

# ***Interactive comment on “Spatial estimation of air PM<sub>2.5</sub> emissions using activity data, local emission factors and land cover derived from satellite imagery” by Hezron P. Gibe and Mylene G. Cayetano***

## **Anonymous Referee #1**

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### General comments

I think there are some major concerns with this manuscript that have to be taken in consideration before it can be accepted for AMT. The main problem is the language that is not clear, which means that it is difficult to fully validate the scientific content in this study. However, I think relevant scientific questions are addressed that are in the scope of AMT, but they have to better emphasise. I think the authors present a novel idea that deserve to be taken in consideration. The present method is interesting, which can also be used in the developing countries dealing with small budgets and

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limitation in resources.

## Major concerns

1. Due to limitation in time the review of the language has only been performed for the four first pages. Even so, it is obvious that the language has to be improved, and suggestions to improve the text are given below for these four pages. However, English is not my native language, which means that all my suggestions are probably not the best ones in an attempt to make the text more readable. The main criticism is that too much of redundant words and phrases are used in the text. However, the selection of words are also not always correct, which makes it difficult to understand the text at several places. In addition, I think the structure of the text could be improved by reducing the many paragraphs introduced. This is purely a scientific text and not a popular scientific text. At some places also very long sentences are found, which should be avoided: for example at the lines 4 – 7 on page 10. I suggest that the authors take contact with someone that is able to improve the text and/or ask AMT if they could support with this work. 2. Paragraph at lines 10 – 19: equation 3 and the corresponding text in this paragraph is very confusing. I suggest to present, where it is missing, units for the different factors included in the equations. Should the three first factors in the bracket actually be multiplied with each other? The factor SDF is not defined. Among other, the following phrase is confusing “PM2.5 per year per square kilometer per kilometer traveled”. For this paragraph I will also give here an example when redundant words are used. Line start with “Emissions for motorcycles. . . .”, which means that you do not need to repeat this in the following sentence after the equation. The same for equations 1&4. 3. Lines 18 – 21. Concerning the low percentage values 1%, 5% and 2%, does this means that it was so few respondents that answered the survey? If so, how useful and solid is this information for the present study? You should at least make a comments on this in the manuscript.

## Minor concerns

1. For E and the corresponding equations 2-4 write out the units somewhere in the text. It is not logical to name the emissions with “fuels, vehicles and straw”. Maybe “households, vehicles and agricultural” instead. 2. “Figure 2. The 2.4 x 4.0 km2 study. ....”

#### Technical/language corrections

Page 1 Line 6, “Exposure to particulate matter (PM) is a serious environmental problem in many urban areas on earth.” Line 8, “. . . . .involving human exposures to particulate pollutants is rare.” Line 9, “fine particulate (PM2.5) emissions” Line 10, “Nueva Ecija in the Philippines,” Line 11, “The emissions estimated” Line 11, “geographic information system (GIS)” Line 12, “The present results suggest that emissions from” Line 14, I think this is better “applied to any urban area, as long” Line 21, “Particulate matter, especially. . . . .haze phenomena, local and regional air quality, and climate.” Line 22, “Exposure to pollutants is a risk for many people leaving in urban areas, since the level of pollution frequently exceeds WHO guidelines (Mage et al., 1996).” Line 24, “The presence of high PM2.5 is linked to increased morbidity. . . . .”

Page 2 Line 1, “carcinogenic, especially exposed for the finest fraction. . . . .” I think “for” instead of “at”. Line 2. “attributed to particles acting as” Line 4 “Sources of PM2.5 are caused by many man-made activities.” Line 4, “A common source of. . . . .areas is related to mobile sources, directly. . . . .” Line 7, Connect this paragraph to the previous one. Line 7, This sentence has to be improved. Line 9, Suggestion “However, PM2.5 emissions from other activities such as burning of agricultural waste occurs as well in Philippines cities. . . . .” Line 14, “At present, air quality monitoring and management are based on. . . . .” Line 15, “Standards for PM2.5 have however not been fully developed and implemented in small cities. Emissions inventories in general have likewise. . . . .in many cities.” Line 17. “In addition, previous investigations are rare and limited in time, which means that temporally resolved long-term air quality monitoring data are not available.” Line 20, “This study present a method to estimate PM2,5 by utilising emission factors, satellite imagery and activity data. The latter is obtained from

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interpretation of geographic information system (GIS) data and by identifying and localising all sources in a city, taking into account the type of emissions (. . . . .) and activities that produces the emissions. This includes factors such as local population, density of households, number of emission-generating. . . . .” Line 27, “A limitation with this study. . . . .sources, since this is required in the mapping process.” Line 30, “This study aims to determine. . . . .PM2.5, caused by individual and several aerosol sources. The present method can specifically be used for similar mixture of man-made activities as in the Philippines cities: open burning of agricultural waste and charcoal (rural activity or population) as well as usage of mobile sources (urban activity or population).”

Page 3 Line 1, Connect this paragraph with the previous one. Line 1, “Another application of this study is planning aids for local governments, as the present method can be used in emission inventories for small cities. The method was developed to be used with minimal required training and effort by stakeholders, in order to create emission inventories of aerosol sources in the cities.” Line 8, “Philippines (Fig. 1).” Line 9, “and an estimated population of 296,584 in 2012.” Line 10, “around half each of the total population (Cabanatuan City SEP, 2015).” Line 13, “A 2.4 by 4.0 kilometre area including the city centre and its nearest environs was selected as the study area.” Line 14, “of the study area shown in Fig. 2.” Line 15, As it is written, marked with grey is not shown in Fig. 2 and what is meant with “point of reference”? I have difficult to understand this sentence. Line 17, “The investigation area includes residential and commercial quarter, and even agricultural areas with less than two kilometres to a main road.” Line 19, “A commercial zone and the main industrial district in Cabanatuan City located south and about 8 km from the eastern border of the investigation area, respectively, are not taken in consideration in the study.” Line 22, “The investigation area was divided with 24 x 40 grid cells (100 x 100 m or 1 ha / 0.01 km<sup>2</sup>). For each cell, the type of man-made activity. . . . .Detailed images over the ground, taken by Google Street View (examples are shown in Fig. 3), were also. . . . .(residential/commercial).” Line 26. “Satellite images were dated 3 March 2016, while street view images. . . . .September 2015. Ad-

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ditionally, maps from OpenStreetMap were also used for identifying special landmarks or since it occasionally present more updated information than Google Street View.” Line 30, “Google Earth Images have been used here instead of raw image data from example the Landsat satellite. This is because the method developed in this study is intended. . . . .familiar with processing of satellite raw imagery data. The Google Earth images have been processed to exclude the presence of clouds and corrected for aberrations from the camera taken the satellite images.” If the images really show some clouds sometimes please modify the latter sentence suggested.

Page 4 Line 2, “These images are not representative for the most current features on the ground, minor . . . . .coordinates. It is also difficult to get access to the metadata of the original images. Even so, the Google product is useful enough and then also for the uninitiated considering the present purpose. In addition, other programs such as the Google Street View or OpenStreetMap (community-based initiative) for mapping can be used.” Line 6, Sentence starting with “Actual verification. . .” is hard to understand. Line 10, “PM2.5 emissions in the Cabanatuan city highly depend on local activity. Therefore, each grid cell (100 x 100 m) within the study area has been classified with respect to the land cover features, i.e. residential/commercial quarter, agricultural areas or other surface characteristics. Figure 4 shows that residential land use (households using liquefied petroleum gas as a fuel) are spread widely, although with noticeable commercial districts and open fields (not settled) located within this area. Two large agricultural areas are found in the northwest and east, occupied by small households likely using fuels.” Improve the latter with just writing “fuels”. Line 19, The Pampa River is marked with blue color in the figure, and in southeast a new residential area near open fields and agricultural areas has been built-up.” Line 23, Connect this paragraph to the previous one. Line 23, “Note that some of the grid cells are marked as land uses directly: cemetery and terminal. The latter corresponding to the central transport terminal of Cabanatuan city, where high vehicular emissions are expected.” Line 27, “Estimation of PM2,5 emission Line 28, “All calculations that have been used here to estimate PM2.5 emissions are based on. . . . .(EPA, 1995): Lines 28 and 31, Emissions

of what? Line 31, “where E is equal to emissions, A is the activity rate/data (e.g. quantity of fuel, percentage of households using fuel), EF represents the. . . . .”

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