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## RESEARCH ARTICLE

### TEHRAN GEOGRAPHICAL ZONING IN RESPECT TO AIR POLLUTION

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#### ABSTRACT

The present study aims at investigating the zoning of Tehran according to the most severe polluted days. In this regard, 100 days with the highest pollution level recorded by the stations were selected from 2004 to 2008 in five selective stations around the city and the zoning progress was done based on them. In respect to  $\text{co.PM}_{10}$  and  $\text{SO}_2$  level, Azadi station was the most polluted and Sarkhehesar and also Ray town were the cleanest regions. Considering the  $\text{NO}_2$ , Ray station was the most polluted and Sarkhehesar station was the cleanest one. Regarding  $\text{O}_3$ , Ray station was the most polluted and Pardisan was the cleanest one. Despite the fact that the wind direction was from west to east, wind flow has no a considerable effect on air purification because of the high density of the buildings and low speed of wind. The findings revealed that pollution level in center and west is more than east. Likewise, pollution concentration level of  $\text{O}_3$  and  $\text{NO}_2$  increase and pollutant concentration levels of  $\text{SO}_2$ ,  $\text{PM}_{10}$  and  $\text{CO}$  decrease from north to south of Tehran.

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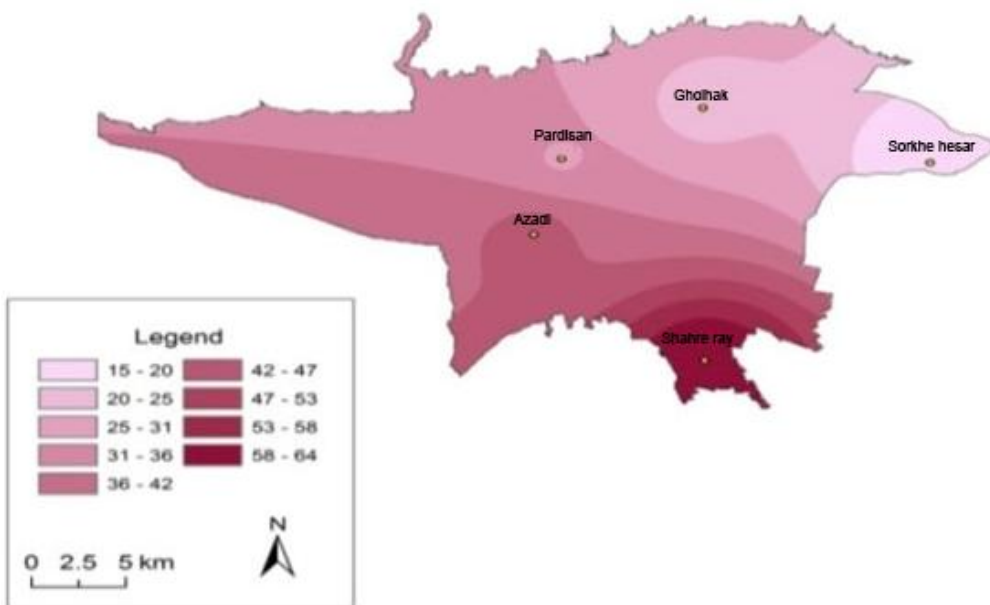
#### INTRODUCTION

Climate is one of the effective structural factors on this planet and indeed nature, human and all creatures are widely affected by climatic conditions. Climate as a classic major has a relation with other majors and also effects agriculture, forestry, hydrology, geology, industrial operations, transportation, urbanization, diseases and many other environmental factors as well as human life. Climatology contains a wide range of studies from the scope of climate nature to duties concerned with human biological environment. One of the important problems in climate analysis which effects on health of a region's creatures is air pollution. Currently, one of the important subjects concerned with climate is the argument in respect with the development of urbanization and urban air pollution and subsequently urban climate (Shokouhi, 2006). The instability of urban and country industry development in previous years is one of the unpleasant legacies which widely affects urban biological environment of the country, particularly metropolises. In metropolises, the number of days with dust and pollution are 2/5 times more than the countryside (Askari, 2005, p. 45). Accelerated growth of population, rural migration, industrial development, traffic density, topographic conditions and natural factors have turned Tehran into one of the most polluted cities of world. Despite human factors, geographical factors such as geographical position, topography and temperature inversion are effective in aggravation of Tehran's pollution. The most important factor which aggravates the pollution of Tehran is temperature inversion.

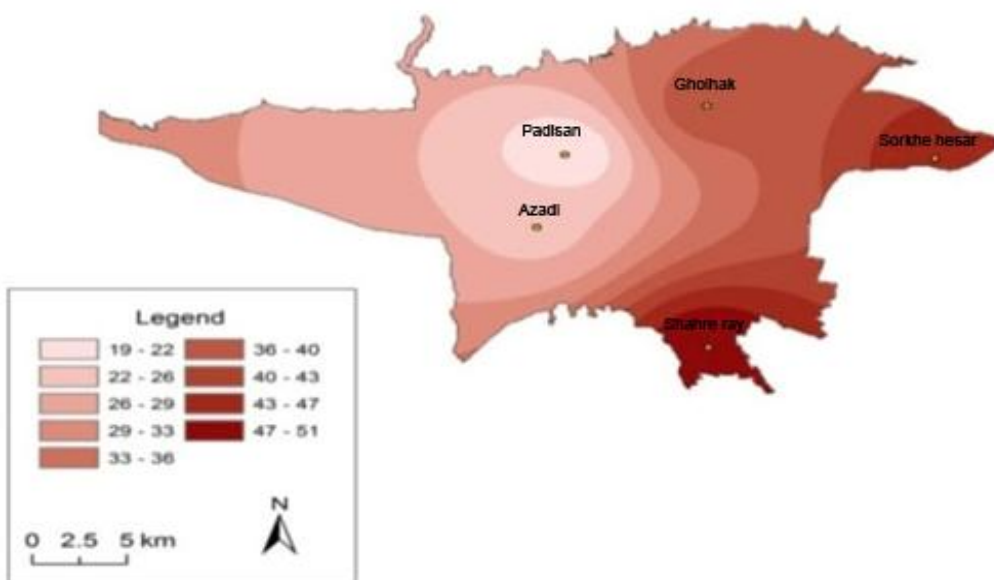
The occurrence of reflective inversion is very usual due to overnight radiation and existing snow on northern highlands. The inversion phenomenon occurs in Tehran annually more than 210 days (Bigdeli, 1996). Thus, it is necessary to do a comprehensive study regarding the identification of pollution aggravation factors and conditions and the effects of each of their levels. This investigation aims to identify the occurrence levels of temperature inversion in Tehran and the level which mostly affects Tehran's air pollution.

The operation done for this purpose includes Cheng and Lami, the synoptic classifying and its function to forecast climate conditions on sulfur dioxide and oxide nitrogen concentration in Hong Cong. Entezari (2005) analyzed synoptic and statistical study of Tehran's air pollution. Moghadam (1993) analyzed Tehran's air pollution and its relation with inversion. Poorahmad (1998) analyzed the role of climate and geographical structure in air the pollution of mountain cities such as Tehran. Sedaghatkerdar (2001, as cited in Legha, 2006) considered the mountain effect on the quality of Tehran climate. Yunesian (2001) studied the relationship between increasing of air pollution and mortality among the individuals over 64 years old in Tehran. The analysis of synoptic sample of Tehran's intense inversion phenomena is another study conducted by Lashkari (2006). Mohamadi (2006) considered the relation between climate components as well as Tehran's pollutants and mortalities due to heart disease (1999-2003). As a result, this study identifies the days in which the highest air pollution level has occurred (opting 100 days from a five years statistical period for each station) zoning Tehran city according to the highest level of air pollution.

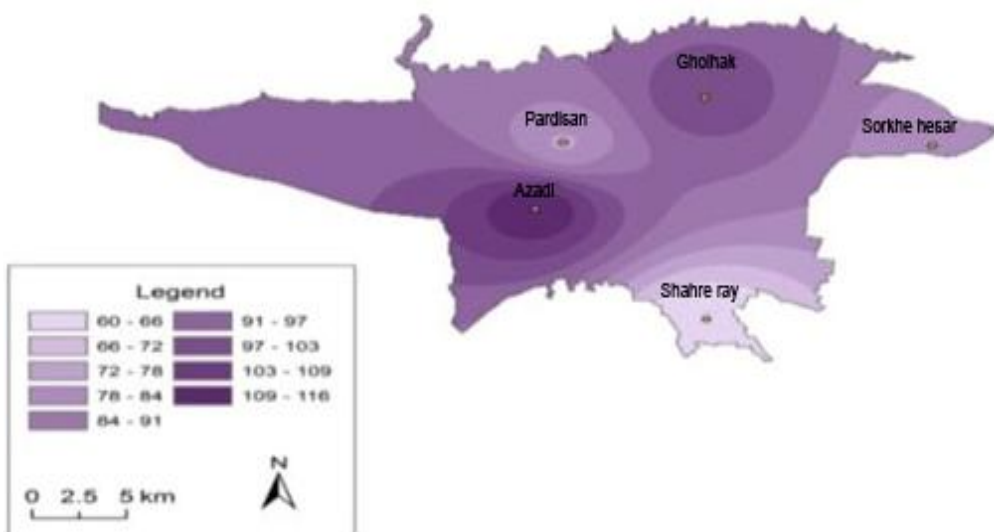
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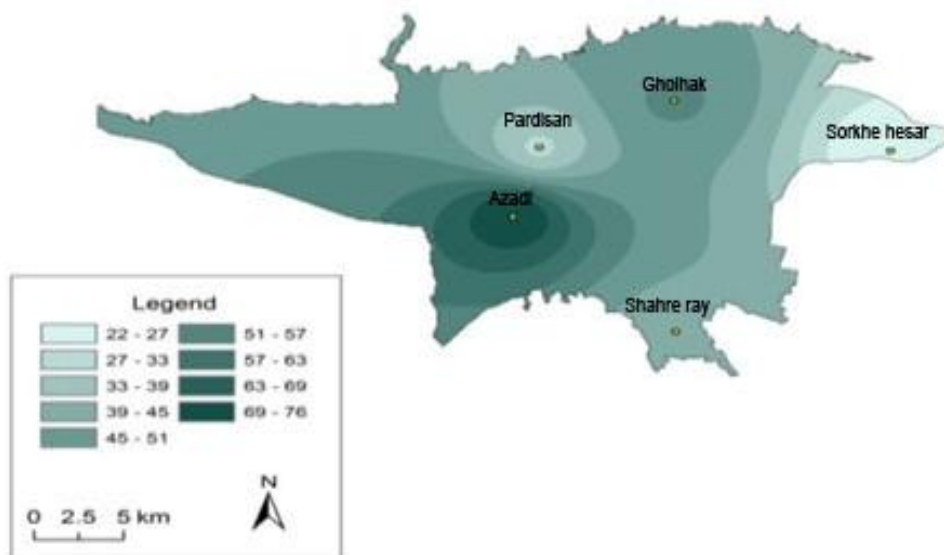
The map of air pollution zoning of the selective stations in respect to NO<sub>2</sub>



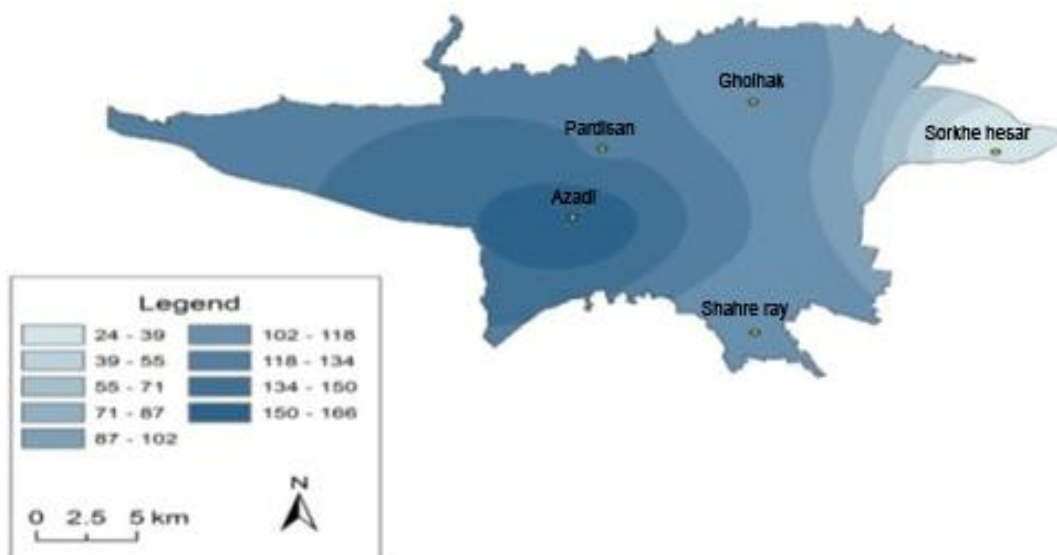
The map of air pollution zoning of the selective stations in respect to O<sub>3</sub>



The map of air pollution zoning of the selective stations in respect to PM<sub>10</sub>



The map of air pollution zoning of the selective stations in respect to CO



The map of air pollution zoning of the selective stations in respect to SO<sub>2</sub>

## Method

First, measuring data regarding the components of Tehran's air pollutants (2004-2009) were compiled in five years from biological-environmental organization of Tehran. Among all pollutants; CO carbon dioxide, NO<sub>2</sub> nitrogen dioxide, SO<sub>2</sub>, O<sub>2</sub>, ozone, PM particles were selected for identification and analysis of air quality. For doing this paper, five stations were selected to measure pollution in Tehran in which their pollution levels were more comprehensive than other Stations. The stations include

1) Azadi 2) Gholhak 3) pardisan 4) sarkhehhesar 5) Rai.

For each of the stations, 100days with the highest level of air pollution recorded from 2004 to 2009) were extracted and accordingly, the pollution mean of the selected 100 days of the stations identification of the most polluted station have been done for zoning the stations' climate with each of five components and spatial analysis of air pollution.

## Geographical condition of Tehran

Tehran is located in north and north west of the country among longitude 51 degrees and 4 minutes to 51degrees and 33 minutes eastern longitude and geographical latitude 35 degrees and 36minutes to 35 degrees and 49 minutes of northern latitude. Tehran altitude over sea level and in southern areas reaches to 1100 meters, 1200m in the center, 1800m in the north, among all measuring Tehran's stations which measure the condition of air pollution and the following stations were selected:

- Sarkhehesar with geographical longitude 03, 34, 51 with geographical latitude 18, 43 and 35 northern degrees.
- Rai with geographical longitude 00, 26, 51 and geographical latitude 00, 35, 35 northern degrees.
- Pardisan with geographical longitude 17, 21, 51 and geographical latitude 37, 44, 35 northern degrees.

- Gholhak with geographical 51, 26, 19 and geographical latitude 35, 46, 48 northern degrees.

#### Air pollutant threshold

Pollutant type	Weight mean(mg/m <sup>2</sup> )	Mean(ppm)	Mean time
SO <sub>2</sub>	350	0/14	1hour
	100-150	0/04-0/06	24hours
CO	40-60	0/023-0/015	1year
	30	26	1hour
NO <sub>2</sub>	10	9	8hours
	400	0/21	1hour
O <sub>2</sub>	150	0/08	24hours
	150-200	0/08-0/1	1hour
PM <sub>10</sub>	100-120	0/05-0/06	8hours
	70		24hours

Reference: environment protection agency (EPA)

Pollution Threshold	Test period	Pollutant type
10ug/m <sup>3</sup>	8hour	Carbon dioxide
365ug/m <sup>3</sup> =14ppm	1day	Sulfur dioxide
150ug/m <sup>3</sup>	1day	Aerosol
94ug/m <sup>3</sup> =0.05ppm	1day	Nitrogen dioxide

#### The findings obtained from air pollution of the stations

The obtained results on air pollution condition and mean concentration of pollutants in stations during (1383-1387) in the selected 100days with the highest pollution level are illustrated as:

1. Considering the concentration level of (PM<sub>10</sub>) particles, Azadi station was the most polluted station by the mean of 116 micrograms on M. The mean of the Gholhak, Pardisan, and Sarkhehesar are 102, 78, 81. ug/m<sup>3</sup>, subsequently.
2. In case of sulfur dioxide concentration level (SO<sub>2</sub>), the highest concentration belonged to Azadi station with 76ug/m<sup>3</sup> and the lowest one was for Sarkhehesar with 22ug/m<sup>3</sup>
3. In respect to concentration level of nitrogen dioxide (NO<sub>2</sub>), Ray station was the most polluted station with the mean of 64ug/m<sup>3</sup> and Sarkhehesar was the cleanest with 15ug/m<sup>3</sup>. The means of these pollutants were in 44, 24 and 31 ug/m<sup>3</sup> in Azadi, Gholhak, and Pardisan stations, subsequently.
4. In respect to (O<sub>3</sub>), the concentration level of ozone, the most pollution level belonged to Rai station with 51ug/m<sup>3</sup> and the least belonged to Pardisan with 19ug/m<sup>3</sup>. For this pollutant, each of Azadi, Pardisan and Sarkhehesar stations has a mean concentration of 25, 39, and 46ug/m<sup>3</sup>, subsequently.
5. Considering carbon mono oxide (CO), Azadi station was the most polluted with 166mg/m<sup>2</sup> and Sarkhehesar was the least one with 24 ug/m<sup>3</sup>.

Carbon mono oxide level in stations of Gholhak, Pardisan and Rai are subsequently 110, 134, 107ug/m<sup>3</sup> in 100days. Results represented from the selective stations during the sample 100

days shows that carbon mono oxide is the most dangerous pollutant. On the other hand, sulfur dioxide gas was the least dangerous pollutant. Among the selective 100 days, fall and winter seasons had the most polluted days because of the of main altitude of temperature and the entrance of high pressure systems to zone and also the use of heating tools. On the other hand, because of the high altitude temperature inversion and increased use of heating tools, spring and summer had the least polluted days. Stations of Azadi, Gholhak and Pardisan have recorded the polluted days in winter and Sarkhehesar and Rai had the most polluted days in fall. Despite the fact that wind direction is from west to east, wind flow does not have a considerable effect on air purification because of the high concentration of buildings and low speed of wind. Regarding the spatial distinction of Tehran's air pollution level, the results represented that pollution level in center as well as west is more than the east. Moreover, from north to south of Tehran the concentration levels of O<sub>3</sub> and NO<sub>2</sub> pollutants increase and the concentration levels of CO, PM<sub>10</sub>, SO<sub>2</sub> pollutants increase. It is worth saying that some other regions of Tehran have certain levels of pollution, but because there was no measuring pollution stations there are not some sufficient data and statistics on their pollution condition.

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