



3.13

Air pollution

	City	City population	Particulate matter	Sulfur dioxide	Nitrogen dioxide
		thousands 2005	micrograms per cubic meter 2004	micrograms per cubic meter 1995–2001 ^a	micrograms per cubic meter 1995–2001 ^a
Argentina	Córdoba	1,423	58	..	97
	Melbourne	3,626	12	..	30
	Perth	1,474	12	5	19
	Sydney	4,331	20	28	81
Austria	Vienna	2,260	41	14	42
Belgium	Brussels	1,012	28	20	48
Brazil	Rio de Janeiro	11,469	35	129	..
	São Paulo	18,333	40	43	83
Bulgaria	Sofia	1,093	61	39	122
Canada	Montréal	3,640	19	10	42
	Toronto	5,312	22	17	43
	Vancouver	2,188	13	14	37
Chile	Santiago	5,683	61	29	81
China	Anshan	1,611	82	115	88
	Beijing	10,717	89	90	122
	Changchun	3,046	74	21	64
	Chengdu	4,065	86	77	74
	Chongqing	6,363	123	340	70
	Dalian	3,073	50	61	100
	Guangzhou	8,425	63	57	136
	Guiyang	3,447	70	424	53
	Harbin	3,695	77	23	30
	Jinan	2,743	94	132	45
	Kunming	2,837	70	19	33
	Lanzhou	2,411	91	102	104
	Liupanshui	1,149	59	102	..
	Nanchang	2,188	78	69	29
	Pingxiang	905	67	75	..
	Qingdao	2,817	68	190	64
	Shanghai	14,503	73	53	73
	Shenyang	4,720	101	99	73
	Taiyuan	2,794	88	211	55
	Tianjin	7,040	125	82	50
	Wulumqi	2,025	57	60	70
	Wuhan	7,093	79	40	43
	Zhengzhou	2,590	97	63	95
	Zibo	2,982	74	198	43
Colombia	Bogotá	7,747	31	..	..
Croatia	Zagreb	908 ^b	33	31	..
Cuba	Havana	2,189	21	1	5
Czech Republic	Prague	1,171	23	14	33
Denmark	Copenhagen	1,088	21	7	54
Ecuador	Guayaquil	2,387	23	15	..
	Quito	1,514	30	22	..
Egypt, Arab Rep.	Cairo	11,128	169	69	..
Finland	Helsinki	1,091	21	4	35
France	Paris	9,820	11	14	57
Germany	Berlin	3,389	22	18	26
	Frankfurt	668 ^b	19	11	45
	Munich	1,263	20	8	53
Ghana	Accra	1,981	33	..	..
Greece	Athens	3,230	43	34	64
Hungary	Budapest	1,693	19	39	51
Iceland	Reykjavik	164 ^b	18	5	42
India	Ahmadabad	5,120	83	30	21
	Bangalore	6,462	45	..	..

About the data

Indoor and outdoor air pollution place a major burden on world health. More than half of the world's population rely on dung, wood, crop waste, or coal to meet their basic energy needs. Cooking and heating with such solid fuels on open fires or stoves without chimneys leads to indoor air pollution. Every year indoor air pollution is responsible for the deaths of 1.6 million people—one death every 20 seconds. In many urban areas exposure to air pollution is the main environmental threat to human health. Long-term exposure to high levels of soot and small particles in the air contributes to a wide range of health effects, including respiratory diseases, lung cancer, and heart disease. Particulate pollution, on its own or in combination with sulfur dioxide, leads to an enormous burden of ill health.

Emissions of sulfur dioxide and nitrogen oxides lead to the deposition of acid rain and other acidic compounds over long distances. Acid deposition changes the chemical balance of soils and can lead to the leaching of trace minerals and nutrients critical to trees and plants.

Where coal is the primary fuel for power plants, steel mills, industrial boilers, and domestic heating, the result is usually high levels of urban air pollution—especially particulates and sometimes sulfur dioxide—and, if the sulfur content of the coal is high, widespread acid deposition. Where coal is not an important primary fuel or is used in plants with effective dust control, the worst emissions of air pollutants stem from the combustion of petroleum products.

The data on sulfur dioxide and nitrogen dioxide concentrations are based on reports from urban monitoring sites. Annual means (measured in micrograms per cubic meter) are average concentrations observed at these sites. Coverage is not comprehensive because not all cities have monitoring systems.

The data on concentrations of particulate matter are estimates, for selected cities, of average annual concentrations in residential areas away from air pollution "hotspots," such as industrial districts and transport corridors. The data are extracted from a complete set of estimates by the World Bank's Development Research Group and Environment Department in a study of annual ambient concentrations of particulate matter in world cities with populations exceeding 100,000 (Pandey and others 2006).

Pollutant concentrations are sensitive to local conditions, and even in the same city different monitoring sites may register different concentrations. Thus these data should be considered only a general

	City	City population	Particulate matter	Sulfur dioxide	Nitrogen dioxide
		thousands 2005	micrograms per cubic meter 2004	micrograms per cubic meter 1995–2001 ^a	micrograms per cubic meter 1995–2001 ^a
India	Kolkata	14,277	128	49	34
	Madras	6,916	37	15	17
	Delhi	15,048	150	24	41
	Hyderabad	6,115	41	12	17
	Kanpur	3,018	109	15	14
	Lucknow	2,566	109	26	25
	Mumbai	18,196	63	33	39
	Nagpur	2,350	56	6	13
	Pune	4,409	47	..	..
Indonesia	Jakarta	13,215	104	..	..
Iran, Islamic Rep.	Tehran	7,314	58	209	..
Ireland	Dublin	1,037	19	20	..
Italy	Milan	2,953	30	31	248
	Rome	3,348	29	..	..
	Turin	1,660	44	..	..
Japan	Osaka-Kobe	11,268	35	19	63
	Tokyo	35,197	40	18	68
	Yokohama	3,366 ^b	31	100	13
Kenya	Nairobi	2,773	43	..	..
Korea, Rep	Pusan	3,554	44	60	51
	Seoul	9,645	41	44	60
	Taegu	2,511	50	81	62
Malaysia	Kuala Lumpur	1,405	29	24	..
Mexico	Mexico City	19,411	51	74	130
Netherlands	Amsterdam	1,147	34	10	58
New Zealand	Auckland	1,148	14	3	20
Norway	Oslo	802	14	8	43
Philippines	Manila	10,686	39	33	..
Poland	Katowice	2,914 ^b	39	83	79
	Lódz	776	39	21	43
	Warsaw	1,680	43	16	32
Portugal	Lisbon	2,761	23	8	52
Romania	Bucharest	1,934	18	10	71
Russian Federation	Moscow	10,654	21	109	..
	Omsk	1,132	22	20	34
Singapore	Singapore	4,326	44	20	30
Slovak Republic	Bratislava	456 ^b	15	21	27
South Africa	Cape Town	3,083	16	21	72
	Durban	2,631	32	31	..
	Johannesburg	3,254	33	19	31
Spain	Barcelona	4,795	35	11	43
	Madrid	5,608	30	24	66
Sweden	Stockholm	1,708	11	3	20
Switzerland	Zurich	1,144	23	11	39
Thailand	Bangkok	6,593	79	11	23
Turkey	Ankara	3,573	46	55	46
	Istanbul	9,712	55	120	..
Ukraine	Kiev	2,672	35	14	51
United Kingdom	Birmingham	2,280	25	9	45
	London	8,505	21	25	77
	Manchester	2,228	15	26	49
United States	Chicago	8,814	25	14	57
	Los Angeles	12,298	34	9	74
	New York–Newark	18,718	21	26	79
Venezuela, RB	Caracas	2,913	10	33	57

a. Data are for the most recent year available. b. Data are for 2000.

indication of air quality in each city, and cross-country comparisons should be made with caution. The current World Health Organization (WHO) air quality guidelines are annual mean concentrations of 20 micrograms per cubic meter for particulate matter less than 10 microns in diameter (PM10) and 40 micrograms for nitrogen dioxide and daily mean concentrations of 20 micrograms per cubic meter for sulfur dioxide.

Definitions

- **City population** is the number of residents of the city or metropolitan area as defined by national authorities and reported to the United Nations.
- **Particulate matter** refers to fine suspended particulates less than 10 microns in diameter (PM10) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Data are extracted from a larger study of urban-population-weighted PM10 levels in residential areas of cities with more than 100,000 residents. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter. The state of a country's technology and pollution controls is an important determinant of particulate matter concentrations.
- **Sulfur dioxide** is an air pollutant produced when fossil fuels containing sulfur are burned. It contributes to acid rain and can damage human health, particularly that of the young and the elderly.
- **Nitrogen dioxide** is a poisonous, pungent gas formed when nitric oxide combines with hydrocarbons and sunlight, producing a photochemical reaction. These conditions occur in both natural and anthropogenic activities. Nitrogen dioxide is emitted by bacteria, motor vehicles, industrial activities, nitrogenous fertilizers, combustion of fuels and biomass, and aerobic decomposition of organic matter in soils and oceans.

Data sources

Data on city population are from the United Nations Population Division. Data on particulate matter concentrations are from a recent World Bank study by Kiran D. Pandey, David Wheeler, Bart Ostro, Uwe Deichman, Kirk Hamilton, and Katharine Bolt, "Ambient Particulate Matter Concentration in Residential and Pollution Hotspot Areas of World Cities: New Estimates Based on the Global Model of Ambient Particulates (GMAPS)" (2006). Data on sulfur dioxide and nitrogen dioxide concentrations are from the WHO's Healthy Cities Air Management Information System and the World Resources Institute.