Monitoring and Regulation on Air Quality

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Introduction

Ambient air quality degradation is becoming a severe environment problem, especially in urban sectors in Sri Lanka. Air pollution is experienced in both indoor and outdoor environments, as a result of a mix of thousands of sources ranging from individual cook stoves to motor vehicles, industrial processes and power plants. There are various categories of air pollutants too, leading to numerous adverse effects and impacts, ranging from human health, effects on plants and animals, agriculture and food production, damage and soiling of buildings and structures, stratospheric ozone depletion, acidification, global warming and climate change. The complex nature of air pollution requires the development of a comprehensive air quality management (AQM) plan to maintain the quality of the air at acceptable levels. Under an AQM plan, appropriate policies, strategies and actions should be developed and implemented to control emissions of air pollutants (i.e. source emission standards), ensuring that pollution concentrations in the ambient air do not exceed defined target levels (i.e. air quality standards - AQS). As such, monitoring and regulation on air quality become essential elements of an AQM plan in any country (see **Figure 1**). The capacity for monitoring in Sri Lanka is weak due to the inadequacy of measuring stations and equipment. However, commendable progress has been achieved in standards and regulations for air pollution control. Presently, ambient AQS (outdoor) are in place and emission standards for mobile sources are being implemented under Sri Lanka Vehicle Emission Testing (SLVET) programme. The emission standards for stationary sources have been already developed and regularized, and are about to be fully enforced. However indoor air quality issues of built environments are yet to be addressed by regularity interventions in the country.

Air Pollution

Air pollution refers to emission of any substance to the atmosphere, altering the air's natural composition and exceeds the capacity of natural processes to convert or disperse it, thus endangering human health and environment. These emissions may result from primary air

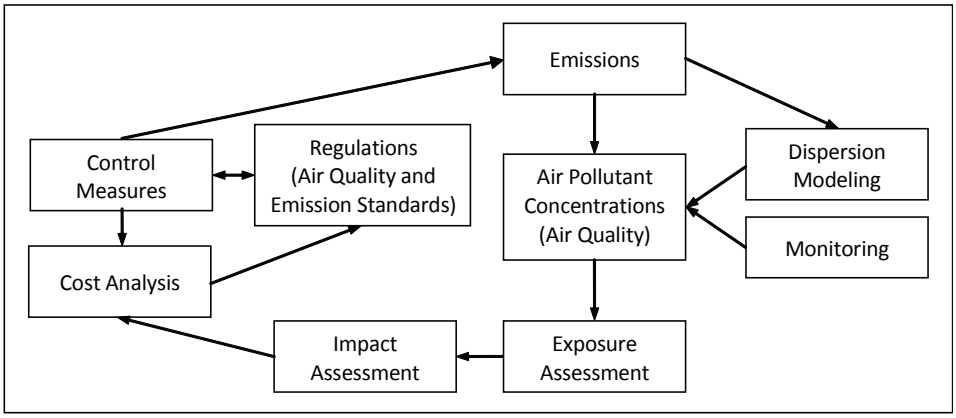

Figure 1 Monitoring and regulations inair quality management (AQM) plan

pollutants emitted to air directly from a source or from the secondary air pollutants produced in the air by the interaction of primary pollutants or by reaction with natural atmospheric constituents. Examples of common primary air pollutants include particulate matter (PM), sulphur oxides, nitrogen oxides, carbon monoxide and volatile organic compounds (VOC) while secondary air pollutants include ozone, formaldehyde, peroxy acetyl nitrate, smog and acid mist. Emissions can be identified on the basis of their sources as point sources such as major industrial sites; area sources such as domestic emissions and emissions from light industry and commercial areas; mobile sources such as motor vehicles; and biogenic (or natural) sources such as dust storms, forest fires, and volcanic eruptions.

Emitted pollutants could also be categorized as criteria pollutants and air toxics, as defined by the United State Environmental Protection Agency (USEPA). Criteria air pollutants are those for which an ambient AQS or guideline has been established to protect human health and welfare. These usually include carbon monoxide, nitrogen oxides, sulfur dioxides, PM (less than 10 micrometer diameter - PM_{10} and less than 2.5 micrometer diameter - $PM_{2.5}$), hydrocarbons and lead. Air toxics consist of chemical, physical and biological agents of different types, which are known or suspected to cause serious health problems. These pollutants include a range of hydrocarbons such as benzene, toluene, polycyclic aromatic hydrocarbons, pesticides, asbestos, chlorine, formaldehyde and other numerous less common substances. Many urban air pollutants can also contribute directly or indirectly to global climate change, but the main greenhouse gases (GHGs) which contribute to climate change are carbon dioxide, methane, nitrous oxide. In AQM, GHGs are often not considered because they do not lead to direct health and environmental impacts.

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Monitoring of Air Pollution

Monitoring of air pollution is of two types: air quality monitoring and source emission monitoring. Each of these monitoring schemes is a key component of an AQM programme. Air quality monitoring refers to the periodic or continuous sampling and analysis of air pollutant concentrations in space and time in ambient air. This provides the data required to assess compliance with the existing ambient air quality (AAQ) guidelines or standards and to assess trends in air pollutant concentrations. In order to obtain accurate and reliable estimates of AAQ in a given local region or city, a network of carefully located air quality monitoring stations capable of measuring and recording real-time concentrations of different pollutants is required. Presently, Sri Lanka does not

have a fully operational air quality monitoring station, but initiatives have been taken by relevant authorities to acquire few stations with government funding.

Table 1: Comparison of AQS of Sri Lanka with international standards (in$\mu g/m^3$)

Pollutant	Sri Lanka NAAQS		EU AQLVs		USEPA NAAQS		WHO AQG	
	Standard	Average	Standard	Average	Standard	Average	Standard	Average
Carbon monoxide	58,000 30,000 10,000	Any time 1 hr 8 hr	10	8 hr	10 40	8 hr 1 hr	10 30	8 hr 1 hr
Sulfur dioxide	200 120 80	1 hr 8 hr 24 hr	350 125 20	1 hr 24 hr Annual	385 80	24 hr Annual	500 20	10 min. 24 hr
Nitrogen dioxide	250 150 100	1 hr 8 hr 24 hr	200 40	1 hr Annual	100	Annual	200 40	1 hr Annual
Ozone	200	1 hr	120	8 hr	160	8 hr	100	8 hr
PM_{10}	100 50	24 hr Annual	50 40	24 hr Annual	150	24 hr	50 20	24 hr Annual
$PM_{2.5}$	50 25	24 hr Annual	-	-	35 15	24 hr Annual	25 10	24 hr Annual

Source emission monitoring refers to the determination of pollutant concentrations in individual pollution sources, and this is used to assess the compliance of each source with relevant source emission standards. The monitored pollutant concentrations could be used in dispersion model, together with information on meteorological and geophysical conditions, to estimate ambient air pollutant concentrations at costs much lower than those for AAQ monitoring stations. Another important modeling tool is source apportionment, which starts from observed concentrations and their chemical composition and estimates the relative contribution of various source types by comparing the composition of sources with the observed composition at the receptors.

Air Quality Standards

AQS are ambient air quality levels for the acceptable presence of selected pollutants in the atmosphere, which are derived from expert evaluation of current scientific evidence of the impacts on human health and the environment. There are two types of standards: primary and secondary. Primary standards define air pollutant concentration limits intended to protect the public health, including sensitive populations such as asthmatics, children and elderly, while secondary standards define limits to protect the environment, including damage to animals, crops, vegetation and buildings.

In each country, AQS are established and published through national legislative and regulatory processes, and will vary according to country-specific approaches towards balancing risks to health and environment, technological feasibility, economic considerations, and other socio-political factors. This variability will depend on the country's level of development, capability in AQM and other factors. In many instances, the national and local government authorities in Asia have adopted a range of AQS either based on World Health Organization (WHO) air quality guideline (AQG) values, or the relevant standards of developed economies such as National Ambient Air Quality Standards (NAAQS) of USEPA or Air Quality Limit Values (AQLVs) of European Union (EU).

The National Environmental (Ambient Air Quality) Regulation of 1994, published under the National Environmental Act No. 47 of 1980 by the Ministry of Environment and Natural Resources, sets NAAQS to protect human health and environment in Sri Lanka. This regulation, amended in 2008, specifies the concentration limits for six air pollutants namely PM_{10}, $PM_{2.5}$, carbon monoxide, sulfur dioxide, nitrogen dioxide and ozone. **Table 1** presents a comparison of NAAQS of Sri Lanka with AQS of USEPA and EU, and AQG of WHO. The data shows that NAAQS of Sri Lanka are in comparable with that of the developed economies. Sri Lanka is among the few countries in the

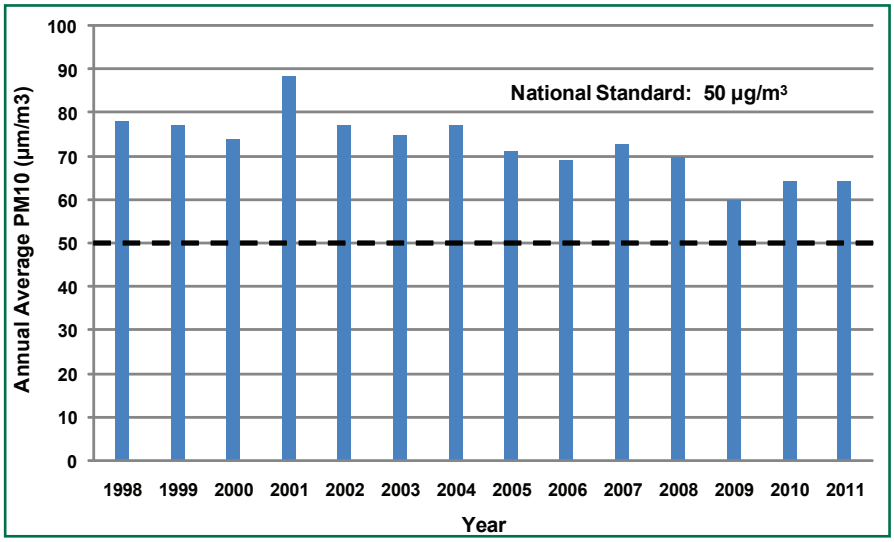

Figure 2 Annual average PM10 concentrations at Colombo Fort Monitoring Station

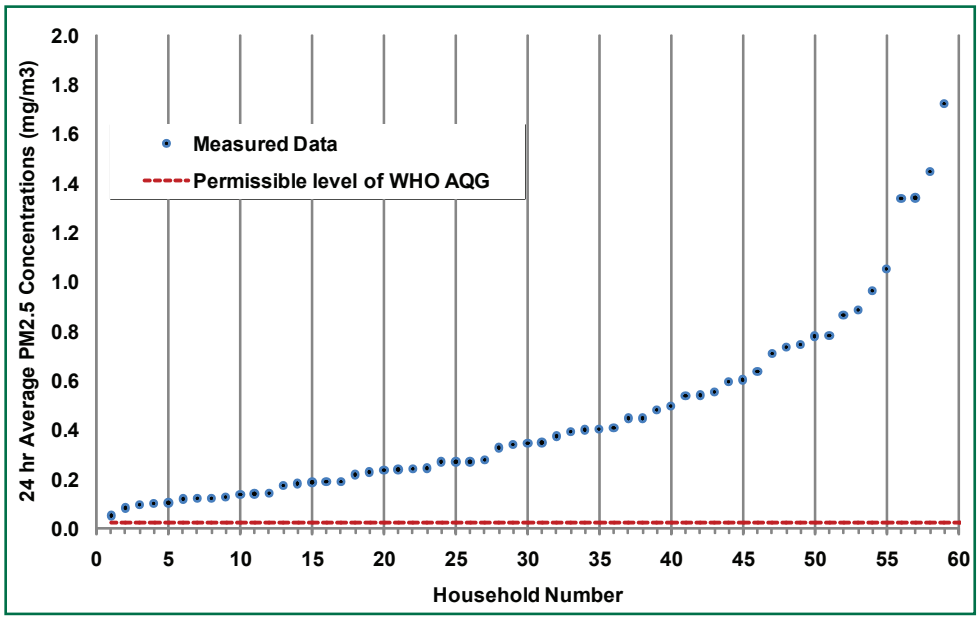

Figure 3 PM2.5 concentrations in estate sector households - arranged in ascending order

region having AQS for $PM_{2.5}$.

The annual average PM10 concentrations in Colombo, as recorded at the Colombo Fort Monitoring Station, exceeds the national standard of 50 µg/m^3, though there is a decreasing trend since 2002 from about 88 µg/m^3 to 64 µg/m^3 (**see Figure 2**). The lowest concentrations have been experienced since 2008, which could be attributed to the implementation of SLVET programme. Yet, these levels far exceed 20 µg/m^3 sets in AQG of WHO, emphasizing the issues of urban air quality degradation. The indoor air pollutions in households show much more severe situations. A study carried out on indoor air pollution in the estate sector households shows that the concentrations of $PM_{2.5}$ in the kitchen (which vary from 50 µg/m^3 to over 4000 µg/m^3) far exceed the limit 25 µg/m^3 set in AQG of WHO, as illustrated in **Figure 3**. This situation is attributed to the solid biomass cooking in conventional cook stoves in poorly ventilated enclosed spaces. Another study under taken in urban road side households revealed that the indoor air quality is affected by infiltration of vehicle pollutions into the indoor environment and both indoor and outdoor air quality levels exceeds the limits in the standards.

Source Emission Standards

The main intervention of controlling air pollution is achieved through enforcement of emission standards at the source itself. There are two categories – mobile and stationary sources emission standards. In order to control emissions from mobile sources, SLVET programme was developed and implemented as a nationwide programme. This was made effective from November 2008, and presently covers eight provinces. This was formulated as a centralized, test-only system with on-line information transfer to a database. The test procedures employed are no-load idle and fast idle test for gasoline vehicles and snap acceleration test for diesel vehicles. There are about 175 centers available island-wide. In year 2011, 2.38 million vehicles

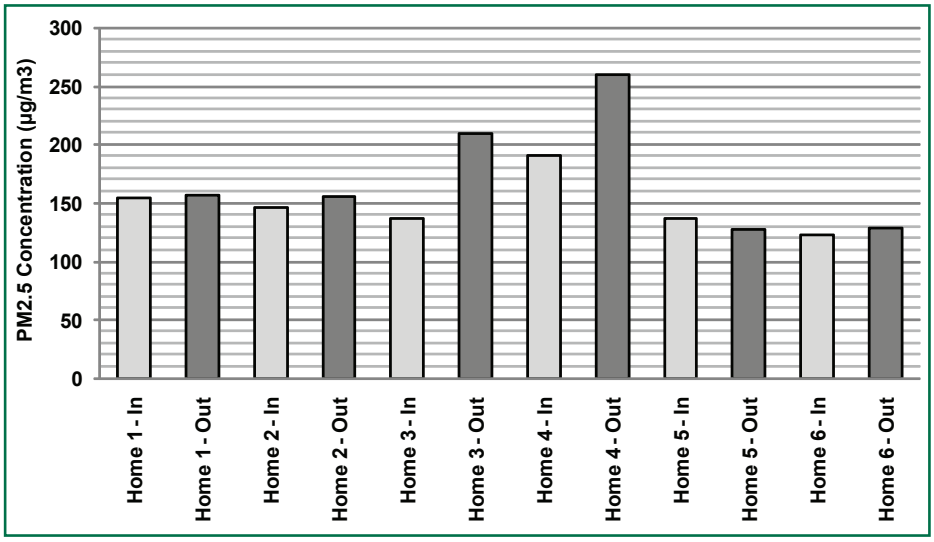

Figure 4 PM2.5 concentrations in indoor and outdoor of households

Another study under taken in urban road side households revealed that the indoor air quality is affected by infiltration of vehicle pollutions into the indoor environment and both indoor and outdoor air quality levels exceeds the limits in the standards.

have been tested, which is about 82% of the active vehicle fleet. Test results show about 17% failure in the first test and 13% failure in the re-test, indicating a 2% final failure rate.

Emission standards for stationary sources have also been developed. Once gazetted, the proposed standards will be mandatory and legally enforceable. In order to cover all the types of stationary sources, the standards adopt a two-tier approach. Tier 1 - equipment based standards is the primary one and covers stack emissions from commonly used equipment in industry including thermal power plants, boilers, thermic-fluid heaters, incinerators, crematorium, cupola, furnaces, ovens and cement kiln. In tier 2 – pollutant based standards, more than twenty pollutants, both combustion and non-combustion sources, are covered. Further, separate schedules for fugitive emissions are also included, covering PM, VOC, acid mists and asbestos fiber. Implementation of these standards would be a very important step towards mitigating air pollution in the country, but would be a challenging task due to the diversity and complexity of the emission processes and pollutants to be covered.

It could be concluded that both monitoring and regulation on air quality are important aspects of air quality management plan of the country, which need comprehensive planning and support for implementation from all relevant agencies and stakeholders.

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