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Research Paper

Comparative Investigation of Traffic Emission Rates in Konya

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Abstract: This study aims to investigate the air pollutants including NO_X, PM and CO caused by motor vehicles in Konya province. The annual average daily traffic of the motor vehicles on Turkish state highways inside Konya borders considering their types and fuel were used for calculation the annual emission rates of the pollutants between 2010 and 2017. The emission values of each year comparatively evaluated and the effects of personal cars in total were identified. As a result, we found that the total taken pathways length increased by 67.8 % in 2017 according to 2010. Therefore, the increase in the amount of NO_X, CO and PM found as 18.2 %, 66.7% and 32.1% respectively in 2017 according to 2010. Lastly the length of the pathways traveled by personal cars was made %64.18 of the total in 2010 and increases to 68.14% in 2017. We understood from study that most significant vehicles with respect to the contribution in air pollutions are ranked as personal cars and then motor vehicles using diesel fuels. While the vehicles using LPG has a lower effect.

Keywords: *Air Pollution, Traffic Emissions, Pollutant Emissions, Konya*

Introduction

The increase in the population of the world brings the significant challenges of protection our environment and atmosphere from being polluted. In parallel with the increasing of the population demands for energy, industrialization and transportation increase. This increasing together with irregular urbanization and traffic network planning with lack of comfort will courage people to choose personal vehicles in their daily life and put the environment in danger with increasing the pollutants. As the economic growth and urban development of any city depends on transportation it's necessary to understand their negative impacts changing rates as well in order to optimize our traffic network planning.

Pollutants and particulates may be caused by artificial (such as domestic heating, industry, motor vehicles) or natural (forest fire, volcanic events) sources. These pollutants can be lost in the form of precipitation and dilution by exposure to different factors such as rain, wind and photochemical reactions in a certain time from the atmosphere (TAS, 2006).

Konya province which ranks 7th in 81 provinces in terms of population density and Intensive result of rapidly development and industrialization, make Konya to pull immigration from other cities. According to the Turkish Statistical Institute the population of Konya which was 1 835 987 in 2000 reached to 2 205 609 in 2018 with 20.13% growth. Increasing population increases the volume of vehicles on existing roads, open new traffic networks and raises the number of vehicles. Therefore, it's so important to examine the air pollution results from motor vehicles which as one the mean sources of pollution and to take the necessary measures (Tuik, 2018).

Konya city is topographically surrounded by mountains (Taurus and Balkar mountains) which limited the wind formations and air pollution transportation to the other region thus specially in wither months which air pollution increases by domestics as well as other sources we can observe and increase in concentration and pollution of the atmosphere over the city (Fatma & Şükrü, 2018). The average annual temperature of Konya is 11.5C and the average temperature of the winter months (October and March) where the air pollution is high, is 3 C, the temperature in the coldest and the hottest month is -0.2 and 23.2 respectively (TSMS, 2018).

The presence of exogenous gasses in motor vehicles and there effective and direct toxic properties make vehicles more important than other pollutant sources. The amount of fresh air which is inhaling by as normal person daily is 15 m^3. This volume of the air simply can be polluted by a vehicle which does contain emission control system in 10 minutes (Atımtay, 2003)

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The first step of studying and preventing air pollution is to determine the amount of emissions released to atmosphere from different pollutant sources which is called inventory. The inventory of emissions can contribute to the future planning and will provide ideas for decision makers (Casanova, Ariztegui, & Valdes, 2004).

In this study, air pollutants (particular mater-PM, carbon monoxide-CO nitrous oxide-NO_X, and sulfur dioxide-SO_2) of vehicle in Konya province were investigated. The study contains only the main roads within provincial boundaries the sub-roads are not taken into consideration.

Properties and effects of vehicle emissions

Carbon Monoxide (CO)

As a result of burning fuel with lack of oxygen inside the motor cylinder the CO extracts. Due to its high affinity of hemoglobin it causes lack of oxygen when by binding to the hemoglobin. Staying in the environment containing 100 ppm for a long period of time will cause mild headache and environments with 500 ppm and 2000 ppm will cause fainting and loose of consciousness and even death respectively (Kaytakoğlu *et al*, 1995)

Nitrogen Oxides (NOX)

NO, NO_2 and N_2O_2 are all compounds of Nitrogen oxides. Nitrogen oxides are changing in relation with air access coefficient (the mass of air in which fuel burns to the amount of the air for complete combustion) and velocity in which vehicle travels. As the car travel by 90 km/h and air access coefficient is bigger than one the NOX emission increases (Alkaya & Yıldırım, 2000)

NOX combine with the hemoglobin in the blood and then with moisture of lungs product nitric acid, as the concentration of the acid increase in puts the human health in danger (SERT, 2008)

Particular Mater-PM

In the internal combustion engines the carbon molecule in the fuels drop which cannot find enough oxygen for burning results the emission of PM and mostly produced by diesel fuels motor vehicles (Dönmez *et al*., 2009). Although it changes according to the dimensions, concentrations and chemical structures of the particulars, it causes many diseases related to respiratory system and even deaths (Turalıoğlu & Bayraktar, 2003).

Material and Method

In this study three mean pollutant emissions, NOX, CO, and PM sourced from motor vehicles, were figured out by using emission factors.

Emission factors are defined by fuel volume or by mass of fuel called mass-based or task-based. The emission factor unit may determine the burning fuel such as Kg / ton or kg / m3. The unit of emission factors can be classified according to the types of activities. For example, if electricity is generated by a power plant, the emission factor unit is g / MJ. Or, if the distance is taken by a vehicle, the emission factor unit is g / km (Nurrohim & Sakugawa, 2004).

In this study, the factors given in Table 1, which shows the amount of emission in grams per kilogram of fuel depending on vehicle types, are used.

Table 1 Emission Factors (IKONAIR, 2012)

Vehicles	Fuel types	NOX (g/kg)	CO (g/kg)	PM (g/kg)
Car	Petrol	14.5	132	0.037
	LPG	15.5	68	0
	Diesel	11	4.7	1.7
Van/Minibus	Petrol	24	155	0.03
	Diesel	15	11	2.8
Autobus	Diesel	37	8	1.2
Trucks	Petrol	24	155	0.03
	Diesel	37	8	1.2
Others	Petrol	24	155	0.03
	Diesel	15	11	2.8

In the table 2 the amount of the fuel that vehicles burn per kilometer related to their types is given.

Table 2 Fuel Consumption According to Vehicle Types (IKONAIR, 2012)

Vehicles/ fuel type	Petrol(kg/km)	LPG (kg/km)	Diesel (kg/km)
Car	0.07	0.0575	0.06
Van/Minibus	0.1		0.08
Autobus			0.24
Trucks	0.1		0.24
Others	0.04	0.035	0.08

By calculating and multiplying the given values, we can find the emission rate according to the types that a vehicle has passed over a kilometer.
As stated in Table 3, the annual average daily traffic volume through State highways within the boundaries of Konya is obtained from the General Directorate of Highways. In this table, the average daily traffic and the length of travel times are given by type. Using the data, we provide daily and yearly total route lengths of the vehicles on the specified highways.

Table 3 Ankara St. 2017 Annual Average Daily Traffic (KGM, 2017)

Ankara Street Section no	Lenght (KM)	Total (aadt) Veh./day	Car Veh./day	Van/minibus Veh./day	Autobus Veh./day	Truck Veh./day	Others Veh./day
715-01	11	7782	6183	269	70	447	813
715-01	35	7157	5351	502	152	490	663
715-01	15	7649	6018	291	70	448	822
715-02	41	8086	5933	545	161	680	767
715-03	29	9652	7049	617	162	721	1103
715-03	19	11467	8054	440	93	970	1911
715-03	5	32449	26093	2637	256	2053	1411
715-04	31	15085	11633	960	268	1074	1151
715-05	25	6301	4641	476	128	530	526
715-05	6	4641	3227	326	98	462	528

The total annual pathways travel over the highways calculated and given in the table below with respect to the year and types of the vehicles.

Table 4 Total Taken Pathways with Respect to Vehicles Types (Km) (KGM, 2017)

Year/Vehicles	CAR	Van/minibus	Autobus	Truck	Others	Total (Km)
2010	4218174	399875	207953	1105093	641006	6572101
2011	4502718	406670	208243	1019705	836572	6973908
2012	4600635	401117	188827	956673	879743	7026995
2013	4823808	396088	202789	936349	1031343	7390377
2014	5761842	419960	316977	958752	1227574	8685105
2015	6136374	440122	281186	976448	1358739	9192869
2016	6641931	492737	277136	970672	1442029	9824505
2017	7167254	679616	252603	848524	1568976	10516973

By computing the data according to following relation, the quantity of the pollutants released by vehicles annually were figured out.
Emission (g) = highways length (km)* annual average daily traffic*emission factor (g/kg) *fuel burn factor (kg/km)

$$Ei = \sum (\mathrm{L} * \mathrm{V}) * \mathrm{EF} * \mathrm{F} *$$

Where;
E_i: is shows amount of Emission (g),
V: annual average daily traffic,
L: length of the traveled pathway,

EF: emission facto (g/kg),
F: fuel burn factor (kg/km)

Results

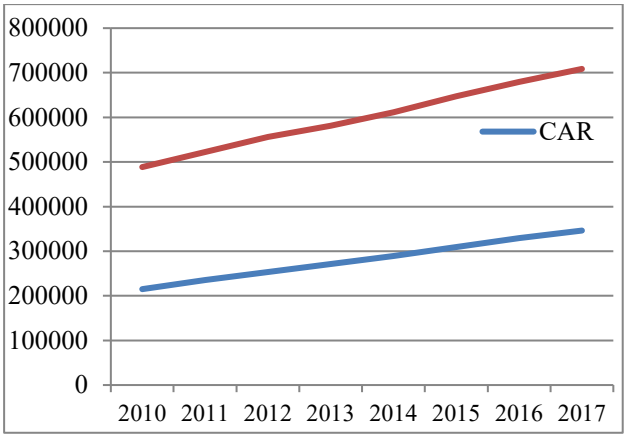

Figure 1. Number of vehicles and personal cars passing through main roads in Konya Province where x axis shows the years and y axis the amount of emissions

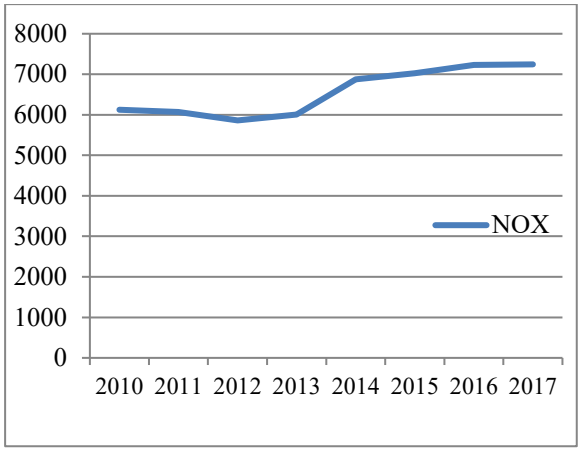

Figure 2. Changes in the amount of NOX pollutant calculated by years where x axis shows the years and y axis the amount of emissions

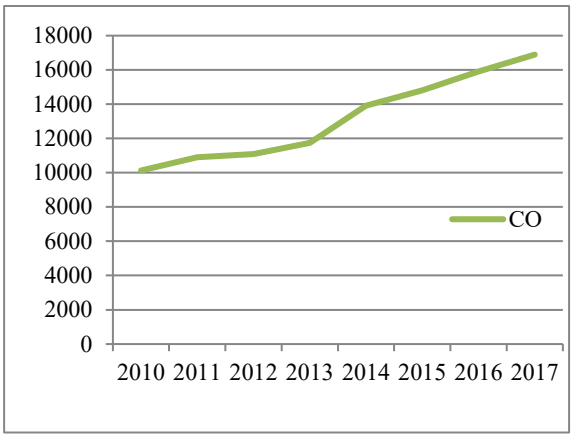

Figure 3 Changes in the amount of CO pollutant calculated by years where x axis shows the years and y axis the amount of emissions

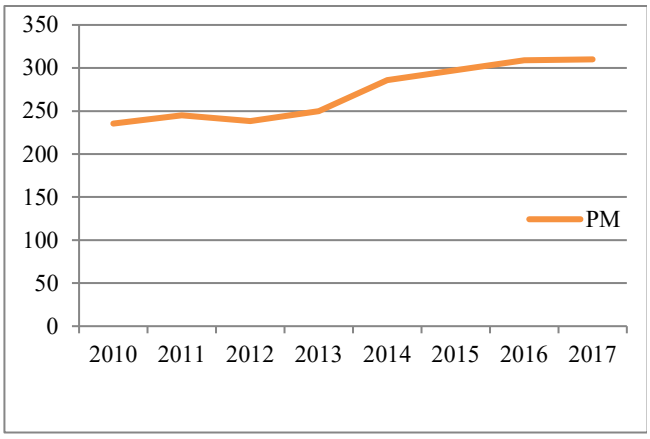

Figure 4 Changes in the amount of PM pollutant calculated by years where x axis shows the years and y axis the amount of emissions

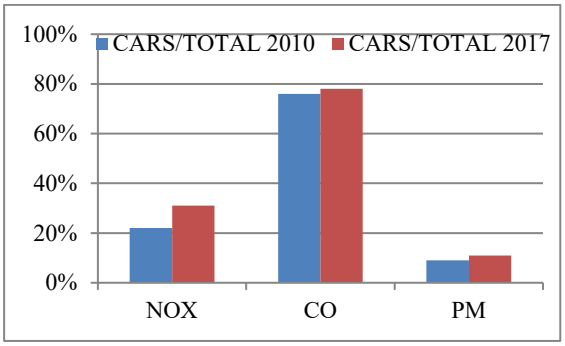

Figure 5 Contribution of the personal car to the total traffic pollutants on main road ways calculated by years where x axis shows the particles and y axis the percentages

Year/ parameters	2010	2017	Changing rates (%)
Vehicles	488,626	708,617	45
Cars	214,970	346,270	61
NOX	6127	7244	18.23
CO	10128	16892	66.7
PM	235	310	32

Table 5 Number of vehicles, amount of emissions in ton and changing rate with respect the years

Conclusions and Discussion

As shown in Figure 1, the total number of motor vehicles was 488,626 in 2010 and 708,617 in 2017 with an increase of 45%. While the total number of personal cars was 214,970 in 2010, it was calculated as 346,270 with an increase of 61 percent in 2017, which is a disproportionate increase.

Figure 2 shows the status and route of NOX from 2010 to 2017. In 2012, the amount of emission was 6127 tons and it decreased by 4.3% to 5861 tons in 2012. In 2014, there was a sharp increase of 14.45% compared to 2013. Confronting to 2010, an increase of 18.23% was observed in 2017 with a rising 1117 tons in the amount of emission.

As shown in Figure 3, the CO showed a sharp change in 2014. It increased from 10128 tons in 2010 to 16892 tons in 2017 with an increase of 66.7%.

The particular matter (PM) showed a sharp increase in 2014 and the total PM change in 2017 was around 32% compared to 2010, which means a total increase of 85 tons.

We figured out that CO is the emission which changes with high rates and NOX is with lowest rates.

The economic growth parallel with increasing of population causes significant raise in the number of personal vehicles which effects air pollution adversely. As shown in the figure 5 the contribution of cars to total amount of emission were 22%, 76% and 9% to NOX, CO and PM respectively in 2010. These percentages increased to 31%, 78% and 11% with respects to the total vehicle's pollutants respectively by 2017.

By changing socio-economic conditions of the urban populations, industrializations and demand for energy consumption as well as tendencies for comfort life will push the pollutant emission releasing rates upper. On account of this it is vital to take some serious decision and put them in action for preventing air pollution and owning a healthy life and sustainable environment. For maintaining this, the following recommendation done for studied area.

- Ensuring that the buses of Konya Metropolitan Municipality pass from diesel to CNG,
- The 11 streets located in the city center should gradually close to the traffic in order to reduce the amount of the measures by decreasing annual daily average traffic volume.
- Refurbishing the existing trams and improving comfort, with the increasing interests to public transports reductions in the number vehicles join to the traffic will be observed,
- Replacement of fuel systems for all minibuses and service vehicles carrying passengers in the city,
- Green wave regulation in order to prevent excessive speed in city center and to provide flow in traffic
- Synchronizing traffic lights to reduce exhaust pollution caused by unnecessary waiting
- The creation of urban traffic control centers for intelligent access systems
- Keeping the prices of all the auto parks in the city centers quite high
- Infrastructure studies for the construction of bicycle paths should be done and bicycle paths have to increase in the city plan depending on urban development.

A good strategy, a good planning and the ability to see the future and to take the necessary measures, therefore, is important for a healthy life, quality and sustainable environment.

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