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The evaluation of PM_{10}, $PM_{2.5}$, and PM_1 concentrations during the Middle Eastern Dust (MED) events in Ahvaz, Iran, from april through september 2010

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In this study, PM_{10}, $PM_{2.5}$, and PM_1 concentrations were measured from April through September 2010. These measurements were made every six days and on days with dust events using a Grimm Model 1.177 aerosol spectrometer. Meteorological data were also collected. Overall mean values of 319.6 ± 407.07, 69.5 ± 83.2, and 37.02 ± 34.9 μg/m^3 were obtained for PM_{10}, $PM_{2.5}$, and PM_1, respectively, with corresponding maximum values of 5337.6, 910.9, and 495 μg/m^3. The presence of the westerly prevailing wind implied that Iraq is the major source of dust events in this area. A total of 72 dust days and 711 dust hours occurred in the study area. The dust events occurred primarily during July. The longest dust event during the study period occurred in July, lasted five days, and had a peak concentration of 2028 μg/m^3. These high concentrations produced AQI values of up to 500. A total estimated mortality and morbidity of 1131 and 8157 cases, respectively, can be attributed to these concentrations. The results of this study indicated the importance of dust events in Ahvaz and their possible health impacts. The study also demonstrated the need to design and implement intergovernmental management schemes to effectively mitigate such events.

1. Introduction

Dust events are defined as natural events with substantial particulate matter (PM) concentrations, usually occurring in arid, semi-arid, or desert areas (Wang et al., 2005) and primarily resulting from low vegetation cover and strong surface winds (Kurosaki and Mikami, 2003). Dust events produce the large-scale or even global transport of large amounts of mineral dusts every year (Moulin, 1997). It is hypothesized that half of this amount is deposited near the sources. The other half can be suspended in the atmosphere, undergoing long-range transport (Zhang, 1995) and strongly affecting PM concentrations (He et al., 2001), the earth's radiation budget (Satheesh and Krishna Moorthy, 2005), traffic and agriculture (Kurosaki and Mikami, 2003), the chemical composition of the troposphere (Dentener et al., 1996), the thermal structure of the atmosphere, and photochemical and dynamic processes in the atmosphere (Liao et al., 1999). Therefore, the dust transported by these events can interfere with normal activities.

In addition to the abovementioned impacts, the health effects of dust events over both the short and the long terms have attracted the attention of scientists. This scientific interest has produced many epidemiological studies in susceptible areas. For example, Kwon et al. (2002) found a statistically significant relationship between dust events and mortality due to cardiovascular and respiratory diseases in Seoul, Korea. Meng and Lu (2007) associated dust events with total respiratory hospitalization, upper respiratory tract infection, pneumonia, hypertension, and cardiovascular hospitalization. Moreover, Perez et al. (2008) hypothesized that

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mineral dust can significantly increase total mortality owing to the coarse fraction of particulate matter. It has also been hypothesized that these health effects are greater in people whose socioeconomic status is low (Neidell, 2004). Similar results were obtained by Chan et al. (2008). Additional sources (Brunekreef and Forsberg, 2005; Pope and Dockery, 2006; WHO, 2006) offer more detailed information.

The other hazard posed by dust events is that the mineral dusts associated with the events can potentially carry different infective agents and transport them over long distances. According to Kellogg and Griffin (2006), dust events can produce large-scale transport of pathogens and thereby affect downwind populations and ecosystems. Griffin (2007) also found that pathogenic microorganisms such as *Bacillus anthracis*, *Yersinia pestis*, *Mycobacterium tuberculosis*, *Legionella pneumophila*, and influenza viruses can be transported by desert dusts and produce outbreaks at downwind sites. In addition, it has been suggested that wind-blown desert dusts commonly carry high amounts of toxins and thereby endanger the organisms and ecosystems exposed to the dust (Sandstrom and Forsberg, 2008). Moreover, metal elements can bind to dust particles and therefore affect respiratory function (Hong et al., 2010). Dust events have also been related to increased deposition rates of radioactive material (Akata et al., 2007). Therefore, the importance of mineral dust particles should not be neglected.

The Sahara Desert, located in North Africa, is considered to represent the major source of mineral dust in the world, releasing approximately one billion tons of dust annually (Moulin, 1997). Western China and parts of Mongolia are believed to be the second major source of desert dust (Wang et al., 2008). Dust from this source is termed “Asian Dust”. Because of their importance, these two sources have been extensively evaluated. For example, studies have been conducted in Libya (O’Hara et al., 2006), Mongolia (Natsagdorj et al., 2003), South Korea (Kwon et al., 2002), Japan (Akata et al., 2007), Taiwan (Liu et al., 2006), and particularly, in China (He et al., 2001; Qian et al., 2002; Wang et al., 2005; Zhang et al., 2010). These studies evaluated the concentrations of particulate pollutants during dust events and their possible sources and health effects. Accordingly, a substantial body of knowledge is available in this field. More detailed information about Asian Dust is presented by Shao and Dong (2006).

The third major source of desert dust is believed to be the Arabian Peninsula, which contributes significantly to the total transport of dust particles worldwide (Goudie and Middleton, 2001). Our knowledge about this source is, however, sparse and is limited to the studies conducted by Leon and Legrand (2003) and Draxler et al. (2001), which reported PM_{10} concentrations of up to 2500 and >3000 $\mu g/m^3$ in Kuwait and Saudi Arabia, respectively. Ahvaz, one of the major cites of Iran, is close to Iraq, Kuwait and

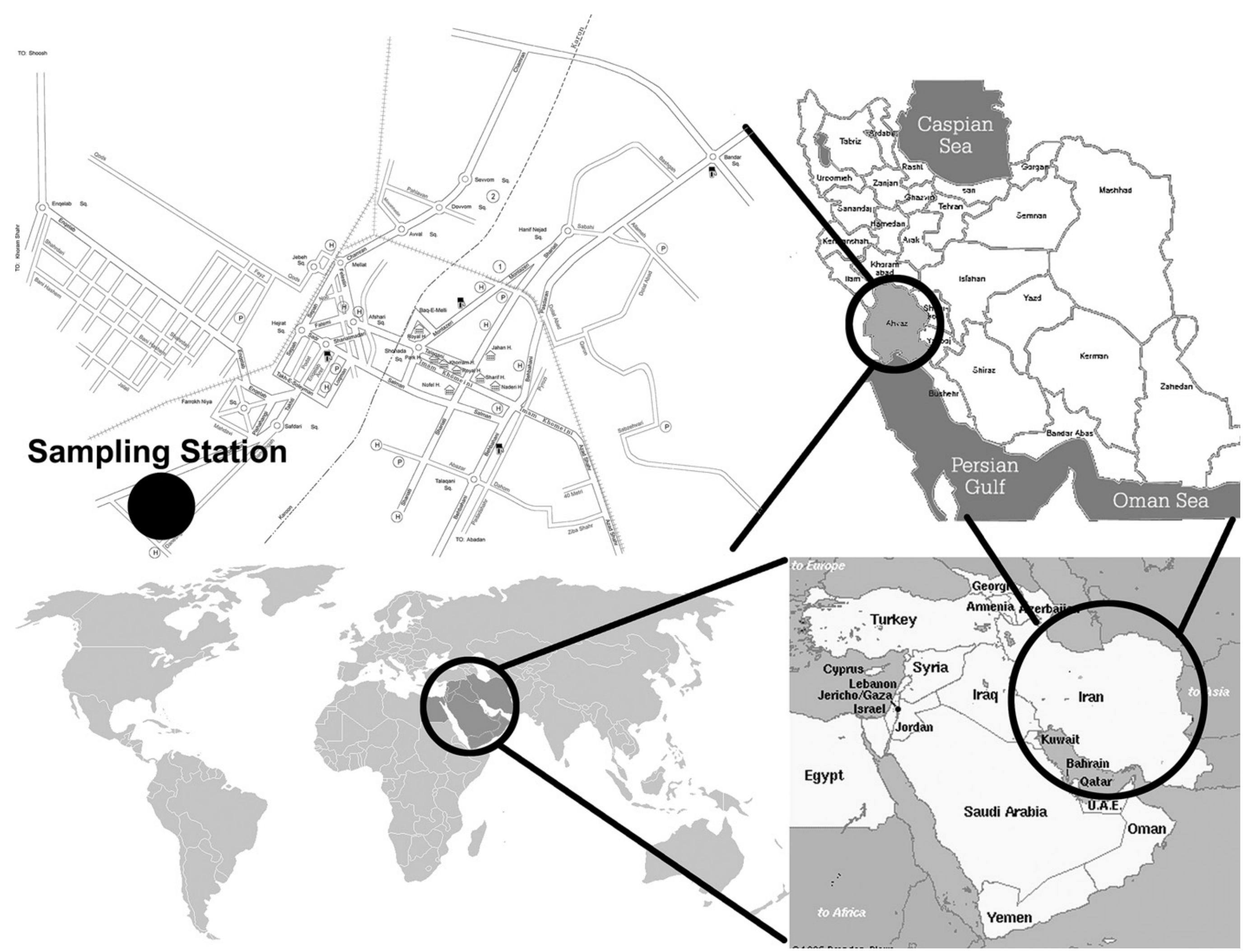

Fig. 1. Location of the study area and measurement station, showing the nearby sources of dust events.