

# Country Synthesis Report on Urban Air Quality Management

## »» Bhutan

Discussion Draft, December 2006



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# Abbreviations

ADB	Asian Development Bank
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
DoF	Department of Forests
DoR	Department of Roads
EAA	Environmental Assessment Act of 2000
GDP	gross domestic product
HSU	Hartridge Smoke Unit
MoP	Ministry of Planning
MTI	Ministry of Trade and Industry
NEC	National Environment Commission
NO <sub>x</sub>	Nitrogen oxide
PM	particulate matter
PM <sub>10</sub>	particulate matter with diameter less than 10 micrograms
RGoB	Royal Government of Bhutan
RSTA	Road Safety and Transport Authority
SACEP	South Asia Co-operative Environment Program
SASEC	South Asia Subregional Economic Cooperation
SO <sub>2</sub>	Sulfur dioxide
TSP	total suspended particulates
UNEP/RRCAP	United Nations Environment Programme Regional Resource Centre for Asia and the Pacific
WHO	World Health Organization

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

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# General Information

## Geography and Climate

The Kingdom of Bhutan covers about 38,394 square kilometers (km<sup>2</sup>) and is landlocked by the Tibetan region of China in the north, and India in the west, south, and east. Geographically, Bhutan can be divided into three regions: the foothills adjoining the Indian plains, the inner highland, and the snowcapped mountains. For administrative purposes, Bhutan is divided into 20 *Dzongkhags* (administrative zones), which is further divided into 201 *geogs* (cluster of villages).

The climate in Bhutan varies with altitude, from subtropical in the south to temperate in the highlands and polar-type climate, with year-round snow in the north. Bhutan experiences five distinct seasons: summer, monsoon, autumn, winter, and spring. Western Bhutan has the heavier monsoon rains; southern Bhutan has hot, humid summers and cool winters; and central and eastern Bhutan, temperate and drier than the west, has warm summers and cool winters.

Forest fire incidents are high during the dry winter months in Bhutan. Freezing temperatures and lack of rainfall cause the drying up of perennial grasses while increasing wind velocity hastens this drying process, thereby making the vegetation flammable. Land preparation for agricultural use is also done during or toward the end of winter months whereby fire is the most common and cheapest tool used for land clearing. Fire is commonly used as cheapest tool for land clearing. As a result, uncontrolled use of fire in or adjacent to the forest brings about forest fires willfully or accidentally.

## Population and Urbanization

An extensive census conducted in 2005 resulted in a population figure of 672,425 (Bhutan Census, 2005) and annual population growth rate of 1.3%. The population density—16 persons per

km<sup>2</sup> of land area (ADB, 2006)—makes Bhutan one of the least densely populated countries in Asia. Most of the population is concentrated in the broad river valleys and southern foothills, while large areas in the north are virtually uninhabited.

Roughly 31% of the population, compared to about only 5% 10 years ago, lives in urban areas comprised of small towns mainly along the central valley and the southern border. The urban population in Bhutan is increasing at a rate of 6.7% annually, with urban-rural migration estimated at 21% per year. Thimphu, the country's capital and largest city, has a population of almost 100,000, which accounts for 15% of the total population. Other urban areas with significant population are Phuentsholing (Chhukha dzongkhag) and Paro. The land available for urban growth is limited by both topography and government policies to maintain the present forest cover and restrictions to land conversion.

Thimphu City is the only city in Bhutan where a city plan has been approved and is being implemented. The increase in construction activities—and associated increases in haphazard stockpiling—is leading to deterioration in the air quality.

## Economy and Industry

Bhutan's economy—one of the world's smallest and least developed—still remains predominantly an agrarian society, with an estimated 79% of the population dependent on subsistence agriculture for employment and livelihood (United Nations, 2006). The national economy also depends, to a large extent, on two other major sources: export of hydropower and tourism. The economic structure is still low and constricted, with the Government as the driving force. In spite of the increasing pressure from socioeconomic development and modernization, the conservation of its natural resources continues to be a priority for the Royal Government of Bhutan.

The conservation of the natural environment is highlighted as one of the four pillars for “Gross National Happiness,”<sup>1</sup> Bhutan’s development philosophy.

Despite being one of the world’s smallest economies, Bhutan’s economy has grown very rapidly at annual economic growth rates of about 8% in 2005 and 14% in 2006. Bhutan’s per capita income is \$834 (Statiscal Year Book, 2005), making it the highest in South Asia. Its traditional economy is based on forestry, animal husbandry, and subsistence agriculture, accounting for less than 50% of the gross domestic product (GDP) due to lack of infrastructure for trading of its produce (Armington, 1998). The industrial sector in Bhutan has grown by more than 200% over a 5-year period, that is, from 1997 to 2002. The number of industries has increased from 4,394 to 13,908, most of which (more than 70%) are of small scale and service industry. The number of industries is based on the number of licenses issued by the Ministry of Trade and Industry (MTI) in 2004.

The developmental role of the vibrant private sector has been increasingly recognized by the Government over recent years. Included in the Ninth Plan<sup>2</sup> period is the development of four industrial estates (including basic infrastructure) at Pasakha in Chukha, Jigmeling in Sarpang, Matanga in Samdrup Jongkhar, and Dhamdhum in Samtse.

## Energy

Bhutan has no known domestic oil or gas reserves, and all the petroleum products necessary for the country’s energy demands are imported. The country’s hydroelectric power potential, nevertheless, is high and allows the country to export hydroelectric power to India. The total power output of Bhutan is 457 megawatt (MW) (Kuensel, 30 March 2005), and the total electricity output from the major hydropower projects stands at 445 MW as of September 2004. The total domestic consumption is estimated at 105 MW. The Chukha Hydro

<sup>1</sup> The concept of Gross National Happiness places the individual at the center of all development efforts. Recognizing that a wide range of factors contribute to human well-being and happiness and that it may not be possible to fully and exhaustively define or list everything for the purpose of its development planning, the country has identified four major areas as the main pillars of Gross National Happiness. These are economic growth and development, preservation and promotion of cultural heritage, preservation and sustainable use of the environment, and good governance. The concept was enunciated by His Majesty the King in the late 1980s and has rapidly evolved into the accepted label for the distinct Bhutanese development concept.

<sup>2</sup> The Ninth Plan began on 1 July 2002 and will end on 30 June 2007.

Power Corporation (CHPC) has been earning more than 40% of the national revenue of Bhutan. According to government sources (Zangmo, 2006), by 2006, Bhutan would have been exporting about 6,400 MW hour of power annually.

Another source of fuel is wood, which accounts for about 75% of the total energy consumption of Bhutan (SASEC, 2005). Of the total fuelwood consumption, the household sector uses 95%; the Government and commercial sectors, 3%; the agriculture sector, 0.9%; and the industrial sector, 0.7%. An estimated 1.2 million cubic meter per year is used for fuelwood cooking and heating: The exact magnitude of Bhutan’s mineral resources is unknown, given that only 30% of the country has been mapped geologically. Although coal reserve is approximated at some 1.3 million tons, its recovery is considerably difficult and the quality of coal or extraction/recovery is poor. Solar energy is used for a variety of purposes, including heating dwellings and greenhouses and lighting hospitals. Despite the potential solar energy that might be produced, Bhutan’s mountainous terrain prevents maximum use.

## Transport

Road transport remains the main mode of passenger as well as freight movement within Bhutan and to the neighboring Indian states. Over the years, with the development of the road network throughout the country, the number of trucks, buses, and taxis has increased manifold. The country’s vehicle fleet has grown rapidly in recent years, doubling from 11,700 vehicles in 1997 to almost 27,000 by the end of 2004, increasing by more than 17% annually on average (RSTA 2004). The urban areas of Thimphu and Phuentsoling have the largest number of vehicles. In 1999, the combined number of vehicles for these two urban areas accounted for more than 92% of the total vehicle population (National Environment Commission 1999b).

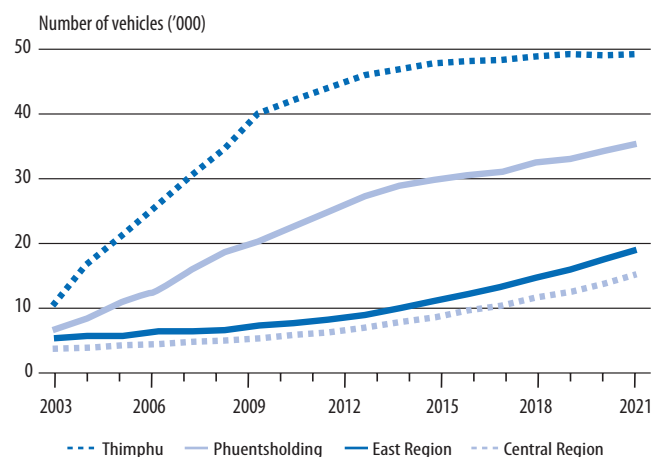
Vehicles less than 5 years old do not exceed 40% of the total vehicle fleet. About 40% of vehicles are between 5 and 10 years old while 20% are more than 10 years old (RSTA, 2004).

In Thimphu, two-wheelers are estimated at 45%, cars and jeeps account for 35%, and buses account for 2% of the total number of vehicles (NEC, 2001). Surveys carried out in Thimphu in 1997, 1999, and 2003 to assess traffic movement and growth rate of traffic frequency during day- and nighttime found a

24% increase in vehicular number during peak hours. Traffic movement in 2003 increased by more than 100% compared with that in 1997. Based on the results of the survey and trend of increase in vehicle fleet, it is projected that by 2020, the number of vehicles in Bhutan would rise to 100,000, with more than 45,000 in Thimphu alone (Figure 1.1).

The country’s road network, with 4,544.73 kilometers (km) of motorable roads (Department of Roads), is limited in terms of coverage and insufficient for the growing demands of larger and heavier vehicles. While all national highways are paved, 20% of these are in poor condition. Improvement, maintenance, and expansion of the existing road network are urgently needed. Half of the country’s population lives more than half a day’s walk from the nearest motorable road (ADB, 2005). The country’s primary road is the East–West highway, known locally as the Lateral Road. It is built to a standard width of only 2.5 meters (8.2 feet) yet is required to support traffic in both directions (the cost of cutting a wider road through the mountainous Middle Himalayas is prohibitive at this time). Safety barriers, road markings, and signage are sparse. Recently, the road network in urban areas, such as Thimphu

FIGURE 1.1  
**Region-wise Number of Vehicles Projection by 2020**



Source: ADB, 2005.

and Phuentsholing, has been streamlined for smoother flow and traffic. Bhutan does not have any traffic lights except for the one guided by the traffic police in the middle of Thimphu town (SASEC, 2005).

# Sources of Air Pollution

## Emission Inventory

While no comprehensive inventory of emissions of air pollutants has ever been conducted in Bhutan, an inventory of greenhouse gas emissions and sequestrations for 1994 has been conducted by the National Environment Commission (NEC).<sup>1</sup>

The first comprehensive survey on air pollution in Thimphu was carried out in 1999 by NEC, with financial assistance from the Bhutan Trust Fund for Environmental Conservation.<sup>2</sup> The study identified vehicle emissions and smoke from domestic *bukharis*<sup>3</sup> as the biggest cause of air pollution in Thimphu during winter. Vehicular emission, although not a major concern in Thimphu, is a growing problem as the number of vehicles is increasing rapidly. In 1995 and 1996, emissions from more than 1,060 motor vehicles were analyzed to establish the vehicle emission standard for Bhutan. It was found that more than 66% of petrol vehicles and 96% of diesel vehicles did not meet the Indian emission standard. According to the analyses, some of the major problems were low fuel quality, high lead content of fuel, inefficient fuel combustion, and increase in traffic movement in and around Thimphu Valley (NEC 1999b).

According to the survey, about 96% of houses burn a total of more than 10,000 cubic feet of firewood in Thimphu each day during the winter months, substantially affecting the total amount of emission during this period. Forest fires, which

are also frequent during winter months, contribute to total suspended particles (TSP). Records of forest fire incidents from 1997 to 2004 show that by 2001, forest fires have been reduced drastically; it is unknown whether this reduction is due to the public awareness or climatic conditions (DoF, 2005).

Other sources of air pollution identified in the study include heating of bitumen during road construction, dust from unpaved roads and open spaces, and burning of kitchen garden waste and farm waste during the dry season. This study did not attempt to determine the emission levels of industries, as appropriate equipment was not available. The study recommended that the Government initiate programs (introduction of smokeless stoves for heating, tax incentives for importing electric heaters, and development of vehicle emission standards) to improve and monitor air quality in the valley.

There are four cement factories in Bhutan producing about 29,000 metric tons of cement annually. In 1998, there were 97 registered industries that used raw materials from forests, 46 agro-based industries, and 27 mineral-based industries. The major products of the chemical industry in Bhutan are calcium carbide, ferro silica, and activated carbon. The industry is highly energy intensive. Calcium carbide and ferro silica industries produce high amounts of dust emissions. Coal dust is the major problem in the activated carbon unit. The main pollutants from the chemical industries are carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), nitrogen oxide (NO<sub>x</sub>), and particulate matter (PM). Owing to the low height of the emission stacks, emissions are not properly dispersed, causing air pollution in the surrounding valley.

<sup>1</sup> Bhutan National Communication to UNFCCC.

<sup>2</sup> With financial assistance from the Bhutan Trust Fund for Environmental Conservation.

<sup>3</sup> Wood-burning stoves used for heating.

# Status of Air Quality

Based on the assessment on the ambient air pollutants in Bhutan, PM<sub>10</sub> is becoming a growing concern in the urban towns of Phuentsholing and Thimphu whereas other primary pollutants, such NO<sub>x</sub>, SO<sub>2</sub>, and CO, are not a cause of concern.

## Air Quality Monitoring

Since air pollution is considerably an emerging concern in Bhutan, the NEC program on air quality monitoring and data collection is still at an infant stage. Only PM is monitored regularly while SO<sub>2</sub> and NO<sub>x</sub> pollutants are being monitored at the Main Traffic Road in Thimphu City and Bhur, Gelephu, on a periodic basis. NEC still needs to enhance its capacity to carry out major monitoring and data collection tasks. NEC has been working in close collaboration with other organizations, such as MTI, for emissions from the industries (Zangmo, 2006).

MTI operates one mobile monitoring van. The van is based in Thimphu and carries out periodic compliance monitoring and emission data collection of all the industries in Bhutan. MTI also needs capacity enhancement, including upgrade of equipment. Furthermore, the maintenance of the mobile van is very high. Although NEC and MTI officers conduct joint monitoring operations, there is need for formal protocol of cooperation so that there would be synchronized air quality monitoring strategy and program between different agencies. NEC, which currently has only three personnel working on ambient air monitoring, intends to increase the number to five within the 10<sup>th</sup> Five-Year Plan (2008–2012) period. (Zangmo, 2006).

## Air Quality Data

NEC established a PM monitoring station in Thimphu in 2003 and since then has been regularly monitoring PM concentration. The results of PM concentration monitoring have been published in the State of Environment report for 2004 and 2005 that was submitted to the National Assembly (Parliament of Bhutan). Under the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia program, NEC carried out SO<sub>2</sub> and NO<sub>2</sub> measurements in Bhur, Gelephu from 2003 to 2004 (Table 3.1). Air samples were also collected for 5 months at the Main Traffic Road in Thimphu City, where the traffic movement is greater than 2,000 vehicles per day. However, the results of the sampling are yet to be published. Although the results clearly show that the level of SO<sub>2</sub> and NO<sub>2</sub> is below detectable level, monitoring has to be more consistent and widespread in order to conclude that air pollution is not a concern.

TABLE 3.1

**Results of SO<sub>2</sub> and NO<sub>2</sub> Monitoring in Bhur Using Diffusive Samplers**

Start Time	Stop Time	Temperature (°C)	SO <sub>2</sub> µg/m <sup>3</sup>	NO <sub>2</sub> µg/m <sup>3</sup>
8/25/2003	9/25/2003	20.0	<0.2	0.7
9/3/2003	11/25/2003	20.0	0.1	0.5
11/25/2003	12/25/2003	20.0	0.2	1.1
12/25/2003	1/25/2004	20.0	0.2	1.6
1/25/2004	3/4/2004	20.0	1.1	3.0
3/18/2004	4/14/2004	10.0	1.7	15.2

SO<sub>2</sub> = Sulfur dioxide, NO<sub>2</sub> = Nitrogen dioxide, µg/m<sup>3</sup> = micrograms per cubic meter  
Source: NEC, 2006.

## Reporting of AQ Information

Data on air pollution is scarce in Bhutan. No system is in place to make air quality information regularly available to the public.

» Part Four

# Impacts of Air Pollution

The likely impacts of air pollution on the environment and human health are not yet a serious concern in Bhutan. There is lack of, information on air pollution or studies conducted to measure and assess air pollution.

# Air Quality Management

## Legislation and Mandate

The year 2005 marked an important step in Bhutan's process of democratization and decentralization with the release of the first draft of the country's Constitution. The implementation of the constitution is bringing about sweeping changes to Bhutan's fundamental system of governance, political, administrative and societal, requiring a process of accelerated institutional strengthening and human resource development at the national and local levels. The nation is preparing for a smooth transition to the new system of parliamentary democracy that will be introduced in 2008.

The Royal Government of Bhutan has ensured that environmental conservation is prioritized and integrated into the economic development process. NEC serves as an advisor to the Government on all matters pertaining to the environment (NEC, 1997). It was given the mandate of coordinating all environmental activities and monitoring the environmental impact of development projects. Medium-term policy objectives include ensuring that adequate pollution abatement techniques and environmental management systems are in place to mitigate the adverse impacts of industrialization. NEC has also been instructed by the Royal Government to develop all relevant policies and guidelines on air quality management in collaboration with all relevant agencies and ministries. NEC has formulated *The Middle Path*, the National Environment Strategy for Bhutan as the guiding principles of development (NEC, 1999c).

Notwithstanding, Bhutan has yet to develop an air quality management system. The target areas for ambient air quality management system in Bhutan are the urban areas that have a population of more than 40,000. Based on the 2005 census, most of the cities or towns (excluding Thimphu and

Phuentsholing) have populations of less than 40,000. Both these cities have very different geographical conditions—Thimphu is located in a valley with an altitude more than 2,000 meters above sea level whereas Phuentsholing is situated at the foothills of the Himalayan region. Therefore, if there are any air pollution problems in these two cities, the situation may differ, suggesting that different measures may be required.

NEC has only recently started focusing on air quality monitoring and baseline data collection. The organization still lacks air quality monitoring equipment and stations. The air quality monitoring program is under the Research, Monitoring, and Statistical Section of NEC. It is in the process of developing an environmental information management system. The purpose of this project is to collect all kinds of information related to the environment, e.g., land-use planning, forest cover, number of projects that have completed environmental impact assessment studies, and air and water monitoring data. NEC has also initiated activities to develop air quality management strategy for Bhutan and the strategy is expected to be in place by early 2007.

NEC has been appointed as the coordinating agency to tackle the air pollution problem with other line ministries, such as MTI, Road Safety and Transport Authority (RSTA), Traffic Police, and Royal Bhutan Police. NEC, in collaboration with MTI and RSTA, developed the industrial air pollution and vehicle emission standards, respectively. NEC is responsible for developing the air quality standards for stationary, mobile, and ambient sources while RSTA, Royal Bhutan Police, the Environment Unit in MTI, and the private industries, in collaboration with NEC, are responsible for collecting baseline data and conducting compliance monitoring. However, the program has had limited success due to lack of financial resources.

## Ambient Air Quality Standards

Bhutan has not been able to establish its own set of standards despite the mandate given to NEC to develop one. This is due to the lack of appropriate monitoring equipment and human resources.

## Management of Mobile Sources

Vehicular emission is a growing problem in Thimphu caused by rapidly increasing number of vehicles. RSTA is the organization responsible for registering vehicles, monitoring emissions, and collecting baseline data (RSTA, 2001). So far, NEC, in collaboration with MTI, RSTA, and Traffic Police, has initiated the following activities:

- (i) 1996, the Ministry of Finance banned the importation of second-hand vehicles and new two-stroke, two-wheelers after the recommendations made by NEC. Prior to the ban, Bhutan imported more than 950 second-hand vehicles within 12 months (DRC 1997).
- (ii) 1999, The Government also established type approval standards for Bhutan for the import of new vehicles. The standards suggest that all new vehicles should be Euro 1 type approval.
- (iii) 2001, Bhutan began to import unleaded petrol.
- (iv) 2003, Bhutan began to import Ultra Low Sulphur Diesel (0.025% sulfur-content diesel)
- (v) Reduction of import tax on vehicle spare parts particularly related to vehicle emission, such as air, oil, and fuel filters.
- (vi) 2003, established the vehicle emission standards for in-use vehicle.

In 1999, RSTA developed the Road Safety and Transport Regulations, which highlights that all vehicles registered in Bhutan should comply with the vehicle emission standards. However, RSTA still does not have enough testing equipment and staff to make the activity meaningful. A Transport Management and Policy is still in the draft stage, and the implementation of the vehicle emission standards is currently limited to emission testing only.

TABLE 5.1

### Emission Standard for In-Use and Type Approval Vehicles

Type of Vehicle	HSU	CO % Volume	Type Approval
Petrol	—	5.0	Euro 1 or above
Diesel	80%	—	Euro 1 or above

HSU = Hartridge Smoke Unit, CO = Carbon dioxide

Source: NEC, 2002.

There is currently no transportation plan for Bhutan. While the Government has taken positive steps to address vehicle emissions through the introduction of in-use vehicle emission standards and type approval standards, policy measures aimed at reducing transportation demand and improving the efficiency of the transportation system are needed. The Government also has taken traffic management measures, such as reorganizing traffic flows, road widening, and introduction of public buses.

## Management of Stationary Sources

All new and existing industries in Bhutan come under the purview of the Environmental Assessment Act of 2000. The Act has been effective in regulating new industries by emphasizing that only new and state-of-the-art machinery and technology<sup>1</sup> be used and by limiting air pollution within the interim ambient air quality standards. However, a major problem that Bhutan still faces concerns industries that were established before the Environmental Assessment Act was instituted. Oftentimes, the technology that these units use is obsolete. Bringing such industries within permissible limits would mean a total change in the production process, which is too costly for these units (NEC, 2000a).

Industrial air quality is right now being monitored by NEC and MTI only. However, human resources constraints have limited monitoring to periodic spot checks and inspections. Although some industries have now started self-monitoring their own air pollution, a more comprehensive system has to be developed to make the self-monitoring more effective.

<sup>1</sup> According to the Bhutanese Environmental Objectives and Standards (NECS 1999), the required particulate removal from the kiln and clinker cooler exhausts is 99.9% of all particulates and 99.5% of particulates less than 10 microns in size (PM<sub>10</sub>). Such levels are to be achieved during at least 95% of the plant's operating time. These requirements correspond to an emission standard of 50m g/m<sup>3</sup> under full-load capacity.

The construction of industrial infrastructure is now being carried out more systematically on sites zoned as industrial estates. The development of the five industrial estates, as detailed in the Ninth Plan,<sup>2</sup> will facilitate the monitoring of air pollution from industries.

## Management of Area Sources

The Department of Forests under the Ministry of Agriculture has carried out campaigns and training programs for the people, especially the local farmers the local farmers and people on how to prevent forest fires. Furthermore, the Department of Forests has been disseminating information through local media, such as radio services and print media, especially during the dry winter months.

In addition, NEC, in collaboration with the Department of Forests and MTI, implemented a project to develop sawdust bukharis and sawdust briquette in order to reduce air pollution from the use of firewood in domestic stoves (Forestry Services Division and NEC, 1999a).

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<sup>2</sup> The Ninth Plan began on 1 July 2002 and will end on 30 June 2007.

These activities primarily focus on the reduction of respirable suspended particulate matter. While there is no concrete formulated strategy for control of secondary pollutants, there are on-going initiatives, such as adoption of rules to import better technology (vehicles), better quality of fuels, improving road network system, etc.

## Transboundary Air Pollution

Bhutan is a member of the South Asia Co-operative Environment Programme (SACEP).<sup>3</sup> Under the SACEP program, all member countries are to implement a program on the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia. Since 2002, Bhutan has been implementing the Malé Declaration program. A monitoring station located in Bhur conducts data collection each month. The parameters measured are PM<sub>10</sub>, NO<sub>x</sub> and Sulfur oxides (SO<sub>x</sub>), and wet and dry deposition (UNEP/RRC-AP 2003).

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<sup>3</sup> South Asia Co-operative Environment Programme (SACEP) is an intergovernment organization established in 1982 by the governments of South Asia to promote and support the protection, management, and enhancement of the environment in the region. SACEP member countries are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

# Conclusion

Unlike its neighboring countries in the South Asia region and with the rest of Asia, air pollution is still not a major problem in Bhutan but is an emerging concern. NEC, appointed as the coordinating agency to tackle the air pollution problem, coordinates initiatives with other line ministries, such as MTI, RSTA, Traffic Police, and Royal Bhutan Police.

At the time of drafting this report, Bhutan has no clear strategy for air quality monitoring. Therefore, developing a clear strategy for air quality monitoring, which is cross-sectoral and delineates specific roles of various agencies, is crucial before other interventions are initiated. Only after a clear strategy had been developed and approved can financial and human resources be mobilized to implement the strategy. Investments in the necessary equipment for data collection and analysis have to be made. A network for monitoring has to be established in coordination with line ministries and relevant organizations. The process of collecting baseline data on air pollution must begin as soon as possible. Proper mechanisms have to be in place to monitor the trends.

Since air pollution is an emerging issue in Bhutan, the country should consider initiating scientific studies to determine the causes and impacts of air pollution. Currently, air pollution is only evident in larger urban centers where the vehicle population is significant and where wood stoves are used for heating purposes in the winter and in the areas where the major chemical and cement industries are located.

The Royal Government of Bhutan has already initiated several steps to address issues related to air pollution—the most significant ones being the establishment of vehicle emission standards and the introduction of sawdust bukharis (stoves)

and the manufacture of sawdust briquettes. However, these initiatives need a clear strategy to ensure their effectiveness and continuity. Various agencies are currently involved in air quality management activities but most of these activities are implemented in isolation from other activities. Bhutan needs to develop an air quality management policy and act that establishes an appropriate ambient air quality standards, appropriate vehicle emission standards, and stationary emission standards. Transportation and traffic plans to reduce transportation demand and improve the efficiency of the transportation system in the urban areas are also needed.

NEC, in collaboration with MTI, shall develop methodology to monitor point source emissions, especially from industries. The EA process requires all industries to submit emissions reports to NEC to show compliance as per the stipulated conditions. However, NEC and MTI do not have trained personnel and the equipment to monitor such emissions. Investments shall be made to build up the monitoring capabilities of NEC, MTI, and other relevant organizations.

However, with the increase in developmental activities—such as infrastructure building, increase in the number of urban centers, increase in the number of vehicles, and the increase in the number of industries—there is a need for a concerted effort to raise public awareness on air quality issues and its impacts on both the environment and human health. Awareness programs can be developed to gradually raise the level of understanding among the general populace and industrial units about potential air pollution problems. This awareness then can translate into legislation and strengthening of institutions on air quality management.

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