Transport

While we commute, our vehicles pollute
-Anonymous

TRANSPORT

Current Status

Issues

Impacts

Trends

Action Plan

CURRENT STATUS

The relation between transport and the environment is paradoxical in nature. On one side, transportation activities support increasing mobility demands for passengers and freight, whereas on the other, transport activities result in growing levels of motorization, congestion and harmful emissions. As a result, the transportation sector is increasingly linked to environmental problems. With a technology that is heavily dependent on the combustion of hydrocarbons to provide momentum, the impact of the transport sector over environmental systems has increased. In recent years, this has reached a level where the spatial accumulation of transportation is a dominant factor behind the emission of most pollutants and their impacts on the environment.

In India, the total estimated pollution load from the transport sector increased from 0.15 million tones in 1947 to 10.3 million tones in 1997 (State of Environment Report, India, 1999). Thus the significance of studying the links between transport and environment cannot be underestimated.

Karnataka has substantial transportation infrastructure that utilizes road, rail, air, and sea modes, and a pipeline for transport of petroleum products.

Karnataka's population of 52.73 million (2001 census) is spread over an area of 1,92,000 square kilometers and lives in 27575 inhabited villages and 270 towns. These villages and towns are connected by about 1.34 lakh kilometers of road. This total road length is exclusive of 10801 kilometers of road maintained by Panchayats and Municipalities.

National and state highways constitute 11 percent of the state road network and carry the bulk of road traffic. 71 percent of state highways and 93 percent of major district roads are of single lane (3.75m). A few districts such as Gulbarga, Raichur and Kodagu have no national highways passing through them. The national highways, state highways and major district roads constitute nearly 32 percent of the road length and are maintained by the state Public Works Department. The remaining roads are maintained by the Zilla Panchayats. On an average, about 69 kilometers of road exists per 100 square kilometers of geographical area and 250 kilometers per lakh population in the state.

Road length in Karnataka (2003)

Road type	Length in Kilometers
National Highways	3,728
State Highways	9,829
Major district roads	28,247
Other district roads, village roads, irrigation & forest Roads	92,258
Total	**134,062**

Source: Karnataka Road Development Corporation Ltd., 2004

In terms of length, National highways account for about 2.8 percent of the total road length in the State. National Highways account for 70 percent of total traffic volume in the state.

An important function of the road system is to provide connectivity to settlements. Nearly two fifths of the villages do not have all weather connectivity, and are not easily accessible during the rainy season.

The total length of railway lines in Karnataka, is 3041 kilometers. Of the 27 districts, only Kodagu has no railway line. The lowest railway length is in Chamarajanagar district (18 kilometres). However, an important railway link between Sakleshpur and Mangalore is not in operation due to gauge conversion work. Some new railway lines, like Hassan-Bangalore and Kadur-Sakleshpur have been taken up for construction.

Karnataka has three functioning airports handling passenger and freight traffic, namely Bangalore, Hubli and Mangalore. An international airport near Devanahalli,

Percentage of villages connected

Type of Road	Percentage of villages connected
All weather roads	60.3
Fair weather roads	23.7
Kuccha roads	15.7
No roads	0.3
Total roads	**100.0**

Source: Public Works Department, 2003

Portwise cargo handled : 2000-01 to 2001-02 (in thousand tons)

Port	Year	
	2000-01	2001-02
Karwar	552	556
Malpe	12	9
Mangalore (old)	111	182
Mangalore (new)	NA	1,750
Other ports	1	1

Source: Economic survey of Karnataka, 2002-03

north of Bangalore would be operational by December 2006. There are also plans to expand the capacity of Mangalore airport to handle wide bodied aircraft.

A major sea port of the state is the New Mangalore port which is an all-weather port situated at Panambur. This port handles crude oil meant for the Mangalore Refinery. A number of minor ports such as old Mangalore, Bhatkal and Karwar are also in operation and cater to a small amount of cargo. The Karnataka port policy envisages development of at least 3 minor ports at strategic locations, so that port facilities are made available to all districts of the State at the shortest distance. The facilities in Karnataka ports are inadequate in view of the various mega-projects coming up in the state in power, petrochemicals, steel, etc. Development of the handling capacity of the ports is urgently needed.

The bus system is the main public transport mode in urban transportation in Karnataka. There is no sub urban railway service being operated anywhere in the state.

■ ISSUES

Increasing vehicular emissions

The pollution load due to vehicles in the state is increasing. Preference for personalised mode of transport, increasing commuting hours and lack of efficient traffic management measures have all led to traffic congestion resulting in longer travel times, extra fuel consumption, high-level of pollution, discomfort to road users, and degradation of the environment.

The number of vehicles in Karnataka has increased from 14.33 lakhs in 1990-91 to 39.96 lakhs in 2001-02 showing almost a threefold increase over the twelve years. When examined across the districts, the highest growth rate is seen in Bangalore Urban district. Of the total number of vehicles in Karnataka, nearly 38.22 percent are plying in Bangalore Urban area and the problems emerging from the traffic in Bangalore are uniquely different from that of other districts in Karnataka.

Among the various types of vehicles plying on the roads, two wheelers constitute 71.81 percent, followed by cars (9.50 percent) and other vehicles (9.57 percent). The

Initiatives of the government

An example of the efforts underway in Karnataka to enhance road safety is the initiative undertaken with Asian Development Bank funding to upgrade the 259 kilometersTumkur-Haveri section of the Western Transport Corridor (WTC) from a two-lane, single-carriage highway to a four-lane, divided highway. The safety features will include a dual carriageway to prevent head-on collisions and service roads to separate slow-moving and fast-moving traffic. They include overbridges for pedestrians, bypasses to separate through traffic from local traffic, and fences to prevent unlawful crossing and reduce noise pollution in populated areas.

The national initiative to improve the highway system, particularly through the construction of the Golden Quadrilateral and North-South Corridor has a beneficial effect on Karnataka. The stretch of national highway in Karnataka that falls in the Golden Quadrilateral (623 kilometers) connects Bangalore with Bombay and that which falls in the North-South Corridor (125 kilometers) connects Bangalore with Hyderabad. These stretches will get converted into four-lane, dual carriageway systems and this will help in ensuring the smooth flow of traffic and in reducing accidents.

Karnataka State Highway Improvement Project (KSHIP) is a major effort to upgrade and improve road transportation infrastructure with assistance from the World Bank. It will widen and strengthen 991 kilometers of road to two-lane width (7 meter) and also rehabilitate 1277 kilometers of existing carriageway in two phases between 2001-2007.

Bangalore-Mysore Infrastructure Corridor: This is a major project that is proposed to be undertaken on a Build-Own-Operate-Transfer basis and has been initiated by a private sector entity. Its aim is to provide fast road access between Bangalore and Mysore through an expressway. The length of the highway is 111 kilometers.

An underground pipeline of about 364 kilometers has been constructed between Mangalore and Bangalore to transport petroluem products. This pipeline will replace the nearly 2.2 lakh tanker trips that are undertaken annually to transport 2.2 million tones of petroleum products.

highest number of two wheelers are seen in Bangalore district (10,49,281) followed by Mysore (1,95,307) and Mandya (45,840). About 39.58 percent of the state's two-wheelers are registered in Bangalore. Similarly, a large percentage of cars (57.55 percent), cabs (31.36 percent), autos (39.48 percent) buses (34.75 percent), goods vehicles (30.75 percent) are in Bangalore.

Air pollution problems are severe where the number of vehicles and distance traveled is maximum. Increasing two wheeler population leads to enhanced per capita emissions. The problem is severe in Bangalore, moderate in other major urban centres like Hubli-Dharwad, Mysore, Belgaum, Mangalore and Gulbarga, and relatively less in other urban centres. Even in these cities, the problem will be concentrated in the city centres rather than in the extended suburbs. The main impacts of the air pollution are on the people who reside or work on the sides of arterial roads and in the city centres. The vulnerable parties are typically pedestrians, traffic police and roadside shop owners.

Problems of automobile technology

Automobile technology has improved over the years by making the manufacturers to adhere to stricter emission norms. These include improvements in combustion processes, treatment of exhaust gases (i.e., with catalytic converters), and use of cleaner burning fuels. However, the improved engine combustion and exhaust gas treatment will have virtually no effect on energy efficiency or green house gas emissions. The use of natural gas, alcohol fuels, and propane in petrol engines will provide reductions of about 20 to 30 percent in green house gas emissions, but their use in diesel engines will not reduce green house gas emissions and may even slightly increase them. Efforts are underway by auto manufacturers in India to introduce improved technologies for engines running on alternative fuels.

Even though, the number of four stroke vehicles is increasing, two wheelers still form a sizable amount of the total vehicle population plying on the roads with two stroke engines. Two stroke vehicles consume more fuel when compared to the four stroke ones and also cause relatively higher pollutant emissions. For two-wheelers and autorickshaws, conversion to four-stroke technology results in 35 percent improvement in fuel economy and reduction in hydrocarbon emissions.

A Euro II compliant vehicle requires multi-point fuel injection system. There are two basic types of engines, spark ignition and compression ignition engines. In the former, fuel ignition is triggered by an electric spark from a spark plug, while in the latter, atomized liquid fuel is injected with the help of a fuel pump and a nozzle into a cylinder full of hot compressed air, which results in ignition taking place. Larger cylinders which need more fuel require more than one injector, thus resulting in a multi-point fuel injection system.

Even though battery driven cars have been introduced in the country, they have failed to garner a sizable proportion of the automobile market in the country. This can be attributed to the cost of the vehicle and the shorter distance of travel per charging session.

Vehicles running on blend of ethanol and petrol are already plying on state roads. There is no need to modify the engine of the vehicles to run on a blend comprising 5 percent ethanol. However, for vehicles to run on 10 percent

The need for a mass rapid transport system

From the energy-efficiency and environmental point of view, the use of mass transport is vastly superior when compared tousing personalised mode of transport. Available literature reveals that to meet each kilometre of passenger travel demand,

- A car consumes nearly five times more energy than a 52 seater bus with 82 percent average load factor, while two wheelers consume about 2.6 times and three wheelers 3 times more energy
- A car occupies over 38 times more road space in comparison to a bus. The corresponding figures for two and three wheelers are 54 and 15 respectively.
- The fuel cost of two wheelers is 6.8 times, three wheeler 7 times, and car 11.8 times, when compared to a bus. While the total cost of operation of two and three wheelers is over 3 times and car 9.5 times higher than the bus.
- A 52-seater bus enjoys similar level of advantage over other vehicles when emission of all types of air pollutants and greenhouse gases are considered.

blend, the engine needs to be modified.

Thus, it is seen that the automobile technology in India still needs to evolve in order to develop more energy efficient, eco friendly and cost-effective vehicles. Unless these factors are addressed, it will be quite long before vehicles operating on clean technologies become popular

Age of vehicles

Age of vehicle fleet is also an important factor as, old vehicles require more maintenance and consume more fuel per unit distance traveled. The Mashelkar Committee has estimated that 9.49 percent of two wheelers, 90.63 percent of cars, 6.94 percent of auto or three wheelers and 35.97 percent of commercial vehicles in Bangalore are aged vehicles. (The Mashelkar Report considered all three-wheelers registered up to 1 April 1990 and all other vehicles registered up to 1 April 1985 as aged).

Vehicle mix on roads

The traffic mix, in the state consists of motorised and non motorised vehicles and they fight for the same road space. These vehicles with different space occupancy, ridership characteristics, acceleration and cruising speeds, coupled with insufficient road space, drastically reduce the average speed on the roads. Reduction in speed increases the travel time and leads to increased consumption of fuel and emission of carbon dioxide, hydrocarbons and oxides of nitrogen.

Insufficient road width and lack of medians

From the point of view of road carrying capacity carriageway widths are very important. Carriage width is classified into three categories: Single lane (3.75 meters), Intermediate lane (5.5 meters), and Two lanes (7 to 7.5 meters). A large part of the road network in Karnataka is made up of single-lane roads or narrower and much of the network is in poor condition. Nearly 71 percent of state highways are single lane, 22 percent are intermediate lane and only 7 percent are two lanes in width. Among the major district roads 98 percent are single lane while two percent are wider than single lane. Almost all the village and rural roads are single lane in width. Narrow carriage width leads to more congestion and reduced speed. A study on the volume-capacity ratio in Bangalore reveals that 8 roads in the city were congested. These roads were handling more traffic than they are designed to handle.

Of the overall 1,34,062 kilometers of road network in Karnataka, only 57 kilometers have medians. The Bangalore-Nelamangala stretch of National Highway 4 has now been converted into a four-lane dual carriageway separated by a median and this stretch has seen the accident rate drop down to 0. Other improvements, such as creating bypasses away from population centres (e.g., the Narasapur bypass on National Highway 4) have also decreased the rate of accidents.

Poor road surfaces

Almost all the state highways (99.9 percent) are surfaced while 65 percent of major district roads are surfaced. The majority of the village and rural roads, however, are not surfaced. Often urban roads and highways have unexpected road humps, many times deliberately and unauthorisedly placed due to some accident in the past. Potholes and wavy road features (resulting from faulty construction and maintenance), rutting due to constant

Alternative fuel vehicles

With increase in the number of vehicles, India's dependence on foreign sources of crude oil will increase in the future unless alternatives are found.

Working with automakers, fuel producers and utility companies, and the private and public sector, countries are making progress towards achieving a truly diverse transportation landscape. One that will offer the consumer competitive choices in transportation technology, fuels and fuelling options, while meeting country's increasingly stringent clean air goals. These choices will include not only reformulated petrol (a cleaner- burning petrol that uses oxygenates to assist in more complete combustion) and clean diesel to fuel our transportation but also electric, ethanol, methanol, natural gas and propane powered vehicles, each playing their own role.

The use of alternative fuels for transportation can have many benefits for the economy. Using alternative fuels can help stop/ reduce the outflow of foreign exchange caused by purchase of oil produced outside of our country.

Source: Society of Indian Automobile Manufacturers

Volume to capacity ratio on major roads in Bangalore

Name of road	Volume - capacity ratio
Nrupantunga Road	3.62
District office Road	2.51
K.G.Road	2.51
Lalbagh Fort Road	2.67
Puttanna Chetty Road	2.45
Richmond Road	2.26
M.G.Road	2.76
Chord Road	2.51
Tumkur Road	2.62
Sankey Road	1.52

Note : All highway roads entering the city are also highly congested
Source: Bangalore Traffic Police, 2004

movement of iron hooped carts, all contribute to poor road quality. Bad quality roads put extra stress on the engine, cause more fuel consumption and result in wear and tear. In addition, engines produce higher emissions while accelerating, deccelarating and climbing so any feature that encourage these actions, also encourage emissions.

Poor network geometry

Bad intersection geometry is one of the main causes for low speeds. When the number of approaches increases, the conflict points increase exponentially. Since drivers become watchful for approaching traffic paths, speed reduces drastically. There are many junctions in the urban centres with five or more approaches.

When traffic volume and geometry are considered together, the degree of saturation becomes a key factor in determining congestion level. For instance, in Bangalore, according to Karnataka Road Development Corporation Limited, 19 intersections were oversaturated. Out of the 19 important intersections chosen for the study, 17 had a congestion index of more than 1 during morning peak hours and 16 had more than 1 during evening peak hours. It was concluded that in all these 19 intersections, grade separators would offer economical and optimal solution for the transport problems. Many roads also showed a volume to capacity ratio of more than one in Bangalore.

Out of these 19 intersections, construction of flyovers in the priority 10 selected would provide 16 percent to 44.29 percent relief in terms of delays. This low speed and

Poor road quality and accidents

Experts ascribe 70 percent of accidents to poor road quality and bad driving. Roads are not maintained as well as they should be, and their condition tends to deteriorate after the monsoons, which leads to increased wear and tear on vehicles and eventual mechanical failure. Further, the mixed nature of traffic causes more accidents, and also because of the speed difference between heterogeneous traffic the severity of accident also increases.

Source: Press Trust of India, 2002.

saturation at traffic signals contributes to air pollution and also to noise pollution, as many of the two wheelers and vehicles with diesel engines are not switched off.

According to a study conducted by Rail India Technical and Economic Services, average network speed has reduced from 25 kilometers per hour in 1989 to 13.3 kilometers per hour in 2000. The average speed of a Bangalore Metropolitan Transport Corporation bus in 1997 was 16.02 kilometers per hour whereas, the same declined to 14.20 kilometers per hour in 2003. A proposal for a one-way system (for the central area) would lead to an estimated fuel saving of 3 million litres per year, and a one-way system would also result in improvements in speed of vehicles. In addition, speed can be increased to more than 35 kilometers per hour in the one way system whereas in 2 way arterial roads, the speed is 15 kilometers per hour. Majority of vehicles operate most efficiently at constant cruising speeds between 80-100 kilometers per hour.

Location of vehicle stops

Location of centralized bus terminals in major towns and cities at the heart of the city contribute to congestion of traffic on the roads leading to bus terminal. This is experienced in Mysore, Tumkur, Kolar, Chitradurga, Raichur etc. Even in small towns such as Gowribidanur, Tiptur, Harihar, Chikmagalur etc., the congestion on the roads leading to bus stands is high. The shifting of the bus-stand from the busy commercial area of Hampankatta in Mangalore has helped in easing the congestion on the roads leading to Hampankatta. However, inability to provide separate space for private vehicles is still causing the congestion in areas around old bus stand in towns such as Doddaballapur, Tumkur, Kolar etc. Faulty location

of bus stands lead to congestion as, buses stop in the middle of the road and flow of traffic is hindered.

The location of autorickshaw stands, taxi stands, and bus stops near intersections has caused problems in almost all urban centers in the state. Absence of parking control near intersections has added to the problem.

Land use and transportation planning deficiencies along roads and railways

Location of administrative offices, shopping areas and service centres on both sides of the main streets of smaller towns and in district headquarters is a contributing factor to air pollution. The problem is complicated as these roads act as both local access roads as well as regional arterials. As a local access road, there is lot of crisscrossing movement due to pedestrians and local traffic. As a regional arterial they also carry quite a bit of through traffic. This high traffic and the many interruptions have caused severe speed reductions. This phenomenon is experienced in Mandya, Shimoga, Mysore, Chikmagalur, etc., and other district headquarters and in smaller towns such as Tiptur, Koratagere, Madhugiri, Bangarpet, Kolar Gold Fields, Anekal, Ramanagaram, Sindhanur, etc.

Expansion of cities and towns towards the bye-pass is causing congestion in towns such as Nelamangala, Mulbagal, Sira, Chitradurga, etc., and is contributing to the congestion of the bye-pass. The bye-pass constructed at Ramanagaram in the 1970s is presently at the centre of the town and is congested.

Land use and the transport system have not developed in an integrated manner in urban areas of Karnataka. Adequate consideration has not been given by the development authorities to the provision of land for bus stand and bus terminus locations, wider roads for bus routes, and land reservation at junctions (for flaring of lanes with signal systems and for grade separation). Multi nodal city development to minimize travel has not developed in the cities. Junction treatment is especially bad with insufficient space for traffic movement, and is further aggravated by location of petrol bunks, bus stands and taxi / auto stands and road humps.

Indeed, intercity roads that pass right through the settlements (leading to deteriorating air quality in populated areas) are common in Karnataka. When bye-passes have been planned, they are often located too close to the city and soon development begins around the bye pass turning it into an inner arterial road.

Inadequate land use control and regulation is found more near railway lines where slums develop to the approach of railway stations and also along railway lines. The impact of these types of land use development results in congestion, higher air and noise pollution and adversely affects safety. Other land use related deficiencies that lead to transport-related environmental problems include:

a) No specific areas are reserved for bus terminuses, especially for city buses in many localities of Bangalore. Consequently, parking of buses on the road affects the traffic flow and contributes to congestion.
b) In Bangalore and in many towns and cities of Karnataka, a large numbers of petrol bunks are located at the intersections of roads leading to accidents and congestion of roads.
c) Multiple approaches to intersections (circles) are contributing to accidents in Bangalore and in other cities.
d) Road designations (main road and cross roads) are unrelated to road importance, road width and plying of public transport.
e) Insufficient parking space compared to the demand generated by public places such as temples, shopping centres, cinema halls, function halls, etc., again leads to congestion.

Public transport and mass transit inadequacies

Public transit represents an alternative that delivers low energy use per passenger kilometer, low emissions per passenger kilometer, and consumes low road space per passenger kilometer. In Bangalore, the Bangalore Metropolitan Transport Corporation operates 3116 buses (45000 work trips per day) and moves around 26.25 lakh people a day. However, according to a study by The Energy and Resource Institute, its contribution to the total pollution load in the city is not more than 0.02 percent. The share

To transport 10,000 people for 1 kilometere

Parameters	Car	Minibus	Regular	Heavy	Articulated	Bi-articulated
Persons/vehicles	3	25	80	105	180	270
Vehicles needed	3333	400	125	95	55	37
Area occupied (m^2)	48000	8800	3900	3260	2600	2370
Fuel consumption(L)	400	120	40	38	31	34

of Bangalore Metropolitan Transport Corporation buses registered to the total vehicle population is nearly 0.17 percent.

Efficient and reliable public transit, priced marginally below the private cost (not including environmental costs such as pollution and congestion) of making the same trip to work or school, would provide an incentive to people to avoid private transportation alternatives in favour of public transport options. The benefits of mass transport system become apparent when one looks at the economics of transporting people across distance. A car would require nearly 400 litres of fuel to transport 10000 people across a distance of 1 kilometer compared to 34 litres consumed by a biarticulated bus for the same.

In the absence of an efficient and affordable mass transit system, people increasingly turn to private vehicles both during peak and non-peak hours. In Bangalore, people are opting for personalised mode of transit inspite of the huge fuel costs. The consequence of increased vehicle usage gets reflected in high air pollution (higher emission per capita with the growth in private vehicles), noise pollution, and accidents.

Rail-based mass transport systems are highly efficient both in terms of energy efficiency per passenger kilometre and pollution emitted per passenger kilometre compared to any other road based petrol or diesel transport system. They are also efficient in terms of land requirement for movement and parking. However, the high initial capital cost involved is a significant negative factor. No urban area in Karnataka has a rail-based mass rapid transport system operating at present. All the mass transit systems operating in the larger urban centres of Bangalore, Mysore, Hubli-Dharwad, Mangalore, Gulbarga, etc, are bus-based, including both government-run networks and private sector operated networks consisting of buses and maxicabs (sometimes operating in contravention of rules regarding stage carriage).

The provision of a mass transport system like a bus system can definitely wean away a substantial number of private transport users (mainly two wheeler users) to the bus system in all major urban centres. The traffic volumes and investment can be justified from the environmental benefits alone. However, a mass rapid transit system, such as a suburban railway system, can be economically justified only in the Bangalore region where the traffic intensity is very high.

Though it may not be economically and financially feasible to provide such a system for other cities in Karnataka such as Mysore, Hubli-Dharwad, Mangalore, etc., it is possible to take an approach of reserving land in these cities which can be currently used by a road based mass transit system such as bus to be upgraded later to a rail based system.

Going green, the BMTC way...

The Bangalore Metropolitan Transport Corporation has initiated many measures in its drive to become a eco friendly transport service provider. Some of which are listed below:

- BMTC has started procuring high speed diesel (0.05 mg of sulphur content)
- Replaced all buses aged 15 years and above.
- Formulated a policy of inducting buses confirming to Euro-II standards. From 2005, all buses inducted would confirm to Euro III standards.
- Introduced bi articulated buses on peak routes.
- All surfaces of BMTC bus depots are being made of cement concrete to prevent dust pollution.
- Formulated an effective preventive maintenance schedule consistent with guidelines issued by chassis manufacturers. The efficiency of this process is reviewed once a week at corporate level.

To own a vehicle in Bangalore

Owning a vehicle in Bangalore is a costly affair when one considers the fuel prices in the city. A litre of petrol in Bangalore costs Rs 5.98(Jan 2004) more than Delhi(having the lowest price). Added to this, Bangalore comes second only to Mumbai in terms of Diesel prices.The difference in pricing is due to the additional cost involved in transporting fuel from the oil refinery in Mangalore(350 km away). In addition, the State government imposes a surcharge of Rs 3 per litre of petrol. The state also imposes the second highest sales tax on petrol in the country at 28 per cent. All this however has not discouraged people in the city who still prefer personalised means of transit.

Fuel adulteration

Fuel adulteration not only affects engine performance, it also leads to higher emissions. While systematic evidence is difficult to obtain, there is concern that there is a high probability of adulterated fuel being used in vehicles consuming petrol.

Adulteration of fuel especially in diesel vehicles is directly related to the price difference between diesel and kerosene. Whenever the prices of diesel and kerosene sold through the Public Distribution System are narrow, the chances of any adulteration seem to be low as the cost of risk is not beneficial.

Sea ports

Ports require regular maintenance. The main maintenance activity carried out in ports is dredging. Due to severe siltation, the New Mangalore Port requires annual dredging of the order 2.87 Mm^3; 1.79 Mm^3/year from the channel and 1.08 Mm^3/year from the lagoon. The siltation in Karwar port is relatively low.

Unscientific dredging can have adverse impacts on the local eco system in the form of re-suspension of bottom sediments, accumulation/dispersion of toxic substances, oxygen depletion, reduced primary production, temperature alteration, increased nutrient level and bed load movement.

Air ports

Bangalore airport is another source of noise pollution particularly from night flights. One study reported noise levels of 86-102 decibels(A) at the airport, which exceeds the level permitted by the Environment Protection Act in industrial areas which is 75 decibels in the day and about 70 decibels at night.

Earlier airports were located far from the city. But with the growth of the city, localities have sprung up near airports. Most of the international flights from Bangalore take off during night time and this creates nuisance for the people residing near the airport.

■ IMPACTS

Impact on environment due to transport can be divided into following categories. The direct impacts arise as an immediate consequence of transport activities. The cause and effect relationship is generally clear and well understood. The second category is that of indirect impacts these impacts are often of higher consequence than direct impacts, but the involved relationships are often difficult to establish. Third category is that of synergetic impacts arising out of transport activities. These take into account the varied effects of direct and indirect impacts on an ecosystem. The specific impacts can be classified as:

Impact on air quality

The transport sector, especially road and air transport, contribute to air pollution. Vehicular air pollution is a very complicated phenomenon that depends on many factors.

The emission is determined by fuel composition, engine maintenance (filters, pollution control devices, fuel systems), vehicle age (older vehicles have higher emissions), engine temperature (catalytic converters do not work before the engine reaches normal operating temperature), road geometry (decreasing and increasing the speed causes higher emissions), type of vehicle (large engines pollute more; petrol engines emit more carbon monoxide and hydrocarbons diesel engines emit more particulate matter, oxides of sulphur and nitrogen). Carbon monoxide is the single biggest pollutant emitted by automobiles.

Vehicle speed and congestion are other important factors

as vehicles are most efficient at speeds between 80 and 100 kilometers per hour. The quality of fuel affects engine performance and use of adulterated fuel results in higher emissions. The age of the vehicle fleet is important since older vehicles contribute more to air and noise pollution.

Impact on water bodies

Activities of the transport sector cause surface and groundwater flow modifications, as well as degradation of water quality. Modifications in the flow of surface waters are due to diversion of water flow, which contribute to soil erosion. These impacts often happen far from the place of diversion and the road itself.

Transport of hazardous wastes, refined petroleum products pose significant risk in terms of soil contamination, water pollution and adverse effects on eco systems. Till recently, petroleum products destined for Bangalore were transported from Mangalore in trucks, which crossed the ecologically sensitive Western Ghats.

Another area of concern is that of marine pollution from shipping vessels carrying petroleum products. The annual oil production in the world over is 3452 million tons, out of which 2026 million tones are transported to different parts of the world. The Arabian Sea is a major route for oil tankers to South East Asia, and beyond, probably accounting for the tar like residue deposits found on the West coast of India. This chronic problem is however a seasonal feature and is largely regulated by the monsoons and associated winds.

The World Watch Institute estimates that alien species of the order of several thousand per day are transported via the ballast water which when let out, spread through canals linking bodies of water and fishery enhancement projects. These alien species compete with native species and reduce biological diversity which can have a direct bearing on the local economy in terms of reduced fish catch. They may also introduce new marine diseases and associated increased incidence of algal blooms. This is a major problem in many ports around the world.

From this we may be able to assume the vulnerability of our seas and coastal environment to oil pollution. Oil slicks can cause irreparable damage to the fragile coastal ecosystem and with increasing tanker traffic, the risk of a ecological disaster also increases. In Karnataka, the crude oil for Mangalore Refineries and Petrochemicals Limited is delivered at the New Mangalore Port.

Contribution to noise pollution

Noise is probably the most obvious impact coming from the transport sector. Vehicular noise pollution is related to the number of vehicles, vehicular types, speed and gradients.

The basic impacts are felt in terms of speech interference, sleep interference and progressive loss of hearing. The World Health Organization's guidelines recommend a nighttime average level suitable for undisturbed sleep from 35 to 30 decibels, including a peak nighttime maximum of 45 decibels. A study by a team from Bangalore University to ascertain the levels of noise in sensitive areas of Bangalore city showed noise levels ranging from 71-111 decibels (A) in traffic zones, 51-69 decibels (A) in residential areas, 72-98 decibels (A) in industrial zones and 86-102 decibels (A) at the airport. The maximum noise was attributed to vehicular movement in the high traffic zones, followed by airways, followed by industries.

Another study in Bangalore on noise levels at two major traffic junctions turned up alarming statistics. Most buses, auto rickshaws, and motorcycles grossly exceeded the noise level, with one bus touching as much as 100 decibels. In 2001 on Bangalore's Mahatma Gandhi Road, the noise levels were as high at 82.5 decibels. Another study by the Dr. S. R. Chandrashekar Institute of Speech and Hearing in Bangalore showed that nearly a quarter of the police force in the Bangalore were suffering from hearing disabilities due to increasing noise pollution. Traffic constables at the city's main junctions are the worst hit. The study also revealed that noise levels in the city's residential areas were as high as 76 decibels almost 10 decibels above the levels prescribed by the Central Pollution Control Board for commercial areas.

Noise level grows arithmetically with speed. For instance

a car traveling at 20 kilometers per hour emits 55 decibels of rolling noise, at 40 kilometers per hour 65 decibels, at 80 kilometers per hour 75 decibels and at 100 kilometers per hour 80 decibels. Noise pollution increases with traffic congestion, as irritated drivers lean on their horns. Under the Central Motor Vehicles (Amendment) Rules 1999 Government has banned the use of shrill horns and multi toned horns . But some vehicle owners continue to use them. In the year 2003, 844 vehicles were booked by the Transport department for noise pollution.

Another cause of noise pollution arises from auto rickshaw drivers removing mufflers from their vehicles with the belief that this improves their pickup. Removal of mufflers increases the noise levels. Autorickshaws rolling out of manufacturing units comply with noise emission norms. But some auto rickshaw owners replace the silencers with cheap ones manufactured locally. These silencers referred to as 'dolly silencers', are easily available.

Overall, noise pollution is a result of cumulative effects, both of the number of vehicles on the road and the ambient noise from industrial sources and other sources like electric generators. Therefore, individual vehicle-oriented standards may be limited in terms of helping to mitigate excessive noise levels.

Rail traffic accounts for 10 percent of total noise emissions by transportation. Noise comes from the engine (mostly diesel), the friction of wheels over the rails, and whistle blowing. Furthermore, when trains are moving at high speed, areoacoustic noise becomes more important than other sources. Depending on the train aerodynamics, noise emissions are from 50 to 80 times the logarithm of train speed.

Another negative effect related to transport is vibration. Vibration, mostly caused by road freight transport and air transport, is very damaging to lightly built structures along the road, as well as cultural heritage monuments. Vibration can also have negative impacts on people, causing sleeping problems and general disturbance of normal living patterns.

Measures for developing sustainable transport system

Traffic management and demand restraint measures:Traffic movement can be streamlined by implementing better traffic management measures like synchornised signals, grade separation of fast and slow traffic,exclusive busways at least along the main arterial city roads,well designed arterial road intersections, well designed and maintained pedestrian crossings and display of traffic diversion maps during peak hour of traffic flow. This will not only result in lower emissions and better fuel efficiency, but also smooth flow of traffic.

For ensuring sustainable transport, a traffic volume count data base should be prepared. This will help in assessing the nature and magnitude of emissions load of various pollutants by type of vehicles in a given area.

A significant amount of additional vehicle travel is generated by drivers who fail to select the best route for their journey. This extra travel could be avoided by better directional signing including available car parking.

Further a combination of strategies can be adopted including:

- Restricting access to sensitive areas.
- Encouraging walking, cycling, public transport.
- Generating awareness among people to make them aware of the implications of their transport choices and improving the alternative routes.
- Promote car pooling
- Augmenting public transport
- Land use planning with regulations

Impact on soil

Soil best suited for constructing transport infrastructure is also best suited for agriculture, as it is both stable and flat. Therefore, transport infrastructure development inevitably leads to the loss of productive soil for agriculture, and thus causes damage to the socioeconomic development of an area. Not only does the soil covered by the transport infrastructure become lost, but also adjacent soil, which is damaged by the construction works as a result of compaction by heavy machinery.

Transport infrastructure construction often requires at least a partial clearance of vegetation. This often leads to erosion as an indirect effect of construction. In some cases, erosion may occur far from the transport infrastructure that actually causes it, as a result of cumulative impacts. Pollution of soils in close vicinity of roads by chromium, lead, and zinc, may be a result of a very busy traffic. These

metals tend to remain in the soil for several hundred years and cause damage to the soil microorganisms and vegetation.

Impact on biodiversity

There are three ways in which the transport sector contributes to biodiversity loss: direct damage, fragmentation, and disturbance. Loss of habitat is an inevitable consequence of land use change during the construction of the transport infrastructure. However, by careful planning, it is possible to keep the damage at an acceptable level. If the construction is not carefully planned, especially in sensitive areas, it can destroy or seriously damage natural ecosystems, thus causing direct damage through loss of habitats for sensitive plant and animals, which is the main cause of biodiversity loss.

Roads cause fragmentation of habitats, preventing free movement of animals and exchange of genetic material. Habitat fragmentation damages ecosystems' stability and health. Habitat fragmentation in biodiversity rich regions like the Western Ghats or national parks etc can cause corridor restrictions and result in man-animal conflict. In other areas, the emissions and dust generated by road traffic would settle on crop leaves and reduce agricultural productivity.

Road construction also opens the ways for intruding species, disrupting in this way the ecological balance of the ecosystems. Noise, lights, and runoff of hazardous compounds from roads cause disturbance in the ecosystems, and lower the reproduction rates of flora and fauna.

The water based ecosystems also suffer disruptions caused by the land transport infrastructure. Erosion leads to accumulation of fine earth particles downstream, which affects habitats for fish spawning. The changes in water flow caused by diversions during road construction work often have negative effects on plankton, upsetting eventually food chains in the ecosystem. Roads can also cut through the migration routes of fish, causing disruptions in the spawning cycle. Avenue plantations along roadsides can go a long way in reducing the impact of road construction on the environment.

Recommendations and Action Plan of the Expert Committee on Auto Fuel Policy, Govt of India

Grade separators to be provided wherever feasible across of all the major roads.

The reduction of idling and stop time and number of frequencies of speed changes will considerably reduce pollution and improve environment.

There should be a strategy to discourage the use of private vehicles (cars and two-wheelers) by levying of high parking fees.

Road pricing may also be considered so as to make the uses pay for the use of the roads. The charges for using the roads during peak hours would be higher by 2-3 times than those other hours of the day.

Physical restrictions could be imposed on entry of vehicles either during part or the whole of the day into certain areas. This would minimize traffic volume within the cordoned area and will enhance the speedy operation resulting in reduction of pollution. The restrictions can also be by class of vehicles.

■ TRENDS

A substantial amount of economic growth in the state is centred in and around Bangalore. It is likely that the trend in vehicular growth will continue, perhaps even at an accelerated pace. Rising incomes are likely to induce people to purchase and utilize personalised transport options. Statistics reveal that around 38.22 percent of the vehicles are in Bangalore and 90 percent of the growth in vehicles within Bangalore Urban Area already represents personalised modes of transport (two-wheelers and cars).

The annual growth rate in traffic on the road system, has exceeded the annual growth rate of road network in the past two decades. On the national highways there has been 20 percent increase in traffic each year and on the state highways the annual growth has been 25 percent, but in the past two decades the road network has expanded to an average rate of 2.6 percent per year only. The absence of a Rapid Transit System in Bangalore Urban Area has also contributed to high private transport systems in terms of two wheelers and cars. This trend is likely to pose a tremendous challenge to policy makers to

Vehicle use and travel patterns in Bangalore City

In terms of the nature of vehicle use and travel patterns in Bangalore City, a series of estimates conducted by Rail India Technical and Economic Services in 2001 show that:

- 78 percent of households owned a motor vehicle, with vehicle ownership at 1.5 per household.
- Trips per person per day were 0.89, and are expected to go up to 1.25 by 2011.
- The average trip length is 7.1 km and average travel time is 30 minutes.
- Average car occupancy is 2.21, scooter occupancy is 1.41, and auto occupancy 2.1.
- Average speed in the city is 13.33 kilometers per hour and is likely to go down to 10 kilometers per hour by 2011.
- In terms of modal split, 8.4 percent of all trips are undertaken by car, 38.1percent by 2 wheelers, 40.9 percent by bus, 1.1 percent by bicycle and 11.5 percent on foot.

manage the expected fallouts in the form of traffic congestion, accidents, air pollution, and decreased quality of life.

Bangalore's population has grown from 12.06 Lakhs in 1961 to 41.3 Lakhs in 1991 to 56.86 Lakhs in 2001, and is about 60 Lakhs currently. At the same time the area of the city has grown rapidly over the years, from 101.21 square kilometers in 1961 to 445.91 square kilometers to 531 square kilometers in 2001. While the city has grown radially over the decades and added more roads as a result, it is important to note that the core areas of the city have essentially stayed the same in terms of road infrastructure. According to the Bangalore Traffic Police, the vehicle population in Bangalore City is expected to touch the five million mark by the year 2011.

Projected vehicle kilometres and percentages by 2010

Vehicle Type	Vehicle kilometers	Percentage
Cars/jeeps	123.12	25.6
Taxis	4.06	0.8
Two wheelers	231.63	48.3
Autos-petrol	86.94	18.1
LCVs	11.42	2.4
HCVs	8.21	1.7
Bus-diesel	14.83	3.1
Total	**480.2**	**100**

Source: Report of the Expert Committee on Auto Fuel Policy, 2002.

Traffic congestion in Commercial street, Bangalore

Thus the huge growth in vehicles has only seen more congestion, alleviated somewhat by the construction of a few flyovers and grade separators, and also the introduction of one-ways on various roads. In Bangalore, the construction of flyovers has reduced congestion at some junctions however, the entry and exit points to these flyovers continue to be congested.

According to the report of the Expert Committee on Auto Fuel Policy, the estimated vehicle kilometres of travel for Bangalore City for 2010 is going to increase. The travel kilometres will increase for all type of vehicles. However the percentage of travel by two wheelers will be reduced. Even though this can be a change in the right direction, the demand may increase for public transport vehicles and private cars. This may increase the traffic and the pressure will be for better traffic management.

When long route vehicles pass through cities and towns they contribute to increased pollution levels as the overall

Avenue plantations

The most effective species to absorb traffic related pollutants include Azadirachta indica (bevu or neem), Tamarindus indica (hunsemara or tamarind), Ficus benghalensis (aladamara or banyan), Terminalia chebula (Hallalemara or arjun) and Dalbergia sisso (White beete or shisham). In addition, in the state, Acacia auriculiformis, Albiziz amara and Mangifera indica are also being planted along the road sides. Prosopis juliflora (Bellary jali) has also been widely used in the existing roadside plantations. This species is planted as second row in the avenue plantations between trees and the road. The Public Works Department is also considering planting Justica Adhadota (Adasala or Adusoge), Jatropha tanjorensis (Gavadal) for the second tier.

Towards more mileage and lesser emmisions

Simple measures can be adopted by vehicle owners to reduce fuel consumption and emmisons.

- Think of the accelerator as a fuel tap; the more it is pressed the more fuel is consumed by the engine.
- It is more economical to press the pedal gently, even if it takes a little longer to reach the speed you want.
- Lot of useful energy is wasted in the form of heat when brakes are slamed.
- Incorrect gear shifting can lead to as much as 20 percent increase in fuel consumption Start your car in the first gear only, except when you are in a muddy patch or going downhill then engage second gear. Get into the top gear as early as possible. In lower gears the engine revolves faster and so consumes more fuel than it normally would at the same travel speed in a higher gear.
- For economical motoring, always try to stow suitcases and other items of luggage in the boot or inside the car. If you use a roof-rack, carefully select the luggage going on it and make sure it is properly stowed a badly packed roof-rack can significantly increase petrol consumption. An empty roof rack can increase petrol consumption by a least 5 percent. Use roof rack only when required.
- A poorly maintained vehicle consumes upto 15 percent more fuel. Three common causes of high fuel consumption are: (a) low tyre pressure (b)-retarded spark timing or misfiring, and (c) over rich mixture in the carburetor. In correct wheel alignment and brake drag can also cause high fuel consumption.

speed on the roads is reduced. This was one of the key problems in Bangalore before the construction of ring road.Traffic on the Mangalore-Bangalore National Highway is expected to reduce following the commissioning of the Mangalore-Hassan-Bangalore pipeline.

After the construction of the ring road, the long route vehicles are diverted and the pollution levels in the narrow streets of Madivala, Viveknagar or Mekhri Circle should now be lower. The possible decrease in the vehicular pollution after the construction of the ring road in Bangalore is as follows:

While forecasting for possible pollution in 2010, two situations are considered:

- "Business as Usual" scenario, without any changes or improvement in the vehicles and fuel technology
- "Road Map," where technological changes in vehicles and improvements in fuel quality are incorporated.

The Expert Committee on Auto Fuel Policy has proposed a road map for improvements in engine technology to Euro III equivalent from the year 2005 and Euro IV equivalent for the year 2010 for city private vehicles and city commercial vehicles in the major cities. Bharat Stage II and Euro III equivalent technologies have been proposed for all the vehicles through out the country from the year 2005 and 2010 respectively. This road map suggested by the committee is expected to bring down the pollution loads significantly (up to 60 percent) in spite of a 50 percent growth in the traffic load.

The air pollution projections suggest that in the Business

Bangalore goes metro….

Come 2008, Bangalore City will witness a new era in urban transportation with the launch of the Bangalore Mass Rapid Transit system. With this, Bangalore will join the list of few cities in India having such a system in place. The project is expected to cater to about 8.20 lakh passengers per day in the initial phase. The number of commuters is expected to rise to 10.20 lakh per day by the year 2011. This initiative of the state government is expected to reduce the number of private vehicles plying on the City roads.

To be built at a cost of Rs 2998 crores, the Bangalore Metro Rail Project is proposed to have rail length of 33 kilometers and is divided into two corridors East-West and North-South. The East-West corridor will be 18.1 kilometers in length and North-South corridor will be 14.9 kilometers. Out of the 33 kilometers, 6.7 kilometers will be underground and 26.3 kilometers will be elevated or at ground level. The East-West corridor will start as an elevated system from Mysore Road and via Chord Road, Magadi Road it will go underground near the City Railway station and surface out at M.G. Road. The elevated system will continue along M.G.Road, CMH Road and terminate at Byappanahalli Railway station.

The North-South corridor will start as an elevated system from Yashwantpur Railway station, travel along West of Chord Road, Kuvempu Road and go underground near Swastik. The train will emerge out near Chickpet go along K.R.Road and terminate at the end of R.V.Road. The two corridors will cross underground and will have an exchange station near Majestic.

Bangalore Metro system is proposed to have light weight rolling stock made of stainless steel. All trains will be air-conditioned, consisting of three coaches initially and six coaches in the future. It is proposed to provide 750 volts DC, third rail traction system. Initially, 166 trains will be run in each direction of each corridor during each day. The fares charged will be 1.5 times that of the Bangalore Metropolitan Transport Corporation. There will be 32 stations, roughly one every kilometers. 18 stations are planned on the East-West corridor out of which four are underground. On the North-South corridor, 14 stations are planned.

as Usual scenario there can be a reduction in oxides of nitrogen by about 14 tones and particulate matter can come down slightly but carbon monoxide and hydrocarbons are going to increase. Under the Road Map scenario, there will be a significant reduction in all pollutants.

While adoption of measures like synchronized traffic signals, land use planning etc may improve the traffic situation, in the long term comprehensive traffic management measures have to be evolved and implemented to deal with problems like congestion, longer commuting hours and low speed of vehicles.

Port traffic in the state is likely to increase in the coming years. In 2002-03, the New Mangalore port handled a record traffic of 21.43 million tones surpassing the earlier record of 17.85 million tones during 2000-01. The inward traffic during this period was 10.59 million tones during 2002-03 surpassing the earlier record of handling 9.19 million tones during 2000-01. There is substantial increase in handling of petrol, oil, lubricants, crude and products, containerised commodities, fertilizer, coal etc.

The outward traffic during the same period was 10.84 million tons surpassing the earlier record of handling 9.18 million tons during 1997-98. and the traffic is expected to increase to 7.049 million tones by 2011-12. Mangalore is one of the two ports chosen by the Government of India to build strategic reserves of crude oil. This is expected to significantly increase the oil traffic handled by the port.

Vehicles driven by electricity may gain more acceptance in the coming years due to changes in technology. Currently, the automobile manufacturers are working on advanced lead acid batteries, lithium ion and nickel metal hydride batteries, which will increase the range to over 150 kilometers on a single charge and issues concerning integration and thermal and electric management are currently being addressed.

The batteries are still expensive, but volume and time will bring this technology within the reach of consumer and solar charging is also a possibility which will increase the range by 10-15 percent. Thus more research and development work is needed to develop cost effective and eco friendly vehicles running from sources like battery and fuel cells.

■ ACTION PLAN

- Traffic police to adopt measures including traffic signals synchronization and display of diversion maps.
- Declare more roads as one ways: One ways reduce conflict points which in turn reduces the junction delays.
- Along with testing the tail pipe emissions, the Transport department should also be test noise emissions.
- Use of horns in traffic junctions to be banned.
- Augmenting public transport: Introduce more biarticulated busses on peak routes.
- Remove subsidies on kerosene to prevent fuel adulteration.
- Parking restraints should be implemented to discourage personalised mode of transport. These include high parking fees, reduction in parking time, declare more no parking zones etc.
- Coordinate land use and transport planning in order to encourage spatial settlement patterns that facilitate access to basic needs such as workplaces, schools, health care, places of worship, goods and services and leisure, thereby reducing the need to travel.
- Transport department to be involved in land use planing.
- The Transport department should develop and maintain a credible database including inventorization of vehicles and their attrition, vehicle utilization, speed, emission factors, continuous monitoring of air quality in critical areas, adulteration, and safety aspects.
- Buy back schemes are already being implemented by many automobile manufacturers. Introduce regulatory measures to ensure technological upgradation of the resold vehicle to cause lesser emissions.
- Automobile manufacturers should invest more in Research and Development to develop cost effective eco friendly vehicles
- Flight take off timings to be revised to avoid night time take off.