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**Research Article**

# City of Bitlis 2014 Air Pollution Emission Inventory

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**Abstract**

**Air pollution adversely affects the lives of all the living, in particular human health. In case its effect increases and it continues to harm the living, it will cause countless health issues and this will incur economical losses in our country. The use of poor-quality coal leads to an increase in air pollution. The coals of this quality used in the city of Bitlis have led to the increase of air pollution. In order to ensure air quality, the polluting amounts should be decreased and the national pollution limiting values should be such that they are applicable. Monitoring the current pollution state by preparing an emission inventory for developing future clean air plans and taking the necessary measures is important for laying out the extent of the air pollution problem. Under the Clean Air Action Plan for the City of Bitlis, the city was evaluated in respect of its general characteristics and considered with regard to the distribution characteristics and effects on human health of the pollutants. The amount of coal consumed in Bitlis in 2014 was obtained from Bitlis Directorate of Environment and Urbanization and this value is approximately 32802 tons. In 2014, due to coal firing in Bitlis, the amounts released to the atmosphere are calculated to be 1178 tons/year for $SO_2$ emission, 105 tons/year for $NO_2$, 124 tons/year for $PM_{10}$ and 1316 tons/year for CO.**
**Keywords: Air pollution, Air pollution due to heating, Primary Pollutants, Emission Inventory, Emission Inventory for the city of Bitlis.**

## 1. Introduction

Thousands of years ago, Bitlis was home for many civilizations and have been nourished by their culture. Today, it is a city that continues to urbanize and increases in population. The long winter season due to its geographical location and also irregular and dense settlement lead to a series of problems due to heating. In particular, the poor-quality coal used for heating carried the air emission above the limiting values. In Erzurum, a similar operation was carried out in order to reduce air emissions due to heating and improve air quality and it was observed that air quality was brought to a level close to limiting values through the use of natural gas [1]. Similarly, the values of $NO_x$ emission generated by houses in Kocaeli[2], air pollution due to sulphur dioxide in Bursa [3] and the change in sulphur dioxide and particulate matter values in between years 1990-2007 in Kayseri were examined [4].

The outbreak of air pollution researches gained importance mainly after the death of thousand people as a result of high $PM_{10}$ and Atmospheric Inversion in Meuse Valley, Belgium in 1934, in Donora, USA in 1947 and in London in 1952. A number of restrictions were imposed only after the disasters. The limiting values used today are those laid down by World Health Organization (WHO) and adopted and implemented by many countries as the air pollution control began being regulated by legal processes. The recent researches around the world have shown that air pollution reached high values in Southeast Asian countries [5].

Another study conducted under the name of air quality data in large cities has shown for air pollution values in the entire world that $SO_2$ concentrations are downward-sloping except at the center of America and in some cities in Asia, $NO_2$ levels are close or even above the WHO (World Health Organization) limits and particulate matter continues to be a major problem in Asia [6].

In 2010, an emission inventory study was conducted in terms of primary pollutants in Yangtze River Delta which encloses 24 large cities in Shanghai. In this study, the $SO_2$, $NO_x$, $PM_{10}$, $PM_{2.5}$, NMVOCs, $NH_3$ emissions which resulted from various sectors (power plants, industrial processes, stockbreeding and fertilizer production, etc.) in 2010 were studied[7].

## 2. Methods and materials

The fuels used in winter for heating decreases air quality in cities in Turkey. In Bitlis, use of coal in winter increases the effect of air pollution. The topographical structure, atmospheric conditions, high number and congestion of housing form a large basis for the increase in air pollution in Bitlis. In this study, the following steps were followed for the calculation of emission.

In the study, fuels such as fuel oil, lignite, wood were not included, only the data on coal consumption were collected. The list showing the coal consumption amounts for 2014 was obtained from Bitlis Directorate of Environment and Urbanization.

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Table 2.1 The amounts of coal used in Bitlis in 2014 (kg)

| Months (year 2014) | Coal Amounts (kg) |
|---|---|
| January | 2519 |
| February | 2360 |
| March | 2519 |
| April | 1937 |
| May | 3186 |
| June | 1962 |
| July | 2386 |
| August | 2036 |
| September | 3021 |
| October | 5170 |
| November | 3339 |
| December | 2367 |
| **TOTAL** | **32802 kg** |

In the calculations made at the stage where emission inventory is formed, the emission factors in the Emission Inventory Guidebook and in the Greenhouse Gas Inventory Report issued by European Environment Agency (EEA) were used, since our country does not have a standard.

According to this situation, in the emission factor tables related to coal, the sulphur content of coal was assumed as 1,2% and its lower heating value as 5,731 kCal/kg for the calculation of $SO_2$ emission factor value. However, the coal types and characteristics used in Bitlis differ from these values. For that reason, for the calculation of $SO_2$ emission factor, the values taken from the Regulation for the Control of Air Pollution due to Heating were used as 6400 Kcal/kg for the lower heating value (LHV) and 1% for sulphur content (S) of imported coal and 4800 Kcal/kg for lower heating value (LHV) and 2% for sulphur content (S) of local coal. These values were substituted in the following equation given in the guidebook issued by European Environment Agency and the $SO_2$ emission factors were calculated for local and imported coal.

$$EF_{SO_2,k} = 2 \cdot \overline{Cs}_k \cdot (1-\bar{\alpha}_{s,k}) \cdot \frac{1}{H_k} \cdot 10^6$$

E.F.SO2,k= emission factor for type-k fuels and $SO_2$ (g/GJ)

$\overline{Cs}_k$ = average sulphur amount in type-k fuel (mass S/mass fuel [kg/kg]

Hk = average lower heating value for type-k fuel [MJ/kg]

$\bar{\alpha}_{s,k}$ = Average of sulphur held in ash. This value is taken as 0,1 for it is not available in national data.

Since in this study, the fuel used was coal and the burning system used was stove and medium-sized boiler (50 kW - 1 MW) for burning coal and small-sized boiler (combi boiler) with thermal power<50 kW for burning natural gas, the emission factors were set as shown in Table 2.1.

Table 2.2 Emission Factors for Coal

| | Emission Factors for Imported Coal (Kg/Ton) | | Emission Factors for Local Coal (Kg/Ton) | |
|---|---|---|---|---|
| **Pollutants** | **Stove** | **Medium-sized boilers (between 50 kW and 1 MW)** | **Stove** | **Medium-sized boilers (between 50 kW and 1 MW)** |
| $SO_2$ | 1717,98 | 17,98 | 35,93 | 35,93 |
| $NO_2$ | 2,68 | 4,28 | 2,01 | 3,21 |
| $PM_{10}$ | 1212,04 | 5,08 | 9,03 | 3,81 |
| CO | 13133,76 | 53,50 | 100,32 | 40,13 |

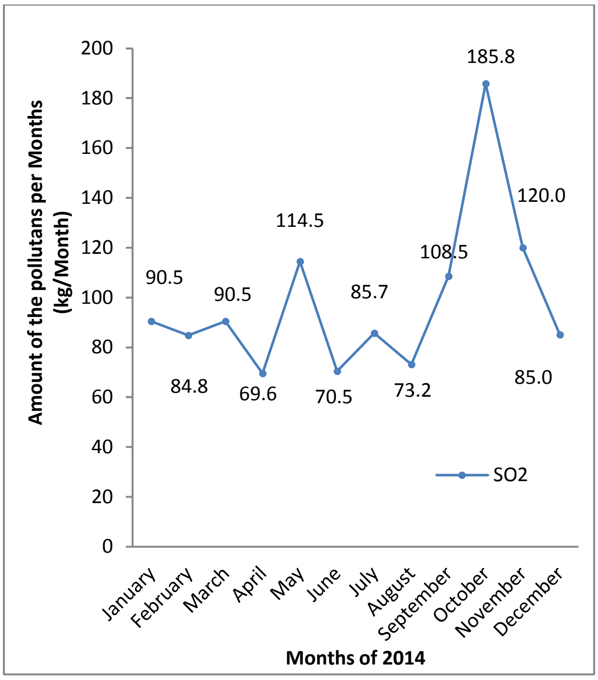


Figure 2.1: Monthly $SO_2$ Pollutant Inventory for the year 2014

In the monthly measurements in 2012 on Fig. 2.1, it can be seen that $SO_2$ pollutant values vary by atmospheric temperature and are at their maximum in October and May.

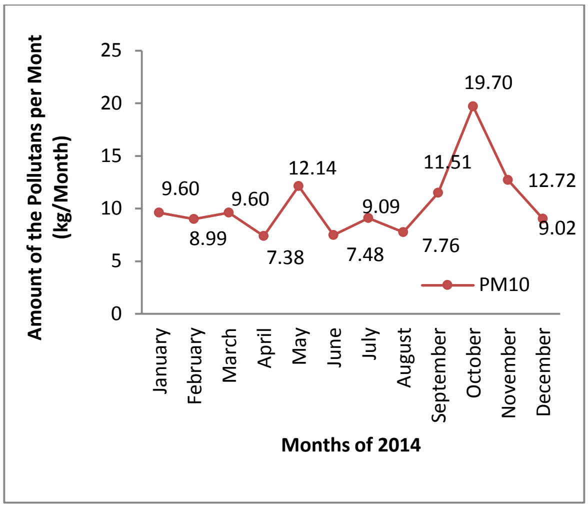


Figure 2.2: Monthly $PM_{10}$ Pollutant Inventory for the year 2014

In Figure 2.2 above, it is again seen that $PM_{10}$ pollutant values reach high levels in October and May.

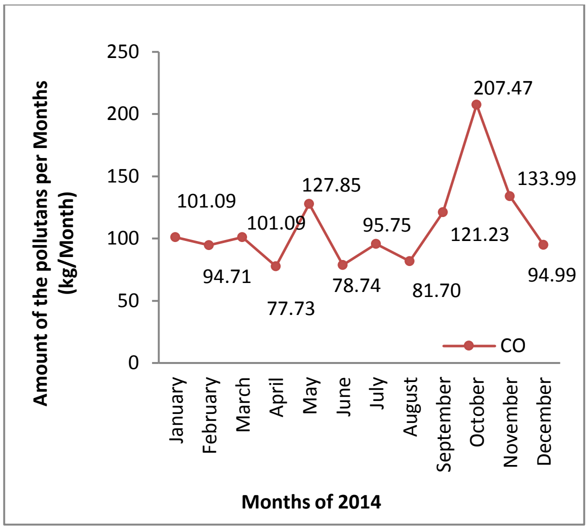


Figure 2.3: Monthly CO Pollutant Inventory for the year 2014

In Figure 2.3, CO concentrations reach the highest levels in May and October.

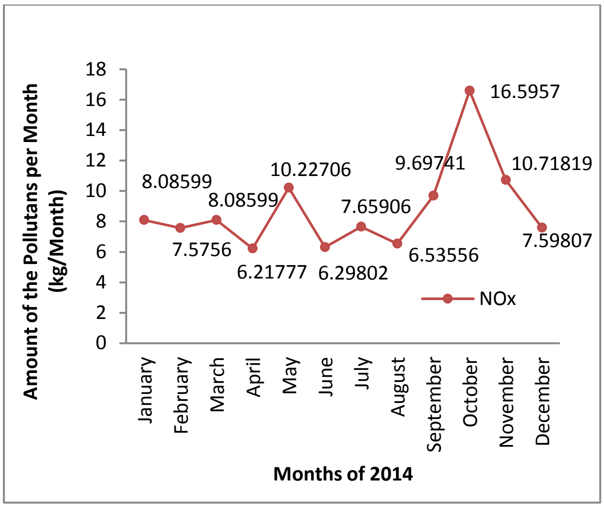


Figure 2.4: Monthly $NO_x$ Pollutant Inventory for the year 2014

In Figure 2.4, the limits at which $NO_x$ pollutant is released to the atmosphere are shown. They are at the highest levels in October and May.

In the figures provided monthly below, the concentrations of CO, $PM_{10}$, $NO_2$ and $SO_2$ were given separately. The air pollutant concentrations that were expected to be high during winter months are also seen to be high in the other months. It can be said that this is associated with the atmospheric temperature in 2014 and that burning the boilers for hot water in both summer and winter led to air pollution.

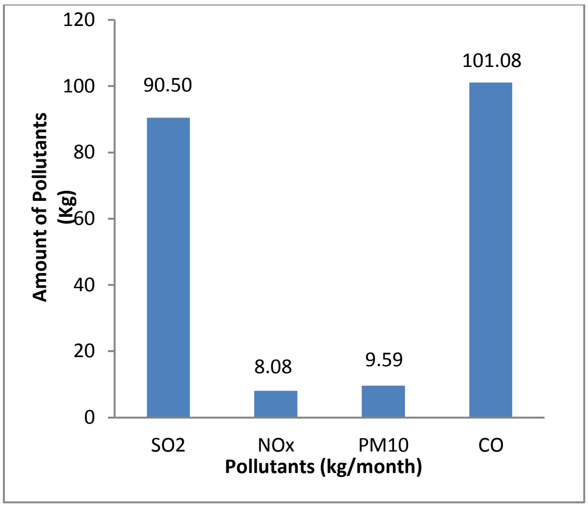


Figure 2.5: Pollutant Inventory for January, 2014

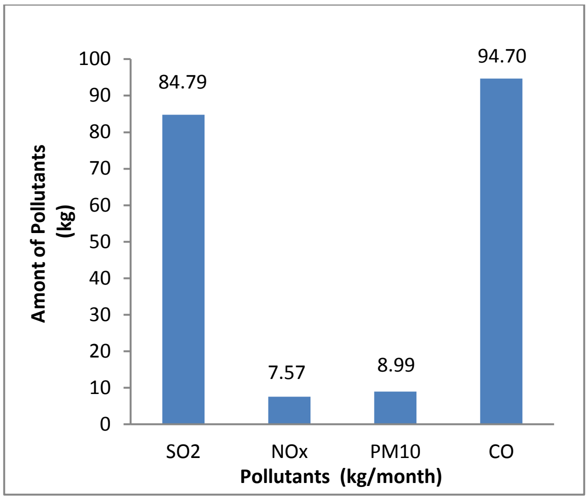


Figure 2.6: Pollutant Inventory for February, 2014

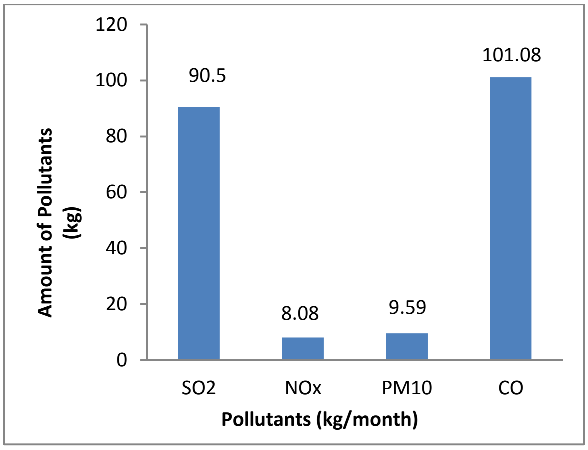


Figure 2.7: Pollutant Inventory for March, 2014

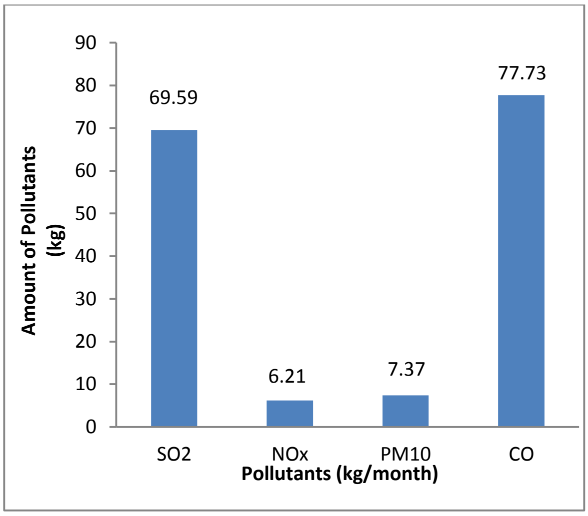


Figure 2.8: Pollutant Inventory for April, 2014

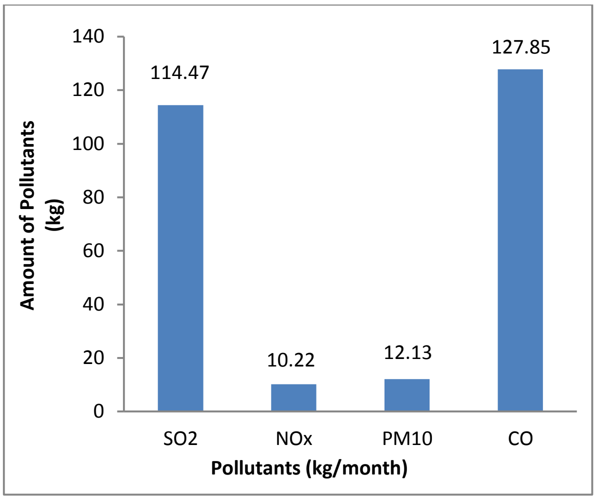


Figure 2.9: Pollutant Inventory for May, 2014

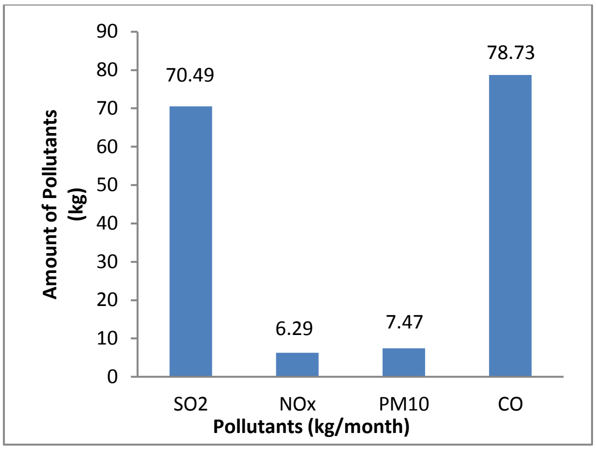


Figure 2.10: Pollutant Inventory for June, 2014

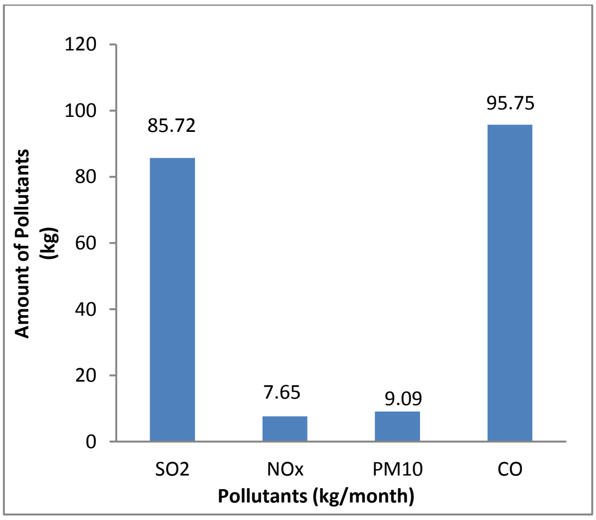


Figure 2.11: Pollutant Inventory for July, 2014

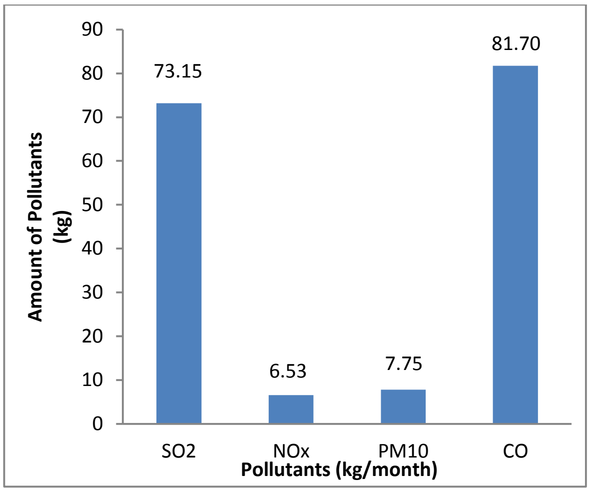


Figure 2.12: Pollutant Inventory for August, 2014

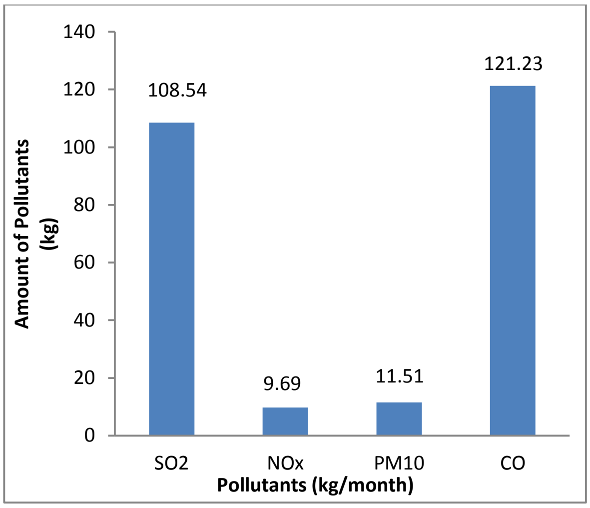


Figure 2.13: Pollutant Inventory for September, 2014

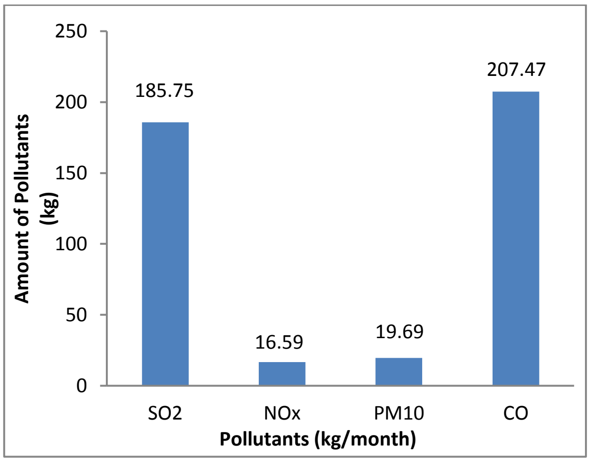


Figure 2.14: Pollutant Inventory for October, 2014

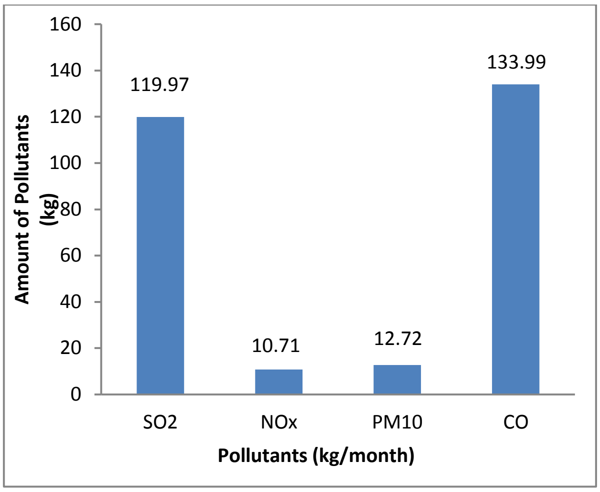


Figure 2.15: Pollutant Inventory for November, 2014

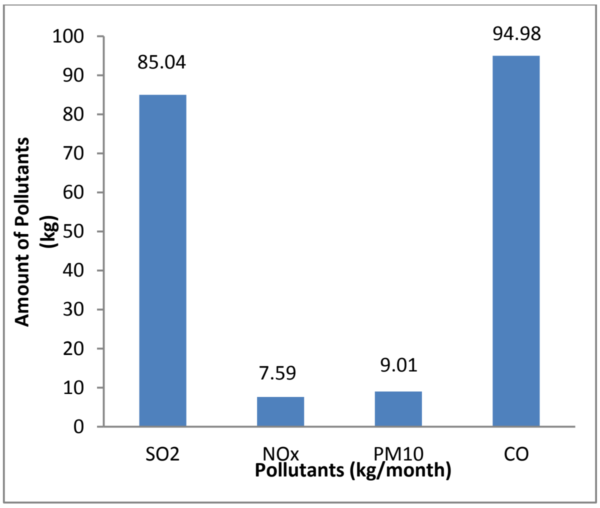


Figure 2.16: Pollutant Inventory for December, 2014

## 3. Results and discussion

The monthly coal usage amounts in Bitlis in 2014 obtained from the Bitlis Provincial Directorate for Environment are shows in Table 2.1. Long winters in Bitlis and use of coal for hot water in summer cause air pollution emission all year long. According to data taken for 2014, use of coal can be as high as approximately 33 tons. While preparing the emission inventory according to coal usage, the emission factors used were those in the Emission Inventory Guidebook and Greenhouse Gas Inventory Report issued by European Environment Agency (EEA). This study was only for coal usage and the emission factors were evaluated for local and imported coal separately. For stove and medium-sized boiler (50kw-1mw), the emission factors calculated of $SO_2$, $NO_2$, $PM_{10}$ and CO were given in Table 2.2.

The monthly values of each pollutant in 2014 were expressed in the figures. The pollutant values reach very high levels in winter months. The polluted air around the city makes it difficult to breathe and poses a serious risk for human health. In this study, the calculation of the inventory for air pollution due to heating were provided and the degree of the highness of pollutant levels were explained through data. Even though it is not an industrial zone, air pollution due to heating in Bitlis is a major problem due to the use of poor-quality coal. This study can be used as a source for further studies and can guide future plans for improving air quality.

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