

Country Synthesis Report on Urban Air Quality Management

»» Cambodia

Discussion Draft, December 2006



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Abbreviations

ADB	Asian Development Bank
AQ	air quality
CAI-Asia	Clean Air Initiative for Asian Cities
CO	Carbon monoxide
CO ₂	Carbon dioxide
GDP	gross domestic product
Km	kilometer
LPG	liquefied petroleum gas
µg/m ³	micrograms per cubic meter
mg/m ³	milligrams per cubic meter
MOE	Ministry of Environment
NIS	National Institute of Statistics
NO ₂	Nitrogen dioxide
NO _x	Nitrogen oxides
O ₃	Ozone
PM	particulate matter
PM ₁₀	particulate matter with diameter equal or less than 10 micrometers
SO ₂	Sulfur dioxide
TSP	total suspended particulates
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

Note: “\$” means “US dollar” in this publication.

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General Information

Geography and Climate

Cambodia is a relatively small country in the Greater Mekong Subregion in Southeast Asia bordered in the northeast by the Lao People's Democratic Republic (Lao PDR), in the east and southeast by Viet Nam, in the west and northwest by Thailand, and in the southwest by the Gulf of Thailand (Chin 2006c). Its mainland area is 181,040 square kilometers (km²), about half the size of Japan and almost as big as Oklahoma (Central Intelligence Agency [CIA] of the United States of America 2006). Its coastline on the southwestern part of the country stretches to about 438 kilometers (km). The mainland is composed mostly of low flat plains, with mountainous regions in the north and southwest. In 2005, the proportion of land area covered by forest is 59.2%; 15 years ago, it was 73.3%. From 2000 to 2005, the annual rate of deforestation averaged 2%.

Cambodia is a tropical country, with relatively cooler temperatures in November to February and summer season from March to May. Monsoon season is from May to November. There is little temperature variation. The average temperature is 28°C, which goes up to 38°C in April and cools down to 17°C in January.

Urbanization and Population

The total population of the country was estimated at 13.8 million as of 1 July 2005 and grew at a rate of 1.9% annually (National Institute of Statistics [NIS] 2006). Cambodia's population density, as of 2005, was 78 persons/km² (NIS 2006). The Khmers are the ethnolinguistic group constituting most of the population of Cambodia. Most Khmers live along the Plain and the Tonle Sap Lake regions. As of 2005, only 17.7% of the population lives in the urban areas, a slight increase from 2001 levels of 16.0%. The annual growth rate of Cambodia's urban population is 4.5% (NIS 2006). Phnom Penh, the primary

city, has 1.5 million inhabitants. The other municipalities are Krong Keb, Krong Pailin, and Krong Preah Sihanouk. The rest of the population is sparsely distributed in the plateau and mountainous regions.

Economy and Industry

Cambodia has been in conflict for decades. It was only in 1999 that Cambodia started experiencing its first full year of peace and started gaining progress on economic reforms. Currently, however, it is still listed among the least-developed countries. In 2004, the proportion of the population living below the poverty line was 34.7%. Annual real growth rate of gross domestic product (GDP) was estimated at 8.4% in 2005—an improvement from 2004's 7.7%.

In the 1990s, agriculture contributed 55.6% to the national GDP and slowly decreased to 32.9% in 2005 (Asian Development Bank [ADB] 2006a). Cambodia posted next to Myanmar and the Lao PDR as among the countries in Southeast Asia with the highest agriculture share in GDP. The GDP contribution of the industry and services sectors, on the other hand, have both been increasing since the 1990s. The industry sector in 1990 only had a GDP share of 11.2% but this has grown to 29.2% in 2005. The services sector also showed a slight increase from 33.2% in 1990 to 37.9% in 2005 (ADB 2006a).

The garment and textile industry has been one of the main contributors of the industry sector GDP. With the January 2005 expiration of the World Trade Organization Agreement on Textiles and Clothing, however, Cambodia is now forced to compete with other countries, such as India and the People's Republic of China, which also have industries producing low-priced garments and textiles (CIA 2006). Cambodia also exports shoes, cigarettes, natural rubber, rice, pepper, wood, and fish (World Health Organization [WHO] 2004). Fishing

along the Tonle Sap Lake contributes about 80% of the total inland fishing produce, with contributions from the Mekong River and its tributaries (ADB 2004). Tourism along the Angkor Wat in Siem Reap Province also provides considerable contribution to the economy.

Energy

Most of the commercial energy used for power generation, transport, industry, residences, and commercial sectors comes from petroleum. Cambodia had consumed 115 million kilowatt per hour (kWh) of electricity in 2003 (CIA 2006). Diesel fuel is the principal source of electricity generation, but alternative energy sources, such as hydroelectricity, clean coal, natural gas, solar, and wind power, are being considered to reduce reliance over petroleum products (Te 2004). Gasoline, diesel oil, jet fuel, kerosene, and liquefied petroleum gas (LPG) are all imported from the region. Transport sector consumes 65% of petroleum products (Ministry of Environment [MOE] and Ministry of Public Works and Transport [MPWT] 2005). Most of the energy consumed comes from biomass burning, particularly firewood and charcoal, for rural activities and industries.

Electricity coverage in the country is limited and fragmented (ADB 2006b).¹ As such, generators are popularly used by the services sectors to meet the demand. These generators are usually located inappropriately along the road or adjacent to the services, thus contributing to roadside air pollution and noise disturbance (ADB 2004). Importation of second-hand generators is not controlled.

Transport

The transport system network in Cambodia, including the road and rail infrastructure, has been heavily damaged by decades of conflict. As of 2005, there are 602 km of railways with 1-meter gauge (Wikipedia 2006) throughout Cambodia and these are linked to adjacent countries through the Trans-Asian Railway (United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP] 2006b). Aside from the usual train coaches, locals in the northwestern part of the country

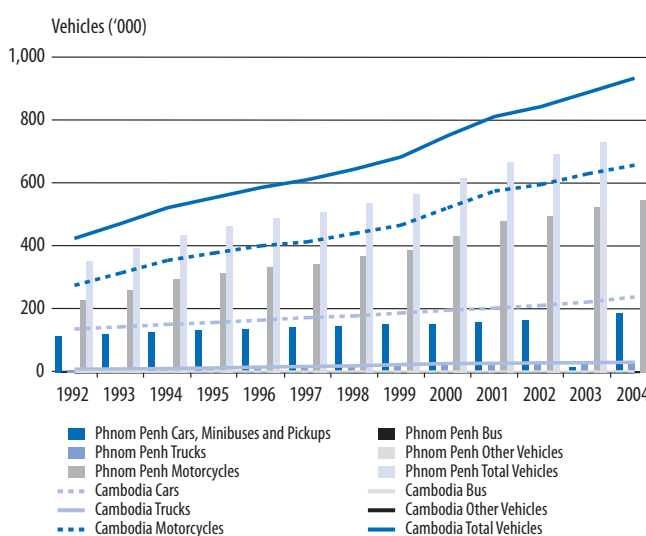
use bamboo railway, known to locals as *nori* or “lorry”. These custom coaches are actually bamboo platforms on wheels that use gasoline-fueled electricity generators (De Launey 2006). Most of the roads in Cambodia are either earthen or gravel. Of the 12,323-km total road network in 2000, only 16.2% is paved (International Road Federation 2004). As such, road dust resuspension contributes to particulate matter (PM).

Road transport vehicles in Cambodia are composed mostly of motorcycles, followed by cars, then trucks. Buses and other vehicles account for less than 1% of the total vehicle fleet. This pattern is reflected in Phnom Penh’s vehicle composition, as it accounts for 82% of the vehicles in Cambodia. Motorization has been steadily increasing in Phnom Penh at an average of 7% annually. The total vehicles in Phnom Penh more than doubled in 12 years (Figure 1.0).

Recently, there have been initiatives from taxi operators and private car owners to convert their engines to run on gas. The price of gas is half that of petrol. Private garages in Phnom Penh have been providing this service but the Ministry of Public Works and Transport has yet to come up with a draft permit for this kind of conversion (Sokha 2006). Unregulated and improper conversions may lead to leaks that release hydrocarbons and prove detrimental to the atmosphere.

FIGURE 1.1

Motorization Growth in Cambodia and Phnom Penh



Sources: Ministry of Public Works and Transport (MPWT) data, Phnom Penh Municipal Traffic Police data, and National Institute of Statistics (NIS) estimates. Quoted in NIS. 2005. *2005 Yearbook*. Available: <http://www.nis.gov.kh/PERIODIC/Yearbook%2003/Yearbook05.htm>

¹ Cambodia's electricity demand is provided by 24 isolated power systems in various provincial cities (ADB 2006b).

Sources of Air Pollution

Emissions Inventory

Emissions inventories of air pollutants are not conducted regularly in Cambodia. Apart from Cambodia's first national communication (MOE 2002) to the United Nations Framework Convention on Climate Change in October 2002, there is no information on whether other inventories have been conducted. The National Communication contained greenhouse gas emissions inventory for base year 1994. However, due to poor activity data, it may be expected that the quality of the emissions inventory may likewise be poor.

Table 2.1 lists the emissions in 1995 as reported in the World Resources Institute's Climate and Atmosphere country profile on Cambodia (World Resources Institute Earth Trends 2003). There was no update on this inventory and, as of this writing, there was no plan from MOE to do so.

TABLE 2.1

Non-CO₂ Air Pollution Emissions in 1995 (metric tons, '000)

Pollutant	Cambodia
Sulfur dioxide	18
Nitrogen oxide	67
Carbon monoxide	2,301
Nonmethane VOC	168

CO₂ = Carbon dioxide; VOC = volatile organic compounds

Source: World Resources Institute Earth Trends. 2003. *Earth Trends Country Profiles: Climate and Atmosphere – Cambodia*. Available: http://earthtrends.wri.org/pdf_library/country_profiles/cli_cou_116.pdf

At the moment, there is no information on source apportionment studies for Cambodia.

Status of Air Quality

Air Quality Monitoring

Across the country, it is only in Phnom Penh where air quality is monitored regularly. All three monitoring points at Phnom Penh use passive tubes for 24 hours at the roadside. These stations are at Kbaltnal, Olympic and Tolkork. Carbon monoxide (CO), Nitrogen dioxide (NO₂), and Sulfur dioxide (SO₂) have been consistently monitored since 2000. Total suspended particulates (TSP) and PM with a diameter equal to or less than 10 micrometers (PM₁₀) are not routinely monitored. Ad-hoc air quality monitoring through research projects have also been done.

Air Quality Data

Data from the air quality monitoring exercise in Phnom Penh are roadside measurements and not ambient data; hence, the results obtained do not allow comparison to the WHO guidelines. Furthermore, the frequency of monitoring and the number of monitoring stations are both limited. Note that despite the stations being on roadside, the concentrations, except for TSP, still do not exceed international guidelines for ambient air quality. The averages and maximum values for CO, NO₂, and SO₂, as reported recently by MOE and the Ministry of Health, are shown in Table 3.1.

The findings of a research study conducted in collaboration with the Yokohama University are shown in Table 3.2.

TABLE 3.1

Results of Roadside Air Quality Monitoring in Phnom Penh

Parameter	2001		2002		2003		2005	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
CO (mg/m ³)	3.94	6.25	3.06	3.5	4.37	5.25	4.32	5.62
NO ₂ (µg/m ³)	—	—	—	—	—	—	0.022	0.038
SO ₂ (µg/m ³)	—	—	—	—	—	—	106.6	215.8

CO = Carbon monoxide; max = maximum values; mean = hourly average among 3 roadside air quality monitoring stations; mg/m³ = milligrams per cubic meter; µg/m³ = micrograms per cubic meter; NO₂ = Nitrogen dioxide; SO₂ = Sulfur dioxide.

Source: MOE and Ministry of Health (2006). *Country Report: Cambodia*. Hang Dara, Chin Chamroeun, Sourn Pun Lork and Chim Sopharo. Paper presented at the *Clean Air for Asia Training Course for Less Developing Countries*, Bangkok, Thailand, 24 May–02 June.

TABLE 3.2

Ambient Air Pollution in Phnom Penh

Parameter	2000		2001		2002	
	Mean	Max	Mean	Max	Mean	Max
CO (mg/m ³)	3.06	7.12	1.98	2.42	3.50	5.71
NO ₂ (µg/m ³)	32.08	47.17	2.45	3.77	30.19	56.60
SO ₂ (µg/m ³)	—	—	2.60	7.80	7.80	13.00
TSP (mg/m ³)	—	—	0.63	0.84	0.41	1.00

CO = Carbon monoxide; mg/m³ = milligrams per cubic meter; µg/m³ = micrograms per cubic meter; NO₂ = Nitrogen dioxide; ppm = parts per million; SO₂ = Sulfur dioxide; TSP = total suspended particulates.

Source: Research collaboration with Yokohama University from 2000–2002. Quoted in MOE and Ministry of Health (2006). *Country Report: Cambodia*. Hang Dara, Chin Chamroeun, Sourn Pun Lork, and Chim Sopharo. Paper presented at the *Clean Air for Asia Training Course for Less Developing Countries*, Bangkok, Thailand, 24 May–02 June.

In both data sets, the average annual levels of NO₂ and SO₂ are within the national standards of 100 µg/m³ for NO₂ and the United States Environmental Protection Agency's (USEPA) standard of 80 µg/m³ for SO₂. Currently, Cambodia has no annual standards for SO₂. Cambodia's national standards for TSP (100 µg/m³) are not met, and the contributions of mobile emissions and road dust resuspension are of concern.

Reporting of Air Quality Information

Air quality monitoring results are provided as hourly averages and maximum concentrations only through requests or as a component of presentations and reports on environmental management. They are not reported to the public on regular basis nor are they routinely shared among the different government agencies and local environment units (Chin 2006d).

» Part Four

Impacts of Air Pollution

Respiratory diseases are among the leading causes of morbidity in Cambodia and PM has been tagged as the potential cause. Vehicle emissions, as well as road dust resuspension, contribute to increasing amounts of TSP. Despite concerns about the possible impacts of air pollution in Cambodia, currently there is no information about studies that can support this claim.

Air Quality Management

Legislation and Mandate

The Ministry of Environment (MOE) was established in 1993 and its mandate was approved in 1997 to oversee environmental management at the national level (ADB 2004). In 2000, a subdecree on air pollution control and noise disturbance was put into place. The subdecree included air quality standards for ambient air quality, emission limits for stationary and mobile sources, as well as limits for hazardous substances in the air.

At the local government level, the 1999 Declaration on the Organization of the Provincial and Municipal Environment Department include the following environmental management responsibilities: (i) definition of illegal activities in national protected areas; (ii) inspection and monitoring of pollution sources; (iii) environmental education programs; and (iv) data management.

Cambodia is party to several international conventions (MOE 2002) that have some relevance to the atmospheric environment: (i) the United Nations Framework Convention on Climate Change; (ii) the Convention on Desertification; (iii) the Montreal Protocol; and (iv) the Convention on Persistent Organic Pollutants.

MOE oversees environmental management at the national level. In terms of air quality management, the related ministries are the Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Works and Transport; Ministry of Planning; Ministry of Water Resources and Meteorology; Cambodia National Mekong Committee; and the Council of Ministers.

MOE has six technical departments, office of inspection, office of administration, and office of financial control. Technical departments are responsible for (i) policy development; (ii) development and implementation of legal instruments for the environmental impact assessment review; (iii) development of

inspection procedures; (iv) technical advisory for other sectors on issues related to natural resources and environmental management; (v) administration and management of national protected areas; (vi) implementation of environmental education; (vii) environmental data gathering, analysis, and management; (viii) ensuring compliance to international environment treaties and conventions; and (ix) providing pollutant inventories.

With regards to air quality management, the Office of Air Quality, Noise and Vibration Management under the Department of Pollution Control is the main unit responsible for Urban Air Quality Management and Monitoring of mobile, stationary, and area sources of air pollution.

Although legislated under the 1999 Declaration on the Organization of the Provincial and Municipal Environment Department, the local governments have minimal capacity to engage in environmental management activities. Enforcement and support to the Office of Inspection is the key role of the provincial bodies. Environmental management has not been formalized at the district and community levels although initiatives are present and often interrelated (ADB 2004). In general, there are overlaps on the mandates and jurisdictions of agencies at different levels.

Ambient Air Quality Standards

Cambodia's ambient air quality standards are generally more lenient compared to WHO Ambient Air Quality Guidelines (WHO 2005). Currently, there is no air quality monitoring station in the country and monitoring is done using passive tubes at roadside. Since 2000, the pollutants NO₂, SO₂, and CO are consistently being monitored through passive monitoring techniques; however, not all data are available. However, there is no routine monitoring for TSP and PM₁₀.

TABLE 5.1

Ambient Air Quality Standards

Pollutant	Averaging Period	Cambodia Air Quality Standards	WHO Air Quality Guidelines (2005 update)	USEPA National Ambient Air Quality Standards
CO	1-hour (mg/m ³)	40	30	40
	8-hour (mg/m ³)	20	10	10
NO ₂	1-hour (µg/m ³)	300	200	n/a
	24-hour (µg/m ³)	100		n/a
	Annual (µg/m ³)	n/a	40	100
SO ₂	10-minute (µg/m ³)	n/a	500	n/a
	1-hour (µg/m ³)	500		n/a
	24-hour (µg/m ³)	300	20	365
	Annual (µg/m ³)	n/a		78
O ₃	1-hour (µg/m ³)	200		235
	8-hour (µg/m ³)	n/a	120	157
TSP	24-hour (µg/m ³)	330	—	n/a
	Annual (µg/m ³)	100	—	n/a

n/a = not applicable

CO = Carbon monoxide; NO₂ = Nitrogen dioxide; O₃ = Ozone; SO₂ = Sulfur dioxide; TSP = total suspended particulate; mg/m³ = milligrams per cubic meter; USEPA = United States Environmental Protection Agency; WHO = World Health Organization; µg/m³ = micrograms per cubic meter.

Note: These standards are applied to evaluate ambient air quality and to monitor the status of air pollution. Standard methods of analysis of ambient air quality are specified in the guidelines of the Ministry of Environment.

Sources: Mekonginfo.org. 2000. Annex 1 of SUB-DECREE on Air Pollution Control and Noise Disturbance. Unofficial translation

United States Environmental Protection Agency. National Ambient Air Quality Standards. Available: <http://www.epa.gov/air/criteria.html>

Management of Mobile Sources

Cambodia has established mobile emissions standards as part of the subdecree on Air Pollution Control and Noise Disturbance. These standards, however, only delineate motorcycles among other vehicles (Table 5.2) and have not been further classified according to vehicle size. This makes it

difficult to compare against Euro standards. As of the moment, MOE has no plan to set the mobile emission standards to be equivalent to the Euro standards (Chin 2006b). In addition to this, there is ambiguity on how *tuk-tuks*—motorcycles with two-wheeled carriages used to transport passengers—will be classified.

TABLE 5.2

Mobile Emissions Standards

Vehicle	Fuel	CO (%)		HC (ppm)		Dark fume (%)
		A (>5 years old)	B (<5 years old)	A (>5 years old)	B (<5 years old)	
2-stroke motorcycle	Petrol	4.5	4	10,000	3,000	—
4-stroke motorcycle	Petrol	4.5	4	10,000	2,400	—
All kinds of vehicles	Petrol	4.5	4	10,000	800	—
All kinds of vehicles	Diesel	—	—	—	—	50

CO = Carbon monoxide; HC = hydrocarbon; ppm = parts per million.

Note: This Standard applies to noise emission control of mobile sources into atmosphere.

A refers to all kinds of vehicles used more than 5 years from year of production.

B refers to all kinds of vehicles that are newly imported and/or within the first 5 years from year of production.

Source: Mekonginfo.org. 2000. Annex 1 of SUB-DECREE on Air Pollution Control and Noise Disturbance. Unofficial translation. Available: http://www.mekonginfo.org/mrc_en/

Policy discussions on cleaner fuels and vehicle inspection maintenance have highlighted the need to develop regulatory policies on these areas, and establish the link between fuels, vehicle technology, and inspection systems (United Nations Centre for Research and Development [UNCRD] 2006). Currently, several vehicle inspection stations established in large cities are only used at the initial registration and with an estimated 30% compliance. Cities have yet to implement the formalization of bus services due to a previous failed attempt in the mid-1990s. At the moment, public transport consists mainly of privately owned motorcycles and *tuk-tuks* that continue to increase in volume due to lack of regulation. Land-use planning in Phnom Penh and in other major urban areas is at an early stage and is largely uncontrolled. Engaging in policy dialogues has allowed Cambodia to be exposed to the experiences in other countries in the region, as well as in other regions of the world and has demonstrated different possibilities for Cambodia to consider formulating a national strategy on environmentally sustainable transport.

Management of Stationary and Area Sources

In addition to national ambient AQ standards, Cambodia has maximum allowable limits for hazardous substances in ambient air, and emission standards for stationary and mobile sources. The 1994 energy sector development policy and the 1999 power sector strategy provide guidance for governance and implementation in these sectors. Energy projects are required to undergo environmental examination according to the Environmental Protection and Natural Resources Management Law and the subdecree on Environmental Impact Assessment in 1999 (ADB 2004). The Cambodian National Petroleum Authority was established in 1999 to provide the framework and policy for petroleum exploration and exploitation, as well as to establish a National Petroleum Center and Petroleum Laboratory. These measures were put into place but information on the status of their implementation was limited.

Conclusion

With Cambodia's high rates of economic growth, rapid growth in its urban population, and increasing demands for transport and energy, the country's transformation from a predominantly agrarian economy to a mixed economy is occurring. Cambodia appears to be facing a growing air pollution challenge, however. Ambient concentrations of PM appear to be very high, with likely severe impacts on the health of residents of Phnom Penh and, possibly, of other urban centers. If Cambodia wishes to address the adverse impacts of air pollution on urban residents, it will need to invest in the development of its capacity to manage air quality.

Although there is some capacity to monitor urban air quality, there are still challenges that need to be addressed. The current

air quality monitoring practice (pollutants covered, frequency of sampling/monitoring, and location of monitoring sites) does not allow the comparison of results to national ambient AQ standards. Overlapping mandates and the need for an adequate legal framework and policies compound Cambodia's air quality management challenges.

Cambodia has the opportunity to learn from its neighbors and introduce some relatively simple measures to control emissions, such as regulations for cleaner fuels, standards for new vehicles, and controls on large stationary sources. These actions require a suitable legal framework, which needs to be considered a priority, if the rapid deterioration in air quality in Cambodia's growing urban centers is to be prevented.

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