# Estimation of emissions from transport sector of Azerbaijan.

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**Abstract.**

İn this work, the author present a mathematical model of COPERT-4 capable of estimate emissions of CO2, NOx and PM based on statistical data at the country level. The under lying methodology has been based on IPCC/CORINAIR air pollutant emissions inventory guidebook. The key results of the study show that calculating vehicles emission using the COPERT-4 methodology can improve the estimation methods and could help to find out the pollution level, the chemical content of pollutants and define the ways for reduce the pollution level in country especially in the cities as Baku,Sumgait where the pollution level is very higher. The amount of harmful emissions, such as (CO, CO2, NOx, SOx) have been calculated by using of the COPERT-4 programme according to the EU Environmental Directives.

Key words: Air pollution, $CO_2$ emissions, air quality, road transport, vehicle emissions, COPERT-4, fuel combustion, road traffic monitoring, fuel consumption, NOx emissions.

## Introduction

According to resarches, world transport system consumes 30% of energy, while load transportation (cars, railways, airways, sea transport and pipelines) and it takes significant place in worsening air quality. Thus, 30% of $NO_x$ and CO emissions, around 70% of PM 2.5, PM 10 and 85% of non-volatile (NMVOC) (European Environment Agent, 2010) [3], emissions comes from transport sector. Technical condition and volume of engine, fuel quality, air temperature, road infrastructure and etc. are main causes of emission. Actually, it is not possible to measure amount of emissions by devices. Therefore, emissions are calculated by using fuel consumption. This method still new for this region because all the calculations had been implemented by applying old Soviet methods. Within COPERT-4 software emissions are assessed by different regimes of engine: different driving regimes and speeds, road infrastructure. Generally, in every years the number of cars increases by 50 mln and according to official statistics in 2014, there are 1.2 bln cars in the world. This is the main cause of worsening air quality[2].

There are 1.291 mln cars in Azerbaijan and it increases 50-80 thousand (6-8%) in every year. The main part of fuel especially gasoline is consumed by transport sector. According to the 2014 statistics 1.36 mln ton gasoline, 897 thousand ton diesel and 23.1 thousand ton LPG have been consumed. Furthermore, refining plants in Azerbaijan unable to provide all volume of gasoline and therefore 193 thousand ton fuel was imported from other countries. Increase in fuel consumption is the main cause of growth in emissions [1]. Although, some measurements has been taken, there is not any improvement at that sector. This article explains calculation of car emissions by applying COPERT-4 software. As a result of above mentioned calculation actual car wastes has been determined and solutions has been suggested to reduce amount of emissions.

COPERT-4 is numerical device and has been improved by European Environmental Agent and combined with scientific basics by Joint Research center. COPERT-4 allows us to calculate transport emissions on the base of inventory of transport emissions including EMEP/EEA basics. This allows us to calculate car wastes from passenger transport, light and heavy trucks, buses, motorcycles (( CO, $NO_x$, VOCs, PM, $NH_3$, $SO_2$, heavy metal) and greenhause gases ($CO_2$, $N_2O$, $CH_4$)). In this method emission has been calculated by taking average annual driving distance, high-average speed, movement at city roads, movement at highways and country roads, type of cars, volume of engine and etc. into consideration[3,4].

COPERT-4 software is used modeling (Atmospheric Emission Inventory Guidebook (AEIG)) main transport emissions by EMEP/CORINAR and it is COPERT-4 introduced by evaluating emissions and inventarization of transport system[3]. This Program has great allowance to calculate emissions in three condition. These conditions are starting in cold condition of engine, stable hot condition and fuel evaporation. According to the modelling general sum of emissions depends on number of cars, average speed and etc. COPERT 4 program calculates emission by applying standards about technical condition and production date[5].

COPERT-4 method evaluation has been implemented by applying macroscopic approach. Therefore, calculation cover all aspects of research. This approach mainly is used for national inventory, which covers large scientific site by applying car types and average speeds. As a result, this approach is popular and we will not consider details of macroscopic method in this article. We will use COPERT-4 program as a part of above-mentioned method, which form is square, in high and low speeds in order to calculate emissions. We will take reference from Ntziachristos (2009) to apply method properly and explain emissions. Although, COPERT-4 software is Square it is possible to calculate little increase in emissions when speed goes down. In contrast to the method used in national calculation, COPERT-4 evaluates larger scope of emissions (CO, NO, SO, hydrocarbons, solid substances, PM and etc.). The main purpose of evaluating with this method, there is large possibility to calculate emissions by applying special coefficients, geographical condition and driving time, as well as volume of engines and technology. Fuel parameters, which is given by SOCAR, has been taken into account in order to calculate Sulfur di-oxide. All categories of modern technology that are installed to vehicles includes to COPERT-4 method[5,6].

Table 1. Average coefficient of annual emission unit

| Fuel | Emission | Annual Average coefficient |
|---|---|---|
| Gasoline | CO | 1.42 |
| | NOx | 1.02 |
| | VOC | 1.3 |
| | PM | 1.23 |
| | Fuel | 1.10 |
| Diesel | CO | 1.15 |
| | NOx | 1.04 |
| | VOC | 1.29 |
| | PM | 1.26 |
| | FUEL | 1.07 |

There is 3 main evaporation condition:

1) Daily wastes;
2) When the engine switched off;
3) Wastes while movement;

**Daily wastes:**

Evaporation process happens in the fuel tank of vehicle and depends on external temperature changes Lack of temperature balancing systems that results disposing emissions to environment. Especially, at night when temperature downs, cold air includes to the fuel tank. This condition creates layer over the fuel and increases evaporation speed.

**Emissions while driving:**

There is vapor during driving car. If temperature is high, losses increases significantly. Amount of emissions are very important while driving and stopping regimes[6,9].

Table 2: Evoparation of volatile organic combinations from injection system.( qr/day) and qr/km)

| | | Annual average |
|---|---|---|
| Evaporation as a result of temperature difference | Qr/(Day.car.) | 2.96 |
| Evaporation after movement | Qr/(day.car.) | 24.9 |
| Evoporation while driving | Qr/car.km | 0.083 |

**Emission at different regimes**.

Car wastes mainly depends on operational condition of engine. Volume of emissions change at different driving and motor regimes. Therefore, schedule is divided into several sections; urban, rural and highways.

Table 3. Results of transport wastes calculated by COPERT-4

| No. | Name of Emission | City roads (thousand ton) | Rural roads (thousand ton) | Highways (thousand ton) | Total Sum (thousand ton) |
|---|---|---|---|---|---|
| 1 | Carbon monoxide-CO | 183.21 | 119.9 | 105.01 | 408.12 |
| 2 | Volatile organic combinations (VOC),wastes | 21.99 | 12.3 | 11.16 | 44.57 |
| 3 | Non-methane organic combination wastes | 10.7 | 11.78 | 19.74 | 42.51 |
| 4 | Nitrogen oxide, NOx | 34.29 | 20.58 | 14.05 | 68.9 |
| 5 | Nitrogen Oxide, NO | 32.48 | 19.4 | 13.218 | 65.101 |
| 6 | Nitrogen-2 Oxide (NO2) | 3.81 | 1.16 | 0.83 | 3.81 |
| 7 | N2O | 0.089 | 0.061 | 0.11 | 0.256 |
| 8 | PM 2.5 | 0.321 | 0.282 | 0.245 | 0.849 |
| 9 | PM 10 | 0.335 | 0.381 | 0.382 | 1.099 |
| 10 | PM exhaust | 0.149 | 0.168 | 0.227 | 0.544 |
| 11 | Other wastes (Methane | 1.047 | 1.05 | 1.682 | 3.78 |

| | | | | | |
|---|---|---|---|---|---|
| | CH4,NH3,EC,OM,SO2) | | | | |
| 12 | Total Sum | 288.421 | 187.062 | 166.654 | 642.018 |

According to the calculation of carbon monoxide 408.12 thousand tons, nitrogen oxides, NOx -138.012 tones, PM(particulate matter) -2,48 million tone of emissions of volatile organic (VOC), 86,78 thousand tons. In addition, and evaluated as the other waste ($NH_3$-ammonia, methane $CH_4$, and $SO_2$ ,OM).

Diagram 1. The volume of CO emissions in urban, rural and high ways.

Diagram 2: The volume of volatile and non-volatile organic combination, Nitrogen oxide, PM emissions and etc. have shown below.

In this diagram shows the emission such as VOC, NOx and PM besides emission of CO and $CO_2$. Also in this diagram shows all the NOx emissions such as NO and $N_2O$. The amount of NOx –emission- 68,9 thousand ton, $NO_2$—65,1 min thousand ton, NO and $N_2O$.

**Summary and Conclusions.**

As a result of this study the amount of harmful emissions, such as (CO, $CO_2$, $NO_x$, $SO_x$) have been calculated by using of the COPERT-4 programme according to the EU Environmental Directives. The methodology proposed in this work is able to start from certification data to define modal emission rates of fuel consumption and $NO_x$ emission according to COPERT-4 software. This data and methodology can be further used in any other driving cycle, using the correspondent vehicle time distribution, to estimate fuel use and emission outcome in a given vehicle ore fleet of vehicles.

The official method of calculation does not apply to wide range of parameters and does not account for a lot of parameters that determines the volume of emissions. Using this program we can determine the amount of fuel consumption and prepare forecasts for the future. The issue volume defines more precisely by means of this program, and it is easier to identify measures to reduce emissions.

Focusing on emissions of air pollutants from motor vehicles for the calculation of the above-mentioned programs, including all the necessary information has been researched and presented. By using this software, you can determine the amount of greenhouse gases (GHG) and will prepare a policy on climate change. Using the opportunities of the program for determining emissions from cars can make an inventory of the sources and ways of reducing emissions, especially in cities such as Baku and Sumgait within a few years.

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