Air Pollution:

Air Quality & Monitoring

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Air Quality

- Air Quality is a dynamic and complex environmental phenomenon exhibiting large temporal and spatial variation.

- The temporal and spatial variations in atmospheric levels of pollution, which is the essence of air quality, are caused by

  (a) changes in the pollutant source(s) emission rates, and

  (b) changes in meteorology and topography,

  which provide the mechanisms for chemical reactions of pollutants in the atmosphere and for the control and removal of atmospheric pollutants.

Clean Air Act (CAA)

- The EPA defines ambient air as “that portion of the atmosphere external to buildings, to which the public has access.”
- The CAA regulates only pollution that enters the outside air. This includes emissions from stacks, chimneys, vents and any other functionally equivalent openings. These are called point source emissions, or area emissions depending on their size.
- The CAA also regulates mobile and fugitive emissions that are released directly into the atmosphere.
- What the CAA does not regulate is indoor air pollution, or air pollution confined to private property, such as occupationally exposed emissions.

National Ambient Air Quality Standards

- EPA must establish National Ambient Air Quality Standards (NAAQS) for every pollutant that has been designated a "criteria“ pollutant.
- EPA has promulgated National Ambient Air Quality Standards for six criteria air pollutants:
  - ozone,
  - particulates (PM10 and PM2.5),
  - sulfur oxides,
  - carbon monoxide,
  - nitrogen dioxide and
  - lead.
- Unlike the other NAAQS pollutants, ozone is not directly emitted, but rather is formed in the atmosphere by the interaction of volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of sunlight. The control of ozone is, thus, based on regulating emissions of VOCs and NOx.
- The value of a standard depends largely upon the time period over which the measurement is averaged.

Types of NAAQS

There are two types of NAAQS specified in Section 109 of the CAA:

- **Primary standard:** "Health-based" standards used to protect human health and the environment. This health-based standard must protect the most sensitive segments of the population, such as children, the elderly and asthmatics.

- **Secondary standard:** Designed to protect general public welfare and prevention of damage to public property (animals, plant life, and property).

- Both primary and secondary NAAQS specify the maximum concentrations of these pollutants that can be present in the ambient air.

NAAQS (Primary & Secondary)

Pollutant	Primary Standard (Health Related)		Secondary Standard (Welfare Related)
	Average	Std. Level Concentration	
CO	8-hour	9 ppm (10 mg/m^3)	No Secondary Standard
	1-hour	35 ppm	No Secondary Standard
Pb	Maximum Quarterly Average	1.5 ug/m^3	Same as Primary Standard
NO_2	Annual Arithmetic Mean	0.053 ppm (100 µg/m^3)	Same as Primary Standard
O_3	Maximum Daily 1-hr Average	.12 ppm (235 µg/m^3)	Same as Primary Standard
	4th Max. Daily 8-hr Average	0.08 ppm (157 ug/m^3)	Same as Primary Standard

Pollutant	Primary Standard (Health Related)		Secondary Standard (Welfare Related)	
	Average	Std. Level Concentration		
PM_{10}	Annual Arithmetic Mean	50 µg/m^3	Same as Primary Standard	
	24-hour	150 µg/m^3	Same as Primary Standard	
$PM_{2.5}$	Annual Arithmetic Mean	15 µg/m^3	Same as Primary Standard	
	24-hour	65 µg/m^3	Same as Primary Standard	
SO_2	Annual Arithmetic Mean	0.03 ppm (80 µg/m^3)	3-hour	0.50 ppm (1300µg/m^3)

Air Monitoring

- Monitoring of the air quality can be very complex, since it requires the collection of data that allows for a resolution of the dynamic nature of air quality in terms of its spatial and temporal variation.

- Ambient air quality monitoring can be defined as a systematic, long-term assessment of air pollutant levels in our communities.

- This monitoring is usually undertaken to characterize air quality in *urban areas*, *near large point sources of air pollution* or *where there are sensitive environmental receptors.*

- The ability to assess the air quality of a region will depend on accurate and representative data describing existing conditions and dispersion models, which can be used to better predict future pollution levels.

- In general, ambient air monitoring networks are typically used to:
    - characterize local, regional, and national air quality conditions
    - assess health impacts
    - assess effectiveness of control programs
    - help form the basis for new control programs
    - assess source impacts
    - provide information to the public

➢ The CAA directed EPA to set primary and secondary standards that would "provide an ample margin of safety" and require EPA to establish acceptable levels of concentration or "criteria" in the ambient air for five pollutants.

➢ Those five pollutants were: sulfur dioxide (SO_2), particulate matter (TSP), carbon monoxide (CO), ozone (O_3), and nitrogen dioxide (NO_2). In a later version of the act, lead (Pb) was added and ozone was adopted as the photochemical oxidant indicator of volatile organic compound (VOC) precursors.

Stationary monitoring

A stationary monitoring network should yield the following information:

(1) background concentration levels,
(2) highest concentration levels,
(3) representative concentration levels in high-density areas,
(4) the impact of local sources,
(5) the impact of remote sources, and
(6) the relative impact of natural and anthropogenic sources

Spatial scales include

microscale (1-100 m),
middle scale (100 m-0.5 km),
neighborhood scale (0.5-4.0 Km),
Urban scale (4-50 Km),
Regional scale (10 – hundreds of Km)

Relationship of the Scale of Representativeness and Monitoring Objectives

Siting scales	Monitoring objectives
Micro, middle, neighborhood, (sometimes urban)	Highest concentration affecting people
Neighborhood, urban	High-density population exposure
Micro, middle, neighborhood	Source impact
Neighborhood, region	General/background concentration

Mobile Monitoring

- Mobile monitoring is accomplished from a movable platform, i.e., an aircraft or vehicle.

- Atmospheric transport and chemical transformation processes occur in the region between the source and the receptor.

- By using mobile platforms containing air pollution instrumentation, one can obtain data to help understand the formation and transport of photochemical smog, acidic deposition, and the dispersion of air pollutants from sources.

- Mobile monitoring platforms may also be moved to *hot spots,* areas suspected of having high concentrations of specific air pollutants. These areas may *be* nearby locations downwind of a large source or a particular location that is an unfavorable receptor due to meteorological conditions. Vehicular and aircraft monitoring systems can also be moved to locations where hazardous chemical spills, nuclear and chemical plants accident have occurred.

Air quality in Jordan

Element	Jordanian Standard 1140-1996		AAEP National Ambient Air Quality standard-2001
	Maximum Limit	Average Time for Measuring	Maximum Limit
SO2	0.135 ppm	1 hour	
SoO2	0.130 ppm	24 hour	0.14 ppm
SO2	0.03 ppm	Yearly	0.03 ppm
CO	26 ppm	1 hour	35 ppm
CO	9 ppm	8 hours	9 ppm
TSP	260µg/m^3	24 hour	
TSP	75 mgram	Yearly	
NO2	0.21 ppm	1 hour	

Element	Jordanian Standard 1140-1996		AAEP National Ambient Air Quality standard-2001
	Maximum Limit	Average Time for Measuring	Maximum Limit
NO2	0.08 ppm	24 hour	
NO2	0.05 ppm	Yearly	0.053 ppm
H2S	0.03 ppm	1 hour	
H2S	0.01ppm	24 hours	
Pb	1 µg/m^3	Seasonally	1.5 µg/m^3
Pb	0.5 µg/m^3	Yearly	
PM10	120 µg/m^3	24 hours	150 µg/m^3
PM10	70 µg/m^3	Yearly	50 µg/m^3

Air quality in Jordan

- Air quality is a problem in low area, high density hotspots of vehicular traffic and industrial activity.

- Most polluting emissions come from vehicles, industries, and residential activities.

Table 1. Pollutant emissions from vehicles and industries (2004)

Source of emissions	NO_x	SO_2	TSP
Road transportation (%)	79[a]	20[b]	39
Other diesel (%)	0	0	1
Air transport (%)	2	1	14
Industry (%)	7	30	18
Electricity production (%)	11	48	29
Total (t)	**72,900**	**123,000**	**6,500**

Sources: AFD, 2006, except for [a] Average corresponding to emissions ranging from 53,063t (AFD, 2006) and 62,160t (Transport chapter); [a] Average corresponding to emissions ranging from 24,240t (AFD, 2006) and 25,994t (Transport chapter).

- Nevertheless, the vehicle fleet is relatively old, with about 33 percent of the vehicles produced before 1990. Old cars are still maintained and used, contributing significantly to emissions. As Amman and South Amman host about 69 percent of all Jordanian vehicles, they represent a major hot spot for air pollution.

- Emissions from the industrial sector mainly originate from the cement plants in Fuheis and Rashidyia, the industrial area of Hashimyeh near Zarqa, power plants and phosphate and potash industries in Aqaba, and others. Among these, mining is the most important contributor to air pollution, accounting for about 62 percent of the TSP, 78 percent of the PM10 and 39 percent of the NOx generated by industry.

Table 2. Main sources of emissions and monitoring institutions

Location	Main source of emissions	Monitoring institutions (stations)	Pollutants monitored	Frequency of monitoring
Fuheis	Cement plant	MoEnv (RSS)	PM10	every 2 days
Rashidya	Cement plant	MoEnv (RSS)	NO_x, CO, SO_2, TSP	once a month
Hashimyeh (near Zarqa)	Refinery, power plant, steel industries, quarries	MoEnv (RSS), through: - Ibn Al-Anbari school for SO_2, H2S, PM10 - Um-Shuriak school for SO2, H2S, PM10 - Electrical training centre for SO2, CO, PM10	SO_2, H_2S, PM_{10}, CO	every hour at Ibn Al-Anbari school for SO_2 and H2S [a]
Remote areas[b]	Phosphate mines	RSS	PM10	n.a.
Aqaba	Phosphorous acid plant	ASEZA (RSS)	SO_2, NOx, CO, HF	once a week
	Power plants	n.a.	n.a.	n.a.
GAM	Traffic	MoH (RSS), through: - Ean Jalout School/ Shmeisani. - Civil Defense / Abu Nusair. - Ali Ben-Abi Taleb Mosque/ Marka - Al- Husaini Mosque/ Down Town (City Center).	TSP, PM_{10}, Pb	n.a.

Sources: AFD, 2006, except for [a] monitored data at Ibn Al-Anbari school.
Notes: [b] including Al-Albiad. n.a. = not available.