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Journal of Science and Technology

E-ISSN 2146-7706

Reply to Discussion of "City of Bitlis 2014 Air Pollution Emission Inventory"

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ARTICLE INFO

Article history:
Received 15 April 2019
Received in revised form 11 December 2019
Accepted 11 December 2019

Keywords:
Air pollution,
Air pollution due to heating,
Primary Pollutants,
Emission Inventory,
Emission Inventory for the city of Bitlis.

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.

1. Introduction

The authors would like to thank Dr. Avşar (referred to as the discusser hereafter) for his comments on the article ("City of Bitlis 2014 Air Pollution Emission Inventory" in Bitlis Eren University Journal of Science and Technology, 2015, DOI: http://dx.doi.org/10.17678/beujst.60329). In the discussion, the discusser pointed out five concerns; consisting of 1) total amount of fuel used in the study 2) use/assumption of emission factors without references 3) sulfur content (S%), lower heating value LHV, and SO_2 emission (the authors assumes that the abbreviation of LHW stated by discusser refers LHV) 4) incorrect emission factors of 1717.98 kg SO_2/ton coal, 1212.04 kg SO_2/ton coal, 13133.76 kg SO_2/ton coal and 5) amount of coal burned in July, August and December. This reply was prepared to address these concerns expressed by Dr. Avşar.

2. Discussions

2.1 Discussion on Total Amount of Fuel

The discusser is right in pointing out that the Bitlis Province Environmental Status Report (ESR) reports the amounts of coal consumed in Bitlis in 2014 were 32,960 tons for imported coal and 11,273 tons for coal provided by Social Assistance Foundation, respectively. However, coal consumption data used in this study were obtained from Bitlis Directory of Environment and Urbanization when the study was initiated (before publication of ESR 2014). The source of coal consumption data was mentioned in the second paragraph of *Materials and Methods* section as is seen. Table 2.1 show the amounts (sorted by months) of coal used in Bitlis in 2014.

The only possible confusion about coal consumption data used in this study may be unit of kg seen in Table 2.1. Units presented in Table 2.1 should be tons instead of kg. This typo may lead miscalculation of emission rates. However, the value of coal consumption was already given as 32,802 tons in *Abstract*, Line 12 and units were also used properly in figures from 2.1 to 2.16. When the typo was corrected, coal consumption data presented in Table 2.1 will show only 0.48% difference in comparison to ESR (2014) data (for Imported Coal). Moreover, coal provided by Social Assistance Foundation was not considered in this study, because this data (11,273 tons) was not provided to the authors when this study was in preparation as a journal

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paper.

Additionally, the discusser stated that there is also 800 m^3 fuel oil consumption in Bitlis in 2015 according to ESR (2014) (Table A.7). The authors highly recommends the discusser to review *Abstract* (Lines 10, 11, 12, 13, and 14), and if possible entire paper again, to arouse the discusser's attention to the statement of "*The amount of coal consumed in Bitlis in 2014 was obtained from Bitlis Directory of Environment and Urbanization and this value is approximately 32802 tons. In 2014,* ***due to coal firing*** *in Bitlis, the amounts of 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*". So, this statement clearly indicates that fuel oil is irrelevant and out of context for this study.

Further, the discusser stated that (Discussion, Paragraph 6) "*According to Table 1 and 2, totally 44,230 tons of coal and 800 m^3 fuel oil were burned in Bitlis in 2014. In this case, the amount of coal used in the emission inventory calculation in Turp and Turp (2015) was* ***1348 times smaller*** *than the amount burned in Bitlis*". The discusser is right that the authors' calculation is 1348 times smaller if the unit is kg, however, kg was a typo and it should be replaced with tons as explained above. Corrected table is given below.

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

Months (year 2014)	Coal Amounts (tons)
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 tons**

2.2 Discussion on Use/Assumption of Emission Factors

The discusser stated that emission factors were estimated and there is no reference to this resource document in the text (EEA 2016). The authors actually did not estimated emission factors but sulfur content and LHV values from RAPCHD. The emission factors were calculated through following equation:

$$EF_{SO2,k} = 2\overline{Cs_k} \times \left(1 - \overline{\alpha_{s,k}}\right) \times \frac{1}{H_k} \times 10^6$$

$\overline{Cs_k}$ = *average sulpur amount in type − k fuel* $(mass\frac{S}{mass}fuel\ \left[\frac{kg}{kg}\right])$

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

$\overline{\alpha_{s,k}}$ = *ave. of sulphur held in ash. This value is taken as* 0.1 *for it is not available in national data*

2.3 Sulfur content (S%), lower heating value LHV, and SO_2 emission

The discusser mentioned that *Turp and Turp (2015) stated that the sulfur content (S%) and LHW were taken as 1.2% and 5731 kcal/kg respectively in the calculation of SO_2 emission factors given in EEA (2016). According to Turp and Turp (2015), this situation was not compatible with the type and characteristics of coal used in Bitlis. Therefore, the values given in the Regulation on Air Pollution Caused by Domestic Heating (RAPCDH) were used for the calculation of the SO_2 emission factors for imported (S%: 1; LHW: 6400 kcal/kg) and local coal (S%: 2; LHW: 4800 kcal / kg) and tabulated in Table 2.2 in Turp and Turp (2015).* Also, discusser adds that S% and LHV values should be 0.627% and 6137 kcal/kg, respectively according to discusser's calculation presented in *Discussion* Eq.1 and 2.

The %S and LHV values were assumed as 1.2% and 5731 kcal/kg, respectively as mentioned in Turp and Turp (2015). The authors obtained these data from EEA (2016) and used them as reference point to estimate the sulfur content and LHV values of coal used in Bitlis. The discusser disagrees with the authors' approach and assumptions of S% and LHV used in Turp and Turp (2015). Moreover, the discusser claims that the use of the value 0.5 for S% and 6400 kcal/kg for LHV (reported by ESR (2015), *Discussion* Table 1 and 2) will result in the absolute accuracy of the estimation of air pollution in Bitlis. However, the authors preferred using intermediate values between ESR (2015) and EEA (2016) since the way to obtain the data or the entire physical and chemical characteristics of coals were not explicitly indicated in both ESR (2015) and EEA (2016). It is well known that the data presented in ESRs and EEA reports were also determined based on some general assumptions. Except self-collected data from a measurement or a lab-scale test, the authors preferred not to fully rely on or to approach towards acquired data with a caution. Therefore, intermediate values (1% for %S and 6400 kcal/kg for LHV) between data from EEA (2015) (1.2% for %S and 5731 kcal/kg) and ESR (2016) (0.4-0.5% for %S and 6800 kcal/kg for LHV) were used in Turp and Turp (2015).

The authors would also like to note that use of the proposed values by discusser (0.5% for %S and 6800

kcal/kg for LHV) will not significantly impact the overall results presented in Turp and Turp (2015).

2.4 Discussion incorrect emission factors of 1717.98 kg SO_2/ton coal, 1212.04 kg SO_2/ton coal, 13133.76 kg SO_2/ton coal

The discusser stated that emission factors of 1717.98 kg SO_2/ton coal, 1212.04 kg SO_2/ton coal, 13133.76 kg SO_2/ton coal were incorrect. The confusion of these values may be related to malfunctioning Excel worksheet error. Presumably, the authors typed the same numbers a couple of times (e.g., typed 1212.04 kg SO2/ton instead of 12 kg) because the entire number did not show up correctly in authors' Excel worksheet cells and cell length adjustment did not allow the authors to see the typed number unless the authors types it several times. This is a common problem in Excel. The authors agree with the discusser that the values needed to be corrected. The correct values should be 17.98 kg of SO_2, 12.04 kg of PM_{10} and 133.76 kg of CO. Corrected table is given below.

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	17.98	17.98	35.93	35.93
NO_2	2.68	4.28	2.01	3.21
PM_{10}	12.04	5.08	9.03	3.81
CO	133.76	53.50	100.32	40.13

2.5 Discussion on amount of coal burned in July, August and December

The discusser stated that "*the amounts of coal burned in July and August were close to the amount of coal burned in December. Therefore, this data is considered to be the amount of coal* ***sold*** *in Bitlis, not the coal burned*". Considering the discusser's concern, the authors would like to direct the discusser's attention to Table 1 and 2 presented in discussion paper prepared by discusser. The tables present the **total coal and fuel oil** (even though the fuel oil is irrelevant to this study) **consumption** in Bitlis. They do not present "burned coal" and "burned fuel oil" in Bitlis. Coal consumption is estimated by the calculation of total amount of coal purchased by residents, institutions or industrial enterprises. Therefore, using "sold coal" or "consumed coal" will never lead a confusion or miscalculation of emission rates. In reality, it is actually impossible to estimate burned coal or burned fuel oil in a city. The authors cannot stop by every single household to make sure that they burned the coal they bought. Typically, air pollution studies and research focus on annual coal consumption or the amount of coal sold in a city to evaluate the quality of air.

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