Dust fallout in northern Kuwait, major sources and characteristics

ALI. M. AL-DOUSARI* AND JASSEM AL-AWADHI**

*Coastal and Air Pollution Department, Kuwait Institute for Scientific Research, P.O.Box: 24885 Safat 13109, adousari@kisr.edu.kw.
**Kuwait University, Department of Earth and Environmental Sciences

ABSTRACT

Fallen dust was monitored and analyzed in preserved (National Park and Al-Liyah) and open areas (Bubiyan, Warba, Al-Jahra, Shuwaikh, Al-Mutla and Sabiya) in Kuwait. Data from satellite images (2000 to 2010) were used to identify major dust trajectories. Five major source areas are identified: the western desert of Iraq, the Mesopotamian Flood Plain, northeastern desert of Saudi Arabia, and drained marshes in southern Iraq and Iran. The Bubiyan and Warba islands, muddy playas, depressions, sabkhas, dry marshes and intertidal zone (especially areas between high tide and high-high tide zone) are the major local sources of dust in Kuwait. There is a trend of westerly coarseening for mean particle size. The sand size fractions represent 37%, while the mud fractions are 63% of the average total dust. Bubiyan dust is negatively skewed, trimodal with dominance of clay (coarse and fine silt size fractions), while Al-Liyah dust in open desert is negatively skewed, unimodal with a dominance of very coarse silt. National park areas show the lowest annual quantity of dust (2 tons/km²) in comparison to Warba (58 tons/km²), Al-Jahra (36 tons/km²), and Al-Liyah (31 tons/km²) areas, while the maximum occurs in Bubiyan (112 tons/km²). Quartz percentages vary from 35% to 52% with 44% as average. Generally, quartz increases with the decrease in carbonate percentages during summer time due to the increase in aeolian activities. Surface area values illustrate higher variability compared to regional and global samples but similar to dust collected from other locations in the Arabian Gulf Coast (Bahrain, Dubai, and Ain).

Keywords: Fallen dust; dust trajectories; surface area; mesopotamian flood plain.

INTRODUCTION

Kuwait is susceptible to dust and sand storms due to its low topographic relief, drought, scantly vegetation, light-textured topsoil, and recurring strong and turbulent winds (Al-Hurban & Al-Ostad, 2010). In general, dust activity in the Arabian Peninsula, including Kuwait, is low during northern hemisphere winter, grows strong in March-April, and increases to its maximum in June and July (Prospero et al., 2002). The dust storms passing over Kuwait are considered to be major sources of sediments (Khalaf et al., 1980, Al-Bakri et al., 1984, Foda et
al., 1985). Frequency and rates of dust deposition indicate that the rates of aeolian accumulation may be of similar magnitude to rates of fluvial erosion (Goudie & Middleton, 2001). Al-Basri (1993) stated that statistical analysis of dust phenomena data (1960-1989) in Kuwait shows that dust storms, rising dust and suspended dust occur during 17.3%, 46% and 35.9%, respectively of the total dusty days. According to Safar (1980), dust (dust/sand storms and rising/ suspended dust) occurs 13% of the time (day and night) throughout the year in Kuwait but this percentage increases to 25% of the daytime throughout April to August. He stated that the annual average number of dusty days in Kuwait is 255.4 days. Therefore, this study aims to investigate sources rather than physical (particle size, surface area and shape) and mineralogical characteristics of fallen dust in Kuwait.

**STUDY AREA**

The study area is located in northern Kuwait along the northwest coast of the Arabian Gulf. This area is the best location in the region to study dust, as it is surrounded by major sources of dust storm (Al-Dousari et al., 2004; Al-Hurban & Al-Ostad, 2010). Also, the location suffers from severe land degradation caused by overgrazing, off road vehicle tracks, camping and quarrying (Al-Dousari et al., 2009). Statistical summary of meteorological data for the period 1957-2008 (International Airport- 10 km south of Shuwaikh) indicates that the climate in Kuwait is arid with a mean annual rainfall of 119 mm, while mean annual potential evapo-transpiration exceeds 2,270 mm. Average air temperature is 37°C and 17°C in summer (May-September) and winter (October-April), respectively. The wind direction is dominantly from the northwest and, to a lesser extent, the southeast. The northwesterly wind represents 60% of the total wind directions in Kuwait. Winds from other directions are less frequent and of shorter duration. The average wind speed is 4.8 m/s, while 12% of the year the wind is negligible (Al-Awadhi, 2005).

**MATERIALS AND METHODS**

A dust storm is meteorologically defined whenever the visibility is less than 1,000 meter (Al-Kulaib, 1990). In the last decade (July 2000 to March 2010), dust storm days were counted in Kuwait using airport meteorological data (Fig. 1). Low resolution images such as METEOSAT (visible and infra red images), MODIS (bands 3, 4 and 7), TOMS, AVHRR, and SeaWiFS were collected within the same period in order to locate the major and intermediate regional and local sources of dust. Dust storm images were also collected from satellites offering free web sites. The collected images from these satellite data, with reference to dust storm days, were used in tracing major trajectories. A map was
produced by locating the major trajectories that shows the trajectory direction and duration. The trajectories were classified into two types according to surface area covered by the dust storm. The trajectories were detected using meteorological data and satellite images. These classifications are major (greater than or equal to 3,000 Km²) and intermediate (less than 3,000 Km²) trajectories.

![Dust storm frequency](image)

**Fig. 1.** The monthly average number for dust storm days in Kuwait (2000-2010).

Modified dust traps were manufactured following the design of Al-Awadhi (2005). The modifications included thermal insulation of the sides and the bottom of the dust containers. The dust traps were installed at 42 sites at 240 cm above ground surface and were chosen to represent the prevailing environmental conditions of Kuwait. The traps were fixed in the field 50 m ((or greater) away from any infrastructure. The dust rates were monitored monthly for the period from 1st November 2006 to 31st December 2007 for all collectors. Dust traps were located in eight distinct zones representing preserved (Sabah Al-Ahmed National Park and Al-Liyah) and open areas (Bubiyan, Warba, Al-Jahra, Shuwaikh, Al-Mutla and Sabiya) (Fig. 2). The collected data were also compared with those from Kuwait Environment Public Authority (KEPA) as well as regional and global literature.
Initially, the characteristics of the dust were examined and interpreted using a series of analytical tools. Grain size parameters were determined using standard sieve analysis and Centrifugal Particle Analyzer (Shimadzu, SA-CP3) for dust fallout in Al-Liyah area (L18) and Bubiyan (D-08), as they are representative samples for desert and coastal areas, respectively. The Brunauer, Emmett and Teller (BET) surface area is expressed as values of a certain weight of loose sand in terms of m²/g measured by using isotherm plot diagrams of volume against pressure, and using the BET equation. All components of the dust samples were gently powdered and analyzed using Philips PW-1830 X-ray Diffraction (XRD). Semi-quantitative analysis was carried out for Bubiyan (D07), Warba (D09), Saliya (S-3) and National Park (RD4) samples and the results were compared with regional and global dust data. Also, Scanning Electron Microscope (SEM) was used to analyze Bubiyan and Al-Liyah dust samples (L18 and D-08) with magnification ranging from 600 to 2700X.

RESULT AND DISCUSSIONS

Dust regional sources

Several authors have discussed the sources of dust storms in Kuwait such as Khalaf et al. (1980), Foda et al. (1985), Gharib et al. (1987), Al-Awadhi (2005), and Al-Harban & Al-Ostad (2010). In this study, a new approach in
understanding the dust fallout phenomena was attempted. Recently, extra new sources of dust storms were noticed on a regional scale by recent satellite images (2000-2010). These are: the areas that suffered from three war activities (the Iraq-Iran war 1980-1988, the first Iraq war August 1990-February 1991 and the second Iraq war (March-April 2003). These major war activities inflicted severe destruction on the surrounding environment. Large farmlands in Iraq and Iran were degraded and abandoned. These farmlands act as new sources of dust. Other interesting aspects of the dust fallout are the possible effects of drained marshes "Ahwar", in the southern part of Iraq. Drought and land degradation acts as a major activator of dust storms in deserts (Strong et al., 2010). Kuwait is surrounded by major rather than intermediate dust source areas. In this study, these regional sources of dust were identified (Fig. 3) and satellite-derived data is increasingly used to identify temporal and spatial variations in their emission intensities. These five major sources of dust are:

1 - Southwestern desert of Iraq.

2 - The Mesopotamian Flood Plain in Iraq.

3 - North eastern desert of Saudi Arabia.

4 - Drained marshes (Ahwar) area in southern Iraq.

5 - Sabkhas, dry marshes and abandoned farms in Iran at northern coastal area of Arabian Gulf.

In addition, four intermediate sources of dust storm trajectories (covering an areas less than 3000 km$^2$) were identified which are:

1 - Bubiyan and Warba islands (sabkhas) in Kuwait.

2 - The drainage systems in the tri-border area between Kuwait, Saudi Arabia and Iraq.

3 - The playas and drainage basins in the southwestern desert of Iraq close to Kuwait.

4 - The coastal sabkha in Saudi Arabia, near southern Kuwaiti borders.
Dust fallout in the study area

It was observed that the amount of collected dust in the Sabah Al-Ahmed National Park is the lowest in comparison to other locations. The rate in the National Park is nearly a quarter as compared to that in Al-Jahra area. On the other hand, Bubiyan Island, Sabiya and Warba Island show the highest quantities of dust (Fig. 4). It is worth mentioning that the annual dust deposited in urban Shuwaikh is higher than some open desert areas such as Al-Mutla and Al-Liyah. This could be due to the presence of sabkhas and a wide intertidal zone (especially between high tide and high-high tide) around Kuwait Bay providing a shallow muddy marine environment upwind of Shuwaikh. The mud size particles are a favorable load for high speed winds. The annual dust data from Kuwait Environment Public Authority (KEPA) for single dust trap in Shuwaikh area shows inverse relationship with annual rainfall (Fig. 5).
Spatial and temporal variations were noted in the dust quantities for all locations (Fig. 6). The final results show higher quantities in November-January and April in winter time, and July-August and September in summer time. The desert of Kuwait contains rare or no vegetation cover due to severe degradation and drought episodes. The National Park, where vegetation is dense, is an exceptional case as it records the lowest fallen dust quantities. The dense vegetation play a major role in controlling mobility of aeolian particle (dust and sand). Vegetation acts as a trap for aeolian particles and can provide a protective cover for soil from wind erosion (Al-Dousari, 2005). The monthly dust fallout quantities coincide with the timing of major dust storm trajectories. The quantities of dust fallout within Bubiyan and Warba Islands are around
triple the average dust fallout in the study area during January, April and August. This observation may be the result of one or more of the following:

1 - The higher contribution of dust from regional sources specially those of Mesopotamian Flood Plain.

2 - Large quantities of mud (silt and clay) particles within the tidal flats and channels are covering most of Warba and Bubiyan islands (about 1,000 km²) and surroundings.

![Graph showing dust fallout variations]

**Fig. 6.** Average monthly variations of dust fallout in the eight study areas.

**Dust fallout in selected regional and global areas**

The overall dust fallout in the study area is higher in comparison to surrounding regional and global areas with the exception of those in the Sahara Desert (Table 1). The higher concentration of dust in the eastern, western and southwestern parts of the study area can be attributed to local geomorphology of the area, where numerous dry wadis contribute in feeding the predominant northwesterly wind with dust particles. On the other hand, the average dust fallout in the National Park in Kuwait is much lower than all regional and some global dust fallout studies, which indicates the importance of protected areas and conservation of natural vegetation in reducing the amount of fallen dust. It is noteworthy that the National Park is protected area since 1994, which is much earlier than the area around Al-Liyah by about 15 years.
Table 1. Average annual fallen dust in tons/km² within local, regional and global area

<table>
<thead>
<tr>
<th>Location</th>
<th>Political region</th>
<th>Reference</th>
<th>Annual dust (tons/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open areas</td>
<td>Kuwait</td>
<td>Present study</td>
<td>61.30</td>
</tr>
<tr>
<td>Preserved areas</td>
<td>Kuwait</td>
<td>Present study</td>
<td>16.76</td>
</tr>
<tr>
<td>Khur Al-Zubir</td>
<td>Iraq</td>
<td>Khalaf et al. 1980</td>
<td>75.92</td>
</tr>
<tr>
<td>Um Qasir</td>
<td>Iraq</td>
<td>Gharib et al. 1987</td>
<td>193.47</td>
</tr>
<tr>
<td>Al Fahal</td>
<td>Oman</td>
<td>Badawy et al. 1992</td>
<td>89</td>
</tr>
<tr>
<td>Riyadh</td>
<td>Saudi Arabia</td>
<td>Modaihsh, 1997</td>
<td>392</td>
</tr>
<tr>
<td>Dead Sea</td>
<td>Palestine</td>
<td>Singer et al. 2003</td>
<td>45</td>
</tr>
<tr>
<td>North Diarnena</td>
<td>Chad</td>
<td>Maley, 1982</td>
<td>142</td>
</tr>
<tr>
<td>Kano</td>
<td>Nigeria</td>
<td>McTainsh et al. 1982</td>
<td>137-181</td>
</tr>
<tr>
<td>Crete</td>
<td>Greece</td>
<td>Pye, 1992</td>
<td>10-100</td>
</tr>
<tr>
<td>Arizona</td>
<td>U.S.A</td>
<td>Pewe, 1981</td>
<td>54</td>
</tr>
<tr>
<td>Nevada</td>
<td>U.S.A</td>
<td>Reheis, 2006</td>
<td>4.3-15.7</td>
</tr>
<tr>
<td>California</td>
<td>U.S.A</td>
<td>Reheis, 2006</td>
<td>6.8-33.9</td>
</tr>
<tr>
<td>Libya</td>
<td>Libya</td>
<td>O’Hara et al. 2006</td>
<td>155</td>
</tr>
<tr>
<td>Tan Tan</td>
<td>Morocco</td>
<td>Rott, 2001</td>
<td>175</td>
</tr>
<tr>
<td>Boujdour</td>
<td>Western Sahara</td>
<td>Khiri et al. 2004</td>
<td>219</td>
</tr>
<tr>
<td>Dakhla</td>
<td>Mauritania</td>
<td>Rott, 2001</td>
<td>191</td>
</tr>
<tr>
<td>Along Niger River</td>
<td>Mali</td>
<td>McTainsh et al. 1997</td>
<td>913-10446</td>
</tr>
<tr>
<td>Namoi Valley</td>
<td>Australia</td>
<td>Cattle et al. 2002</td>
<td>16.9-58.2</td>
</tr>
<tr>
<td>Shapotou</td>
<td>China</td>
<td>Li et al. 2004</td>
<td>372</td>
</tr>
</tbody>
</table>

Grain size characteristics

The long distance suspended dust consists of mud particles that originated from regional sources such as the Western Desert of Iraq and Mesopotamian Flood Plain. In addition, the coarse dust material (larger than 63 μm) and grain size fractions (sand) originated locally. The mud particles represent 63%, while the sand is 37% from the total dust samples. The sand particles, which are heavier than mud, move in the form of saltation or short term suspension. They are transported for short distances only and dominantly originate from local sources (Pye, 1992). The grain size percentages vary between those collected in open desert and others in sabkhas (Bubiyan and Warba). Bubiyan dust is negatively skewed, trimodal predominantly clay, with coarse and fine silt size fractions (Fig.
7a). The trimodality of the distribution curves indicate multiple sources. Al-Liyah dust in the open desert is negatively skewed, unimodal with a dominance of very coarse sand size fraction (Fig. 7b). There is a trend of coarsening of the mean size fraction towards the west. Also, the dust particles collected from western sector is larger and smoother than those in the eastern side of the study area (Fig. 8b). Bubiyan dust is finer and contains multi-grain particles, mainly gypsum (CaSO$_4$.2H$_2$O) and bassanite (CaSO$_4$.1/2H$_2$O) (Fig. 9d).

**BET surface area**

The BET surface area of dust fallout from Al-Mutla (J66), Warba and Bubiyan was analyzed and compared with mud size particles from the Dibdibba Formation in order to identify the main sources of dust. The Dibdibba Formation represents a main geological unit which is exposed in the surface of the study area. It is mainly composed of calcereic sand. Also, comparison was extended to cover regional and global aeolian samples.

The surface area values of the dust samples obtained from the study area varied quite significantly from the surrounding sand samples. The samples in Bubiyan and Warba islands are quite different compared to those of Al-Mutla and other sites. This is attributed to the sedimentological and geographical settings of the two islands. Comparison of these values with regional and global aeolian particles, illustrates higher variability with regional (Amman-Jordan and Cairo-Egypt) and global (Cartagena-Colombia), but similar to dust samples collected from Arabian Gulf countries by the authors (Fig. 9). In addition, the dust samples are quite different than the Dibdibba Formation. The previous results may lead to a hypothesis based the following main conclusions:

1 - Variability of the surface area with time in the study area indicates multiple sources. On the other hand, Warba and Bubiyan islands dust drifted from multi regional sources, but dominantly from the Mesopotamian Flood Plain (Fig. 10).

2 - Due to the large differences in the BET surface area between the Dibdibba Formation and dust samples, the formation is eliminated from the expected sources of dust.
Fig. 7. Average grain size percentages of dust fallout in Bubiyan (a) and Al-Liyah (b).

Fig. 8. Smooth dust particles within Al-Liyah with dominancy of very coarse silt (a), smooth sub-angular quartz grain with some adhering carbonates particles (b), and 30 micrometer carbonate particles from Bubiyan with a large number of adhering gypsum and bassanite particles (c and d).
**Mineralogical analysis**

The XRD semi-quantitative results show that quartz and calcite are the major minerals in the dust fallout samples of the study area. Feldspars are found with appreciable amounts (13% in average), while other minerals are recorded with minor percentages (3%). Quartz percentage varies from 35% to 52% with an average of 44% (Table 2). Generally, quartz percentages increase with decrease of carbonates during the summer time due to the increase in aeolian activities (Fig. 11). Dust is characterized by higher carbonates and lower clay minerals compared to the dust in Sahara Desert, east and middle Asian regions.
Table 2. The XRD mineralogical results of fallen dust in Kuwait and surroundings.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Area</th>
<th>Collected by</th>
<th>Quartz</th>
<th>Calcite</th>
<th>Dolomite</th>
<th>Carbonates</th>
<th>Feldspars</th>
<th>Clay</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubiyan</td>
<td>East Kuwait</td>
<td>Authors</td>
<td>28</td>
<td>20</td>
<td>14</td>
<td>34</td>
<td>18</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>National Park</td>
<td>North Kuwait</td>
<td>Authors</td>
<td>38</td>
<td>38</td>
<td>7</td>
<td>45</td>
<td>10</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Warba</td>
<td>NE Kuwait</td>
<td>Authors</td>
<td>36</td>
<td>30</td>
<td>11</td>
<td>42</td>
<td>8</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Sabiya</td>
<td>East Kuwait</td>
<td>Authors</td>
<td>39</td>
<td>26</td>
<td>11</td>
<td>37</td>
<td>12</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Dubai</td>
<td>East U.A.E</td>
<td>Authors</td>
<td>21</td>
<td>25</td>
<td>21</td>
<td>45</td>
<td>6</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Ain</td>
<td>West U.A.E</td>
<td>Authors</td>
<td>26</td>
<td>34</td>
<td>19</td>
<td>52</td>
<td>20</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Doha</td>
<td>Qatar</td>
<td>Authors</td>
<td>48</td>
<td>21</td>
<td>7</td>
<td>28</td>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Amman</td>
<td>Jordan</td>
<td>Authors</td>
<td>21</td>
<td>52</td>
<td>16</td>
<td>68</td>
<td>4</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Manama</td>
<td>Bahrain</td>
<td>Authors</td>
<td>32</td>
<td>25</td>
<td>16</td>
<td>41</td>
<td>10</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Wadi Dawasir</td>
<td>South Arabia</td>
<td>Authors</td>
<td>62</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>24</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Riyadh</td>
<td>Saudi Arabia</td>
<td>Modaigh, 1997</td>
<td>68</td>
<td>32</td>
<td>0</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Negev Desert</td>
<td>Palestine</td>
<td>Craviet et al. 2008</td>
<td>41</td>
<td>21</td>
<td>2</td>
<td>23</td>
<td>18</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Libya</td>
<td>Libya</td>
<td>O’Hara et al. 2006</td>
<td>64</td>
<td>27</td>
<td>0</td>
<td>27</td>
<td>5</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Andong</td>
<td>South Korea</td>
<td>Jeong, 2008</td>
<td>28</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>19</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Beijing</td>
<td>China</td>
<td>LongY et al. 2007</td>
<td>20</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>40</td>
<td>23</td>
</tr>
</tbody>
</table>

Summary and Conclusions

This detailed study of the dust leads to the following conclusions:

- The northwestern, western and northern winds play a major role in the sourcing of dust storms into the study area.
- Regional areas represent the dominant sources of dust fallout, while local sources contribute appreciable amounts.
- The very fine and fine sand particles originate from local sources as they
move in the form of salination or short term suspension for a short distance. They represent 37% of the average dust fallout in Kuwait.

- There is a trend of fining in mean size for dust particles towards the east and the northeast.
- Carbonates and quartz are the major components of dust in Kuwait, feldspars are found in appreciable amounts.
- Other minerals in the dust are gypsum, anhydrite, bassanite and heavy minerals.
- The muddy playas, depressions, sabkhas and intertidal zone (Bubiyan and Warba islands) are the major sources of local dust.
- Natural vegetation plays a major role in minimizing and reducing fallen dust. Open desert areas show an increase in the quantities of dust fallout by at least two thirds more than in the National Park within Kuwait.
- Further studies should concentrate on other aerosols associated with dust (pollen, organic matter, hydrocarbons) rather than dust control measures.

ACKNOWLEDGMENT

The authors express their gratitude to Kuwait Foundation for the Advancement of Science (KFAS) for project (2008-1401-01) and the Kuwait Institute for Scientific Research (KISR) for funding the projects ECO41K and EC063C. Appreciations are also extended to Kuwait Environment Public Authority (KEPA) and Meteorology Department (Kuwait Airport) for data support. Thanks to Dr. Subramaniam, Dr. Misir and Mr. Majeed for proofreading.

REFERENCES


Submitted : 15/6/2011
Revised : 6/2/2012
Accepted : 7/2/2012
الغبار المشتقات في شمال الكويت،مصادره الرئيزة وخواصه

علي محمد الدوسي
* ** جاسم العوسي
* معهد الكويت للأبحاث العلمية - مجموعة الدراسات الصحراوية ص. ب: 24885 الصفات 13109

خلاصه

تم مراقبة وتحليل الغبار المشتقات على الكويت في المناطق الصحراوية (محميّاً صاحب الأحمد واللياح) والمفتوحة (بوبيان ووربة والجهراء والشويخ والمطلاع والصبية). استخدمت المعلومات المستقاة من صور الأقمار الصناعية من 2000-2010 لتحديد مصادر ومسارات العواصف الغبارية الرئيزة. حددت عبر هذه الصور خمس مناطق رئيسية هي: الصحراء الغربية للعراق، السهل الفيضي للمرافدين، الصحراي الشمالية الشرقية للمملكة والأهوار الجافة في العراق وإيران. ومن ناحية أخرى تُعتبر جزيئات بوبيان ووربة والخبارى الطيني والنسج. إضافة إلى الأهوار الجافة ومنطقة المد (حديقة المنطقة المحصورة بين المد العالي والمد العالي جدًا) أهم المصادر المحلية للغبار في الكويت.

أظهرت نتائج التحليل الحجمي أن الحجم الرملي يمثل 37.3% من متوسط الحجم الكلي. لعينات الغبار في حين أن دخان الطين تمثل 63%. إن الأجزاء العام للتصنيف الحجمي لعينات يكرب في اتجاه الغرب ويقل باتجاه الشرق. يتميز الغبار في بوبيان بأنه دقيق حجمًا وذو ترطح سالب وثلاثي التوزيع للحيانات مع وجود غالبية لحيانات الطين والغرين الخشن والناعم. الغبار في الزياد، من ناحية أخرى ذو توزيع أحادي وترطح سالب مع غلبة الغرين الخشن جدًا. تعتبر محمية صاحب الأحمد الأقل في الغبار المترسب (2 طن/كم²) بالمقارنة مع مناطق ورية (58 طن/كم²) والجهراء (36 طن/كم²) واللياح (31 طن/كم²) في حين أن بوبيان الأعلى (112 طن/كم²). يتم الكوارترز النسبة الأعلى من المعادن ويتراوح بين 35-52%. ويستقر 44%. أظهرت نسبة الكوارترز ارتفاعًا مع انخفاض نسبة الكربونات في فترات الصيف نتيجة زيادة العمليات البحريّة في المنطقة.

أبرز تحليل المساحة الكلية ثلاثية الأبعاد لحيانات الغبار في الكويت اختلافًا كبيرًا بالمقارنة مع الغبار إقليميًا وعالميًا وتشابها مع الغبار في مواقع بدول الخليج العربي (البحرين ودبى والعين).
الشريعة الإسلامية والقضايا المعاصرة

رئيس التحرير الأساتذة الدكتور: 

صدر العدد الأول في رجب 1444 هـ - أبريل 1924 م

تهدف إلى معالجة المشكلات المعاصرة والقضايا المستجدة من وجهة نظر الشريعة الإسلامية.

تشمل موضوعاتها معظم علوم الشريعة الإسلامية: من تفسير، وحديث، فقه، واقتصاد و التربية الإسلامية، إلى غير ذلك من تقارير عن المؤتمرات، ودراسة كتاب شريعة معاصرة، وفناي شرعية، وتعمق.

على قضايا علمية. 

تتنوع الباحثون فيها، فكانوا من أعضاء هيئة التدريس في مختلف الجامعات والكليات الإسلامية وعلى رقعة العالمين: العربي والإسلامي.

تخضع البحوث المقدمة للملحة إلى عملية فحص وتحكيم حسب الضوابط التي النمت بها المجلة، ويقوم بها كبار العلماء والمختصين في الشريعة الإسلامية، بهدف الارتقاء بالبحث العلمي الإسلامي الذي يخدم الأم، ويصل زيارة شاربها، نشاط المولي زوج مزيداً من التقدم والاستغلال.

المراسلات توجه باسم رئيس التحرير

العنوان الإلكتروني: jsis@ku.edu.kw

E-mail: jsis@ku.edu.kw

http://pubcouncil.kuniv.edu.kw/JSIS

Social and Human Sciences Documentation Center

عنوان المجلة على شبكة الإنترنت:  

www.unesco.org/general/eng/infoserv/db/dare.html

في شبكة الإنترنت تحت الموقع
تfühت أبوابها أمان
أوسع مشاركة للباحثين العرب في مجال
العلوم الاجتماعية لنشر البحوث الأصيلة
والاسهام في مواجهة قضايا مجتمعاتهم
التفاعل المحلي مع القارئ المثقف والمهم
بالقضايا المطرحه
المقابلات والمناقشات الجادة
ومراجعات الكتب والمناقشة.
تتعدّ مجلة المجلة بالإلتزام بالإجماع والالتزام بوصولها في
مؤاعدها المحددة إلى جميع شؤونها ومشاركتها.

الاشتراكات

<table>
<thead>
<tr>
<th>الدول الأجنبية</th>
<th>الكويت والدول العربية</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 دولاراً</td>
<td>أفراد</td>
</tr>
<tr>
<td>60 دولاراً في السنة</td>
<td>أفراد</td>
</tr>
<tr>
<td>110 دولارات لستين</td>
<td>مؤسسات</td>
</tr>
<tr>
<td>3 دنانير سنوياً وضيف إليها</td>
<td>15 ديناراً في السنة</td>
</tr>
<tr>
<td>دينار واحد في الدول العربية</td>
<td>25 ديناراً لمدة سنتين</td>
</tr>
</tbody>
</table>

تتدهع إشتراكات الأفراد فقط أو شبكي باسم المجلة مسبقاً على أحد المسارع الكويتية، وبرسول على عنوان المجلة، أو بتحويل مصرى
لحساب مجلة العلوم الاجتماعية رقم 07101685 لدى بنك الخليج في الكويت (فرع العدودية).

Visit our web site: http://pubcouncil.kuniv.edu.kw/jss
المجلة التربوية

مجلة فصلية، تخصصية، محكمة

تصدر عن مجلس النشر العلمي - جامعة الكويت

رئيس التحرير: د. عبد الله محمد الشيخ

نشر:
- البحوث التربوية المحكمة
- مراجعات الكتب التربوية الحديثة
- محاورات الحوار التربوي
- التقارير عن المؤتمرات التربوية
- ملخصات الرسائل الجامعية

تقبل البحوث باللغتين العربية والإنجليزية.

نشر لأساتذة التربية والمختصين بها من مختلف الأقطار العربية والدول الأجنبية.

الاشتراكات:
- في الكويت: ثلاثة دنانير للأفراد، وخمسة عشر ديناراً للمؤسسات.
- في الدول العربية: أربعة دنانير للأفراد، وخمسة عشر ديناراً للمؤسسات.
- في الدول الأجنبية: خمسة عشر دولاراً للأفراد، وستون دولاراً للمؤسسات.

توجه جميع الرسائل إلى:
رئيس تحرير المجلة التربوية - مجلس النشر العلمي صب ب - الكويت 1955
الكويت 13628-7777777 (داخلي)، 44-09424-7777777 (داخلي)، 44-09424-7777777 (داخلي)
E-mail: jee@ku.edu.kw