The Effect of Gasoline-fueled Vehicle Emissions on Air Pollution in Addis Ababa, Ethiopia: Baseline Study

This study was performed by Vehicular-Smogless Air for Ethiopia (V—SAFE) in collaboration with the Addis Ababa Environmental Protection Authority (AAEPA)

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1 Executive Summary

This study evaluates the contribution of vehicular exhaust gas emissions to the ever-worsening ambient air pollution of the city of Addis Ababa. It was a joint effort between the Addis Ababa Environmental Protection Authority (AAEPA) and Vehicular-Smogless Air for Ethiopia (V-SAFE). The two major data collection tasks performed were:

1) to measure the ambient concentrations of hydrocarbons (HC), carbon monoxide (CO) and particulate matter (PM) at two sites for five days and
2) to perform visual and tailpipe tests on randomly selected in-use vehicles at roadside inspection stations. This part of the study was done for ten days at nineteen strategically selected sites. The duration of the study was from March 12 to March 25, 2011.

The two ambient sites selected for the current studies were Kera (Gofa Mazoria) and Urael. These sites were chosen because they were part of a 2007 and 2008 study (A Kume, 2010) that examined Addis Ababa's ambient air CO pollution. Kera (Gofa Mazoria) has high vehicle traffic volume and Urael is known for traffic congestion (Teju, 2005). This study attempted to determine if there were any significant changes since then; indeed, at both sites the pollution had gotten measurably worse. Additionally, the ambient HC, CO and PM concentration levels were found to be much higher than the USA standards. In particular, the ambient 3-hour average HC concentration levels for all test days at both test locations were approximately between eight to fifty-eight times higher than the USA 3-hour standard (New York, 1977).

The ambient CO concentration levels for all test days at both locations differed from each other. At Kera site, the 1-hour averages for all test days were approximately three times higher than the USA 1-hour standard. At the Urael site, however, the 1-hour averages for Wednesday and Friday were about four times higher than the USA 1-hour standard, but on Monday, Tuesday and Thursday it was about two times higher than USA 1-hour standard. This is probably because the quantity and density of Kera's traffic were relatively constant, while that of Urael varied widely from day to day. The daily ambient PM 6-hour average concentration levels for all test days at both locations were between four to thirteen times higher than the comparable USA 6-hour PM average readings (USEPA data, 2012).

The roadside inspections were conducted on 781 randomly selected vehicles. The median age of the sampled vehicles was 17 years. Most observed vehicles in the Addis Ababa fleet were taxis, but they were under-represented in the sample of tested vehicles because few of the drivers were willing to stop and get their vehicles tested.

The findings indicated that most of the tested vehicles were equipped with the factory-supplied emissions control devices, regardless of whether or not they were functioning. In addition, the roadside testing did not detect any use of leaded gasoline.

The overall weighted average vehicle tailpipe HC and CO emissions were 876 ppm and 4.6%, respectively, which is almost equal to the maximum allowable standards for the oldest vehicles (1966-1967) in the California BAR-90 Smog Check program (700 ppm and 5.5 % for idle and 600 ppm and 4.5 % for 2500 rpm) (California BAR, 1996).

Roughly, 50% of the Addis Ababa vehicles tested produced about 90% of the HC and CO emissions.

The HC & CO emission rates within the model-year groups measured in Addis are approximately 10 times greater than those from similar model-year groups measured in the California Smog Check program.

The volumetric HC and CO results (ppm and percent) of Addis Ababa's roadside data were converted to mass results as grams per mile using the techniques developed by the Eastern Research Group, Inc. for the State of California (DeFries, May 10, 2001). The techniques were specifically developed to estimate IM240[1] and FTP[2] mass emission rates from Two-Speed Idle (TSI) emission concentrations, which is the testing method used in the Addis roadside testing.

The Addis Ababa fleet of roughly 275,500 vehicles is adding between 25,000 and 32,000 tons of hydrocarbons per year and 49,000 to 58,000 tons per year of carbon monoxide to the city's air. This does not take into account evaporative hydrocarbon emissions caused by vapor leaks from most fuel tanks and fuel lines, nor does it account for truck and other diesel emissions.

These are serious quantities of pollutants, which are causing health problems and environmental problems.

In comparison, the State of Vermont (USA), which has a fleet of roughly 760,000 vehicles, is adding about 3,300 tons of hydrocarbons and 39,000 tons of carbon monoxide per year to its air (Vermont, 2010).

Further examination shows that, while Addis Ababa's fleet of taxis is less than 15% of the vehicle population, it contributes almost one-half of the fleet's hydrocarbon emissions and more than 27% of the fleet's carbon monoxide emissions.

This study confirms that exhaust gases from vehicles pollute Addis Ababa's air, and that improperly maintained vehicles contribute significantly to this pollution. The health effects of Ethiopia's urban air pollution are a strong contributor to its people's average life expectancy of only 56.19 years (Factbook, 2011) (Brunekreef, 1997, pp. 54: 781-784)' (Arden Pope, 2009) (Krewski, January 22, 2009).