Investigation of Chemical and Mineralogical Properties of Dust Entering Northeastern Iran and its Pathogenic Potential

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1. Introduction

Dust is one of the most important natural hazards in the world, especially on the edge of deserts and arid and semi-arid climates. In summer, dust storms caused by 120-day winds that originate from Karakum Desert in southern Turkmenistan and sometimes the dry bed of the Aral Sea affect the northeastern parts of Iran and endanger the living conditions of the inhabitants of these areas. In order to understand the effect of dust on health, the chemical properties of dust entering these areas have been studied. For this purpose, a sampler was installed on the border of Iran and Turkmenistan (Sarakhs) and Iran and Afghanistan (Taybad). Sampling was done monthly from July to September 2017 and the mineralogical and chemical properties of dust were done using ICP and XRD methods. The results showed that among the main elements, calcium, aluminum and silicon have a higher percentage, respectively, and there are significant amounts of trace elements like B, S, Ba and Sr than other elements in the region. Quartz, calcite, dolomite and montmorillonite minerals have a higher percentage than other minerals among the studied samples. The presence of heavy elements such as arsenic, lead, tungsten, cadmium and iron in dust samples at high concentrations may lead to sinusitis, bronchitis, asthma and allergies, and damage the defense function of macrophages, which leads to increased nosocomial infections.

2. Study Area

East of Greater Khorasan is affected by strong wind currents, usually known as 120-day winds or Lavar winds. These winds usually blow from north to south in spring and especially in summer, and eventually lead to dust storms, especially in Sistan region, but the deserts in Turkmenistan, especially Karakum desert is one of the major dust distribution areas and has been introduced in East Khorasan, but other local sources in Afghanistan as well as in Iran are among the dusty areas. Sarakhs city, as the easternmost city of Khorasan Razavi, is the first region to be affected by this dust coming from Turkmenistan, and then Taybad city, due to its proximity to Afghanistan,

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can also receive dust from Afghanistan. For the mentioned reasons, these two areas were selected as dust sampling areas.

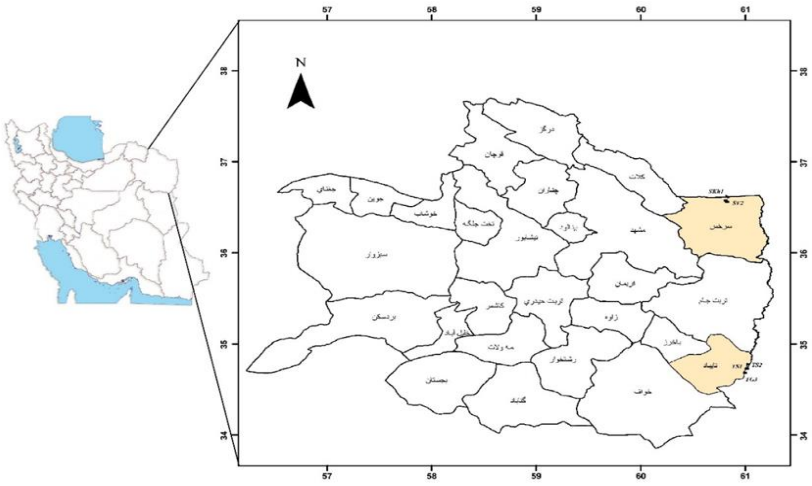

Figure1. Sampling installation location map

3. Materials and Methods

First, various studies on the chemical and mineralogical properties of dust, tracking its transmission paths using the HYSPLIT model in Iran and the world were reviewed. In the next step, meteorological data were processed with the help of which the region's wind was drawn to detect the direction and frequency of dust-carrying winds to have an overview of the region's wind conditions. Then, to track the movement of air masses during the occurrence of dust storms in the area, the Lagrangian model of Hysplit was used. For this purpose, after identifying the dust days in each of the studied stations, the trajectory of air mass movement was calculated and its map was prepared and drawn. In the next stage, suitable sampling equipment was designed and installed in the direction of the prevailing wind in the northeastern borders of the country, near the border of Turkmenistan and Afghanistan in summer, when the frequency of high dust phenomenon occurs. Visits and collection of collected samples of equipment were performed over a period of four months. At the end of each month, samples were collected from sedimentary and transit samples and transferred to Ferdowsi University Central Laboratory for ICP-OES analysis and identification of major and minor elements in the samples. Chemical analysis of dust particles can identify heavy metals as well as trace elements that are commonly harmful to human health. XRD (X-ray diffraction) analysis was also performed to determine the type of minerals in the samples.

4. Results and Discussion

Studies show that dust events mostly affect the region in spring and summer. The rose of Sarakhs shows that the prevailing wind blows from the northwest all year round and the highest wind speed is related to summer. In Taybad, the prevailing wind blows from

the northeast in spring, and in summer, the prevailing wind is northeast, but the north wind also has a considerable amount, both of which are faster than 11 m/s. Due to the fact that the prevailing winds in the region and the wind speed are the highest in summer, it is expected that dustier days will occur in summer.
The results of the HYSPLIT model show that most of the particles transferred from Turkmenistan and a small part from Uzbekistan have moved to Sarakhs. Due to the altitude-based particle transport route, which is the lowest in Turkmenistan and reaches zero, it is likely that dust particles have moved from this loaded area to Sarakhs.
During the chemical analysis of the dust samples collected in Sarakhs and Taybad regions, nine main elements were identified. Comparison of the six main elements SiO_2, CaO, Al_2O_3, Fe_2O_3, MgO and K_2O with the study area with Sistan, Khuzestan, Iraq and the global average shows that the amount of quartz mineral in Iranian dust is less than the global average and the amount of Al2O3 is almost average. The world is equal but higher than other regions and the global average CaO is lower than the regions mentioned in Iran and Iraq.
Based on the results of XRD analysis, nine minerals were identified in the dust samples that quartz, calcite, dolomite and montmorillonite had a higher percentage than other minerals among the studied samples. Due to the prevailing northeast wind direction, Hysplit model outputs and the presence of clay deserts in the north of Sarakhs in Turkmenistan, the presence of clay minerals in this region can originate from the upstream regions in Turkmenistan.

5. Conclusion

An elevation study of the particle motion path in the sampling interval based on the HYSPLIT model expenditures indicates that wind-transported particles may have entered the study area from Turkmenistan and a small part of Uzbekistan. The elements in the dust of the study area in comparison with the global dust show that CaO is almost twice the global percentage and other oxides correspond almost to the global percentages. The elements in Taybad samples are more than ferns and also the amount of elements in sediment samples is more than the passage which shows the efficiency of most of these samples in the region. The mineral composition of dust particles indicates that the minerals that make up most of the samples include quartz, clay minerals, and calcite. Mineralogical similarity between Central Asia, Northeast of Iran and Sistan with respect to the direction of dust movement in the direction of the prevailing wind and according to the Hysplit model indicates the movement of particles from Central Asia to the south to the Sistan region. According to the test results, the amount of lead, copper and manganese is more than the allowable limit and affects the health of residents in the area.

Keywords: Dust, Chemical Properties, XRD, Health, Northeast

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