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Analysis of the Temporal-Spatial Changes of Pollutants in Tehran City

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ABSTRACT

Air pollution is one of the dimensions of environmental pollution and it impacts on the quality of life, directly. Air pollutants are the elements that their existence in the atmosphere harms to human, animal, plant and microbial life. The main objective of the research is studying of the temporal-spatial changes of pollution in Tehran. Therefore, the data evaluated hourly or daily pm 10 pollutants and CO, during the common period of 7 years (2013-2007). The results showed that at the annual scale, the pollution of Tehran on a spatial and temporal scale changes in all stations and increasing and decreasing of the pollutants are not the same. However, pollutants recorded at most stations for 2010 are remarkable. In quarterly and monthly scale the spatial and temporal variations are not same as well as, but it have been recorded the maximum amount of pollutants for most stations the season of autumn. In monthly scale, mainly frequency of polluted days in December is more than other months. Also, in the daily scale around the Hours 7 to 9 pm, we can see the maximum of the pollutant in the studied stations. Spatially, the most frequency of pollution days is in the western and central regions of Tehran and spatial process of pollution occurrence decrease relatively to the South and East, noticeably. In general, in Tehran the more recorded pollutant is in the cold season. This situation can occur because of the geographic location of Tehran and the penetration of cool and stable systems in this season.

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INTRODUCTION

Environment is one of the crucial warp and woof of life and development, because it plays numerous roles in creating of balance. But, currently, this component is abused due to the absence of laws and regulations and in definition of special property for it that resulting destruction of the environment and creating of various pollution. Air pollution constitutes one of the dimensions of the environmental pollution which includes too much consequences such as increase in heart and respiratory disease, reduction in visibility, eye irritation and damages to plants and animals and objects and global warming, decline of stratospheric ozone, acid rain, etc., universally. [10].

Air pollution and emphasis on live on a healthy environment has been considered by scientists and philosophers from the beginning of history. Hippocrates believed that the most important and effective principle of public health is benefits from clean air. Avicenna believed that existence of dust in the air is one of the reasons for shortness of human life [4]. Air pollution, means that the existence of pollutant substance such as dust, gases, fumes and vapors in the air that are dangerous for human, plant or animal life. This phenomenon increases under the influence of two cases A- natural factors including natural gas, volcanoes, lagoons, natural firing and dust. B- Human factors including heating and cooling equipment and automobiles industries. Sustainability and impact of these sources is different. Unlike human pollutants, the natural contaminants remain short duration in the atmosphere and do not cause permanent changes in the environment [5]. With regard to the expansion of cities and increasing of sources of air pollutants, we can say that the air in the often large and industrial cities is polluted. With attention to the dangers of pollution to human health, the recognition and awareness of the outcomes of this problem is important. Cox *et al*, [8], was used TAPM model to simulate pollution transport from Melbourne to Cape Grim in Australia. Ccoyllo *et al*, [7] in a paper titled "climatic conditions and its impact on contaminant concentration of São Paulo Brazil", evaluate the relationship between weather systems and concentrations of pollutants. Their results indicate a high concentration of pollutants in the North Atlantic subtropical along with high-pressure system. Quah and Boon, [14], in the study have mentioned the cost of air pollution in effect of suspended particles in Singapore more than 4 percent of the total costs of the

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GDP of the country. Koop and Tole, [12], were studied during the period 1992 to 1997 the death rate due to air pollution in Toronto, Canada. Krivascy *et al*, [13], studied in winter due to suspended particles smaller than μm10 using advanced techniques of chemical in the big cities of New Zealand and Christchurch. The results showed that the main cause of air pollution in winter is heating. Schurmann *et al*, [16], have been examined in southern Italy during 4 periods of 5 to 7 days, as the representative of each season the concentration of ozone. Became clear that the wind of sea-mountains develops well in the area in ozone levels. Wang *et al*, [18], were identified using HYSPLIT model and MM5-CMAQ and synoptic pressure pattern analysis of regional atmospheric PM10 transport pathways in Beijing, China. Results showed that the frequency of high concentrations PM10 in the field of convergence between breeze and breeze mountain northeast southwest plains in the lee of the mountains Tayhang. Grigoras *et al*, [11], studied the distribution of air pollution in industrial areas of Romania TIM model. Results show that the complex features of the earth's surface is one of the factors the concentration of pollution in the area. Blouki [6] has identified sources of pollution energy consumption and emissions of these sources and the atmospheric parameters of emissions in the city. Samadi *et al* [15] have studied the most pollutants released from two stations in Isfahan and Tabriz for one year at a radius of 20 km with modeling of dispersion of pollutants and the share of each station in the pollution of the city and surroundings. Bidokhti and *et al* showed by using of the DNS model surface roughness effects on the Tehran area as one of the factors affecting the distribution and atmospheric dispersion. Alijani [2] has studied the relationship between pressure and density distribution of pollutants in Tehran. Alijani and Safavi [3] has studied affecting geographical factors in Tehran's air pollution. Results indicated that the large proportion of natural features is the main causes of pollution of the city.

Ghasami and *et al* [9] have investigated the situation Synoptic some of acute conditions of air pollution in Tehran. Their results showed that when there is a high pressure zone of middle zone widths systems increases two or three times greater than the maximum permissible pollutant concentration. Sharee Pour [17] deals with the daily and seasonal variation of air contaminants and their relationship with meteorological parameters. Abed and *et al* [1] have measured the modeling output of distribution patterns of nitrous oxide emissions from integrated steel production in the Gilan province. Shamsi Pour and Najibzadeh has been simulated the distribution pattern of air pollution in Tehran in the windy conditions. The results indicated that wind direction reduces air pollution by increasing the amount of kinetic energy and volatility caused by wind speed and atmospheric unstable conditions with the horizontal transport of pollutants and creating a vertical movement. In Iran has increased the emission amount of air pollutants in many cities growingly, such as Tehran, Mashhad, Isfahan and Kermanshah. Pollution caused by fossil fuels especially in the mega cities is in critical and dangerous condition. In the meantime, Tehran as the capital of economy, education and politics has polluted most of the other cities. With the regard to the existence of elements of pollution in Tehran and problems arising from it in the environment, nature and human, it is important to study of temporal-spatial changes of the elements and factors influencing the changes, climatologically. Therefore, in this study, we have been attempt to examine the process of pollutants of PM10 and CO in Tehran by using of data of stations of weather quality control.

MATERIALS AND METHODS

In this study, the statistical survey by visiting the Tehran air pollution meteorology and air quality control company in Tehran were found by pollution data for selected stations from the station since 2013 (Figure 1). The processed data revealed that the common statistical period is between the selected stations from 2007 to 2013. Thus selected high-pollution days in the period 2007-2013 on the basis of two co pollutants and PM10. After processing, the data were analyzed the pollution to determine the time of concentration of pollution in temporal, seasonal monthly and annual scales. The data selected stations in 2007 and 2013, used based on the common period and were examined in every station in the period of the pollution process. Reviewing of the temporal process of the above data is done by Trend Analysis and on the environment of ArcGIS software. Finally, the maps of distribution and concentration of pollutants in Tehran prepared based on the extent of pollutants in the selected stations.

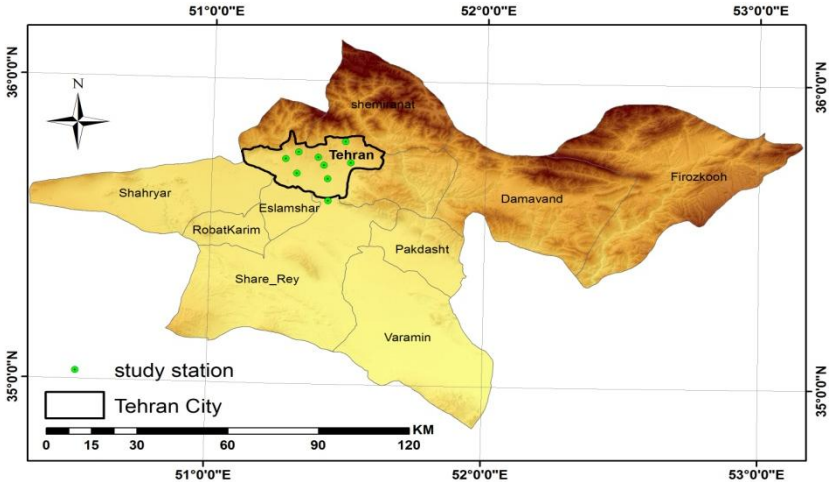

Fig. 1: geographical position of the studied stations in Tehran

Discussion and Findings:
Annual Frequency:

Reviewing of the PM10 and CO for selected stations in Tehran at the annually scale indicated that pollutants have been increased in Geophysics station during the years 2007 and 2009 and they have decreased form the years 2009 to 2013. In this station has been registered the maximum level of pollution in 2007. Process pollution in Aghdasieh station has a low amount of CO in statistical period of 2005 to 2013. However, the amount of PM10 have declined gradationally and increased from the year 2011 onwards. The pollution has been excessive based on the pollutants of CO and PM10 in period of 2006 -2013 in Rey station since before 2011 that the amount of CO is higher than to PM10 which has been the same in year 2011 approximately and this process has been reversed from this year onwards. In other words, PM10, has increased and CO is reduced. Statistical periods in the Pounak station from the years 2007-2013 have shown a peak in 2008 and after 2008 have decreased generally, and since 2012 each two pollutants have been increased. The amount of this increase has been more for CO. this station in the statistical period has the maximum number of polluted days on the basis of pollutants of CO related to 2010 and based on pollutants of PM10 related to the year 2011.

Pollutants of co had a decreasing trend in the recent years, so that from 2011 onwards has not been observed the day with high amount of pollution of CO. PM10 pollutants until 2011 and then in the 2013 had a rising trend and after this significantly declined. Generally, in all statistical periods of the Golbarg station has been recorded the higher amount of PM10 than CO. The amount of CO has a decreasing trend so that from 2011 up to onwards, we has not been reported a day with high CO. However, changes of PM10 has been reduced and increased gradually. In this section, we displayed the process of annual changes in Geophysics station.

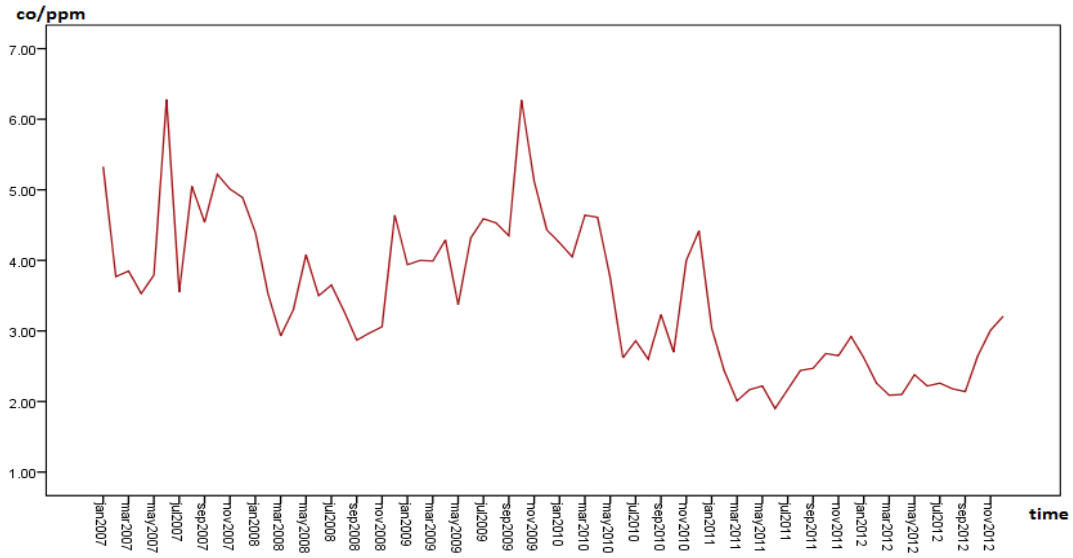

Fig. 2: The process of temporal changes of CO pollutants in the Geophysics station (2012-2007)

Monthly and Seasonal Frequency:

After the reviews of pollutants process, we will investigate the spatial and temporal changes of pollutants annually and in monthly and seasonal scale for the selected stations in Tehran. For Aghdasieh stations, pollutants have been increased in monthly scale from March and its amount has intensified in the months of the cold days of the season. In seasonal scale, autumn has the maximum of pollution. In geophysics the station the minimum of pollutants is recorded in the months of July and August. Also, in this station intensified the amount of pollution of CO and PM10. In the month of December and in June also has been recorded the highest pollution. Comparison of amounts of CO and PM10 in this station indicated that pollution of PM10 is higher than CO in the all months. Also, Reviewing of the amount of this pollutants in seasonal scale indicated that winter has the maximum of pollution and summer the minimum (Fig. 3, A, B). For Rey station in monthly scale, the amounts of CO have been increased from month of February to October and the amount of PM10 has increased from the month of March up to July and then decreased. Process of pollutants in seasonal scale is similar to each other approximately, with this difference that the amount of CO is more than PM10 and maximum of pollution have been recorded in the summer. Reviewing of the changes in Pounak stations showed that the amount of PM10 has varied in monthly scale from one month to another month, so that its maximum is in the of June and its minimum in August. The minimum amount of CO is recorded in September and its maximum in December. At seasonal scale, as well as, maximum and minimum amount of CO is recorded in the season of autumn and spring respectively and maximum of PM10pollutants is during the winter and spring, and its minimum in the autumn. Temporal trends of the changes of CO and PM10 pollutants in the Golbarg Station showed that the proportion of changes in both pollutants has been the approximately same in monthly period and in the all months the PM10 is more than CO. Also, the maximum amounts of these pollutants has occurred during March and April. In the seasonal scale, also, autumn has the most pollution. Eventually, studies on the monthly, seasonal scale from the Park station showed that it has not been observed days polluted by CO from March to August. Changes of PM10 reduced and increased in the months of the year gradually and in the December the highest levels of both pollutants have been recorded. In the seasonal scale has been observed the most days with PM10 in the autumn and the maximum amount of CO in the summer (Fig. 3, C,D).

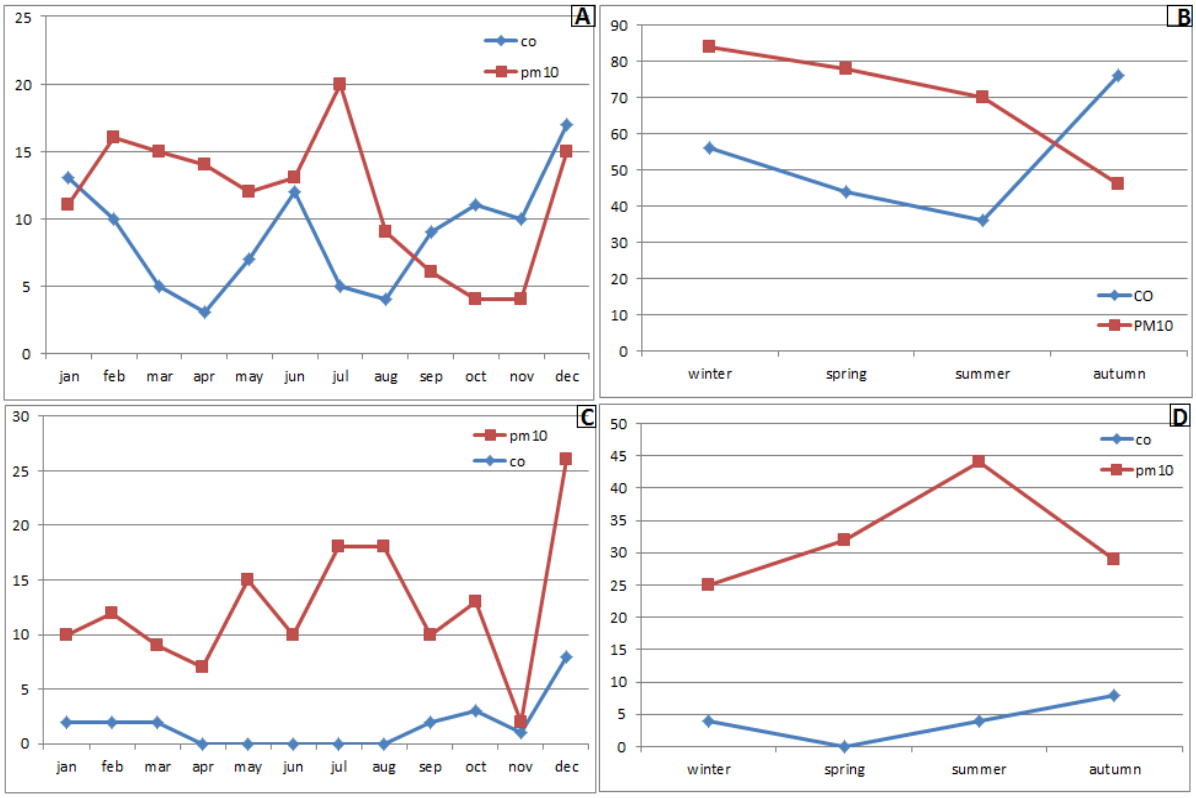

Fig. 3: temporal Trends of changes of CO and PM10 Pollutants in the temporal, monthly and seasonal scales (2013-2007).

Hourly Frequency:

Reviewing of the process of CO and PM10 pollutants in hourly scale at selected stations in the study area, showed a spatial-temporal changes in this pollutants. As in the Aghdasieh station the amount of pollutants

showed two maximum amounts at 8 am and 20 in daily scale and the amount of pollutants have fallen in with increasing of surface temperature and the surrounding air the middle of the day (Fig. 4, A). In Geophysics station the amount of CO pollutant has fallen in mid-day and with warming of weather, we have two amount maximum at the hours of 9 and 23. However, the amount of PM10 increased from 11 am until the end of the day significantly and at 20 o'clock reached to the maximum value (Fig. 4, B). Hourly changes of pollutants was in Rey station with two maximum amounts at 8 am and 1 am and the pollution has reached to the lowest amount in hours of mid-day until 16 (Fig. 4, C). Studying of the hourly changes of pollutants in Pounak station indicated that their amount have risen from the beginning of morning (at 8 am) has reached to the maximum value and then declined. At 4 pm, pollutants have reached to the minimum and then increased again and reached to the maximum at 22, and then decreased. In other words, in daily the scale existed the maximum amount of pollutants around at 8 am and 22. In the Golbarg station, there are two peaks on the daily scale: one at 9 o'clock and another at 23. Studying of hourly changes of pollutants indicates the lowest emissions of PM10 in Park Station in the 9 and 16pm. The maximum amount of CO is at 3 o'clock and then decreased at 12 and reached from 12 to 16 hours in minimum and then increased (Fig. 4, D).

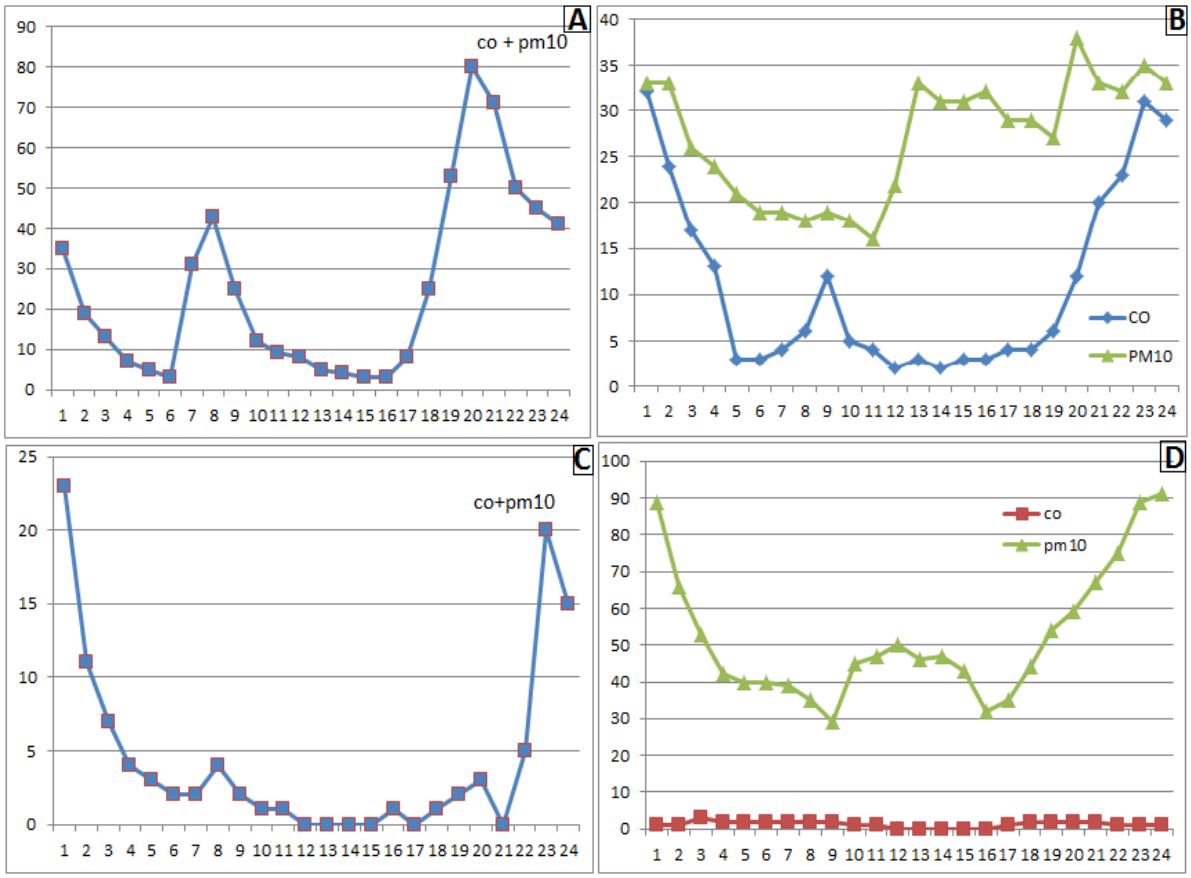

Fig. 4: temporal trends of CO and PM10 pollutants in hourly scale (2013-2007)

Spatial distribution:

Mapping of the spatial distribution of pollutants showed that in annual and seasonal scale concentration of pollutants is in central and western Tehran. The reason for the high concentration of heavy traffic vehicles, particularly in the areas mentioned. Figure 5 shows the spatial distribution of frequencies on a seasonal scale. We can see that the general trend in the all seasons of the year is the same and distribution of polluted days reduced to the East and South.

In the all cases, years, Pounak station has the highest frequency of pollution. In the winter, Golbarg station, with 4 days is the core of minimum pollution.

In the spring, summer and autumn there is the lowest pollution in the Station Park, respectively with 1, 2 and 12 days. Because the Park station located in the green space and forested area. Overall, in the studied statistical period (2007-2013), Pounak and Geophysics stations have the highest pollution levels with 216 and 106 polluted days.

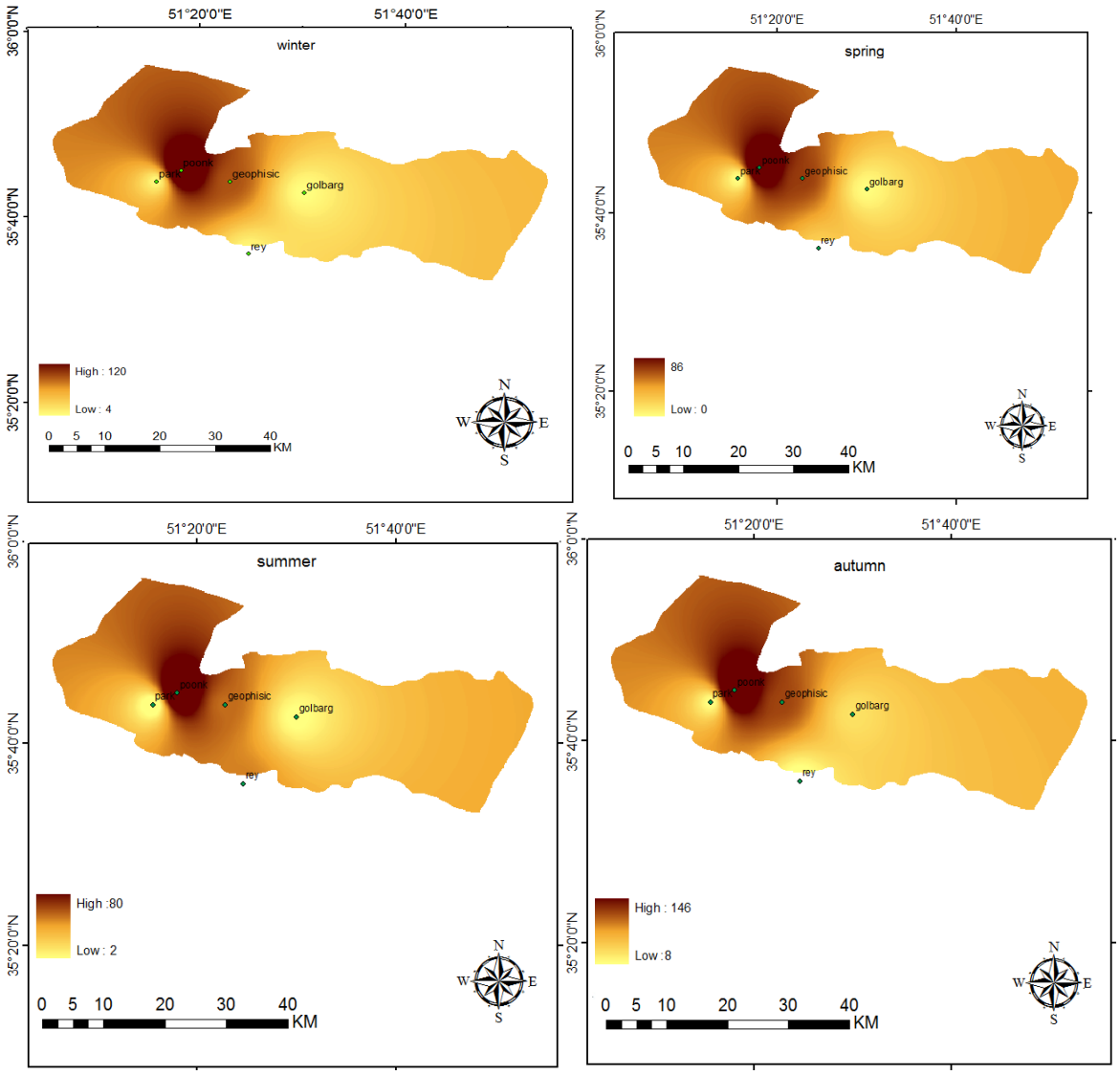

Fig.e 5: The frequency of spatial distribution of polluted days in the temporal scale of season (2013-2007).

Conclusions:

Due to the enormous effects and problems of air pollution, such as increased heart disease, respiratory, reduced visibility, eye irritation and damage to plants, animals and objects, loss of stratospheric ozone, acid rain, etc. the main purpose of the present study is investigating of temporal-spatial changes of air pollutants in Tehran. Therefore, the data of pollution stations (that given from Control Quality of Tehran air Inc.) evaluated from CO and PM10 pollutants.

Results showed that there are annually changes in the pollutants trend in Tehran on basis of temporal and spatial scale and in the all stations increase or reduce pollutants are not same. Nevertheless, the record of the pollutant is noticeable in the most stations for the year 2010. In the seasonal and monthly Scale the process, of temporal-spatial change as well as are not the same, but, in autumn recorded the maximum amount of pollutants in most stations. In the monthly scale, also is mainly frequency of polluted days in December. Also, in the daily scale around 7 to 9 pm has been observed the maximum in studied pollutant stations. Concentration of pollutants in this time is due to the environmental conditions of Tehran. Rather, energy of the earth is withdrawn from the sunset by the effects of long-wave radiation from the earth's surface. Consequently, the temperature reduced as in the early morning and the surface of the earth is colder than air temperature. As a result, cannot be provide the possibility of the air climbing and in this context focus on pollutants in the morning hours. Spatially, we has been observed the most frequency of polluted days in the west and central area of Tehran and the spatial process of pollution reduced proportionally from the South and East. Exile concentration of pollutants in western and central regions is due to the presence of factories and industries and concentration of traffic in the center of the city, and on the other hand, is due to the direction of local and regional winds in Tehran. As a result, the proximity to the region of origin and passing of input winds from these direction results the more

concentration of pollutants on the West and Center. Generally, in the district of Tehran city, has recorded more pollutants in the cold season of the year. This situation can be due to geographic and topographic location and influence of input systems to Tehran in cold periods. During the cold period of season become lower the creating stable, unstable and possibility of the air climbing with penetration of cooling systems. As a result, this condition along with the inversion shapes more focus and recording of pollutants during cold period of years in the stations of Tehran.

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