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Emission inventory of trace gases from road transport in India

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ABSTRACT

In India, road transport sector is one of the major anthropogenic contributor of GHGs and other pollutants into the atmosphere which have significant adverse human health effects. National and state level pollutants' emissions from road transport in India have been estimated by using VKT approach for the period of 2001–2013 which includes the values of average vehicle kilometres travelled (VKT) by different vehicle types and emission factors (EF) for different vehicle types. The results revealed a Compound Annual Growth Rate (CAGR) of 8.5%, 8.5%, 8.1%, 8.3%, 8.4%, 8.2% and 9% respectively of carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matters (PM) & hydrocarbon (HC) emissions from vehicles in road transport sector during the periods 2001–2013 due to increase of vehicle population. The study also showed a negative temporal trend in the CO_2 emissions per unit of GDP indicating reduced CO_2 emission intensities in transport sector. Statewise emission estimates from different vehicle categories confirmed that states like Maharashtra, Gujarat, Tamil Nadu, Kerala, Uttar Pradesh, Rajasthan, Andhra Pradesh, Karnataka and Delhi are responsible for about 68% of total emissions of CO_2, CO, CH_4, NO_x, SO_2, HC and PM.

1. Introduction

Transport sector involves different modes of travel such as air, maritime, rail and road and sustainable transport system requires optimum use and mix of each of these modes. The pollutants' emissions from road transport cause severe pressure on urban air quality and global warming (Colvile et al., 2001). Transport sector is significant contributor to global carbon dioxide (CO_2) emissions which consumed 20% of total fossil fuel used and contributed 23% of total energy related CO_2 emissions in the year 2012 (IEA, 2014).

Over the last few decades, motor vehicle numbers have been doubling in about every decade in many Asian countries, due to which transport sector has become one of the major anthropogenic contributor of air pollutants like nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM), besides greenhouse gases (GHGs) like CO_2 into the atmosphere. The road transport sector in Asia emits more than a billion tons of CO_2 per year having the largest share from the People's Republic of China (52%) and India (21%). The carbon intensity of the road transport sector in Asian countries has been estimated to have increased by up to 4.8% annually since 2002 (Clean Air Asia, 2012).

In People's Republic of China Cai and Xie (2007) had estimated the emissions of GHGs and other pollutants from different types of vehicles and concluded that emission varied from province to province while vehicular emission and GDP were

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positively correlated. Using COPERT III methodology, Song and Xie (2006) estimated that developed area of People's Republic of China emitted more in comparison to less developed areas. MOBILE 5 and IVE models were used by Li et al. (2003) and Wang et al. (2006) respectively for assessing the vehicular emissions from People's Republic of China and Shanghai city. COPERT III model has also been used for estimation of vehicular pollutants' emissions for other places (Buron et al., 2003, 2005; Bellasio et al., 2006; Andrew et al., 2009). In Turkey, passenger cars have been identified as major source of CO, hydrocarbons (HC) & lead (Pb) while heavy duty vehicles have been found to be the main sources of NO_x, PM and SO_2 emission (Soylu, 2007). Kousoulidou et al. (2008) used TREMOVE for projecting road transport emission for 2020 in European countries. In South Africa motorcars and trucks produced 70.6% of the total road transport emissions which have increased by approximately 2.6% in South Africa and 2.5% in Lesotho during the period of 2000–2009 (Tongwane et al., 2015).

In India road transport has increased by manifolds which accounted for a share of 6.5% in India's Gross Domestic Product (GDP) in 2011–12 while the total number of registered vehicles in the country has increased from 55 to 173 million during the period of 2001–2013 (Fig. 1) with a Compound Annual Growth Rate (CAGR) of 9.2% in total vehicle population (MORTH, 2014). Two wheelers (2 W) and cars together constituted nearly 83% and 85.4% of the total vehicles at the national level in the years 2001 & 2013 respectively. India's Second National Communication (SNC) has reported that in 2007, Indian transport sector emitted 142.04 million tons of CO_2 equivalent (eq.) in which road transport contributed 87% of the total CO_2 eq. emissions (MoEF&CC, 2010). Singh et al. (2008), by using top down approach, have estimated that 27 Mt of CO_2 was emitted in 1980 from road transport which increased to about 105 Mt in 2000. Garg et al. (2006) earlier estimated, that during the period of 1985–2005, road transport CO_2 emissions increased from 47 Tg to 143 Tg with a CAGR value of 5.7%. Baidya and Borken-kleefeld (2009) studied emissions of 10 pollutants' species from seven different vehicle categories at city and national level by using bottom up approach for the period of 1980–2005 for India. Ramachandra and Shwetmala (2009) estimated emissions of 258.10 Tg of CO_2 from transport sector of which 94.5% was contributed by road transport during the period of 2003–2004.

In this paper, emission inventory of trace gases and GHGs from different vehicle categories at states and national levels has been developed to identify the dominant vehicle categories responsible for emissions which would help in targeted mitigation measures. In India, for the national communications to United Nations Framework Convention on Climate Change (UNFCCC), GHG emission inventories from road transport sector have been prepared using the top down approach of IPCC methodology where in fuel consumption is taken into account. But this does not provide emission estimates for different types of vehicles. In India, VKT approach has been used to develop pollutants' emissions inventories by Ramachandra and Shwetmala (2009) only for the period 2003–04. In the present study, an emission inventory for road transport sector in India for the 2001–2013 period is reported. The estimations were made for different vehicle types using a Vehicular Kilometer Travelled (VKT) approach. An attempt has also been made to investigate the influence of country's economic growth on CO_2 emissions from road transport vehicles. A detailed statewise emission inventory for road transport sector in India has

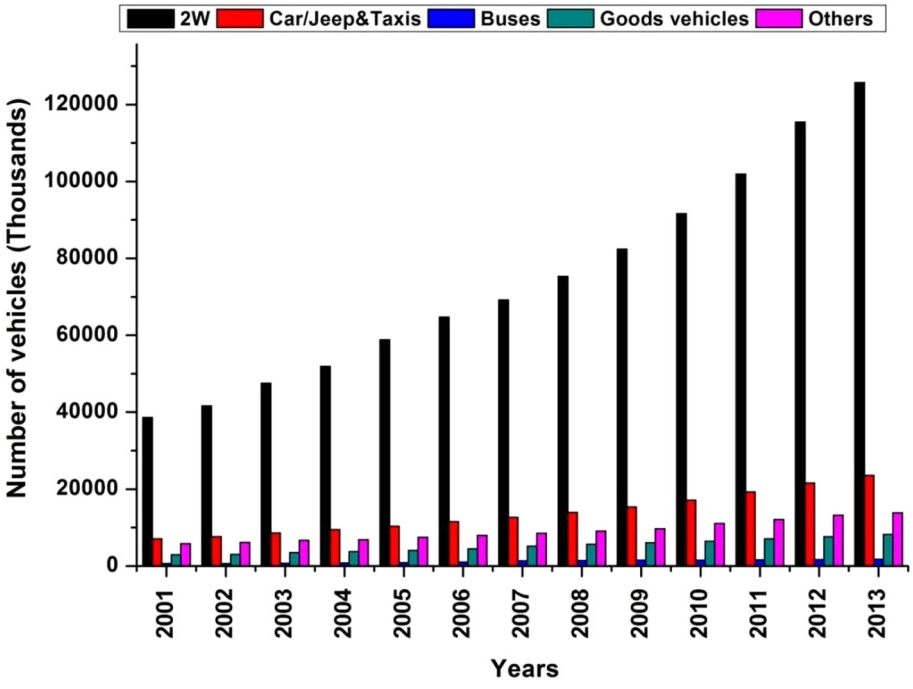

Fig. 1. Number of registered motor vehicles in India during 2001–2013.