 | 1,7 | 3,7 | 0,6 | 1,4 | 2,3 |

Similar to the results obtained for atmospheric air quality, the water quality data indicate that all monitoring sites are affected by dust storms. The spatial distribution of the impact exhibits a pronounced latitudinal pattern, with the highest levels observed in the northern part of the study area and gradually decreasing toward the south.

Changes in Soil Quality under the Influence of Dust Storms. The results of monitoring chloride, sulfate, and total dissolved solids (TDS) in soils at the study sites are presented in Table 3. Analysis of the obtained data also revealed a pronounced latitudinal pattern in the distribution of these indicators, reflecting the dominant influence of dust storms originating from the Aralkum Desert. The observed spatial distribution is consistent with the regional wind regime, which is characterized by the predominance of northerly winds that transport salt–dust aerosols southward.



*Licensed under a Creative Commons Attribution 4.0 International License.*

Table 3 Dust Storm-Induced Changes in Soil Quality

| Monitoring Site | Cl | | | SO₄ | | | Dry Residue | | |
|---|---|---|---|---|---|---|---|---|---|
| | Normal (Non-Dust Storm) Days, % | During Dust Storms, % | Increase Factor | Normal (Non-Dust Storm) Days, % | During Dust Storms, % | Increase Factor | Normal (Non-Dust Storm) Days, % | During Dust Storms, % | Increase Factor |
| **Muynak Bay** | **0,052** | **0,296** | 5,7 | **0,075** | **0,482** | 6,4 | **0,74** | **3,5** | 4,7 |
| **Telman waterbody (Chimbay District)** | **0,04** | **0,146** | **3,7** | **0,053** | **0,193** | 3,6 | **0,44** | **1,6** | 3,6 |
| **Lake Dautkul** | **0,043** | **0,152** | **3,5** | **0,035** | **0,126** | **3,6** | **0,42** | **1,3** | **3,1** |
| **Kvadrat urban waterbody (Nukus)** | **0,038** | **0,126** | **3,3** | **0,032** | **0,095** | **3,0** | **0,25** | **0,7** | **2,8** |
| **Lake Akshakol** | **0,031** | **0,074** | **2,4** | **0,082** | **0,156** | **1,9** | **0,22** | **0,58** | **2,6** |
| **Tuyamuyun Reservoir** | **0,095** | **0,132** | **1,4** | **0,062** | **0,074** | **1,2** | **0,6** | **1,1** | **1,8** |

However, the magnitude of the increase in soil contaminant concentrations during dust storms was lower than that observed for atmospheric air and surface waters. This can be explained by the greater buffering capacity and cumulative properties of the soil cover, whereby a single deposition event results in less pronounced relative changes in contaminant concentrations compared with other environmental components.

To quantitatively assess the single-event impact of dust storms on the environment, an index-based evaluation was performed for all three investigated components: atmospheric air, surface waters, and soils. The integrated impact index was calculated by summing the corresponding component indices (Fig. 2), where the first term represents atmospheric air quality, the second term characterizes surface water quality, and the third term reflects the condition of the soil cover. Based on the proposed model (Eq. 1), a map of the seasonal impact of dust storms on the environmental conditions of the region was developed.

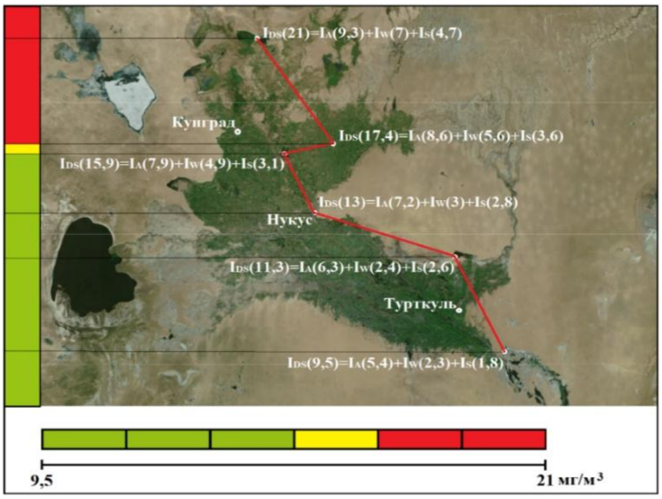


Fig.2. Integrated assessment of environmental pollution caused by a dust storm.



*Licensed under a Creative Commons Attribution 4.0 International License.*

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

The present study of the single-event impact of dust storms on environmental conditions demonstrated that, within Karakalpakstan, the intensity of their effects is characterized predominantly by a latitudinal pattern. Assuming that this spatial pattern is maintained throughout the broader region, the obtained results can be used to provide an approximate assessment of the environmental impact of dust storms in areas located at the same latitudes as the investigated monitoring sites (Fig. 2). The most pronounced effects of dust storms were observed for atmospheric air quality, as evidenced by the multiple-fold increase in airborne particulate concentrations within the near-surface atmosphere.

**Discussion**

The obtained results confirm that dust storms exert complex effects on atmospheric air, surface waters, and soils in the Southern Aral Sea region; however, the magnitude of these effects differs substantially among environmental components. The near-surface atmosphere proved to be the most sensitive component, with $PM_{10}$ concentrations increasing by 5.4–9.3-fold during dust storm events compared with background conditions. These findings are consistent with previous studies reporting substantial increases in airborne particulate matter during dust storms (Middleton, 2019; Middleton & Kang, 2017). In contrast to atmospheric air, changes in hydrochemical and soil properties were less pronounced but exhibited a cumulative character. Following the cessation of a dust storm, atmospheric aerosol concentrations decrease rapidly due to atmospheric dispersion, whereas salts deposited on the surfaces of water bodies and soils gradually accumulate, thereby enhancing long-term environmental impacts. The identified latitudinal pattern of the integrated impact index indicates the dominant role of the Aralkum Desert as the present-day source of salt–dust aerosols in the region. The highest index values were recorded in the northern part of Karakalpakstan, adjacent to the dried bed of the Aral Sea, with a gradual decrease toward the south. Future research should focus on determining the chemical composition of atmospheric dust, including heavy metals, trace elements, and organic pollutants, as well as conducting long-term monitoring to evaluate the seasonal and interannual accumulation of contaminants and to validate the proposed model of the cumulative environmental impact of dust storms.

**Conclusion**

The present study confirms that dust storms are one of the major drivers of environmental degradation in the Southern Aral Sea region. Based on monitoring conducted at six sites within the Lower Amu Darya oasis during 2023–2026, it was established that dust storms affect atmospheric air, surface waters, and soils. The most pronounced changes were observed in the near-surface atmosphere, where $PM_{10}$ concentrations increased by 5.4–9.3-fold during dust storm events. In surface waters and soils, elevated concentrations of chlorides, sulfates, and total dissolved solids (TDS) were recorded, indicating the intensification of secondary salinization processes. A distinct latitudinal pattern of dust storm impact was identified, with the highest values of the integrated impact index occurring in northern Karakalpakstan, adjacent to the Aralkum Desert, and gradually decreasing southward. The proposed integrated index provides a quantitative tool for assessing the impact of dust storms on the major environmental



*Licensed under a Creative Commons Attribution 4.0 International License.*

components and can be applied in environmental monitoring, ecological risk assessment, and the development of mitigation and land management strategies under the continuing desertification of the Southern Aral Sea region.

**References**


1. Вальдберг А.Ю., Исянов Л.М., Яламов Ю.И. (1993) Теоретические основы охраны атмосферного воздуха от загрязнения промышленными аэрозолями СПылевых бурь.: МП «НИИОГАЗ-ФИЛЬТР», 1993. – 235 с.
2. Молоснова Т.И., Субботина О.И., Чанышева С.Г. Климатические последствия хозяйственной деятельности в зоне Аральского моря. – М.: Гидрометеоиздат, 1987. – 119 с.
3. Мукашева Б.Г. Влияние климата на состояние здоровья населения Приаралья // Гигиена труда и медицинская экология. – 2015. – № 4 (49). – С. 21–30.
4. Разаков Р.М. Эоловый вынос и выпадение солепылевых частиц в Приаралье // Проблемы Аральского моря и природоохранные мероприятия. — Ташкент, 1987. — С. 24–32.
5. Разаков Р.М., Косназаров К.А. Миграция солей и токсикантов в Приаралье // Проблемы освоения пустынь. – 1998. – № 3–4. – С. 63-70.
6. Семендяева Н. В., Мармулев А. Н., Добротворская Н. И. Методы исследования почв и почвенного покрова: учебное пособие. – Новосибирск: Изд-во Новосибирского государственного аграрного университета, 2011. – 202 с.
7. Тлеумуратова Б.С. и др. Тепловой эффект опустынивания в Южном Приаралье: коллективная монография / под ред. Б.С. Тлеумуратовой. — Нукус, 2024. — 244 с.
8. Тлеумуратова Б.С., Кубланов Ж.Ж. Количественная оценка воздействия выноса солей с осушенного дна Аральского моря на соленость воды // Доклады Академии наук Республики Узбекистан (ДАН). Ташкент, 2022. № 2. – С.78-81.
9. Тлеумуратова Б.С., Нарымбетов Б.Ж. Конвективный вынос аэрозоля в пустынных зонах как фактор повышения температуры воздуха // Аридные экосистемы. 2022. Т. 28. № 1(90). С. 11–19.
10. Тлеумуратова.Б.С. Математическое моделирование влияния трансформаций экосистемы Южного Приаралья на почвенно–климатические условия. Дисс. … д–ра физ.–мат. наук. – Ташкент, 2018. –209 с.
11. Уразымбетова Э.П., Тлеумуратова Б.С., Нарымбетов Б.Ж. (2025) Мониторинг и анализ пылевых бурь в Южном Приаралье Universum: химия и биология, 2025, №11(137)
12. Aghababaeian H., Ostadtaghizadeh A., Ardalan A., et al. (2021). Global Health Impacts of Dust Storms: A Systematic Review. Environmental Health Insights,15,11786302211018390. DOI:10.1177/11786302211018390.
13. Broomandi P., Crape B., Jahanbakhshi A., et al. (2022). Assessment of the association between dust storms and COVID-19 infection rate in southwest Iran. Environmental Science and Pollution Research, 29(24), 36392–36411. DOI: 10.1007/s11356-021-18195-7.




Licensed under a Creative Commons Attribution 4.0 International License.

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

14. Field, J. P., et al. (2010). The ecology of dust. Frontiers in Ecology and the Environment, 8(8), 423–430.
15. Groll M., Opp C., Aslanov I. Spatial and temporal distribution of the dust deposition in Central Asia: results from a long-term monitoring program // Aeolian Research. – 2013. – Vol. 9. – P. 49–62.
16. Groll M., Opp C., Issanova G., Vereshagina N., Semenov O. (2019). Physical and Chemical Characterization of Dust Deposited in the Turan Lowland (Central Asia). E3S Web of Conferences, 99, 03005. DOI: 10.1051/e3sconf/20199903005.
17. Lau, W. K. M., Kim, M. K., Kim, K. M., & Lee, W. S. (2010). Enhanced surface warming and accelerated snow melt in the Himalayas and Tibetan Plateau induced by absorbing aerosols. Environmental Research Letters, 5(2), 025204. https://doi.org/10.1088/1748-9326/5/2/025204.
18. Middleton, N. (2019). Variability and Trends in Dust Storm Frequency on Decadal Timescales: Climatic Drivers and Human Impacts. Geosciences, 9(6), 261.
19. Middleton, N., & Kang, U. (2017). Desert dust hazards: A global review. Aeolian Research, 24, 53–63. https://doi.org/10.1016/j.aeolia.2016.12.001.
20. Rashki A. et al. Dust-storm dynamics over Sistan region, Iran: Seasonality, transport characteristics and affected areas // Aeolian Research. – 2015. – T. 16. – C. 35-48.
21. Shao, Y., et al. (2011). Dust cycle: An emerging core theme in Earth system science. Aeolian Research, 2(4), 181–204. DOI: 10.1016/j.aeolia.2011.02.001.
22. Tleumuratova B.S., Kublanov J.J. Long-term dynamics of impact of salt removal from the drained bottom of the Aral Sea on water salinity // Turkish Journal of Physiotherapy and Rehabilitation. - Volume 32 Issue 3. – 2021. P. 30307-30323.
23. World Health Organization (WHO). Guidelines for Drinking-water Quality. 4th edition incorporating the first and second addenda. Geneva: WHO, 2022. – 541 p.



*Licensed under a Creative Commons Attribution 4.0 International License.*