Air Quality Management in Pakistani Cities: Trends and Challenges

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ABSTRACT:
As impact of airborne pollution been widely recognized, its management is considered as an important component in controlling AQ in the Asian Context. Important parameters and components of Air Quality Management are being discussed. AQ can be improved by integrating a number of technical and management options and financial incentives including, monitoring, evaluation and actions e.g. emission inventorization of various type of activities, estimation of Emission Load & future projections, incorporate atmospheric dispersion models in pollution dispersion / dilution, initiate pollution index levels being monitored / dissipated with weather reports, direct & indirect ecological damage and environmental damage by these emissions in urban environment, direct and indirect health impacts, share in the global climate change & warming by this region, revise Emission Standards for various sources including vehicular emissions, policy options for adoption or Action Plans, calculation of effect of abatement and control measures, establishment, improvement and implementation of air pollution regulations, regulations for development of NAAQS / IAQS, Emission Standards for sources, assess the efficiency of these measures in reducing these pollution levels, enhanced public awareness, and for transport sector (which is the main urban air polluter) better traffic flow and transport management / planning in the urban areas (which has not been given due importance until now in Pakistan), change of technology including fuel substitution & conversion to less polluted fuels (e.g. low Sulphur / Lead fuels, CNG), development/enforcement of vehicular emission standards and using management tools for effective implementation of laws linking control on emissions and fuel adulteration, strengthening vehicle inspection and maintenance and transport planning. The present talk will be helpful in briefing about change in the existing air quality management procedures available to Pak EPA, local governments & traffic police in Pakistan, current activities for controlling this menace, their impact on air quality management and future suggestions to include reduction of Air Pollution in the context of a developing country like Pakistan.

KEYWORDS : Air Quality Management (AQM), Air Quality Management System (AQMS), National Ambient Air Quality Standard (NAAQS), Ambient Air Quality (AAQ), Urban / Air Pollution (AP or UAP), Indoor Air Pollution (IAP), Indoor Air Quality Standards (IAQS),

1.0 INTRODUCTION:

Ambient Air Pollution is an emerging environmental issue in major cities of Asia and has attracted attention from variety of corners (WB, USEPA, US-AEP and ADB has funded projects on Ambient Air Quality (AAQ) in Asia and recently CAI-Asia been initiated) with a proven direct impact on health & ecosystem of earth. Rapid growth of cities with minimum infrastructure in slum areas, improved economic situation increasing vehicle ownership and quest for development has made the region increasingly concerned for these air emissions and pollutants. According to a report [1], 7 % increase per annum of vehicular ownership and use been observed due to economic growth, rising incomes and urbanization over the last 10 years in India. AAQ impacts generally include direct health problems to the life forms (e.g. humans, animals, fish etc), vegetation and forest growths, damage to soils, climate change impacts including changing the regular patterns of seasons, rains, floods, draughts; desertification, deforestation, global warming, Oxygen and other gas blanket affecting global warming, Ozone layer depletion in stratosphere & formation of smog in lower levels, Acid Rain effects, material and building damage associated with high levels of oxides. This has resulted in depletion of the scarce natural resources needed for long-term sustainability of ecosystem etc [2].

Transport and energy sectors are considered to be one of the major air polluters. Road transport sector causes more Urban Air Pollution (UAP) than any other single human activity. Improved current technology (for new vehicles) alone has not been able to outweigh the amount of pollution emitted by number of vehicles in addition to the share of old vehicles on the road in the developing countries of the South Asian region. Transport and energy sector contributes nearly one half of the NO_x, two-thirds of CO, and about one half of hydrocarbon emissions as described by a WB report. It has been noted in the last 2 decades that AP from vehicles exceeds the maximum limits set by various organizations including WHO, US-EPA, WB, ADB and is likely to be a major cause of respiratory diseases [3]. The WB's estimation reports that AP causes 168,000 premature deaths annually in Pakistan (60 percent of them attributable to IAP) and 132,000 premature deaths in Bangladesh (70 percent from IAP) [4] and in addition, IAP accounts for 6 percent of the environmental health burden in India. Estimates by Anand [5], reveals that 10,000 people may die prematurely with more than 100,000 cases of respiratory diseases are linked with AP caused mainly by vehicular emissions in India in a year. Continuous exposures to high concentration of SPM and other gases could adversely affect health and welfare of people. Research has already proved direct relationship of respiratory diseases with level of SPM and other gases in the ambient air. Dust allergy, throat irritation and cough are very common in urban areas of Pakistan. Direct affects of AP on health, climate change, vegetation, rainfall patterns and ecosystem is well established.

Air Quality can be improved by integrating a number of technical and management options and financial incentives including, monitoring, evaluation and actions e.g. emission inventorization of various type of activities, estimation of Emission Load & future projections, incorporate atmospheric dispersion models in pollution dispersion / dilution, initiate pollution index levels being monitored / dissipated with weather reports, direct & indirect ecological damage and environmental damage by these emissions in urban environment, direct and indirect health impacts, share in the global climate change & warming by this region, revise Emission Standards for various sources including vehicular emissions, policy options for adoption or Action Plans, calculation of effects of abatement and control measures, establishment, improvement and implementation of air pollution regulations, regulations for development of NAAQS / IAQS, assess the efficiency of these measures in reducing these pollution levels, enhanced public awareness, and for **transport sector** (which is main air polluter) better traffic flow and transport management / planning in the urban areas (which has not been given due importance until now in Pakistan), change of technology including fuel substitution & conversion to less polluted fuels (e.g. low Sulphur / Lead fuels, CNG), and using management tools for effective implementation of laws linking control on emissions and fuel adulteration, strengthening vehicle inspection and maintenance and transport planning. Two stroke engine vehicles constitute nearly half of the total vehicles population in South Asian cities, contribute significantly to UAP in terms of noise, fine particulates SPM, PM_{10} & $PM_{2.5}$, unburnt HC, Lead, CO, SO_2, NOx, O_3, soot etc. Incorporating vehicle age, maintenance, lubricant and fuel quality, two stroke engines are polluter in order of magnitude than 4 stroke engines of same size. Two stroke engines have typically lower fuel efficiency than 4-stroke engine.

The seriousness of the atmospheric pollution for urban communities had led to the introduction of **National Pollution Control (NPC) Policies** in the developed countries in 70-80's and implementation of **NAAQS (National Ambient Air Quality Standards) / IAQS (Indoor Air Quality Standards) for domestic, commercial, public and industrial application.** These NPC, NAAQS and IAQS were basically aimed at tackling local pollution problems without considering trans-national transport of pollutants. Given that pollution control is itself costly and long-term gains cannot be achieved without international support, since developing countries lack the technical and financial resources to address this issue. It is necessary for the individual country to decide how much of their limited resources should be allocated for Ambient and Indoor Air Pollution Control programs. We believe that **pollution control and prevention are not desirable luxuries suitable for the rich developed nations but necessary parts of sustainability and survival of the ecosystem and can equally benefit Asian countries**.

Direct and indirect **cost-benefit analyses of environmental problems** are difficult to evaluate and needs prioritization and judgment. We have not yet learned how to factor the health of the environment into our economic paradigm. We need to get to work on this calculus quickly, since there is no economic resource that would be directly benefited by this process. With limited resources to address environmental degradation and its associated impacts, attempt to establish clear priorities requires assessment of environmental quality and losses in monetary units. Analysis conducted so far [6] indicates that environmental costs are high and indirect. A recent WB report estimated 3% of GDP cost for estimation of Lead & SPM related economic cost in Malaysia [7]. It has been pointed out that UAP causes average annual damages to the economy in the range of US $ 369 million [6] to the Pakistani exchequer and is ranked as the second most important contributor after Municipal Solid and Liquid wastes. These losses to national exchequer are colossal when compared to the costs of pollution abatement. Failures in incorporation of these factors in economic policies contribute to significant loss to GDP and create many health / environmental problems. According to study carried out in the Ministry of Environment, Government of Pakistan, about 16.28 million people (40% of the total urban population) of Pakistan are under risk of AP which is costing Rs. 25.7 billion every year on account of health merely by not complying with the WHO AAQS [6]. It is observed that

some population groups are more sensitive than others e.g. Children, Elderly, people with heart and lung disease; Asthma is growing, 150 million asthmatics worldwide, increasing in most countries (2% to 5% per year) Asthmatics are much more sensitive to AP and WHO reports that 3 M people die each year from AP exceeding 1M in traffic fatalities [8].
The WB and UNDP had launched **monitoring of UAQ** projects in 6 major Asian Metropolitan cities including Beijing, Mumbai, Colombo, Jakarta, Katmandu, and Manila under Metropolitan Environmental Improvement Program (**MEIP**) in 1992 [9]. Objectives of MEIP was to assist Asian urban areas in addressing / minimizing rapidly growing AP problems and was supported by Governments of Australia, Belgium, Netherlands and Norway. The WB initiated Urban Air Quality Management Strategy (**URBAIR**) under **MEIP** program to develop **action plans** to assist local bodies for controlling the AP problems in these cities. This action plan was an integral part of their **Air Quality Management System** (**AQMS**) for these metropolitan cities including assessment of air quality, environmental damage to health and materials, control options, and cost–benefit or cost-effectiveness analysis. Selection of abatement measures for short / medium / long-term implementation was suggested on the bases of these assessment.

APCS OR AIR QUALITY MANAGEMENT SYSTEM (AQMS):
Air pollution control strategy, a **master plan to control / prevent AAP problems**, was introduced with the help of Male Declaration amongst countries of South Asia since end of 1998. **Air Quality Management (AQM)** designates the level of pollution established in terms of **outdoor ambient air quality standards (NAAQS)** in the first phase and controlling pollutant emissions from these sources to ensure that these limits are not exceeded in the outdoor environment. Obviously an approach involving regulating emissions from millions of outdoor and indoor pollution sources with varying characteristics, location and use patterns are not simple. **APCS** be identified and implemented to ensure that AP concentrations in the cities are reduced or are maintained below a specific level deemed acceptable. These **AQMS parameters** may be short term or long-term and may differ in implementation but have these common elements [9] as shown in the figures 1 & 2:-

a) **Air Quality assessment and Management System** (**AQMS**),
   (i) Inventory of pollution activities,
   (ii) Emissions characteristics of different sources,
   (iii) Monitoring of air pollution concentrations and dispersion / dilution parameters,
   (iv) Calculation of air pollution concentrations by atmospheric dispersion / dilution models,
   (v) Inventory of population / demography, materials and urban development,
   (vi) Calculation of effect of abatement and control measures,
   (vii) Establishment, improvement and implementation of air pollution regulations.
b) Emission Standards,
c) Environmental damage assessment,
d) Economic Assessment and Cost-benefit analysis,
e) Abatement measures selection (action plan),
   (i) Improved fuel quality,
   (ii) Technology improvements including source control, product changes, Raw Material Substitute, Product Substitution, Product Conservation, Changes in Product Composition, Input Material Changes, Technology Changes like Process Changes, Equipment etc changes, Changes in operational setting etc.
   (iii) Fuel switching,
   (iv) Traffic management,
   (v) Transport demand management,
   (vi) Improvement of databases in monitoring and information system, emissions inventorization and dispersion / dilution / exposure modeling, damage assessment, cost benefit analysis and institutional strengthening,
   (vii) Awareness campaign and environmental education,
f) Optimum control strategy including technology improvements, maintenance culture, regulations for development of NAAQS / IAQS / sector specific regulations.

AQMS designates the level of pollution established in terms of **outdoor / indoor air quality standards** and controlling pollutant emissions from fixed and mobile sources to ensure that these limits are not exceeded. De Nevers et al [10] has defined **AQMS** as "**regulation of the amount, location, and time of pollutant emissions to achieve some clearly defined set of ambient air quality standards or goals**", and following figure 1 explains some of these stages. This **AQMS** will provide input to the cost-benefit analysis which is also based on establishment of objectives like guidelines and standards leading to action plan for abatement and control measures for implementation in the short, medium and long term. Unfortunately efforts in developing countries of the region to improve air quality could not identify transport sector, its planning and management as an important parameter until recently.

AQMS require data from continuous fixed monitoring stations, which determine the level of pollution in the cities and their potential impact on human health. The goal of such continuous monitoring system is to ensure a thorough assessment in changes of AQ, dissemination of this information through TV / print media, its direct health impact, assessing the results of any abatement measures and thereby providing feedback to the abatement action plan. Continuous air monitoring system provides an indication of the AP load in wider areas within a country or to show the development of long-range transport of AP. The data from these stations are important as they may be used to indicate general trends in AP across a large region, rather than the changes in local pollution sources. They may also be used to validate models of long-range atmospheric transport of AP, which can be important tools in the regional / trans-boundary transport process. Monitoring in suburban areas is also important as it can give a value for the city in general. It would be useful to include here an analysis of the number of sites which may be classified as A) Urban, B) Sub-urban, C) Rural and to describe in more detail the sites which are more rural in nature.

Following are required relative environmental concerns for the first phase of AQMS in Pakistan:-.

(i) Inventory of pollution activities, Emission inventorization of various type (make, models, fuel consumption, age etc) of vehicles
(ii) Direct & indirect ecological damage and environmental damage by these emissions in urban environment
(iii) Share in the global climate change & warming by this region
(iv) Direct and indirect health impacts ; Health & Environmental damage assessment,
(v) Economic Assessment and Cost-benefit analysis,
(vi) Calculation of effect of abatement and control measures,
(vii) Establishment, improvement and implementation of air pollution regulations
(viii) Identification of gaps in our understanding & data available to us
(ix) Action Plan for minimization of AP.
(x) Enhanced public awareness
(xi) Policy options for adoption or Action plans

Thus efforts are required in the first phase for Pakistan to:-

- Collect baseline continuous ambient airborne pollution indicator data / levels in the country,
- Develop linkages between pollutant concentration, source identification & their contribution / quantification,
- Estimate emission factors for various polluting activities,
- Incorporate atmospheric dispersion models in pollution dispersion / dilution,
- Initiate pollution index levels being monitored / dissipated with weather reports,
- Investigate direct & indirect health impacts,
- Assessment of environmental losses in monetary terms,
- Implement certain feasible mitigating measures to reduce these levels,
- Assess the efficiency of these measures in reducing these pollution levels and
- Reduce the emissions of these pollutants through improvement programs in the region.

Adoption of NAAQS/IAQS, consistency in laws and strong enforcement will be able to provide the required results. Policy instruments can range from simple command and control instruments to communication tools.

Male Declaration on Control and Prevention of Air Pollution and its likely trans-boundary Effects for South Asia, March 2000, Phase I reported the following comparison (table 1 & 2) amongst the countries of the South Asian region and table 2 shows the present situation of various environmental laws for AAQS for the region.

WORK DONE ON AQM IN PAKISTAN:

The Pakistan Environmental Protection Council (PEPC), an apex environmental body, in its meeting held on 3 February 2001 under the chairmanship of Chief Executive of Government of Pakistan, approved an action plan, **National Environmental Action Plan (NEAP)** to control and reverse environmental degradation in the country. One of the four elements of NEAP is "Clean Air" to assess the state of the existing AAQ on continuous basis by utilizing fixed monitoring stations and generate data for policy makers to take appropriate decisions to control / minimize air emissions of concern. Pakistan's National Conservation Strategy (NCS) identified 14 core areas including abatement of air pollution. The importance of mitigation measures in combating urban air pollution is evident and had been incorporated in various mega-cities of the World and Asia in the recent past.

Very little work has been initiated in Pakistan on integrated AQMS and mostly isolated in nature. Some broad based inventorization of AP Sources have been conducted under UNFCCC protocol (only qualification not quantification), UAQ monitoring using mobile vans (SUPARCO & Pun EPD have conducted few studies in various cities of Pakistan for various clients), Emission Standards for industries (NEQS) have been identified and implemented although these are very relaxed and loopy in nature, Fuel Quality have recently been improved by removing Lead from Gasoline & reducing Sulphur levels from Diesel, Fuel Switching from gasoline to CNG has a government backed incentives making it a success (more than 25 % of privately own vehicles / cars have already been converted) although this conversion should be really conducted to convert diesel driven vehicles to CNG to minimize environmental impacts and patchy mass awareness campaigns has been observed in the last few years [11].

Recent surveys carried out in the country using mobile units revealed presence of very high levels of suspended particulate matter (SPM) in major cities (about 6 times higher than the WHO's guidelines). In Lahore, Rawalpindi and Karachi levels of CO, NO_x and SO_2 were also found in high concentration in other studies [11 & 13]. Most of these measuring campaigns have been conducted using mobile units. This situation warrants continuous monitoring of AAQ through fixed monitoring stations to establish baseline data, understand the impacts and adopt remedial measures to minimize these impacts as had been experienced in other mega-cities of Europe, USA and Asia. Confidence criteria and reliability of existing inferences obtained through mobile units does not permit us to develop a comprehensive picture of current existing AAQ in various cities. It is believed that SPM / PM_{10} / $PM_{2.5}$ are generated mainly due to vehicular (2 stroke & diesel engines) and natural sources while oxides of C, N & S from transport and industrial sectors involved in burning of petroleum products on large scale.

Vehicular emissions are treated as one of the important sources for total emissions for Pakistan (e.g. Male document) but its contribution has not been quantifiable accurately as yet. Total emissions by transport sector in 1998 was estimated in National Emissions Inventory of Pakistan for **Male Declaration** on "**Control and Prevention of Air Pollution & its likely Tran boundary Effects for South Asia**" in May 2000 and is reproduced as 324,473 tons of NO_x (over 90 % by diesel as source of fuel & 9.5 % by Gasoline: 65 % share of total NO_x emissions by all sectors), 35,362 tons of PM (93% by diesel driven vehicles & 6.5 % by Gasoline: 2 wheelers, motor cars & tractors are dominant sources; 6 % share of total emissions), 120,871 tons of SO_2 (99 % diesel driven vehicles: 16 % of total SO_2 emissions). Emission factors were estimated with slight inaccuracies since quality of roads, vehicle age / maintenance & fuels are important parameters which were ignored.

ENERCON is working on vehicular emission concerns, energy conservation activities and is implementing Fuel Efficiency in Road Transport Sector (FERTS) project funded by GEF (www.ferts.8k.com) and is concentrating on the tune up facilities in various cities of Pakistan and has tuned more than 28000 gasoline vehicles so far in the last 2 years from 15 tune up facilities improving AP and petrol consumption. It was indicated that 94% of vehicles being tuned are older than 7 years and only 6% are newer models. An overall 54% reduction of CO, 462 Tons of CO_2 and 15% efficiency in fuel consumption is being claimed by ENERCON so far. This reduction can be attributed because of improved engine working and fuel saved because of consumption improvement. The project will result in savings of US $ 19.8 million per annum to vehicle owners due to better efficiency and will result in annual reductions in emissions of CO_2 (262,040 tons), SO_2 (1478 tons), lead (7 tons), Hydrocarbons (5659 tons), CO (67343 tons) and SPM (5342 tons) estimated by Pak-EPA in the report on Male Declaration. A loan of US $ 3 Million is being negotiated for expansions to 200 tune up stations planned in the next 2-3 years [11].

VETS by GTZ: Vehicle Emission Testing Station (VETS) had tested over 18000 (Petrol & Diesel) vehicles and based on their data average reduction in smoke emissions from diesel is reported as 28% in terms of opacity and 77% in CO in samples of randomly selected vehicles [14, 15]. Possible reduction in PM_{10} emissions from diesel vehicles ranges 160 Tons/year and CO from petrol vehicles 913 tons/year [14 & 15].

Fuel substitution & clean up [16,17]; Ministry of Petroleum and Natural Resources (www.mpnr.gov.pk), Government of Pakistan, had eliminated Lead from Petrol, reduced Sulphur in HSD & Fuel (Sulphur in HSD from 1.0 % by weight to 0.5 % and in fuel oil from 3.5 to 2 %) ; introduction of catalytic converters for all new cars and restrictions on import of vehicles without catalytic converter; restriction on 2 stroke engine technology for fitting catalytic converters (rickshaw, motor cycles etc) and finally price of unleaded and leaded petrol to be same for control on adulteration. This objective will be addressed by modification of configuration of existing oil refineries, setting up of new refineries with latest technology & import of low Sulphur HSD & Fuel Oil. Estimated additional cost on import / introduction of low Sulphur HSD & Fuel oil will be in the range of US $ 300 million per year.

Committee on Clean Fuels [16,17] also recommended catalytic converters to be fitted on all two-Stroke engines and all public / private vehicles to testing and meeting of standards.

Shift towards gas driven processes in industries (especially Power plants, transport sector using Gasoline & heavy burning industries) will improve the environment and budgetary import constraints for Pakistan on Gasoline.

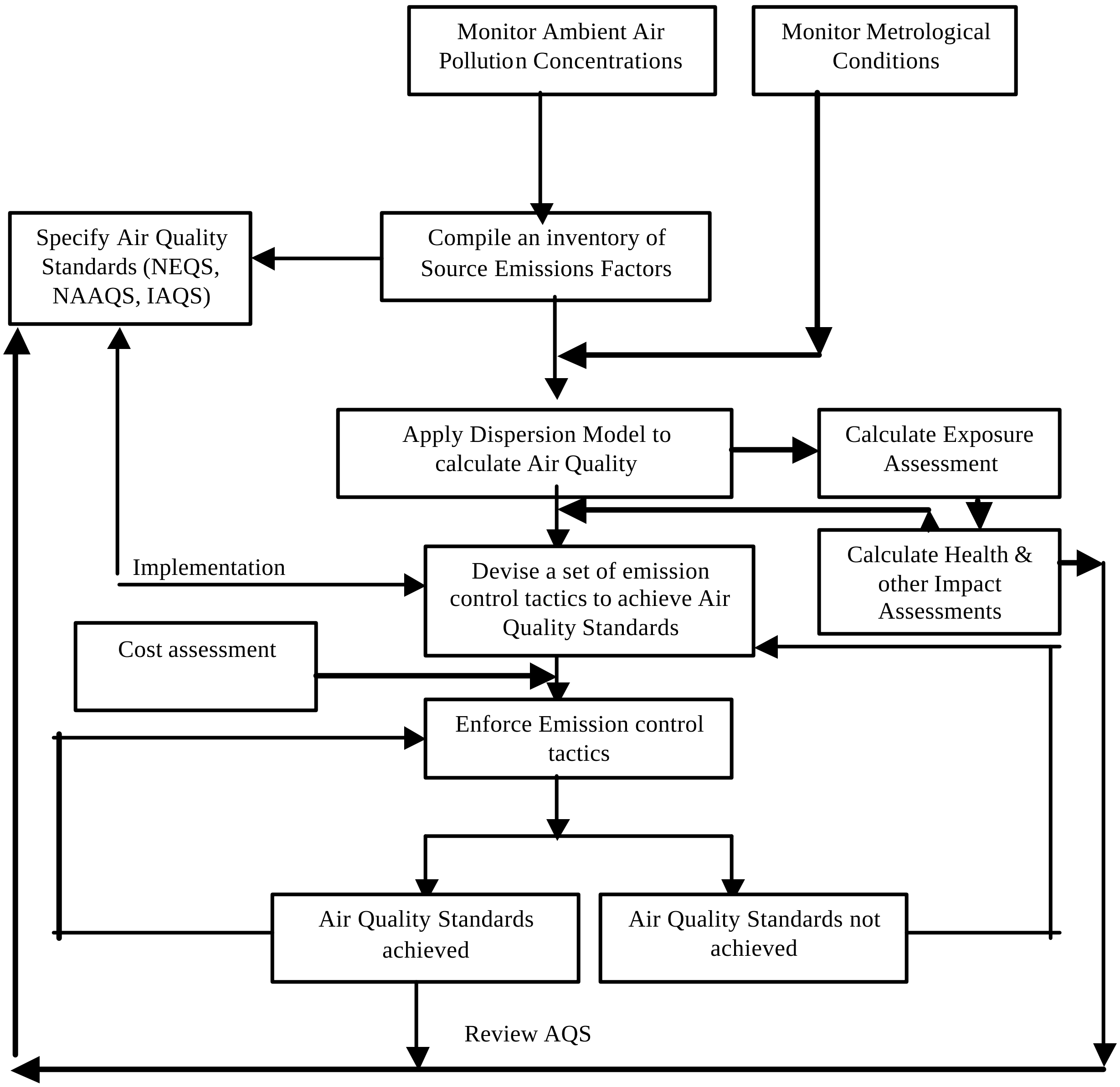

Figure 1:- Stages involved in the **Air Quality Management Strategy (AQMS)**

Conversion to CNG [18]; Hydro-Carbon Development Institute of Pakistan (HDIP; www.hdip.com.pk) has been promoting CNG as an alternate fuel for transport sector and is successful due to market forces. Environmental considerations are a byproduct, since CNG is claimed to be more environment friendly for NOx emissions [14]. HDIP claimed that a) 250 CNG stations are operational in the country which are providing conversion & filling facilities, b) 235,000 petrol driven vehicles (25% of 4 wheeler petrol driven vehicles) have been converted to CNG, c) estimated daily CNG consumption is 17 MMCFD as in year 2001, d) Replacing 142,000 (13%) Tons per year of petrol and e) reducing Greenhouse and other gas emissions from transport sector. Although this shift has caused serious capacity and financial issues relating to refinery operation for gasoline production.

Fuel related air pollution abatement measures include vehicle inspection programs, better fuel formulation, availability of unleaded & low Sulphur fuels, and promotion / use of alternate fuels (CNG, LNG, LPG), shift to gas are cost effective and require cost sharing by individuals and need a time frame in view of fast growing magnitude of air pollution. These measures, if implemented with proposed levels, will reduce CO_2 emissions by 3 million tons i.e. ~ 3% reduction [19]. In addition, shift to gas will also reduce Sulphur, Lead and SPM from road transport and power plants.

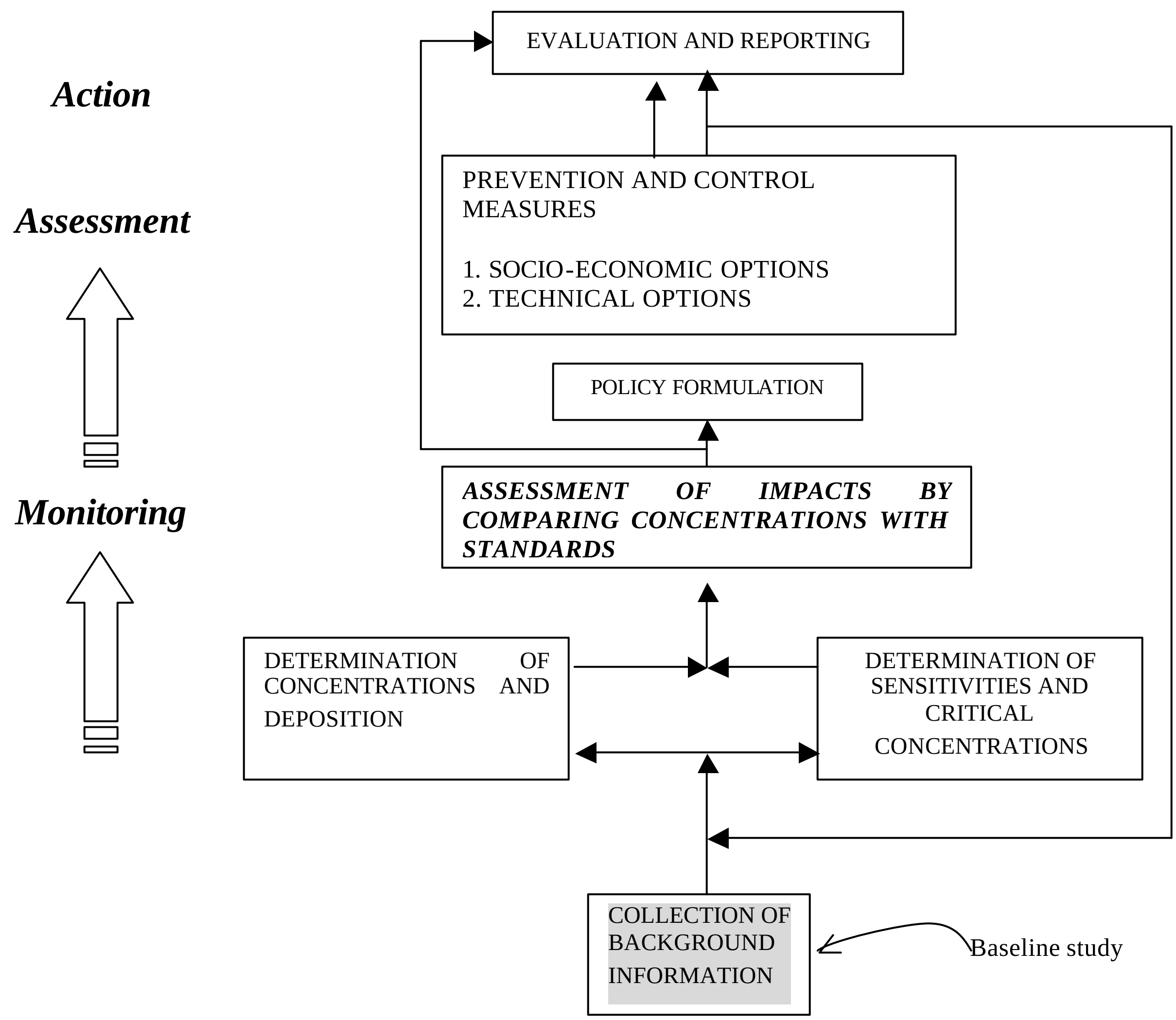

Figure 2: Illustration of an air quality assessment procedure

LIMITATIONS AND CONSTRAINTS:

Quest for growth (in terms of industry, power generation & transportation) play a key role in the development process of a country but ultimately deteriorates surrounding environmental conditions. Cities have become major **"environmental hot spots**" that urgently require special attention for studies and proper environmental and transport planning /and traffic management for air pollution and wastes management, ecological sustainability and pollution controls. For an effective AQMS, pollution problems solution is not effective due to a variety of reasons which may include:-

(i) No understanding on AQMS by planners, implementers, No effective linkage amongst various players of integrated AQMS including EPAs, local governments, traffic police, academia, industries / chambers, MO Industries & Production, MO Science & Technology, health professionals etc.

(ii) No priority on government's part & supply of resources,

(iii) No continuous monitoring station present in country i.e. most of the data reported is obtained from mobile monitoring units or spontaneous onsite sampling with laboratories based results – no complete clear picture of Air Pollution in various cities has emerged from these temporary monitoring campaigns,

Table 1 : Ambient air Pollution comparison amongst countries of South Asia:- A summary [13]

Country	Nature of Air problems	Status	Pollutants monitored	No. of Monitoring Stations	Capacity of MS	AQ standards notified	SO_2 Concentration or total emissions	NO_2 Concentration ?g/m^3 or total emissions
Pakistan	Vehicular, Industrial, Power plants, Biomass, waste	No systematic monitoring: Random monitoring	PM_{10}, SO_2, NO_x, CO, metal	3 mobile	Limited	NEQS for industries, AAQS for thermal power plants	0.3 – 1.0 m ton / y	-
Bangladesh	Vehicular Coal burning, Industrial	No systematic monitoring: Random monitoring	SPM, SO_2, NO_x, CO, Pb	4	Limited	Env. Conservation Rule 1997 covering column 4	Dhaka City, 1998, 95-150??g/m^3	
Bhutan	Vehicular, Industrial, Forest fires	As above	SPM, SO_2, NO_x, CO,	3	None	No		
India	Industrial, power vehicular,	Systematic for few industries / cities	SPM, RSPM, SO_2, NO_x, CO, Pb, PAH, H_2S, NH_3	280	CPCP, NEERI	AAQS 1981 for RSPM, SO_2, NO_x, CO, Pb,	3-4 million ton / yr from 1991-97	5.5 – 8.2 million ton / yr from 1991-97
Iran	Vehicular, Industrial	No systematic monitoring: Random monitoring in Tehran only	SO_2, NO_x, CO, O_3, TSP	15 stationary 23 portable	Limited	1995 order of ICA	0.3 – 0.75 Million ton S / yr from 1980-98	0.3 – 0.95 Million ton S / yr from 1980-97

Maldives	Urban, Tran boundary over ocean	No Monitoring data from INDOEX [1]	No	No	No	No	No	No
Nepal	Vehicular, Industrial, Fossil fuel, rural	No systematic monitoring: Random monitoring	TSP, PM_{10}, SO_2, NO_x, CO, Pb	No continuous monitoring	Limited	No standards for stationery sources, Vehicles emission standards introduced	~15000-20000 Ton S / yr from 1992-96	24000 – 36000 ton S / yr from 1992-97
Sri Lanka	Vehicular, Power	No systematic monitoring: Random monitoring	PM_{10}, SO_2, NO_x, CO, O_3,	2 fixed in CMR, 5 mobile	Limited	CEA standards for column 4	25000 – 40000 Tones / y	82,000 – 118,000 Tones equ/y
Egypt [16]	Vehicular traffic, industries	Partial systematic monitoring for few area and pollutants	SO_2, NO_x, CO, O_3, HC, SPM, heavy metals	6 mobile units for measuring AAQ	Limited	Notified 1994, 1982	100 – 260 ?g/m^3	90-200 ?g/m^3

Table 2 : Comparison on Air Quality Standards :- A summary [13]

Pollutant	**SPM** (?g/m^3)				**SO_2** Units: ppm (?g/m^3)			**NO_2** Units: ppm (?g/m^3)				**CO** Units: ppm (mg/m^3)			**O_3** ppm (?g/m^3)	
Name of country / Standard	**1 hr**	**8 hr**	**24 hrs**	**1 yr**	**1 hr**	**24 hrs**	**1 yr**	**1 hr**	**24 hrs**	**1 yr**	**Notes**	**1 hr**	**8 hrs**	**24 hrs**	**1 hr**	**8 hrs**
Pakistan Unpolluted Highly Polluted	-	-	-	-	 - -	 - -	 (50) (10)	-	-	0.05 (100)		-	-	-	-	-
USA 10 ?m 2.5 ?m	-	150	50 65	AAM 50 15 AAM	0.5 (1300) 3-hr	0.134, (365)	AAM 0.03 (80)	-	-	0.053 (100)		35 (40)	10 (35)	-	0.12 (235)	0.08 (157)
Japan 10 ?m 2.5 ?m	200	-	100	-	0.1	0.04	-	-	0.04 - 0.06	-		-	20	10	0.06 (120)	-
Saudi Arabia 15 ?m	-	-	340	80	0.28 (730)	0.14 (365)	0.03 (80)	0.35 (660)	-	0.05 (100)		35 (40000)	9 (10000)	-	0.15 (195)	
Mexico 10 ?m TSP	- -	- -	150 275	- -	-	0.13	-	0.21 (395)	-	-		-	13	-	0.11	
Chile TSP	-	-	260	80	-	0.14	0.03	0.25	0.16	-		35	9	-	0.12 (235)	
Netherlands 10 ?m	-	-	150	-	(200) 6 months	(100)	(50)	0.06 (110)	0.04 (75)	0.025 (50)	Sweden winter				0.12 (235) Netherland	

UAE 10 ?m	300	-	150	-	0.13	-	0.03	0.15	-	0.06		20 (22860)	-	-	0.08 (157)	
Kuwait 10 ?m	-	-	350	90	0.17	0.06	0.03	0.1	-	0.5		35 (40000)	8 (9140)	-	0.08 (157)	
WHO Recommended Level	50	-	120	-	(350)	0.048 (125)	0.02 (50)	0.21 (400)	0.08 (150)	0.02 (40)		35 (40000)	9 (10000)	-	0.09 (180)	(0.11)

(iv) No development of NAAQS / IAQS/ ES for vehicles,
(v) No effective mechanism to follow up the implementation of MEA on Air Pollution like UNFCCC, MP, Male Declaration, Kyoto Protocol, etc.,
(vi) Two stroke engines, fuel adulteration, lack of maintenance culture,
(vii) Lack of trained staff to develop, follow & implement AQMS, lack of capacity & linkage amongst all the linkages on EPA, local governments, traffic police, mobile laboratories to check vehicular emissions etc.
(viii) In the absence of an effective **urban mass transport system** in all the major cities, traffic problems are on the rise in these heavily populated cities thereby deteriorating urban air pollution concerns.

CONCLUSION:

Due to these limitations and constraints, it is concluded that correcting air pollution problems is not a desirable luxury for the developed nations only, but necessary for long term public safety and can equally benefit Asian countries. Only elimination of the source of the problem can result in clean Unpolluted Air nearly free from pollutants already disbursed, and the desired result will only be seen by citizens of the third millennium if we start cleaning up mess already created. The battle to change the way we produce, consume and pollute has just begun, but I believe it is essential that it be fought now with full vigor.

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