

**ASSESSMENT OF LEVELS OF URBAN AIR POLLUTANTS AND
TRACE ELEMENTS IN ROADSIDE SOILS; A CASE STUDY IN
EASTLEIGH AREA, NAIROBI.**

BY

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DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other University.



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Abstract

In this study, the assessment of five most common air pollutants from vehicular emissions were done along Juja road in Eastleigh area, Nairobi. Sampling was done for soil samples, particulate matter (PM₁₀), sulfur dioxide (SO₂), carbon monoxide (CO), nitric oxide (NO) and nitrogen dioxide (NO₂).

Sampling for PM₁₀ and soil samples was done during dry and rainy season, while sampling for SO₂, CO, NO and NO₂ was done during the dry season. Rainy season sampling was done during the month of April 2005, while sampling for dry season was done from November 2005 to January 2006.

Gases and PM₁₀ sampling was done in 3 places along Juja road (described as Area 1, 2 and 3). Area 1 was at St. Theresa Catholic Church, which is near Eastleigh Avenue 1 and Juja road junction. Sampling Area 2 was at Radiant hospital near Pangani roundabout, while Area 3 was near Huruma Chief's office, near Mathare North road and Juja road junction.

Sampling for SO₂, NO₂, NO and CO pollutants was done using Z-1300XP, Z-1400XP, Z-700XP and Z-500XP monitors respectively, and "Gent" stack filter unit (SFU) was used for PM₁₀ sampling. In area 1, the sampling was done for 5 days while in area 2 and 3 it was done for 4 days. The measurements were taken for 8 hours (from 9.30 am to 5.30 pm). This was repeated for PM₁₀ during rainy season and a total of 55 samples were collected and analyzed using EDXRF for elemental content. Vehicle tallying was done in area 1 and 3, for 8 hours on Fridays while sampling for the gases.

Soil samples were collected at an interval of approximately 250 meters along Juja road. And at point 4 other samples were collected in consecutive places (about 20 meters apart) away from the road. Top surface soil sample weighing 0.5 to 1 kg (0-2 cm), was scooped out within 1 meter from the road kerb. A total of 50 soil samples were collected in both dry and rainy season.

The soil samples were analyzed in triplicate, and the mean obtained. Association between air pollutants levels and the vehicle density was assessed by performing a simple correlation analysis. ANOVA was used to indicate any statistical differences in concentration levels for different pollutants at $P \leq 0.05$.

The results showed that the PM₁₀ was high during dry season sampling with an average of 441±116 µg/m³ corresponding to an average of 393±102 µg/m³ for coarse particles and 48±45 µg/m³ for the fine particles. While the result for rainy season sampling showed an average PM₁₀ of 427±105 µg/m³ corresponding to 404±102 µg/m³ and 24±14 µg/m³ average levels for coarse and fine particles respectively. The daily range for PM₁₀ variation was between 233 and 621 µg/m³; a value that exceeds the WHO permitted level of a daily average of 150-230 µg/m³.

In coarse particles, the elements average concentration in aerosols during dry season sampling (in µg/m³) was observed to be 1.48±0.99 for Mn; 13.29±5.67 for Fe; 0.02±0.02 for Cu; 0.15±0.05 for Zn; 0.07±0.03 for Br; 0.14±0.06 for Zr; 0.03±0.01 for Nb; and 0.2±0.08 for Pb. While during rainy season sampling, it was observed to be 1.87±0.92 for Mn; 17.0±7.96 for Fe; 0.01±0.01 for Cu; 0.17±0.08 for Zn; 0.04±0.01 for Br; 0.18±0.09 for Zr; 0.04±0.02 for Nb; and 0.13±0.05 for Pb. Bromine and lead in aerosols showed a correlation of $r^2=0.843$ and $r^2=0.898$ during rainy and dry season sampling respectively. The lead level in ambient air was observed to be within WHO permitted guideline of 0.5-1 µg/m³.

The average concentration for CO in area 1, 2 and 3 was observed to be 5.7, 3.9 and 2.5 mg/m³ respectively and for SO₂ was 4.9, 37.1 and 119.4 µg/m³ in area 1, 2 and 3 respectively. The average level for NO in area 1, 2 and 3 was observed to be 5.2, 1.8 and 1.1 mg/m³ respectively, while 118.0, 24.0 and 47.3 µg/m³ was the average for NO₂ in area 1, 2 and 3 respectively. The daily range for gases during the sampling period was; CO, 2.1 - 6.6 mg/m³; SO₂, 0.2 - 476.5 µg/m³; NO, 0.4 - 7.3 mg/m³; and NO₂, 0.1 - 245.5 µg/m³.

The daily average level of gases was found to be within WHO daily limit of 10 mg/m³ for CO and NO, and 150 µg/m³ for NO₂ and SO₂. Fridays were the days that low pollutants level were observed followed by Saturdays (except for the case of SO₂), while from Tuesday to Thursday, there were high concentration levels.

The traffic density was observed to be low between noon and 3:00 pm, and then increased gradually thereafter. The public vehicles, consisting of Matatu's (36-sitter) and Nissan's (14-sitter), were the majority on the road and contributed to 56% and 63% in

area 1 and 3 respectively. Nitrogen dioxide showed a correlation of $r^2=0.59$ with the traffic density.

In this study, the range of elements in soil during dry season sampling was found to be; Pb, 87.4-242.4 $\mu\text{g/g}$; Br, 2.1-20.9 $\mu\text{g/g}$; Zn, 70.0-648.0 $\mu\text{g/g}$; Fe, 72.4-133.0 mg/g ; and Mn, 4.2-14.9 mg/g . During the rainy season, the range was; Pb, 41.1-177.9 $\mu\text{g/g}$; Br, 0.5-13.6 $\mu\text{g/g}$; Zn, 70.1-1187.0 $\mu\text{g/g}$; Fe, 16.4-168.2 mg/g ; and Mn, 1.4-17.1 mg/g . The level of lead and bromine was seen to decrease gradually with increasing distance from the road.

Most of pollutants levels especially gases and trace element in soil and aerosols were found to be within WHO permitted guidelines. But the results of PM_{10} levels were shown to exceed the WHO guideline, which could pose possible adverse health effects to the Eastleigh residents.