Geared for change? CO_2 emissions from South Africa's road transport sector

Yerdashin R. Padayachi*[1] and Tirusha Thambiran[1]
[1]CSIR Natural Resources and the Environment, Durban, South Africa

Road transport is considered to be a growing source of atmospheric emissions in African countries. In South Africa, competition in the business sector, reduction in rail usage, deregulation of freight transportation and a growing middle income class have promoted increased road transport usage. Not surprisingly motor vehicles are the largest source of greenhouse gas (GHG) emissions within the transport sector in the country. A study of road transport GHG emissions in South Africa was carried out. The first phase of this study involved the collection of motor vehicle and fuel sales data for the period of 2001 to 2010 which were used to determine trends in greenhouse gas emissions. The greenhouse gas inventory for this sector was compared against previous national inventories for 1990, 1994 and 2000. It was found that on average, carbon dioxide (CO_2) emissions have rapidly grown since 1990 by 43 % with notable peaks observed in 2007-2008. These increases are noted despite recent policy mechanisms that have increased pressure on road transport users through increasing road tolling and fuel prices. The spatial allocation of GHG emissions was not evident in previous national inventories. The second phase of this study therefore focused on the estimation of emissions at a provincial level for the period 2001 to 2010. Gauteng emissions were noted as being the highest, whereas the provinces of the Free State and Mpumalanga showed CO_2 increases greater than 30%, which were related to increased consumption of diesel. CO_2 emissions were reduced by 30% in the Northern Cape and Limpopo provinces due to reductions in both diesel and petrol. This indicates a spatial disproportion in emissions across the country attributable to varying economic, infrastructural and social factors.

Keywords: Greenhouse gas emissions, CO_2, trends, road transport, South Africa

1. Introduction

The transport sector is recognised as being one of the fastest growing energy sectors (Paravantis et al. 2007) and thus a large source of greenhouse gas (GHG) emissions. Globally there is a significant drive toward reducing the contribution of GHG emissions from the road transport sector. The identification of key factors driving carbon dioxide (CO_2) emissions is critical to the development of actionable climate change mitigation strategies.

Within a developing world context there are political and economic hurdles to the implementation of regulatory measures within this sector which has stalled the provision of improved transportation services, presenting unique challenges to achieving climate change mitigation in these regions of the world. In Africa's largest economy, South Africa, the road transport sector was in 2000 responsible for over 8 % of the total CO_2-eq emissions (DEAT 2009a). Road transport is therefore a significant contributor to South African GHG emissions. Road transport is also significant contributor to air pollution in the major South African cities (Thambiran and Diab, 2011) and is increasingly a focus in air quality management planning initiatives.

The aim of this paper is to characterise trends in CO_2 emissions from the road transport sector of South Africa. In section 2 of this paper, national CO_2 trends from road transport are presented followed by a description of these national trends in comparison to other countries. This is followed by discussion on provincial CO_2 emission trends. These trends in emissions are used in the final section of the paper to provide insight into the possible drivers of these emissions.

2. Road transport in South Africa

In order to understand the contribution of road transport to GHG emissions in the country, fuel consumption data for the period of 2001 to 2010 were obtained from the Department of Energy. The fuel consumption data together with emission factors derived from the Greenhouse Gas Protocol (WRI and WBCSD 2005, Morgan 2011) were used to generate an emissions inventory, presented in section 2.1. These emission factors were deemed suitable for use in this study by following the procedures as outlined in the IPCC (2006) guidelines.

Two further assumptions were made in this study. The first was the balance between the bulk import and exportation of crude oil. Furthermore, in the 2000 GHG inventory (DEAT 2009b), the energy sector received a greater contribution from transportation (11%) compared to the agricultural, forestry and fisheries sector (1%). Thus, the final assumption was that the fuel consumption from off-road transport in the agriculture, forestry and fisheries sector was minor in comparison to fuel consumption from the road transportation sector.

Gross Domestic Profit (GDP) per capita data were obtained from Stats SA (2010a) and Stats SA (2011).

2.1 CO_2 emissions

As part of its commitments to the Kyoto Protocol, South Africa as a non-annex 1 country has been reporting to the United Nations Framework Convention on Climate Change (UNFCCC) on its GHG emissions since 1994. Table 1 shows how the CO_2-eq emissions calculated in this study compare to previous estimates for South Africa (SA, 1990, 1994, 2000 and 2010). CO_2-eq emissions from 1990 to 2010 have increased about 2 fold.

Table 1: Annual estimates of road transport CO_2-eq emissions (kt) in South Africa (DEAT, 2009 a;b)

Year	**1990**	**1994**	**2000**	**2010**
CO_2-eq	29579	29817	36601	52050

In order to understand the contribution of South Africa's road transport emissions globally, the CO_2 emissions calculated in this study were compared to emissions of other countries (figures not shown here) using data from the International Energy Association (IEA) and information from various literature sources. It was found that on the African continent, South Africa's road transport emissions were the highest, followed by Egypt and Nigeria (IEA 2011). Furthermore whilst South Africa has shown an increasing trend in emissions, developed world countries such as Germany who have managed to reduce their emissions are still larger contributors of road transport emissions globally.

Details of the estimated CO_2 emissions for the period 2001 to 2010 are shown in Figure 1 in order to better understand annual trends and drivers of GHG emissions. This figure shows that cumulatively there was an increasing trend in CO_2 emissions from road transport between 2001 and 2010 with the greatest spike observed in 2007. Emissions related to petrol consumption generally exceed those from diesel consumption for the period of 2001 to 2010, with slight exceptions noted in 2007 and 2008. An increasing trend in diesel emissions from 2001-2010 is also observed. The ratio of diesel and petrol consumption has important implications not just for CO_2 emissions but also for air quality pollutants. However, atmospheric emissions from road transport are also influenced by the type of motor vehicle, and the vehicle kilometres travelled (VKT). As there is a lack of access to reliable data on the VKT by different types of motor vehicles in South Africa, this prevents a more robust analysis of the relationship between atmospheric emissions, fuel type and motor vehicles. However, we are able to consider the key socio-economic drivers of emissions.

Specifically, in developing regions of the world such as those in Latin America and in Asia socio-economic trends play a dominant role in road transport emissions (Timilsina and Shrestha 2009 a;b). For example, in India, increasing population growth and GDP per capita has lead to rapid growth of India's motor vehicle fleet and travel economy within the heavy commercial and light vehicle clusters (Singh et al. 2008; Timilsina and Shrestha 2009a). This has directly impacted on rising fuel usage (Singh et al. 2008), driving India's GHG emissions (121 080 kt) to levels comparable to first world countries such as Canada in 2008 (126 860 kt), (ITF and OECD 2010)

In contrast South Africa's GDP per capita has grown sluggishly and population growth has slowed down, reducing the impact of country level drivers on South Africa's road transport emissions. South Africa's population growth rate decreased from 1.4% for 2001/2002 to 1.06% for 2009/2010 (Stats SA 2010b). Figure 2 indicates how trends in national and transport sector GDP with fuel consumption are not always similar. The impact of population and economy on GHG emissions increases the complexity in trying to understand the mechanisms by which South Africa's road transport CO_2 emissions are accelerating. This makes it difficult to distinguish the individual contributions culpable for the increase in road transport emissions (Preston

2001). Also the contributions from off road transportation in the energy consuming commercial sectors may make it more difficult to identify the contributions of economic drivers to road transportation

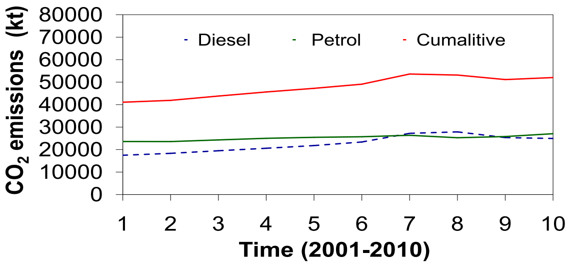

Figure 1: Trends of South African road transport CO_2 emissions for the period 2001 to 2010

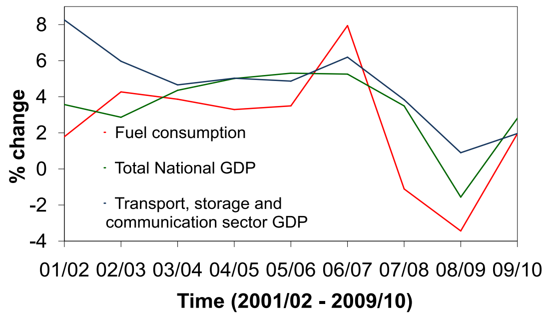

Figure 2: GDP and fuel consumption for the road transport sector in South Africa (2001-2010)

2.2 GHG emissions at a provincial level

At a provincial level, it was found that Gauteng had the highest emissions for the 2001 to 2010 period with an increase of 10% noted for this time (Fig. 3). Limpopo and Northern Cape emissions peaked in 2008 and showed a 40% decrease in emissions for the period 2001 to 2010. In all provinces, the GDP per capita at constant 2005 prices from Stats SA (2011) increased overall, with peaks in GDP per capita noted in 2008. Gauteng and the Western Cape had the greatest GDP per capita over this period, with Limpopo and the Eastern Cape having the lowest GDP per capita. There is significant variability in GDP per capita between each province, which mirrors the heterogeneity in the CO_2 emission trends between provinces.

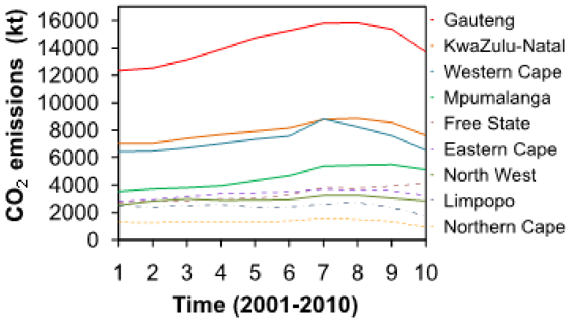

Figure 3: Road transport CO_2 emissions from for each of the provinces in South Africa

These trends may indicate dynamism in the composition of environmental and socio-economic factors that are driving emissions in each of the provinces. Included as likely factors are country level and localised drivers of emissions such as human population growth, GDP per sector, vehicle population composition, vehicle mileage, fuel composition and combustion technologies (Thambiran and Diab 2011). These factors need to be investigated further in order to develop province specific mitigation scenarios that can contribute to the national objectives for GHG reduction and local improvements in air quality.

3. Concluding remarks

Road transport CO_2 emissions from South Africa are the largest on the African continent. However, these emissions are amongst the lowest in the world and the growth in emissions is significantly lower than that observed in developing countries in Asia and Latin America. However, road transport in South Africa is not just a source of GHG emissions but also air pollutants. Thus, even though CO_2 road transport emissions are relatively low, there could be multiple benefits to reducing emissions from this sector. As GHG emissions are fair proxies for initially gauging the extent of air pollution from road transport due to fossil fuel consumption, it is recommended that this sector needs to be geared for change. Greater emphasis needs to be placed on characterising the VKT and motor vehicle types in Gauteng, the Western Cape and KwaZulu-Natal in order to develop robust atmospheric emission reduction strategies that will guide policies and facilitate GHG mitigation and air quality improvements.

4. Acknowledgement

The authors would like to acknowledge the Department of Energy, South Africa for the use of South African fuel sales data.

5. References

Department of Environmental Affairs and Tourism (DEAT) 2009a, 'Greenhouse Gas inventory South Africa: 1990 to 2000', *Government Gazette*, **32490**: 5-12.

Department of Environmental Affairs and Tourism (DEAT) 2009b, 'Greenhouse Gas Inventory South Africa: 1990 to 2000', Available at: http://www.pmg.org.za/files/docs/090812greenhouseinventory.pdf [on-line], Date accessed 28 August 2012.

Intergovernmental Panel on Climate Change (IPCC) 2006, '2006 IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 3. Mobile combustion', Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf [on-line], Date accessed 28 August 2012.

International Energy Agency (IEA) 2011, 'CO_2 emissions from fuel combustion: Highlights', http://new.iea.org/co2highlights/co2highlights.pdf [on-line], Date accessed 28 August 2012.

International Transport Forum (ITF) and Organisation for Economic Co-operation and Development (OECD) 2010, 'Transport Greenhouse Gas Emissions: Country Data 2010', Available at: http://www.internationaltransportforum.org/Pub/pdf/10GHGcountry.pdf, Date accessed 21 August 2012.

Morgan, D. 2009, 'Industry greenhouse gas reporting: Durban chemicals and automotive clusters', *Energy Efficiency Network: Climate Change Mitigation Workshop* [presentation], South Africa.

Paravantis, J.A. and Georgakellos, D.A. 2007, 'Trends in energy consumption and carbon dioxide emissions of passenger cars and buses', *Technological Forecasting and Social Change*, **74**: 682-707.

Preston, J. 2001. 'Integrating transport with socio-economic activity - a research agenda for the new millennium', *Journal of Transport Geography*, **9:** 13-24.

Singh, A., Gangopadhyay, S., Nanda, P.K., Bhattacharya, S., Sharma, C. and Bhan, C. 2008. 'Trends of greenhouse gas emissions from the road transport sector in India', *Science of the Total Environment*, **390**: 124-131.

Statistics South Africa (Stats SA) 2010a, 'Gross Domestic Product', Available at: www.statssa.gov.za/publications/P0441/P04413rdQuarter2010.pdf [on-line], Accessed 28 August 2012.

Statistics South Africa (Stats SA) 2010b, 'Mid-year population estimates', Available at: http://www.statssa.gov.za/publications/P0302/P03022010.pdf [on-line], Accessed 28 August 2012.

Statistics South Africa (Stats SA) 2011, 'Gross Domestic Product', Available at: www.statssa.gov.za/publications/P0441/P04413rdQuarter2011.pdf [on-line], Accessed 28 August 2012.

Thambiran, T and Diab, R.D. 2011, 'Air pollution and climate change co-benefit opportunities in the road transportation sector in Durban, South Africa, *Atmospheric Environment*, **45**: 2683-2689.

Timilsina, G.R. and Shrestha, A. 2009a, 'Transport sector CO_2 emissions growth in Asia: Underlying factors and policy options', *Energy Policy*, **37**: 4523-4539.

Timilsina, G.R. and Shrestha, A. 2009b, 'Factors affecting transport sector CO_2 emissions growth in Latin American and Caribbean countries: An LMDI decomposition analysis', *International Journal of Energy Research,* **33**: 396-414.

World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) 2005, 'Greenhouse Gas Protocol: The GHG Protocol for Project Accounting', World Resources Institute, Washington, DC.