STUDY OF PERSISTENCE OF DAYS INFECTED POLLUTANT PARTICULATE MATTER (PM10) IN CITY OF TEHRAN USING MARKOV CHAIN MODEL

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1. INTRODUCTION

Air pollution is one indication of Citizens growth, population increase, excessive use of fossil fuel resources, lack of utilizing environmentally friendly technologies and most importantly lack of proper environmental management.

Tehran, with an area of 780 square kilometers, is located on the southern part of Alborz Mountains. It is one of the polluted and very crowded cities in the world. Due to traffic jams and enormous vehicles many accidents occur every day (Nadim 2009). Most of factories were located in the west of the city. These conditions coupled with the prevalent westerly and northwesterly winds increase the pollution potential of the city (Alijani 2004). The elevation of the land increases from 1200 meters in the South to about 2000 in the North. Therefore the establishment of an inversion layer creates different pollution conditions over the city (Bidokhti 2010; Pour Ahmad 1998).

In the assessment of air quality, concentration of Particulate Matter less than 10μm (PM10) in diameter, among the various pollutants, has of great importance.

In this study, the probability of persistence of two to seven days unauthorized amounts of pollutants Particulate Matter (PM10) in city of Tehran was investigated.

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2. DATA AND METHODOLOGY

In order to study the persistence of days infected pollutant Particulate Matter (PM10), the hourly pollution data of PM10were obtained from the Air Quality Control Company (AQCC) of Iran for the central pollution stations of Tehran including Bazar, Fatemi, Aqdasiyeh, Shahr-Rey and Geophysic during the period 2002-2006.(Fig.1)

To do this research, first, quality control of PM10 data related to five stations of interest were done. Then, using National Ambient Air Quality Standards (NAAQS) the clean and polluted days were determined based on the concentration and persistence of PM10. Based on this manual, it is not allowed cessation in 150 μg/m^3 of PM10.

In this investigation, Markov chain model was used to calculate the accidence probability of the allowing threshold of PM10 for 2 to 7 consecutive days.

The model assumes that the movement from one state to another is dependent only on the present state and is independent of past history (Timjs 1998) .

Determining transition probability matrix, fitting Markov chain model on data was studied. For doing this, the chi-square test was used. The hypothesis H0 was defined as data are time independence and alternative, as the serial correlation exist between consecutive data.
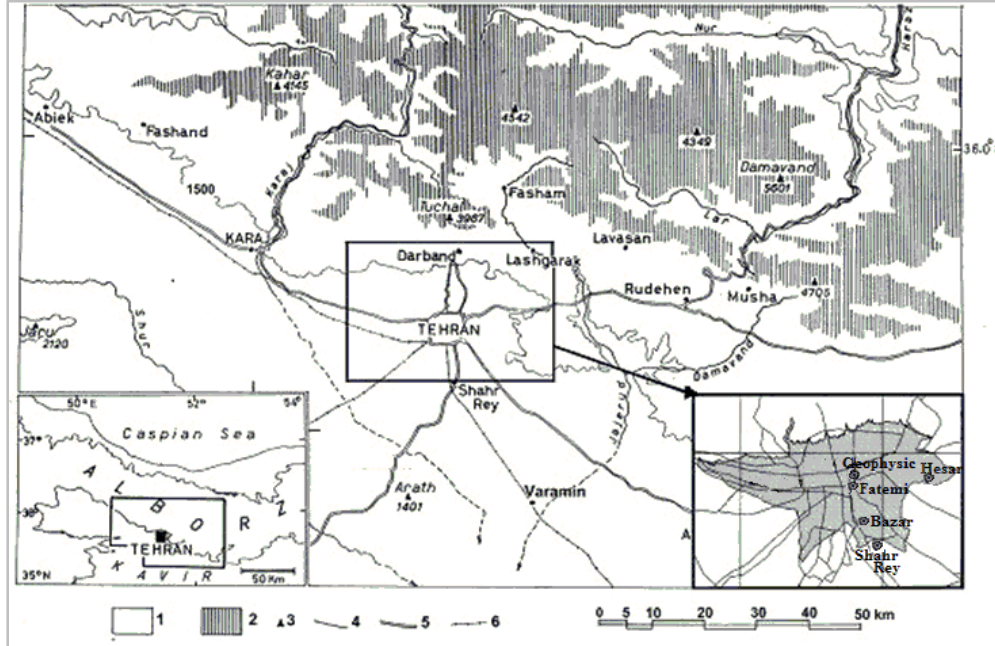
Fig.1: The situation of air pollution stations in city of Tehran. The numbers show 1: regions of altitude less than 1500 m a.s.l., 2: altitude ranges of 1500-3000 m a.s.l., 3: summit of mountain, 4: river, 5: highway, and 6: railway.

Fitting the Markov chain model on data, an important parameter, persistence of consecutive days with inadmissible contamination of PM10 were analyzed. If p_{dd} is considered the probability of two consecutive days with PM10 greater than critical limit, duration of n days which PM10 exceeded from a given threshold would have a probability as following:

$$P_{(n)} = p_{dd}^{n-1} \times p_{dc}$$

Where P_{dc} is the probability of a polluted day continued with a clean day.

3. RESULTS AND DISCUSSION

The results of the chi-squares test at 5% level, in first step, were showed that first-order two-state Markov chain models have a good fitting on the data of five selected stations in Tehran city. Using the obtained models the probability of 2 to 7 consecutive days with admissible PM10 were estimated at five stations including Fatemi, Bazar, Geophysics, Shahr-Rey, Aghdasieh. Probabilistic analyses for different month of year at stations of interest were showed:

- In most months of the year, the probability of two consecutive days of admissible PM10 in Bazar and Fatemi stations is more than other stations (Fig. 2)
- In spring, maximum probability of two consecutive days of admissible PM10 is happened at Bazar, Aghdasieh and Fatemi stations, respectively.
- In summer, most probability of two consecutive days of admissible PM10 is occurred at Bazar, Aghdasieh and Fatemi stations, respectively.
- In autumn, most probability of two consecutive days of admissible PM10 is occurred at Bazar station.
- In winter, compared with other seasons, the probability of two consecutive days of admissible PM10 is least. However, maximum probability is occurred at Aghdasieh, Bazar, and Fatemi stations.

– In general, maximum concentration of pollutants for two consecutive days in Tehran city is related to Bazar and Fatemi stations.

Therefore, it is necessary to reduce traffic at these locations for decreasing the pollution of air.
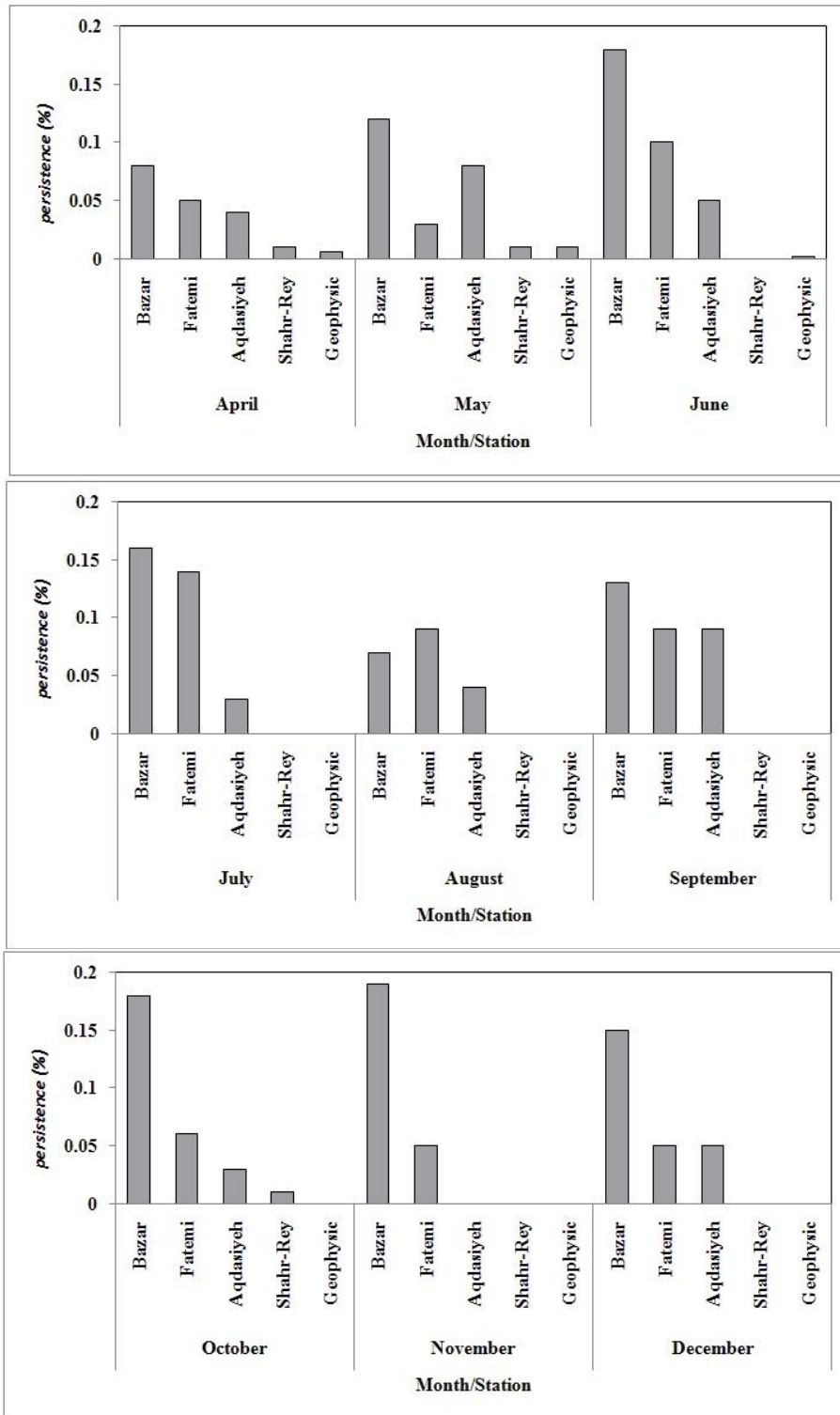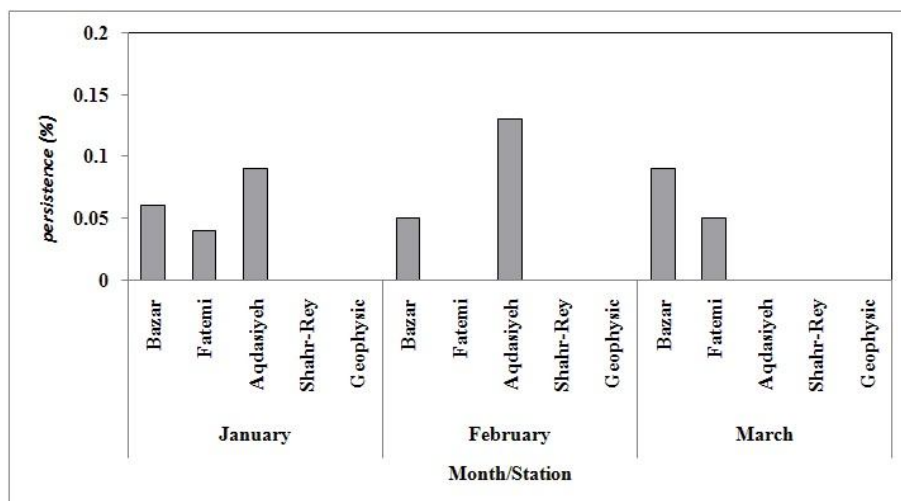
Fig.2: persistence of days along with PM10 pollutant at different months of the year in stations of interest.

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