O 13. ESTIMATION OF NITROGEN OXIDES POLLUTION USING GEOGRAPHICAL INFORMATION SYSTEM IN TURKEY

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ABSTRACT: Air pollution is become one of the most important problems we are facing and has a negative impact on the health of living things, it is the presence of solid, liquid and gaseous pollutants that change the composition of the air in the atmosphere, which may harm human life and ecological balance. In this study, nitrogen oxides pollution was investigated by using GIS technique, the air pollution data had been collected from 137 air monitoring stations during 2016, 2017 and 2018 in turkey. The spatial distribution maps of the annual average concentrations of nitrogen oxides were created with the help of spatial analyst tools, interpolation (inverse Distance Weighted method) within ArcGIS environment. The critical level of NO_x for the protection of vegetation is 30 µg/m^3 measured as an annual mean. The results indicated that most NO_x concentrations, about 77.4%, 79% and 65.5% during 2016, 2017 and 2018 respectively, exceeding (30 ug/m^3) the allowable limit value, where high levels of nitrogen oxides can make happen harm to the human respiratory tract and rise a person's susceptibility to, and the seriousness of, respiratory diseases and asthma.

Keywords: Air pollution, nitrogen oxides, geographical information system

1. INTRODUCTION

Air pollution in cities is closely related to human conditions as well as natural conditions. Increased energy consumption especially due to population growth and industrialization plays an increasing role in air pollution. Many factors have effects on air pollution. Among these factors, human activities take the first place. As a result of these activities, large amounts of SO_x, NO_x, CO and PM are mixed into the air (Çiçek, Türkoğlu, & Gürgen, 2004). It is observable that people living in big cities do not breathe fresh air. Smoke from factories, exhausts of vehicles that can see everywhere, fossil fuels and the list of factors that pollute the air we breathe is extended. Nitrogen oxides are the most important pollutants in the air. Nitrogen oxides composed of NO and NO_2 gases cause acid precipitation and directly affect human health and have poison effect, especially NO_2 causes edema and bleeding in the lungs. Nitrogen dioxide is known as the invisible killer because it is very toxic, this gas is very difficult to detect at low concentrations (Le Page, 2016). The presence of NO_x in the atmosphere is approximately half due to vehicle exhaust and stationary combustion plants. These gases enter the natural gas cycle in the atmosphere and complete the chain reactions resulting in the formation of nitric acid (HNO_3). The formation of HNO_3 in the atmosphere affects the formation of acid precipitation. In recent years, a study conducted in Denmark, ammonia evaporation of the sun. It is determined that its contribution to the formation of nitric acid in the atmosphere when exposed to radiation is negligible. Ammonium content of rain also increases the acidity of rain by 4 times when ammonium nitrite is converted to acid by the bacteria and oxygen that make nitrification in soil, water basins and lakes (Denhez, 2007; Đncecik, 1994; Edwards, 2019; Elkoca, 2003; İlhan, Dündar, Öz, & Kılınç, 2011; Lange, Richter, & Burrows, 2019; Robertson, Nowakowski, Hannum, & Storslett, 2019; Wei et al., 2019). NOx mainly impacts on respiratory conditions causing inflammation of the airways at high levels. Long term exposure can decrease lung function, increase the risk of respiratory conditions and increases the response to allergens. NOx also contributes to the formation of fine particles (PM) and ground level ozone, both of which are associated with adverse health effects (Bhandari & Bijlwan, 2019; Kampa & Castanas, 2008; Machin, Nascimento, Mantovani, & Machin, 2019; Muthusamy et al., 2019). Geographical Information Systems are distinguished from other information systems in terms of the data they contain and the characteristics of this data. The ability to address the location of objects or events (phenomena) on the earth is characteristic of such data. Therefore, the locations of objects or events and their relations with each other can be visualized and this visualization is called map. The aim of this study is producing the spatial distribution maps of the annual NO_x values that covered all Turkey regions for the period 2016–2019 by using Inverse Distance Weighted (IDW) method within the ArcGIS software environment.

2. METHODOLOGY

Numerous researches using Geographical Information Systems (GIS) technology are used in the spatial and temporal analysis of air quality. Within the scope of this study, spatial pollution distribution maps were created by determining positional patterns related to air pollution parameters with GIS technique. Spatial variability and positional dependence relations of air pollutants were examined, and the findings were interpreted. Time-dependent changes of nitrogen oxides concentrations were investigated and analyzes were made with trend graphs. The air pollution data were collected from Turkish Ministry of Environment and Urbanization http://www.havaizleme.gov.tr/Default.ltr.aspx for 137 air monitoring stations during 2016, 2017 and 2018 in turkey. In ArcGIS 10.5 GIS software, a point layer was created using the coordinates of measurement stations and the annual average concentration values were added to this point layer as the attribute data. The spatial distribution maps of the annual average concentrations of nitrogen oxides were created with the help of spatial analyst tools, interpolation (Inverse Distance Weighted method) within ArcGIS version 10.5.1 environment.

3. RESULTS AND DISCUSSIONS

The critical level of NO_x for the protection of vegetation is 30 µg/m^3 measured as an annual mean. In the ArcGIS software, the NO_x distribution maps of the Turkey were produced using the inverse Distance Weighted Interpolation Method (IDW).The results indicated that most NO_x concentrations, about 77.4%, 79% and 65.5% during 2016, 2017 and 2018 respectively, exceeding (30 µg/m^3) the allowable limit value especially in the central parts of Turkey as shown in the figures 1, 2 and 3, where the maximum values of NO_x found in the Konya city in Konya Selçuklu Belediye (811.1675 µg/m^3) and Konya Karatay Belediye (562.4825 µg/m^3) stations during 2018, the high levels of nitrogen oxides can make happen harm to the human respiratory tract and rise a person's susceptibility to, and the seriousness of, respiratory diseases and asthma.

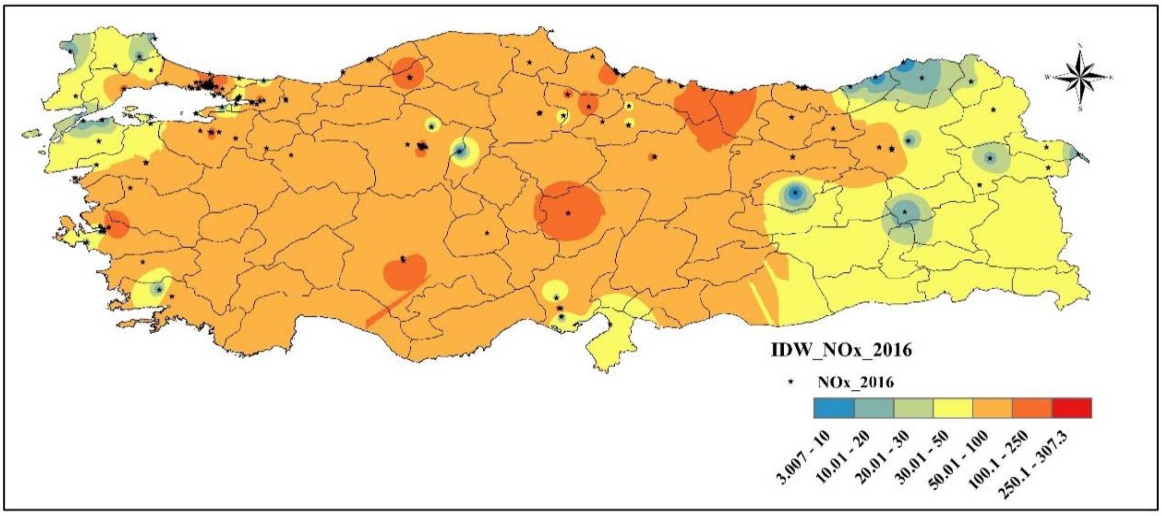

Figure 1. Spatial analysis of NO_x during 2016 by using IDW method.

Figure 4 shows the prediction map of spatial analysis of NO_x during 2018 by using ordinary kriging prediction method that chosen as best method after testing all semiveriogram methods, there are small differences when comparsion between figure 3 that shows IDW method and figure 4 that shows ordinary kriging prediction method. Figure 5 presents the relation between measured values of NO_x as x-axis and predicted values of NO_x as y-axis, the regression equation of the relationship is ($y=0.51*x+32.71$, $R^2=0.97$) R^2 values indicated to the strong correlation between measured and predicted values of NO_x this mean fitting model.

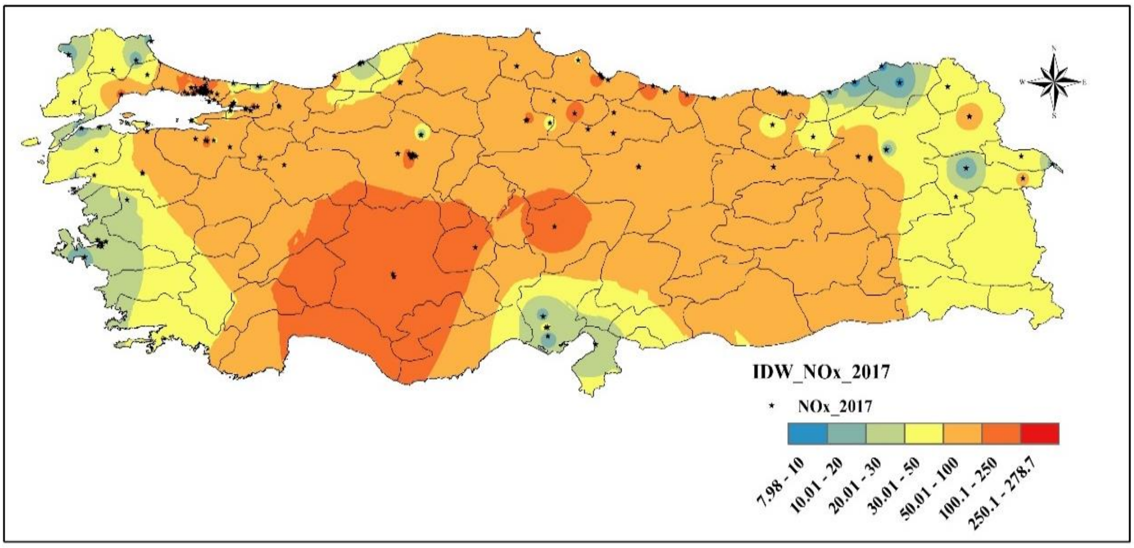

Figure 2. Spatial analysis of NO_x during 2017 by using IDW method.

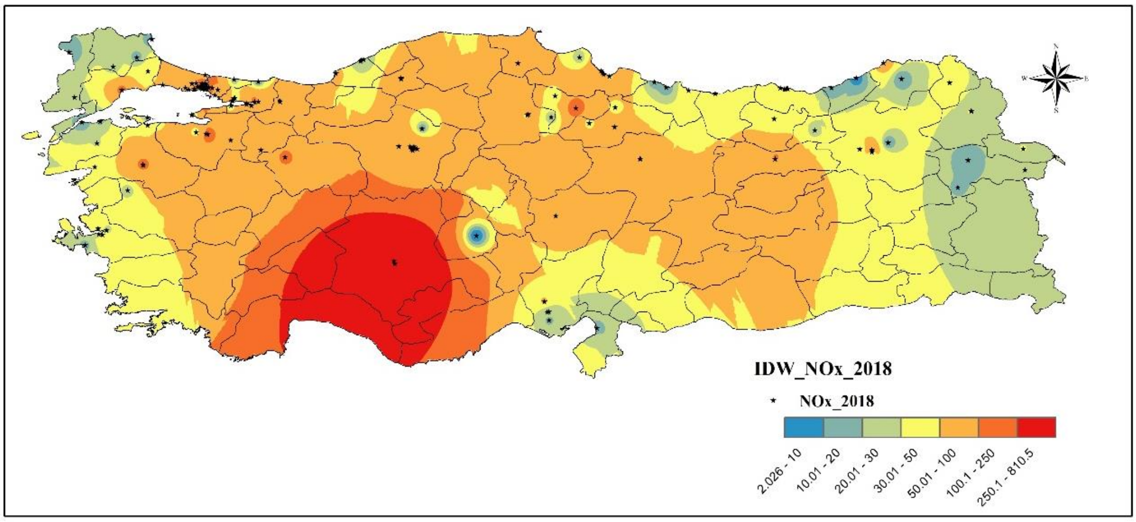

Figure 3. Spatial analysis of NO_x during 2018 by using IDW method.

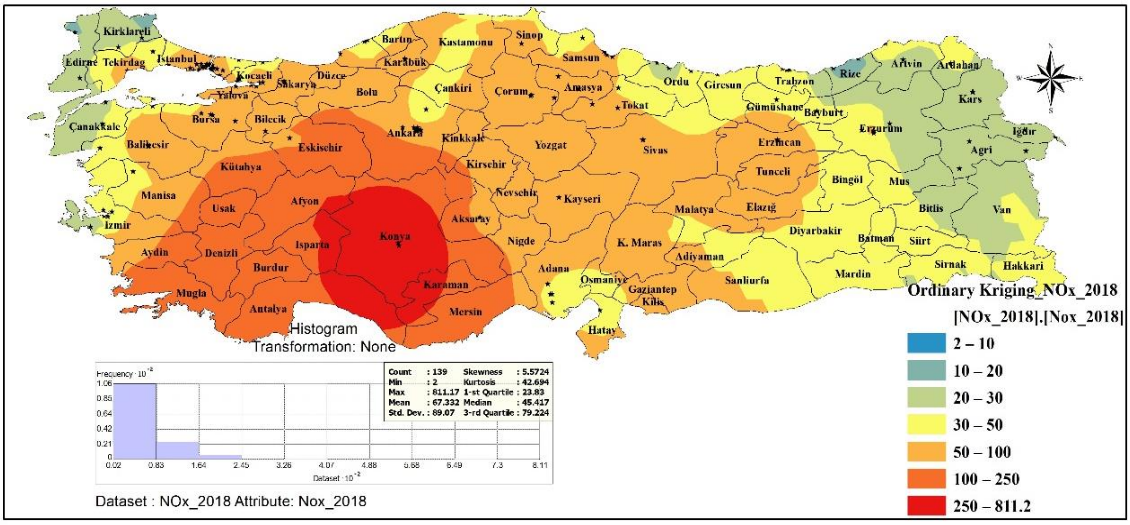

Figure 4. Spatial analysis of NO_x during 2018 by using Ordinary Kriging prediction method.

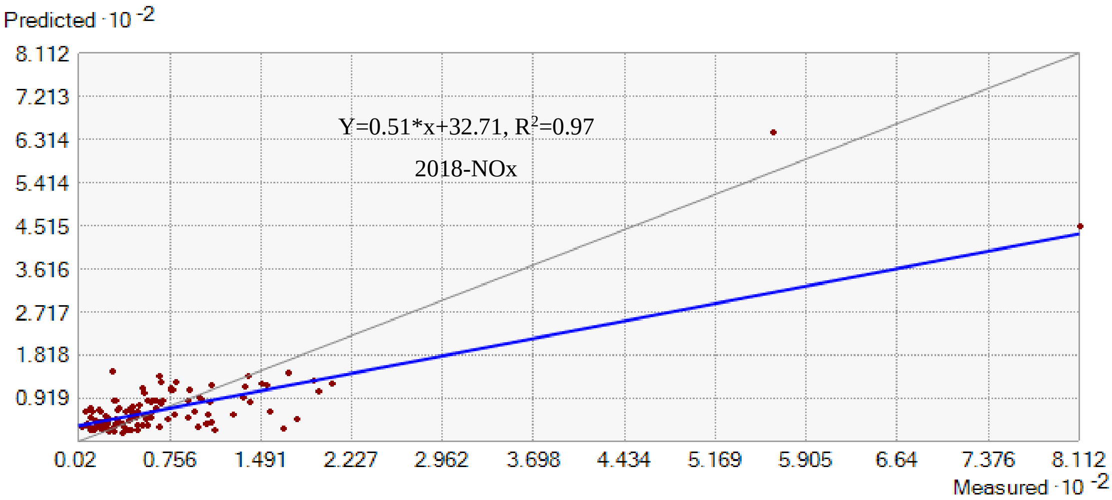

Figure 5. The relation between measured and prediction values of NO_x, OK method.

According to the air quality assessment and management regulation limit values and warning thresholds assessment, the NO_x limit value is 30 µg/m³ per year. As a result of the comparison of the measurement results with the limit values, most values of NO_x were exceeded limit value as shown in the figures 6, 7, and 8. Whereas figure 9 shows results of NO_x measurement during 2016, 2017 and 2018 that shows the differences of values through these years.

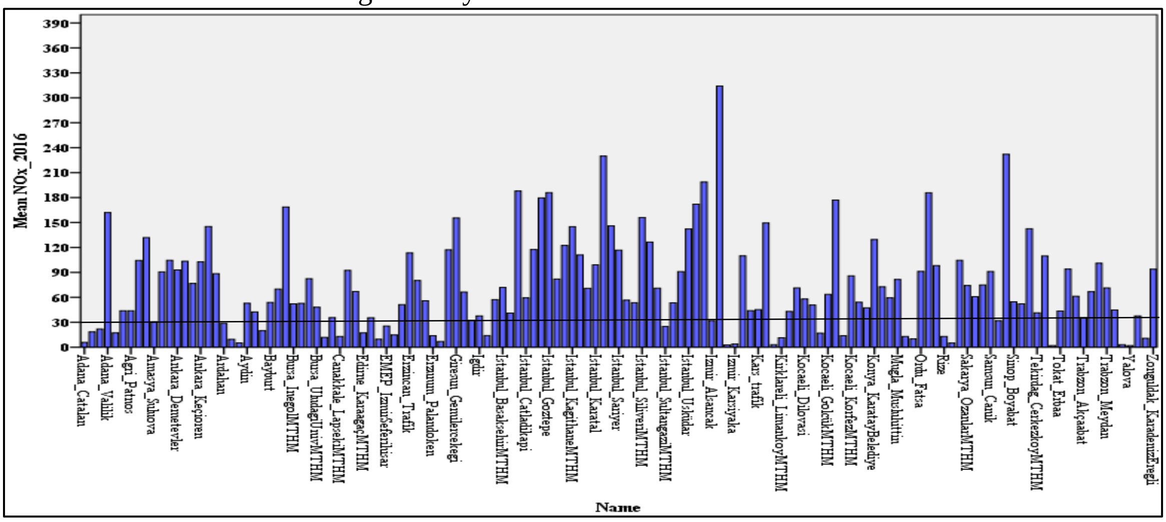

Figure 6. Results of NOx measurement 2016

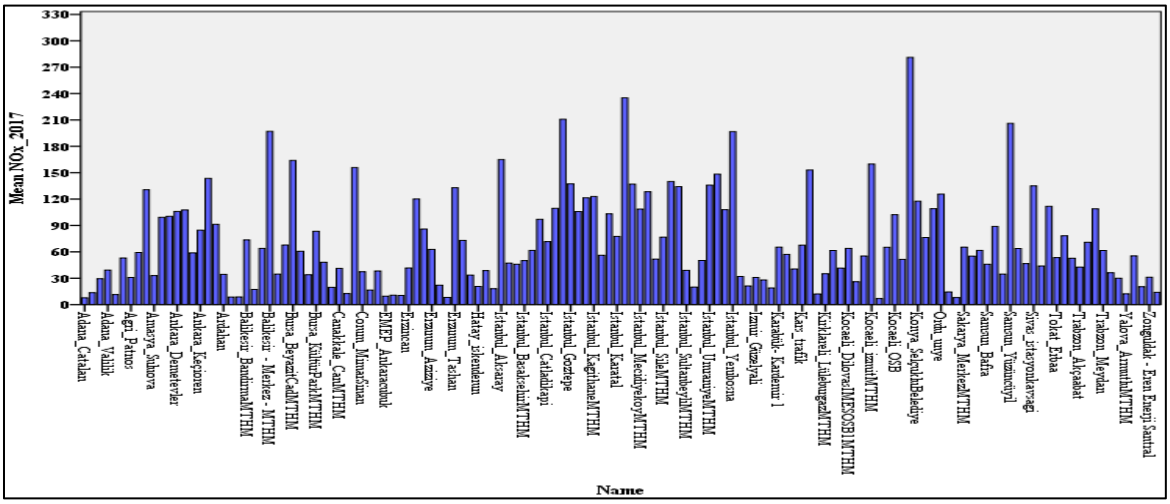

Figure 7. Results of NOx measurement 2017

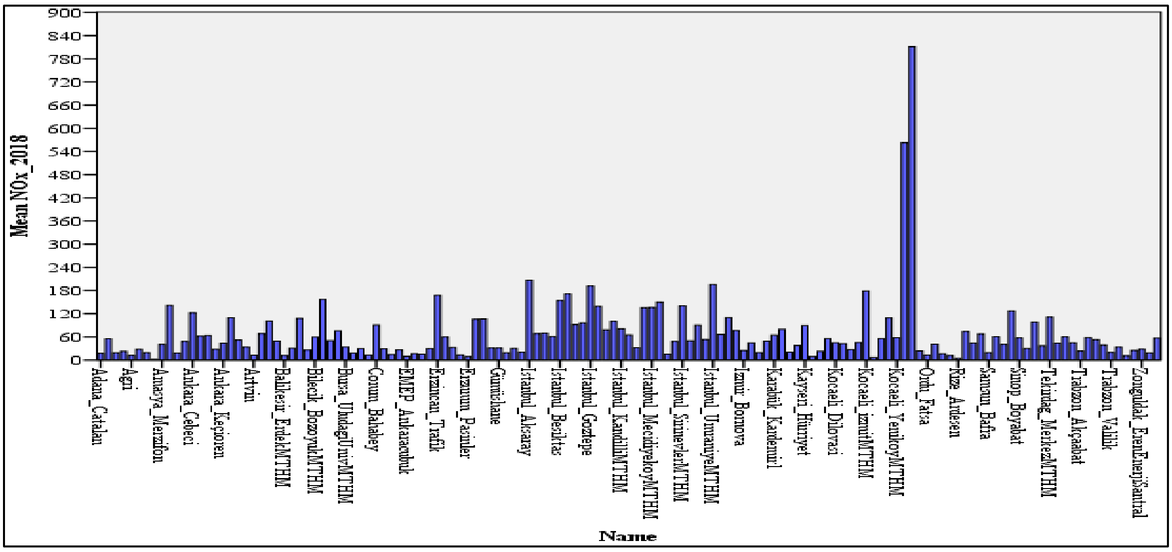

Figure 8. Results of NOx measurement 2018

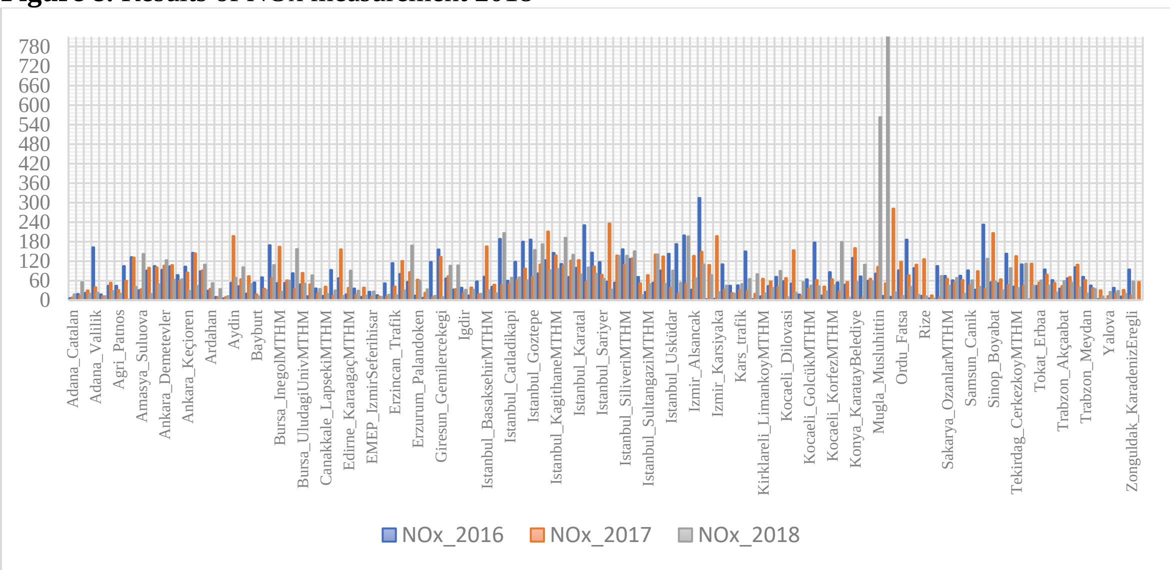

Figure 9. Results of NOx measurement 2016, 2017 and 2018

4. CONCLUSION

In this study, the annual and spatial distribution of NOx measured by passive sampling at 137 points in Turkey, was investigated. According to the results, most values of NO_x were exceeded limit value where the high levels of nitrogen oxides can make happen harm to the human respiratory tract and rise a person's sensitivity to, and the seriousness of, respiratory diseases and asthma, it is thought that the data obtained from this large scale study will be an important guide in the air quality improvement plans to be created by local decision makers in the region. As a result, local managements could organize an action plan and emission models for air pollution reduction in residential areas.

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