

Issanova G., Ustemirova A.
Dust storm sources in Kazakhstan

Dust storms is a common dangerous weather phenomenon in arid and semi-arid regions of Kazakhstan, especially in its southern parts with a great variety of desert types and are a powerful source of mineral and salt aerosols. In this study was used long-term meteorological data on dust storms recurrence and their regional division in Kazakhstan. On the basis of generalization and analyses of the meteorological observations, we identified the powerful sources of dust storms. The regions in Kazakhstan with the highest frequency of dust storms are: Aral Sea region; southern Kazakhstan regions; northern Caspian plain; central Kazakhstan region; southern Pre-Balkhash Deserts. The most active source of dust storms is located in sandy deserts or in areas, which have suffered from human economic activity. They are particularly dangerous for the environment and have a great negative impact on soil conditions.

Key words: dust storms, arid region, soil texture.

Исанова Г., Устемирова А.
**Источники пыльных бурь
в Казахстане**

Пыльные и песчаные бури опасные природные явления, которые распространены в аридных и полуаридных регионах Казахстана. Южная часть Казахстана покрыта пустынями различного типа, которые являются источником солевых и минеральных аэрозолей. В этих исследованиях были использованы долгосрочные метеорологические данные по повторяемости пыльных/песчаных бурь и их районирование на территории Казахстана. На основе обобщения и анализа многолетних метеорологических наблюдений были определены источники пыльных/песчаных бурь.

На территории Казахстана Приаралья пустыни Аралкүм и Кызылкүм являются источниками пыльных/песчаных бурь с их высокой частотой. Наиболее активные источники пыльных и песчаных бурь находятся в песчаных пустынях или в районах, где в большей части доминирует хозяйственная деятельность человека. Пыльные/песчаные бури очень опасны для окружающей среды и имеют большое негативное влияние на состояние почвенного покрова.

Ключевые слова: пыльные бури, аридные регионы, механический состав почвы.

Исанова Г., Устемирова А.
**Қазақстандағы шаңды
дауылдардың
(шаң-тозаңдардың) ошақтары**

Шаңды және құмды дауылдар (шаң-тозаңдар) өте қауіпті табиғат құбылысы және олар Қазақстанның құрғақ және жартылай құрғақ аудандарында кездеседі. Қазақстанның оңтүстік бөлігінде әртүрлі шөлдер таралған. Осы шөлдер минералды және тұзды аэрозольдардың негізгі көзі болып табылады. Бұл зерттеу жұмысында шаңды және құмды дауылдардың (шаң-тозаңдардың) қайталануы бойынша ұзақ мерзімді метеорологиялық мәліметтер, сонымен қатар олардың Қазақстан территориясында аудандастырылуы туралы мағлұматтар қолданылған. Көпжылдық метеорологиялық бақылау мәліметтерін жалпылау және талдау негізінде шаңды және құмды дауылдардың (шаң-тозаңдардың) қуатты көздерін анықтадық. Қазақстан территориясында Арал маңы Аралкүм және Қызылкүм негізгі көзі болып табылады. Белсенді шаңды және құмды дауылдардың (шаң-тозаңдардың) шөлдері шаңды және құмды дауылдардың (шаң-тозаңдардың) қайталану жиілігі жоғары болатын) аймақтары құмды шөлдерде немесе адам әрекеті басым аймақтарда шоғырланған. Шаңды және құмды дауылдар (шаң-тозаңдар) қоршаған орта үшін өте зиян және олар топырақтың жағдайына үлкен кері әсер етеді.

Түйін сөздер: шаңды дауылдар, құрғақ аймақтар, топырақтың механикалық құрамы.

DUST STORM SOURCES IN KAZAKHSTAN

Introduction

A dust event is a meteorological phenomenon common in arid and semi-arid regions and arises when a gust front passes or when the wind force exceeds the threshold value where loose sand and dust are removed from the dry surface [1-2]. Dust storms sources usually are associated with arid and semi-arid areas of the temperate, tropical and subtropical latitudes, where the mean annual precipitations are below 200-300 mm [1]. According to a large number of researchers dust storms are the result of turbulent wind systems entering particles of dust into the air, when the visibility is reduced to below 1000 m [3-5].

Dust, sand and salt storms are common events that occur in the arid and semi-arid regions of Kazakhstan and Central Asia. Central Asia and the Southern Kazakhstan is a region with a high frequency of dust, sand and salt storms. The region is characterized by strong winds, scarcity of vegetation cover, continental climate with long and dry summers, frequent of soil and atmospheric droughts. Many Kazakhstan drylands are represented by sandy and solonchak deserts of natural and anthropogenic origin, which are the powerful source of mineral and salt aerosols [6-7]. Sandy deserts and other types of deserts identified like active source areas of dust and sand storms. A powerful source of dust and salt aerosols is the dried bottom of the Aral Sea, which for millions of years was the receiver of the salts of the Aral basin [8-10].

Materials and methods

Dust/sand storms appear in the condition of some critical thresholds of wind speed, depending on topography and soil structure when unrelated particles are less than 250 microns, high soil dryness, and scarcity of the vegetation cover and so these thresholds vary from region to region. Dust storm observations were made at meteorological stations located in particular areas of interest in Kazakhstan [5, 11].

For the analyses, we used data of the «Dust storm climatology for Kazakhstan database». Our database is the archive data collections contained in the «Reference Books of Kazakhstan climate (2003)».

This database contained the monthly 39 years average number of days with dust storm for each weather station (30 weather stations) and their frequencies. We have analyzed seasonal frequency of dust storms in different regions in Kazakhstan according to average number of days with dust storms in different months for the period 1966-2003.

Results and discussion

Dust and sand storms are common events in the arid and semi-arid regions of Kazakhstan [11-12]. According to observations of the meteorological stations, the high wind speed regime and scarcity of vegetation cover, frequent of soil and atmospheric droughts and for the continental climate of Kazakhstan dust storms are typical for continental climate of Kazakhstan almost all over territory of the republic. However, the distribution and frequency of dust storms in Kazakhstan is heterogeneous and spotty within the territory of Kazakhstan and is characterized by large diversity. Sandy and solonchak deserts such as Naryn, Pre-Aral Karakum,

Kyzylkum, Aralkum and Southern pre-Balkhash in the southern part of Kazakhstan are main source of dust and sand storms.

The dust storms dynamics in the different Kazakhstan regions were demonstrated in Fig. 1. The number of days with dust storms increases from northwest to southeast. In the south part of Kazakhstan the number of days with dust storms is high in the sandy deserts and river valleys. In general, the annual number of days with dust storms is 20-38 days in the steppe zone and 55-60 days in the desert zone (near the Aral Sea and Balkhash Lake regions) [13]. The sites with dust storms of higher frequency (20 days/year) are situated in areas with higher wind speeds and where soils have light texture which are under intensive use, or in sandy areas with sparse vegetation. On the basis of generalization and analyses of the numerous cartographic materials, meteorological observations and satellite images, outbreaks of dust storms in Kazakhstan were identified as: 1. Aral Sea region; 2. Southern Kazakhstan areas; 3. Northern Caspian plain; 4. Central Kazakhstan region (Fig.1).

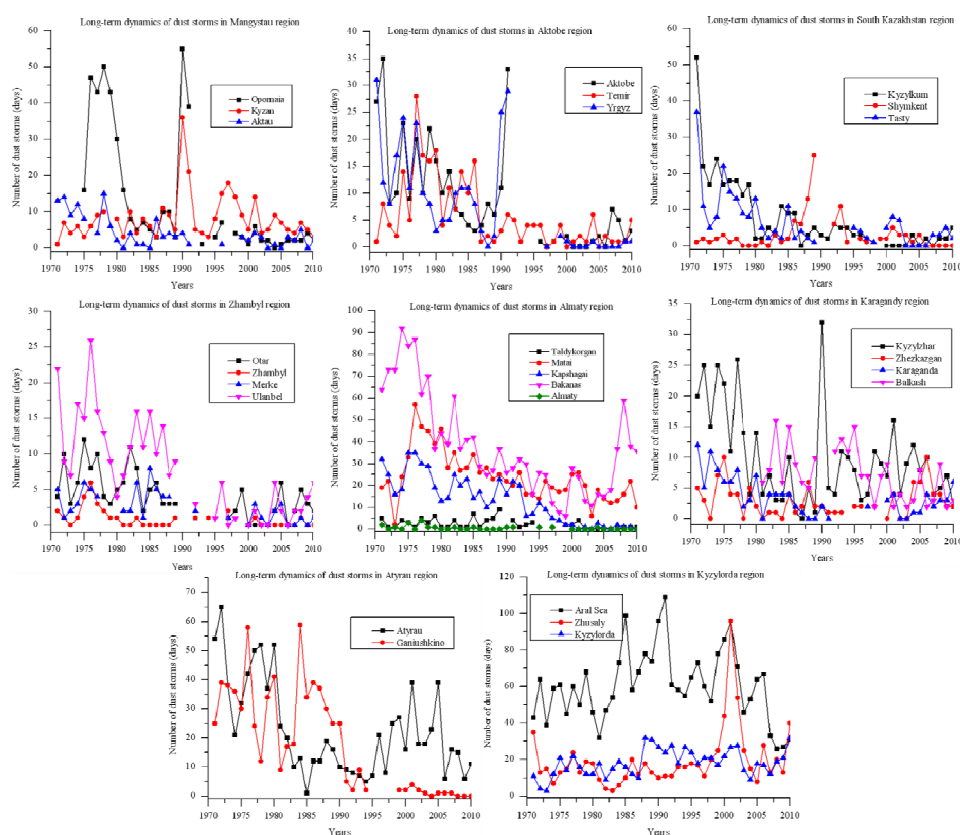


Figure 1 – Dust storm dynamics in different regions of Kazakhstan during 1971-2010

Aral Sea region is the main dust, sand and salt storm source

The high frequency and long duration of dust storms is a feature of arid regions, including the Aral Sea region. Arid climatic conditions and open surfaces with fine grain sizes are quite favorable for the development of dust storms in the region. Formation of dust and sand storms in the Aral Sea region contribute to unfavorable (adverse) weather conditions and the state of the soil surface. Strong winds are often recorded in the region, with mean wind speeds reaching 6 to – 7 m s⁻¹ at the meteorological stations of the region. In the summer, the maximum wind speeds can reach 20 to – 25 m s⁻¹ [11, 14]. The most frequent storms were observed in the northern Aral Sea region (Aral Sea MS), where their long-term average frequency reached 36 to – 110 days per year, compared to 9 to – 33 days per year in the east (Kyzylorda MS, Zhusaly MS).

The largest dust storm sources were the the Pre-Aral Karakum (Aral Sea MS) and Kyzylkum deserts, where dust storms occur from 40 to – 110 days out of the year (Fig.1).

Additionally, the Aralkum Desert is the main source of dust, sand and salt storms. The arid climate, open surface with fine grain sizes are favorable for the development of regular dust, sand and salt storms in the man-made Aralkum Desert. In the Aralkum region the frequency of dust storms has increased since the 1980s and since 2000 almost all meteorological stations in Central Asia are registering an increase in the dust storm activity [15].

Southern Pre-Balkhash desert region

Meteorological features (temperature and dryness) of the Southern Pre-Balkhash deserts and its landscape with sparse vegetation are prone to dust and sand storms, because winds blow the soil particles from the ground surface very easily [16]. Dust and sand storms are common events and often happen simultaneously with hot dry winds in the region [11, 17].

The dust and sand storms dynamics in the region are demonstrated on Fig.1. According to long-term meteorological data we found areas, which are undergone by dust storms more frequently. There are large numbers of dust and sand storms in the station Bakanas, because there takyrl-like soils contain many silty sand sediment and clay particles [16]. The takyrl-like soils are distributed in most areas of Bakanas and Akdala ancient dry delta plains, along

the left bank of Karatal River and northeast outskirts of Zhusandala. The takyrl-like soils have mostly fine structure [18]. The grains size (more than 100 microns) of the sands in most areas of this region belongs to the easily deflated type of soils [16].

In the Southern Pre-Balkhash deserts, the windy dry weather with wind speed of 6 m/s is observed from 60 to 127 days per year. In the most areas of Taukum and Saryesikatyrau deserts, such weather is 80-100 days per year, in the southern shore of Balkhash Lake reaches up to 100-120 days per year. Sand deflation starts when winds cross threshold of 6 m/s speed [17]. The number of days with deflation processes (dust and sand storms) reaches 30-90 days in the Moiynkum and Taukum Deserts, in the Ili river deltas and valley and on the southern coast of Balkhash Lake, decreasing up to 10-20 days in Saryesikatyrau desert, in the foothills of Zhetysu (Zhungar) Alatau [11]. While the most frequent storms were observed in the northern Aral Sea region, where their long-term average frequency reached 36-84 days per year, from 9 to 23 days every year in the eastern Aral Sea region. More often they happen in summer, then a wind speed reaches 10-14 m/s. However, the significant decreasing trend is most obvious over the Karakum Desert in Turkmenistan where dust and sand storm occurrences declined from an average of 30 days per year to less than 20 days per year. In general during the last decades dust and sand storm frequency in the Central Asian deserts were decreased and considerable changes in the active source areas [15]. The Aralkum Desert remains the dominant active source of aeolian sand, dust and salt aerosols in the Central Asia and Kazakhstan.

Conclusion

The vast expanse of deserts across Kazakhstan and Central Asia experience dust storms of different frequencies, intensities and durations. The frequency of dust events varies over a wide range of 5-146 days of dust storms per year. The areas, which are most prone to the dust, sand and salt storms, are following: Aral Sea region and Southern Kazakhstan region, north part of Caspian Sea, Central Kazakhstan and southern Pre-Balkhash Deserts. Dust, sand and salt storm sources lead to the degradation of pastures and agricultural fields, impoverishment of biodiversity, soil salinization, and general aridization process.

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