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Vehicular exhaust emissions under current and alternative future policy measures for megacity Delhi, India

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ABSTRACT

This study analyses the impact of integrated mass rapid transit system (IMRTS) and other policy measures on air emissions from vehicular sources in Delhi region. The impacts have been studied for the passenger and goods vehicles separately. For this purpose three alternative scenarios for the passenger vehicles and two alternative scenarios for the goods vehicles have been analysed for the year 2021. The interventions include stringent source emission norms, modal shift resulting from introduction of effective public transport alternatives, speed regulation measures and hiking of parking fee of private vehicles. These scenarios have been compared to the base year 2007. An important finding that emerged from the study is that stringent fuel emission norms and introduction of alternative public transport systems alone may not result in the modal shift and hence reduction in exhaust emissions. It is actually a combination of these measures and management measures such as increased parking fee and regulated uniform speed of public transport that results in desired benefits. Further, the inclusion of goods vehicle demand during transport policy formulation can help in controlling air pollution in new urban centres in India and in major developing regions of the world.

1. Introduction

Motor vehicles are one of the major sources that contribute to air pollution at local, regional and global scale (Jain and Khare, 2010). The increasing shift in motorised mode of transport in megacities of the developing countries is raising the levels of air pollutants (Kumar et al., 2013). A report by the World Energy Council shows that growing megacities in developing countries will have increased commuting distance per person per day compared with the Organisation for Economic Co-operation and Development (OECD) countries which may result increase in air pollution in future (World Energy Council, 2011).

Megacity Delhi, being the seat of political, economic and commercial activities, has an influx of population from different parts of the country. These reasons have led to a huge increase in travel demand and made Delhi as the most motorised city of India (Sahai and Bishop, 2010). Further, increase in per capita income, mobility, city expansion, education facilities and proliferation of employment centres has created an imbalance between the growth of vehicles and road network (Ahmad et al., 2013). This has resulted in issues of heavy traffic congestion and reduced vehicle speed (Planning Department, 2011) that are causing serious problems of air and noise pollution (Sen et al., 2010; Lebel et al., 2007; Tiwari, 2002). Emission contributions from vehicles place Delhi among one the highest polluted cities of the world (Kumar et al., 2013). These increased levels are responsible for a notable amount of excess deaths and hospital admissions in Delhi (Aggarwal and Jain, 2015; Central Pollution Control Board, 2012; Kumar et al., 2011; Gurjar et al., 2008). Several initiatives have been undertaken by the national and local governments in the past to address the issues of traffic management and air pollution caused by vehicular sources (Jain et al., 2014). These include command and control measures to reduce vehicular pollution such as phasing out of vehicles older than 15 years of age, use of unleaded petrol, mandatory use of compressed natural gas (CNG) in public transport and light

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duty commercial vehicles, and development of integrated mass rapid transit system (IMRTS) to cater to larger travel demands (RITES Ltd, 2010; Thynell et al., 2010; Goyal and Sidhartha, 2003; Kathuria, 2002). These measures have resulted in the reduction of ambient air pollutant concentrations including particulate matter $\leq 10\ \mu m$ (PM_{10}), carbon monoxide (CO), nitrogen oxides (NO_x), and sulphur dioxide (SO_2) in Delhi (Kumar et al., 2013). However, this reduction is still not up to an acceptable level and problems arising from urban transportation still prevail (Kumar et al., 2013; Yagi and Nagayama, 2010). Estimation and modelling of emissions from vehicular sources is the first step to assess the impact of these sources on the ambient air quality. It is therefore imperative to make accurate estimates of emissions from these sources.

The present study aims at modelling vehicular emissions under current and future alternative policy interventions. The base year for modelling emissions has been taken as 2007. The Master Plan of Delhi has been prepared with a perspective up to 2021 to cater to the increasing population and the changing requirements of the city. Thus, the BAU and alternative (ALT) scenarios have been generated for the year 2021 for modelling future emissions in order to assess the impact of policy interventions. The modelling has been done using the ASF model – **A**ctivity (in vehicle-km), modal **S**tructure (i.e. Modes of vehicles, technology (2/4 stroke), type of fuel and vintage), and the emission **F**actors (in grams of criteria pollutants released per km vehicle travelled). The VKT data have been used for accounting the intensity of road transport usage or demand. The highlight of the study includes activity based emission factors and vehicle characterization data collected through *primary* field surveys in order to capture the vintage, engine technology, occupancy, modal-structure, fuel, make and mileage for modelling the emissions from various transport modes.

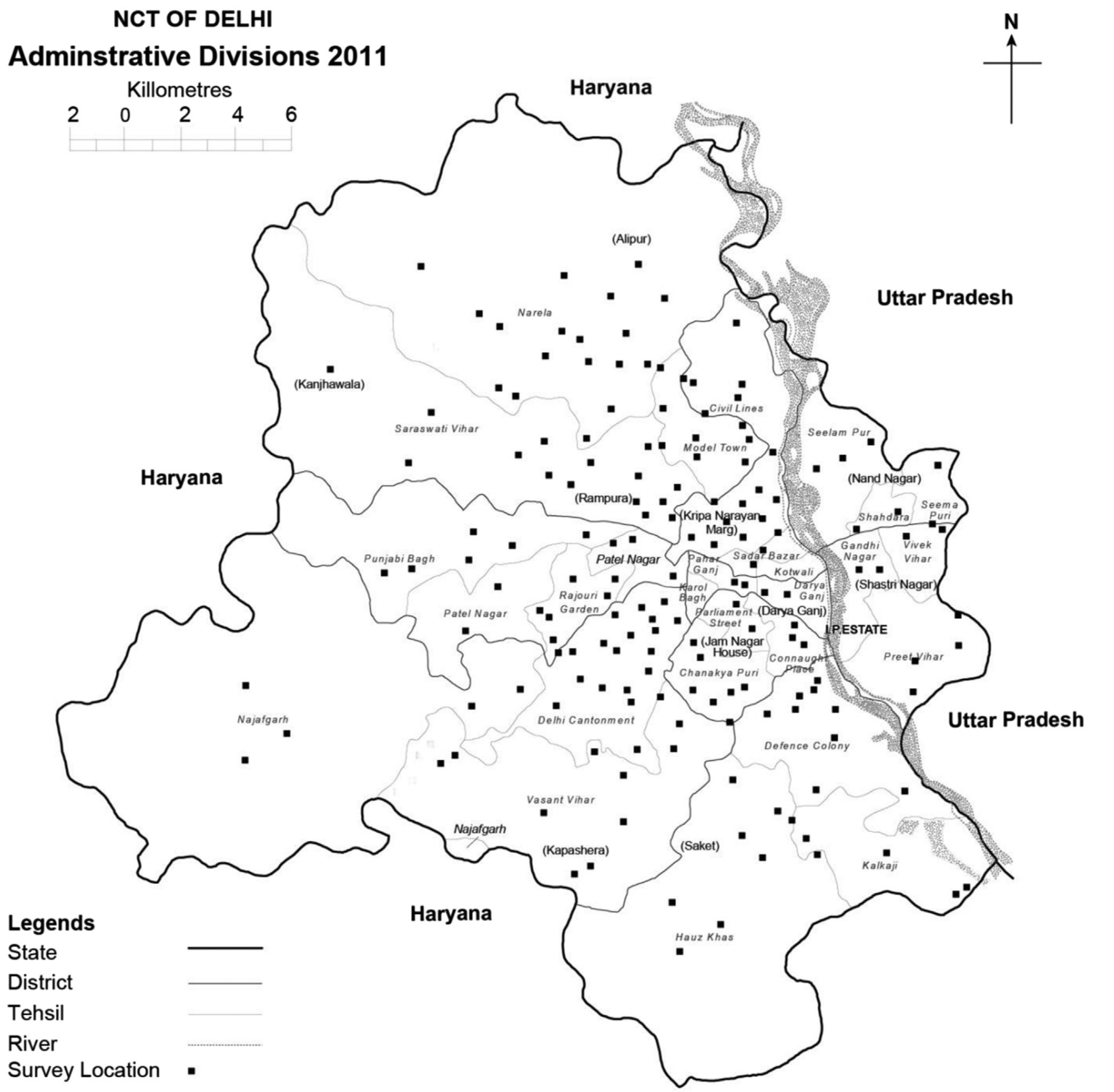

Fig. 1. Map of Delhi showing a total of ~200 survey locations used for vehicle classification surveys.

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