# Country Synthesis Report on Urban Air Quality Management

# Philippines

Discussion Draft, December 2006

ADB

CLEAN AIR INITIATIVE for Asian Cities

Country Synthesis Report on
Urban Air Quality Management

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## Tables



## Figures



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# Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| AdeMU | Ateneo de Manila University |
| AQM | air quality management |
| CAA | Philippine Clean Air Act |
| CAI | Clean Air Initiative |
| CAMP | Clean Air Management Program |
| CENRO | City/Community Environment and Natural Resources Office |
| CME | coco-methyl ether |
| CNG | compressed natural gas |
| CSR | country synthesis report |
| CO | Carbon monoxide |
| DAO | department administrative order |
| DENR | Department of Environment and Natural Resources |
| DOE | Department of Energy |
| DOTC | Department of Transportation and Communications |
| ECAP | Energy and Clean Air Program |
| EDSA | Epifanio delos Santos Avenue |
| EMB | Environmental Management Bureau |
| GB | governing board |
| GDP | gross domestic product |
| IBP | Integrated Bar of the Philippines |
| LCP | League of Cities of the Philippines |
| LGU | local government unit |
| LPG | liquefied petroleum gas |
| LRT | light rail transit |
| LTO | Land Transportation Office |
| MMAAAQMN | Metro Manila Airshed Ambient Air Quality Monitoring Network |
| MMAQISDP | Metro Manila Air Quality Improvement Sector Development Project |
| MMASBA | Metro Manila Anti-Smoke Belching Association |
| MO | Manila Observatory |
| NCR | National Capital Region |
| NGO | nongovernment organization |
| $NO_2$ | Nitrogen dioxide |
| NSO | National Statistics Office |
| $O_3$ | ozone |
| Pb | lead |
| PCA | partnership for clean air |
| PD | presidential decree |
| PENRO | Provincial Environment and Natural Resources Office |
| PM | particulate matter |
| PM2.2 | particulate matter with diameter less than 2.2 micrograms |
| PM2.5 | particulate matter with diameter less than 2.5 micrograms |
| PM10 | particulate matter with diameter less than 10 micrograms |
| PNRI | Philippine Nuclear Research Institute |
| ppm | parts per million |
| SOx | Sulfur oxide |
| $SO_2$ | Sulfur dioxide |
| TOG | total organic gas |
| TSP | total suspended particulate |
| $ug/m^3$ | microgram per cubic meter |
| USEPA | United States Environment Protection Agency |
| VOC | volatile organic compound |
| WHO | World Health Organization |

Note: "$" means "US dollar" in this publication.

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» Part One

# General Information

## Geography and Climate

The Philippines is an archipelago of more than 7,000 islands with an area totaling about 300,000 square kilometers. The country is of volcanic origin—forms part of the "Pacific Ring of Fire"—and is therefore mainly mountainous, creating narrow coastal plains and forested interior valleys. Three prominent bodies of water surround the archipelago: the Pacific Ocean on the east, the South China Sea on the west and the north, and the Celebes Sea on the south. This position accounts for much of the variations in geographic, climatic, and vegetational conditions in the country. The Philippines is located in a subtropical climate zone with a dry season from January to June and a wet season from July to December. Air temperature averages between 26°C and 27°C, and the seasonal variation is only 3–4°C. Regional climate differences are largely due to rainfall distribution.

The country is divided into three geographical areas: Luzon, Visayas, and Mindanao. There are 17 administrative regions with 117 cities. The country's capital, Metro Manila, also known as the National Capital Region (NCR), is the country's smallest administrative region but the biggest metropolis composed of 14 cities and municipalities.

## Population and Urbanization

As of 2005, the Philippines has an estimated total population of 85.3 million (National Statistics Office ([NSO], 2006) and ranks as the 14th most populous country in the world (CIA, 2006). The World Bank estimates that 62% lives in the urban areas (World Bank, 2005). The country's population density is 284 persons per square kilometer. The annual population growth rate has remained stable since 1990; it was 2.1% in 2004. The projected population for 2025 is almost 120 million.

The annual growth rate of the country's urban population is 5.4%, accounting for more than 2.5 million persons every year. The Philippines, except for Singapore, is the most urbanized country in Southeast Asia, the seventh most urbanized country in all Asia and the country with the sixth highest urbanization rate in Asia. The top three regions in terms of population count are Region IV–Southern Tagalog (11.32 million or 15.04% of the total), Metro Manila (10.49 million or 13.93%), and Region III–Central Luzon (7.80 million or 10.35%). The population residing in these regions combined comprises 39.32% of the total Filipino population. This means that 4 out of 10 persons in the country reside in Metro Manila and the adjoining regions of Central Luzon and Southern Tagalog. The other dominant urban centers are Metro Cebu and Davao, which have populations of more than one million.

## Industry and Economy

Although agricultural in nature, light industry and services have grown in importance. Economic growth has been on the rise since 2001. The country's gross domestic product (GDP) for 2005 is $105 billion with an average of 5.1% growth rate per year. Growth of GDP to 2010 is expected to average 5–6% a year. In 2005, the primary sector contributed 14%, secondary sector 32%, and tertiary sector 53% to the total GDP. Within industry, manufacturing and construction were the major growth drivers. The industry sector expanded by 5.3% from the previous year, spurred by a significant expansion in mining and manufacturing. Manufacturing, trade, construction, and energy generation collectively grew at an annual rate of about 3.2% between 1988 and 2002. This rapid industrialization, occurring largely in urban centers, has caused increased congestion in urban areas, increased demand on environmental and natural resources, and increased air pollution (ADB, 2006).

Urban areas are, and will continue to be, the center of economic growth in the Philippines. According to the NSO 2003 Annual Survey of Philippine Business and Industry, almost half (47.3%) of the manufacturing establishments were located in Metro Manila and the far second was Region IV[1] with 22.8%, while Region VII[2] and Region III[3] accounted for 9.1% and 8.8%, respectively (NSO, 2006). The number of businesses and industries had increased considerably in the past decade. The 2003 Annual Survey of Philippine Business and Industry covered 20,579 establishments, 29% (5,900) of which are in the manufacturing sector. Metro Manila, albeit geographically is only 0.21% of the country's land area, recorded the highest number of establishments with 45.8% of the total.

# Energy

The Philippines is historically a net importer of oil products until 2001 when it started producing crude oil.[4] Coal supply in 2003 amounted to 9.6 million short tons of which 7.4 million short tons were imported mainly from Indonesia, the People's Republic of China (PRC), and Australia. Notwithstanding the substantial importation of crude oil and coal, the Philippines has an increasing rate of energy self-sufficiency, i.e., the total indigenous supply is greater than the total imported energy supply. The Philippines is the world's second largest producer of geothermal power with plans of expanding the use of other renewables for energy production. The country also has a strong potential for wind generation. The continuous escalation and the volatility of prices of fossil fuel oil in the world market since 2004 have led to major changes in the Philippine energy policy, thus, shifting from the more expensive oil-based power generation to less expensive ones, such as those that run on hydro, geothermal, and natural gas (National Power Corporation, 2006).

Table 1.1 shows energy supply mix in 2000 and 2005 and the projected values for 2010 and 2014 based on the Philippine Energy Plan (2004–2013).[5] Total fuel import (oil and coal) in 2005 decreased to 47% from 55% in 2000 due to increasing use of local fuel and renewable resources from 2000 to 2005. Use of coco-methyl ether (CME) and ethanol contributed 0.6% of the energy supply mix in 2005 and this is projected to continue at the same proportion until 2014. Imports proportion is targeted to decrease to 38.3% in 2010 and eventually to 37.8% in 2014, which will be compensated by increasing use of local fuel, indigenous energy resources, and renewable energy. The Department of Energy (DOE) projects that the national aggregate energy demand will rise to 385 MMBFOE[6] in 2014. Households, transport, industry, commercial entities, and agriculture, will drive the energy demand on an uptrend. Petroleum products used mainly by the transport sector will comprise the bulk of the total final energy demand.

TABLE 1.1

**Primary Energy Supply Mix—Actual Usage and Projections (MMBFOE)**

| Energy Source | 2000 | 2005 | 2010 | 2014 |
|---|---|---|---|---|
| Imported oil | 45.4 | 37.3 | 29.6 | 31.9 |
| Imported coal | 9.2 | 9.6 | 8.7 | 5.9 |
| Local oil | 0.2 | 1.8 | 6.8 | 3.8 |
| Local coal | 1.8 | 3.5 | 5.1 | 6.1 |
| Natural gas | 0.4 | 4.0 | 5.5 | 8.0 |
| Hydro | 5.3 | 5.1 | 6.6 | 6.2 |
| Geothermal | 8.0 | 21.1 | 22.0 | 23.6 |
| Biomass | 29.8 | 16.8 | 14.9 | 13.7 |
| Other RE | — | 0.2 | 0.2 | 0.2 |
| CME and ethanol | — | 0.6 | 1.0 | 0.6 |
| Total imports | 54.6 | 46.9 | 38.3 | 37.8 |
| Self -sufficiency level (%) | 45.0 | 53.0 | 62.0 | 62.0 |
| **Total MMBFOE** | **252.0** | **281.0** | **333.13** | **384.5** |

CME = coco-methyl ether, DOE = Department of Energy, MMBFOE = million barrels of fuel oil equivalent, RE = renewable energy, % = percent
Source: DOE, 2006.

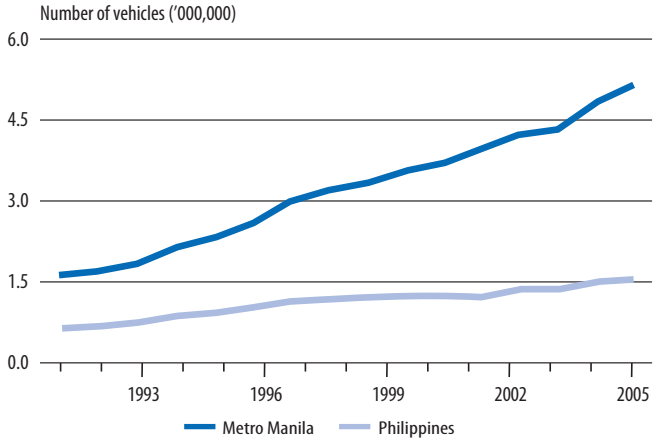
[1] Region IV (Southern Tagalog) – Calamba, Laguna, Batangas, Rizal, and Quezon (Calabarzon) Provinces with 11 cities
[2] Region VII (Central Visayas) – 12 cities including Metro Cebu
[3] Region III (Central Luzon) – 12 cities
[4] Production has been steady at 25,000 barrels per day since 2003 (Department of Energy [DOE], 2005)
[5] The new Philippines Energy Plan (2004–2013) outlines strategies that are directed at deregulating and liberalizing the energy sector—increasing use of indigenous energy resources (such as natural gas, coco-methyl ether, and ethanol) and renewable energy sources, and increasing energy efficiencies. The 2005 update sets out to appraise the possibilities and courses of action toward providing adequate supply to the increasing energy demand. With energy independence as its theme, the plan calls for the development of the country's indigenous energy resources and the promotion of clean technologies to sustain energy-efficient energy supply and demand chains that will eventually lead to increased self-reliance and provide the much-needed boost to the country's economic front. DOE has set forth a goal of 60% self-sufficiency level in 2010. (DOE, 2006).
[6] million barrels of fuel oil equivalent (MMBFOE)

# Transportation

Increasing population and urbanization creates an increasing demand for mobility and more efficient means of transportation in the Philippines. The rapid expansion of the vehicle fleet in the country has resulted in increased traffic congestion and fuel use. Figure 1.1 shows the number of motor vehicles in the Philippines and in Metro Manila from 1990 to 2005. There has been more than a threefold increase in the number of road vehicles in the past decade from 1.6 million in 1990 to more than 5 million in 2005, but the growth rate has decreased from the 9% annual average in the 1990s to 6.5% from 2001 to 2005. In Metropolitan Manila, the number of vehicles increased from about 600,000 in 1990 to approximately 1.6 million in 2005, which is about 31% of the total for the whole country.

FIGURE 1.1

**Registered Motor Vehicles in the Philippines and Metro Manila, 1990–2005**



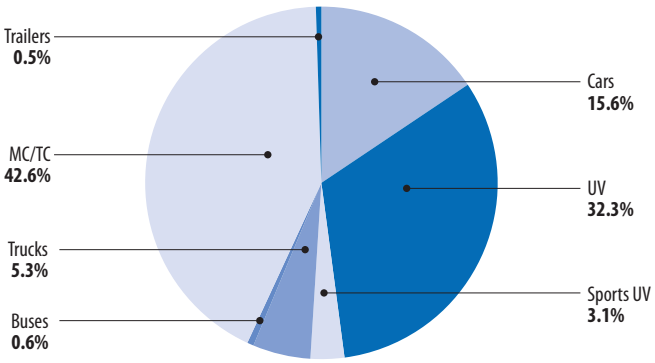

Source: Land Transportation Office, 2006 graphed by Clean Air Initiative-Asia.

Motorcycles dominate the vehicle fleet in the country. Figure 1.2 shows that in 2005, 42.6% or almost 2.15 million units are motorcycles, 32.3% (1.6 million) are utility vehicles, 15.6% (790,000) are cars, and the remaining 9.5% are trucks, sports utility vehicles, buses, and trailers. Majority of registered vehicles are in Metro Manila, Regions III, and IV, except for motorcycles—which is the preferred mode of transport for short-distance travels. A study conducted by ADB in 2005 showed that 94% of the country's motorcycles are with two-stroke engines and use untreated used oil (ADB, 2005a) instead of the quality of lubricant recommended by vehicle manufacturers.

The proportion of vehicles registered in Metro Manila has been declining from 42% (1990) to 31% (2005), suggesting that the growth of vehicle numbers in other major cities and urban centers are increasing. The Cordillera Autonomous Region[7] has the highest percent vehicle growth rate at 22% and five other regions have more than 10% annual growth rate for 2004–2005. Other than Region IV, all of the highly industrialized regions (NCR, Regions III, VII, and XI) have less than 10% growth rate meaning that motorization is likewise rapidly increasing in nonurbanized areas in the country.

FIGURE 1.2

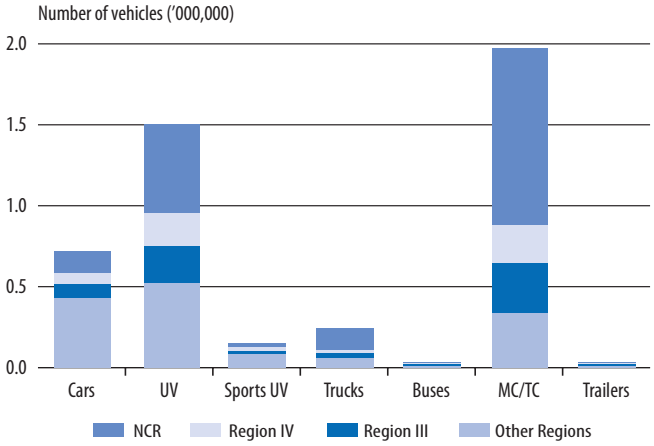
**% Share of Vehicle Types in the Overall Fleet, 2005**




CAI = Clean Air Initiative; LTO = Land Transportation Office; MC/TC = motorcycle/tricycle; NCR = National Capital Region; UV = utility vehicle; % = percent
Source: LTO, 2006 and graph by CAI-Asia.

FIGURE 1.3

**Regional Distribution by Vehicle Type, 2005**




CAI = Clean Air Initiative; LTO = Land Transportation Office; MC/TC = motorcycle/tricycle; NCR = National Capital Region; UV = utility vehicle; % = percent
Source: LTO, 2006 and graph by CAI-Asia.

[7] The Cordillera Administrative Region consists of six provinces, Abra, Benguet, Ifugao, Kalinga, Apayao, and Mountain Province. Population as of 2000 is 1.6 million. Baguio City is the regional center.

Gasoline-fuelled vehicles (72% of the total fleet) dominate the country. Both gas- and diesel-fuelled vehicles showed threefold increase in 15 years. Gasoline-fuelled vehicles increased from 1.16 million in 1990 to more than 2.5 million while diesel-fuelled vehicles increased from 440,000 in 1990 to 1.4 million in 2005. Diesel-fuelled vehicles are increasing at an average annual growth rate of 6%.

Public transport system in the country is highly variable, depending on geographic and economic conditions. The Land Transportation Office (LTO) 2005 data showed that only 18% of the country's vehicle fleet (890,000 units) is used for public transport, while 80.6% is registered as private vehicles.

Light rail transit (LRT) systems are available in Metro Manila only where they were built primarily to alleviate the chronic traffic congestion in the metropolis. There are three LRT lines in operation: LRT Line 1 (15-km line with current ridership of 300,000 passengers/day), LRT Line 2 (13-km line with current ridership of 200,000 passengers per day), and Epifanio delos Santos Avenue (EDSA)-MRT (17-km line with current ridership of 400,000 passengers per day). As the lines expanded, more commuters have been utilizing LRT resulting to a 29% increase in ridership from 118 million in 2004 to 147 million passengers in 2005 (National Statistical Coordinating Board, Light Rail Transit Authority, Department of Transportation and Communications [DOTC] 2006).

» Part Two

# Sources of Air Pollution

he major sources of air pollution are both mobile (primarily, motor vehicles) and stationary (mainly, power plants and boilers in various industrial processes). Road dust, construction, and waste burning also contribute to air pollution.

## Emissions Inventory

The Environmental Management Bureau (EMB) is required by law to conduct emissions inventories once every 3 years. Emissions inventories use information submitted by companies as part of the permit acquisition process. The first emissions inventory was conducted in 1990 and was updated only in 2001. The latest inventory was based on a number of studies, a combination of limited field surveys and emission factors established in developing countries. The emissions inventory covered PM, sulfur oxide (SOx), nitrogen oxide, carbon monoxide (CO), volatile organic compounds, and total organic gases (TOGs) from mobile sources.

2001 Philippine Emissions Inventory covered PM, SOx, NOx, CO, volatile organic compound (VOC), and TOGs, while lead (Pb) and ozone ($O_3$) were not included. It was estimated that 54% of the pollutants come from stationary sources, 20% from mobile sources, and the remaining 26% from area sources. Of the pollutants inventoried, CO has the biggest contribution total pollution load (39%). Other pollutants contributed the following: NOx – 35%, SOx – 8%, PM – 8%, TOG – 7%, and VOC – 2%.

Self-monitoring reports submitted to EMB in 2001 show that power plants emissions contributed 23% out of 467,102 tons of particulate matter (PM), 18% of 830,100 tons of sulfur dioxide ($SO_2$), 23% of 113,503 CO, and 35% of 517,212 tons of $NO_2$ to total stationary source emissions nationwide.

Table 2.1 shows estimated emissions for NCR for 2005. It is estimated that more than 14 million tons (89%) of the pollutants come from stationary sources, 1.5 million tons (9.6%) from mobile sources and the remaining 1% contributed by area sources. The emissions inventory also shows $SO_2$ as the main pollutant emitted by stationary sources, CO for the mobile sources and PM for area sources.

TABLE 2.1

**National Capital Region Emissions Inventory, 2005**

| Item | Area (%) | Mobile (%) | Stationary (%) |
|---|---|---|---|
| PM | 90.80 | 4.23 | 4.88 |
| SOx | 0.05 | 0.00 | 57.51 |
| NOx | 1.15 | 7.89 | 31.57 |
| CO | 1.12 | 71.32 | 4.92 |
| VOC/TOG | 6.88 | 16.57 | 1.11 |
| **Total (tons per year)** | **161,631.00** | **1,544,664.00** | **14,336,347.00** |

CO = carbon monoxide, EMB = Environmental Management Bureau, NOx = nitrogen oxide, PM = particulate matter, SOx = sulfur oxide, t = tons, TOG = total organic gases, VOC = volatile organic compound, % = percent
Source: EMB, 2006.

The Outsource Sampling Project of MMAQISDP, funded through a loan program from ADB, performed emission testing on over 960 sources over a 3-year period located inside the Metro Manila Airshed (NCR, Regions III, and IV). The data were compared with the allowable limits described in the Philippine Clean Air Act (CAA). Test parameters were based on the facility, source and fuel type, and included a combination of PM, $SO_x$, $NO_x$, sulfuric acid mist, CO, hydrogen sulfide, metals (antimony, arsenic, cadmium, copper, Pb, mercury, nickel, and zinc) oxygen, carbon dioxide ($CO_2$) and volumetric flow rate. Of the over 900 sources tested, approximately 50% failed to meet the CAA limits for at least one parameter.

## Source Apportionment

Source apportionment studies are not carried out regularly and are not being used for developing AQM plans. There are no current uniform guidelines for carrying out source apportionment studies. Only a few institutions are engaged in conducting source apportionment studies in the country. The Philippine Nuclear Research Institute (PNRI) has been conducting source apportionment of PMs 10 and 2.2 (particulate matters with diameters less than 10 and 2.2 micrograms respectively) using nuclear analytical techniques. Although not specifically mandated by law, PNRI has the capacity and some resources to conduct source apportionment for research purposes. PNRI has been doing this exercise for Metro Manila for more than 5 years now and is recently engaged in expanding the research to other key urban areas such as Davao City.

Apart from PNRI, the Manila Observatory (MO)—a nongovernment research institution—also collects PM samples for source apportionment analyses. MO's Urban Air Quality Program[1] aims to provide scientific guidance to air quality assessment and mitigation policy development. It seeks to achieve this through monitoring and modeling activities that form the scientific basis of effective AQM. The modeling branch of the program applies source apportionment, dispersion, and mesoscale modeling systems to deepen the understanding of the sources, transport, and fate of critically important air pollutants in Asian urban centers such as Metro Manila. Through the support of Swedish International Development Agency, MO has also completed a study that focused on investigating the severity of fine PM2.5, a major component of PM10.

Source apportionment analyses of three years of PM10 and PM2.5 sample filters indicate that the transport sector is the most significant source of pollution in Metro Manila. The transport sector's contribution ranges from 50 to 90%, depending on the sampling sites. Next to transport, sources such as biomass burning, sea salt, and soil have also been found to contribute—in varying degrees—to particulate pollution. Source inventory of PM also confirms the significance of the transport sector in the particulate pollutant load of Metro Manila.

Dispersion modeling results indicate the serious but localized contribution of stationary sources to particulate pollution over the northwestern part of Metro Manila. These also point to the extensive contribution of mobile (i.e., transport-related) sources throughout the city. Major pollution hotspots are found to be concentrated along major arteries and dense traffic networks (such as those in the central part of the city).

Given its geography and meteorology and the absence of emissions from neighbors to the west, the country is less vulnerable to long-range transport of particles, $O_3$, or acid deposition. Because of its more southerly location, the Philippines is less affected by emissions of yellow sand (loess) that blow across much of East Asia, especially Korea and Japan. Similarly, the Philippines is less affected than other Southeast Asian countries by smoke from forest fires in Indonesia, although the most extreme events of 1997 did have some impact in the southern provinces.

[1] The Urban Air Quality program aims to provide scientific guidance to air quality assessment and mitigation policy development. It seeks to achieve this through monitoring and modeling activities that form the scientific basis of effective air quality management.

» Part Three

# Status of Air Quality

## Ambient Air Quality Monitoring

Ambient air quality monitoring in the country started in Metro Manila in the 1970s. Most of the current monitoring activities are through EMB, with some other organizations conducting their own sampling and monitoring for research purposes. Although monitoring is conducted nationwide, monitoring in Metro Manila is generally more advanced in terms of frequency, scope, and sophistication of equipment. The most recent sources of data on air quality are listed in Table 3.1. A summary of the key results from each source is included. (Energy and Clean Air Program [ECAP], 2006).

Routine air quality monitoring has not been sustained by the government. Only total suspended particulate (TSP) concentrations in Metro Manila and some other major cities have been consistently done. Monitoring of PM10 and other gaseous pollutants were on intermittent and discontinuous basis. The required minimum TSP sampling[1] of 16 hours a day (for daily average) and 50 days a year (for annual average) has not been fully complied with in some monitoring stations due to problems such as power failure, inclement weather, and equipment breakdown. This is further aggravated by inadequate financing for operation and maintenance of monitoring instruments, as well as inadequate infrastructure for supporting analytical work and very serious shortage of skilled technical staff. This, in turn, results to weakness in areas such as systematic estimation of uncertainty or error in the data.

**Metro Manila.** Three groups are monitoring air quality in Metro Manila – EMB, MO, and PNRI. EMB set up the Metro Manila Airshed Ambient Air Quality Monitoring Network (MMAAAQMN), composed of 10 automated continuous

[1] The values monitored for more than 16 hours (daily average) and 50 days (annual) are considered as a representative value for assessing air quality.

TABLE 3.1

**Summary of Recent AQ Data and Sources**

| Source of Data and Period Covered | Pollutants | Method and Instruments; Type of Data | Remarks | Key Results |
|---|---|---|---|---|
| DENR-EMB, 2000–present | TSP | High-volume sampler; gravimetric; and one 24-hour grab sample per quarter | Roadside data; infrequent | Data not used |
| MO, 2000–2005 | PM10, PM2.5 | Low-volume sampler; gravimetric; and 24-hour grab samples | Raw data available; good quality; and four stations in program | EDSA station most polluted, exceeds PM10 standard; PM2.5 levels above USEPA limits |
| PNRI, 2000–present | PM10, PM2.2 | Dichotomous sampler; gravimetric; and 24-hour grab samples | Box plots available; good quality; and main stations: Poveda in EDSA and Ateneo | Raw data not available; Annual mean PM10 complies with standards, PM2.2 levels near or above USEPA limits |
| ETI, 2003–present | $SO_2$, $NO_2$, CO, $O_3$, PM10, PM2.5 | Continuous | 15-minute raw data available but not yet for public release | Data not yet available |

AQ = air quality; CO = carbon monoxide; DENR = Department of Environment and Natural Resources; EDSA = Epifanio delos Santos Avenue; EMB = Environmental Management Bureau; ETI = Emissions Technologies, Inc. ; MO = Manila Observatory; $NO_2$ = nitrogen dioxide; $O_3$ = ozone; PM2.2 = particulate matter with diameter less than 2.2 micrograms; PM2.5 = particulate matter with diameter less than 2.5 micrograms; PM10 = particulate matter with diameter less than 10 micrograms; PNRI = Philippine Nuclear Research Institute; $SO_2$ = sulfur dioxide; TSP = total suspended particulate; USEPA = United States Environment Protection Agency

Source: Inventory of Air Quality Data in Metro Manila, 2006.

monitoring stations, to monitor air quality in the Metro Manila Airshed. These stations have the capability to measure criteria pollutants (PM10, $SO_2$, CO, nitrogen dioxide [$NO_2$], and $O_3$) and meteorological parameters. Two stations have the capability to measure non-criteria pollutants (PM2.5, methane, non-methane hydrocarbon, benzene, toluene, and xylene). Installation of the monitoring network was completed in April 2005, but shut down in February 2006 due to contractual disputes between the Department of Environment and Natural Resources (DENR) and the private operator of the network.

MO has two existing ambient air quality monitoring stations that measure PM10 and PM2.5 concentrations. One of these stations also measures $O_3$, $NO_2$, $SO_2$, benzene, toluene, and xylene concentrations. PNRI has four existing sampling sites in Metro Manila that monitor PM10 and PM2.2, three of which are colocated with the MMAAAQMN. PM samples collected by PNRI are also used in source apportionment studies.

PNRI has an ongoing particulate monitoring program which collects data from five stations in Metro Manila: Ateneo de Manila University, University of Sto. Tomas, Poveda Learning Center, Vista Verde Homes in Cainta, and the La Mesa Dam. The program started in 1996, with occasional interruptions, but with enough length to allow calculations of annual average concentrations from 24-hour readings. Data is collected using dichotomous samplers that simultaneously measure PM10 and PM2.2, which may be taken to be equivalent to PM2.5. (ECAP, 2006). Raw data are not available, although a summary was obtained from an unpublished report (Santos, 2005).

**Other Cities**. Cebu City and Cagayan de Oro City each has one continuous automatic monitoring station that measures PM10, $NO_2$, $SO_2$, $O_3$, benzene, toluene, and xylene. EMB-Region 11 manually monitors $SO_2$, $NO_2$, and CO in four locations in Davao City. EMB regional offices in Davao City and Baguio City are in the process of establishing their ambient air monitoring stations similar to that in Cebu City.

The summary of the information on ambient air quality monitoring stations in the Philippines is presented in Table 3.2:

TABLE 3.2

**Existing Ambient Air Quality Monitoring Stations in Major Cities in the Philippines**

| Agency/Organization | Station | Pollutants and Method of Sampling and Measurement | Status |
|---|---|---|---|
| EMB – DENR through a sub-contractor | Valenzuela City<br>Taguig City<br>Manila<br>MO, Quezon City<br>Muntinlupa City<br>Pasig City (mobile van)<br>Batangas City<br>Indang, Cavite<br>Angeles City<br>Los Baños, Laguna | $O_3$ – UV photometric<br>$SO_2$ – pulsed florescence $SO_2$<br>CO – gas filter correlation<br>NOx – chemiluminescence<br>PM10, PM2.5 – BAM<br>BTX – DOAS[a]<br>HC – cross-flow modulated selective combustion with hydrogen ion detection | Shut down since March 2006 |
| MO–AdeMU | MO, Quezon City | PM10, PM2.5 – low volume sampler<br>DOAS – $SO_2$, $NO_2$, $O_3$, and BTX | Operational |
| | Good Shepherd Spiritual Center, Antipolo City | PM10, PM2.5 – low volume sampler | |
| PNRI-DOST | MO, Quezon City<br>Poveda Learning Center, Mandaluyong City<br>Valenzuela City<br>Taguig City | PM10 and PM2.2 – gent dichotomous sampler<br>Lead using XRF[b] | Operational |
| EMB Region VII | Cebu City | TEOM – PM10<br>DOAS – $NO_2$, $SO_2$, $O_3$, benzene, toluene, and xylene | TEOM – not operational since 2005<br>DOAS – operational |

BTX = benzene, toluene, and xylene, CO = carbon monoxide, DENR = Department of Environment and Natural Resources, DOAS = differential optical absorption spectroscopy, DOST = Department of Science and Technology, EDSA = Epifanio delos Santos Avenue, EMB = Environmental Management Bureau, HC = hydrocarbon, MO = Manila Observatory, $NO_2$ = nitrogen dioxide, $O_3$ = ozone, PM2.2 = particulate matter with diameter less than 2.2 micrograms, PM2.5 = particulate matter with diameter less than 2.5 micrograms, PM10 = particulate matter with diameter less than 10 micrograms, PNRI = Philippine Nuclear Research Institute, $SO_2$ = sulfur dioxide, TEOM = tapered element oscillating microbalance, TSP = total suspended particulate, USEPA = United States Environment Protection Agency, XRF = X-ray fluorescence

[a] Only in Quezon City and Valenzuela City stations.

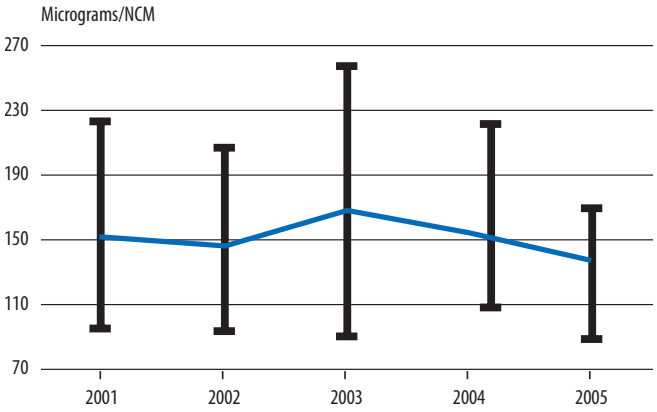
[b] Analysis is done only for the Ateneo de Manila University station.

Source: National Air Quality Status Report, 2003–2004. EMB.

Some of the large industries maintain their own ambient monitoring programs as required by the Philippine Environmental Impact Studies System. Data are submitted as part of the self-monitoring reports to the regional offices of DENR-EMB. Quality assurance/quality control strategies for these stations are not known and data compilations are not available.

Currently, the calibration of equipment is outsourced by the government and is not adequate to meet the requirements in the entire country. There are no available data on the calibration activities conducted.

FIGURE 3.1
**Ambient TSP Concentration in Metro Manila, 2001–2005**




EMB = Environmental Management Bureau, NCM = normal cubic meter, TSP = total suspended particulate
Source: EMB, 2006.

# Ambient Air Quality

The air pollutant most studied in Metro Manila has been PM in its various forms. An extensive record of monitoring data for TSPs, especially on the roadside, is available. Latest available ambient air monitoring data in Metro Manila shows that roadside TSP concentrations exceed the annual mean guideline value. Annual mean PM2.5 concentration exceeds the United States Environment Protection Agency (USEPA) guideline value in all monitoring locations. PM10 concentrations did not exceed the annual mean and 24-hour guideline values. $SO_2$, $NO_2$, and Pb ambient concentrations are below the short- and long-term guideline values.

There are only limited historical data on air quality in Metro Manila and in other major urban centers from 2000 to 2004. There is no significant improvement in air quality as far as PM10 and PM2.2 are concerned. There was a significant decrease in ambient Pb concentration because of the phasing out of Pb in December 2000.

## TSP

**Metro Manila.** Based on monitoring data from eight locations, TSP concentrations in Metro Manila have not improved with a decrease of only 9% from 2001 to 2005 (refer to Figure 3.1). The slight improvement from 2001 to 2002 was negated by the increase from 2002 to 2003. In the last 2 years, concentrations decreased by about 9% annually. In 2005, TSP concentrations in 10 out of 11 DENR-EMB roadside TSP monitoring locations in Metro Manila exceeded the 90 μg/m$^3$ Philippine annual mean TSP guideline value (24-hour sampling). The two highest annual mean values (323 μg/m$^3$ and 213 μg/m$^3$) were measured along EDSA, Metro Manila's busiest thoroughfare.

**Major cities and urban centers.** In 2005, 45% of the 29 operational stations exceeded the annual mean guideline value.

## PM10

**Metro Manila.** In 2004, mean annual PM10 concentrations measured were below the 60 μg/m$^3$ Philippine guideline value. Concentrations based on a 24-hour averaging time have been within value except during the New Year because of heavy use of fireworks.

PM2.5 levels are compliant to the short-term standards of USEPA. Trends for annual means indicate noncompliance to the long-term standard.

**Other cities.** Monitoring in Cagayan de Oro City in 2003 showed that 24-hour and annual mean PM10 concentrations are below the guideline values.

## PM2.5 and PM2.2

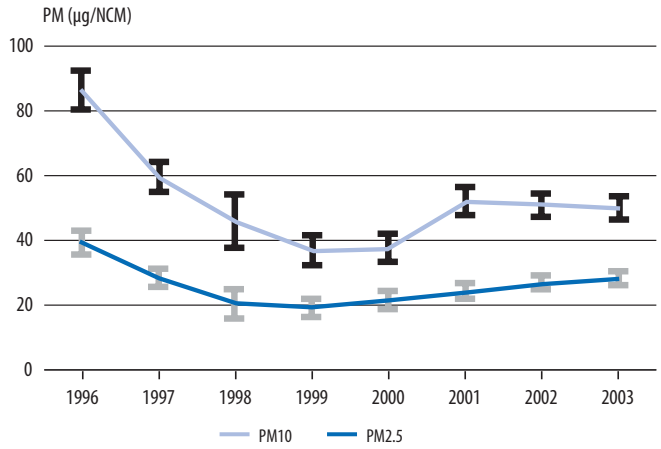
**Metro Manila.** In 2004, mean annual PM2.5 concentrations measured in the four MO–AdeMU stations exceeded the 15 μg/m$^3$ USEPA guideline value. PNRI-Department of Science and Technology monitored PM2.2 concentrations in its three

stations also exceeded the USEPA annual mean guideline value for PM2.5 while the 24-hour concentrations exceeded more than 50% of the time in two of the stations and more than 75% of the time in one station.

Annual mean PM10 and PM2.2 concentrations measured by PNRI at their AdeMU station show a sharp decrease from 1996 to 1999 and a gradual increase from 1999 to 2003. The decrease and the increase in PM10 and PM2.2 concentrations can be explained by the corresponding decrease and increase in private vehicle sales (Anglo, 2006). However, trends from another PNRI station along EDSA show no significant change in PM10 and PM2.2 from 2001 to 2004.

FIGURE 3.2

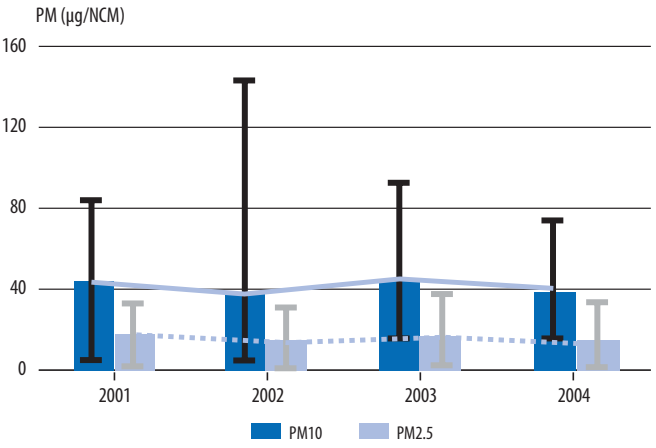
**PNRI PM10 and PM2.5 (ug/m³) Monitoring Data—Ateneo Station**




EMB = Environmental Management Bureau, NCM = normal cubic meter , PNRI = Philippine Nuclear Research Institute, PM2.5 = particulate matter with diameter less than 2.5 micrograms, PM10 = particulate matter with diameter less than 10 micrograms, ug/m3 = microgram per cubic meter
Source: EMB, 2006.

FIGURE 3.3

**PNRI PM10 and PM2.5 (ug/m³) Monitoring Data—Poveda Station**



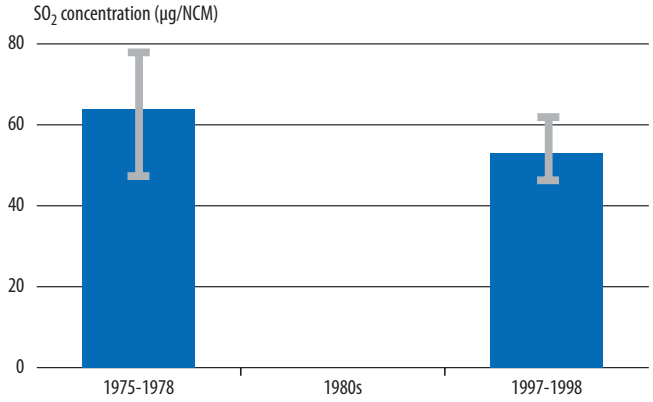

EMB = Environmental Management Bureau, NCM = normal cubic meter , PNRI = Philippine Nuclear Research Institute, PM2.5 = particulate matter with diameter less than 2.5 micrograms, PM10 = particulate matter with diameter less than 10 micrograms, ug/m3 = microgram per cubic meter
Source: EMB, 2006.

## $SO_2$

**Metro Manila.** Historical $SO_2$ data in Metro Manila shows compliance with the annual $SO_2$ guideline value of 80 µg/m³ (Figure 3.4). In 2003, measurement at the MO–AdeMU monitoring station reported that the 1-hour, 24-hour, and annual mean $SO_2$ concentrations are within the guideline value (Figure 3.5).

FIGURE 3.4

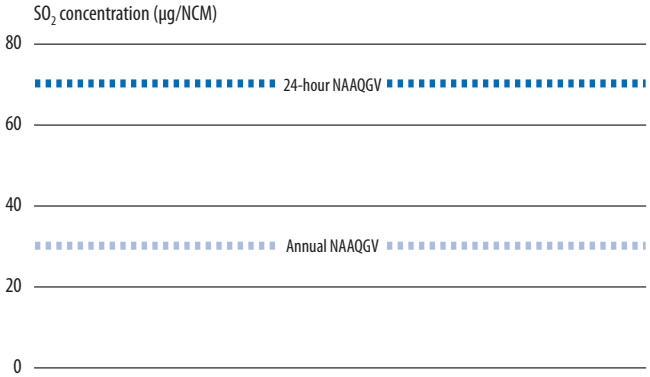
**Historical $SO_2$ Data for NCR**




EMB = Environmental Management Bureau, NCM = normal cubic meter, NCR = National Capital Region, NAAQGV = national ambient air quality guideline values, $SO_2$ = sulfur dioxide, ug = microgram
Source: EMB, 2006.

FIGURE 3.5

**$SO_2$ Monitoring Data for Ateneo Station**




EMB = Environmental Management Bureau, NCM = normal cubic meter, NCR = National Capital Region, NAAQGV = national ambient air quality guideline values, $SO_2$ = sulfur dioxide, ug = microgram
Source: EMB, 2006.

**Other Cities.** In 2003, $SO_2$ concentration in the cities of Davao and Cagayan de Oro are well below the 24-hour and annual average guideline values.

## $NO_2$

**Metro Manila.** In 2003, the MO–AdeMU station reported 24-hr concentrations were well below the guideline values. The highest concentration using 24-hour averaging time was 0.03 parts per million (ppm), much lower than the 0.08 ppm guideline value.

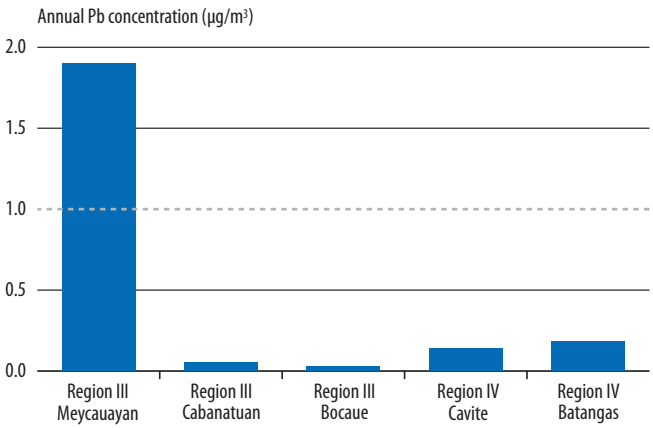
## Lead

**Metro Manila.** Monitoring data from PNRI showed that in 2003, the annual average concentration of Pb in the ambient air was much less than the 1.0 µg/m³ national ambient air quality guideline value (NAAQGV); and

Annual Pb monitoring in Region 3 for 2005 shows the Meycauayan Station registered an annual mean high value of 1.89 µg/m³, which exceeded the NAAQGV (1.0 microgram per cubic meter [ug/m³]). For Region 4, annual Pb concentrations at the two monitoring stations are way below the standard (Figure 3.6).

FIGURE 3.6

**Lead (µg/m³) Monitoring Data for Regions III and IV**




EMB = Environmental Management Bureau, ug/m³ = microgram per cubic meter
Source: EMB, 2006.

# Reporting of AQ Information

The air quality data is compiled and published by DENR-EMB, but the availability of compiled data to users is delayed. Data interpretation and impact analysis of various interventions on air quality are also not being carried out in detail. DENR-EMB publishes National Air Quality Status Reports, the most recent covers 2003 to 2004. The publication documented the air quality, sources of air pollutants, quantitative accomplishment assessment, and evaluation in relation to the CAA, improvement of air quality in major Philippine cities, specifically Metro Manila. Real time air quality reporting for MMAAAQMN is yet to be established.

Real time monitoring data of MO is available through their website (www.observatory.ph/resources/doas/doas.php). Real time monitoring data for Cebu City and Cagayan de Oro City can be accessed through http://airquality-philippines.com.

» Part Four

# Impacts of Air Pollution

A number of international studies have computed the numbers of pollution-related excess deaths and incidence of disease, and associated costs (CAI-Asia, 2006). There is limited information on the economic and human health effects of air quality in the Philippines, but previous assessments suggest that poor air quality is a major incremental drain on the national economy through premature death and chronic respiratory illnesses; and PM is the largest contributor to these effects (ADB, 2005b). World Bank estimated in 2001 that the health costs of PM10 pollution in Metro Manila, Cebu, Davao, and Baguio cities reach more than $400 million. This cost is equivalent to almost 0.5% of the 2004 Philippine GDP. Accordingly, the World Bank Philippine Environment Monitor 2004 computed that the annual estimate for urban heath cost can amount to over $1.5 billion or 1.8% of the 2004 GDP. Nonetheless, most of the health impacts studies are focused only in Metro Manila.

A Department of Health Study (2004) reported, "considerable morbidity and mortality due to respiratory and cardiovascular diseases could have been prevented with better air quality in Metro Manila in 2002." The report estimated the following numbers of morbidity and mortality attributable to PM10 level higher than 50 μg/m$^3$ (Table 4.1).

TABLE 4.1

**Air Pollution Impacts on Public Health of Metro Manila**

| Morbidity | Mortality |
|---|---|
| 10,000 excess cases of acute bronchitis | 40–200 persons due to cardiovascular causes |
| 300 excess cases of asthma | 300–330 persons due to respiratory causes |
| 9 excess cases of chronic bronchitis | |

Source: DOH, 2004.

Perception survey on air pollution conducted by the Philippine Information Agency in 2001 revealed that more than 72% of residents in Manila were alarmed by air pollution and 73% said that the government was not taking any action to control it (DENR and PIA, 2001).

An Asian air pollution survey conducted by Synovate in December 2004 showed that 98% of residents in Manila are affected by the city's air pollution and 71% believed that the air quality has worsened over the past year. 82% of the respondents indicated that they were experiencing irritation to their eyes, nose, and throat; 57% experienced breathlessness or have more difficulties in breathing; and 27% attributed skin problems to pollution (Synovate, 2005). The results of the survey demonstrated that residents believe air pollution has a significant impact on their lives and that the problem was not improving.

There are no plans to establish nor to strengthen national and local epidemiological monitoring programs. Limited ambient air quality data in the Philippines is a deterrent to the identification of correlation between the severity of air pollution and its health effects on the exposed communities. Other gaps include: limited exposure-assessment data to estimate the presence and severity of health outcomes related to air pollution and establishing exposure-response relationship coefficients; studies to estimate public exposure to potential health impacts from air pollution is limited to Metro Manila; limited implementation of standardized health reporting and recording system; and the absence of a centralized system for the collection of health-related data with respect to air pollution.

» Part Five

# Air Quality Management

## Legislation and Mandate

Activities in environmental and natural resource management[1] in the Philippines are guided by the following overarching policy frameworks: (i) 1977 Philippine Environmental Policy[2] (Presidential Decree [PD] 1151); (ii) 1977 Environment Code[3] (PD 1152); (iii) 1989 Philippine National Strategy for Sustainable Development[4]; and (iv) 1996 National Action Plan for Sustainable Development[5] (Philippine Agenda 21, Appendix 5). The major legal instrument guiding urban AQM is RA 8749 or the Philippine CAA[6], signed into law in 1999. The National Air Quality Improvement Framework and Action Plan prepared by DENR as part of the Implementing Rules and Regulations of the CAA is one of the sector or agency strategies and plans for urban AQM.

DENR is mandated to be the primary government agency responsible for urban AQM. EMB, one of the six staff sectoral bureaus under DENR, functions as the policy-making and standard-setting body and provides technical services related to AQM. At the operational level, functions are decentralized to three levels: (i) Regional Environment and Natural Resources, (ii) Provincial Environmental and Natural Resources Offices (PENROs), and (iii) City/Community Environment and Natural Resources Offices (CENROs). A regional office is established in each of the 15 administrative regions performing regulatory functions and delivering mandates that mirror the bureaus at the central level. The regional offices are also authorized to issue permits, monitor ambient environmental quality conditions, and take appropriate enforcement actions against violators of permits and environmental standards. PENROs and CENROs perform regulatory functions and are responsible for public complaint-driven surveillance, facility inspection, review of environmental impact assessments, and the evaluation of authorizations to construct and permits to operate.

To implement the CAA, DENR's EMB has been transformed into a line bureau. As a line bureau, EMB is expected to be involved in the operational aspect of the CAA. However, its structure, work force, and resources are still insufficient to respond to the needs of CAA's enforcement.

There is no or little up-to-date information available on appropriations expenditure to urban AQM in the Philippines. DENR receives an extraordinarily small share of the national budget. ADB's country environment assessment report cites that about 70% of appropriations to DENR have historically been for core programs, with the remainder being for targeted projects. EMB has an extremely large and growing mandate, but continues to receive a very small percentage of DENR's overall budget.

Interagency collaboration remains a challenge despite many multi-sectoral working committees and memoranda of agreement. Local government units (LGUs) have the authority and/or circle of influence to implement the CAA strictly, but lack AQM capabilities and under-prepared to carry out the functions devolved to them by the CAA.

[1] Environmental legislation enacted during the 1970s (under martial law) was in the form of presidential decrees. After martial law, additional legislations were enacted—mostly in the form of republic acts. By the powers vested in them by the executive branch, Philippine departments promulgate procedures and policies through administrative orders. Policy directions and administrative orders are also issued by the President's Office through executive orders.

[2] Designates the Department of Environment and Natural Resources as the implementing authority.

[3] Provides the framework and mandates necessary policies to implement a "comprehensive program of environmental protection and management" for air and water quality as well as waste management.

[4] Overall goal is to achieve economic growth with adequate protection of the country's biological resources and its diversity, vital ecosystem functions, and overall environmental quality.

[0] Provides goals and guidelines for sustainable national development and identifies main themes and specific regions that will be targeted.

[6] The Clean Air Act lays down policies to mitigate air pollution, sets standards for vehicle owners and manufacturing industry, imposes/sets fines and penalties for violators of the law, and outlines the different programs to be implemented by the government and other sectors to manage air quality.

The Philippines is unique in Asia with the airshed approach to AQM. The concept is derived from the CAA of the United States, which uses air quality control regions as the basis for AQM. The CAA divides the entire country into airsheds[7] to facilitate monitoring. Each airshed has a governing board (GB) which will function as a policy and planning organization to complement the regulatory functions provided by DENR-EMB. In addition, GB coordinates the actions of other governmental agencies in the airshed, provides a forum to gather input from the public, and disseminate important information to the public. They shall formulate local policies and standards based on the national guidelines. The board shall also prepare a comprehensive plan, coordinate the functions of its members, and publish an annual air quality status report for each airshed. The activities of GB and its technical secretariat are to be funded by the Air Quality Management Fund. The sources of funds include air emission charges, fines and penalties, grants, and fees.

When implemented properly, the airshed concept can be a powerful tool for generating a consensus for defining air quality goals and action plans to improve air quality.

In support of the implementation of the CAA, the Philippine Government has secured a loan from ADB. Although the loan is aimed at improving the air quality in the Metro Manila airshed, the activities of the program have also gained positive impacts on the national policies especially those relating to management of mobile sources of pollution (Box 5.1).

Under CAA, LGUs share the responsibility of managing and maintaining air quality within their territorial jurisdiction. However, DENR is required to provide LGUs with technical assistance, training, and continuing capability-building to prepare them to undertake full administration of AQM and regulation. This has not yet materialized. Furthermore, CAA calls for the establishment of an environment and natural resources officer or any other officer for each LGU who is tasked to assist LGUs in the implementation of CAA through the preparation of AQM programs, giving technical assistance, and recommendation to the board air quality standards (Acosta, 2002).

To check the effectiveness of these air pollution control measures, MMAQISDP also facilitated the installation of ambient AQM stations and establish an air quality database, as the basis for strategy review and modifications of the measures. The program has assisted DENR in setting up nine fixed ambient stations and one mobile station to monitor the ambient air quality in Metro Manila. These nine stations have been fully operational since October 2004, and have been generating data that could be displayed to the public.

Further to the above policy reforms and investment supports, MMAQISDP also recognizes the vital role of the government's enforcement capacity. Capacity-building activities were provided to DENR, Pollution Adjudication Board, DOE, DOTC, and the Metro Manila Development Authority staff to increase their knowledge on air pollution and strengthen their capacity for enforcement. The Supreme Court also acknowledged the importance of the judiciary's role in air pollution control, and conducted training for judges—with MMAQISDP's support—to familiarize them with CAA and other environment regulations.

BOX 5.1

**Metro Manila Air Quality Improvement Sector Development Program**

ADB, as a major development partner of the Philippines, has been working actively with the government to address the air pollution issues in the country since 1998, with emphasis on those associated with transport sector.

ADB has been providing assistance through lending and technical supports. The Metro Mania Air Quality Improvement Sector Development Program, approved in December 1998, was the first and the most comprehensive program provided by ADB to support the government's CAA.

The primary objective of the program is to improve air quality in Metro Manila Airshed (Metro Manila, Regions III, and IV, through the abatement of the main mobile and stationary sources of air pollution using integrated medium- to long-term control measures.

The program helps the government reduce air pollution through policy reform, capacity building, and infrastructure investment for public and private sectors.

Major objectives and activities of the program include:

(i) improvement of fuel quality;
(ii) improvement of vehicle emission inspection and maintenance;
(iii) implementation of an anti-smoke belching program;
(iv) rehabilitating ambient air quality monitoring system;
(v) strengthening regulatory enforcement; and
(vi) raising public awareness.

MMAQISDP is coordinated by DENR. Participating institutions include EMB, regional offices of DENR, Metro Manila Development Authority, Laguna Lake Development Authority, DOTC, LTO, Department of Trade and Industry, DOE, Department of Public Works and Highways (DPWH), Department of Health (DOH), LGUs, and nongovernment organizations (NGOs).

[7] An airshed is a contiguous area with common air sources of air pollution and weather or meteorological conditions that affect the interchange and diffusion of pollution in the surrounding atmosphere.

# Ambient AQ Standards

Table 5.1 compares the Philippine guideline values with the World Health Organization (WHO) guidelines and standards implemented in the US. The Philippine guideline values for short- and long-term PM10, $SO_2$, are more lenient compared to WHO values and relatively similar to USEPA values. These standards were established in 1999. There is no information on government plans to change the standards in response to updates released by WHO in 2005.

TABLE 5.1

**Philippine Guideline Values vs. WHO Guidelines and US Standards (ug/m³)**

| Pollutant | Averaging Time | Philippine NAAQGV[a] | WHO (2005)[b] | USEPA[d] |
|---|---|---|---|---|
| TSP | 24 hours | 230 | — | — |
| | 1 year | 90 | — | — |
| PM10 | 1 hour | 200 | — | — |
| | 24 hours | 150 | 50 | 150 |
| | 1 year | 60 | 20 | revoked |
| PM2.5 | 24 hours | — | 25 | 15 |
| | 1 year | — | 10 | 35 |
| $SO_2$ | 10 minutes | — | 500 | — |
| | 1 hour | 340 | — | — |
| | 24 hours | 180 | 20 | 365 (0.14 ppm) |
| | 1 year | 80 | — | 78 (0.03 ppm) |
| $NO_2$ | 1 hour | 260 | 200 | — |
| | 24 hours | 150 | — | — |
| | 1 year | | 40 | 100 |
| $O_3$ | 8 hours | 60 | 100 | 157 (0.08ppm) |
| | 1 hour | 140 | — | 235 (0.12ppm) |
| CO | 1 hour | 35,000 | 30,000[c] | 40,000 |
| | 8 hours | 10,000 | 10,000[c] | 10,000 |
| Pb | 1 year | 1 | 0.5[c] | — |
| | 3 months | 1.5 | — | 1.5 |

DENR = Department of Environment and Natural Resources, NAAQGV = national ambient air quality guideline values, NO2 = nitrogen dioxide, Pb = lead, PM2.5 = particulate matter with diameter less than 2.5 micrograms, PM10 = particulate matter with diameter less than 10 micrograms, ppm = parts per million, SO2 = sulfur dioxide, TSP = total suspended particulate, ug/m3 = microgram per cubic meter WHO = World Health Organization, US = United States, USEPA = United States Environment Protection Agency

Sources: [a] DENR (1999), [b] WHO (2005), [c] WHO (2000) and [d] USEPA (2006).

# Management of Mobile Sources

The continuing increase in motor vehicles and population, inadequate mass transit system, and worsening traffic conditions further contribute to increasing air pollution. ADB (2002) cites that in the past, mobile sources occupied a lesser place in Philippine environment regulation. This is being addressed by CAA which specifies emission standards for different classes of vehicles. Compliance with emission standards is a condition for the registration of all new vehicles. The requirement of passing an emission test before registration was implemented starting 1 January 2003. Emission tests of private vehicles were conducted in Private Emissions Testing Centers (PETC) authorized by DOTC and duly accredited by the Department of Trade and Industry.

**Emission Standards.** EMB set the maximum HC emissions from motorcycles and tricycles at 7,800 ppm for those operating in urban centers and 10,000 ppm for those operating in rural areas or outside urban centers. (Department Administrative Order [DAO] No. 2003 – 25). The bureau also issued revised emissions standards for in-use gasoline-fed and diesel vehicles (DAO 2003 – 51).

a. All motor vehicles (MV) must comply with exhaust emission standards;
b. Prior to registration and operation in public highways; and
c. Types of MV regulated: new, in-use, rebuilt and imported, used/secondhand completely built units (CBUs) including motorcycles/tricycles

**Fuel Quality.** Leaded gasoline was phased out in December 2000. There was a reduction of aromatics and benzene in gasoline to 35% and 2% by volume, respectively in 2003; and a reduction of sulfur content of automotive diesel fuel to 0.05% by weight in 2004. For diesel quality, with respect to sulfur content, the Philippines is at Euro 1 level. Starting 1 July 2007, if the present administrative orders will be in place, both the fuel quality with respect to sulfur limits (diesel and gasoline) and the standards for new vehicles will be compliant with Euro II. The automotive industry has expressed its willingness to provide Euro IV-compliant vehicles by 2010; however, no policies are in place to adjust the present fuel standards in line with the Euro IV specifications.

**Fuel additive registration.** DOE issued permanent registrations to five fuel additives in 2003, while four were issued in 2004. Permanent registration is granted to fuel additives after screening their chemical components and ensuring that these chemicals do not contribute harmful emissions.

**Coco-Methyl Ether.** Beginning July 2004, government vehicles were required to use diesel fuel blended with 1% CME. Biodiesel refueling pump stations have been set up inside the Philippine Coconut Authority compound in Metro Manila. The Philippine National Standard for CME was established in 2004 (EMB, 2006)

**Compressed Natural Gas (CNG).** The Natural Gas Vehicle Program for Public Transport was launched in 2002. A mother-daughter fueling system will be set up in Batangas for Region IV and in Metro Manila to promote the use of CNG by 100 public buses. The Development Bank of the Philippines approved the loan applications of several companies for the acquisition of CNG buses. Incentives and privileges include income tax holiday for qualified NGV industry and related activities. In addition, only 1% rate of duty is levied on imported NGVs, NGV engines, and other related equipment, facilities, parts, and components. Through MMAQISDP, the government (through the DOE) has prepared a CNG Master Plan for the development of natural gas infrastructure.

**Liquefied Petroleum Gas (LPG).** Initiatives on the use of LPG as automotive fuel are private sector-led. At present, about 5,000 cars around the country—mostly taxis—are already running on LPG. Price is the biggest obstacle to a more widespread use of LPG. A conversion kit, which is imported from Europe, for carburetor engines costs P25,000 ($500), including the LPG tank and the labor to install it. The kit for a fuel injection engine costs P50,000 ($1,000). The other obstacle is the lack of refilling stations to serve the needs of the growing fleet of taxis running on LPG.

**Ethanol.** Four Shell stations carry premixed ethanol fuel that can be used in gasoline engines.

**Anti-Smoke Belching Campaigns.** In 2004 and 2003, a total of 16,250 and 21,141 diesel vehicles, respectively, were apprehended for smoke emissions (Box 5.2). From 2000 to September 2003, the teams tested more than 67,000 vehicles. As of 2006, more than 56 million pesos of fines were collected from emission violators and contributed to the Air Quality Management Fund. The government has also actively rehabilitated the main thoroughfares of Metro Manila to reduce traffic congestion and thus improve traffic flow and reduce vehicular emissions.

BOX 5.2

**Anti-Smoke Belching Campaign**

A Metro Manila Anti-Smoke Belching Association (MMASBA) has been established in Metro Manila in 2005. MMASBA formulated an action plan, consistent with the AQM framework prescribed in CAA to complement the anti-smoke belching activities of the government. Currently, the association has mobilized the participation of 17 Metro Manila LGUs through the enactment of local ordinances, capacity building, and roadside apprehension.

Another initiative is the "Take a Picture for Clean Air," where MMASBA serves as 'roadside enforcers'. Pictures of smoke-belching vehicles are submitted to the Integrated Bar of the Philippines (IBP) for appropriate action. IBP will then send notices to sue the owner/operators of vehicles; the latter will be given 30 days to submit the vehicles to LTO for emission testing. This gives MMASBA members who caught the smoke-belching vehicles on camera the right to sue them under the citizen suit provision of CAA. IBP, through its volunteer lawyers, will represent the members of MMASBA in the suit.

**Motor Vehicle Inspection System.** This is another activity of MMAQISDP aimed at improving the operation and maintenance of vehicles to ensure that their emissions meet national standards. ADB encouraged the DOTC to first privatize its own six lanes for the Motor Vehicle Inspection System to demonstrate the efficiency of the system. DOTC has yet to improve the six lanes. Alternatively, more than 130 private emission testing centers have been set up in Metro Manila, which also serve the purpose of vehicle emission testing. DENR, DOTC, and the Department of Trade and Industry have set up jointly a work force to monitor the testing centers, which invites the public and NGOs to participate and ensure their performance.

**Tricycle Improvement Strategy.** Motorized tricycle operators and drivers usually have very low incomes and have low capacities to accommodate regulatory requirements, making it difficult for them to maintain their tricycles properly and avoid air pollution problems. The government is working toward pilot testing a set of strategies that would include both technical solutions and social supports to tackle the problem of air pollution from tricycles.

## Management of Stationary Sources

All stationary sources of air pollution are required to submit to DENR-EMB, on a quarterly period, a self-monitoring report to monitor compliance with emission standards. Periodic auditing, monitoring, and source stack sampling are being conducted by the regional offices. The method followed is based on USEPA procedures. Major industrial facilities such as power plants, petroleum/petrochemical plants, and cement plants are required to install continuous emissions monitoring systems. Incinerators that emit toxic and hazardous fumes are banned in the Philippines.

**Tax Incentives.** Assistance was extended by DENR to industries with the issuance of DAO 2004-53 (Guidelines to Implement the Tax Incentive Provision of the Philippine CAA of 1999). The guidelines apply to the installation of pollution control devices or retrofitting of existing facilities with mechanisms that reduce emissions. Under DAO, industrial firms can avail of the following tax incentives provided by the National Internal Revenue Code of 1997:

- Accelerated depreciation;
- Deductibility of research and development expenditures;
- Tax credits;
- Exemption from real property tax; and
- Tax incentives for qualified enterprises operating within a special economic zone and freeport zones

**Issuance of Permits.** DENR also rationalized procedures to systematize the process of issuing air pollution permits and its requirements (i.e., DENR deleted the authority to construct requirement prior to the installation of air pollution source equipment) as provided for in DAO 2004-26.

**Loan.** The Land Bank of the Philippines granted loans amounting to ¥721.636 million to four companies involved in transportation, manufacturing, and power generation as part of the $25 million (¥3,057 million) ADB-Air Pollution Control Facility loan. The ADB loan facility—aimed at financing investments in air pollution control devices and technology to improve air quality—was closed on 29 December 2003 because of low availment.

## Management of Area Sources

The Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003) prohibits the open burning of wastes. Enforcement of this provision ensures the elimination of emissions from waste burning, including the release of dioxins and furans.

Although road-sweeping activities are also conducted in urban areas, these are not specialized programs to tackle air pollution because most of the roads in cities are concrete and resuspended road dust has not been considered as main sources of pollution.

## Public/Nongovernment Participation

Multi-sector networks such as PCA (Philippines), a local network of CAI-Asia, help bring stakeholders together to take action to improve air quality in Metro Manila.

PCA is collaborating with IBP-National Environmental Action Team to operationalize the citizen suit provision of the Philippine CAA.

PCA also worked with one of the country's largest broadcasting networks (ABS-CBN) to conduct conferences, prepare public dissemination programs, and materials, and air TV and radio plugs to raise public awareness on air pollution-related issues. The Bantay Kalikasan Foundation of ABS-CBN also launched in 2000 its Bantay Usok campaign whereby the public can report to the foundation by mobile short messaging service plate numbers of smoke-belchers on the road. This NGO-initiated effort has enhanced the public's awareness on smoke belching and resulted in more than 10,000 vehicle apprehensions between 2000 and 2003.

Through a 4-year technical assistance from the United States Agency for International Development (until September 2008), initiatives to alleviate the deteriorating air quality condition in the country are underway with ECAP (Box 5.3)

BOX 5.3

**Energy and Clean Air Program (ECAP)**

ECAP is implemented in strong partnership with key government agencies such as DOE, the Energy Regulatory Commission DENR, and DOTC.

Operating in four project sites—Metro Manila, Cebu, Davao, and Baguio, ECAP seeks to help the government address the challenges facing the energy and clean air sectors, guided by its threefold mission to:

(i) Strengthen sector governance through institutional capacity building;
(ii) Improve policy frameworks through policy reforms and implementation; and
(iii) Increase public understanding and support through communication and outreach.

ECAP assists implementers of CAA in regular discussions and coordination meetings. It also provides the transport sector venues for dialogues with transport authorities and opportunities to learn best practices in inspection and maintenance. By focusing on mobile sources, ECAP also helps in strengthening the implementation of the anti-smoke belching program and in improving motor vehicle standards. It also promotes the use of alternative fuel that have more efficient combustion process. PM10 apportionment studies in Metro Manila and Davao are also being conducted to increase understanding of air pollution in these cities.

# Local Government Initiatives

LGUs are mandated by CAA and the Local Government Code to implement programs on AQM and to abate pollution coming from mobile, stationary, and area sources through the issuance of business permits to industries, commercial establishments, and institutions; franchising of three-wheelers (tricycles); and control of open burning of garbage. The League of Cities of the Philippines (LCP), an association of 117 cities, has established its environmental unit to coordinate, assist, and collaborate with agencies to harmonize efforts of several LGUs implementing their own Clean Air Management Programs (CAMPs).

The league has assisted the city governments of Mandaue (Cebu) and Calbayog (Samar) in establishing their own CAMPs. To extend this program to other cities, LCP Environment Unit is coordinating with PCA and CAI-Asia for possible cofinancing. LCP, in coordination with PCA and the United States Asia Environment Program (USAEP), organized a meeting in December 2005 where Philippine mayors learned from their peers about pioneering clean air programs and explored opportunities for partnerships on air quality projects.

» Part Six

# Conclusion

Rapid urbanization and economic growth, coupled by increased demand for motorization and energy, are putting increased pressures to the quality of the country's atmospheric environment. The country's main pollutant of concern is PM (coming mostly from mobile sources (primarily, motor vehicles) and stationary sources (mainly, power plants and boilers of various industrial processes). PM10 concentrations are higher in Metro Manila than other cities and urban centers but are within the 24-hour guideline values. PM2.5 annual mean concentrations in Metro Manila are above WHO and USEPA guideline values.

The high levels of PM in Manila and some other cities clearly indicate that they are having substantial impacts on the health of urban residents. However, limited information is available to assess these impacts, but the best recent estimates suggest that the cost of air pollution is equivalent to about $1.5 billion annually, about 1.8% of the national GDP in 2004. These findings clearly highlight the need to address priority air pollution issues.

Current strategies to reduce emissions are often short-term in nature and fail to address the problem adequately. More stress is given to end-of-pipe treatment and best available technology rather than implementing solutions that prevent pollution such as traffic demand management. Notwithstanding that economic instruments are in place, there is a need for improved implementation to encourage industries to adopt cleaner technologies and other conservation practices. Cost-benefit studies must be conducted before implementing new strategies and further studies are needed to assess and evaluate the impact on air pollution after the implementation of various interventions.

There is a general acceptance of the use of market-based instruments in the Philippines as an adjunct to command-and-control measures, and this acceptance is long-standing. Emissions fees in particular have political support in the government since they can both improve incentives regarding pollution and raise revenues for the relevant agencies for monitoring and enforcement.

The extent as to how polluted the air in the country is and how effective the measures to improve air pollution are not fully determined because of the inadequacy in efforts to monitor air quality. The capacity to monitor ambient air in terms of adequacy of equipment, frequency of monitoring, number of pollutants monitored and area of coverage is generally more advanced in the Metro Manila airshed. There is a need to upgrade the air quality monitoring capacity of cities outside Metro Manila. Improvements in the availability of air quality monitoring information in other urban areas will also allow the academe and the government to expand air-pollution related studies (such as source apportionment, dispersion modeling, and health impact studies) to these cities. To enlist public participation in increasing awareness on air pollution fully, there is also a need to improve on reporting activities of air quality monitoring results.

Technical capacity to undertake air-pollution related studies are limited in areas outside Metro Manila. Expertise of the academe, central government, and NGOs such as the National Center for Transport Studies, MO, Department of Health, and Central EMB office can be transferred to other cities via continuous training and education.

In terms of legislation, the Philippines is more advanced than many other countries in Asia. Although the implementation of the Philippine CAA had a slow start in the first few years following its promulgation, the law itself has paved the way for an increased awareness and policy making at the local and national levels. Recent examples are the development of fuel quality road maps, promotion of lower emission fuel (such as LPGs for taxis and CMEs for jeepneys).

Under CAA, DENR-EMB shares with LGUs the responsibility of managing and maintaining air quality within their territorial jurisdiction. Coordination within the central and regional

offices of DENR-EMB is weak and needs to be strengthened. There is the need to build the capability of regional offices as well as LGUs to manage local air quality.

Despite investments in air quality-related activities and projects being focused mostly in Metro Manila, the local government has shown its commitment and success in implementing air quality improvement activities. It can be expected that AQM capacity of the local government will be enhanced further once the airshed GBs are convened and funds from the Air Quality Management Fund are provided to finance the implementation of local air quality action plans. Private associations, multi-stakeholder networks, advocacy groups, academe, and NGOs as well as external funding agencies can also be tapped to improve AQM in the Philippines.

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