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# Gaseous air pollutants dispersion emitted from point and line sources by coupling WRF-AERMOD models (Case study: Lowshan, Guilan Province, Iran)

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## ABSTRACT

The cement factories in urban areas can affect the air quality of cities due to the variety of pollutants emitted from cement production processes. In the present study, the impacts of the Khazar cement factory and two transportation axes between Guilan and Qazvin provinces were investigated on the air quality of Lowshan in Guilan Province, Iran in 2019. Due to the lack of suitable meteorological data for dispersion modeling, the WRF model was used to predict the meteorological parameters. The pollutants dispersion modeling was conducted by AERMOD software and the accuracy of results was confirmed by field measurements of $NO_2$ obtained by passive samplers. The CO and $NO_2$ dispersion modeling results showed that the air quality of Lowshan is in an acceptable situation compared to the ambient air quality standards. So that, the maximum one-hour concentration of $NO_2$ in most residential areas was lower than the ambient standard, and only in small parts of the areas close to line sources, the concentration value was close to the standard limits. The maximum value of annually-averaged concentration of $NO_2$ and the maximum one-hour concentration of CO were 17 ppb and 2.5 ppm, respectively, which are much lower than the clean air standards. Further investigation showed that in the cold weather seasons, due to the less vertical displacement of air and the decrease in the boundary layer height, the concentration of pollutants in the urban environment is higher than that in the warm weather seasons. Considering the night and day time wind roses showed that despite the existence of valley-mountain structure in the city, the air quality of the city is not affected by the mountain and valley breezes and also night and day wind roses do not follow the trend of these breezes.

**Keywords:** cement factory; air pollutant; passive samplers; WRF; AERMOD.
**Article type:** Research Article.

## INTRODUCTION

Sometimes, in the process of implementing industrial development programs, side products and often harmful compounds are released into the environment, which has many negative effects on the environment. Air pollution is one of the consequences of industrial development, which is considered a serious threat to public health (Boudaghpour & Jadidi 2009; Masoudi 2014; Goudarzi *et al*. 2016). The cement industry is one of the largest industries in the world that emits various gaseous and particulate pollutants to the atmosphere at different stages of production. Nitrogen oxides ($NO_x$) and carbon monoxide (CO) as well as particles with diameter smaller than 10 micrometers ($PM_{10}$) and 2.5 micrometers ($PM_{2.5}$) are the most important air pollutants in this industry (Holmes 2006). By Applying numerical simulation, it is possible to understand how the pollutants emitted from emission sources, disperse in the air. Also, dispersion modeling results can be used to manage the emission sources to mitigate their emissions. One of the most widely used software for dispersion modeling of air pollutants is the AERMOD model (EPA 2004). The AERMOD model is used to predict the ambient concentration of various pollutants from the point, line, and surface sources. In addition to the main AERMOD processor, this model also

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uses a meteorological data preprocessor called AERMET and a train data preprocessor called AERMAP (Atabi *et al*. 2014, Barjoee *et al*. 2019). As cement factories' economic prosperity, the environmental effects of gaseous and particulate pollutants emitted from the cement factory have been studied by various researchers, and many studies have been conducted in this regard. Among them, Baroutian *et al*. (2006) studied the dispersion of particulate matter (PM) around the Kerman cement factory using the Gaussian dispersion model. The results of the study showed that the ambient concentration of PM is higher than the World Health Organization (WHO) standards at distance 590 m to 1370 m from the factory. Khaniabadi *et al*. (2018) evaluated the dispersion of PM using the Gaussian plume model in the Doroud cement factory. Comparing the results with the EPA standard showed that in none of the monitoring surveys, the $PM_{10}$ concentration was higher than the clean air standard. Almasi *et al*. (2013) examined the emission of air pollutants from the Saman cement factory in Kermanshah, in which the concentration of PM in the flue gas is much lower than the national emission standard of pollutants released from the crusher.

While the concentrations of the gaseous exhaust pollutants are higher than the emission standards. In another study, Fakinle *et al*. (2018) studied the dispersion modeling of air pollutants from all Nigerian cement plants. Comparison of ambient pollutants' concentrations with WHO and World Bank standards to assess air quality in the vicinity of cement plants, showed that in some areas around cement plants, the concentrations of pollutants are higher than standard values. Adetayo *et al*. (2019) measured PM and gas pollutants' ambient concentrations through sampling and used the AERMOD for dispersion modeling of pollutants from a cement plant in Nigeria. The study results indicate that in the case of simultaneous operation of point sources, the maximum one-hour averaged concentrations of pollutants, except for $NO_x$, remain within the standard ranges, within 50 km of the factory. Also, Mishra *et al*. (2019) studied the ambient air quality within a radius of 2 km around a cement plant in Odisha, India, in the case of PMs and gaseous pollutants. The results showed that the pollutions' concentrations observed were in accordance with the standards of the Central Pollution Control Board (CPCB) of India.

Considering the issues mentioned above regarding the importance of examining the pollutants dispersion emitted from a cement factory and due to the lack of investigation of this issue in the Khazar cement factory in Lowshan, Guilan province, the aim of this study is to investigate the dispersion of CO and $NO_x$ emitted from the Khazar cement factory and mobile sources in two roads (freeway and old road) in the study area and also determine the spatial distribution of pollutants in the urban areas of Lowshan. In addition, in existing studies, meteorological parameters, which are the most important factor in air pollutants' dispersion, have been estimated with simplification. However, in this study, the weather research forecasting (WRF) model has been used to estimate the meteorological parameters at the ground level and their vertical profiles.

## MATERIALS AND METHODS

### Study area

Khazar cement factory is located 80 km from Qazvin City, in the vicinity of Qazvin-Rasht freeway and in Lowshan City, which is the city of the entrance to Guilan Province. The factory has been in operation since 1975 (GPSIS 2018). Lowshan City is located in the central part of Roodbar county, Guilan Province. The geographical location of Lowshan and the relative location of the cement factory are given schematically in Fig. 1. The point sources of air pollutants in this factory include five stacks, given in Table 1. Notably, all stacks are equipped with the particle matters emission control device. The output pollutants of the hybrid stack and the SF cooler stack include gaseous and PM pollutants, and the output of other stacks only includes PM.

**Table 1.** Physical properties of point sources in the Khazar cement factory.

| Stack | Longitude (m) | Latitude (m) | Height (m) | Inside diameter (m) |
|---|---|---|---|---|
| Hybrid stack | 367494 | 4057118 | 120 | 2.5 |
| SF cooler stack | 367463 | 4057048 | 25 | 2.5 |
| Filtax. S. stack | 367538 | 4056840 | 21 | 2 |
| Old cement mill stack | 367541 | 4056956 | 21 | 2 |
| Filtax. D. stack | 367521 | 4056849 | 23 | 2 |

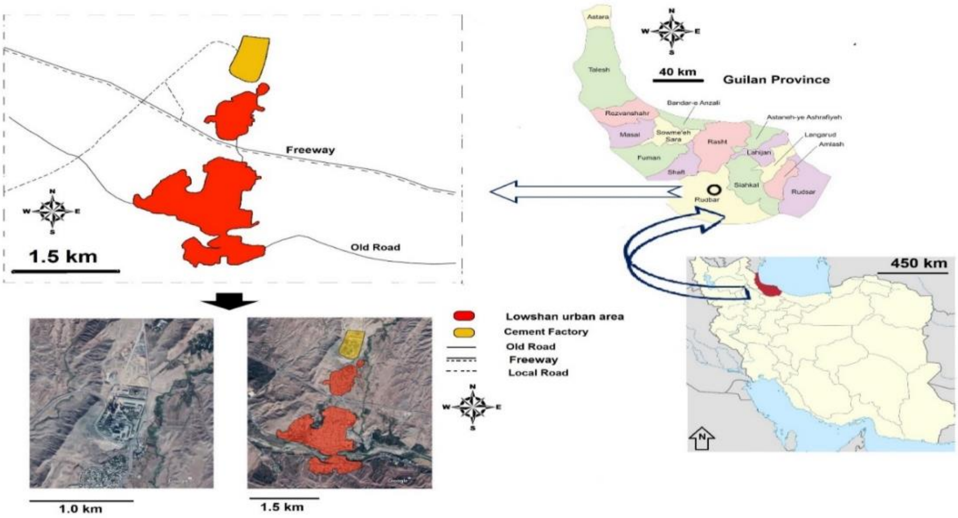



**Fig. 1**. The geographic location of the study area in Khazar cement factory located in Lowshan City, Guilan Province.

## Dispersion modeling (AERMOD model)

AERMOD is a steady-state and near-field (less than 50 km) Gaussian plume dispersion model, which is based on the structure and concepts of the planetary boundary layer (Seangkiatiyuth *et al*. 2011, Ramavandi *et al*. 2016). This model can simultaneously simulate multiple sources from different points, lines, surface, and volume sources. It has two pre-processors called AERMET and AERMAP. AERMET pre-processor computes meteorological data and the boundary layer parameters required for dispersion modeling. The AERMAP pre-processor analyzes the terrain data to calculate the real elevation of receptor and pollutant sources and finally, the AERMOD model performs the dispersion calculations using the information of these two pre-processors and the emission sources' information (Jayadipraja *et al*. 2016, Moein *et al*. 2018). In this study, AERMOD was run for the whole of 2019, from January to December. Since there was no reliable meteorological data for dispersion modeling in the studied area, the WRF global meteorological model was used to produce the required data. Also, the CO and $NO_x$ pollutant emission data from point sources as well as the mobile emission data (traffic source) were used in AERMOD software. Noteworthy, the traffic information related to line sources in the study area was gathered through the I.R. of Iran Road Management Center traffic counting data archives (141 center 2019) for each month and the emission rates of CO and $NO_x$ from line sources were calculated by motor vehicle emission simulator (MOVES) software.

## WRF model application

The WRF model is one of the numerical models for meteorological parameters prediction and is the new generation of the MM5 meteorological model. In areas similar to Lowshan City, where reliable meteorological data are not available for dispersion models, one of the best and reliable choice is to use WRF software to estimate surface and vertical profiles of meteorological parameters (Kumar *et al*. 2017; Afzali *et al*. 2017; Mirrezaei & Orkomi 2020). The WRF model is a non-hydrostatic compressible Eulerian model. In this study, the horizontal grid structure of the WRF model was Arakawa C-grid staggering, followed by considering a terrain-following hydrostatic pressure vertical coordinates (Azadi *et al*. 2010). The WRF model configuration is given in Table 2 and the WRF model domain is depicted in Fig. 2. The mesoscale model interface (MMIF) program was employed to convert the netCDF formatted data of WRF output to the appropriate format to be used by the AERMOD model.

## MOVES software application

The MOVES software is designed to estimate the air pollutants emissions from mobile sources. The first version of MOVES was released by the US Environmental Protection Agency. In the present study, the latest version (2014) was used. MOVES2014a software calculates the emission using the emission source (motor vehicles) data, meteorological data and drive schedules. This software has the ability to estimate the emission of pollutants on national, county and micro-scale (link scale) (Vallamsundar & Lin 2011; Zhang *et al*. 2016; Orkomi *et al*. 2019). In this study, the emission rates of CO and $NO_x$ emitted from line sources, including the Rasht-Qazvin freeway and the old Rasht-Qazvin road, were estimated using MOVES software for a one-year period from January 2019 to December 2019.

**Table 2.** Configuration of the WRF model for the studied area.

| Domain | 2 |
|---|---|
| Number of mesh | 100 × 89 for the first domain and 91 × 79 for the second one |
| Horizontal grid resolution | 9 and 3 kilometers for the first and second domain |
| Vertical levels | 34 |
| Microphysics | WRF Single–moment 3–class and 5–class scheme |
| Advection | Kain–Fritsch scheme |
| Boundary level | YSU scheme |
| Longwave radiation | scheme Dudhia Shortwave |
| Shortwave radiation | scheme Dudhia Shortwave |
| Dynamics | Non-Hydrostatics |

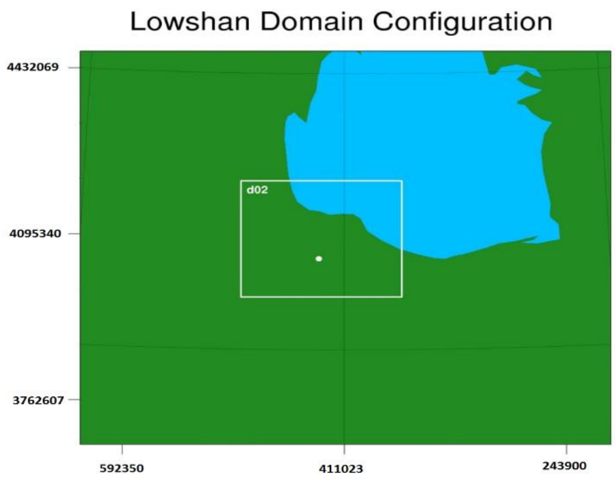



**Fig. 2.** WRF model domains for meteorological data prediction.

## RESULTS AND DISCUSSION

### Gaseous pollutants emission rates

The first step in air pollution dispersion modelling is determining the pollutants' emission rates from emission sources. In this study, as mentioned in the proceeding section, the emission sources are point and line sources. The emission rates of pollutants from the Khazar cement factory stacks were determined using periodic monitoring data (Table 3). Since the stacks seasonal emission monitoring results were almost the same for all seasons, the Spring monitoring data were applied to calculate the emission rates (Table 3). The emission rates of pollutants from mobile sources were estimated using MOVES software, hence, Table 4 depicts the monthly-averaged emission rates of pollutants from mobile sources.

**Table 3.** Emission rates of air pollutants from smoke stacks.

| Stack | Emission rate (g $sec^{-1}$) | | |
|---|---|---|---|
| | NO | $NO_2$ | CO |
| Hybrid stack | 9.047 | 0.457 | 1.279 |
| SF cooler stack | 0.0673 | 0 | 0.235 |
| Filtax. S. stack | - | - | - |
| Old cement mill stack | - | - | - |
| Filtax. D. stack | - | - | - |

**Table 4.** Emission rates of CO and $NO_x$ from line sources in 2019 (g $sec^{-1}$).

| Pollutant | Month | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | Freeway | 1.764 | 2.205 | 1.863 | 2.934 | 1.866 | 7.754 | 4.042 | 5.691 | 6.632 | 3.557 | 2.804 | 1.846 |
| | Old road | 0.358 | 0.392 | 0.454 | 0.709 | 0.613 | 0.719 | 0.535 | 0.617 | 0.534 | 0.416 | 0.276 | 0.392 |
| NOx | Freeway | 0.36 | 0.435 | 0.394 | 0.461 | 0.314 | 0.466 | 0.402 | 0.546 | 0.624 | 0.433 | 0.532 | 0.376 |
| | Old road | 0.485 | 0.521 | 0.6 | 0.292 | 0.430 | 0.406 | 0.363 | 0.381 | 0.281 | 0.315 | 0.338 | 0.559 |

## Dispersion model validation

Although the AERMOD software has been used extensively in numerous studies and its results have been verified with field data (Paladino & Massabò 2017; Mirrezaei & Orkomi 2020), in this study, the accuracy of the model results were also verified by field data. In the study area, the diffusive passive sampler of $NO_2$ made by PASSAM-ag company was applied for air sampling in five points (Fig. 3). To reduce the negative effects of wind and rain, the samplers were installed at sheltered places and the exposure time was 25 days in February 2020. Then, the samplers were extracted and analysed in PASSAM company spectrophotometrically by the well-established Saltzmann method which is accredited to ISO 17025 (Hangartner *et al*. 1989; Monn & Hangartner 1996; Honsa & McIntyre 2003; Salem *et al*. 2009). The installation location of one of the samplers is shown in Fig. 4 and the results of the samplers' analysis are given in Table 5. For the mentioned 25-day period, the AERMOD model was run. The 25-day averaged $NO_2$ concentrations predicted by AERMOD software at the samplers' locations are also depicted in Table 5. Although passive sampling are the cheapest reliable methods for determining the average concentration and model validation, due to the high cost of passive samplers and the lack of research budget, it was not possible to apply more samplers in this study. To verify the dispersion modelling results, the statistical method presented by Hannah *et al*. (1991, 1993) was used. The relevant statistical parameters are introduced in Equations 1 to 5.

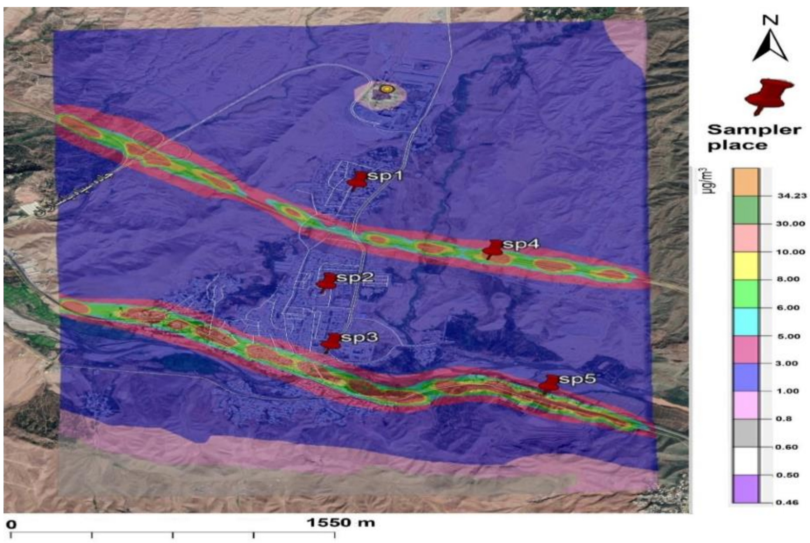



**Fig. 3.** Schematic view of sampling points.

**Fig. 4.** Mounted sampler (SP4) in the studied area.

**Table 5.** Measured and predicted concentrations of $NO_2$ at sampling locations.

| Sampler | Longitude (m) | Latitude (m) | Concentration (μg m$^{-3}$) model | passive sampler |
|---|---|---|---|---|
| SP1 | 367312 | 4056094 | 3 | 2.6 |
| SP2 | 367113 | 4055006 | 2 | 2.5 |
| SP3 | 367129 | 4054359 | 4 | 3.2 |
| SP4 | 368101 | 4055315 | 14 | 17 |
| SP5 | 368411 | 4053891 | 20 | 44.1 |

$$\mathrm{FB} = \left(\overline{C}_o - \overline{C}_p\right) / 0.5\left(\overline{C}_o + \overline{C}_p\right), \quad \textbf{(1)}$$

$$\mathrm{MG} = \mathrm{Exp}\left(\overline{\ln(C_o)} - \overline{\ln(C_p)}\right), \quad \textbf{(2)}$$

$$\mathrm{NMSE} = \overline{\left(C_o - C_p\right)^2} / \left(\overline{C}_o \overline{C}_p\right), \quad \textbf{(3)}$$

$$\mathrm{VG} = \mathrm{Exp}\left(\overline{[\ln(C_o) - \ln(C_p)]^2}\right), \quad \textbf{(4)}$$

Fraction of data have the property Fac2= $0.5 < C_o / C_p < 2$ **(5)**

where FB, MG, NMSE, VG, $C_o$ and $C_p$ are fractional bias, geometric mean bias, normalized mean square error, geometric variance, observed and predicted concentration, respectively. The over bar sign stands for average. The statistical parameters for the data in Table 5 were calculated and presented in Table 6.

**Table 6.** Statistical parameter values.

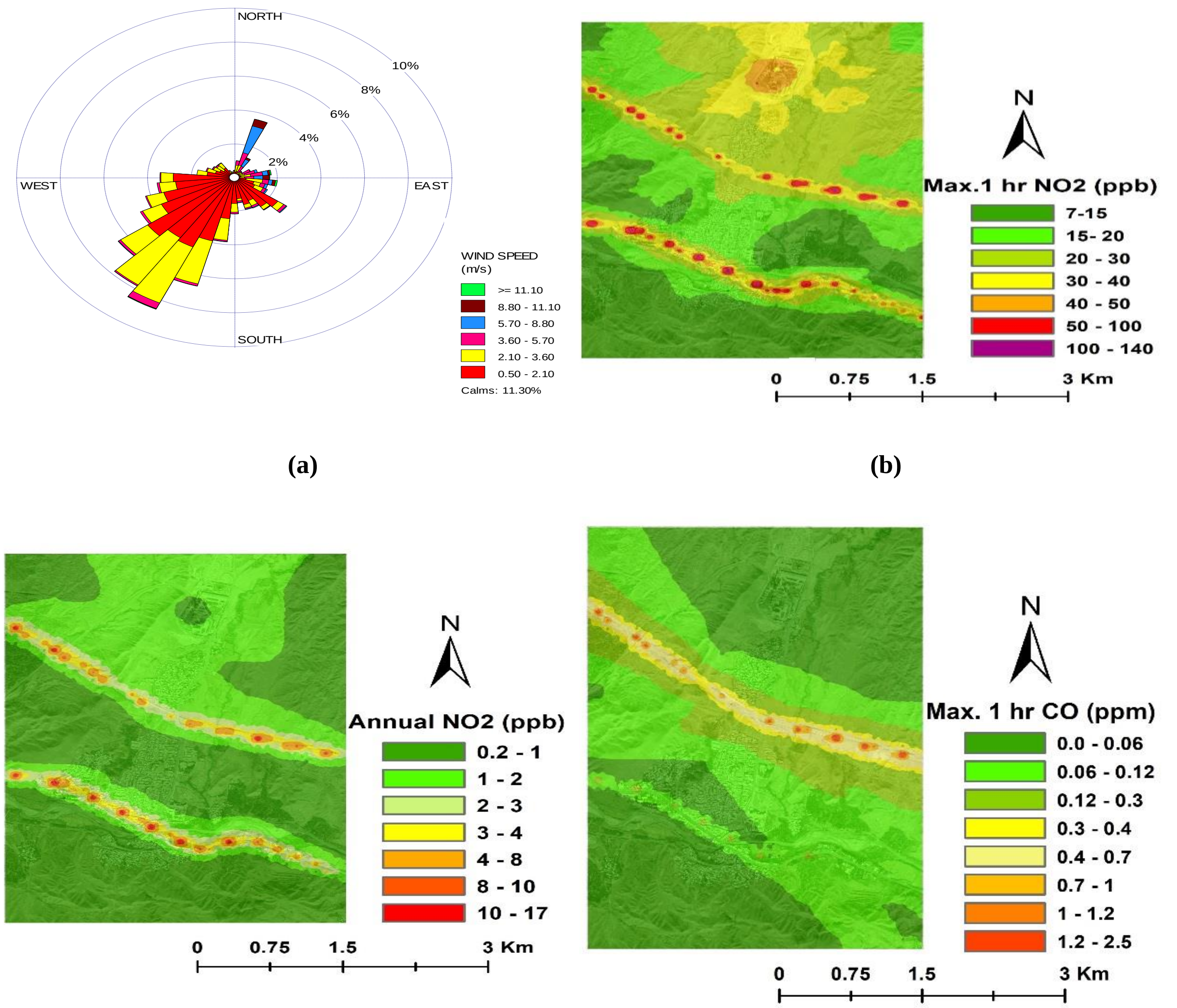
| Fac2 | NMSE | VG | MG | FB |
|---|---|---|---|---|
| 1 | 1.008 | 1.244 | 1.098 | 0.455 |

The above-mentioned statistical indices should meet the conditions in Eq. 6 to evaluate the modelling results (Chang & Hanna 2004, Marro *et al*. 2014). Given the values of statistical parameters in Table 6, all conditions of Eq. 6 except the fractional bias parameter were satisfied for the AERMOD model results, concluding that the performance of the model in predicting field data is acceptable.

**Spatial distribution of pollutants in the urban area**

The most important affecting parameter on the air pollutant dispersion is the prevailing wind direction and magnitude. Using WRF simulation results and WRPLOTview8.8 software, the monthly, seasonal, and annual wind rose plots were drawn for the study area. The annual wind rose plot is given in Fig. 5.a.

$$\begin{cases} 0.5 < \mathrm{Fac2} < 2 \\ \mathrm{FB} < 0.3 \\ 0.7 < \mathrm{MG} < 1.3 \\ \mathrm{NMSE} < 1.5 \\ \mathrm{VG} < 4 \end{cases} \qquad \textbf{(6)}$$




(c) (d)

**Fig. 5** a) annual wind rose plot, b) Maximum 1-hour averaged $NO_2$ concentration, c) Annually averaged $NO_2$ concentration, d) Maximum 1-hour averaged CO concentration.

According to the annual wind rose plot (Fig. 5a), the prevailing wind direction is from the southwest. The dispersion of CO and $NO_x$, emitted from the point and line sources, was conducted by the hybrid WRF-AERMOD model. To compare with ambient air quality standards, the maximum one-hour averaged concentration of CO and $NO_2$ and the annually averaged concentration of $NO_2$ are given in Fig. 5. According to Fig. 5b, the minimum value of maximum one-hour $NO_2$ concentration was 7 ppb and its maximum value was 140 ppb. However, only at very limited points and close to line sources, the concentration was above the one-hour ambient $NO_2$ standard value (100 ppb). Hence, in general, it can be said that from the one-hour standard point of view, the $NO_2$ concentration was less than the standard value. In addition, according to Fig. 5c, the maximum annually averaged concentration of $NO_2$ was 17 ppb, which is much lower than the annual standard (53 ppb). Therefore, from the annual standard point of view, the concentration of $NO_2$ was also within the standard range. Since the prevailing wind direction is from the southwest, pollutants emitted from the mentioned emission sources are often dispersed and transported to the north and northeast and outward the residential areas (Figs. 5b-c). Fig. 5d illustrates the maximum one-hour CO concentration contour. According to the annual standard of CO (35 ppm), the ambient air of the study area is in good condition in terms of CO pollution. Furthermore, to examine the seasonal variations in the dispersion of pollutants in urban areas of Lowshan, $NO_2$ dispersion modelling was performed in all seasons, individually. The seasonal wind rose plots in 2019 are illustrated in Fig. 6, while the contour plots of the average seasonal concentration of $NO_2$ are given in Fig. 7.

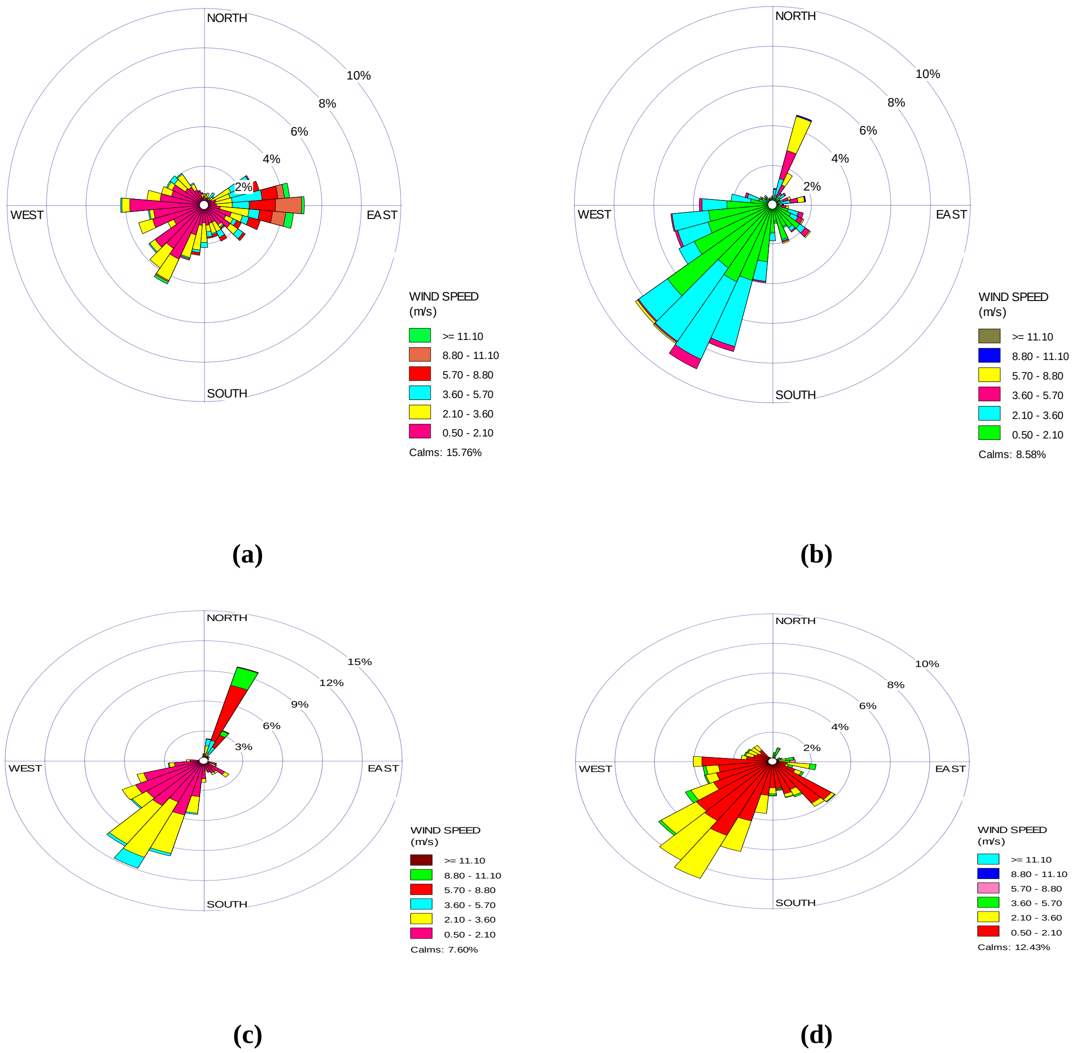



**Fig. 6.** Seasonal wind rose plot of a) winter, b) spring, c) summer and d) fall 2019.

According to Fig. 6a, since the wind blew almost uniformly in all directions in winter, there was not prevailing direction for the pollutant dispersion (Fig. 7a). The prevailing wind direction in spring was from the southwest (Fig. 6b), which moves pollutants to the north and northeast of Lowshan City. This is clearly observed in Fig. 7b. According to Fig. 6c, although wind blew from the north-northeast in almost 10% of cases, the prevailing wind direction in summer was from the southwest, which further spread pollutants to the north and northeast of the study area, far from the residential areas (Fig. 7c), as in spring. Figs. 6d and 7d also confirm that due to the prevailing wind direction from the southwest in fall, the pollutants were mostly dispersed to the northeast.

## DISCUSSION

In this study, the gaseous air pollutants' dispersion in the urban environment of Lowshan City were evaluated. Although PM is one of the main pollutants in the cement industries, all stacks in the Khazar cement factory have a particle control system and the emission source monitoring results of stacks showed that the PM concentration for all stacks was lower than the national standards for point emission sources. In addition, the dispersion modelling of PM showed that the ambient concentration of the particles was much lower than the ambient air quality standard limits (For the sake of brevity, the results have not been presented).

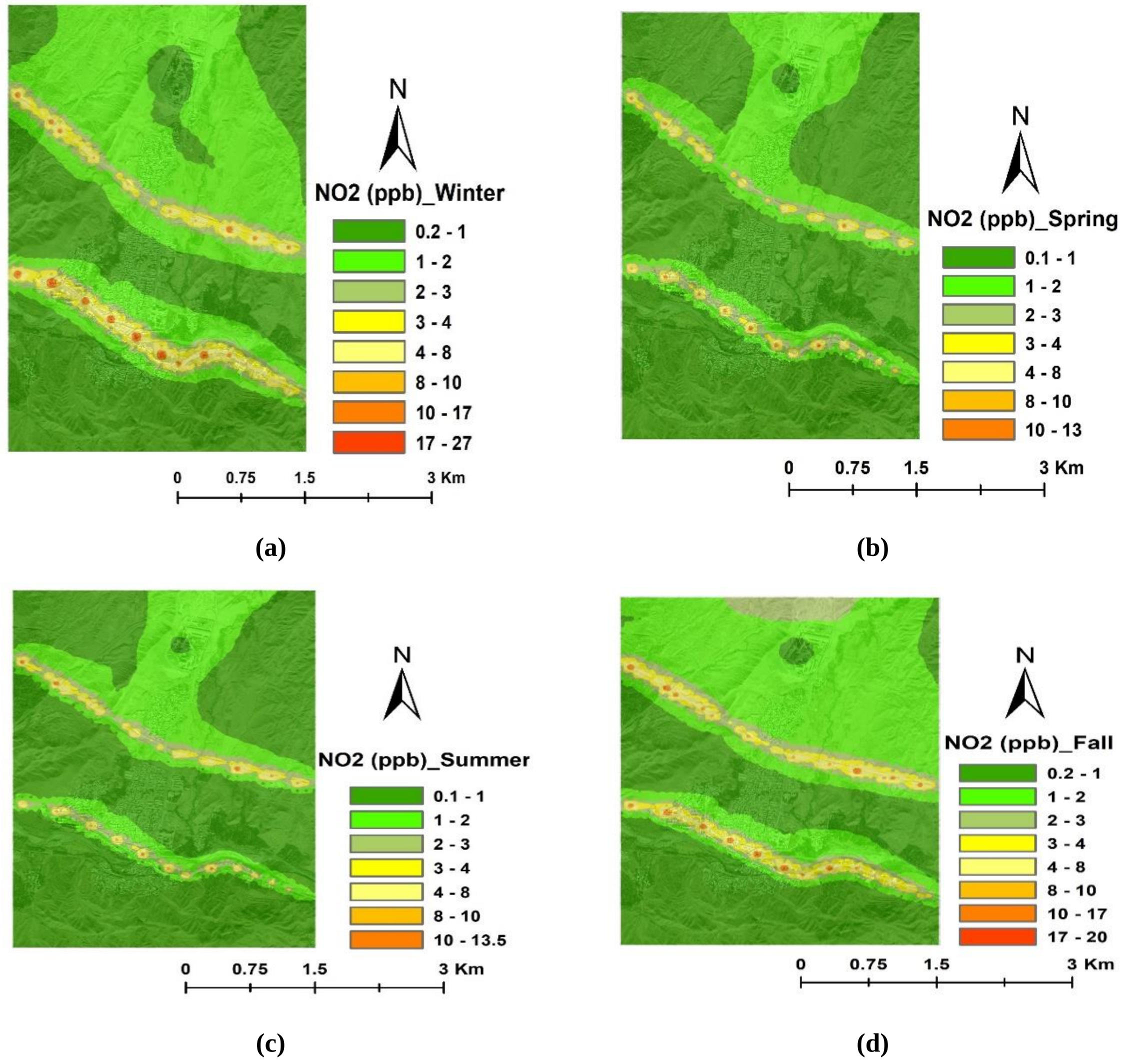



**Fig. 7.** Seasonal averaged $NO_2$ concentration for a) winter, b) spring, c) summer and d) fall 2019.

Therefore, only the gaseous pollutants dispersion was investigated. The results depicted in Fig. 5 show that the pollutant concentrations in urban areas, especially in the southern part of the city, were much lower than the ambient standard, and only in areas close to line sources (freeway and old road) were sometimes close to the standard value. However, the point emission source monitoring results show that the $NO_x$ concentration in the hybrid stack, from which over 99% of the total $NO_x$ is emitted, was almost twice the allowable emission standard limit in point sources ($NO_x$ concentration in hybrid stack was equal to 519 mg/Nm$^3$ and the standard value was 250 mg/Nm$^3$). Another issue shown in Figs. 5c-d is that the concentration of CO pollutants around the freeway was higher than that for the old road and the $NO_2$ concentration around the old road was higher than that for the freeway. This confirms that CO emission in freeway was higher than that in the old road and also the $NO_x$ emissions in the old road was higher than that in the freeway. The reason for these observations is that most of the passing vehicles in the old road are diesel trucks that produce more $NO_x$ than gasoline cars, and in the freeway, most of the vehicles are gasoline-powered, which produce more CO than diesel-powered vehicles (Orkomi *et al*. 2019). Also, trucks are not allowed on the freeway. At Lowshan, the terrain has a south-facing slope that the Shahroud river passes through its southern part. Due to this, one of the hypotheses of this research was that the air pollutants' dispersion in Lowshan is affected by the mountain and valley breezes and the pollutants are dispersed towards the residential areas at night time due to the direction of the breeze toward the valley (south of the city). However, the daytime and night time wind rose plots from the WRF simulation results (results are not reported) showed that day and night wind rose plots were almost the same, which violates the hypothesis that the valley-mountain breeze has an effect on the pollutants dispersion in the studied areas. The seasonal averaged contours of $NO_2$ concentration (Fig. 7) show that the $NO_2$ concentrations in winter were overall higher than that in fall. The concentrations in summer and spring are lower than that in cold weather seasons. One of the reasons for this issue can be the decrease in the emission rate of pollutants in summer compared to winter, which is not correct considering the values of emission rates in Tables 3 - 4. Another reason for this observation is related to the dispersion mechanisms and atmospheric parameters. During cold seasons, due to the reduction of mechanical and especially thermal turbulence in the atmosphere, the height of the atmospheric boundary layer decreases and as a result, pollutants are dispersed in a smaller volume of air, which causes the ambient concentration of pollutants to be higher in cold-weather seasons than in warm ones when the height of the boundary layer is higher.

## CONCLUSION

In this study, the ambient air quality of Lowshan in Guilan Province was examined by dispersion analysis of gas pollutants emitted from the Khazar cement factory and the line sources. For modelling the dispersion of pollutants, the hybrid WRF and AERMOD models were used. The dispersion model validation was performed by field measurement of $NO_2$ in urban areas using passive samplers. Afterward, the spatial distributions of CO and $NO_2$ in the city were analysed in 2019. The results showed that the city air quality was in a good condition in terms of CO and $NO_2$, so that the highest annually-averaged concentration of $NO_2$ in the city was 17 ppb, which is much lower than the ambient standard of 53 ppb. Also, the maximum hourly-concentration of $NO_2$ in the city in most residential areas was less than the ambient standard of 100 ppb, and only in the areas close to the line sources, the concentration values were within the limits of the ambient standard values. In the case of CO pollution, the maximum hourly-concentration was 2.5 ppm, which was much lower than the ambient standard (35 ppm). In general, due to the prevailing wind direction in the city, which is from southwest to north and northeast, and due to the cement factory's location (in the north of the city), pollutants are transported to the north and northeast, away from the city. Therefore, the city air quality was in a good condition according to the clean air standards, which is especially true for the southern, and close to the old road than the northern and central areas of the city.

## ABBREVIATIONS

| | |
|---|---|
| AERMAP | AERMOD map |
| AERMET | AERMOD meteorological |
| AERMOD | The American Meteorological Society/Environmental Protection Agency regulatory model |
| CO | Carbon monoxide |
| CPCB | Central Pollution Control Board |
| EPA | United States Environmental Protection Agency |
| ISO | International Standards Organization |
| FB | Fractional bias |
| MG | Geometric mean bias |
| MOVES | Motor vehicle emission simulator |
| MM5 | Fifth-generation Penn State/NCAR mesoscale model |
| MMIF | Mesoscale model interface |
| NMSE | Normalized mean square error |
| $NO_2$ | Nitrogen dioxide |
| $NO_X$ | Nitric oxide |
| PASSAM | Passive and active systems on severe accident source term mitigation |
| PM | Particulate matter |
| $PM_{10}$ | particles with a diameter smaller than 10 micrometers |
| $PM_{2.5}$ | particles with a diameter smaller than 2.5 micrometers |
| ppb | Parts per billion |
| ppm | parts per million |
| TSP | Total suspended particles |
| VG | Geometric variance |
| WHO | World Health Organization |
| WRF | Weather research and forecasting |

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