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Effect of Chahar-Shanbe Suri Celebration on Air Quality in Iran: A Case Study of Tehran (Megacity)

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Abstract

Energy consumption, driven by the burning of fossil fuels and motor vehicle emissions are regarded as two main primary causes of air pollution. However, culture is a less-obvious factor affecting air pollution, which is often overlooked by researchers. The Chahar-Shanbe Suri culture in Iran is a significant and direct factor leading to air pollution in Iran. Unfortunately, few people recognize the role of culture in dealing with environmental problems. Culture plays an important role in many environmental problems. This study investigates why and how "Chahar-Shanbe Suri" culture leads to increase air pollution in Iran. Following the fireworks of Chahar-Shanbe Suri in Tehran, Tehran's air quality index increase by a high slope and the clean condition with the 49 index at 20 pm was unhealthy for all segments of society with a 177 index at 23 o'clock. Of course, according to the data measured in Tehran's air quality assessment stations, the air quality index in the areas of the city has risen above or near 200, which indicates a very unhealthy condition. The people, governments and industry should work together to navigate positive initiatives. Public education and media navigation are necessary for dealing with the cultural aspects of environmental pollution.

Keywords: Chahar-Shanbe Suri; Pollution; Tehran; AQI

Introduction

Human activities and production in factories and industries is a key driver of air pollution so it is hardly surprising that celebrations and cultural activities can have a profound impact and increases the concentration of atmospheric particles. One of the best studied is the regularly occurring weekend effect and or in holidays religious ceremonies, which is defined as the difference of air pollutant concentrations between weekdays and holidays, with a general reduction of major pollutants. Although culture plays an important role in many environmental problems, it is a less-obvious factor affecting air pollution,

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which is often overlooked by researchers. Some cultural rituals in communities lead to environmental problems. Many of these rituals are accompanied by fire. Fireworks contain chemicals such as potassium chlorate, sodium oxalate, sulfur, charcoal, potassium nitrates, iron and aluminum dust powder, strontium nitrate, potassium perchlorate, barium nitrate and manganese, etc. [1,2]. The heat generated by the firecrackers can release various particulate and gaseous air pollutants and toxic metals to significant quantity and degrades the air quality as a whole and dangerous conditions caused for all ages. In United States a study following the Fourth of July holiday reveals a significant increase in the levels of ambient air Al, Sr, Cu, K, Mg, Br [3].

Also, chemically resolved size distributions and chemical composition of fine aerosol particles were measured during the New Year's 2005 fireworks in Central Germany [4]. In studies, Qin et al. [5] reported that the average concentrations of CO, PM10, NOx and NMOC at weekends were lower than those on weekdays in southern California. for first observed in the USA in the 1970s [6] and since then, many studies have reported these effects that are influenced by traffic rush hours [7,8], population size (e.g., Butenhoff et al. [9] and degree of urbanisation [10]. Diverse cultural activities in the world can directly enhance primary pollutants, such as the Sunday roast of Victorian England [11] or barbecues [12]. There are numerous reports on the impact of key events where fireworks contribute to visibility reduction [13], illicit use of the metalloid arsenic [14], toxic metals (e.g., Camilleri and Vella 2010) [15] and enhanced particulate loads in German New Year [4], the USA on Independence Day [16-18], Slovenia, Spain or in India during the Diwali festival [1,19-21] or the numerous festivals that occur throughout the summer in Malta [15].

Air pollution in Iran has attracted all attention again since recent years. Especially in densely populated industrial cities such as Tehran. The burning of fossil fuels and motor vehicle emissions are regarded as two main primary causes of air pollution in Iran and Megacity’s. There are reports of lower concentrations of atmospheric particles in metropolitan areas such as Tehran during working days as well as weekend holidays and official holidays. But until now, a study has not been done in the amount of air pollution in a traditional ceremony Tuesday the end of the year (with title Chahar-Shanbeh Suri). This is one of the oldest people in Iran who are happy to illuminate the fire and exploding explosives on this day. There are always deaths and injuries due to fire and explosives. Chahar-Shanbe Suri, one of the most important things to do in Iran is to check out the calendar for annual festivals. Iran holds and celebrates various events and festivals all year round. Some of the rituals and festivals in Iran consist of religious ceremonies and rites and many others have more historic and ceremonial backgrounds which can be tracked into the pre-islamic era. There are also many feasts and celebrations to pay homage to many deities and they are mostly farming festivals. The festivals in Iran vary greatly by region due to Iran's multi-ethnic make-up. One of the most important and old festivals is Chahar-Shanbe Suri. This study investigates why and how Chahar-Shanbe Suri culture leads to increased air pollution Iran and Tehran city.

Materials and Methods

The sampling time for each station was 14 hours by high volume sampler. Glass filters were used to collect particles. Preliminary SEM/EDS measurements were performed on some of the samples to get elemental information on individual aerosol particles; also particles were imaged with a Zeiss EVOSOXP SEM. The X-ray energy spectra were measured using a Bruker Quantax 200 EOS system with a Peltier-cooled X Flash silicon detector. The aerosol samples were coated with a thin

layer of conductive material before the measurements were performed.

Study area

Tehran has a population of about 10 million people and an area of about 800 km^2 on the southern slopes of the Alborz Mountain Range. Also, from the southern part of Tehran, leads to open plains and agricultural fields as well as Qazvin plain. Tehran's plain, located in the south of the Alborz Mountains at an altitude of 900 to 1500 meters, is one of the main gatherings and human activities in the province of Tehran. The geographical location of the study area is shown in FIG. 1. Based on the Air Quality Index (AQI) calculated by the methods described in the Iranian National Standards in 2016, the period under study consisted of 17 clean days (AQI<50), 260 days with healthy conditions (50<AQI<100), 80 days of unhealthy conditions for sensitive groups (100<AQI<150) and 9 days of unhealthy conditions (150<AQI<200) [22]. In total, the number of polluted days decreased by 22 days compared with the last year.

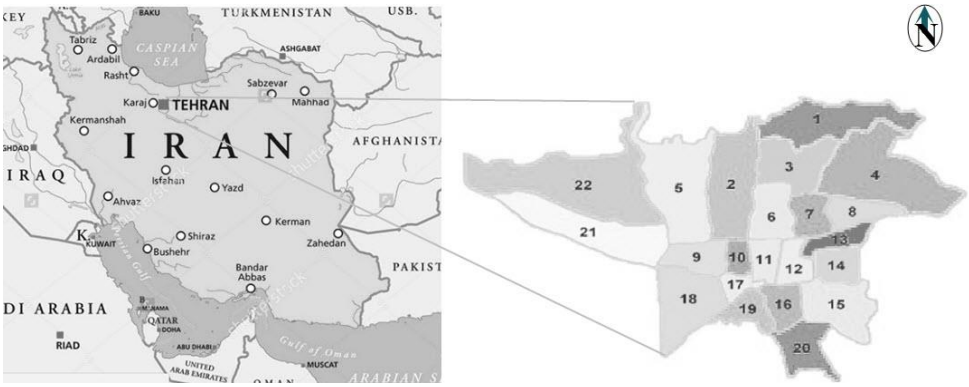

FIG. 1. **Geographical location of the study area.**

TABLE 1 showed the annual emission of air pollution in Tehran (AQCC, 2017). According to reports, particulate OM was the dominant component during most of the year, with a contribution of 13-54% and an average of 35%. OM and EC together comprised 44% of fine PM on average, reflecting the significance of anthropogenic urban sources, i.e., vehicles. Most of the OC was formed from water-insoluble compounds (82.5 ± 4.3% on average), suggesting a large contribution from the incomplete combustion of fossil fuels.

TABLE 1. **Annual emission of air pollution in Tehran.**

Source	NOx (%)	CO (%)	PM (%)
Stationary	53.2	2.5	29.8
Mobile	46.8	97.5	70.2

Results and Discussion

Following the fireworks of Chahar-Shanbe Suri in Tehran, Tehran's air quality index increased by a high slope and the clean condition with the 49 index at 20 pm was unhealthy for all segments of society with a 177 index at 23 O'clock. Of course, according to the data measured in Tehran's air quality assessment stations, the air quality index in the areas of the city has risen above or near 200, which indicates a very unhealthy condition. The next day (February 14th), the pollutant of the Tehran city index is a suspended particle of fewer than 2.5 microns, but this day increasing concentrations are observed in other pollutants, including carbon monoxide and carbon monoxide. The amount of pollutants in this day was such that the

online index of Tehran's air quality was in a violet (very unhealthy) situation in some areas. According to the pollution index, the condition is declining five days after the celebration. Accordingly, the index of air pollution in Tehran at 11th district, Shahedabad and Rey municipality stations was 202, 240 and 235, respectively. Also, Tehran's air pollution index was reported in red (very unhealthy) status in 9 other stations on March 13th. The values of CO, O_3, NO_2, SO_2, PM_{10} and $PM_{2.5}$ are shown in TABLE 2.

TABLE 2. **Concentration of the elements from 17th Feb to 19th Mar 2018 in the study area (µg/m^3).**

Date	AQI	$PM_{2.5}$	PM_{10}	SO_2	NO_2	O_3	CO
2018/02/17	69	69	46	12	49	18	24
2018/02/18	114	114	69	15	68	8	52
2018/02/19	80	80	59	11	67	18	40
2018/02/20	73	73	53	11	52	24	33
2018/02/21	80	80	51	12	63	30	34
2018/02/22	102	102	64	11	67	19	41
2018/02/23	79	79	43	10	54	26	26
2018/02/24	65	65	41	13	47	28	31
2018/02/25	39	39	23	11	47	20	27
2018/02/26	65	65	46	13	51	20	30
2018/02/27	58	58	45	13	51	25	31
2018/02/28	90	90	58	14	64	18	38
2018/03/01	82	82	56	10	68	29	33
2018/03/02	66	66	42	10	50	30	32
2018/03/03	63	63	44	12	49	35	27
2018/03/04	67	67	57	13	50	30	29
2018/03/05	82	82	64	12	52	26	30
2018/03/06	90	90	67	14	55	29	38
2018/03/07	72	72	56	12	45	27	25
2018/03/08	111	111	80	13	61	29	43
2018/03/09	96	96	73	13	56	31	36
2018/03/10	88	88	76	11	43	33	26
2018/03/11	86	86	74	13	57	34	35
2018/03/12	114	114	91	15	57	29	30
2018/03/13	59	59	53	11	51	36	28
2018/03/14	143	143	77	16	57	31	36
2018/03/15	97	97	61	15	70	33	41
2018/03/16	87	87	66	14	56	30	43
2018/03/17	62	62	53	11	44	37	27
2018/03/18	62	62	43	11	47	30	30
2018/03/19	73	73	49	14	69	36	34

The average AQI in the last few days is shown in FIG. 2. Based on the current situation and climate change, air stability in February and March is less than normal. But on the day of celebration, at 4:00 pm, the concentration increased and the increase was at most from 20:00 to 4:00. Relative air stability on 14th February caused the weather index to be unhealthy and this situation continues until the very last hours of the night. Such conditions were present in most cities of Iran. But atmospheric conditions did not change the air quality index.

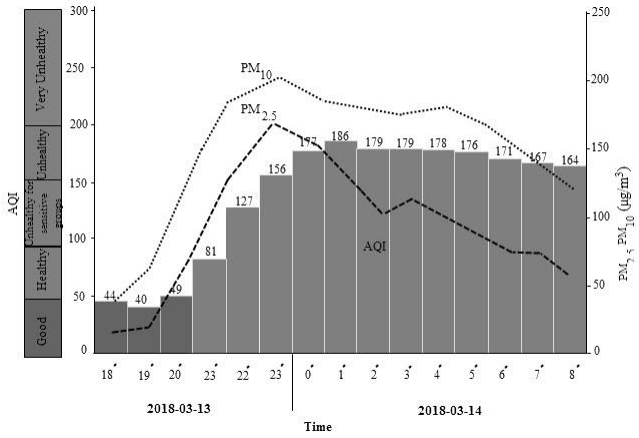

FIG. 2. **Changes in the concentration of PM_{10}, $PM_{2.5}$ and AQI during the celebration in Tehran.**

As shown in FIG. 3, the concentration of $PM_{2.5}$ and PM_{10} continues with a constant trend from 17th February to 19th March 2018. But this trend will show a large increase in 13th and 14th March. Air pollution was in an emergency during the day after the celebration and was in sensitive situations.

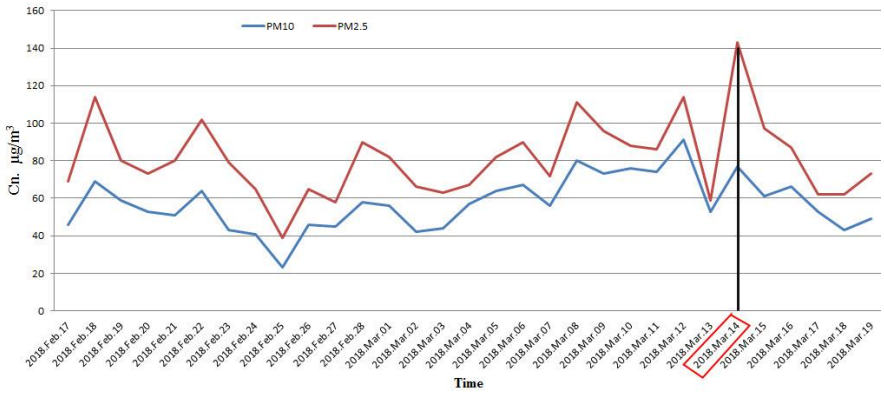

FIG. 3. **Concentration trend PM_{10} and $PM_{2.5}$ in 17th February to 19th March 2018 in the study area.**

FIG. 4 shows the SEM micrograph spectrum of aerosol particles in the study area, it is obvious that the particles show irregular, spherical and cluster shapes. The particles Ca, Fe, K, O, Si and Al follow the similar trend. TABLE 3 showed concentrations of elements aerosol particles in central regions of the study area.

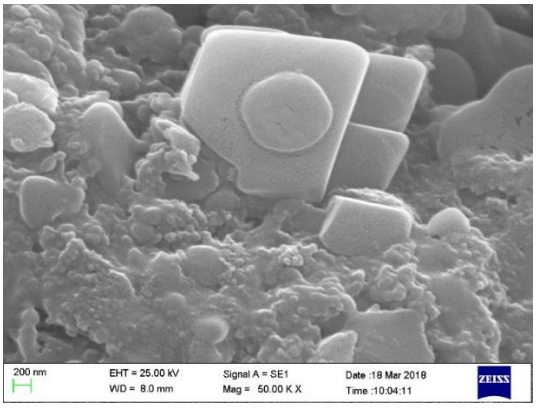

FIG. 4. **SEM images of aerosol particles in central regions of the study area.**

TABLE 3. **Concentrations of elements aerosol particles in the study area.**

Element	Weight %
C	35.64
O	48.48
Al	1.37
Cl	3.59
Ca	8.04
Ti	1.10
Fe	1.12
Pb	0.65

Similar studies have been done in different parts of the world. Tsai et al. in research found that the average concentration of PM_{10} rose to high levels over Kaohsiung Harbour, influenced by fireworks during Taiwan's lantern festival. Air pollution from fireworks is frequently observed at the Chinese Spring Festival period; widely celebrated in Asia and within the Chinese diaspora. Firecrackers are thought to drive away evil spirits, that lurk around to torment human beings, but the noise causes them to vanish into thin air [23]; however, such celebrations contribute to a reduction in air quality. Gong et al. [24] reported a reduction in aerosol during the Lunar new Year period and revealed that the concentrations of major air pollutants had significantly decreased around the holiday, but a short-term peak could be seen for NO_2, SO_2 and PM_{10} due to fireworks along with peaks in the concentration of a range of metals Cu, Al, K, Sr, Mg, Pb and Ba, [25], dicarboxylic acids [2]. According to a similar study conducted in China, it was found that 25, 57 and 183%, respectively, increase in NO_2, SO_2 and PM_{10} levels over the previous day. Also, the $PM_{2.5}$ concentration was found to be 6 times higher over a normal day.

Analysis of different elements and ions in fine particulates revealed that over 90% of the total mineral aerosol and 98% of Pb, 43% of C_{Total}, 28% of Zn, 8% of NO_3^- and 3% of SO_4^{-2} in $PM_{2.5}$ were from the emissions of fireworks on the lantern night. In another similar study in Italy, it was reported that one-hour concentration of elements like Ba, Cu, K, Mg and Sr increased by 12, 6, 11, 22 and 120 times [26]. Following New Year celebration in Mexico City in January 2005 reported that "left a dense gray pall over much of city" and described the air as more polluted over a normal Saturday, Ozone level was reported to climb 190 on a scale with normal cut-off a level of 100.

Attri et al., [27] during your research reported display of fireworks could produce ozone (O_3), a strong and harmful oxidizing agent, at the ground level without the participation of NO_x. In another study on India, the effect of firework display during Deepawali on the mass concentration of atmospheric black carbon reveals over three times increase compared to normal days [28]. According to a study conducted in Hisar India, the short-term variation in air quality during Deepawali reported 2-10 times increase in concentrations of TSP, NO_2, SO_2 and PM_{10} over a typical winter day [1]. According to a research published in Hyderabad India following a study of various metals in firework borne particles during Deepawali reported about 1091, 25, 18 and 15 times, respectively, increase in the concentrations of Al, Sr, Ba and K over a normal day [29]. Barman et a1., 2008 in Lucknow India reported that an average increase in SO_2, NOx, PM_{10} concentrations over pre-Deepawali period and a normal day by 1.95 and 6.59 times, 1.79 and 2.69 times and 2.49 and 5.67 times, respectively. The PM_{10} samples were further studied for trace metals like Co, Cu, Fe, Ca, Cd, Cr, Mn, Pb, Ni, Zn and their values were found to be higher than normal days and pre-Deepawali period except Fe [30].

Conclusion

During Chahar-Shanbe Suri in Tehran, widespread use of fireworks caused heavy pollution with extremely high aerosol concentrations. Fireworks sources should be controlled and limited. Besides limiting the usage of fireworks by individuals, the Iran government should also limit firecrackers and fireworks sales. The Chahar-Shanbe Suri culture in Iran is a significant and direct factor leading to air pollution in Iran. Unfortunately, few people recognize the role of culture in dealing with environmental problems. Although cultural changes do not take place over a short time, people can gradually change the traditions, as long as they fully realize the threats and risks that traditions or customs exert on the environment. In the future, policies and laws should be designed to improve the effectiveness of $PM_{2.5}$ control. The people, governments and industry should work together to navigate positive initiatives. Public education and media navigation are necessary for dealing with the cultural aspects of environmental pollution. People should also be provided more green options to make up for the loss of traditional activities or customs.

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