

First Edit

Comprehensive Environmental Monitoring Report

For Selected Pilot Areas in Pakistan

-From the Results of TCP-EMS Trainings-

by Trainees of TCP-EMS from

Pak-EPA, Punjab-EPA, Sindh-EPA, KP-EPA and Balochistan-EPA

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CHAPTER 1 OVERVIEW OF THE REPORT

1.1 Outlook of Pakistan

Nature has blessed Pakistan with adequate surface and groundwater resources. However, rapid population growth, urbanization, motorization and the continued industrial development has placed immense stress on Environment of the country.

Pakistan's current population of 141 million is expected to grow to about 221 million by the year 2025. This increase in population will have direct impact on the water sector for meeting the domestic, industrial and agricultural needs while rapid motorization and industrial development has have immense impact on Air.

The per capita water availability has dropped from 5,000 m³ in 1951 to 1,100 m³ currently, which is just above the internationally recognized scarcity rate. It is projected that water availability will be less than 700 cubic meters per capita by 2025 (Pak-SCEA 2006). The situation might get worse in areas situated outside the Indus basin where the average per capita water availability per annum is already below 1000 m³ (PAK-EPA, 2005b).

In the same time, air pollution is an emerging environmental issue in major cities of Pakistan. In the year,2004 – 2005, Pakistan achieved the growth rate over 8% especially in the service sector.

This results rapid growth of infrastructure in cities together with growth in road transport. For the last few years, the density of transport has increased many folds on the roads of Pakistan.

The present cities roads infrastructure cannot cater the need of growing automobiles flow. The result is the worsening condition of ambient air quality in Pakistan cities.

Pakistan is on the verge of becoming a water deficit country. Cleary, water resources are vital to Pakistan's economic well-being while the Air quality directly linked to health condition of people of Pakistan, and their improved management is vital to poverty reduction.

1.2 Objective of the JICA Project

Given this situation, the establishment of an environmental monitoring system is urgently required to conduct appropriate environmental administration. With the aim of establishing the basis of a permanent nationwide environmental monitoring system in Pakistan, under the "Establishment of Environmental Monitoring System" grand aid program of 2006, the Japanese government has built a central environmental analysis laboratory (Islamabad), and completed the implementation of air and water quality monitoring systems and the analysis equipment in April 2007.

Regarding this technological cooperation project, the first and second preliminary studies were completed in February 2006 and September 2007, respectively. After reaching an agreement on the basic framework of the project, an R/D was signed in November 2008.

Based on the vision that Pakistan will adopt appropriate environmental administration using facilities and

CHAPTER 2 WATER IN PAKISTAN AND THE PILOT AREAS

2.1 Water Use

In Pakistan, water is mainly used for industrial, agricultural and domestic purposes. The following shows its percentage consumption for every use.

Table 2.1.1 Water Consumption

Purpose	Percentage (%)
Agriculture	69
Industry	23
Domestic uses	8

2.2 Agriculture

Pakistan has the largest contiguous irrigation system in the world. Irrigated land provides about 80 % of agricultural output, contributes 25 % of GDP, employs over 50 % of the rural labor force, and provides 60 – 70 % of exports.

The water shortage in the agriculture sector is another serious issue. As per SOE 2005, the shortage has been estimated at 29% for the year 2010 and 33% for 2025. In addition, uncontrolled harvesting of groundwater for irrigation purposes has also led to severe environmental problems.

Irrigation water does not satisfy the quality standard which leads to contamination of vegetables cultivated in certain regions further increasing the risk of human health.(SOE 2005)

It is estimated that 40 million residents depend on irrigation water for their domestic use, especially in areas where the groundwater is brackish. The associated health risks are grave, as bacteriological contamination of irrigation water often exceeds FAO limits even for irrigation.

2.3 Industry

Industrial wastewater contains toxic chemicals. It is alarming that most industries have been started without proper planning and waste treatment plants. They just dispose of untreated toxic waste into nearby drains, canals or rivers. Lahore, Faisalabad, Karachi, Sialkot contribute major pollution loads into their water bodies.

According to an EPD source, 9000 million gallons of wastewater having 20,000 tons of BOD5 loading are daily discharged into water bodies from the industrial sector. [Proceedings of International Symposium by CEWR in 1993, Paper by M.A. Saleemi].

2.4 Drinking Water

Only 80 percent of the urban and 45 percent of the rural population is estimated to have access to clean water in Pakistan, and migration to the city is putting pressure on inadequate urban water and sanitation facility. Pollution has led to the spread of water-related infections: more than 40 percent of the hospital beds in Pakistan are occupied by patients with water-related diseases.

The vast majority of the rural population has either piped water or water from a hand pump or motor pump. It is stated that only 7 % of the rural population depends on a dug well or a river, canal or stream.

Over 60% of the population gets their drinking water from hand or motor pumps, in rural areas being over 70%. In almost all urban centres, groundwater quantity and quality has deteriorated to the extent that the availability of good quality raw water has become a serious issue. Over abstraction has also resulted in declining groundwater levels (Pak-SCEA 2006).

2.5 Water Pollution

In Pakistan, water remains a critical resource for sustained well being of its citizens. The water shortages and increasing competition for multiple uses of water has adversely affected the quality of water, consequently, water pollution has become a serious problem in Pakistan.

Results from various investigations and surveys indicate that water pollution has increased in Pakistan. The pollution levels are higher particularly in and around the big cities of the country where cluster of industries have been established. The results of various investigations and surveys by several agencies had indicated that water pollution has become a serious problem in Pakistan. In this regard, improvement of the environmental water quality is one of the most important countermeasures to solve water deficit in Pakistan.

The poor quality of water has major socioeconomic consequences for Pakistan. The high pollution level of rivers and groundwater has led to different environmental consequences such as reduction of biodiversity, increase in water related diseases, and decrease in agricultural productivity. In addition, mismanagement of water resources has strong socioeconomic repercussions, especially on food security and health (SOE 2005).

It is estimated that only some 8% of urban wastewater is treated in municipal treatment plants. The treated wastewater generally flows into open drains, and there are no provisions for reuse of the treated wastewater for agriculture or other municipal uses. Water bodies can no longer cope with the increasing pollution load.

Another important aspect is that there is very little separation of municipal wastewater from industrial effluent in Pakistan. Both flow directly into open drains, which then flow into nearby natural water bodies.

2.6 1.4 Law

There is no regular monitoring programme to assess the water quality of the surface and groundwater bodies. There is no surface water quality standard or drinking water quality standard in Pakistan. A comparison of the quality of surface water with the effluent discharge standard clearly demonstrates the extent of pollution in the water bodies due to the discharge of industrial and municipal effluent.

The level of compliance to environmental laws in the country is extremely low, particularly in the industrial and housing sectors, as law enforcement is weak. Strong law enforcement and compliance are necessary for the protection of freshwater resources. Organizations working in the environmental sector

in Pakistan appreciate the recent decision of the Supreme Court demanding that Environmental Tribunals must be functional in all provinces.

2.7 Importance of Water Quality Control

President of Pakistan General Pervez Musharraf has said that up to 60% diseases in Pakistan are water borne and there would be a tremendous amount of saving in monetary terms if safe drinking water is made available to the people. “This would help control almost 60% of diseases in the country,” he said, adding that it would also help ease the load on hospitals, basic health centers and rural health.

It is said that the cost of cleaning a river already polluted with industrial waste or sewage is far higher than the cost of the infrastructure to prevent the pollutants properly. Improvement of the pollution situation, therefore, must get top priority to solve shortage of water resources, food security and health.

The followings are very important which may help to control or diminish the problems of deteriorating water quality in Pakistan.

- 1) There should be continuous monitoring of drinking and environment water throughout the country both in rural and urban locations.
- 2) Industrial wastewater disposal should be strictly monitored and all industries should be forced to adapt wastewater treatment measures.
- 3) Active and operating sewage collecting and treatment plants in large cities for municipal wastewater treatment must be installed.
- 4) Local authorities should be provided with facilities for monitoring and purification of drinking water.

As listed above, regular monitoring needs to be conducted in various parts of the country to obtain clear picture of countermeasures. The monitoring results would lead to remedial measures for improving the quality and sustainable use of the water resources. In this context , the role and responsibility of each EPA through water quality monitoring are very important.

Since it corresponds to such a situation, Japan International Agency (JICA) has started bilateral cooperation with the Government of Pakistan in the field of environmental protection. The objective is to strengthen the capacity of the environmental administration of EPA through technical cooperation of Japan in areas where it is feasible.

2.8 Project Pilot Area for Environmental Water Quality Monitoring

The pilot areas selected by each EPAs are shown in following table.

Table 2.8.1 Areas of Pilot Project by EPA

EPA	Pilot Area	Water use
PAK	Rawal lake	Drinking, Irrigation
Punjab	Upper Chenab canal	Irrigation
Sindh	Keenjhar lake	Drinking, Irrigation, Industry
KPK	Warsak canal	Irrigation
Baluchistan	Down stream of Hub river	-

General description of pilot areas is explained as follows.

2.8.1 Pak-EPA: Rawal lake

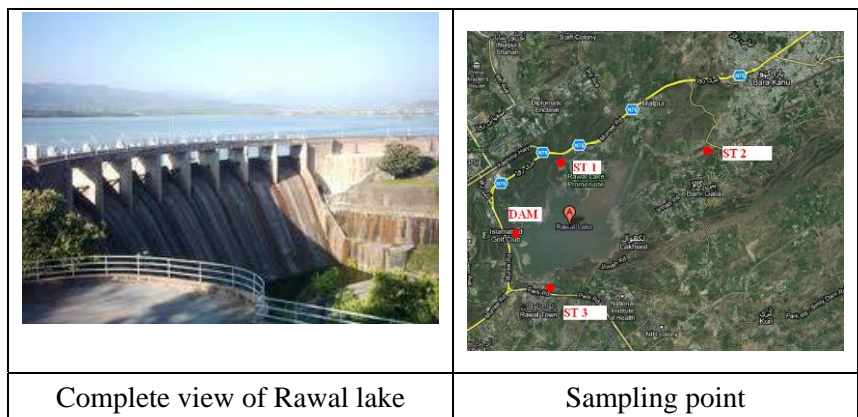


Figure 2.8.1 Pilot Area of Pak-EPA

Rawal dam is constructed on Kurrang river and has a catchments area of 106 sq miles, which generates 84,000 acre feet of water in an average rainfall year. There are four major streams and 43 small streams contributing to its storage.

Rawal Lake is an important artificial fresh water reservoir in the country that provides clean drinking water to 1.1 million inhabitants of Rawalpindi city and 0.25 million serving army troops in GHQ Rawalpindi.

However, regardless of being an important area the water of the lake for the last few decades is subjected to pollution by a number of sources. This includes Human settlements, Poultry wastes (There are approximately 170 poultry farms having about 360 poultry sheds lie with in the catchment area), Recreational activities, Agricultural activities (including pesticides), Deforestation (The catchment area is subjected to deforestation due to grazing of livestock and cutting of wood for fuel by villagers), Erosion and sedimentation and Eutrophication.

2.8.2 Punjab-EPA: Upper Chenab canal

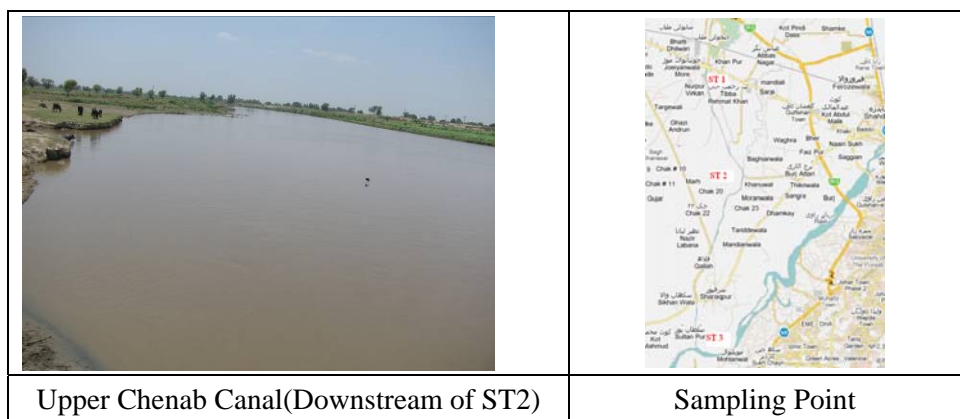
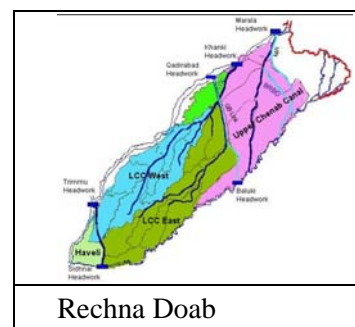


Figure 2.8.2 Pilot Area of Pak-EPA

Upper Chenab Canal (UCC) off takes from Marala Barrage across River Chenab which was constructed in 1968 . The UCC runs almost diagonal in Rechna Doab, the land between Ravi and Chenab Rivers, before conveying some of its water to the Ravi River. The area of Rechna Doab covers 2.98 million hectares. Out of the area, about 2.3 million hectares is cultivated and classified as the irrigated croplands. About 21.1 million people inhabit the Rechna Doab, with a population density of nearly 599 persons per square kilometer(Govt. of Punjab, 2000) The UCC runs almost diagonal in this area before conveying some of its water to the Ravi River as shown in the map.

The UCC has been operating in the Upper Rechna Doab area since 1915. The UCC was constructed under the Triple Canal Project during 1905-15 (Upper Jhelum and Lower Bari Doab canals were the other two) by the then British-ruled Indian Government in this part of the subcontinent (Ahmed, 1988). The design discharge of the UCC is 467 cumecs and covers a canal command area of 0.59 million hectares Irrigation and Power Department, Government of Punjab, reported results of water quality monitoring of the UCC in the annual report in 2007 as follows.



- Amongst the irrigation parameters (pH, EC, SAR and RSC), the data show that the water is fit for irrigation purpose.
- An increasing trend has been noticed in the concentration of trace metals (Zn and Cu) from head to tail.

2.8.3 Sindh-EPA: Keenjhar lake

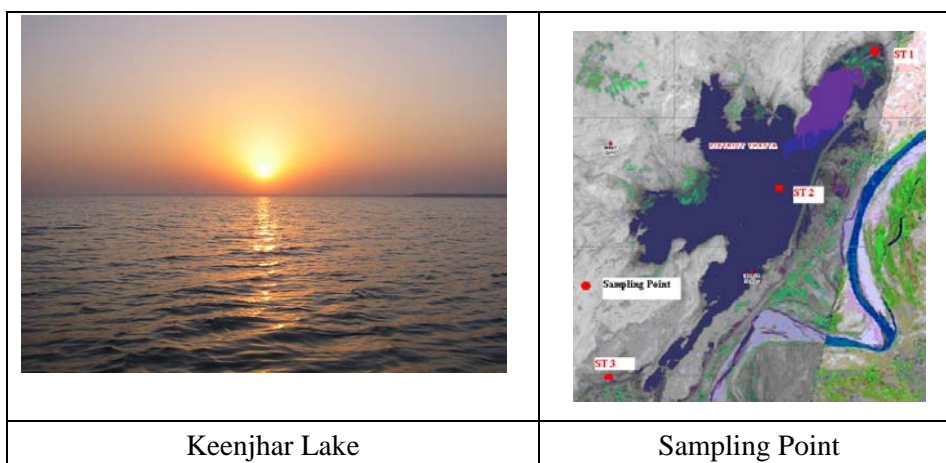


Figure 2.8.3 Pilot Area of Pak-EPA

The Keenjhar Lake is known as the largest freshwater lake of the country. Keenjhar lake is the major source of supply of drinking water for 200 million peoples of Karachi metropolitan city and 50000 thousand peoples of Thatta are dependent on this fresh water lake and a total of 800 fishing crafts are operating in the area. The lake was declared wildlife sanctuary in 1977

under the Sindh wild life protection ordinance, 1972. It has also designated as Ramsar site in 1976. Keenjhar lake supports a rich biological diversity being situated along Indus flyway zone. Also it is important for breeding & wintering area for water fowl and migratory birds.

The lake, however, has steadily declined in both productivity and its freshwater resources chiefly on account of chemical pollution, over fishing and eutrophication. (stated by Dr. Laiq Ahmed Memon, Secretary Livestock & Fisheries Department, Sindh). Also, the number has reduced considerably in the recent years (from 205,000 in 1987/1988 to 13,760 in 2006).

Main causes that “the chemical wastes from industries and raw sewage from city along the river. The lake, therefore, is facing serious environmental degradation.

2.8.4 KP-EPA: Warsak canal

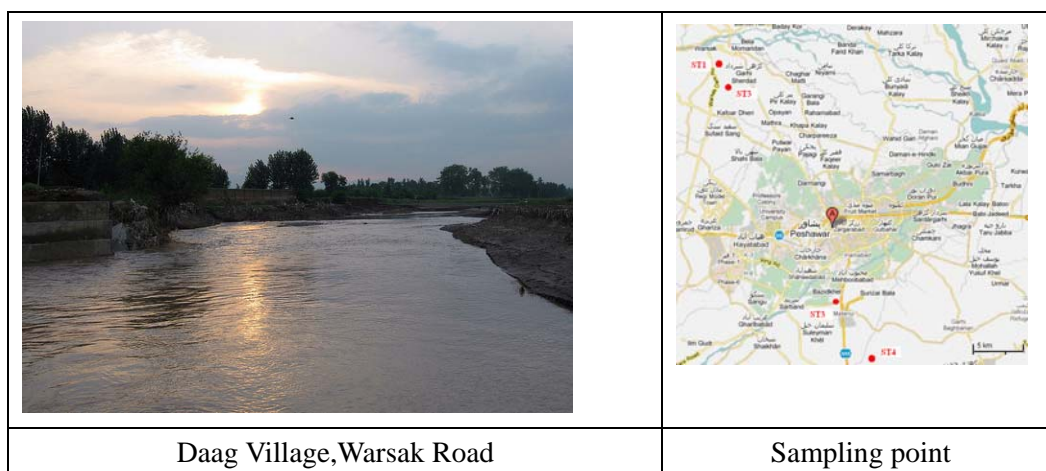


Figure 2.8.4 Pilot Area of Pak-EPA

The Warsak Dam is located on Kabul Biver 19 miles North-West of Peshawar. Built during the 1960s, Warsak Dam was one of the biggest reservoirs in the country. Two main canals, Warsak Lift and Walsak Gravel, take-off upstream of Warsak dam. This multi purpose dam supplies water for irrigating Peshawar valley, generates electricity, and provided drinking water not only to residents of surrounding villages, but also to the provincial capital.

For over two decades, the villagers living on the banks of the Kabul River have been complaining about pollution. The complaints are the result of the increasingly obvious signs of pollution, including periodic fish kills. Some people have complained of reduced crop yields in fields irrigated with water polluted with industrial effluents.

The biggest problem is water pollution because the Kabul River and its tributaries transport untreated sewage from the cities, towns and villages of Afghanistan.

2.8.5 Balochistan-EPA: Down stream of Hub river



Figure 2.8.5 Pilot Area of Pak-EPA

Hub River is located in Lasbela, Balochistan, Pakistan. It forms the provincial boundary between Sindh and Balochistan, west of Karachi. Hub Dam is a large water storage reservoir constructed in 1981 on the Hub River in the arid plains north of Karachi. The reservoir supplies water for irrigation in the Lasbella district of Balochistan and drinking water for the city of Karachi. However, the fresh water discharge from the Hub River has been disrupted as a result of construction of the Hub dam. The river estuary thus remains mostly dry and it affects fish resource.

It is an important staging and wintering area for an appreciable number of water birds and contains a variety of fish species which increase in abundance during periods of high water.

Hub River finally drain into the Arabian Sea in the Makran coast. Pollution is a growing problem in the country and heavy use of agro chemicals has been a major cause for decline in the populations of useful fauna and flora. Marine pollution, particularly from oil spills has occasionally contaminated many estuaries and the sea.

2.9 Industrial Effluent Water

Selected factories for effluent water monitoring are listed in following table.

Table 2.9.1 List of facility for the effluent monitoring

EPA	Name of facility	Type of facility
PAK	Treatment plant-A	Domestic Sewerage Treatment Plant
	Industrial effluent -A	Various Industrial Waste Water
Punjab	Industry-A	Pharmacy
	Industry-B	Textile
	Industry-C	Paper
Sindh	Industry-D	Chemical
	Industry-E	Fertilizer
	Industry-F	Chemical
	Treatment plant-A	Domestic Sewerage Treatment Plant

CHAPTER 3 AIR IN PAKISTAN AND THE PILOT AREA

3.1 Over view of Air quality

As previously mentioned, air pollution is an emerging environmental issue in major cities of Pakistan. In the year, 2004 – 2005, Pakistan achieved the growth rate over 8% especially in the service sector. This results rapid growth of infrastructure in cities together with growth in road transport. For the last few years, due to the liberal leasing system adopted by the financial institutions, the density of transport has increased many folds on the roads of Pakistan. The present cities roads infrastructure cannot cater the need of growing automobiles flow.

The result is the worsening condition of ambient air quality in Pakistan cities. Pakistan Environmental Protection Agency (Pak-EPA) has conducted number of studies to investigate the ambient air quality in the major cities of Pakistan. Some of these studies were technically and financially supported by the Japan International Cooperation Agency (JICA). All these studies revealed that the number one problem relevant to the ambient air quality is the Particulate Matter (PM). PM (both TSP and PM10) concentration in all major cities are extremely high. According to the Pak-EPA/JICA three cities investigation report¹, very high concentration of TSP and PM10 has been recorded at Lahore, Rawalpindi and Islamabad. The concentration of SPM in these cities are 4.4 to 7.5 times higher than WHO Guidelines.

3.2 Law

The Pakistan Environmental Protection Act (PEPA) was enacted on 6th December 1997, repealing the Pakistan Environmental Protection Ordinance, 1983. The PEPA' 1997 provides the framework for implementation of NCS, establishment of Provincial Sustainable development Funds, Protection and conservation of species, conservation of renewable resources, establishment of Pak-EPA, and provincial EPAs, Environmental Tribunals and appointment of Environmental Magistrates, Initial Environmental Examination (IEE), and Environmental Impact Assessment (EIA).

Subject to the provisions of this Act and the rules and regulations made there under no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards or, where applicable, the standards established.

The Pakistan Clean Air Programme (PCAP) will require partnerships between multiple tiers and sectors of government, with

- (i) Pakistan EPA responsible for setting air quality and emissions standards,
- (ii) implementation of these standards delegated to provincial environmental authorities,
- (iii) integration of air quality management with urban planning by municipal authorities, and
- (iv) policies for clean air in the industry, energy, fuel and transportation sectors.

It is essential for pursuing PCAP to incorporate new initiatives in the following sectors: Vehicles / Public

Service Transport, Industry, Agriculture, Infrastructure/ Housing and Physical Planning.

In April 1996, the PEPC set up an Environmental Standards Committee (ESC) to review NEQS and suggested necessary changes based on conditions in Pakistan. On December 28, 1999 PEPC approved the revised NEQS and the proposed modalities for general NEQS compliance and implementation.

The industry has agreed upon to NEQS enforcement package based on self-respect and self-honoured implementation of this package will provide while compliance of all stakeholders, from governmental body to private sector is essential for effective implementation of NEQS.

3.3 Project Pilot Areas for Air Monitoring

The pilot areas selected by each EPAs are shown in following table.

According to the training plan (activity 1-3) for the Environmental Monitoring Plan, each EPA selected pilot areas for ambient air and stationary sources of air pollution as shown in the following table. The factory emission source and its neighboring residential areas were selected. However, Sindh-EPA targeted a suburb of Karachi as the emission source. KP-EPA chose three cities of the province, but the measurement points have not been identified. Balochistan-EPA has not submitted about the stationary sources.

Table 3.3.1 Areas of Pilot Project by EPA

Monitoring plan	Pak-EPA	Punjab-EPA	Sindh-EPA	KP-EPA	Balochistan-EPA
Ambient air	· H-8 Residential area in Islamabad	1) Raiwind industrial area 2) 2 monitoring stations in Lahore	· Main streets (6 locations) in Karachi	· KP-EPA building	· Balochistan-EPA building
Emission gas	· I-9, I-10 Industrial area	· Kohe-noor power plant	· Cement factory, (10 locations)		

Note: Punjab-EPA, Ambient air 2) is for SPM monitoring plan.

General description of pilot areas is explained as follows.

3.3.1 Pak-EPA

(1) Ambient Air Quality

Islamabad is located at the edge of the Potohar Plateau at the foot of the Margalla Hills. The Rawalpindi / Islamabad Metropolitan Area is the third largest in Pakistan with a population of over 4.5 million inhabitants. Islamabad Industrial Estate is situated on the southern side of the city, and stand side by side of Rawalpindi city. Heavy traffic load has been observed in major avenues in Blue Area and high ways. Commercial and industrial facilities are spread over the Rawalpindi city to provide goods and supplies to the capital city through major highway, and the downwind also blows towards with polluted air in summer season.

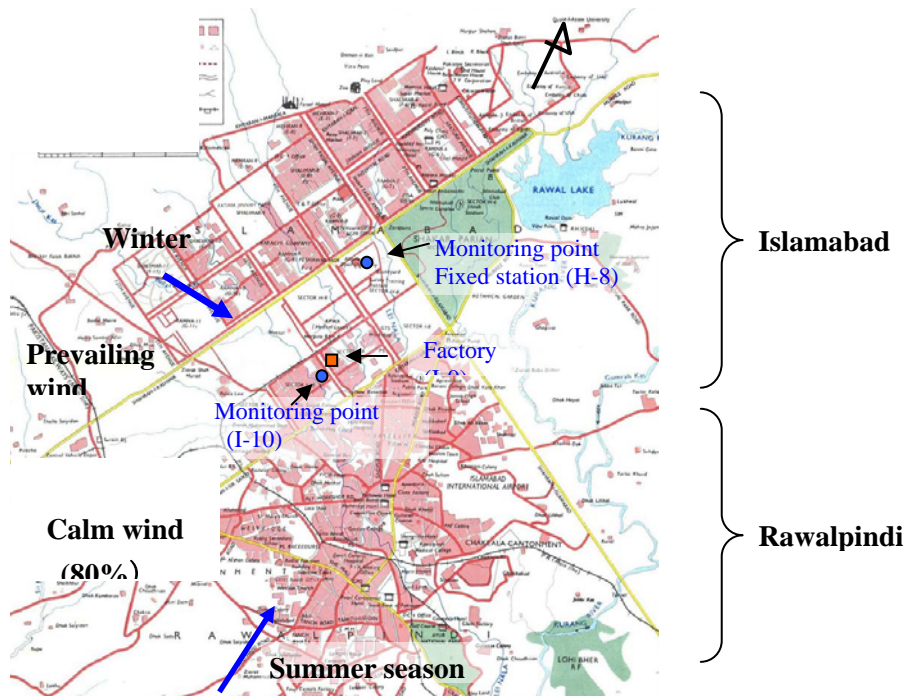


Figure 3.3.1 Pilot Area in National Capital Region

The above figure shows the meteorological characteristics of the pilot area. Industrial area, I-9 & I-10 are planned to be studied. Two ambient air monitoring sites have been selected in northern and southern side of these iron factories. Residential area (R), Schools (S), Universities (U) and many private offices, automobile workshops, commercial shops existing in surrounding area. H-9 sector is rich in farmlands and green tract and has many governmental offices.

Because the prevailing (dominant) wind direction is from south in summer season, the selected ambient air monitoring sites are suitable to detect air flow from entire Rawalpindi city and industrial sources to other areas of the city.

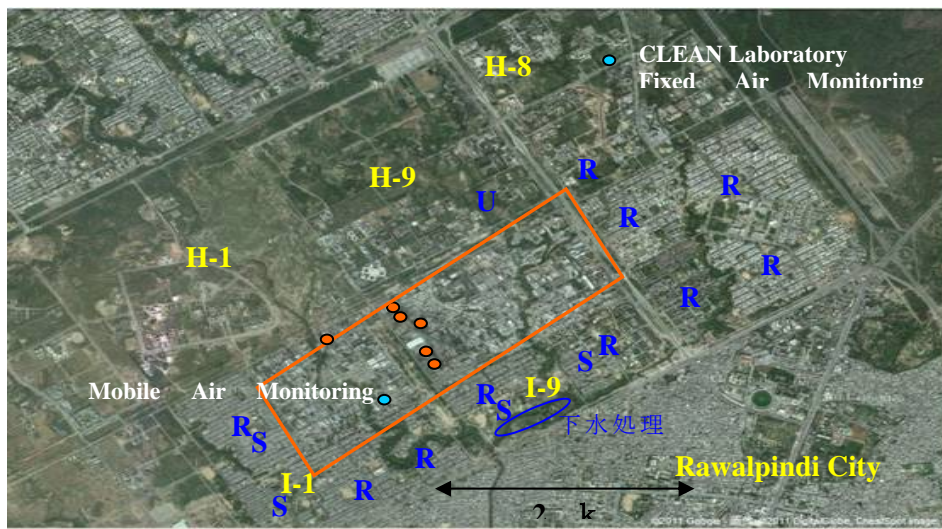


Figure 3.3.2 Target Area

(2) Stationary Source Monitoring

The following table describes the sampling sites for “Stationary Source Monitoring” as in above figure.

Table 3.3.2 Sampling Sites for Stack Monitoring

Factory Name / Type of Industry	Location
Mat Cast	I-9 sector
Potohar Steel / Scrap Iron refinery	I-9 sector
KSR Iron Factory	I-10 sector
Ittehad Steel	I-9 sector

Following industries are in operation in the Industrial area:

- i. Steel mill
- ii. Flour mill
- iii. Edible oil Industries
- iv. Marble Industries
- v. Auto industries
- vi. Chemicals industries

3.3.2 Pilot Area of Punjab-EPA

(1) Ambient Air Quality

Most of industrial facilities are located on suburban area of Lahore city, but small scale industrial areas are scattering throughout the major city as shown in the following figure. Past studies suggest that vehicles would be the major air pollution source in Lahore city.

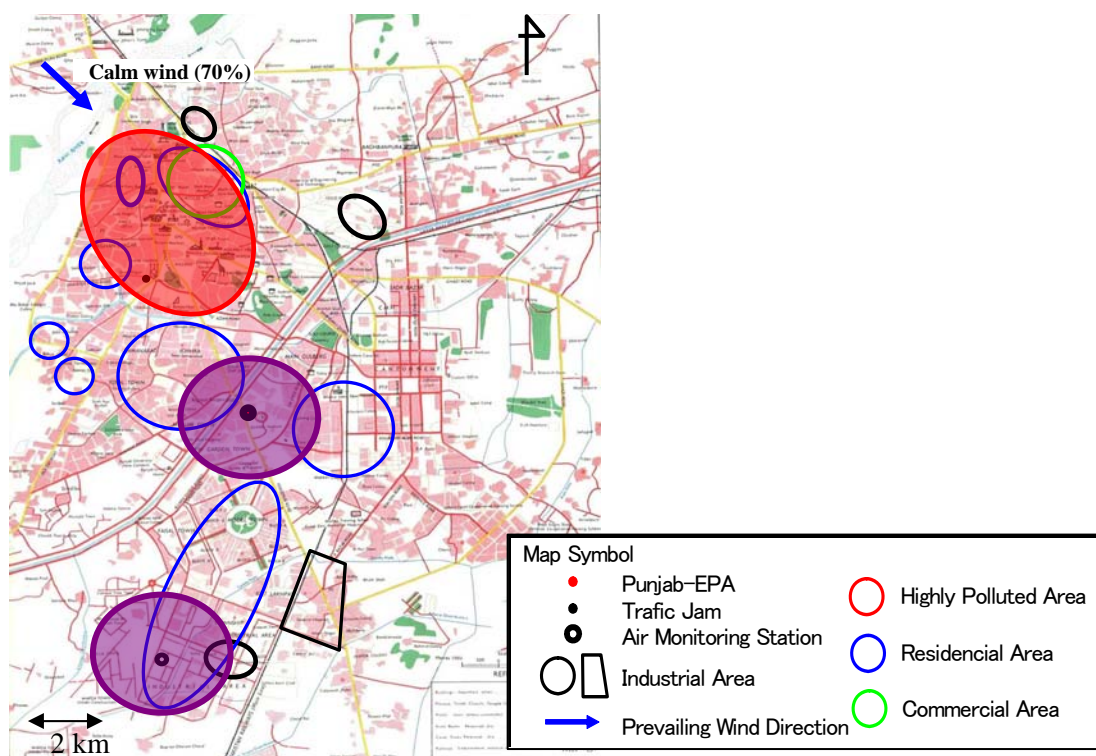


Figure 3.3.3 Pilot Area for Air Monitoring in Lahore City

1) Northern area, 2) southern area of the major portion of city, and 3) middle point of both areas are selected as the sampling sites for “Ambient Air Monitoring”. In the old town which lies towards the north west of center city, poor air quality is expected to measure due to high traffic density and chronic traffic congestion heavier than other city area, while lower concentration is expected in southern side area where the traffics volume is light and rich in green in the vicinity.

The following figures show the photos of the sampling site of Town Hall and Township.



Figure 3.3.4 Monitoring Site (Town Hall: left and Township; right)

Town Hall is a typical commercial area of Lahore. Mall road, Kachehry road and some small to medium cottage industries are around the point. In Town Hall area most of the land is being used for Government offices, Commercial shops, educational institutes etc.

On the other hand, Township area is a typical residential area. An industrial area of kot lakhpat exists about 2 kilometers of ariel distance. Small to medium industrial units all situated in this area having small boilers or furnaces.

As shown in the following figure, fix monitoring station is sit in Gulburg area where residential dominates while the area is being converted to commercial activities with the passage of time. Possible source of air pollution at this site is traffic load. No stationary source has been identified near this station so far.

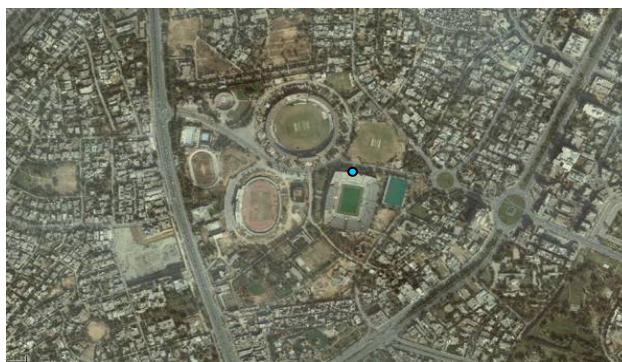


Figure 3.3.5 Monitoring Site (Punjab-EPA)

(2) Stationary Source Monitoring

Raiwind Town lies on the outskirts of Lahore city around 40 km south west away from the center of city. Further, the Sunder industrial area is situated around 3 km northwest away from Raiwind town where a number of industrial activities have been established, but the prominent source of air pollution is Kohinoor energy limited, 125 megawatt HFO fired thermal power plant. There are 2 more thermal power plants operating in southwest of Lahore namely SEPTCOL and Japan power plant with 125 and 120 megawatt HFO fired thermal power plants.

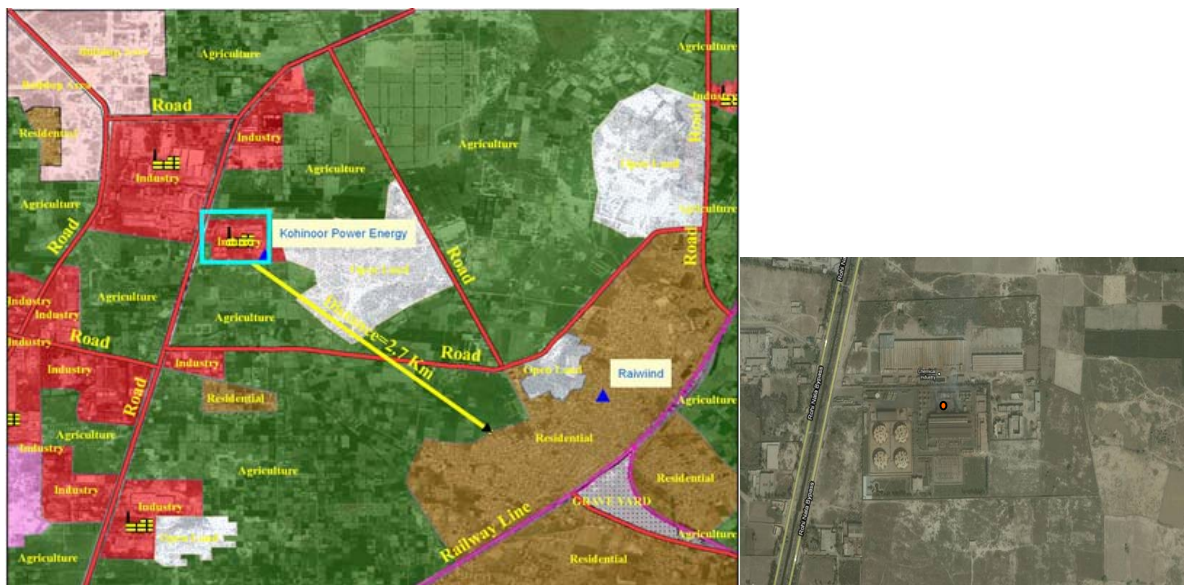


Figure 3.3.6 Sampling Site for Stationary Source (Kohinoor Power Plant)

The orange colored mark on Figure 6 shows the position of stationary source monitoring internal combustion reciprocating engines in Kohinoor power plant.

3.3.3 Pilot Area of Sindh-EPA

(1) Ambient Air Quality

Karachi is the main industrial hub of Pakistan where various types of industries. Many industries emit black smoke with soot which can be seen from a quite distance. Air pollution control measures seem to be either unavailable or inadequate. Situation is pragmatic from the public complaints lodged time to time against individual industrial units. Beside the stationary sources main threat to ambient air quality is from heavy traffic load on roads of the city. Ambient Air quality in Karachi city is being continuously monitored by 3 Automatic Air Monitoring Stations.

We studied the measured data from air monitoring stations to verify the characteristics of air pollution in Karachi city.

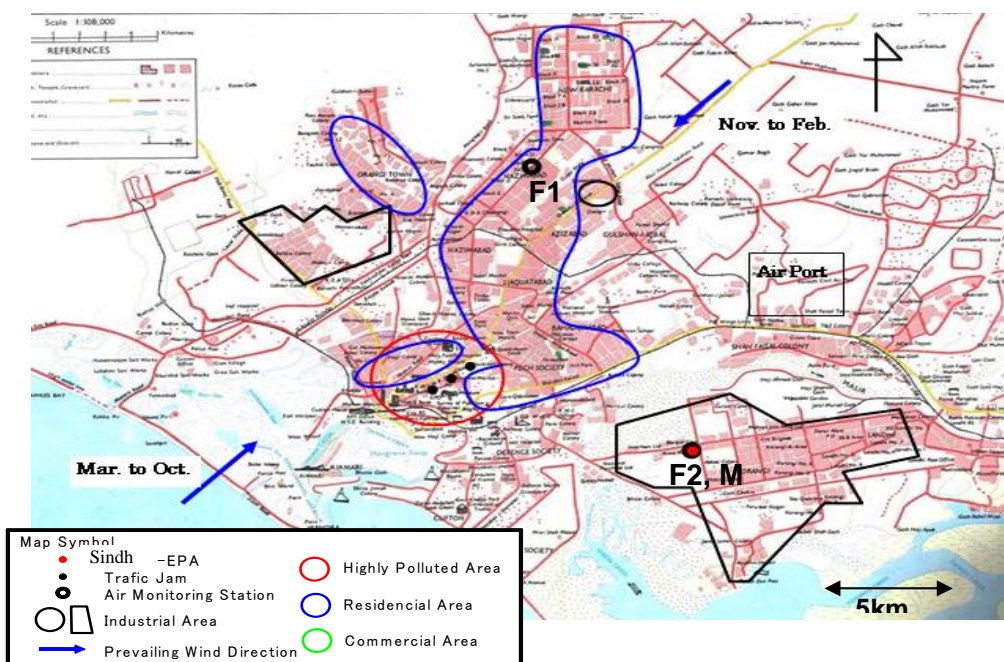


Figure 3.3.7 Pilot Area for Air Monitoring in Karachi City

SND-F1 (AQMS) is located at the roof top of DC office in North Nazimabad Town. This area represents the residential area with commercial activities. The main pollution source for air in the area is heavy traffic due to many schools and fugitive-dust (solid airborne particulate matter emitted from any source other than a stack or chimney).

SND-F2 is installed at the roof top of the Sindh-EPA building which situated at the Sector 23 in Korangi Industrial State. A large oil refinery which occupies a town bloc more than 1 km² area is across the one of heavy traffic load, Korangi road, 500m north away from EPA building.

According to the surrounding view from the EPA building, no facilities looks continuously blowing flue gas in surrounding area but some generator emissions can be observed during the electricity breakdown. Some influence is expected from these sources to the air monitoring in AQMS, CNG gas station is also just next to the Sindh-EPA complex building.

(2) Stationary Source Monitoring

A plan for monitoring of cement factories located in province of Sindh was approved on 30th April 2010. Total 10 cement industries were targeted in the plan and Six of them were conducted while two of the results, one is from Dewan Cement and Lucky Cement were analyzed in current condition. Dewan Cement and Lucky cement Pvt .Ltd. both factories have dust controlling system. Whereas the Dewan Cement has two production units named as 1 (Old) & Unit 2 (New). The results of unit-2 were within NEQS while in Unit-1 Dust emissions were higher than the Prescribed limits.

3.3.4 Pilot Area of KP-EPA

A fixed air monitoring station is placed on roof top of Provincial EPA building which is located around 2 km west away from congestion intersection. It is right position to detect the influence of traffic volume as this building faces to Grand Trunk Road.

Vehicles to go towards Islamabad or Noshera city frequently get stuck in a big traffic jam near an intersection where major roads Mortar Way, Grand Trunk Road and Sadar Road crosses. Indus Highway is situated around 10 km south away from EPA building, is another big source of vehicular air pollution.

Usually traffic has jammed at the east or north side of the intersections, but after going through the intersection westbound traffic is much smooth to go. Thus, air monitoring station tends to detect higher concentration when east wind blows.

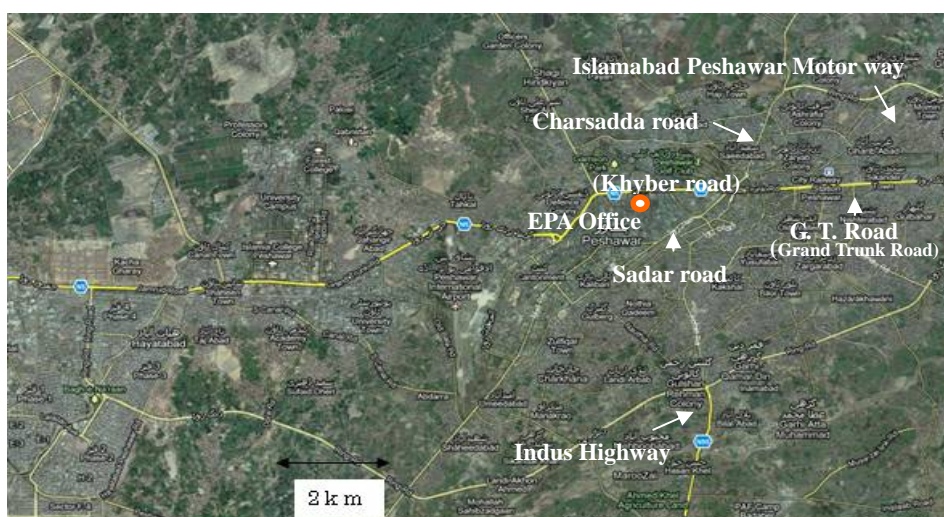


Figure 3.3.8 Pilot Area for Air Monitoring in Peshawar: Major Road

3.3.5 Pilot Area of Balochistan-EPA

Quetta is the largest city and the provincial capital of the Balochistan Province. The city is situated at an average elevation of 1,654 meters above sea level, making it Pakistan's only high-altitude major city with a population of around 0.9 million inhabitants. Lies in a basin and series of valleys surrounded on all sides by a number of hills, stagnate air has been polluted by vehicular gas especially concentrated in old town where the severe health damage are reported. Particulate matter is the one of urgent environment problem in Quetta city as it has been observed in high concentration at road side even in past air monitoring program.

An automated air monitoring station has been operated in the old city. We planned to verify the characteristics of air pollution in Quetta city by analyzing the measured data from air monitoring stations.

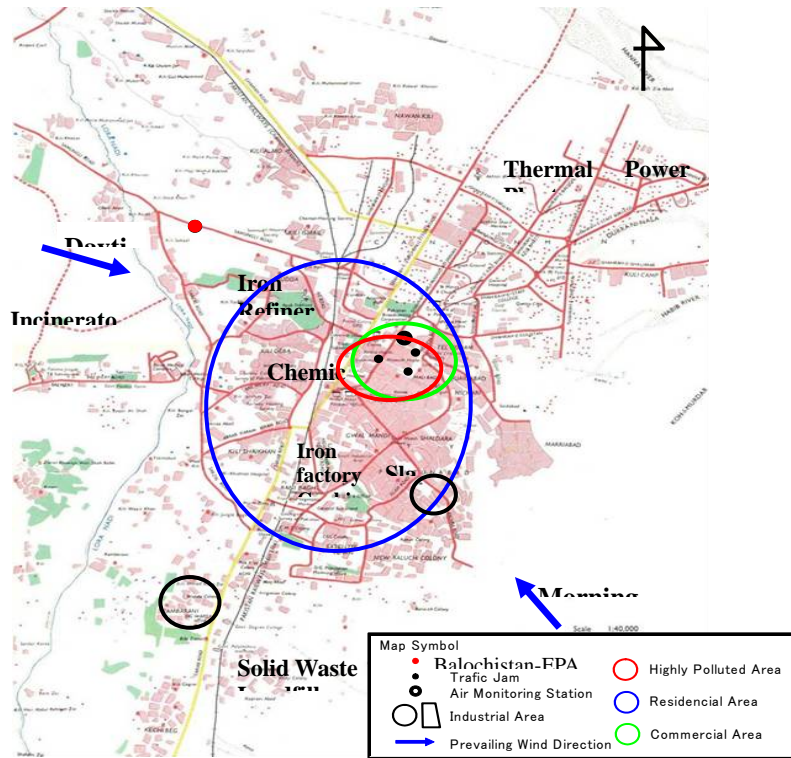


Figure 3.3.9 Pilot Area for Air Monitoring in Quetta

CHAPTER 4 RESULTS OF THE MONITORING

4.1 Water Quality Monitoring

The monitoring results by type of the pilot area, lake and canal, are discussed as follows. Japanese Environmental Water Quality Standard apply to the project for the evaluation because Pakistan have not Environmental Water Quality Standard.

4.1.1 Ambient Water Monitoring

The results of the conducted monitoring are described as follows.

(1) Rawal Lake (PAK-EPA)

ST1 and ST2 are inlet of the Rawal Lake and the later is main water supplier for the lake. ST3 is outlet. The results show that ST2, Korskng River, is main pollution supplier to the lake because COD and TSS at ST3 is much higher than ST1. The water is unsuitable for both drinking and irrigation water uses in almost all seasons because the all parameters are over the standard..

There is the monitoring report of Rawal Lake prepared by Japanese Expert in 2005. The report showed that the annual average of COD value of the lake was 8.7 mg/l. And the monitoring by Pak-EPA in 2010 and 2011 reported that the average was 23.7 mg/l. The both data suggest, though the both data may not compare as a same level, the water quality of the lake is deteriorating rapidly.

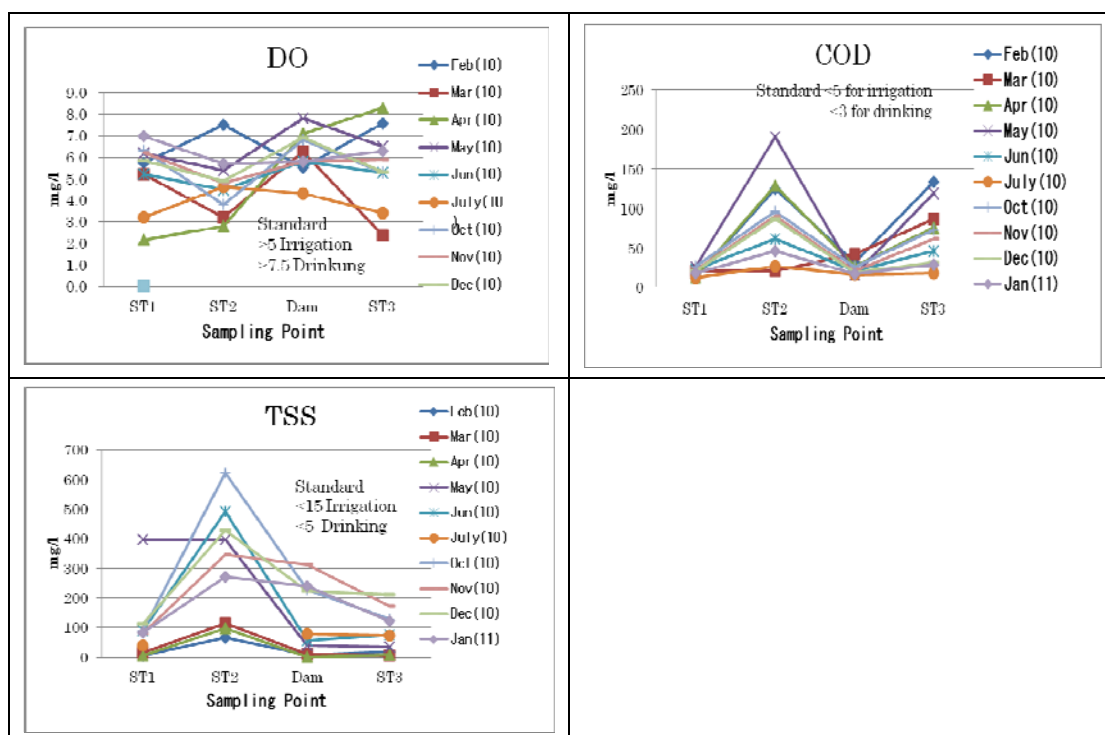


Figure 4.1.1 Monitoring Results of Rawal Lake

(2) Upper Chenab Canal (Punjab)

The data shows that the most of parameters at the ST1, located upstream of the canal, is within the limits of the standard for agriculture purpose. However, the parameters much deteriorate at the ST2,

where all parameters are not suitable for the purpose. The main pollution sources are effluent of Flying paper mill and sewage from city flowing into the canal. These two sources are located between the ST1 and ST2. The industry stopped the operation in begging of 2011. However, the data do not show clear change before and after the shutdown. It means that the pollution from the sewage much contributes to the pollution. Alleviation of the pollution load from sewage is urged to use water for original purpose.

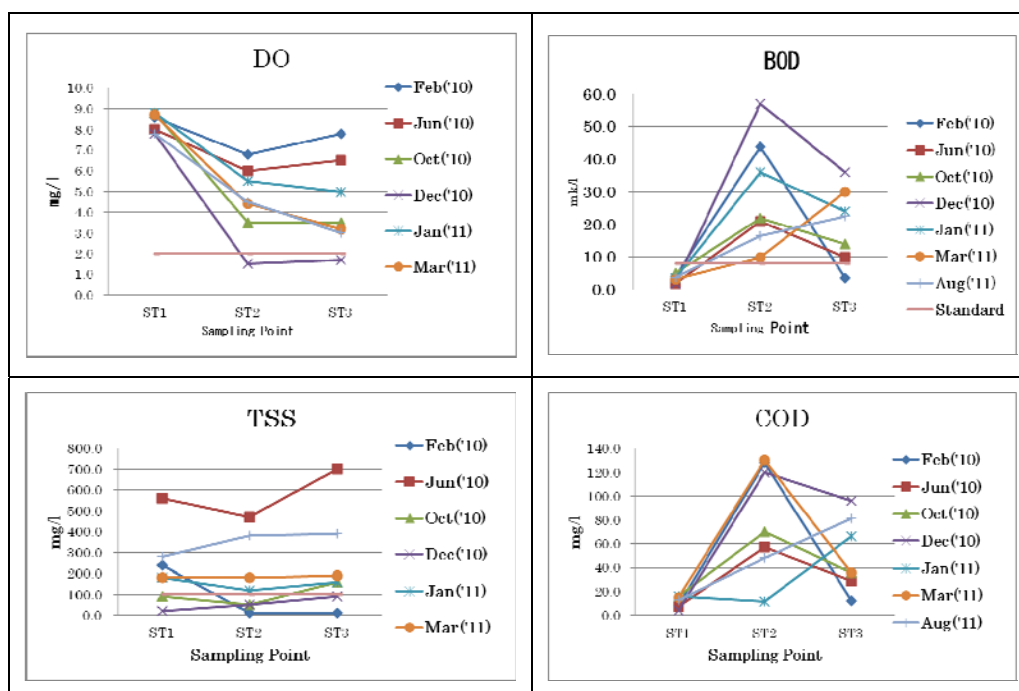


Figure 4.1.2 Upper Chenab Canal (Punjab)

(3) Keenjhar Lake (Sindh-EPA)

The ST1 is located at inlet canal, the Kalri Baghar canal, source from Indus River, the ST2 is at center of the lake and ST3 is outlet to Karachi drinking water canal. The lake is source of drinking water supply for 20 million people in Karachi metropolitan city. The canal is managed by the Karachi Water and Sewerage Board.

Results show that COD is far higher than the standard and hazardous parameters such as heavy metals are also much higher than the standard. The water also is unsuitable for drinking purpose. And there is risk to damage human health when people continue to drink it. Main pollution sources of the lake are untreated industrial effluent from Katori industrial area located in upstream of the inlet canal and municipal sewerage directly discharged into the inlet canal.

However, more accurate monitoring and chemical analysis should implement to confirm the data because of the limited information and the rough analysis.

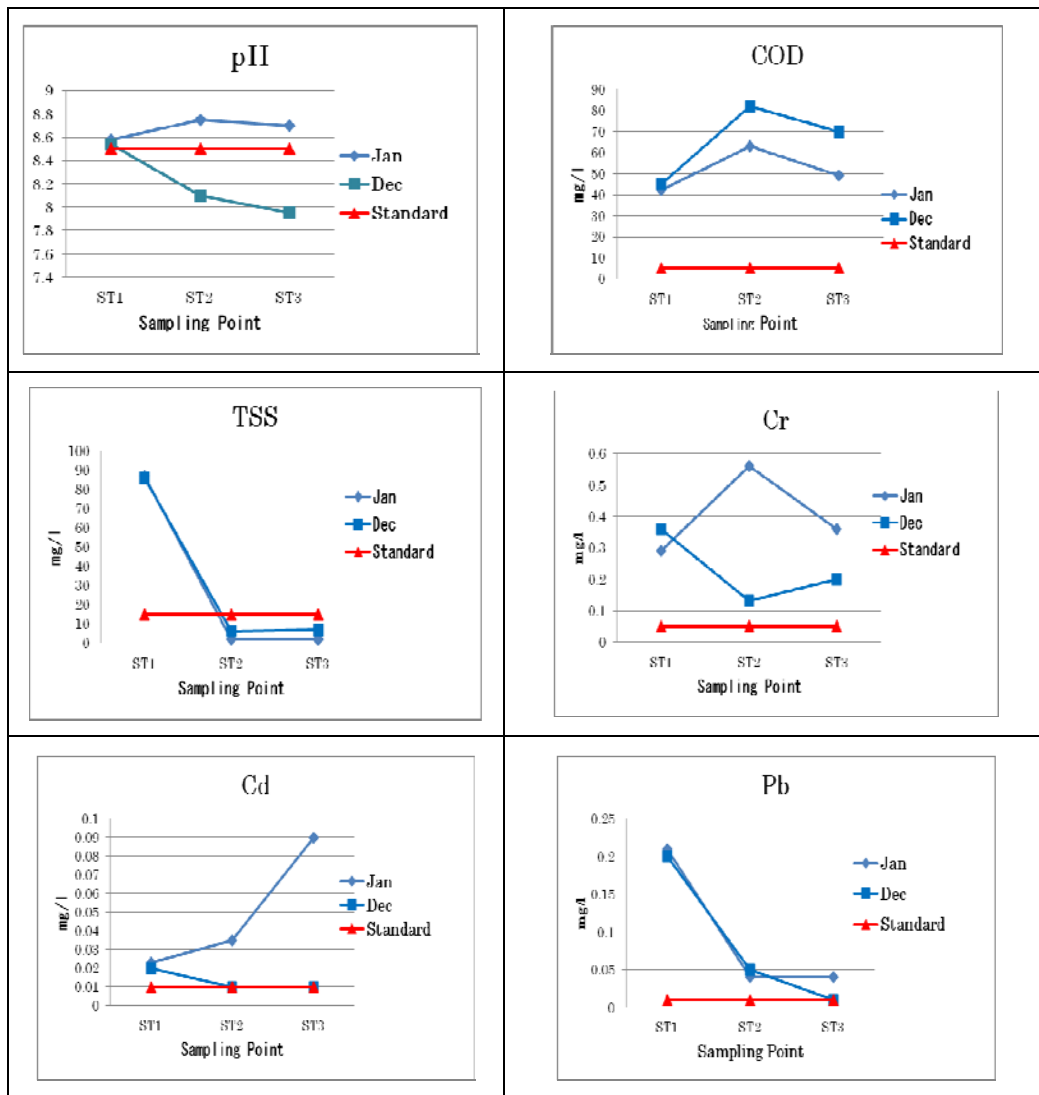


Figure 4.1.3 Monitoring Results of Keenjhar Lake

(4) Warsak Canal (KP-EPA)

The canal is already polluted from the upper stream of ST1 because the water quality at ST1 exceeded the standard for irrigation use (<8mg/l). Furthermore, BOD goes up rapidly between ST3 and ST4, where locate Peshawar city.

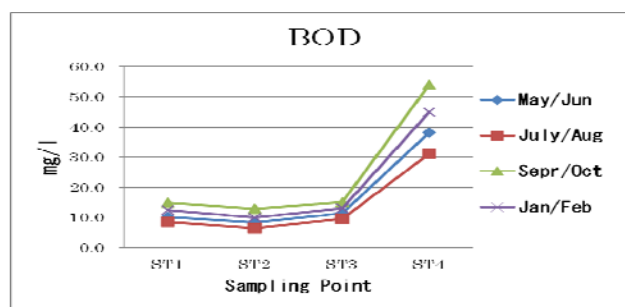


Figure 4.1.4 Warsak Canal(Peshawar)

4.1.2 Industrial Effluent Monitoring

Selected industries can be divided into three categories; international industry, local industry and waste water treatment plant. The results discuss by category as follows.

(1) International Industry

a) Industry-D (Punjab-EPA)

Almost all data of industry-D is within the NEQS limit because the industry has installed own waste water treatment facility.

Table 4.1.1 Industry-D

	Temp	pH	BOD	COD	TDS	TSS	Cl	Sulphate
NEQS	≤3 °C	6-9	80mg/l	150mg/l	3500mg/l	200mg/l	1000mg/l	600mg/l
2010								
Feb 15	22.0	7.3	15	40	810	40	182	250
May 17	-	7.8	105	48	760	40	140	169
Aug 14	35.0	7.2	56	112	810	70	115	25
Dec 22	25.7	7.7	8	32	420	20	80	86
2011								
Mar 22	30.7	7.6	27	85	740	60	145	139
Aug 16	30.0	7.7	16	44	410	180	55	96

Red shows the value beyond the NEQS.

(2) Local Industry

a) Industrial Effluent-A (Pak-EPA)

Both nonhazardous and hazardous parameters such as heavy metals are exceeded the NEQS. The situation should improve immediately because the parameters have possibility to cause a health hazard.

Table 4.1.2 Industrial Effluent-A

	pH	DO	BOD	COD	TSS	Fe	Cu	Cd	Pb	Phenol
NEQS	6-9	mg/l	250mg/l	400mg/l	400mg/l	8mg/l	1mg/l	0.1mg/l	0.5mg/l	0.5mg/l
Dec	6.8	1.2	276	692	886	3.7	0.3	0.2	0.1	1.6
Jan	6.7	0.7	178	519	998	8.9	3.0	0.3	0.8	1.8

b) Industry-A (PAK-EPA)

The industry is also over the standard with many parameters.

Table 4.1.3 Industry-A

	pH	DO	BOD	COD	TSS	Oil & G	Sulphide	Phenol
NEQS	6-9	mg/l	250mg/l	400mg/l	400mg/l	1mg/l	1mg/l	0.5mg/l
Dec	7.5	2.3	232	541	621	3.5	0.1	0.5
Jan	6.8	2.8	182	286	728	5.8	2.3	1.8

c) Industry-B (Punjab-EPA)

Almost all parameters of effluent from Industry-B exceed the NEQS values. The effluent is characterized by strong alkaline because the industry uses breaching agent. And high BOD and COD values are caused by dyes and starch. The main cause is that the treatment plant does not

operate regularly though the industry has installed a treatment plant. The operation is urged to start effectively.

Table 4.1.4 Industry-B

Date	Temp =<3 °C	pH 6-9	BOD 80mg/l	COD 150mg/l	TDS 3500mg/l	TSS 200mg/l	Cl 1000mg/l	Sulphate 600mg/l
2010								
Jan 15	-	4.9	770	1,600	1,570	10	160	256
Mar 16		12.0	640	1,536	5,820	3,170	640	1,078
Oct 13		12.3	310	762	2,460	200	100	354
Dec 22	28.0	10.7	510	1,340	5,240	2,820	715	895
2011								
Mar 22	47.4	12.3	450	1,075	5,090	5,090	120	606
Aug 16	47.0	9.0	4	10	640	520	60	98

d) Industry-C (Punjab-EPA)

Most of parameters are far exceed the NEQS values, about more than ten times of the standard. The effluent much contribute to the pollution of the Upper Chenab Canal because the industry locate between ST1 and ST2 of the canal as shown in figure 4.1.3.

Table 4.1.5 Industry-C

Date	Temp =<3 °C	pH 6-9	BOD 80mg/l	COD 150mg/l	TDS 3500mg/l	TSS 200mg/l	Cl 1000mg/l	Sulphate 600mg/l	Sulphide 1mg/l
Jan 14	6.7	6.8	412	848	1,600	350	70	411	36
Mar 16	-	5.6	1,220	3,176	3,320	1,580	570	592	32
Oct 4	20.6	6.2	840	1,728	2,460	370	425	226	48
Dec 22	27.3	6.5	2,410	8,400	2,640	600	350	623	28

e) Industry-E and F (Sindh-EPA)

These two industries observe the NEQS because all parameters are within the NEQS. The industry has installed a treatment plant. They has prepared monthly report and present it to Sindh-EPA regularly according to SMART program. It can be said to be the model case because even if an local industry observe the regulation by administrative guidance.

Table 4.1.6 Industry-E

	pH	COD	TSS	TDS	Cl	SO4
NEQS	6-9	150mg/l	200mg/l	3500mg/l	1000mg/l	1600mg/l
Oct	8.7	139	89	2182	351	550

Table 4.1.7 Industry-F

	pH	COD	TSS	TDS	Cl	SO4
NEQS	6-9	150mg/l	200mg/l	3500mg/l	1000mg/l	1600mg/l
	7.2	116	125	1,118	20	68

(3) Treatment Plant

a) Treatment Plant-A (Pak-EPA)

The plant mainly treats for domestic sewerage from I-9 Islamabad and the capacity is 77 thousand cubic meter. The plant operates effectively because main parameter of the effluent regarding organic substance is within the NEQS value. However, hazardous parameters such as heavy metal and phenol are exceed the standard. It is suspected that untreated waste water from industries is flowing into the facility because the treated water includes the toxic pollutants such as heavy metals.

Table 4.1.8 Treatment Plant-A

	pH	DO	BOD	COD	TSS	Fe	Cu	Cd	Pb	Phenol
NEQS	6-9	mg/l	250mg/l	400mg/l	400mg/l	8mg/l	1mg/l	0.1mg/l	0.5mg/l	0.5mg/l
Dec	7.6	3.8	42.1	72	116	8.3	0.1	0.2	LDL	1.3
Jan	7.9	4.5	40.1	66	242	9.2	0.9	0.4	LDL	1.1

b) Treatment Plant-B (Sindh-EPA)

The plant constructed in 1989 for treatment of domestic sewerage to alleviate the pollution of Arabian Sea. The plant is managed by Karachi Water and Sewerage Board.

The data showed that only COD is over the standard. There is some possibility that the plant is over the capacity or poor operation. The situations should improve to keep the standard value.

Table 4.1.9 Treatment Plant-B

	pH	COD	TSS	TDS	Cl	SO4
NEQS	6-9	150mg/l	200mg/l	3500mg/l	1000mg/l	1600mg/l
	7.6	248	164	1132	198	306

4.2 Results of Air Quality Monitoring

The monitoring results of the pilot area are described as follows. Standard values defined in NEQS apply to the project for the evaluation.

4.2.1 Pak-EPA

(1) Ambient Air Monitoring

Data was collected from 1st to 31st of June 2011. The following figures shows daily mean value for each measuring item. Dotted line shows the standard value derived from the draft version of Air Quality Standard in Pakistan.

SO₂ satisfies the standard while CO and NO₂ almost satisfy the standard. However, NO and PM_{2.5} exceed the standard constantly. No significant difference of SO₂ and CO between the value in I-10 industrial area and H-8 observed.

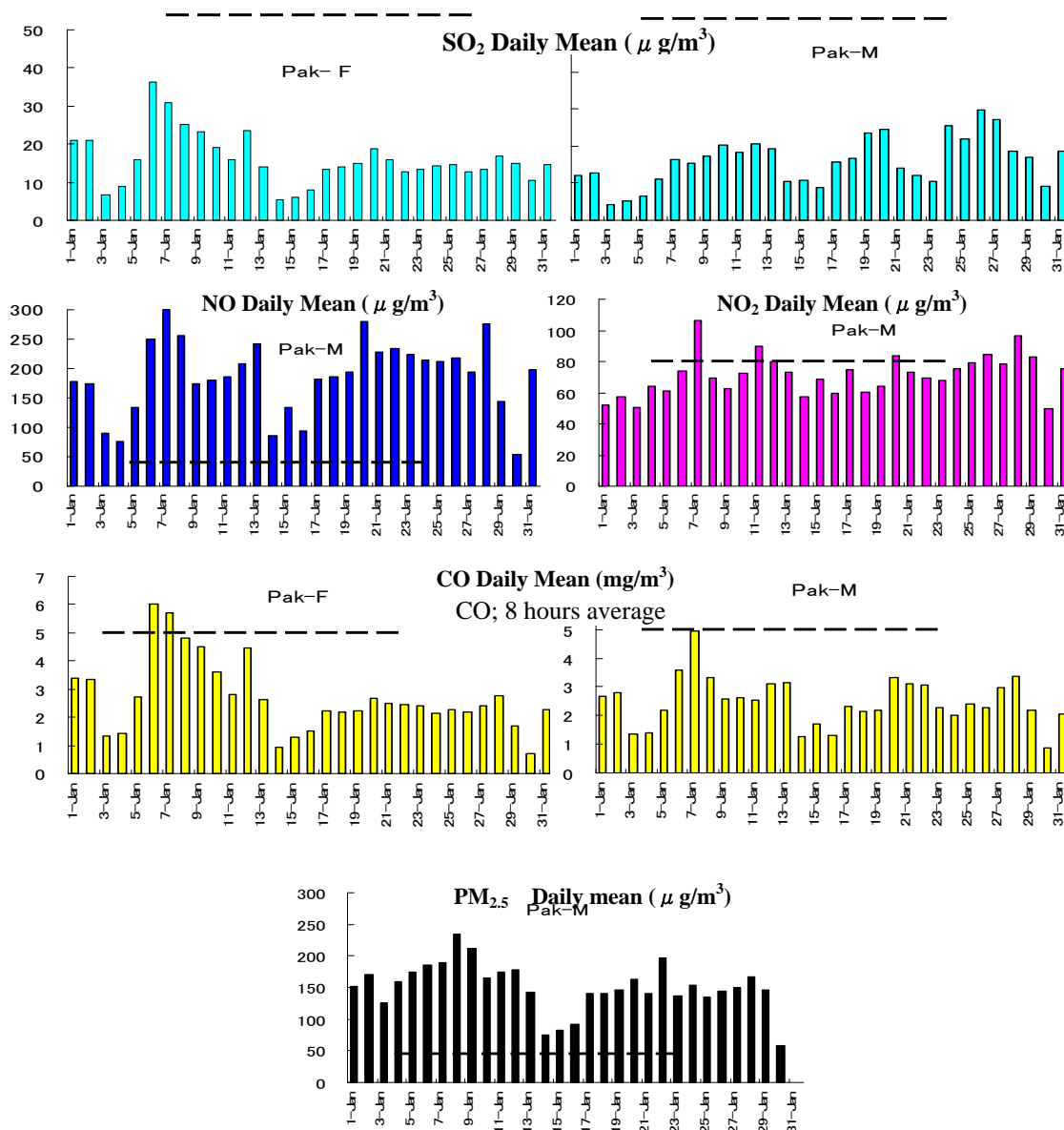


Figure 4.2.1 Comparison of Daily Average Data with NEQS

Similar shift pattern among some parameters can be observed. Furthermore same tendency appeared in PM2.5. Fluctuation of Methane tends to coincide Non-Methyl Hydrocarbons (NMHC) in extremely high concentration. The high concentration of SO2 appeared at daytime, however, its relationship with other pollutants is not clear. Low radiation during 6th to 8th January seems to contributed lower concentration of O3 during this term.

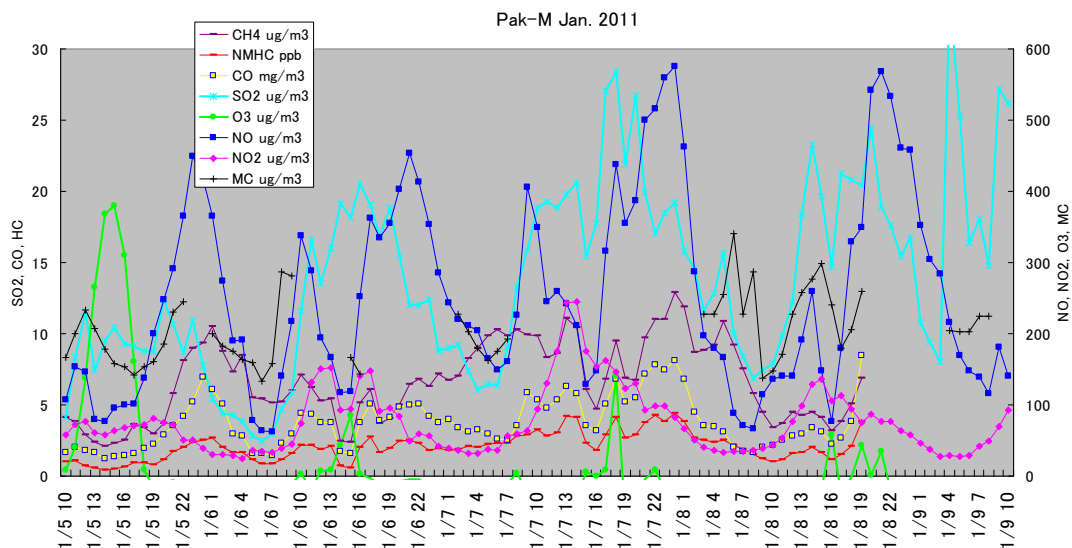
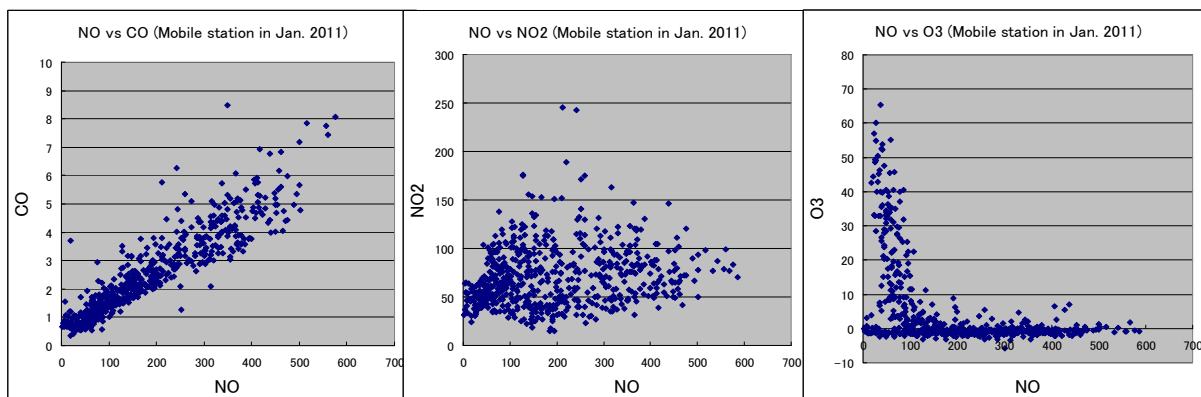


Figure 4.2.2 Change in Concentration of Ambient Air Pollutants in Industrial Area

Also, the followings can be observed by the analysis of acquired data as described in following figures.

- 1) Positive correlation among NO, CO and NMHC
- 2) Inverse proportion between NO and O3
- 3) Positive proportion between O3 and Insolation
- 4) Appearance of High concentration of O3 in daytime
- 5) Appearance of High concentration of CO and NO in night time



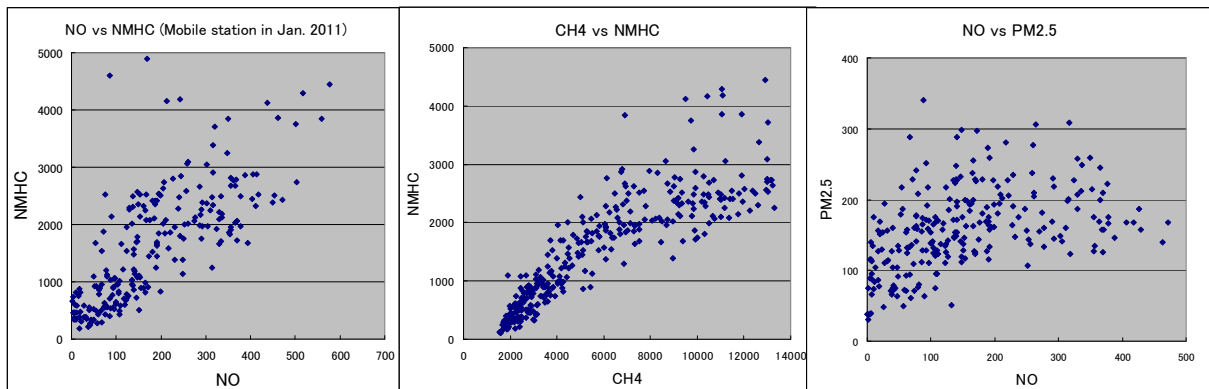


Figure 4.2.3 Relationship among Ambient Air Pollutants in Atmosphere

(2) Stationary Source Monitoring

The following table shows the stack gas monitoring results in industrial area:

Table 4.2.1 Results of Stack Gas Monitoring at Iron Refineries

Measurement Item	Unit	NEQS	Result				
			Met Cast	Potohar	KSR	Modern st.	
Dust	mg/Nm ³	500	32	115	353	99	-
NO _x		600	0	0	-	2	0
SO ₂		1700	0	0	-	0	0
CO		800	0	0	0	0	5
CO ₂	%	/	0.1	0.1	0.1	0.1	0
O ₂			20.9	20.8	20.9	20.3	20.4
Moisture in Flue Gas			3.6	3.8	1.3	1.2	2.0
Velocity of Flue Gas	m/s		3.1	9.2	11.7	7.9	7.7
Temperature of Flue Gas	°C		40	57	29	29	21
Flow Rate of Wet Flue Gas	Nm ³ /h		6900	9300	16000	6100	6700
Flow Rate of Dry Flue Gas			6700	9000	16000	6000	6600

Iron refineries are the measured target for this investigation as many complaints were lodged by the residents living in the vicinity of the Industrial Area due to the smoke emitted by these factories. The impurities in scrap iron burning in electrical furnace are the cause of heavy black smoke discharged from the stacks.

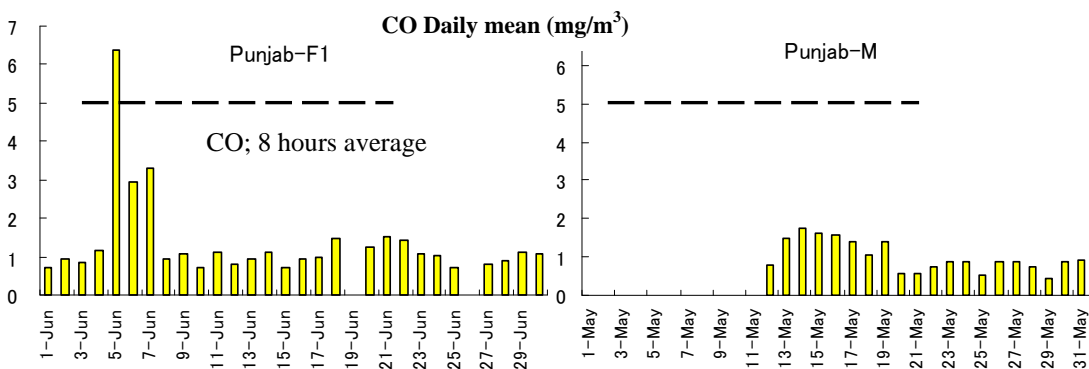
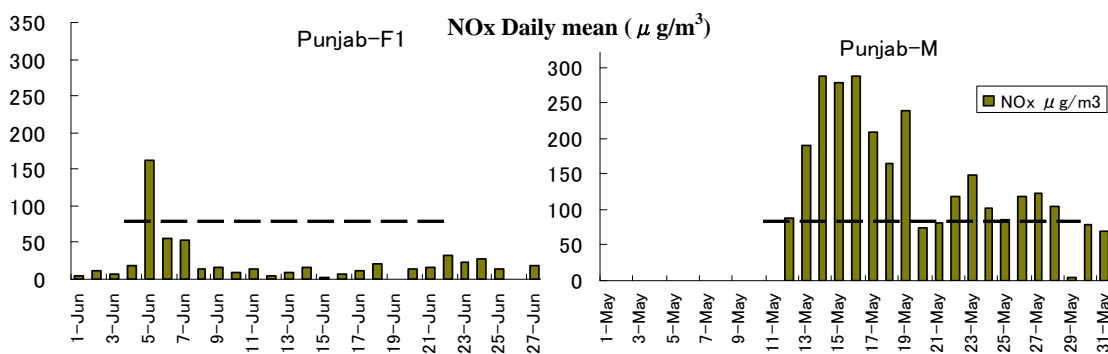
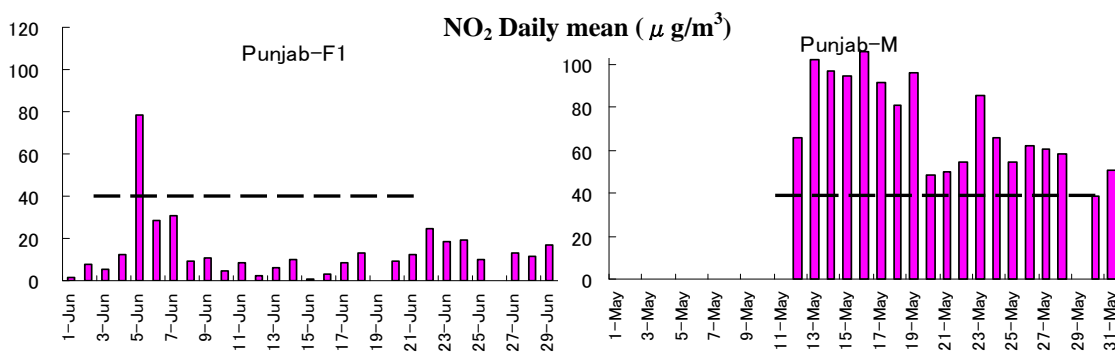
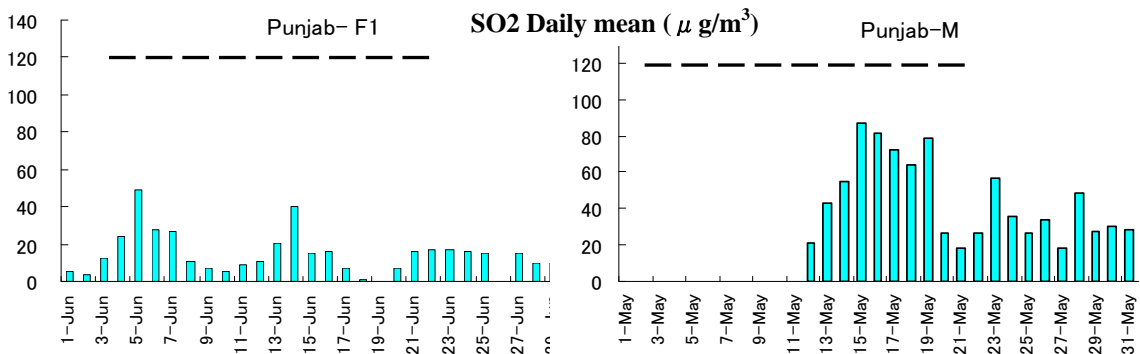
However, monitored values are within the NEQS, the color of smoke during sampling period was much thinner than usual heavy black. The monitored values do not seem to represent the average pollution level of smokes from factories. In case of iron factory, if they use the low quality of raw material, the color turns to brown or black. Some factories dared to run the exhaust gas treatment system just during the stack monitoring due to which actual pollution level could not be measured.

4.2.2 Punjab-EPA

(1) Ambient Air Monitoring

Data was collected from 1st to 31st of June 2011. The following figures shows daily mean value for each measuring item. Dotted line shows the standard value derived from the draft version of Air Quality Standard in Pakistan.

SO₂ satisfies the standard while CO and NO₂ in F1 station almost satisfy the standard. However, NO₂ and NO_x at mobile station, and PM_{2.5} exceed the standard constantly. In general, the results of mobile station shows much higher values than that of F1 station.



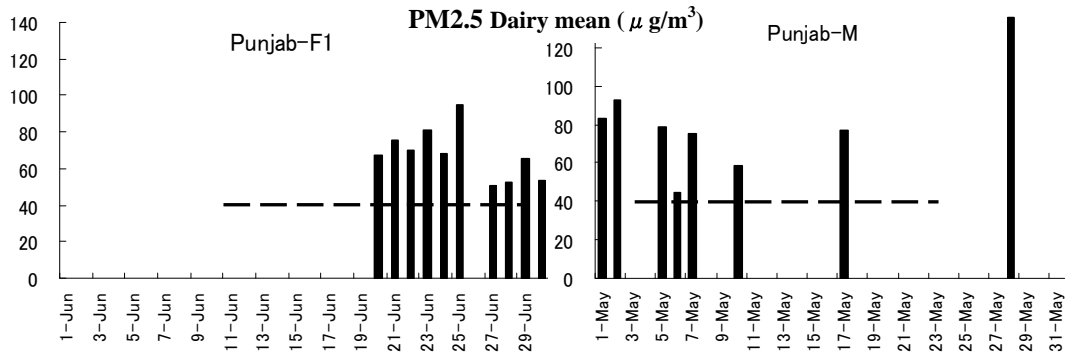


Figure 4.2.4 Comparison Between Daily Average Data and AQS Value

By the following figure, similar shift pattern in NO and CO can be observed.

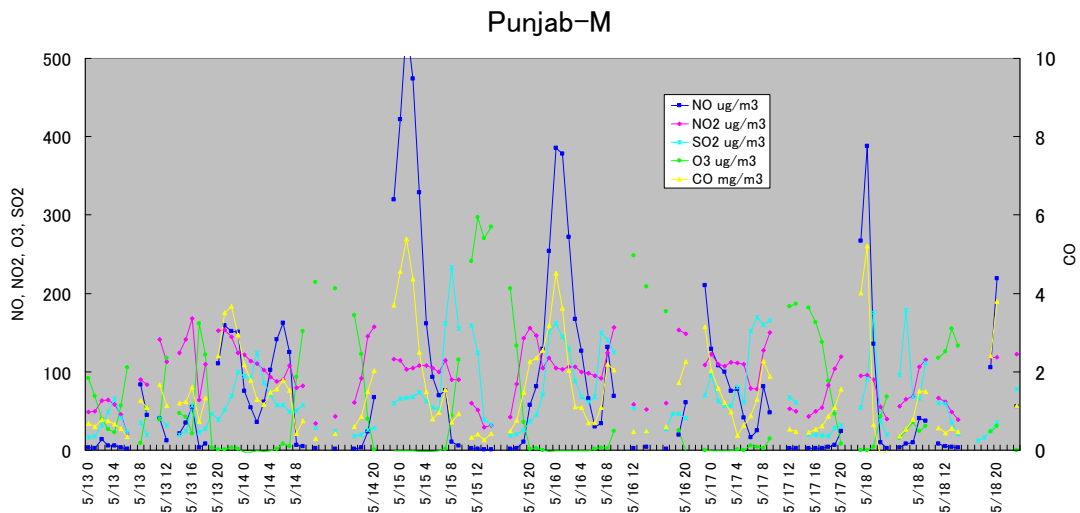


Figure 4.2.5 Concentration Changing in F1 and Mobile Air Monitoring Station in Lahore

Also, the followings can be observed by the analysis of acquired data.

- 1) Proportional relationship between NO and CO
- 2) Inverse relationship between NO and O₃
- 3) Proportional relationship between O₃ and Insolation (Radiation)
- 4) Concentration peak appears in daytime
- 5) High concentration of CO, NO and NO₂ appears in midnight

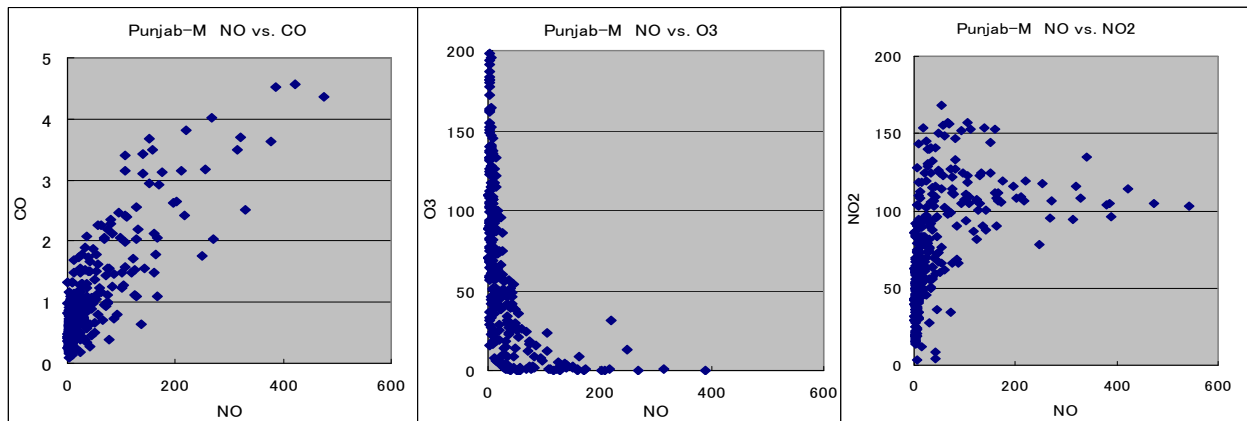


Figure 4.2.6 Relationship between Measured Items in Air Monitoring Station

Vehicles would be the leading source of air pollution in Lahore, and traffic volume obviously deeply related to the air pollution. It is probable that the large number of heavy duty trucks, are just allowed to run in midnight, might affect more to the air environment, as high appearance of high concentration of NO_x and CO or PM_{2.5} have being observed especially in midnight. Generation of inversion layer on city of Lahore during nighttime may be one of the reason for high air pollution during night time.

(2) Stationary Source Monitoring

The following table shows the stack monitoring results.

Table 4.2.2 Results of Stack Gas Monitoring in Kohinoor Power Plant

Measurement Item	Unit	NEQS	Result			
			Kohinoor	Atlas Power	SEPCOL	
Dust	mg/Nm ³	500	34	21	52	
NO _x		-	1103	2587	1980	
SO ₂		1700 for 1% sulfur ur in HFO	869	109	1908	
CO		800	0.0	0.0	0.0	
CO ₂	%	/	2.4	6.4	5.7	
O ₂			17.1	11.8	13.0	
Moisture in Flue Gas			8.3	7.3	8.8	
Velocity of Flue Gas	m/s		27.1	26.3	29.0	
Temperature of Flue Gas	°C		200	185	351	
Flow Rate of Wet Flue Gas	Nm ³ /h			11,108	123,268	154,178
Flow Rate of Dry Flue Gas				10,189	114,229	140,607

Measured objects are the flue gas discharged from thermal power plants, equipped with the excellent

performance foreign diesel engines. Monitoring team confirmed slight black smoke discharged from their chimneys at monitoring day. They surely are the cleaner pollution source, comparing to other heavy pollution sources in Pakistan where the black smoke have spewed.

This emission source monitoring was carried out during their facilities working normally. Measured concentrations of Dust satisfied the all NEQS items.

4.2.3 Sindh-EPA

(1) Ambient Air

Daily mean values collected 1st to 31st of May 2011 is described in following figures. Dotted line shows the standard value derived from the draft version of Air Quality Standard in Pakistan. SO₂, NO₂ and CO satisfies the standard while NO exceed the standard frequently.

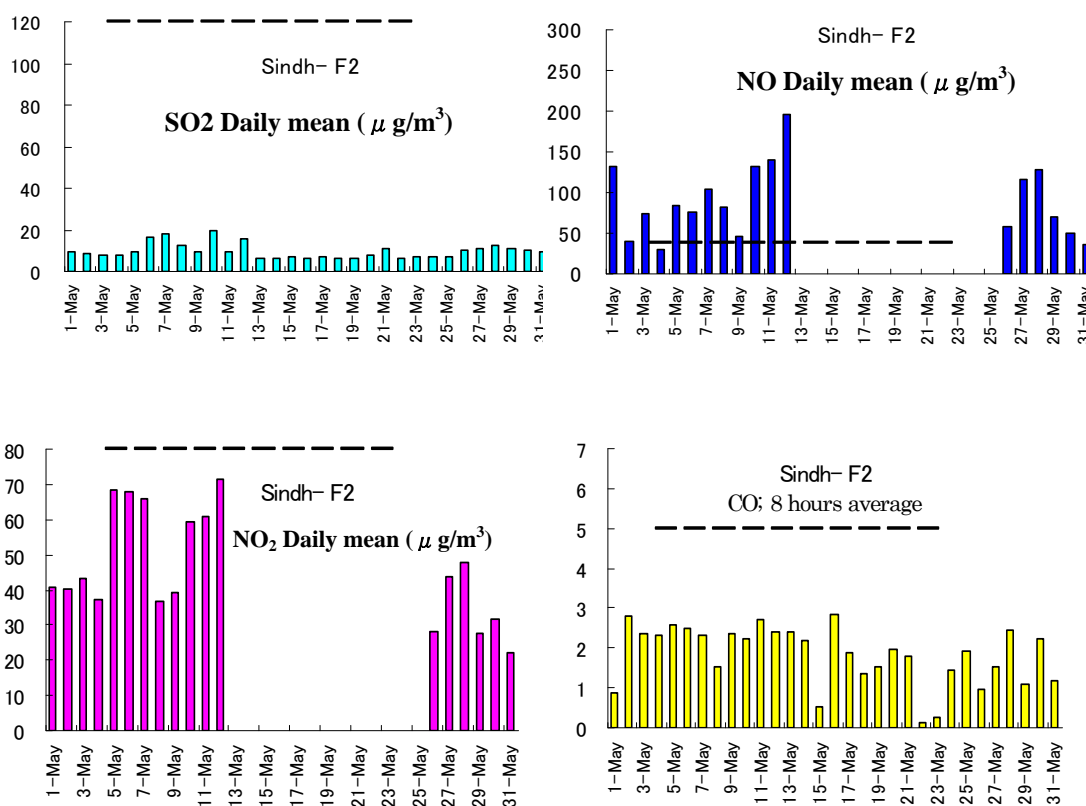
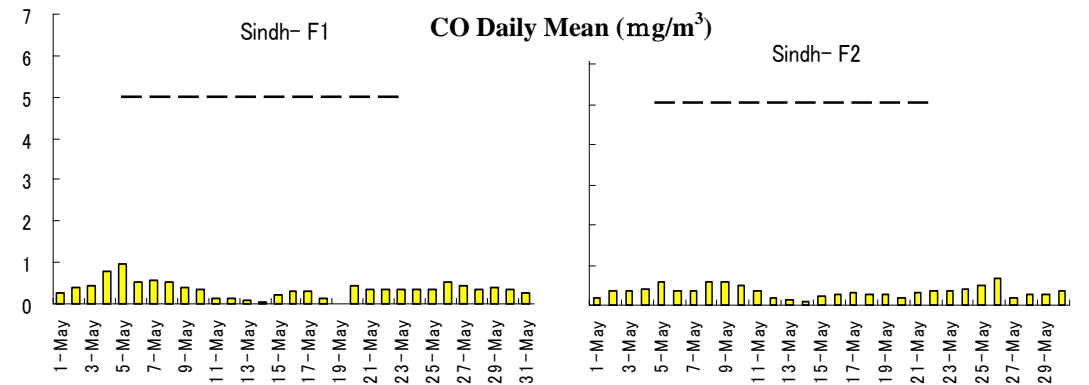
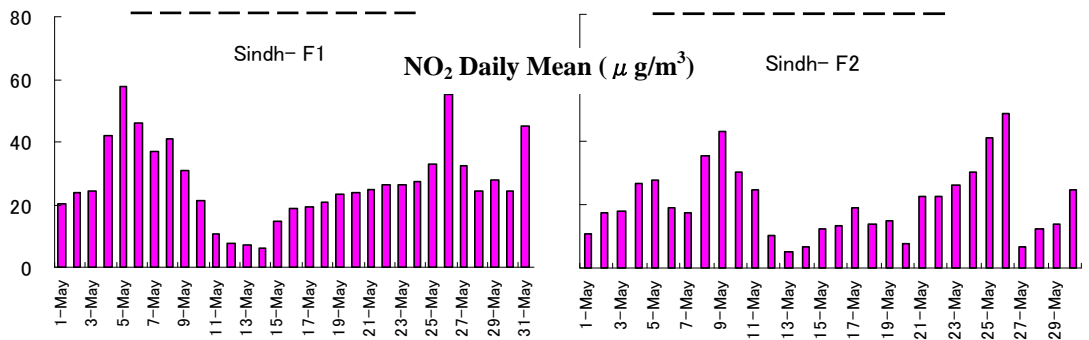
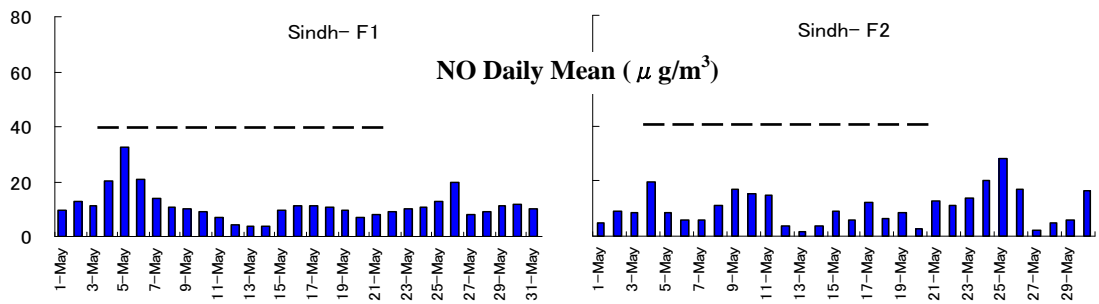
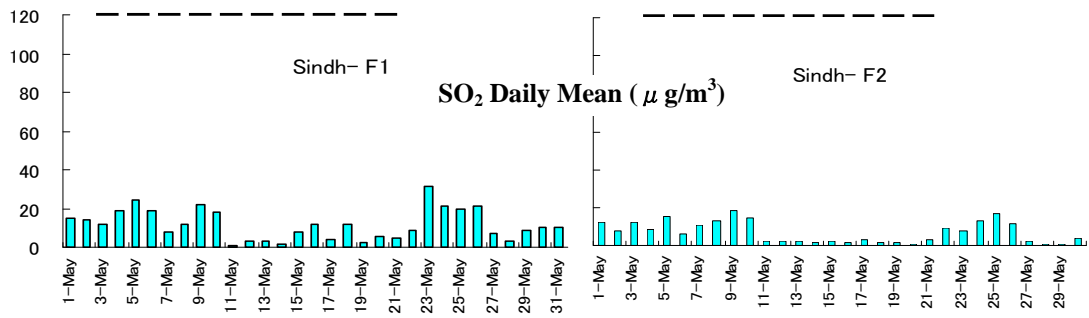


Figure 4.2.7 Monthly graphical variation of SO₂, NO, NO₂ and CO in May 2011

Due to temporal non-availability of SND-F1 and mobile station, data collected in year 2007 is utilized in this report for comparing values of two stations to understand the air pollution characteristics in the city.



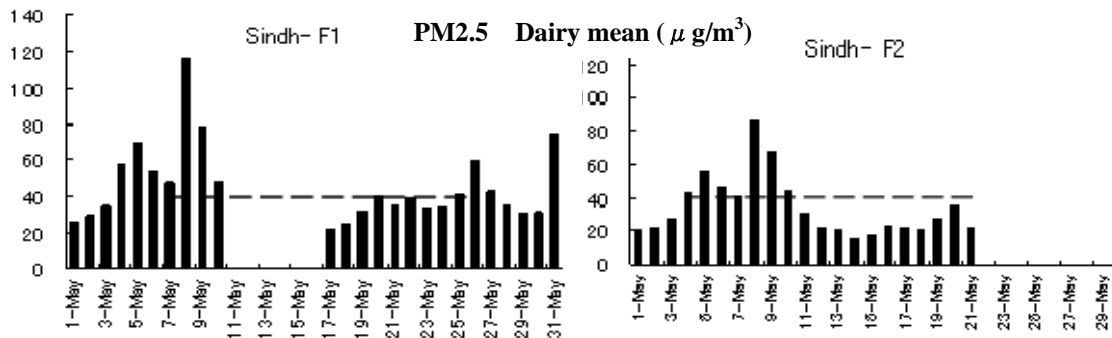


Figure 4.2.8 Comparison of Daily Average Data with NEQS for the month of May 2007

Although, the values of SND-F1 is slightly higher than that of SND-F2 station for most of measured pollutants, however the difference is not significant. The shift patterns of concentration change also appeared similar with little difference, which may be attributed to the complex air pollution load from local source and wide distribution of pollutants due to wind.

Only PM2.5 values exceed the standard value.

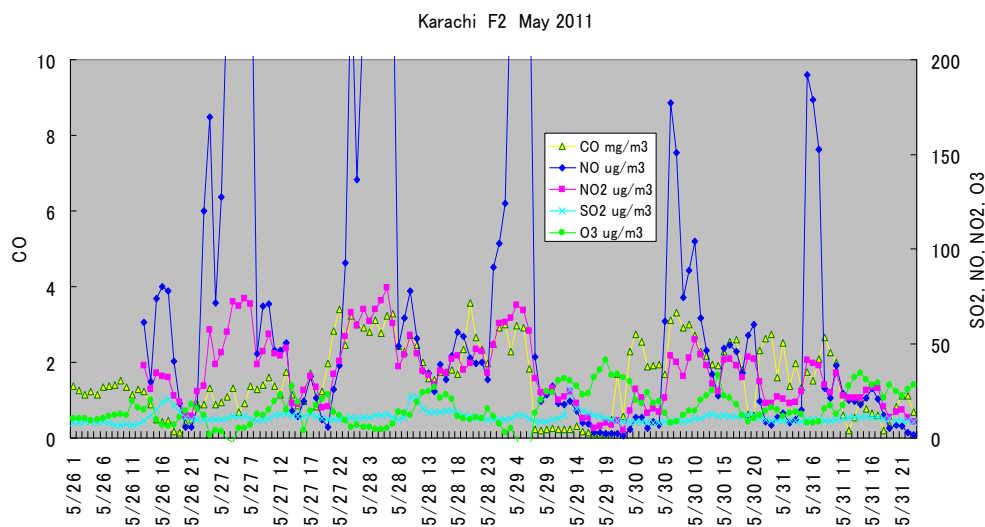


Figure 4.2.9 Concentration change characteristic of SND-F2 in May 2011

By the above figure, showing data from 26th to 31st of May 2011 in SND-F2, similar shift pattern CO and NO can be observed. The O3 peak tends to appear in daytime. Regarding the weather condition, average wind speed during study period found 3 to 4 m/sec minimum and 7 m/sec maximum, while average speeds in other major cities were observed at around 1 m/sec. Weather was fine in constant at around 30 oC with humid air in this season in Karachi city.

Also, the followings can be observed by the analysis of acquired data as described in following figures.

- 1) Positive correlation between NO, CO (not always appeared)
- 2) High concentration appeared at low wind speed except O₃, SO₂ and NO₂
- 3) Inverse proportion between NO and O₃ in daytime
- 4) Appearance of Low Methane concentration in daytime
- 5) Appearance of High O₃ concentration in daytime

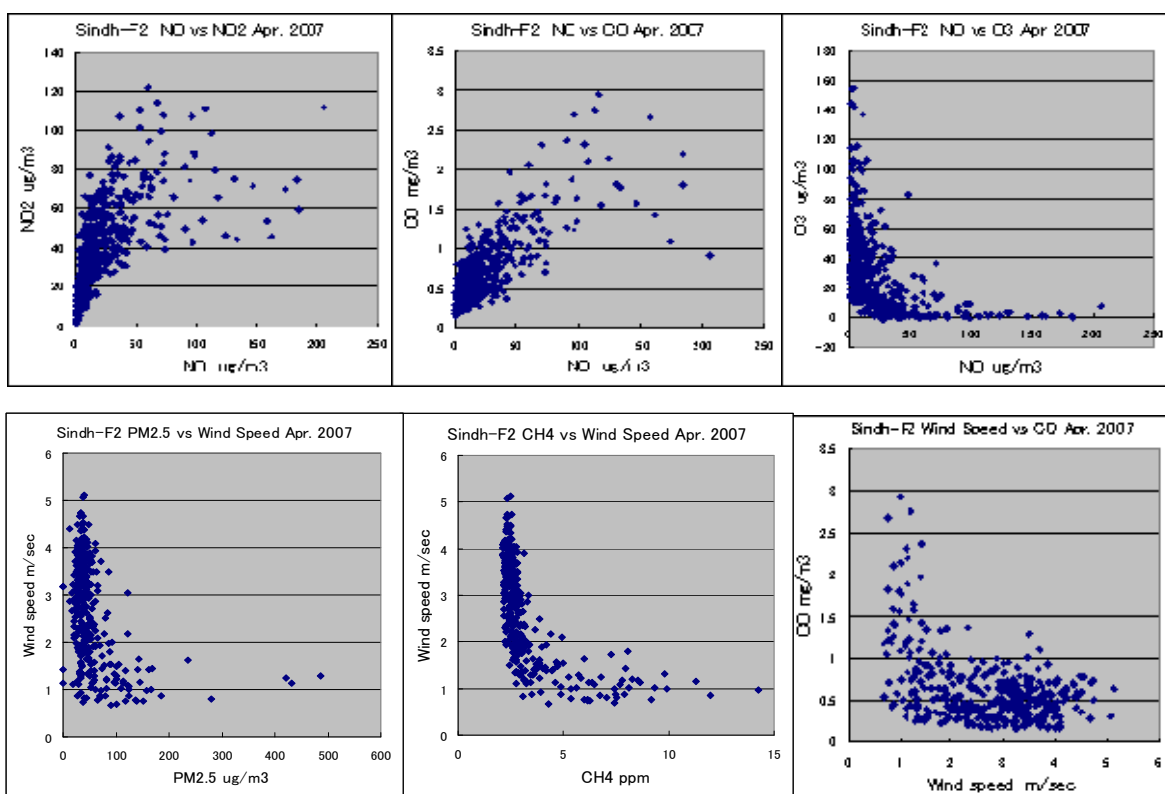


Figure 4.2.10 Relationships between Measured Items in Air Monitoring Station

The unique shift pattern has been observed in other cities like Quetta city where the condensed high concentration peak always appeared in every pollutant except O₃ every night. This shift pattern is not observed clearly in Karachi city, this indicates many pollution sources in the city.

The temperature near ground surface from April to June was around 30 oC at night and just 5 oC greater in daytime in constant. The low concentration appeared in nighttime may be caused by little descent of the height of boundary layer in nighttime and strong clean wind from West direction.

The concentration of SO₂, NO and CO decreased on Sunday in SND-F2 station while no such tendency was found on SND-F1 station. It indicates that the air pollution in SND-F2 area comes from industrial activities in Korangi Industrial Estate.

Considering the size and human activities of Karachi city, the expected total amount of emitted pollutants could be large enough. However lower concentration in Karachi have been observed most likely due to strong sea wind in the city. The appearance time of PM_{2.5} is close to NO peak, it is possible that discharged NO is relating to the producing process of PM_{2.5}.

(2) Stationary Source Monitoring

The following table shows one of the the stack gas monitoring results in industrial area:

Table 4.2.3 Results of Emission Source Monitoring

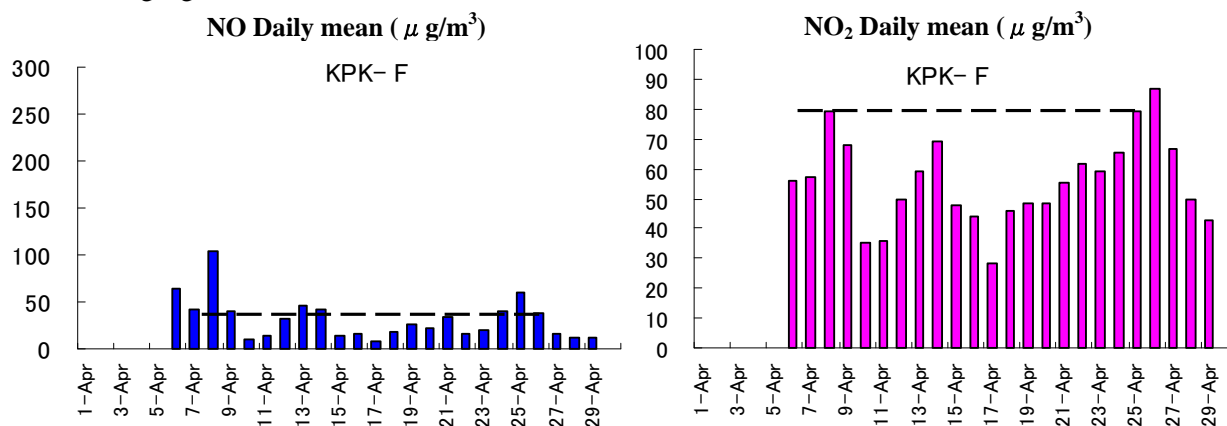
S.No	Parameter	NEQS (mg/Nm ³)	Result (mg/Nm ³)	Remarks
1.	NO _x	400	284	Within limits
2.	SO ₂	1700	BDL	Within limits
3.	CO	800	162	Within limits
4.	Particulate Matter (Cement Kiln)	500	203.8	Within limits

Note: Results obtained from Dewan Cement(Pakland).

4.2.4 KP-EPA

Data was collected from 7th to 27th April in 2011, while one or two hours data were missed every day due to the planned power outage. The following figures shows daily mean value for each measuring item. Dotted line shows the standard value derived from the draft version of Air Quality Standard in Pakistan.

NO, NO₂ almost satisfy the standard, CO satisfies the standard, however PM_{2.5} is mostly above the limit. The daily mean valuation of Hydrocarbons, which is not defined as NEQS, are also shown in the following figure as a reference.



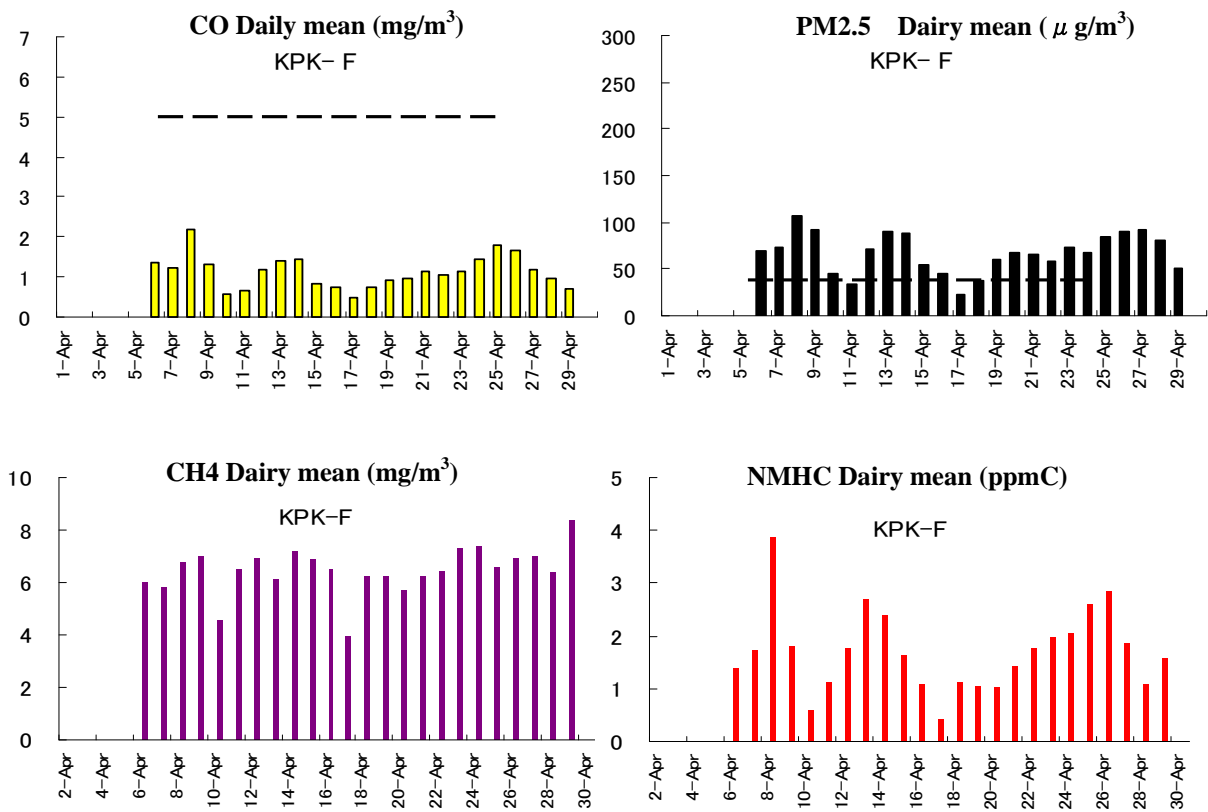


Figure 4.2.11 Comparison Between Daily Mean Value with NEQS Value

By the following figure, similar shift pattern among NO, NO₂, CO can be observed. Furthermore same tendency appeared in PM_{2.5}. The pattern of Hydrocarbons differs a little from those above, while very close to the pattern observed in methane and NMHC. Although we could not find the inverse proportion relationship between NO and O₃ due to temporal non-availability of O₃ analyzer, we believe photochemical reaction surely occurred at Peshawar city because there is obvious relationship between NO and Radiation.

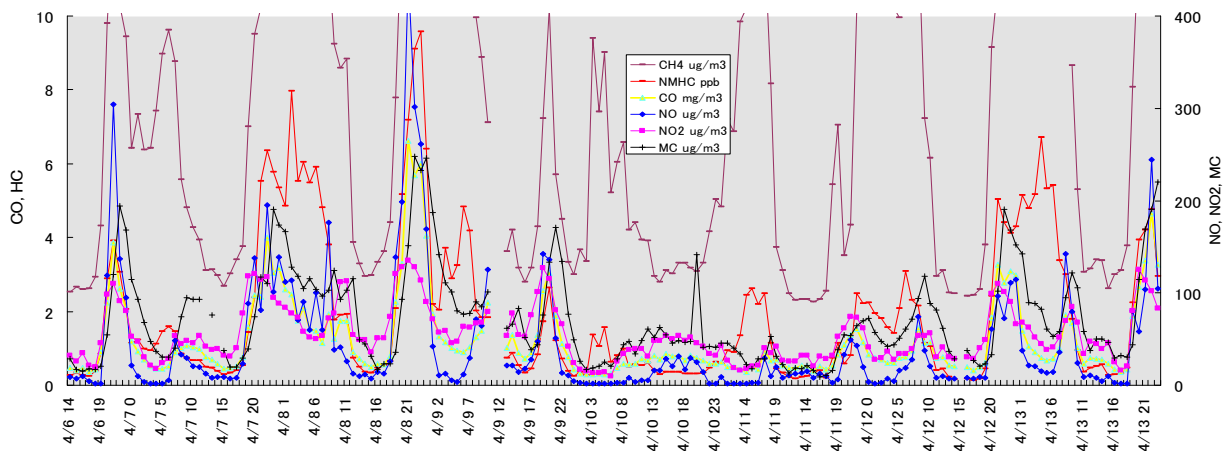


Figure 4.2.12 Concentration Changing in Air Monitoring Station in Peshawar

Also, the followings can be observed by the analysis of acquired data as described in following figures.

- 1) Positive correlation among NO and CO
- 2) Appearance of High concentration of CO, NO and NO₂ in night time.
- 3) Positive correlation among Methane and NMHC

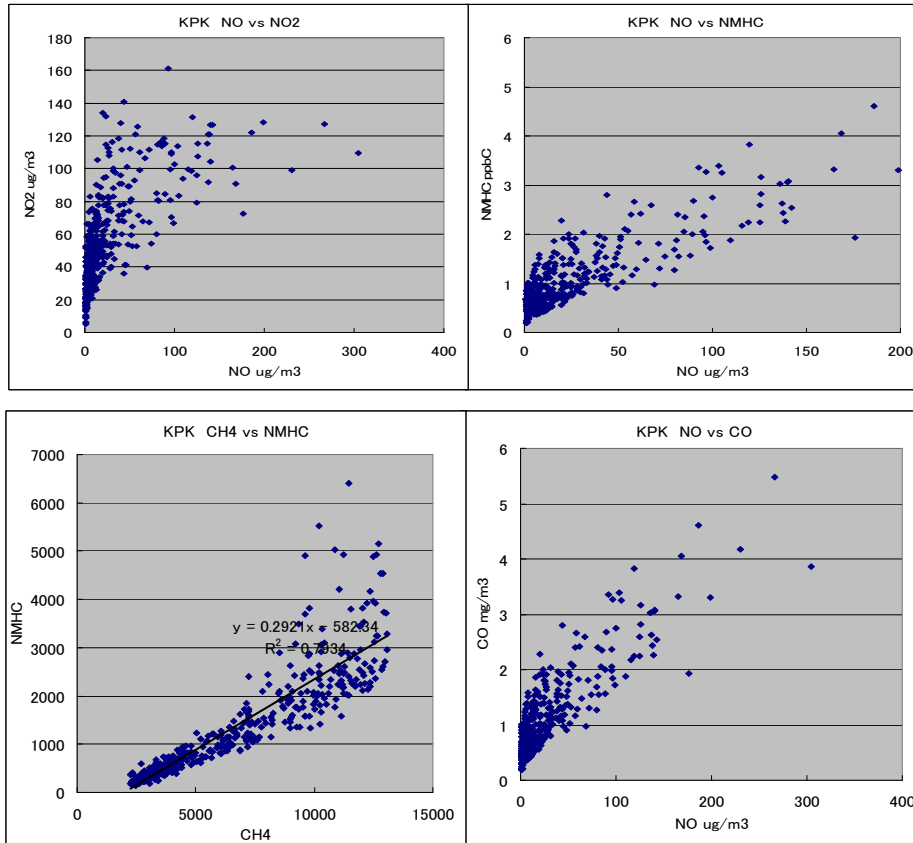


Figure 4.2.13 Relationship between Measured Items in Air Monitoring Station

High concentration peak frequently appeared at night, and this imply the heavy traffic flows in every day.

4.2.5 Balochistan-EPA

Data was collected from 1st to 31st of May in 2011. The following figures shows daily mean value for each measuring item. Dotted line shows the standard value derived from the draft version of Air Quality Standard in Pakistan.

SO₂, NO, NO₂, CO and O₃ satisfied the standard, while PM_{2.5} values mostly exceeded standard value.

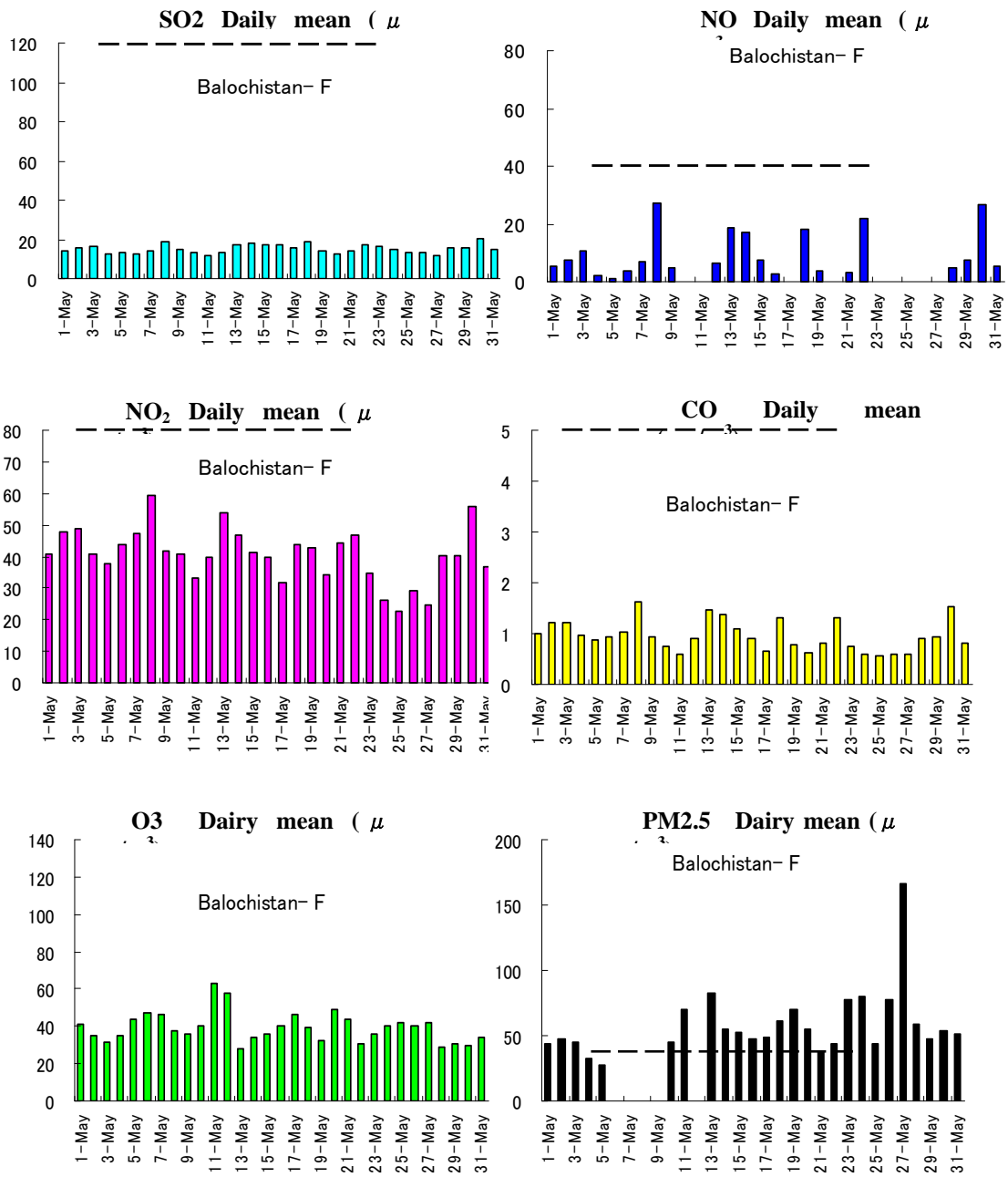


Figure 4.2.14 Comparison Between Daily Average Data and AQS Value

By the following figure, similar shift pattern among SO₂, NO, NO₂ and CO can be observed. Furthermore same tendency appeared in PM_{2.5} and hydrocarbons. NO and O₃ show clear inverse proportion relationship. Simple pollution source may contribute to Quetta city air pollution.

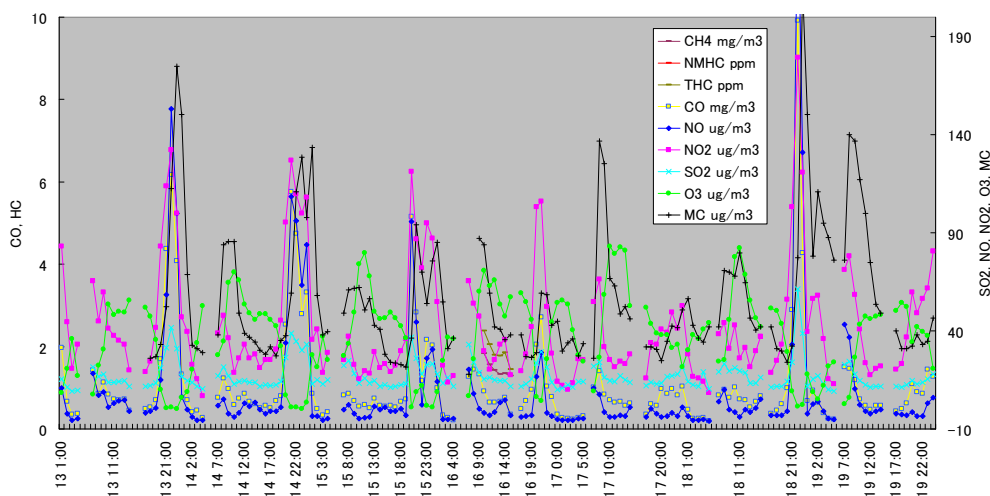


Figure 4.2.15 Concentration Changing in Air Monitoring Station in Quetta

Also, the followings can be observed by the analysis of acquired data as described in following figures.

- 1) Positive correlation among NO, CO
- 2) Inverse proportion between NO and O3
- 3) Positive proportion between O3 and Insolation
- 4) Appearance of High concentration of O3 in daytime
- 5) Appearance of High concentration of CO, NO and NO₂ in night time.

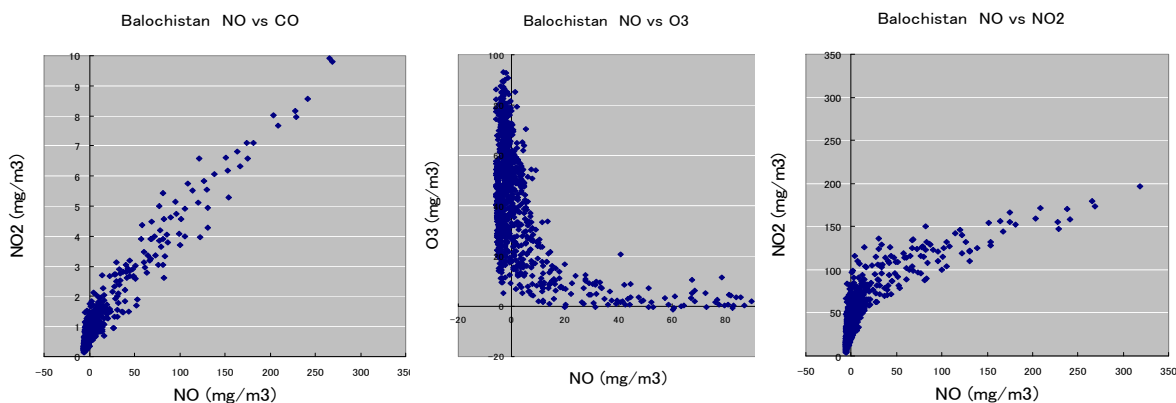


Figure 4.2.16 Relationship between Measured Items in Air Monitoring Station

High concentration peak frequently appeared at nighttime for most of all pollutants except O₃, it implies the much traffic flow even at 1am every day.

O₃ peak was observed sometimes in midnight despite photochemical reaction can not be occurred in night. By considering geographic condition of Quetta city which is situated around 30 degree in north latitude, it is possible that Ozone in stratosphere could fall down to ground level in above season along with the movement of Hadley circulation cell. Low concentration of NO and CO was observed at this time period, it proves that NO_x and CO reacted with O₃ and consumed in nighttime.

CHAPTER 5 DISCUSSION

5.1 Discussion for Water Quality Monitoring in Project Pilot Areas

Pakistan ranks at number 80 among 122 nations regarding drinking water quality. Drinking water sources, both surface and groundwater are contaminated throughout the country.

The results of the environmental monitoring of the pilot area show that the various water quality parameters are frequently violated. Parameters of almost all environmental water monitoring does not meet standard by water use. It is said that human activities like improper disposal of municipal and industrial effluents are the main factors contributing to the deterioration of environmental water quality.

According to the results of effluent monitoring, some industries have discharged their effluent in water bodies without treatment as shown in tables of the effluent monitoring. These are running without proper waste water treatment facility. That why many industrial effluent parameters are far violated NEQS as shown in the above tables.

On the other hand, monitoring results show that some industries both local and international are observing the standard. These have installed proper waste treatment plant and have prepared monitoring report according to SMART. It suggests that contamination may be mitigated by administrative abidance etc.

As discussed in chapter 1, the water quality degradation is caused by water resource deficit. To solve the problem is essential for Pakistan's further population growth and economic development because they require an increased demand for fresh water.

It is very important to create and implement the remedy based on the information acquired by monitoring in order to improve water pollution. Regular monitoring activity, therefore, becomes more important to achieve the objectives.

5.2 Discussion for Air Quality Monitoring in Project Pilot Areas

The results of the environmental monitoring of the pilot areas show that the various Air quality parameters frequently exceed NEQS. From the results of the followings, It can be said that human activities mostly contribute to given pollution status.

5.2.1 Ambient Air Quality

The graph shows daily-repeated patterns of the concentration. The cause of the variations in the patterns can be explained by the photochemical reaction to an extent. Therefore, the Expert provided an introductory lecture on the photochemical basics as shown in the table below.

The results from the data evaluation are described in the Monitoring Reports from five EPAs, and show the typical characteristics of urban type air pollution as summarized as below.

Table 5.2.1 Characteristics of Air Pollution in Each City

EPA	Air Pollution Characteristics
Common Characteristics	<ul style="list-style-type: none"> · Inverse relationship between NO and O₃, Correlation between NO and CO · Night-time increase of the pollutant concentrations except O₃ · Lower concentration of Day-time Hydrocarbon · O₃ high concentration during summer
Pak-EPA	<ul style="list-style-type: none"> · Exhaust concentration of pollutants are very high such as NOx and hydrocarbon. · The variation tendencies match between SO₂ and CO at fixed station. · Possibly detected the vehicle exhaust gas in addition to the industrial exhaust gases
Punjab-EPA	<ul style="list-style-type: none"> · Exhaust concentration of pollutants are very high such as NOx and hydrocarbon. Vehicle traffic is suspected to be the chief cause.
Sindh-EPA	<ul style="list-style-type: none"> · The ocean breeze lowers the pollutant influence in comparison to other cities. The variation patters are complex. The pollution characteristics between the towns distanced by 20 km north and south show different patterns.
KP-EPA	<ul style="list-style-type: none"> · Exhaust densities of pollutants are high. Vehicle traffic from the main highway nearby is considered the chief cause.
Balochistan-EPA	<ul style="list-style-type: none"> · Exhaust concentrations of pollutants are high such as NOx and hydrocarbon. The variation pattern is simple and clear such that the source may be also simple and constrained.

Further investigations are required to figure out clear generation mechanism of the high concentration PM_{2.5}. Nonetheless, the potential prime materials for the process, NOx and hydrocarbon were detected at extremely high concentrations at each city, so that the supply volume is considered to be sufficient.

It is very important to create and implement the remedy based on the information acquired by monitoring in order to improve the current conditions. Regular monitoring activity, therefore, becomes more important to achieve the objectives.

5.2.2 Stationary emission sources

The measurement results from emission source monitoring were compared with the NEQS standard values in Pak-EPA, Punjab-EPA, Sindh-EPA. There is no case reported for dust particles that exceeds the standard value except for Pb in which there are few cases exceeded the NEQS standard values while.

The reasons for phenomena is that factories have intentionally stopped their operation during the measurement periods. As consequences, the monitored values do not reflect the actual condition of pollution.

On the other hand, there were types of emission sources such as SO₂ and NO_x, that are not defined as monitoring target facilities in the current NEQS. In the advanced countries, those are been majored as emission sources and if those were majored in Pakistan, the values would be far beyond the standard limits.

As consequences above, the results do not show the actual status of emission, even if they most likely contribute pollution significantly. Besides this, due to the nature of the exhaust gas measurements which is spot measurements, we cannot obtain a long-term and large volume of data .