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Contribution of Smoke-Belching Vehicles to the Green House Gases Concentration in the City of Dipolog, Philippines

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Abstract - Among 212 nations in the world, the Philippines is ranked 48th in terms of carbon emission in the transportation sector. The study sought to determine and estimate the amount of gaseous pollutants emitted by the vehicles in Dipolog City in relation to the overall gaseous pollutants of the Philippines. Results revealed an annual gaseous pollutant contribution of 1,072929.597%V for carbon monoxide and 501,282,073.1 ppm for hydrocarbon emission which, together, roughly explain 6% of the country's overall GHG (Green house gases) output per year. Considering that there are 122 cities in the Philippines, the 6% GHG contribution of Dipolog City is considered well beyond the normal threshold. The study also identified some of the factors leading to this inordinate amount of GHG output of the city, such as, but not limited to: (a) strict implementation of the standards for vehicle emission levels prior to renewal of registration, and (b) strict monitoring and implementation of the anti-smoke belching law or the Clean Air Act (RA 8749).

Keywords - Ecology, emission, hydrocarbon, carbon monoxide, RA 8749, greenhouse gases, psychology, Philippines

INTRODUCTION

On the verge of escalating environmental crises brought by the GHG, countries worldwide through international agreements such as, the UN Convention and the Kyoto Protocol, agreed to reduce GHG emissions all over the world. The Philippines is one of the countries which believes that all countries can, and must, cooperate to address climate change through mitigation by adapting these agreements. In response to the call to mitigate the effects of climate change, RA 8749, known as the Philippine Air Act was passed in 1999.

The law requires emission testing for all cars registered annually. The law aimed to ensure substantial improvement in air quality for the health safety and welfare of the public and pursue a policy of balancing development and environmental protection. It also sets a maximum limits for all major pollutants found in auto exhausts as follows: For light duty vehicles, the CO emission is 2.72 g/km, 0.97g/km for HC & NO and o.14 g/km for PM for compression-ignition engines only. For heavy duty vehicles the exhaust emission limit are 4.5 g/k/Wh for CO, 1.1 g/k/Wh for HC, for NO_x is 8 g/k/Wh and .36 g/k/Wh for PM is allowed. And in the case of 85 kW or less engines, the limit value for particular emissions is increased by multiplying the quoted limit by a coefficient of 1.7. (RA 8749, 1999).

The law further provides that the fuel evaporated emission for spark-ignition engines shall not exceed 2.0 gm hydrocarbons per test and it shall not allow any emission of gases from crankcase ventilation system into the atmosphere.

Dipolog City is a growing city in the south with a population of 131,016, growing at a rate of 2.4% per annum. Vehicular traffic is becoming congested due to the increasing numbers of motor vehicles attendant to the needs of a fast growing urban city. Consequently, the city's air quality over the years had been observed to deteriorate. There is now an urgent need to ascertain just how much the city's vehicular traffic has contributed to air pollution and, subsequently ascertain compliance to the provisions of RA 8749.

OBJECTIVE OF THE STUDY

This study aims to determine the average amount of gaseous pollutants emitted by the transportation sector in Dipolog City which can guide policymakers and environmentalists in their efforts to minimize emission of hazardous gases from motor vehicles.

METHODOLOGY

The study used the descriptive method of research. Second information such as volume of traffic in the three entry points in Dipolog City and types of motor vehicle were gathered from the department of Public Works and Highways while emission test results were obtained from the Land Transportation Office. Date gathered were summarized as to the average volume of motor vehicles per day and motor vehicles were categorized according to utilization and fuel used. Gasoline emission test results only include hydrocarbons (HC) in ppm and carbon monoxide (CO) in percent by volume (%/v) while for diesel emission test was in terms of opacity. Opacity is the degree to which smoke blocks light. It is expressed as the absorption coefficient "k" (1/k). Average amount of HC, CO and opacity per vehicle type was calculated and used to estimate the average emission per day and per year.

Motor Vehicles were classified as follows; motor tricycles (motorcycles and tricycles); passenger Car (multicab and other light public motor vehicles weighing › 1500kg.); passenger utility (public motor vehicles with the average weight ‹1500kg.), goods utility vehicles (those vehicles that transport goods); small bus, large bus; rigid trucks 2 axles; rigid trucks 3+axles; truck semi-trailer 3 & 4 axles; truck semi trailers 5+ axels; and truck trailers 4 axels.

RESULTS AND DISCUSSION

Traffic Volume. As revealed in Table 1, motor-tricycles have the largest volume (1323.55 $\pm$144.94 motor-tricycles per day), followed by the passenger car (660.12$\pm$33.41passenger car/day) and public utility (254.86$\pm$30.77 public utility/day). Motor-tricycles, passenger cars, passenger utility and goods utility are known to use gasoline,

although there were also passenger cars, passenger utility and goods utility which used diesel.

Table 1. Daily average number of motor vehicles running around Dipolog City

Types of Motor vehicle	Daily Average of Motor Vehicle	SD
Motor-Tricycle	1323.547619	144.9392
Passenger Car	660.1190476	33.40793
Passenger Utility	254.8571429	30.76997
Goods Utility	194.9761905	23.2282
Small Bus	54.14285714	3.641871
Large Bus	33.07142857	2.443542
Rigid Trucks 2 axles	173.1428571	23.38792
Rigid Trucks 3+ axles	34.64285714	11.53835
Truck Semi-Trailer 3&4 axles	2.857142857	1`.064706
Truck Semi-Trailer 5+ axles	0.119047619	0.125988
Truck Trailers 4 axles	0	0
Truck Trailers 5+ axles	0.023809524	0.062994
Total	2731.5	242.7633

Greenhouse Gases Emission of Gasoline and Diesel Powered Vehicles. Based on the emission test results (Table 2), the motor-tricycle (n= 45) which is a gasoline fueled vehicle has the highest hydrocarbon emission, HC (844±707.61) and carbon monoxide (1.33±0.796). This is followed by passenger car (HC=262±139.5; CO=0.941±0.726), passenger utility car (HC =167.33±120.12, CO =0.391±0.484) and good utility car (HC=209.2±140.25 CO =0.656±0.688).

For the diesel powered vehicles, opacity was the only parameter available. It refers to the degree to which smoke blocks light. It is expressed as the absorption coefficient "k" (1/m). Nowadays, opacity is the basis for measuring the amount of smoke coming from a diesel-powered vehicle. It should be noted that an engine that smokes is emitting numerous toxic compounds, particulate matter and oxides of nitrogen and sulfur that can adversely affect public health and the environment. As shown in Table 2, a passenger car has an opacity coefficient, 1.201±0.462 k.

Table 2. Average amount of green house gases emitted per vehicle type

Motor Vehicle Type	HC	CO	Opacity
	(ppm)	%	k
A. Gasoline			
Motor-Tricycle	844±707.61	1.33±0.796	-
Passenger car (n=15)	262±139.5	0.941±0.726	-
Passenger Utility	167.33±120.12	0.391±0.484	-
Goods Utility	209.2±140.25	0.656±0.688	-
B.Diesel			
Passenger car	-	-	1.201±0.462
Passenger Utility	-	-	0.68±0.376
Goods Utility	-	-	1.093±0.368
Small Bus	-	-	-
Large Bus	-	-	-
Rigid Trucks 2 axles	-	-	1.114±0.47
Rigid Trucks 3+ axles	-	-	0.812±0.486

Using the emission data obtained, the daily average amount of hydrocarbon, carbon monoxide and other greenhouse gases emitted per vehicle type were calculated. As shown in table 3, the motor-tricycle consistently has the greatest amount of hydrocarbon and carbon monoxide emission per day. With regard to the opacity measure, all diesel vehicles had values below the standard k = 2.5. Table 3 also presents the daily average and annual amount of CO and HC emitted by the motor vehicle in Dipolog City. The type of motor vehicle that contributes more CO and HC is the Motor-Tricycle with the daily average gas contribution of 1760.318333 %V and 1117074.19ppm, followed by the Public Cars and Public Utility. The total daily amount of CO of the gasoline fueled vehicles in Dipolog City is 2939.533143% and the total HC is 1373375.543 ppm.

Table 3. Average annual amount of CO and HC emitted by the motor vehicles

Types of Motor Vehicle	Average of CO	Average of HC	Average Daily Vehicle	Total Daily Amount of CO	Total Daily Amount of HC	Estimated Total Annual Amount of CO	Estimated Total Annual Amount of HC
MT	1.33	844	1323.55	$1.76X10^{10}$	1117074.19	$6.42X10^{12}$	407732079.5
PC	1.201	262	660.12	$1.24X10^{10}$	172951.1905	$4.54X10^{12}$	63127184.52
PU	0.68	167	254.86	$5.8X10^{9}$	42561.14286	$1.88X10^{12}$	15534817.14
GU	1.093	209.2	194.98	$8.68X10^{9}$	40789.01905	$3.17X10^{12}$	14887991.95
TOTAL				$4.4X10^{10}$	1373375.543	$1.60X10^{13}$	501282073.1

The preponderance of motorized tricycles in the city of Dipolog contributes largely to the GHG noted. However, for a city of this size, motorized tricycles should have been limited to small arterial roads with limited distance and should be banned from plying along main city roads (RA 8749). A reduction in the number of motorized tricycles in the City of Dipolog can contribute significantly to a reduced GHG emission for the city 1.76/4.6 =40% reduction.

A comparison with the estimated value of carbon monoxide contributed or emitted by the motor vehicle in Dipolog City ($1.60x10^{13}$ ppb per year) showed that it is greater than the monthly tropospheric carbon monoxide reading by the NASA Terra Satellite (April 2010). It should be noted that the estimate was based on the actual results of car emission test, hence the greater values. Moreover, CO when released to the atmosphere is eventually oxidized to carbon dioxide through natural processes and concentration is both short-lived in the atmosphere and spatially variable which explain the great difference between the annual CO in concentration (actual emission test result) and tropospheric CO concentration. However, this estimate can be grossly understated.

Older vehicles tend to be less efficient than the newer ones. We conjecture that this could be one reason for the inordinate amount of gaseous pollutants noted in the city. However, when we tested for statistical significance of the difference between the CO emissions of older and newer vehicles we found a minimal mean difference of

0.8026 resulting in a t-value of t=0.716 (p>.05). What this implies is that as per records, no statistical evidence exists to show that older vehicles are less efficient than newer ones. However, this is certainly contrary to scientific results, and so, we deduce that this is probably due to a serious under reporting of the carbon emissions for older vehicles (either intentionally or nonintentionally).

The City of Dipolog should be contributing less than 1% of the country's GHG output annually, but our results indicated that it is in fact contributing 600 times more (6%). Of course, Metro Manila contributes 20% GHG but this can be easily explained by the shown volume of traffic in this area. In Dipolog we established that the CO emissions are mainly attributed to the motorized tricycles plying the city roads.

Policy Implications

Analysis of the fuel-burning emissions of vehicles in the City of Dipolog show that, under grossly understated data, the city contributes at least 6% of the country's total emission. This can be considered high (and even higher if data were correctly stated by the testing centers).

These results have far-reaching implications on the implementation of RA 8749 or the Clean Air Act of 1997:

The mechanism of implementation of RA 8749, particularly at the Emission Testing Centers to be reviewed and zealously guarded. In particular there are implications to the accreditation process adopted by the LTO for these testing centers.

Since it has been established that older vehicles tend to be quite inefficient in terms of complete combustion, there is a need to define which vehicles should be allowed to register in the Philippines in mores advanced countries, for instance, vehicles that are more than five (5) years old are automatically phased out (Japan, Land Transport Ministry, 2005).

Importation policies for vehicle surpluses should similarly be reviewed in particular, tax penalties for buying surplus vehicles can be set higher in order to discourage local consumers from patronizing the products.

CONCLUSION

The City of Dipolog, Philippines contributes a significant portion to the country's annual CO emission, and inordinately so (>6%). Such a huge annual CO emission can be attributed to the main factors that obtain in the city: (a.) presence of fuel inefficient motorized tricycles which constitute the bulk of public transport in the city, and (b.) huge number of older vehicle types which are also inefficient in burning fuel. Serious under reporting of the CO emissions of older vehicle types lead to the conclusion that the implementation of RA 8749 or the Clean Air Act leaves much to be desired in the city.

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