Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia

DATA ANALYSIS REPORT 2012

May 2013

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVE

The United Nations Conference on Environment and Development (UNCED), held in Rio de Janerio in 1992 produced a major strategic outlook for the 21st century in the Agenda 21. In addition to the many important sectoral declarations, it made some important observations on vital cross-cutting issues. One of these vital issues is described in Chapter 40 on Information for Decision Making: the importance of improved availability of information on all aspects of environment and development for decision making towards sustainable development. Agenda 21 also emphasizes the need for improved collection as well as presentation of data and information. Chapter 9 of Agenda21, states that "trans-boundary atmospheric pollution has adverse health impacts on human and other detrimental environmental impacts, such as tree and forest loss and the acidification of water bodies". It emphasizes the necessity of regional cooperation.

Further, one of the most important commitments made at the World Summit on Sustainable Development (WSSD) in 2002 was the acceptance of the international development goals which included the collective responsibility to advance and strengthen mutually reinforcing pillars of sustainable development at different levels. Key activities in these fields included development of the State of Environment (SoE) reports as well as effective data collection and processing.

Land, air, water and biodiversity are the major components of the environment which need regular assessment. Towards this end, the basis of any regional cooperation is the knowledge of present state of affairs and the future trends.

1.1.1 GLOBAL AND REGIONAL CONCERNS OF AIR POLLUTION

One of the most important characteristics of air pollution is that it cuts across national boundaries and often has global effects, i.e., its transboundary nature – many air borne pollutants can easily travel and affect the areas far away from the point of origin. Thus, the impacts of climate change and air pollution are generally transboundary and global in nature. The impacts can be experienced in places far away from the original place where pollution occurred as national actions often have regional and global implications regarding environmental pollution. It is now undisputed that primary air pollutants and their chemical products could be transported over distances of many thousands of kilometers. This transport of pollutants converts local issues into regional and global concerns. Global concerns of air pollution include:

- Climate Change
- Ozone Depletion
- Acid Rain
- Asian Brown Clouds

The co-benefits of GHG and air pollutants reduction have also been realized. Thus, addressing air pollution and its sources would also take care of climate change. It is important that the global and regional communities work collectively to tackle the problem of air pollution. In order to prevent transboundary air pollution from becoming a more serious, widespread problem, it was thought imperative to initiate regional cooperation to undertake remedial measures. Various global and regional level initiatives have been taken to lessen the impacts of climate change and air pollution.

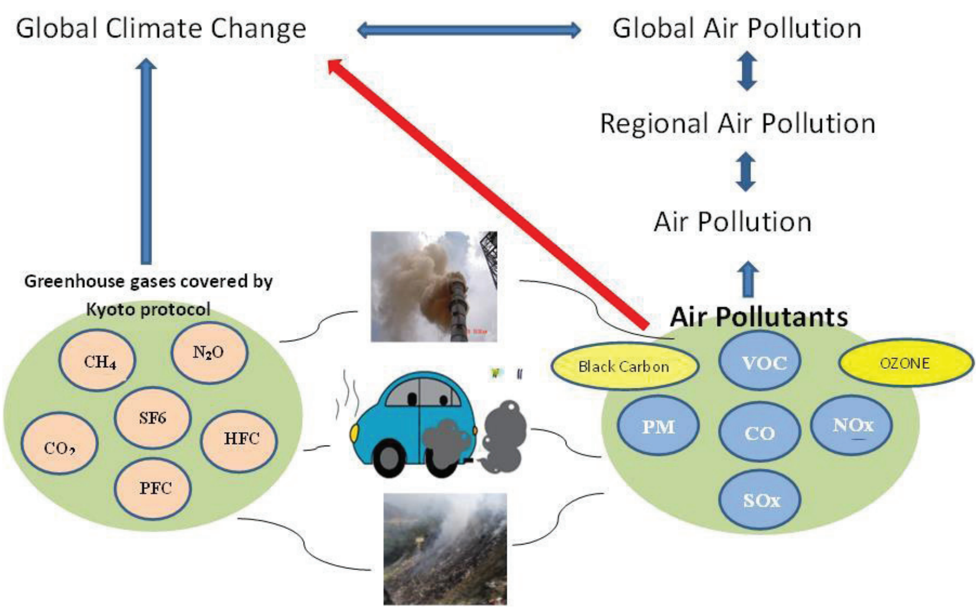

Figure 1-1 Co-benefits: GHGs and Air Pollutants Reduction

1.1.2 THE MALÉ DECLARATION

In keeping with the spirit of Agenda 21 and realizing the transboundary nature of air pollution, the United Nations Environment Programme, Regional Resource Center for Asia and the Pacific (UNEP RRCAP) in collaboration with the Stockholm Environment Institute (SEI) organized a round-table policy dialogue in March 1998 regarding the rapidly increasing problem of regional air pollution, with a focus on South Asia. The meeting was attended by distinguished groups of senior level environment ministry officials from South Asian countries, analysts and policy influencers, and representatives from key environmental organizations in the region. Noting the experience of Europe, it was agreed that there is a need for regional cooperation and a draft declaration was prepared. The Seventh Meeting of the Governing Council of South Asia Cooperative Environment Programme (SACEP), held in April 1998 in Malé, the Republic of Maldives, adopted the declaration naming it the "Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia". It is a regional level initiative and effort taken by governments of countries of South Asia to tackle air pollution problem of this region. The basic objective of this declaration is to foster regional cooperation to address the rapidly increasing problem of regional air pollution with a focus on South Asia.

The Malé Declaration stated the need for countries to carry forward, or initiate, studies and programmes on air pollution in each country of South Asia. The first stage in this process is to document current knowledge and information/ institutional capacity in each nation relevant to air pollution issues. To this end, it was agreed that baseline studies would be developed. Gaps in the current status of knowledge and capacity would become apparent and national action plans to fill these gaps could then be implemented, creating a solid scientific basis for the policy process. Implementation of the action plan will put in place expertise, equipment and information for quantitative monitoring, analysis and policy recommendations for eventual prevention of air pollution. Eight countries of the region, namely, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka signed the Malé Declaration and agreed to initiate and/or carry forward programmes in each country to

- Assess and analyze the origin and causes, nature, extent and effects of local and regional air pollution, using the in-house identified institutions, universities, colleges etc., building up or enhancing capacities in them where required;
- Develop and/or adopt strategies to prevent and minimize air pollution;

- Work in cooperation with each other to set up monitoring arrangements beginning with the study of sulphur and nitrogen and volatile organic compounds emissions, concentrations and deposition;
- Cooperate in building up standardized methodologies to monitor phenomena like acid depositions and analyze their impacts without prejudice to the national activities in such fields;
- Take up the aforesaid programmes and training programmes which involves then transfer of financial resources and technology and work towards securing incremental assistance from bilateral and multilateral sources;
- Encourage economic analysis that will help arriving at optimal results;
- Engage other key stakeholders for example industry, academic institutions, NGOs, communities and media etc. in the effort and activities.

Figure 1-2 Participating countries

Figure 1.2 indicates the countries participating in the Malé Declaration, viz., Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka. Each country has a National Focal Point and a National Implementing Agency as given in Table 1.1 below.

Table 1.1 Details of Participating Countries

No.	Name of Country	National Focal Point	National Implementing Agency
1	Bangladesh	Ministry of Environment and Forest	Department of Environment, Dhaka
2	Bhutan	National Environment Commission, Thimphu	National Environment Commission, Thimphu
3	India	Ministry of Environment and Forest	Central Pollution Control Board, New Delhi
4	Iran	Department of Environment, Tehran	Department of Environment, Tehran
5	Maldives	Ministry of Environment and Energy Malé	Ministry of Environment and Energy, Malé
6	Nepal	Ministry of Environment, Science and Technology	International Center for Integrated Mountain Development, Kathmandu
7	Pakistan	Ministry of Climate Change	Environment Protection Agency, Islamabad
8	Sri Lanka	Ministry of Environment and Natural Resources	Central Environment Authority, Colombo

1.2 AIR QUALITY IN ASIAN CITIES

Air pollution is a term used to describe the contamination of the air with substances that cause harm or discomfort to human beings or other living organisms and the environment. Emission of unwanted chemicals or other materials, in the form of gases and finely divided solid and liquid aerosols (loosely defined as "any solid or liquid particles suspended in the air") can result in the degradation of air quality. This happens when the quantities emitted exceed the capacity of natural processes to convert or disperse them. Air pollutants may be primary or secondary in nature as a result of chemical reactions which take place in the air.
As per the continuous ambient air quality monitoring data of several Asian cities, the maximum annual average concentration of nitrogen oxides (NOx), particulate matter less than 10 µm in diameter (PM10), ozone (O_3), and carbon monoxide (CO), generally exceed the Ambient Air Quality guidelines stipulated by the World Health Organization (WHO).

Degrading air quality in urban areas is affecting the lives of millions of people due to health impacts associated with air pollution. Continued economic growth in Asia will result in further pressure on air quality. According to WHO estimation, about 5, 30,000 premature deaths in Asia occur every year because of outdoor air pollution. The quality of life of millions continues to be negatively affected, and the economic cost of air pollution is now believed to amount to 2-3% of GDP in many of the developing countries of Asia. In addition to this, air pollution is also affecting crops and biodiversity through acid deposition, damaging cultural and heritage properties through corrosion and contributing to climatic variability and extremes. Thus, air pollution is an environmental problem that transcends national boundaries.

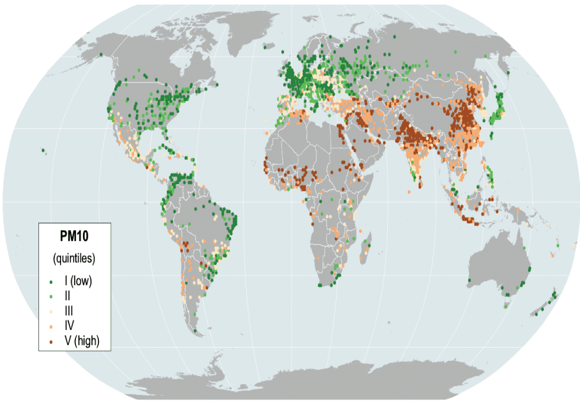

Figure 1-3 Asian cities are exposed to PM10, which is relatively higher than other cities in the world
Photo Sumber:Cohen, et al,2005

The above situation is an indication that though there are ongoing air quality management programs, there is definitely a need to further improve and strengthen them. It has also become clear over the years that the success of any program can be highly influenced by the support or otherwise of key stakeholders including the public. This is also important for a program to get its share of 'brain space' with decision makers.

The main driving forces for the deteriorating air quality in Asian cities are:

Population growth and urbanization

As population grows, demand for transport, energy, housing, and environmental services also increases. Such increases create pressure on the environment in the form of emissions of air pollutants which can affect air quality. Over the past decades, urban populations have grown more rapidly than rural populations. This is true as cities and towns become the engine of economic development in many Asian countries. As cities expand to their hinterlands, so does the distance from home to work in city centers which further raises the need for energy and transport, creating more burdens on the environment.

Figure 1-4 Dense city
Photo by DaniHamdan

Economic development

Many countries have experienced economic development and higher standards of living over the past decades. Conventional wisdom relates economic growth to increased air pollution; however, this is not always the case for all countries. In many developing countries as they undergo economic and industrial development, and motorization, demand for energy/fossil fuels tends to increase, thus, increasing levels of air pollution in the absence of effective policies or else their weak implementation.

Figure 1-5 City Development
Photo by Gracia

1.2.1 SOURCES OF AIR POLLUTION

Sources of air pollutants in Asian countries are both man-made (anthropogenic) or natural (biogenic). However, the former is of main concern, especially in urban areas of these countries with both stationary and mobile sources of air pollution. Stationary sources include point sources, like industries, or area sources like domestic, agricultural residue burning, release of gases from solid waste dumps, etc. The mobile source of air pollution is principally the transport sector, which includes road/rail based transportation, as well as water and air transportation. In cities motor vehicles are considered as the single largest mobile source of air pollution.

1.2.2 TYPES OF POLLUTANTS

Stationary Sources of Air Pollution

In keeping with the increasing demand for energy, thermal power plants, associated with combustion of fossil fuels, are the single largest source of air pollution. Other air polluting industries emit different pollutants depending upon their production processes, including combustion for energy conversion; incineration, evaporation, etc. Use of cleaner fuels, cleaner & more efficient technologies and adopting better pollution control measures would mean lesser emissions.

Figure 1-6 Stationary source

Domestic air pollution is mainly due to indiscriminate garbage dumping and open burning of garbage and biomass (Figure 1-7). Combustion of coal and wood in the kitchens (specially the weaker sections and in rural areas) has a potential to cause in-door and out-door air pollution (Figure 1-8).

Air pollution from the agricultural sector covers emissions as result of land clearing especially through burning crop residue after harvesting (Figure 1-9) or by its aerobic or anaerobic decomposition. It is a common practice in Asian countries to burn the agricultural residue left in the fields after harvesting for the purpose of quick clearing the land and preparing for the next crop. Moreover, most of these countries are rice producing and emission of methane and other greenhouse gases from the paddy fields is also well known. Intensive spraying of pesticides' is also a common practice and pesticide aerosols in air are common.

Figure 1-7 Open burning of garbage

Figure 1-8 Domestic pollution

Mobile Sources of Air Pollution

Automobiles are a significant mobile source of air pollution. Atmospheric pollutants commonly associated with motor vehicles are nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), sulphur oxides (SOx), lead (Pb), and particulate matter less than 10 microns in diameter (PM10and finer particles). Figure 1.10 gives the contribution of transport sector to air pollution in Iran and Sri Lanka.

Figure 1-9Agricultural residue burning in fields

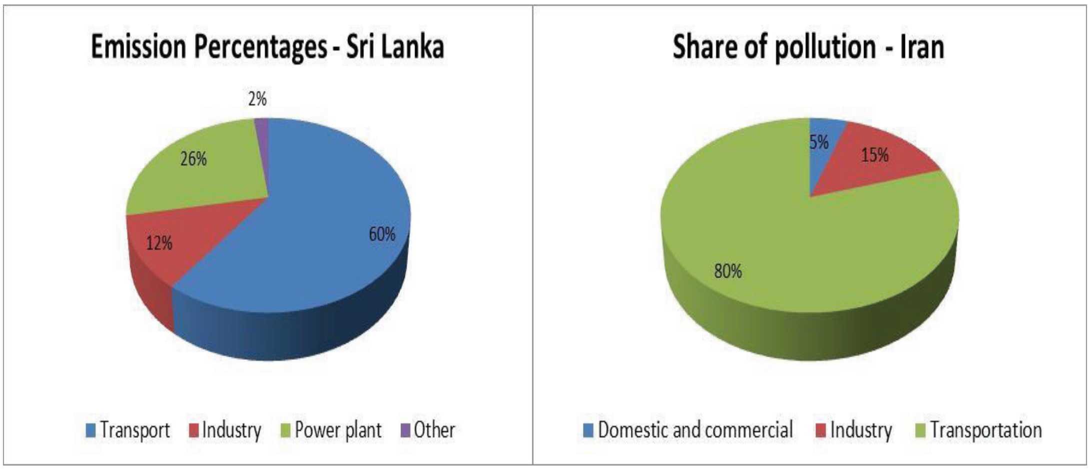

Figure 1-10 Emission percentages

The compounds in exhaust gases of vehicles are formed during the combustion of fossil fuels in the combustion chamber. Emissions from an individual car are generally low, relative to the smoky stack image many people associate with air pollution. But in numerous Asian cities, private cars and two wheelers are the single greatest polluters, as emissions from millions of vehicles on the road add up. Driving a private car is probably a citizen's most "polluting" daily activity. Apart from the increasing number of vehicles, vehicular pollution is also associated with the types of engines used, age of vehicles (old vehicles also exist often with outdated technology and non-observance of emission norms), congested traffic, poor road conditions, outdated automotive technologies and traffic management systems. The quality of fuel supplied has also compounded the problem of vehicular pollution. The composition of emissions depends on fuel used, driving conditions, engine type, gas emission controller, operational temperature, and other factors, all of which make emission pattern more complicated.

Pollutants emitted from motor vehicles are closer to the ground and can affect the air quality more directly as compared with the high rise smoke stacks of industry. Thus, people who live on the streets or do their activities in places with congested traffic, including drivers, pedestrians, traffic police and street vendors are exposed to high concentration of pollutants. Estimates of exposure dosage depend very much on the concentration of pollutants, which is related to the condition of traffic at that time.

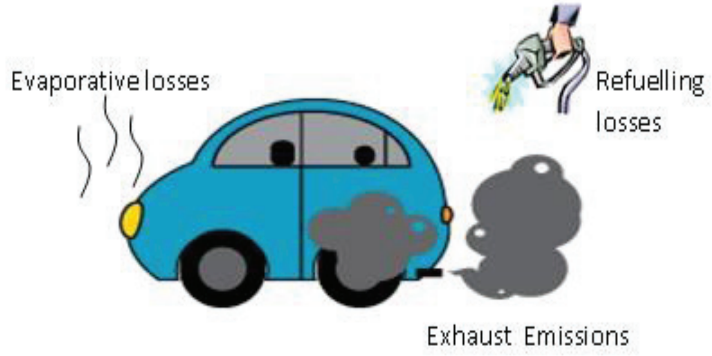

Figure 1-11 Emissions from motor vehicles

Once released to the atmosphere the exhaust gases from vehicles change because of chemical reactions, in the presence of sunrays and water vapour or due to reactions between themselves. Some more stable pollutants such as lead (Pb), several halogenated hydrocarbons and poly aromatic hydrocarbons fall to ground with rain or with dust and contaminate the soil and groundwater. The compounds can also enter the food chain and finally human body through vegetables, milk, products of food industry and other animal husbandry products.

Figure 1-12 Mobile source

Primary air pollutants such as, Particulate Matter (PM or “aerosols”), black carbon, sulphur dioxide (SO2), nitrogen oxide (NO) and carbon monoxide (CO), are the ones that are emitted directly into the atmosphere by sources (such as industry or automobiles). Volatile organic compounds (VOCs) are also considered as primary pollutants.

Secondary air pollutants are the ones that are formed as a result of atmospheric reactions between primary air pollutants and other elements in the atmosphere, e.g., ozone (O_3) is formed from photochemical reactions of nitrogen oxides and volatile organic compounds (VOCs); nitrogen dioxide (NO_2) and nitric acid (HNO_3) are formed from NO.

Some secondary pollutants like sulphates, nitrates, and organic particles can be transported over long distances. Wet and dry deposition of these pollutants contributes to the “acid deposition problem (often called “acid rain”), with possible damage to soil, vegetation and water bodies.

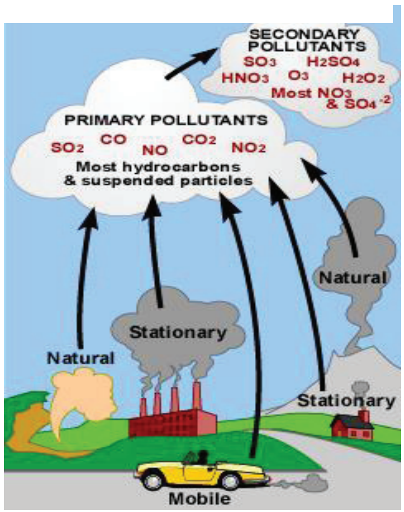

Figure 1-13.Sources of air pollution

Source : http://www.epa.gov/apti/course422/ap3.html

Air pollutants can be broadly classified into two groups:

- Criteria or major air pollutants and
- Hazardous air pollutants (HAPs).

Criteria pollutants

The criteria air pollutants consist of:
Nitrogen oxides ($NO+NO_2$): NO_2 is a reddish-brown gas with a sharp odour. The primary source of this gas is vehicular emissions and it plays a role in the formation of tropospheric ozone.

Sulphur dioxide (SO_2): It is a colourless gas with a suffocating, pungent odour. The primary source of SO2 is the combustion of sulphur-containing fuels (e.g., oil and coal). Coal based thermal power plants are the single largest source.

Carbon monoxide (CO): This odourless, colourless gas is formed from the incomplete combustion of fuels. The largest source of CO today is vehicular emissions.

Particulate Matter (PM): PM can exist in solid or liquid form, and includes smoke, dust, aerosols, metallic oxides, and pollen. Sources of PM include combustion, factories, construction, demolition, agricultural activities, motor vehicles, and wood burning.

Ozone (O_3): Ozone occurs in two layers in the atmosphere1 It can protect or harm life on earth depending on the layer it is in. The layer closest to the Earth's surface is Troposphere. Tropospheric ("low-level") ozone or "bad ozone" is harmful to breathe and it damages crops, trees and other vegetation and is formed as a result of photochemical reactions involving NO and VOCs. Automobiles are the largest source of VOCs necessary for these reactions. Ozone concentrations tend to peak in the afternoon. High up in the atmosphere, ozone forms a layer that shields the Earth from ultraviolet rays. However, at ground level, ozone is considered a major air pollutant. Ozone concentration is likely to reach unhealthy levels particularly on hot sunny days in urban environments. It is a major part of urban smog. Significant reduction in agricultural yields is expected because of increase in ground-level ozone and due to pollution. These interfere with photosynthesis and stunt the overall growth of some plant species. The troposphere generally extends up to 6miles up from earth's surface where it meets the second layer the Stratosphere which extends upward from about 6 to 30miles. The Stratospheric ozone protects life on earth from the Sun's harmful ultraviolet (UV) rays.
Lead: The largest source of lead in the atmosphere has been from leaded gasoline combustion. However, there is now a gradual elimination of lead in gasoline. Of the eight participating countries, India and Sri Lanka have already phased out lead from gasoline Other airborne sources of lead include combustion of solid waste, coal, and oils, emissions from iron and steel production and lead smelters, and tobacco smoke.

The HAPs, also called toxic air pollutants or air toxins, consist of chemical, physical and biological agents of different types that cause or may cause cancer or other serious health effects, such as birth defects. There are 189 hazardous air pollutants identified by the Clean Air Act of the USA. These are present in the atmosphere in much lower concentrations and are often more localized, but are toxic or hazardous in nature. Examples of HAPs include a range of organic compounds like, benzene, toluene, xylene, and other toxic organic pollutants, e.g., polycyclic aromatic hydrocarbons (PAHs), pesticides and polychlorinated biphenyls (PCBs). HAPs also get adsorbed on particulate matter, specially the fine particulate matter-PM2.5.

Common Pollutants of Concern and Health Impacts

Clean air is a basic necessity for sustenance of life. In spite of introduction of cleaner technologies in industry, energy production and transport sectors, air pollution remains a major health and ecological risk. Recent epidemiological studies have provided evidence that even low pollution levels increase mortality and morbidity (the rate of disease or proportion of diseased persons in a given locality, nation, etc., that is, the incidence or prevalence of a disease).

The relationship between urban air pollution and its risks to health has only been discussed in the last several decades. Its harmful effects range from increasing mortality rate due to smog episode to aesthetics and life discomforts. Other health disturbances are pulmonary, cancer, acute or chronic throat disorders, and other harmful effects of pollutants on body organs such as lungs and the central nervous system. Because every individual is exposed to many compounds at the same time, it is often very difficult to determine which compound or which combination of compounds has the most prominent role in causing danger to health.

The danger of emissions or air pollution to health depends on the toxicity of each compound and how many people are exposed to it. Several factors which cause uncertainty analyzing the risks of air pollution are definitions used regarding to dangers to health, relevance and interpretation of epidemiological study and experiment, reliability of exposure data, number of people exposed, decisions regarding which risk groups will be protected, interaction between various compounds in exhaust gas, either of similar type or different type and period of exposure.

In general, the term danger to health is the effect of pollutant on anyone or any group of people, which can increase risk towards any disease or other kinds of medical condition. The risk is not only to clinical diseases but also risk to longevity, etc.

It has been proven that children and old people are the highest risk groups in air pollution cases. Children are more sensitive to respiratory tract infections than adults, and their lungs also have not developed fully. Old people are included in the high-risk group because their lung capacity and function have decreased and their immunity also has weakened. Heart and lung disease patients are also included in this high risk group to air pollution.

Based on their chemical property and environmental behavior, air pollutants can be classified as follows:

- Air pollutants which cause respiratory tract disorders, i.e., oxides of sulphur, particulate matter, oxides of nitrogen, ozone, and other oxides.
- Systemic poison air pollutants, i.e., hydrocarbons, carbon monoxide and lead, toxic substance such as mercury whose effect is not localized in one spot but spreads to all body organs and systems in varying degrees - that affects the entire body. Also called systemic toxicant.
- Carcinogenic pollutants such as hydrocarbons.
- Others such as noise, dust, etc.

1.3 THE MALÉ DECLARATION MONITORING PROGRAMME

The objective is to gather national information on air pollution to facilitate the implementation of the Malé Declaration in South Asian countries in order to achieve significant environmental and public health benefits through reductions in emissions of air pollutants. Deposition reductions are unlikely to be met solely through national policies and measures because of the transboundary nature of air pollution transfer.

Monitoring of air quality is an important component of any Air Quality Management (AQM) program as is evident from the figure below. One of the main challenges in air quality management (AQM) is to have timely and appropriate access to air quality data which are relevant and of known quality as it allows effective decision-making on air quality issues. The air quality monitoring data also helps in assessing compliance with current ambient air quality guidelines and standards and to assess trends in air pollutant concentrations. It can also be used to determine the effectiveness of existing national and regional and proposed policies.

Therefore, there is a need for inter-governmental cooperation and the development of uniform sub-regional air quality assessment procedures and appropriate action plans.

The information collected from baseline studies will be used to develop national and sub- regional action plans and to establish a consistent air quality assessment procedure for each nation.

Thus, the assessment procedure has to begin with the collection of detailed knowledge describing the existing situation. The aim is to know which air pollutants are present and in what quantities, their origin, their dispersal patterns, the potential that they will impact on sensitive receptors, and what response measures should be taken to ameliorate the situation.

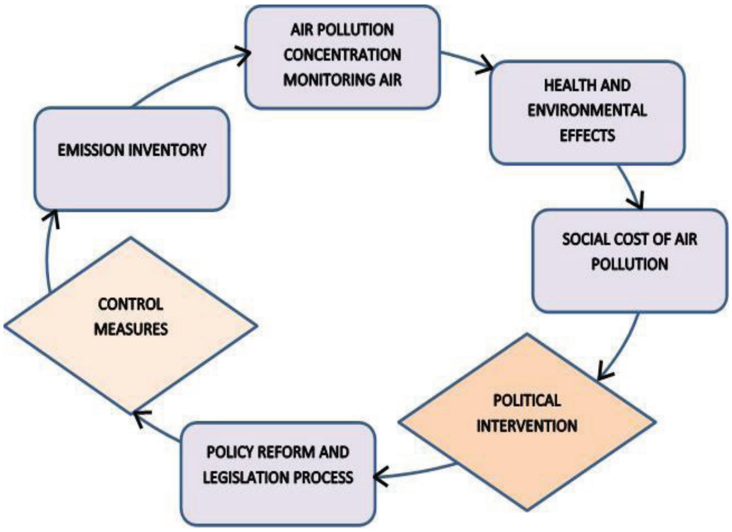

Figure 1-14 Air Quality Management Cycle

Malé Declaration is dedicated to creating a common understanding of the status of trans boundary air pollution and its effects among member countries and collaborating organizations, and for providing useful inputs for the assessment of air quality in the region and that this understanding will provide the scientific basis for steps to tackle this problem. Hence, it is very important that uniform and regular monitoring be carried out by all the participating countries at the selected locations for the decided parameters; the results be compiled in a systematic database, as information on outcome of monitoring activities is known only through monitoring data.

The transport of atmospheric gases and particulate matter (aerosols) and adsorption by the Earth's surface (land surfaces, plant surfaces, building surfaces, water surfaces), without the mediation of precipitation is known as the dry deposition, while dissolution of these species in clouds, fog, rain or snow and eventually rain out or wash out by the falling rain or snow is known as the wet deposition.

The proportion of wet and dry deposition can vary with location and time and will largely be related to the meteorological conditions. Wet deposition is responsible for 30-50% of deposition fluxes to ecosystems in South Asia. Precipitation chemistry measurements provide information on the exchange of trace materials between the atmosphere and the earth's surface. Dry deposition accounts for 50-70% of total deposition fluxes to the ecosystem. It is therefore important to monitor dry and wet deposition to obtain a complete evaluation of total deposition in a region, which is necessary for assessment of the effects of the atmospheric pollution.

One of the goals of the Malé Network is to share high-quality data and other information on wet and dry deposition and its composition with the Malé Declaration participating countries.

This report presents the data generated by the participating countries over the last three years (2009-2011) with a goal to share the results of monitoring as well as to evaluate the data generated specially with respect to trends if any. It is expected to provide an important basis for a common understanding of the present status of monitoring and the environment in the countries as well as the matters needing future attention.

CHAPTER 2. MONITORING PROGRAM

2.1 MONITORING LOCATIONS

The Malé Declaration monitoring programme was started in 2001. Each of the eight countries identified monitoring locations as per the laid down criteria in remote areas away from factors of direct influence. The details of the monitoring site in each participating country are presented in Table 2.1

Table 2.1 Details of Monitoring Locations

S No	Country	Site Type	Location	Longitude Latitude	Remarks
1	Bangladesh	Rural	Kulna	22o 18.975’ N; 89o 02.607’E	About 30 km North to the Sundarbans forest.
2	Bhutan	Remote	Thimphu	27°0’N; 90°30’E	350m above sea level close to Jigme Singye Wangchuk National Park and Manas National park
3	India	Rural	Port Canning	22019´8″N	Average annual rainfall: 1750 – 1800 mm. Dominant wind direction: N/NE during winter and S/ SW in summer close to Sundarbans
			Dawki, Meghalaya	26047´06″ N	Bordering Bangladesh Operating since August 2009
		Rural	Pathankot, Punjab	3201´60″ N 7501´0″	Bordering Pakistan
		Rural	Daranga, Assam	26048´ N	Bordering Bhutan
			Kavaratti , Lakshadweep	100 0´ N 730 0´	Bordering Maldives
			Andaman & Nicobar Islands		Bordering South-east Asia
4	Iran	Rural	Chamsari	32° 24’N, 47°31’E	40 km south to the town of Dehlaran and about 200 km south to Ilam, the headquarters of the province
5	Maldives	Remote	Hanimaadhoo		Altitude: ~2 m. Located in the northernmost atoll of Maldives located about 400 km to the north of the country’s capital, Malé.

S No	Country	Site Type	Location	Longitude Latitude	Remarks
6	Nepal	Rural	Rampur	27o 38'N; 84o 20'E	At the premises of the Institute of Agriculture and Animal Sciences (IAAS) located about 15 km to the south of the Royal Chitawan national park. Altitude: 164.95 m
7	Pakistan	Rural	Bahawalnagar	290 57'N; 730 15'E	
8	Sri Lanka	Rural	Doramadalawa	080 24' 22.39" N 800 29' 11.74" E	On a rock near Doramadalawa Buddhist temple and 10 km arial distance from the ancient city of Anuradhapura

In order to ensure the ownership of the programme, National Implementation Agencies (NIAs) were given complete freedom on site selection with technical guidance from the MoC. The local communities and the village heads were also consulted during site selection in most of the countries. The details of the site location in some of the countries is as follows,

2.1.1 BANGLADESH

Figure 2.1 gives the installation of diffusive samplers and bulk sampler at the Bangladesh monitoring site. Figure 2.3 gives the wind rose for the meteorological data available for 2008.

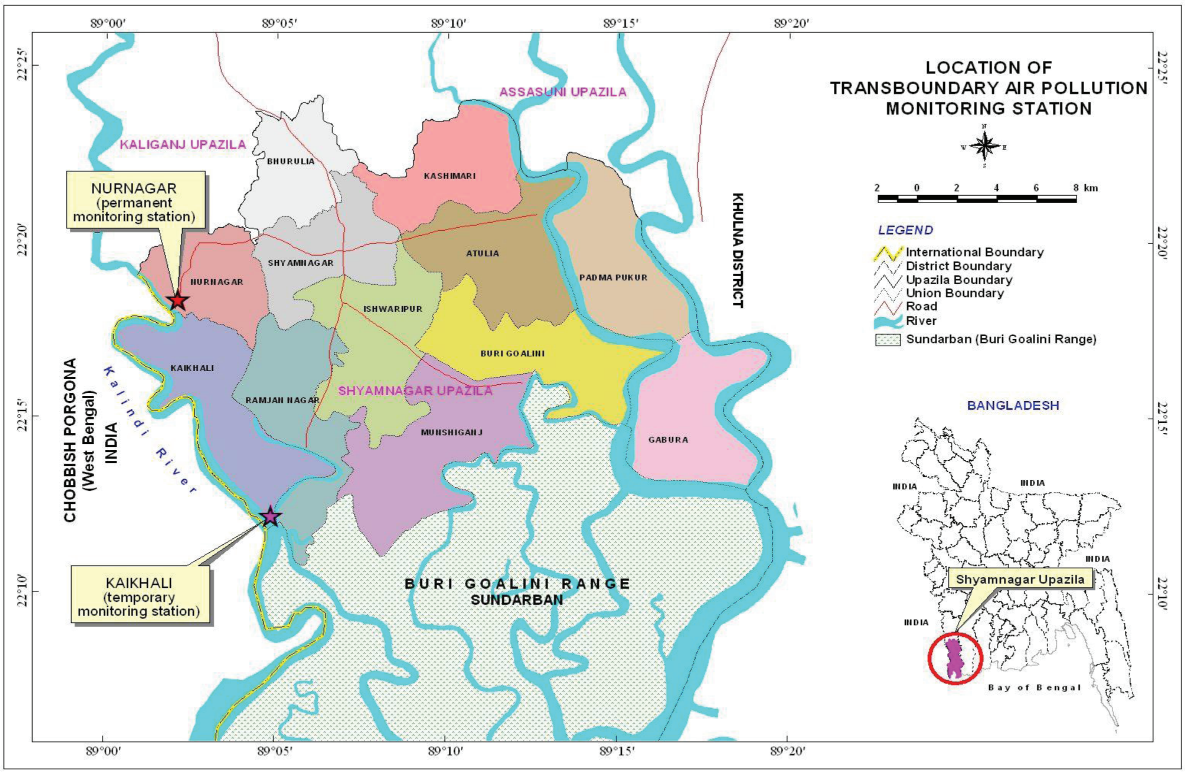

Figure 2-1 Site for monitoring location, Bangladesh

Figure 2-2 Passive Sampler; Station with bulk sampler

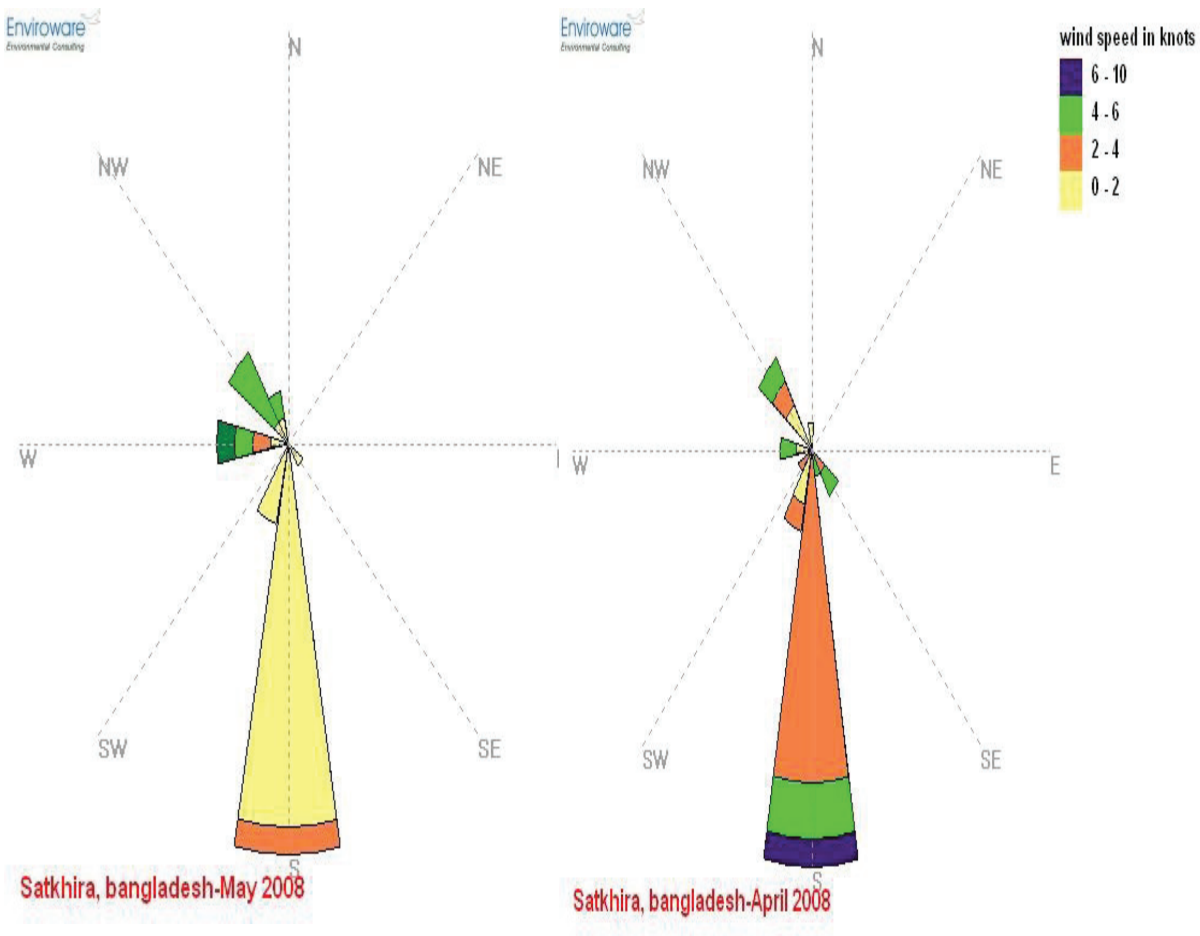

Figure 2-3 Wind rose for met station, Bangladesh

2.1.2 BHUTAN

The location details for the two sites in Bhutan are given in Figures 2.4 and 2.5.

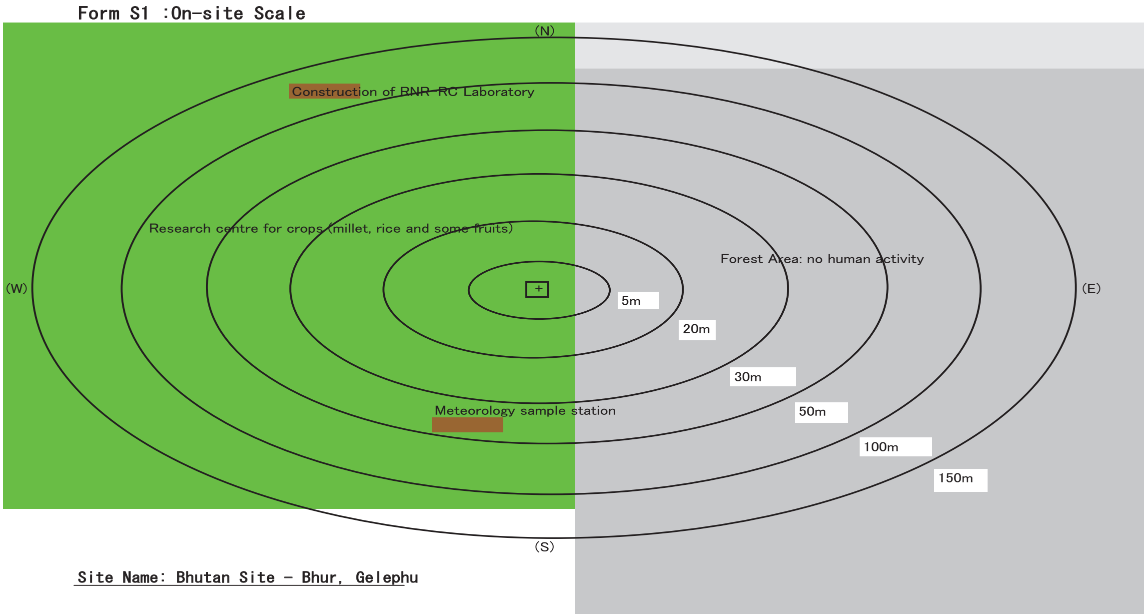

Figure 2-4 Urban site – Bhur, Gelephu - Bhutan

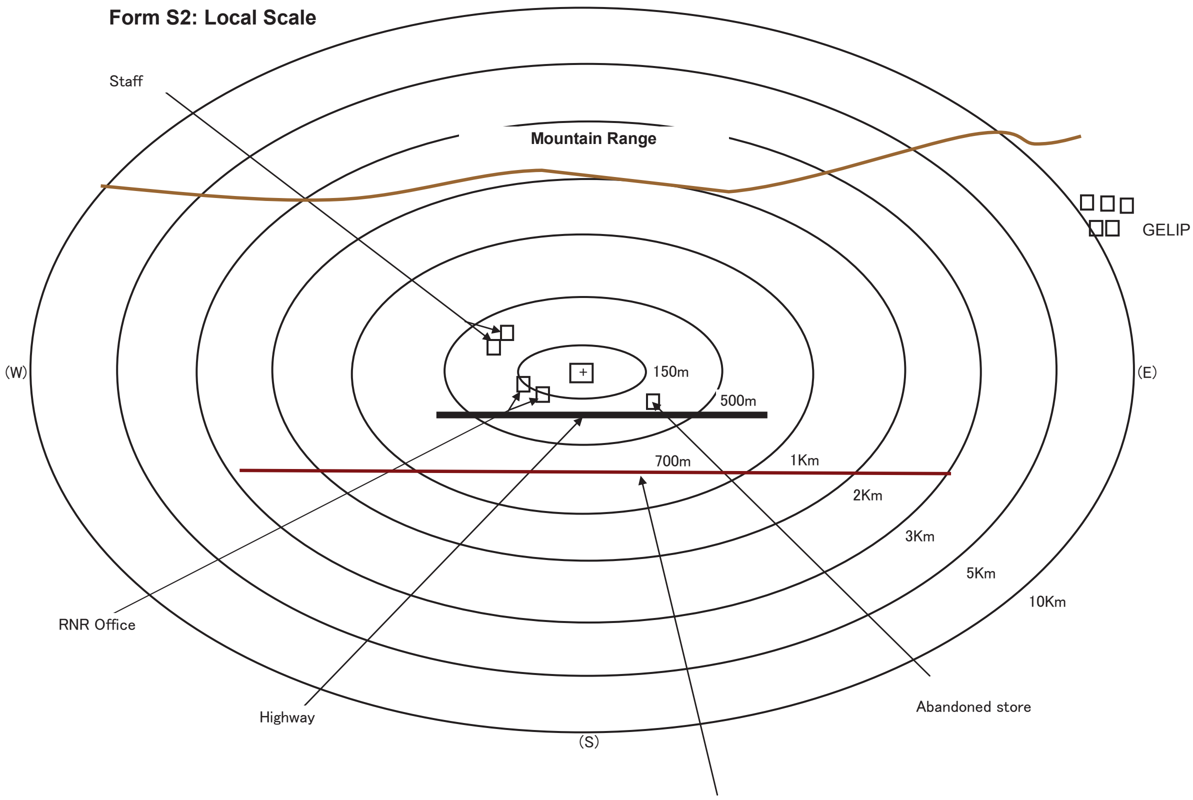

Figure 2-5 Gelephu in Southern Bhutan

Figure 2-6 Wet monitoring, Bhutan

2.1.3 IRAN

The first monitoring station is located at Chamsari, on the Iraq border, in the southern part of Ilam Province. A map of the monitoring site and its surroundings is provided in Figure 2.7.

The site is at Chamsari, which is located a few kilometers from the Iraq border. Chamsari is 40 km south of the town Dehlaran and about 200 km south of Ilam, the head quarter of the province. The monitoring site is in a military area. There are two small villages at a distance of 5-7 km to the north and northwest of site. The site is barren and has loose gravel. The cooking energy used by the villagers is LPG (Liquefied Petroleum Gas). No biomass burning was reported to occur in the villages.

Chamsari is a deposition-monitoring site.

There are two oil wells located about 12-15 km north and south of the site, respectively. The oil wells have flares.

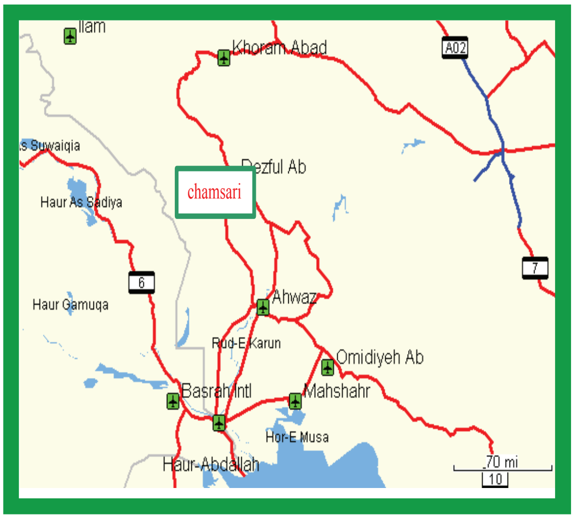

Figure 2-7 Site for the monitoring station - Iran

DoE officials had looked for alternative sites to Chamsari. Either the existence of hill ranges very close to the Iraq border or the lack of power lines made Chamsari the only viable site in the proximity of Baghdad, the major emission source across the border.

No meteorological station exists within a 50 km radius of Chamsari. Summer temperatures at the site exceed 50°C.

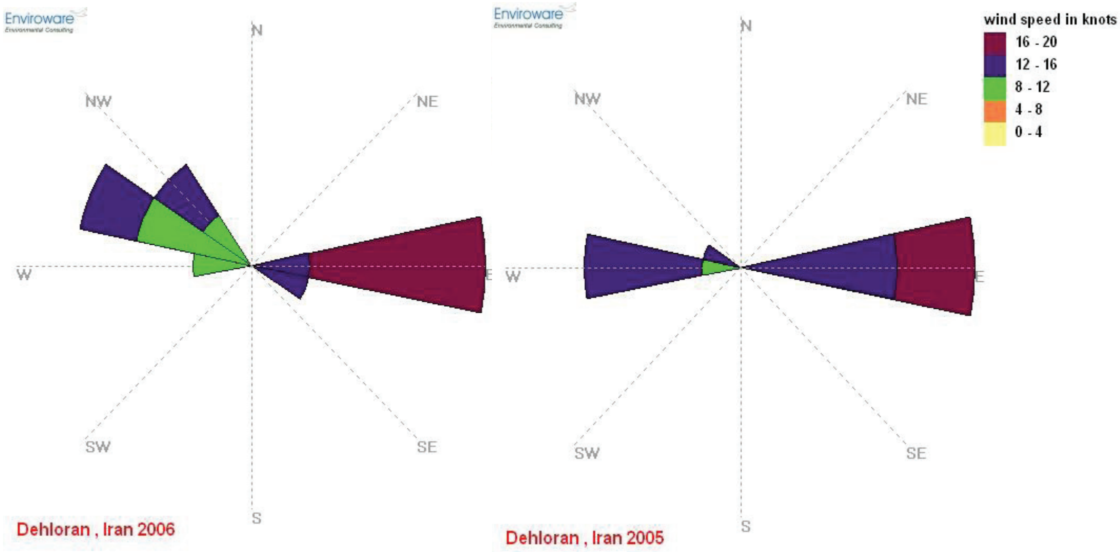

Figure 2-8 Wind rose for met station, Iran

2.1.4 MALDIVES

The monitoring station is located on the Hanimaadhoo Island, located about 400 km north of the country’s capital, Malé. The same location was to be used to monitor the Atmospheric Brown Cloud. A training programme for handling the monitoring instruments was conducted on Hanimaadhoo Island. A map of the monitoring site and its surroundings is provided in Figure 2.9.

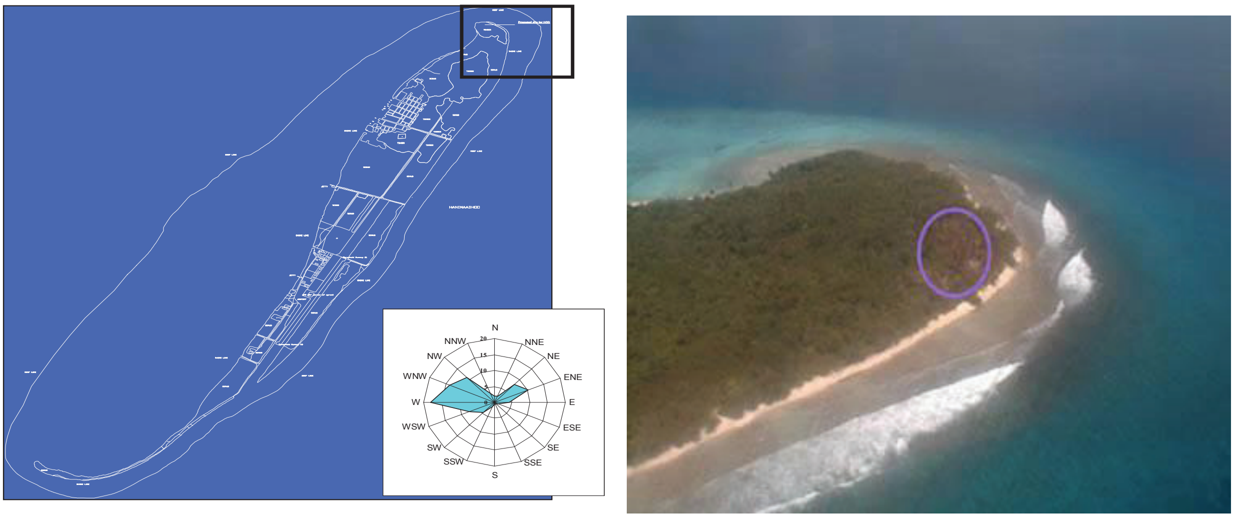

Figure 2-9 Site for monitoring location, Maldives

The site where the instruments were located is at the northern tip of Hanimaadhoo Island, which is about 5 km in length and half a kilometer at its widest point. The island has an airstrip and a daily air service from Malé. It also has a small village with a population of 800 persons located between the airstrip and the monitoring station which is about 1.5 km north of the village. The cooking energy used by the villagers is LPG.

No biomass burning was reported to occur on the island. There is thick vegetation all over the island, including between the village and the proposed monitoring station.

There is a diesel generator power station of 400 KW capacity located in the village. The stack height of the station is 20 m and below the tree-line.

Monitoring for wet and dry deposition can be done on Hanimaadhoo Island.

A meteorological station exists at the airport. The station monitors wind direction and speed, relative humidity, temperature and pressure.

Though other uninhabited islands that had no anthropogenic interferences were available, transport costs to such islands would have been prohibitively expensive. It was therefore felt that Hanimaadhoo Island was a practical choice

Figure 2-10 Sampling at Maldives monitoring site

2.1.5 NEPAL

The IAAS campus was chosen to be first monitoring station. The IAAS campus is located about 15 km south of the Royal Chitawan national Park and about 25 km north of the Indian border. The maps of the monitoring site and its surroundings are provided in Figure 2.11 and 2.12. The site is bounded by two roads which lie outside the campus and which have some vehicular traffic on them. The campus has some internal roads, but with little vehicular traffic. The site is in the midst of experimental agricultural farms of IAAS.

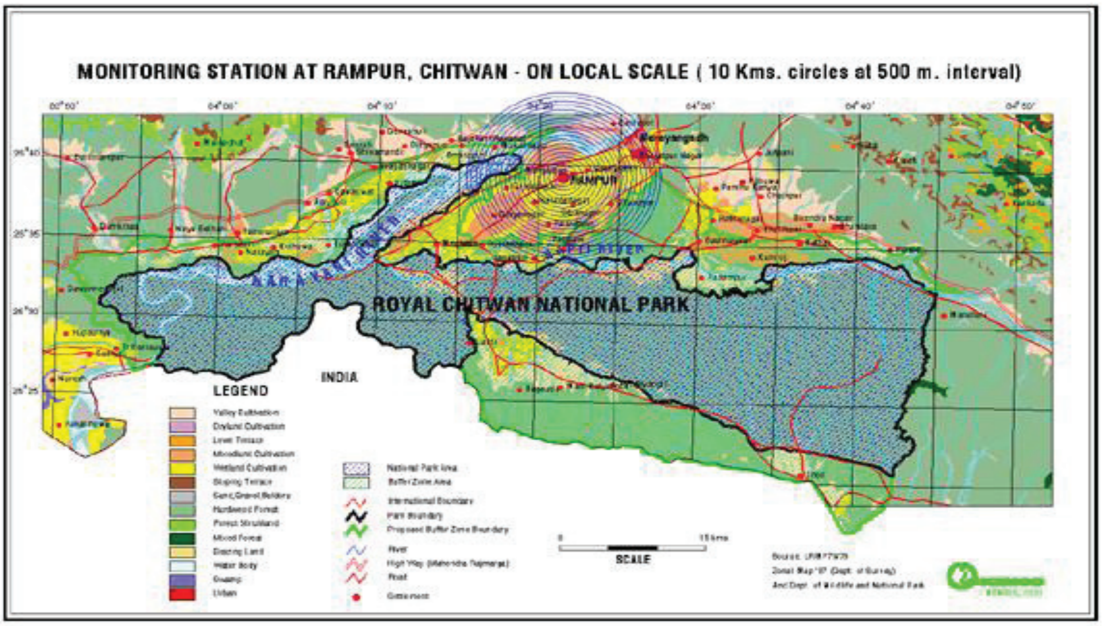

Figure 2-11 Site for the monitoring station - Nepal

The IAAS site is a deposition-monitoring site and it meets the following siting criteria:

- The site is close to the Indian border.
- The site is in a broad downwind direction from major power plants in India.
- There is no forest between the site and Indian border, nor is the forest too close to the site.
- The site is not influenced by local meteorological conditions.
- The terrain between the site and the international border is flat land.
- The site is secure and easily accessible.

Since sample analysis will be done on the IAAS campus, there will be little time gap between sample collection and analysis.

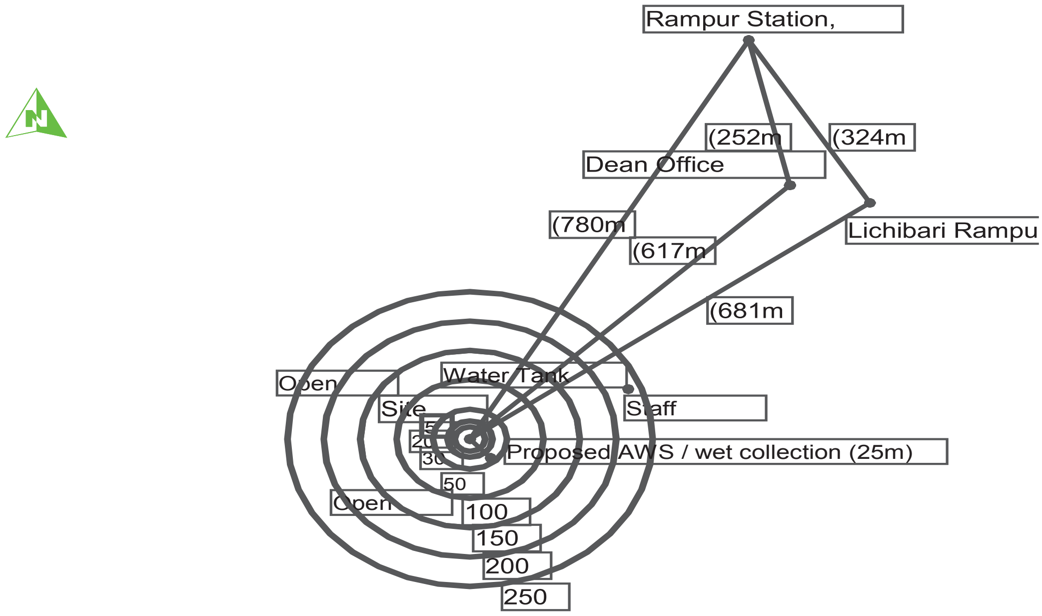

Figure 2-12 On Site Scale (5m-250m) – Nepal

2.1.6 PAKISTAN

The boundaries of Bahawalnagar District touches the Indian territory in the East and South while Bahawalpur district lies on its West and river Sutlej flows on its Northern side across which districts Okara, Pakpattan and Vehari are situated. The distance of International Border is about 10 Km from the monitoring site .

Figure 2-13 Monitoring location Bahawalnagar, Pakistan

Figure 2-14 Photographs of Bahawalnagar site

Figure 2.15 gives the annual wind rose diagram at the monitoring location in Pakistan.

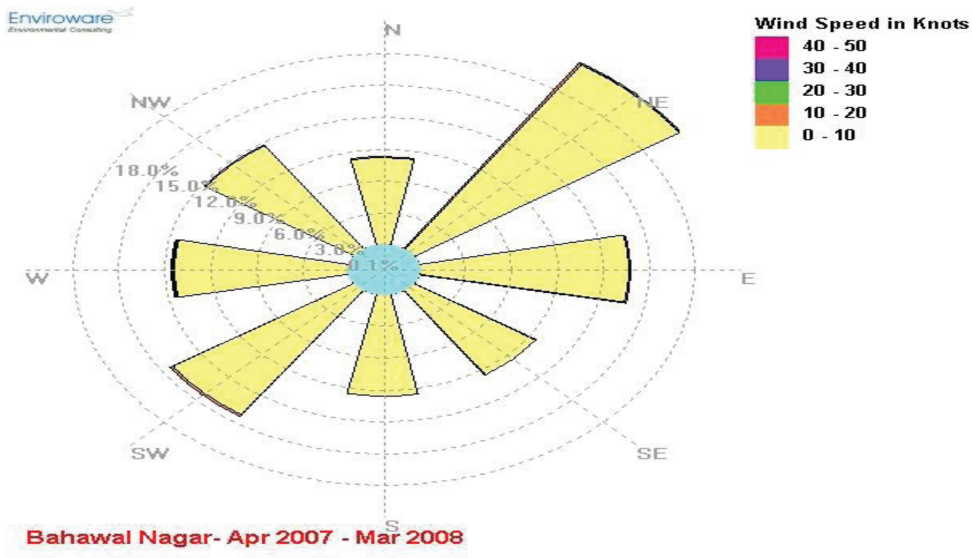

Figure 2-15 Annual average wind rose for Bahawalnagar met station, Pakistan

2.1.7 SRI LANKA

The intensity of the annual rainfall divides the Sri Lanka island into two distinct climatic zones, the wet zone and the dry zone. Nearby three quarters of Sri Lanka lies in 'Dry Zone', comprising the northern half and the whole of the east of the country. Average annual rainfall in this region is generally between 1,200-1,800 mm.

The monitoring site in Sri Lanka was changed from Dutuwewa to Doramadalawa in 2009 due to non-availability of uninterrupted power supply for carrying out PM-10 sampling.

The present sampling location of Sri Lanka is situated at Doramadalawa (080 24’ 22.39” N, 800 29’ 11.74” E) in dry zone around at 10 km areal distance from the ancient city called Anuradhapura. This monitoring site is on the small rock nearby Doramadalawa Buddhist temple at the edge of the Mihinthale reserve forest. This location is classified as rural site.

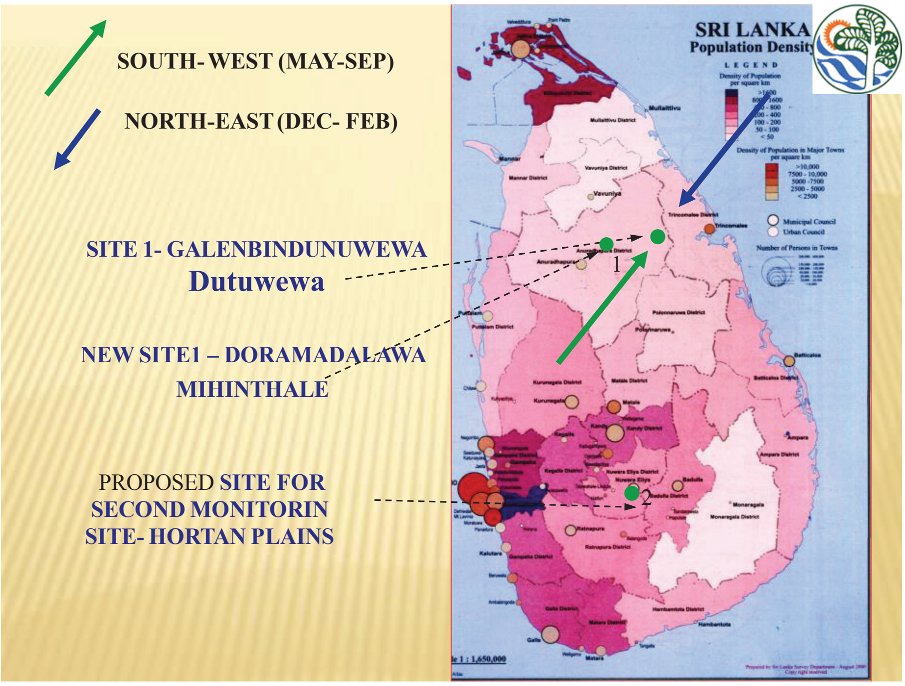

Figure 2.16 Major wind direction

Parallel monitoring of wet deposition was done during the year 2009 with previous monitoring site which was located at Dutuwewa also in dry zone. Wet and dry deposition monitoring was done at Dutuwewa is located about 40 km east of Anuradhapura from2004 to 2009.PM10 monitoring was started at the new site 10th January2010 onwards.

There are no major emission sources close to the Doramadalawa monitoring site. However, there is a seasonal impact due to open burning of forest residues and the paddy straws during the preparation of agriculture fields for cultivation before rain during from July to October which is the main activity at dry zone during the second intremonsoon and north east monsoon period from end August to February

Figure 2.17 Doramadalawa monitoring location – Sri Lanka

A second monitoring location under the programme is now proposed at Hortan Plains to represent the wet zone.

2.2 PARAMETERS AND METHODOLOGIES

The following monitoring parameters and methodologies were identified under the measurement protocol developed for each of the monitoring locations. Based on the methodologies finalized, the participating countries were provided with equipment, glassware and chemicals. The methodologies to be adopted could be broadly grouped into:

- Wet Deposition Monitoring;
- Dry Monitoring; and
- Collection of Meteorological Data.

2.2.1 WET DEPOSITION MONITORING

A large number of chemicals released from natural or anthropogenic sources are present in the atmosphere as gases or aerosols. These are absorbed by the rain droplets and snow on their way to the earth. Natural sources of pollution may broadly include sea salt, eroded earth material and biogenic activities while fossil fuel combustion and agricultural are the major anthropogenic sources. The composition of the rain water depends on the chemical species that have dissolved in it and thus gives a fair idea of the status of air quality of a region. With this in mind it was thought imperative to monitor the wet deposition and study its characteristics'

To obtain uniformity and high quality monitoring data a protocol was developed and each participating country was required to carry out the wet deposition monitoring using the two common methodologies which have been specified in the "Technical Document for Wet and Dry Deposition Monitoring for Malé Declaration". This document was provided to the concerned during the in-country training programmes. The sample so collected was required to be refrigerated before analysis. Under the wet monitoring the weekly composite samples collected by two methods were to be analysed for the same parameters as per the detail Table2-1.

Figure 2-18 Learning rainwater sampling

Table 2-1 Parameters for Wet Measurements

S No	Method	Duration/Frequency	Parameters
1	Wet(Wet) Method	Weekly composite	H+(pH), electrical conductivity(EC), concentration of NH4+,Na+,K+,Mg2+,Cl-,SO42-,NO3-, precipitation
2	Wet(Bulk)Method	Weekly composite	H+(pH), electrical conductivity, concentration of NH4+,Na+,K+,Mg2+,Cl-,SO42-,NO3-, precipitation

The wet-only and bulk samplers are recommended methods for sampling of precipitation. Samples collected are sent to laboratories for chemical analysis. For the wet deposition samples collected in a tropical region, a preservation of samples from microbial decomposition has to be considered. Biocides such as Thymol are added for that purpose when a refrigerator is not available during sampling, transportation and storage. Samples without biocides are refrigerated to keep the sample temperature low enough to preserve the sample chemistry, and sent to the laboratories for further chemical analysis. The analytical methodologies are also detailed in the Technical Document.

At each site one sampler for bulk precipitation was located. Precipitation samplers (Standards for Swedish deposition monitoring) were placed in an open field area windy places were avoided as far as possible.

The equipment (Figure 2. 19) consists of a funnel (A) (diameter 20.3 cm). Within this large funnel, a smaller funnel (B), containing a screen, is placed to protect the sample from litter and evaporation. The sample is collected in a 5 L bottle (D). The sampling equipment is placed on a pole (F) equipped with a plate (E), approximately 1.5 m above the ground.

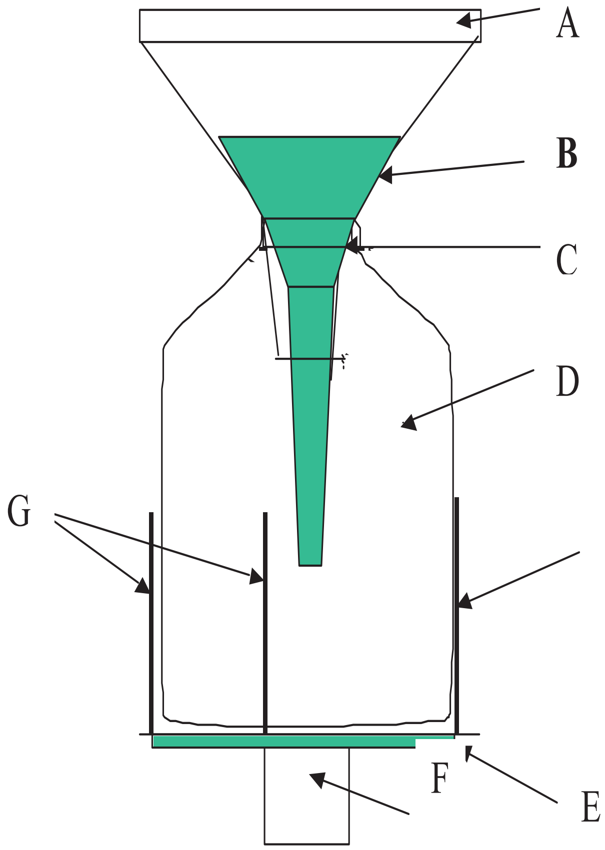

Figure 2-19 Open field collector for precipitation.

(A) Funnel of polyetene (20.3 cm dia.) . (B): Inner funnel of polyetene with small opening. (C): Cap, leakage free connection. (D): Polyetene bottle (5L) (E): Bottom plate fastened onto the pole. (F): Pole of wood (50x50 mm) length ca 1.5m above ground. (G): Four rods to ke ep the equipment in place

Weekly composite rainwater samples were collected with both an automated wet-only collector technique and a bulk sample collector technique. The countries used a wet only sampler to collect samples during rain events only and bulk sampler representing the total deposition during the period.

A flow chart for sampling and analysis of the wet deposition samples is shown in Figure2.20.

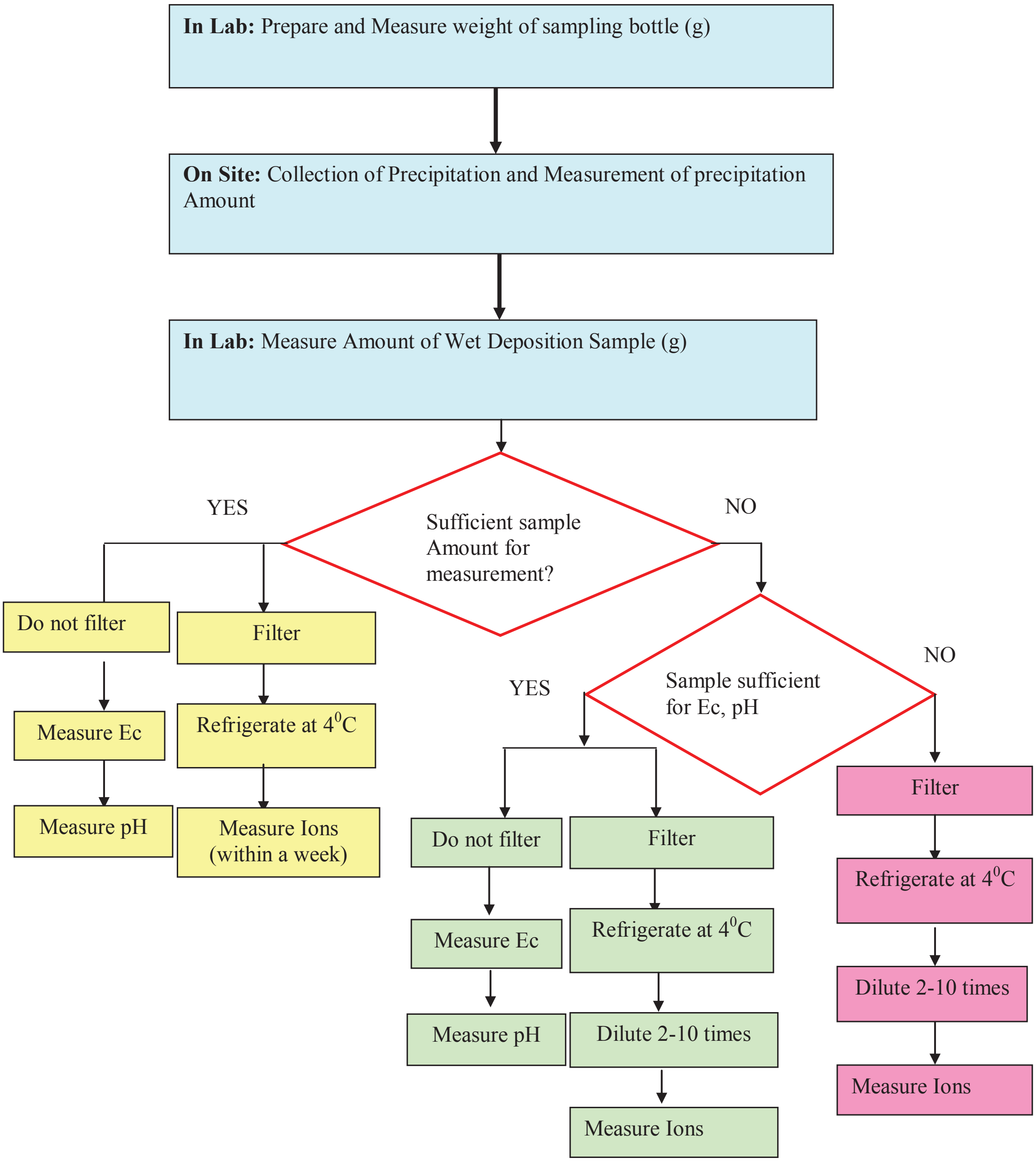

Figure 2-20 Flow chart for sampling and wet analysis deposition

Note: In case of very low volume of sample the order of measurement should be as follows
SO42-, NO3- and Cl-
NH4+, Na+, K+, Ca2+ and Mg2+
If IC is being used, NH4+, Na+, K+, Ca2+ and Mg2+
If no IC is used, NH4+ by spectrophotometry, Na+, K+, Ca2+ and Mg2+ by AAS

Bangladesh, Bhutan, Iran, Nepal, Pakistan and Sri Lanka have submitted the rainwater analysis data from their monitoring site. A perusal of Table 2.2 indicates that the sampling frequency is different for most of the countries. The samples were collected on a daily basis at two sites (Bhutan and Bangladesh); weekly collection is performed at the site in Sri Lanka, monthly collection and analysis at Nepal and random collection at Pakistan site.

Bangladesh, Bhutan, Iran, Nepal, Pakistan and Sri Lanka have submitted the rainwater analysis data from their monitoring site. A perusal of Table 2.2 indicates that the sampling frequency is different for most of the countries. The samples were collected on a daily basis at two sites (Bhutan and Bangladesh); weekly collection is performed at the site in Sri Lanka, monthly collection and analysis at Nepal and random collection at Pakistan site.

2.2.2 DRY DEPOSITION MONITORING

Dry Deposition monitoring was carried out by two methods,

1. High Volume Samplers (HVS)/PM10 Samplers

High Volume Samplers were used to monitor SO_2, NO_2, PM10 and SPM in Malé Declaration Network. Two 12hourly samples were required to be collected each day to get a 24hr average. Monitoring was to be carried out for 10days between 5-25th of each month. The samples from HVS were analyzed in their respective laboratories using suitable analytical methods such as gravimetric for particulate matter and spectrophtometric for SO2 and NO2

Figure 2-21 Learning rainwater air sampling

2. Diffusive (Passive) Samplers

Diffusive samplers were used to collect monthly composite samples of SO_2, NO_2 and ozone. The samples collected with diffusive samplers were repacked in their containers at the end of sampling interval and sent to IVL-Swedish Environmental

Figure 2-22 Diffusive samplers at a Malé station

Research Institute Ltd. for analysis. The start and end time of the sampling period were recorded.

Under the dry measurements also the monitoring was required to be carried out by two methods for the parameters as per following details,

Table 2-2 Parameters for Dry Measurements

S No	Method	Duration/Frequency	Parameters
1	Diffusive (Passive) Sampling	Monthly composite	Concentration of SO2, NO2,and O3
2	Air concentration Sampling(Using PM10 samplers)	24hr composite(consisting of two samples – 9am to 9pm and 9pm to 9am)To be carried out for 10days in a month between 5th and 25th of each month	Concentration of PM10, TSPM, SO2 and NO2

Note: PM10 – particulate matter of 10µm or less particulate size (respirable particulate matter)
TSPM – total Suspended particulate matter

2.3 ANALYTICAL PROCEDURES

The procedures suggested for analysis of the major constituents of rainwater given in Table 2.3.

Table 2-3 Techniques suggested for analysis of major constituents in rainwater

S No	Parameter	Instrumental Method
1	Electric Conductivity (EC)	Conductivity meter
2	pH	pH meter(glass electrode)
3	Chloride(Cl-)	Ion chromatography or Argentometric method
	Nitrate(NO3-)	Ion chromatography or Cadmium reduction method Spectrometry
	Sulphate (SO42-)	Ion chromatography or turbidimetry
4	Ammonium(NH4+)	Ion chromatography, Spectrometry
5	Sodium(Na+)	Ion chromatography, atomic absorption spectrometry, Flame photometry
	Potassium(K+)	Ion chromatography, atomic absorption spectrometry, Flame photometry
	Calcium(Ca2+)	Ion chromatography, titrimetry (EDTA method)
	Magnesium(Mg2+)	Ion chromatography , titrimetry (EDTA method)

In rainwater, analysis for pH and electrical conductivity (EC) is recommended in addition to the concentrations of anions (sulphate, nitrate, chloride) and cations (ammonium, calcium, magnesium, potassium and sodium). The analytical methods detailed above are typical for the analysis of precipitation samples with the instrumentation commonly available in many laboratories.

2.4 METEOROLOGICAL MEASUREMENTS

The participating Malé Declaration countries were required to collect meteorological data regularly and submit it along with the monitoring data. Meteorological parameters (wind direction/speed, temperature, relative humidity, precipitation and solar radiation) in relation to wet deposition were to be measured at the site. However, it was decided that instead of setting up separate meteorological stations, the required data could be procured from the nearest meteorological station in accordance with the measurement frequencies and methods of the meteorological monitoring system of each country.

2.5 DATA MANAGEMENT

The entire analytical data were to be submitted by the participating laboratories to NIAs which in turn forwarded the same to UNEP RRCAP. After that the Monitoring Committee members held a discussion with each of the NIAs at the refresher course training which is held regularly every year. After discussion, RRCAP compiled and stored the monitoring data on the website. The data is accessible only to the participating country NIAs.

CHAPTER 3. AIR QUALITY

The eight participating countries have been monitoring the Ambient Air Quality at the selected locations for the parameters prescribed under the programme since 2004. The first Data Analysis Report was published in 2009. It described the air quality based on the monitoring results for the period 2004 to 2008. The present report is based on the monitoring results for the period 2009 to 2011. The monitoring data received from the countries is given in Annexure I to III.

Skillful interpretation of air quality data is critical to the development of proper solutions to air quality problems. This is generally done by comparing the data with the prescribed ambient air quality standards of a country or else with some international standards, say WHO guidelines. Table3.1 gives the Ambient Air Quality guidelines prescribed by WHO and the National Ambient Air Quality Standards of some of the participating countries.

Table 3.1 Ambient Air Quality Standards - ($\mu g/m^3$)

Country	PM_{10}		$PM_{2.5}$		SO_2		NO_2		O_3	
	24 hrs	Annual	24 hrs	Annual	24 hrs	Annual	24 hrs	Annual	1hr	8hrs
WHO	50	20	25	10	20	--	--	40	--	100
Bangladesh	150	50	65	15	365	80	--	100	235	157
Bhutan		60* 120**								
India (residential, rural and other areas)	100	60	60	40	80	50 20***	80	40 30***	180	100
Iran										
Nepal	120				70	50	80	40		
Pakistan										
Sri Lanka	100	50	50	25	120	80	100		200	

*Mixed area (urban, commercial); **Industrial Area;***Ecologically Sensitive areas notified by GOI

The exceedence factor and the number of days the pollutant exceeds the standards also decides the extent of its impact. Meteorology plays an important role in knowing the source of pollution and its dispersion. Based on the information, the data is correlated with the different emission sources in the area. Due care must be taken to ensure that the data is representative, with respect to location of stations, duration of sampling, etc.

3.1 QUALITY ASSURANCE, QUALITY CONTROLAND DATA QUALITY

The conclusions drawn from any data are directly related to the quality of the data received. Thus, Quality Assurance and Quality Control (QA/QC) play a critical role while assessing the data because, "No Data is better than Data of Unknown or Bad Quality". One of the main challenges in air quality management (AQM) is to have timely and appropriate access to air quality data which are relevant and of known quality as it allows,

- To determine current status, trends of ambient air quality and better insight into science of air pollution,
- To ascertain whether the prescribed ambient air quality standards are violated
- To identify Non-attainment Cities/areas
- To identify the potential sources of pollutants (source apportionment)
- To assess impacts
- To assess the effectiveness of air quality management strategies.
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures, i.e., review/formulation of the Air Quality Management Program.

Thus, it is essential to have credible data.

With this in view, extensive Quality Assurance / Quality Control (QA/QC) measures were thought of under this programme and a system of flagging the data was developed The data flags were to assist not only in knowing the validity of the data but also the type of errors whether in the field during sampling or else in the laboratory while analyzing and reporting the results.

Perusal of the data clearly indicates that all the countries are as yet in the process of stabilizing/ standardizing/ strengthening their sampling, analysis and reporting methodologies and the system of flagging the data has not been initiated by all the countries. Thus, while analyzing the data no overemphasis has been given to any particular value. In this process certain results thought to be totally improbable(this is especially true in case of certain Field Blanks found to be very high, in some cases higher than the samples) have been ignored. Monthly and annual averaged values have been used instead of daily or event-wise data to focus on bulk properties and to have an overall view of the status.

3.2 STATUS OF MONITORING

3.2.1 DRY DEPOSITION MONITORING

The participating countries were required to carry out dry deposition monitoring by two methods using,

- PM10 Samplers
- Diffusive/passive samplers.

Air concentration monitoring: Data using High Volume Samplers/PM10 samplers has been received from seven countries, namely: Bangladesh, Bhutan, India, Iran, Nepal, Pakistan and Sri Lanka. India has reported PM10, SO_2 and NO_2, the remaining countries have reported only PM10.The period and parameters for which monitoring was carried out by each participating countries is given in Table 3.2

As dry deposition flux is dependant on ambient air sources of the acidic gases and dry deposition velocity which in turn depends on a number of factors like physical and chemical properties of the gases, surface properties and other environmental factors, the dry deposition flux is not measured and reported. However, to measure the magnitude of dry deposition flux, the ambient air concentration of the gases SO_2, NO_2 and O_3 are being discussed.

Table 3.2 Air Concentration Data Received; Air (H)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	Jan – Dec	PM10, SPM1
		2010	Jan – Dec	PM10
		2011	Jan – Dec	PM10
2	Bhutan	2009	Feb-July , Dec	PM10
		2010	Jan –Oct, Dec	PM10
		2011	Jan-Jun ,Oct – Dec	PM10
3	India	2009	Jan – Dec	PM10 , SO_2, NO_2
		2010	Jan – Dec	PM10 , SO_2, NO_2
		2011	Jan – Dec	PM10 , SO_2, NO_2
4	Iran	2009	Jan – Dec	PM10, SPM
		2010	Jan –Sep, Dec	PM10, SPM
		2011	Jan – Jul	PM10, SPM
5	Maldives		--	--
6	Nepal	2009	Jun-Aug, Nov, Dec	PM10
7	Pakistan	2009	Jan,Feb,Dec	PM10
8	Sri Lanka	2009	--	--
		2010	Jan – Dec	PM10
		2011	Jan – Dec	PM10

Note 1- SPM reported only till June 2009

Diffusive/Passive sampling has been reported by Bangladesh, Bhutan, Iran, Maldives, Nepal and Sri Lanka (Annexure II).

Table 3-3 gives the details of the parameters, period and the frequency for which each of the countries conducted passive monitoring. The passive samplers received by them are exposed and the exposed samplers are sent to IVL for analysis. The analytical data has been received directly from IVL by the respective countries. A perusal of Table 3.3 indicates that some of the countries have not reported results after February2010.

In general, most of the countries have not been exposing the field blanks in parallel to the samples. However, since the concentration of blanks was generally 0.1 to 0.2µg/m3, all results below 0.2µg/m3 have been ignored. In many cases the samplers were sent very late to IVL for analysis or there was incorrect labeling, no reporting of temperature, exposure for more than two months as pointed out by IVL in the results conveyed by them. Such data has also been generally ignored

It is also important that most of the variables remain constant so that the results can be compared. At present this is not so as most of the countries are not collecting monthly composite samples (Annexure II). Thus, the interpretation and comparison of results can only be indicative with no emphasis on any particular value.

Table 3-3 Air Passive Monitoring Data Received; Air (P)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan – Dec	SO_2,NO_2,O_3
		2011	Jan-Dec	SO_2,NO_2,O_3
2	Bhutan	2009	Bhur: Feb – Dec SerpangDzong : Jan – Mar, May – Nov	SO_2,NO_2,O_3
		2010	Bhur : Jan – Dec	SO_2,NO_2,O_3
3	India		--	--
4	Iran	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan (15 days)	SO_2,NO_2,O_3
5	Maldives	2009	Feb – Nov	SO_2,NO_2,O_3
6	Nepal	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan , Feb	SO_2,NO_2,O_3
7	Pakistan		--	--
8	Sri Lanka	2009	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3
		2010	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3
		2011	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3

3.2.2 WET DEPOSITION MONITORING/ PRECIPITATION CHEMISTRY

A large number of chemicals released from natural or anthropogenic sources are present in the atmosphere as gases or aerosols. Clouds and precipitation have long been recognized as important sinks for atmospheric pollutants and aerosol, with size and solubility-induced selective removal affecting both the aerosol size distribution and the rainwater characteristics. Gaseous pollutants such as SO_2 and NOx once emitted into the atmosphere are oxidized to sulphate and nitrate through gaseous and aqueous phase processes. The absorption and desorption of gaseous pollutants by clouds, rain and snow is the beginning of the removal process of these gases. However, absorption and desorption involves a complex mechanism which incorporates dissolving and extraction of these species in and out of water droplets. In-cloud scavenging is a determining factor for the precipitation of sulphate, while it is relatively unimportant in the case of ammonium. The sub-cloud scavenging of NO_2 and SO_2 is not too significant. However, for HNO_3, and NH_3 it is an effective process.

Wet deposition is generally influenced by two factors: meteorological conditions such as the wind system and rainfall pattern and geographical distribution of emission sources of chemical substances through natural and anthropogenic activities. Natural sources of pollution may broadly include sea salt, eroded earth material and biogenic activities while fossil fuel combustion and agricultural wastes are the major anthropogenic sources. Wet deposition is the scavenging approach of removal of pollutants from the atmosphere. Rain and snow are the natural scavenging processes of air pollutants changing their air concentrations. The composition of the rain water depends on the chemical species that have dissolved in it. H_2SO_4 and HNO_3 are regarded as the major acids, whereas calcium carbonate and ammonia are regarded as the major bases.

Once the acids in rain droplets were identified as a potential cause of acidification of lakes and soils, it was widely recommended that regular monitoring of pH and chemical composition of rainwater must commence. It was thus decided to include wet deposition monitoring at the Malé Declaration sites. However, not all the countries have started this monitoring regularly and as per the protocol.

The results have been analyzed to assess the chemical properties of rain water with regard to, chemical composition, specially pH, conductance and concentration of various anions and cations.

Table 3-4 Wet Only Data Received; Wet (W)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	May-Sep	Ec, pH, NH^{4+}, Na^+, K^+, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^-
		2010	Apr-Aug	
		2011	Mar-Sep	
2	Bhutan		--	--
3	India		--	--
4	Iran	--	--	--
5	Maldives		--	--
6	Nepal		--	--
				--
7	Pakistan		--	--
8	Sri Lanka	2010	Jan, Mar - May, Jul, Sep-Dec	Ec, pH, NH^{4+}, Na^+, K^+, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^-
		2011	Jan-Mar, May, Aug	

Rainwater contains various dissolved anions and cations after incorporating gaseous and aerosol species from the ambient air. The wet deposition was monitored by two methods, namely, Wet (Bulk) and Wet (Wet) techniques. In the former technique the sampler is exposed for the entire period and includes dry period, in the latter, the sampler has arrangements to do sampling only when it rains. The samples so collected were preserved and transported to the laboratory for analysis. The cations and anions to be monitored at the Malé monitoring sites were , NH^{4+}, Na^+, K^+, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^- and NO_3- . Some quantitative parameters were proposed to analyze the wet deposition measurements in terms of acid-base chemistry. Acidity, or pH, is a fundamental measure of precipitation acidity. It is determined by the nature and proportions of acids and basis in water. In this sense, pH is a secondary parameter, whereas acids and bases are primary ones. If any two of these three quantities are properly determined, then the other can be calculated theoretically.

Wet(Wet) and Wet(Bulk) monitoring is being carried out by the countries as per details in Tables 3.4 and Table 3.5 respectively, which also give the parameters for which these samples were analyzed. Whereas Wet (Wet) results have been reported by two countries, viz., Bangladesh, and Sri Lanka, Wet(Bulk) results have been reported only by five countries, viz., Bangladesh, Bhutan, Pakistan, Nepal and Sri Lanka.

Table 3-5Wet Bulk Data Received, Wet (B)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	May – Sep	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Apr – Aug	
		2011	Mar-Sep	
2	Bhutan	2009	May – Sep, Nov	Ec, pH
		2010	Sep -Dec	Ec, pH
		2011	Jan – Sep	Ec, pH
3	India		--	--
4	Iran	2009	Apr, Dec	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Feb, Dec	
		2011	Jan, Feb	
5	Maldives		-	--
6	Nepal	2009	Feb-Dec	
		2010	Jan-Oct	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2011	Apr-Dec	
7	Pakistan	2009	Jan-Sep	Ec, pH
8	Sri Lanka	2009	Mar-May , Aug,Oct-Dec	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Jan,Mar-May,Sep-Nov	
		2011	Aug,Oct-Dec	

A perusal of the tables indicates that most of the countries have measured only pH and electrical conductance. Only Bangladesh and Sri Lanka have measured all the cations and anions in the wet only samples and only Bangladesh, Iran, Nepal and Sri Lanka have measured all the ions in the Bulk samples as well.

3.2.3 METEOROLOGICAL DATA

Air pollutants show short term, seasonal and long term variations. Atmospheric conditions determine the fate of the air pollutants after their release into the atmosphere. The mean transport wind direction, velocity, turbulence and mass diffusion are three important and dominant mechanisms in the dispersal of air pollutants. Wind direction is the measurement of direction from which the wind is blowing, measured in points of compass viz. North, South, East, and West or in Azimuth degrees. Wind direction has an important role in distributing and dispersing pollutants from stationary and mobile sources in horizontally long downwind areas.

The effect of wind speed on air pollution is two-fold. It determines the travel time from a source to a given receptor while on the other causes dilution of pollutants in downwind direction. The stronger the wind, the greater will be the dissipation and dilution of pollutants emitted. Knowledge of the frequency distribution of wind direction as well as wind speed is essential for accurate estimation of the dispersion of pollutants in the atmosphere. The frequency distribution of wind speed and direction varies considerably from month to month. Air pollutants show diurnal variations in their levels. During the daytime, solar heating causes maximum turbulence and strongest vertical motions. This causes the maximum amount of momentum exchange between the various levels in the atmosphere.

On clear nights with light winds, heat is radiated from the Earth's surface resulting in cooling of the ground and air adjacent to it. This results in extreme stability of the atmosphere near the Earth's surface. Under these conditions turbulence is at a minimum.

The meteorological data along with wind speed and direction has not been received from (Table 3.6) any of the countries except a few months data from Bangladesh. The meteorological data given in Chapter 2 is from the previous report.

Table 3-6 Meteorological Data Received (2009-11)

S No	Country	Met. Station	Available Data
1	Bangladesh	Kulna	
2	Bhutan	Gelephu	NA
3	India	Port Canning	NA
4	Iran	Chamsari	NA
5	Maldives	Hanimaadhoo	NA
6	Nepal	Rampur	NA
7	Pakistan	Bahawalnagar	NA
8	Sri Lanka	Doramadalawa	NA

NA: Not available

3.3 RESULTS

Countrywise results are discussed below to understand the status of air pollution. An effort has been made to correlate the results to the activities/sources in the area as well as those in the country.

3.3.1 BANGLADESH

The monitoring location is in Sathkira, a city in Khulna Division of Bangladesh. It has a population of about 2million and most of the people depend on pisciculture. Poorly serviced vehicles, brick kilns, dust from roads and construction sites and industrial emissions are the major sources of air pollution. Brick kilns account for about 30% of the air pollution in the country, the brick kiln industry being one of the fastest-growing sectors, with the current manufacturing capacity of 12 billion bricks a year by 4,500 brick kilns surrounding all major cities of Dhaka, Khulna, Rajshahi, and Chittagong *(Reference : Particulate pollution from brick kiln clusters in the GreaterDhaka region, Bangladesh, Air Qual Atmos Health; DOI 10.1007/s11869-012-0187-2; Sarath K. Guttikunda et. al)*

Figure 3-1 Brick kiln Photo by: GungaJim

There are about 80 brick kilns around Sathkira. These brick kilns use firewood/low grade coal as fuel. The coal comes mainly from the eastern regions of India. The emissions from the low-lying sources like vehicle exhaust and the domestic fuel use are fairly constant over all months of the year and are confined to the city limits, thus contribute more to the locally attributable pollution levels. However, the brick kilns spread across the area are operated with a stack height of about 50m each and are capable of transporting the emissions to larger distances. Moreover, the brick kilns do not operate throughout the year; the main brick producing season is from October to March, the brick manufacturing is at its peak during December and January.

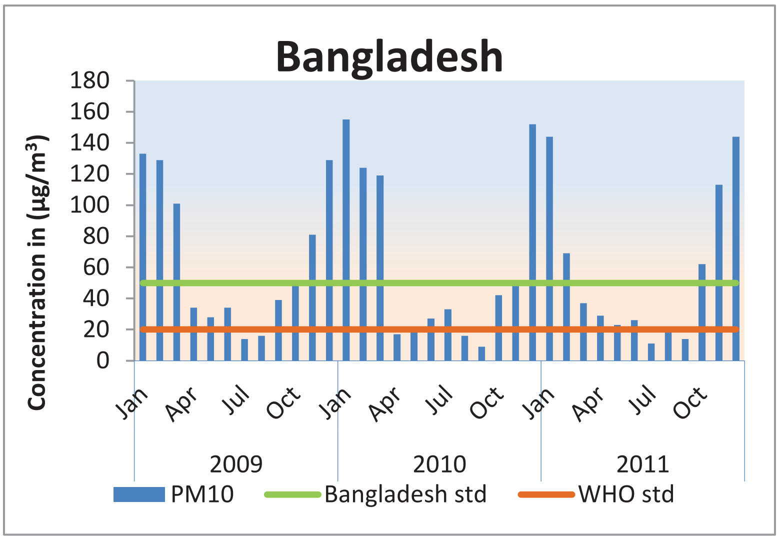

Figure 3-2 Temporal variation of PM10 concentration

Bangladesh has warm temperatures throughout the year, with relatively little variation from month to month. January tends to be the coolest month and May the warmest. June to October monsoon is south-west monsoon. Khulna receives an annual rainfall of about 1800mm. Nearly 81 per cent of total rainfall occurs during June-October. Some rainfall also occurs during March-May. Winter is the dry period with little or nearly no rainfall. However, during the months of December and January little rainfall is recorded. The monsoon winds blow from the south with sustained force from March to October, The wind blows from the north and northeast in January. February is a calm month with foggy weather particularly in the morning.

3.3.1.1 Dry Deposition Monitoring

Bangladesh has been participating in the Male monitoring programme since 2004; however, the monitoring of PM10 was started in 2009. The results are depicted in Figure 3.2 and Table-3.7. A perusal of the results indicates that the highest concentrations are observed during December and January of each year. These are the dry months of winter and also the peak brick manufacturing season. Thus, the PM10 monitoring data is split between the brick manufacturing dry season and the remaining months presenting a distinct pollution trend, coinciding with the brick manufacturing cycles. Lowest concentrations have been observed during the monsoon period which also happens to be the non-brick manufacturing season. The annual average concentration of PM10 exceeded the annual Bangladesh standard of 50µg/m^3 during 2009-2011.

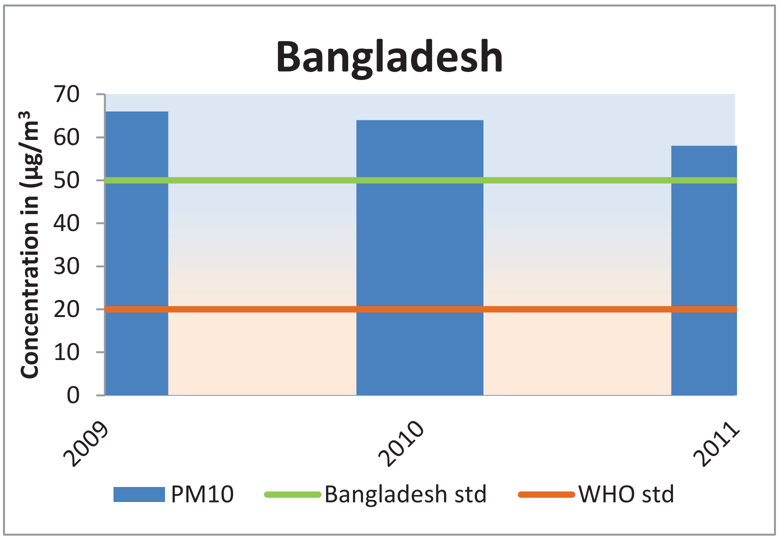

Figure 3-3 Annual average PM10 concentration

At the same time, the PM10 concentration in ambient air has been decreasing (Figure 3.3) over the years. This could be due to the measures introduced by the Bangladesh Government. These include, introduction of cleaner brick manufacturing technology, reducing traffic congestion, introduction of cleaner fuels and imposing an emission tax and by carrying out extensive awareness campaigns for the people.

Table 3-7 Monthly variation of PM10 concentration (μg/m^3) - Bangladesh

Month		**2009**			**2010**			**2011**	
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Jan	133	125	140	155	150	161	144	99	196
Feb	129	110	158	124	101	172	69	66	78
Mar	101	99	106	119	94	142	37	24	51
Apr	34	28	42	17	12	20	29	21	54
May	28	20	42	21	12	30	23	16	19
Jun	34	27	43	27	17	30	26	18	36
Jul	14	7	25	33	21	45	11	8	15
Aug	16	10	22	16	4	36	20	19	21
Sep	39	24	56	9	5	12	14	10	16
Oct	50	36	60	42	37	53	62	31	90
Nov	81	74	96	49	44	51	113	57	157
Dec	129	113	149	152	115	190	144	117	187
Annual avg	66			64					58

Diffusive Sampling

Bangladesh has reported the results of diffusive sampling from July 2004 onwards. However, regular monitoring was started from March 2006 onwards.

A look at the results indicates that there is a strong seasonal variation in the results. The maximum monthly average concentration of (7.9 to 8.4 μg/m^3) SO_2 and (6.6 to 7.6) μg/m^3 NO_2 (Table 3.8) was observed during the winter months of December to February and the lowest concentrations during June –September i.e. the monsoon period. (Figure 3.4) Whereas the maximum and the annual average concentration of SO_2 has decreased over the years, that of NO_2 has increased, although the increase is not appreciable. The higher concentration of SO_2 in winter coincides with the higher concentration of PM10during these months and the concentration of both the parameters has shown a decreasing trend which might be due to the introduction of cleaner technology in brick manufacturing. On the other hand the source of NO_2 could

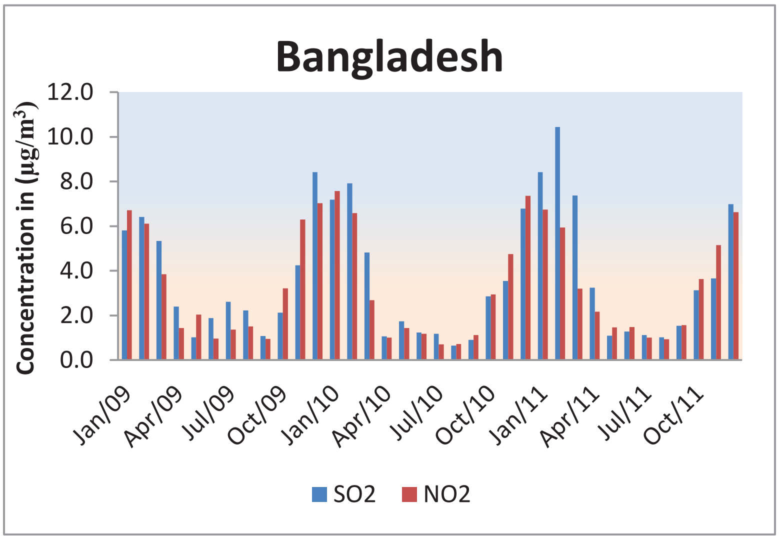

Figure 3-4 Temporal variation of average SO_2& NO_2 concentration

be increasing vehicular emissions in the area as the ozone concentration (Figure 3.5) is also higher during the same period.

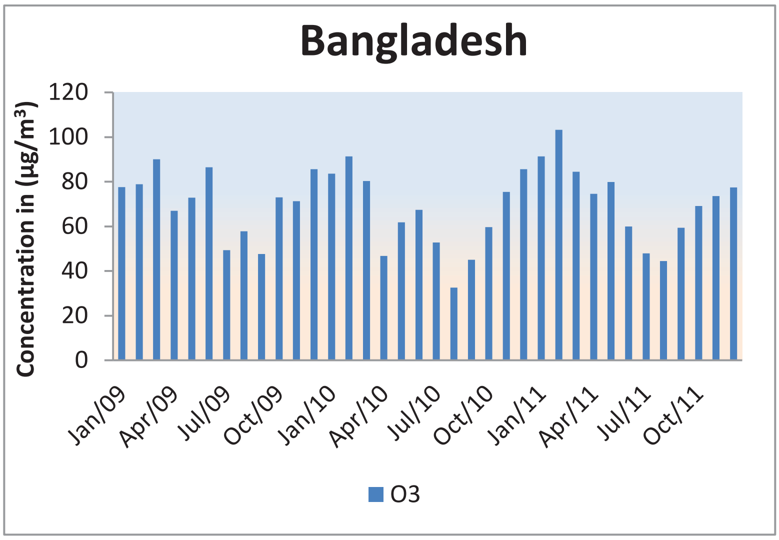

Figure 3-5 Temporal variation of average O3 concentration

Table 3-8 Average concentration of SO_2, NO_2 and O_3 in μg/m[3] - Bangladesh

	2009			2010			2011		
Month	SO_2	NO_2	O_3	SO_2	NO_2	O_3	SO_2	NO_2	O_3
Jan	5.8	6.7	78	7.2	7.6	84	8.4	6.7	91
Feb	6.4	6.1	79	7.9	6.6	91	10.4	5.9	103
Mar	5.3	3.9	90	4.8	2.7	80	7.4	3.2	84
Apr	2.4	1.4	67	1.1	1.0	47	3.2	2.2	75
May	1.0	2.0	73	1.7	1.4	62	1.1	1.5	80
Jun	1.9	1.0	87	1.2	1.2	67	1.3	1.5	60
Jul	2.6	1.4	49	1.2	0.7	53	1.1	1.0	48
Aug	2.2	1.5	58	0.6	0.7	33	1.0	0.9	45
Sep	1.1	0.9	48	0.9	1.1	45	1.5	1.6	59
Oct	2.1	3.2	73	2.9	2.9	60	3.1	3.6	69
Nov	4.2	6.3	71	3.5	4.8	75	3.7	5.2	74
Dec	8.4	7.0	86	6.8	7.4	86	7.0	6.6	77
Annual avg	3.6	3.5	72	3.3	3.2	65	4.1	3.3	72

3.3.1.2 Wet Deposition Monitoring

The Wet(Bulk) and Wet(Wet) monitoring was conducted during 2009,2010 and 2011. The monitoring was also conducted only from March to September. The results of wet only and bulk monitoring (Figure 3.6 and 3.7) indicate that the minimum average conductance over the three years was 0.3mS/m and the highest 7.9mS/m. A perusal of the results of Wet (Wet) and Wet(Bulk) monitoring reveal that Ec is highest in during March to May(Annexure III) and lowest during monsoons and in the broader sense is related to the amount of precipitation, i.e., lowest conductance at highest precipitation times. High concentration of ammonium, sulfate and nitrate ions corresponds with the high Ec values during March-May. This is probably due to the washing out of the atmosphere with pre-monsoon showers. The pH varied between 5 and 6(Tables 3.9 and 3.10) during wet and dry monitoring with lowest values of pH corresponding with the high electrical conductance. Figure 3.6

gives the frequency distribution of pH during the monitoring period (samples exposed for one to seven days). In general, inter annual concentration changes might be due to variations in meteorology and emissions, but no clear cut tendencies or trends were visible.

Among the ions, (Annexure III) the highest concentration was that of the sodium and chloride ions(highest observed concentration of sodium and chloride ions during the period was 218 and 301µmol/l respectively). Since the site is in coastal area, the results are greatly affected by sea-salt input because they are incorporated into cloud or rain droplets in the form of salt.

The R1 and R2 values are generally within the allowable limits pointing to the fact that the quality of data has improved over the past years.

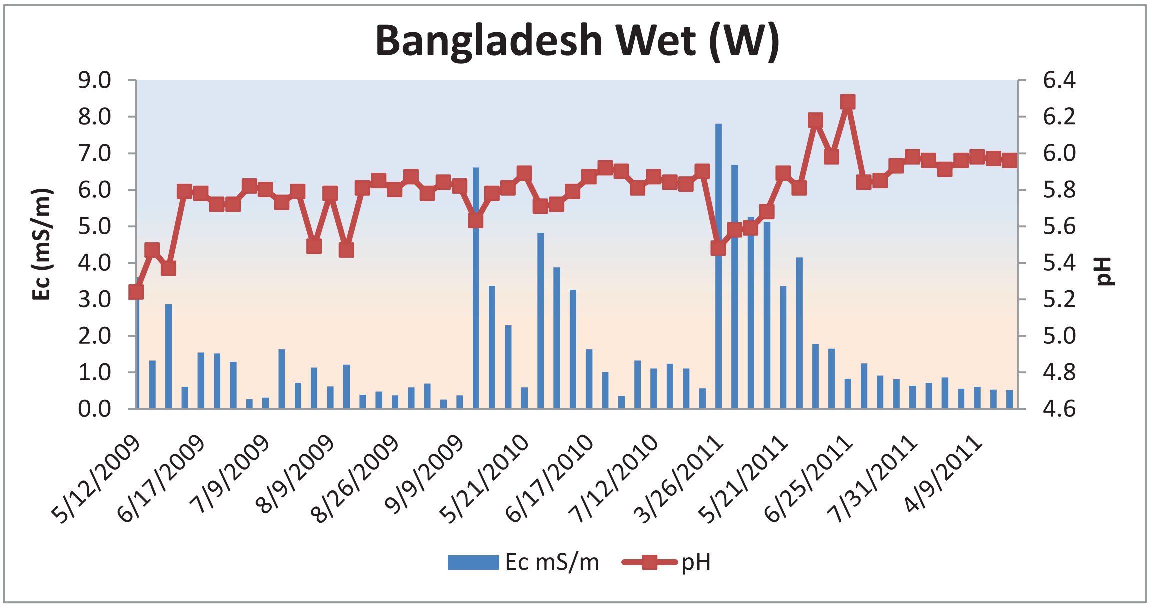

Figure 3-6 Variation in electrical conductance and pH Wet(Wet)

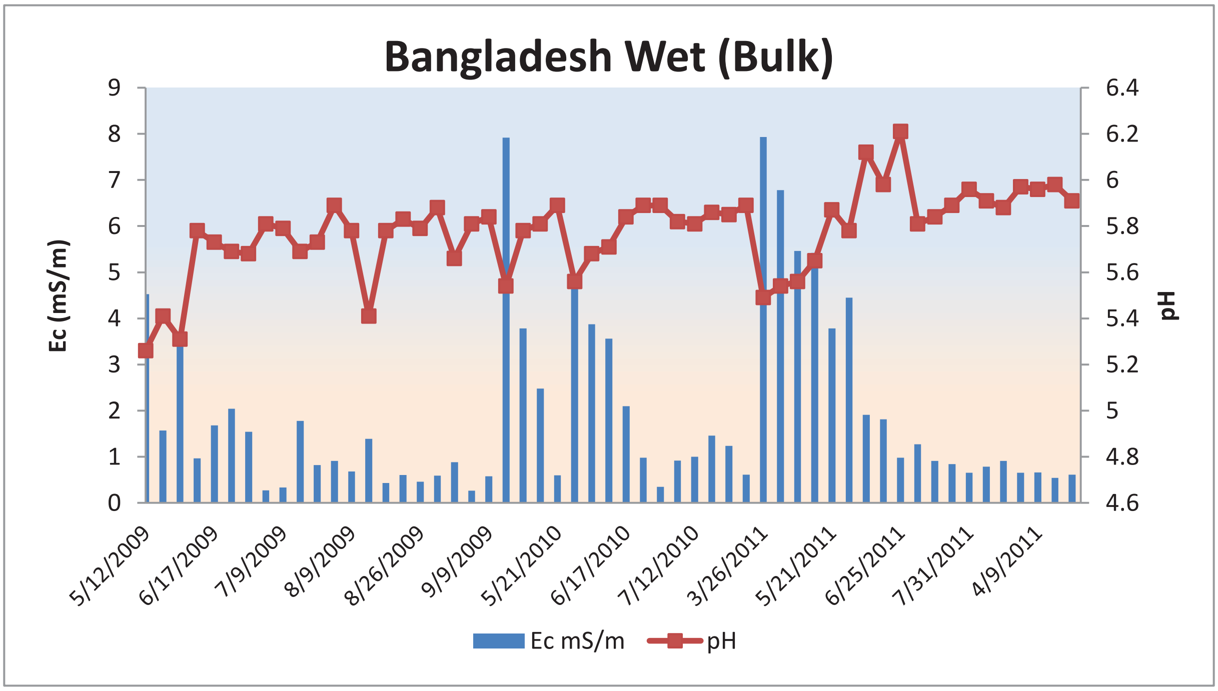

Figure 3-7 Variation in electrical conductance and pH Wet(Bulk)

Table 3-9 Results of wet monitoring using wet collector - Bangladesh

	2009					2010			2011
Month	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)
Apr				1.9	5.8	1275	7.8	5.5	1170
May	2.4	5.4	1167	1.4	5.9	1867	6.7	5.6	700
Jun	1.2	5.8	1150	1.8	5.9	1575	4.4	5.8	1243
Jul	0.6	5.8	1550	0.7	5.9	1417	1.3	6.1	4710
Aug	0.7	5.7	1600	0.8	5.9	1867	0.9	5.9	4600
Sep	0.3	5.8	2100	--	--	--	0.7	5.9	4500

Table 3-10 Results of wet monitoring using bulk collector - Bangladesh

		2009			2010			2011	
	Ec(mS/m)	pH	Precipitation (ml)	Ec(mS/m)	pH	Precipitation (ml)	Ec(mS/m)	pH	Precipitation (ml)
Mar	--		--	--	--	--	7.9	5.5	50
Apr	--	--	--	5.1	5.7	950	6.8	5.5	700
May	3.0	5.3	1167	1.5	5.8	1867	4.7	5.7	1243
Jun	1.5	5.7	1150	1.9	5.8	1575	1.6	6.1	4567
Jul	0.6	5.8	1700	0.6	5.9	1417	0.8	5.9	4128
Aug	0.7	5.8	1514	1.1	5.9	50	0.8	5.9	2553
Sep	0.4	5.8	2233	--	--	--	0.6	5.9	2487

3.3.2 BHUTAN

3.3.2.1 Dry Deposition Monitoring

Bhutan started the monitoring of PM10 in 2009. The monitoring station is located in Thimpu which is the largest city and the capital of Bhutan, located in the western central part of the country. The southwest monsoon brings rainfall from May to September marking the wet season. Rest of the year is mostly dry and as spring (March to May) approaches, the weather is marked by violent winds and dusty weather with rain showers at the end of May. A look at Figure 3.8 and perusal of Table 3.11 indicates that the sampling has not been conducted continuously throughout the year.

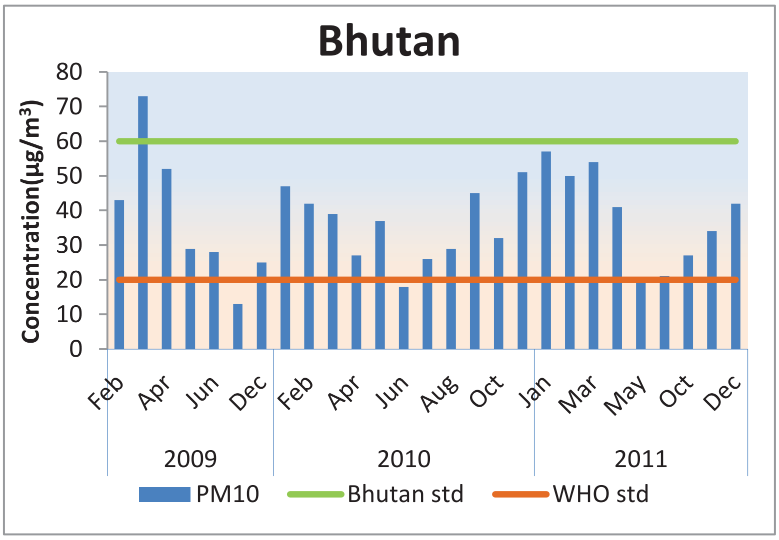

Figure 3-8Temporal variation of PM10 concentration

The concentration of PM10remains within the prescribed national annual average standard of 60µg/m^{3}for mixed area (urban & commercial) during the wet months, however, the concentrations are higher during the winter and spring months which are dry. .Exceptionally high concentrations (Annexure I) have been attributed to forest fires in general and such data has been ignored for the purpose of averaging. Growing concern here is that there is an increasing trend in emissions. It is thus very timely for policy interventions for Air Quality Management so as to prevent adverse impacts of uncontrolled air pollution.

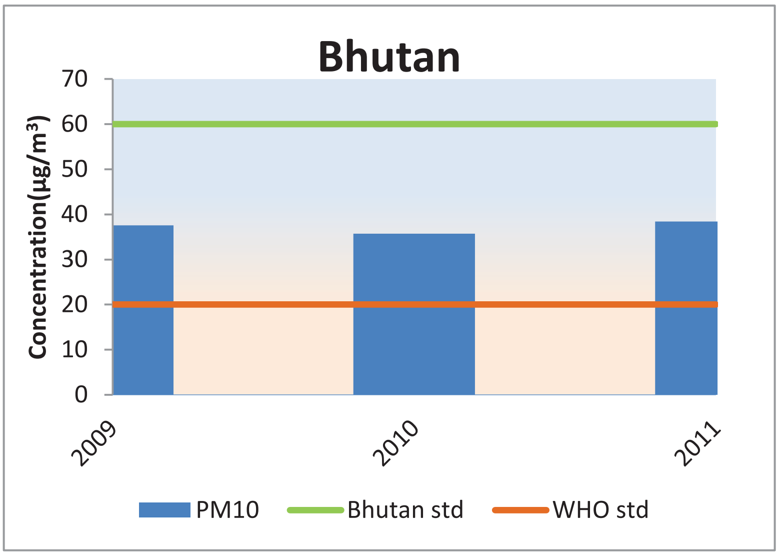

Figure 3-9 Annual variation of PM10 concentration

Table 3-11 Average variation of PM10concentration in µg/m^3 - Bhutan

		2009			2010			2011	
Month	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Jan	--	--	--	47	43	54	57	31	72
Feb	43	28	56	42	13	70	50	20	76
Mar	73	18	152	39	11	74	54	16	94
Apr	52	35	90	27	7	79	41	31	71
May	29	11	59	37	9	68	20	11	40
Jun	28	3	140	18	11	31	21	10	52
Jul	13	4	46	26	24	28	--	--	--
Aug	--	--	--	29	22	29	--	--	--
Sep	--	--	--	45	11	108	--	--	--
Oct	--	--	--	32	39	39	27	15	68
Nov	--	--		--	--	--	34	18	47
Dec	25	17	37	51	26	74	42	16	61
Annual avg*	38			36			38		

*only seven months data-average not representative

The increasing trend has been attributed to two driving forces, namely,

- Socio-economic development
- Increasing Population & urbanization

Rapid socio-economic development and urbanization is an emerging threat to the existing air quality. Localized air pollution is already being experienced due to increasing number of vehicles, manufacturing industries and increasing number of construction activities. Emissions from motor vehicles are one of the primary sources of local air pollution. The number of vehicles has been increasing at an annual growth rate of 1% in last one year (The State of the Nation 2012). Forest fires, especially during the dry season (November-May) are another major factor contributing to local air pollution. Household heating using wood fed heaters, especially during the cold winter months and cooking from woodstoves and kerosene stoves in the rural areas is yet another factor contributing to air pollution in the country.

3.3.2.2 Wet Deposition Monitoring

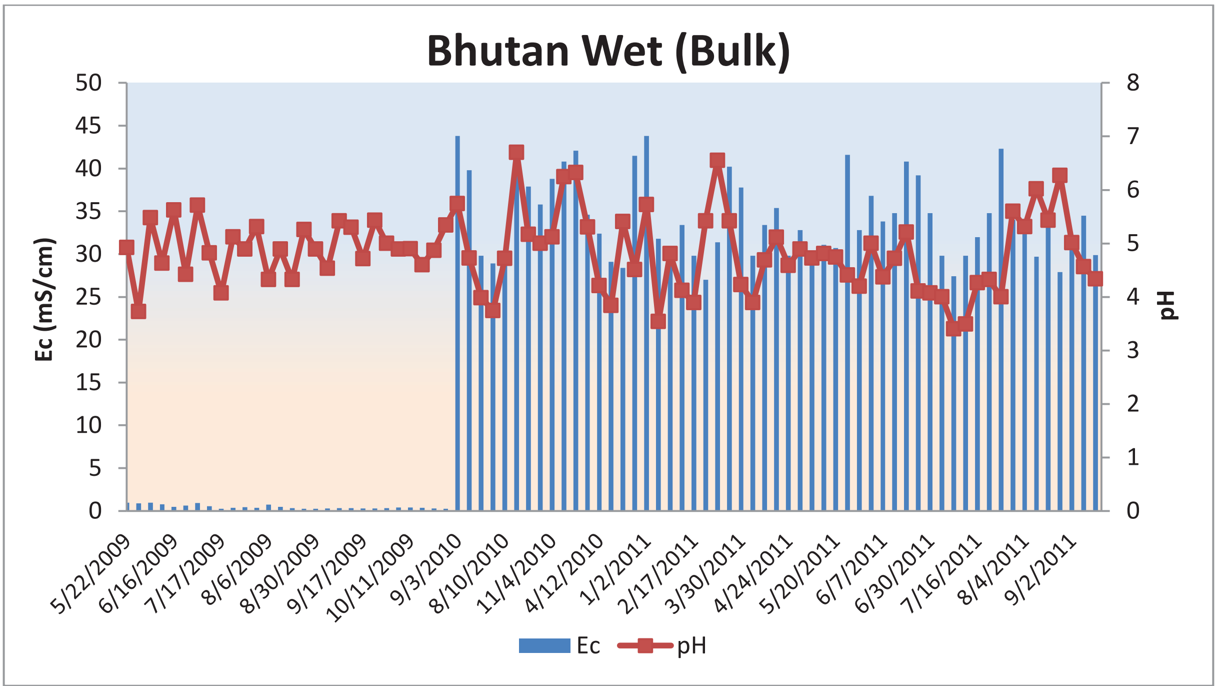

Figure 3-10 Variation in electrical conductance and pH (bulk collector)

Figure 3.10 and Table 3.12 give the results of wet monitoring (Wet Bulk) and Wet (Wet).

Table 3-12 Results of wet monitoring using bulk collector - Bhutan

		2009			2010			2011	
Month	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)
Jan							36.0	3.5	3
Feb							31.0	4.0	8
Mar							34.8	5.7	16
Apr							32.0	4.6	39
May	0.9	3.8	81				35.9	4.6	17
Jun	0.8	5.5	84				35.8	4.4	58
Jul	0.4	5.0	119				33.8	4.0	77
Aug	0.3	4.9	99				32.8	5.6	61
Sep	0.3	5.2	86	39.1	4.9	67	26.8	3.8	57
Oct	0.4	4.9	37	31.9	4.8	8			
Nov				42.1	6.3	16			
Dec				32.9	4.5				

The results indicate nearly a tenfold increase in the conductance of the precipitation samples. The pH of the samples varies between 3.5 to 6.3 with pH 4 or less at least in a few months, there is no particular trend. However, since the results are available for a very short period and the months for which the results have been reported for 2009, 2010 and 2011 are generally different, no specific conclusions can be drawn. There is no correlation between precipitation , Ec and/or pH. There is an urgent need to look into the reasons for sudden increase in the Ec of rain water.

3.3.3 INDIA

India has reported the air concentration monitoring results for two new locations under the Male' monitoring programme. The results from the monitoring location at Darranga in Baksa district, BTAD, Assam have been reported 2009 onwards whereas the monitoring results for the location in Dera Baba Nanak, Punjab have been reported 2011 onwards.

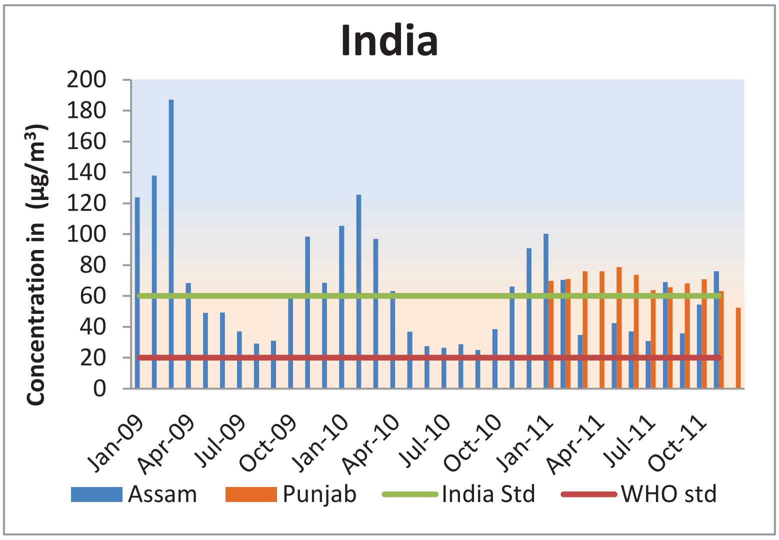

Figure 3-11 Temporal variation of SO2 and NO2 concentration

Baksa district is located in North-Western part of Assam. The district shares the International Boundary with Bhutan in the North. Major part of the world famous Manas National Park is located in this district. The park is well known for its Wild Water Buffaloes and Golden Langurs. Darranga is a small sub-urban town located in the northern part of the district Baksa of the State of Assam and near Sandoop Jhankar Town of Bhutan. Darranga is a sub-urban habitation covering a small area with 20,000-30,000. The main source of income of the people in this area is agriculture. Being a border area, a few commercial activities are also growing nowadays including movement of trucks etc. Industrial growth in the Indian part is negligible. The climate of the district is sub-tropical in nature with warm and humid summer and also followed by cool and dry winter.

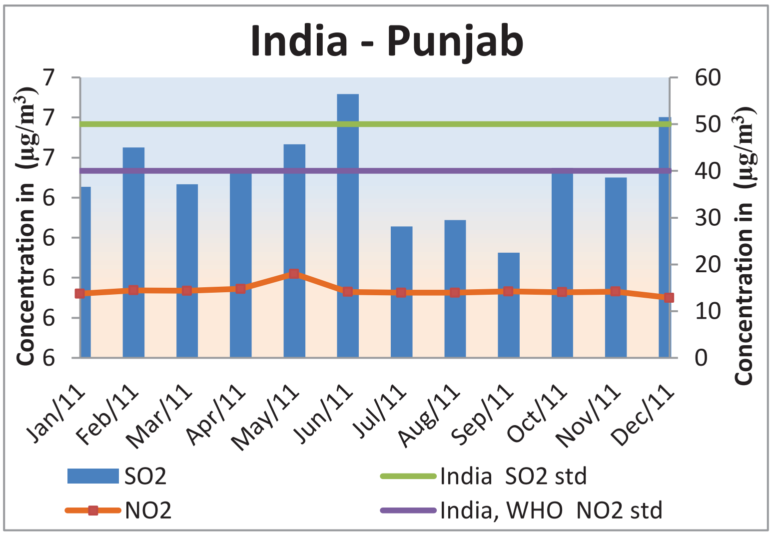

Figure 3-12 Temporal variation of SO2 and NO2 concentration

Dera Baba Nanak is situated 35 kms to west of Gurdaspur in Punjab, on the left bank of river Ravi on the right bank of Ravi, just opposite to Dera Baba Nanak, is the town of Kartarpur which is in Pakistan.

3.3.3.1 Dry Deposition Monitoring

The results of monitoring for the two locations are depicted in Figures 3.11 to 3.14 and given in Tables 3.13 and 3.14

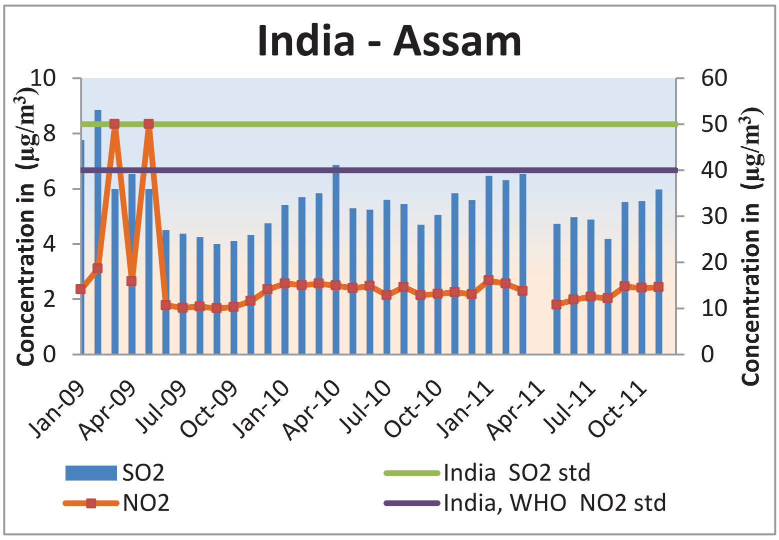

Figure 3-13 Temporal variation of PM10 concentration

There is a clear seasonal variation in the PM10 concentration at the Assam monitoring location with relatively very high concentrations during the winter months of Dec to Jan and very low concentration during the wet summer months. The annual average remains within the national standard of 60µg/m^3. On the other hand, there is not much seasonal variation in PM10 concentration at the Punjab location, however, the annual average concentration is more than the prescribed national standard.
At the same time SO_2 and NO_2 concentrations remain very low throughout the year at both the locations.

Thus, the reason for very high concentration of PM10 in winters at the Assam location and the high annual average concentration at the Punjab location needs to be established so that long term air quality management programmes can be prepared and implemented.

Table 3-13 Monthly variation of PM10 concentration (µg/m^3) – Assam, India

		2009			2010			2011	
Month	**PM10**	**SO_2**	**NO_2**	**PM10**	**SO_2**	**NO_2**	**PM10**	**SO_2**	**NO_2**
Jan-09	124	8	14	106	5	15	100	6	16
Feb-09	138	9	19	126	6	15	70	6	15
Mar-09	187	6	16	97	6	15	35	7	14
Apr-09	68	7	16	63	7	15			
May-09	49	6	16	37	5	14	42	5	11
Jun-09	49	4	11	27	5	15	37	5	12
Jul-09	37	4	10	26	6	13	31	5	13
Aug-09	29	4	10	29	5	15	69	4	12
Sep-09	31	4	10	25	5	13	36	6	15
Oct-09	61	4	10	39	5	13	55	6	14
Nov-09	98	4	12	66	6	14	76	6	15
Dec-09	68	5	14	91	6	13	--	--	--
Annual avg	77	6	13	59	6	14	57	6	14

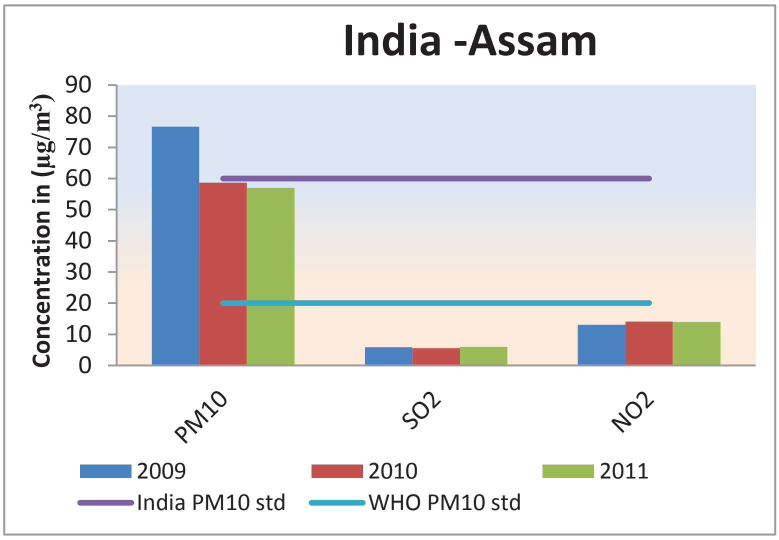

Figure 3-14 Annual variation of PM10 concentration

Table 3-14 Monthly variation of PM10 concentration (µg/m³) – Punjab, India

Month	PM10	SO_2	NO_2
Jan-11	70	6	14
Feb-11	71	7	14
Mar-11	76	6	14
Apr-11	76	7	15
May-11	79	7	18
Jun-11	74	7	14
Jul-11	64	6	14
Aug-11	66	6	14
Sep-11	68	6	14
Oct-11	71	7	14
Nov-11	63	7	14
Dec-11	52	7	13
Annual avg	69	7	14

3.3.4 IRAN

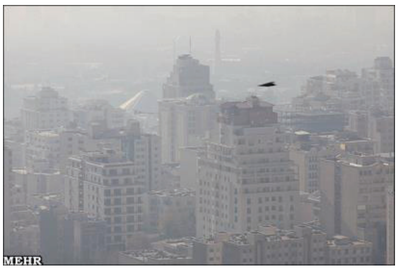

Figure 3-15 Iran

3.3.4.1 Dry DepositionMonitoring

The monitoring location is in Dehloran which is one of the cities in Ilam province located in the west of the country bordering Iraq .It is among the warmest regions of Iran, although the mountainous areas of north and north eastern Ilam are relatively cold. The average annual SPM. SO_2 and NO_2 were monitored for a few months in 2007-2008 but the same has been discontinued. The monitoring results of PM10 and SPM for the years 2009-11 are presented in Table 3.15 and Figure 3.16.

A perusal of Table3.15-and Figure 3.16 indicate that the highest concentrations occur in the months May-July on days that are dusty and cloudy. Lower concentrations are observed on sunny days .Comparing the monthly average results of 2009-2011 for the months May to July with those reported during 2004-2007, it is seen that the concentration of PM10and SPM has been rising over the years. The results of May 2011 monitoring also indicate a very high concentration of PM10 and SPM, i.e., 340 and 733µg/m^3respectively. The results of 2009-11 are considerably higher when compared to those of 2004-08(Reference Data Analysis Report 2008).It may be mentioned that in Iran the concentration of particulate matter in ambient air is also influenced by the occurrence of dust storms.

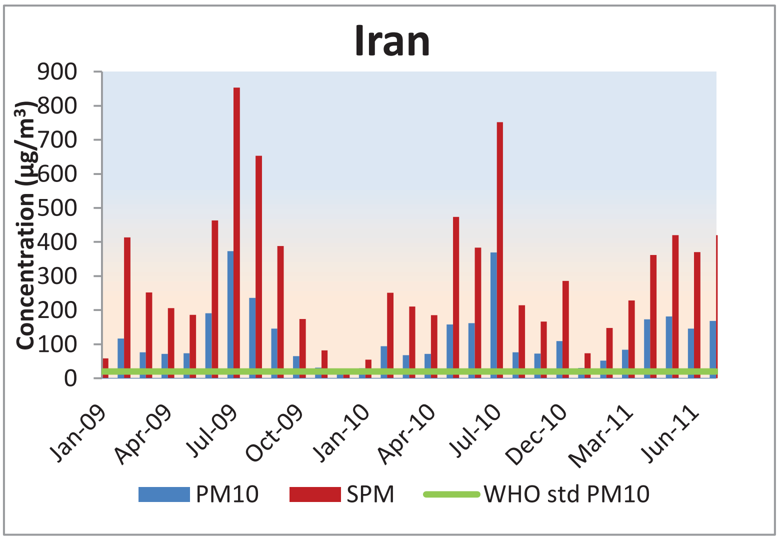

Figure 3-16 Temporal variation of PM10 concentration

Table 3-15 Average variation of PM10 concentration in µg/m^3 - Iran

	2009				2010			2010	
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
Jan	26	12	40	29	15	53	30	11	55
Feb	117	24	227	94	23	402	52	19	136
Mar	77	24	219	68	41	96	84	15	358
Apr	72	23	159	72	19	193	173	49	351
May	74	30	187	159	59	422	182	34	375
Jun	191	41	477	162	44	311	146	68	252
Jul	373	236	534	370	86	474	169	53	528
Aug	236	147	375	76	41	167			
Sep	146	23	338	73	29	188			
Oct	65	29	109						
Nov	32	11	80						
Dec	15	9	26	109	44	244			
Annual avg	118			121			119*		

*Only seven months data- not representative

At the same time referring to the SO_2 concentration in passive sampling (2004-08 and 2009-10) it is seen that the SO_2 concentrations at the Iran monitoring location are much higher as compared to those in the other countries with highest results reported generally for the months of June-July (17.6µg/m^3 in July). Two oil wells in Iraq are located about 12-15 km north and south of the site, respectively. The oil wells have flares. Thus, it is very important to correlate the results with the meteorological conditions on the days of monitoring. If needed, the monitoring location be change to a place with no direct influence of the oil well flares.

This point for the need to look into the cause for the increasing concentrations and taking corrective measures.

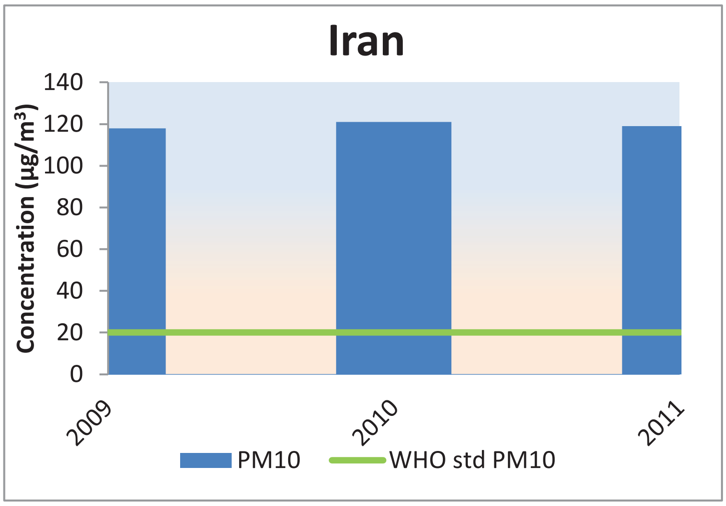

Figure 3-17 Annual variation of PM10 concentration

Diffusive Sampling

The concentration of SO_2 observed in the case of Iran was in the range of 8.4 to 18.5µg/m^{3}during 2009-10, with the lower concentrations generally corresponding with the monsoon period of the country (Figure 3.15 and 3.16). A perusal of the Table 3.14 giving the annual average concentration indicates that there is no definite trend and the annual average SO_2 concentration in 2009 was 11.7-µg/m^3. The NO_2 concentration on the other hand is very low and the annual average concentration was 2.1 µg/m^3. The samplers were reported to be sandy by IVL in a few cases, at the same time the sampling location is not clear as it is written. Station and only in one case Chamsari has been mentioned. The high SO_2 concentrations are in the same months as PM10 and the same source could be responsible. Further studies need to be undertaken.

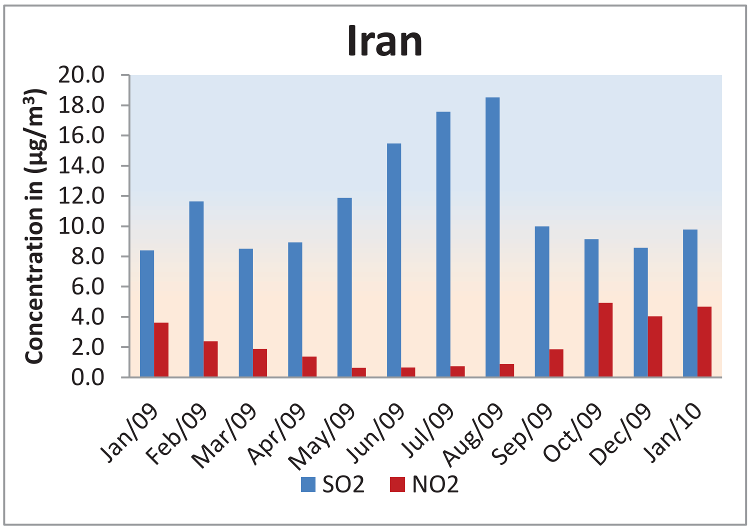

Figure 3-18 Temporal variation of average SO2& NO2 concentration

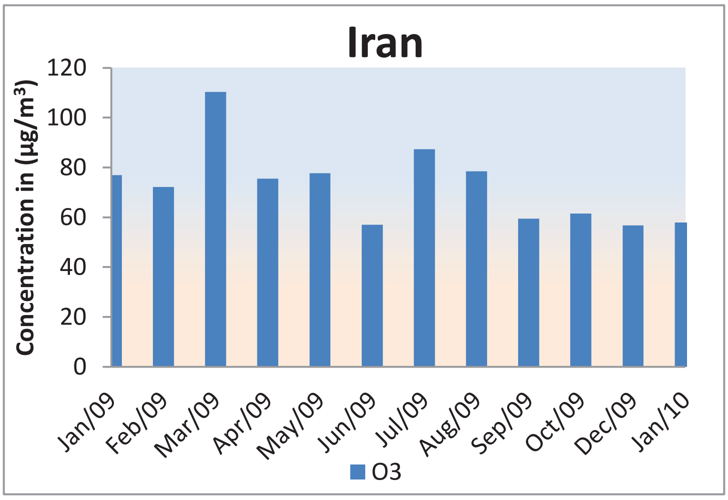

Figure 3-19 Temporal variation of O3 concentration

Table 3-16 Average concentration of SO_2, NO_2 and O_3 in (($\mu g/m^3$) - Iran

	SO_2	NO_2	O_3
Jan-09	8.4	3.6	77
Feb-09	11.6	2.4	72
Mar-09	8.5	1.9	110
Apr-09	8.9	1.4	75
May-09	11.9	0.6	78
Jun-09	15.5	0.7	57
Jul-09	17.6	0.7	87
Aug-09	18.5	0.9	78
Sep-09	10.0	1.9	59
Oct-09	9.1	4.9	61
Dec-09	8.6	4.0	57
Jan-10	9.8	4.7	58
Annual avg	11.7	2.1	74

3.3.4.2 Wet Deposition Monitoring

Iran collected very few samples of Wet Deposition monitoring during 2009-11.The pH of the samples does not vary much and remains between 7 and 7.7. No particular trends can be established, although there is variation in conductance. Higher concentration of sulphate are in line with the higher SO_2 concentrations in diffusive sampling. The source needs to be established.

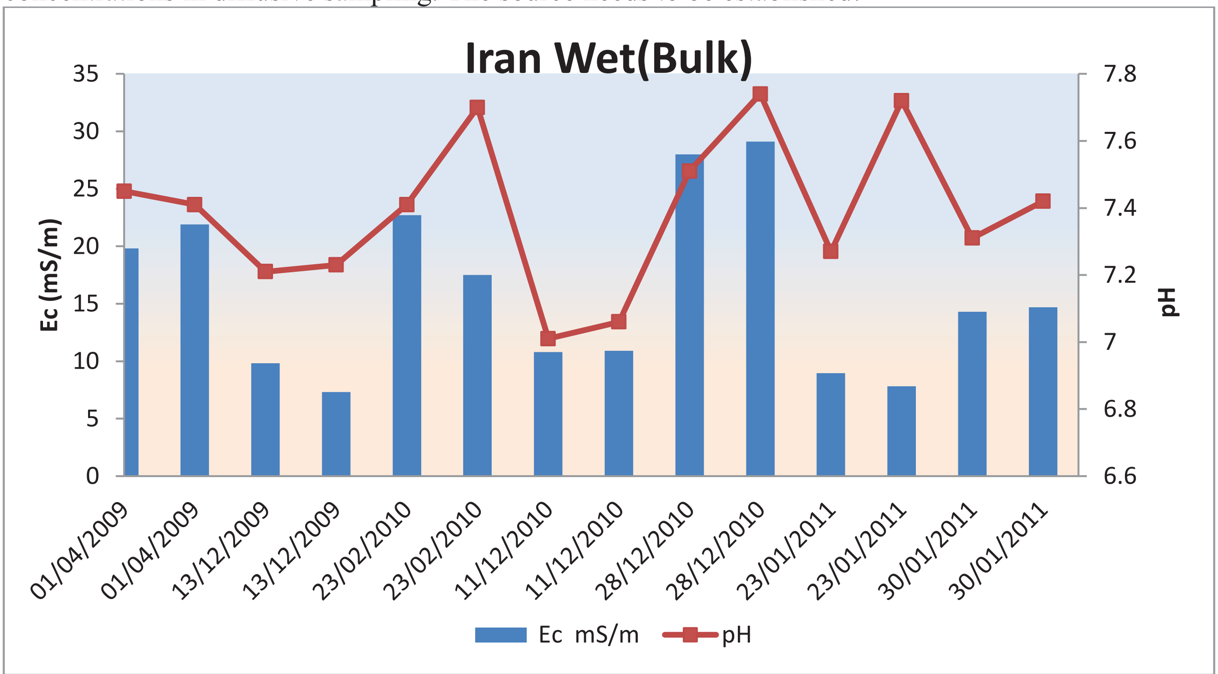

Figure 3-20 Variation in electrical conductance and pH Wet (Bulk)

Table 3-17 Results of wet monitoring using bulk collector - Iran

Month	Ec (mS/m)	pH	Precipitation (ml)
Jan-09	20.8	7.4	176
Dec-09	8.6	7.2	605
Feb-10	20.2	7.5	275
Dec-10	18.2	7.6	272.5
Jan-11	11.4	7.4	585

3.3.5 MALDIVES

The monitoring station is located on the Hanimaadhoo Island, located about 400 km north of the country's capital, Malé. In Maldives, air pollution is more pronounced in Male' while in the islands in can be generally termed good due to limited vehicles and industrial activities in islands. However, in Male', the capital, pollution is often stated as an emerging health hazard. The parameter of major concern currently is particulate matter (PM10). PM10 data results show that PM10 concentration is within WHO standards. Average concentration for 2 months in 2011 was 20 micrograms per cubic meter. Passive sampler is located in'' HukuruMisky'' area of Male' which is located in north of Male'.

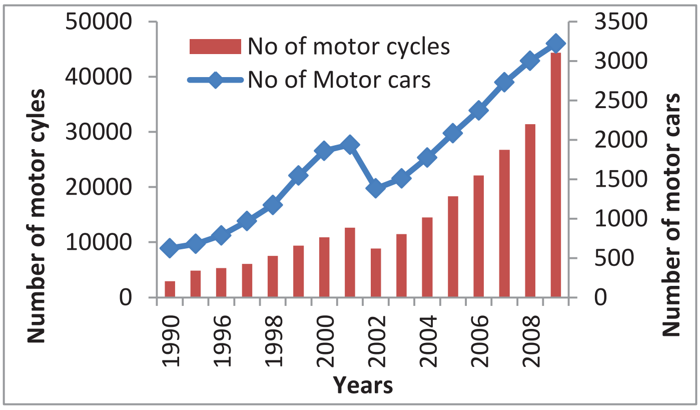

Figure 3-21 Increasing vehicles trend

Traffic congestion is limited in this area. However it is adjacent to a road. Due to congestion finding a suitable location for a station in Male' City is a big challenge. The monitoring station location is considered a clean area away from sea and salt spray.

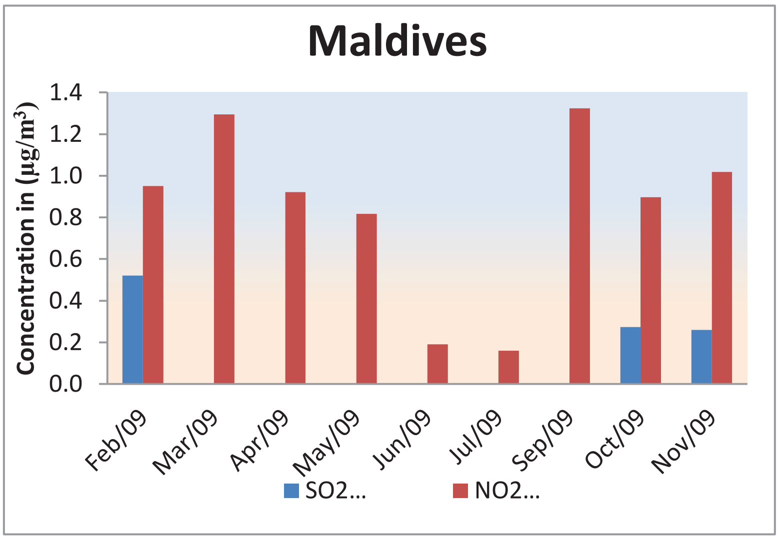

Figure 3-22 Temporal variation of average SO2& NO2 concentration

3.3.5.1 Dry Deposition Monitoring

Maldives conducted diffusive sampling during 2009.The SO_2 and NO_2 concentrations remain low throughout the year and SO_2 was detected only during the period February to October. The NO_2 concentration is low during the monsoon period, high concentration during the month of September coincides with the high ozone concentration during the same period. In general higher NO_2 and ozone concentration is observed during the same period. Increasing number of vehicles, mostly two wheelers, are the main source of air pollution in the area. The total numbers of vehicles registered in Male' from Jan 2006 to Dec 2010 was 19,767 (Figure 3.21). The country is taking steps for the control of vehicular emissions.

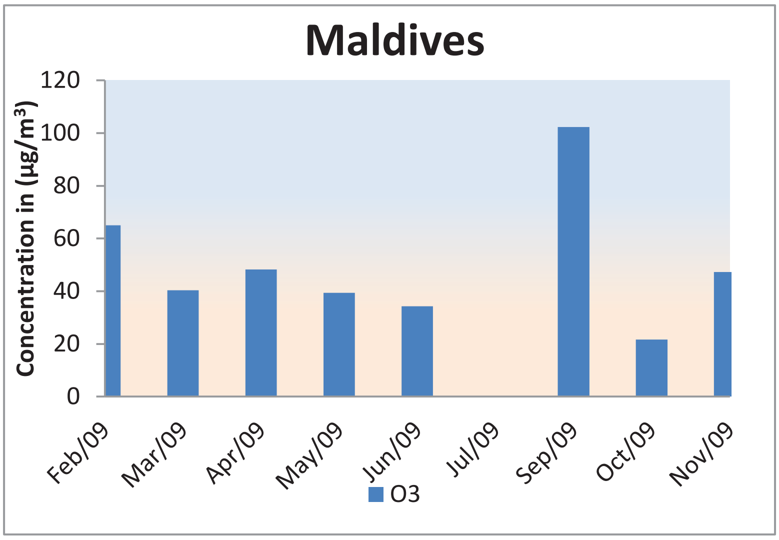

Figure 3-23 Temporal variation of O3 concentration

Table 3-18 Average concentration of SO_2, NO_2 and O_3 in (($\mu g/m^3$) - Maldives

	SO_2	NO_2	O_3
Feb-09	0.5	1.0	65
Mar-09	BDL	1.3	40
Apr-09	BDL	0.9	48
May-09	BDL	0.8	39
Jun-09	BDL	0.2	34
Jul-09	BDL	0.2	BDL
Sep-09	BDL	1.3	102
Oct-09	0.3	0.9	22
Nov-09	0.3	1.0	47
Annual avg	0.4	0.8	48

3.3.6 NEPAL

3.3.6.1 Dry Deposition Monitoring

The data of Nepal has been presented in Table 3.19 & Figure 3.24. A perusal of the Table 3.19 indicates that the monitoring has been carried out only for a few months in 2009 alone, and thus although annual averages have been calculated these cannot be taken as conclusive and no definite trends can be established.

The monitoring was started in 2003 which seems to have got regularized by 2006. However, the monitoring has been discontinued since 2009 due to problems with availability of power.

Rampur is a village in southern Nepal. The monitoring station is located in IAAS (Institute of Agriculture and Animal Science), Rampur.

The monsoon period is approximately from the end of June to the middle of September. About 80 per cent of the rain falls during that period, so the remainder of the year is dry.

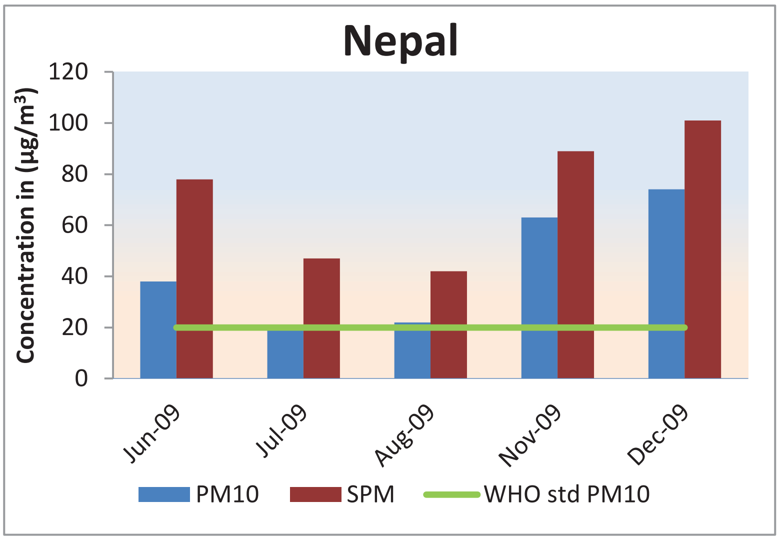

Figure 3-24 Temporal variation of PM10 concentration

Table 3-19 Average variation of PM10 concentration in µg/m³– Nepal

		PM10			SPM	
	Avg	Min	Max	Avg	Min	Max
Jun-09	38	15	56	78	42	109
Jul-09	20	10	30	47	31	67
Aug-09	22	14	33	42	34	50
Nov-09	63	57	74	89	67	111
Dec-09	74	60	119	101	75	173

Diffusive Sampling

The SO_2 concentration remains low and there is no clear trend. (Figure 3.25 and Table 3.20).The highest concentration of NO_2 (9.7µg/m^3) occurs in winters, in the month of February 2009 and 2010, at the same time there is a clear increasing trend over the previous years with the highest concentration in 2007 as 4.9 µg/m^3. The maximum PM10 concentration is also reported in winters (monitoring only June to Dec) The ozone concentration on the other hand is higher February to June with highest concentrations occurring in March-May. There is a need to look into the emission sources and the meteorological conditions.

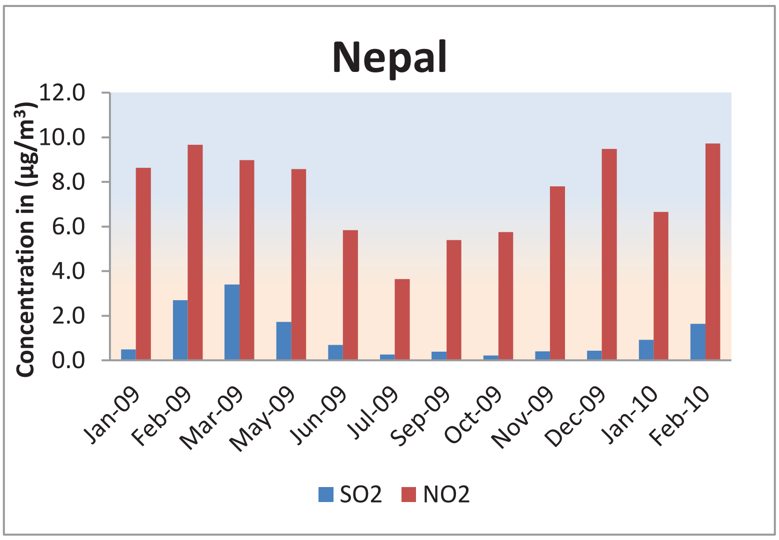

Figure 3-25 Temporal variation of average SO2& NO2 concentration

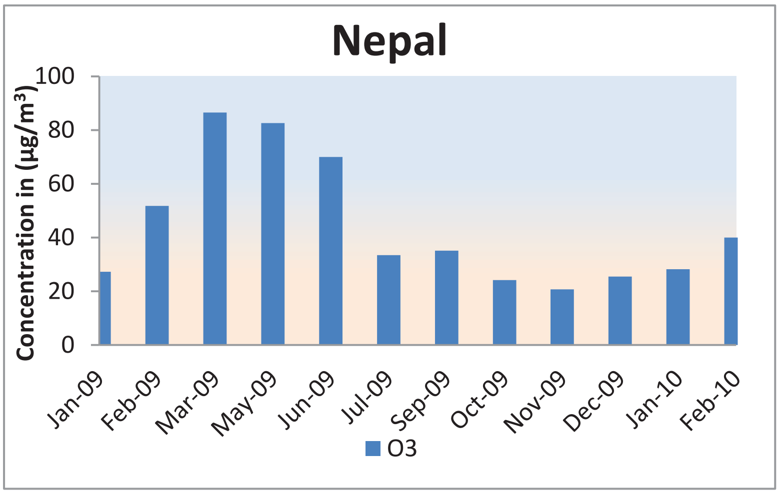

Figure 3-26 Temporal variation of average O3 concentration

Table 3-20 Average concentration of SO_2, NO_2 and O_3 - Nepal

	SO_2 μg/m³	NO_2 μg/m³	O_3 μg/m³
Jan-09	0.5	8.6	27
Feb-09	2.7	9.7	52
Mar-09	3.4	9.0	86
May-09	1.7	8.6	83
Jun-09	0.7	5.8	70
Jul-09	0.3	3.6	33
Sep-09	0.4	5.4	35
Oct-09	0.2	5.8	24
Nov-09	0.4	7.8	21
Dec-09	0.4	9.5	26
Annual avg	1.1	7.4	46
Jan-10	0.9	6.7	28
Feb-10	1.6	9.7	40

3.3.6.2 Wet Deposition Monitoring

Only Wet Bulk monitoring was conducted (sampling period:one month or more)by Nepal for a few months in each year during 2009 - 2011. The samples were analysed for pH, Ec, anions and a very few samples for some cations (Table 3.21). The pH varied between 5.4 and 7. (Figure 3.27) over the years, the electrical conductivity showed a decreasing trend. The reason for very high electrical conductivity in a few months during the monitoring period needs to be looked into. There is no correlation between the ion concentrations and Ec (Annexure III). No specific trend or tendencies could be established.

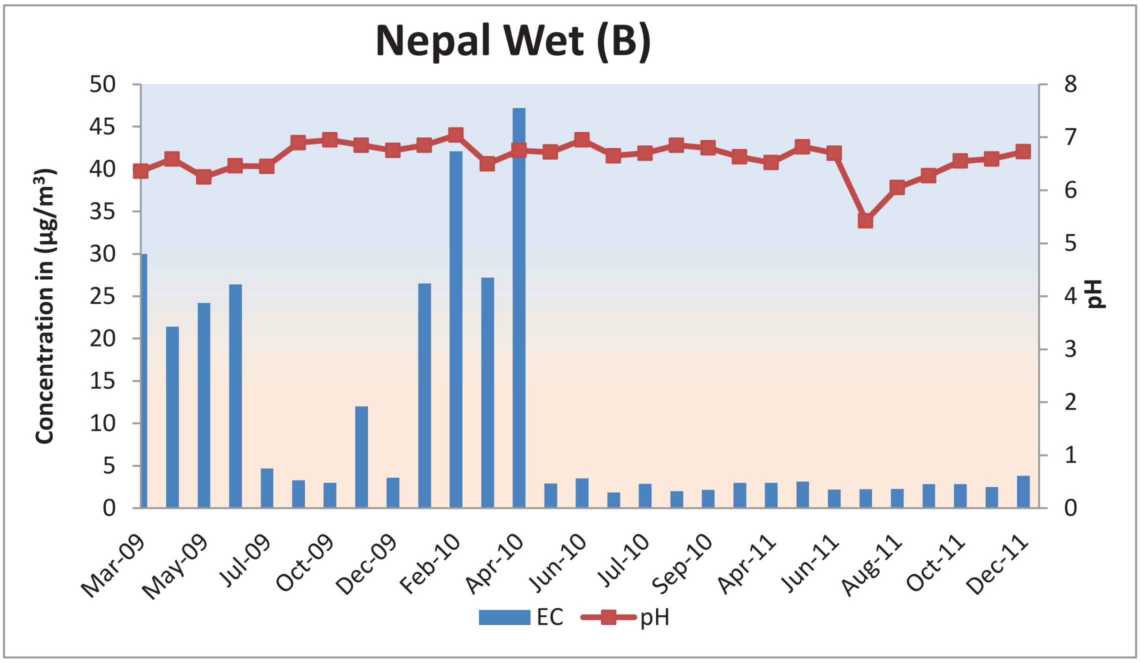

Figure 3-27 Variation in electrical conductance and pH Wet(Bulk)

Table 3-21 Results of wet monitoring using bulk collector - Nepal

	Ec (mS/cm)	pH	Ec (mS/cm)	pH	Ec (mS/cm)	pH
	2009		2010		2011	
Jan	--	--	26.5	6.9	--	--
Feb	--	--	42.1	7.0	--	--
Mar	30.0	6.4	27.2	6.5	--	--
Apr	21.4	6.6	47.2	6.8	3.0	6.5
May	24.2	6.3	2.9	6.7	3.2	6.8
Jun	26.4	6.5	3.5	7.0	2.2	6.7
Jul	4.7	6.5	1.9	6.7	2.2	5.4
Aug	--	--	2.9	6.7	2.3	6.1
Sep	3.3	6.9	2.0	6.9	2.8	6.3
Oct	3.0	7.0	2.2	6.8	2.8	6.6
Nov	12.0	6.9			2.5	6.6
Dec	3.6	6.8			3.8	6.7

3.3.7 PAKISTAN

3.3.7.1 Dry Deposition Monitoring

Pakistan monitored the PM10 concentration in ambient air for three winter months during 2009 (Figure 3.28; Table 3.22). The observed monthly average concentration of PM10 is appreciably high. There is a need to correlate the data with meteorology and the emission sources in the area of influence. However no conclusions can be drawn in view of very less data.

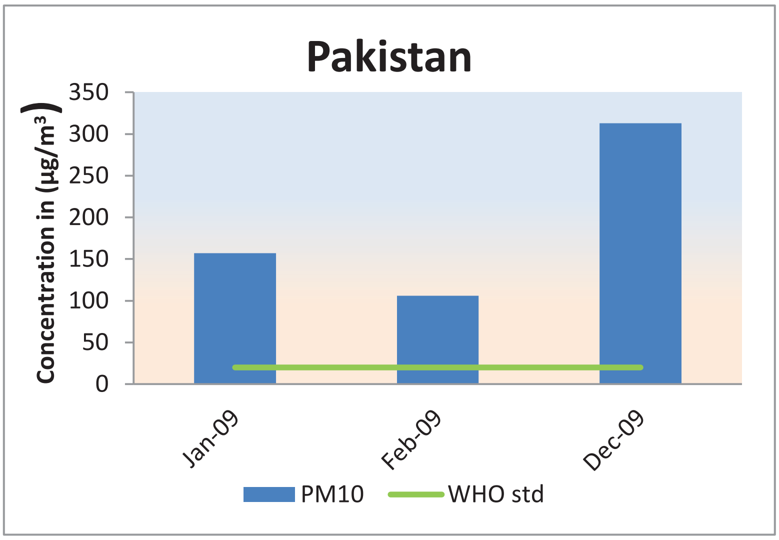

Figure 3-28 Temporal variation of PM10 concentration

Table 3-22 Monthly variation of PM10 concentration (µg/m³) - Pakistan

		PM10			SPM	
	Avg	Min	Max	Avg	Min	Max
Jan-09	157	118	254	303	259	354
Feb-09	138	127	149	311	310	312
Dec-09	313	272	386	353	231	447

3.3.7.2 Wet Deposition Monitoring

Pakistan has also done Wet (Bulk) monitoring during 2009 and analysed the samples for pH and Ec. The results are depicted in Figure 3.29 and Table 3.23. The pH varies between 7.4 to 9.7. The pH levels in Pakistan are high, probably due to the alkaline soil dust in the region.

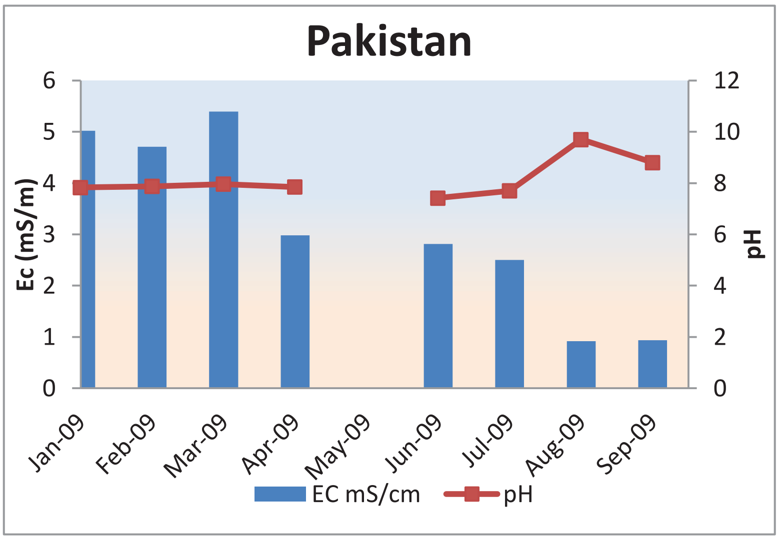

Figure 3-29 Variation in electrical conductance and pH Wet(Bulk)

Table 3-23 Results of wet monitoring using bulk collector - Pakistan

	EC (mS/m)	pH
Jan-09	5.02	7.8
Feb-09	4.71	7.9
Mar-09	5.39	8.0
Apr-09	2.98	7.9
Jun-09	2.81	7.4
Jul-09	2.5	7.7
Aug-09	0.92	9.7
Sep-09	0.94	8.8

3.3.8 SRI LANKA

Sri Lanka is an island located in Indian Ocean between latitudes 050 and 100 N, and longitudes 790 and 820E. The central part of the southern half of the island is mountainous with heights more than 2.5 km. The core regions of the central highlands contain many complex topographical features such as ridges, peaks, plateaus, basins, valleys and escarpments. The remainder of the island is practically flat except for several small hills that rise abruptly in the lowlands. These topographical features strongly affect the spatial patterns of winds, seasonal rainfall, temperature, relative humidity and other climatic elements, particularly during the monsoon season.

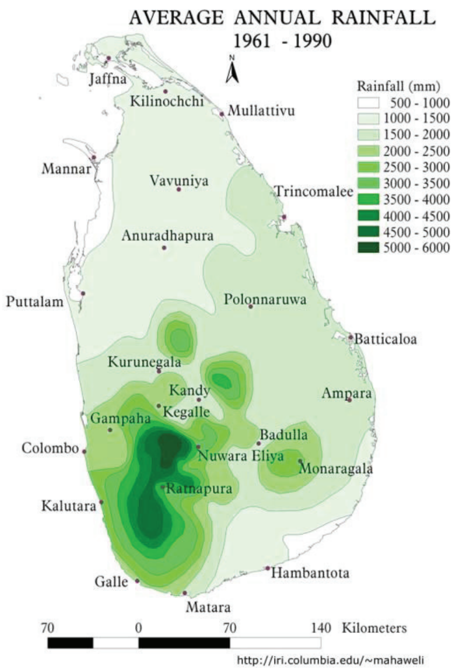

Figure 3-30 Climatic zones in Sri Lanka

There is a marked climatic variation in Sri Lanka Four basic types of rains namely, monsoonal, convectional , cyclonic and orographicare identified in the country which occur singly or in combination. There are two distinct monsoon driven rainy seasons namely the southwest or summer monsoon (May to September) and northeast or winter monsoon (December to February). The island is also influenced by the atmospheric depressions that form in the southwest Bay of Bengal and southeast Arabian Sea which promote cyclonic rains. However, orographic rainfall prevails specially in the highlands and the cyclonic rains during the second inter-monsoon (October and November) are fairly widespread. The intensity of the annual rainfall divides the island into two distinct climatic zones, the wet zone and the dry zone. Nearby three quarters of Sri Lanka lies in 'Dry Zone', comprising the northern half and the whole of the east of the country. Average annual rainfall in this region is generally between 1,200-1,800 mm.

3.3.8.1 Dry Deposition Monitoring

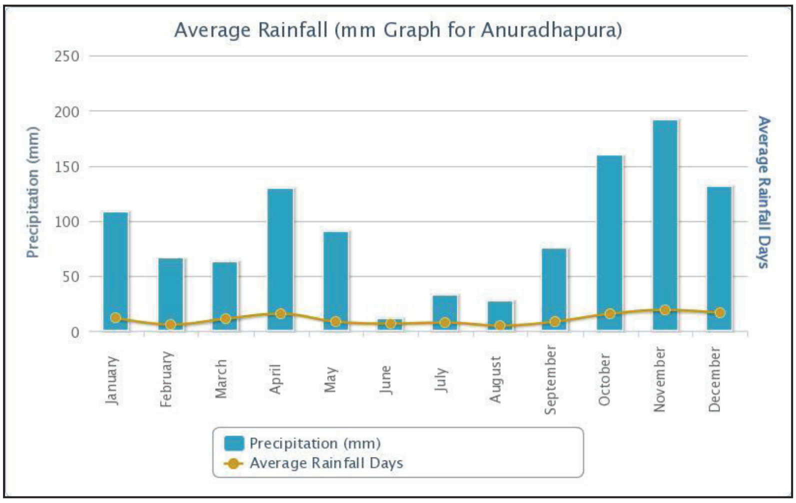

Figure 3-31 Monthly variations of rainfall and the average number of rainy days at the area of sampling (Source Department of Meteorology)

Sampling location of Sri Lanka is situated at Doramadalawa (080 24' 22.39" N, 800 29' 11.74" E) in dry zone around 10 km areal distance from the ancient city called Anuradhapura. Anuradhapura is a major city in Sri Lanka with a population of about 60,000 people. The city, a UESCO world Heritage site and a tourist destination, especially during the months of May-June. This monitoring site is on the small rock, nearby Doramadalawa Buddhist temple at the edge of the Mihinthale reserve forest. There is a highway at about 10km in the east of the sampling location. This location is classified as rural site. Monthly variation in rainfall and the average number of rainy days in the area of sampling is given in Figure-3.23. The predominant wind direction is Southwest from May to September and Northeast from December to February.

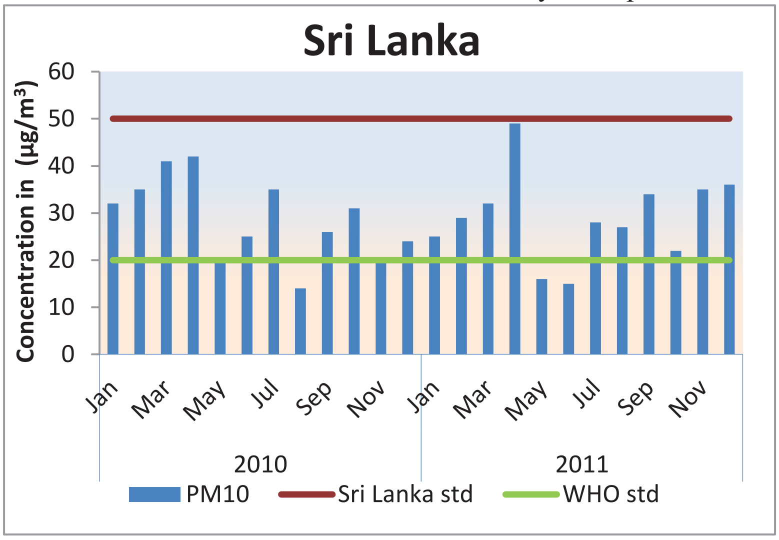

Figure 3-32 Temporal variation of PM10 concentration

Regular monitoring of PM10 at the Doramadalawa location was started in January 2010 .Monitoring was done by using high volume sampler (Model 2000) located at about 7m height from the top of rock (around 20m height from ground). The results are given in Table -3.23 and Figure -3.29. Perusal of Table-3.23 and Figure -3.29 indicate that there is a large variation in PM10 concentrations from 12 to 59 µg/m3 with annual average 29 µg/m^3 and standard deviation 11.18. Highest monthly average concentrations were observed during March-April and September whereas the lowest concentrations were generally in the months of August in 2010 and May, June in 2011. On comparing the concentration with the rainfall data (Figure-3.29),it is seen that variation in rainfall is not the main reason for the variations of PM10 concentrations as the High concentrations were observed in the month of April which is not a dry period. At the same time, in 2011 the lowest concentrations were observed during May-June, June being a dry month. Highest concentrations of PM10 have been attributed to some construction activities in the area nearby and to the period of open fires (agricultural residue burning in the fields) in dry period(from July to September) during the land preparation for the next crop. Other activities which could influence the results include rice mills in the area which operate throughout the year.

3-24 Table Average variation of PM10 concentration in µg/m³– Sri Lanka

	2010			**2011**		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**
Jan	32	22	44	25	16	34
Feb	35	27	48	29	19	41
Mar	41	24	54	32	16	58
Apr	42	23	24	49	49	49
May	20	23	24	16	15	17
Jun	25	23	24	15	15	15
Jul	35	23	24	28	19	34
Aug	14	23	23	27	21	36
Sep	26	23	24	34	24	43
Oct	31	22	22	22	19	28
Nov	20	23	23	35	15	59
Dec	24	21	29	36	25	52
Annual avg	29			29		

Diffusive Sampling

Sri Lanka has been conducting passive sampling regularly since Aug 2003. SO_2 and NO_2 concentrations have been monitored only by the diffusive sampling method. The data of 2009-2010 is presented in Table-3.24 and Figure 3.30.Since the monitoring location was shifted from Dutuwewa to Doramadalwa in 2009, one year parallel monitoring was carried out to know the variation of results due to change of location. A perusal of Table3.24 and Figure -3.30 indicates that the concentration of both SO_2 and NO_2 remains higher at Doramadalwa as compared to Dutuwewa indicating greater emission sources/activity at the new monitoring location. Although the concentrations remain low and no definite trend can be established, highest concentrations of SO_2 was observed in April and May and that of NO_2 in April and August. The high concentration of SO_2 and NO_2 in April coincides with the high concentration of PM10 (although years are different) in the same month. Further studies may be carried out to know if the source is the same.

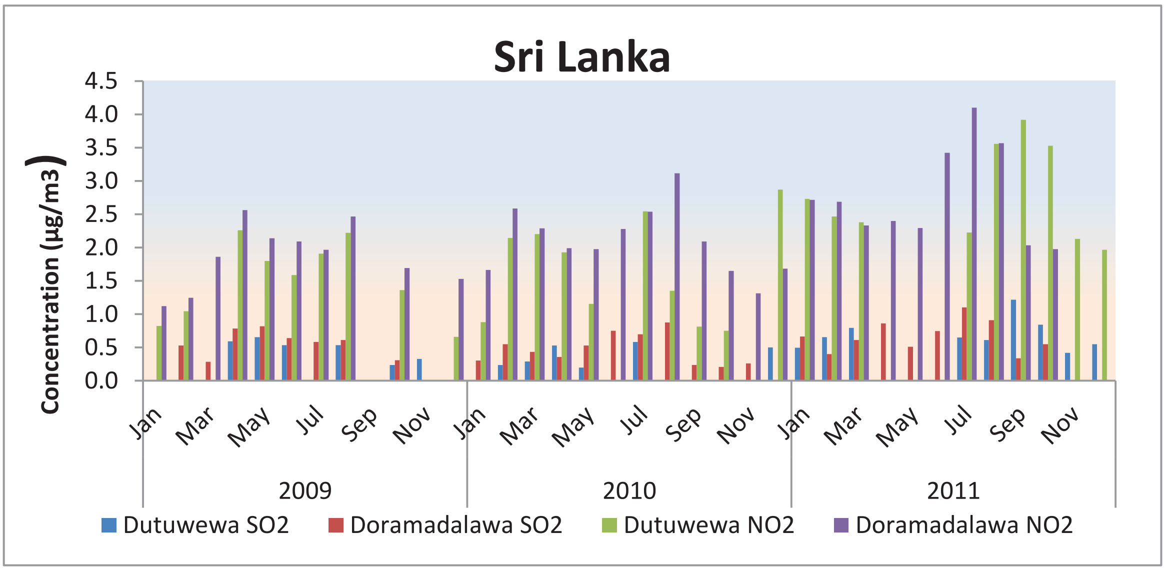

Figure 3-33 Temporal variation of average SO2 & NO2 concentration

Table 3-25 Average concentration of SO_2, NO_2 and O_3 in $NO_2 \mu g/m^3$– Sri Lanka

		Dutuwewa	Doramadalawa	Dutuwewa	Doramadalawa	Dutuwewa	Doramadalawa
		SO_2		**NO_2**		**O_3**	
2009	Jan	BDL	BDL	0.8	1.1	27	38
	Feb	BDL	0.5	1.0	1.2	23	35
	Mar		0.3		1.9	15	21
	Apr	0.6	0.8	2.3	2.6	36	34
	May	0.7	0.8	1.8	2.1	40	40
	Jun	0.5	0.6	1.6	2.1	38	37
	Jul	BDL	0.6	1.9	2.0	36	41
	Aug	0.5	0.6	2.2	2.5	31	38
	Sep						
	Oct	0.2	0.3	1.4	1.7		28
	Nov	0.3	BDL		BDL		BDL
	Dec		BDL	0.7	1.5	31	39
Annual avg		0.5	0.6	1.5	1.9	31	35
2010	Jan	BDL	0.3	0.9	1.7	23	34
	Feb	0.2	0.5	2.1	2.6	28	42
	Mar	0.3	0.4	2.2	2.3	25	31
	Apr	0.5	0.4	1.9	2.0	35	39
	May	0.2	0.5	1.2	2.0	16	39
	Jun		0.8		2.3		39
	Jul	0.6	0.7	2.5	2.5	34	34
	Aug	BDL	0.9	1.4	3.1	23	41
	Sep	BDL	0.2	0.8	2.1	BDL	28
	Oct	BDL	0.2	0.8	1.7	73	43
	Nov		0.3		1.3		47
	Dec	0.5	BDL	2.9	1.7	40	41
Annual avg		0.4	0.5	1.7	2.2	32	38
	Jan	0.5	0.7	2.7	2.7	51	41
	Feb	0.7	0.4	2.5	2.7	41	40
	Mar	0.8	0.6	2.4	2.3	38	40
	Apr		0.9		2.4		41
	May		0.5		2.3		42
	Jun		0.7		3.4		36
	Jul	0.7	1.1	2.2	4.1	40	37
	Aug	0.6	0.9	3.6	3.6	39	34
	Sep	1.2	0.3	3.9	2.0	36	38
	Oct	0.8	0.5	3.5	2.0	32	53

	Nov	0.4		2.1		35	
	Dec	0.5		2.0		52	
Annual avg		0.7	0.7	2.8	2.8	41	40

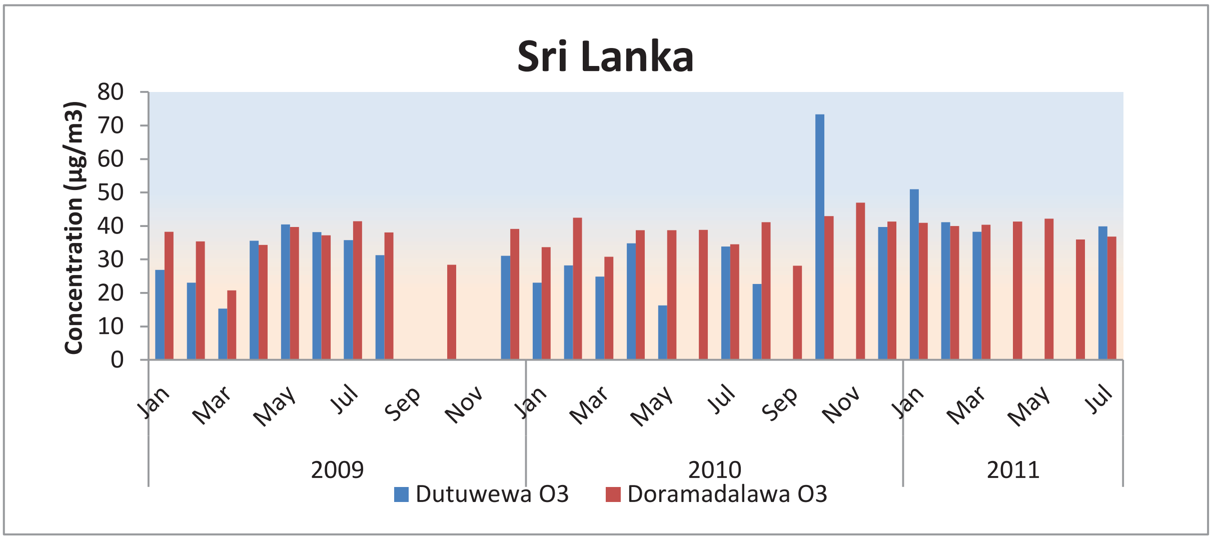

Figure 3-34 Temporal variation of O3 concentration

Ozone being a secondary pollutant its presence in the atmosphere depends on the concentration of NO_2 and VOCs in the atmosphere and the reaction between them. Table -3.24 and Figure- 3.31 give the variation in O_3 concentration over the year.Highest concentrations were observed during the months of May and July.

3.3.8.2 Wet Deposition Monitoring

Sri Lanka has been carrying out the wet deposition studies regularly for all the cations and anions since 2004.

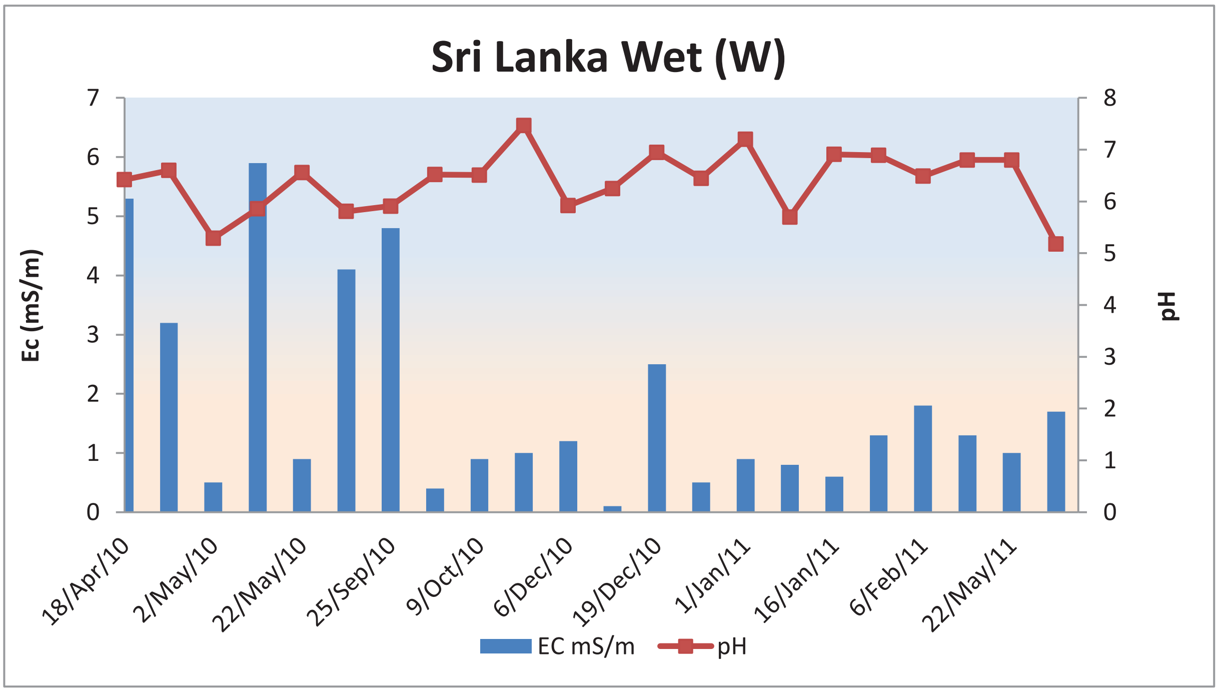

Figure 3-35 Variation in electrical conductance and pH wet (wet)

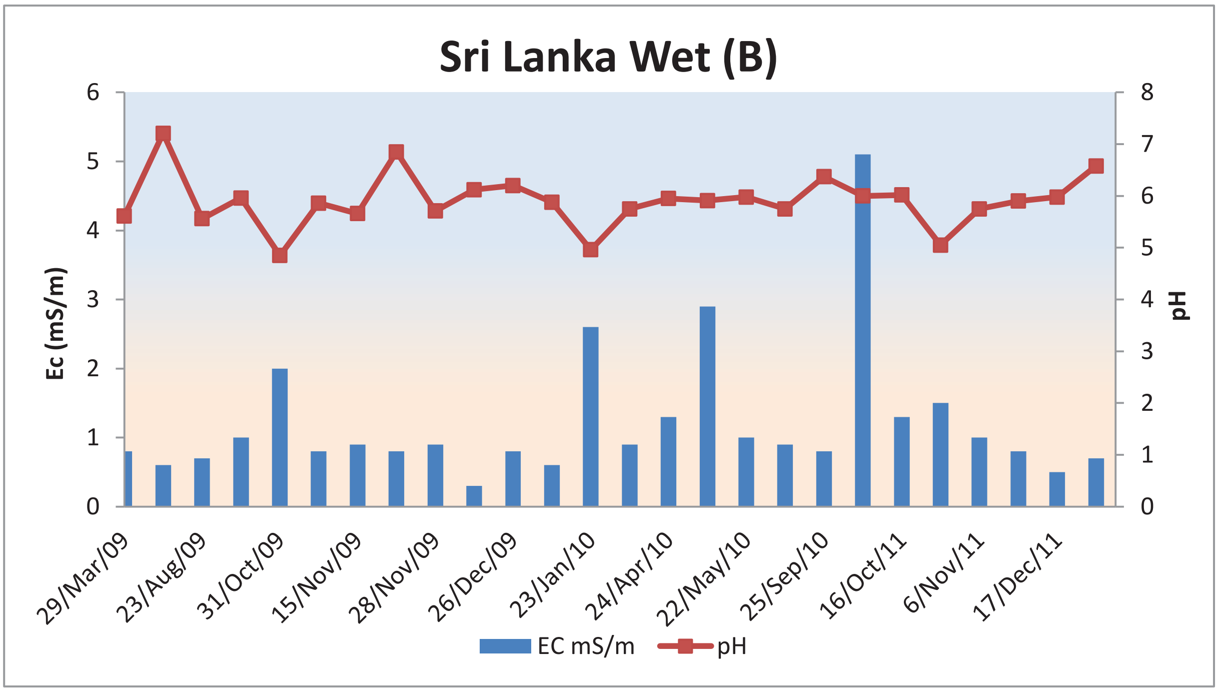

Figure 3-36 Variation in electrical conductance and pH wet (bulk)

Table 3-26 Results of wet monitoring using wet wet and bulk collector – Sri Lanka

			Wet wet			Wet bulk	
		Ec mS/m	pH	Precipitation ml	Ec mS/m	pH	Precipitation ml
2009	Mar	0.8	5.6	148	0.8	5.6	148
	May	0.6	7.2	260	0.6	7.2	260
	Aug	0.7	5.6	2700	0.7	5.6	2700
	Oct	1.2	5.8	1200	1.2	5.8	1200
	Nov	0.8	6.0	2483	0.8	6.0	2483
	Dec	0.7	6.2	3025	0.7	6.2	3025
2010	Jan	0.9	5.7	763	0.9	5.7	753
	Apr	1.0	5.8	1650	1.0	5.8	1650
	May	1.3	3.8	3400	1.3	3.8	3400
	Sep	0.9	6.0	1250	0.9	6.0	1250
	Oct	5.1	6.0	1300	5.1	6.0	1300
2011	Oct	1.4	5.5	1575	1.4	5.5	1575
	Nov	1.0	5.8	840	1.0	5.8	840
	Dec	0.7	6.1	800	0.7	6.1	933

A look at Figures 3.35 and 3.36 and Table 3.26 indicates that the pH varied from 5.5 to 7.5 with only one occasion in May 2010 when it was 2.8. The fluctuations were also associated with fluctuations in precipitation amounts both above and below the long term averages although no particular trend was

observed in the seasonal variation of the pH. No clear conclusions can be drawn as the monitoring location has been changed since 2009
The data reported for 2009-11 indicates a conductance range from 0.5 to 9.4mS/m in the wet only and the bulk samples. Unusually high Ec in certain months needs to be correlated with the meteorological data and the emission sources to know the reasons.

Sulphate and nitrate are the most important acid anions in precipitation both of which are correlated with hydrogen ion concentrations and to acid rain. The sulphate concentration varied between 0.19 to 18.28µmol/l with the lowest values recorded during Oct 2010 and the highest in Jan 2011. Moreover, the concentrations were higher during certain months as compared to the others. No particular trends in seasonal variations or correlation with Ec could be established.

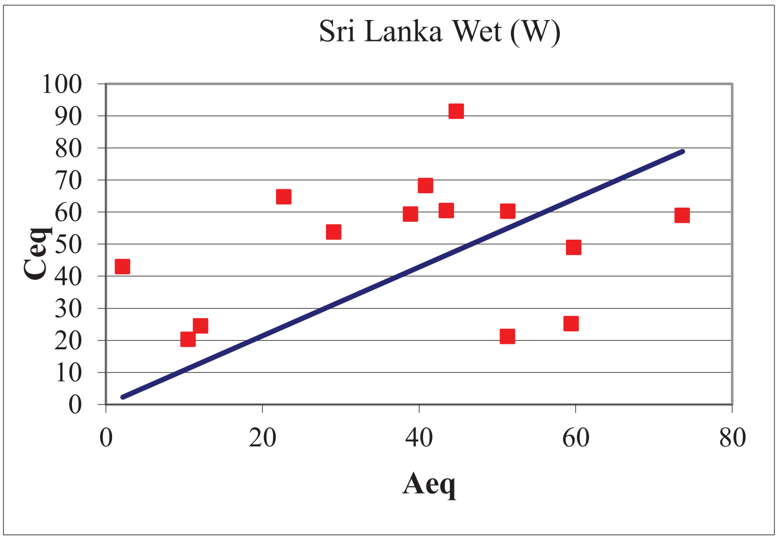

Figure 3-37 Aeq vs Ceq wet wet

The nitrate concentration varied from 0.23 µmol/l in May, 2010 to 18.67µmol/l in Jan, 2011 over the three years of monitoring. There are large variations in the concentration and no particular seasonal trend can be established. The influence that precipitation volumes exert on wet depositions is not very evident from the nitrate concentration trends. No definite correlation exists between the concentration of sulphate, nitrate and pH, however it may be noted that the highest concentrations of both sulphate and nitrate were observed during Jan 2011.

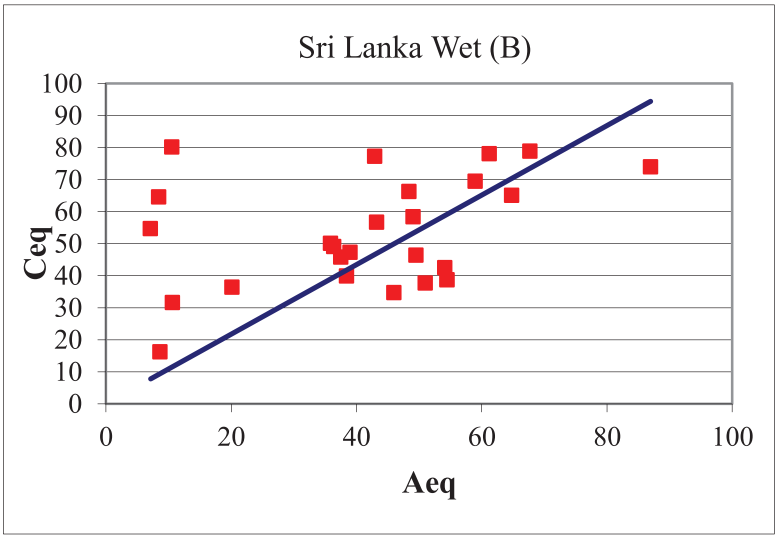

Figure 3-38 Aeq vs Ceq wet bulk

Ammonium concentrations are of particular interest because of their potential contribution to nutrient enrichment and/or acidification of surface waters. Ammonium concentrations in precipitation are a by-product of agricultural activity, so their concentrations are generally higher near and downwind of large-scale agricultural operations, poultry farms, animal feedlots, etc. Biological decomposition of plant materials in shallow surface waters can also contribute to local spatial patterns. Ammonium concentration in precipitation ranged from 4.77 to 34.98µmol/l. Correlation with the occurrence of other ions was not there, however, the highest concentration of ammonium coincides with the highest concentration of potassium. No seasonal or annual trends could be established.

Figures 3.37 and 3.38 give the correlation of the anion vs. cation equivalent concentrations.

Calcium and magnesium ions were found in concen trations ranging from 0.25 to 22.23 and 0.45 to 7.94 µmol/l respectively. The highest concentration of calcium and magnesium in wet only samples was 0.30 and 22.23µmol/ and in the Bulk samples it was 0.25 and 22.01 µmol/l respectively. The concentrations of the two ions across the year are random and no clear trend was observed. Compared to the inland sites, the sea salt driven ions, chloride and sodium, appeared higher and calcium+, as a soil-driven ion, appeared lower at the coastal monitoring site of Sri Lanka

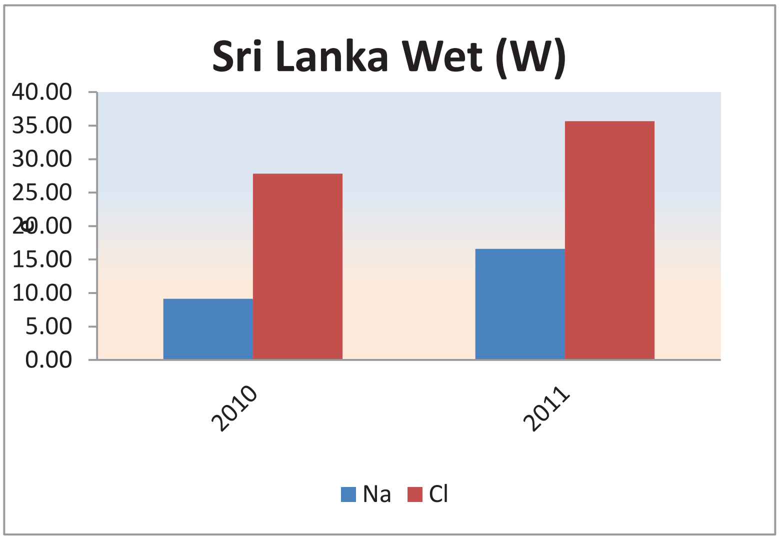

Figure 3-39 Na and Cl distribution wet only collector

Potassium occurs at the Sri Lanka site in concentrations ranging from 0.15 to 9.46µmol/l. The lowest concentration was observed during July, 2009 wet sample. Potassium containing fertilizers and soil disturbance near the site could be a contributing factor. No consistent temporal patterns in potassium concentrations exist across the monitoring period.

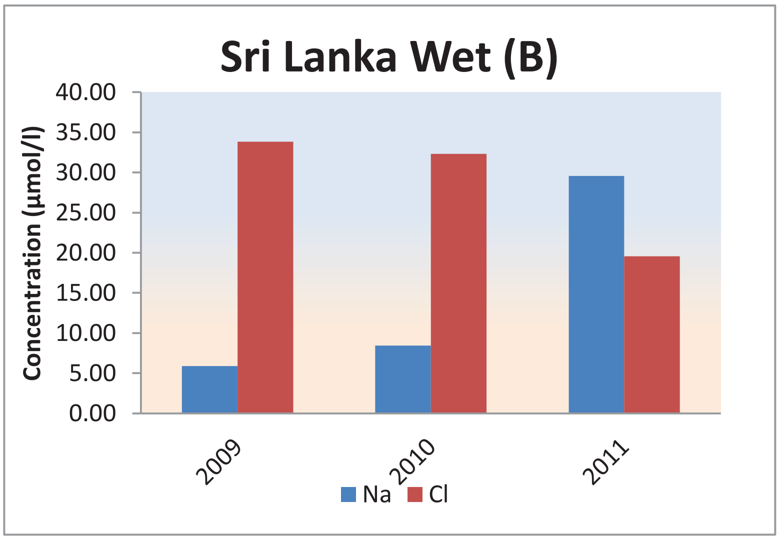

Figure 3-40 Na and Cl distribution bulk collector

Chloride and sodium concentrations generally exhibit a fairly definable temporal pattern which could be associated with the origin and direction of storms and the presence of sea salt (sodium chloride) from coastal influences. Relatively high sodium and chloride concentrations were found as the site is near the coastal region; Sodium concentration mimics the chloride concentration. At the same time the equivalent concentration of sodium is always higher than that of chloride indicating the presence of other sodium salts.

CHAPTER 4. CONCLUSIONS AND RECOMMENDATIONS

The monitoring results of 2009-11 have been discussed in this Data Analysis Report. The eight countries participating in the Malé programme were required to carry out both Wet and Dry Deposition monitoring. Dry deposition was monitored using two methods, viz., using PM10 samplers (for PM10, SO_2 and NO_2) and using Diffusive samplers (for SO_2, NO_2 and O_3). Wet deposition was monitored using Wet(Wet) and Wet(Bulk) samplers for pH, Ec, NH^{4+}, Na^+, K^+, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^- and NO_3- by each method. However, some of the participating countries were unable to carry out the complete monitoring by all methods. An attempt has been made to compare the reported results, however, it may be kept in mind that the discussion is only indicative as in some cases the averages are based on very few values and some of the countries have not followed the monitoring protocols.

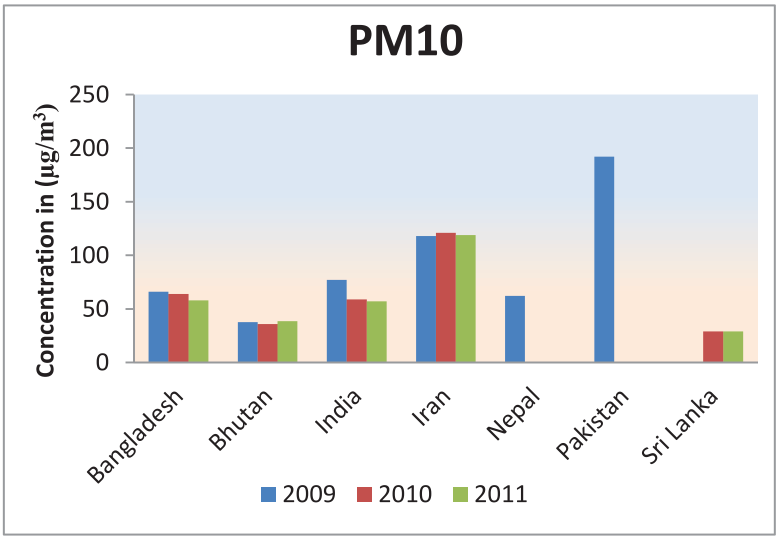

Figure 4-1 Annual average PM10 concentration

The comparative results of PM10 monitoring are given in Table 4.1.

Of the countries that monitored PM10, the highest annual average was observed in the case of Iran (Figure 4.1), followed by Bangladesh, India, Nepal, Bhutan and Sri Lanka(the Pakistan average is of only three months, thus not representative). The annual average concentration of PM10 in case of Bangladesh and India has been decreasing over the years.

Table 4-1Average PM10 concentration in µg/m³

S No	Country	2009	2010	2011
1	Bangladesh	66	64	58
2	Bhutan	38	36	38
3	India	77	59	57
4	Iran	118	121	119
5	Nepal	62	--	--
6	Pakistan*	192	--	--
7	Sri Lanka	--	29	29

*only three months data

The results of SO_2, NO_2 and Ozone by diffusive sampling are given in Table 4.2 and depicted in Figure 4.2 to 4.5. The highest observed concentration of SO_2 is in case of Iran followed by Bangladesh and Nepal. Sri Lanka. The highest NO_2 concentrations have been observed in Nepal followed by Bangladesh, Iran, Sri Lanka and Maldives. Ozone concentration was highest in case of Iran and Bangladesh followed by Maldives, Nepal and Sri Lanka (Figure 4.2)

Table 4-2 Annual Average SO_2 , NO_2 and O_3concentration in μg/m^3 -2009

S No	Country	SO_2	NO_2	O_3
1	Bangladesh	3.6	3.5	72
2	Iran	11.7	2.1	74
3	Maldives	0.4	0.8	48
4	Nepal	1.1	7.4	46
5	Sri Lanka	0.6	1.9	35

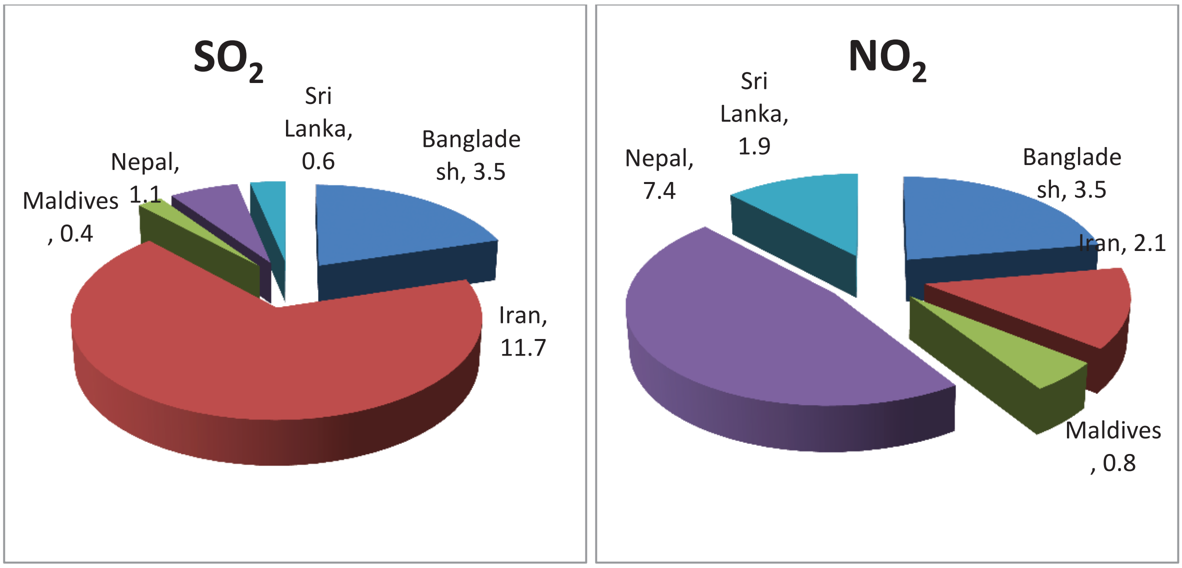

Figure 4-2 Annual Average SO_2 , NO_2 and O_3concentration in μg/m^3 -2009

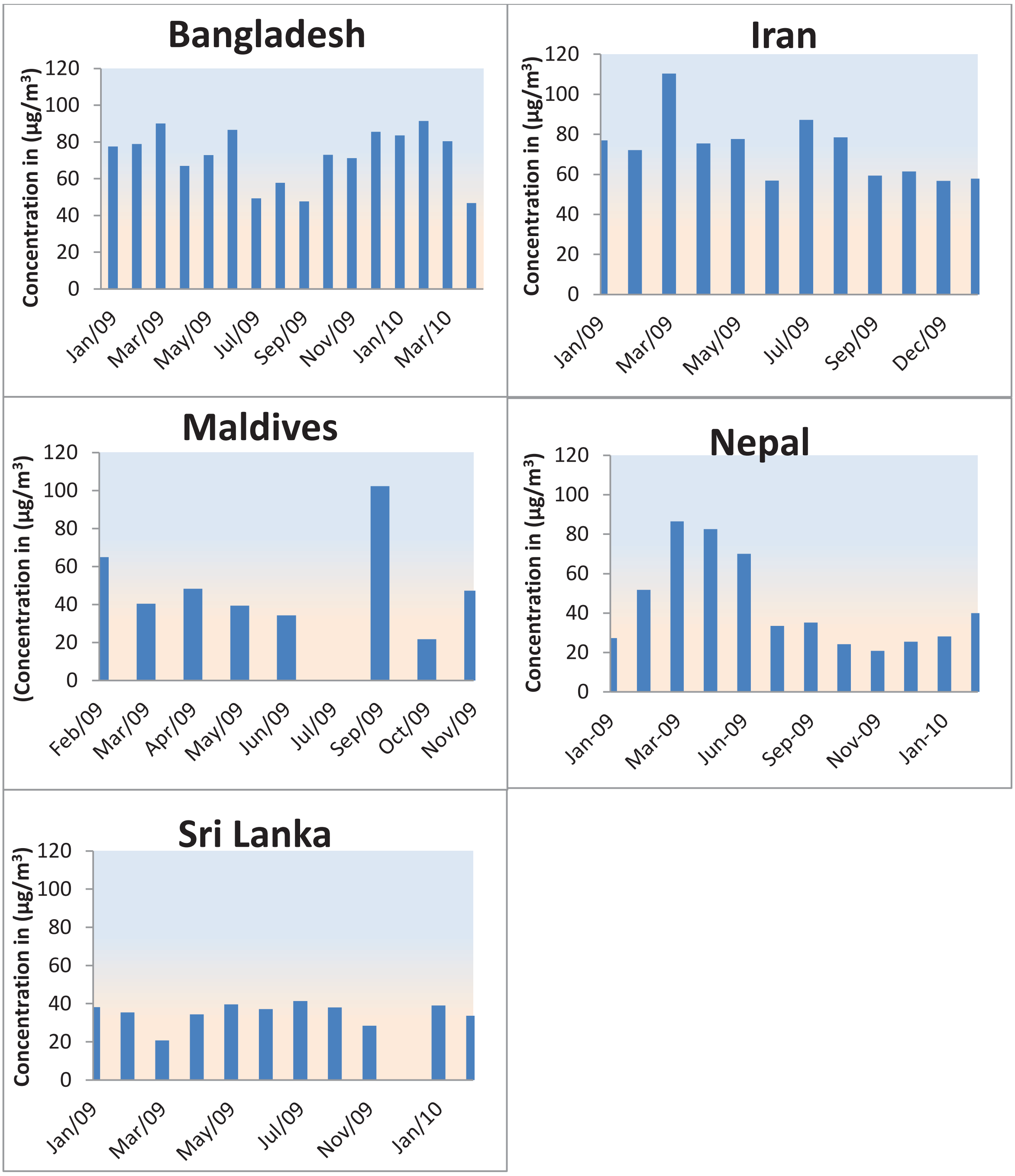

Figure 4-3 O_3 variation

The results of wet deposition monitoring have not been reported by all the countries (Annexure III). No particular trends or conclusions could be drawn. The variation in pH during 2009-2011 is given in Figure- 4.4. Although some variations in pH have been observed, no particular trends could be established. Higher sodium and chloride ion concentrations in case of Bangladesh and Sri Lanka could be due to sea breeze. No trends could be established in the ion concentrations and Ec.
Iran has exceptionally high PM10 concentrations combined with high SO_2. It may be mentioned that the results of Wet deposition monitoring in case of Iran (Annexure III) also show high sulphate concentrations. The results need to be analysed in view of meteorology and sources of emissions in the area. Higher NO_2 and ozone could also be from the same source. In case the location is in the

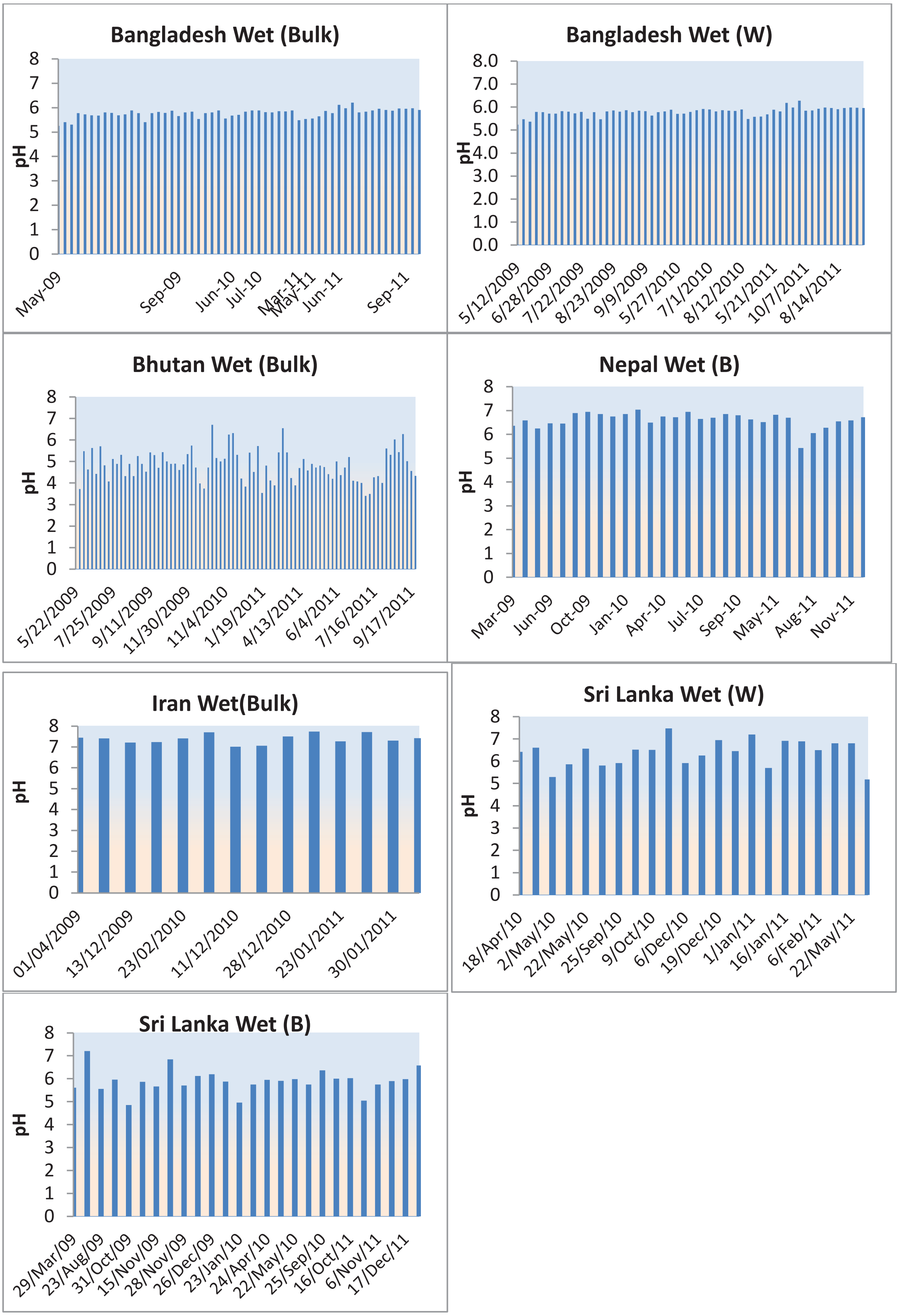

Figure 4-4 pH variation

direct influence of the flare of oil wells in adjoining Iran an alternative monitoring location which is more representative may be identified for monitoring under the programme.

The next highest PM10 concentration was observed in case of Bangladesh and India. The concentration of SO_2, NO_2 and ozone by diffusive sampling is also high in case of Bangladesh when compared to the other countries. The main source has been identified as the brick kilns and vehicular emissions. India has not reported the results of diffusive sampling, however, the results of Air concentration monitoring (Table-4.1) indicate negligible concentration of SO_2 and very low concentration of NO_2. India needs to identify the sources of PM10 so that air quality management strategies can be formulated accordingly. The PM10 concentration in the two countries has been decreasing over the years as a result of measures taken to control the sources of air pollution.

The highest NO_2 concentration has been observed in the case of Nepal. Air pollution in Nepal has been attributed mainly to rapid urbanization, increasing number of vehicles, large number of brick kilns and industrialization.

The above comparison is only indicative. For meaningful conclusions and comparison it is important that all the countries carry out regular Dry and Wet deposition monitoring as per the protocols established under the Malé declaration monitoring programme.

Correlation of results and trends by each country in relation to meteorology and emission sources in the area is of utmost importance.

ANNEXURE I: CONCENTRATION OF PM10 BY AIR CONCENTRATION MONITORING

RESULTS OF AIR CONCENTRATION – BANGLADESH

S No	Month	Start Date	End date	PM10 (µg/m^3)	SPM (µg/m^3)	Remarks
1	Jan - 09	11-Jan-09	12-Jan-09	125	149	
2		13-Jan-09	14-Jan-09	136	156	
3		15-Jan-09	16-Jan-09	140	167	
4		17-Jan-09	18-Jan-09	133	152	
5		19-Jan-09	20-Jan-09	133	157	
	Jan - 09	Average		133	156	
6	Feb-09	16-Feb-09	17-Feb-09	125	150	
7		17-Feb-09	18-Feb-09	111	138	
8		19-Feb-09	20-Feb-09	158	187	
9		20-Feb-09	21-Feb-09	140	167	
10		21-Feb-09	22-Feb-09	110	138	
	Feb-09	Average		129	156	
11	Mar-091	10-Mar-09	11-Mar-09	100	123	
12		12-Mar-09	13-Mar-09	102	123	
13		14-Mar-09	15-Mar-09	106	142	
14		16-Mar-09	17-Mar-09	99	126	
15		20-Mar-09	21-Mar-09	100	129	
	Mar-09	Average		101	129	
	The samples are not representative a day due to frequent electricity fail. The electricity is available at night					
16	Apr-09	11-Apr-09	12-Apr-09	28	46	
17		13-Apr-09	14-Apr-09	32	49	
18		16-Apr-09	17-Apr-09	41	60	
19		18-Apr-09	19-Apr-09	38	57	
20		20-Apr-09	21-Apr-09	32	49	
	Apr-09	Average		34	52	
21	May-09	10-May-09	11-May-09	31	46	
22		12-May-09	13-May-09	42	49	
23		14-May-09	15-May-09	28	60	
24		17-May-09	18-May-09	20	39	
25		19-May-09	20-May-09	20	37	
	May-09	Average		28	46	
26	Jun-09	10-Jun-09	11-Jun-09	27	40	

27		12-Jun-09	13-Jun-09	43	60	
28		14-Jun-09	15-Jun-09	28	47	
29		16-Jun-09	17-Jun-09	34	53	
30		18-Jun-09	19-Jun-09	40	59	
	Jun-09	Average		34	52	
31	Jul-09	13-Jul-09	14-Jul-09	7		
32		17-Jul-09	18-Jul-09	9		
33		20-Jul-09	21-Jul-09	25		
	Jul-09			14		
	The NRSPM is very amount which below detection limit Less number of sampling than Male guideline due to heavy rain and shortage electricity which interrupted random sampling					
34	Aug-09	10-Aug-09	11-Aug-09	17		
35		12-Aug-09	13-Aug-09	22		
36		14-Aug-09	15-Aug-09	12		
37		16-Aug-09	17-Aug-09	10		
38		19-Aug-09	20-Aug-09	19		
	Aug-09	Average		16		
39	Sep-09	10-Sep-09	11-Sep-09	40		
40		12-Sep-09	13-Sep-09	56		
41		14-Sep-09	15-Sep-09	39		
42		16-Sep-09	17-Sep-09	24		
43		19-Sep-09	20-Sep-09	37		
	Sep-09	Average		39		
44	Oct-09	10-Oct-09	11-Oct-09	36		
45		12-Oct-09	13-Oct-09	48		
46		14-Oct-09	15-Oct-09	46		
47		17-Oct-09	18-Oct-09	60		
48		19-Oct-09	20-Oct-09	60		
	Oct-09	Average		50		
49	Nov-09	10-Nov-09	11-Nov-09	86		
50		12-Nov-09	13-Nov-09	96		
51		14-Nov-09	15-Nov-09	76		
52		16-Nov-09	17-Nov-09	74		
53		19-Nov-09	20-Nov-09	74		
	Nov-09	Average		81		
54	Dec-09	10-Dec-09	11-Dec-09	119		
55		12-Dec-09	13-Dec-09	113		
56		14-Dec-09	15-12-	130		

57		16-Dec-09	17-Dec-09	133		
58		19-Dec-09	20-Dec-09	149		
	Dec-09	Average		129		
	2009	Annual average		66		
59	Jan-10	12-Jan-10	13-Jan-10	152		
60		14-Jan-10	15-Jan-10	161		
61		16-Jan-10	17-Jan-10	156		
62		19-Jan-10	20-Jan-10	150		
	Jan-10	Average		155		
63	Feb-10	12-Feb-10	13-Feb-10	172		
64		14-Feb-10	15-Feb-10	101		
65		16-Feb-10	17-Feb-10	123		
66		19-Feb-10	20-Feb-10	101		
	Feb-10	Average		124		
67	Mar-10	10-Mar-10	11-Mar-10	142		
68		12-Mar-10	13-Mar-10	135		
69		15-Mar-10	16-Mar-10	104		
70		17-Mar-10	18-Mar-10	119		
71		19-Mar-10	20-Mar-10	94		
	Mar-10	Average		119		
72	Apr-10	10-Apr-10	11-Apr-10	19		
73		15-Apr-10	16-Apr-10	15		
74		17-Apr-10	18-Apr-10	12		
75		20-Apr-10	21-Apr-10	20		
	Apr-10	Average		17		
76	May-10	16-May-10	17-May-10	30		
77		19-May-10	20-May-10	12		
	May-10	Average		21		
78	Jun-10	14-Jun-10	15-Jun-10	30		
79		15-Jun-10	16-Jun-10	33		
80		18-Jun-10	19-Jun-10	17		
	Jun-10	Average		27		
81	Jul-10	15-Jul-10	16-Jul-10	45		
82		16-Jul-10	17-Jul-10	32		
83		18-Jul-10	19-Jul-10	21		
	Jul-10	Average		33		
84	Aug-10	10-Aug-10	11-Aug-10	26		
85		12-Aug-10	13-Aug-10	36		

86		15-Aug-10	16-Aug-10	9		
87		18-Aug-10	18-Aug-10	4		
88		20-Aug-10	21-Aug-10	4		
	Aug-10	Average		16		
89	Sep-10	10-Sep-10	11-Sep-10	5		
90		13-09-201	14-092010	12		
91		16-Sep-10	17-Sep-10	10		
92		18-Sep-10	17-Sep-10	9		
93		20-Sep-10	21-Sep-10	10		
	Sep-10	Average		9		
94	Oct-10	10-Oct-10	11-Oct-10	53		
95		12-Oct-10	13-Oct-10	38		
96		14-Oct-10	15-Oct-10	37		
97		16-Oct-10	17-Oct-10	41		
	Oct-10	Average		42		
98	Nov-10	10-Nov-10	11-Nov-10	51		
99		12-Nov-10	13-Nov-10	52		
100		14-Nov-10	15-Nov-10	44		
101		16-Nov-10	17-Nov-10	47		
	Nov-10	Average		49		
	There are no SPM data for Month of sept to Oct of 2010 due to Very low wieght difference of initial and final Cap wt					
102	Dec-10	10-Dec-10	11-Dec-10	115		
103		12-Dec-10	13-Dec-10	124		
104		14-Dec-10	15-Dec-10	190		
105		16-Dec-10	17-Dec-10	145		
106		18-Dec-10	19-Dec-10	187		
	Dec-10	Average		152		
	2010	Annual average		64		
107	Jan-11	10-Jan-11	11-Jan-11	196		
108		12-Jan-11	13-Jan-11	155		
109		14-Jan-11	15-Jan-11	175		
110		16-Jan-11	17-Jan-11	103		
111		18-Jan-11	19-Jan-11	99		
	Jan-11	Average		146		
112	Feb-11	10-Feb-11	11-Feb-11	69		
113		12/21/11	13-Feb-11	56		
114		14-Feb-11	15-Feb-11	78		
115		16-Feb-11	17-Feb-11	66		

116		19-Feb-11	20-Feb-11	78		
	Feb-11	Average		69		
117	Mar-11	10-Mar-11	11-Mar-11	46		
118		12-Mar-11	13-Mar-11	51		
119		14-Mar-11	15-Mar-11	38		
120		17-Mar-11	18-Mar-11	24		
121		19-Mar-11	20-Mar-11	28		
	Mar-11	Average		37		
122	Apr-11	10-Apr-11	11-Apr-11	26.5		
123		13-Apr-11	14-Apr-11	53.7		
124		15-Apr-11	16-Apr-11	22		
125		17-Apr-11	18-Apr-11	21		
126		19-Apr-11	20-Apr-11	22		
	Apr-11	Average		29		
127	May-11	10-May-11	11-May-11	29		
128		12-May-11	13-May-11	27		
129		14-May-11	15-May-11	26		
130		16-May-11	17-May-11	18		
131		18-May-11	19-May-11	16		
	May-11	Average		23		
132	Jun-11	10-Jun-11	11-Jun-11	20		
133		12-Jun-11	14-Jun-11	18		
134		14-Jun-11	15-Jun-11	29		
135		16-Jun-11	17-Jun-11	36		
	Jun-11	Average		26		
136	Jul-11	10-Jun-11	11-Jun-11	10		
137		12-Jun-11	14-Jun-11	10		
138		14-Jun-11	15-Jun-11	8		
139		16-Jun-11	17-Jun-11	11		
140		10-Jun-11	11-Jun-11	15		
	Jul-11	Average		11		
141	Aug-11	13-Aug-11	14-Aug-11	19		
142		15-Aug-11	16-Aug-11	20		
143		19-Aug-11	20-Aug-11	21		
	Aug-11	Average		20		
144	Sep-11	10-Sep-11	11-Sep-11	13		
145		12-Sep-11	13-Sep-11	15		
146		14-Sep-11	15-Sep-11	10		
147		16-Sep-11	17-Sep-11	16		

	Sep-11	Average		14		
148	Oct-11	10-Oct-11	11-Oct-11	60		
149		12-Oct-11	13-Oct-11	84		
150		15-Oct-11	16-Oct-11	31		
151		17-Oct-11	18-Oct-11	45		
152		19-Oct-11	20-Nov-11	90		
	Oct-11	Average		62		
153	Nov-11	10-Nov-11	11-Nov-11	57		
154		13-Nov-11	14-Nov-11	90		
155		16-Nov-11	17-Nov-11	127		
156		17-Nov-11	18-Nov-11	132		
157		19-Nov-11	20-Nov-11	157		
	Nov-11	Average		113		
158	Dec-11	12-Dec-11	13-Dec-11	128		
159		14-Dec-11	15-Dec-11	158		
160		16-Dec-11	17-Dec-11	131		
161		18-Dec-11	19-Dec-11	187		
162		12-Dec-11	13-Dec-11	117		
	Dec-11	Average		144		
	2011	Annual average		58		

RESULTS OF AIR CONCENTRATION – BHUTAN

S No	Month	Start Date	End date	PM10 ($\mu g/m^3$)	Remarks
1	Feb-09	1-Feb-09	2-Feb-09	48	
2		2-Feb-09	3-Feb-09	54	
3		3-Feb-09	4-Feb-09	50	
4		4-Feb-09	5-Feb-09	47	
5		5-Feb-09	6-Feb-09	28	
6		9-Feb-09	10-Feb-09	46	
7		10-Feb-09	11-Feb-09	45	
8		11-Feb-09	12-Feb-09	43	
9		19-Feb-09	20-Feb-09	46	
10		23-Feb-09	24-Feb-09	40	
11		24-Feb-09	25-Feb-09	28	
12		27-Feb-09	28-Feb-09	33	
13		28-Feb-09	29-Feb-09	56	
	Feb-09	Average		43	
14	Mar-09	2-Mar-09	3-Mar-09	42	

15		3-Mar-09	4-Mar-09	21	
16		4-Mar-09	5-Mar-09	54	
17		5-Mar-09	6-Mar-09	84	
18		6-Mar-09	7-Mar-09	80	found insect in the dust cup
19		9-Mar-09	3-Oct-09	18	
20		10-Mar-09	11-Mar-09	90	Forest fire
21		11-Mar-09	12-Mar-09	88	
22		12-Mar-09	13-Mar-09	152	
23		13-Feb-09	14-Mar-09	99	
24		14-Mar-09	15-Mar-09	125	
25		16-Mar-09	17-Mar-09	37	
26		17-Mar-09	18-Mar-09	81	
27		18-Mar-09	19-Mar-09	73	
28		19-Mar-09	20-Mar-09	52	
	Mar-09	Average		73	
29	Apr-09	21-Apr-09	22-Apr-09	36	
30		22-Apr-09	23-Apr-09	57	
31		23-Apr-09	24-Apr-09	90	
32		24-Mar-09	25-Apr-09	47	
33		25-Apr-09	26-Apr-09	41	
34		28-Apr-09	29-Apr-09	663	Power failure
35		29-Apr-09	30-Apr-09	35	
36		30-Apr-09	1-May-12	55	
	Apr-09	Average		52	
37	May-09	1-May-09	1-May-09	38	
38		20-May-09	21-May-09	59	
39		21-May-09	22-May-09	16	
40		27-May-09	28-May-09	19	
41		28-May-09	29-May-09	11	
	May-09	Average		29	
42	Jun-09	1-Jun-09	2-Jun-09	3	
43		2-Jun-09	3-Jun-09	8	
44		3-Jun-09	4-Jun-09	9	
45		8-Jun-09	9-Jun-09	9	
46		9-Jun-09	10-Jun-09	21	
47		10-Jun-09	11-Jun-09	26	
48		11-Jun-09	12-Jun-09	22	
49		15-Jun-09	16-Jun-09	18	
50		16-Jun-09	17-Jun-09	8	

51		17-Jun-09	18-Jun-09	8	
52		18-Jun-09	19-Jun-09	22	
53		22-Jun-09	23-Jun-09	128	
54		23-Jun-09	24-Jun-09	140	
55		24-Jun-09	25-Jun-09	15	
56		25-Jun-09	26-Jun-09	17	
57		26-Jun-09	27-Jun-09	4	
58		27-Jun-09	28-Jun-09	11	
59		28-Jun-09	29-Jun-09	8	
60		29-Jun-09	30-Jun-09	76	
61		30-Jun-09	1-Jul-09	16	
	Jun-09	Average		28	
62		1-Jul-09	2-Jul-09	8	
63		7-Jul-09	8-Jul-09	6	
64		8-Jul-09	9-Jul-09	5	Rainfall
65	Jul-09	9-Jul-09	7-Oct-09	46	
66		13-Jul-09	14-Jul-09	16	
67		14-Jul-09	15-Jul-09	4	
68		15-Jul-09	16-Jul-09	5	
	Jul-09	Average		13	
69		23-Nov-09	25-Nov-09	37	
70	Nov-09	25-Nov-09	26-Nov-09	21	
71		26-Nov-09	27-Nov-09	17	
	Nov-09	Average		25	
	2009	Annual	average	38	
72		12-Jan-10	13-Jan-10	54	
73	Jan-10	13-Jan-10	14-Jan-10	43	
74		14-Jan-10	15-Jan-10	44	wind &sunshine
	Jan-10	Average		47	
75		1-Feb-10	2-Feb-10	41	
76		2-Feb-10	3-Feb-10	28	
77		3-Feb-10	4-Feb-10	64	wind &sunshine
78		4-Feb-10	5-Feb-10	70	
79	Feb-10	8-Feb-10	9-Feb-10	61	
80		9-Feb-10	10-Feb-10	15	
81		10-Feb-10	11-Feb-10	31	
82		11-Feb-10	12-Feb-10	36	
83		25-Feb-10	26-Feb-10	59	

84		26-Feb-10	27-Feb-10	13	
	Feb-10	Average		42	
85	Mar-10	8-Mar-10	9-Mar-10	74	windy & sunshine
86		9-Mar-10	10-Mar-10	39	
87		10-Mar-10	11-Mar-10	26	windy&rainfall.
88		11-Mar-10	12-Mar-10	65	
89		12-Mar-10	13-Mar-10	55	
90		13-Mar-10	14-Mar-10	61	
91		14-Mar-10	15-Mar-10	48	
92		15-Mar-10	16-Mar-10	11	rainfall
93		16-Mar-10	17-Mar-10	35	
94		17-Mar-10	18-Mar-10	34	wind &sunshine
95		18-Mar-10	19-Mar-10	36	sunshine
96		19-Mar-10	20-Mar-10	29	
97		20-Mar-10	21-Mar-10	41	
98		21-Mar-10	22-Mar-10	11	little Rainfall.
99		22-Mar-10	23-Mar-10	22	
	Mar-10	Average		39	
100	Apr-10	6-Apr-10	7-Apr-10	38	Forest fire
101		7-Apr-10	8-Apr-10	79	
102		8-Apr-10	9-Apr-10	39	Forest fire
103		12-Apr-10	13-Apr-10	12	rainfall.
104		13-Apr-10	14-Apr-10	23	
105		14-Apr-10	15-Apr-10	16	
106		15-Apr-10	16-Apr-10	13	
107		20-Apr-10	21-Apr-10	21	
108		21-Apr-10	22-Apr-10	25	
109		22-Apr-10	23-Apr-10	32	
110		23-Apr-10	24-Apr-10	39	sunshine
111		26-Apr-10	27-Apr-10	19	
112		27-Apr-10	28-Apr-10	22	
113		28-Apr-10	29-Apr-10	7	
	Apr-10		Average	27	
114	May-10	4-May-10	5-May-10	17	
115		5-May-10	6-May-10	39	
116		6-May-10	7-May-10	41	
117		7-May-10	8-May-10	68	
118		18-May-10	19-May-10	47	
119		19-May-10	20-May-10	38	windy&cloudy

120		20-May-10	21-May-10	22	rainfall.
121		21-May-10	22-May-10	35	sunshine
122		22-May-10	23-May-10	9	rainfall
123		23-May-10	24-May-10	40	
124		24-May-10	25-May-10	53	sunshine
125		25-May-10	26-May-10	24	rainfall.
126		27-May-10	28-May-10	64	
127		28-May-10	29-May-10	14	little rainfall
128		29-May-10	30-May-10	44	sunshine
	May-10	Average		37	
130		9-Jun-10	10-Jun-10	21	
131		10-Jun-10	11-Jun-10	18	
132		16-Jun-10	17-Jun-10	12	rainfall
133	Jun-10	17-Jun-10	18-Jun-10	13	
134		22-Jun-10	23-Jun-10	11	
135		23-Jun-10	24-Jun-10	17	
136		24-Jun-10	25-Jun-10	15	
137		28-Jun-10	29-Jun-10	31	
138		29-Jun-10	30-Jun-10	15	
139		30-Jun-10	1-Jul-10	30	
	Jun-10	Average		18	
140	Jul-10	17-Jul-10	18-Jul-10	24	
141		18-Jul-10	19-Jul-10	28	
	Jul-10	Average		26	
	* only two days data because there was heavy rainfall through out the month				
142	Aug-10	2-Aug-10	3-Aug-10	29	
143		3-Aug-10	4-Aug-10	22	
144		4-Aug-10	5-Aug-10	21	
145		5-Aug-10	6-Aug-10	56	
146		9-Aug-10	10-Aug-10	18	
147		10-Aug-10	11-Aug-10	17	
148		11-Aug-10	12-Aug-10	53	
149		12-Aug-10	13-Aug-10	34	
150		16-Aug-10	17-Aug-10	30	
151		17-Aug-10	18-Aug-10	17	
152		22-Aug-10	23-Aug-10	11	rainfall
153		24-Aug-10	25-Aug-10	37	
154		25-Aug-10	26-Aug-10	43	
155		26-Aug-10	27-Aug-10	22	

	Aug-10	Average		29	
156	Sep-10	6-Sep-10	7-Sep-10	13	slight rainfall
157		8-Sep-10	9-Sep-10	43	
158		9-Sep-10	10-Sep-10	12	
159		14-Sep-10	15-Sep-10	11	
160		20-Sep-10	21-Sep-10	108	
161		21-Sep-10	22-Sep-10	13	rainfall
162		27-Sep-10	28-Sep-10	73	Road maintenance
163		28-Sep-10	29-Sep-10	88	
	Sep-10	Average		45	
164	Oct-10	11-Oct-10	12-Oct-10	38	
165		12-Oct-10	13-Oct-10	39	
166		13-Oct-10	14-Oct-10	28	
167		14-Oct-10	15-Oct-10	23	
	Oct-10	Average		32	
168		30-Nov-10	1-Dec-10	46	
169	Dec-10	1-Dec-10	2-Dec-10	26	
170		2-Dec-10	3-Dec-10	46	
171		6-Dec-10	7-Dec-10	44	
172		13-Dec-10	14-Dec-10	35	
173		14-Dec-10	15-Dec-10	46	
174		15-Dec-10	16-Dec-10	52	
175		23-Dec-10	24-Dec-10	49	
176		27-Dec-10	28-Dec-10	68	
1877		28-Dec-10	29-Dec-10	59	
178		29-Dec-10	30-Dec-10	55	
179		30-Dec-10	31-Dec-10	74	windy
180		31-Dec-10	1-Jan-11	60	
	Dec-10	Average		51	
	2010	Annual	average	36	
181					
182	Jan-11	1-Jan-11	2-Jan-11	47	
183		2-Jan-11	3-Jan-11	31	
184		3-Jan-11	4-Jan-11	53	
185		4-Jan-11	5-Jan-11	57	
186		5-Jan-11	6-Jan-11	58	
187		6-Jan-11	7-Jan-11	53	
188		7-Jan-11	18-Jan-11	56	
189		18-Jan-11	9-Jan-11	43	

190		9-Jan-11	10-Jan-11	48	
191		10-Jan-11	11-Jan-11	51	
192		11-Jan-11	12-Jan-11	63	
193		12-Jan-11	13-Jan-11	40	
194		13-Jan-11	14-Jan-11	39	
195		14-Jan-11	15-Jan-11	59	
196		15-Jan-11	16-Jan-11	49	
197		16-Jan-11	17-Jan-11	45	sunshine
198		17-Jan-11	18-Jan-11	57	Cloudy
199		18-Jan-11	19-Jan-11	63	Cloudy
200		19-Jan-11	20-Jan-11	64	snowfall
201		20-Jan-11	21-Jan-11	61	cloudy
202		21-Jan-11	22-Jan-11	34	cloudy
203		22-Jan-11	23-Jan-11	38	windy
204		23-Jan-11	24-Jan-11	43	sunshine
205		24-Jan-11	25-Jan-11	49	sunshine
206		25-Jan-11	26-Jan-11	56	sunshine
207		26-Jan-11	27-Jan-11	61	sunshine
208		27-Jan-11	28-Jan-11	57	sunshine
209		28-Jan-11	29-Jan-11	201	sunshine
210		29-Jan-11	30-Jan-11	72	sunshine
211		30-Jan-11	31-Jan-11	62	cloudy
	Jan-11	Average		57	
211	Feb-11	1-Feb-11	2-Feb-11	76	
212		2-Feb-11	3-Feb-11	58	
213		3-Feb-11	4-Feb-11	47	
214		4-Feb-11	5-Feb-11	51	
215		5-Feb-11	6-Feb-11	57	
216		6-Feb-11	7-Feb-11	59	
217		7-Feb-11	8-Feb-11	49	
218		8-Feb-11	9-Feb-11	74	
219		9-Feb-11	10-Feb-11	62	
220		10-Feb-11	11-Feb-11	64	
221		11-Feb-11	12-Feb-11	47	
222		12-Feb-11	13-Feb-11	57	
223		13-Feb-11	14-Feb-11	53	
224		14-Feb-11	15-Feb-11	76	
225		15-Feb-11	16-Feb-11	62	
226		16-Feb-11	17-Feb-11	21	

227		17-Feb-11	18-Feb-11	20	
228		18-Feb-11	19-Feb-11	51	
229		19-Feb-11	20-Feb-11	42	
230		20-Feb-11	21-Feb-11	39	
230		21-Feb-11	22-Feb-11	25	
231		23-Feb-11	24-Feb-11	42	
232		24-Feb-11	25-Feb-11	47	
233		25-Feb-11	26-Feb-11	43	
234		26-Feb-11	27-Feb-11	43	
235		27-Feb-11	1-Mar-11	44	
236	Feb-11	Average		50	
237	Mar-11	1-Mar-11	2-Mar-11	55	
238		2-Mar-11	3-Mar-11	60	
239		3-Mar-11	4-Mar-11	65	
240		4-Mar-11	5-Mar-11	58	
241		5-Mar-11	6-Mar-11	81	
242		6-Mar-11	7-Mar-11	425	HKP: ignored for averaging
243		7-Mar-11	8-Mar-11	49	
244		8-Mar-11	9-Mar-11	62	
245		9-Mar-11	10-Mar-11	23	
246		10-Mar-11	11-Mar-11	49	
247		11-Mar-11	12-Mar-11	55	
230		12-Mar-11	13-Mar-11	69	
231		13-Mar-11	14-Mar-11	62	
232		14-Mar-11	15-Mar-11	68	
233		15-Mar-11	16-Mar-11	43	
234		16-Mar-11	17-Mar-11	69	
235		17-Mar-11	18-Mar-11	94	
236		18-Mar-11	19-Mar-11	63	
237		19-Mar-11	20-Mar-11	58	
238		20-Mar-11	21-Mar-11	67	
239		21-Mar-11	22-Mar-11	62	
240		22-Mar-11	23-Mar-11	51	
241		23-Mar-11	24-Mar-11	60	
242		24-Mar-11	25-Mar-11	64	
243		25-Mar-11	26-Mar-11	48	
244		26-Mar-11	27-Mar-11	53	
245		27-Mar-11	28-Mar-11	18	
246		29-Mar-11	30-Mar-11	16	

247		30-Mar-11	31-Mar-11	26	
248		31-Mar-11	1-Apr-11	33	
	Mar-11	Average		54	
248	Apr-11	1-Apr-11	2-Apr-11	31	
249		2-Apr-11	3-Apr-11	33	
250		3-Apr-11	4-Apr-11	33	
251		4-Apr-11	5-Apr-11	27	
252		5-Apr-11	6-Apr-11	71	
253		6-Apr-11	7-Apr-11	59	
254		7-Apr-11	8-Apr-11	52	
255		8-Apr-11	9-Apr-11	51	
256		9-Apr-11	10-Apr-11	45	
257		10-Apr-11	11-Apr-11	37	
258		11-Apr-11	12-Apr-11	44	
259		12-Apr-11	13-Apr-11	34	
260		13-Apr-11	14-Apr-11	33	
261		14-Apr-11	15-Apr-11	57	
262		15-Apr-11	16-Apr-11	49	
263		16-Apr-11	17-Apr-11	35	
264		17-Apr-11	18-Apr-11	40	
265		18-Apr-11	19-Apr-11	29	
266		19-Apr-11	20-Apr-11	36	
267		20-Apr-11	21-Apr-11	32	
268		21-Apr-11	22-Apr-11	32	
	Apr-11	Average		41	
	May-11	3-May-11	4-May-11	34	
269		4-May-11	5-May-11	40	
270		5-May-11	6-May-11	23	
271		6-May-11	7-May-11	22	
272		7-May-11	8-May-11	20	
273		8-May-11	9-May-11	14	
274		9-May-11	10-May-11	27	
275		10-May-11	11-May-11	19	
276		11-May-11	12-May-11	16	
277		12-May-11	13-May-11	24	
278		13-May-11	14-May-11	21	
279		14-May-11	15-May-11	25	
280		15-May-11	16-May-11	26	
281		16-May-11	17-May-11	14	

282		17-May-11	18-May-11	15	rainfall
283		18-May-11	19-May-11	16	
284		19-May-11	20-May-11	15	
285		20-May-11	21-May-11	15	
286		21-May-11	22-May-11	13	
287		22-May-11	23-May-11	21	
288		23-May-11	24-May-11	17	
289		24-May-11	25-May-11	15	
290		25-May-11	26-May-11	18	
291		26-May-11	27-May-11	19	
292		27-May-11	28-May-11	14	
293		28-May-11	29-May-11	18	
294		29-May-11	30-May-11	19	
295		30-May-11	31-May-11	16	
296		31-May-11	1-Jun-11	11	
	May-11	Average		20	
297		1-Jun-11	2-Jun-11	17	Cloudy
298		2-Jun-11	3-Jun-11	18	cloudy
299		3-Jun-11	4-Jun-11	15	Cloudy
297		4-Jun-11	5-Jun-11	39	Cloudy
298		5-Jun-11	6-Jun-11	33	slight rainfall
299		6-Jun-11	7-Jun-11	18	Rainfall
300		7-Jun-11	8-Jun-11	24	Cloudy
301		8-Jun-11	9-Jun-11	20	Cloudy
302		9-Jun-11	10-Jun-11	26	Cloudy
303		10-Jun-11	11-Jun-11	40	Cloudy
304		11-Jun-11	12-Jun-11	18	Cloudy
305		12-Jun-11	13-Jun-11	22	Cloudy
306		13-Jun-11	14-Jun-11	17	Cloudy
307		14-Jun-11	15-Jun-11	16	Cloudy
308		15-Jun-11	16-Jun-11	52	rainfall
309		16-Jun-11	17-Jun-11	11	Rainfall
310		17-Jun-11	18-Jun-11	11	Rainfall
311		18-Jun-11	19-Jun-11	16	Rainfall
312		19-Jun-11	20-Jun-11	10	Rainfall
313		20-Jun-11	21-Jun-11	10	Sunny
314		21-Jun-11	22-Jun-11	10	Cloudy
	Jun-11	Average		21	
		* Sampling was stoped due to heavy rain during the moonsoon period			

315		17-Oct-11	18-Oct-11	30	
316		18-Oct-11	19-Oct-11	31	
317		19-Oct-11	20-Oct-11	68	
318		20-Oct-11	21-Oct-11	15	Heavy Rainfall
319		21-Oct-11	22-Oct-11	20	
320		22-Oct-11	23-Oct-11	27	
321		23-Oct-11	24-Oct-11	15	
322	Oct-11	24-Oct-11	25-Oct-11	30	
323		25-Oct-11	26-Oct-11	29	
324		26-Oct-11	27-Oct-11	24	
325		27-Oct-11	28-Oct-11	29	
326		28-Oct-11	29-Oct-11	16	
327		29-Oct-11	30-Oct-11	23	
328		30-Oct-11	31-Oct-11	23	
329		31-Oct-11	1-Nov-11	29	Late due to rain (time)
	Oct-11	Average		27	
326		1-Nov-11	2-Nov-11	22	
327		2-Nov-11	3-Nov-11	25	
328		3-Nov-11	4-Nov-11	24	
329		4-Nov-11	5-Nov-11	19	
330		5-Nov-11	6-Nov-11	18	
331		6-Nov-11	7-Nov-11	24	
332		7-Nov-11	8-Nov-11	26	
333		8-Nov-11	9-Nov-11	37	
334		9-Nov-11	10-Nov-11	37	
335		10-Nov-11	11-Nov-11	31	
336		11-Nov-11	12-Nov-11	31	
337	Nov-11	12-Nov-11	13-Nov-11	32	
338		13-Nov-11	14-Nov-11	23	
339		14-Nov-11	15-Nov-11	45	
340		15-Nov-11	16-Nov-11	38	
341		16-Nov-11	17-Nov-11	32	
342		17-Nov-11	18-Nov-11	37	
343		18-Nov-11	19-Nov-11	32	
344		19-Nov-11	20-Nov-11	39	
345		20-Nov-11	21-Nov-11	38	
346		21-Nov-11	22-Nov-11	37	
347		22-Nov-11	23-Nov-11	45	
348		23-Nov-11	24-Nov-11	39	

349		24-Nov-11	25-Nov-11	42	
350		25-Nov-11	26-Nov-11	40	
351		26-Nov-11	27-Nov-11	47	
352		27-Nov-11	28-Nov-11	40	
353		28-Nov-11	29-Nov-11	31	
354		29-Nov-11	30-Nov-11	39	
355		30-Nov-11	1-Dec-11	36	
	Nov-11	Average		34	
353		1-Dec-11	2-Dec-11	44	
354		2-Dec-11	3-Dec-11	44	
355		3-Dec-11	4-Dec-11	30	rainfall during night
356		4-Dec-11	5-Dec-11	45	
357		5-Dec-11	6-Dec-11	16	
358		6-Dec-11	7-Dec-11	38	
359		7-Dec-11	8-Dec-11	28	
360		8-Dec-11	9-Dec-11	30	
361		9-Dec-11	10-Dec-11	36	
362		10-Dec-11	11-Dec-11	33	
363		11-Dec-11	12-Dec-11	37	
364		12-Dec-11	13-Dec-11	41	
365		13-Dec-11	14-Dec-11	37	
366		14-Dec-11	15-Dec-11	41	
367		15-Dec-11	16-Dec-11	34	
368	Dec-11	16-Dec-11	17-Dec-11	33	
369		17-Dec-11	18-Dec-11	34	
370		18-Dec-11	19-Dec-11	33	
371		19-Dec-11	20-Dec-11	55	
		20-Dec-11	21-Dec-11	49	
		21-Dec-11	22-Dec-11	51	
		22-Dec-11	23-Dec-11	51	
		23-Dec-11	24-Dec-11	59	
		24-Dec-11	25-Dec-11	53	
		25-Dec-11	26-Dec-11	52	
		26-Dec-11	27-Dec-11	56	
		27-Dec-11	28-Dec-11	61	
		28-Dec-11	29-Dec-11	57	
		29-Dec-11	30-Dec-11	35	
		30-Dec-11	31-Dec-11	33	
		31-Dec-11	1-Jan-12	47	

	Dec-11	Average		42	

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – INDIA

S No	Month	Start Date	PM10 (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	Remarks
	Assam					
1	Jan-09	07-Jan-09	95	6	12	
2		08-Jan-09	99	5	13	
3		15-Jan-09	135	5	13	
4		16-Jan-09	92	BDL	8	
5		21-Jan-09	140	10	18	
6		22-Jan-09	139	9	16	
7		30-Jan-09	134	10	16	
8		31-Jan-09	157	10	16	
	Jan-09	Average	124	8	14	
9	Feb-09	05-Feb-09	146	8	20	
10		06-Feb-09	131	6	22	
11		12-Feb-09	151	21	22	
12		13-Feb-09	136	7	13	
13		17-Feb-09	126	10	17	
14		18-Feb-09	140	8	17	
15		24-Feb-09	130	6	14	
16		25-Feb-09	143	5	25	
	Feb-09	Average	138	9	19	
17	Mar-09	05-Mar-09	193	6	21	
18		06-Mar-09	250	8	21	
19		12-Mar-09	250	BDL	10	
20		13-Mar-09	231	4	17	
21		19-Mar-09	203	4	30	
22		20-Mar-09	120	4	25	
23		26-Mar-09	175	9	21	
24		27-Mar-09	75	9	20	
	Mar-09	Average	187	6	21	
25	Apr-09	02-Apr-09	52	8	17	
26		03-Apr-09	79	5	18	
27		10-Apr-09	54	10	20	
28		11-Apr-09	47	8	18	
29		18-Apr-09	64	4	10	
30		19-Apr-09	59	5	11	

31		25-Apr-09	95	5	15	
32		26-Apr-09	98	8	18	
	Apr-09	Average	68	7	16	
33	May-09	09-May-09	78	4	10	
34		10-May-09	72	BDL	9	
35		15-May-09	36	6	14	
36		16-May-09	48	7	16	
37		17-May-09	35	7	14	
38		21-May-09	55	5	11	
39		22-May-09	49	6	14	
40		23-May-09	62	5	12	
41		29-May-09	28	BDL	7	
42		30-May-09	26	BDL	11	
	May-09	Average	49	6	12	
43	Jun-09	06-Jun-09	46	BDL	10	
44		11-Jun-09	59	BDL	9	
45		18-Jun-09	76	6	14	
46		19-Jun-09	65	4	11	
47		25-Jun-09	29	4	10	
48		26-Jun-09	22	BDL	10	
	Jun-09	Average	49	4	11	
49	Jul-09	03-Jul-09	44	BDL	7	
50		04-Jul-09	30	BDL	10	
51		09-Jul-09	45	BDL	BDL	
52		10-Jul-09	31	BDL	7	
53		16-Jul-09	29	BDL	10	
54		17-Jul-09	38	4	11	
55		22-Jul-09	50	5	14	
56		23-Jul-09	36	4	12	
57		29-Jul-09	19	5	10	
	Jul-09	Average	37	4	10	
58	Aug-09	04-Aug-09	39	BDL	7	
59		05-Aug-09	25	BDL	9	
60		06-Aug-09	59	4	11	
61		12-Aug-09	14	5	13	
62		13-Aug-09	17	4	12	
63		19-Aug-09	29	BDL	15	
64		27-Aug-09	15	BDL	9	
65		28-Aug-09	27	BDL	11	

66		29-Aug-09	31	BDL	8	
	Aug-09	Average	29	4	10	
67	Sep-09	03-Sep-09	38	BDL	11	
68		04-Sep-09	41	5	11	
69		09-Sep-09	24	4	7	
70		10-Sep-09	21	BDL	11	
71		18-Sep-09	20	BDL	10	
72		19-Sep-09	19	BDL	11	
73		23-Sep-09	40	5	12	
74		24-Sep-09	50	4	8	
	Sep-09	Average	31	4	10	
75	Oct-09	01-Oct-09	50	4	9	
76		02-Oct-09	38	4	9	
77		14-Oct-09	63	5	12	
78		15-Oct-09	61	BDL	11	
79		16-Oct-09	70	BDL	11	
80		21-Oct-09	90	4	10	
81		22-Oct-09	67	5	10	
82		23-Oct-09	60	4	9	
83		29-Oct-09	62	4	11	
84		30-Oct-09	49	5	12	
	Oct-09	Average	61	4	10	
85	Nov-09	05/11/2009	71	BDL	11	
86		06/11/2009	98	BDL	10	
87		11/11/2009	114	4	11	
88		12/11/2009	124	4	13	
89		19/11/2009	84	5	14	
	Nov-09	Average	98	4	12	
90	Dec-09	09/12/2009	65	5	14	
91		11/12/2009	67	BDL	13	
92		17/12/2009	73	5	15	
	Dec-09	Average	68	5	14	
	2009	Annual	77	6	13	
93	Jan-10	09-Jan-10	126	5	17	
94		10-Jan-10	101	5	20	
95		14-Jan-10	92	5	12	
96		25-Jan-10	120	5	15	
97		26-Jan-10	70	6	15	

98		29-Jan-10	101	6	13	
99		30-Jan-10	116	6	17	
100		31-Jan-10	118	7	16	
	Jan-10	Average	106	5	15	
101	Feb-10	09-Feb-10	101	6	17	
102		11-Feb-10	89	8	17	
103		16-Feb-10	147	6	15	
104		18-Feb-10	130	6	16	
105		24-Feb-10	159	4	12	
106		25-Feb-10	110	6	16	
107		27-Feb-10	143	4	13	
	Feb-10	Average	126	6	15	
108	Mar-10	04-Mar-10	87	6	15	
109		06-Mar-10	87	7	14	
110		08-Mar-10	108	6	16	
111		13-Mar-10	126	5	17	
112		15-Mar-10	78	8	16	
113		17-Mar-10	96	5	15	
	Mar-10	Average	97	6	15	
114	Apr-10	16-Apr-10	61	6	14	
115		18-Apr-10	62	8	19	
116		22-Apr-10	56	6	15	
117		24-Apr-10	77	10	17	
118		28-Apr-10	60	6	13	
119		30-Apr-10	63	6	13	
	Apr-10	Average	63	7	15	
120	May-10	05-May-10	53	7	16	
121		07-May-10	46	7	16	
122		12-May-10	48	6	16	
123		14-May-10	29	4	12	
124		21-May-10	26	4	14	
125		23-May-10	44	4	12	
126		27-May-10	24	BDL	13	
127		31-May-10	25	5	17	
	May-10	Average	37	5	14	
128	Jun-10	04-Jun-10	40	5	15	
129		10-Jun-10	21	5	17	
130		12-Jun-10	29	5	19	
131		17-Jun-10	35	4	11	

132		19-Jun-10	21	8	21	
133		24-Jun-10	25	5	14	
134		26-Jun-10	21	4	8	
	Jun-10	Average	27	5	15	
135	Jul-10	01-Jul-10	18	4	11	
136		03-Jul-10	30	5	12	
137		08-Jul-10	39	6	14	
138		10-Jul-10	25	7	16	
139		15-Jul-10	28	8	14	
140		17-Jul-10	30	5	9	
141		22-Jul-10	15	6	16	
142		24-Jul-10	29	6	16	
143		29-Jul-10	24	4	11	
144		31-Jul-10	27	6	12	
	Jul-10	Average	26	6	13	
145	Aug-10	05-Aug-10	31	6	17	
146		07-Aug-10	35	6	14	
147		12-Aug-10	29	BDL	13	
148		14-Aug-10	33	4	15	
149		19-Aug-10	25	6	15	
150		21-Aug-10	27	6	14	
151		26-Aug-10	27	6	14	
152		28-Aug-10	23	5	15	
	Aug-10	Average	29	5	15	
153	Sep-10	02-Sep-10	23	5	14	
154		04-Sep-10	22	BDL	11	
155		09-Sep-10	21	BDL	11	
156		11-Sep-10	29	5	13	
157		16-Sep-10	22	6	14	
158		18-Sep-10	37	4	13	
159		23-Sep-10	27	4	14	
160		30-Sep-10	20	4	14	
	Sep-10	Average	25	5	13	
161	Oct-10	02-Oct-10	11	5	15	
162		07-Oct-10	29	BDL	15	
163		09-Oct-10	27	4	14	
164		11-Oct-10	58	5	17	
165		13-Oct-10	31	5	11	
166		21-Oct-10	35	5	10	

167		23-Oct-10	62	6	12	
168		28-Oct-10	56	5	12	
169		30-Oct-10	38	6	13	
	Oct-10	Average	39	5	13	
170	Nov-10	04-Nov-10	39	6	14	
171		13-Nov-10	67	6	12	
172		18-Nov-10	71	7	16	
173		20-Nov-10	36	6	13	
174		25-Nov-10	79	5	13	
175		27-Nov-10	105	5	14	
	Nov-10	Average	66	6	14	
176		02-Dec-10	89	5	15	
177	Dec-10	04-Dec-10	94	5	13	
178		09-Dec-10	83	6	14	
179		11-Dec-10	85	6	13	
180		16-Dec-10	89	6	13	
181		18-Dec-10	112	6	12	
182		23-Dec-10	117	5	10	
183		25-Dec-10	59	6	14	
		30-Dec-10				
	Dec-10	Average	96	6	13	
	2010	Annual	59	6	14	
184	Jan-11	03-Jan-11	79	7	14	
185		06-Jan-11	109	6	14	
186		11-Jan-11	176	7	19	
187		13-Jan-11	77	7	20	
188		20-Jan-11	87	7	18	
189		22-Jan-11	88	6	17	
190		27-Jan-11	77	7	15	
191		29-Jan-11	82	8	16	
	Jan-11	Average	97	7	17	
192	Feb-11	03-Feb-11	80	7	16	
193		05-Feb-11	97	7	16	
194		10-Feb-11	96	6	15	
195		12-Feb-11	49	5	14	
196		17-Feb-11	43	6	16	
197		19-Feb-11	77	7	17	
198		24-Feb-11	56	6	13	

199		26-Feb-11	66	6	16	
	Feb-11	Feb-11	70	6	15	
200	Mar-11	03-Mar-11	52	6	12	
201		10-Mar-11	40	8	16	
202		12-Mar-11	36	6	15	
203		17-Mar-11	19	7	14	
204		19-Mar-11	25	8	14	
205		24-Mar-11	21	6	13	
206		26-Mar-11	40	6	13	
207		31-Mar-11	45	7	14	
	Mar-11	Mar-11	35	7	14	
208	May-11	07-May-11	59	7	14	
209		09-May-11	28	5	11	
210		14-May-11	41	5	10	
211		16-May-11	40	4	10	
212		21-May-11	43	4	10	
	May-11	May-11	42	5	11	
213	Jun-11	01-Jun-11	46	5	10	
214		03-Jun-11	25	6	13	
215		07-Jun-11	22	7	13	
216		09-Jun-11	43	5	12	
217		15-Jun-11	53	6	13	
218		17-Jun-11	50	5	12	
219		22-Jun-11	32	5	13	
220		24-Jun-11	29	4	10	
221		30-Jun-11	32	4	11	
	Jun-11	Jun-11	37	5	12	
222	Jul-11	05-Jul-11	36	6	12	
223		07-Jul-11	31	BDL	12	
224		12-Jul-11	36	4	13	
225		15-Jul-11	36	5	13	
226		20-Jul-11	32	4	12	
227		22-Jul-11	27	5	13	
228		30-Jul-11	18	5	13	
	Jul-11	Jul-11	31	5	13	
229	Aug-11	04-Aug-11	25	4	11	
230		06-Aug-11	32	4	12	
231		11-Aug-11	61	4	12	
232		13-Aug-11	25	4	11	

233		18-Aug-11	30	4	13	
234		20-Aug-11	117	4	12	
235		25-Aug-11	115	5	13	
236		27-Aug-11	147	5	14	
	Aug-11	Aug-11	69	4	12	
237	Sep-11	01-Sep-11	33	5	13	
238		03-Sep-11	32	6	14	
239		08-Sep-11	31	5	16	
240		14-Sep-11	44	6	17	
241		17-Sep-11	35	6	15	
242		22-Sep-11	28	6	15	
243		28-Sep-11	59	5	14	
244		30-Sep-11	24	6	14	
	Sep-11	Sep-11	36	6	15	
245	Oct-11	07-Oct-11	58	5	14	
246		11-Oct-11	23	5	14	
247		14-Oct-11	44	6	15	
248		20-Oct-11	57	6	15	
249		22-Oct-11	73	5	14	
250		27/10/2011	73	6	15	
	Oct-11	Oct-11	55	6	14	
251	Nov-11	03-Nov-11	41	6	13	
252		05-Nov-11	85	6	15	
253		10-Nov-11	72	6	14	
254		12-Nov-11	72	6	15	
255		17-Nov-11	83	6	15	
256		19-Nov-11	102	5	15	
257		24-Nov-11	78	6	15	
	Nov-11	Nov-11	76	6	15	
	2011	Annual	57	6	14	
	Punjab					
1	Jan-11	5-Jan-11	80	6	12	
2		7-Jan-11	72	6	14	
3		10-Jan-11	67	6	13	
4		12-Jan-11	65	7	14	
5		17-Jan-11	66	8	13	
6		19-Jan-11	66	7	15	
7		21-Jan-11	70	5	15	
8		31-Jan-11	71	7	14	

	Jan-11	Average	70	6	14	
9	Feb-11	4-Feb-11	66	7	14	
10		7-Feb-11	70	7	15	
11		9-Feb-11	67	7	15	
12		11-Feb-11	82	7	15	
13		14-Feb-11	69	6	14	
14		16-Feb-11	62	7	16	
15		21-Feb-11	72	6	14	
16		23-Feb-11	73	6	16	
17		25-Feb-11	65	7	14	
18		28-Feb-11	85	8	13	
	Feb-11	Average	71	7	14	
19	Mar-11	4-Mar-11	87	6	16	
20		7-Mar-11	77	7	13	
21		9-Mar-11	61	6	15	
22		11-Mar-11	69	8	15	
23		14-Mar-11	78	7	16	
24		16-Mar-11	80	5	13	
25		18-Mar-11	71	7	15	
26		21-Mar-11	80	6	14	
27		28-Mar-11	79	7	15	
28		30-Mar-11	78	6	13	
	Mar-11	Average	76	6	14	
29	Apr-11	1-Apr-11	76	7	14	
30		4-Apr-11	82	7	16	
31		6-Apr-11	79	7	15	
32		8-Apr-11	70	7	15	
33		11-Apr-11	67	6	16	
34		13-Apr-11	81	7	15	
35		15-Apr-11	75	6	14	
36		18-Apr-11	76	7	15	
37		20-Apr-11	63	6	15	
38		25-Apr-11	86	7	15	
39		27-Apr-11	73	7	14	
40		29-Apr-11	85	6	15	
	Apr-11	Average	76	7	15	
	May-11	2-May-11	79	7	32	
41		4-May-11	75	7	15	
42		9-May-11	93	6	15	

43		25-May-11	76	6	15	
44		27-May-11	71	6	15	
	May-11	Average	79	7	18	
45	Jun-11	1-Jun-11	65	7	16	
46		3-Jun-11	74	7	14	
47		6-Jun-11	74	7	14	
48		8-Jun-11	75	7	14	
49		10-Jun-11	72	7	14	
50		13-Jun-11	70	8	14	
51		17-Jun-11	67	7	13	
52		20-Jun-11	77	7	15	
53		22-Jun-11	71	6	14	
54		24-Jun-11	84	7	14	
55		27-Jun-11	84	8	14	
56		29-Jun-11	72	7	15	
	Jun-11	Average	74	7	14	
57	Jul-11	1-Jul-11	67	6	14	
58		4-Jul-11	65	7	14	
59		6-Jul-11	63	7	15	
60		8-Jul-11	62	7	13	
61		11-Jul-11	67	6	14	
62		13-Jul-11	58	5	13	
63		15-Jul-11	61	6	12	
64		18-Jul-11	69	7	14	
65		20-Jul-11	66	7	14	
66		22-Jul-11	65	6	15	
67		25-Jul-11	59	6	13	
68		27-Jul-11	61	7	14	
		29-Jul-11	66	6	15	
	Jul-11	Average	64	6	14	
69	Aug-11	1-Aug-11	63	5	13	
70		3-Aug-11	66	6	13	
71		5-Aug-11	71	6	15	
72		8-Aug-11	72	7	15	
73		10-Aug-11	62	7	13	
74		12-Aug-11	57	5	12	
75		17-Aug-11	58	6	14	
76		19-Aug-11	66	7	14	
77		24-Aug-11	69	7	14	

78		26-Aug-11	68	6	15	
79		29-Aug-11	69	7	14	
	Aug-11	Average	66	6	14	
80	Sep-11	2-9-11-2011	60	5	14	
81		5-Sep-11	68	6	14	
82		7-Sep-11	64	7	14	
83		9-Sep-11	66	6	14	
84		12-Sep-11	71	5	15	
85		14-Sep-11	68	6	14	
86		16-Sep-11	64	7	15	
87		19-Sep-11	73	6	14	
88		21-Sep-11	79	7	14	
89		23-Sep-11	75	5	13	
90		26-Sep-11	60	6	14	
91		30-Sep-11	72	7	15	
	Sep-11	Average	68	6	14	
92	Oct-11	3-Oct-11	64	6	14	
93		5-Oct-11	83	6	14	
94		7-Oct-11	65	6	13	
95		12-Oct-11	79	6	14	
96		14-Oct-11	70	7	14	
97		17-Oct-11	62	7	15	
98		19-Oct-11	73	7	13	
	Oct-11	Average	71	7	14	
99	Nov-11	2-Nov-11	75	7	14	
100		4-Nov-11	71	6	14	
101		9-Nov-11	71	7	15	
102		11-Nov-11	85	6	14	
103		14-Nov-11	75	7	14	
104		16-Nov-11	56	6	14	
105		18-Nov-11	53	6	14	
106		23-Nov-11	49	6	15	
107		25-Nov-11	53	6	15	
108		30-Nov-11	44	7	13	
	Nov-11	Average	63	7	14	
109	Dec-11	2-Dec-11	52	7	13	
110		5-Dec-11	48	7	13	
111		7-Dec-11	55	6	14	
112		9-Dec-11	53	7	14	

113		12-Dec-11	50	7	14	
114		14-Dec-11	52	7	13	
115		16-Dec-11	48	7	12	
116		19-Dec-11	56	7	12	
117		21-Dec-11	58	7	12	
118		23-Dec-11	51	7	13	
119		26-Dec-11	53	7	13	
120		30-Dec-11				
	Dec-11	Average	52	7	13	
	2011	Annual	69	7	14	

RESULTS OF AIR CONCENTRATION – IRAN

S No	Month	Start Date	End date	PM10 (µg/m^3)	TSPM (µg/m^3)	Remarks
1	Jan-09	12-Jan-09	13-Jan-09	34	134	
2		13-Jan-09	14-Jan-09	23	28	
3		15-Jan-09	16-Jan-09	19	31	
4		16-Jan-09	17-Jan-09	21	31	
5		17-Jan-09	18-Jan-09	30	82	
6		18-Jan-09	19-Jan-09	40	98	
7		19-Jan-09	20-Jan-09	30	59	
8		20-Jan-09	21-Jan-09	12	27	
9		21-Jan-09	22-Jan-09	29	50	
10		22-Jan-09	23-Jan-09	19	46	
	Jan-09	Average		26	59	
11	Feb-09	12-Feb-09	13-Feb-09	152	461	
12		13-Feb-09	14-Feb-09	95	385	
13		14-Feb-09	15-Feb-09	109	340	
14		15-Feb-09	16-Feb-09	24	118	
15		17-Feb-09	18-Feb-09	178	576	
16		19-Feb-09	20-Feb-09	89	287	
17		20-Feb-09	21-Feb-09	126	508	
18		21-Feb-09	22-Feb-09	743	1861	
19		22-Feb-09	23-Feb-09	227	716	
20		23-Feb-09	24-Feb-09	56	336	
	Feb-09	Average		117	414	
21	Mar-09	5-Mar-09	6-Mar-09	24	98	
22		6-Mar-09	7-Mar-09	25	80	
23		7-Mar-09	8-Mar-09	27	87	
24		8-Mar-09	9-Mar-09	44	137	

25		9-Mar-09	10-Mar-09	75	394	
26		10-Mar-09	11-Mar-09	30	141	
27		11-Mar-09	12-Mar-09	34	123	
28		13-Mar-09	14-Mar-09	83	289	
29		14-Mar-09	15-Mar-09	219	624	
30		15-Mar-09	16-Mar-09	205	551	
	Mar-09	Average		77	252	
31		15-Apr-09	16-Apr-09	139	495	
32		16-Apr-09	17-Apr-09	529	1131	
33		18-Apr-09	19-Apr-09	159	405	
34		19-Apr-09	20-Apr-09	90	199	
35		20-Apr-09	21-Apr-09	23	71	
36		21-Apr-09	22-Apr-09	24	71	
37		22-Apr-09	23-Apr-09	31	100	
38		23-Apr-09	24-Apr-09	95	264	
39		25-Apr-09	26-Apr-09	42	142	
40		26-Apr-09	27-Apr-09	50	109	
	Apr-09	Average		72	206	
41	May-09	10-May-09	11-May-09	187	436	
42		11-May-09	12-May-09	47	95	
43		12-May-09	13-May-09	42	116	
44		13-May-09	14-May-09	54	119	
45		14-May-09	15-May-09	50	151	
46		15-May-09	16-May-09	163	276	
47		16-May-09	17-May-09	70	298	
48		17-May-09	18-May-09	51	162	
49		18-May-09	19-May-09	42	124	
50		19-May-09	20-May-09	30	87	
	May-09	Average		74	186	
51	Jun-09	13-Jun-09	14-Jun-09	221	559	
52		14-Jun-09	15-Jun-09	239	545	
53		16-Jun-09	17-Jun-09	477	1068	
54		17-Jun-09	18-Jun-09	618	1295	
55		18-Jun-09	19-Jun-09	764	1364	
56		20-Jun-09	21-Jun-09	306	677	
57		22-Jun-09	23-Jun-09	140	357	
58		24-Jun-09	25-Jun-09	41	133	
59		25-Jun-09	26-Jun-09	50	180	
60		26-Jun-09	27-Jun-09	56	187	

	Jun-09	Average		191	463	
61	Jul-09	4-Jul-09	5-Jul-09	3198	5189	
62		5-Jul-09	6-Jul-09	867	1895	
63		6-Jul-09	7-Jul-09	534	1410	
64		7-Jul-09	8-Jul-09	322	797	
65		8-Jul-09	9-Jul-09	284	528	
66		9-Jul-09	10-Jul-09	400	907	
67		10-Jul-09	11-Jul-09	236	462	
68		12-Jul-09	13-Jul-09	460	1016	
69		13-Jul-09	14-Jul-09	1535	3349	
70		14-Jul-09	15-Jul-09	1543	3532	
	Jul-09	Average		373	853	
71	Aug-09	1-Aug-09	2-Aug-09	372	1116	
72		2-Aug-09	3-Aug-09	375	1199	
73		3-Aug-09	4-Aug-09	343	980	
74		4-Aug-09	5-Aug-09	157	474	
75		5-Aug-09	6-Aug-09	238	698	
76		6-Aug-09	7-Aug-09	155	480	
77		7-Aug-09	8-Aug-09	147	408	
78		8-Aug-09	9-Aug-09	170	503	
79		18-Aug-09	19-Aug-09	223	367	
80		19-Aug-09	20-Aug-09	179	307	
				236	653	
81	Sep-09	14-Sep-09	15-Sep-09	338	940	
82		15-Sep-09	16-Sep-09	282	610	
83		16-Sep-09	17-Sep-09	198	516	
84		17-Sep-09	18-Sep-09	276	608	
85		19-Sep-09	20-Sep-09	159	551	
86		21-Sep-09	22-Sep-09	54	138	
87		22-Sep-09	23-Sep-09	23	117	
88		23-Sep-09	24-Sep-09	41	129	
89		24-Sep-09	25-Sep-09	56	155	
90		25-Sep-09	26-Sep-09	33	121	
	Sep-09	Average		146	388	
91	Oct-09	12-Oct-09	13-Oct-09	80	161	
92		13-Oct-09	14-Oct-09	61	145	
93		15-Oct-09	16-Oct-09	109	312	
94		16-Oct-09	17-Oct-09	52	149	
95		17-Oct-09	18-Oct-09	84	181	

96		18-Oct-09	19-Oct-09	50	144	
97		19-Oct-09	20-Oct-09	60	170	
98		20-Oct-09	21-Oct-09	29	97	
99		21-Oct-09	22-Oct-09	46	117	
100		22-Oct-09	23-Oct-09	78	265	
	Oct-09	Average		65	174	
101	Nov-09	14-Nov-09	15-Nov-09	80	135	
102		15-Nov-09	16-Nov-09	41	127	
103		16-Nov-09	17-Nov-09	44	143	
104		17-Nov-09	18-Nov-09	39	146	
105		22-Nov-09	23-Nov-09	11	43	
106		23-Nov-09	24-Nov-09	13	44	
107		24-Nov-09	25-Nov-09	15	31	
108		25-Nov-09	26-Nov-09	19	58	
109		26-Nov-09	27-Nov-09	27	50	
110		27-Nov-09	28-Nov-09	27	43	
	Nov-09	Average		32	82	
111	Dec-09	13-Dec-09	14-Dec-09	14	15	
112		14-Dec-09	15-Dec-09	11	18	
113		15-Dec-09	16-Dec-09	9	11	
114		16-Dec-09	17-Dec-09	17	20	
115		17-Dec-09	18-Dec-09	14	26	
116		18-Dec-09	19-Dec-09	12	26	
117		19-Dec-09	20-Dec-09	26	39	
118		20-Dec-09	21-Dec-09	20	38	
119		21-Dec-09	22-Dec-09	13	39	
120		22-Dec-09	23-Dec-09	11	16	
	Dec-09	Average		15	25	
	2009	Annual	average	118		
121	Feb-10	15-Feb-10	16-Feb-10	26	48	
122		16-Feb-10	17-Feb-10	26	62	
123		17-Feb-10	18-Feb-10	30	69	
124		18-Feb-10	19-Feb-10	31	114	
125		19-Feb-10	20-Feb-10	30	47	
126		20-Feb-10	21-Feb-10	32	59	
127		21-Feb-10	22-Feb-10	23	38	
128		22-Feb-10	23-Feb-10	138	470	
129		23-Feb-10	24-Feb-10	402	983	

130		24-Feb-10	25-Feb-10	203	617	
	Feb-10	Average		94	251	
131	Mar-10	8-Mar-10	9-Mar-10	80	218	
132		9-Mar-10	10-Mar-10	41	139	
133		10-Mar-10	11-Mar-10	65	198	
134		11-Mar-10	12-Mar-10	61	165	
135		12-Mar-10	13-Mar-10	50	125	
136		13-Mar-10	14-Mar-10	60	201	
137		14-Mar-10	15-Mar-10	65	174	
138		15-Mar-10	16-Mar-10	96	252	
139		16-Mar-10	17-Mar-10	72	345	
140		17-Mar-10	18-Mar-10	92	293	
	Mar-10	Average		68	211	
141	Apr-10	13-Apr-10	14-Apr-10	48	121	
142		14-Apr-10	15-Apr-10	62	147	
143		15-Apr-10	16-Apr-10	49	122	
144		16-Apr-10	17-Apr-10	56	141	
145		17-Apr-10	18-Apr-10	129	299	
146		18-Apr-10	19-Apr-10	193	408	
147		20-Apr-10	21-Apr-10	49	129	
148		21-Apr-10	22-Apr-10	19	105	
149		22-Apr-10	23-Apr-10	86	313	
150		24-Apr-10	25-Apr-10	31	69	
		Average		72	185	
151	May-10	10-May-10	11-May-10	59	195	
152		11-May-10	12-May-10	121	292	
153		13-May-10	14-May-10	74	195	
154		15-May-10	16-May-10	108	245	
155		16-May-10	17-May-10	162	557	
156		17-May-10	18-May-10	260	912	
157		18-May-10	19-May-10	199	702	
158		19-May-10	20-May-10	422	1053	
159		20-May-10	21-May-10	100	353	
160		22-May-10	23-May-10	80	233	
	May-10	Average		159	474	
161	Jun-10	14-Jun-10	15-Jun-10	80	192	
162		16-Jun-10	17-Jun-10	76	251	
163		17-Jun-10	18-Jun-10	63	215	
164		18-Jun-10	19-Jun-10	44	152	

165		19-Jun-10	20-Jun-10	145	356	
166		21-Jun-10	22-Jun-10	288	671	
167		22-Jun-10	23-Jun-10	286	630	
168		23-Jun-10	24-Jun-10	888	1964	
169		24-Jun-10	25-Jun-10	612	1357	
170		25-Jun-10	26-Jun-10	311	605	
	Jun-10	Average		162	384	
171	Jul-10	13-Jul-10	14-Jul-10	354	687	
172		14-Jul-10	15-Jul-10	263	541	
173		15-Jul-10	16-Jul-10	328	631	
174		18-Jul-10	19-Jul-10	359	620	
175		19-Jul-10	20-Jul-10	384	772	
176		20-Jul-10	21-Jul-10	389	979	
177		21-Jul-10	22-Jul-10	782	1265	
178		22-Jul-10	23-Jul-10	474	1156	
179		23-Jul-10	24-Jul-10	279	569	
180		24-Jul-10	25-Jul-10	86	298	
	Jul-10	Average		370	752	
181	Aug-10	14-Aug-10	15-Aug-10	136	424	
182		15-Aug-10	16-Aug-10	167	524	
183		16-Aug-10	17-Aug-10	68	181	
184		17-Aug-10	18-Aug-10	56	164	
185		18-Aug-10	19-Aug-10	46	132	
186		19-Aug-10	20-Aug-10	79	198	
187		21-Aug-10	22-Aug-10	41	104	
188		22-Aug-10	23-Aug-10	54	124	
189		23-Aug-10	24-Aug-10	50	128	
190		24-Aug-10	25-Aug-10	66	163	
	Aug-10	Average		76	214	
191	Sep-10	14-Sep-10	15-Sep-10	47	157	
192		15-Sep-10	16-Sep-10	188	457	
193		16-Sep-10	17-Sep-10	38	89	
194		17-Sep-10	18-Sep-10	29	73	
195		18-Sep-10	19-Sep-10	33	105	
196		19-Sep-10	20-Sep-10	33	108	
197		20-Sep-10	21-Sep-10	74	173	
198		21-Sep-10	22-Sep-10	97	183	
199		22-Sep-10	23-Sep-10	98	169	
200		23-Sep-10	24-Sep-10	91	157	

	Sep-10	Average		73	167	
201	Dec-10	11-Dec-10	12-Dec-10	59	298	
202		13-Dec-10	14-Dec-10	244	747	
203		14-Dec-10	15-Dec-10	139	302	
204		15-Dec-10	16-Dec-10	140	303	
205		16-Dec-10	17-Dec-10	72	158	
206		17-Dec-10	18-Dec-10	93	206	
207		18-Dec-10	19-Dec-10	168	295	
208		19-Dec-10	20-Dec-10	47	189	
209		20-Dec-10	21-Dec-10	44	112	
210		22-Dec-10	23-Dec-10	89	253	
	Dec-10	Average		109	286	
	2010	Annual	average	121		
211	Jan-11	9-Jan-11	10-Jan-11	55	177	
212		10-Jan-11	11-Jan-11	42	113	
213		11-Jan-11	12-Jan-11	42	133	
214		12-Jan-11	13-Jan-11	17	41	
215		13-Jan-11	14-Jan-11	47	92	
216		14-Jan-11	15-Jan-11	11	17	
217		15-Jan-11	16-Jan-11	16	23	
218		20-Jan-11	21-Jan-11	16	36	
219		23-Jan-11	24-Jan-11	17	34	
220		24-Jan-11	25-Jan-11	37	68	
	Jan-11	Average		30	73	
221	Feb-11	7-Feb-11	8-Feb-11	19	27	
222		10-Feb-11	11-Feb-11	37	49	
223		13-Feb-11	14-Feb-11	108	241	
224		15-Feb-11	16-Feb-11	29	57	
225		16-Feb-11	17-Feb-11	35	186	
226		17-Feb-11	18-Feb-11	39	158	
227		18-Feb-11	19-Feb-11	40	160	
228		19-Feb-11	20-Feb-11	22	47	
229		20-Feb-11	21-Feb-11	58	120	
230		21-Feb-11	22-Feb-11	136	432	
	Feb-11	Average		52	148	
231	Mar-11	5-Mar-11	6-Mar-11	358	794	Dusty
232		6-Mar-11	7-Mar-11	135	363	Dusty
233		7-Mar-11	8-Mar-11	95	345	Dusty
234		10-Mar-11	11-Mar-11	31	106	Sunny

235		11-Mar-11	12-Mar-11	81	192	Sunny
236		12-Mar-11	13-Mar-11	50	194	Cloudy
237		14-Mar-11	15-Mar-11	33	93	Sunny
238		15-Mar-11	16-Mar-11	19	55	Sunny
239		16-Mar-11	17-Mar-11	15	57	Sunny
240		19-Mar-11	20-Mar-11	20	83	Sunny
	Mar-11	Average		84	228	
241	Apr-11	13-Apr-11	14-Apr-11	1001	2049	Dusty
242		15-Apr-11	16-Apr-11	273	508	Dusty
243		16-Apr-11	17-Apr-11	351	664	Dusty
244		17-Apr-11	18-Apr-11	177	443	Dusty
245		19-Apr-11	20-Apr-11	166	327	Dusty
246		20-Apr-11	21-Apr-11	210	391	Dusty
247		21-Apr-11	22-Apr-11	581	1062	Dusty
248		22-Apr-11	23-Apr-11	49	131	Cloudy
249		23-Apr-11	24-Apr-11	90	243	Sunny
250		24-Apr-11	25-Apr-11	64	188	Cloudy
	Apr-11	Average		173	362	
251	May-11	10-May-11	11-May-11	111	246	Sunny
252		11-May-11	12-May-11	188	392	Dusty
253		12-May-11	13-May-11	176	400	Dusty
254		13-May-11	14-May-11	375	808	Dusty
255		14-May-11	15-May-11	1757	3545	Dusty and Cloudy
256		15-May-11	16-May-11	213	469	Dusty
257		16-May-11	17-May-11	34	277	Sunny
258		17-May-11	18-May-11	166	334	Dusty and Cloudy
259		18-May-11	19-May-11	166	397	Dusty
260		20-May-11	21-May-11	209	459	Dusty
	May-11	Average		182	420	
261	Jun-11	12-Jun-11	13-Jun-11	252	717	Dusty
262		13-Jun-11	14-Jun-11	175	394	Dusty
263		14-Jun-11	15-Jun-11	128	327	Dusty
264		15-Jun-11	16-Jun-11	68	201	Sunny
265		17-Jun-11	18-Jun-11	148	347	Dusty
266		18-Jun-11	19-Jun-11	139	335	Dusty
267		19-Jun-11	20-Jun-11	152	346	Dusty
268		21-Jun-11	22-Jun-11	186	507	Dusty

269		22-Jun-11	23-Jun-11	126	295	Sunny
270		24-Jun-11	25-Jun-11	87	230	Sunny
	Jun-11	Average		146	370	
271	Jul-11	10-Jul-11	11-Jul-11	528	1334	Dusty
272		11-Jul-11	12-Jul-11	153	425	Dusty
273		12-Jul-11	13-Jul-11	53	192	Sunny
274		13-Jul-11	14-Jul-11	59	211	Sunny
275		14-Jul-11	15-Jul-11	53	119	Sunny
276		16-Jul-11	17-Jul-11	295	662	Dusty
277		17-Jul-11	18-Jul-11	170	384	Dusty
278		18-Jul-11	19-Jul-11	201	410	Dusty
279		19-Jul-11	20-Jul-11	92	188	Sunny
280		20-Jul-11	21-Jul-11	85	273	Sunny
	Jul-11	Average		169	420	
	2011	Annual	average	119		

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – NEPAL

S No	Month	Start Date	End date	PM10 (µg/m^3)	TSPM (µg/m^3)	Remarks
1	Jun-09	10-Jun-09	6/11/2009	56	109	-
2		11-Jun-09	12-Jun-09	52	91	-
3		12-Jun-09	13-Jun-09	39	95	-
4		13-Jun-09	14-Jun-09	35	75	-
5		16-Jun-09	17-Jun-09	53	101	-
6		17-Jun-09	18-Jun-09	40	77	-
7		22-Jun-09	23-Jun-09	37	90	-
8		25-Jun-09	26-Jun-09	27	49	-
9		28-Jun-09	29-Jun-09	15	42	Raining
10		29-Jun-09	30-Jun-09	25	50	-
	Jun-09			38	78	
11	Jul-09	12-Jul-09	13-Jul-09	19	40	-
12		15-Jul-09	16-Jul-09	20	49	Raining & Cloudy
13		16-Jul-09	17-Jul-09	10	49	Cloudy
14		17-Jul-09	18-Jul-09	17	44	Raining
15		19-Jul-09	20-Jul-09	16	31	Raining
16		21-Jul-09	22-Jul-09	24	45	Raining
17		21-Jul-09	22-Jul-09	17	40	-

18		22-Jul-09	23-Jul-09	24	54	Raining & Cloudy
19		24-Jul-09	25-Jul-09	20	54	Raining
20		25-Jul-09	26-Jul-09	30	67	-
	Jul-09	Average		20	47	
21	Aug-09	11-Aug-09	12-Aug-09	33	49	-
22		12-Aug-09	13-Aug-09	26	49	Cloudy
23		13-Aug-10	14-Aug-10	20	41	-
24		14-Aug-09	15-Aug-09	14	35	raining
25		17-Aug-09	18-Aug-09	16	34	Cloudy & Raining
26		18-Aug-09	19-Aug-09	22	35	Raining
27		19-Aug-09	20-Aug-09	20	37	Raining
28		20-Aug-09	21-Aug-09	22	50	raining
29		23-Aug-09	24-Aug-09	27	46	Cloudy
30		24-Aug-09	25-Aug-09	23	48	-
	Aug-09	Average		22	42	
31	Nov-09	27-Nov-09	28-Nov-09	58	98	-
32		28-Nov-09	29-Nov-09	74	111	-
33		29-Nov-09	30-Nov-09	57	67	-
34		30-Nov-09	1-Dec-09	62	80	-
	Nov-09	Average		63	89	
35	Dec-09	2-Dec-09	3-Dec-09	65	85	-
36		3-Dec-09	4-Dec-09	68	92	-
37		4-Dec-09	5-Dec-09	60	75	-
38		5-Dec-09	6-Dec-09	76	108	-
39		6-Dec-09	7-Dec-09	75	82	-
40		7-Dec-09	8-Dec-09	68	90	-
41		8-Dec-09	9-Dec-09	66	89	-
42		9-Dec-09	10-Dec-09	82	108	-
43		10-Dec-09	11-Dec-09	77	97	-
44		11-Dec-09	12-Dec-09	77	112	-
45		12-Dec-09	13-Dec-09	83	116	-
46		13-Dec-09	14-Dec-09	119	173	-
47		14-Dec-09	15-Dec-09	76	100	-
48		15-Dec-09	16-Dec-09	65	101	-
49		16-Dec-09	17-Dec-09	62	99	-
50		17-Dec-09	18-Dec-09	65	90	-
	Dec-09			74	101	
	2009	Annual	average	43		

RESULTS OF AIR CONCENTRATION – PAKISTAN

S No	Month	Start Date	End date	PM10 (µg/m^3)	NRSPM (µg/m^3)	Remarks
1	Jan-09	05-Jan-09	06-Jan-09	205	333	
2		06-Jan-09	07-Jan-09	186	301	
3		07-Jan-09	08-Jan-09	172	303	Invalid; short time
4		15-Jan-09	16-Jan-09	140	138	Invalid; short time
5		20-Jan-09	21-Jan-09	153	291	Invalid; short time
6		21-Jan-09	22-Jan-09	118	302	
7		22-Jan-09	23-Jan-09	254	330	
8		25-Jan-09	26-Jan-09	134	259	
9		26-Jan-09	27-Jan-09	133	354	
10		27-Jan-09	28-Jan-09	135	281	
	Jan-09	Average		157		
11	Feb-09	05-Feb-09	06-Feb-09	45	131	Invalid; short time
12		06-Feb-09	07-Feb-09	149	310	
13		07-Feb-09	08-Feb-09	127	312	
14		15-Feb-09	16-Feb-09	103	307	Invalid; short time
	Feb-09	Average		106		
15	Dec-09	04-Dec-09	05-Dec-09	326	391	
16		05-Dec-09	06-Dec-09	321	280	
17		06-Dec-09	07-Dec-09	386	447	
18		14-Dec-09	15-Dec-09	272	375	
19		15-Dec-09	16-Feb-09	275	231	
20		16-Dec-09	17-Dec-09		394	
	Dec-09				313	

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – SRI LANKA

S No	Month	Start Date	End date	PM10 (µg/m^3)	Remarks
1	Jan-10	10-Jan-10	11-Jan-10	25	Hour Meter not working
2		16-Jan-10	17-Jan-10	44	
3		23-Jan-10	24-Jan-10	22	
4		30-Jan-10	31-Jan-10	36	
	Jan-10	Average		32	
6	Feb-10	6-Feb-10	7-Feb-10	48	
7		13-Feb-10	14-Feb-10	31	

8		20-Feb-10	21-Feb-10	27	
9		27-Feb-10	28-Feb-10	34	
	Feb-10	Average		35	
10	Mar-10	6-Mar-10	7-Mar-10	50	Hour meter not working
11		13-Mar-10	14-Mar-10	36	
12		20-Mar-10	21-Mar-10	54	
13		27-Mar-10	28-Mar-10	24	
	Mar-10	Average		41	
14	Apr-10	3-Apr-10	4-Apr-10	45	
15		10-Apr-10	11-Apr-10	47	
16		17-Apr-10	18-Apr-10	32	
17		24-Apr-10	25-Apr-10	42	
	Apr-10	Average		42	
18	May-10	1-May-10	2-May-10	15	
19		8-May-10	9-May-10	12	
20		15-May-10	16-May-10	25	
21		22-May-10	23-May-10	24	
22		29-May-10	30-May-10	25	
	May-10	Average		20	
23	Jun-10	5-Jun-10	6-Jun-10	22	
24		12-Jun-10	13-Jun-10	26	
25		19-Jun-10	20-Jun-10	40	
26		26-Jun-10	27-Jun-10	13	
	Jun-10	Average		25	
27	Jul-10	3-Jul-10	4-Jul-10	25	
28		10-Jul-10	11-Jul-10	35	
29		17-Jul-10	18-Jul-10	29	
30		25-Jul-10	26-Jul-10	52	
31		31-Jul-10	1-Aug-10	32	
	Jul-10	Average		35	
32	Aug-10	8-Aug-10	9-Aug-10	15	
33		14-Aug-10	15-Aug-10	14	
34		21-Aug-10			
35		28-Aug-10			
	Aug-10	Average		14	
36	Sep-10	5-Sep-10	6-Sep-10	20	
37		11-Sep-10	12-Sep-10	32	
38		19-Sep-10	20-Sep-10	26	
39		25-Sep-10	26-Sep-10	25	

	Sep-10	Average		26	
40	Oct-10	2-Oct-10	3-Oct-10	29	
41		9-Oct-10	10-Oct-10	32	
42		17-Oct-10	18-Oct-10	34	
43		24-Oct-10	25-Oct-10	30	
	Oct-10	Average		31	
44	Nov-10	1-Nov-10	2-Nov-10	25	
45		5-Nov-10	6-Nov-10	19	
46		13-Nov-10	14-Nov-10	18	
47		20-Nov-10			
48		28-Nov-10	29-Nov-10	20	
	Nov-10	Average		20	
49	Dec-10	6-Dec-10	7-Dec-10	23	
50		12-Dec-10			
51		20-Dec-10	21-Dec-10	21	
52		25-Dec-10	26-Dec-10	29	
	Dec-10	Average		24	
	2010	Annual	average		
53	Jan-11	1-Jan-11	2-Jan-11	22	
54		9-Jan-11	10-Jan-11	30	
55		22-Jan-11	23-Jan-11	34	
56		29-Jan-11	30-Jan-11	16	
	Jan-11	Average		25	
57	Feb-11	6-Feb-11	7-Feb-11	20	
58		13-Feb-11	14-Feb-11	41	
59		19-Feb-11	20-Feb-11	19	
60		27-Feb-11	28-Feb-11	36	
	Feb-11	Average		29	
61	Mar-11	6-Mar-11	7-Mar-11	26	
62		12-Mar-11	13-Mar-11	16	
63		20-Mar-11	21-Mar-11	28	
64		26-Mar-11	27-Mar-11	58	
	Mar-11	Average		32	
65		2-Apr-11	3-Apr-11	49	
66		10-Apr-11			Not operated due to instrument failure
67		17-Apr-11			
68		24-Apr-11			

69	May-11	1-May-11			Not operated due to instrument falure
70		8-May-11			
71		15-May-11		16	
72		21-May-11		17	
73		29-May-11		15	
	May-11	Average		16	
74	Jun-11	4-Jun-11		15	23.68
75		12-Jun-11			Not operated due to calibration failure
76		19-Jun-11			
77		26-Jun-11			
78	Jul-11	3-Jul-11	4-Jul-11	79	Rejected due to calibration error
79		10-Jul-11			Not operated due to dust emitting special activities in the visinity of the sampler
80		17-Jul-11	18-Jul-11	32	
81		24-Jul-11	25-Jul-11	34	
82		31-Jul-11	1-Aug-11	19	
	Jul-11	Average		28	
83	Aug-11	6-Aug-11	7-Aug-11	21	
84		14-Aug-11	15-Aug-11	28	
85		20-Aug-11	21-Aug-11	24	
86		28-Aug-11	29-Aug-11	36	
	Aug-11	Average		27	
87	Sep-11	4-Sep-11	5-Sep-11	42	
88		10-Sep-11	11-Sep-11	24	
89		18-Sep-11	19-Sep-11	43	
90		25-Sep-11	26-Sep-11	26	
	Sep-11	Average		34	
91	Oct-11	2-Oct-11	3-Oct-11	22	
92		9-Oct-11	10-Oct-11	19	
93		16-Oct-11	17-Oct-11	28	
94		23-Oct-11	24-Oct-11	20	
95		30-Oct-11	31-Oct-11	23	
	Oct-11	Average		22	
96	Nov-11	6-Nov-11	7-Nov-11	15	
97		13-Nov-11	14-Nov-11	59	
98		20-Nov-11	21-Nov-11	43	
99		27-Nov-11	28-Nov-11	21	

	Nov-11	Average		35	
100	Dec-11	4-Dec-11	5-Dec-11	25	
101		11-Dec-11	12-Dec-11	33	
102		17-Dec-11	18-Dec-11	32	
103		24-Dec-11	25-Dec-11	52	
	Dec-11	Average		36	
	2011	Annual	average	29	

ANNEXURE II: DATA FROM PASSIVE (DIFFUSIVE) SAMPLING

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - BANGLADESH

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samples							
1	2009	01-Jan	31-Jan	18.3	5.8	6.7	78	
2		31-Jan	28-Feb	19.7	6.4	6.1	79	
3		01-Mar	31-Mar	21.8	5.3	3.9	90	
4		01-Apr	30-Apr	23.6	2.4	1.4	67	
5		01-May	31-May	24.2	1.0	2.0	73	
6		01-Jun	30-Jun	24.8	1.9	1.0	87	
7		01-Jul	31-Jul	24.2	2.6	1.4	49	
8		01-Aug	31-Aug	24.5	2.2	1.5	58	
9		01-Sep	30-Sep	26.3	1.1	0.9	48	
10		01-Oct	31-Oct	25.0	2.1	3.2	73	
11		01-Nov	30-Nov	21.7	4.2	6.3	71	
12		01-Dec	31-Dec	17.1	8.4	7.0	86	
	2009	Annual average			3.6	3.5	71.5	
13	2010	01-Jan	31-Jan	12.9	7.2	7.6	84	
14		01-Feb	28-Feb	19.1	7.9	6.6	91	
15		01-Mar	31-Mar	25.7	4.8	2.7	80	
16		01-Apr	30-Apr	28.5	1.1	1.0	47	
17		1-May	31-May	28.2	1.7	1.4	62	
18		1-Jun	30-Jun	29.9	1.2	1.2	67	
19		1-Jul	31-Jul	29.7	1.2	0.7	53	
20		1-Aug	31-Aug	29.8	0.6	0.7	33	
21		1-Sep	30-Sep	28.8	0.9	1.1	45	
22		1-Oct	31-Oct	26.4	2.9	2.9	60	
23		1-Nov	1-Dec	21.8	3.5	4.8	75	
24		1-Dec	1-Jan-11	15.8	6.8	7.4	86	
	2010	Annual average			3.3	3.2	65.2	
25	2011	1-Jan	1-Feb	13.5	8.4	6.7	91	Same site as Stn 7?
26		1-Feb	1-Mar	19.4	10.4	5.9	103	
27		1-Mar	1-Apr	22.9	7.4	3.2	84	
28		1-Apr	1-May	25.4	3.2	2.2	75	
29		1-May	1-Jun	27.5	1.1	1.5	80	

30		1-Jun	1-Jul	29.4	1.3	1.5	60	
31		1-Jul	1-Aug	28.9	1.1	1.0	48	
32		1-Aug	1-Sep	28.7	1.0	0.9	45	
33		1-Sep	1-Oct	27.0	1.5	1.6	59	
34		1-Oct	1-Nov	27.7	3.1	3.6	69	
35		1-Nov	1-Dec	21.3	3.7	5.2	74	
36		1-Dec	1-Jan-12	18.0	7.0	6.6	77	
	2011	Annual average			4.1	3.3	72.1	
	Field Blanks							
1	2009	01-Jan	28-Feb	19.0	<0.1	<0.1	1	
2		01-Mar	30-Apr	20.0	0.2	<0.1	<1	Exposure date changed to 090301 - 090430 according to e-mail from Hashmi 091112
3		01-May	30-Jun	24.8	<0.1	0.1	<1	Exposure time changed to 090501 06:00 - 090630 06:00 according to e-mail from Hashmi 091112
4		01-Jul	31-Aug		<0.1	<0.1	<1	
5		01-Sep	31-Oct		<0.2	0.1	<1	
6		01-Nov	31-Dec	17.1	<0.2	0.3	<1	
7	2010	01-Jan	28-Feb	19.1	<0.2	<0.2	1	
8		01-Mar	30-Apr		<0.2	<0.2	<1	
9		01-May	30-Jun		<0.2	<0.2	<1	
10		01-Jul	31-Aug		<0.2	<0.2	<1	
11		01-Sep	30-Sep	28.8	<0.2	<0.2	<1	
12		01-Oct	01-Dec	21.8	<0.2	<0.2	<1	
13		01-Dec	01-Jan-11	15.8	<0.2	<0.2	<1	
14	2011	01-Jan	01-Mar		<0.2	<0.2	<1	
15		01-Mar	01-May	25.4	<0.2	<0.2	<1	
16		01-May	01-Jul		<0.2	<0.2	<1	
17		01-Jul	01-Sep		<0.2	<0.2	<1	
18		01-Sep	01-Nov		<0.2	<0.2	<1	
19		01-Nov	01-Jan-12	18.0	<0.2	<0.2	<1	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - BHUTAN

S No	Station	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samples							
	Bhur	1-Feb-09	1-Mar-09	24.0		0.2	72	Old samplers from 2008-06.
	Bhur	1-Feb-09	1-Mar-09	24.0		2.2		NO_2 arrived to lab with SO_2 label. Double exposure of NO_2 in Feb, no SO_2
	Bhur	1-Mar-09	1-Apr-09	23.0	2.2		104	
	Bhur	1-Mar-09	1-Apr-09	23.0	2.8			SO_2 arrived to lab with NO_2 label. Double exposure of SO_2 in March, no NO_2
	Bhur	1-Apr-09	1-May-09	26.0	0.5	2.9	86	Old samplers from 2008-06.
	Bhur	10-Oct-09	10-Dec-09	24.5	0.3	1.7	49	Earlier stop date 091122 14:45. Old samplers from 2008-02.
	Field blanks							
		5-Jan-09	4-Mar-09	26.0			162	Gelephu Station. Unreasonable high ozone value, longer exposure time?
		5-Jan-09	4-Mar-09	26.0			214	Gelephu Station. Unreasonable high ozone value, longer exposure time?
	Background site Stn 2	5-Jan-09	3-Mar-09	27.0			172	SerpangDzong Station. Unreasonable high ozone value, longer exposure time?
	SerpangDzong Station Stn 2	5-Jan-09	3-Mar-09	27.0			183	SerpangDzong Station. Unreasonable high ozone value, longer exposure time?
	Bhur	1-May-09	1-Sep-09	29.5	0.5	1.4	53	Time for change assumed to be 12:00. Samplers old, was sent out 0804. Have there been several samplers exposed in parallel for different time periods.
	Bhur	23-May-09	21-Aug-09		<0.2	2.7	36	How many stations in background air do you run?? 4 in parallel for 3 months (May-August)?
	Gelephu	23-May-09	21-Aug-09		0.9	5.0	40	
	Sarpang Dzong	23-May-09	21-Aug-09		0.4	3.5	34	

	Slelgana, Punakha	21-May-09	19-Aug-09		<0.2	2.7	51	
	Bhur	21-Aug-09	22-Nov-09	26.0	0.2	1.2	39	How many stations in background air do you run?? 3 in parallel for 3 months (Aug-Nov)?
	Gelephu	21-Aug-09	22-Nov-09	26.0	0.8	5.7	29	
	SarpangDzong	21-Aug-09	21-Nov-09	25.0	0.2	1.4	37	
								How many stations do you run? See comments above.
	Bhur	22-Nov-09	1-Jan-10	17.5	1.0	3.0	110	Time for change assumed to be 12:00.
	Bhur	1-Feb-10	1-May-10	26.0	0.9	2.9	69	Time for change assumed to be 12:00. Samplers exposed for 3 months.
	Slelgana, Punakha	19-Aug-09	3-Dec-09		<0.2	0.7	33	Start date missing, assumed to be the same as stop date for the earlier exposed samplers. Temp missing.
	- Slelgana, Punakha	3-Dec-09	3-Jun-10		0.2	0.9	59	Temp missing. O_3 might be uncertain. Samplers exposed for 6 months!
	Urban site Field blank	18-Mar-04	14-Apr-04	10	1.7	15.2		Probably not field blanks?
	Thimphu Stn 2	14-Apr-04	18-May-04	10	1.3	15.3		
	Stn 2	10-Jan-09	10-Feb-09	20.0	0.9	0.9	62	Thimphu NEC. Urban background site??
	NEC Office roof top	4-Apr-09	25-May-09	22.0	0.5	4.8	135	Thimphu. Samplers from 2008-05, sent to SEI-York within another project UPR:1104 2009-07-31. Result for O_3 uncertain.
	NEC Office roof top	22-Sep-09	24-Nov-09	21.0	0.3	6.7	99	Samplers from 2008-08. Result for O_3 uncertain.
	NEC Office roof top	24-Nov-09	2-Feb-10		0.3	6.2	57	Temperature missing.
	NEC Office roof top	2-Feb-10	9-Jun-10		<0.2	1.9	54	Temperature missing. Samplers exposed > 4 months!
	Traffic (Thimphu)	20-May-09	18-Aug-09		1.8	12.9		O_3 missing, but no remark on the protocol
	Traffic (Thimphu)	18-Aug-09	18-Nov-09	21.0	1.2	10.2	32	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - IRAN

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samples							
1	2009	15-Jan	15-Feb	15.0	8.4	3.6	77	
2		15-Feb	15-Mar	18.0	11.6	2.4	72	
3		15-Mar	15-Apr	20.0	8.5	1.9	110	
4		15-Apr	15-May	28.0	8.9	1.4	75	
5		15-May	15-Jun	36.0	11.9	0.6	78	
6		15-Jun	15-Jul	38.9	15.5	0.7	57	Samplers sandy
7		15-Jul	15-Aug	38.6	17.6	0.7	87	Samplers sandy
8		15-Aug	15-Sep	37.6	18.5	0.9	78	
9		15-Sep	15-Oct	30.6	10.0	1.9	59	
10		15-Oct	15-Nov	25.7	9.1	4.9	61	
11		15-Nov	15-Dec	15.2	8.6	4.0	57	
	2009	Annual average			11.7	2.1	74	
12	2010	15-Dec-09	15-Jan	15.7	9.8	4.7	58	O_3 sampler sandy. Chamsari = Stn 6?
	Field blanks							
	2009	15-Jan	15-Jun	20.0	<0.1	0.1	2	
		15-Nov	15-Dec	15.2	0.4	1.3		Old samplers from 2007-06. SO_2 and NO_2 samplers exposed? O_3 sampler damaged

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - MALDIVES

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samplers							
1	2009	31-Jan	28-Feb	30.0	0.5	1.0	65	
2		28-Feb	31-Mar	32.0	<0.2	1.3	40	
3		31-Mar	30-Apr	31.0	<0.2	0.9	48	
4		30-Apr	31-May	31.0	<0.2	0.8	39	
5		31-May	30-Jun	29.0	<0.2	0.2	34	
6		30-Jun	31-Jul	29.0	<0.2	0.2	<1	O_3: Unexposed?
7		31-Aug	30-Sep	29.0	<0.2	1.3	102	Samplers for August not sent to the laboratory.

								Samplers for September high values (especially O_3), exposed for 2 months (Aug-Sep)?
8		30-Sep	31-Oct	30.0	0.3	0.9	22	
9		31-Oct	30-Nov	30.0	0.3	1.0	47	Earlier stop date 2009-09-30 10:00.
	2009	Annual average			0.4	0.8	48	
	Field blanks							
11		30-Nov-08	31-Jan-09	30.0	<0.1	<0.1	1	
12	2009	31-Jan	31-Mar	31.0	<0.1	<0.1	<1	
13		31-Mar	31-May	31.0	<0.1	0.1	<1	
14		31-May	30-Sep	29.0	<0.2	<0.1	2	
15		30-Sep	30-Nov	30.0	<0.2	<0.1	<1	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - NEPAL

S No	Year	Start time	Stop time	Temp C	SO_2 $\mu g/m^3$	NO_2 $\mu g/m^3$	O_3 $\mu g/m^3$	Remarks
	Exposed samplers							
1	2009	01-Jan	1-Feb	20.0	0.5	8.6	27	Temp missing.
2		01-Feb	2-Mar	20.0	2.7	9.7	52	Temp missing.
3		29-Mar	1-May		3.4	9.0	86	Temp missing.
4		01-May	2-Jun		1.7	8.6	83	Temp missing.
5		02-Jun	1-Jul		0.7	5.8	70	Temp missing.
6		01-Jul	30-Aug		0.3	3.6	33	Temp. missing. Stop time missing.
7		12-Sep	9-Oct		0.4	5.4	35	Temp missing
8		09-Oct	9-Nov		0.2	5.8	24	Temp missing
9		09-Nov	2-Dec		0.4	7.8	21	Temp missing
10		02-Dec	7-Jan-10		0.4	9.5	26	Temp missing
	2009	Annual average			1.1	7.4	76	
11	2010	17-Jan	5-Feb		0.9	6.7	28	Temp missing
12		05-Feb	3-Mar		1.6	9.7	40	Temp missing
	Field blanks							
1	2009	01-Jan	2-Mar		<0.1	<0.05	<1	Temp missing.
2		29-Mar	2-Jun		<0.1	<0.05	1	
3		02-Jun	30-Aug		<0.1	<0.05	<1	
4		12-Sep	9-Nov		<0.2	<0.2	<1	

5		09-Nov	7-Jan-10		<0.2	<0.2	<1	
6	2010	17-Jan	3-Mar		<0.2	<0.2	<1	

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - SRI LANKA

S No		Start time	Stop time	Temp C	SO_2	NO_2	O_3	Remarks
	Exposed samplers							
	Dutuwewa							
1		04-Jan	01-Feb	33.0	<0.2	0.8	27	
2		01-Feb	01-Mar	34.0	<0.2	1.0	23	
3		01-Mar	04-Apr	30.0			15	NO_2 and SO_2 missing, samplers stolen by monkies!
4		04-Apr	02-May	30.0	0.6	2.3	36	
5		02-May	06-Jun	30.0	0.7	1.8	40	
6		06-Jun	05-Jul	32.0	0.5	1.6	38	
7		05-Jul	08-Aug	33.0	<0.2	1.9	36	
8	2009	09-Aug	06-Sep	32.0	0.5	2.2	31	
9								
10		08-Nov	07-Dec	32.0	0.2	1.4		Earlier stop date 2009-09-06 12:10. Monsoon rain.
11		08-Nov	07-Dec	32.0	0.3			SO_2 double sampler. 2 SO_2 was sent instead of 1 SO_2 and 1 O_3.
12		07-Dec	03-Jan-10	32.0		0.7	31	2 O_3 was sent instead of 1 SO_2 and 1 O_3. Only 1 O_3 exposed.
13		31-Jan	28-Feb	30.0	<0.2	0.9	23	
14		28-Feb	04-Apr	30.0	0.2	2.1	28	
15		04-Apr	01-May	30.0	0.3	2.2	25	
16		30-May	03-Jul	35.0	0.5	1.9	35	
17	2010	03-Jul	29-Aug	32.0	0.2	1.2	16	
18		29-Aug	02-Oct					Samplers stolen, due to protocol
19		02-Oct	30-Oct	30.0	0.6	2.5	34	
20		30-Oct	06-Dec	25.0	<0.2	1.4	23	
21		06-Dec	02-Jan-11	28.0	<0.2	0.8	<1	O_3-sampler unexposed?
22		02-Jan	29-Jan	26.0	<0.2	0.8	73	
23	2011	29-Jan	27-Feb					Rain and storm, samplers found on the ground.
24		06-Mar	02-Apr	32.0	0.5	2.9	40	
25		02-Apr	30-Apr	32.0	0.5	2.7	51	

26		30-Apr	04-Jun	32.0	0.7	2.5	41	Exposed in April due to protocol, May assumed since there were samples for April already.
27		04-Jun	02-Jul	31.0	0.8	2.4	38	
28		02-Jul	31-Jul	32.0	0.7	2.2	40	
29		31-Jul	04-Sep	31.0	0.6	3.6	39	
30		04-Sep	02-Oct	30.0	1.2	3.9	36	
31		02-Oct	30-Oct	30.0	0.8	3.5	32	
32		30-Oct	03-Dec	31.0	0.4	2.1	35	
33		03-Dec	01-Jan-12	31.0	0.5	2.0	52	
	Doramadalawa							
1	2009	5-Jan	2-Feb	33.0	<0.2	1.1	38	
2		2-Feb	2-Mar	34.0	0.5	1.2	35	
3		2-Mar	4-Apr	30.0	0.3	1.9	21	
4		4-Apr	2-May	30.0	0.8	2.6	34	
5		2-May	6-Jun	30.0	0.8	2.1	40	
6		6-Jun	5-Jul	30.0	0.6	2.1	37	
7		5-Jul	8-Aug	32.0	0.6	2.0	41	
8		8-Aug	6-Sep	32.0	0.6	2.5	38	
9								
10		7-Nov	6-Dec	33.0	0.3	1.7	28	Earlier stop date 2009-09-06 12:10. Monsoon rain.
11		6-Dec	3-Jan-10	32.0	<0.2	<0.2	<1	Monsoon rain. O_3 conc on blank level, unexposed sampler?
	2009	Annual	avg		0.5	1.5	31	
12	2010	3-Jan	30-Jan	30.0	<0.2	1.5	39	Start time due to protocol 100102 10:40.
13		30-Jan	27-Feb	32.0	0.3	1.7	34	
14		27-Feb	3-Apr	30.0	0.5	2.6	42	North-east monsoon due to protocol.
15		3-Apr	2-May	32.0	0.4	2.3	31	
16		2-May	29-May	32.0	0.4	2.0	39	
17		29-May	4-Jul	32.0	0.5	2.0	39	
18		4-Jul	31-Jul	32.0	0.8	2.3	39	
19		28-Aug	2-Oct	32.0	0.7	2.5	34	
20		3-Oct	29-Oct	30.0	0.9	3.1	41	
21		29-Oct	5-Dec	22.0	0.2	2.1	28	
22		5-Dec	1-Jan-11	28.0	0.2	1.7	43	Start time 11:15 due to protocol, but 11:50 has been assumed to match

								stop time for the sampler exposed earlier.
	2010	Annual	avg		0.4	1.6	26	
23	2011	1-Jan	29-Jan	29.0	0.3	1.3	47	
24		29-Jan	6-Mar		<0.2	1.7	41	Temperature missing
25		6-Mar	2-Apr	32.0	0.7	2.7	41	
26		2-Apr	30-Apr	32.0	0.4	2.7	40	
27		30-Apr	4-Jun	32.0	0.6	2.3	40	
28		4-Jun	2-Jul	30.0	0.9	2.4	41	
29		2-Jul	31-Jul	30.0	0.5	2.3	42	
30		31-Jul	4-Sep	30.0	0.7	3.4	36	
31		4-Sep	2-Oct	30.0	1.1	4.1	37	
32		2-Oct	30-Oct	30.0	0.9	3.6	34	
33		30-Oct	3-Dec	31.0	0.3	2.0	38	Temperature assumed
34		3-Dec	1-Jan-12	30.0	0.5	2.0	53	
	2011	Annual	avg		0.7	2.6	73	
	Field blanks							
1		4-Jan-09	1-Mar-09	34.0	<0.1	0.1	<1	
2		1-Mar-09	2-May-09	30.0	<0.1	0.1	1	
3		2-May-09	5-Jul-09	30.0	<0.1	<0.05	<1	
4		5-Jul-09	6-Sep-09	32.0	<0.2	<0.1	<1	
5								
6		7-Nov-09	3-Jan-10	32.0	<0.2	<0.2	<1	Earlier period stopped 2009-09-06.
7		3-Jan-10	27-Feb-10	32.0	<0.2	<0.2	<1	Start time due to protocol 100102 10:40.
8		27-Feb-10	3-Apr-10	30.0	<0.2	<0.2	<1	
9		1-May-10	4-Jul-10	32.0	<0.2	<0.2	<1	
10		4-Jul-10	31-Jul-10	30.0	<0.2	<0.2	1	Start time 10:00 due to protocol, does not match stop time for earlier sampler.
11		28-Aug-10	29-Oct-10	32.0	<0.2	<0.2	<1	
12		30-Oct-10	1-Jan-11	28.0	<0.2	<0.2	<1	
13		1-Jan-11	6-Mar-11		<0.2	<0.2	<1	Temperature missing
14		6-Mar-11	30-Apr-11	32.0	<0.2	<0.2	<1	
15		30-Apr-11	2-Jul-11	30.0	<0.2	<0.2	<1	
16		2-Jul-11	4-Sep-11	30.0	<0.2	<0.2	<1	
17		4-Sep-11	2-Oct-11	30.0	<0.1	<0.2	2	
18		30-Oct-11	1-Jan-12	31.0	<0.1	<0.2	<1	

ANNEXURE III: WET DEPOSITION DATA FROM WET ONLY AND BULK COLLECTOR (DATA AS RECEIVED)

RESULTS OF WET ONLY MONITORING - BANGLADESH

S No	Start Date	End Date	EC mS/m	pH	Amt of precipation (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	12-May-09	13-May-09	3.6	5.2	1000	18	105	9	37	0	37	26	151	
2	15-May-09	16-May-09	1.3	5.5	1500	22	30	4	6	0	3	5	73	
3	24-May-09	25-May-09	2.9	5.4	1000	14	173	11	4	0	4	6	173	
	May-09	Weighted avg	2.4	5.4	1167	18.6	92.3	7.4	14.3	0.0	13.0	11.3	123.9	
4	02-Jun-09	03-Jun-09	0.6	5.8	1400	9	22	1	2	0	0	6	35	
5	17-Jun-09	18-Jun-09	1.6	5.8	1200	5	30	3	26	7	18	10	64	
6	28-Jun-09	29-Jun-09	1.5	5.7	1000	2	55	5	16	10	7	6	83	
7	29-Jun-09	30-Jun-09	1.3	5.7	1000	12	47	2	7	6	0	6	88	
	Jun-09	Weighted avg	1.2	5.8	1150	7.1	36.7	2.6	12.4	5.3	6.2	7.0	64.5	
8	06-Jul-09	07-Jul-09	0.3	5.8	2000	1	8	0	1	0	0	0	18	
9	09-Jul-09	10-Jul-09	0.3	5.8	2000	2	10	0	1	1	0	0	20	
10	20-Jul-09	21-Jul-09	1.6	5.7	1000	3	72	5	5	8	7	6	99	
11	22-Jul-09	23-Jul-09	0.7	5.8	1200	0	35	1	1	1	2	3	44	
	Jul-09	Weighted avg	0.6	5.8	1550	1.5	24.2	1.0	1.6	1.8	1.5	1.5	36.7	
12	03-Aug-09	04-Aug-09	1.1	5.5	1700	14	8	1	30	3	8	10	56	
13	09-Aug-09	10-Aug-09	0.6	5.8	2200	11	22	1	1	1	6		40	
14	13-Aug-09	14-Aug-09	1.2	5.5	1100	17	36	3	3	3	4	2	72	

Annexure III: Wet Deposition Data

15	19-Aug-09	20-Aug-09	0.4	5.8	1300	3	19	1	1	1	2		32	
16	23-Aug-09	24-Aug-09	0.5	5.9	1300	3	23	9	1		3	3	28	
17	26-Aug-09	27-Aug-09	0.4	5.8	2400	0	20	1	1		1	2	28	
18	30-Aug-09	31-Aug-09	0.6	5.9	1200	0	29	1			0	1	40	
	Aug-09	Weighted avg	0.7	5.7	1600	6.7	21.3	2.1	5.5	1.1	3.6	2.6	40.7	
19	04-Sep-09	05-Sep-09	0.7	5.8	1000	2	22	7	5	2	2	0	39	
20	06-Sep-09	07-Sep-09	0.3	5.8	4200	2	14	1	0	0	0	0	22	
21	09-Sep-09	10-Sep-09	0.4	5.8	1100	2	22	1	1	0	0	0	32	
	Sep-09	Weighted avg	0.3	5.8	2100	2.0	16.7	2.0	1.0	0.3	0.3	0.0	26.4	
22	28-Apr-10	29-04-2010	6.6	5.6	600	3	178	29	85	24	55	103	158	
23	05-Apr-10	05-05-2010	3.4	5.8	1300	6	97	10	32	7	32	52	101	
	Apr-10	Weighted avg	1.9	5.8	1275	3.1	57.3	7.0	18.8	4.7	14.8	25.4	62.1	
24	05-May-10	05-Sep-10	2.3	5.8	1350	11	78	10	13	3	4	54	84	
25	21-May-10	24-May-10	0.6	5.9	3700	5	21	1	1	1	2	0	32	
26	27-May-10	29-May-10	4.8	5.7	550	2	176	2	83	12	35	50	187	
	May-10	Weighted avg	1.4	5.9	1867	6.2	50.0	3.3	11.9	2.6	5.7	17.9	59.8	
27	05-Jun-10	08-Jun-10	3.9	5.7	700	6	99	14	53	13	51	31	116	
28	13-Jun-10	14-Jun-10	3.3	5.8	900	7	85	51	22	5	38	78	68	
29	17-Jun-10	19-Jun-10	1.6	5.9	1100	5	61	5	12	5	14	25	50	
30	26-Jun-10	29-Jun-10	1.0	5.9	3600	5	29	6	7	0	15	8	31	
	Jun-10		1.8	5.9	1575	5.4	50.4	13.1	15.1	3.2	22.1	23.5	49.0	
31	01-Jul-10	03-Jul-10	0.4	5.9	2500	0	3	2	1	1	0	0	17	
32	06-Jul-10	08-Jul-10	1.3	5.8	1050	5	37	10	3	7	6	10	56	
33	12-Jul-10	15-Jul-10	1.1	5.9	700	6	27	3	5	7	5	5	50	
	Jul-10	Weighted avg	0.7	5.9	1417	2.2	15.4	4.1	2.2	3.5	2.3	3.3	32.1	

Annexure III: Wet Deposition Data

13	11-Aug-10	13-Aug-10	1.2	5.8	1000	6	43	2	7	2	5	5	77	
34	14-Aug-10	17-Aug-10	1.1	5.8	1100	5	39	8	6	5	5	4	54	
35	12-Aug-10	15-Jul-10	0.6	5.9	3500	4	11	3	4	2	0	0	29	
	Aug-10	Weighted avg	0.8	5.9	1867	4.6	22.2	3.8	4.9	2.6	1.9	1.7	42.5	
36	26-Mar-11	04-Feb-11	7.8	5.5	1170	49	213	45	88	23	84	85	287	
	Mar-11	Average	7.8	5.5	1170	49	213	45	88	23	84	85	287	
37	04-Feb-11	04-Sep-11												It has not been collectable raining
38	04-Sep-11	16-Apr-11												
39	16-Apr-11	23-Apr-11												
40	23-Apr-11	30-Apr-11												
41	30-Apr-11	05-Jul-11	6.7	5.6	700	34	179	32	76	21	78	72	232	
	Apr-11	Weighted avg	6.7	5.6	700	34	179	32	76	21	78	72	232	
42	05-Jul-11	14-May-11	5.3	5.6	1550	29	147	27	54	18	68	62	169	
43	14-May-11	21-May-11	5.1	5.7	900	25	138	25	56	19	67	66	156	
44	21-May-11	28-May-11	3.4	5.9	2000	19	82	10	39	14	50	38	97	
45	28-May-11	06-Apr-11	4.2	5.8	520	22	105	13	44	15	56	44	139	
	May-11	Weighted avg	4.4	5.8	1243	23.5	114.8	18.3	47.3	16.3	59.3	51.2	134.5	
46	06-Apr-11	06-Nov-11												It has not been collectable raining
47	11-Jun-11	18-Jun-11	1.8	6.2	3930	12	32	6	21	5	15	18	61	
48	18-Jun-11	25-Jun-11	1.7	6.0	5110	12	30	5	16	11	14	14	53	
49	25-Jun-11	02-Jul-11	0.8	6.3	5090	6	25	3	11	2	8	11	41	
	Jun-11	Weighted avg	1.4	6.1	4710	9.8	28.8	4.6	15.6	6.1	12.1	14.0	50.9	
50	03-Jul-11	10-Jul-11												It has not been collectable raining
51	10-Jul-11	17-Jul-11	1.3	5.8	4800	3	54	6	10	2	11	9	60	

52	17-Jul-11	24-Jul-11	0.9	5.9	5700	2	30	5	7	1	8	7	40	
53	24-Jul-11	31-Jul-11	0.8	5.9	3600	4	31	4	6	1	7	5	36	
54	31-Jul-11	08-Jul-11	0.6	6.0	4300	3	23	3	6	BDL	7	4	26	
	Jul-11	Weighted avg	0.9	5.9	4600	2.9	34.8	4.6	7.4	1.0	8.4	6.4	41.2	
55	07-Aug-11	14-Aug-11	0.7	6.0	5500	3	25	3	9	BDL	9	3	27	
56	14-Aug-11	21-Aug-11	0.9	5.9	4600	3	32	4	9	1	10	4	32	
57	21-Aug-11	28-Aug-11	0.6	6.0	3400	3	22	1	7	BDL	5	3	28	
58	28-Aug-11	04-Sep-11												It has not been collectable raining
	Aug-11	Weighted avg	0.7	5.9	4500	3.0	26.6	2.8	8.5	0.3	8.3	3.3	29.0	
59	04-Sep-11	11-Sep-11	0.6	6.0	3200	2	21	3	6	1	6	3	25	
60	11-Sep-11	18-Sep-11	0.5	6.0	3300	3	18	2	5	1	7	2	21	
61	18-Sep-11	25-Sep-11	0.5	6.0	3500	2	21	1	7	BDL	5	4	19	
	Sep-11	Weighted avg	0.6	6.0	3625	2.3	20.0	2.0	6.0	0.7	6.0	3.0	21.6	

RESULTS OF WET BULK MONITORING - BANGLADESH

S No	Start Date	End Date	EC mS/m	pH	Amt of precipation (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	12-May-09	13-May-09	4.5	5.3	1000	35	131	9	49		53	47	168	
2	15-May-09	16-May-09	1.6	5.4	1500	24	40	5	7		8	8	78	
3	24-May-09	25-May-09	3.5	5.3	1000	10	186	16	4		6	6	223	
	May-09	Weighted avg	3.0	5.3	1166.7	23.1	107.7	9.3	18.1		20.3	18.6	145.1	
4	02-Jun-09	03-Jun-09	1.0	5.8	1400	9	41	2	4		6	5	55	
5	17-Jun-09	18-Jun-09	1.7	5.7	1200	3	49	4	20	7	18	12	76	

Annexure III: Wet Deposition Data

6	28-Jun-09	29-Jun-09	2.0	5.7	1000	1	79	6	21	11	10	5	118	
7	29-Jun-09	30-Jun-09	1.5	5.7	1000	5	70	2	8	7	0	6	106	
	Jun-09	Weighted avg	1.5	5.7	1150.0	4.8	57.7	3.4	12.7	8.1	9.4	8.7	86.2	
8	06-Jul-09	07-Jul-09	0.3	5.8	2200	2	7	1	1	0	0	0	18	
9	09-Jul-09	09-Jul-09	0.3	5.8	2200	2	11		1	1	0	0	22	
10	20-Jul-09	21-Jul-09	1.8	5.7	1100	4	80	6	5	8	8	9	110	
11	22-Jul-09	23-Jul-09	0.8	5.7	1300	0	44	2	2	1	2	3	55	
	Jul-09	Weighted avg	0.6	5.8	1700.0	1.9	27.2	1.7	1.8	1.8	1.7	2.0	41.3	
12	03-Aug-09	04-Aug-09	0.9	5.9	1500	14	10	3	11	3	4		62	
13	09-Aug-09	10-Aug-09	0.7	5.8	2000	11	20	1	3	1	5	1	45	
14	13-Aug-09	14-Aug-09	1.4	5.4	900	17	41	3	4	4	4	1	84	
15	19-Aug-09	20-Aug-09	0.4	5.8	1200	3	25	1	1	1	2	1	34	
16	23-Aug-09	24-Aug-09	0.6	5.8	1200	5	24	10	1		3	2	39	
17	26-Aug-09	27-Aug-09	0.5	5.8	2800	0	23	3	1		4	1	28	
18	30-Aug-09	31-Aug-09	0.6	5.9	1000	0	32	2	1	1	0	0	47	
	Aug-09	Weighted avg	0.7	5.8	1514.3	6.4	23.3	3.1	3.0	1.2	3.5	0.9	44.5	
19	04-Sep-09	05-Sep-09	0.9	5.7	1100	2	31	10	20	4	16	0	45	
20	06-Sep-09	07-Sep-09	0.3	5.8	4400	3	15	1		0	0	0	26	
21	09-Sep-09	10-Sep-09	0.6	5.8	1200	3	36	1	1	0	0	0	45	
	Sep-09	Weighted avg	0.4	5.8	2233.3	2.8	21.4	2.5	3.5	0.7	2.6	0.0	32.5	
22	28-Apr-10	29-Apr-10	7.9	5.5	600	12	218	51	101	22	78	102	191	
23	05-Apr-10	05-May-10	3.8	5.8	1300	6	121	8	35	7	36	83	118	
	Apr-10	Weighted avg	5.1	5.7	950.0	7.9	151.6	21.6	55.8	11.7	49.3	89.0	141.1	
24	05-May-10	05-Sep-10	2.5	5.8	1350	17	83	8	15	4	13	53	90	
25	21-May-10	24-May-10	0.6	5.9	3700	2	27	2	1	1	0	0	34	

Annexure III: Wet Deposition Data

26	27-May-10	29-May-10	4.8	5.6	550	2	182	4	86	10	36	51	192	
	May-10	Weighted avg	1.5	5.8	1866.7	5.6	55.7	3.6	12.7	2.6	6.7	17.8	63.0	
27	05-Jun-10	08-Jun-10	3.9	5.7	700	7	92	13	59	12	55	38	122	
28	13-Jun-10	14-Jun-10	3.6	5.7	900	8	88	50	32	9	55	37	73	
29	17-Jun-10	19-Jun-10	2.1	5.8	1100	5	61	20	11	6	26	26	56	
30	26-Jun-10	29-Jun-10	1.0	5.9	3600	4	27	5	7	0	9	7	33	
	Jun-10	Weighted avg	1.9	5.8	1575.0	5.1	48.9	14.9	17.0	3.8	23.7	18.0	52.6	
31	01-Jul-10	03-Jul-10	0.3	5.9	2500	0	3	1	1	1	0	0	16	
32	06-Jul-10	08-Jul-10	0.9	5.8	1050	5	26	2	1	3	0	2	50	
33	12-Jul-10	15-Jul-10	1.0	5.8	700	4	26	3	4	6	0	2	56	
	Jul-10	Weighted avg	0.6	5.9	1416.7	1.9	12.5	1.6	1.6	2.4	0.0	0.8	31.0	
34	11-Aug-10	13-Aug-10	1.5	5.9	50	6	47	10	5	1	6	5	77	
35	14-Aug-10	17-Aug-10	1.2	5.9	50	5	39	6	6	2	5	10	63	
36	12-Aug-10	23-Aug-10	0.6	5.9	50	5	13	5	3	1	0	0	35	
	Aug-10	Weighted avg	1.1	5.9	50.0	5.3	33.0	7.0	4.7	1.3	3.7	5.0	58.3	
37	26-Mar-11	04-Feb-11	7.93	5.49		46	213	48	91	26	86	88	301	
	Mar-11		7.9	5.5	50.0	46.0	213.0	48.0	91.0	26.0	86.0	88.0	301.0	
38	30-Apr-11	05-Jul-11	6.78	5.54	700	36	178	34	78	23	82	78	244	
	Apr-11		6.8	5.5	700.0	36.0	178.0	34.0	78.0	23.0	82.0	78.0	244.0	
39	05-Jul-11	14-May-11	5.46	5.56	1550	38	156	25	58	21	78	67	178	
40	14-May-11	21-May-11	5.42	5.65	900	37	154	27	66	25	72	76	175	
41	21-May-11	28-May-11	3.78	5.87	2000	21	88	11	45	12	52	42	101	
42	28-May-11	06-Apr-11	4.45	5.78	520	22	111	15	56	15	58	48	144	
	May-11	Weighted avg	4.7	5.7	1242.5	29.3	123.6	18.7	54.0	17.5	64.4	56.6	142.9	
43	06-Nov-11	18-Jun-11	1.91	6.12	3930	11	44	8	23	6	24	21	66	

44	18-Jun-11	25-Jun-11	1.81	5.98	5110	17	38	7	18	13	28	19	48	
45	25-Jun-11	02-Jul-11	0.98	6.21	4660	8	22	4	22	3	8	15	45	
	Jun-11	Weighted avg	1.6	6.1	4566.7	12.2	34.3	6.3	20.8	7.6	20.0	18.2	52.1	
46	10-Jul-11	17-Jul-11	1.271	5.81	870	4	56	8	11	1	11	8	65	
47	17-Jul-11	24-Jul-11	0.912	5.84	6840	2	32	6	8	1	7	8	42	
48	24-Jul-11	31-Jul-11	0.841	5.89	3100	3	32	5	7	1	8	6	38	
49	31-Jul-11	08-Jul-11	0.651	5.96	5700	2	26	4	5	BDL	6	5	28	
	Jul-11	Weighted avg	0.8	5.9	4127.5	2.3	31.2	5.2	6.9	0.7	7.1	6.6	37.6	
50	07-Aug-11	14-Aug-11	0.782	5.91	3400	3	29	4	10	BDL	8	4	30	
51	14-Aug-11	21-Aug-11	0.912	5.88	2460	4	35	3	11	2	11	5	34	
52	21-Aug-11	28-Aug-11	0.652	5.97	1800	2	26	2	8		6	4	30	
	Aug-11	Weighted avg	0.8	5.9	2553.3	3.1	30.2	3.2	9.9	0.6	8.5	4.3	31.3	
53	04-Sep-11	11-Sep-11	0.662	5.96	2500	3	27	2	7	1	5	4	29	
54	11-Sep-11	18-Sep-11	0.543	5.98	1800	2	20	1	6	1	6	3	22	
55	18-Sep-11	25-Sep-11	0.611	5.91	3160	3	22	2	8	BDL	7	4	23	
	Sep-11	Weighted avg	0.6	5.9	2486.7	2.8	23.2	1.8	7.2	0.6	6.1	3.8	24.8	

RESULTS OF WET BULK MONITORING - BHUTAN

S. No	Date	Time (hrs)	EC (mS/cm)	pH	Rainfall	Remarks
1	22-May-09	9:00 am	0.972	4.924	6.4	
2	27-May-09	9:00 am	0.886	3.724	154.6	
	May-09	Weighted avg	0.9	3.8	81	
3	2-Jun-09	9:00 am	0.977	5.48	40.2	
4	9-Jun-09	9:00 am	0.771	4.632	10.8	

5	16-Jun-09	9:00 am	0.489	5.622	54.4	
6	23-Jun-09	9:00 am	0.638	4.42	46.8	
7	30-Jun-09	9:00 am	0.943	5.71	268.8	
	Jun-09	Weighted avg	0.8	5.5	84	
8	8-Jul-09	9:00 am	0.567	4.82	65.8	
9	17-Jul-09	9:00 am	0.257	4.07	24	
10	25-Jul-09	9:00 am	0.378	5.12	257.2	
11	27-Jul-09	9:00 am	0.427	4.892	163	
12	31-Jul-09	9:00 am	0.368	5.31	85.8	
	Jul-09	Weighted avg	0.4	5.0	119	
13	6-Aug-09	9:00 am	0.726	4.321	27.2	
14	12-Aug-09	9:00 am	0.486	4.891	90.8	
15	16-Aug-09	9:00 am	0.328	4.321	113	
16	19-Aug-09	9:00 am	0.24	5.255	189	
17	30-Aug-09	9:00 am	0.236	4.892	76.2	
	Aug-09	Weighted avg	0.3	4.9	99	
18	6-Sep-09	9:00 am	0.278	4.532	11.8	
19	11-Sep-09	9:00 am	0.328	5.421	35.4	
20	14-Sep-09	9:00 am	0.312	5.301	30.8	
21	17-Sep-09	9:00 am	0.306	4.71	77.4	
22	19-Sep-09	9:00 am	0.289	5.43	256.6	
23	24-Sep-09	9:00 am	0.309	5.001	29.4	
	Sep-09	Weighted avg	0.3	5.2	86	
24	7-Oct-09	9:00 am	0.42	4.89	57.6	
25	11-Oct-09	9:00 am	0.416	4.901	16.2	

Annexure III: Wet Deposition Data

26	24-Oct-09	9:00 am	0.38	4.602		Wash
	Sep-09	Weighted avg	0.4	4.9	37	
27	5-Nov-09	9:00 am	0.28	4.871	wash	
28	30-Nov-09	9:00 am	0.265	5.339	wash	
29	3-Sep-10	9:00 am	43.8	5.742	93	
30	11-Sep-10	9:00 am	39.8	4.722	119.6	
31	21-Sep-10	9:00 am	29.8	3.984	34.8	
32	28-Sep-10	9:00 am	28.9	3.743	19.4	
	Sep-10	Weighted avg	39.1	4.9	67	
33	8-Oct-10	9:00 am	29.7	4.721	11.8	
34	15-Oct-10	9:00 am	41.6	6.7		
35	21-Oct-10	9:00 am	37.9	5.165	4.4	
36	28-Oct-10	9:00 am	35.8	5.002		
	Oct-10	Weighted avg	31.9	4.8	8	
37	4-Nov-10	9:00 am	38.8	5.123		
38	11-Nov-10	9:00 am	40.8	6.248		
39	19-Nov-10	9:00 am	42.1	6.321	16	
40	27-Nov-10	9:00 am	34.6	5.308		
	Nov-10	Weighted avg	42.1	6.3	16	
41	4-Dec-10	9:00 am	32.4	4.21		
42	12-Dec-10	9:00 am	29.1	3.84		
43	21-Dec-10	9:00 am	28.4	5.41		
44	31-Dec-10	9:00 am	41.5	4.51		
	Dec-10	Average	32.9	4.5		

45	2-Jan-11	9:00 am	43.8	5.724	1.8	
46	19-Jan-11	9:00 am	31.8	3.541	3.4	
47	28-Jan-11	9:00 am	~~29.8~~	~~4.81~~		
	Jan-11	Weighted avg	36.0	3.5	3	
48	10-Feb-11	9:00 am	33.4	4.119	7.2	
49	17-Feb-11	9:00 am	29.8	3.894	9.2	
	Feb-11	Weighted avg	31.4	4.0	8	
50	9-Mar-11	9:00 am	27	5.421	5.8	
51	19-Mar-11	9:00 am	31.4	6.551	27.4	
52	27-Mar-11	9:00 am	40.2	5.421	18.4	
53	10-Mar-11	9:00 am	37.8	4.229	12.4	
	Mar-11	Weighted avg	34.8	5.7	16	
54	1-Apr-11	9:00 am	29.8	3.894	51.6	
55	13-Apr-11	9:00 am	33.4	4.692	6.6	
56	20-Apr-11	9:00 am	35.4	5.116	56.4	
57	24-Apr-11	9:00 am	29.8	4.589	42	
	Apr-11	Weighted avg	32.0	4.6	39	
58	1-May-11	9:00 am	32.8	4.892	7.6	
59	8-May-11	9:00 am	30.1	4.722	13	
60	12-May-11	9:00 am	31.1	4.81	24.2	
61	20-May-11	9:00 am	30.7	4.744	4	
62	24-May-11	9:00 am	41.6	4.41	46.2	
63	30-May-11	9:00 am	32.8	4.2	7.2	
	May-11	Weighted avg	35.9	4.6	17	
64	4-Jun-11	9:00 am	36.8	5.001	44.8	

65	7-Jun-11	9:00 am	33.8	4.371	100.8	
66	12-Jun-11	9:00 am	34.8	4.72	44	
67	19-Jun-11	9:00 am	40.8	5.212	21.8	
68	24-Jun-11	9:00 am	39.2	4.11	50	
69	30-Jun-11	9:00 am	34.8	4.07	88.6	
	Jun-11	Weighted avg	35.8	4.4	58	
70	4-Jul-11	9:00 am	29.8	4.003	85.6	
71	8-Jul-11	9:00 am	27.4	3.399	56.2	
72	13-Jul-11	9:00 am	29.8	3.491	21.2	
73	16-Jul-11	9:00 am	32	4.262	92.2	
74	22-Jul-11	9:00 am	34.8	4.321	108.6	
75	26-Jul-11	9:00 am	42.3	4	100.8	
	Jul-11	Weighted avg	33.8	4.0	77	
76	1-Aug-11	9:00 am	34	5.601	35.2	
77	4-Aug-11	9:00 am	32.5	5.31	71.6	
78	10-Aug-11	9:00 am	29.7	6.02	30.8	
79	15-Aug-11	9:00 am	34.8	5.431	129.8	
80	24-Aug-11	9:00 am	27.9	6.271	37	
	Aug-11	Weighted avg	32.8	5.6	61	
81	2-Sep-11	9:00 am	30.8	5.011	43.6	
82	17-Sep-11	9:00 am	34.5	4.562	105.8	
83	24-Sep-11	9:00 am	29.9	4.334	37	
	Sep-11	Weighted avg	26.8	3.8	57	

Stikethrough values are ignored during calculation.

RESULTS OF WET BULK MONITORING - NEPAL

S No.	Start Date	End Date	EC mS/cm	pH	Physical Amount mg/l	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	22-Feb-09	19-Apr-09	30	6.36	1000	1.68	2.05	1.84	0.4	0.486	2.15	1.29	2.99	
2	19-Apr-09	1-May-09	21.4	6.59	935	0.84	0.8	2.24	0.8	0.486	0.88	0.51	3.99	
3	1-May-09	26-May-09	24.2	6.25	4980	1.12	1	1.23	1.2	0.486	1.16	0.67	4	
4	26-May-09	26-Jun-09	26.4	6.46	4560	0.84	1.05	1.49	0.8	0.972	1.16	0.62	4.99	
5	26-Jun-09	9-Sep-10	4.7	6.45	4930	0.56	1.29	1.49	1.6	0.8	2.74	0.91	3.33	
6	23-Aug-09	18-Sep-09	3.3	6.9	1000	1.12	1.64	1.62	0.4	0.73	11.22	5.6	4	
7	18-Sep-09	19-Oct-09	3	6.95	1000	0.56	1.59	1.55	0.8	0.97	6.18	0.75	3	
8	19-Oct-09	27-Nov-09	12	6.85	1000	0.84	1.52	1.74	1.2	0.49	3.88	1.12	2	
9	27-Nov-09	12-Dec-09	3.6	6.75	1000	0.56	1.45	1.42	1.6	0.73	2.91	0.55	4	
10	12-Dec-09	25-Jan-10	26.5	6.85	1000	0.56	1.63	1.65	1.2	0.49	11.48	0.4	1.5	
11	25-Jan-10	25-Feb-10	42.1	7.04	1000	1.68	1.7	1.78	2.8	0.73	13.31	0.19	4	
12	25-Feb-10	25-Mar-10	27.2	6.5	1000	1.12	1.62	1.76	3.6	1.46	4.99	3	1.5	
13	25-Mar-10	25-Apr-10	47.2	6.75	1035	1.4	1.67	1.7	6	0.73	10.02	5.45	2	
14	30-Apr-10	25-May-10	2.93	6.72	4980	0.84	1.72	1.75	2	1.21	10.51	0.4	2.5	
15	25-May-10	20-Jun-10	3.5	6.95	5000	1.12	1.68	1.68	4	1.7	12.17	0.34	3	
16	20-Jun-10	10-Jul-10	1.85	6.65	4970	0.84	*	*	0.8	0.73	11.77	0.67	2	
17	10-Jul-10	25-Jul-10	2.87	6.7	5000	1.4	*	*	1.2	1.21	9.98	0.54	2.5	
18	25-Jul-10	20-Aug-10	2	6.85	5000	1.12	*	*	0.8	0.97	9.57	0.37	1	
19	20-Aug-10	25-Sep-10	2.15	6.8	4790	1.12	*	*	1.6	0.97	9.75	4.29	3	
20	25-Sep-10	27-Oct-10	3	6.63	1000	1.4	*	*	0.8	0.73	9.18	1.12	4	
21	5-Apr-11	29-Apr-11	3	6.52	3450	1.04	*	*	1.92	1.21	5.74	1.29	3	

22	29-Apr-11	20-May-11	3.15	6.82	1965	1.68	*	*	3.6	1.46	7.18	1.58	4	
23	20-May-11	17-Jun-11	2.2	6.7	5160	0.84	*	*	2	0.97	10	1	2.5	
24	17-Jun-11	19-Jul-11	2.24	5.425	5000	0.63	0.94	1.1	1.1	1	1.975	0.69	1.995	
25	19-Jul-11	21-Aug-11	2.26	6.05	4995	1.26	1.85	1.21	1.96	1.335	6.125	0.59	3.25	
26	21-Aug-11	22-Sep-11	2.825	6.275	5117.5	1.54	2.8	1.63	2.9	0.855	5.965	0.845	3	
27	22-Sep-11	17-Oct-11	2.83	6.55	5015	1.26	1.875	1.73	1.6	0.97	7.74	0.635	3.165	
28	17-Oct-11	19-Nov-11	2.485	6.59	2175	1.36	1.45	2.215	2.225	1.235	5	0.44	3.8	
29	19-Nov-11	15-Dec-11	3.83	6.725	1000	0.84	1.325	1.975	1.9	1.245	2.88	0.99	2.5	

RESULTS OF WET ONLY MONITORING - SRILANKA

S No		Date	EC mS/m	pH	Amt of Sample (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1		23-Jan-10												Contaminated with bird drops
2		28-Mar-10												Contaminated with mob
3		11-Apr-10												Contaminated with mob
4		18-Apr-10	5.3	6.42	1850	11.86	2.97	0.23	1.87	1.03	5.33	4.00	36.67	
5		24-Apr-10	3.2	6.6	1600	9.53	25.80	2.86	1.30	3.95	1.69	4.21	52.19	
	Apr-09	Weighted avg	4.3	6.5	1725	10.8	13.6	1.5	1.6	2.4	3.6	4.1	43.9	
6		2-May-10	0.5	5.29	3750	8.26	2.03	2.35	0.30	0.99	3.27	1.74	2.26	
7		8-May-10												Contaminated with mob
8		15-May-10	5.9	5.86	3450	23.34	16.04	1.41	8.28	3.00	2.09	0.94	17.63	
9		22-May-10	0.9	6.56	1280	13.36	17.86	4.94	7.93	4.07	3.29	1.66	35.26	

Annexure III: Wet Deposition Data

	May-09	Weighted avg	2.8	5.7	2826.7	15.2	10.1	2.4	4.7	2.3	2.8	1.4	13.5	
10		11-Jul-10	4.1	5.81	1350	12.80	6.57	0.15	0.67	1.40	6.65	5.24	40.90	
11		28-Jul-10												Contaminated with mob
12		19-Sep-10												Contaminated with mob
13		25-Sep-10	4.8	5.91	2250	20.07	14.09	3.58	6.66	0.74	1.17	7.03	19.75	
14														
15		2-Oct-10	0.4	6.52	4500	8.98	2.39	3.79	2.30	2.22	4.85	0.29	2.12	
16		9-Oct-10	0.9	6.51	500	17.74	12.91	4.02	2.30	1.73	0.27	0.34	1.27	
	Oct-09	Weighted avg	0.5	6.5	2500	9.9	3.4	3.8	2.3	2.2	4.4	0.3	2.0	
17		5-Nov-10												Contaminated with mob
18		28-Nov-10	1	7.47	5000	28.88	0.52	0.43	13.65	1.56	4.38	1.98	40.62	
19		6-Dec-10	1.2	5.92	1050	34.98	12.11	0.90	13.20	7.94	7.61	1.35	28.21	
20		12-Dec-10	0.1	6.25	2550	18.96	3.22	0.92	14.17	3.50	6.49	4.26	56.42	
21		19-Dec-10	2.5	6.95	1450	26.72	8.74	1.13	10.65	5.14	6.05	0.53	28.21	
22		25-Dec-10	0.5	6.45	3450	28.88	2.74	0.41	10.75	2.76	4.54	1.64	28.21	
	Dec-09	Weighted avg	0.8	6.4	2125	26.3	5.1	0.7	12.1	4.0	5.8	2.2	36.7	
	2009	Annual avg	2.24	6.32	2430.71	18.88	9.14	1.94	6.72	2.86	4.12	2.52	27.84	
23		1-Jan-11	0.9	7.2	1400	29.88	36.00	5.60	22.23	5.88	18.28	18.56	32.50	
24		9-Jan-11	0.8	5.7	2600	17.90	24.00	1.43	13.90	4.69	9.61	15.24	32.02	
25		16-Jan-11	0.6	6.91	4000	30.43	2.03	1.33	0.30	0.99	7.43	2.06	8.12	
26		22-Jan-11												Contaminated with mob

27		29-Jan-11	1.3	6.89	950	23.34	16.04	1.41	8.28	3.00	8.34	18.67	40.20	
	Jan-11	Weighted avg	0.8	6.6	2237.5	26.0	15.2	2.0	8.5	3.0	9.9	10.2	22.3	
28		6-Feb-11	1.8	6.49	5400	13.36	22.48	4.94	15.42	4.07	3.29	1.66	35.26	
29		13-Feb-11												Contaminated with mob
30		6-Mar-11	1.3	6.8	340	23.89	6.57	1.43	13.15	1.40	7.17	7.34	52.75	
31		22-May-11	1	6.8	230	30.54	0.52	0.43	15.39	1.56	4.69	2.47	37.80	
32		20-Aug-11	1.7	5.18	200	21.18	24.96	0.92	21.41	3.50	9.61	8.93	46.66	
	2011	Annual avg	1.18	6.50	1890.00	23.82	16.57	2.19	13.76	3.14	8.55	9.37	35.66	

RESULTS OF WET BULK MONITORING - SRILANKA

S No		Date	EC mS/m	pH	Amt of Sample (ml)	NH4+ µmol/L	Na^{+} µmol/L	K^{+} µmol/L	Ca^{+} µmol/L	Mg^{+} µmol/L	SO^{-}_{4} µmol/L	NO_3^{-} µmol/L	Cl^{-} µmol/L	Remarks
1	Mar	29-Mar-09	0.8	5.61	148	24.45	9.30	8.13	11.93	4.52	2.28	5.22	33.15	
2	Apr	12-Apr-09												Contaminated with bird drop
3		18-Apr-09												Contaminated with bird drop
4	May	2-May-09	0.6	7.21	260	33.98	0.30	0.38	22.01	0.70	2.09	2.11	4.23	
5		24-May-09												Contaminated exact source not known bad smell
6	Aug	15-Aug-09												Contaminated exact source not known dark

Annexure III: Wet Deposition Data

													7bownishcolour
7		23-Aug-09	0.7	5.56	2700	22.84	5.52	2.15	5.04	1.52	1.48	6.64	39.92	
8	Oct	24-Oct-09	1	5.96	1950	10.25	9.22	9.46	10.15	7.98	2.51	3.18	40.20	
9		31-Oct-09	2	4.85	450	9.31	9.13	7.08	9.31	7.86	4.64	5.06	72.64	
	Oct-09	Weighted avg	1.2	5.8	1700	10.1	9.2	9.0	10.0	8.0	2.9	3.5	46.3	
10	Nov	7-Nov-09	0.8	5.86	5580	4.77	8.87	6.96	8.26	5.31	1.94	1.66	30.89	
11		15-Nov-09	0.9	5.66	1800	17.41	4.61	2.58	4.62	5.64	2.10	1.95	32.86	
12		21-Nov-09	0.8	6.85	1850	13.64	4.74	7.57	4.57	5.27	2.08	1.90	31.48	
13		28-Nov-09	0.9	5.71	700	10.86	5.57	3.45	2.67	5.27	1.78	2.73	44.71	
	Nov-09	Weighted avg	0.8	6.0	2482.5	9.1	7.1	6.0	6.5	5.4	2.0	1.8	32.3	
14	Dec	6-Dec-09	0.3	6.12	1250	12.08	1.91	0.03	0.25	0.45	2.99	0.29	2.40	
15		26-Dec-09	0.8	6.2	4800	11.64	5.78	3.58	2.57	3.95	1.75	2.60	39.92	
	Dec-09	Weighted avg	0.7	6.2	3025	11.7	5.0	2.8	2.1	3.2	2.0	2.1	32.2	
16	Jan	2-Jan-10	0.6	5.88	1275	12.20	9.17	8.47	4.94	8.68	5.33	4.58	33.85	
17		11-Jan-10												comtaminated with bird drops
18		23-Jan-10	2.6	4.96	230	10.25	6.65	2.71	10.28	6.95	2.73	3.39	55.99	
	Jan-10	Weighted avg	0.9	5.7	752.5	11.9	8.8	7.6	5.8	8.4	4.9	4.4	37.2	
19	Mar	28-Mar-10												comtaminated with mob

Annexure III: Wet Deposition Data

20	Apr	11-Apr-10											comtaminated light brownish colour
21		18-Apr-10	0.9	5.75	2150	8.20	6.14	4.02	4.44	4.85	2.98	2.00	46.54	
22		24-Apr-10	1.3	5.95	1150	17.52	5.28	5.42	3.44	1.85	4.43	2.77	26.80	
	Apr-10	Weighted avg	1.0	5.8	1650.0	11.4	5.8	4.5	4.1	3.8	3.5	2.3	39.7	
23	May	2-May-10	2.9	5.91	3400	7.32	18.33	7.62	6.71	3.37	1.69	0.23	3.53	
24		8-May-10											Contaminated exact source not known unknown particals in
25		15-May-10											comtaminated with mob
26		22-May-10	1	5.98	3400	11.36	4.57	3.94	3.02	7.77	1.36	2.03	49.39	
	May-10	Weighted avg	2.0	5.9	3400	9.3	11.4	5.8	4.9	5.6	1.5	1.1	26.5	
27	Sep	19-Sep-10	0.9	5.75	1650	8.20	6.13	4.02	4.44	4.85	2.98	2.00	46.54	
28		25-Sep-10	0.8	6.37	850	15.52	10.57	4.14	7.91	1.81	5.17	5.08	20.45	
	Sep-10	Weighted avg	0.9	6.0	1250.0	10.7	7.6	4.1	5.6	3.8	3.7	3.0	37.7	
29	Oct	2-Oct-10											comtaminated with mob
30		9-Oct-10	5.1	6	1300	24.89	9.26	4.53	9.41	3.04	0.19	0.34	7.76	
31	Nov	5-Nov-10											comtaminated with bird drops
32	Aug	20-Aug-11											comtaminated with mob

Annexure III: Wet Deposition Data

33	Oct	9-Oct-11											comtaminated with mob
34		16-Oct-11	1.3	6.02	1550	4.21	0.83	0.90	11.30	1.07	1.83	3.18	3.81	
35		23-Oct-11												
36		30-Oct-11	1.5	5.05	1600	9.15	28.43	0.59	10.68	0.53	10.01	12.34	26.60	
		Weighted avg	1.4	5.5	1575	6.7	14.8	0.7	11.0	0.8	6.0	7.8	15.4	
37	Nov	6-Nov-11	1	5.75	840	4.77	23.39	0.46	2.79	0.21	5.09	2.48	7.48	
38		13-Nov-11												comtaminated with bird drops
39		20-Nov-11												comtaminated with unknown particles light browniscolour
40		27-Nov-11												comtaminated with bird drops
41	Dec	3-Dec-11	0.8	5.9	1200	4.71	42.39	0.87	12.20	2.22	10.27	15.71	24.99	
42		11-Dec-11												comtaminated with unknown particles
43		17-Dec-11	0.5	5.98	850	9.09	40.17	0.56	0.35	2.55	5.40	10.39	22.06	
44		25-Dec-11	0.7	6.58	750	3.60	42.26	4.45	11.05	3.09	10.54	14.11	32.52	
		Weighted avg	0.7	6.1	933.3	5.7	41.7	1.7	8.3	2.6	8.9	13.7	26.1	

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVE

The United Nations Conference on Environment and Development (UNCED), held in Rio de Janerio in 1992 produced a major strategic outlook for the 21st century in the Agenda 21. In addition to the many important sectoral declarations, it made some important observations on vital cross-cutting issues. One of these vital issues is described in Chapter 40 on Information for Decision Making: the importance of improved availability of information on all aspects of environment and development for decision making towards sustainable development. Agenda 21 also emphasizes the need for improved collection as well as presentation of data and information. Chapter 9 of Agenda21, states that "trans-boundary atmospheric pollution has adverse health impacts on human and other detrimental environmental impacts, such as tree and forest loss and the acidification of water bodies". It emphasizes the necessity of regional cooperation.

Further, one of the most important commitments made at the World Summit on Sustainable Development (WSSD) in 2002 was the acceptance of the international development goals which included the collective responsibility to advance and strengthen mutually reinforcing pillars of sustainable development at different levels. Key activities in these fields included development of the State of Environment (SoE) reports as well as effective data collection and processing.

Land, air, water and biodiversity are the major components of the environment which need regular assessment. Towards this end, the basis of any regional cooperation is the knowledge of present state of affairs and the future trends.

1.1.1 GLOBAL AND REGIONAL CONCERNS OF AIR POLLUTION

One of the most important characteristics of air pollution is that it cuts across national boundaries and often has global effects, i.e., its transboundary nature – many air borne pollutants can easily travel and affect the areas far away from the point of origin. Thus, the impacts of climate change and air pollution are generally transboundary and global in nature. The impacts can be experienced in places far away from the original place where pollution occurred as national actions often have regional and global implications regarding environmental pollution. It is now undisputed that primary air pollutants and their chemical products could be transported over distances of many thousands of kilometers. This transport of pollutants converts local issues into regional and global concerns. Global concerns of air pollution include:

- Climate Change
- Ozone Depletion
- Acid Rain
- Asian Brown Clouds

The co-benefits of GHG and air pollutants reduction have also been realized. Thus, addressing air pollution and its sources would also take care of climate change. It is important that the global and regional communities work collectively to tackle the problem of air pollution. In order to prevent transboundary air pollution from becoming a more serious, widespread problem, it was thought imperative to initiate regional cooperation to undertake remedial measures. Various global and regional level initiatives have been taken to lessen the impacts of climate change and air pollution.

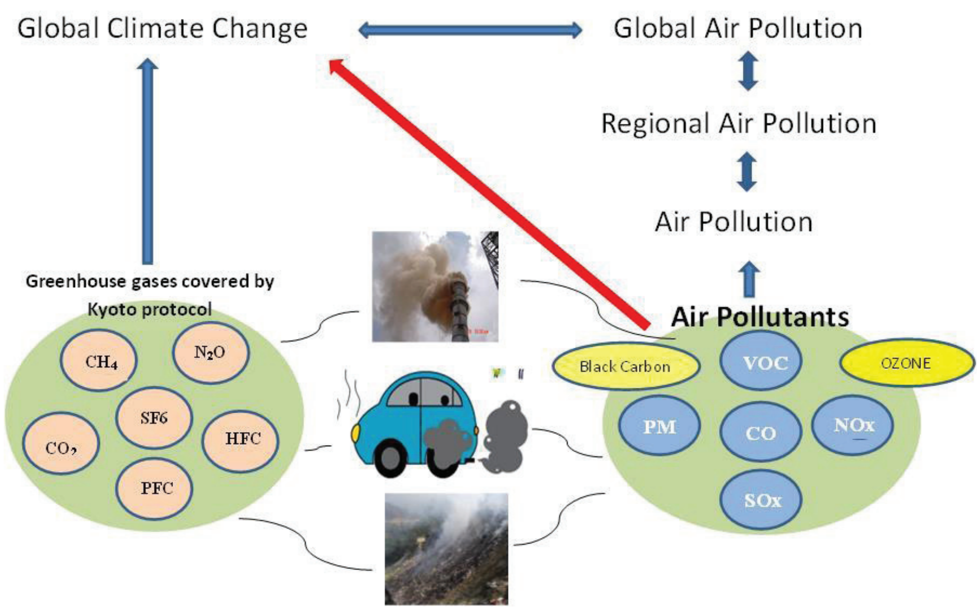

Figure 1-1 Co-benefits: GHGs and Air Pollutants Reduction

1.1.2 THE MALÉ DECLARATION

In keeping with the spirit of Agenda 21 and realizing the transboundary nature of air pollution, the United Nations Environment Programme, Regional Resource Center for Asia and the Pacific (UNEP RRCAP) in collaboration with the Stockholm Environment Institute (SEI) organized a round-table policy dialogue in March 1998 regarding the rapidly increasing problem of regional air pollution, with a focus on South Asia. The meeting was attended by distinguished groups of senior level environment ministry officials from South Asian countries, analysts and policy influencers, and representatives from key environmental organizations in the region. Noting the experience of Europe, it was agreed that there is a need for regional cooperation and a draft declaration was prepared. The Seventh Meeting of the Governing Council of South Asia Cooperative Environment Programme (SACEP), held in April 1998 in Malé, the Republic of Maldives, adopted the declaration naming it the "Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia". It is a regional level initiative and effort taken by governments of countries of South Asia to tackle air pollution problem of this region. The basic objective of this declaration is to foster regional cooperation to address the rapidly increasing problem of regional air pollution with a focus on South Asia.

The Malé Declaration stated the need for countries to carry forward, or initiate, studies and programmes on air pollution in each country of South Asia. The first stage in this process is to document current knowledge and information/ institutional capacity in each nation relevant to air pollution issues. To this end, it was agreed that baseline studies would be developed. Gaps in the current status of knowledge and capacity would become apparent and national action plans to fill these gaps could then be implemented, creating a solid scientific basis for the policy process. Implementation of the action plan will put in place expertise, equipment and information for quantitative monitoring, analysis and policy recommendations for eventual prevention of air pollution. Eight countries of the region, namely, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka signed the Malé Declaration and agreed to initiate and/or carry forward programmes in each country to

- Assess and analyze the origin and causes, nature, extent and effects of local and regional air pollution, using the in-house identified institutions, universities, colleges etc., building up or enhancing capacities in them where required;
- Develop and/or adopt strategies to prevent and minimize air pollution;

- Work in cooperation with each other to set up monitoring arrangements beginning with the study of sulphur and nitrogen and volatile organic compounds emissions, concentrations and deposition;
- Cooperate in building up standardized methodologies to monitor phenomena like acid depositions and analyze their impacts without prejudice to the national activities in such fields;
- Take up the aforesaid programmes and training programmes which involves then transfer of financial resources and technology and work towards securing incremental assistance from bilateral and multilateral sources;
- Encourage economic analysis that will help arriving at optimal results;
- Engage other key stakeholders for example industry, academic institutions, NGOs, communities and media etc. in the effort and activities.

Figure 1-2 Participating countries

Figure 1.2 indicates the countries participating in the Malé Declaration, viz., Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka. Each country has a National Focal Point and a National Implementing Agency as given in Table 1.1 below.

Table 1.1 Details of Participating Countries

No.	Name of Country	National Focal Point	National Implementing Agency
1	Bangladesh	Ministry of Environment and Forest	Department of Environment, Dhaka
2	Bhutan	National Environment Commission, Thimphu	National Environment Commission, Thimphu
3	India	Ministry of Environment and Forest	Central Pollution Control Board, New Delhi
4	Iran	Department of Environment, Tehran	Department of Environment, Tehran
5	Maldives	Ministry of Environment and Energy Malé	Ministry of Environment and Energy, Malé
6	Nepal	Ministry of Environment, Science and Technology	International Center for Integrated Mountain Development, Kathmandu
7	Pakistan	Ministry of Climate Change	Environment Protection Agency, Islamabad
8	Sri Lanka	Ministry of Environment and Natural Resources	Central Environment Authority, Colombo

1.2 AIR QUALITY IN ASIAN CITIES

Air pollution is a term used to describe the contamination of the air with substances that cause harm or discomfort to human beings or other living organisms and the environment. Emission of unwanted chemicals or other materials, in the form of gases and finely divided solid and liquid aerosols (loosely defined as “any solid or liquid particles suspended in the air”) can result in the degradation of air quality. This happens when the quantities emitted exceed the capacity of natural processes to convert or disperse them. Air pollutants may be primary or secondary in nature as a result of chemical reactions which take place in the air.
As per the continuous ambient air quality monitoring data of several Asian cities, the maximum annual average concentration of nitrogen oxides (NOx), particulate matter less than 10 µm in diameter (PM10), ozone (O_3), and carbon monoxide (CO), generally exceed the Ambient Air Quality guidelines stipulated by the World Health Organization (WHO).

Degrading air quality in urban areas is affecting the lives of millions of people due to health impacts associated with air pollution. Continued economic growth in Asia will result in further pressure on air quality. According to WHO estimation, about 5, 30,000 premature deaths in Asia occur every year because of outdoor air pollution. The quality of life of millions continues to be negatively affected, and the economic cost of air pollution is now believed to amount to 2-3% of GDP in many of the developing countries of Asia. In addition to this, air pollution is also affecting crops and biodiversity through acid deposition, damaging cultural and heritage properties through corrosion and contributing to climatic variability and extremes. Thus, air pollution is an environmental problem that transcends national boundaries.

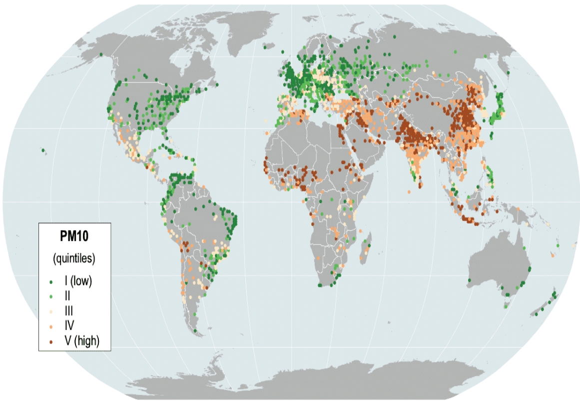

Figure 1-3 Asian cities are exposed to PM10, which is relatively higher than other cities in the world
Photo Sumber:Cohen, et al,2005

The above situation is an indication that though there are ongoing air quality management programs, there is definitely a need to further improve and strengthen them. It has also become clear over the years that the success of any program can be highly influenced by the support or otherwise of key stakeholders including the public. This is also important for a program to get its share of ‘brain space’ with decision makers.

The main driving forces for the deteriorating air quality in Asian cities are:

Population growth and urbanization

As population grows, demand for transport, energy, housing, and environmental services also increases. Such increases create pressure on the environment in the form of emissions of air pollutants which can affect air quality. Over the past decades, urban populations have grown more rapidly than rural populations. This is true as cities and towns become the engine of economic development in many Asian countries. As cities expand to their hinterlands, so does the distance from home to work in city centers which further raises the need for energy and transport, creating more burdens on the environment.

Figure 1-4 Dense city
Photo by DaniHamdan

Economic development

Many countries have experienced economic development and higher standards of living over the past decades. Conventional wisdom relates economic growth to increased air pollution; however, this is not always the case for all countries. In many developing countries as they undergo economic and industrial development, and motorization, demand for energy/fossil fuels tends to increase, thus, increasing levels of air pollution in the absence of effective policies or else their weak implementation.

Figure 1-5 City Development
Photo by Gracia

1.2.1 SOURCES OF AIR POLLUTION

Sources of air pollutants in Asian countries are both man-made (anthropogenic) or natural (biogenic). However, the former is of main concern, especially in urban areas of these countries with both stationary and mobile sources of air pollution. Stationary sources include point sources, like industries, or area sources like domestic, agricultural residue burning, release of gases from solid waste dumps, etc. The mobile source of air pollution is principally the transport sector, which includes road/rail based transportation, as well as water and air transportation. In cities motor vehicles are considered as the single largest mobile source of air pollution.

1.2.2 TYPES OF POLLUTANTS

Stationary Sources of Air Pollution

In keeping with the increasing demand for energy, thermal power plants, associated with combustion of fossil fuels, are the single largest source of air pollution. Other air polluting industries emit different pollutants depending upon their production processes, including combustion for energy conversion; incineration, evaporation, etc. Use of cleaner fuels, cleaner & more efficient technologies and adopting better pollution control measures would mean lesser emissions.

Figure 1-6 Stationary source

Domestic air pollution is mainly due to indiscriminate garbage dumping and open burning of garbage and biomass (Figure 1-7). Combustion of coal and wood in the kitchens (specially the weaker sections and in rural areas) has a potential to cause in-door and out-door air pollution (Figure 1-8).

Air pollution from the agricultural sector covers emissions as result of land clearing especially through burning crop residue after harvesting (Figure 1-9) or by its aerobic or anaerobic decomposition. It is a common practice in Asian countries to burn the agricultural residue left in the fields after harvesting for the purpose of quick clearing the land and preparing for the next crop. Moreover, most of these countries are rice producing and emission of methane and other greenhouse gases from the paddy fields is also well known. Intensive spraying of pesticides' is also a common practice and pesticide aerosols in air are common.

Figure 1-7 Open burning of garbage

Figure 1-8 Domestic pollution

Mobile Sources of Air Pollution

Automobiles are a significant mobile source of air pollution. Atmospheric pollutants commonly associated with motor vehicles are nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), sulphur oxides (SOx), lead (Pb), and particulate matter less than 10 microns in diameter (PM10and finer particles). Figure 1.10 gives the contribution of transport sector to air pollution in Iran and Sri Lanka.

Figure 1-9Agricultural residue burning in fields

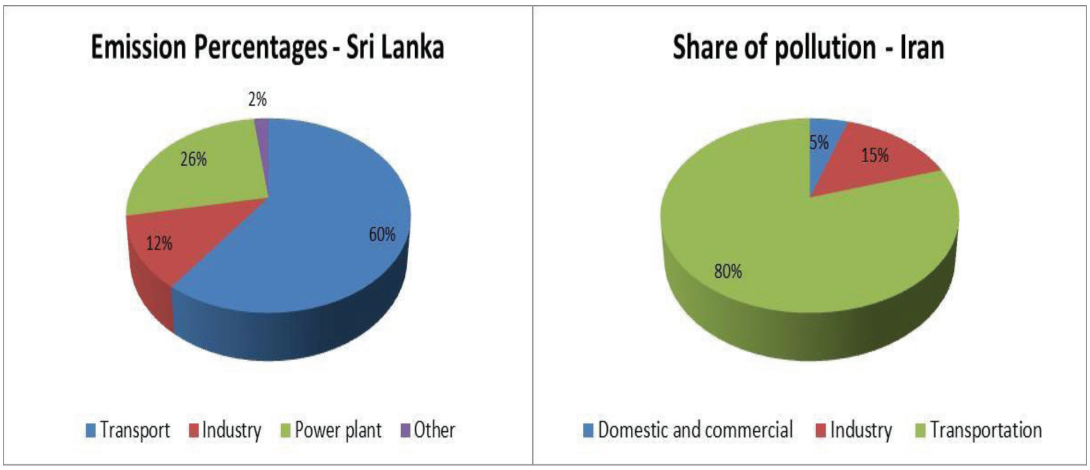

Figure 1-10 Emission percentages

The compounds in exhaust gases of vehicles are formed during the combustion of fossil fuels in the combustion chamber. Emissions from an individual car are generally low, relative to the smoky stack image many people associate with air pollution. But in numerous Asian cities, private cars and two wheelers are the single greatest polluters, as emissions from millions of vehicles on the road add up. Driving a private car is probably a citizen's most "polluting" daily activity. Apart from the increasing number of vehicles, vehicular pollution is also associated with the types of engines used, age of vehicles (old vehicles also exist often with outdated technology and non-observance of emission norms), congested traffic, poor road conditions, outdated automotive technologies and traffic management systems. The quality of fuel supplied has also compounded the problem of vehicular pollution. The composition of emissions depends on fuel used, driving conditions, engine type, gas emission controller, operational temperature, and other factors, all of which make emission pattern more complicated.

Pollutants emitted from motor vehicles are closer to the ground and can affect the air quality more directly as compared with the high rise smoke stacks of industry. Thus, people who live on the streets or do their activities in places with congested traffic, including drivers, pedestrians, traffic police and street vendors are exposed to high concentration of pollutants. Estimates of exposure dosage depend very much on the concentration of pollutants, which is related to the condition of traffic at that time.

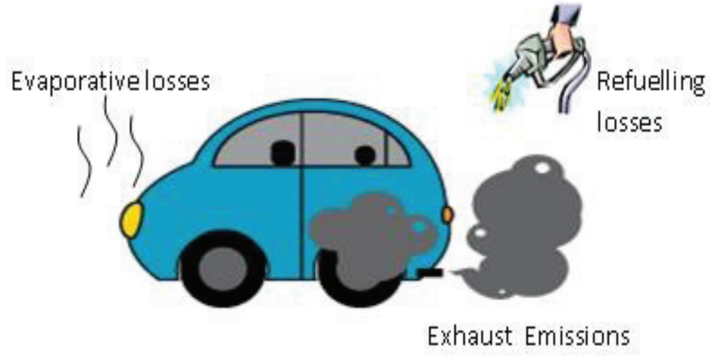

Figure 1-11 Emissions from motor vehicles

Once released to the atmosphere the exhaust gases from vehicles change because of chemical reactions, in the presence of sunrays and water vapour or due to reactions between themselves. Some more stable pollutants such as lead (Pb), several halogenated hydrocarbons and poly aromatic hydrocarbons fall to ground with rain or with dust and contaminate the soil and groundwater. The compounds can also enter the food chain and finally human body through vegetables, milk, products of food industry and other animal husbandry products.

Figure 1-12 Mobile source

Primary air pollutants such as, Particulate Matter (PM or “aerosols”), black carbon, sulphur dioxide (SO2), nitrogen oxide (NO) and carbon monoxide (CO), are the ones that are emitted directly into the atmosphere by sources (such as industry or automobiles). Volatile organic compounds (VOCs) are also considered as primary pollutants.

Secondary air pollutants are the ones that are formed as a result of atmospheric reactions between primary air pollutants and other elements in the atmosphere, e.g., ozone (O_3) is formed from photochemical reactions of nitrogen oxides and volatile organic compounds (VOCs); nitrogen dioxide (NO_2) and nitric acid (HNO_3) are formed from NO.

Some secondary pollutants like sulphates, nitrates, and organic particles can be transported over long distances. Wet and dry deposition of these pollutants contributes to the “acid deposition problem (often called “acid rain”), with possible damage to soil, vegetation and water bodies.

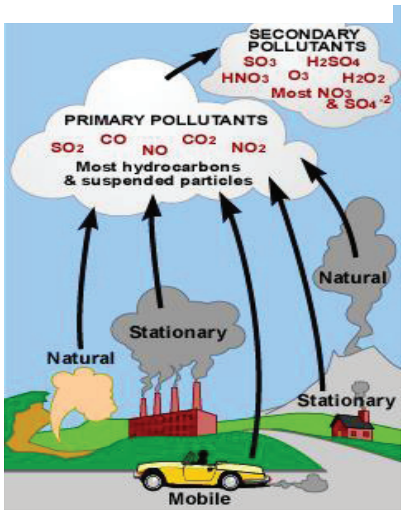

Figure 1-13.Sources of air pollution

Source : http://www.epa.gov/apti/course422/ap3.html

Air pollutants can be broadly classified into two groups:

- Criteria or major air pollutants and
- Hazardous air pollutants (HAPs).

Criteria pollutants

The criteria air pollutants consist of:
Nitrogen oxides ($NO+NO_2$): NO_2 is a reddish-brown gas with a sharp odour. The primary source of this gas is vehicular emissions and it plays a role in the formation of tropospheric ozone.

Sulphur dioxide (SO_2): It is a colourless gas with a suffocating, pungent odour. The primary source of SO2 is the combustion of sulphur-containing fuels (e.g., oil and coal). Coal based thermal power plants are the single largest source.

Carbon monoxide (CO): This odourless, colourless gas is formed from the incomplete combustion of fuels. The largest source of CO today is vehicular emissions.

Particulate Matter (PM): PM can exist in solid or liquid form, and includes smoke, dust, aerosols, metallic oxides, and pollen. Sources of PM include combustion, factories, construction, demolition, agricultural activities, motor vehicles, and wood burning.

Ozone (O_3): Ozone occurs in two layers in the atmosphere1 It can protect or harm life on earth depending on the layer it is in. The layer closest to the Earth's surface is Troposphere. Tropospheric ("low-level") ozone or "bad ozone" is harmful to breathe and it damages crops, trees and other vegetation and is formed as a result of photochemical reactions involving NO and VOCs. Automobiles are the largest source of VOCs necessary for these reactions. Ozone concentrations tend to peak in the afternoon. High up in the atmosphere, ozone forms a layer that shields the Earth from ultraviolet rays. However, at ground level, ozone is considered a major air pollutant. Ozone concentration is likely to reach unhealthy levels particularly on hot sunny days in urban environments. It is a major part of urban smog. Significant reduction in agricultural yields is expected because of increase in ground-level ozone and due to pollution. These interfere with photosynthesis and stunt the overall growth of some plant species. The troposphere generally extends up to 6miles up from earth's surface where it meets the second layer the Stratosphere which extends upward from about 6 to 30miles. The Stratospheric ozone protects life on earth from the Sun's harmful ultraviolet (UV) rays.
Lead: The largest source of lead in the atmosphere has been from leaded gasoline combustion. However, there is now a gradual elimination of lead in gasoline. Of the eight participating countries, India and Sri Lanka have already phased out lead from gasoline Other airborne sources of lead include combustion of solid waste, coal, and oils, emissions from iron and steel production and lead smelters, and tobacco smoke.

The HAPs, also called toxic air pollutants or air toxins, consist of chemical, physical and biological agents of different types that cause or may cause cancer or other serious health effects, such as birth defects. There are 189 hazardous air pollutants identified by the Clean Air Act of the USA. These are present in the atmosphere in much lower concentrations and are often more localized, but are toxic or hazardous in nature. Examples of HAPs include a range of organic compounds like, benzene, toluene, xylene, and other toxic organic pollutants, e.g., polycyclic aromatic hydrocarbons (PAHs), pesticides and polychlorinated biphenyls (PCBs). HAPs also get adsorbed on particulate matter, specially the fine particulate matter-PM2.5.

Common Pollutants of Concern and Health Impacts

Clean air is a basic necessity for sustenance of life. In spite of introduction of cleaner technologies in industry, energy production and transport sectors, air pollution remains a major health and ecological risk. Recent epidemiological studies have provided evidence that even low pollution levels increase mortality and morbidity (the rate of disease or proportion of diseased persons in a given locality, nation, etc., that is, the incidence or prevalence of a disease).

The relationship between urban air pollution and its risks to health has only been discussed in the last several decades. Its harmful effects range from increasing mortality rate due to smog episode to aesthetics and life discomforts. Other health disturbances are pulmonary, cancer, acute or chronic throat disorders, and other harmful effects of pollutants on body organs such as lungs and the central nervous system. Because every individual is exposed to many compounds at the same time, it is often very difficult to determine which compound or which combination of compounds has the most prominent role in causing danger to health.

The danger of emissions or air pollution to health depends on the toxicity of each compound and how many people are exposed to it. Several factors which cause uncertainty analyzing the risks of air pollution are definitions used regarding to dangers to health, relevance and interpretation of epidemiological study and experiment, reliability of exposure data, number of people exposed, decisions regarding which risk groups will be protected, interaction between various compounds in exhaust gas, either of similar type or different type and period of exposure.

In general, the term danger to health is the effect of pollutant on anyone or any group of people, which can increase risk towards any disease or other kinds of medical condition. The risk is not only to clinical diseases but also risk to longevity, etc.

It has been proven that children and old people are the highest risk groups in air pollution cases. Children are more sensitive to respiratory tract infections than adults, and their lungs also have not developed fully. Old people are included in the high-risk group because their lung capacity and function have decreased and their immunity also has weakened. Heart and lung disease patients are also included in this high risk group to air pollution.

Based on their chemical property and environmental behavior, air pollutants can be classified as follows:

- Air pollutants which cause respiratory tract disorders, i.e., oxides of sulphur, particulate matter, oxides of nitrogen, ozone, and other oxides.
- Systemic poison air pollutants, i.e., hydrocarbons, carbon monoxide and lead, toxic substance such as mercury whose effect is not localized in one spot but spreads to all body organs and systems in varying degrees - that affects the entire body. Also called systemic toxicant.
- Carcinogenic pollutants such as hydrocarbons.
- Others such as noise, dust, etc.

1.3 THE MALÉ DECLARATION MONITORING PROGRAMME

The objective is to gather national information on air pollution to facilitate the implementation of the Malé Declaration in South Asian countries in order to achieve significant environmental and public health benefits through reductions in emissions of air pollutants. Deposition reductions are unlikely to be met solely through national policies and measures because of the transboundary nature of air pollution transfer.

Monitoring of air quality is an important component of any Air Quality Management (AQM) program as is evident from the figure below. One of the main challenges in air quality management (AQM) is to have timely and appropriate access to air quality data which are relevant and of known quality as it allows effective decision-making on air quality issues. The air quality monitoring data also helps in assessing compliance with current ambient air quality guidelines and standards and to assess trends in air pollutant concentrations. It can also be used to determine the effectiveness of existing national and regional and proposed policies.

Therefore, there is a need for inter-governmental cooperation and the development of uniform sub-regional air quality assessment procedures and appropriate action plans.

The information collected from baseline studies will be used to develop national and sub- regional action plans and to establish a consistent air quality assessment procedure for each nation.

Thus, the assessment procedure has to begin with the collection of detailed knowledge describing the existing situation. The aim is to know which air pollutants are present and in what quantities, their origin, their dispersal patterns, the potential that they will impact on sensitive receptors, and what response measures should be taken to ameliorate the situation.

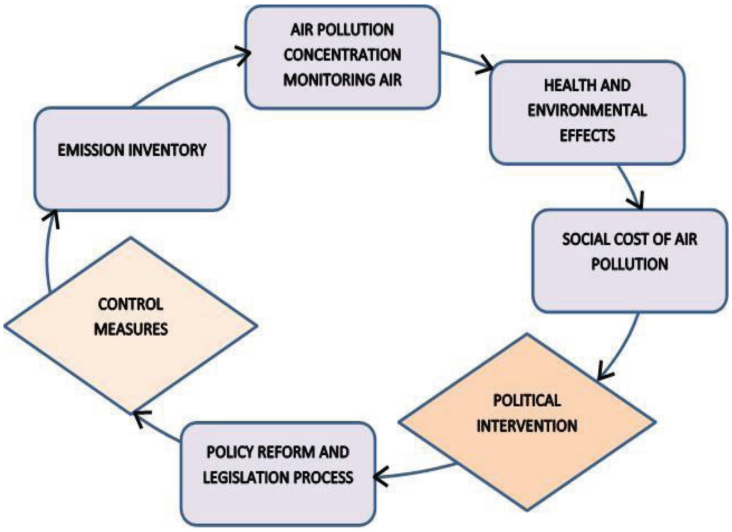

Figure 1-14 Air Quality Management Cycle

Malé Declaration is dedicated to creating a common understanding of the status of trans boundary air pollution and its effects among member countries and collaborating organizations, and for providing useful inputs for the assessment of air quality in the region and that this understanding will provide the scientific basis for steps to tackle this problem. Hence, it is very important that uniform and regular monitoring be carried out by all the participating countries at the selected locations for the decided parameters; the results be compiled in a systematic database, as information on outcome of monitoring activities is known only through monitoring data.

The transport of atmospheric gases and particulate matter (aerosols) and adsorption by the Earth's surface (land surfaces, plant surfaces, building surfaces, water surfaces), without the mediation of precipitation is known as the dry deposition, while dissolution of these species in clouds, fog, rain or snow and eventually rain out or wash out by the falling rain or snow is known as the wet deposition.

The proportion of wet and dry deposition can vary with location and time and will largely be related to the meteorological conditions. Wet deposition is responsible for 30-50% of deposition fluxes to ecosystems in South Asia. Precipitation chemistry measurements provide information on the exchange of trace materials between the atmosphere and the earth's surface. Dry deposition accounts for 50-70% of total deposition fluxes to the ecosystem. It is therefore important to monitor dry and wet deposition to obtain a complete evaluation of total deposition in a region, which is necessary for assessment of the effects of the atmospheric pollution.

One of the goals of the Malé Network is to share high-quality data and other information on wet and dry deposition and its composition with the Malé Declaration participating countries.

This report presents the data generated by the participating countries over the last three years (2009-2011) with a goal to share the results of monitoring as well as to evaluate the data generated specially with respect to trends if any. It is expected to provide an important basis for a common understanding of the present status of monitoring and the environment in the countries as well as the matters needing future attention.

CHAPTER 2. MONITORING PROGRAM

2.1 MONITORING LOCATIONS

The Malé Declaration monitoring programme was started in 2001. Each of the eight countries identified monitoring locations as per the laid down criteria in remote areas away from factors of direct influence. The details of the monitoring site in each participating country are presented in Table 2.1

Table 2.1 Details of Monitoring Locations

S No	Country	Site Type	Location	Longitude Latitude	Remarks
1	Bangladesh	Rural	Kulna	22o 18.975' N; 89o 02.607'E	About 30 km North to the Sundarbans forest.
2	Bhutan	Remote	Thimphu	27°0'N; 90°30'E	350m above sea level close to Jigme Singye Wangchuk National Park and Manas National park
3	India	Rural	Port Canning	22019′8″N	Average annual rainfall: 1750 – 1800 mm. Dominant wind direction: N/NE during winter and S/ SW in summer close to Sundarbans
			Dawki, Meghalaya	26047′06″ N	Bordering Bangladesh Operating since August 2009
		Rural	Pathankot, Punjab	3201′60″ N 7501′0″	Bordering Pakistan
		Rural	Daranga, Assam	26048′ N	Bordering Bhutan
			Kavaratti , Lakshadweep	100 0′ N 730 0′	Bordering Maldives
			Andaman & Nicobar Islands		Bordering South-east Asia
4	Iran	Rural	Chamsari	32° 24'N, 47°31'E	40 km south to the town of Dehlaran and about 200 km south to Ilam, the headquarters of the province
5	Maldives	Remote	Hanimaadhoo		Altitude: ~2 m. Located in the northernmost atoll of Maldives located about 400 km to the north of the country's capital, Malé.

S No	Country	Site Type	Location	Longitude Latitude	Remarks
6	Nepal	Rural	Rampur	27o 38'N; 84o 20'E	At the premises of the Institute of Agriculture and Animal Sciences (IAAS) located about 15 km to the south of the Royal Chitawan national park. Altitude: 164.95 m
7	Pakistan	Rural	Bahawalnagar	290 57'N; 730 15'E	
8	Sri Lanka	Rural	Doramadalawa	080 24' 22.39" N 800 29' 11.74" E	On a rock near Doramadalawa Buddhist temple and 10 km arial distance from the ancient city of Anuradhapura

In order to ensure the ownership of the programme, National Implementation Agencies (NIAs) were given complete freedom on site selection with technical guidance from the MoC. The local communities and the village heads were also consulted during site selection in most of the countries. The details of the site location in some of the countries is as follows,

2.1.1 BANGLADESH

Figure 2.1 gives the installation of diffusive samplers and bulk sampler at the Bangladesh monitoring site. Figure 2.3 gives the wind rose for the meteorological data available for 2008.

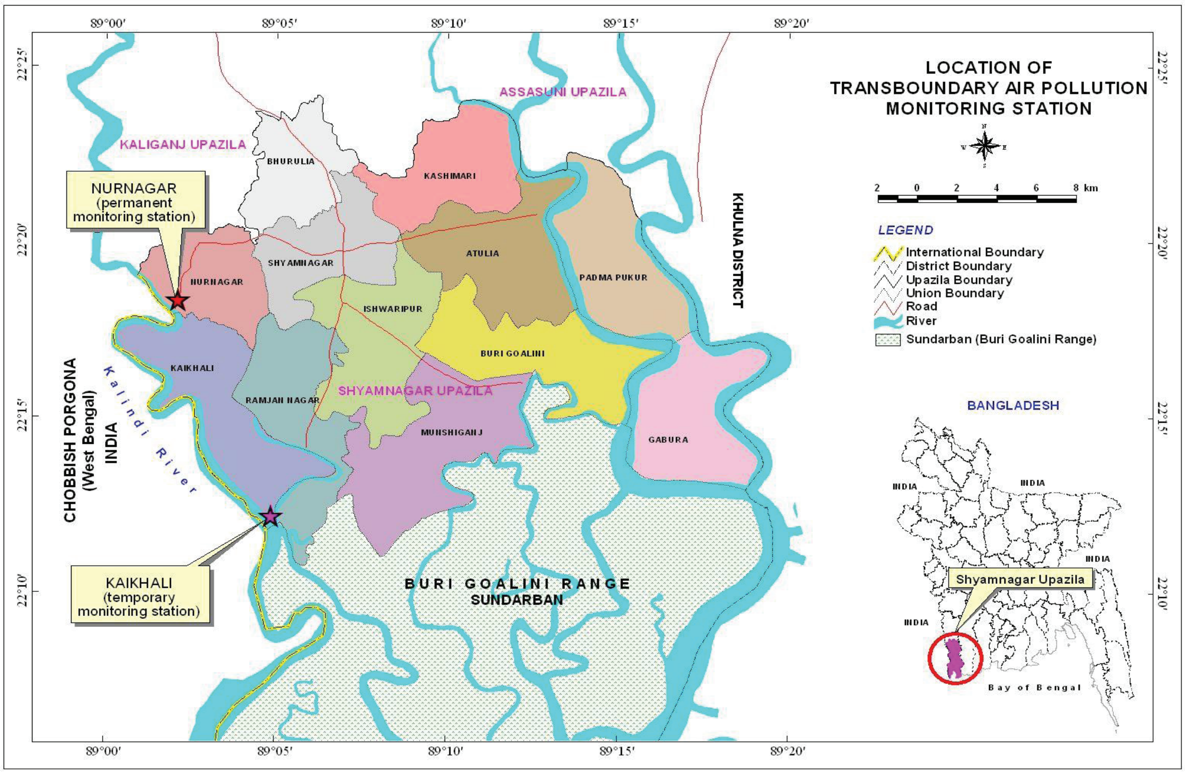

Figure 2-1 Site for monitoring location, Bangladesh

Figure 2-2 Passive Sampler; Station with bulk sampler

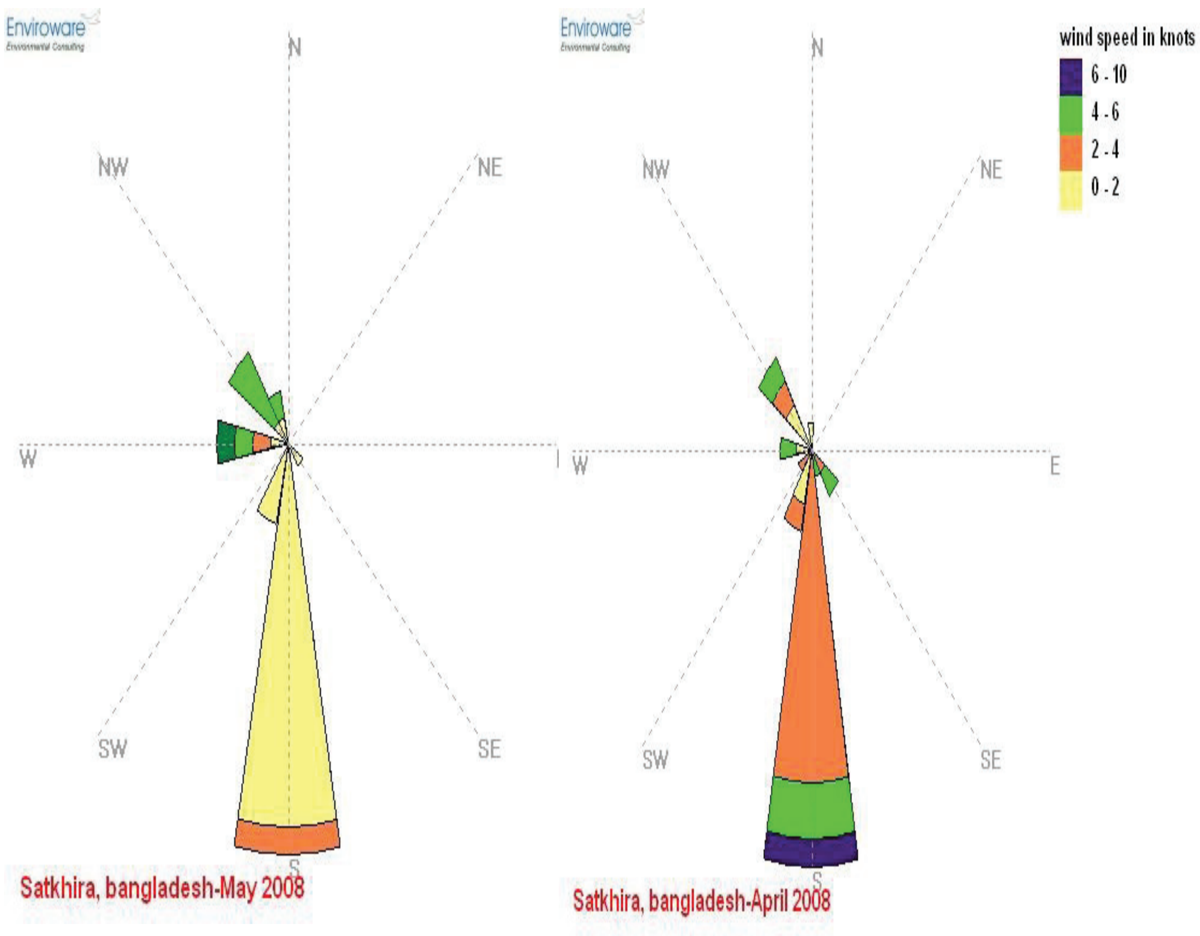

Figure 2-3 Wind rose for met station, Bangladesh

2.1.2 BHUTAN

The location details for the two sites in Bhutan are given in Figures 2.4 and 2.5.

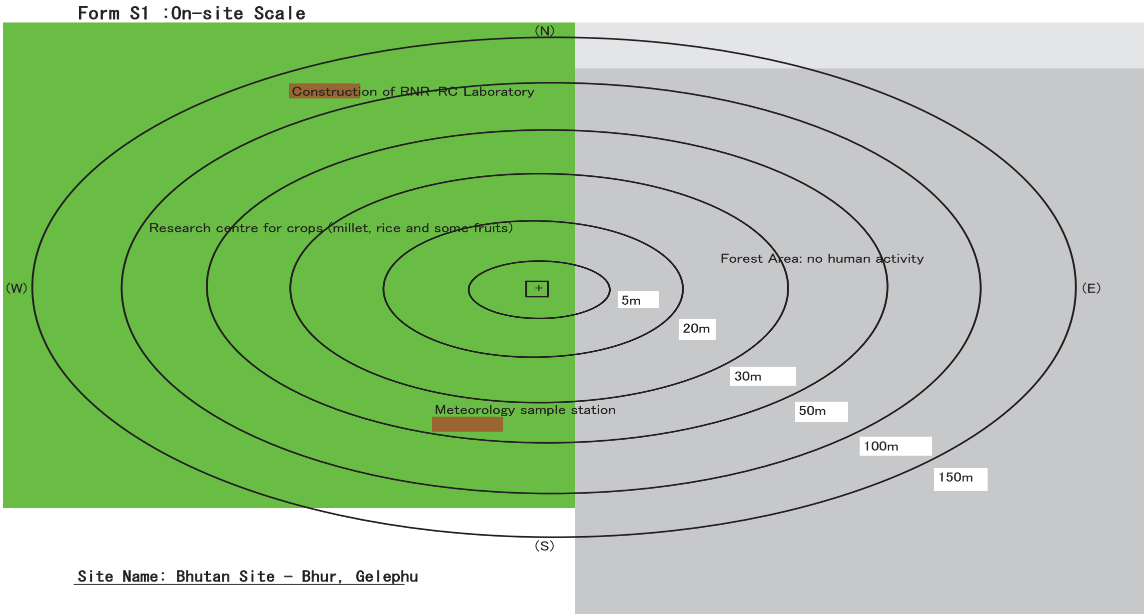

Figure 2-4 Urban site – Bhur, Gelephu - Bhutan

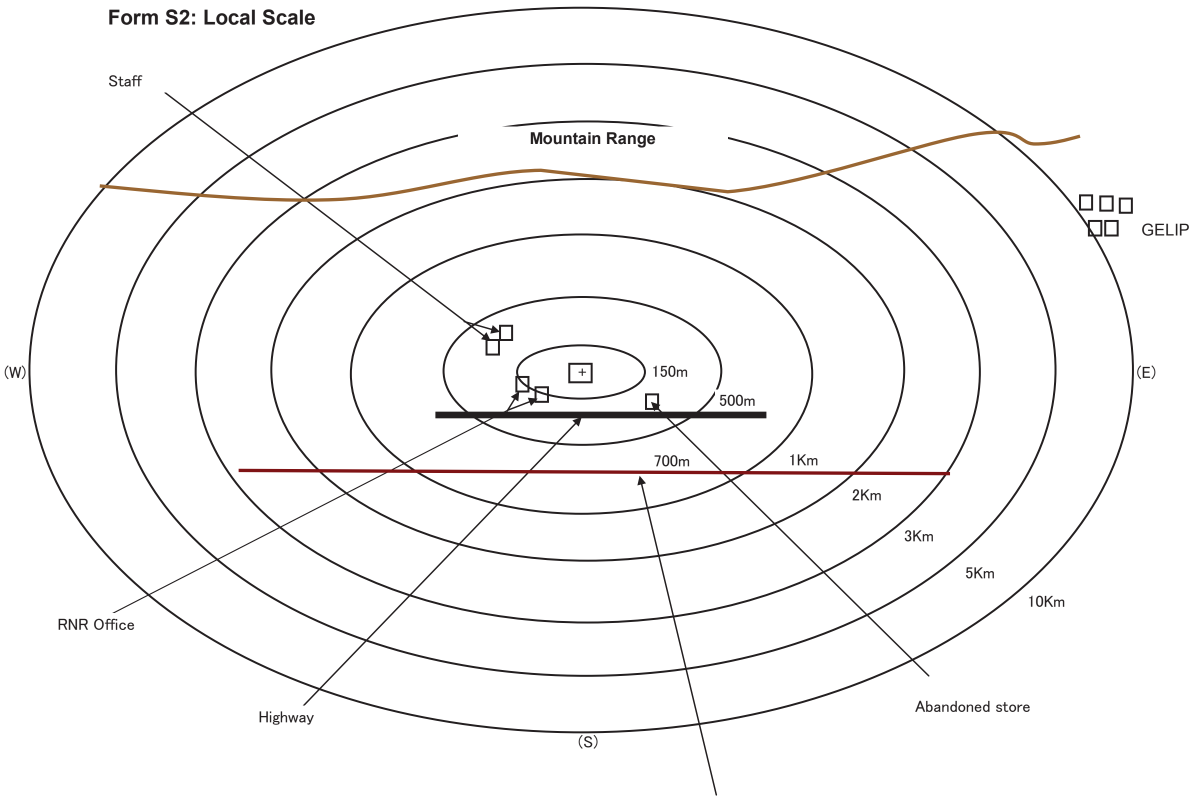

Figure 2-5 Gelephu in Southern Bhutan

Figure 2-6 Wet monitoring, Bhutan

2.1.3 IRAN

The first monitoring station is located at Chamsari, on the Iraq border, in the southern part of Ilam Province. A map of the monitoring site and its surroundings is provided in Figure 2.7.

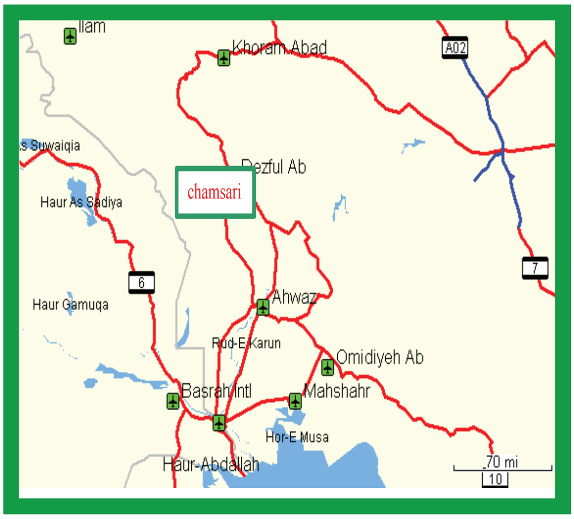

Figure 2-7 Site for the monitoring station - Iran

The site is at Chamsari, which is located a few kilometers from the Iraq border. Chamsari is 40 km south of the town Dehlaran and about 200 km south of Ilam, the head quarter of the province. The monitoring site is in a military area. There are two small villages at a distance of 5-7 km to the north and northwest of site. The site is barren and has loose gravel. The cooking energy used by the villagers is LPG (Liquefied Petroleum Gas). No biomass burning was reported to occur in the villages.

Chamsari is a deposition-monitoring site.

There are two oil wells located about 12-15 km north and south of the site, respectively. The oil wells have flares.

DoE officials had looked for alternative sites to Chamsari. Either the existence of hill ranges very close to the Iraq border or the lack of power lines made Chamsari the only viable site in the proximity of Baghdad, the major emission source across the border.

No meteorological station exists within a 50 km radius of Chamsari. Summer temperatures at the site exceed 50°C.

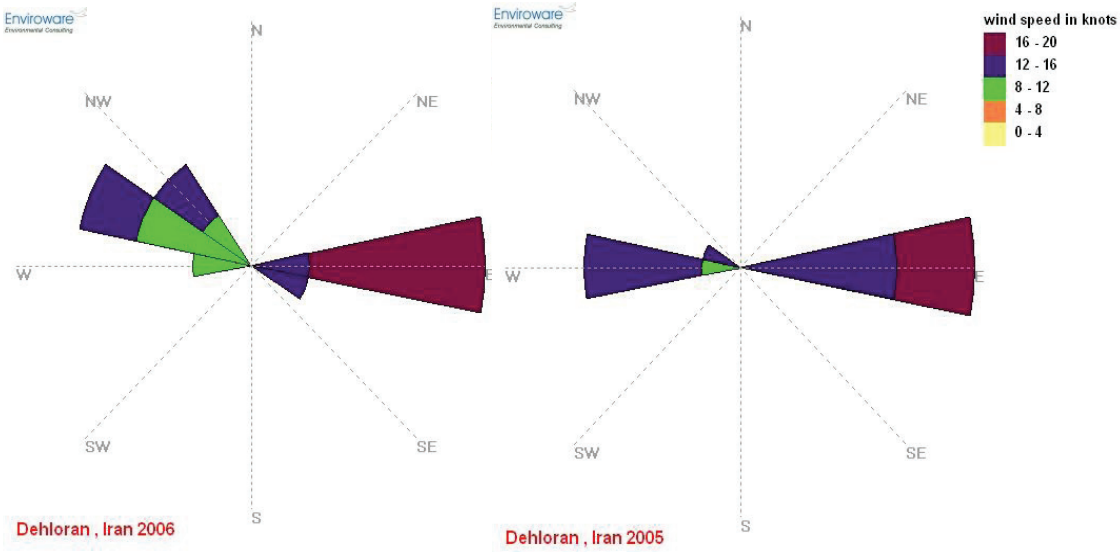

Figure 2-8 Wind rose for met station, Iran

2.1.4 MALDIVES

The monitoring station is located on the Hanimaadhoo Island, located about 400 km north of the country's capital, Malé. The same location was to be used to monitor the Atmospheric Brown Cloud. A training programme for handling the monitoring instruments was conducted on Hanimaadhoo Island. A map of the monitoring site and its surroundings is provided in Figure 2.9.

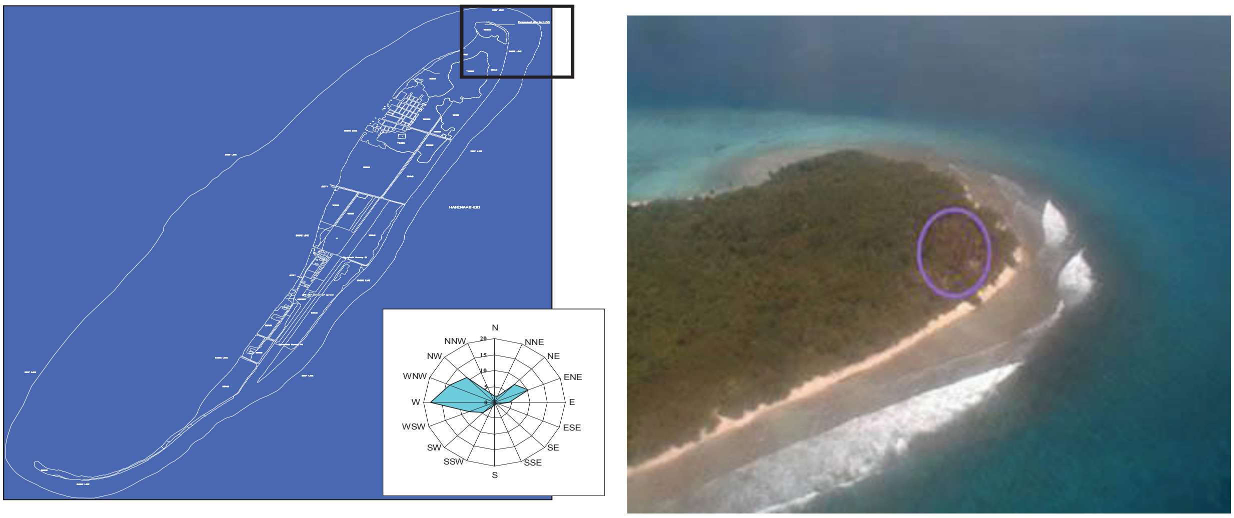

Figure 2-9 Site for monitoring location, Maldives

The site where the instruments were located is at the northern tip of Hanimaadhoo Island, which is about 5 km in length and half a kilometer at its widest point. The island has an airstrip and a daily air service from Malé. It also has a small village with a population of 800 persons located between the airstrip and the monitoring station which is about 1.5 km north of the village. The cooking energy used by the villagers is LPG.

No biomass burning was reported to occur on the island. There is thick vegetation all over the island, including between the village and the proposed monitoring station.

There is a diesel generator power station of 400 KW capacity located in the village. The stack height of the station is 20 m and below the tree-line.

Monitoring for wet and dry deposition can be done on Hanimaadhoo Island.

A meteorological station exists at the airport. The station monitors wind direction and speed, relative humidity, temperature and pressure.

Though other uninhabited islands that had no anthropogenic interferences were available, transport costs to such islands would have been prohibitively expensive. It was therefore felt that Hanimaadhoo Island was a practical choice

Figure 2-10 Sampling at Maldives monitoring site

2.1.5 NEPAL

The IAAS campus was chosen to be first monitoring station. The IAAS campus is located about 15 km south of the Royal Chitawan national Park and about 25 km north of the Indian border. The maps of the monitoring site and its surroundings are provided in Figure 2.11 and 2.12. The site is bounded by two roads which lie outside the campus and which have some vehicular traffic on them. The campus has some internal roads, but with little vehicular traffic. The site is in the midst of experimental agricultural farms of IAAS.

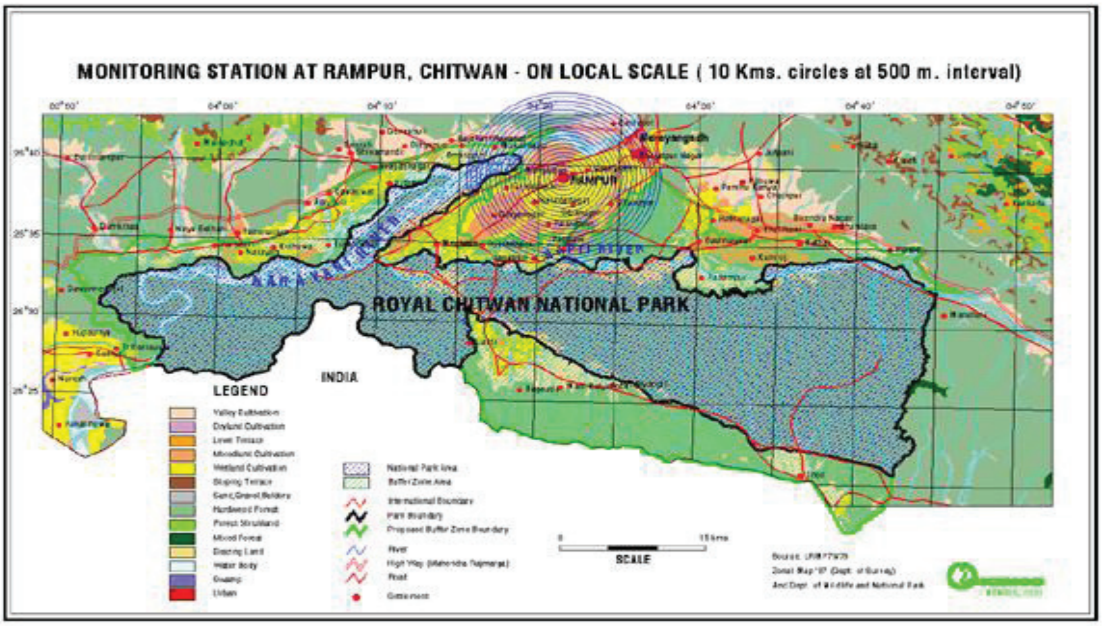

Figure 2-11 Site for the monitoring station - Nepal

The IAAS site is a deposition-monitoring site and it meets the following siting criteria:

- The site is close to the Indian border.
- The site is in a broad downwind direction from major power plants in India.
- There is no forest between the site and Indian border, nor is the forest too close to the site.
- The site is not influenced by local meteorological conditions.
- The terrain between the site and the international border is flat land.
- The site is secure and easily accessible.

Since sample analysis will be done on the IAAS campus, there will be little time gap between sample collection and analysis.

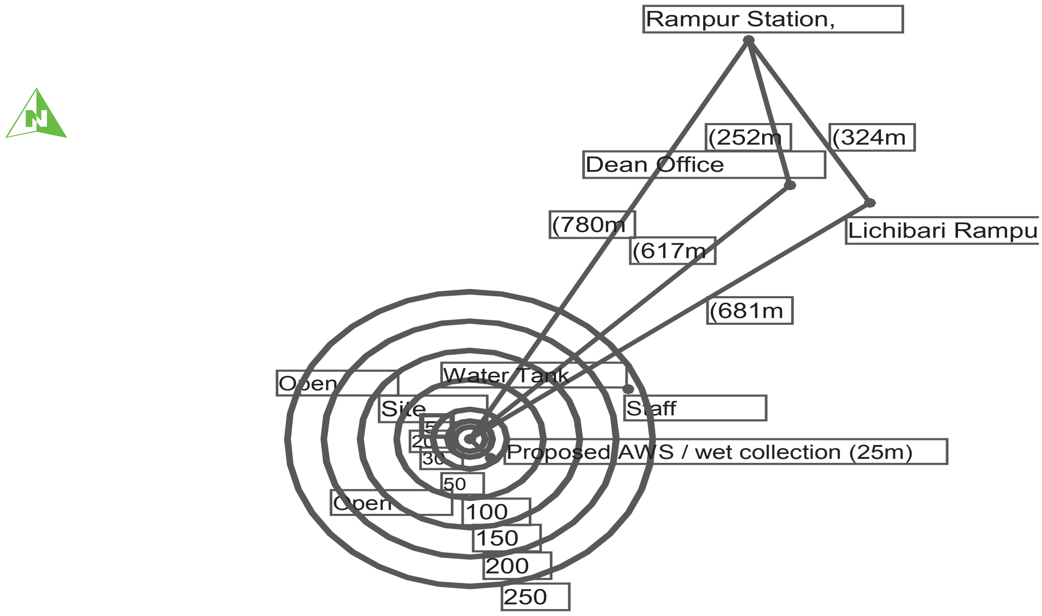

Figure 2-12 On Site Scale (5m-250m) – Nepal

2.1.6 PAKISTAN

The boundaries of Bahawalnagar District touches the Indian territory in the East and South while Bahawalpur district lies on its West and river Sutlej flows on its Northern side across which districts Okara, Pakpattan and Vehari are situated. The distance of International Border is about 10 Km from the monitoring site .

Figure 2-13 Monitoring location Bahawalnagar, Pakistan

Figure 2-14 Photographs of Bahawalnagar site

Figure 2.15 gives the annual wind rose diagram at the monitoring location in Pakistan.

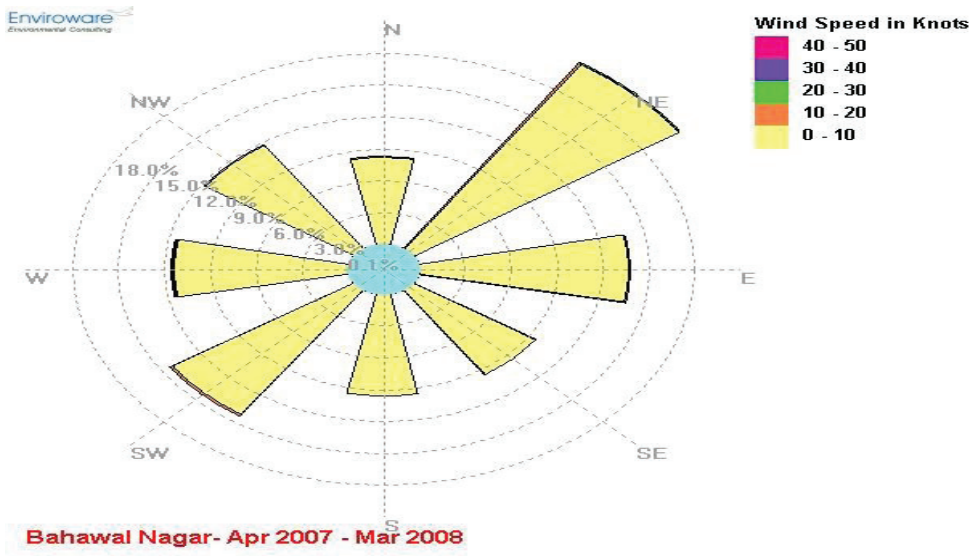

Figure 2-15 Annual average wind rose for Bahawalnagar met station, Pakistan

2.1.7 SRI LANKA

The intensity of the annual rainfall divides the Sri Lanka island into two distinct climatic zones, the wet zone and the dry zone. Nearby three quarters of Sri Lanka lies in 'Dry Zone', comprising the northern half and the whole of the east of the country. Average annual rainfall in this region is generally between 1,200-1,800 mm.

The monitoring site in Sri Lanka was changed from Dutuwewa to Doramadalawa in 2009 due to non-availability of uninterrupted power supply for carrying out PM-10 sampling.

The present sampling location of Sri Lanka is situated at Doramadalawa (080 24' 22.39" N, 800 29' 11.74" E) in dry zone around at 10 km areal distance from the ancient city called Anuradhapura. This monitoring site is on the small rock nearby Doramadalawa Buddhist temple at the edge of the Mihinthale reserve forest. This location is classified as rural site.

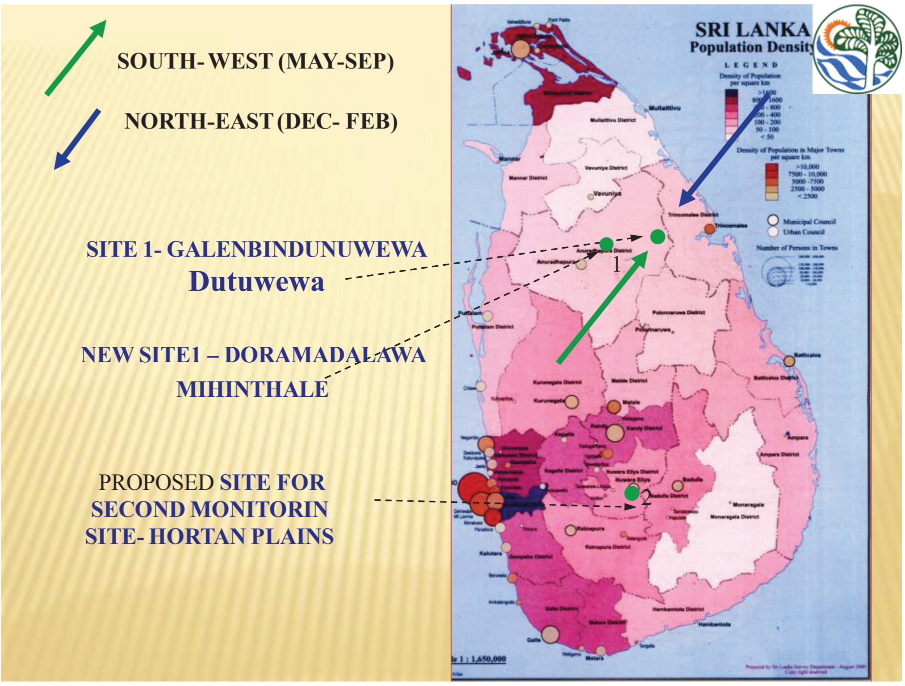

Figure 2.16 Major wind direction

Parallel monitoring of wet deposition was done during the year 2009 with previous monitoring site which was located at Dutuwewa also in dry zone. Wet and dry deposition monitoring was done at Dutuwewa is located about 40 km east of Anuradhapura from2004 to 2009.PM10 monitoring was started at the new site 10th January2010 onwards.

There are no major emission sources close to the Doramadalawa monitoring site. However, there is a seasonal impact due to open burning of forest residues and the paddy straws during the preparation of agriculture fields for cultivation before rain during from July to October which is the main activity at dry zone during the second intremonsoon and north east monsoon period from end August to February

Figure 2.17 Doramadalawa monitoring location – Sri Lanka

A second monitoring location under the programme is now proposed at Hortan Plains to represent the wet zone.

2.2 PARAMETERS AND METHODOLOGIES

The following monitoring parameters and methodologies were identified under the measurement protocol developed for each of the monitoring locations. Based on the methodologies finalized, the participating countries were provided with equipment, glassware and chemicals. The methodologies to be adopted could be broadly grouped into:

- Wet Deposition Monitoring;
- Dry Monitoring; and
- Collection of Meteorological Data.

2.2.1 WET DEPOSITION MONITORING

A large number of chemicals released from natural or anthropogenic sources are present in the atmosphere as gases or aerosols. These are absorbed by the rain droplets and snow on their way to the earth. Natural sources of pollution may broadly include sea salt, eroded earth material and biogenic activities while fossil fuel combustion and agricultural are the major anthropogenic sources. The composition of the rain water depends on the chemical species that have dissolved in it and thus gives a fair idea of the status of air quality of a region. With this in mind it was thought imperative to monitor the wet deposition and study its characteristics'

To obtain uniformity and high quality monitoring data a protocol was developed and each participating country was required to carry out the wet deposition monitoring using the two common methodologies which have been specified in the "Technical Document for Wet and Dry Deposition Monitoring for Malé Declaration". This document was provided to the concerned during the in-country training programmes. The sample so collected was required to be refrigerated before analysis. Under the wet monitoring the weekly composite samples collected by two methods were to be analysed for the same parameters as per the detail Table2-1.

Figure 2-18 Learning rainwater sampling

Table 2-1 Parameters for Wet Measurements

S No	Method	Duration/Frequency	Parameters
1	Wet(Wet) Method	Weekly composite	H+(pH), electrical conductivity(EC), concentration of NH4+,Na+,K+,Mg2+,Cl-,SO42-,NO3-, precipitation
2	Wet(Bulk)Method	Weekly composite	H+(pH), electrical conductivity, concentration of NH4+,Na+,K+,Mg2+,Cl-,SO42-,NO3-, precipitation

The wet-only and bulk samplers are recommended methods for sampling of precipitation. Samples collected are sent to laboratories for chemical analysis. For the wet deposition samples collected in a tropical region, a preservation of samples from microbial decomposition has to be considered. Biocides such as Thymol are added for that purpose when a refrigerator is not available during sampling, transportation and storage. Samples without biocides are refrigerated to keep the sample temperature low enough to preserve the sample chemistry, and sent to the laboratories for further chemical analysis. The analytical methodologies are also detailed in the Technical Document.

At each site one sampler for bulk precipitation was located. Precipitation samplers (Standards for Swedish deposition monitoring) were placed in an open field area windy places were avoided as far as possible.

The equipment (Figure 2. 19) consists of a funnel (A) (diameter 20.3 cm). Within this large funnel, a smaller funnel (B), containing a screen, is placed to protect the sample from litter and evaporation. The sample is collected in a 5 L bottle (D). The sampling equipment is placed on a pole (F) equipped with a plate (E), approximately 1.5 m above the ground.

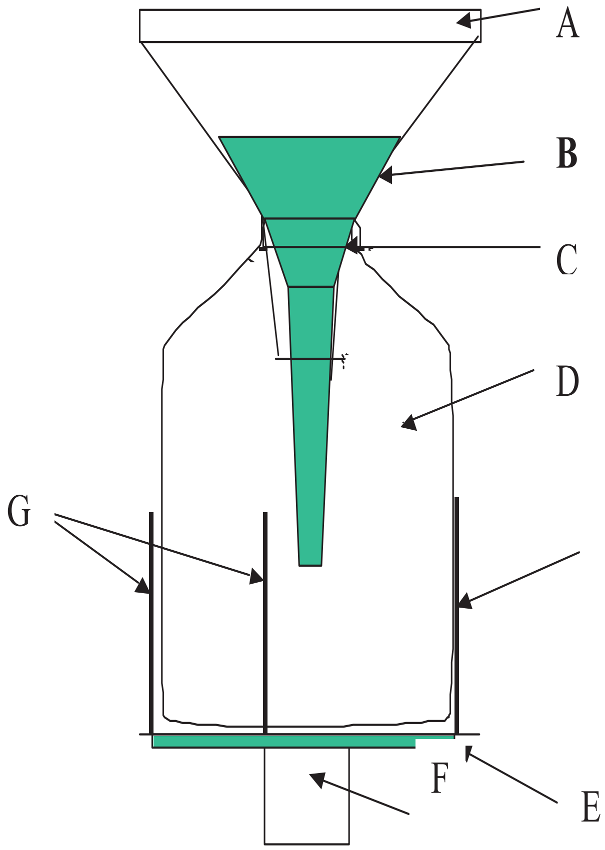

Figure 2-19 Open field collector for precipitation.

(A) Funnel of polyetene (20.3 cm dia.) . (B): Inner funnel of polyetene with small opening. (C): Cap, leakage free connection. (D): Polyetene bottle (5L) (E): Bottom plate fastened onto the pole. (F): Pole of wood (50x50 mm) length ca 1.5m above ground. (G): Four rods to ke ep the equipment in place

Weekly composite rainwater samples were collected with both an automated wet-only collector technique and a bulk sample collector technique. The countries used a wet only sampler to collect samples during rain events only and bulk sampler representing the total deposition during the period.

A flow chart for sampling and analysis of the wet deposition samples is shown in Figure2.20.

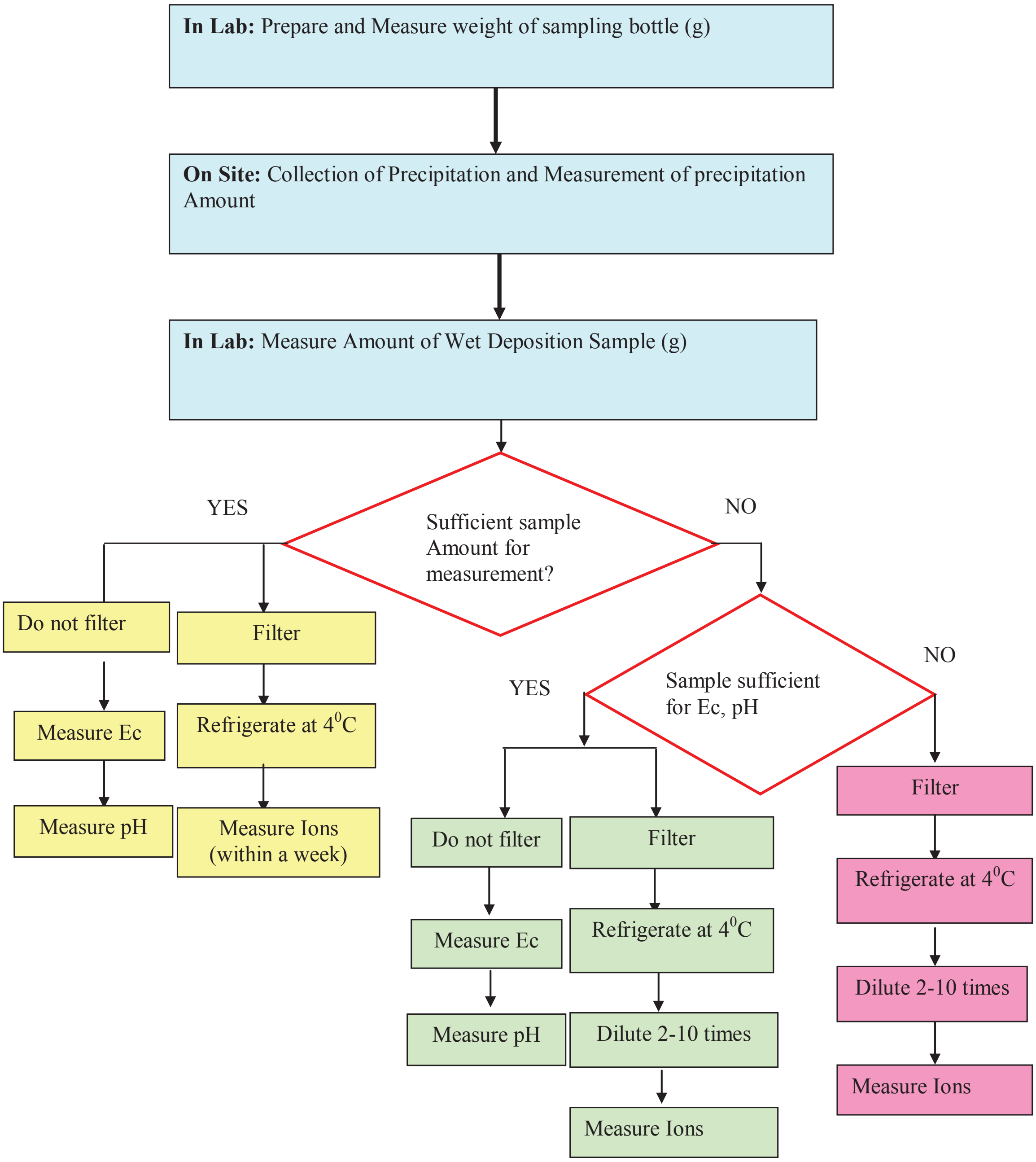

Figure 2-20 Flow chart for sampling and wet analysis deposition

Note: In case of very low volume of sample the order of measurement should be as follows
SO42-, NO3- and Cl-
NH4+, Na+, K+, Ca2+ and Mg2+
If IC is being used, NH4+, Na+, K+, Ca2+ and Mg2+
If no IC is used, NH4+ by spectrophotometry, Na+, K+, Ca2+ and Mg2+ by AAS

Bangladesh, Bhutan, Iran, Nepal, Pakistan and Sri Lanka have submitted the rainwater analysis data from their monitoring site. A perusal of Table 2.2 indicates that the sampling frequency is different for most of the countries. The samples were collected on a daily basis at two sites (Bhutan and Bangladesh); weekly collection is performed at the site in Sri Lanka, monthly collection and analysis at Nepal and random collection at Pakistan site.

Bangladesh, Bhutan, Iran, Nepal, Pakistan and Sri Lanka have submitted the rainwater analysis data from their monitoring site. A perusal of Table 2.2 indicates that the sampling frequency is different for most of the countries. The samples were collected on a daily basis at two sites (Bhutan and Bangladesh); weekly collection is performed at the site in Sri Lanka, monthly collection and analysis at Nepal and random collection at Pakistan site.

2.2.2 DRY DEPOSITION MONITORING

Dry Deposition monitoring was carried out by two methods,

1. High Volume Samplers (HVS)/PM10 Samplers

High Volume Samplers were used to monitor SO_2, NO_2, PM10 and SPM in Malé Declaration Network. Two 12hourly samples were required to be collected each day to get a 24hr average. Monitoring was to be carried out for 10days between 5-25th of each month. The samples from HVS were analyzed in their respective laboratories using suitable analytical methods such as gravimetric for particulate matter and spectrophtometric for SO2 and NO2

Figure 2-21 Learning rainwater air sampling

2. Diffusive (Passive) Samplers

Diffusive samplers were used to collect monthly composite samples of SO_2, NO_2 and ozone. The samples collected with diffusive samplers were repacked in their containers at the end of sampling interval and sent to IVL-Swedish Environmental

Figure 2-22 Diffusive samplers at a Malé station

Research Institute Ltd. for analysis. The start and end time of the sampling period were recorded.

Under the dry measurements also the monitoring was required to be carried out by two methods for the parameters as per following details,

Table 2-2 Parameters for Dry Measurements

S No	Method	Duration/Frequency	Parameters
1	Diffusive (Passive) Sampling	Monthly composite	Concentration of SO2, NO2,and O3
2	Air concentration Sampling(Using PM10 samplers)	24hr composite(consisting of two samples – 9am to 9pm and 9pm to 9am)To be carried out for 10days in a month between 5th and 25th of each month	Concentration of PM10, TSPM, SO2 and NO2

Note: PM10 – particulate matter of 10µm or less particulate size (respirable particulate matter)
TSPM – total Suspended particulate matter

2.3 ANALYTICAL PROCEDURES

The procedures suggested for analysis of the major constituents of rainwater given in Table 2.3.

Table 2-3 Techniques suggested for analysis of major constituents in rainwater

S No	Parameter	Instrumental Method
1	Electric Conductivity (EC)	Conductivity meter
2	pH	pH meter(glass electrode)
3	Chloride(Cl-)	Ion chromatography or Argentometric method
	Nitrate(NO3-)	Ion chromatography or Cadmium reduction method Spectrometry
	Sulphate (SO42-)	Ion chromatography or turbidimetry
4	Ammonium(NH4+)	Ion chromatography, Spectrometry
5	Sodium(Na+)	Ion chromatography, atomic absorption spectrometry, Flame photometry
	Potassium(K+)	Ion chromatography, atomic absorption spectrometry, Flame photometry
	Calcium(Ca2+)	Ion chromatography, titrimetry (EDTA method)
	Magnesium(Mg2+)	Ion chromatography , titrimetry (EDTA method)

In rainwater, analysis for pH and electrical conductivity (EC) is recommended in addition to the concentrations of anions (sulphate, nitrate, chloride) and cations (ammonium, calcium, magnesium, potassium and sodium). The analytical methods detailed above are typical for the analysis of precipitation samples with the instrumentation commonly available in many laboratories.

2.4 METEOROLOGICAL MEASUREMENTS

The participating Malé Declaration countries were required to collect meteorological data regularly and submit it along with the monitoring data. Meteorological parameters (wind direction/speed, temperature, relative humidity, precipitation and solar radiation) in relation to wet deposition were to be measured at the site. However, it was decided that instead of setting up separate meteorological stations, the required data could be procured from the nearest meteorological station in accordance with the measurement frequencies and methods of the meteorological monitoring system of each country.

2.5 DATA MANAGEMENT

The entire analytical data were to be submitted by the participating laboratories to NIAs which in turn forwarded the same to UNEP RRCAP. After that the Monitoring Committee members held a discussion with each of the NIAs at the refresher course training which is held regularly every year. After discussion, RRCAP compiled and stored the monitoring data on the website. The data is accessible only to the participating country NIAs.

CHAPTER 3. AIR QUALITY

The eight participating countries have been monitoring the Ambient Air Quality at the selected locations for the parameters prescribed under the programme since 2004. The first Data Analysis Report was published in 2009. It described the air quality based on the monitoring results for the period 2004 to 2008. The present report is based on the monitoring results for the period 2009 to 2011. The monitoring data received from the countries is given in Annexure I to III.

Skillful interpretation of air quality data is critical to the development of proper solutions to air quality problems. This is generally done by comparing the data with the prescribed ambient air quality standards of a country or else with some international standards, say WHO guidelines. Table3.1 gives the Ambient Air Quality guidelines prescribed by WHO and the National Ambient Air Quality Standards of some of the participating countries.

Table 3.1 Ambient Air Quality Standards - (μg/m³)

Country	PM_{10}		$PM_{2.5}$		SO_2		NO_2		O_3	
	24 hrs	Annual	24 hrs	Annual	24 hrs	Annual	24 hrs	Annual	1hr	8hrs
WHO	50	20	25	10	20	--	--	40	--	100
Bangladesh	150	50	65	15	365	80	--	100	235	157
Bhutan		60* 120**								
India (residential, rural and other areas)	100	60	60	40	80	50 20***	80	40 30***	180	100
Iran										
Nepal	120				70	50	80	40		
Pakistan										
Sri Lanka	100	50	50	25	120	80	100		200	

*Mixed area (urban, commercial); **Industrial Area;***Ecologically Sensitive areas notified by GOI

The exceedence factor and the number of days the pollutant exceeds the standards also decides the extent of its impact. Meteorology plays an important role in knowing the source of pollution and its dispersion. Based on the information, the data is correlated with the different emission sources in the area. Due care must be taken to ensure that the data is representative, with respect to location of stations, duration of sampling, etc.

3.1 QUALITY ASSURANCE, QUALITY CONTROLAND DATA QUALITY

The conclusions drawn from any data are directly related to the quality of the data received. Thus, Quality Assurance and Quality Control (QA/QC) play a critical role while assessing the data because, "No Data is better than Data of Unknown or Bad Quality". One of the main challenges in air quality management (AQM) is to have timely and appropriate access to air quality data which are relevant and of known quality as it allows,

- To determine current status, trends of ambient air quality and better insight into science of air pollution,
- To ascertain whether the prescribed ambient air quality standards are violated
- To identify Non-attainment Cities/areas
- To identify the potential sources of pollutants (source apportionment)
- To assess impacts
- To assess the effectiveness of air quality management strategies.
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures, i.e., review/formulation of the Air Quality Management Program.

Thus, it is essential to have credible data.

With this in view, extensive Quality Assurance / Quality Control (QA/QC) measures were thought of under this programme and a system of flagging the data was developed The data flags were to assist not only in knowing the validity of the data but also the type of errors whether in the field during sampling or else in the laboratory while analyzing and reporting the results.

Perusal of the data clearly indicates that all the countries are as yet in the process of stabilizing/ standardizing/ strengthening their sampling, analysis and reporting methodologies and the system of flagging the data has not been initiated by all the countries. Thus, while analyzing the data no overemphasis has been given to any particular value. In this process certain results thought to be totally improbable(this is especially true in case of certain Field Blanks found to be very high, in some cases higher than the samples) have been ignored. Monthly and annual averaged values have been used instead of daily or event-wise data to focus on bulk properties and to have an overall view of the status.

3.2 STATUS OF MONITORING

3.2.1 DRY DEPOSITION MONITORING

The participating countries were required to carry out dry deposition monitoring by two methods using,

- PM10 Samplers
- Diffusive/passive samplers.

Air concentration monitoring: Data using High Volume Samplers/PM10 samplers has been received from seven countries, namely: Bangladesh, Bhutan, India, Iran, Nepal, Pakistan and Sri Lanka. India has reported PM10, SO_2 and NO_2, the remaining countries have reported only PM10.The period and parameters for which monitoring was carried out by each participating countries is given in Table 3.2

As dry deposition flux is dependant on ambient air sources of the acidic gases and dry deposition velocity which in turn depends on a number of factors like physical and chemical properties of the gases, surface properties and other environmental factors, the dry deposition flux is not measured and reported. However, to measure the magnitude of dry deposition flux, the ambient air concentration of the gases SO_2, NO_2 and O_3 are being discussed.

Table 3.2 Air Concentration Data Received; Air (H)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	Jan – Dec	PM10, SPM1
		2010	Jan – Dec	PM10
		2011	Jan – Dec	PM10
2	Bhutan	2009	Feb-July , Dec	PM10
		2010	Jan –Oct, Dec	PM10
		2011	Jan-Jun ,Oct – Dec	PM10
3	India	2009	Jan – Dec	PM10 , SO_2, NO_2
		2010	Jan – Dec	PM10 , SO_2, NO_2
		2011	Jan – Dec	PM10 , SO_2, NO_2
4	Iran	2009	Jan – Dec	PM10, SPM
		2010	Jan –Sep, Dec	PM10, SPM
		2011	Jan – Jul	PM10, SPM
5	Maldives		--	--
6	Nepal	2009	Jun-Aug, Nov, Dec	PM10
7	Pakistan	2009	Jan,Feb,Dec	PM10
8	Sri Lanka	2009	--	--
		2010	Jan – Dec	PM10
		2011	Jan – Dec	PM10

Note 1- SPM reported only till June 2009

Diffusive/Passive sampling has been reported by Bangladesh, Bhutan, Iran, Maldives, Nepal and Sri Lanka (Annexure II).

Table 3-3 gives the details of the parameters, period and the frequency for which each of the countries conducted passive monitoring. The passive samplers received by them are exposed and the exposed samplers are sent to IVL for analysis. The analytical data has been received directly from IVL by the respective countries. A perusal of Table 3.3 indicates that some of the countries have not reported results after February2010.

In general, most of the countries have not been exposing the field blanks in parallel to the samples. However, since the concentration of blanks was generally 0.1 to 0.2µg/m3, all results below 0.2µg/m3 have been ignored. In many cases the samplers were sent very late to IVL for analysis or there was incorrect labeling, no reporting of temperature, exposure for more than two months as pointed out by IVL in the results conveyed by them. Such data has also been generally ignored

It is also important that most of the variables remain constant so that the results can be compared. At present this is not so as most of the countries are not collecting monthly composite samples (Annexure II). Thus, the interpretation and comparison of results can only be indicative with no emphasis on any particular value.

Table 3-3 Air Passive Monitoring Data Received; Air (P)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan – Dec	SO_2,NO_2,O_3
		2011	Jan-Dec	SO_2,NO_2,O_3
2	Bhutan	2009	Bhur: Feb – Dec SerpangDzong : Jan – Mar, May – Nov	SO_2,NO_2,O_3
		2010	Bhur : Jan – Dec	SO_2,NO_2,O_3
3	India		--	--
4	Iran	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan (15 days)	SO_2,NO_2,O_3
5	Maldives	2009	Feb – Nov	SO_2,NO_2,O_3
6	Nepal	2009	Jan – Dec	SO_2,NO_2,O_3
		2010	Jan , Feb	SO_2,NO_2,O_3
7	Pakistan		--	--
8	Sri Lanka	2009	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3
		2010	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3
		2011	Duttuwewa: Jan – Dec Doramadalawa: Jan – Dec	SO_2,NO_2,O_3

3.2.2 WET DEPOSITION MONITORING/ PRECIPITATION CHEMISTRY

A large number of chemicals released from natural or anthropogenic sources are present in the atmosphere as gases or aerosols. Clouds and precipitation have long been recognized as important sinks for atmospheric pollutants and aerosol, with size and solubility-induced selective removal affecting both the aerosol size distribution and the rainwater characteristics. Gaseous pollutants such as SO_2 and NOx once emitted into the atmosphere are oxidized to sulphate and nitrate through gaseous and aqueous phase processes. The absorption and desorption of gaseous pollutants by clouds, rain and snow is the beginning of the removal process of these gases. However, absorption and desorption involves a complex mechanism which incorporates dissolving and extraction of these species in and out of water droplets. In-cloud scavenging is a determining factor for the precipitation of sulphate, while it is relatively unimportant in the case of ammonium. The sub-cloud scavenging of NO_2 and SO_2 is not too significant. However, for HNO_3, and NH_3 it is an effective process.

Wet deposition is generally influenced by two factors: meteorological conditions such as the wind system and rainfall pattern and geographical distribution of emission sources of chemical substances through natural and anthropogenic activities. Natural sources of pollution may broadly include sea salt, eroded earth material and biogenic activities while fossil fuel combustion and agricultural wastes are the major anthropogenic sources. Wet deposition is the scavenging approach of removal of pollutants from the atmosphere. Rain and snow are the natural scavenging processes of air pollutants changing their air concentrations. The composition of the rain water depends on the chemical species that have dissolved in it. H_2SO_4 and HNO_3 are regarded as the major acids, whereas calcium carbonate and ammonia are regarded as the major bases.

Once the acids in rain droplets were identified as a potential cause of acidification of lakes and soils, it was widely recommended that regular monitoring of pH and chemical composition of rainwater must commence. It was thus decided to include wet deposition monitoring at the Malé Declaration sites. However, not all the countries have started this monitoring regularly and as per the protocol.

The results have been analyzed to assess the chemical properties of rain water with regard to, chemical composition, specially pH, conductance and concentration of various anions and cations.

Table 3-4 Wet Only Data Received; Wet (W)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	May-Sep	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Apr-Aug	
		2011	Mar-Sep	
2	Bhutan		--	--
3	India		--	--
4	Iran	--	--	--
5	Maldives		--	--
6	Nepal		--	--
				--
7	Pakistan		--	--
8	Sri Lanka	2010	Jan, Mar - May, Jul, Sep-Dec	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2011	Jan-Mar, May, Aug	

Rainwater contains various dissolved anions and cations after incorporating gaseous and aerosol species from the ambient air. The wet deposition was monitored by two methods, namely, Wet (Bulk) and Wet (Wet) techniques. In the former technique the sampler is exposed for the entire period and includes dry period, in the latter, the sampler has arrangements to do sampling only when it rains. The samples so collected were preserved and transported to the laboratory for analysis. The cations and anions to be monitored at the Malé monitoring sites were , NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-} and NO_3- . Some quantitative parameters were proposed to analyze the wet deposition measurements in terms of acid-base chemistry. Acidity, or pH, is a fundamental measure of precipitation acidity. It is determined by the nature and proportions of acids and basis in water. In this sense, pH is a secondary parameter, whereas acids and bases are primary ones. If any two of these three quantities are properly determined, then the other can be calculated theoretically.

Wet(Wet) and Wet(Bulk) monitoring is being carried out by the countries as per details in Tables 3.4 and Table 3.5 respectively, which also give the parameters for which these samples were analyzed. Whereas Wet (Wet) results have been reported by two countries, viz., Bangladesh, and Sri Lanka, Wet(Bulk) results have been reported only by five countries, viz., Bangladesh, Bhutan, Pakistan, Nepal and Sri Lanka.

Table 3-5Wet Bulk Data Received, Wet (B)

S. No	Country	Year	Months	Parameters
1	Bangladesh	2009	May – Sep	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Apr – Aug	
		2011	Mar-Sep	
2	Bhutan	2009	May – Sep, Nov	Ec, pH
		2010	Sep -Dec	Ec, pH
		2011	Jan – Sep	Ec, pH
3	India		--	--
4	Iran	2009	Apr, Dec	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Feb, Dec	
		2011	Jan, Feb	
5	Maldives		-	--
6	Nepal	2009	Feb-Dec	
		2010	Jan-Oct	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2011	Apr-Dec	
7	Pakistan	2009	Jan-Sep	Ec, pH
8	Sri Lanka	2009	Mar-May , Aug,Oct-Dec	Ec, pH, NH^{4+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^{-}
		2010	Jan,Mar-May,Sep-Nov	
		2011	Aug,Oct-Dec	

A perusal of the tables indicates that most of the countries have measured only pH and electrical conductance. Only Bangladesh and Sri Lanka have measured all the cations and anions in the wet only samples and only Bangladesh, Iran, Nepal and Sri Lanka have measured all the ions in the Bulk samples as well.

3.2.3 METEOROLOGICAL DATA

Air pollutants show short term, seasonal and long term variations. Atmospheric conditions determine the fate of the air pollutants after their release into the atmosphere. The mean transport wind direction, velocity, turbulence and mass diffusion are three important and dominant mechanisms in the dispersal of air pollutants. Wind direction is the measurement of direction from which the wind is blowing, measured in points of compass viz. North, South, East, and West or in Azimuth degrees. Wind direction has an important role in distributing and dispersing pollutants from stationary and mobile sources in horizontally long downwind areas.

The effect of wind speed on air pollution is two-fold. It determines the travel time from a source to a given receptor while on the other causes dilution of pollutants in downwind direction. The stronger the wind, the greater will be the dissipation and dilution of pollutants emitted. Knowledge of the frequency distribution of wind direction as well as wind speed is essential for accurate estimation of the dispersion of pollutants in the atmosphere. The frequency distribution of wind speed and direction varies considerably from month to month. Air pollutants show diurnal variations in their levels. During the daytime, solar heating causes maximum turbulence and strongest vertical motions. This causes the maximum amount of momentum exchange between the various levels in the atmosphere.

On clear nights with light winds, heat is radiated from the Earth's surface resulting in cooling of the ground and air adjacent to it. This results in extreme stability of the atmosphere near the Earth's surface. Under these conditions turbulence is at a minimum.

The meteorological data along with wind speed and direction has not been received from (Table 3.6) any of the countries except a few months data from Bangladesh. The meteorological data given in Chapter 2 is from the previous report.

Table 3-6 Meteorological Data Received (2009-11)

S No	Country	Met. Station	Available Data
1	Bangladesh	Kulna	
2	Bhutan	Gelephu	NA
3	India	Port Canning	NA
4	Iran	Chamsari	NA
5	Maldives	Hanimaadhoo	NA
6	Nepal	Rampur	NA
7	Pakistan	Bahawalnagar	NA
8	Sri Lanka	Doramadalawa	NA

NA: Not available

3.3 RESULTS

Countrywise results are discussed below to understand the status of air pollution. An effort has been made to correlate the results to the activities/sources in the area as well as those in the country.

3.3.1 BANGLADESH

The monitoring location is in Sathkira, a city in Khulna Division of Bangladesh. It has a population of about 2million and most of the people depend on pisciculture. Poorly serviced vehicles, brick kilns, dust from roads and construction sites and industrial emissions are the major sources of air pollution. Brick kilns account for about 30% of the air pollution in the country, the brick kiln industry being one of the fastest-growing sectors, with the current manufacturing capacity of 12 billion bricks a year by 4,500 brick kilns surrounding all major cities of Dhaka, Khulna, Rajshahi, and Chittagong *(Reference : Particulate pollution from brick kiln clusters in the GreaterDhaka region, Bangladesh, Air Qual Atmos Health; DOI 10.1007/s11869-012-0187-2; Sarath K. Guttikunda et. al)*

Figure 3-1 Brick kiln
Photo by: GungaJim

There are about 80 brick kilns around Sathkira. These brick kilns use firewood/low grade coal as fuel. The coal comes mainly from the eastern regions of India. The emissions from the low-lying sources like vehicle exhaust and the domestic fuel use are fairly constant over all months of the year and are confined to the city limits, thus contribute more to the locally attributable pollution levels. However, the brick kilns spread across the area are operated with a stack height of about 50m each and are capable of transporting the emissions to larger distances. Moreover, the brick kilns do not operate throughout the year; the main brick producing season is from October to March, the brick manufacturing is at its peak during December and January.

Bangladesh has warm temperatures throughout the year, with relatively little variation from month to month. January tends to be the coolest month and May the warmest. June to October monsoon is south-west monsoon. Khulna receives an annual rainfall of about 1800mm. Nearly 81 per cent of total rainfall occurs during June-October. Some rainfall also occurs during March-May. Winter is the dry period with little or nearly no rainfall. However, during the months of December and January little rainfall is recorded. The monsoon winds blow from the south with sustained force from March to October, The wind blows from the north and northeast in January. February is a calm month with foggy weather particularly in the morning.

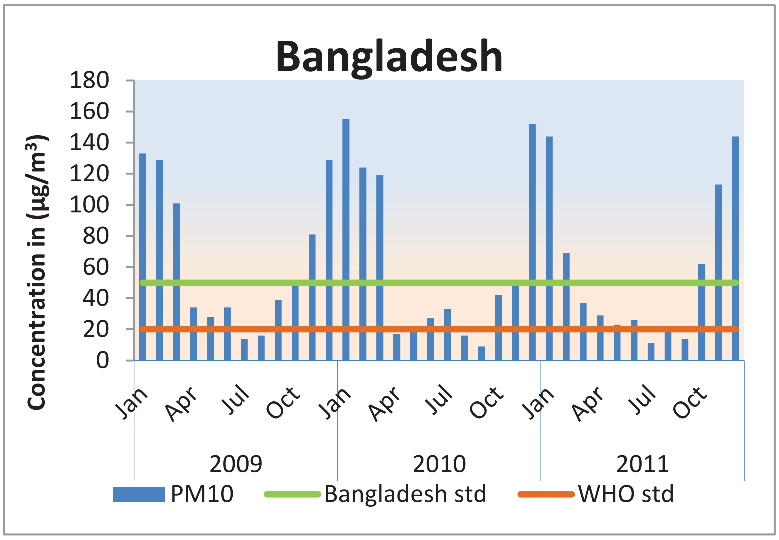

Figure 3-2 Temporal variation of PM10 concentration

3.3.1.1 Dry Deposition Monitoring

Bangladesh has been participating in the Male monitoring programme since 2004; however, the monitoring of PM10 was started in 2009. The results are depicted in Figure 3.2 and Table-3.7. A perusal of the results indicates that the highest concentrations are observed during December and January of each year. These are the dry months of winter and also the peak brick manufacturing season. Thus, the PM10 monitoring data is split between the brick manufacturing dry season and the remaining months presenting a distinct pollution trend, coinciding with the brick manufacturing cycles. Lowest concentrations have been observed during the monsoon period which also happens to be the non-brick manufacturing season. The annual average concentration of PM10 exceeded the annual Bangladesh standard of 50μg/m^3 during 2009-2011.

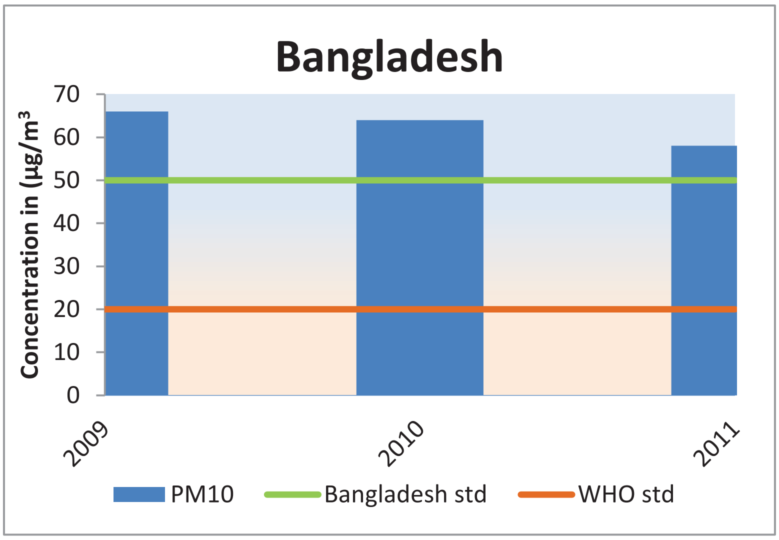

Figure 3-3 Annual average PM10 concentration

At the same time, the PM10 concentration in ambient air has been decreasing (Figure 3.3) over the years. This could be due to the measures introduced by the Bangladesh Government. These include, introduction of cleaner brick manufacturing technology, reducing traffic congestion, introduction of cleaner fuels and imposing an emission tax and by carrying out extensive awareness campaigns for the people.

Table 3-7 Monthly variation of PM10 concentration (µg/m³) - Bangladesh

Month		**2009**			**2010**			**2011**	
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Jan	133	125	140	155	150	161	144	99	196
Feb	129	110	158	124	101	172	69	66	78
Mar	101	99	106	119	94	142	37	24	51
Apr	34	28	42	17	12	20	29	21	54
May	28	20	42	21	12	30	23	16	19
Jun	34	27	43	27	17	30	26	18	36
Jul	14	7	25	33	21	45	11	8	15
Aug	16	10	22	16	4	36	20	19	21
Sep	39	24	56	9	5	12	14	10	16
Oct	50	36	60	42	37	53	62	31	90
Nov	81	74	96	49	44	51	113	57	157
Dec	129	113	149	152	115	190	144	117	187
Annual avg	66			64					58

Diffusive Sampling

Bangladesh has reported the results of diffusive sampling from July 2004 onwards. However, regular monitoring was started from March 2006 onwards.

A look at the results indicates that there is a strong seasonal variation in the results. The maximum monthly average concentration of (7.9 to 8.4 µg/m³) SO_2 and (6.6 to 7.6) µg/m³ NO_2 (Table 3.8) was observed during the winter months of December to February and the lowest concentrations during June –September i.e. the monsoon period. (Figure 3.4) Whereas the maximum and the annual average concentration of SO_2 has decreased over the years, that of NO_2 has increased, although the increase is not appreciable. The higher concentration of SO_2 in winter coincides with the higher concentration of PM10during these months and the concentration of both the parameters has shown a decreasing trend which might be due to the introduction of cleaner technology in brick manufacturing. On the other hand the source of NO_2 could

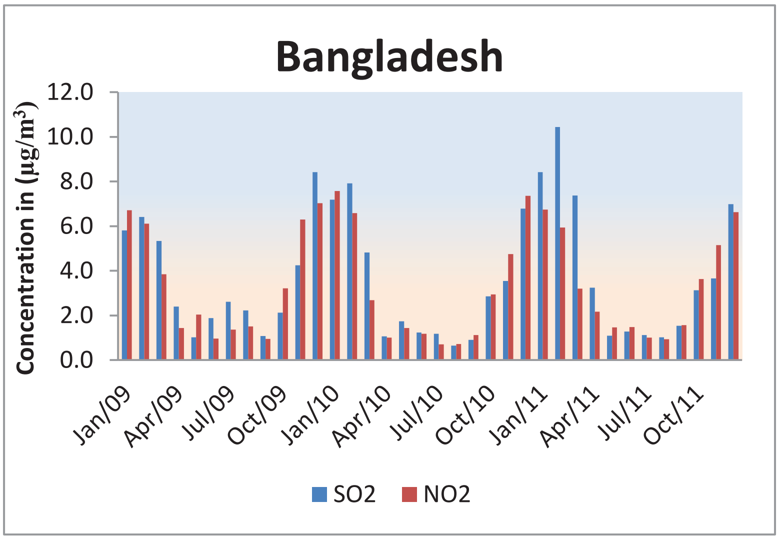

Figure 3-4 Temporal variation of average SO_2& NO_2 concentration

be increasing vehicular emissions in the area as the ozone concentration (Figure 3.5) is also higher during the same period.

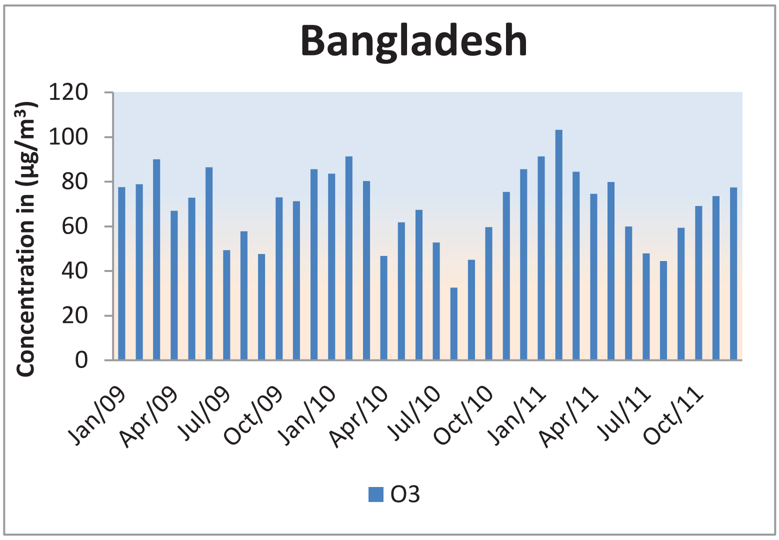

Figure 3-5 Temporal variation of average O3 concentration

Table 3-8 Average concentration of SO_2, NO_2 and O_3 in $\mu g/m^3$ - Bangladesh

	2009			2010			2011		
Month	SO_2	NO_2	O_3	SO_2	NO_2	O_3	SO_2	NO_2	O_3
Jan	5.8	6.7	78	7.2	7.6	84	8.4	6.7	91
Feb	6.4	6.1	79	7.9	6.6	91	10.4	5.9	103
Mar	5.3	3.9	90	4.8	2.7	80	7.4	3.2	84
Apr	2.4	1.4	67	1.1	1.0	47	3.2	2.2	75
May	1.0	2.0	73	1.7	1.4	62	1.1	1.5	80
Jun	1.9	1.0	87	1.2	1.2	67	1.3	1.5	60
Jul	2.6	1.4	49	1.2	0.7	53	1.1	1.0	48
Aug	2.2	1.5	58	0.6	0.7	33	1.0	0.9	45
Sep	1.1	0.9	48	0.9	1.1	45	1.5	1.6	59
Oct	2.1	3.2	73	2.9	2.9	60	3.1	3.6	69
Nov	4.2	6.3	71	3.5	4.8	75	3.7	5.2	74
Dec	8.4	7.0	86	6.8	7.4	86	7.0	6.6	77
Annual avg	3.6	3.5	72	3.3	3.2	65	4.1	3.3	72

3.3.1.2 Wet Deposition Monitoring

The Wet(Bulk) and Wet(Wet) monitoring was conducted during 2009,2010 and 2011. The monitoring was also conducted only from March to September. The results of wet only and bulk monitoring (Figure 3.6 and 3.7) indicate that the minimum average conductance over the three years was 0.3mS/m and the highest 7.9mS/m. A perusal of the results of Wet (Wet) and Wet(Bulk) monitoring reveal that Ec is highest in during March to May(Annexure III) and lowest during monsoons and in the broader sense is related to the amount of precipitation, i.e., lowest conductance at highest precipitation times. High concentration of ammonium, sulfate and nitrate ions corresponds with the high Ec values during March-May. This is probably due to the washing out of the atmosphere with pre-monsoon showers. The pH varied between 5 and 6(Tables 3.9 and 3.10) during wet and dry monitoring with lowest values of pH corresponding with the high electrical conductance. Figure 3.6

gives the frequency distribution of pH during the monitoring period (samples exposed for one to seven days). In general, inter annual concentration changes might be due to variations in meteorology and emissions, but no clear cut tendencies or trends were visible.

Among the ions, (Annexure III) the highest concentration was that of the sodium and chloride ions(highest observed concentration of sodium and chloride ions during the period was 218 and 301µmol/l respectively). Since the site is in coastal area, the results are greatly affected by sea-salt input because they are incorporated into cloud or rain droplets in the form of salt.

The R1 and R2 values are generally within the allowable limits pointing to the fact that the quality of data has improved over the past years.

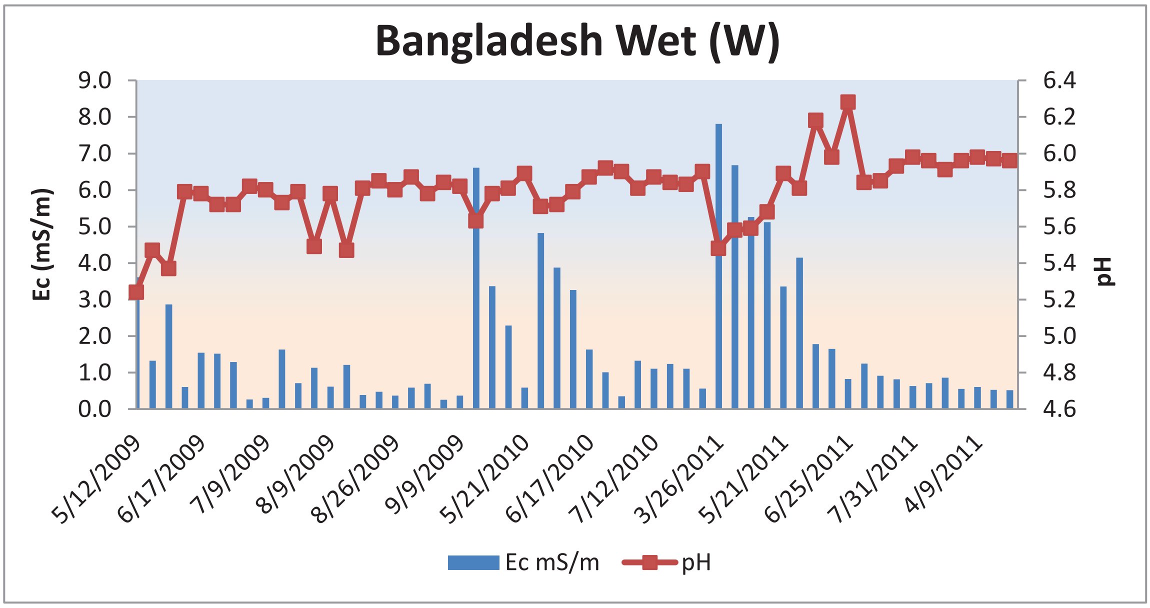

Figure 3-6 Variation in electrical conductance and pH Wet(Wet)

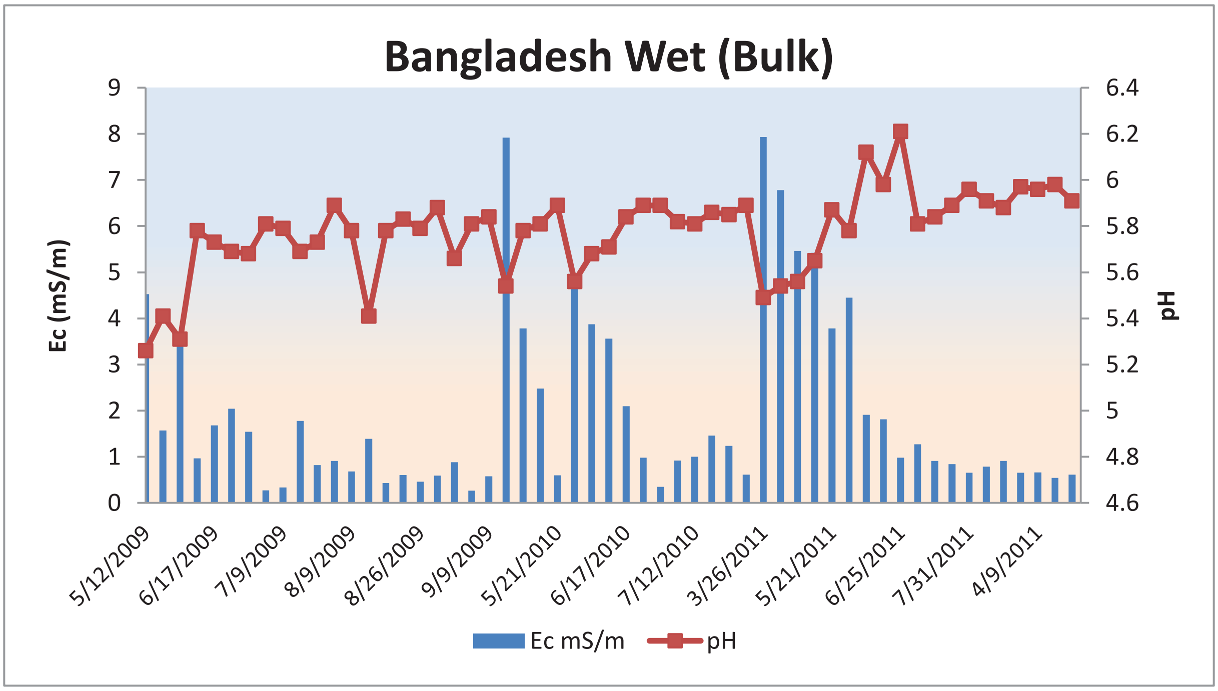

Figure 3-7 Variation in electrical conductance and pH Wet(Bulk)

Table 3-9 Results of wet monitoring using wet collector - Bangladesh

	2009					2010			2011
Month	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)
Apr				1.9	5.8	1275	7.8	5.5	1170
May	2.4	5.4	1167	1.4	5.9	1867	6.7	5.6	700
Jun	1.2	5.8	1150	1.8	5.9	1575	4.4	5.8	1243
Jul	0.6	5.8	1550	0.7	5.9	1417	1.3	6.1	4710
Aug	0.7	5.7	1600	0.8	5.9	1867	0.9	5.9	4600
Sep	0.3	5.8	2100	--	--	--	0.7	5.9	4500

Table 3-10 Results of wet monitoring using bulk collector - Bangladesh

		2009			2010			2011	
	Ec(mS/m)	pH	Precipitation (ml)	Ec(mS/m)	pH	Precipitation (ml)	Ec(mS/m)	pH	Precipitation (ml)
Mar	--		--	--	--	--	7.9	5.5	50
Apr	--	--	--	5.1	5.7	950	6.8	5.5	700
May	3.0	5.3	1167	1.5	5.8	1867	4.7	5.7	1243
Jun	1.5	5.7	1150	1.9	5.8	1575	1.6	6.1	4567
Jul	0.6	5.8	1700	0.6	5.9	1417	0.8	5.9	4128
Aug	0.7	5.8	1514	1.1	5.9	50	0.8	5.9	2553
Sep	0.4	5.8	2233	--	--	--	0.6	5.9	2487

3.3.2 BHUTAN

3.3.2.1 Dry Deposition Monitoring

Bhutan started the monitoring of PM10 in 2009. The monitoring station is located in Thimpu which is the largest city and the capital of Bhutan, located in the western central part of the country. The southwest monsoon brings rainfall from May to September marking the wet season. Rest of the year is mostly dry and as spring (March to May) approaches, the weather is marked by violent winds and dusty weather with rain showers at the end of May. A look at Figure 3.8 and perusal of Table 3.11 indicates that the sampling has not been conducted continuously throughout the year.

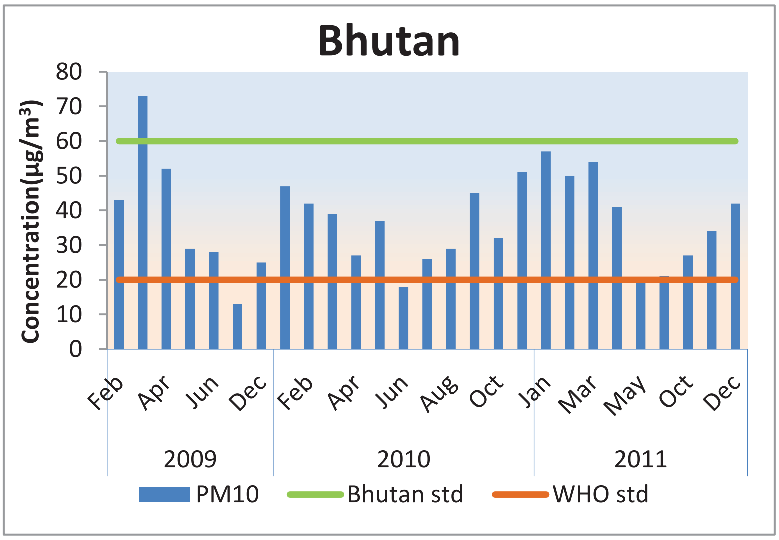

Figure 3-8Temporal variation of PM10 concentration

The concentration of PM10remains within the prescribed national annual average standard of 60µg/m^{3}for mixed area (urban & commercial) during the wet months, however, the concentrations are higher during the winter and spring months which are dry. .Exceptionally high concentrations (Annexure I) have been attributed to forest fires in general and such data has been ignored for the purpose of averaging. Growing concern here is that there is an increasing trend in emissions. It is thus very timely for policy interventions for Air Quality Management so as to prevent adverse impacts of uncontrolled air pollution.

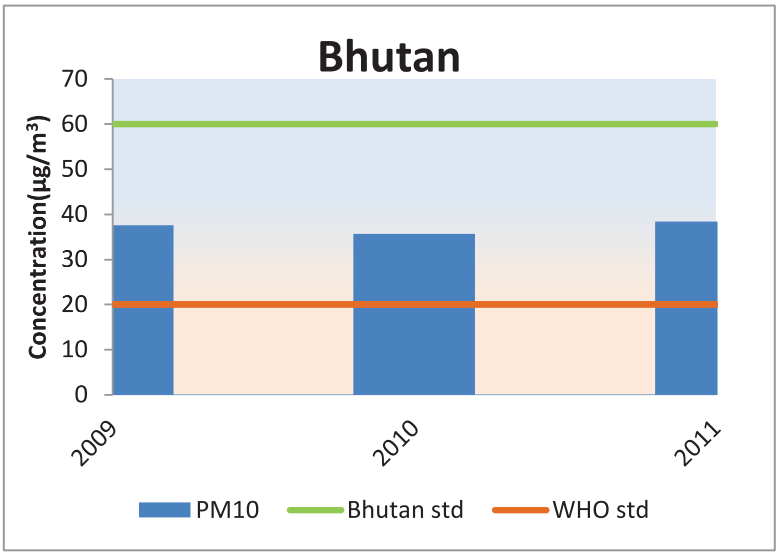

Figure 3-9 Annual variation of PM10 concentration

Table 3-11 Average variation of PM10concentration in µg/m^3 - Bhutan

		2009			2010			2011	
Month	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Jan	--	--	--	47	43	54	57	31	72
Feb	43	28	56	42	13	70	50	20	76
Mar	73	18	152	39	11	74	54	16	94
Apr	52	35	90	27	7	79	41	31	71
May	29	11	59	37	9	68	20	11	40
Jun	28	3	140	18	11	31	21	10	52
Jul	13	4	46	26	24	28	--	--	--
Aug	--	--	--	29	22	29	--	--	--
Sep	--	--	--	45	11	108	--	--	--
Oct	--	--	--	32	39	39	27	15	68
Nov	--	--		--	--	--	34	18	47
Dec	25	17	37	51	26	74	42	16	61
Annual avg*	38			36			38		

*only seven months data-average not representative

The increasing trend has been attributed to two driving forces, namely,

- Socio-economic development
- Increasing Population & urbanization

Rapid socio-economic development and urbanization is an emerging threat to the existing air quality. Localized air pollution is already being experienced due to increasing number of vehicles, manufacturing industries and increasing number of construction activities. Emissions from motor vehicles are one of the primary sources of local air pollution. The number of vehicles has been increasing at an annual growth rate of 1% in last one year (The State of the Nation 2012). Forest fires, especially during the dry season (November-May) are another major factor contributing to local air pollution. Household heating using wood fed heaters, especially during the cold winter months and cooking from woodstoves and kerosene stoves in the rural areas is yet another factor contributing to air pollution in the country.

3.3.2.2 Wet Deposition Monitoring

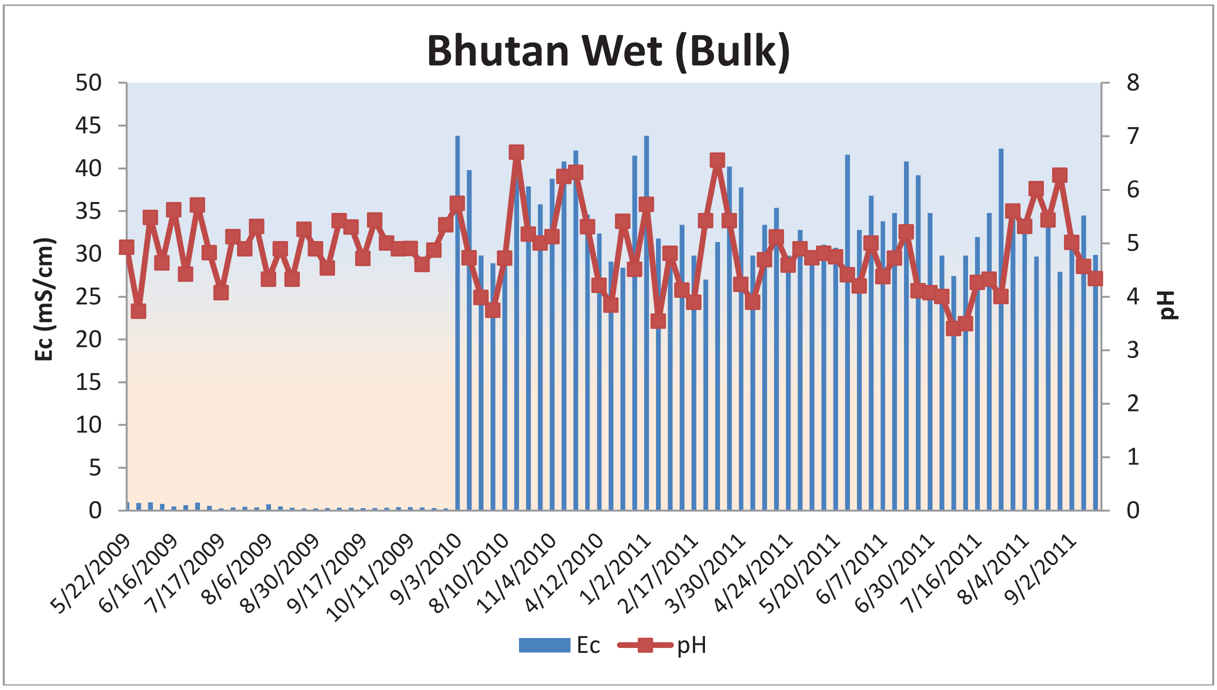

Figure 3-10 Variation in electrical conductance and pH (bulk collector)

Figure 3.10 and Table 3.12 give the results of wet monitoring (Wet Bulk) and Wet (Wet).

Table 3-12 Results of wet monitoring using bulk collector - Bhutan

		2009			2010			2011	
Month	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)	Ec (mS/m)	pH	Precipitation (ml)
Jan							36.0	3.5	3
Feb							31.0	4.0	8
Mar							34.8	5.7	16
Apr							32.0	4.6	39
May	0.9	3.8	81				35.9	4.6	17
Jun	0.8	5.5	84				35.8	4.4	58
Jul	0.4	5.0	119				33.8	4.0	77
Aug	0.3	4.9	99				32.8	5.6	61
Sep	0.3	5.2	86	39.1	4.9	67	26.8	3.8	57
Oct	0.4	4.9	37	31.9	4.8	8			
Nov				42.1	6.3	16			
Dec				32.9	4.5				

The results indicate nearly a tenfold increase in the conductance of the precipitation samples. The pH of the samples varies between 3.5 to 6.3 with pH 4 or less at least in a few months, there is no particular trend. However, since the results are available for a very short period and the months for which the results have been reported for 2009, 2010 and 2011 are generally different, no specific conclusions can be drawn. There is no correlation between precipitation , Ec and/or pH. There is an urgent need to look into the reasons for sudden increase in the Ec of rain water.

3.3.3 INDIA

India has reported the air concentration monitoring results for two new locations under the Male' monitoring programme. The results from the monitoring location at Darranga in Baksa district, BTAD, Assam have been reported 2009 onwards whereas the monitoring results for the location in Dera Baba Nanak, Punjab have been reported 2011 onwards.

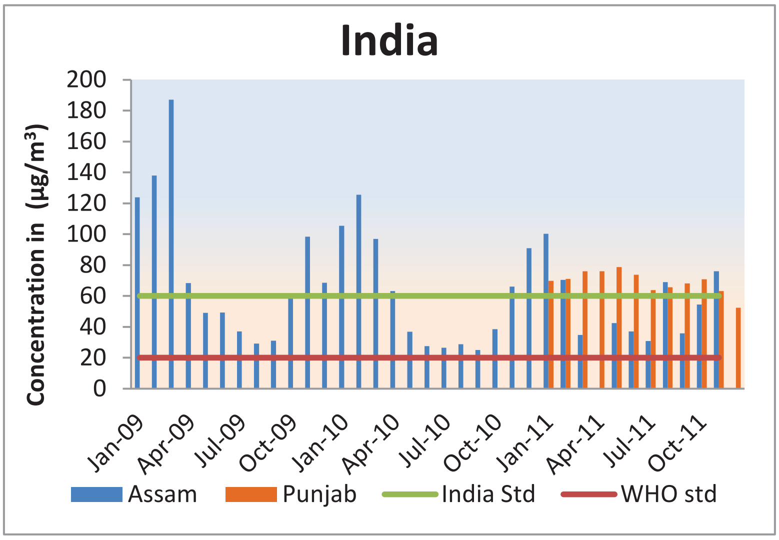

Figure 3-11 Temporal variation of SO2 and NO2 concentration

Baksa district is located in North-Western part of Assam. The district shares the International Boundary with Bhutan in the North. Major part of the world famous Manas National Park is located in this district. The park is well known for its Wild Water Buffaloes and Golden Langurs. Darranga is a small sub-urban town located in the northern part of the district Baksa of the State of Assam and near Sandoop Jhankar Town of Bhutan. Darranga is a sub-urban habitation covering a small area with 20,000-30,000. The main source of income of the people in this area is agriculture. Being a border area, a few commercial activities are also growing nowadays including movement of trucks etc. Industrial growth in the Indian part is negligible. The climate of the district is sub-tropical in nature with warm and humid summer and also followed by cool and dry winter.

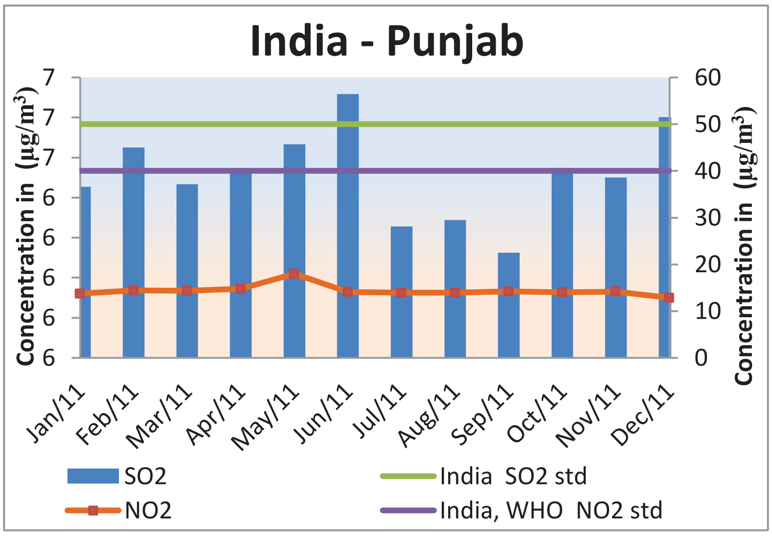

Figure 3-12 Temporal variation of SO2 and NO2 concentration

Dera Baba Nanak is situated 35 kms to west of Gurdaspur in Punjab, on the left bank of river Ravi on the right bank of Ravi, just opposite to Dera Baba Nanak, is the town of Kartarpur which is in Pakistan.

3.3.3.1 Dry Deposition Monitoring

The results of monitoring for the two locations are depicted in Figures 3.11 to 3.14 and given in Tables 3.13 and 3.14

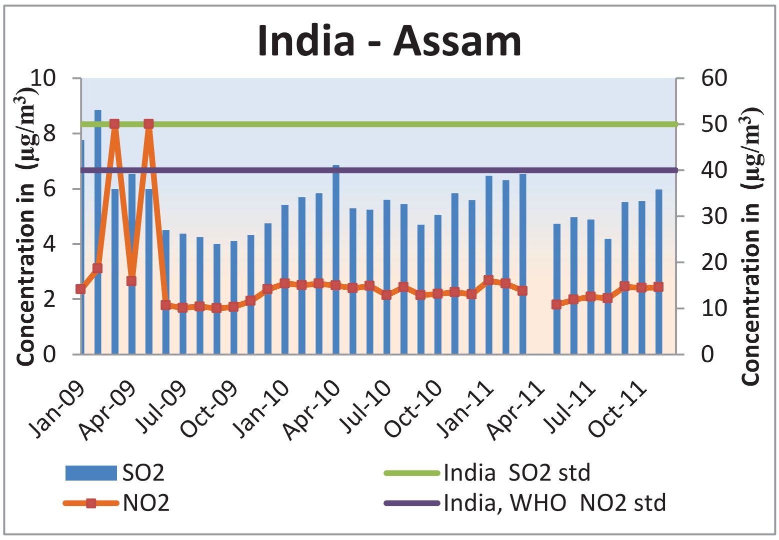

Figure 3-13 Temporal variation of PM10 concentration

There is a clear seasonal variation in the PM10 concentration at the Assam monitoring location with relatively very high concentrations during the winter months of Dec to Jan and very low concentration during the wet summer months. The annual average remains within the national standard of 60µg/m^3. On the other hand, there is not much seasonal variation in PM10 concentration at the Punjab location, however, the annual average concentration is more than the prescribed national standard.
At the same time SO_2 and NO_2 concentrations remain very low throughout the year at both the locations.

Thus, the reason for very high concentration of PM10 in winters at the Assam location and the high annual average concentration at the Punjab location needs to be established so that long term air quality management programmes can be prepared and implemented.

Table 3-13 Monthly variation of PM10 concentration (µg/m^3) – Assam, India

		2009			2010			2011	
Month	**PM10**	**SO_2**	**NO_2**	**PM10**	**SO_2**	**NO_2**	**PM10**	**SO_2**	**NO_2**
Jan-09	124	8	14	106	5	15	100	6	16
Feb-09	138	9	19	126	6	15	70	6	15
Mar-09	187	6	16	97	6	15	35	7	14
Apr-09	68	7	16	63	7	15			
May-09	49	6	16	37	5	14	42	5	11
Jun-09	49	4	11	27	5	15	37	5	12
Jul-09	37	4	10	26	6	13	31	5	13
Aug-09	29	4	10	29	5	15	69	4	12
Sep-09	31	4	10	25	5	13	36	6	15
Oct-09	61	4	10	39	5	13	55	6	14
Nov-09	98	4	12	66	6	14	76	6	15
Dec-09	68	5	14	91	6	13	--	--	--
Annual avg	77	6	13	59	6	14	57	6	14

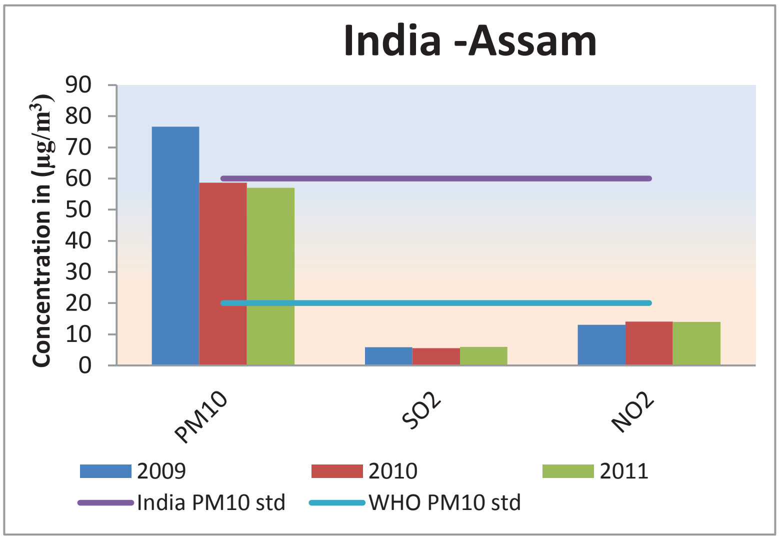

Figure 3-14 Annual variation of PM10 concentration

Table 3-14 Monthly variation of PM10 concentration (µg/m³) – Punjab, India

Month	PM10	SO_2	NO_2
Jan-11	70	6	14
Feb-11	71	7	14
Mar-11	76	6	14
Apr-11	76	7	15
May-11	79	7	18
Jun-11	74	7	14
Jul-11	64	6	14
Aug-11	66	6	14
Sep-11	68	6	14
Oct-11	71	7	14
Nov-11	63	7	14
Dec-11	52	7	13
Annual avg	69	7	14

3.3.4 IRAN

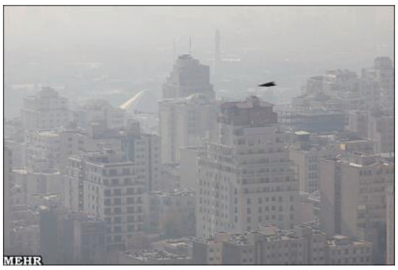

Figure 3-15 Iran

3.3.4.1 Dry DepositionMonitoring

The monitoring location is in Dehloran which is one of the cities in Ilam province located in the west of the country bordering Iraq .It is among the warmest regions of Iran, although the mountainous areas of north and north eastern Ilam are relatively cold. The average annual SPM. SO_2 and NO_2 were monitored for a few months in 2007-2008 but the same has been discontinued. The monitoring results of PM10 and SPM for the years 2009-11 are presented in Table 3.15 and Figure 3.16.

A perusal of Table3.15-and Figure 3.16 indicate that the highest concentrations occur in the months May-July on days that are dusty and cloudy. Lower concentrations are observed on sunny days .Comparing the monthly average results of 2009-2011 for the months May to July with those reported during 2004-2007, it is seen that the concentration of PM10and SPM has been rising over the years. The results of May 2011 monitoring also indicate a very high concentration of PM10 and SPM, i.e., 340 and 733µg/m^{3}respectively. The results of 2009-11 are considerably higher when compared to those of 2004-08(Reference Data Analysis Report 2008).It may be mentioned that in Iran the concentration of particulate matter in ambient air is also influenced by the occurrence of dust storms.

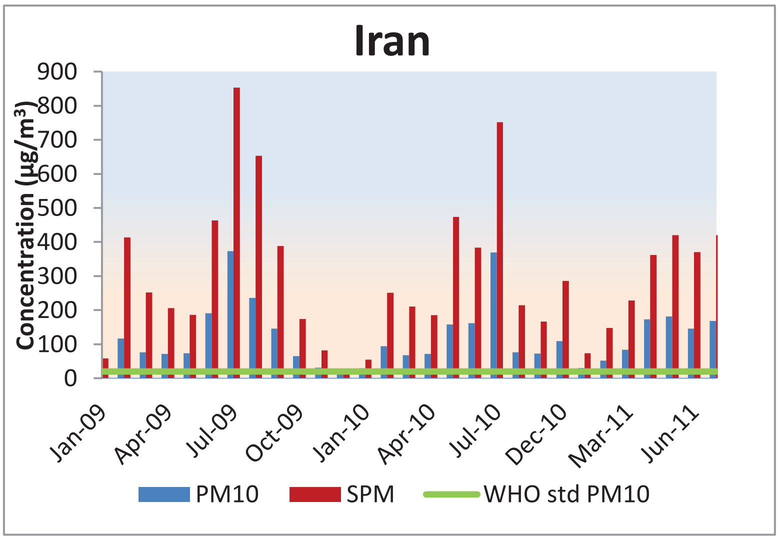

Figure 3-16 Temporal variation of PM10 concentration

Table 3-15 Average variation of PM10 concentration in µg/m^3 - Iran

	2009				2010			2010	
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
Jan	26	12	40	29	15	53	30	11	55
Feb	117	24	227	94	23	402	52	19	136
Mar	77	24	219	68	41	96	84	15	358
Apr	72	23	159	72	19	193	173	49	351
May	74	30	187	159	59	422	182	34	375
Jun	191	41	477	162	44	311	146	68	252
Jul	373	236	534	370	86	474	169	53	528
Aug	236	147	375	76	41	167			
Sep	146	23	338	73	29	188			
Oct	65	29	109						
Nov	32	11	80						
Dec	15	9	26	109	44	244			
Annual avg	118			121			119*		

*Only seven months data- not representative

At the same time referring to the SO_2 concentration in passive sampling (2004-08 and 2009-10) it is seen that the SO_2 concentrations at the Iran monitoring location are much higher as compared to those in the other countries with highest results reported generally for the months of June-July (17.6µg/m^3 in July). Two oil wells in Iraq are located about 12-15 km north and south of the site, respectively. The oil wells have flares. Thus, it is very important to correlate the results with the meteorological conditions on the days of monitoring. If needed, the monitoring location be change to a place with no direct influence of the oil well flares.

This point for the need to look into the cause for the increasing concentrations and taking corrective measures.

Diffusive Sampling

The concentration of SO_2 observed in the case of Iran was in the range of 8.4 to 18.5µg/m^{3}during 2009-10, with the lower concentrations generally corresponding with the monsoon period of the country (Figure 3.15 and 3.16). A perusal of the Table 3.14 giving the annual average concentration indicates that there is no definite trend and the annual average SO_2 concentration in 2009 was 11.7-µg/m^3. The NO_2 concentration on the other hand is very low and the annual average concentration was 2.1 µg/m^3. The samplers were reported to be sandy by IVL in a few cases, at the same time the sampling location is not clear as it is written. Station and only in one case Chamsari has been mentioned. The high SO_2 concentrations are in the same months as PM10 and the same source could be responsible. Further studies need to be undertaken.

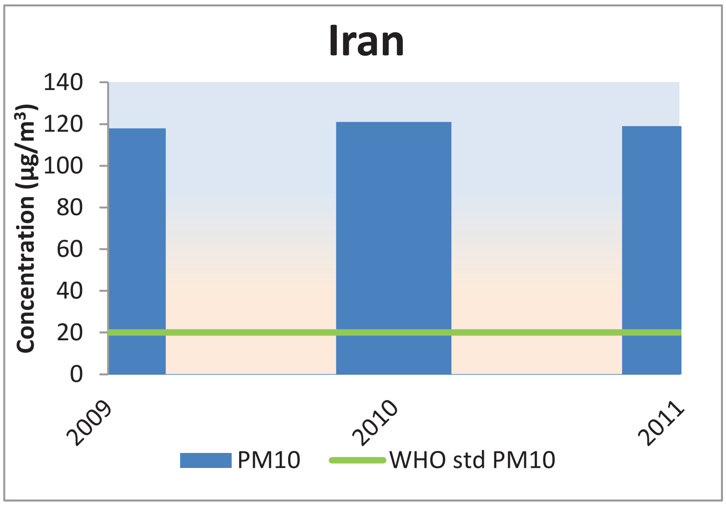

Figure 3-17 Annual variation of PM10 concentration

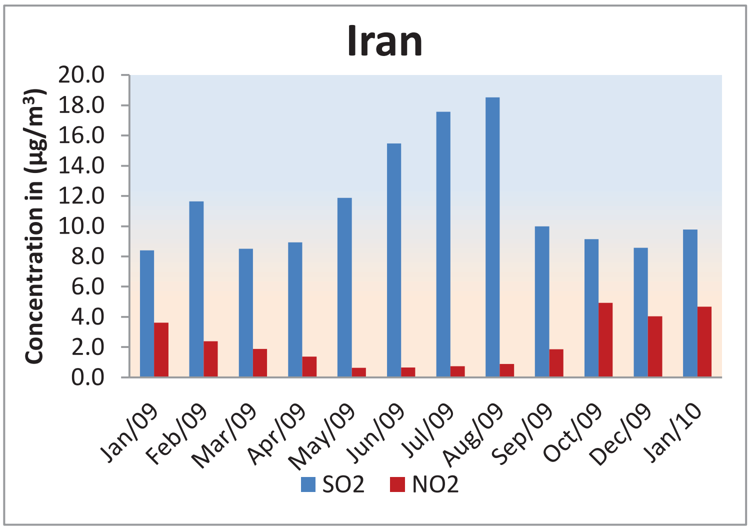

Figure 3-18 Temporal variation of average SO2& NO2 concentration

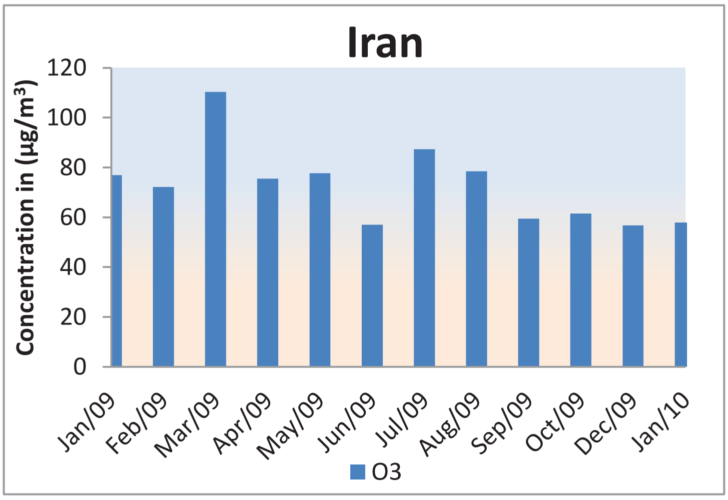

Figure 3-19 Temporal variation of O3 concentration

Table 3-16 Average concentration of SO_2, NO_2 and O_3 in (($\mu g/m^3$) - Iran

	SO_2	NO_2	O_3
Jan-09	8.4	3.6	77
Feb-09	11.6	2.4	72
Mar-09	8.5	1.9	110
Apr-09	8.9	1.4	75
May-09	11.9	0.6	78
Jun-09	15.5	0.7	57
Jul-09	17.6	0.7	87
Aug-09	18.5	0.9	78
Sep-09	10.0	1.9	59
Oct-09	9.1	4.9	61
Dec-09	8.6	4.0	57
Jan-10	9.8	4.7	58
Annual avg	11.7	2.1	74

3.3.4.2 Wet Deposition Monitoring

Iran collected very few samples of Wet Deposition monitoring during 2009-11.The pH of the samples does not vary much and remains between 7 and 7.7. No particular trends can be established, although there is variation in conductance. Higher concentration of sulphate are in line with the higher SO_2 concentrations in diffusive sampling. The source needs to be established.

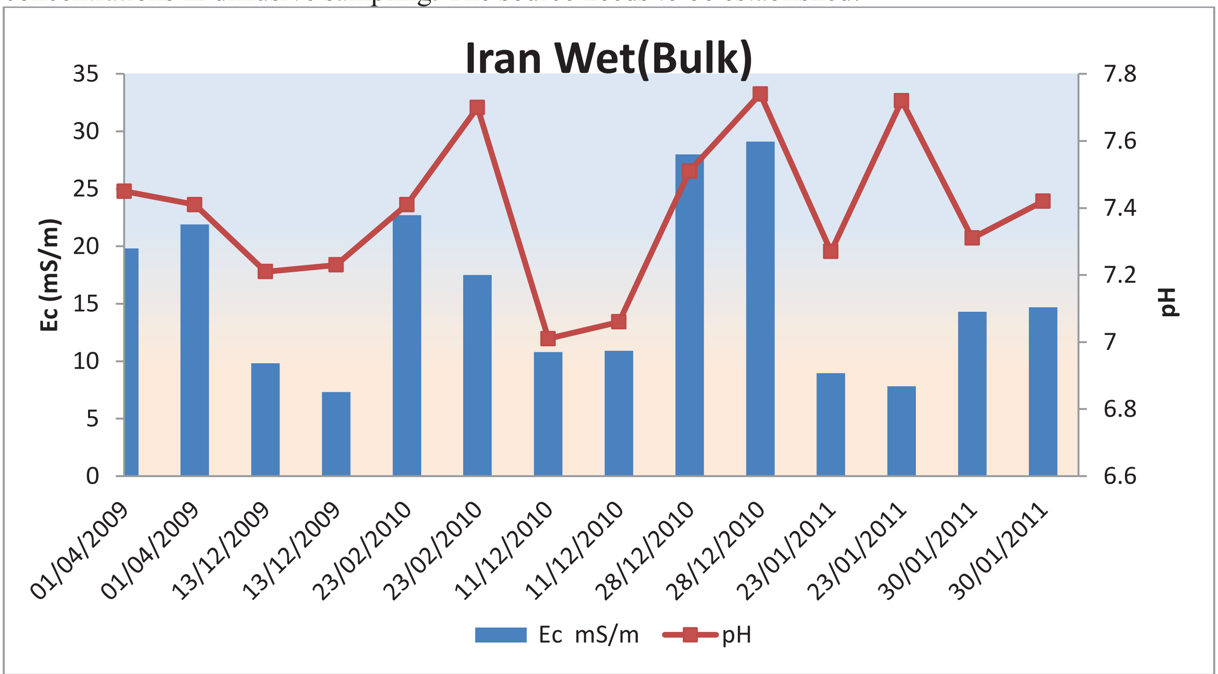

Figure 3-20 Variation in electrical conductance and pH Wet (Bulk)

Table 3-17 Results of wet monitoring using bulk collector - Iran

Month	Ec (mS/m)	pH	Precipitation (ml)
Jan-09	20.8	7.4	176
Dec-09	8.6	7.2	605
Feb-10	20.2	7.5	275
Dec-10	18.2	7.6	272.5
Jan-11	11.4	7.4	585

3.3.5 MALDIVES

The monitoring station is located on the Hanimaadhoo Island, located about 400 km north of the country's capital, Malé. In Maldives, air pollution is more pronounced in Male' while in the islands in can be generally termed good due to limited vehicles and industrial activities in islands. However, in Male', the capital, pollution is often stated as an emerging health hazard. The parameter of major concern currently is particulate matter (PM10). PM10 data results show that PM10 concentration is within WHO standards. Average concentration for 2 months in 2011 was 20 micrograms per cubic meter. Passive sampler is located in'' HukuruMisky'' area of Male' which is located in north of Male'.

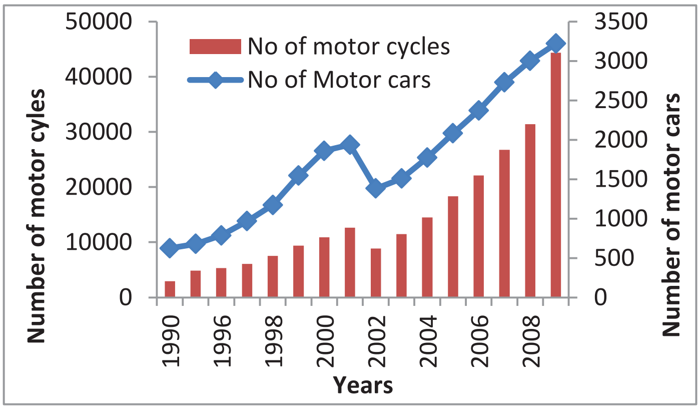

Figure 3-21 Increasing vehicles trend

Traffic congestion is limited in this area. However it is adjacent to a road. Due to congestion finding a suitable location for a station in Male' City is a big challenge. The monitoring station location is considered a clean area away from sea and salt spray.

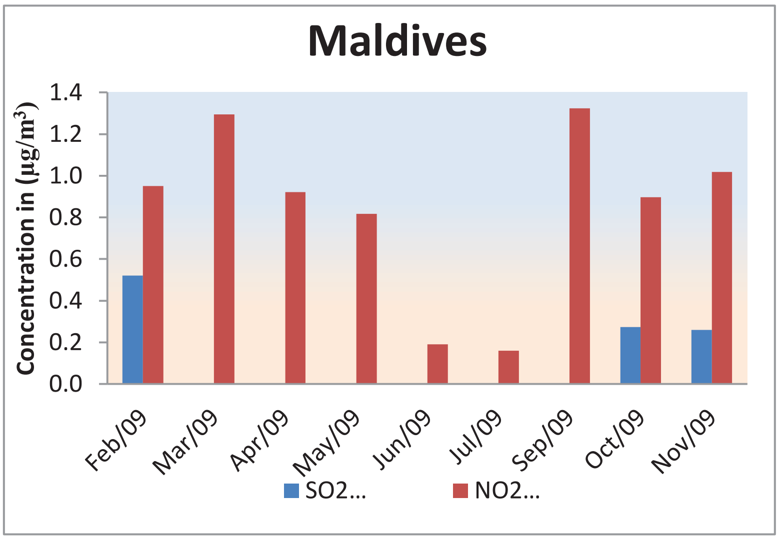

Figure 3-22 Temporal variation of average SO2& NO2 concentration

3.3.5.1 Dry Deposition Monitoring

Maldives conducted diffusive sampling during 2009.The SO_2 and NO_2 concentrations remain low throughout the year and SO_2 was detected only during the period February to October. The NO_2 concentration is low during the monsoon period, high concentration during the month of September coincides with the high ozone concentration during the same period. In general higher NO_2 and ozone concentration is observed during the same period. Increasing number of vehicles, mostly two wheelers, are the main source of air pollution in the area. The total numbers of vehicles registered in Male' from Jan 2006 to Dec 2010 was 19,767 (Figure 3.21). The country is taking steps for the control of vehicular emissions.

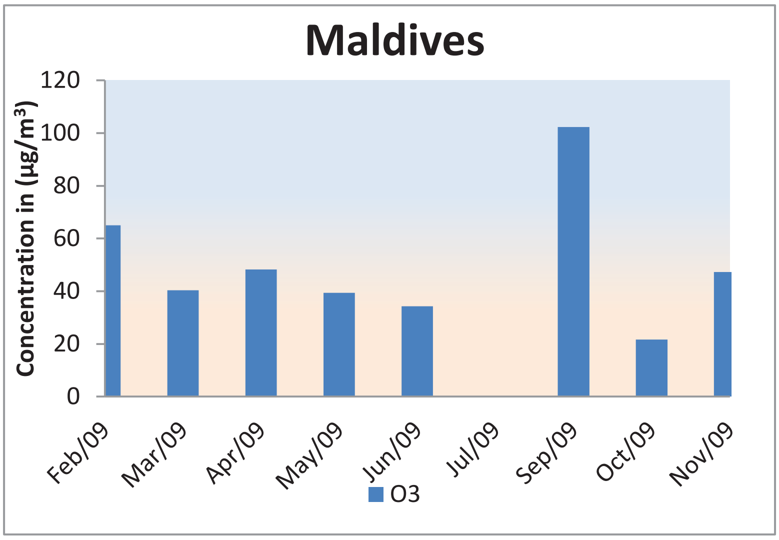

Figure 3-23 Temporal variation of O3 concentration

Table 3-18 Average concentration of SO_2, NO_2 and O_3 in (($\mu g/m^3$) - Maldives

	SO_2	NO_2	O_3
Feb-09	0.5	1.0	65
Mar-09	BDL	1.3	40
Apr-09	BDL	0.9	48
May-09	BDL	0.8	39
Jun-09	BDL	0.2	34
Jul-09	BDL	0.2	BDL
Sep-09	BDL	1.3	102
Oct-09	0.3	0.9	22
Nov-09	0.3	1.0	47
Annual avg	0.4	0.8	48

3.3.6 NEPAL

3.3.6.1 Dry Deposition Monitoring

The data of Nepal has been presented in Table 3.19 & Figure 3.24. A perusal of the Table 3.19 indicates that the monitoring has been carried only for a few months in 2009 alone, and thus although annual averages have been calculated these cannot be taken as conclusive and no definite trends can be established.

The monitoring was started in 2003 which seems to have got regularized by 2006. However, the monitoring has been discontinued since 2009 due to problems with availability of power.

Rampur is a village in southern Nepal. The monitoring station is located in IAAS (Institute of Agriculture and Animal Science), Rampur.

The monsoon period is approximately from the end of June to the middle of September. About 80 per cent of the rain falls during that period, so the remainder of the year is dry.

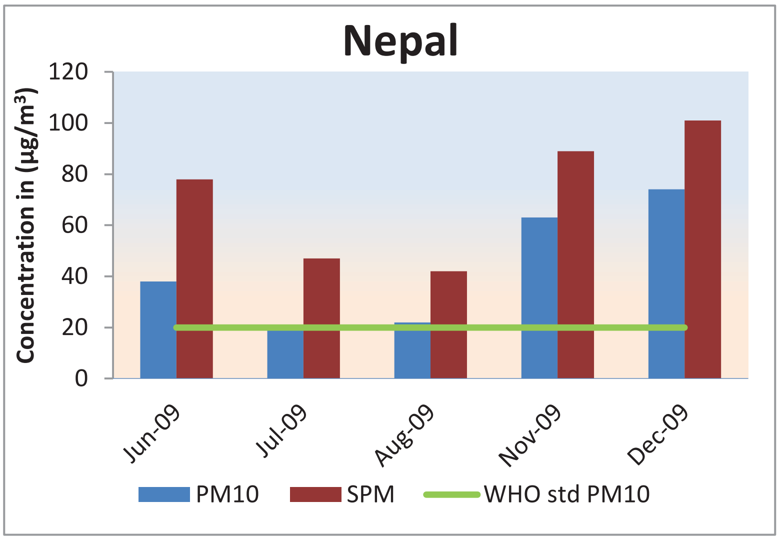

Figure 3-24 Temporal variation of PM10 concentration

Table 3-19 Average variation of PM10 concentration in µg/m³– Nepal

		PM10			SPM	
	Avg	Min	Max	Avg	Min	Max
Jun-09	38	15	56	78	42	109
Jul-09	20	10	30	47	31	67
Aug-09	22	14	33	42	34	50
Nov-09	63	57	74	89	67	111
Dec-09	74	60	119	101	75	173

Diffusive Sampling

The SO_2 concentration remains low and there is no clear trend. (Figure 3.25 and Table 3.20).The highest concentration of NO_2 (9.7µg/m^3) occurs in winters, in the month of February 2009 and 2010, at the same time there is a clear increasing trend over the previous years with the highest concentration in 2007 as 4.9 µg/m^3. The maximum PM10 concentration is also reported in winters (monitoring only June to Dec) The ozone concentration on the other hand is higher February to June with highest concentrations occurring in March-May. There is a need to look into the emission sources and the meteorological conditions.

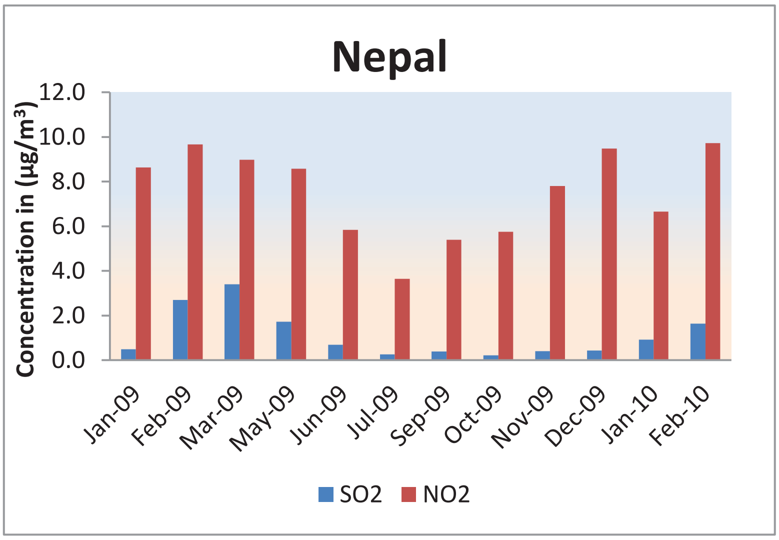

Figure 3-25 Temporal variation of average SO2& NO2 concentration

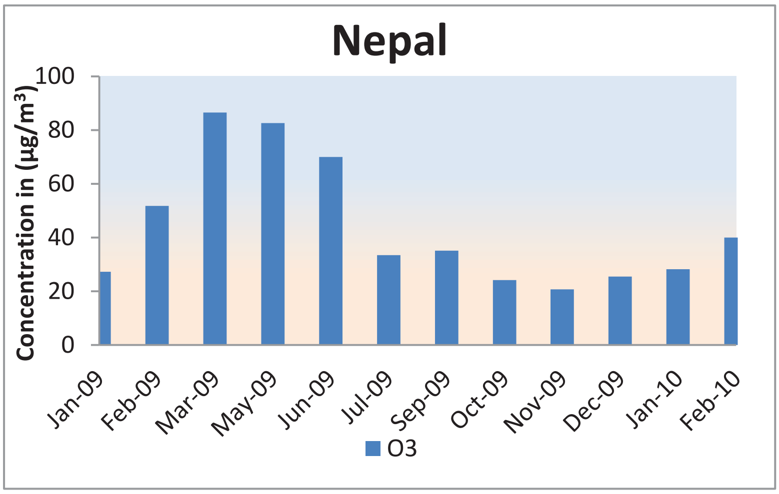

Figure 3-26 Temporal variation of average O3 concentration

Table 3-20 Average concentration of SO_2, NO_2 and O_3 - Nepal

	SO_2µg/m^3	NO_2µg/m^3	O_3µg/m^3
Jan-09	0.5	8.6	27
Feb-09	2.7	9.7	52
Mar-09	3.4	9.0	86
May-09	1.7	8.6	83
Jun-09	0.7	5.8	70
Jul-09	0.3	3.6	33
Sep-09	0.4	5.4	35
Oct-09	0.2	5.8	24
Nov-09	0.4	7.8	21
Dec-09	0.4	9.5	26
Annual avg	1.1	7.4	46
Jan-10	0.9	6.7	28
Feb-10	1.6	9.7	40

3.3.6.2 Wet Deposition Monitoring

Only Wet Bulk monitoring was conducted (sampling period:one month or more)by Nepal for a few months in each year during 2009 - 2011. The samples were analysed for pH, Ec, anions and a very few samples for some cations (Table 3.21). The pH varied between 5.4 and 7. (Figure 3.27) over the years, the electrical conductivity showed a decreasing trend. The reason for very high electrical conductivity in a few months during the monitoring period needs to be looked into. There is no correlation between the ion concentrations and Ec (Annexure III). No specific trend or tendencies could be established.

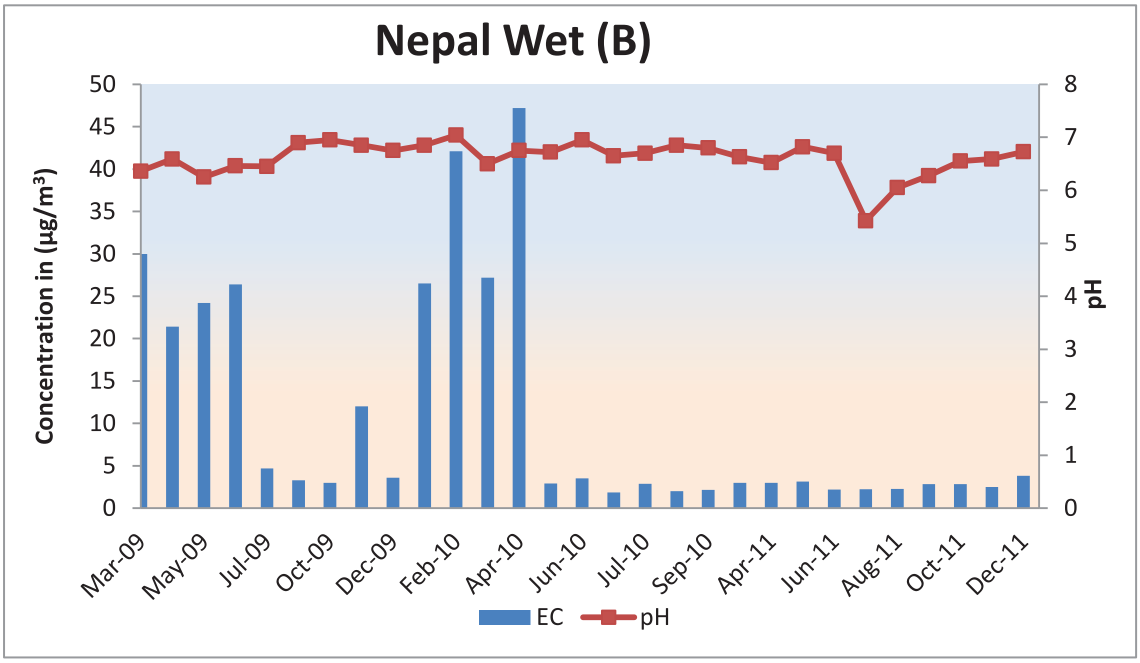

Figure 3-27 Variation in electrical conductance and pH Wet(Bulk)

Table 3-21 Results of wet monitoring using bulk collector - Nepal

	Ec (mS/cm)	pH	Ec (mS/cm)	pH	Ec (mS/cm)	pH
	2009		2010		2011	
Jan	--	--	26.5	6.9	--	--
Feb	--	--	42.1	7.0	--	--
Mar	30.0	6.4	27.2	6.5	--	--
Apr	21.4	6.6	47.2	6.8	3.0	6.5
May	24.2	6.3	2.9	6.7	3.2	6.8
Jun	26.4	6.5	3.5	7.0	2.2	6.7
Jul	4.7	6.5	1.9	6.7	2.2	5.4
Aug	--	--	2.9	6.7	2.3	6.1
Sep	3.3	6.9	2.0	6.9	2.8	6.3
Oct	3.0	7.0	2.2	6.8	2.8	6.6
Nov	12.0	6.9			2.5	6.6
Dec	3.6	6.8			3.8	6.7

3.3.7 PAKISTAN

3.3.7.1 Dry Deposition Monitoring

Pakistan monitored the PM10 concentration in ambient air for three winter months during 2009 (Figure 3.28; Table 3.22). The observed monthly average concentration of PM10 is appreciably high. There is a need to correlate the data with meteorology and the emission sources in the area of influence. However no conclusions can be drawn in view of very less data.

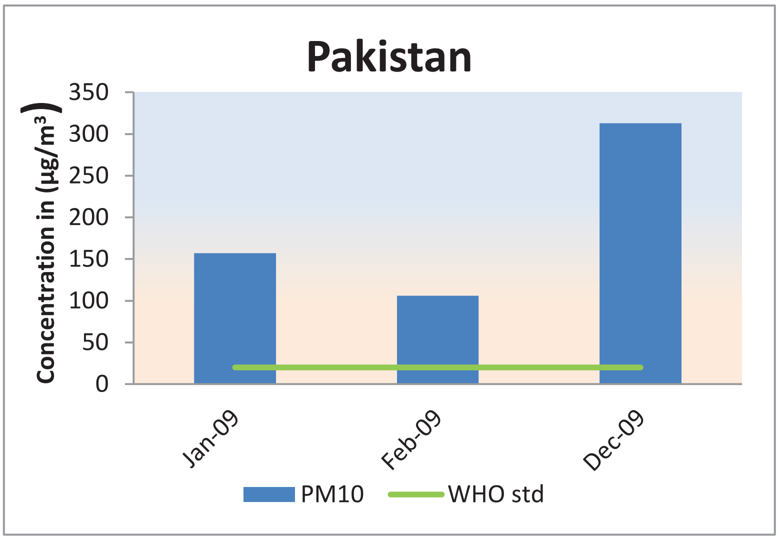

Figure 3-28 Temporal variation of PM10 concentration

Table 3-22 Monthly variation of PM10 concentration (µg/m³) - Pakistan

		PM10			SPM	
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**
Jan-09	157	118	254	303	259	354
Feb-09	138	127	149	311	310	312
Dec-09	313	272	386	353	231	447

3.3.7.2 Wet Deposition Monitoring

Pakistan has also done Wet (Bulk) monitoring during 2009 and analysed the samples for pH and Ec. The results are depicted in Figure 3.29 and Table 3.23. The pH varies between 7.4 to 9.7. The pH levels in Pakistan are high, probably due to the alkaline soil dust in the region.

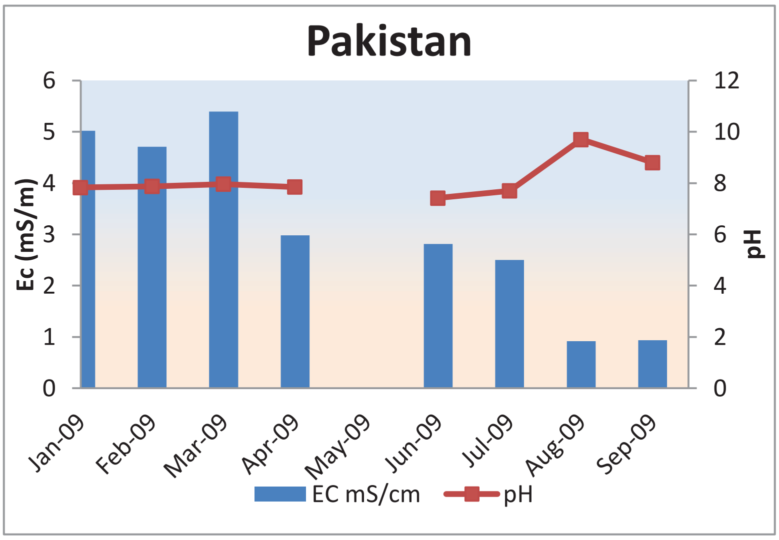

Figure 3-29 Variation in electrical conductance and pH Wet(Bulk)

Table 3-23 Results of wet monitoring using bulk collector - Pakistan

	EC (mS/m)	pH
Jan-09	5.02	7.8
Feb-09	4.71	7.9
Mar-09	5.39	8.0
Apr-09	2.98	7.9
Jun-09	2.81	7.4
Jul-09	2.5	7.7
Aug-09	0.92	9.7
Sep-09	0.94	8.8

3.3.8 SRI LANKA

Sri Lanka is an island located in Indian Ocean between latitudes 050 and 100 N, and longitudes 790 and 820E. The central part of the southern half of the island is mountainous with heights more than 2.5 km. The core regions of the central highlands contain many complex topographical features such as ridges, peaks, plateaus, basins, valleys and escarpments. The remainder of the island is practically flat except for several small hills that rise abruptly in the lowlands. These topographical features strongly affect the spatial patterns of winds, seasonal rainfall, temperature, relative humidity and other climatic elements, particularly during the monsoon season.

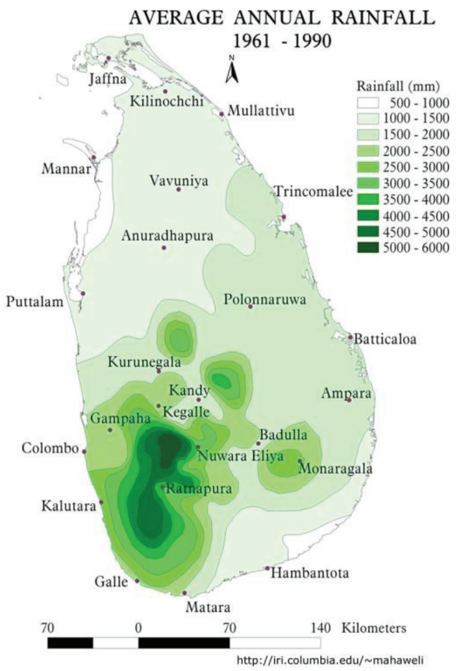

Figure 3-30 Climatic zones in Sri Lanka

There is a marked climatic variation in Sri Lanka Four basic types of rains namely, monsoonal, convectional , cyclonic and orographicare identified in the country which occur singly or in combination. There are two distinct monsoon driven rainy seasons namely the southwest or summer monsoon (May to September) and northeast or winter monsoon (December to February). The island is also influenced by the atmospheric depressions that form in the southwest Bay of Bengal and southeast Arabian Sea which promote cyclonic rains. However, orographic rainfall prevails specially in the highlands and the cyclonic rains during the second inter-monsoon (October and November) are fairly widespread. The intensity of the annual rainfall divides the island into two distinct climatic zones, the wet zone and the dry zone. Nearby three quarters of Sri Lanka lies in 'Dry Zone', comprising the northern half and the whole of the east of the country. Average annual rainfall in this region is generally between 1,200-1,800 mm.

3.3.8.1 Dry Deposition Monitoring

Sampling location of Sri Lanka is situated at Doramadalawa (080 24' 22.39" N, 800 29' 11.74" E) in dry zone around 10 km areal distance from the ancient city called Anuradhapura. Anuradhapura is a major city in Sri Lanka with a population of about 60,000 people. The city, a UESCO world Heritage site and a tourist destination, especially during the months of May-June. This monitoring site is on the small rock, nearby Doramadalawa Buddhist temple at the edge of the Mihinthale reserve forest. There is a highway at about 10km in the east of the sampling location. This location is classified as rural site. Monthly variation in rainfall and the average number of rainy days in the area of sampling is given in Figure-3.23. The predominant wind direction is Southwest from May to September and Northeast from December to February.

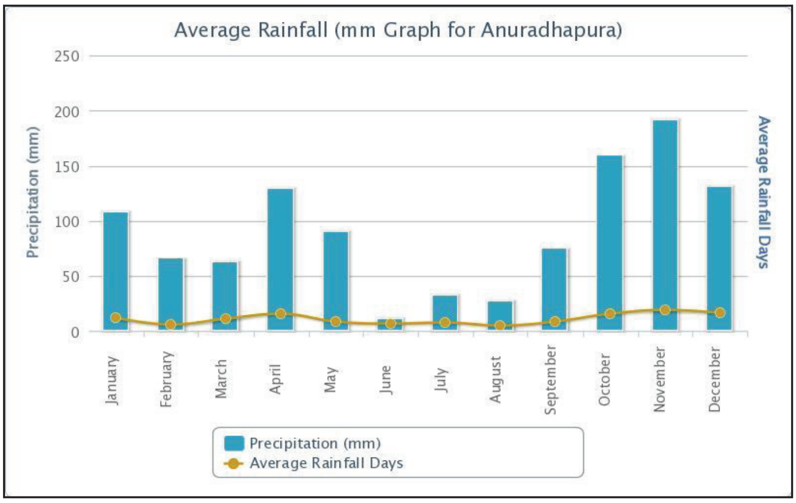

Figure 3-31 Monthly variations of rainfall and the average number of rainy days at the area of sampling (Source Department of Meteorology)

Regular monitoring of PM10 at the Doramadalawa location was started in January 2010 .Monitoring was done by using high volume sampler (Model 2000) located at about 7m height from the top of rock (around 20m height from ground). The results are given in Table -3.23 and Figure -3.29. Perusal of Table-3.23 and Figure -3.29 indicate that there is a large variation in PM10 concentrations from 12 to 59 µg/m3 with annual average 29 µg/m^3 and standard deviation 11.18. Highest monthly average concentrations were observed during March-April and September whereas the lowest concentrations were generally in the months of August in 2010 and May, June in 2011. On comparing the concentration with the rainfall data (Figure-3.29),it is seen that variation in rainfall is not the main reason for the variations of PM10 concentrations as the High concentrations were observed in the month of April which is not a dry period. At the same time, in 2011 the lowest concentrations were observed during May-June, June being a dry month. Highest concentrations of PM10 have been attributed to some construction activities in the area nearby and to the period of open fires (agricultural residue burning in the fields) in dry period(from July to September) during the land preparation for the next crop. Other activities which could influence the results include rice mills in the area which operate throughout the year.

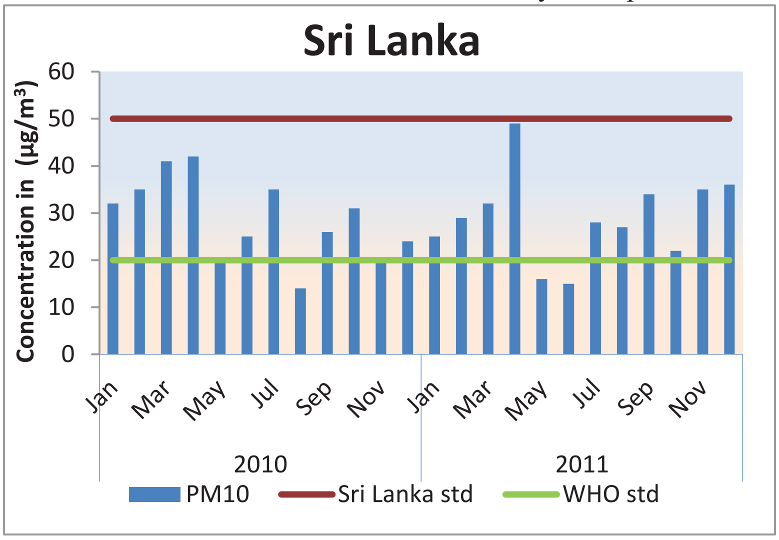

Figure 3-32 Temporal variation of PM10 concentration

3-24 Table Average variation of PM10 concentration in µg/m³– Sri Lanka

	2010			2011		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**
Jan	32	22	44	25	16	34
Feb	35	27	48	29	19	41
Mar	41	24	54	32	16	58
Apr	42	23	24	49	49	49
May	20	23	24	16	15	17
Jun	25	23	24	15	15	15
Jul	35	23	24	28	19	34
Aug	14	23	23	27	21	36
Sep	26	23	24	34	24	43
Oct	31	22	22	22	19	28
Nov	20	23	23	35	15	59
Dec	24	21	29	36	25	52
Annual avg	29			29		

Diffusive Sampling

Sri Lanka has been conducting passive sampling regularly since Aug 2003. SO_2 and NO_2 concentrations have been monitored only by the diffusive sampling method. The data of 2009-2010 is presented in Table-3.24 and Figure 3.30.Since the monitoring location was shifted from Dutuwewa to Doramadalwa in 2009, one year parallel monitoring was carried out to know the variation of results due to change of location. A perusal of Table3.24 and Figure -3.30 indicates that the concentration of both SO_2 and NO_2 remains higher at Doramadalwa as compared to Dutuwewa indicating greater emission sources/activity at the new monitoring location. Although the concentrations remain low and no definite trend can be established, highest concentrations of SO_2 was observed in April and May and that of NO_2 in April and August. The high concentration of SO_2 and NO_2 in April coincides with the high concentration of PM10 (although years are different) in the same month. Further studies may be carried out to know if the source is the same.

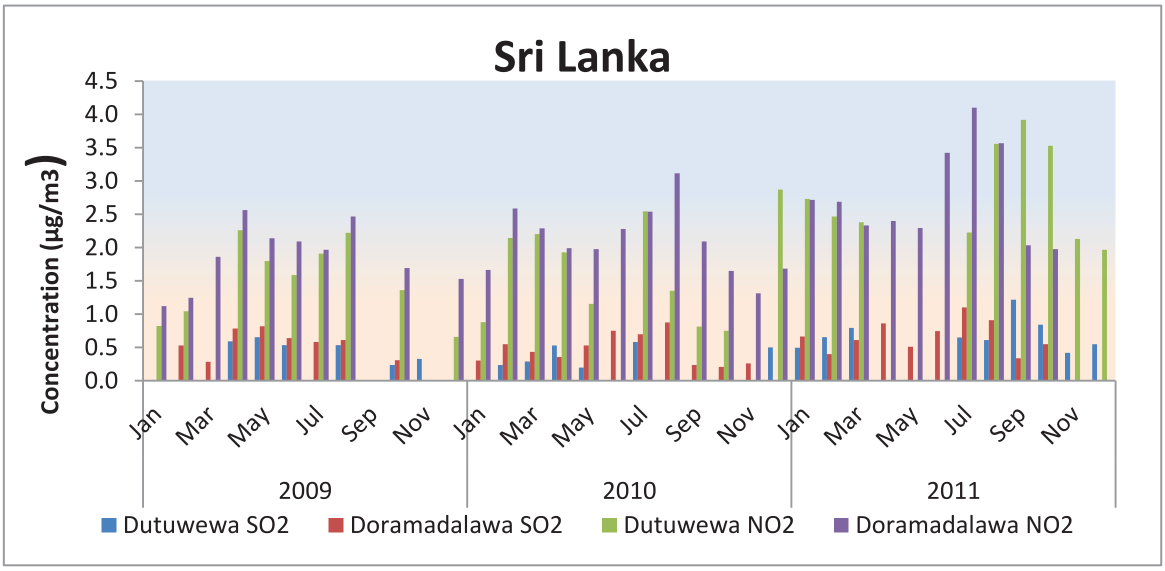

Figure 3-33 Temporal variation of average SO2 & NO2 concentration

Table 3-25 Average concentration of SO_2, NO_2 and O_3 in $NO_2 \mu g/m^3$ – Sri Lanka

		Dutuwewa	Doramadalawa	Dutuwewa	Doramadalawa	Dutuwewa	Doramadalawa
		SO_2		**NO_2**		**O_3**	
2009	Jan	BDL	BDL	0.8	1.1	27	38
	Feb	BDL	0.5	1.0	1.2	23	35
	Mar		0.3		1.9	15	21
	Apr	0.6	0.8	2.3	2.6	36	34
	May	0.7	0.8	1.8	2.1	40	40
	Jun	0.5	0.6	1.6	2.1	38	37
	Jul	BDL	0.6	1.9	2.0	36	41
	Aug	0.5	0.6	2.2	2.5	31	38
	Sep						
	Oct	0.2	0.3	1.4	1.7		28
	Nov	0.3	BDL		BDL		BDL
	Dec		BDL	0.7	1.5	31	39
Annual avg		0.5	0.6	1.5	1.9	31	35
2010	Jan	BDL	0.3	0.9	1.7	23	34
	Feb	0.2	0.5	2.1	2.6	28	42
	Mar	0.3	0.4	2.2	2.3	25	31
	Apr	0.5	0.4	1.9	2.0	35	39
	May	0.2	0.5	1.2	2.0	16	39
	Jun		0.8		2.3		39
	Jul	0.6	0.7	2.5	2.5	34	34
	Aug	BDL	0.9	1.4	3.1	23	41
	Sep	BDL	0.2	0.8	2.1	BDL	28
	Oct	BDL	0.2	0.8	1.7	73	43
	Nov		0.3		1.3		47
	Dec	0.5	BDL	2.9	1.7	40	41
Annual avg		0.4	0.5	1.7	2.2	32	38
	Jan	0.5	0.7	2.7	2.7	51	41
	Feb	0.7	0.4	2.5	2.7	41	40
	Mar	0.8	0.6	2.4	2.3	38	40
	Apr		0.9		2.4		41
	May		0.5		2.3		42
	Jun		0.7		3.4		36
	Jul	0.7	1.1	2.2	4.1	40	37
	Aug	0.6	0.9	3.6	3.6	39	34
	Sep	1.2	0.3	3.9	2.0	36	38
	Oct	0.8	0.5	3.5	2.0	32	53

	Nov	0.4		2.1		35	
	Dec	0.5		2.0		52	
Annual avg		0.7	0.7	2.8	2.8	41	40

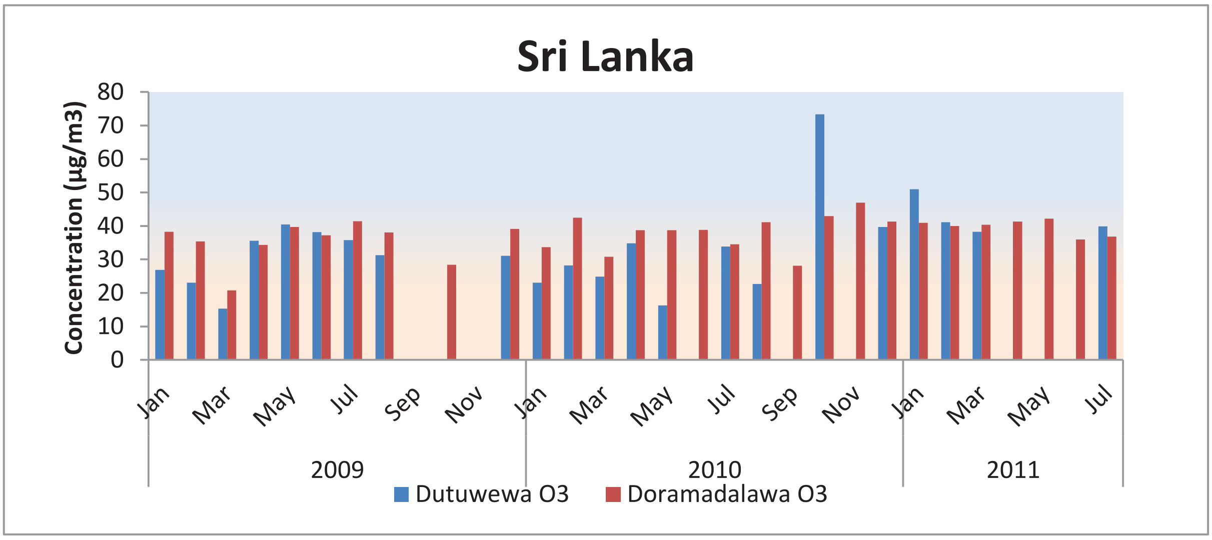

Figure 3-34 Temporal variation of O3 concentration

Ozone being a secondary pollutant its presence in the atmosphere depends on the concentration of NO_2 and VOCs in the atmosphere and the reaction between them. Table -3.24 and Figure- 3.31 give the variation in O_3 concentration over the year.Highest concentrations were observed during the months of May and July.

3.3.8.2 Wet Deposition Monitoring

Sri Lanka has been carrying out the wet deposition studies regularly for all the cations and anions since 2004.

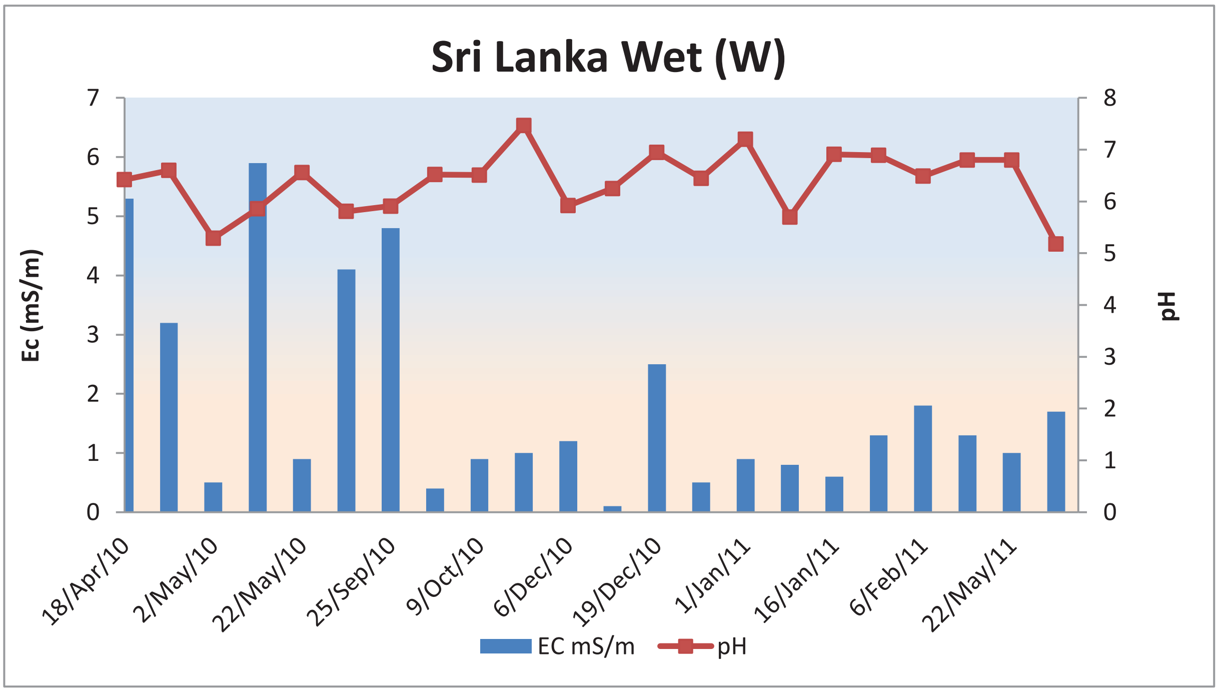

Figure 3-35 Variation in electrical conductance and pH wet (wet)

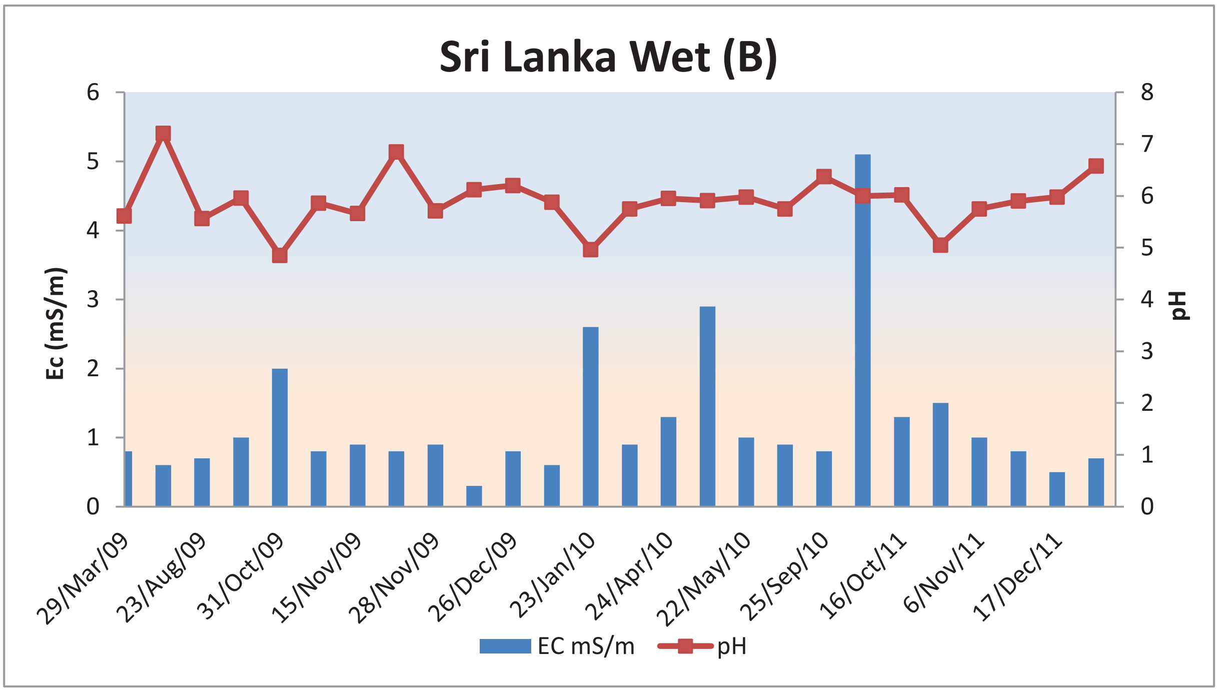

Figure 3-36 Variation in electrical conductance and pH wet (bulk)

Table 3-26 Results of wet monitoring using wet wet and bulk collector – Sri Lanka

			Wet wet			Wet bulk	
		Ec mS/m	pH	Precipitation ml	Ec mS/m	pH	Precipitation ml
2009	Mar	0.8	5.6	148	0.8	5.6	148
	May	0.6	7.2	260	0.6	7.2	260
	Aug	0.7	5.6	2700	0.7	5.6	2700
	Oct	1.2	5.8	1200	1.2	5.8	1200
	Nov	0.8	6.0	2483	0.8	6.0	2483
	Dec	0.7	6.2	3025	0.7	6.2	3025
2010	Jan	0.9	5.7	763	0.9	5.7	753
	Apr	1.0	5.8	1650	1.0	5.8	1650
	May	1.3	3.8	3400	1.3	3.8	3400
	Sep	0.9	6.0	1250	0.9	6.0	1250
	Oct	5.1	6.0	1300	5.1	6.0	1300
2011	Oct	1.4	5.5	1575	1.4	5.5	1575
	Nov	1.0	5.8	840	1.0	5.8	840
	Dec	0.7	6.1	800	0.7	6.1	933

A look at Figures 3.35 and 3.36 and Table 3.26 indicates that the pH varied from 5.5 to 7.5 with only one occasion in May 2010 when it was 2.8. The fluctuations were also associated with fluctuations in precipitation amounts both above and below the long term averages although no particular trend was

observed in the seasonal variation of the pH. No clear conclusions can be drawn as the monitoring location has been changed since 2009
The data reported for 2009-11 indicates a conductance range from 0.5 to 9.4mS/m in the wet only and the bulk samples. Unusually high Ec in certain months needs to be correlated with the meteorological data and the emission sources to know the reasons.

Sulphate and nitrate are the most important acid anions in precipitation both of which are correlated with hydrogen ion concentrations and to acid rain. The sulphate concentration varied between 0.19 to 18.28µmol/l with the lowest values recorded during Oct 2010 and the highest in Jan 2011. Moreover, the concentrations were higher during certain months as compared to the others. No particular trends in seasonal variations or correlation with Ec could be established.

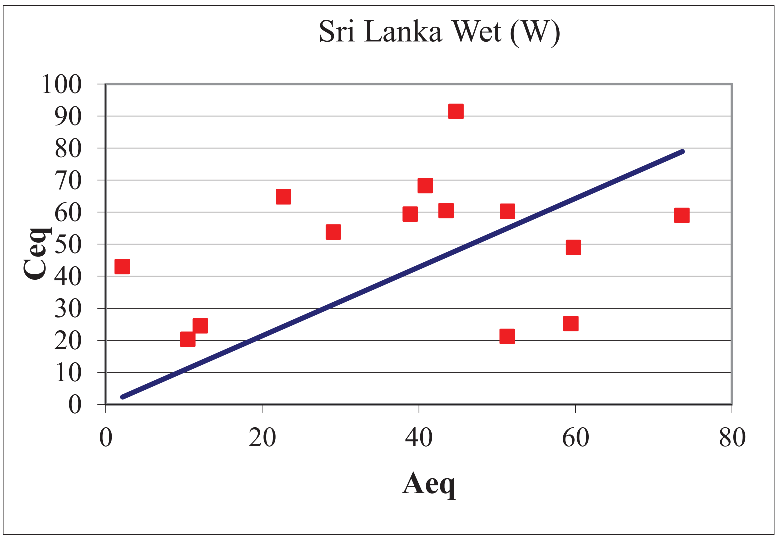

Figure 3-37 Aeq vs Ceq wet wet

The nitrate concentration varied from 0.23 µmol/l in May, 2010 to 18.67µmol/l in Jan, 2011 over the three years of monitoring. There are large variations in the concentration and no particular seasonal trend can be established. The influence that precipitation volumes exert on wet depositions is not very evident from the nitrate concentration trends. No definite correlation exists between the concentration of sulphate, nitrate and pH, however it may be noted that the highest concentrations of both sulphate and nitrate were observed during Jan 2011.

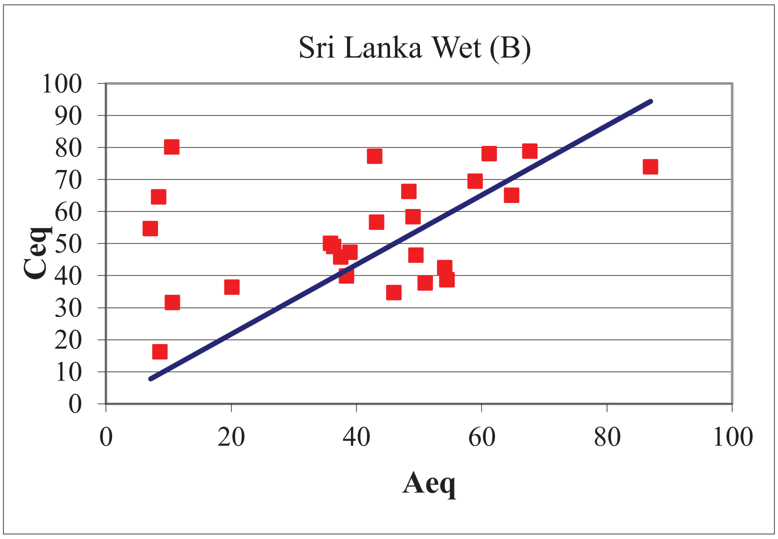

Figure 3-38 Aeq vs Ceq wet bulk

Ammonium concentrations are of particular interest because of their potential contribution to nutrient enrichment and/or acidification of surface waters. Ammonium concentrations in precipitation are a by-product of agricultural activity, so their concentrations are generally higher near and downwind of large-scale agricultural operations, poultry farms, animal feedlots, etc. Biological decomposition of plant materials in shallow surface waters can also contribute to local spatial patterns. Ammonium concentration in precipitation ranged from 4.77 to 34.98µmol/l. Correlation with the occurrence of other ions was not there, however, the highest concentration of ammonium coincides with the highest concentration of potassium. No seasonal or annual trends could be established.

Figures 3.37 and 3.38 give the correlation of the anion vs. cation equivalent concentrations.

Calcium and magnesium ions were found in concen trations ranging from 0.25 to 22.23 and 0.45 to 7.94 µmol/l respectively. The highest concentration of calcium and magnesium in wet only samples was 0.30 and 22.23µmol/ and in the Bulk samples it was 0.25 and 22.01 µmol/l respectively. The concentrations of the two ions across the year are random and no clear trend was observed. Compared to the inland sites, the sea salt driven ions, chloride and sodium, appeared higher and calcium+, as a soil-driven ion, appeared lower at the coastal monitoring site of Sri Lanka

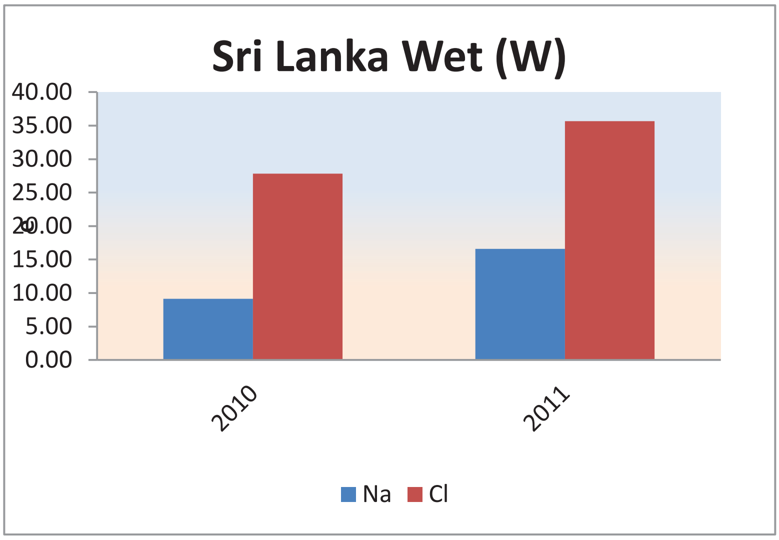

Figure 3-39 Na and Cl distribution wet only collector

Potassium occurs at the Sri Lanka site in concentrations ranging from 0.15 to 9.46µmol/l. The lowest concentration was observed during July, 2009 wet sample. Potassium containing fertilizers and soil disturbance near the site could be a contributing factor. No consistent temporal patterns in potassium concentrations exist across the monitoring period.

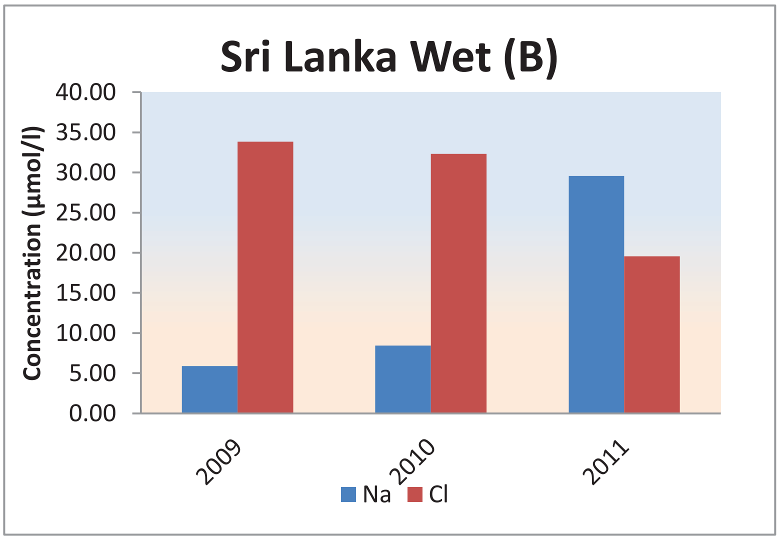

Figure 3-40 Na and Cl distribution bulk collector

Chloride and sodium concentrations generally exhibit a fairly definable temporal pattern which could be associated with the origin and direction of storms and the presence of sea salt (sodium chloride) from coastal influences. Relatively high sodium and chloride concentrations were found as the site is near the coastal region; Sodium concentration mimics the chloride concentration. At the same time the equivalent concentration of sodium is always higher than that of chloride indicating the presence of other sodium salts.

CHAPTER 4. CONCLUSIONS AND RECOMMENDATIONS

The monitoring results of 2009-11 have been discussed in this Data Analysis Report. The eight countries participating in the Malé programme were required to carry out both Wet and Dry Deposition monitoring. Dry deposition was monitored using two methods, viz., using PM10 samplers (for PM10, SO_2 and NO_2) and using Diffusive samplers (for SO_2, NO_2 and O_3). Wet deposition was monitored using Wet(Wet) and Wet(Bulk) samplers for pH, Ec, NH^{4+}, Na^+, K^+, Mg^{2+}, Ca^{2+},SO_4^{2-}, Cl^- and NO_3- by each method. However, some of the participating countries were unable to carry out the complete monitoring by all methods. An attempt has been made to compare the reported results, however, it may be kept in mind that the discussion is only indicative as in some cases the averages are based on very few values and some of the countries have not followed the monitoring protocols.

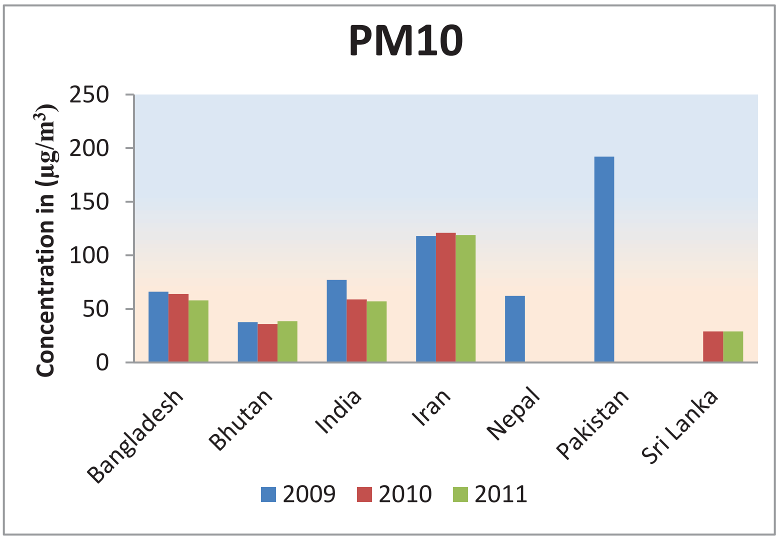

Figure 4-1 Annual average PM10 concentration

The comparative results of PM10 monitoring are given in Table 4.1.

Of the countries that monitored PM10, the highest annual average was observed in the case of Iran (Figure 4.1), followed by Bangladesh, India, Nepal, Bhutan and Sri Lanka(the Pakistan average is of only three months, thus not representative). The annual average concentration of PM10 in case of Bangladesh and India has been decreasing over the years.

Table 4-1Average PM10 concentration in µg/m³

S No	Country	2009	2010	2011
1	Bangladesh	66	64	58
2	Bhutan	38	36	38
3	India	77	59	57
4	Iran	118	121	119
5	Nepal	62	--	--
6	Pakistan*	192	--	--
7	Sri Lanka	--	29	29

*only three months data

The results of SO_2, NO_2 and Ozone by diffusive sampling are given in Table 4.2 and depicted in Figure 4.2 to 4.5. The highest observed concentration of SO_2 is in case of Iran followed by Bangladesh and Nepal. Sri Lanka. The highest NO_2 concentrations have been observed in Nepal followed by Bangladesh, Iran, Sri Lanka and Maldives. Ozone concentration was highest in case of Iran and Bangladesh followed by Maldives, Nepal and Sri Lanka (Figure 4.2)

Table 4-2 Annual Average SO_2 , NO_2 and O_3concentration in µg/m^3 -2009

S No	Country	SO_2	NO_2	O_3
1	Bangladesh	3.6	3.5	72
2	Iran	11.7	2.1	74
3	Maldives	0.4	0.8	48
4	Nepal	1.1	7.4	46
5	Sri Lanka	0.6	1.9	35

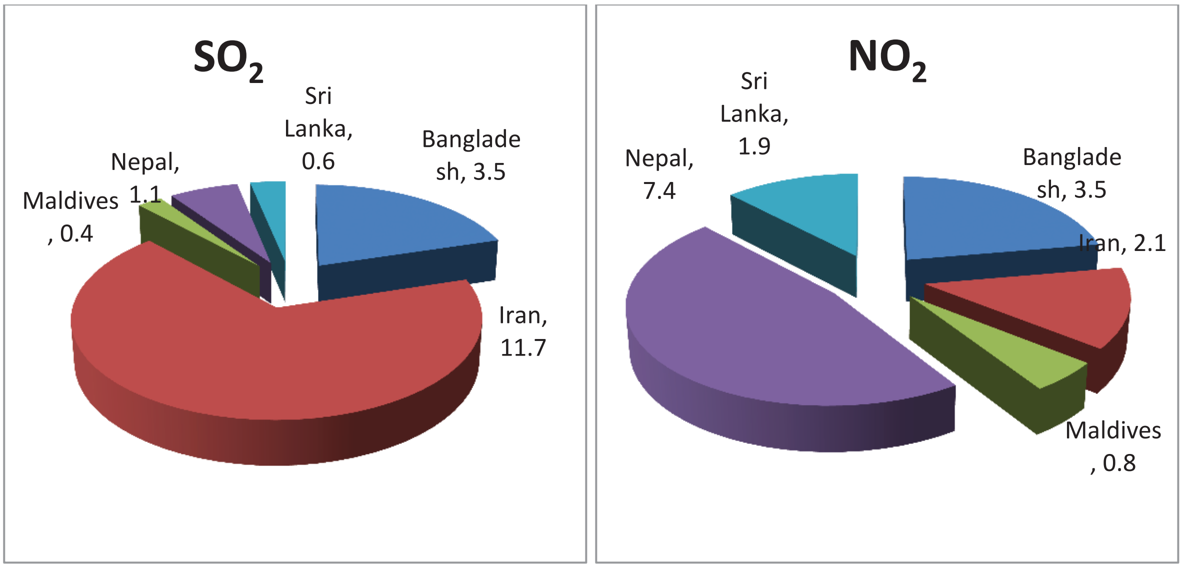

Figure 4-2 Annual Average SO_2 , NO_2 and O_3concentration in µg/m^3 -2009

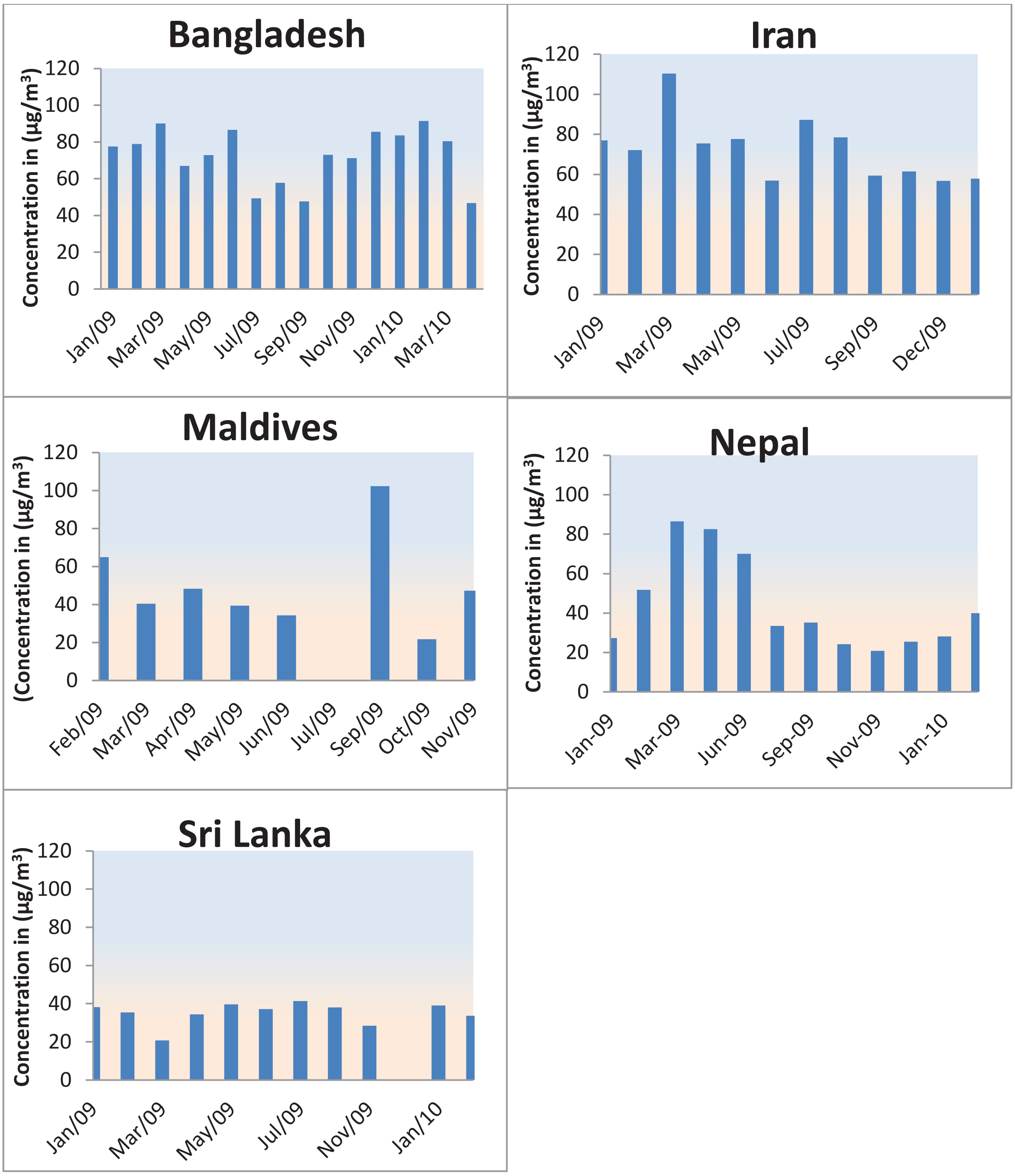

Figure 4-3 O_3 variation

The results of wet deposition monitoring have not been reported by all the countries (Annexure III). No particular trends or conclusions could be drawn. The variation in pH during 2009-2011 is given in Figure- 4.4. Although some variations in pH have been observed, no particular trends could be established. Higher sodium and chloride ion concentrations in case of Bangladesh and Sri Lanka could be due to sea breeze. No trends could be established in the ion concentrations and Ec.
Iran has exceptionally high PM10 concentrations combined with high SO_2. It may be mentioned that the results of Wet deposition monitoring in case of Iran (Annexure III) also show high sulphate concentrations. The results need to be analysed in view of meteorology and sources of emissions in the area. Higher NO_2 and ozone could also be from the same source. In case the location is in the

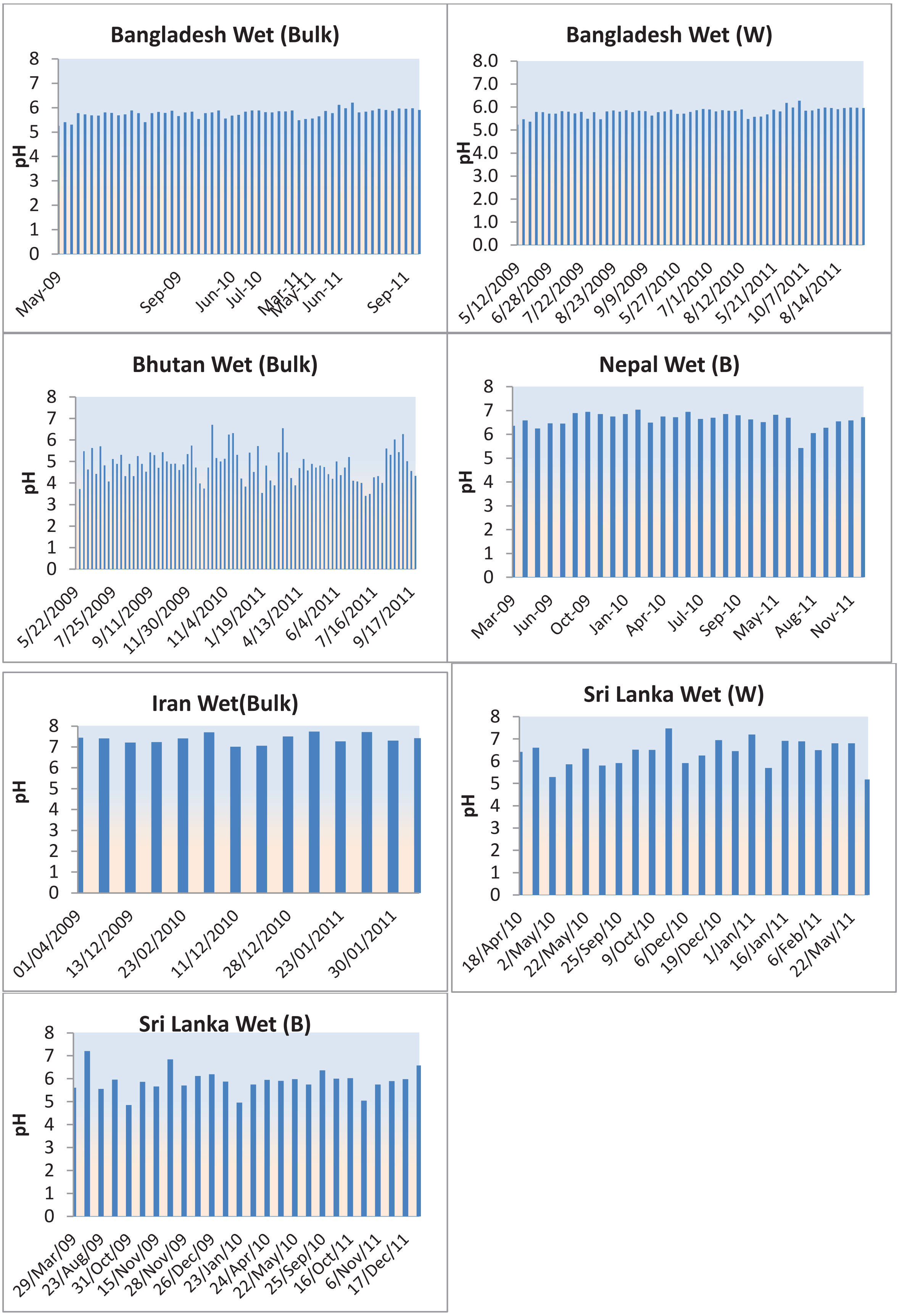

Figure 4-4 pH variation

direct influence of the flare of oil wells in adjoining Iran an alternative monitoring location which is more representative may be identified for monitoring under the programme.

The next highest PM10 concentration was observed in case of Bangladesh and India. The concentration of SO_2, NO_2 and ozone by diffusive sampling is also high in case of Bangladesh when compared to the other countries. The main source has been identified as the brick kilns and vehicular emissions. India has not reported the results of diffusive sampling, however, the results of Air concentration monitoring (Table-4.1) indicate negligible concentration of SO_2 and very low concentration of NO_2. India needs to identify the sources of PM10 so that air quality management strategies can be formulated accordingly. The PM10 concentration in the two countries has been decreasing over the years as a result of measures taken to control the sources of air pollution.

The highest NO_2 concentration has been observed in the case of Nepal. Air pollution in Nepal has been attributed mainly to rapid urbanization, increasing number of vehicles, large number of brick kilns and industrialization.

The above comparison is only indicative. For meaningful conclusions and comparison it is important that all the countries carry out regular Dry and Wet deposition monitoring as per the protocols established under the Malé declaration monitoring programme.

Correlation of results and trends by each country in relation to meteorology and emission sources in the area is of utmost importance.

ANNEXURE I: CONCENTRATION OF PM10 BY AIR CONCENTRATION MONITORING

RESULTS OF AIR CONCENTRATION – BANGLADESH

S No	Month	Start Date	End date	PM10 (µg/m^3)	SPM (µg/m^3)	Remarks
1	Jan - 09	11-Jan-09	12-Jan-09	125	149	
2		13-Jan-09	14-Jan-09	136	156	
3		15-Jan-09	16-Jan-09	140	167	
4		17-Jan-09	18-Jan-09	133	152	
5		19-Jan-09	20-Jan-09	133	157	
	Jan - 09	Average		133	156	
6	Feb-09	16-Feb-09	17-Feb-09	125	150	
7		17-Feb-09	18-Feb-09	111	138	
8		19-Feb-09	20-Feb-09	158	187	
9		20-Feb-09	21-Feb-09	140	167	
10		21-Feb-09	22-Feb-09	110	138	
	Feb-09	Average		129	156	
11	Mar-091	10-Mar-09	11-Mar-09	100	123	
12		12-Mar-09	13-Mar-09	102	123	
13		14-Mar-09	15-Mar-09	106	142	
14		16-Mar-09	17-Mar-09	99	126	
15		20-Mar-09	21-Mar-09	100	129	
	Mar-09	Average		101	129	
	The samples are not representative a day due to frequent electricity fail. The electricity is available at night					
16	Apr-09	11-Apr-09	12-Apr-09	28	46	
17		13-Apr-09	14-Apr-09	32	49	
18		16-Apr-09	17-Apr-09	41	60	
19		18-Apr-09	19-Apr-09	38	57	
20		20-Apr-09	21-Apr-09	32	49	
	Apr-09	Average		34	52	
21	May-09	10-May-09	11-May-09	31	46	
22		12-May-09	13-May-09	42	49	
23		14-May-09	15-May-09	28	60	
24		17-May-09	18-May-09	20	39	
25		19-May-09	20-May-09	20	37	
	May-09	Average		28	46	
26	Jun-09	10-Jun-09	11-Jun-09	27	40	

27		12-Jun-09	13-Jun-09	43	60	
28		14-Jun-09	15-Jun-09	28	47	
29		16-Jun-09	17-Jun-09	34	53	
30		18-Jun-09	19-Jun-09	40	59	
	Jun-09	Average		34	52	
31		13-Jul-09	14-Jul-09	7		
32	Jul-09	17-Jul-09	18-Jul-09	9		
33		20-Jul-09	21-Jul-09	25		
	Jul-09			14		
	The NRSPM is very amount which below detection limit Less number of sampling than Male guideline due to heavy rain and shortage electricity which interrupted random sampling					
34		10-Aug-09	11-Aug-09	17		
35		12-Aug-09	13-Aug-09	22		
36	Aug-09	14-Aug-09	15-Aug-09	12		
37		16-Aug-09	17-Aug-09	10		
38		19-Aug-09	20-Aug-09	19		
	Aug-09	Average		16		
39		10-Sep-09	11-Sep-09	40		
40		12-Sep-09	13-Sep-09	56		
41	Sep-09	14-Sep-09	15-Sep-09	39		
42		16-Sep-09	17-Sep-09	24		
43		19-Sep-09	20-Sep-09	37		
	Sep-09	Average		39		
44		10-Oct-09	11-Oct-09	36		
45		12-Oct-09	13-Oct-09	48		
46	Oct-09	14-Oct-09	15-Oct-09	46		
47		17-Oct-09	18-Oct-09	60		
48		19-Oct-09	20-Oct-09	60		
	Oct-09	Average		50		
49		10-Nov-09	11-Nov-09	86		
50		12-Nov-09	13-Nov-09	96		
51	Nov-09	14-Nov-09	15-Nov-09	76		
52		16-Nov-09	17-Nov-09	74		
53		19-Nov-09	20-Nov-09	74		
	Nov-09	Average		81		
54		10-Dec-09	11-Dec-09	119		
55	Dec-09	12-Dec-09	13-Dec-09	113		
56		14-Dec-09	15-12-	130		

57		16-Dec-09	17-Dec-09	133		
58		19-Dec-09	20-Dec-09	149		
	Dec-09	Average		129		
	2009	Annual average		66		
59	Jan-10	12-Jan-10	13-Jan-10	152		
60		14-Jan-10	15-Jan-10	161		
61		16-Jan-10	17-Jan-10	156		
62		19-Jan-10	20-Jan-10	150		
	Jan-10	Average		155		
63	Feb-10	12-Feb-10	13-Feb-10	172		
64		14-Feb-10	15-Feb-10	101		
65		16-Feb-10	17-Feb-10	123		
66		19-Feb-10	20-Feb-10	101		
	Feb-10	Average		124		
67	Mar-10	10-Mar-10	11-Mar-10	142		
68		12-Mar-10	13-Mar-10	135		
69		15-Mar-10	16-Mar-10	104		
70		17-Mar-10	18-Mar-10	119		
71		19-Mar-10	20-Mar-10	94		
	Mar-10	Average		119		
72	Apr-10	10-Apr-10	11-Apr-10	19		
73		15-Apr-10	16-Apr-10	15		
74		17-Apr-10	18-Apr-10	12		
75		20-Apr-10	21-Apr-10	20		
	Apr-10	Average		17		
76	May-10	16-May-10	17-May-10	30		
77		19-May-10	20-May-10	12		
	May-10	Average		21		
78	Jun-10	14-Jun-10	15-Jun-10	30		
79		15-Jun-10	16-Jun-10	33		
80		18-Jun-10	19-Jun-10	17		
	Jun-10	Average		27		
81	Jul-10	15-Jul-10	16-Jul-10	45		
82		16-Jul-10	17-Jul-10	32		
83		18-Jul-10	19-Jul-10	21		
	Jul-10	Average		33		
84	Aug-10	10-Aug-10	11-Aug-10	26		
85		12-Aug-10	13-Aug-10	36		

86		15-Aug-10	16-Aug-10	9		
87		18-Aug-10	18-Aug-10	4		
88		20-Aug-10	21-Aug-10	4		
	Aug-10	Average		16		
89	Sep-10	10-Sep-10	11-Sep-10	5		
90		13-09-201	14-092010	12		
91		16-Sep-10	17-Sep-10	10		
92		18-Sep-10	17-Sep-10	9		
93		20-Sep-10	21-Sep-10	10		
	Sep-10	Average		9		
94	Oct-10	10-Oct-10	11-Oct-10	53		
95		12-Oct-10	13-Oct-10	38		
96		14-Oct-10	15-Oct-10	37		
97		16-Oct-10	17-Oct-10	41		
	Oct-10	Average		42		
98	Nov-10	10-Nov-10	11-Nov-10	51		
99		12-Nov-10	13-Nov-10	52		
100		14-Nov-10	15-Nov-10	44		
101		16-Nov-10	17-Nov-10	47		
	Nov-10	Average		49		
	There are no SPM data for Month of sept to Oct of 2010 due to Very low wieght difference of initial and final Cap wt					
102	Dec-10	10-Dec-10	11-Dec-10	115		
103		12-Dec-10	13-Dec-10	124		
104		14-Dec-10	15-Dec-10	190		
105		16-Dec-10	17-Dec-10	145		
106		18-Dec-10	19-Dec-10	187		
	Dec-10	Average		152		
	2010	Annual average		64		
107	Jan-11	10-Jan-11	11-Jan-11	196		
108		12-Jan-11	13-Jan-11	155		
109		14-Jan-11	15-Jan-11	175		
110		16-Jan-11	17-Jan-11	103		
111		18-Jan-11	19-Jan-11	99		
	Jan-11	Average		146		
112	Feb-11	10-Feb-11	11-Feb-11	69		
113		12/21/11	13-Feb-11	56		
114		14-Feb-11	15-Feb-11	78		
115		16-Feb-11	17-Feb-11	66		

116		19-Feb-11	20-Feb-11	78		
	Feb-11	Average		69		
117	Mar-11	10-Mar-11	11-Mar-11	46		
118		12-Mar-11	13-Mar-11	51		
119		14-Mar-11	15-Mar-11	38		
120		17-Mar-11	18-Mar-11	24		
121		19-Mar-11	20-Mar-11	28		
	Mar-11	Average		37		
122	Apr-11	10-Apr-11	11-Apr-11	26.5		
123		13-Apr-11	14-Apr-11	53.7		
124		15-Apr-11	16-Apr-11	22		
125		17-Apr-11	18-Apr-11	21		
126		19-Apr-11	20-Apr-11	22		
	Apr-11	Average		29		
127	May-11	10-May-11	11-May-11	29		
128		12-May-11	13-May-11	27		
129		14-May-11	15-May-11	26		
130		16-May-11	17-May-11	18		
131		18-May-11	19-May-11	16		
	May-11	Average		23		
132	Jun-11	10-Jun-11	11-Jun-11	20		
133		12-Jun-11	14-Jun-11	18		
134		14-Jun-11	15-Jun-11	29		
135		16-Jun-11	17-Jun-11	36		
	Jun-11	Average		26		
136	Jul-11	10-Jun-11	11-Jun-11	10		
137		12-Jun-11	14-Jun-11	10		
138		14-Jun-11	15-Jun-11	8		
139		16-Jun-11	17-Jun-11	11		
140		10-Jun-11	11-Jun-11	15		
	Jul-11	Average		11		
141	Aug-11	13-Aug-11	14-Aug-11	19		
142		15-Aug-11	16-Aug-11	20		
143		19-Aug-11	20-Aug-11	21		
	Aug-11	Average		20		
144	Sep-11	10-Sep-11	11-Sep-11	13		
145		12-Sep-11	13-Sep-11	15		
146		14-Sep-11	15-Sep-11	10		
147		16-Sep-11	17-Sep-11	16		

	Sep-11	Average		14		
148		10-Oct-11	11-Oct-11	60		
149		12-Oct-11	13-Oct-11	84		
150	Oct-11	15-Oct-11	16-Oct-11	31		
151		17-Oct-11	18-Oct-11	45		
152		19-Oct-11	20-Nov-11	90		
	Oct-11	Average		62		
153		10-Nov-11	11-Nov-11	57		
154		13-Nov-11	14-Nov-11	90		
155	Nov-11	16-Nov-11	17-Nov-11	127		
156		17-Nov-11	18-Nov-11	132		
157		19-Nov-11	20-Nov-11	157		
	Nov-11	Average		113		
158		12-Dec-11	13-Dec-11	128		
159		14-Dec-11	15-Dec-11	158		
160	Dec-11	16-Dec-11	17-Dec-11	131		
161		18-Dec-11	19-Dec-11	187		
162		12-Dec-11	13-Dec-11	117		
	Dec-11	Average		144		
	2011	Annual average		58		

RESULTS OF AIR CONCENTRATION – BHUTAN

S No	Month	Start Date	End date	PM10 (µg/m^3)	Remarks
1	Feb-09	1-Feb-09	2-Feb-09	48	
2		2-Feb-09	3-Feb-09	54	
3		3-Feb-09	4-Feb-09	50	
4		4-Feb-09	5-Feb-09	47	
5		5-Feb-09	6-Feb-09	28	
6		9-Feb-09	10-Feb-09	46	
7		10-Feb-09	11-Feb-09	45	
8		11-Feb-09	12-Feb-09	43	
9		19-Feb-09	20-Feb-09	46	
10		23-Feb-09	24-Feb-09	40	
11		24-Feb-09	25-Feb-09	28	
12		27-Feb-09	28-Feb-09	33	
13		28-Feb-09	29-Feb-09	56	
	Feb-09	Average		43	
14	Mar-09	2-Mar-09	3-Mar-09	42	

15		3-Mar-09	4-Mar-09	21	
16		4-Mar-09	5-Mar-09	54	
17		5-Mar-09	6-Mar-09	84	
18		6-Mar-09	7-Mar-09	80	found insect in the dust cup
19		9-Mar-09	3-Oct-09	18	
20		10-Mar-09	11-Mar-09	90	Forest fire
21		11-Mar-09	12-Mar-09	88	
22		12-Mar-09	13-Mar-09	152	
23		13-Feb-09	14-Mar-09	99	
24		14-Mar-09	15-Mar-09	125	
25		16-Mar-09	17-Mar-09	37	
26		17-Mar-09	18-Mar-09	81	
27		18-Mar-09	19-Mar-09	73	
28		19-Mar-09	20-Mar-09	52	
	Mar-09	Average		73	
29	Apr-09	21-Apr-09	22-Apr-09	36	
30		22-Apr-09	23-Apr-09	57	
31		23-Apr-09	24-Apr-09	90	
32		24-Mar-09	25-Apr-09	47	
33		25-Apr-09	26-Apr-09	41	
34		28-Apr-09	29-Apr-09	663	Power failure
35		29-Apr-09	30-Apr-09	35	
36		30-Apr-09	1-May-12	55	
	Apr-09	Average		52	
37	May-09	1-May-09	1-May-09	38	
38		20-May-09	21-May-09	59	
39		21-May-09	22-May-09	16	
40		27-May-09	28-May-09	19	
41		28-May-09	29-May-09	11	
	May-09	Average		29	
42	Jun-09	1-Jun-09	2-Jun-09	3	
43		2-Jun-09	3-Jun-09	8	
44		3-Jun-09	4-Jun-09	9	
45		8-Jun-09	9-Jun-09	9	
46		9-Jun-09	10-Jun-09	21	
47		10-Jun-09	11-Jun-09	26	
48		11-Jun-09	12-Jun-09	22	
49		15-Jun-09	16-Jun-09	18	
50		16-Jun-09	17-Jun-09	8	

51		17-Jun-09	18-Jun-09	8	
52		18-Jun-09	19-Jun-09	22	
53		22-Jun-09	23-Jun-09	128	
54		23-Jun-09	24-Jun-09	140	
55		24-Jun-09	25-Jun-09	15	
56		25-Jun-09	26-Jun-09	17	
57		26-Jun-09	27-Jun-09	4	
58		27-Jun-09	28-Jun-09	11	
59		28-Jun-09	29-Jun-09	8	
60		29-Jun-09	30-Jun-09	76	
61		30-Jun-09	1-Jul-09	16	
	Jun-09	Average		28	
62		1-Jul-09	2-Jul-09	8	
63		7-Jul-09	8-Jul-09	6	
64		8-Jul-09	9-Jul-09	5	Rainfall
65	Jul-09	9-Jul-09	7-Oct-09	46	
66		13-Jul-09	14-Jul-09	16	
67		14-Jul-09	15-Jul-09	4	
68		15-Jul-09	16-Jul-09	5	
	Jul-09	Average		13	
69		23-Nov-09	25-Nov-09	37	
70	Nov-09	25-Nov-09	26-Nov-09	21	
71		26-Nov-09	27-Nov-09	17	
	Nov-09	Average		25	
	2009	Annual	average	38	
72		12-Jan-10	13-Jan-10	54	
73	Jan-10	13-Jan-10	14-Jan-10	43	
74		14-Jan-10	15-Jan-10	44	wind &sunshine
	Jan-10	Average		47	
75		1-Feb-10	2-Feb-10	41	
76		2-Feb-10	3-Feb-10	28	
77		3-Feb-10	4-Feb-10	64	wind &sunshine
78		4-Feb-10	5-Feb-10	70	
79	Feb-10	8-Feb-10	9-Feb-10	61	
80		9-Feb-10	10-Feb-10	15	
81		10-Feb-10	11-Feb-10	31	
82		11-Feb-10	12-Feb-10	36	
83		25-Feb-10	26-Feb-10	59	

84		26-Feb-10	27-Feb-10	13	
	Feb-10	Average		42	
85	Mar-10	8-Mar-10	9-Mar-10	74	windy & sunshine
86		9-Mar-10	10-Mar-10	39	
87		10-Mar-10	11-Mar-10	26	windy&rainfall.
88		11-Mar-10	12-Mar-10	65	
89		12-Mar-10	13-Mar-10	55	
90		13-Mar-10	14-Mar-10	61	
91		14-Mar-10	15-Mar-10	48	
92		15-Mar-10	16-Mar-10	11	rainfall
93		16-Mar-10	17-Mar-10	35	
94		17-Mar-10	18-Mar-10	34	wind &sunshine
95		18-Mar-10	19-Mar-10	36	sunshine
96		19-Mar-10	20-Mar-10	29	
97		20-Mar-10	21-Mar-10	41	
98		21-Mar-10	22-Mar-10	11	little Rainfall.
99		22-Mar-10	23-Mar-10	22	
	Mar-10	Average		39	
100	Apr-10	6-Apr-10	7-Apr-10	38	Forest fire
101		7-Apr-10	8-Apr-10	79	
102		8-Apr-10	9-Apr-10	39	Forest fire
103		12-Apr-10	13-Apr-10	12	rainfall.
104		13-Apr-10	14-Apr-10	23	
105		14-Apr-10	15-Apr-10	16	
106		15-Apr-10	16-Apr-10	13	
107		20-Apr-10	21-Apr-10	21	
108		21-Apr-10	22-Apr-10	25	
109		22-Apr-10	23-Apr-10	32	
110		23-Apr-10	24-Apr-10	39	sunshine
111		26-Apr-10	27-Apr-10	19	
112		27-Apr-10	28-Apr-10	22	
113		28-Apr-10	29-Apr-10	7	
	Apr-10		Average	27	
114	May-10	4-May-10	5-May-10	17	
115		5-May-10	6-May-10	39	
116		6-May-10	7-May-10	41	
117		7-May-10	8-May-10	68	
118		18-May-10	19-May-10	47	
119		19-May-10	20-May-10	38	windy&cloudy

120		20-May-10	21-May-10	22	rainfall.
121		21-May-10	22-May-10	35	sunshine
122		22-May-10	23-May-10	9	rainfall
123		23-May-10	24-May-10	40	
124		24-May-10	25-May-10	53	sunshine
125		25-May-10	26-May-10	24	rainfall.
126		27-May-10	28-May-10	64	
127		28-May-10	29-May-10	14	little rainfall
128		29-May-10	30-May-10	44	sunshine
	May-10	Average		37	
130	Jun-10	9-Jun-10	10-Jun-10	21	
131		10-Jun-10	11-Jun-10	18	
132		16-Jun-10	17-Jun-10	12	rainfall
133		17-Jun-10	18-Jun-10	13	
134		22-Jun-10	23-Jun-10	11	
135		23-Jun-10	24-Jun-10	17	
136		24-Jun-10	25-Jun-10	15	
137		28-Jun-10	29-Jun-10	31	
138		29-Jun-10	30-Jun-10	15	
139		30-Jun-10	1-Jul-10	30	
	Jun-10	Average		18	
140	Jul-10	17-Jul-10	18-Jul-10	24	
141		18-Jul-10	19-Jul-10	28	
	Jul-10	Average		26	
	* only two days data because there was heavy rainfall through out the month				
142	Aug-10	2-Aug-10	3-Aug-10	29	
143		3-Aug-10	4-Aug-10	22	
144		4-Aug-10	5-Aug-10	21	
145		5-Aug-10	6-Aug-10	56	
146		9-Aug-10	10-Aug-10	18	
147		10-Aug-10	11-Aug-10	17	
148		11-Aug-10	12-Aug-10	53	
149		12-Aug-10	13-Aug-10	34	
150		16-Aug-10	17-Aug-10	30	
151		17-Aug-10	18-Aug-10	17	
152		22-Aug-10	23-Aug-10	11	rainfall
153		24-Aug-10	25-Aug-10	37	
154		25-Aug-10	26-Aug-10	43	
155		26-Aug-10	27-Aug-10	22	

	Aug-10	Average		29	
156	Sep-10	6-Sep-10	7-Sep-10	13	slight rainfall
157		8-Sep-10	9-Sep-10	43	
158		9-Sep-10	10-Sep-10	12	
159		14-Sep-10	15-Sep-10	11	
160		20-Sep-10	21-Sep-10	108	
161		21-Sep-10	22-Sep-10	13	rainfall
162		27-Sep-10	28-Sep-10	73	Road maintenance
163		28-Sep-10	29-Sep-10	88	
	Sep-10	Average		45	
164	Oct-10	11-Oct-10	12-Oct-10	38	
165		12-Oct-10	13-Oct-10	39	
166		13-Oct-10	14-Oct-10	28	
167		14-Oct-10	15-Oct-10	23	
	Oct-10	Average		32	
168		30-Nov-10	1-Dec-10	46	
169	Dec-10	1-Dec-10	2-Dec-10	26	
170		2-Dec-10	3-Dec-10	46	
171		6-Dec-10	7-Dec-10	44	
172		13-Dec-10	14-Dec-10	35	
173		14-Dec-10	15-Dec-10	46	
174		15-Dec-10	16-Dec-10	52	
175		23-Dec-10	24-Dec-10	49	
176		27-Dec-10	28-Dec-10	68	
1877		28-Dec-10	29-Dec-10	59	
178		29-Dec-10	30-Dec-10	55	
179		30-Dec-10	31-Dec-10	74	windy
180		31-Dec-10	1-Jan-11	60	
	Dec-10	Average		51	
	2010	Annual	average	36	
181					
182	Jan-11	1-Jan-11	2-Jan-11	47	
183		2-Jan-11	3-Jan-11	31	
184		3-Jan-11	4-Jan-11	53	
185		4-Jan-11	5-Jan-11	57	
186		5-Jan-11	6-Jan-11	58	
187		6-Jan-11	7-Jan-11	53	
188		7-Jan-11	18-Jan-11	56	
189		18-Jan-11	9-Jan-11	43	

190		9-Jan-11	10-Jan-11	48	
191		10-Jan-11	11-Jan-11	51	
192		11-Jan-11	12-Jan-11	63	
193		12-Jan-11	13-Jan-11	40	
194		13-Jan-11	14-Jan-11	39	
195		14-Jan-11	15-Jan-11	59	
196		15-Jan-11	16-Jan-11	49	
197		16-Jan-11	17-Jan-11	45	sunshine
198		17-Jan-11	18-Jan-11	57	Cloudy
199		18-Jan-11	19-Jan-11	63	Cloudy
200		19-Jan-11	20-Jan-11	64	snowfall
201		20-Jan-11	21-Jan-11	61	cloudy
202		21-Jan-11	22-Jan-11	34	cloudy
203		22-Jan-11	23-Jan-11	38	windy
204		23-Jan-11	24-Jan-11	43	sunshine
205		24-Jan-11	25-Jan-11	49	sunshine
206		25-Jan-11	26-Jan-11	56	sunshine
207		26-Jan-11	27-Jan-11	61	sunshine
208		27-Jan-11	28-Jan-11	57	sunshine
209		28-Jan-11	29-Jan-11	201	sunshine
210		29-Jan-11	30-Jan-11	72	sunshine
211		30-Jan-11	31-Jan-11	62	cloudy
	Jan-11	Average		57	
211	Feb-11	1-Feb-11	2-Feb-11	76	
212		2-Feb-11	3-Feb-11	58	
213		3-Feb-11	4-Feb-11	47	
214		4-Feb-11	5-Feb-11	51	
215		5-Feb-11	6-Feb-11	57	
216		6-Feb-11	7-Feb-11	59	
217		7-Feb-11	8-Feb-11	49	
218		8-Feb-11	9-Feb-11	74	
219		9-Feb-11	10-Feb-11	62	
220		10-Feb-11	11-Feb-11	64	
221		11-Feb-11	12-Feb-11	47	
222		12-Feb-11	13-Feb-11	57	
223		13-Feb-11	14-Feb-11	53	
224		14-Feb-11	15-Feb-11	76	
225		15-Feb-11	16-Feb-11	62	
226		16-Feb-11	17-Feb-11	21	

227		17-Feb-11	18-Feb-11	20	
228		18-Feb-11	19-Feb-11	51	
229		19-Feb-11	20-Feb-11	42	
230		20-Feb-11	21-Feb-11	39	
230		21-Feb-11	22-Feb-11	25	
231		23-Feb-11	24-Feb-11	42	
232		24-Feb-11	25-Feb-11	47	
233		25-Feb-11	26-Feb-11	43	
234		26-Feb-11	27-Feb-11	43	
235		27-Feb-11	1-Mar-11	44	
236	Feb-11	Average		50	
237		1-Mar-11	2-Mar-11	55	
238		2-Mar-11	3-Mar-11	60	
239		3-Mar-11	4-Mar-11	65	
240		4-Mar-11	5-Mar-11	58	
241		5-Mar-11	6-Mar-11	81	
242		6-Mar-11	7-Mar-11	425	HKP: ignored for averaging
243		7-Mar-11	8-Mar-11	49	
244		8-Mar-11	9-Mar-11	62	
245		9-Mar-11	10-Mar-11	23	
246		10-Mar-11	11-Mar-11	49	
247		11-Mar-11	12-Mar-11	55	
230		12-Mar-11	13-Mar-11	69	
231		13-Mar-11	14-Mar-11	62	
232	Mar-11	14-Mar-11	15-Mar-11	68	
233		15-Mar-11	16-Mar-11	43	
234		16-Mar-11	17-Mar-11	69	
235		17-Mar-11	18-Mar-11	94	
236		18-Mar-11	19-Mar-11	63	
237		19-Mar-11	20-Mar-11	58	
238		20-Mar-11	21-Mar-11	67	
239		21-Mar-11	22-Mar-11	62	
240		22-Mar-11	23-Mar-11	51	
241		23-Mar-11	24-Mar-11	60	
242		24-Mar-11	25-Mar-11	64	
243		25-Mar-11	26-Mar-11	48	
244		26-Mar-11	27-Mar-11	53	
245		27-Mar-11	28-Mar-11	18	
246		29-Mar-11	30-Mar-11	16	

247		30-Mar-11	31-Mar-11	26	
248		31-Mar-11	1-Apr-11	33	
	Mar-11	Average		54	
248	Apr-11	1-Apr-11	2-Apr-11	31	
249		2-Apr-11	3-Apr-11	33	
250		3-Apr-11	4-Apr-11	33	
251		4-Apr-11	5-Apr-11	27	
252		5-Apr-11	6-Apr-11	71	
253		6-Apr-11	7-Apr-11	59	
254		7-Apr-11	8-Apr-11	52	
255		8-Apr-11	9-Apr-11	51	
256		9-Apr-11	10-Apr-11	45	
257		10-Apr-11	11-Apr-11	37	
258		11-Apr-11	12-Apr-11	44	
259		12-Apr-11	13-Apr-11	34	
260		13-Apr-11	14-Apr-11	33	
261		14-Apr-11	15-Apr-11	57	
262		15-Apr-11	16-Apr-11	49	
263		16-Apr-11	17-Apr-11	35	
264		17-Apr-11	18-Apr-11	40	
265		18-Apr-11	19-Apr-11	29	
266		19-Apr-11	20-Apr-11	36	
267		20-Apr-11	21-Apr-11	32	
268		21-Apr-11	22-Apr-11	32	
	Apr-11	Average		41	
	May-11	3-May-11	4-May-11	34	
269		4-May-11	5-May-11	40	
270		5-May-11	6-May-11	23	
271		6-May-11	7-May-11	22	
272		7-May-11	8-May-11	20	
273		8-May-11	9-May-11	14	
274		9-May-11	10-May-11	27	
275		10-May-11	11-May-11	19	
276		11-May-11	12-May-11	16	
277		12-May-11	13-May-11	24	
278		13-May-11	14-May-11	21	
279		14-May-11	15-May-11	25	
280		15-May-11	16-May-11	26	
281		16-May-11	17-May-11	14	

282		17-May-11	18-May-11	15	rainfall
283		18-May-11	19-May-11	16	
284		19-May-11	20-May-11	15	
285		20-May-11	21-May-11	15	
286		21-May-11	22-May-11	13	
287		22-May-11	23-May-11	21	
288		23-May-11	24-May-11	17	
289		24-May-11	25-May-11	15	
290		25-May-11	26-May-11	18	
291		26-May-11	27-May-11	19	
292		27-May-11	28-May-11	14	
293		28-May-11	29-May-11	18	
294		29-May-11	30-May-11	19	
295		30-May-11	31-May-11	16	
296		31-May-11	1-Jun-11	11	
	May-11	Average		20	
297		1-Jun-11	2-Jun-11	17	Cloudy
298		2-Jun-11	3-Jun-11	18	cloudy
299		3-Jun-11	4-Jun-11	15	Cloudy
297		4-Jun-11	5-Jun-11	39	Cloudy
298		5-Jun-11	6-Jun-11	33	slight rainfall
299		6-Jun-11	7-Jun-11	18	Rainfall
300		7-Jun-11	8-Jun-11	24	Cloudy
301		8-Jun-11	9-Jun-11	20	Cloudy
302		9-Jun-11	10-Jun-11	26	Cloudy
303		10-Jun-11	11-Jun-11	40	Cloudy
304		11-Jun-11	12-Jun-11	18	Cloudy
305		12-Jun-11	13-Jun-11	22	Cloudy
306		13-Jun-11	14-Jun-11	17	Cloudy
307		14-Jun-11	15-Jun-11	16	Cloudy
308		15-Jun-11	16-Jun-11	52	rainfall
309		16-Jun-11	17-Jun-11	11	Rainfall
310		17-Jun-11	18-Jun-11	11	Rainfall
311		18-Jun-11	19-Jun-11	16	Rainfall
312		19-Jun-11	20-Jun-11	10	Rainfall
313		20-Jun-11	21-Jun-11	10	Sunny
314		21-Jun-11	22-Jun-11	10	Cloudy
	Jun-11	Average		21	
		* Sampling was stoped due to heavy rain during the moonsoon period			

315		17-Oct-11	18-Oct-11	30	
316		18-Oct-11	19-Oct-11	31	
317		19-Oct-11	20-Oct-11	68	
318		20-Oct-11	21-Oct-11	15	Heavy Rainfall
319		21-Oct-11	22-Oct-11	20	
320		22-Oct-11	23-Oct-11	27	
321		23-Oct-11	24-Oct-11	15	
322	Oct-11	24-Oct-11	25-Oct-11	30	
323		25-Oct-11	26-Oct-11	29	
324		26-Oct-11	27-Oct-11	24	
325		27-Oct-11	28-Oct-11	29	
326		28-Oct-11	29-Oct-11	16	
327		29-Oct-11	30-Oct-11	23	
328		30-Oct-11	31-Oct-11	23	
329		31-Oct-11	1-Nov-11	29	Late due to rain (time)
	Oct-11	Average		27	
326		1-Nov-11	2-Nov-11	22	
327		2-Nov-11	3-Nov-11	25	
328		3-Nov-11	4-Nov-11	24	
329		4-Nov-11	5-Nov-11	19	
330		5-Nov-11	6-Nov-11	18	
331		6-Nov-11	7-Nov-11	24	
332		7-Nov-11	8-Nov-11	26	
333		8-Nov-11	9-Nov-11	37	
334		9-Nov-11	10-Nov-11	37	
335		10-Nov-11	11-Nov-11	31	
336		11-Nov-11	12-Nov-11	31	
337	Nov-11	12-Nov-11	13-Nov-11	32	
338		13-Nov-11	14-Nov-11	23	
339		14-Nov-11	15-Nov-11	45	
340		15-Nov-11	16-Nov-11	38	
341		16-Nov-11	17-Nov-11	32	
342		17-Nov-11	18-Nov-11	37	
343		18-Nov-11	19-Nov-11	32	
344		19-Nov-11	20-Nov-11	39	
345		20-Nov-11	21-Nov-11	38	
346		21-Nov-11	22-Nov-11	37	
347		22-Nov-11	23-Nov-11	45	
348		23-Nov-11	24-Nov-11	39	

349		24-Nov-11	25-Nov-11	42	
350		25-Nov-11	26-Nov-11	40	
351		26-Nov-11	27-Nov-11	47	
352		27-Nov-11	28-Nov-11	40	
353		28-Nov-11	29-Nov-11	31	
354		29-Nov-11	30-Nov-11	39	
355		30-Nov-11	1-Dec-11	36	
	Nov-11	Average		34	
353		1-Dec-11	2-Dec-11	44	
354		2-Dec-11	3-Dec-11	44	
355		3-Dec-11	4-Dec-11	30	rainfall during night
356		4-Dec-11	5-Dec-11	45	
357		5-Dec-11	6-Dec-11	16	
358		6-Dec-11	7-Dec-11	38	
359		7-Dec-11	8-Dec-11	28	
360		8-Dec-11	9-Dec-11	30	
361		9-Dec-11	10-Dec-11	36	
362		10-Dec-11	11-Dec-11	33	
363		11-Dec-11	12-Dec-11	37	
364		12-Dec-11	13-Dec-11	41	
365		13-Dec-11	14-Dec-11	37	
366		14-Dec-11	15-Dec-11	41	
367		15-Dec-11	16-Dec-11	34	
368	Dec-11	16-Dec-11	17-Dec-11	33	
369		17-Dec-11	18-Dec-11	34	
370		18-Dec-11	19-Dec-11	33	
371		19-Dec-11	20-Dec-11	55	
		20-Dec-11	21-Dec-11	49	
		21-Dec-11	22-Dec-11	51	
		22-Dec-11	23-Dec-11	51	
		23-Dec-11	24-Dec-11	59	
		24-Dec-11	25-Dec-11	53	
		25-Dec-11	26-Dec-11	52	
		26-Dec-11	27-Dec-11	56	
		27-Dec-11	28-Dec-11	61	
		28-Dec-11	29-Dec-11	57	
		29-Dec-11	30-Dec-11	35	
		30-Dec-11	31-Dec-11	33	
		31-Dec-11	1-Jan-12	47	

	Dec-11	Average		42	

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – INDIA

S No	Month	Start Date	PM10 (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	Remarks
	Assam					
1	Jan-09	07-Jan-09	95	6	12	
2		08-Jan-09	99	5	13	
3		15-Jan-09	135	5	13	
4		16-Jan-09	92	BDL	8	
5		21-Jan-09	140	10	18	
6		22-Jan-09	139	9	16	
7		30-Jan-09	134	10	16	
8		31-Jan-09	157	10	16	
	Jan-09	Average	124	8	14	
9	Feb-09	05-Feb-09	146	8	20	
10		06-Feb-09	131	6	22	
11		12-Feb-09	151	21	22	
12		13-Feb-09	136	7	13	
13		17-Feb-09	126	10	17	
14		18-Feb-09	140	8	17	
15		24-Feb-09	130	6	14	
16		25-Feb-09	143	5	25	
	Feb-09	Average	138	9	19	
17	Mar-09	05-Mar-09	193	6	21	
18		06-Mar-09	250	8	21	
19		12-Mar-09	250	BDL	10	
20		13-Mar-09	231	4	17	
21		19-Mar-09	203	4	30	
22		20-Mar-09	120	4	25	
23		26-Mar-09	175	9	21	
24		27-Mar-09	75	9	20	
	Mar-09	Average	187	6	21	
25	Apr-09	02-Apr-09	52	8	17	
26		03-Apr-09	79	5	18	
27		10-Apr-09	54	10	20	
28		11-Apr-09	47	8	18	
29		18-Apr-09	64	4	10	
30		19-Apr-09	59	5	11	

31		25-Apr-09	95	5	15	
32		26-Apr-09	98	8	18	
	Apr-09	Average	68	7	16	
33	May-09	09-May-09	78	4	10	
34		10-May-09	72	BDL	9	
35		15-May-09	36	6	14	
36		16-May-09	48	7	16	
37		17-May-09	35	7	14	
38		21-May-09	55	5	11	
39		22-May-09	49	6	14	
40		23-May-09	62	5	12	
41		29-May-09	28	BDL	7	
42		30-May-09	26	BDL	11	
	May-09	Average	49	6	12	
43	Jun-09	06-Jun-09	46	BDL	10	
44		11-Jun-09	59	BDL	9	
45		18-Jun-09	76	6	14	
46		19-Jun-09	65	4	11	
47		25-Jun-09	29	4	10	
48		26-Jun-09	22	BDL	10	
	Jun-09	Average	49	4	11	
49	Jul-09	03-Jul-09	44	BDL	7	
50		04-Jul-09	30	BDL	10	
51		09-Jul-09	45	BDL	BDL	
52		10-Jul-09	31	BDL	7	
53		16-Jul-09	29	BDL	10	
54		17-Jul-09	38	4	11	
55		22-Jul-09	50	5	14	
56		23-Jul-09	36	4	12	
57		29-Jul-09	19	5	10	
	Jul-09	Average	37	4	10	
58	Aug-09	04-Aug-09	39	BDL	7	
59		05-Aug-09	25	BDL	9	
60		06-Aug-09	59	4	11	
61		12-Aug-09	14	5	13	
62		13-Aug-09	17	4	12	
63		19-Aug-09	29	BDL	15	
64		27-Aug-09	15	BDL	9	
65		28-Aug-09	27	BDL	11	

66		29-Aug-09	31	BDL	8	
	Aug-09	Average	29	4	10	
67	Sep-09	03-Sep-09	38	BDL	11	
68		04-Sep-09	41	5	11	
69		09-Sep-09	24	4	7	
70		10-Sep-09	21	BDL	11	
71		18-Sep-09	20	BDL	10	
72		19-Sep-09	19	BDL	11	
73		23-Sep-09	40	5	12	
74		24-Sep-09	50	4	8	
	Sep-09	Average	31	4	10	
75	Oct-09	01-Oct-09	50	4	9	
76		02-Oct-09	38	4	9	
77		14-Oct-09	63	5	12	
78		15-Oct-09	61	BDL	11	
79		16-Oct-09	70	BDL	11	
80		21-Oct-09	90	4	10	
81		22-Oct-09	67	5	10	
82		23-Oct-09	60	4	9	
83		29-Oct-09	62	4	11	
84		30-Oct-09	49	5	12	
	Oct-09	Average	61	4	10	
85	Nov-09	05/11/2009	71	BDL	11	
86		06/11/2009	98	BDL	10	
87		11/11/2009	114	4	11	
88		12/11/2009	124	4	13	
89		19/11/2009	84	5	14	
	Nov-09	Average	98	4	12	
90	Dec-09	09/12/2009	65	5	14	
91		11/12/2009	67	BDL	13	
92		17/12/2009	73	5	15	
	Dec-09	Average	68	5	14	
	2009	Annual	77	6	13	
93	Jan-10	09-Jan-10	126	5	17	
94		10-Jan-10	101	5	20	
95		14-Jan-10	92	5	12	
96		25-Jan-10	120	5	15	
97		26-Jan-10	70	6	15	

98		29-Jan-10	101	6	13	
99		30-Jan-10	116	6	17	
100		31-Jan-10	118	7	16	
	Jan-10	Average	106	5	15	
101	Feb-10	09-Feb-10	101	6	17	
102		11-Feb-10	89	8	17	
103		16-Feb-10	147	6	15	
104		18-Feb-10	130	6	16	
105		24-Feb-10	159	4	12	
106		25-Feb-10	110	6	16	
107		27-Feb-10	143	4	13	
	Feb-10	Average	126	6	15	
108	Mar-10	04-Mar-10	87	6	15	
109		06-Mar-10	87	7	14	
110		08-Mar-10	108	6	16	
111		13-Mar-10	126	5	17	
112		15-Mar-10	78	8	16	
113		17-Mar-10	96	5	15	
	Mar-10	Average	97	6	15	
114	Apr-10	16-Apr-10	61	6	14	
115		18-Apr-10	62	8	19	
116		22-Apr-10	56	6	15	
117		24-Apr-10	77	10	17	
118		28-Apr-10	60	6	13	
119		30-Apr-10	63	6	13	
	Apr-10	Average	63	7	15	
120	May-10	05-May-10	53	7	16	
121		07-May-10	46	7	16	
122		12-May-10	48	6	16	
123		14-May-10	29	4	12	
124		21-May-10	26	4	14	
125		23-May-10	44	4	12	
126		27-May-10	24	BDL	13	
127		31-May-10	25	5	17	
	May-10	Average	37	5	14	
128	Jun-10	04-Jun-10	40	5	15	
129		10-Jun-10	21	5	17	
130		12-Jun-10	29	5	19	
131		17-Jun-10	35	4	11	

132		19-Jun-10	21	8	21	
133		24-Jun-10	25	5	14	
134		26-Jun-10	21	4	8	
	Jun-10	Average	27	5	15	
135	Jul-10	01-Jul-10	18	4	11	
136		03-Jul-10	30	5	12	
137		08-Jul-10	39	6	14	
138		10-Jul-10	25	7	16	
139		15-Jul-10	28	8	14	
140		17-Jul-10	30	5	9	
141		22-Jul-10	15	6	16	
142		24-Jul-10	29	6	16	
143		29-Jul-10	24	4	11	
144		31-Jul-10	27	6	12	
	Jul-10	Average	26	6	13	
145	Aug-10	05-Aug-10	31	6	17	
146		07-Aug-10	35	6	14	
147		12-Aug-10	29	BDL	13	
148		14-Aug-10	33	4	15	
149		19-Aug-10	25	6	15	
150		21-Aug-10	27	6	14	
151		26-Aug-10	27	6	14	
152		28-Aug-10	23	5	15	
	Aug-10	Average	29	5	15	
153	Sep-10	02-Sep-10	23	5	14	
154		04-Sep-10	22	BDL	11	
155		09-Sep-10	21	BDL	11	
156		11-Sep-10	29	5	13	
157		16-Sep-10	22	6	14	
158		18-Sep-10	37	4	13	
159		23-Sep-10	27	4	14	
160		30-Sep-10	20	4	14	
	Sep-10	Average	25	5	13	
161	Oct-10	02-Oct-10	11	5	15	
162		07-Oct-10	29	BDL	15	
163		09-Oct-10	27	4	14	
164		11-Oct-10	58	5	17	
165		13-Oct-10	31	5	11	
166		21-Oct-10	35	5	10	

167		23-Oct-10	62	6	12	
168		28-Oct-10	56	5	12	
169		30-Oct-10	38	6	13	
	Oct-10	Average	39	5	13	
170	Nov-10	04-Nov-10	39	6	14	
171		13-Nov-10	67	6	12	
172		18-Nov-10	71	7	16	
173		20-Nov-10	36	6	13	
174		25-Nov-10	79	5	13	
175		27-Nov-10	105	5	14	
	Nov-10	Average	66	6	14	
176		02-Dec-10	89	5	15	
177	Dec-10	04-Dec-10	94	5	13	
178		09-Dec-10	83	6	14	
179		11-Dec-10	85	6	13	
180		16-Dec-10	89	6	13	
181		18-Dec-10	112	6	12	
182		23-Dec-10	117	5	10	
183		25-Dec-10	59	6	14	
		30-Dec-10				
	Dec-10	Average	96	6	13	
	2010	Annual	59	6	14	
184	Jan-11	03-Jan-11	79	7	14	
185		06-Jan-11	109	6	14	
186		11-Jan-11	176	7	19	
187		13-Jan-11	77	7	20	
188		20-Jan-11	87	7	18	
189		22-Jan-11	88	6	17	
190		27-Jan-11	77	7	15	
191		29-Jan-11	82	8	16	
	Jan-11	Average	97	7	17	
192	Feb-11	03-Feb-11	80	7	16	
193		05-Feb-11	97	7	16	
194		10-Feb-11	96	6	15	
195		12-Feb-11	49	5	14	
196		17-Feb-11	43	6	16	
197		19-Feb-11	77	7	17	
198		24-Feb-11	56	6	13	

199		26-Feb-11	66	6	16	
	Feb-11	Feb-11	70	6	15	
200	Mar-11	03-Mar-11	52	6	12	
201		10-Mar-11	40	8	16	
202		12-Mar-11	36	6	15	
203		17-Mar-11	19	7	14	
204		19-Mar-11	25	8	14	
205		24-Mar-11	21	6	13	
206		26-Mar-11	40	6	13	
207		31-Mar-11	45	7	14	
	Mar-11	Mar-11	35	7	14	
208	May-11	07-May-11	59	7	14	
209		09-May-11	28	5	11	
210		14-May-11	41	5	10	
211		16-May-11	40	4	10	
212		21-May-11	43	4	10	
	May-11	May-11	42	5	11	
213	Jun-11	01-Jun-11	46	5	10	
214		03-Jun-11	25	6	13	
215		07-Jun-11	22	7	13	
216		09-Jun-11	43	5	12	
217		15-Jun-11	53	6	13	
218		17-Jun-11	50	5	12	
219		22-Jun-11	32	5	13	
220		24-Jun-11	29	4	10	
221		30-Jun-11	32	4	11	
	Jun-11	Jun-11	37	5	12	
222	Jul-11	05-Jul-11	36	6	12	
223		07-Jul-11	31	BDL	12	
224		12-Jul-11	36	4	13	
225		15-Jul-11	36	5	13	
226		20-Jul-11	32	4	12	
227		22-Jul-11	27	5	13	
228		30-Jul-11	18	5	13	
	Jul-11	Jul-11	31	5	13	
229	Aug-11	04-Aug-11	25	4	11	
230		06-Aug-11	32	4	12	
231		11-Aug-11	61	4	12	
232		13-Aug-11	25	4	11	

233		18-Aug-11	30	4	13	
234		20-Aug-11	117	4	12	
235		25-Aug-11	115	5	13	
236		27-Aug-11	147	5	14	
	Aug-11	Aug-11	69	4	12	
237	Sep-11	01-Sep-11	33	5	13	
238		03-Sep-11	32	6	14	
239		08-Sep-11	31	5	16	
240		14-Sep-11	44	6	17	
241		17-Sep-11	35	6	15	
242		22-Sep-11	28	6	15	
243		28-Sep-11	59	5	14	
244		30-Sep-11	24	6	14	
	Sep-11	Sep-11	36	6	15	
245	Oct-11	07-Oct-11	58	5	14	
246		11-Oct-11	23	5	14	
247		14-Oct-11	44	6	15	
248		20-Oct-11	57	6	15	
249		22-Oct-11	73	5	14	
250		27/10/2011	73	6	15	
	Oct-11	Oct-11	55	6	14	
251	Nov-11	03-Nov-11	41	6	13	
252		05-Nov-11	85	6	15	
253		10-Nov-11	72	6	14	
254		12-Nov-11	72	6	15	
255		17-Nov-11	83	6	15	
256		19-Nov-11	102	5	15	
257		24-Nov-11	78	6	15	
	Nov-11	Nov-11	76	6	15	
	2011	Annual	57	6	14	
	Punjab					
1	Jan-11	5-Jan-11	80	6	12	
2		7-Jan-11	72	6	14	
3		10-Jan-11	67	6	13	
4		12-Jan-11	65	7	14	
5		17-Jan-11	66	8	13	
6		19-Jan-11	66	7	15	
7		21-Jan-11	70	5	15	
8		31-Jan-11	71	7	14	

	Jan-11	Average	70	6	14	
9	Feb-11	4-Feb-11	66	7	14	
10		7-Feb-11	70	7	15	
11		9-Feb-11	67	7	15	
12		11-Feb-11	82	7	15	
13		14-Feb-11	69	6	14	
14		16-Feb-11	62	7	16	
15		21-Feb-11	72	6	14	
16		23-Feb-11	73	6	16	
17		25-Feb-11	65	7	14	
18		28-Feb-11	85	8	13	
	Feb-11	Average	71	7	14	
19	Mar-11	4-Mar-11	87	6	16	
20		7-Mar-11	77	7	13	
21		9-Mar-11	61	6	15	
22		11-Mar-11	69	8	15	
23		14-Mar-11	78	7	16	
24		16-Mar-11	80	5	13	
25		18-Mar-11	71	7	15	
26		21-Mar-11	80	6	14	
27		28-Mar-11	79	7	15	
28		30-Mar-11	78	6	13	
	Mar-11	Average	76	6	14	
29	Apr-11	1-Apr-11	76	7	14	
30		4-Apr-11	82	7	16	
31		6-Apr-11	79	7	15	
32		8-Apr-11	70	7	15	
33		11-Apr-11	67	6	16	
34		13-Apr-11	81	7	15	
35		15-Apr-11	75	6	14	
36		18-Apr-11	76	7	15	
37		20-Apr-11	63	6	15	
38		25-Apr-11	86	7	15	
39		27-Apr-11	73	7	14	
40		29-Apr-11	85	6	15	
	Apr-11	Average	76	7	15	
	May-11	2-May-11	79	7	32	
41		4-May-11	75	7	15	
42		9-May-11	93	6	15	

43		25-May-11	76	6	15	
44		27-May-11	71	6	15	
	May-11	Average	79	7	18	
45	Jun-11	1-Jun-11	65	7	16	
46		3-Jun-11	74	7	14	
47		6-Jun-11	74	7	14	
48		8-Jun-11	75	7	14	
49		10-Jun-11	72	7	14	
50		13-Jun-11	70	8	14	
51		17-Jun-11	67	7	13	
52		20-Jun-11	77	7	15	
53		22-Jun-11	71	6	14	
54		24-Jun-11	84	7	14	
55		27-Jun-11	84	8	14	
56		29-Jun-11	72	7	15	
	Jun-11	Average	74	7	14	
57	Jul-11	1-Jul-11	67	6	14	
58		4-Jul-11	65	7	14	
59		6-Jul-11	63	7	15	
60		8-Jul-11	62	7	13	
61		11-Jul-11	67	6	14	
62		13-Jul-11	58	5	13	
63		15-Jul-11	61	6	12	
64		18-Jul-11	69	7	14	
65		20-Jul-11	66	7	14	
66		22-Jul-11	65	6	15	
67		25-Jul-11	59	6	13	
68		27-Jul-11	61	7	14	
		29-Jul-11	66	6	15	
	Jul-11	Average	64	6	14	
69	Aug-11	1-Aug-11	63	5	13	
70		3-Aug-11	66	6	13	
71		5-Aug-11	71	6	15	
72		8-Aug-11	72	7	15	
73		10-Aug-11	62	7	13	
74		12-Aug-11	57	5	12	
75		17-Aug-11	58	6	14	
76		19-Aug-11	66	7	14	
77		24-Aug-11	69	7	14	

78		26-Aug-11	68	6	15	
79		29-Aug-11	69	7	14	
	Aug-11	Average	66	6	14	
80	Sep-11	2-9-11-2011	60	5	14	
81		5-Sep-11	68	6	14	
82		7-Sep-11	64	7	14	
83		9-Sep-11	66	6	14	
84		12-Sep-11	71	5	15	
85		14-Sep-11	68	6	14	
86		16-Sep-11	64	7	15	
87		19-Sep-11	73	6	14	
88		21-Sep-11	79	7	14	
89		23-Sep-11	75	5	13	
90		26-Sep-11	60	6	14	
91		30-Sep-11	72	7	15	
	Sep-11	Average	68	6	14	
92	Oct-11	3-Oct-11	64	6	14	
93		5-Oct-11	83	6	14	
94		7-Oct-11	65	6	13	
95		12-Oct-11	79	6	14	
96		14-Oct-11	70	7	14	
97		17-Oct-11	62	7	15	
98		19-Oct-11	73	7	13	
	Oct-11	Average	71	7	14	
99	Nov-11	2-Nov-11	75	7	14	
100		4-Nov-11	71	6	14	
101		9-Nov-11	71	7	15	
102		11-Nov-11	85	6	14	
103		14-Nov-11	75	7	14	
104		16-Nov-11	56	6	14	
105		18-Nov-11	53	6	14	
106		23-Nov-11	49	6	15	
107		25-Nov-11	53	6	15	
108		30-Nov-11	44	7	13	
	Nov-11	Average	63	7	14	
109	Dec-11	2-Dec-11	52	7	13	
110		5-Dec-11	48	7	13	
111		7-Dec-11	55	6	14	
112		9-Dec-11	53	7	14	

113		12-Dec-11	50	7	14	
114		14-Dec-11	52	7	13	
115		16-Dec-11	48	7	12	
116		19-Dec-11	56	7	12	
117		21-Dec-11	58	7	12	
118		23-Dec-11	51	7	13	
119		26-Dec-11	53	7	13	
120		30-Dec-11				
	Dec-11	Average	52	7	13	
	2011	Annual	69	7	14	

RESULTS OF AIR CONCENTRATION – IRAN

S No	Month	Start Date	End date	PM10 (µg/m^3)	TSPM (µg/m^3)	Remarks
1	Jan-09	12-Jan-09	13-Jan-09	34	134	
2		13-Jan-09	14-Jan-09	23	28	
3		15-Jan-09	16-Jan-09	19	31	
4		16-Jan-09	17-Jan-09	21	31	
5		17-Jan-09	18-Jan-09	30	82	
6		18-Jan-09	19-Jan-09	40	98	
7		19-Jan-09	20-Jan-09	30	59	
8		20-Jan-09	21-Jan-09	12	27	
9		21-Jan-09	22-Jan-09	29	50	
10		22-Jan-09	23-Jan-09	19	46	
	Jan-09	Average		26	59	
11	Feb-09	12-Feb-09	13-Feb-09	152	461	
12		13-Feb-09	14-Feb-09	95	385	
13		14-Feb-09	15-Feb-09	109	340	
14		15-Feb-09	16-Feb-09	24	118	
15		17-Feb-09	18-Feb-09	178	576	
16		19-Feb-09	20-Feb-09	89	287	
17		20-Feb-09	21-Feb-09	126	508	
18		21-Feb-09	22-Feb-09	743	1861	
19		22-Feb-09	23-Feb-09	227	716	
20		23-Feb-09	24-Feb-09	56	336	
	Feb-09	Average		117	414	
21	Mar-09	5-Mar-09	6-Mar-09	24	98	
22		6-Mar-09	7-Mar-09	25	80	
23		7-Mar-09	8-Mar-09	27	87	
24		8-Mar-09	9-Mar-09	44	137	

25		9-Mar-09	10-Mar-09	75	394	
26		10-Mar-09	11-Mar-09	30	141	
27		11-Mar-09	12-Mar-09	34	123	
28		13-Mar-09	14-Mar-09	83	289	
29		14-Mar-09	15-Mar-09	219	624	
30		15-Mar-09	16-Mar-09	205	551	
	Mar-09	Average		77	252	
31		15-Apr-09	16-Apr-09	139	495	
32		16-Apr-09	17-Apr-09	529	1131	
33		18-Apr-09	19-Apr-09	159	405	
34		19-Apr-09	20-Apr-09	90	199	
35		20-Apr-09	21-Apr-09	23	71	
36		21-Apr-09	22-Apr-09	24	71	
37		22-Apr-09	23-Apr-09	31	100	
38		23-Apr-09	24-Apr-09	95	264	
39		25-Apr-09	26-Apr-09	42	142	
40		26-Apr-09	27-Apr-09	50	109	
	Apr-09	Average		72	206	
41	May-09	10-May-09	11-May-09	187	436	
42		11-May-09	12-May-09	47	95	
43		12-May-09	13-May-09	42	116	
44		13-May-09	14-May-09	54	119	
45		14-May-09	15-May-09	50	151	
46		15-May-09	16-May-09	163	276	
47		16-May-09	17-May-09	70	298	
48		17-May-09	18-May-09	51	162	
49		18-May-09	19-May-09	42	124	
50		19-May-09	20-May-09	30	87	
	May-09	Average		74	186	
51	Jun-09	13-Jun-09	14-Jun-09	221	559	
52		14-Jun-09	15-Jun-09	239	545	
53		16-Jun-09	17-Jun-09	477	1068	
54		17-Jun-09	18-Jun-09	618	1295	
55		18-Jun-09	19-Jun-09	764	1364	
56		20-Jun-09	21-Jun-09	306	677	
57		22-Jun-09	23-Jun-09	140	357	
58		24-Jun-09	25-Jun-09	41	133	
59		25-Jun-09	26-Jun-09	50	180	
60		26-Jun-09	27-Jun-09	56	187	

	Jun-09	Average		191	463	
61	Jul-09	4-Jul-09	5-Jul-09	3198	5189	
62		5-Jul-09	6-Jul-09	867	1895	
63		6-Jul-09	7-Jul-09	534	1410	
64		7-Jul-09	8-Jul-09	322	797	
65		8-Jul-09	9-Jul-09	284	528	
66		9-Jul-09	10-Jul-09	400	907	
67		10-Jul-09	11-Jul-09	236	462	
68		12-Jul-09	13-Jul-09	460	1016	
69		13-Jul-09	14-Jul-09	1535	3349	
70		14-Jul-09	15-Jul-09	1543	3532	
	Jul-09	Average		373	853	
71	Aug-09	1-Aug-09	2-Aug-09	372	1116	
72		2-Aug-09	3-Aug-09	375	1199	
73		3-Aug-09	4-Aug-09	343	980	
74		4-Aug-09	5-Aug-09	157	474	
75		5-Aug-09	6-Aug-09	238	698	
76		6-Aug-09	7-Aug-09	155	480	
77		7-Aug-09	8-Aug-09	147	408	
78		8-Aug-09	9-Aug-09	170	503	
79		18-Aug-09	19-Aug-09	223	367	
80		19-Aug-09	20-Aug-09	179	307	
				236	653	
81	Sep-09	14-Sep-09	15-Sep-09	338	940	
82		15-Sep-09	16-Sep-09	282	610	
83		16-Sep-09	17-Sep-09	198	516	
84		17-Sep-09	18-Sep-09	276	608	
85		19-Sep-09	20-Sep-09	159	551	
86		21-Sep-09	22-Sep-09	54	138	
87		22-Sep-09	23-Sep-09	23	117	
88		23-Sep-09	24-Sep-09	41	129	
89		24-Sep-09	25-Sep-09	56	155	
90		25-Sep-09	26-Sep-09	33	121	
	Sep-09	Average		146	388	
91	Oct-09	12-Oct-09	13-Oct-09	80	161	
92		13-Oct-09	14-Oct-09	61	145	
93		15-Oct-09	16-Oct-09	109	312	
94		16-Oct-09	17-Oct-09	52	149	
95		17-Oct-09	18-Oct-09	84	181	

96		18-Oct-09	19-Oct-09	50	144	
97		19-Oct-09	20-Oct-09	60	170	
98		20-Oct-09	21-Oct-09	29	97	
99		21-Oct-09	22-Oct-09	46	117	
100		22-Oct-09	23-Oct-09	78	265	
	Oct-09	Average		65	174	
101		14-Nov-09	15-Nov-09	80	135	
102		15-Nov-09	16-Nov-09	41	127	
103		16-Nov-09	17-Nov-09	44	143	
104		17-Nov-09	18-Nov-09	39	146	
105		22-Nov-09	23-Nov-09	11	43	
106	Nov-09	23-Nov-09	24-Nov-09	13	44	
107		24-Nov-09	25-Nov-09	15	31	
108		25-Nov-09	26-Nov-09	19	58	
109		26-Nov-09	27-Nov-09	27	50	
110		27-Nov-09	28-Nov-09	27	43	
	Nov-09	Average		32	82	
111		13-Dec-09	14-Dec-09	14	15	
112		14-Dec-09	15-Dec-09	11	18	
113		15-Dec-09	16-Dec-09	9	11	
114		16-Dec-09	17-Dec-09	17	20	
115		17-Dec-09	18-Dec-09	14	26	
116	Dec-09	18-Dec-09	19-Dec-09	12	26	
117		19-Dec-09	20-Dec-09	26	39	
118		20-Dec-09	21-Dec-09	20	38	
119		21-Dec-09	22-Dec-09	13	39	
120		22-Dec-09	23-Dec-09	11	16	
	Dec-09	Average		15	25	
	2009	Annual	average	118		
121		15-Feb-10	16-Feb-10	26	48	
122		16-Feb-10	17-Feb-10	26	62	
123		17-Feb-10	18-Feb-10	30	69	
124		18-Feb-10	19-Feb-10	31	114	
125	Feb-10	19-Feb-10	20-Feb-10	30	47	
126		20-Feb-10	21-Feb-10	32	59	
127		21-Feb-10	22-Feb-10	23	38	
128		22-Feb-10	23-Feb-10	138	470	
129		23-Feb-10	24-Feb-10	402	983	

130		24-Feb-10	25-Feb-10	203	617	
	Feb-10	Average		94	251	
131	Mar-10	8-Mar-10	9-Mar-10	80	218	
132		9-Mar-10	10-Mar-10	41	139	
133		10-Mar-10	11-Mar-10	65	198	
134		11-Mar-10	12-Mar-10	61	165	
135		12-Mar-10	13-Mar-10	50	125	
136		13-Mar-10	14-Mar-10	60	201	
137		14-Mar-10	15-Mar-10	65	174	
138		15-Mar-10	16-Mar-10	96	252	
139		16-Mar-10	17-Mar-10	72	345	
140		17-Mar-10	18-Mar-10	92	293	
	Mar-10	Average		68	211	
141	Apr-10	13-Apr-10	14-Apr-10	48	121	
142		14-Apr-10	15-Apr-10	62	147	
143		15-Apr-10	16-Apr-10	49	122	
144		16-Apr-10	17-Apr-10	56	141	
145		17-Apr-10	18-Apr-10	129	299	
146		18-Apr-10	19-Apr-10	193	408	
147		20-Apr-10	21-Apr-10	49	129	
148		21-Apr-10	22-Apr-10	19	105	
149		22-Apr-10	23-Apr-10	86	313	
150		24-Apr-10	25-Apr-10	31	69	
		Average		72	185	
151	May-10	10-May-10	11-May-10	59	195	
152		11-May-10	12-May-10	121	292	
153		13-May-10	14-May-10	74	195	
154		15-May-10	16-May-10	108	245	
155		16-May-10	17-May-10	162	557	
156		17-May-10	18-May-10	260	912	
157		18-May-10	19-May-10	199	702	
158		19-May-10	20-May-10	422	1053	
159		20-May-10	21-May-10	100	353	
160		22-May-10	23-May-10	80	233	
	May-10	Average		159	474	
161	Jun-10	14-Jun-10	15-Jun-10	80	192	
162		16-Jun-10	17-Jun-10	76	251	
163		17-Jun-10	18-Jun-10	63	215	
164		18-Jun-10	19-Jun-10	44	152	

165		19-Jun-10	20-Jun-10	145	356	
166		21-Jun-10	22-Jun-10	288	671	
167		22-Jun-10	23-Jun-10	286	630	
168		23-Jun-10	24-Jun-10	888	1964	
169		24-Jun-10	25-Jun-10	612	1357	
170		25-Jun-10	26-Jun-10	311	605	
	Jun-10	Average		162	384	
171	Jul-10	13-Jul-10	14-Jul-10	354	687	
172		14-Jul-10	15-Jul-10	263	541	
173		15-Jul-10	16-Jul-10	328	631	
174		18-Jul-10	19-Jul-10	359	620	
175		19-Jul-10	20-Jul-10	384	772	
176		20-Jul-10	21-Jul-10	389	979	
177		21-Jul-10	22-Jul-10	782	1265	
178		22-Jul-10	23-Jul-10	474	1156	
179		23-Jul-10	24-Jul-10	279	569	
180		24-Jul-10	25-Jul-10	86	298	
	Jul-10	Average		370	752	
181	Aug-10	14-Aug-10	15-Aug-10	136	424	
182		15-Aug-10	16-Aug-10	167	524	
183		16-Aug-10	17-Aug-10	68	181	
184		17-Aug-10	18-Aug-10	56	164	
185		18-Aug-10	19-Aug-10	46	132	
186		19-Aug-10	20-Aug-10	79	198	
187		21-Aug-10	22-Aug-10	41	104	
188		22-Aug-10	23-Aug-10	54	124	
189		23-Aug-10	24-Aug-10	50	128	
190		24-Aug-10	25-Aug-10	66	163	
	Aug-10	Average		76	214	
191	Sep-10	14-Sep-10	15-Sep-10	47	157	
192		15-Sep-10	16-Sep-10	188	457	
193		16-Sep-10	17-Sep-10	38	89	
194		17-Sep-10	18-Sep-10	29	73	
195		18-Sep-10	19-Sep-10	33	105	
196		19-Sep-10	20-Sep-10	33	108	
197		20-Sep-10	21-Sep-10	74	173	
198		21-Sep-10	22-Sep-10	97	183	
199		22-Sep-10	23-Sep-10	98	169	
200		23-Sep-10	24-Sep-10	91	157	

	Sep-10	Average		73	167	
201	Dec-10	11-Dec-10	12-Dec-10	59	298	
202		13-Dec-10	14-Dec-10	244	747	
203		14-Dec-10	15-Dec-10	139	302	
204		15-Dec-10	16-Dec-10	140	303	
205		16-Dec-10	17-Dec-10	72	158	
206		17-Dec-10	18-Dec-10	93	206	
207		18-Dec-10	19-Dec-10	168	295	
208		19-Dec-10	20-Dec-10	47	189	
209		20-Dec-10	21-Dec-10	44	112	
210		22-Dec-10	23-Dec-10	89	253	
	Dec-10	Average		109	286	
	2010	Annual	average	121		
211	Jan-11	9-Jan-11	10-Jan-11	55	177	
212		10-Jan-11	11-Jan-11	42	113	
213		11-Jan-11	12-Jan-11	42	133	
214		12-Jan-11	13-Jan-11	17	41	
215		13-Jan-11	14-Jan-11	47	92	
216		14-Jan-11	15-Jan-11	11	17	
217		15-Jan-11	16-Jan-11	16	23	
218		20-Jan-11	21-Jan-11	16	36	
219		23-Jan-11	24-Jan-11	17	34	
220		24-Jan-11	25-Jan-11	37	68	
	Jan-11	Average		30	73	
221	Feb-11	7-Feb-11	8-Feb-11	19	27	
222		10-Feb-11	11-Feb-11	37	49	
223		13-Feb-11	14-Feb-11	108	241	
224		15-Feb-11	16-Feb-11	29	57	
225		16-Feb-11	17-Feb-11	35	186	
226		17-Feb-11	18-Feb-11	39	158	
227		18-Feb-11	19-Feb-11	40	160	
228		19-Feb-11	20-Feb-11	22	47	
229		20-Feb-11	21-Feb-11	58	120	
230		21-Feb-11	22-Feb-11	136	432	
	Feb-11	Average		52	148	
231	Mar-11	5-Mar-11	6-Mar-11	358	794	Dusty
232		6-Mar-11	7-Mar-11	135	363	Dusty
233		7-Mar-11	8-Mar-11	95	345	Dusty
234		10-Mar-11	11-Mar-11	31	106	Sunny

235		11-Mar-11	12-Mar-11	81	192	Sunny
236		12-Mar-11	13-Mar-11	50	194	Cloudy
237		14-Mar-11	15-Mar-11	33	93	Sunny
238		15-Mar-11	16-Mar-11	19	55	Sunny
239		16-Mar-11	17-Mar-11	15	57	Sunny
240		19-Mar-11	20-Mar-11	20	83	Sunny
	Mar-11	Average		84	228	
241	Apr-11	13-Apr-11	14-Apr-11	1001	2049	Dusty
242		15-Apr-11	16-Apr-11	273	508	Dusty
243		16-Apr-11	17-Apr-11	351	664	Dusty
244		17-Apr-11	18-Apr-11	177	443	Dusty
245		19-Apr-11	20-Apr-11	166	327	Dusty
246		20-Apr-11	21-Apr-11	210	391	Dusty
247		21-Apr-11	22-Apr-11	581	1062	Dusty
248		22-Apr-11	23-Apr-11	49	131	Cloudy
249		23-Apr-11	24-Apr-11	90	243	Sunny
250		24-Apr-11	25-Apr-11	64	188	Cloudy
	Apr-11	Average		173	362	
251	May-11	10-May-11	11-May-11	111	246	Sunny
252		11-May-11	12-May-11	188	392	Dusty
253		12-May-11	13-May-11	176	400	Dusty
254		13-May-11	14-May-11	375	808	Dusty
255		14-May-11	15-May-11	1757	3545	Dusty and Cloudy
256		15-May-11	16-May-11	213	469	Dusty
257		16-May-11	17-May-11	34	277	Sunny
258		17-May-11	18-May-11	166	334	Dusty and Cloudy
259		18-May-11	19-May-11	166	397	Dusty
260		20-May-11	21-May-11	209	459	Dusty
	May-11	Average		182	420	
261	Jun-11	12-Jun-11	13-Jun-11	252	717	Dusty
262		13-Jun-11	14-Jun-11	175	394	Dusty
263		14-Jun-11	15-Jun-11	128	327	Dusty
264		15-Jun-11	16-Jun-11	68	201	Sunny
265		17-Jun-11	18-Jun-11	148	347	Dusty
266		18-Jun-11	19-Jun-11	139	335	Dusty
267		19-Jun-11	20-Jun-11	152	346	Dusty
268		21-Jun-11	22-Jun-11	186	507	Dusty

269		22-Jun-11	23-Jun-11	126	295	Sunny
270		24-Jun-11	25-Jun-11	87	230	Sunny
	Jun-11	Average		146	370	
271	Jul-11	10-Jul-11	11-Jul-11	528	1334	Dusty
272		11-Jul-11	12-Jul-11	153	425	Dusty
273		12-Jul-11	13-Jul-11	53	192	Sunny
274		13-Jul-11	14-Jul-11	59	211	Sunny
275		14-Jul-11	15-Jul-11	53	119	Sunny
276		16-Jul-11	17-Jul-11	295	662	Dusty
277		17-Jul-11	18-Jul-11	170	384	Dusty
278		18-Jul-11	19-Jul-11	201	410	Dusty
279		19-Jul-11	20-Jul-11	92	188	Sunny
280		20-Jul-11	21-Jul-11	85	273	Sunny
	Jul-11	Average		169	420	
	2011	Annual	average	119		

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – NEPAL

S No	Month	Start Date	End date	PM10 (µg/m^3)	TSPM (µg/m^3)	Remarks
1	Jun-09	10-Jun-09	6/11/2009	56	109	-
2		11-Jun-09	12-Jun-09	52	91	-
3		12-Jun-09	13-Jun-09	39	95	-
4		13-Jun-09	14-Jun-09	35	75	-
5		16-Jun-09	17-Jun-09	53	101	-
6		17-Jun-09	18-Jun-09	40	77	-
7		22-Jun-09	23-Jun-09	37	90	-
8		25-Jun-09	26-Jun-09	27	49	-
9		28-Jun-09	29-Jun-09	15	42	Raining
10		29-Jun-09	30-Jun-09	25	50	-
	Jun-09			38	78	
11	Jul-09	12-Jul-09	13-Jul-09	19	40	-
12		15-Jul-09	16-Jul-09	20	49	Raining & Cloudy
13		16-Jul-09	17-Jul-09	10	49	Cloudy
14		17-Jul-09	18-Jul-09	17	44	Raining
15		19-Jul-09	20-Jul-09	16	31	Raining
16		21-Jul-09	22-Jul-09	24	45	Raining
17		21-Jul-09	22-Jul-09	17	40	-

18		22-Jul-09	23-Jul-09	24	54	Raining & Cloudy
19		24-Jul-09	25-Jul-09	20	54	Raining
20		25-Jul-09	26-Jul-09	30	67	-
	Jul-09	Average		20	47	
21		11-Aug-09	12-Aug-09	33	49	-
22		12-Aug-09	13-Aug-09	26	49	Cloudy
23		13-Aug-10	14-Aug-10	20	41	-
24		14-Aug-09	15-Aug-09	14	35	raining
25	Aug-09	17-Aug-09	18-Aug-09	16	34	Cloudy & Raining
26		18-Aug-09	19-Aug-09	22	35	Raining
27		19-Aug-09	20-Aug-09	20	37	Raining
28		20-Aug-09	21-Aug-09	22	50	raining
29		23-Aug-09	24-Aug-09	27	46	Cloudy
30		24-Aug-09	25-Aug-09	23	48	-
	Aug-09	Average		22	42	
31		27-Nov-09	28-Nov-09	58	98	-
32	Nov-09	28-Nov-09	29-Nov-09	74	111	-
33		29-Nov-09	30-Nov-09	57	67	-
34		30-Nov-09	1-Dec-09	62	80	-
	Nov-09	Average		63	89	
35		2-Dec-09	3-Dec-09	65	85	-
36		3-Dec-09	4-Dec-09	68	92	-
37		4-Dec-09	5-Dec-09	60	75	-
38		5-Dec-09	6-Dec-09	76	108	-
39		6-Dec-09	7-Dec-09	75	82	-
40		7-Dec-09	8-Dec-09	68	90	-
41		8-Dec-09	9-Dec-09	66	89	-
42	Dec-09	9-Dec-09	10-Dec-09	82	108	-
43		10-Dec-09	11-Dec-09	77	97	-
44		11-Dec-09	12-Dec-09	77	112	-
45		12-Dec-09	13-Dec-09	83	116	-
46		13-Dec-09	14-Dec-09	119	173	-
47		14-Dec-09	15-Dec-09	76	100	-
48		15-Dec-09	16-Dec-09	65	101	-
49		16-Dec-09	17-Dec-09	62	99	-
50		17-Dec-09	18-Dec-09	65	90	-
	Dec-09			74	101	
	2009	Annual	average	43		

RESULTS OF AIR CONCENTRATION – PAKISTAN

S No	Month	Start Date	End date	PM10 (µg/m^3)	NRSPM (µg/m^3)	Remarks
1	Jan-09	05-Jan-09	06-Jan-09	205	333	
2		06-Jan-09	07-Jan-09	186	301	
3		07-Jan-09	08-Jan-09	172	303	Invalid; short time
4		15-Jan-09	16-Jan-09	140	138	Invalid; short time
5		20-Jan-09	21-Jan-09	153	291	Invalid; short time
6		21-Jan-09	22-Jan-09	118	302	
7		22-Jan-09	23-Jan-09	254	330	
8		25-Jan-09	26-Jan-09	134	259	
9		26-Jan-09	27-Jan-09	133	354	
10		27-Jan-09	28-Jan-09	135	281	
	Jan-09	Average		157		
11	Feb-09	05-Feb-09	06-Feb-09	45	131	Invalid; short time
12		06-Feb-09	07-Feb-09	149	310	
13		07-Feb-09	08-Feb-09	127	312	
14		15-Feb-09	16-Feb-09	103	307	Invalid; short time
	Feb-09	Average		106		
15	Dec-09	04-Dec-09	05-Dec-09	326	391	
16		05-Dec-09	06-Dec-09	321	280	
17		06-Dec-09	07-Dec-09	386	447	
18		14-Dec-09	15-Dec-09	272	375	
19		15-Dec-09	16-Feb-09	275	231	
20		16-Dec-09	17-Dec-09		394	
	Dec-09				313	

Note : Stirkethrough text ignored for averaging

RESULTS OF AIR CONCENTRATION – SRI LANKA

S No	Month	Start Date	End date	PM10 (µg/m^3)	Remarks
1	Jan-10	10-Jan-10	11-Jan-10	25	Hour Meter not working
2		16-Jan-10	17-Jan-10	44	
3		23-Jan-10	24-Jan-10	22	
4		30-Jan-10	31-Jan-10	36	
	Jan-10	Average		32	
6	Feb-10	6-Feb-10	7-Feb-10	48	
7		13-Feb-10	14-Feb-10	31	

8		20-Feb-10	21-Feb-10	27	
9		27-Feb-10	28-Feb-10	34	
	Feb-10	Average		35	
10	Mar-10	6-Mar-10	7-Mar-10	50	Hour meter not working
11		13-Mar-10	14-Mar-10	36	
12		20-Mar-10	21-Mar-10	54	
13		27-Mar-10	28-Mar-10	24	
	Mar-10	Average		41	
14	Apr-10	3-Apr-10	4-Apr-10	45	
15		10-Apr-10	11-Apr-10	47	
16		17-Apr-10	18-Apr-10	32	
17		24-Apr-10	25-Apr-10	42	
	Apr-10	Average		42	
18	May-10	1-May-10	2-May-10	15	
19		8-May-10	9-May-10	12	
20		15-May-10	16-May-10	25	
21		22-May-10	23-May-10	24	
22		29-May-10	30-May-10	25	
	May-10	Average		20	
23	Jun-10	5-Jun-10	6-Jun-10	22	
24		12-Jun-10	13-Jun-10	26	
25		19-Jun-10	20-Jun-10	40	
26		26-Jun-10	27-Jun-10	13	
	Jun-10	Average		25	
27	Jul-10	3-Jul-10	4-Jul-10	25	
28		10-Jul-10	11-Jul-10	35	
29		17-Jul-10	18-Jul-10	29	
30		25-Jul-10	26-Jul-10	52	
31		31-Jul-10	1-Aug-10	32	
	Jul-10	Average		35	
32	Aug-10	8-Aug-10	9-Aug-10	15	
33		14-Aug-10	15-Aug-10	14	
34		21-Aug-10			
35		28-Aug-10			
	Aug-10	Average		14	
36	Sep-10	5-Sep-10	6-Sep-10	20	
37		11-Sep-10	12-Sep-10	32	
38		19-Sep-10	20-Sep-10	26	
39		25-Sep-10	26-Sep-10	25	

	Sep-10	Average		26	
40	Oct-10	2-Oct-10	3-Oct-10	29	
41		9-Oct-10	10-Oct-10	32	
42		17-Oct-10	18-Oct-10	34	
43		24-Oct-10	25-Oct-10	30	
	Oct-10	Average		31	
44	Nov-10	1-Nov-10	2-Nov-10	25	
45		5-Nov-10	6-Nov-10	19	
46		13-Nov-10	14-Nov-10	18	
47		20-Nov-10			
48		28-Nov-10	29-Nov-10	20	
	Nov-10	Average		20	
49	Dec-10	6-Dec-10	7-Dec-10	23	
50		12-Dec-10			
51		20-Dec-10	21-Dec-10	21	
52		25-Dec-10	26-Dec-10	29	
	Dec-10	Average		24	
	2010	Annual	average		
53	Jan-11	1-Jan-11	2-Jan-11	22	
54		9-Jan-11	10-Jan-11	30	
55		22-Jan-11	23-Jan-11	34	
56		29-Jan-11	30-Jan-11	16	
	Jan-11	Average		25	
57	Feb-11	6-Feb-11	7-Feb-11	20	
58		13-Feb-11	14-Feb-11	41	
59		19-Feb-11	20-Feb-11	19	
60		27-Feb-11	28-Feb-11	36	
	Feb-11	Average		29	
61	Mar-11	6-Mar-11	7-Mar-11	26	
62		12-Mar-11	13-Mar-11	16	
63		20-Mar-11	21-Mar-11	28	
64		26-Mar-11	27-Mar-11	58	
	Mar-11	Average		32	
65		2-Apr-11	3-Apr-11	49	
66		10-Apr-11			Not operated due to instrument failure
67		17-Apr-11			
68		24-Apr-11			

69	May-11	1-May-11			Not operated due to instrument falure
70		8-May-11			
71		15-May-11		16	
72		21-May-11		17	
73		29-May-11		15	
	May-11	Average		16	
74	Jun-11	4-Jun-11		15	23.68
75		12-Jun-11			Not operated due to calibration failure
76		19-Jun-11			
77		26-Jun-11			
78	Jul-11	3-Jul-11	4-Jul-11	79	Rejected due to calibration error
79		10-Jul-11			Not operated due to dust emitting special activities in the visinity of the sampler
80		17-Jul-11	18-Jul-11	32	
81		24-Jul-11	25-Jul-11	34	
82		31-Jul-11	1-Aug-11	19	
	Jul-11	Average		28	
83	Aug-11	6-Aug-11	7-Aug-11	21	
84		14-Aug-11	15-Aug-11	28	
85		20-Aug-11	21-Aug-11	24	
86		28-Aug-11	29-Aug-11	36	
	Aug-11	Average		27	
87	Sep-11	4-Sep-11	5-Sep-11	42	
88		10-Sep-11	11-Sep-11	24	
89		18-Sep-11	19-Sep-11	43	
90		25-Sep-11	26-Sep-11	26	
	Sep-11	Average		34	
91	Oct-11	2-Oct-11	3-Oct-11	22	
92		9-Oct-11	10-Oct-11	19	
93		16-Oct-11	17-Oct-11	28	
94		23-Oct-11	24-Oct-11	20	
95		30-Oct-11	31-Oct-11	23	
	Oct-11	Average		22	
96	Nov-11	6-Nov-11	7-Nov-11	15	
97		13-Nov-11	14-Nov-11	59	
98		20-Nov-11	21-Nov-11	43	
99		27-Nov-11	28-Nov-11	21	

	Nov-11	Average		35	
100	Dec-11	4-Dec-11	5-Dec-11	25	
101		11-Dec-11	12-Dec-11	33	
102		17-Dec-11	18-Dec-11	32	
103		24-Dec-11	25-Dec-11	52	
	Dec-11	Average		36	
	2011	Annual	average	29	

ANNEXURE II: DATA FROM PASSIVE (DIFFUSIVE) SAMPLING

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - BANGLADESH

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samples							
1	2009	01-Jan	31-Jan	18.3	5.8	6.7	78	
2		31-Jan	28-Feb	19.7	6.4	6.1	79	
3		01-Mar	31-Mar	21.8	5.3	3.9	90	
4		01-Apr	30-Apr	23.6	2.4	1.4	67	
5		01-May	31-May	24.2	1.0	2.0	73	
6		01-Jun	30-Jun	24.8	1.9	1.0	87	
7		01-Jul	31-Jul	24.2	2.6	1.4	49	
8		01-Aug	31-Aug	24.5	2.2	1.5	58	
9		01-Sep	30-Sep	26.3	1.1	0.9	48	
10		01-Oct	31-Oct	25.0	2.1	3.2	73	
11		01-Nov	30-Nov	21.7	4.2	6.3	71	
12		01-Dec	31-Dec	17.1	8.4	7.0	86	
	2009	Annual average			3.6	3.5	71.5	
13	2010	01-Jan	31-Jan	12.9	7.2	7.6	84	
14		01-Feb	28-Feb	19.1	7.9	6.6	91	
15		01-Mar	31-Mar	25.7	4.8	2.7	80	
16		01-Apr	30-Apr	28.5	1.1	1.0	47	
17		1-May	31-May	28.2	1.7	1.4	62	
18		1-Jun	30-Jun	29.9	1.2	1.2	67	
19		1-Jul	31-Jul	29.7	1.2	0.7	53	
20		1-Aug	31-Aug	29.8	0.6	0.7	33	
21		1-Sep	30-Sep	28.8	0.9	1.1	45	
22		1-Oct	31-Oct	26.4	2.9	2.9	60	
23		1-Nov	1-Dec	21.8	3.5	4.8	75	
24		1-Dec	1-Jan-11	15.8	6.8	7.4	86	
	2010	Annual average			3.3	3.2	65.2	
25	2011	1-Jan	1-Feb	13.5	8.4	6.7	91	Same site as Stn 7?
26		1-Feb	1-Mar	19.4	10.4	5.9	103	
27		1-Mar	1-Apr	22.9	7.4	3.2	84	
28		1-Apr	1-May	25.4	3.2	2.2	75	
29		1-May	1-Jun	27.5	1.1	1.5	80	

30		1-Jun	1-Jul	29.4	1.3	1.5	60	
31		1-Jul	1-Aug	28.9	1.1	1.0	48	
32		1-Aug	1-Sep	28.7	1.0	0.9	45	
33		1-Sep	1-Oct	27.0	1.5	1.6	59	
34		1-Oct	1-Nov	27.7	3.1	3.6	69	
35		1-Nov	1-Dec	21.3	3.7	5.2	74	
36		1-Dec	1-Jan-12	18.0	7.0	6.6	77	
	2011	Annual average			4.1	3.3	72.1	
	Field Blanks							
1	2009	01-Jan	28-Feb	19.0	<0.1	<0.1	1	
2		01-Mar	30-Apr	20.0	0.2	<0.1	<1	Exposure date changed to 090301 - 090430 according to e-mail from Hashmi 091112
3		01-May	30-Jun	24.8	<0.1	0.1	<1	Exposure time changed to 090501 06:00 - 090630 06:00 according to e-mail from Hashmi 091112
4		01-Jul	31-Aug		<0.1	<0.1	<1	
5		01-Sep	31-Oct		<0.2	0.1	<1	
6		01-Nov	31-Dec	17.1	<0.2	0.3	<1	
7	2010	01-Jan	28-Feb	19.1	<0.2	<0.2	1	
8		01-Mar	30-Apr		<0.2	<0.2	<1	
9		01-May	30-Jun		<0.2	<0.2	<1	
10		01-Jul	31-Aug		<0.2	<0.2	<1	
11		01-Sep	30-Sep	28.8	<0.2	<0.2	<1	
12		01-Oct	01-Dec	21.8	<0.2	<0.2	<1	
13		01-Dec	01-Jan-11	15.8	<0.2	<0.2	<1	
14	2011	01-Jan	01-Mar		<0.2	<0.2	<1	
15		01-Mar	01-May	25.4	<0.2	<0.2	<1	
16		01-May	01-Jul		<0.2	<0.2	<1	
17		01-Jul	01-Sep		<0.2	<0.2	<1	
18		01-Sep	01-Nov		<0.2	<0.2	<1	
19		01-Nov	01-Jan-12	18.0	<0.2	<0.2	<1	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - BHUTAN

S No	Station	Start time	Stop time	Temp C	SO_2 µg/m³	NO_2 µg/m³	O_3 µg/m³	Remarks
	Exposed samples							
	Bhur	1-Feb-09	1-Mar-09	24.0		0.2	72	Old samplers from 2008-06.
	Bhur	1-Feb-09	1-Mar-09	24.0		2.2		NO_2 arrived to lab with SO_2 label. Double exposure of NO_2 in Feb, no SO_2
	Bhur	1-Mar-09	1-Apr-09	23.0	2.2		104	
	Bhur	1-Mar-09	1-Apr-09	23.0	2.8			SO_2 arrived to lab with NO_2 label. Double exposure of SO_2 in March, no NO_2
	Bhur	1-Apr-09	1-May-09	26.0	0.5	2.9	86	Old samplers from 2008-06.
	Bhur	10-Oct-09	10-Dec-09	24.5	0.3	1.7	49	Earlier stop date 091122 14:45. Old samplers from 2008-02.
	Field blanks							
		5-Jan-09	4-Mar-09	26.0			162	Gelephu Station. Unreasonable high ozone value, longer exposure time?
		5-Jan-09	4-Mar-09	26.0			214	Gelephu Station. Unreasonable high ozone value, longer exposure time?
	Background site Stn 2	5-Jan-09	3-Mar-09	27.0			172	SerpangDzong Station. Unreasonable high ozone value, longer exposure time?
	SerpangDzong Station Stn 2	5-Jan-09	3-Mar-09	27.0			183	SerpangDzong Station. Unreasonable high ozone value, longer exposure time?
	Bhur	1-May-09	1-Sep-09	29.5	0.5	1.4	53	Time for change assumed to be 12:00. Samplers old, was sent out 0804. Have there been several samplers exposed in parallel for different time periods.
	Bhur	23-May-09	21-Aug-09		<0.2	2.7	36	How many stations in background air do you run?? 4 in parallel for 3 months (May-August)?
	Gelephu	23-May-09	21-Aug-09		0.9	5.0	40	
	Sarpang Dzong	23-May-09	21-Aug-09		0.4	3.5	34	

	Slelgana, Punakha	21-May-09	19-Aug-09		<0.2	2.7	51	
	Bhur	21-Aug-09	22-Nov-09	26.0	0.2	1.2	39	How many stations in background air do you run?? 3 in parallel for 3 months (Aug-Nov)?
	Gelephu	21-Aug-09	22-Nov-09	26.0	0.8	5.7	29	
	SarpangDzong	21-Aug-09	21-Nov-09	25.0	0.2	1.4	37	
								How many stations do you run? See comments above.
	Bhur	22-Nov-09	1-Jan-10	17.5	1.0	3.0	110	Time for change assumed to be 12:00.
	Bhur	1-Feb-10	1-May-10	26.0	0.9	2.9	69	Time for change assumed to be 12:00. Samplers exposed for 3 months.
	Slelgana, Punakha	19-Aug-09	3-Dec-09		<0.2	0.7	33	Start date missing, assumed to be the same as stop date for the earlier exposed samplers. Temp missing.
	- Slelgana, Punakha	3-Dec-09	3-Jun-10		0.2	0.9	59	Temp missing. O_3 might be uncertain. Samplers exposed for 6 months!
	Urban site Field blank	18-Mar-04	14-Apr-04	10	1.7	15.2		Probably not field blanks?
	Thimphu Stn 2	14-Apr-04	18-May-04	10	1.3	15.3		
	Stn 2	10-Jan-09	10-Feb-09	20.0	0.9	0.9	62	Thimphu NEC. Urban background site??
	NEC Office roof top	4-Apr-09	25-May-09	22.0	0.5	4.8	135	Thimphu. Samplers from 2008-05, sent to SEI-York within another project UPR:1104 2009-07-31. Result for O_3 uncertain.
	NEC Office roof top	22-Sep-09	24-Nov-09	21.0	0.3	6.7	99	Samplers from 2008-08. Result for O_3 uncertain.
	NEC Office roof top	24-Nov-09	2-Feb-10		0.3	6.2	57	Temperature missing.
	NEC Office roof top	2-Feb-10	9-Jun-10		<0.2	1.9	54	Temperature missing. Samplers exposed > 4 months!
	Traffic (Thimphu)	20-May-09	18-Aug-09		1.8	12.9		O_3 missing, but no remark on the protocol
	Traffic (Thimphu)	18-Aug-09	18-Nov-09	21.0	1.2	10.2	32	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - IRAN

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samples							
1	2009	15-Jan	15-Feb	15.0	8.4	3.6	77	
2		15-Feb	15-Mar	18.0	11.6	2.4	72	
3		15-Mar	15-Apr	20.0	8.5	1.9	110	
4		15-Apr	15-May	28.0	8.9	1.4	75	
5		15-May	15-Jun	36.0	11.9	0.6	78	
6		15-Jun	15-Jul	38.9	15.5	0.7	57	Samplers sandy
7		15-Jul	15-Aug	38.6	17.6	0.7	87	Samplers sandy
8		15-Aug	15-Sep	37.6	18.5	0.9	78	
9		15-Sep	15-Oct	30.6	10.0	1.9	59	
10		15-Oct	15-Nov	25.7	9.1	4.9	61	
11		15-Nov	15-Dec	15.2	8.6	4.0	57	
	2009	Annual average			11.7	2.1	74	
12	2010	15-Dec-09	15-Jan	15.7	9.8	4.7	58	O_3 sampler sandy. Chamsari = Stn 6?
	Field blanks							
	2009	15-Jan	15-Jun	20.0	<0.1	0.1	2	
		15-Nov	15-Dec	15.2	0.4	1.3		Old samplers from 2007-06. SO_2 and NO_2 samplers exposed? O_3 sampler damaged

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - MALDIVES

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samplers							
1	2009	31-Jan	28-Feb	30.0	0.5	1.0	65	
2		28-Feb	31-Mar	32.0	<0.2	1.3	40	
3		31-Mar	30-Apr	31.0	<0.2	0.9	48	
4		30-Apr	31-May	31.0	<0.2	0.8	39	
5		31-May	30-Jun	29.0	<0.2	0.2	34	
6		30-Jun	31-Jul	29.0	<0.2	0.2	<1	O_3: Unexposed?
7		31-Aug	30-Sep	29.0	<0.2	1.3	102	Samplers for August not sent to the laboratory.

								Samplers for September high values (especially O_3), exposed for 2 months (Aug-Sep)?
8		30-Sep	31-Oct	30.0	0.3	0.9	22	
9		31-Oct	30-Nov	30.0	0.3	1.0	47	Earlier stop date 2009-09-30 10:00.
	2009	Annual average			0.4	0.8	48	
	Field blanks							
11		30-Nov-08	31-Jan-09	30.0	<0.1	<0.1	1	
12	2009	31-Jan	31-Mar	31.0	<0.1	<0.1	<1	
13		31-Mar	31-May	31.0	<0.1	0.1	<1	
14		31-May	30-Sep	29.0	<0.2	<0.1	2	
15		30-Sep	30-Nov	30.0	<0.2	<0.1	<1	

STP=Standard Temperature and Pressure 20C 1013hPa
*Status: b = below detection limit

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - NEPAL

S No	Year	Start time	Stop time	Temp C	SO_2 µg/m^3	NO_2 µg/m^3	O_3 µg/m^3	Remarks
	Exposed samplers							
1	2009	01-Jan	1-Feb	20.0	0.5	8.6	27	Temp missing.
2		01-Feb	2-Mar	20.0	2.7	9.7	52	Temp missing.
3		29-Mar	1-May		3.4	9.0	86	Temp missing.
4		01-May	2-Jun		1.7	8.6	83	Temp missing.
5		02-Jun	1-Jul		0.7	5.8	70	Temp missing.
6		01-Jul	30-Aug		0.3	3.6	33	Temp. missing. Stop time missing.
7		12-Sep	9-Oct		0.4	5.4	35	Temp missing
8		09-Oct	9-Nov		0.2	5.8	24	Temp missing
9		09-Nov	2-Dec		0.4	7.8	21	Temp missing
10		02-Dec	7-Jan-10		0.4	9.5	26	Temp missing
	2009	Annual average			1.1	7.4	76	
11	2010	17-Jan	5-Feb		0.9	6.7	28	Temp missing
12		05-Feb	3-Mar		1.6	9.7	40	Temp missing
	Field blanks							
1	2009	01-Jan	2-Mar		<0.1	<0.05	<1	Temp missing.
2		29-Mar	2-Jun		<0.1	<0.05	1	
3		02-Jun	30-Aug		<0.1	<0.05	<1	
4		12-Sep	9-Nov		<0.2	<0.2	<1	

5		09-Nov	7-Jan-10		<0.2	<0.2	<1	
6	2010	17-Jan	3-Mar		<0.2	<0.2	<1	

RESULTS OF PASSIVE (DIFFUSIVE) SAMPLING - SRI LANKA

S No		Start time	Stop time	Temp C	SO_2	NO_2	O_3	Remarks
	Exposed samplers							
	Dutuwewa							
1	2009	04-Jan	01-Feb	33.0	<0.2	0.8	27	
2		01-Feb	01-Mar	34.0	<0.2	1.0	23	
3		01-Mar	04-Apr	30.0			15	NO_2 and SO_2 missing, samplers stolen by monkies!
4		04-Apr	02-May	30.0	0.6	2.3	36	
5		02-May	06-Jun	30.0	0.7	1.8	40	
6		06-Jun	05-Jul	32.0	0.5	1.6	38	
7		05-Jul	08-Aug	33.0	<0.2	1.9	36	
8		09-Aug	06-Sep	32.0	0.5	2.2	31	
9								
10		08-Nov	07-Dec	32.0	0.2	1.4		Earlier stop date 2009-09-06 12:10. Monsoon rain.
11		08-Nov	07-Dec	32.0	0.3			SO_2 double sampler. 2 SO_2 was sent instead of 1 SO_2 and 1 O_3.
12		07-Dec	03-Jan-10	32.0		0.7	31	2 O_3 was sent instead of 1 SO_2 and 1 O_3. Only 1 O_3 exposed.
13	2010	31-Jan	28-Feb	30.0	<0.2	0.9	23	
14		28-Feb	04-Apr	30.0	0.2	2.1	28	
15		04-Apr	01-May	30.0	0.3	2.2	25	
16		30-May	03-Jul	35.0	0.5	1.9	35	
17		03-Jul	29-Aug	32.0	0.2	1.2	16	
18		29-Aug	02-Oct					Samplers stolen, due to protocol
19		02-Oct	30-Oct	30.0	0.6	2.5	34	
20		30-Oct	06-Dec	25.0	<0.2	1.4	23	
21		06-Dec	02-Jan-11	28.0	<0.2	0.8	<1	O_3-sampler unexposed?
22	2011	02-Jan	29-Jan	26.0	<0.2	0.8	73	
23		29-Jan	27-Feb					Rain and storm, samplers found on the ground.
24		06-Mar	02-Apr	32.0	0.5	2.9	40	
25		02-Apr	30-Apr	32.0	0.5	2.7	51	

26		30-Apr	04-Jun	32.0	0.7	2.5	41	Exposed in April due to protocol, May assumed since there were samples for April already.
27		04-Jun	02-Jul	31.0	0.8	2.4	38	
28		02-Jul	31-Jul	32.0	0.7	2.2	40	
29		31-Jul	04-Sep	31.0	0.6	3.6	39	
30		04-Sep	02-Oct	30.0	1.2	3.9	36	
31		02-Oct	30-Oct	30.0	0.8	3.5	32	
32		30-Oct	03-Dec	31.0	0.4	2.1	35	
33		03-Dec	01-Jan-12	31.0	0.5	2.0	52	
	Doramadalawa							
1	2009	5-Jan	2-Feb	33.0	<0.2	1.1	38	
2		2-Feb	2-Mar	34.0	0.5	1.2	35	
3		2-Mar	4-Apr	30.0	0.3	1.9	21	
4		4-Apr	2-May	30.0	0.8	2.6	34	
5		2-May	6-Jun	30.0	0.8	2.1	40	
6		6-Jun	5-Jul	30.0	0.6	2.1	37	
7		5-Jul	8-Aug	32.0	0.6	2.0	41	
8		8-Aug	6-Sep	32.0	0.6	2.5	38	
9								
10		7-Nov	6-Dec	33.0	0.3	1.7	28	Earlier stop date 2009-09-06 12:10. Monsoon rain.
11		6-Dec	3-Jan-10	32.0	<0.2	<0.2	<1	Monsoon rain. O_3 conc on blank level, unexposed sampler?
	2009	Annual	avg		0.5	1.5	31	
12	2010	3-Jan	30-Jan	30.0	<0.2	1.5	39	Start time due to protocol 100102 10:40.
13		30-Jan	27-Feb	32.0	0.3	1.7	34	
14		27-Feb	3-Apr	30.0	0.5	2.6	42	North-east monsoon due to protocol.
15		3-Apr	2-May	32.0	0.4	2.3	31	
16		2-May	29-May	32.0	0.4	2.0	39	
17		29-May	4-Jul	32.0	0.5	2.0	39	
18		4-Jul	31-Jul	32.0	0.8	2.3	39	
19		28-Aug	2-Oct	32.0	0.7	2.5	34	
20		3-Oct	29-Oct	30.0	0.9	3.1	41	
21		29-Oct	5-Dec	22.0	0.2	2.1	28	
22		5-Dec	1-Jan-11	28.0	0.2	1.7	43	Start time 11:15 due to protocol, but 11:50 has been assumed to match

								stop time for the sampler exposed earlier.
	2010	Annual	avg		0.4	1.6	26	
23	2011	1-Jan	29-Jan	29.0	0.3	1.3	47	
24		29-Jan	6-Mar		<0.2	1.7	41	Temperature missing
25		6-Mar	2-Apr	32.0	0.7	2.7	41	
26		2-Apr	30-Apr	32.0	0.4	2.7	40	
27		30-Apr	4-Jun	32.0	0.6	2.3	40	
28		4-Jun	2-Jul	30.0	0.9	2.4	41	
29		2-Jul	31-Jul	30.0	0.5	2.3	42	
30		31-Jul	4-Sep	30.0	0.7	3.4	36	
31		4-Sep	2-Oct	30.0	1.1	4.1	37	
32		2-Oct	30-Oct	30.0	0.9	3.6	34	
33		30-Oct	3-Dec	31.0	0.3	2.0	38	Temperature assumed
34		3-Dec	1-Jan-12	30.0	0.5	2.0	53	
	2011	Annual	avg		0.7	2.6	73	
	Field blanks							
1		4-Jan-09	1-Mar-09	34.0	<0.1	0.1	<1	
2		1-Mar-09	2-May-09	30.0	<0.1	0.1	1	
3		2-May-09	5-Jul-09	30.0	<0.1	<0.05	<1	
4		5-Jul-09	6-Sep-09	32.0	<0.2	<0.1	<1	
5								
6		7-Nov-09	3-Jan-10	32.0	<0.2	<0.2	<1	Earlier period stopped 2009-09-06.
7		3-Jan-10	27-Feb-10	32.0	<0.2	<0.2	<1	Start time due to protocol 100102 10:40.
8		27-Feb-10	3-Apr-10	30.0	<0.2	<0.2	<1	
9		1-May-10	4-Jul-10	32.0	<0.2	<0.2	<1	
10		4-Jul-10	31-Jul-10	30.0	<0.2	<0.2	1	Start time 10:00 due to protocol, does not match stop time for earlier sampler.
11		28-Aug-10	29-Oct-10	32.0	<0.2	<0.2	<1	
12		30-Oct-10	1-Jan-11	28.0	<0.2	<0.2	<1	
13		1-Jan-11	6-Mar-11		<0.2	<0.2	<1	Temperature missing
14		6-Mar-11	30-Apr-11	32.0	<0.2	<0.2	<1	
15		30-Apr-11	2-Jul-11	30.0	<0.2	<0.2	<1	
16		2-Jul-11	4-Sep-11	30.0	<0.2	<0.2	<1	
17		4-Sep-11	2-Oct-11	30.0	<0.1	<0.2	2	
18		30-Oct-11	1-Jan-12	31.0	<0.1	<0.2	<1	

ANNEXURE III: WET DEPOSITION DATA FROM WET ONLY AND BULK COLLECTOR (DATA AS RECEIVED)

RESULTS OF WET ONLY MONITORING - BANGLADESH

S No	Start Date	End Date	EC mS/m	pH	Amt of precipation (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	12-May-09	13-May-09	3.6	5.2	1000	18	105	9	37	0	37	26	151	
2	15-May-09	16-May-09	1.3	5.5	1500	22	30	4	6	0	3	5	73	
3	24-May-09	25-May-09	2.9	5.4	1000	14	173	11	4	0	4	6	173	
	May-09	Weighted avg	2.4	5.4	1167	18.6	92.3	7.4	14.3	0.0	13.0	11.3	123.9	
4	02-Jun-09	03-Jun-09	0.6	5.8	1400	9	22	1	2	0	0	6	35	
5	17-Jun-09	18-Jun-09	1.6	5.8	1200	5	30	3	26	7	18	10	64	
6	28-Jun-09	29-Jun-09	1.5	5.7	1000	2	55	5	16	10	7	6	83	
7	29-Jun-09	30-Jun-09	1.3	5.7	1000	12	47	2	7	6	0	6	88	
	Jun-09	Weighted avg	1.2	5.8	1150	7.1	36.7	2.6	12.4	5.3	6.2	7.0	64.5	
8	06-Jul-09	07-Jul-09	0.3	5.8	2000	1	8	0	1	0	0	0	18	
9	09-Jul-09	10-Jul-09	0.3	5.8	2000	2	10	0	1	1	0	0	20	
10	20-Jul-09	21-Jul-09	1.6	5.7	1000	3	72	5	5	8	7	6	99	
11	22-Jul-09	23-Jul-09	0.7	5.8	1200	0	35	1	1	1	2	3	44	
	Jul-09	Weighted avg	0.6	5.8	1550	1.5	24.2	1.0	1.6	1.8	1.5	1.5	36.7	
12	03-Aug-09	04-Aug-09	1.1	5.5	1700	14	8	1	30	3	8	10	56	
13	09-Aug-09	10-Aug-09	0.6	5.8	2200	11	22	1	1	1	6		40	
14	13-Aug-09	14-Aug-09	1.2	5.5	1100	17	36	3	3	3	4	2	72	

15	19-Aug-09	20-Aug-09	0.4	5.8	1300	3	19	1	1	1	2		32	
16	23-Aug-09	24-Aug-09	0.5	5.9	1300	3	23	9	1		3	3	28	
17	26-Aug-09	27-Aug-09	0.4	5.8	2400	0	20	1	1		1	2	28	
18	30-Aug-09	31-Aug-09	0.6	5.9	1200	0	29	1			0	1	40	
	Aug-09	Weighted avg	0.7	5.7	1600	6.7	21.3	2.1	5.5	1.1	3.6	2.6	40.7	
19	04-Sep-09	05-Sep-09	0.7	5.8	1000	2	22	7	5	2	2	0	39	
20	06-Sep-09	07-Sep-09	0.3	5.8	4200	2	14	1	0	0	0	0	22	
21	09-Sep-09	10-Sep-09	0.4	5.8	1100	2	22	1	1	0	0	0	32	
	Sep-09	Weighted avg	0.3	5.8	2100	2.0	16.7	2.0	1.0	0.3	0.3	0.0	26.4	
22	28-Apr-10	29-04-2010	6.6	5.6	600	3	178	29	85	24	55	103	158	
23	05-Apr-10	05-05-2010	3.4	5.8	1300	6	97	10	32	7	32	52	101	
	Apr-10	Weighted avg	1.9	5.8	1275	3.1	57.3	7.0	18.8	4.7	14.8	25.4	62.1	
24	05-May-10	05-Sep-10	2.3	5.8	1350	11	78	10	13	3	4	54	84	
25	21-May-10	24-May-10	0.6	5.9	3700	5	21	1	1	1	2	0	32	
26	27-May-10	29-May-10	4.8	5.7	550	2	176	2	83	12	35	50	187	
	May-10	Weighted avg	1.4	5.9	1867	6.2	50.0	3.3	11.9	2.6	5.7	17.9	59.8	
27	05-Jun-10	08-Jun-10	3.9	5.7	700	6	99	14	53	13	51	31	116	
28	13-Jun-10	14-Jun-10	3.3	5.8	900	7	85	51	22	5	38	78	68	
29	17-Jun-10	19-Jun-10	1.6	5.9	1100	5	61	5	12	5	14	25	50	
30	26-Jun-10	29-Jun-10	1.0	5.9	3600	5	29	6	7	0	15	8	31	
	Jun-10		1.8	5.9	1575	5.4	50.4	13.1	15.1	3.2	22.1	23.5	49.0	
31	01-Jul-10	03-Jul-10	0.4	5.9	2500	0	3	2	1	1	0	0	17	
32	06-Jul-10	08-Jul-10	1.3	5.8	1050	5	37	10	3	7	6	10	56	
33	12-Jul-10	15-Jul-10	1.1	5.9	700	6	27	3	5	7	5	5	50	
	Jul-10	Weighted avg	0.7	5.9	1417	2.2	15.4	4.1	2.2	3.5	2.3	3.3	32.1	

Annexure III: Wet Deposition Data

13	11-Aug-10	13-Aug-10	1.2	5.8	1000	6	43	2	7	2	5	5	77	
34	14-Aug-10	17-Aug-10	1.1	5.8	1100	5	39	8	6	5	5	4	54	
35	12-Aug-10	15-Jul-10	0.6	5.9	3500	4	11	3	4	2	0	0	29	
	Aug-10	Weighted avg	0.8	5.9	1867	4.6	22.2	3.8	4.9	2.6	1.9	1.7	42.5	
36	26-Mar-11	04-Feb-11	7.8	5.5	1170	49	213	45	88	23	84	85	287	
	Mar-11	Average	7.8	5.5	1170	49	213	45	88	23	84	85	287	
37	04-Feb-11	04-Sep-11												It has not been collectable raining
38	04-Sep-11	16-Apr-11												
39	16-Apr-11	23-Apr-11												
40	23-Apr-11	30-Apr-11												
41	30-Apr-11	05-Jul-11	6.7	5.6	700	34	179	32	76	21	78	72	232	
	Apr-11	Weighted avg	6.7	5.6	700	34	179	32	76	21	78	72	232	
42	05-Jul-11	14-May-11	5.3	5.6	1550	29	147	27	54	18	68	62	169	
43	14-May-11	21-May-11	5.1	5.7	900	25	138	25	56	19	67	66	156	
44	21-May-11	28-May-11	3.4	5.9	2000	19	82	10	39	14	50	38	97	
45	28-May-11	06-Apr-11	4.2	5.8	520	22	105	13	44	15	56	44	139	
	May-11	Weighted avg	4.4	5.8	1243	23.5	114.8	18.3	47.3	16.3	59.3	51.2	134.5	
46	06-Apr-11	06-Nov-11												It has not been collectable raining
47	11-Jun-11	18-Jun-11	1.8	6.2	3930	12	32	6	21	5	15	18	61	
48	18-Jun-11	25-Jun-11	1.7	6.0	5110	12	30	5	16	11	14	14	53	
49	25-Jun-11	02-Jul-11	0.8	6.3	5090	6	25	3	11	2	8	11	41	
	Jun-11	Weighted avg	1.4	6.1	4710	9.8	28.8	4.6	15.6	6.1	12.1	14.0	50.9	
50	03-Jul-11	10-Jul-11												It has not been collectable raining
51	10-Jul-11	17-Jul-11	1.3	5.8	4800	3	54	6	10	2	11	9	60	

52	17-Jul-11	24-Jul-11	0.9	5.9	5700	2	30	5	7	1	8	7	40	
53	24-Jul-11	31-Jul-11	0.8	5.9	3600	4	31	4	6	1	7	5	36	
54	31-Jul-11	08-Jul-11	0.6	6.0	4300	3	23	3	6	BDL	7	4	26	
	Jul-11	Weighted avg	0.9	5.9	4600	2.9	34.8	4.6	7.4	1.0	8.4	6.4	41.2	
55	07-Aug-11	14-Aug-11	0.7	6.0	5500	3	25	3	9	BDL	9	3	27	
56	14-Aug-11	21-Aug-11	0.9	5.9	4600	3	32	4	9	1	10	4	32	
57	21-Aug-11	28-Aug-11	0.6	6.0	3400	3	22	1	7	BDL	5	3	28	
58	28-Aug-11	04-Sep-11												It has not been collectable raining
	Aug-11	Weighted avg	0.7	5.9	4500	3.0	26.6	2.8	8.5	0.3	8.3	3.3	29.0	
59	04-Sep-11	11-Sep-11	0.6	6.0	3200	2	21	3	6	1	6	3	25	
60	11-Sep-11	18-Sep-11	0.5	6.0	3300	3	18	2	5	1	7	2	21	
61	18-Sep-11	25-Sep-11	0.5	6.0	3500	2	21	1	7	BDL	5	4	19	
	Sep-11	Weighted avg	0.6	6.0	3625	2.3	20.0	2.0	6.0	0.7	6.0	3.0	21.6	

RESULTS OF WET BULK MONITORING - BANGLADESH

S No	Start Date	End Date	EC mS/m	pH	Amt of precipation (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	12-May-09	13-May-09	4.5	5.3	1000	35	131	9	49		53	47	168	
2	15-May-09	16-May-09	1.6	5.4	1500	24	40	5	7		8	8	78	
3	24-May-09	25-May-09	3.5	5.3	1000	10	186	16	4		6	6	223	
	May-09	Weighted avg	3.0	5.3	1166.7	23.1	107.7	9.3	18.1		20.3	18.6	145.1	
4	02-Jun-09	03-Jun-09	1.0	5.8	1400	9	41	2	4		6	5	55	
5	17-Jun-09	18-Jun-09	1.7	5.7	1200	3	49	4	20	7	18	12	76	

Annexure III: Wet Deposition Data

6	28-Jun-09	29-Jun-09	2.0	5.7	1000	1	79	6	21	11	10	5	118	
7	29-Jun-09	30-Jun-09	1.5	5.7	1000	5	70	2	8	7	0	6	106	
	Jun-09	Weighted avg	1.5	5.7	1150.0	4.8	57.7	3.4	12.7	8.1	9.4	8.7	86.2	
8	06-Jul-09	07-Jul-09	0.3	5.8	2200	2	7	1	1	0	0	0	18	
9	09-Jul-09	09-Jul-09	0.3	5.8	2200	2	11		1	1	0	0	22	
10	20-Jul-09	21-Jul-09	1.8	5.7	1100	4	80	6	5	8	8	9	110	
11	22-Jul-09	23-Jul-09	0.8	5.7	1300	0	44	2	2	1	2	3	55	
	Jul-09	Weighted avg	0.6	5.8	1700.0	1.9	27.2	1.7	1.8	1.8	1.7	2.0	41.3	
12	03-Aug-09	04-Aug-09	0.9	5.9	1500	14	10	3	11	3	4		62	
13	09-Aug-09	10-Aug-09	0.7	5.8	2000	11	20	1	3	1	5	1	45	
14	13-Aug-09	14-Aug-09	1.4	5.4	900	17	41	3	4	4	4	1	84	
15	19-Aug-09	20-Aug-09	0.4	5.8	1200	3	25	1	1	1	2	1	34	
16	23-Aug-09	24-Aug-09	0.6	5.8	1200	5	24	10	1		3	2	39	
17	26-Aug-09	27-Aug-09	0.5	5.8	2800	0	23	3	1		4	1	28	
18	30-Aug-09	31-Aug-09	0.6	5.9	1000	0	32	2	1	1	0	0	47	
	Aug-09	Weighted avg	0.7	5.8	1514.3	6.4	23.3	3.1	3.0	1.2	3.5	0.9	44.5	
19	04-Sep-09	05-Sep-09	0.9	5.7	1100	2	31	10	20	4	16	0	45	
20	06-Sep-09	07-Sep-09	0.3	5.8	4400	3	15	1		0	0	0	26	
21	09-Sep-09	10-Sep-09	0.6	5.8	1200	3	36	1	1	0	0	0	45	
	Sep-09	Weighted avg	0.4	5.8	2233.3	2.8	21.4	2.5	3.5	0.7	2.6	0.0	32.5	
22	28-Apr-10	29-Apr-10	7.9	5.5	600	12	218	51	101	22	78	102	191	
23	05-Apr-10	05-May-10	3.8	5.8	1300	6	121	8	35	7	36	83	118	
	Apr-10	Weighted avg	5.1	5.7	950.0	7.9	151.6	21.6	55.8	11.7	49.3	89.0	141.1	
24	05-May-10	05-Sep-10	2.5	5.8	1350	17	83	8	15	4	13	53	90	
25	21-May-10	24-May-10	0.6	5.9	3700	2	27	2	1	1	0	0	34	

Annexure III: Wet Deposition Data

26	27-May-10	29-May-10	4.8	5.6	550	2	182	4	86	10	36	51	192	
	May-10	Weighted avg	1.5	5.8	1866.7	5.6	55.7	3.6	12.7	2.6	6.7	17.8	63.0	
27	05-Jun-10	08-Jun-10	3.9	5.7	700	7	92	13	59	12	55	38	122	
28	13-Jun-10	14-Jun-10	3.6	5.7	900	8	88	50	32	9	55	37	73	
29	17-Jun-10	19-Jun-10	2.1	5.8	1100	5	61	20	11	6	26	26	56	
30	26-Jun-10	29-Jun-10	1.0	5.9	3600	4	27	5	7	0	9	7	33	
	Jun-10	Weighted avg	1.9	5.8	1575.0	5.1	48.9	14.9	17.0	3.8	23.7	18.0	52.6	
31	01-Jul-10	03-Jul-10	0.3	5.9	2500	0	3	1	1	1	0	0	16	
32	06-Jul-10	08-Jul-10	0.9	5.8	1050	5	26	2	1	3	0	2	50	
33	12-Jul-10	15-Jul-10	1.0	5.8	700	4	26	3	4	6	0	2	56	
	Jul-10	Weighted avg	0.6	5.9	1416.7	1.9	12.5	1.6	1.6	2.4	0.0	0.8	31.0	
34	11-Aug-10	13-Aug-10	1.5	5.9	50	6	47	10	5	1	6	5	77	
35	14-Aug-10	17-Aug-10	1.2	5.9	50	5	39	6	6	2	5	10	63	
36	12-Aug-10	23-Aug-10	0.6	5.9	50	5	13	5	3	1	0	0	35	
	Aug-10	Weighted avg	1.1	5.9	50.0	5.3	33.0	7.0	4.7	1.3	3.7	5.0	58.3	
37	26-Mar-11	04-Feb-11	7.93	5.49		46	213	48	91	26	86	88	301	
	Mar-11		7.9	5.5	50.0	46.0	213.0	48.0	91.0	26.0	86.0	88.0	301.0	
38	30-Apr-11	05-Jul-11	6.78	5.54	700	36	178	34	78	23	82	78	244	
	Apr-11		6.8	5.5	700.0	36.0	178.0	34.0	78.0	23.0	82.0	78.0	244.0	
39	05-Jul-11	14-May-11	5.46	5.56	1550	38	156	25	58	21	78	67	178	
40	14-May-11	21-May-11	5.42	5.65	900	37	154	27	66	25	72	76	175	
41	21-May-11	28-May-11	3.78	5.87	2000	21	88	11	45	12	52	42	101	
42	28-May-11	06-Apr-11	4.45	5.78	520	22	111	15	56	15	58	48	144	
	May-11	Weighted avg	4.7	5.7	1242.5	29.3	123.6	18.7	54.0	17.5	64.4	56.6	142.9	
43	06-Nov-11	18-Jun-11	1.91	6.12	3930	11	44	8	23	6	24	21	66	

44	18-Jun-11	25-Jun-11	1.81	5.98	5110	17	38	7	18	13	28	19	48	
45	25-Jun-11	02-Jul-11	0.98	6.21	4660	8	22	4	22	3	8	15	45	
	Jun-11	Weighted avg	1.6	6.1	4566.7	12.2	34.3	6.3	20.8	7.6	20.0	18.2	52.1	
46	10-Jul-11	17-Jul-11	1.271	5.81	870	4	56	8	11	1	11	8	65	
47	17-Jul-11	24-Jul-11	0.912	5.84	6840	2	32	6	8	1	7	8	42	
48	24-Jul-11	31-Jul-11	0.841	5.89	3100	3	32	5	7	1	8	6	38	
49	31-Jul-11	08-Jul-11	0.651	5.96	5700	2	26	4	5	BDL	6	5	28	
	Jul-11	Weighted avg	0.8	5.9	4127.5	2.3	31.2	5.2	6.9	0.7	7.1	6.6	37.6	
50	07-Aug-11	14-Aug-11	0.782	5.91	3400	3	29	4	10	BDL	8	4	30	
51	14-Aug-11	21-Aug-11	0.912	5.88	2460	4	35	3	11	2	11	5	34	
52	21-Aug-11	28-Aug-11	0.652	5.97	1800	2	26	2	8		6	4	30	
	Aug-11	Weighted avg	0.8	5.9	2553.3	3.1	30.2	3.2	9.9	0.6	8.5	4.3	31.3	
53	04-Sep-11	11-Sep-11	0.662	5.96	2500	3	27	2	7	1	5	4	29	
54	11-Sep-11	18-Sep-11	0.543	5.98	1800	2	20	1	6	1	6	3	22	
55	18-Sep-11	25-Sep-11	0.611	5.91	3160	3	22	2	8	BDL	7	4	23	
	Sep-11	Weighted avg	0.6	5.9	2486.7	2.8	23.2	1.8	7.2	0.6	6.1	3.8	24.8	

RESULTS OF WET BULK MONITORING - BHUTAN

S. No	Date	Time (hrs)	EC (mS/cm)	pH	Rainfall	Remarks
1	22-May-09	9:00 am	0.972	4.924	6.4	
2	27-May-09	9:00 am	0.886	3.724	154.6	
	May-09	Weighted avg	0.9	3.8	81	
3	2-Jun-09	9:00 am	0.977	5.48	40.2	
4	9-Jun-09	9:00 am	0.771	4.632	10.8	

5	16-Jun-09	9:00 am	0.489	5.622	54.4	
6	23-Jun-09	9:00 am	0.638	4.42	46.8	
7	30-Jun-09	9:00 am	0.943	5.71	268.8	
	Jun-09	Weighted avg	0.8	5.5	84	
8	8-Jul-09	9:00 am	0.567	4.82	65.8	
9	17-Jul-09	9:00 am	0.257	4.07	24	
10	25-Jul-09	9:00 am	0.378	5.12	257.2	
11	27-Jul-09	9:00 am	0.427	4.892	163	
12	31-Jul-09	9:00 am	0.368	5.31	85.8	
	Jul-09	Weighted avg	0.4	5.0	119	
13	6-Aug-09	9:00 am	0.726	4.321	27.2	
14	12-Aug-09	9:00 am	0.486	4.891	90.8	
15	16-Aug-09	9:00 am	0.328	4.321	113	
16	19-Aug-09	9:00 am	0.24	5.255	189	
17	30-Aug-09	9:00 am	0.236	4.892	76.2	
	Aug-09	Weighted avg	0.3	4.9	99	
18	6-Sep-09	9:00 am	0.278	4.532	11.8	
19	11-Sep-09	9:00 am	0.328	5.421	35.4	
20	14-Sep-09	9:00 am	0.312	5.301	30.8	
21	17-Sep-09	9:00 am	0.306	4.71	77.4	
22	19-Sep-09	9:00 am	0.289	5.43	256.6	
23	24-Sep-09	9:00 am	0.309	5.001	29.4	
	Sep-09	Weighted avg	0.3	5.2	86	
24	7-Oct-09	9:00 am	0.42	4.89	57.6	
25	11-Oct-09	9:00 am	0.416	4.901	16.2	

Annexure III: Wet Deposition Data

26	24-Oct-09	9:00 am	0.38	4.602		Wash
	Sep-09	Weighted avg	0.4	4.9	37	
27	5-Nov-09	9:00 am	0.28	4.871	wash	
28	30-Nov-09	9:00 am	0.265	5.339	wash	
29	3-Sep-10	9:00 am	43.8	5.742	93	
30	11-Sep-10	9:00 am	39.8	4.722	119.6	
31	21-Sep-10	9:00 am	29.8	3.984	34.8	
32	28-Sep-10	9:00 am	28.9	3.743	19.4	
	Sep-10	Weighted avg	39.1	4.9	67	
33	8-Oct-10	9:00 am	29.7	4.721	11.8	
34	15-Oct-10	9:00 am	41.6	6.7		
35	21-Oct-10	9:00 am	37.9	5.165	4.4	
36	28-Oct-10	9:00 am	35.8	5.002		
	Oct-10	Weighted avg	31.9	4.8	8	
37	4-Nov-10	9:00 am	38.8	5.123		
38	11-Nov-10	9:00 am	40.8	6.248		
39	19-Nov-10	9:00 am	42.1	6.321	16	
40	27-Nov-10	9:00 am	34.6	5.308		
	Nov-10	Weighted avg	42.1	6.3	16	
41	4-Dec-10	9:00 am	32.4	4.21		
42	12-Dec-10	9:00 am	29.1	3.84		
43	21-Dec-10	9:00 am	28.4	5.41		
44	31-Dec-10	9:00 am	41.5	4.51		
	Dec-10	Average	32.9	4.5		

Annexure III: Wet Deposition Data

45	2-Jan-11	9:00 am	43.8	5.724	1.8	
46	19-Jan-11	9:00 am	31.8	3.541	3.4	
47	28-Jan-11	9:00 am	~~29.8~~	~~4.81~~		
	Jan-11	Weighted avg	36.0	3.5	3	
48	10-Feb-11	9:00 am	33.4	4.119	7.2	
49	17-Feb-11	9:00 am	29.8	3.894	9.2	
	Feb-11	Weighted avg	31.4	4.0	8	
50	9-Mar-11	9:00 am	27	5.421	5.8	
51	19-Mar-11	9:00 am	31.4	6.551	27.4	
52	27-Mar-11	9:00 am	40.2	5.421	18.4	
53	10-Mar-11	9:00 am	37.8	4.229	12.4	
	Mar-11	Weighted avg	34.8	5.7	16	
54	1-Apr-11	9:00 am	29.8	3.894	51.6	
55	13-Apr-11	9:00 am	33.4	4.692	6.6	
56	20-Apr-11	9:00 am	35.4	5.116	56.4	
57	24-Apr-11	9:00 am	29.8	4.589	42	
	Apr-11	Weighted avg	32.0	4.6	39	
58	1-May-11	9:00 am	32.8	4.892	7.6	
59	8-May-11	9:00 am	30.1	4.722	13	
60	12-May-11	9:00 am	31.1	4.81	24.2	
61	20-May-11	9:00 am	30.7	4.744	4	
62	24-May-11	9:00 am	41.6	4.41	46.2	
63	30-May-11	9:00 am	32.8	4.2	7.2	
	May-11	Weighted avg	35.9	4.6	17	
64	4-Jun-11	9:00 am	36.8	5.001	44.8	

65	7-Jun-11	9:00 am	33.8	4.371	100.8	
66	12-Jun-11	9:00 am	34.8	4.72	44	
67	19-Jun-11	9:00 am	40.8	5.212	21.8	
68	24-Jun-11	9:00 am	39.2	4.11	50	
69	30-Jun-11	9:00 am	34.8	4.07	88.6	
	Jun-11	Weighted avg	35.8	4.4	58	
70	4-Jul-11	9:00 am	29.8	4.003	85.6	
71	8-Jul-11	9:00 am	27.4	3.399	56.2	
72	13-Jul-11	9:00 am	29.8	3.491	21.2	
73	16-Jul-11	9:00 am	32	4.262	92.2	
74	22-Jul-11	9:00 am	34.8	4.321	108.6	
75	26-Jul-11	9:00 am	42.3	4	100.8	
	Jul-11	Weighted avg	33.8	4.0	77	
76	1-Aug-11	9:00 am	34	5.601	35.2	
77	4-Aug-11	9:00 am	32.5	5.31	71.6	
78	10-Aug-11	9:00 am	29.7	6.02	30.8	
79	15-Aug-11	9:00 am	34.8	5.431	129.8	
80	24-Aug-11	9:00 am	27.9	6.271	37	
	Aug-11	Weighted avg	32.8	5.6	61	
81	2-Sep-11	9:00 am	30.8	5.011	43.6	
82	17-Sep-11	9:00 am	34.5	4.562	105.8	
83	24-Sep-11	9:00 am	29.9	4.334	37	
	Sep-11	Weighted avg	26.8	3.8	57	

Stikethrough values are ignored during calculation.

RESULTS OF WET BULK MONITORING - NEPAL

S No.	Start Date	End Date	EC mS/cm	pH	Physical Amount mg/l	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	22-Feb-09	19-Apr-09	30	6.36	1000	1.68	2.05	1.84	0.4	0.486	2.15	1.29	2.99	
2	19-Apr-09	1-May-09	21.4	6.59	935	0.84	0.8	2.24	0.8	0.486	0.88	0.51	3.99	
3	1-May-09	26-May-09	24.2	6.25	4980	1.12	1	1.23	1.2	0.486	1.16	0.67	4	
4	26-May-09	26-Jun-09	26.4	6.46	4560	0.84	1.05	1.49	0.8	0.972	1.16	0.62	4.99	
5	26-Jun-09	9-Sep-10	4.7	6.45	4930	0.56	1.29	1.49	1.6	0.8	2.74	0.91	3.33	
6	23-Aug-09	18-Sep-09	3.3	6.9	1000	1.12	1.64	1.62	0.4	0.73	11.22	5.6	4	
7	18-Sep-09	19-Oct-09	3	6.95	1000	0.56	1.59	1.55	0.8	0.97	6.18	0.75	3	
8	19-Oct-09	27-Nov-09	12	6.85	1000	0.84	1.52	1.74	1.2	0.49	3.88	1.12	2	
9	27-Nov-09	12-Dec-09	3.6	6.75	1000	0.56	1.45	1.42	1.6	0.73	2.91	0.55	4	
10	12-Dec-09	25-Jan-10	26.5	6.85	1000	0.56	1.63	1.65	1.2	0.49	11.48	0.4	1.5	
11	25-Jan-10	25-Feb-10	42.1	7.04	1000	1.68	1.7	1.78	2.8	0.73	13.31	0.19	4	
12	25-Feb-10	25-Mar-10	27.2	6.5	1000	1.12	1.62	1.76	3.6	1.46	4.99	3	1.5	
13	25-Mar-10	25-Apr-10	47.2	6.75	1035	1.4	1.67	1.7	6	0.73	10.02	5.45	2	
14	30-Apr-10	25-May-10	2.93	6.72	4980	0.84	1.72	1.75	2	1.21	10.51	0.4	2.5	
15	25-May-10	20-Jun-10	3.5	6.95	5000	1.12	1.68	1.68	4	1.7	12.17	0.34	3	
16	20-Jun-10	10-Jul-10	1.85	6.65	4970	0.84	*	*	0.8	0.73	11.77	0.67	2	
17	10-Jul-10	25-Jul-10	2.87	6.7	5000	1.4	*	*	1.2	1.21	9.98	0.54	2.5	
18	25-Jul-10	20-Aug-10	2	6.85	5000	1.12	*	*	0.8	0.97	9.57	0.37	1	
19	20-Aug-10	25-Sep-10	2.15	6.8	4790	1.12	*	*	1.6	0.97	9.75	4.29	3	
20	25-Sep-10	27-Oct-10	3	6.63	1000	1.4	*	*	0.8	0.73	9.18	1.12	4	
21	5-Apr-11	29-Apr-11	3	6.52	3450	1.04	*	*	1.92	1.21	5.74	1.29	3	

22	29-Apr-11	20-May-11	3.15	6.82	1965	1.68	*	*	3.6	1.46	7.18	1.58	4	
23	20-May-11	17-Jun-11	2.2	6.7	5160	0.84	*	*	2	0.97	10	1	2.5	
24	17-Jun-11	19-Jul-11	2.24	5.425	5000	0.63	0.94	1.1	1.1	1	1.975	0.69	1.995	
25	19-Jul-11	21-Aug-11	2.26	6.05	4995	1.26	1.85	1.21	1.96	1.335	6.125	0.59	3.25	
26	21-Aug-11	22-Sep-11	2.825	6.275	5117.5	1.54	2.8	1.63	2.9	0.855	5.965	0.845	3	
27	22-Sep-11	17-Oct-11	2.83	6.55	5015	1.26	1.875	1.73	1.6	0.97	7.74	0.635	3.165	
28	17-Oct-11	19-Nov-11	2.485	6.59	2175	1.36	1.45	2.215	2.225	1.235	5	0.44	3.8	
29	19-Nov-11	15-Dec-11	3.83	6.725	1000	0.84	1.325	1.975	1.9	1.245	2.88	0.99	2.5	

RESULTS OF WET ONLY MONITORING - SRILANKA

S No		Date	EC mS/m	pH	Amt of Sample (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1		23-Jan-10												Contaminated with bird drops
2		28-Mar-10												Contaminated with mob
3		11-Apr-10												Contaminated with mob
4		18-Apr-10	5.3	6.42	1850	11.86	2.97	0.23	1.87	1.03	5.33	4.00	36.67	
5		24-Apr-10	3.2	6.6	1600	9.53	25.80	2.86	1.30	3.95	1.69	4.21	52.19	
	Apr-09	Weighted avg	4.3	6.5	1725	10.8	13.6	1.5	1.6	2.4	3.6	4.1	43.9	
6		2-May-10	0.5	5.29	3750	8.26	2.03	2.35	0.30	0.99	3.27	1.74	2.26	
7		8-May-10												Contaminated with mob
8		15-May-10	5.9	5.86	3450	23.34	16.04	1.41	8.28	3.00	2.09	0.94	17.63	
9		22-May-10	0.9	6.56	1280	13.36	17.86	4.94	7.93	4.07	3.29	1.66	35.26	

Annexure III: Wet Deposition Data

	May-09	Weighted avg	2.8	5.7	2826.7	15.2	10.1	2.4	4.7	2.3	2.8	1.4	13.5	
10		11-Jul-10	4.1	5.81	1350	12.80	6.57	0.15	0.67	1.40	6.65	5.24	40.90	
11		28-Jul-10												Contaminated with mob
12		19-Sep-10												Contaminated with mob
13		25-Sep-10	4.8	5.91	2250	20.07	14.09	3.58	6.66	0.74	1.17	7.03	19.75	
14														
15		2-Oct-10	0.4	6.52	4500	8.98	2.39	3.79	2.30	2.22	4.85	0.29	2.12	
16		9-Oct-10	0.9	6.51	500	17.74	12.91	4.02	2.30	1.73	0.27	0.34	1.27	
	Oct-09	Weighted avg	0.5	6.5	2500	9.9	3.4	3.8	2.3	2.2	4.4	0.3	2.0	
17		5-Nov-10												Contaminated with mob
18		28-Nov-10	1	7.47	5000	28.88	0.52	0.43	13.65	1.56	4.38	1.98	40.62	
19		6-Dec-10	1.2	5.92	1050	34.98	12.11	0.90	13.20	7.94	7.61	1.35	28.21	
20		12-Dec-10	0.1	6.25	2550	18.96	3.22	0.92	14.17	3.50	6.49	4.26	56.42	
21		19-Dec-10	2.5	6.95	1450	26.72	8.74	1.13	10.65	5.14	6.05	0.53	28.21	
22		25-Dec-10	0.5	6.45	3450	28.88	2.74	0.41	10.75	2.76	4.54	1.64	28.21	
	Dec-09	Weighted avg	0.8	6.4	2125	26.3	5.1	0.7	12.1	4.0	5.8	2.2	36.7	
	2009	Annual avg	2.24	6.32	2430.71	18.88	9.14	1.94	6.72	2.86	4.12	2.52	27.84	
23		1-Jan-11	0.9	7.2	1400	29.88	36.00	5.60	22.23	5.88	18.28	18.56	32.50	
24		9-Jan-11	0.8	5.7	2600	17.90	24.00	1.43	13.90	4.69	9.61	15.24	32.02	
25		16-Jan-11	0.6	6.91	4000	30.43	2.03	1.33	0.30	0.99	7.43	2.06	8.12	
26		22-Jan-11												Contaminated with mob

27		29-Jan-11	1.3	6.89	950	23.34	16.04	1.41	8.28	3.00	8.34	18.67	40.20	
	Jan-11	Weighted avg	0.8	6.6	2237.5	26.0	15.2	2.0	8.5	3.0	9.9	10.2	22.3	
28		6-Feb-11	1.8	6.49	5400	13.36	22.48	4.94	15.42	4.07	3.29	1.66	35.26	
29		13-Feb-11												Contaminated with mob
30		6-Mar-11	1.3	6.8	340	23.89	6.57	1.43	13.15	1.40	7.17	7.34	52.75	
31		22-May-11	1	6.8	230	30.54	0.52	0.43	15.39	1.56	4.69	2.47	37.80	
32		20-Aug-11	1.7	5.18	200	21.18	24.96	0.92	21.41	3.50	9.61	8.93	46.66	
	2011	Annual avg	1.18	6.50	1890.00	23.82	16.57	2.19	13.76	3.14	8.55	9.37	35.66	

RESULTS OF WET BULK MONITORING - SRILANKA

S No		Date	EC mS/m	pH	Amt of Sample (ml)	NH4+ µmol/L	Na^+ µmol/L	K^+ µmol/L	Ca^+ µmol/L	Mg^+ µmol/L	SO^-_4 µmol/L	NO_3^- µmol/L	Cl^- µmol/L	Remarks
1	Mar	29-Mar-09	0.8	5.61	148	24.45	9.30	8.13	11.93	4.52	2.28	5.22	33.15	
2	Apr	12-Apr-09												Contaminated with bird drop
3		18-Apr-09												Contaminated with bird drop
4	May	2-May-09	0.6	7.21	260	33.98	0.30	0.38	22.01	0.70	2.09	2.11	4.23	
5		24-May-09												Contaminated exact source not known bad smell
6	Aug	15-Aug-09												Contaminated exact source not known dark

Annexure III: Wet Deposition Data

													7bownishcolour
7		23-Aug-09	0.7	5.56	2700	22.84	5.52	2.15	5.04	1.52	1.48	6.64	39.92	
8	Oct	24-Oct-09	1	5.96	1950	10.25	9.22	9.46	10.15	7.98	2.51	3.18	40.20	
9		31-Oct-09	2	4.85	450	9.31	9.13	7.08	9.31	7.86	4.64	5.06	72.64	
	Oct-09	Weighted avg	1.2	5.8	1700	10.1	9.2	9.0	10.0	8.0	2.9	3.5	46.3	
10	Nov	7-Nov-09	0.8	5.86	5580	4.77	8.87	6.96	8.26	5.31	1.94	1.66	30.89	
11		15-Nov-09	0.9	5.66	1800	17.41	4.61	2.58	4.62	5.64	2.10	1.95	32.86	
12		21-Nov-09	0.8	6.85	1850	13.64	4.74	7.57	4.57	5.27	2.08	1.90	31.48	
13		28-Nov-09	0.9	5.71	700	10.86	5.57	3.45	2.67	5.27	1.78	2.73	44.71	
	Nov-09	Weighted avg	0.8	6.0	2482.5	9.1	7.1	6.0	6.5	5.4	2.0	1.8	32.3	
14	Dec	6-Dec-09	0.3	6.12	1250	12.08	1.91	0.03	0.25	0.45	2.99	0.29	2.40	
15		26-Dec-09	0.8	6.2	4800	11.64	5.78	3.58	2.57	3.95	1.75	2.60	39.92	
	Dec-09	Weighted avg	0.7	6.2	3025	11.7	5.0	2.8	2.1	3.2	2.0	2.1	32.2	
16	Jan	2-Jan-10	0.6	5.88	1275	12.20	9.17	8.47	4.94	8.68	5.33	4.58	33.85	
17		11-Jan-10												comtaminated with bird drops
18		23-Jan-10	2.6	4.96	230	10.25	6.65	2.71	10.28	6.95	2.73	3.39	55.99	
	Jan-10	Weighted avg	0.9	5.7	752.5	11.9	8.8	7.6	5.8	8.4	4.9	4.4	37.2	
19	Mar	28-Mar-10												comtaminated with mob

Annexure III: Wet Deposition Data

20	Apr	11-Apr-10											comtaminated light brownish colour
21		18-Apr-10	0.9	5.75	2150	8.20	6.14	4.02	4.44	4.85	2.98	2.00	46.54	
22		24-Apr-10	1.3	5.95	1150	17.52	5.28	5.42	3.44	1.85	4.43	2.77	26.80	
	Apr-10	Weighted avg	1.0	5.8	1650.0	11.4	5.8	4.5	4.1	3.8	3.5	2.3	39.7	
23	May	2-May-10	2.9	5.91	3400	7.32	18.33	7.62	6.71	3.37	1.69	0.23	3.53	
24		8-May-10											Contaminated exact source not known unknown particals in
25		15-May-10											comtaminated with mob
26		22-May-10	1	5.98	3400	11.36	4.57	3.94	3.02	7.77	1.36	2.03	49.39	
	May-10	Weighted avg	2.0	5.9	3400	9.3	11.4	5.8	4.9	5.6	1.5	1.1	26.5	
27	Sep	19-Sep-10	0.9	5.75	1650	8.20	6.13	4.02	4.44	4.85	2.98	2.00	46.54	
28		25-Sep-10	0.8	6.37	850	15.52	10.57	4.14	7.91	1.81	5.17	5.08	20.45	
	Sep-10	Weighted avg	0.9	6.0	1250.0	10.7	7.6	4.1	5.6	3.8	3.7	3.0	37.7	
29	Oct	2-Oct-10											comtaminated with mob
30		9-Oct-10	5.1	6	1300	24.89	9.26	4.53	9.41	3.04	0.19	0.34	7.76	
31	Nov	5-Nov-10											comtaminated with bird drops
32	Aug	20-Aug-11											comtaminated with mob

Annexure III: Wet Deposition Data

33	Oct	9-Oct-11												comtaminated with mob
34		16-Oct-11	1.3	6.02	1550	4.21	0.83	0.90	11.30	1.07	1.83	3.18	3.81	
35		23-Oct-11												
36		30-Oct-11	1.5	5.05	1600	9.15	28.43	0.59	10.68	0.53	10.01	12.34	26.60	
		Weighted avg	1.4	5.5	1575	6.7	14.8	0.7	11.0	0.8	6.0	7.8	15.4	
37	Nov	6-Nov-11	1	5.75	840	4.77	23.39	0.46	2.79	0.21	5.09	2.48	7.48	
38		13-Nov-11												comtaminated with bird drops
39		20-Nov-11												comtaminated with unknown particles light browniscolour
40		27-Nov-11												comtaminated with bird drops
41	Dec	3-Dec-11	0.8	5.9	1200	4.71	42.39	0.87	12.20	2.22	10.27	15.71	24.99	
42		11-Dec-11												comtaminated with unknown particles
43		17-Dec-11	0.5	5.98	850	9.09	40.17	0.56	0.35	2.55	5.40	10.39	22.06	
44		25-Dec-11	0.7	6.58	750	3.60	42.26	4.45	11.05	3.09	10.54	14.11	32.52	
		Weighted avg	0.7	6.1	933.3	5.7	41.7	1.7	8.3	2.6	8.9	13.7	26.1	