punjab geographer

A JOURNAL OF THE ASSOCIATION OF PUNJAB GEOGRAPHERS, INDIA

VOLUME 3 OCTOBER 2007

PATTERNS OF VEHICULAR TRAFFIC ON THE ROADS OF ALIGARH CITY: A CASE STUDY

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Abstract

Motorization is inextricably linked to urbanization. Mobility in urban areas is of particular interest, because limits of space and high densities of land-intensive individual transport modes (cars, two- and three-wheelers) result in congestion. India also has witnessed rapid increase in urbanization and motorization, but in India the road traffic is characterized by heterogeneity of traffic.

The present study tries to investigate the influence of the process of urbanization on the vehicular traffic and the vice-versa in Aligarh city. The results show that the increase in income level, inadequate provision of public transport services, and uncontrolled expansion of urban limits have given rise to the number of vehicles in the city. The important feature of vehicular traffic in Aligarh city is the dominance of non-motorized vehicles. There is also increase in the number of individual means of transport (motorized) apart from the public transportation system which has led to high emission level of pollutants.

The situation is alarming, because these are ground level sources of pollution and a large number of people live, move and operate along the roads, and are thus exposed to automotive pollutants. Levels of traffic congestion and emission along the major roads of Aligarh city have been found on the basis of traffic surveys.

Introduction

Three years after the millennium, for the first time in human history, a majority of the world's six billion people will live in cities, (United Nations Centre for Human Settlements -UNCHS, 1996). Already, the world's cities are growing in total by more than 60 million – equivalent to the entire population of the United Kingdom or France – each year. But this growth is unequally distributed. The explosive growth is occurring, and will occur, in the cities of the developing world, because the process of urbanization in these countries is still in full flood. Populations will spread beyond metropolitan borders to secondary centers, and far into what are now largely rural areas' (Koch-Weser, 1996).

The pace of urbanization in India has also witnessed significant increase and now approximately one in every three person is living in the urban areas. Significantly, most of the increase has been witnessed in class- I cities accounting for more than 65 per cent of country's urban population. Most of these cities lie in the shadow of mega – cities, where the conditions are far different from the mega – cities; they appear more as large villages than urban areas in terms of basic amenities and facilities (Fazal, 2001).

The growth of population in urban areas

has instigated significant changes in urban land use. There is transformation of land for residential, commercial, industrial and transportation activities. There has been increasing pressure on urban transport, because of increasing demand for it. Road Transport is the most efficient, reliable and popular mode of transport in India because it needs lesser capital. The newly acquired wealth, economic, political and social development has led to rapid increase in the number of vehicles on Indian roads. Traffic congestion has become a common sight and a problem that the commuters have to bear every day. Slow movement of vehicle lead to longer travel time, extra fuel consumption, more air pollutants and discomfort to road users, and degradation of the urban environment.

Much of the air pollution problems in India are restricted to the urban areas, where automobiles are the major contributors. Rapid urbanization, especially around larger cities, has created acute problems of transport. The pattern of transportation in urban centre differs – it is determined by factors such as size of the city, the employment characteristics, industrialization, commercial growth, topography, and the form and structure of the city. In view of the prevalent socio-economic environment, the road-based transport system will continue to play an important role in the movement of passengers and freight in cities of all sizes. Due to the increase in income level, inadequate provision of public transport services, unconstrained expansion of cities, the private modes of transportation will continue to dominate the transport system in the foreseeable future with consequent problems of congestion, higher costs, inefficient energy consumption and severe atmospheric pollution. Falling traffic speed is also leading to increased energy consumption and emissions.

To provide an efficient and environmentally sound transport system is now a matter of great urgency in these cities, without which it would be difficult to achieve quality urban life for the inhabitants and to sustain economic growth. The present study therefore,

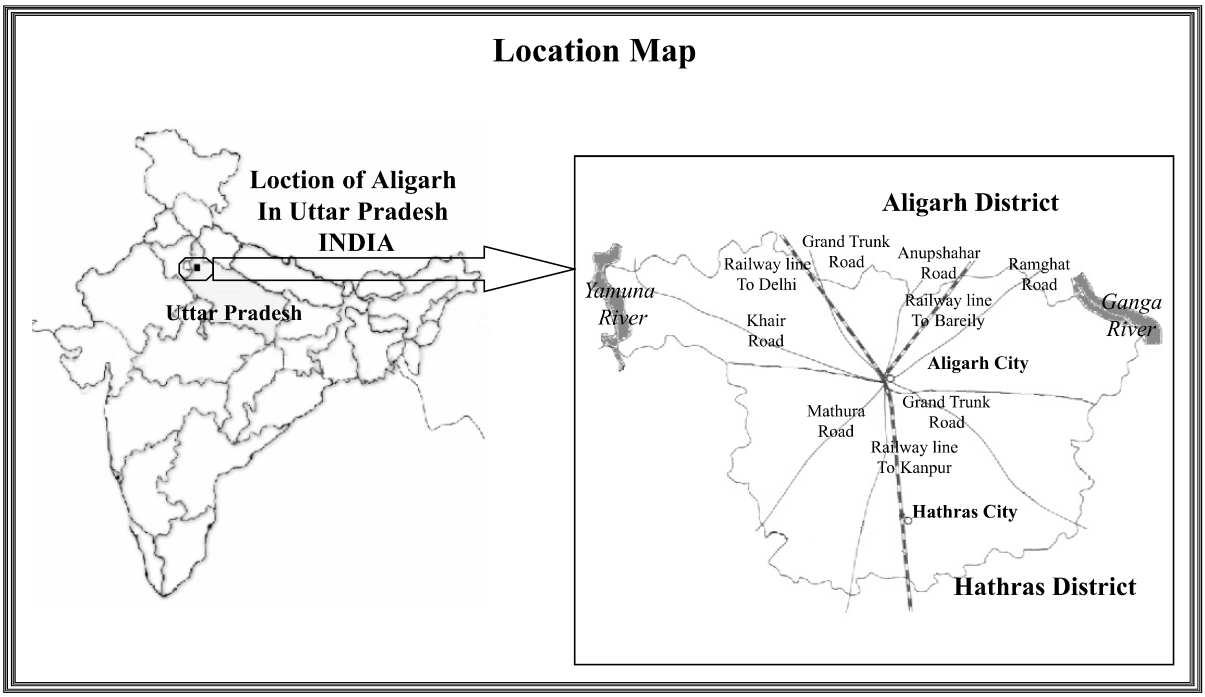

Figure: 1

tries to investigate the road traffic scenario in a growing urban centre of north India.

Study Area

Aligarh is an old city, which witnessed a long and cherished history including *Mughal's, Maratha's and Britisher's rule*. Aligarh city situated in the western part of Uttar Pradesh (Fig. 1), between *Ganga* and *Yamuna* rivers at 27°53' north latitude and 78°35' east longitude. Apart from district headquarter it is famous as an educational and industrial city. This city has gained importance because of its proximity to the national capital (New Delhi) and industrial cities of Uttar Pradesh (Kanpur and Ghaziabad). The city is very well connected to the other parts of the country through six main roads (Fig.1).

Data and Methodology

The present study is based on both primary and secondary sources. Secondary sources include published data from different governmental agencies. The land use data were acquired through Survey of India Maps and IRS (Indian Remote Sensing) 1D Satellite Imagery which was processed in GIS environment to extract land transformation data. The vehicular traffic data related to traffic congestion, volume of traffic, traffic mobility etc. were gathered through field surveys. The survey on the six main roads of Aligarh city was conducted in 2004. The vehicular traffic data were collected on three normal working days in the month of September. The data were collected for one hour at every four-hour interval, starting from 00hrs, i.e. 00hrs, 04hrs, 08hrs, 12hrs, 16hrs and 20hrs. On the basis of these data, average vehicle flow was calculated for the entire day. The vehicular emissions were calculated taking into account the average emission of vehicles suggested by Tata Energy Research Institute (TERI).

Land Use of Aligarh City

The present study is spread over 15680 hectares of land, which is much beyond the actual urban limit of Aligarh city. This extended area includes expansion of the city in all directions. The statistics show that urban area has increased from 2,234.3 hectares in 1974 to 5,653.2 hectares in 2004 and recorded an increase of 153 per cent. During this period the city has witnessed changes among various classes of land use. The residential area recorded an increase of 2,768.6 hectares (280.2 per cent), commercial area, 142.3 hectares (241.5 per cent), vacant land, 429 hectares (96.2 per cent) and industrial area, 86.3 hectares (138.7 per cent). These changes basically swallowed the agricultural land of the surrounding rural areas.

Aligarh city has recorded a significant increase in built- up area mainly due to growth of population and addition of secondary and tertiary activities. However, the expansion of built- up area was haphazard and without any planning. Even most of the recent residential colonies are developed without the provisions of basic amenities, resulting in severe congestion in road traffic.

Features of Vehicular Traffic in Aligarh City

The urbanization process in India is characterized by increasing population, conglomeration of industries, commercial activities and the consequent demand for transport. Mobility in urban areas is of particular interest, because inadequate public transport system has instigated a phenomenal growth of personalized vehicles. Nearly 75 per cent (0.25 million) of all vehicles are two wheelers mostly two-stroke engine driven. The number of motor vehicles in Aligarh city has increased from an estimated 16,000 in 1971 to 81,000 in 2001[1]. Nearly 75 per cent (0.25 million) of all vehicles are two wheelers mostly

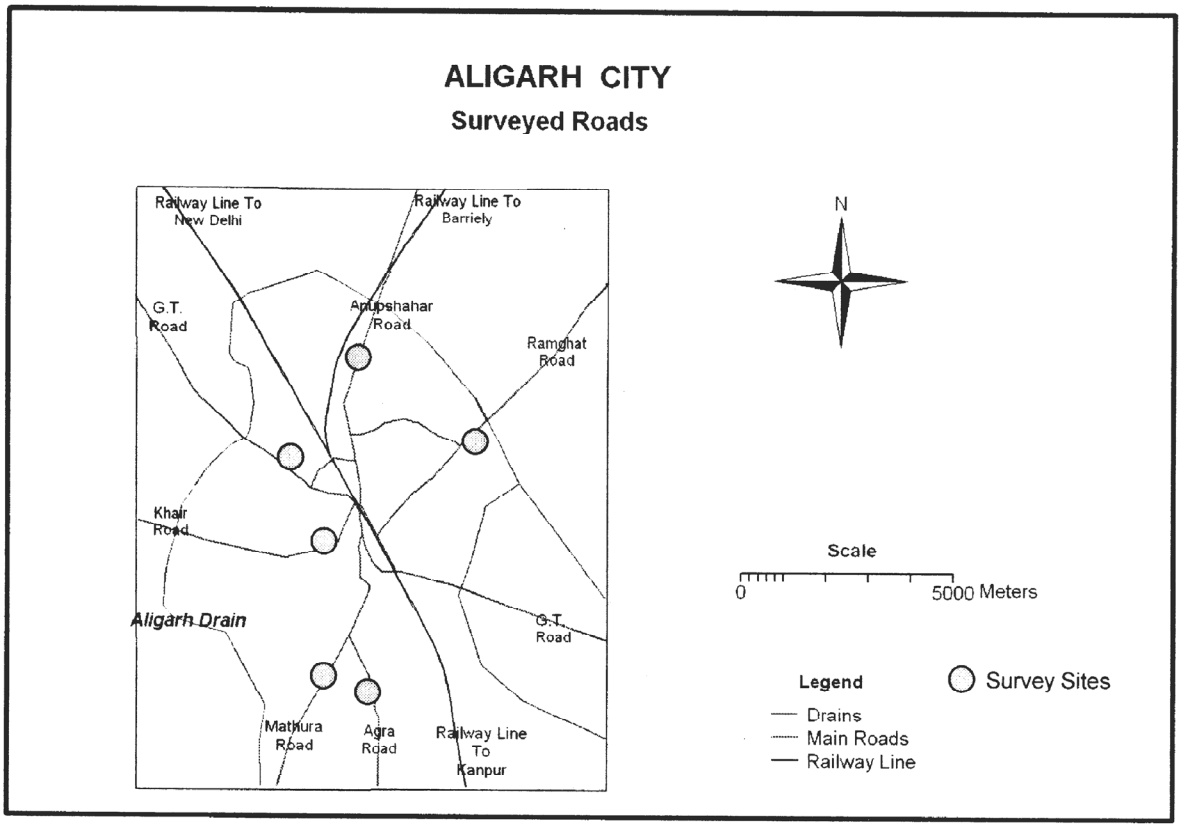

Fig. 2

two-strokeengine driven. Significantly, despite the considerable increase in number of vehicles in the city, the road infrastructure has been marginally upgraded.

The city is connected to other parts of the country by six main roads (Fig. 2) and from these main roads the data were drawn through field survey. The six main roads along which the buffer zones were drawn are:

I. **Grand Trunk road**: This is one of the most important roads not only of the country but also the Indian sub-continent. It connects Aligarh to the two metro cities, Delhi (capital of the country) and Kolkata. This road bears heavy traffic inflow because most of the commercial transactions are made through this road.

II. **Agra road**: This is another important road which connects Aligarh with another world famous Agra city. This road also connects the city to the state of Madhya Pradesh. This road is important for the movement of agricultural goods, inputs and implements.

III. **Mathura road**: This road connects the city with Mathura town. This road, entering from the south, facilitates the movement of agricultural commodities from the nearby regions to Aligarh city and connects it to the state of Rajasthan.

IV. **Ramghat road**: This road connects the city to Atrauly town in the north-east. This road is also important for bringing agricultural

1. To enumerate vehicles in any urban center is difficult, because RTO (Road Transport Office) which register the vehicles, for entire district and not for a particular settlement / urban centre.

Table 1
Aligarh City: Volume of Vehicles on Important Roads

Road/ Vehicles		Heavy Vehicles	Light Heavy Vehicles	Car/ Jeep	Two Wheeler	Three Wheeler	Cycle	Cycle Rickshaw	Bullock Driven Cart	Total Motorized Vehicles	Total Non-Motorized Vehicles	Total
G.T. Road	Vehicles/ hour	16	18	33	165	35	205	51	3	268	259	**527**
	Vehicles/ day	384	432	799	3967	840	4920	1224	70	6422	6214	**12636**
Agra Road	Vehicles/ hour	15	16	18	158	30	226	60	3	237	289	**815**
	Vehicles/ day	360	384	438	3786	720	5424	1440	66	5688	6930	**12618**
Mathura Road	Vehicles/ hour	12	14	11	74	18	188	73	7	128	268	**396**
	Vehicles/ day	288	336	259	1764	432	4512	1752	170	3079	6434	**9513**
Anupshahar Road	Vehicles/ hour	13	13	11	71	16	174	48	15	124	237	**598**
	Vehicles/ day	312	312	262	1706	384	4176	1152	360	2976	5688	**8664**
Ramghat Road	Vehicles/ hour	15	16	25	90	42	97	64	2	188	163	**351**
	Vehicles/ day	364	384	588	2160	1008	2328	1536	53	4504	3917	**8421**
Khair Road	Vehicles/ hour	5	6	15	60	12	97	34	1	98	132	**230**
	Vehicles/ day	124	145	347	1442	289	2328	815	29	2347	3172	**5519**

Source: Based on field survey, 2004.

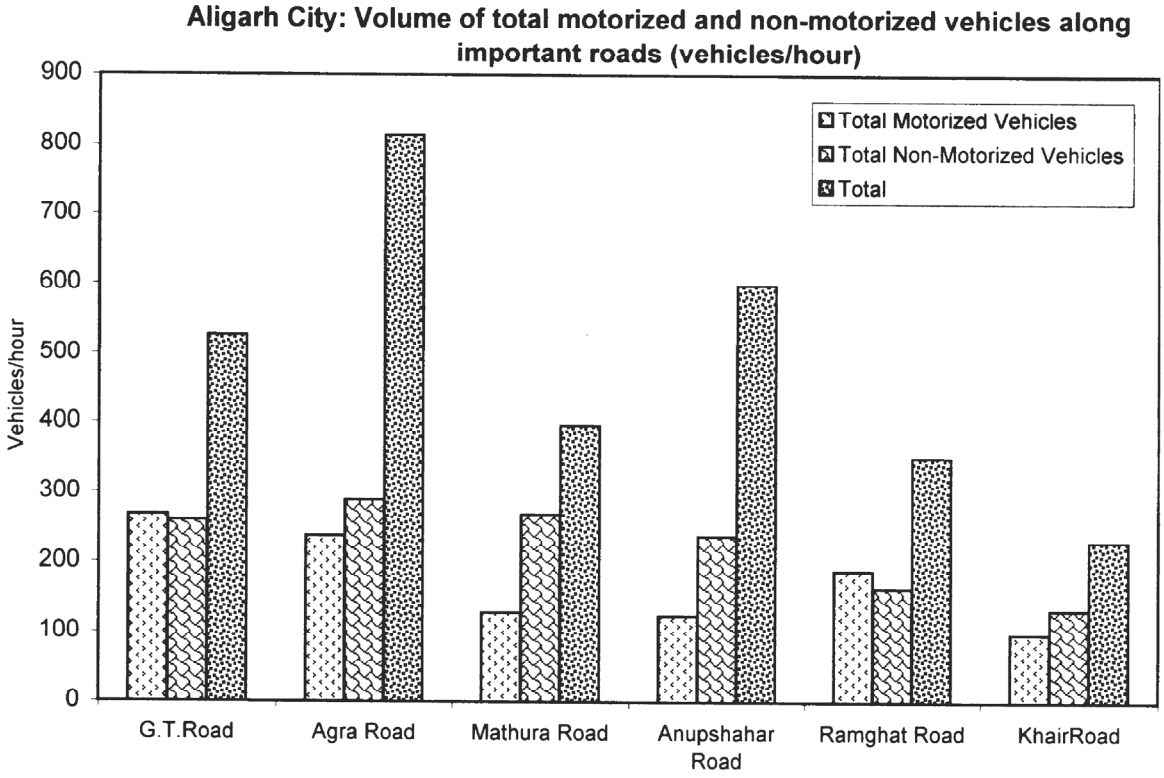
Aligarh City: Volume of total motorized and non-motorized vehicles along important roads (vehicles/hour)
Vehicles/hour
900
800
700
600
500
400
300
200
100
0
Total Motorized Vehicles
Total Non-Motorized Vehicles
Total
G.T.Road
Agra Road
Mathura Road
Anupshahar Road
Ramghat Road
KhairRoad

Fig. 3

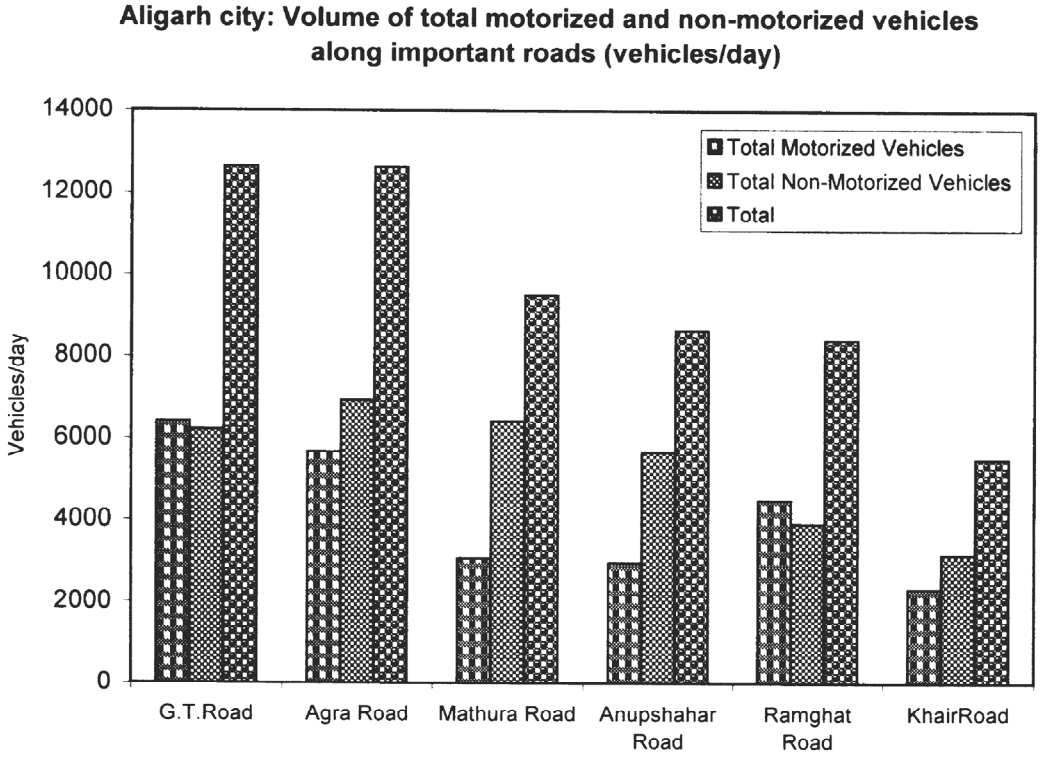
Aligarh city: Volume of total motorized and non-motorized vehicles along important roads (vehicles/day)
Vehicles/day
14000
12000
10000
8000
6000
4000
2000
0
Total Motorized Vehicles
Total Non-Motorized Vehicles
Total
G.T.Road
Agra Road
Mathura Road
Anupshahar Road
Ramghat Road
KhairRoad

Fig. 4

commodities and construction materials from the nearby areas.

V. **Anupshahar road**: This is another very important road that passes through Aligarh University and joins the city with the energy generating towns of Narora and Qasimpur. It facilitates the movement of agricultural commodities and construction materials to the city.

VI. **Khair road**: This road is a good link between Aligarh and Khair town to the east. This road is also used for transporting agricultural commodities and construction materials from the nearby areas.

The vehicles plying on the important roads of Aligarh city are categorized as under:

1. **Motorized vehicles**: This category comprises of all the motor driven vehicles like heavy diesel based vehicles (Bus, Truck etc.); light motor vehicles (L.H.V.), private four wheelers (car, jeep etc.), two wheelers, three wheelers and tractors.
2. **Non-motorized vehicles**: This category includes cycles, cycle rickshaws, and bullock and horse driven carts.

Volume of Traffic in Aligarh City

The survey revealed that the important roads of Aligarh city had a heavy flow of vehicles (5,7371vehicles per day). But it is important to note that share of non-motorized vehicle (NMV) was higher than motorized vehicles (MV). G.T. Road bears the maximum traffic in the city. This road had an average flow of 12,636 vehicles per day followed by Agra Road (12,618 vehicles per day), Mathura Road (9,513 vehicles per day), Anupshahar Road (8,664 vehicles per day) Ramghat Road (8,421vehicles per day) and Khair Road (5,519 vehicles per day). For detail see Table 1, Fig. 3 and 4.

Traffic Congestion in Aligarh City

Another important feature of traffic is its carrying capacity or the level of congestion on roads. Again due to heterogeneity in mode of traffic, Indian roads are characterized by varying levels of congestion. To measure the level of congestion on the roads of Aligarh city, different modes of transport were converted into Passenger Car Unit (PCU). Here the different modes of transport, depending on their size, speed and turning radius are assigned equivalent PCU factor (Table 2).

The survey revealed that the important roads of Aligarh city had a heavy flow of motorized and non-motorized vehicles, especially during the day times while at night hours these hardly have any non-motorized

Table 2
Transport Mode, Equivalent PCU and Type of Vehicle

Vehicle	Equivalent PCU Factor	Type of Vehicle
Bus/truck	3	Motorized
Car/Jeep	1	Motorized
LHV	1	Motorized
Auto Rikshaw	1	Motorized
Two Wheeler	0.5	Motorized
Cycle Rikshaw	1.5	Non Motorized
Bicycle	0.5	Non Motorized
Bullock Cart	6	Non Motorized

Source: Based on Central Pollution Control Board specifications (CPCB, 1999)

Table 3
Aligarh City: Traffic Congestion on Important Roads

Road/ Vehicles		Heavy Vehicles	Light Heavy Vehicles	Car/ Jeep	Two Wheeler	Three Wheeler	Cycle	Cycle Rickshaw	Bullock Driven Cart	Total Motorized Vehicles	Total Non-Motorized Vehicles	**Total**
G.T. Road	PCU/ hour	48	18	33	83	35	103	77	17	217	196	**413**
	PCU/ day	1152	432	799	1984	840	2460	1836	419	5207	4715	**9922**
Agra Road	PCU/ hour	45	16	18	79	30	113	90	17	188	220	**408**
	PCU/ day	1080	384	438	1893	720	2712	2160	396	4515	5268	**9783**
Mathura Road	PCU/ hour	36	14	11	37	18	94	110	42	116	246	**362**
	PCU/ day	864	336	259	882	432	2256	2628	1020	2773	5904	**8677**
Anupshahar Road	PCU/ hour	39	13	11	36	16	87	72	90	114	249	**363**
	PCU/ day	936	312	262	853	384	2088	1728	2160	2747	5976	**8723**
Ramghat Road	PCU/ hour	45	16	25	45	42	49	96	13	173	158	**331**
	PCU/ day	1092	384	588	1080	1008	1164	2304	318	4152	3786	**7937**
Khair Road	PCU/ hour	16	6	15	30	12	49	51	10	78	187	**265**
	PCU/ day	372	145	347	721	289	1164	123	232	1874	4493	**6367**

Source: Prepared on the basis of table 1 and 2.

Aligarh city: Traffic congestion of total motorized and non-motorized vehicles along important roads (PCU/hour)

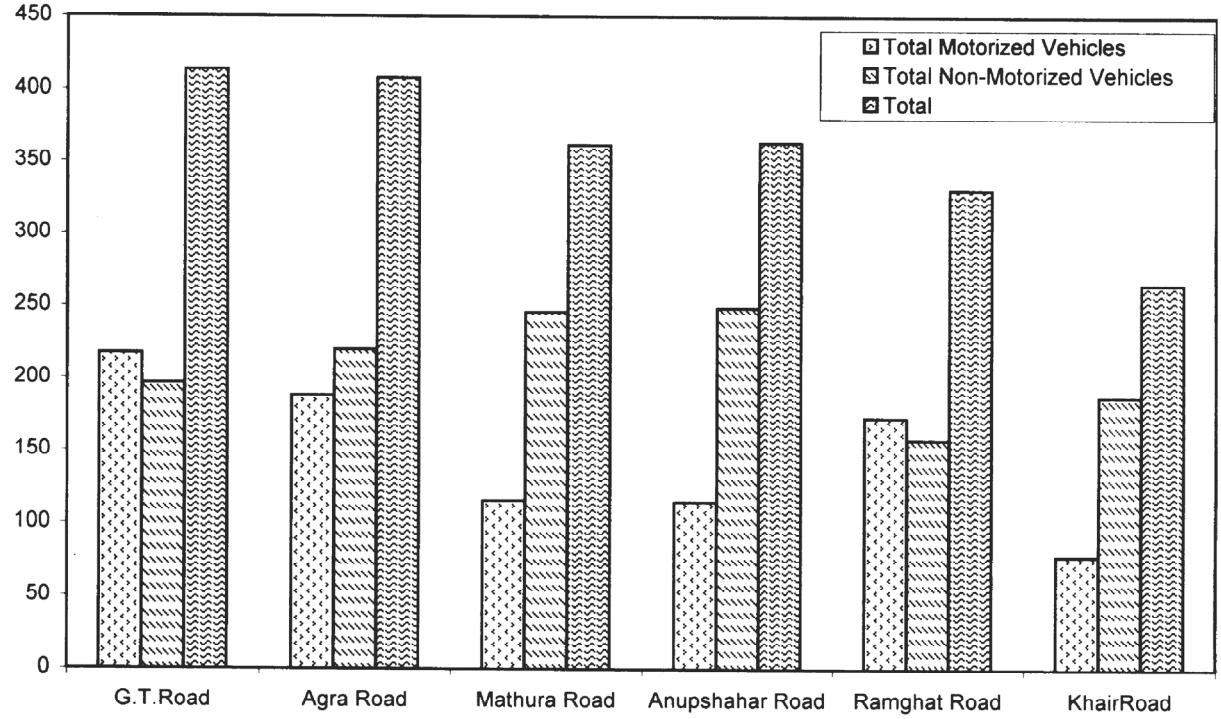

Fig. 5

Aligarh city: Traffic congestion of total motorized and non-motorized vehicles along important roads (PCU/day)

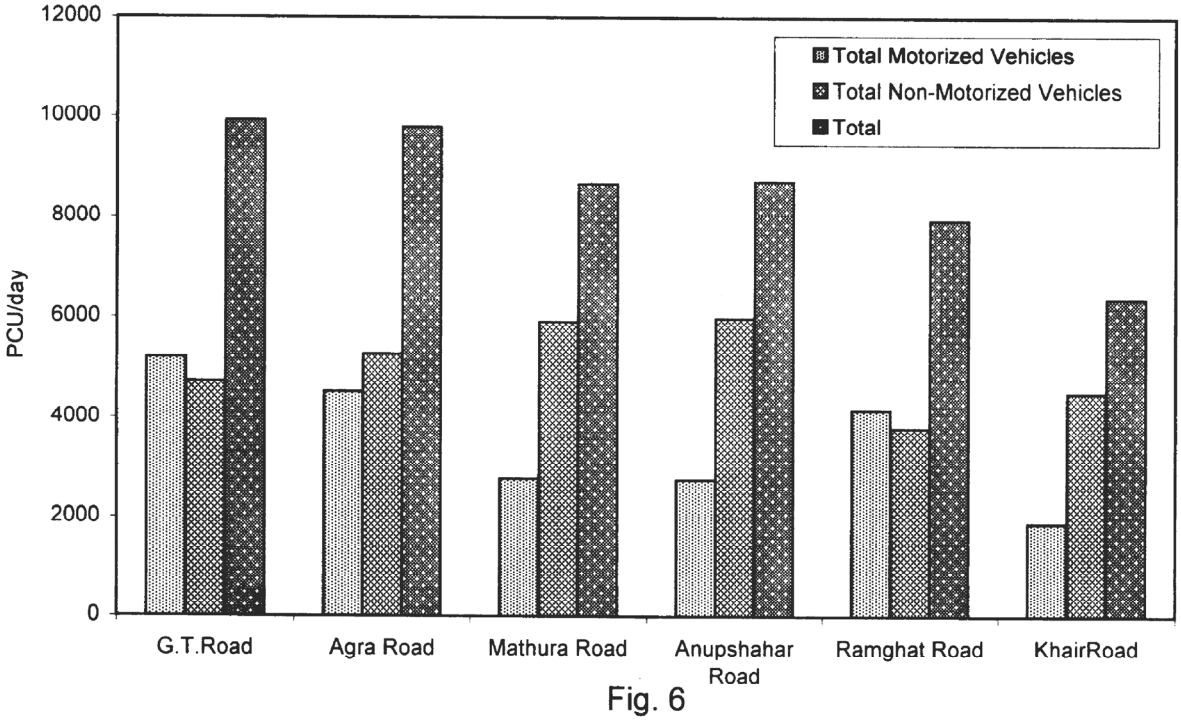

Fig. 6

traffic. The number of motorized vehicles also declines considerably on all roads except the G.T. Road during the night. So congestion on roads is a common phenomenon during the peak business hours. G.T. Road is the most congested road in the city. The Table 3, Fig. 5 and 6 reveal that G.T. Road recorded 9,922 PCU per day followed by Agra Road (9,783 PCU per day), Anupshahar Road (8,723 PCU per day), Mathura Road (8,677 PCU per day) Ramghat Road (7,937 PCU per day) and Khair Road (6,367 PCU per day). Traffic congestion is severe on roads of Aligarh city because the share of non-motorized vehicles is higher than motorized vehicles on all the roads. The survey also revealed high temporal variations in the levels of congestion; it was significantly high during daytime on all the roads and almost zero at night except G.T. Road. The maximum congestion was recorded, as 987 PCU per hour at 12hrs on G.T. Road and minimum was 6 PCU per hour at 04hrs on Khair Road.

Emission Levels in Aligarh City

Motor vehicles are the major source of air pollution. Motor vehicles emit CO (*carbon monoxide*), HCs (*hydro carbons*), NO_2 (*nitrogen dioxides*), SO_2 (*sulphur dioxide*) and other toxic substances such as TSP (total suspended particulate) and Pb (lead). Emissions of CO and HCs are most pronounced when engines are idling and SPM (*suspended particulate matter*) and NO_2 emissions are higher when vehicle accelerates. All these emissions are in varying degrees deleterious not only to human health but to entire environmental setting. Vehicular emissions are of particular concern since these are ground level sources and a large number of population live, move and operate along the roads, thus exposed to automotive pollutants. This further contribute to wider environmental problems, like NO_2 and HCs to photochemical oxidant pollution and SO_2 and NO_2 to acid rains etc. (Evteev, 1989)

In the absence of efficient and reliable public transport in urban centres, the levels of vehicular emissions are significantly high in India. Traffic pollution in Indian cities is largely influenced by higher number of poor conditioned vehicles with higher emission levels, higher number of two strokes – two wheelers which emit 10 times more HC and smoke and use of adulterated fuel. Major vehicular emission related pollutants are:

Carbon monoxide (CO) : This is one of the important pollutants, which contribute to the green house effect through oxidation, it hamper methane oxidation and thereby accelerate the growth of methane accumulations. The

Table 4

Emission Factors (gm/km) of Pollutants for Indian Vehicles

Type of Vehicle	So_2	No_2	PM	HC	CO
Two Wheeler	0.02	0.07	0.2	10.0	17.0
Car/Jeep	0.08	3.2	0.33	6.0	40.0
Auto Rickshaw	0.25	0.60	1.3	0.14	0.7
Light Heavy Vehicles *(Diesel Operated)*	1.0	13.0	2.0	1.5	8.5
Heavy Vehicles *(Diesel Operated)*	1.5	21.0	3.0	2.1	12.7

Source: Based on Central Pollution Control Board specifications (CPCB, 1999)

Table 5

Aligarh City: Emission of Vehicular Pollutants on Important Roads

Pollutants	Emission	G.T. Road	Agra Road	Mathura Road	Anupshahar Road	Ramghat Road	Khair Road	Total Roads
Sulphur Dioxide (SO_2)	gm/hour	56.72	50.61	38.83	38.79	53	19.1	257.06
	gm/day	**1361.28**	**1214.76**	**932**	**931.07**	**1272**	**458.4**	**6169.51**
Nitrogen Dioxide (NO_2)	gm/hour	709.13	610.44	484.50	491.48	636.26	244.18	3176
	gm/day	**17149.44**	**14650.62**	**17019.14**	**11795.70**	**15270.24**	**5859.91**	**81745.05**
Particulate Matter (PM)	gm/hour	173.54	153.57	105.66	89.61	158.16	59.85	740.41
	gm/day	**4165.17**	**3685.74**	**2535.93**	**2487.49**	**3795.95**	**1436.63**	**18106.92**
Hydro-Carbons (HC)	gm/hour	1918.30	1746.70	848.52	825.30	1108.71	708.49	7156.02
	gm/day	**47097.60**	**41920.80**	**20364.48**	**19807.20**	**26609.18**	**17003.56**	**172802.82**
Carbon Monoxide (CO)	gm/hour	3522.8	3759.25	1953.5	1931.56	2867.93	1724.93	15759.97
	gm/day	**84547.2**	**90222.00**	**46884.00**	**46357.44**	**68830.30**	**41398.32**	**378239.26**

Source: Based on table 1 and 4

Note: Data obtained during the survey have been converted into gm/hour and gm/day with the help of standard conversion table (CPCB, 1999, Table 4).

important roads of Aligarh city receive an average of 378,239.26 gm of CO daily (Table 5, Fig.7 and 8). The emission level of CO is higher from two wheelers, three wheelers (petrol driven auto- rickshaw) and older models of cars and jeeps. These vehicles are the most important and most commonly used. Among the important roads, Agra road receives highest emission of CO; it receives an average of 90,222.00 gm/day followed by G.T road (84,547.2 gm/day), Ramghat road (68830.3 gm/day), Mathura road (46,884.00 gm/day), Anupshahar road (46,357.44 gm/day) and Khair road (41,398.32 gm/day).

Hydrocarbon (HC) : Hydrocarbon emissions, derived from fuel evaporation as well as incomplete combustion has a detectable odour and contain carcinogenic compounds. The emission level of HC is higher from two stroke engine operated two wheelers, three wheelers (petrol driven auto- rickshaw) and older models of cars and jeeps. The important roads of Aligarh city receive an average emission of 172,802.78 gm of HC daily (Table5, Fig. 7 and 9). Among the important roads, G.T. road receives highest emission of HCs (it receives an average of 47,097.6 gm/day) followed by Agra road (41,920.80 gm/day), Ramghat road (26609.18 gm/day), Mathura road (20364.48 gm/day), Anupshahar road (19,807.2 gm/day) and Khair road (17003.56 gm/day).

Particulate matter (PM) : Particulates are derived from incomplete fuel combustion, excessive combustion of lubricating oil especially from diesel and worn or badly adjusted engines. The emission level of PM is higher from heavier diesel operated vehicles. The important roads of Aligarh city receive an average of 18,106.92 gm of PM daily (Table 5, Fig.7 and 8). Among the important roads, G.T. road receives highest emission of PM because higher number of heavy vehicles ply on this road. It receives an average of 4,165.17 gm/day followed by Ramghat road (3795.95 gm/day),

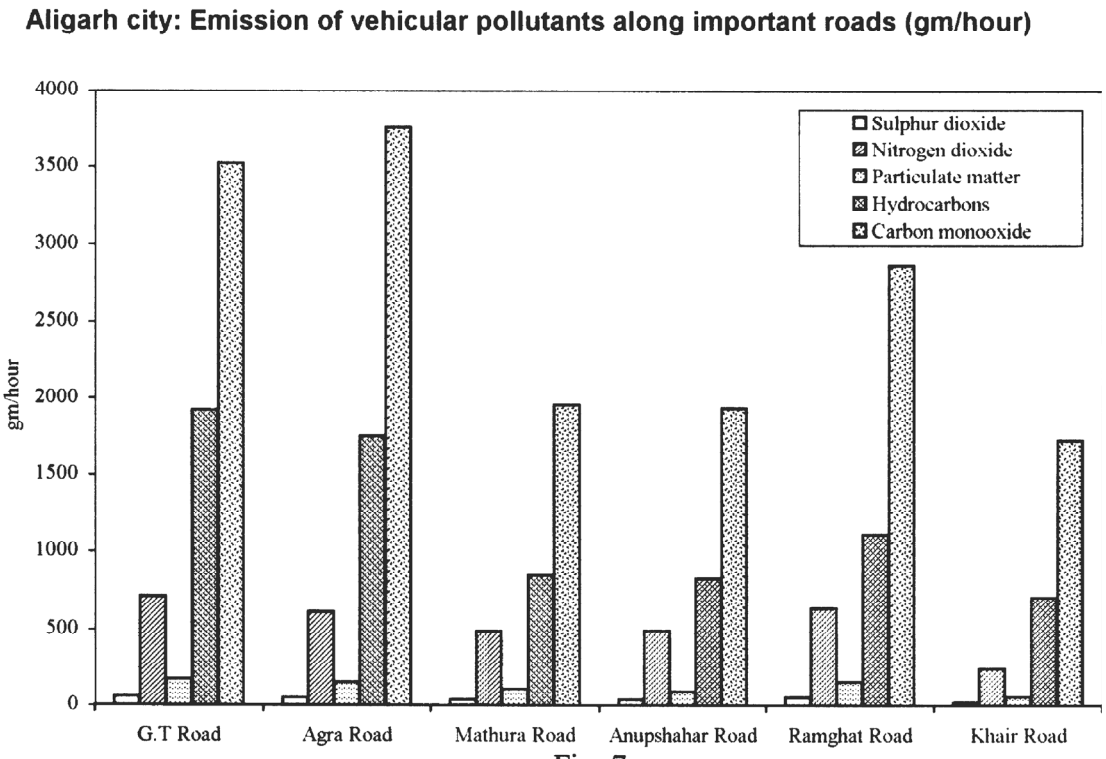
Aligarh city: Emission of vehicular pollutants along important roads (gm/hour)
gm/hour
4000
3500
3000
2500
2000
1500
1000
500
0
Sulphur dioxide
Nitrogen dioxide
Particulate matter
Hydrocarbons
Carbon monooxide
G.T Road
Agra Road
Mathura Road
Anupshahar Road
Ramghat Road
Khair Road

Fig. 7

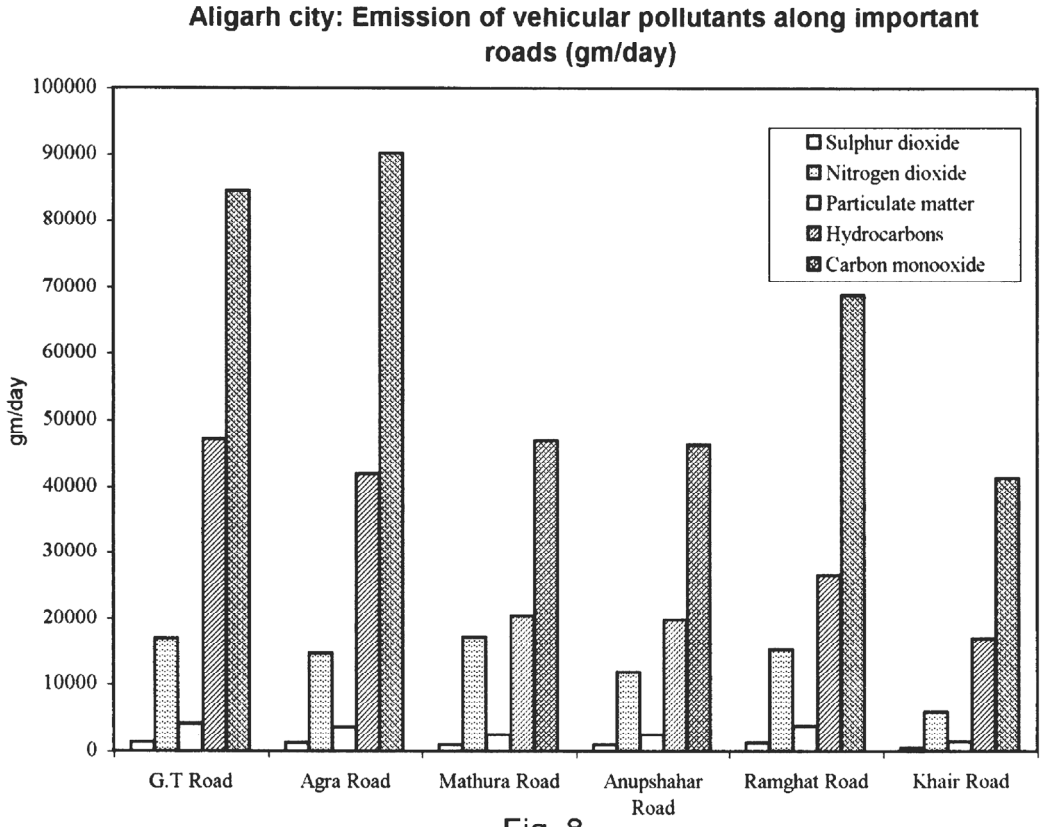
Aligarh city: Emission of vehicular pollutants along important roads (gm/day)
gm/day
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Sulphur dioxide
Nitrogen dioxide
Particulate matter
Hydrocarbons
Carbon monooxide
G.T Road
Agra Road
Mathura Road
Anupshahar Road
Ramghat Road
Khair Road

Fig. 8

Agra road (3,685.74 gm/day), Mathura road (2,535.93 gm/day), Anupshahar road (2,487.49 gm/day) and Khair road (1,436.63 gm/day).

Sulphur dioxide (SO_2) : Ambient concentration of SO_2, a potent respiratory irritant, originates largely from using fuel with high sulphur contents. Heavy vehicles have higher emission level of SO_2 and the main roads of Aligarh city receive an average of 6,169.51 gm of SO2 daily from vehicular emissions alone (Table 5, Fig. 7 and 8). Among the important roads, G.T. road receives the highest emission of SO2, (1,361.28 gm/day) followed by Ramghat road (1,272 gm/day), Agra road (1,214.76 gm/day), Mathura road (932 gm/day), Anupshahar road (931.07 gm/day) and Khair road (458.4 gm/day).

Nitrogen dioxide (NO_2) : Transport is the principal contributor to NO_2 pollution in urban areas. The formation of typical brown photochemical smog by NO_2 is also the result of poor condition of vehicles with higher emission levels. Heavy vehicles again have higher emission level of NO_2. Aligarh city receives an average of 81,745.05 gm of NO_2 daily from vehicular emissions alone (Table5, Fig. 7 and 8). Among the important roads, G.T. road receives the highest emission of NO_2 (17,149.44 gm/day) followed by Mathura road (17,019.14 gm/day), Ramghat road (15,270.24 gm/day), Agra road (14,650.62 gm/day) Anupshahar road (11,795.7 gm/day) and Khair road (5,859.91 gm/day).

Conclusion

The study shows that Aligarh city is growing very fast due to rapid growth of population. The city is experiencing a large scale land transformation as the built up area has expanded by encroaching upon the agricultural land. But the urbanization process in Aligarh city is characterized by lack of planning and co-ordination among various government authorities for developing infrastructure facilities, which are under severe stress from mounting pressure of population. The overall spatial organization in Aligarh city represents indigenous characteristics, which stem from indigenous living conditions and the indigenous ways of adaptation with them. The road transport is the most important mode of transport in the city but it is in very bad shape.

The study leads to the following conclusions:

- The road traffic in Aligarh city is characterized by heterogeneity of vehicles. It ranges from two-stroke petrol driven two and three wheeler, petrol driven four-wheeler, diesel operated LHV and HV to man driven bicycle and rickshaw and animal driven carts.
- There was high degree of temporal variation in the volume of traffic. During day time it was recorded as very high while at night it was negligible.
- The dependence on non-motorized vehicles was higher than on motorized vehicles. This was the root cause of traffic congestion on roads because these NMV's have higher turning radius and lower speed particularly, in case of animal driven carts.
- Traffic congestion is directly related to emission levels both in spatial and temporal terms.

Suggestions

In the prevalent socio – economic environment, the road-based transport will continue to remain the only mode of transport for movement of passengers and freight. The improvements in income level, inadequate provision of public transport services and unconstrained expansion of urban limits have given rise to the number of private vehicles in the city. This rise of individual transport system

has also led to high emission level of pollutants from vehicular traffic. In view of the foregoing analysis of Aligarh city, following measures are suggested for improvements in road traffic:

- Improvement of traffic regulations and enforcement of traffic rules.
- Separation of slow and fast moving traffic, wherever possible.
- Strengthening efficient public transport system at least along the main arterial roads of the city.
- Congestion on roads can be checked by removing encroachments on pavements and checking parking of vehicles along the roads.
- Level of pollution can be reduced to a considerable extent by checking the plying of old polluting vehicles and curbing fuel adulteration.
- Above all, there is an urgent need to bring about the behavioral change, which should encourage stress on usage efficiency.

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