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ORIGINAL RESEARCH PAPER

# Risk Assessment of $PM_{2.5}$ on the Health of Citizens (Case Study: District 10 of Tehran)

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## ABSTRACT

The purpose of this study was to evaluate the environmental and health risk of $PM_{2.5}$ microns in district 10 of Tehran. Initially, data related to the year 2019 were collected and analyzed through pollutant measurement at the regional level. Based on Kriging's interpolation the corresponding raster was produced and classified according to the minimum and maximum range. Finally, according to the air quality index, the level of importance of health safety was classified and the relevant map was prepared. Through the IO technique, the location layer of sensitive and vulnerable land uses and the carbon monoxide contaminant zoning layer were mapped. Results showed that District 10 of Tehran with the average concentration of 42µg/m3 is the most polluted area in terms of this contaminant in Tehran. Also, most of the PM2.5 pollutants belong to the northern, southern and western half of the region. Also, December was the most polluted month of the year with an average concentration of 56µg/m3. From the point of view of the air quality index based on the type of pollutants, the area had 104 days of unhealthy and unhealthy days for sensitive groups. Environmental and health risk assessment of these pollutants indicates that according to William Fine method, the risk number is 105, which indicates the average risk level. Therefore, it requires corrective and emergency risk control measures.

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## 1. Background

Air pollution is one of the most important factors that affect the quality of human life and adversely affect human health. These effects cause biochemical and physiological changes in the body that eventually lead to severe illness and even death (Amesano et al., 2016). Urban air pollution includes both primary and secondary pollutants (Adams, 2010). In 2013, air pollution and particulate matter were classified as grade 1 carcinogens for humans (Qias al-din, 2015). According to a World Health Organization study, more than four million people die prematurely each year from air pollution (WHO, 2017). According to the World Bank, the risks that air pollution can pose to health are highest in developing countries (WB, 2015). Despite much research on the causes and methods of controlling air pollution, air quality is still one of the problems of large cities (Nasibulina, 2015).

Suspended particulate matter can be divided into two categories(Mostofie et al., 2014):

1. Particularly respirable particles ($PM_{10}$) such as suspended particles found near roads or dust-producing industries, larger than 2.5 microns in diameter and less than 10 microns in diameter. Suspended particles 10 microns or less in diameter are more dangerous to health because they can generally pass through the nose and throat and into the lungs and sometimes into the bloodstream. Inhalation of these particles can affect the heart and lungs and have serious health consequences.
2. Medium particles ($PM_{2.5}$) like suspended particles found in smoke and fumes with a diameter of 2.5 microns or less. These particles either enter the air directly from sources such as forest fires or are formed in the air as a result of the reaction of exhaust gases from power plants, industries and vehicles. The size of these particles is directly related to their ability to harm human health. The World Health Organization estimates that about 800,000 people worldwide die each year from the pollutant.

Figure 1 shows the distribution map of $PM_{2.5}$ in the world. As can be seen, the concentration of this pollutant in Iran is relatively high. $PM_{2.5}$ pollutants contain pollutants such as sulfate, nitrate and carbon black that pose the greatest risk to human health. According to the global data for 2018 among 62 cities in the capital of the world, Tehran with an annual concentration of 26.1 micrograms per cubic meter is ranked 23rd, which is more than twice the amount provided by the World Health Organization (10 Micrograms per cubic meter). The daily allowable level of $PM_{2.5}$ is 25 micrograms per cubic meter and its annual standard is 10 micrograms per cubic meter (WHO, 2017).

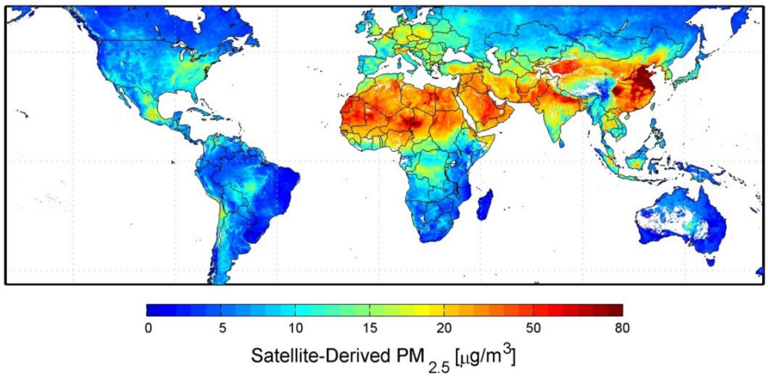


**Figure 1.** Distribution map and concentration of ($PM_{2.5}$) in the world in 2016 (WHO, 2017)

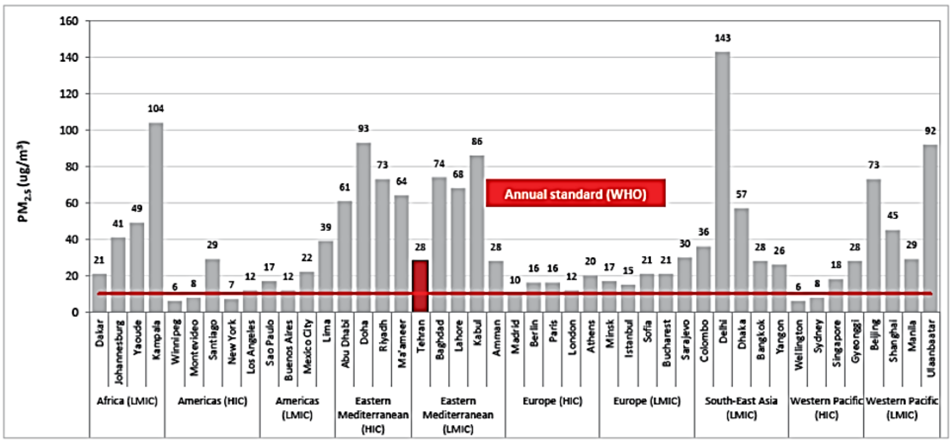


**Figure 2.** Average annual concentration of $PM_{2.5}$ in some cities around the world based on data from 2016-2010

(Source: TAQCC, 2018)

Low and middle income areas (LMIC), high income areas (HIC)

**Table 1.** Pollutant effects of particulate matter on the health of citizens

| Pollutant | Impact |
|---|---|
| $PM_{2.5}$ | ▪ $PM_{2.5}$ is the main indicator of airborne matter due to its access to the lower respiratory tract.<br>▪ According to epidemiological studies, particulate matter is more dangerous to human health than sulfur oxides and nitrogen oxides. Premature mortality and cancer play a major role.<br>▪ 95% of the world's population lives in areas where the annual concentration of the pollutant exceeds WHO guidelines. In general, the share of particles in the increase of chronic lung diseases has been reported by 3.3%, heart diseases by 2.1% and pneumonia by 4%. |
| Asilian, 2016; Qiase-aldin, 2015; Pierson, 1989; Carlisle & Sharp, Bahmanpour, 2017; 2001; Kim et al., 2001; Folinsbee, 2001; Brunekreef & Holgate, 2002; Daisey et al., 2003; Vedal et al., 2003; USEPA, 2004; Florida & James, 2004; Lippi et al., 2008; Blair et al., 2010; Hastings, 2010; Holzer, 2012; Wu et al, 2015; Widodo, 2015. | |

The following figure shows the average annual concentration of this pollutant in some cities of the world. As can be seen, the amount of this pollutant in Tehran is too standard. Table 1 summarizes the harmful effects of particulate matter on citizens' health.

The air pollution crisis has become a human catastrophe due to improper urban planning (Siahpour et al., 2021). Tehran metropolis is one of the eight largest cities in the country in terms of topographic and climatic conditions, as well as the traffic of nearly 5 million vehicles and the establishment of a large number of large and small industrial units, where air pollution is one of the major problems facing people and officials. This city has become. The annual damage of air pollution in Iran until 2016 is estimated at about 16 billion dollars (Bahmanpour, 2017). Every year in Tehran, more than 4,400 people die due to air pollution (Asilian, 2016). Examination of the average annual concentration of $PM_{2.5}$ pollutants in the studied stations and also comparing it with the last annual standard limit of Iran (red line equal to (12 µg/m3) shows that in Shadabad (district 18), Sadr (district 3) and Shahre Rey stations (District 20) The highest concentration of $PM_{2.5}$ pollutants has been measured, respectively. It has been unfavorable (TAQCC, 2018). Since all human activities are associated with risk (Jozi & Padash, 2009) assessing and determining the risk of actions and activities can be used as a tool in planning and managing future actions. Therefore; the purpose of this study is to assess the risk of particulate matter ($PM_{2.5}$) in relation to the health of citizens. Since District 10 of Tehran Municipality is one of the busiest and busiest southern areas of Tehran and has only 1 pollution measuring station, which does not fully, measure this pollution, therefore; this area was selected as a study area in this study to accurately and regularly measure this pollutant to comment on the level of environmental and health risk. Environmental risk assessment is the process of qualitative analysis of risk potentials and the coefficient of realization of potential risks in the area or project, as well as the sensitivity or vulnerability of the surrounding environment (Fataei, 2021; Sadigh et al., 2021). The main purpose of risk analysis and evaluation is to determine the degree of uncertainty of the system under study and the resulting cost and to provide solutions to reduce it, as well as the accumulation of the cost of the relevant solution (Allen et al., 2009). District 10 of the municipality with an area of 817 hectares is one of the smallest districts in Tehran. The population of the region is about 320 thousand people and with a density of about 420 people per hectare, which in this regard, is one of the most densely populated areas of Tehran among the 22 regions and its population is four times the standard and twice the average density in Tehran. About one hundred thousand families live in this area (Saman Mohit Azma, 2018). This area has 27 parks with an area of more than twenty hectares. District 10 is one of the central and somewhat western areas of Tehran.

The main purpose of this study is to measure the rate of suspended particles in District 10 of Tehran and assess the related environmental risk. The main research question is what is the level of risk in this area?

## 2. Methodology

This research is of survey type and in terms of data analysis method, it is of comparative-analytical type. Initially, pollutant data ($PM_{2.5}$) were collected and analyzed from the Air Pollution Monitoring Center and the Tehran Air Quality Control Company. For this purpose, statistical data of 5 stations active in the region and around the study and in the period from the beginning of April 2019 to February 1, 2019, were collected and reviewed. Data and statistics were pre-processed in order to extract the desired results and true information. Since there is no air pollution measuring station in District 10 of Tehran Municipality that can measure particulate matter with a diameter of less than 2.5 microns in most of the year, inevitably and in order to increase the accuracy of the analysis. Stations in neighboring areas were also used. Finally, the data extracted from the studied stations were also matched with the data of the Air Vision database.

Then, based on the table of average pollutant concentrations in selected stations, the weight numbers of each pollutant were entered in the relevant table. Then, by introducing the method (Kriging) based on the weight of pollutants, the relevant roster was generated and classification was performed based on the minimum and maximum range.

**Table 2.** Study stations in measuring $PM_{2.5}$ pollutants

| Row | Station |
|---|---|
| 1 | District 10 (Main Station) |
| 2 | District 11 (Side Station) |
| 3 | District 9 - Fatah Square (side station) |
| 4 | District 2 (Side Station) |
| 5 | District 6- Tarbiat-e- Modares (Side Station) |


**Figure 3.** Location of $PM_{2.5}$ sampling stations in the area and surrounding area of district 10
**Figure 4.** Location of $PM_{2.5}$ sampling stations in the area and surrounding area of district 10

To estimate the values by kriging method, there are different techniques that in this research, conventional kriging method has been used.

Equation (1)

$$Z_0^1 = \sum_{i=1}^{N} Wi\ Zi$$

In this equation  is equal to the estimated values, ‘ is equal to the weight and is equal to the sample values. The weights depend on the degree of correlation between the sample points and the estimated points, and their sum is always equal to 1 (Bohling & Geoff, 2005). Thus, for $PM_{2.5}$, this method was repeated and the output was mapped. Finally, based on the air quality index table, which is based on the EPA standard, 2004, the level of importance of health safety was classified and mapped. The basis for measuring the number of pollutants is based on the Air Quality Index (AQI). The range of this index varies between 0 and 500. The higher the index, the more polluted the air and the greater its effect on health (Table 3).

To calculate the short-term standard of pollutants, the National Guide (Ministry of Health, 2011) and to calculate the long-term standard (annual) of pollutants, the standard approved by the Environmental Protection Organization in 2017 is used. They are derived from the standards developed by (EPA) and (WHO). The table below lists the limits used to determine the standard of this pollutant.

Then, through the IO technique, the location layer of sensitive and vulnerable land uses and the contaminated zoning layers were superimposed. Comparing Index Overlay with Boolean Models executive routines, it is identified that Index Overlay model has more flexibility and ability for priority indication on spatial units of factor maps.

The William Fine method was used to assess the risk of various aspects and factors in the present study. In this method, the risk is calculated by multiplying the following three parameters:

Equation (2) $R = C \times E \times P$

R = Risk rating, C = Consequences rate, E = Exposure rate, P = Probability rate

The table below is a guide to risk calculation.

## 3. Results

Findings of research on particulate pollutants in District 10 of Tehran Municipality are presented in several separate sections.

### *A) Results of sample analysis in measuring stations*

Table 6 shows the polluted condition measured at the sampling points based on the standard provided by the Center for Environmental Management and Sustainable Development of Tehran Municipality and the AQI air pollution index. As it turns out, all the stations around the region and the region 10 itself are in an unhealthy state for sensitive groups in terms of the average daily concentration of this pollutant. On the other hand, the average annual concentration of pollutants for all stations in the whole city of Tehran was 35 micrograms per cubic meter.

**Table 3.** Air Quality Index Guide (US EPA, 2004)

| Numerical values | AQI | Descriptaion | Breakpoints $PM_{2.5}$ (µg/m$^3$) 24 hours |
|---|---|---|---|
| 0-50 | Good (Clean) | The air quality is satisfactory and there is no risk. | 0 – 15.4 |
| 51-100 | Healthy | Air quality is acceptable and moderate for sensitive people. | 15.5 – 35.0 |
| 101--150 | Unhealthy foe sensitive groups | Air quality is not good for sensitive people, but the general public may not be affected. Doing outdoor sports is not recommended. | 35.1 – 65.4 |
| 151-200 | Unhealthy | Air quality is not good for the general public and is a dangerous situation for sensitive people. Physical activity is not recommended under any circumstances. | 65.5 – 150.4 |
| 201-300 | Very unhealthy | Health conditions are on alert and all people will be affected. | 150.5 – 250.4 |
| 301-500 | Hazardous | Air quality is dangerous and these conditions pose serious risks to everyone. | More than 250.5 |

**Table 4.** Permissible limits of particulate pollutants

| Pollutant | Standard | Timespan |
|---|---|---|
| $PM_{2.5}$ | 25 µg/m$^3$ | Daily |
| | µg/m$^3$ 12 | Yearly |

### B) Results of comparison of $PM_{2.5}$ concentrations in different months in the study area

Based on the results obtained from the database and their processing, the average concentration of $PM_{2.5}$ pollutants in different months in the study area was presented in Figure 4, respectively. As shown in Figure 4, in the study period, the lowest concentration of pollutants belonged to April (25 micrograms per cubic meter) and the highest amount belonged to December (56 micrograms per cubic meter).

### C) The results of the study and comparison of $PM_{2.5}$ concentrations in the study area and other areas of Tehran

Table 7 lists the average $PM_{2.5}$ concentrations in air pollution monitoring stations during the study period. Accordingly, district 10 had the highest average concentration of this pollutant (42 micrograms per cubic meter).

**Table 5.** Guide to calculating risk by the William Fine method (Jozy & Padash, 2009)

| (E) | | (P) | |
|---|---|---|---|
| **Score** | Description of exposure rate and frequency of risk | **Score** | Description of the probability of occurrence |
| 7 | Constantly - several times a day - more than 8 hours of contact - continuous emission of pollutants | 7 | Most likely (close to 100%) |
| 6 | Often - several times a week - contact between 6 and 8 hours - high emissions | 6 | High chance of occurrence (less than 100 and more than 75%) |
| 5 | Occasionally - Fish several times - Contact between 4 to 6 hours a day - Moderate emissions | 5 | Relatively high chance (less than 75% and more than 50%) |
| 4 | Unusual - Several times a year - Contact between 2 to 4 hours a day - Abnormal emission of pollutants | 4 | The chance of occurrence is equal (50-50). |
| 3 | Rarely - once every few years - Contact between 1 and 2 hours a day - Low emissions | 3 | It can happen by accident (chance less than 50%) |
| 2 | In part - very little - less than 1 hour of contact per day - negligible emissions | 2 | It probably won't happen until a few years after the call, but it can |
| 1 | No contact - no frequency of occurrence - no pollutant emission ، | 1 | In practice it is impossible (it never happens) |

**Table 5.** Continue

| (C) | |
|---|---|
| Score | Risk Outcome Description |
| 7 | Multiple mortality - Irreversible environmental damage with long-term effects - High financial losses - Excessive consumption of resources and energy - Excessive concentrations of pollutants (50% above standard) |
| 6 | Death of one person - Irreparable environmental damage with medium-term effects - High concentration of pollutants (30% higher than standard) |
| 5 | Damage leading to permanent disability - Irreparable environmental damage with short-term effects - High concentrations of pollutants (10% higher than standard) |
| 4 | Long-term damage without permanent disability - Compensable environmental damage with long-term effects - Medium concentration of pollutants (5% higher than standard) |
| 3 | Temporary damage - Compensable environmental damage with short-term effects - Pollutant concentration less than 5% higher than standard |
| 2 | Minor damage requires first aid (less than 3 days), low resource consumption, standard contaminant concentration |
| 1 | No need for further investigation, no environmental damage, no resource consumption, pollutants as standard |

Also; district 4 had the lowest rate (10 micrograms per cubic meter).

Figure 5 shows the average annual concentration of $PM_{2.5}$ in the study period (April 2019 to February 2019) using the size of the circles located at stations located in Tehran. Obviously, the larger the size of these circles, the higher the average annual concentration of particulate matter at that station. As can be seen in this figure, the highest concentration (with the exception of Sadr station) occurred in stations located in the center and southwest of Tehran, which are mostly affected by dust currents.

According to Figure 5, the highest concentration of $PM_{2.5}$ is seen in areas that are more exposed to dust originating outside of Tehran.

**Table 6.** Status of average $PM_{2.5}$ concentration According to AQI standard in the studied stations (Research results)

| Row | Station | Air pollutant $PM_{2.5}$ ($\mu g/m^3$) | AQI |
|---|---|---|---|
| 1 | District 10 | 42 | Unhealthy foe sensitive groups |
| 2 | District 11 | 37 | Unhealthy foe sensitive groups |
| 3 | District 9- Fath square | 39 | Unhealthy foe sensitive groups |
| 4 | District 2 | 30 | Healthy |
| 5 | District 6 – Tarbiat –e- modares | 29 | Healthy |
| 6 | District 17 | 36 | Unhealthy foe sensitive groups |
| 7 | District 18 | 37 | Unhealthy foe sensitive groups |

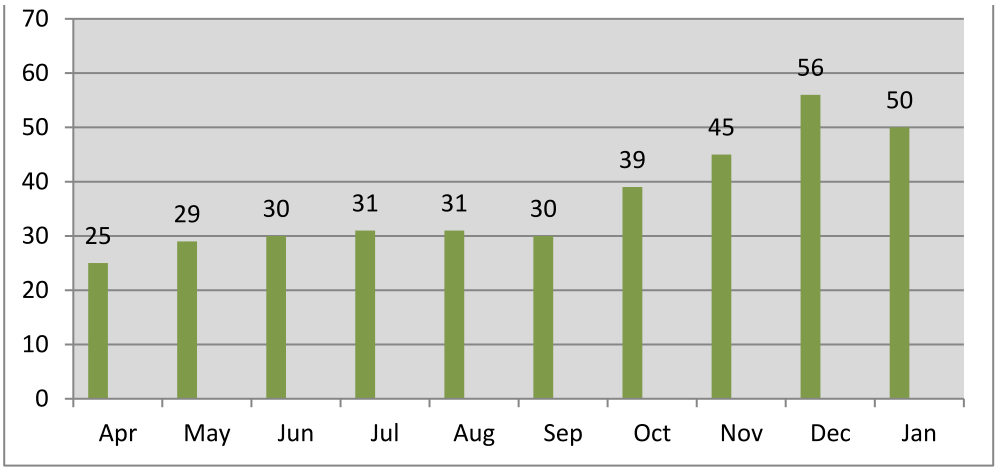


**Figure 4.** Trend of changes in the average concentration of $PM_{2.5}$ (based on micrograms per cubic meter) in different months in the study area in 2019

It should be noted that in addition to the effect of traffic and dust phenomenon, the activities of resident sources of air pollution, including construction activities and construction projects around the stations are also effective in emitting this pollutant.

### *D) Results of air quality index*

From the point of view of air quality index, Tehran had 30 days of clean air, 221 days of healthy air, 52 unhealthy days for sensitive groups and 4 unhealthy days in the studied period (beginning of April to the beginning of February 2017). During the same period, District 10 of Tehran Municipality; it had 20 clean days, 183 healthy days, 86 unhealthy days for sensitive groups and 18 unhealthy days for this contaminant. Comparative comparison of the concentration of suspended particles in region 10 with Tehran shows that the concentration of this pollutant in region 10 is higher than Tehran.

**Table 7.** Mean $PM_{2.5}$ concentration during 2019 in Tehran (Research findings)

| District | Average of $PM_{2.5}$ (μg/m$^3$) |
|---|---|
| 1 | 20 |
| 2 | 30 |
| 3 | 38 |
| 4 | 10 |
| 5 | 19 |
| 6 | 29 |
| 7 | 23 |
| 8 | 21 |
| 9 | 39 |
| 10 | 42 |
| 11 | 37 |
| 12 | 38 |
| 13 | 38 |
| 14 | 33 |
| 15 | 22 |
| 16 | 33 |
| 17 | 36 |
| 18 | 37 |
| 19 | 36 |
| 20 | 36 |
| 21 | 37 |
| 22 | 29 |

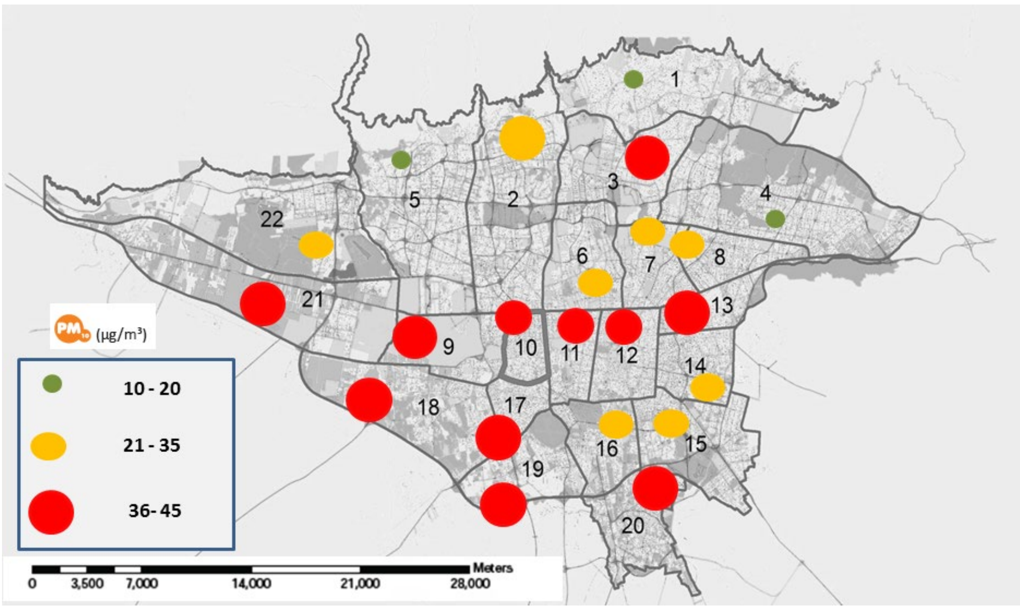


**Figure 5.** Status of the average annual concentration of $PM_{2.5}$ in different stations of Tehran in comparison with district 10 (Research results)

On the other hand, the number of clean and acceptable weather days in District 10 is less than other areas of Tehran and also the number of unhealthy days in this area is about 4 times the average of Tehran.

### *E) The results of layer superimposition*

The zoning map of $PM_{2.5}$ for Area 10 is shown in Figure 6.

Based on the overlap of air pollution layers and the map of sensitive and vulnerable land uses in District 10 of Tehran Municipality, it is determined that children and adolescents are one of the groups sensitive to air pollution. These groups spend a large part of their activities in schools and colleges. Therefore, schools and educational centers can be described as centers for the acceptance of sensitive particles to particulate matter less than 10 microns in diameter. Also; Medical centers and hospitals are also considered as one of the vulnerable centers. The following figure shows the location of these identified centers in the region.

As shown in the map, most of these sensitive centers are located in the eastern half of the region. By overlapping these two maps ($PM_{2.5}$ zoning and sensitive land uses), it is revealed that the northern, southern, western and even central parts have the highest levels of this pollutant, which will naturally affect the existing land uses.

### *F) Results of risk assessment*

Using the William Fine method guide, $PM_{2.5}$ environmental and health risk was assessed and analyzed. In order to determine the outcome, exposure and probability, the evaluation was performed according to Table 9. Since the average concentration of this pollutant in District 10 of Tehran Municipality was equal to 42 micrograms per cubic meter, it is found that more than 50% of the relevant standard (25 micrograms per cubic meter) is higher. As a result, the risk consequence is high and is equivalent to the number 7. On the other hand, in terms of probability of occurrence, considering that in a total of 307 days of pollutant harvest, 104 days had contamination due to this contaminant, as a result, the chance of occurrence was less than 50% (33%) and the probability of occurrence was 3 Is taken. also; According to the database, the call rate is considered equal to 5.

Finally, this factor was evaluated by William Fine method as follows:

**Table 8.** Status of average PM2.5 concentration according to AQI standard in different stations (Research results)

| Row | Station | Average of $PM_{2.5}$ | Air quality | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Clean | Healthy | Unhealthy foe sensitive groups | Unhealthy | Very unhealthy | Hazardous |
| 1 | Disrtict 10 | 105 | 20 | 183 | 86 | 18 | - | - |
| 2 | Tehran | 81 | 30 | 221 | 52 | 4 | - | - |

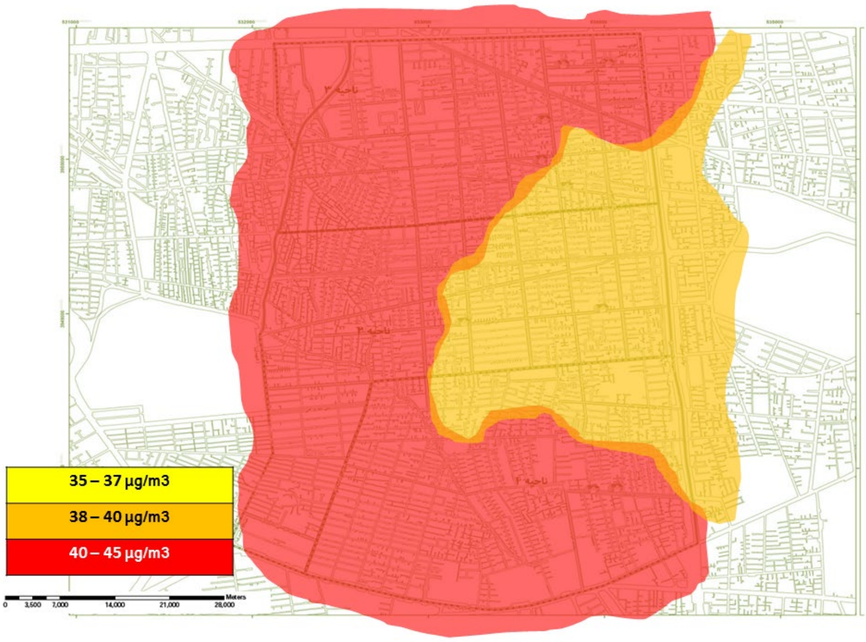


**Figure 6.** Air quality zoning map in District 10 of Tehran Municipality based on the studied pollutant concentration ($PM_{2.5}$) in 2019 (Authors based on research findings)

$$E \times C \times P$$

$$5 \times 7 \times 3 = \mathbf{105}$$

## 4. Discussion

In general, according to Table 10, it can be said that the risk rating is 105, which indicates the state of emergency and the “average level of risk” and it is necessary to pay attention as soon as possible. The results showed that $PM_{2.5}$ did not have the same distribution in the study area and there was a complete difference. Based on zoning maps, it is determined that the most polluted areas are located in the northern, southern and western half of the region. Also, the distribution of pollution does not follow a specific pattern and there is no visible order in it. Examination and analysis of information layers and drawing maps show that a large part of the sensitive and vulnerable uses of the area are in direct and high contact with this pollutant.

The results of the present study are consistent with the study conducted by Bahmanpour et al. (2013). Because in that research, it was found that the manner and type of air pollution in Tehran is diverse and numerous based on the type of pollutant. On the other hand, the results of the present study with the research conducted by Azizi et al. (2007); it is similar in only one case and does not match in other cases because the results of Azizi’s research indicate that the concentration of pollutants in Tehran increases from north to south and from west to east and the maximum concentration are observed in urban district 11 and 12 and at least in district 4 and 21.

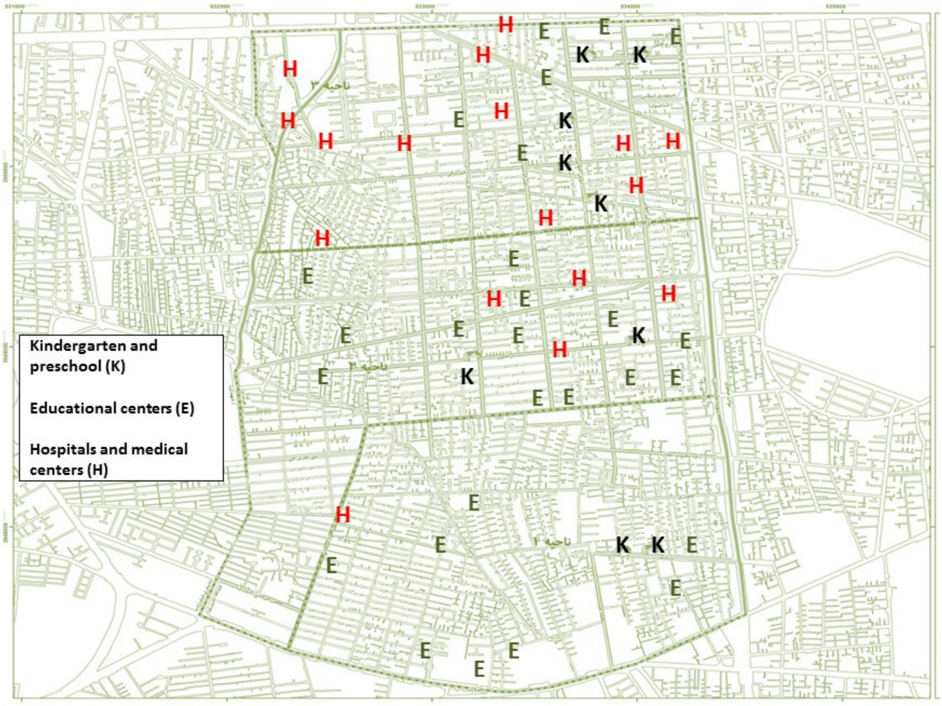


**Figure 7.** Location map of sensitive and vulnerable uses (kindergartens, preschools, educational centers, hospitals and medical centers) In District 10 of Tehran Municipality (Authors based on research findings)

**Table 9.** Consequences rate (C), Exposure rate (E) and probability rate (P) (Authors based on research findings)

| Aspect | Possible consequences | Risk | | | Risk rating | Risk level |
|---|---|---|---|---|---|---|
| | | C | E | P | | |
| $PM_{2.5}$ distribution | Poisoning / health effects and Decreased efficiency | 7 | 5 | 3 | 105 | Moderate |

**Table 10.** Summary of risk rating and measures (Authors based on research findings)

| Rank | Action | Risk level |
|---|---|---|
| 200 < | Immediate corrections are needed to control the risk. | High |
| 90 - 199 | Emergency (necessary attention should be taken as soon as possible) | Moderate |
| 89 > | The risk is monitored and controlled. | Low |

The results of environmental risk assessment of this pollutant in the study area indicate that according to the obtained rank (105) the level of risk is moderate and emergency action is necessary. Also; calculating the risk level of adjacent areas (9, 11 and 17) also shows that there is not much difference between areas. So that the risk rating of Zone 9 is similar to Zone 10 (105 and equal to the average risk level) is estimated. The risk rating of areas 11 and 17 is 90, which is originally considered as the minimum average risk level.

## 5. Conclusion

Overall, it is found that the level of $PM_{2.5}$ is high in the central and southwestern part of Tehran. In principle, based on the allowable limit for this pollutant (25 micrograms per cubic meter), it can be said that with the exception of districts 1, 4, 5, 7, 8 and 15 other areas of Tehran have an average concentration of above the allowable limit. According to the results of the research, it is clear that District 10 of Tehran is not in a good condition in terms of particulate matter pollution and it is necessary for the city management to pay more attention to this issue.

The research innovation is that for the first time in Area 10, a study on air pollutants has been conducted to measure as well as assess risk. The level of risk and its effects on citizens' health have been calculated.

## References


1. Adams K.J., 2010, Exercise Physiology. In: Ehrman JK, editor. ACSM Resourse Manual for Guidelines for Exercise testing and prescription.6th ed.Philadelphia: Lippincott Williams and Wilkin; p. 73-4
2. Allen H.H., Chia-wei, H., Tsai-Chi K., Wei-Cheng W., 2009, Risk evaluation of green components to hazardous substance using FMEA and FAHP, Expert Systems with Applications., 36,7142-7147.
3. Arnesano. M., Revel. G.M., Seri. F.A., 2016, tool for the optimal sensor placement to optimize temperature monitoring in large sports spaces, Automation in Construction 68 (2016) 223–234.
4. Asilian. H., 2016, Air pollution, Sobhan etd, Vol 3, pp 152.
5. Azizi, Gh., 2007, Tehran air pollution simulation, Natural Geographic Researchs, Vol 68, 15-32 pp.
6. Bahmanpour. H., 2017, Environmental education for managers, Department of environment, I.R.IRAN, PP 233.
7. Blair, C., Walls, J., Davies, N. W., Jacobson, G.A., 2010, Volatile organic compounds in runners near a roadway: increased blood levels after short-duration exercise. Br J Sports Med 2010; 44(10):731.
8. Bohling, Geoff, 2005. Kriging. Kansas Geological Survey
9. Brunekreef, S.T., Holgate, 2002, Air pollution and health, Lancet 360 (2002), 1233–1242.
10. Carlisle, A.J., Sharp. N. C., 2001, Exercise and outdoor ambient air pollution, Br J Sports Med 2001; 35: 214-222.
11. Daisey, J. M., Angell, W. J., Apte, M. G., 2003, Indoor air quality, ventilation and health symptoms in schools: analysis of existing information. Indoor Air 13, 53–64.
12. Fataei, E. (2021) The Assessment of Environmental and Health Risks in Sabalan Dam Basin Using WRASTIC Model, Journal of Health, 11 (4), 555-573. https://www.sid.ir/fa/journal/ViewPaper.aspx?id=573294
13. Florida K, James G., 2004, Athens 2004: the pollution climate and athletic performance. J Sports Sci2004; 22:967-80.
14. Folinsbee, L. J., 2001, Air pollution: acute and chronic effects.2nd edition. London: The Royal Society of Medicine; 45 p.
15. Hastings, J., 2010, Exercise prescription and medical considerations. In:Ehrman JK,editor. ACSM Recourse Manual for Guidelines for Exercise testing and prescription.6th ed.Philadelphia:Lippincott Williams and Wilkin; 556 p.
16. Holzer, K., 2012, Respiratory symptoms during exercise. In:Brukner P editor. Brukner and Khan clinical sports medicine.4th ed. McGraw-Hill; 2012.P.1049
17. IARC, 2013, International Agency for Research on Cancer, Latest world cancer statistics Global cancer burden raises to 14.1 million new cases in 2012: Marked increase in breast cancers must be addressed, WHO website.
18. Jozi, A., Padash, A., 2009, Risk assessment and Management, IAU publisher, 344 pp.
19. Kim, Y. M., Harrad, S., Harrison, R., 2001, Concentrations and sources of volatile organic compounds in urban domestic and public microenvironments. Indoor Built Environ; 10:147-53.
20. Lippi, G., Guidi. G.C., Maffulli, N., 2008, Air pollution and sports performance in Beijing. Int J Sports Med 2008 Aug; 29(8):696-8.
21. Mostofie, N., Fataei, E., Kheikhah Zarkesh M.M., Hezhabrpour Gh. (2014) Assessment centers and distribution centers dust(case study: NorthWest, Iran), International Journal of Farming and Allied Sciences, 3(2):235-243.
22. Nasibulina, Anastasia, 2015, Education for Sustainable Development and Environmental Ethics. Available online at www.sciencedirect.com, Procedia - Social and Behavioral Sciences 214 (2015) 1077 – 1082.
23. Pierson W. E., 1989, Impact of air pollution on athletic performance. Allergy Proc 2013 Jan;10(3):209
24. Qiase-aldin. M., 2015, Air pollution and control, Tehran University Etd, pp 380.
25. Saman Mohit Azma, 2018, Identification and Monitoring of Pollutant Resources and Preparation of Environmental Atlas of District 10, Deputy of Urban Affairs and Environment of District 10 of Tehran Municipality, 126 p.
26. Sadigh, A., Fataei, E., Arzanloo, M., Imani, A.A.(2021). Bacteria bioaerosol in the indoor air of educational microenvironments: Measuring exposures and assessing health effects. Journal of Environmental Health Science and Engineering, 19, 1635-1642.
27. Siahpour, G., Jozi, S.A., Orak, N., Fathian, H., Dashti, S. 2021. Estimation of Concentration of Air Pollutants in Shazand Thermal Power Plant with Support Vector Machine Model Based on Selection of Effective Input Variables with Partial Mutual Information (PMI) Algorithm of Distribution of Air Pollutants, Anthropogenic Pollution Journal, Vol 5 (1), 2021: 81-97
28. TAQCC, 2018, Teharan Air Quality Control Company, Report of Tehran, Tehran Municipality, Nashr-e- Shahr, pp 265.
29. USEPA, 2004. An examination of EPA risk assessment principles and practices. EPA/100/B-04/001. Washington (DC): OSA, USEPA; 2004, http://www.epa.gov/OSA/pdfs/ratf-final.pdf [accessed 30.10.13].
30. Vedal, S., Brauer, M., White, R., 2003, J. Air pollution and daily mortality in a city with low levels of pollution. Environ Health Perspect 2003; 111:45-51.
31. WB, 2015, Air pollution cost in global, World Bank Reports, www.worldbank.org/en/.../air-pollution-deaths-cost-global-economy
32. WHO, 2017, Air quality and health, www.who.int. Retrieved 2011-11-26.
33. Widodo, B, Lupyantob, R, Sulistionoc, D, Harjitod, A, Hamidin, J, Hapsaria, E ,Yasin, M, Ellinda ,C., 2015, Analysis of environmental carrying capacity for the development of sustainable settlement in Yogyakarta urban area, Available online at www.sciencedirect.com,2015, Procedia Environmental Sciences 28 (2015) 519 – 527
34. Wu, D., Xu, Y., Zhang, S., 2015, Will joint regional air pollution control be more cost-effective? An empirical study of China's BeijingeTianjineHebei region, www.elsevier.com/locate/jenvman, Journal of Environmental Management, 2015,149 (2015) 27e36.