Transport Sector Dynamics and Its Contribution to Urban Health Burden in a Rapidly growing Metropolitan Areas of India

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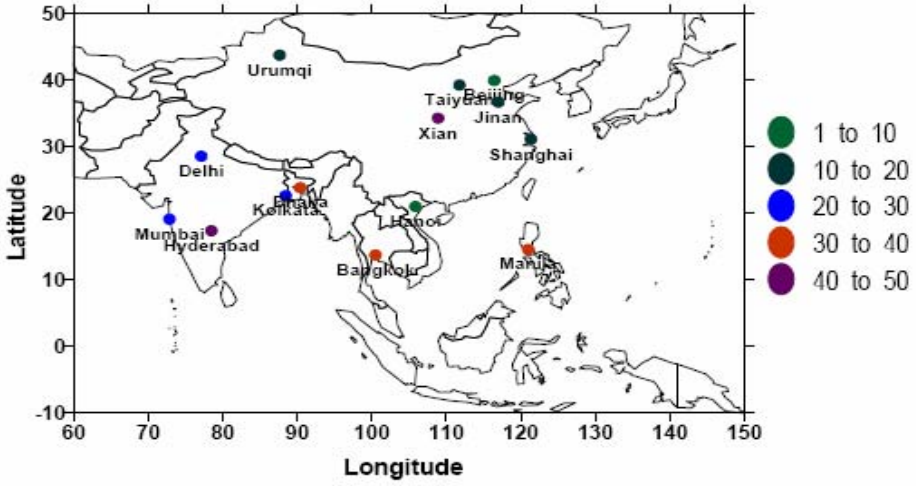
Introduction

The transportation sector could be attributed to wide range of issues viz. air pollution, noise, congestion, accidents and increased travel time as also responsible for quality of life. Asian developing cities, with the expected increase in levels of industrialization and further economic growth, would eventually have to target air pollution control and sustainable transport issues more vigorously than before in the short as well as the long term.

The travel behavior and the mode of transport (transformed to motorized transport) is not only increasing the vehicle kilometers traveled per day, but also exerting pressure on the limited infrastructure, leading to traffic congestion, idling, and pollution. The rapid growth in the number of vehicles, increased fuel combustion, poor traffic management, and lack of sufficient public transport has led to rapid deterioration of air quality and consequent increase in diseases burden. The extended commuting times due to congestion and expansion of the city areas results in longer exposure times to increasing pollution and health impacts.



Share of Transport Emissions Contributing to the Measured Ambient Air Quality in Asia

At the global level, there is a general consensus that oil is going to remain a major transport fuel, and that the world has to confront the environmental implications of oil-based transport, for at least the next three to four decades. The latest figures indicate that oil accounts for more than 95 percent of total energy use in transport in almost all countries in the Organization for Economic Cooperation and Development (OECD).

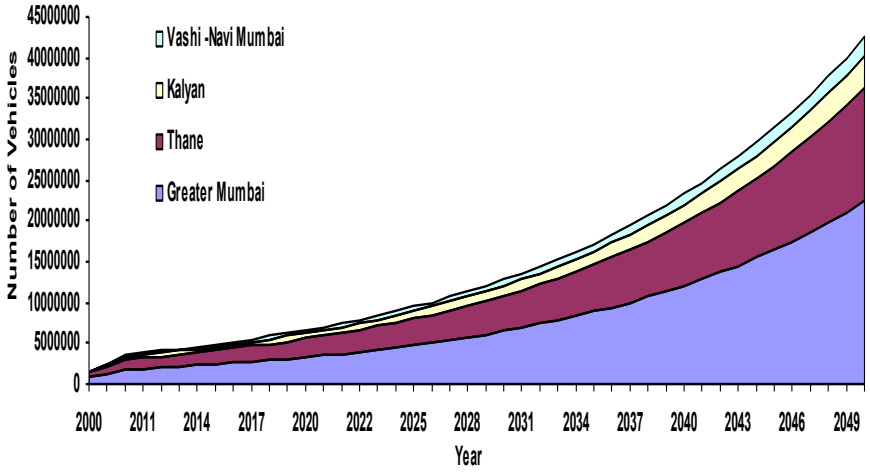
Rapid growth, low incomes, and extreme inequality are among the main underlying causes of transport problems in developing countries like India. Although the nature and extent of transport problems obviously vary from one country to another, virtually all developing countries suffer from the following:

- Unplanned, haphazard development at the suburban fringe without adequate infrastructure, transport, and other public services.
- Extremely congested roads with an incompatible mix of both motorized and non-motorized vehicles traveling at widely different speeds.

- Rapidly increasing ownership and use of private cars and motorcycles.
- Overcrowded, reasonably expensive uncomfortable, undependable, slow, uncoordinated, inefficient, and dangerous public transport.
- Extremely high levels of transport-related pollution, noise and green house gas emission especially in large cities.

Mumbai Metropolitan Region (MMR)

MMR is one of the fastest growing metropolitan regions in India. With geographical spread of about 4,335 sq. km. MMR comprises seven municipal corporations (Navi Mumbai, Mumbai, Kalyan –Dombivali, Ulhasnagar, Thane, Bhiwandi, Virar-Vasai, and Mira-Bhayander) and 9 municipal councils and 996 villages Alibag, Pen, Navghar –Manikpur, Karjat, Khopoli, Matheran, Panvel, Ambernath and Uran). With a population of 19 million (census 2001), it is ranked as the sixth largest metropolitan region in the World (**Figure below**). The Region's estimated 2005 population is nearly 21 million, which is expected to grow to about 34 millions by the year 2031, with the distinction of becoming the largest metropolitan region in the World (*TRANSFORM, 2007)*. The workforce participation rate is anticipated to reach about 45% by the year 2031 (37% in 2005). Mumbai city aspire to be one of the globally competitive cities in the World. Some of the major shortcomings are transportation inadequacies and civic amenities Annual percent variation in vehicles with respect to Maharashtra vehicle growth in MMR Region is shown below.



Growth of Registered Vehicles in MMR Region (1980-2050)

Transport Indicators:

The transport indicators for the period 1991-2005 indicate that, buses are capturing a much smaller share of travel and suburban services are not keeping pace with population growth. Bus services are loosing out of autos and two wheelers for shorter distance trips particularly to the railway stations. The very large increase in the number of autos and two wheelers is a reflection of this trend. In the newly developing urban areas outside Municipal Corporation Greater Mumbai (MCGM) the auto industry has found a niche market in areas not well served by public transit. Suburban train rider ship growth is only about 80% of the population increase, but it is unable to cater to all the increase in population with Mumbai and MMR. The 137% increase in cars, a 306% increase in two wheelers, the 420% increase in autos and 128% increase in taxis during 1991-2005 has created

a lethal dose of traffic congestion which has categorized Mumbai and region as one of the most congested cities in the World *(TRANSFORM, 2007)*.

Mumbai Transportation Scenarios

In the case of Mumbai, a major part of MMRDA, GDP has increased from Rs. 90.2 to 149.9 billion during 1997 to 2005, while human population has increased from 10.8 to 11.9 million (Das and Parikh, 2004). These increases have also increased the total passenger travel demand from 32 to 61 billion passenger kms. Similar situation prevails in other major metropolitan cities in India *(Ramachandra et al., 2009)*

The road length in Mumbai is about 2,000 km, comprising of about 1,950 km of MCGM maintained roads and about 50 km of State Highways (23.55 km of Eastern Express Highway from Sion to Thane and 25.33 km of Western Express Highway from Bandra to Dahisar). Currently MCGM maintains 62 flyovers, 47 ROBs (Road over Bridges) and 104 bridges. In addition, for pedestrian facilitation MCGM has constructed 68 foot-over-bridges (FOB) and 28 pedestrian subways. About 85 per cent of the total trips are carried out through mass transport systems almost equally divided among bus transport provided by Bombay Electric Supply and Transport (BEST) Corporation, an MCGM undertaking and the suburban railway system operated by Central and Western Railway Divisions of Indian Railways *(Vishwanath, 2003)*.

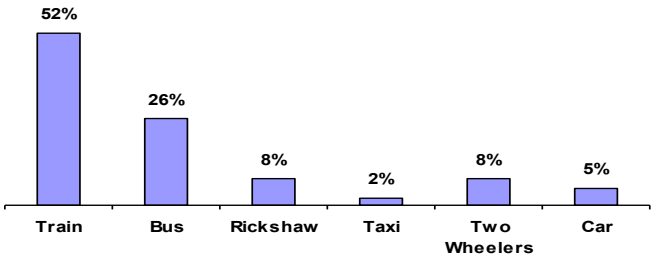
A total of about 10 million people in MMR make about 28.5 million journeys (trips) every day, counting going-to and coming-back separately. Another 13.5 million trips are made by a combination of modes, at least one of which is motorized. It has been estimated that all these journey total to about 250 million kilometers of travel every day. Details of Mumbai travel demand on main mode (average working day) are given.

Almost seven million journeys are made by Suburban Rail. It is the most important mode of travel after walk. Equally important are public bus services on which another 3.5 million trips are made. In addition, these buses also double as an access mode for people who use suburban railways. Out of seven million journeys made by rail, about 1.5 to 2.0 million use buses to reach their railway station. Thus buses carry about 5.5 million passengers. About one million journeys are made by Two wheelers. Equal numbers are made by auto rickshaw. About 8,50,000 journeys are performed by cars and taxis. In spite of each of these being less than one-fifth of train or bus, their high per capita road coverage creates almost high congestion (*TRANSFORM, 2007)*

Mumbai Travel Demand –Main Mode (Average Working Day)

Main Mode	Trips per Day
Walk	1,48,50,000
Train	69,75,000
Bus	35,50,000
Rickshaw	10,50,000
Taxi	2,25,000
Two Wheelers	10,50,000
Car	6,25,000
Total	2,83,25,000

52% People walk but they are excluded from this figure



Mode Share of Transport (Without Walk)

Congestion Impact in Mumbai City

Most of the cities in India are facing road congestion, which are extremes in many cases, bringing average speed below 10 km/hr. The main reason for this is high vehicle density per unit length of roads, population,

urbanization and incredible increase in the number of two and four wheelers. Traffic congestion results in delays, fuel wastage leading to increase in air pollution, increased travel time, noise pollution and stress.

A study was carried out to understand the congestion effect on emissions. The key findings of the test show that both fuel and journey time increase in peak traffic. Emissions increase by 33% to 75% whereas travel time increase by 5min to 30min for the same route. Denser traffic condition leads to higher emissions, slow moving traffic (stop-start vehicle movement), increased journey times and higher vehicle operating costs. City planning and urban design practices can have a huge impact on levels of future traffic congestion. Congestion can be reduced by either increasing road capacity (supply), or by reducing traffic (demand). Road pricing, charging money for access onto a road/specific area at certain times, may be other options to reduce congestion. The major impact can be seen only when all other measures are combined with efficient, reliable, cost effective, accessible and seamless integrated public transport system.

Emission Estimation in MMR Region

The total emission from all the category vehicles at each region is given below

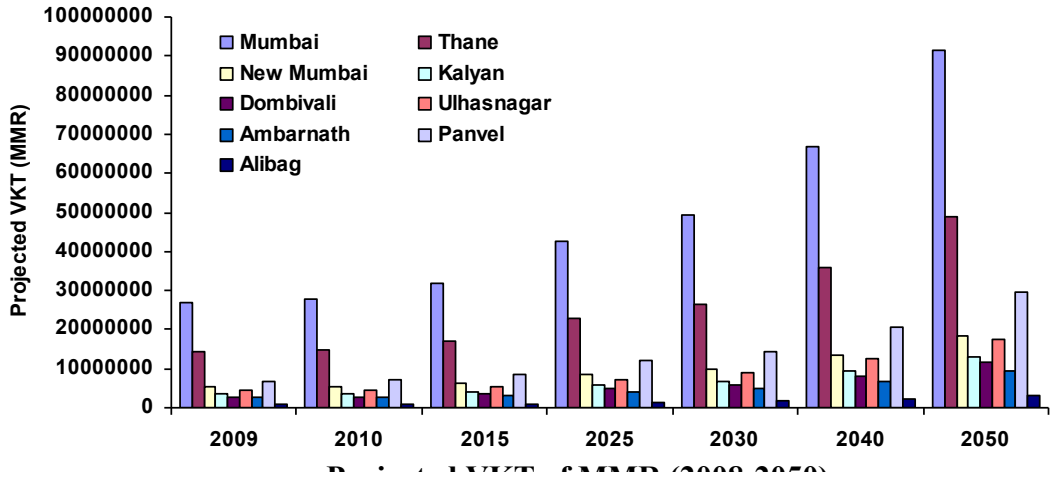
Total Emission load from Different Regions of MMR (2009)

	PM	NOx	HC	SO_2	CO	CO_2
Thane	1148.6	7308.5	4458.0	403.33	10341.0	911627.5
Nav_Mum	619.5	4286.0	1459.6	224.45	4679.4	463855.4
Kalyan	176.2	1034.2	1273.8	45.65	2058.9	122315.0
Dombivali	94.5	542.1	910.0	21.51	1629.7	67042.6
Ulhasnagar	169.7	961.9	1525.5	39.03	2502.2	117132.2
Ambarnath	106.9	587.4	935.3	24.83	1405.9	72600.7
Panvel	361.9	2494.3	1573.2	127.03	4923.0	292253.5
Alibag	66.3	400.3	362.0	19.37	574.6	47337.1
Mumbai	1551.1	9167.6	6552.3	639.82	18221.6	1571765.4

The total pollutant load is maximum at Mumbai and closely followed by Thane, Navi Mumbai. The highest concentration of PM is in Mumbai and Thane (1551.7 and 1148.6 T/y). It is important to note that most of the PM emissions from vehicles are fine sizes (less than 2.5 μm) which are very toxic. CO_2 is the dominant pollutant of vehicular emission with highest concentration at Mumbai (1571765.4 T/y) followed by Thane (911627.5 T/y).

Projections of Emission for MMR Region

With the major roads and high corridors development taking place at different location viz. Dombivali –link road, Fly over Thane –Ghodbandar, Bhiwandi Bypass, Sea Link at Nhavaseva to Shivadi, EEH to Ghodbandar Road Bypass, New Mumbai Panvel expansion etc. will increase movement of vehicles in near future. If we keep the existing growth of vehicles and transportation, infrastructures, the VKT will increase on the similar patter of Mumbai. The projected VKT for the year is 2050 shown below.



PM emission loads for Mumbai, Thane and Navi Mumbai are higher, at 1583.3, 1172.6 and 632.3 T/y for 2010 respectively which will increase to 3665.9, 2737.9 and 1457.1 T/y in 2050 for respective cities. The Kalyan and Ulhasnagar PM concentrations are 180.1 and 173.7 T/y (2010) respectively which increases by 60-64% in 2050. The Ambarnath, Dombivali and Alibag are also showing increasing trend by 62, 65 and 58% increase by the year 2050, when compared with 2010 values.

Mumbai, Thane and Navi Mumbai, where concentrations of NOx in 2010 are 9364.6, 7464.3 and 4375.5 T/y, which will increase to 2252.2, 17786.8 and 10176.6 (T/y) in 2050 for respective cities. In cities viz. Kalyan, Ulhasnagar, Ambarnath and Dombivali NOx concentrations for 2010 is 1058.6, 986.6, 601.9, 556.8 T/y respectively, overall percent increase is about 60% by the year 2050.

The CO_2 emission for cities like Mumbai, Thane, and Navi Mumbai in the year 2010 is (1610744, 932590.6 and 474011.1 T/y) which will increase by 65 %, 62 % and 59% respectively in the year 2050. The other emission loads for SO_2, HC, CO shows same type of trends due to projected vehicular activities in MMR region.

Health Issues

In recent times, City doctors are baffled with the increasing number of patients with respiratory ailments requiring hospitalisation. While they say there is around 25-30% increase in cases of upper respiratory ailments, a good 2-4% of these patients required urgent hospitalisation. In some cases, it has been found that the lungs are severely damaged.

Environmental Pollution Research Centre at King Edward Memorial Hospital in Mumbai have been collecting regular health information especially for respiratory diseases. A recent study by Patankar et al (2011) analysed these data using logistic regression to investigate the link between air pollution and morbidity impacts. The monetary burden of morbidity was estimated through the cost of illness approach. Particulate matter and nitrogen dioxide emerged as the critical pollutants for a range of health impacts, including symptoms such as cough, breathlessness, wheezing and cold, and illnesses such as allergic rhinitis and chronic obstructive pulmonary disease (COPD). The study developed the concentration-response coefficients for these health impacts. The total monetary burden of these impacts, including personal burden, government expenditure and societal cost, is estimated at 4522.96 million Indian Rupees (INR) or US$ 113.08 million for a 50-μg/m3 increase in PM10, and Rs 8723.59 million or US$ 218.10 million for a similar increase in NO2.

It is important to note that Mumbai region, which used to be an industrial city till early 1990, has transformed itself into a major urban center with commercial and residential landuse. The number of air polluting industrial units in the year 2002 was 181 which drastically declined to less than 40 by 2007.

It is witnessed that most of the air pollution in the city currently can be attributed to transport and construction sector. Of many pollutants, NOx and CO can be mainly attributed to transport sector, whereas PM contributions come from construction, refuse burning, resuspended dust and other combustion processes. Most of the future illnesses due to air pollution would majorly come from transport sector, not only due to its higher contribution but also due to toxics emissions.

Conclusions

Awareness programmes for policy makers, people, drivers-mechanic, traffic police, health professionals, academicians etc. will bring the importance of better air quality. Land use and transport planning need to be looked at seriously for future sustainability of the cities. In dense cities like MMR, public transport saves valuable space and energy compared to private transport, and can make a healthy profit at the same time. But cities need to nurture their public transport by giving then some priority on the road over cars.

The sustainable air quality goals can be achieved by a continuous process of updating knowledge, especially highlighting the health implications of emissions from all sectors and take appropriate actions. Though our standards are supposed to get derived from health studies and to protect health, we have been able to carry out enough studies and develop understanding. Without appropriate understanding of health issues pertaining to each sectors, mere stipulation of standards will not bring the benefits as desired for the human health and environment.

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