Current status of urban air quality in Eastern Africa

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Introduction

- Air quality indoors and outside the home
- Analytical quality parameters used in assessment of air quality are:
  - Particulate matter
  - Carbon monoxide
  - Nitrogen dioxide
  - Sulphur dioxide
  - Ozone
  - Lead (Pb)

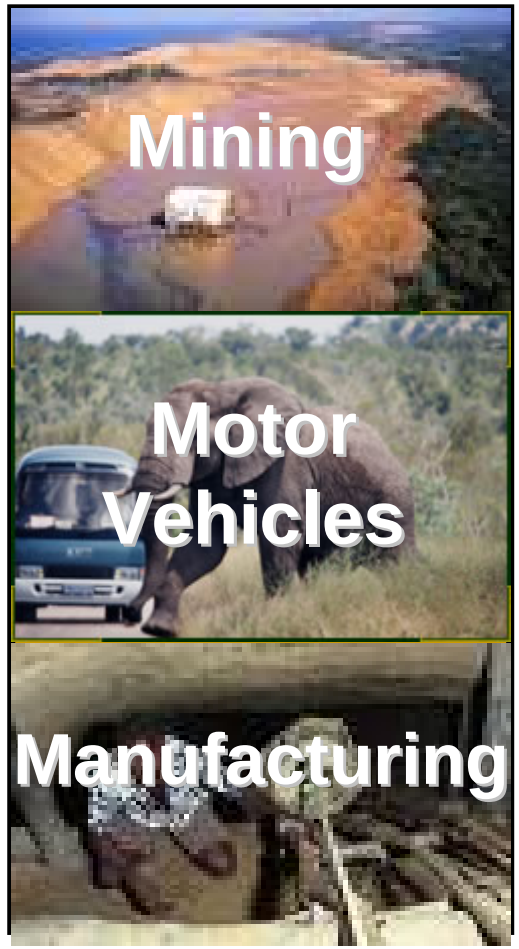
Indoors: -burning of biomass fuels in confined space

-use of household waste in informal settlements

Outside: Stationary sources

Mobile sources

Sources of Pollutant Emissions



Sources of air pollutants in the cities

- Countries in Eastern Africa are principally agricultural with few industries and some mining activities.
- Anthropogenic sources of air pollutants in the region are:
  - Vehicular emissions
  - Industries
  - Forest fires
  - Refuse incinerators
  - Mining activities

- Air quality data from Eastern Africa sub-region is scarce and inadequate since there are no regular monitoring programs.
- Data available will be influenced by variations in methodologies, equipment used and sampling sites, and expertise in air monitoring.
- Cities in this region lack detailed and accurate data bases of environmental related diseases and longer term health effects.


Heavy traffic on friday afternoon.
Notice the reduced visibility at a distance

Air quality standards

WHO and USEPA, also US national standards

- Particulate matter as TSP or PM_{10}, $PM_{2.5}$
- Gaseous pollutants including ozone

WHO standards for PM_{10} and $PM_{2.5}$

PM_{10} 30 µg/m^3 $PM_{2.5}$ 20 µg/m^3

WHO air quality guidelines

Pollutant	Time weighted average	Averaging time
Sulphur dioxide	500 µg/m^3	10 min
	350 µg/m^3	1h
	125 µg/m^3	24 h
	40 - 60 µg/m^3	1 yr
Carbon monoxide	30 µg/m^3	1h
	10 µg/m^3	8h
Nitrogen dioxide	400 µg/m^3	1h
	150 µg/m^3	24h
Total suspended solids	60 µg/m^3	1h
	150 µg/m^3	24h
Lead	0.5 – 1.0 µg/m^3	1 yr

Examples of air quality data

- Nairobi
  - 1997 – PM – 66.7 – 444.4 µg/m^3
    - Ozone -0.006 – 0.081 ppm
    - NO – 94.0 – 174 µg/m^3
    - NO_2 - 8.3 – 69.6 µg/m^3
  - 1999 –PM_{10} along Uhuru highway – 234 µg/m^3 (above WHO and USEPA daily and annual quality standards)
  - 2000 – over 50% of Nairobi had TSP >180 µg/m^3.

- 2002

Pollutant	Ozone	NO	NO_2	NO_x
Conc(ppm)*	0.015	0.024	0.018	0.040

* - Daily mean of 26 days

- PM_{10} – 231 ±114 µg/m^3 and $PM_{2.5}$ – 54 ± 38 µg/m^3
- 8 h variation PM_{10} 77.5-469 $PM_{2.5}$ 11.9– 52.5 µg/m^3
- Highest levels of PM_{10} during the months of July, August and September

- 2004
  - Along mombasa road (3 day average)

    PM_{10} 169.7 µg/m^3

    $PM_{2.5}$ 26.5 µg/m^3
- 2007
  - 12 sampling sites around the city

    NO 25.0 – 162.2 µg/m^3

    NO_2 37.1 – 231.7 µg/m^3

    SO_2 32.2 – 224.1 µg/m^3

  Sites with highest concentrations were city cabanas and globe roundabout. These had highest traffic concentration.
- August 2008
  - SO_2 17 -257 µg/m^3
  - NO_2 9 – 30 µg/m^3
  - TSP 1000 - 17000 µg/m^3

- **Dar es Salaam**
- 2002
  - SPM, Pb, NO_2 in 6 areas of Dar es Salaam were found to below the WHO guidelines
- 2003
  - Sites at 8 bus stations and road junctions found NO_2, SO_2, TSP all above WHO guideline levels
- 2005
  - PM_{10} values exceeded the WHO 24h air quality guideline values of 20 µg/m^3
- 2006
  - Roadside PM_{10} values exceeded WHO guideline values
  - SO_2 values below WHO guideline values
  - NO_2 values exceeded WHO guideline values

- Ethiopia

  2004

  PM_{10} <20 – 100 µg/m^3 complies with USEPA

  Pb <0.07 µg/m^3 :1.5 not exceeded

  CO not detected

  SO_2 not detected

  O_3 midday <45 ppb which is below 120 ppb USEPA standard

  WHO estimates for Ethiopia are PM_{10} in range 16-20 µg/m^3 . WHO guideline value of 50 is violated in Addis Ababa

Air pollution -Trend

- There is an increasing trend of air pollution in the region due to:
  - Increase in industries
  - Increase in human population
  - Increase in vehicular fleet imported as either secondhand or reconditioned
  - Inappropriate waste disposal
- Major sources are industries and combustion of fossil fuels.
- Vehicular emissions are;
  - Pb, CO, NOx, VOCs, PM_{10} and CO_2 and ground level O_3.
  - Diesel engines generate x40 times more PM_{10} per mile compared with gasoline.
  - Sulphur content of petroleum products critical in generation of sulphur oxide which leads to acid rain.
  - Traffic movement characteristics critical in the level of pollution caused.
  - Underground car parks will be places of high pollution when ventilation is not considered and pollution levels are not monitored.

Issues within the region

Policy- Air pollution does not respect boundaries. Therefore standards and implementation should be harmonized within the region.

- Vehicular emissions:-
  - Consider the fuel used
    - Sulphur content – upgrade refinery
    - Additives to fuel
  - Traffic jams
  - Motor vehicle technology
  - No Pb. What about vocs and toluene
- Industries
  - Need to use the best environmentally available technology from the EIA
- Domestic pollution
  - Technology in house design
  - fuel

Acknowledgements

1. My students and colleagues who availed the data.
    a) Odhiambo G. et al. Msc thesis 1997
    b) Muiru R. et al. Msc thesis 2008
    c) Wamoto J.M. et al. Msc thesis 2008
2. Jomo Kenyatta University of Agriculture and Technology
3. UNEP