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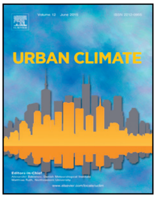

A GIS based emission inventory development for Tehran

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ABSTRACT

Tehran with a population of 8.2 million urban residents, suffers from rapid urbanization in recent years resulting in severe air pollution. The aim of this study is to develop a high resolution emission inventory of primary air pollutants for Tehran. Tehran pollution sources are classified into two major categories. Mobile sources, including vehicles such as passenger car, taxi, motorcycle, pickup, minibus, bus and truck, and stationary sources; consisting of industries, general service and household, energy conversion, terminals and gas stations. The emission of SOx, NOx, CO, VOCs and PM in the year of 2013 were estimated as 37.411 kt, 85.524 kt, 506.690 kt, 83.640 kt and 8.496 kt, respectively. The results also indicate that mobile sources produced nearly 85% of the total aggregated pollutants while the stationary sources pollutants accounted for the remaining 15%. In a more elaborated view, 6.22% of SOx, 46.1% of NOx, 97.5% of CO, 86% of VOCs and 69.8% of PM were emitted from mobile sources while stationary sources produced the remaining amount of pollutants.

1. Introduction

With rapid growth of energy consumption and number of motor vehicles in urban areas, air pollutant emissions have drastically increased in recent years. Several scientific studies confirm the association between cardiovascular and respiratory diseases with increased level of air pollution (Mabahwi et al., 2014; Wai et al., 2015). Furthermore, cities with higher level of air pollution have higher mortality and

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morbidity rate, especially among infants and other vulnerable groups of society (Cao et al., 2011; Zhou et al., 2014).

Tehran with a population of 8.2 million residents and a daily greater population due to migration from vicinities, suffers from severe air pollution (Amini et al., 2014). The overall visibility trends show a great decrease in visual range during 1958 to 2008 in Tehran (Sabetghadam et al., 2012). Moreover, Lung cancer, angina pectoris, and hospital emergency admissions for respiratory diseases are the results of high levels of air pollution (Hosseinpoor et al., 2005). Therefore, air quality monitoring, predicting future year air quality, and developing air quality control plans play an important role in developing countries and populated cities such as Tehran.

Emission inventories are official databases that specify the amount of air pollution and greenhouse gases discharged into the atmosphere from different pollution sources for a given period of time. They are usually developed for variety of spatial and temporal scales based on usage purposes (Gioli et al., 2015). Emission inventories can also be used as a major foundation for air quality modeling in order to understand the fate of pollution emitted from different sources, spatial distribution of pollutant concentrations, and identify the emission reduction opportunities (Fu et al., 2013; McGraw et al., 2010). Spatially and temporally emission inventories are used as primary inputs for atmospheric dispersion models like AERMOD and CALPUFF (Gabusi and Volta, 2005), Trajectory models such as LAGRANTO, TRAJKS and FLEXTRA (Stohl et al., 2001) and coupled chemical-atmospheric air quality models like CAMx (Nopmongcol et al., 2012). An accurate and updated emission inventory can help governments for air quality policymaking to control pollution sources (Zhao et al., 2015).

Different kinds of emission inventories have currently been developed. Some inventories are related to specific sources of pollution (Mazaheri et al., 2011) or individual pollutants (Kyung et al., 2014). Additionally, some of them are continental (Ohara et al., 2007), national (Zhang et al., 2014), regional (Fu et al., 2013), or urban (Guttikunda and Calori, 2013).

The amount of emissions and their characteristics may change significantly over periods of time due to substantial changes in vehicle numbers, fleet composition, emission standards and fuel quality. Therefore, an updated emission inventory should be established in developing regions (Fu et al., 2013). This is especially crucial in Tehran, the economical and industrial center of Iran. Average emission rates for different categories of vehicles and mobile sources can be calculated by the means of International Vehicle Emission (IVE) model (Guo et al., 2007). Shahbazi et al., developed an emission inventory for Tehran mobile sources, using the IVE model. They showed that passenger cars are one of the main sources of CO, VOCs, NOx and SOx. According to the results, 41, 64 and 85% of NOx, SOx and PM were emitted from medium and heavy-duty vehicles (Shahbazi et al., 2016).

However, the only comprehensive Tehran emission inventory was collaborated with Japan international cooperation agency (JICA) in 1997. Based on the results of JICA report, mobile sources produced nearly 71.2% of the total pollutants while the stationary sources pollutants accounted for the remaining 28.8%. Besides, it is worth mentioning that the public services and residential sector, energy conversion and industry were responsible for 4.6%, 5.9% and 18.2% of total pollutants, respectively ((JICA), 1997). As one of the fastest developing cities in the Middle East, the emission inventory for Tehran has not been updated. Therefore, it is not presently reliable in air quality analysis and policymaking.

In this paper, we have established an emission inventory with high spatial resolution for city of Tehran in 2013, including SO_x, NOx, CO, VOCs, and PM. Combination of emission factors and activity data were used to estimate emissions from each pollution sources.

The spatial distribution of pollutant emissions over Tehran were estimated and presented based on the location of pollution sources, activity data, and Tehran land-use.

Detail traffic modeling results in each road of Tehran were used in order to generate 500 m $\times$ 500 m gridded vehicle emission inventory. Diurnal variation of traffic related emissions were obtained based on traffic volume data counted at about 106 intersections over Tehran.

For other pollution sources, high resolutions of population census, land-use data, and source location were used to estimate 500 m $\times$ 500 m gridded emission inventories.

In Section 2, the emission estimation methodology for each pollution sector, data sources for preparing emission factors and activity data are comprehensively discussed. Spatial distribution of pollutant emissions over Tehran and source contributions are also presented in Section 3.