A Statistical Study of Isfahan Air Polluted Days

Amir Gandomkar

Abstract—For a precise study of polluted days in terms of persistence and stability, this paper statistically studies the air pollution of Isfahan city. The data related to the pollution was provided daily by environment department of Isfahan province from 2008 to 2013. After collecting the data and specifying statistical period, the pollutants with the most impact on the air pollution of Isfahan (carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone and particulate matters (PM10) were selected among these data for specifying air quality. Then, statistical analysis was made in order to specify persistence and number of the polluted days and finally, these results were obtained that the air pollution has been ranging from 2008 to 2013 with a increasing trend. The most polluted seasons of Isfahan city are winter and autumn. In the terms of annual distribution, the year 2013 with 26 days had the maximum amount of pollution. January with 30 days has been specified as the most polluted and September and October the cleanest months of the year.

Keywords—Statistical Study, Polluted days, Isfahan city.

I. INTRODUCTION

Air pollution is one of the issues not only threats the human health but also has adverse effects on all of environmental factors. In fact, air pollution is regarded as one of the aspects of the environmental pollution. In Isfahan, increasing and density of population, pilgrims entrance, inappropriate city texture, much vehicle traffic in the city, existing old cars producing much smoke, industries and small and big factories specially the workshops and encumbrance factories into the city, using heavy fossil fuels in business industries and geographical and climate conditions cause it should be considered one of polluted cities of Iran. In Isfahan, regarding that in some seasons of the year high concentrations and the persistence of polluted days were recorded and no comprehensive research has been done in this field, this paper studies statistically polluted days in this city. Some research has been done about statistical analysis of the air pollution. For an instance Entezari [1] studied statistically and synoptically the air pollution of Tehran in his Ph.D thesis. Waseghi et al. [2] and Ziv et al. [3] analyzed the air pollution in two Saint Petersburg & Copenhagen cities. Analyzing statistically two NO2 and NOX pollutants, they found that there is a reasonable relationship between the reduction and magnitude of the pollutants in different seasons. Janes et al. [4] analyzed the air pollution panel and illustrated the pollution of this city using pollution data of Seattle. Demuzere & Lipzig van [5] studied two O3 and PM10 using linear regression. Lozada et al. [6] studied the trend of the air pollution and quality using a mixed model. Also, in Iran Sedaghat kerdar [7] in a paper titled “potential abilities of statistical models in a short term prediction of air quality” indicates that the statistical models are suitable for a short term prediction of sulfur dioxide, controlling pollutants distribution and analysis and prediction of time series related to urban pollutants studied one-year time series of standard index related to the air pollution daily through the station measuring air pollution of Shiraz using regression and nonregression methods in a paper titled “predicting air pollution of Shiraz city”. Azizifar et al. [8] studied the quality index of air pollution and particulate matters with a aero-dynamical dimensions into the atmosphere of Qom city and concluded that concerning particulate matters (PM10), November is considered as the most polluted and October the most cleanest months in Qom. From the view of being pollutant (pm2/5), November is considered as the most polluted and August, September and October the cleanest months in this city. Ensafi Moghaddam [9], Introduction statistically analyzed and compared the dust in Ilam and Tehran and concluded that January and February months in 2008 with a mean indices 128 and August in 2009 with a mean index 96 have been the most pollutant months of the year.

II. METHODOLOGY

Isfahan city is the center of Isfahan province located in the center of Iran. The city elevation from the sea level is 1550m. For conducting statistical analysis and studying magnitude and longtime of pollution in Isfahan, the pollution air data prepared by environment department of Isfahan was used. The pollution air data was related to Azadi station located in the South of Isfahan city. The pollutants include carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone and particulate matters (PM10) prepared on daily-based and for a seven-year statistical period (2003-2010) and processed (Fig.2).

After collecting the daily and hourly data and regarding much amount of statistic and information, the data was changed to statistical standard tables using Excel software in order to make a statistical analysis. To study the frequency of the days in which the air of Isfahan was polluted, after calculating the standard index for each day during the year, the days in which the index was 150 were identified and accordingly, the percent of frequency for each year calculated and then respecting the yearly data, the polluted days calculated for a 6 years period (2008-2013).
Fig. 1. Location of Isfahan City in Iran and Isfahan province.

Fig. 2. Location of Azadi stations measuring air pollution over the surface of Isfahan city.
III. DISCUSSION

A 6 years amount of pollutants in Azadi station over the city of Isfahan was calculated and arranged with the related statistical index.

In yearly studying of polluted days in Isfahan, these results have been obtained (Tab.2): (1) Year 2007 has been the most pollutant year among these years and gradually the amount of pollutants has been reduced until 2011. (2) The percent of polluted days for the years 2007 and 2008 is 7.98 and 7.14, respectively showing a higher percent in relation to the next years. As it is obvious from the Fig. (3) and Tab. (2), the frequency of polluted days in 2007 has been more than the other days (29 days) and gradually reached 8 days until 2009 with a reduction trend and it fairly increased in 2010 (11 days) and again reached 4 days in 2011 indicating a reduction trend on Isfahan pollution.

After a seasonal study of polluted days in Isfahan, these results were obtained: (1) The most pollutant season of year in Isfahan is the winter with 39 pollutant days and autumn, summer and spring are located at the next orders in terms of pollution, (2) From the view of the air quality, spring and summer are better than the other seasons (Tab.3).

In Isfahan, the most number of polluted days is related to January with 30 and December with 26 days. Fig.4

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Sum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant Days</td>
<td>5</td>
<td>9</td>
<td>23</td>
<td>14</td>
<td>20</td>
<td>26</td>
<td>97</td>
<td>16.2</td>
</tr>
</tbody>
</table>

**TABLE II**

ANNUAL NUMBER OF POLLUTANT DAYS IN ISFAHAN (2008-2013)

![Pollutant Days](image)

**TABLE III**

SEASONAL DISTRIBUTION OF POLLUTED DAYS OVER AZADI STATION

<table>
<thead>
<tr>
<th>year</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>4</td>
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<tr>
<td>2012</td>
<td>7</td>
<td>2</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>2013</td>
<td>19</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>20</td>
<td>14</td>
<td>28</td>
</tr>
</tbody>
</table>

![Polluted Days](image)
IV. CONCLUSIONS

Studying the total amount of Isfahan’s pollutants with the air quality index status (PSI) in stations measuring the pollution and in different zones of Isfahan shows that the status of air pollution in winter and autumn seasons are mostly located at a warning phase. Therefore, regarding the study of number and persistence of polluted days in Isfahan, the year 2013 has the maximum amount of pollution with 26 days during under study years.

REFERENCES


Dr Amir Gandomkar. Faculty member of Najafabad Branch, Islamic Azad University, Isfahan, Iran.
I was born on Isfahan at 1972.
Ph. D on Climatology at Isfahan University, 2006.