APPRAISAL OF AIR AND WATER POLLUTION IN HYDERABAD AND KARACHI, PAKISTAN

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ABSTRACT

Environmental pollution refers to mixing or contamination of undesirable substances in the environment, affecting the living organisms of the biosphere. This obviously includes human beings, who themselves may be responsible for introducing pollutants in the biosphere. Worldwide, more than 10 million people, die every year from the ingestion or inhalation of these pollutants.

This paper, mainly deals with pollution of air and water, which are the main sources of damage to the life of human beings. In this framework, the two largest cities of Sindh, namely Karachi and Hyderabad, and the areas around them, are selected for the analysis of contaminated air and water in these areas. Guidelines formulated by the US Environmental Agency, World Health Organization, as well as the Environmental Protection Agency of Pakistan are consulted. Clean air is essential for human health and environmental. Consequently, the presence of excessive amounts of pollutants, such as particulate matter, together with oxides of Carbon, Sulphur and Nitrogen, as well as Ozone is the main ingredients of concern in the studied areas. In a similar context, *water* is also an important ingredient of the environment. It is used for drinking, municipal, irrigation and *industrial* purposes. The discharge of untreated industrial and municipal waste, as well as the presence of contaminated drinking water, poses serious environmental concerns in Karachi and Hyderabad. Noise pollution is also a matter of apprehension, particularly in the thickly populated settlements, around the two cities surveyed in this study. Suggested are given to circumvent some of the environmental concerns through legislation and implementation by relevant authorities

***Keywords**: Pollution, environment, greenhouse gases, air, drinking water, wastewater*

1. INTRODUCTION

Pollution is defined as the introduction of contaminants into the environment that may cause undesirable changes in air, water and land, affecting living organisms in the ecosystem. As shown in Figure 1, there are four basic components of global environment. These include Atmosphere (Air), Lithosphere (Land), Hydrosphere (Water) and Biosphere. The latter is the living component of the environment including human beings, as well as parts of other components of the global environment.

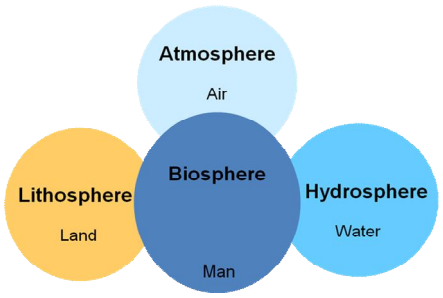

Fig. 1: Global Environment

It may be emphasized that the biosphere is a composite of living as well as nonliving parts (Figure 2). The living part constitutes ecosystem, which varies with type of species. Furthermore, each ecosystem requires a kind of habitat that may include living and nonliving counter parts, for its survival. A habitat is, therefore, a place where a living organism finds its shelter, obtains food and where it can reproduce.

The science of ecology, on the other hand, deals with the study of living organisms in their natural environment. However, the impact of anthropogenic activities, in particular, on the pollution of environment is a matter of concern for all involved in the study of environmental health hazards. A wide variety of environmental issues, generally resulting from the rapid urbanization together with industrialization, have led to contamination of air, water, land and the ecosystem of living organisms.

The influx of such contaminants, particularly the toxic materials and other pollutants, threatening survival of

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living organisms, predominantly human beings, is a pollutants, including the ones', introduced by the intensive use of materials, employed for the generation of energy needed for socioeconomic development of countries, has seriously affected the quality of life in the biosphere.

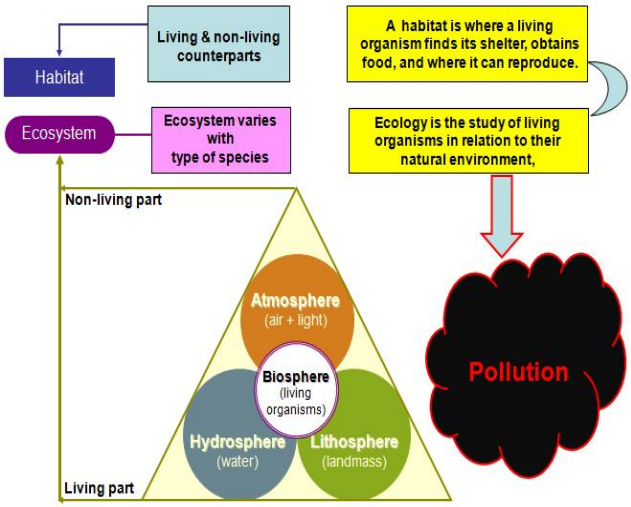

Fig. 2: Global Ecosystem

This paper will essentially address issues caused by the pollution of air and water in broad-spectrum and shed some light on guidelines for drinking water and disposal of industrial effluents. Finally, the situation of pollution related matters in the most populated two district of Sindh, namely Hyderabad and Karachi, as shown in Figure 3, will be addressed and remedial measures to circumvent the adverse situation affirmed.

Hyderabad and Karachi, and are the two most important cities of the province of Sindh (Figure 3). The urban and rural constituencies of these two cities constitute less than 5% of the total area of the Province. The two cities are inhabited by approximately 27 million people.

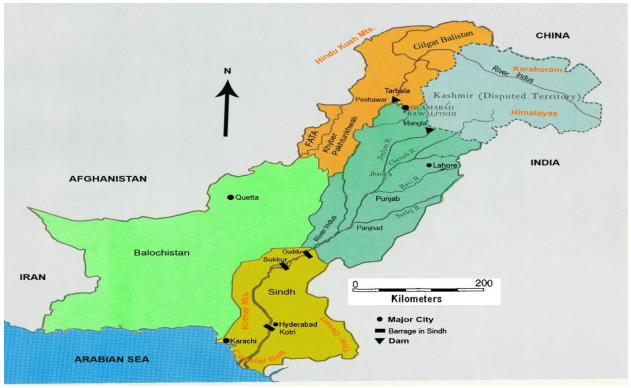

Fig. 3: Map of Pakistan, showing the route of River Indus and its main tributaries, contributing water to the Province of Sindh

matter of great concern. The cumulative effect of all these The main occupation of the rural population is generally agriculture, while the urban population is mainly involved in office work, service and industrial sectors.

The rural areas have generally clean air, mostly free of air pollutants, as well as the nuisance of noise. However, the lack of clean and hygienic water together with absence of hygienic conditions and poor sanitation, are a major problem in the rural surroundings. The urban areas, on the other hand are inflicted mostly with problems of air pollution, and generally untreated wastewater, as well as disposal of the untreated industrial effluents in the channels, carrying river water, or dispose it off directly in the Arabian Sea.

2. POLLUTION OF ENVIRONMENT

Air and water, besides others, are among the most significant pollutants affecting human beings. Environmental imbalance in these and noise, as well as other components often gives rise to a wide variety of health problems to human beings and other living organisms.

The earth's atmosphere consists of a mixture of various gases. By volume, it contains approximately 78% nitrogen, 21% oxygen, as well as argon and other inert gases to the extent of about 1.0%. Furthermore, carbon dioxide is another important constituent of the atmosphere, which varies in amount from 0.1% to 0.3%. The gaseous composition of clean dry air is given in Table 1.

TABLE 1: MAJOR CONSTITUENTS OF DRY AIR [17]

Gas	Volume Percentage
Nitrogen (N_2)	78.084%
Oxygen (O_2)	20.946%
Argon (Ar)	0.9340%
Carbon Dioxide (CO_2)	0.0397%
Neon (Ne)	0.001818%
Helium (He)	0.000524%
Methane (CH_4)	0.000179%
Not included in Major Constituents of dry air*	
* Water Vapor (H_2O)	Locally varies from 0.001% to 5.0%

Air pollution is a major environmental risk to health. It can be defined broadly as the introduction of chemicals, particulate matter, or biological materials into the atmosphere that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment. By reducing air pollution levels, countries can reduce the burden of disease from cardiovascular and respiratory diseases.

Air pollution can be classified into anthropogenic and non-anthropogenic origin. The latter includes natural events such as wildfires, volcanic activity and dust/sand storms [4]. These, as well as the anthropegenic pollutants including Carbon, Nitrogen, Sulphur, Lead and Ozone, as well as other containments, which may pose environmental hazards. The effect of Greenhouse gases, such as water vapor, carbon dioxide, methane, nitrous oxide. Ozone and Chloroflorocarbons, which greatly affect the temperature of the earth, are beyond the scope of this article.

Water pollution is the second most crucial environmental concern to human beings after air. It is estimated that over 96% of the water is saline. Of the total fresh water, fit for human consumption, more than 68% is locked up in glaciers and ice caps. Another 30% of freshwater is under the ground. Rivers are the source of surface water that people mostly use; but this constitutes only 0.0002% of the total water available in the hydrosphere. Table 2 and Figure 4 present, an estimate of global water distribution [10] [11].

TABLE 2: ESTIMATED GLOBAL WATER DISTRIBUTION [10]

Water source	Water volume in cubic miles	Water volume in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas & Bays	321,000,000	1,338,000,000	--	96.54
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Groundwater	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Water pollution is a grave problem in Sindh. Water is polluted from a wide variety of sources. It gets contaminated, when pollutants from different sources either come in contact with sources of water or are discharged into bodies of water. However, the effects of water contamination depend on the composition of effluent pollutants that get mixed up with water. This is particularly true for untreated industrial waste. The same is true for habitation situated close to urban centers.

The assimilation of garbage and other untreated hazardous chemicals, with sources of surface and groundwater, are a major health hazard in this regard. This reflects lack of hygienic control, which promotes the local inhabitants, as well as municipal authorities and manufacturing chemical industries to make use of the uncontrolled situation.

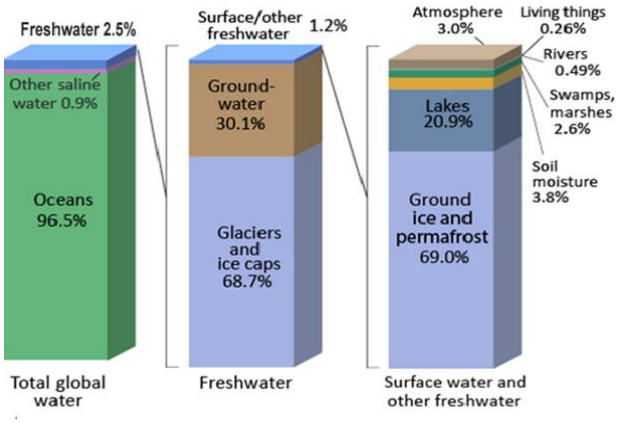

Fig. 4: Distribution of Earth's Water

There is a long list of hazardous chemicals, which generally pollute water, and are the main cause of environmental degradation. These, among others, include inorganic and organic, as well as microbial contaminants

and radio nuclides. The guidelines and specification together with environments guidelines including permissible limits, of these and other chemicals, will be outlined later on.

3. GUIDELINES FOR AIR POLLUTANTS

Air pollution often causes stroke, heart disease, lung cancer, and both chronic as well as acute respiratory diseases, including asthma. Guidelines for clean air are set by several international and domestic organizations for the benefits of public health and environment. The modified Clean Air Act requires [13] to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. For a lay person, one may refer to Air Quality Index [12] to make an assessment of the quality of air. This practice is nonexistent in Pakistan. Table 3, summarizes the type of air pollutants and the standards used in Pakistan [8].

TABLE 3: NATIONAL ENVIRONMENTAL QUALITY STANDARDS FOR AMBIENT AIR

Pollutants	Time-weighted average	Concentration in Ambient Air	
		Effective from 1st January 2009	Effective from 1st January 2012
Sulphur Dioxide (SO_2)	Annual Average*	80 µg/m³	80 µg/m³
	24 hours**	120 µg/m³	120 µg/m³
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m³	40 µg/m³
	24 hours **	40 µg/m³	40 µg/m³
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m³	40 µg/m³
	24 hours **	80 µg/m³	80 µg/m³
Ozone O_3	1 hour	180 µg/m³	130µg/m³
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m³	360 µg/m³
	24 hours**	550µg/m³	500µg/m³
Respirable Particulate Matter. PM_{10}	Annual Average*	200 µg/m³	120 µg/m³
	24 hours**	250 µg/m³	150 µg/m³
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 µg/m³	15 µg/m³
	24 hours**	40 µg/m³	35 µg/m³
	1 hour	25 µg/m³	15 µg/m³
Lead (Pb)	Annual Average*	1.5 µg/m³	1 µg/m³
	24 hours**	2 µg/m³	1.5 µg/m³
Carbon Monoxide (CO)	8 hours**	5 mg/m³	5 mg/m³
	1 hour	10 mg/m³	10 mg/m³
* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.			
** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.			

The "WHO Air Quality Guidelines" [15], also provide an assessment of health effects of air pollution and thresholds for health-harmful pollution levels. These Guidelines apply worldwide in all WHO regions; and are based on expert evaluation of current scientific evidence for the presence of Particulate matter (PM), Ozone (O_3), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) as the indicator of larger group of nitrogen oxides. These guidelines include most of the pollutants listed by US EPA (2012) [13], but further troughs light on Nitrogen Oxide (NO_2), Chloroflorocarbons (CFCs), which affects the lower atmospheric zone leading to climate change, which among other things causes global warming. Furthermore, the presence of Ozone, in particular, at the upper atmospheric zone, is a blessing. It prevents the penetration of this zone by Ultraviolet radiation; and thus protects human beings from the incidence of cardiovascular and respiratory diseases. However, at the lower ground level, these constituents cause decrease in visibility, and difficulty in driving.

Commenting on climate change, Mu and Mu [16] reflect on the influence of mining of fossil fuels and other substances, which destroy the 'thermal insulating' layers inside the Earth's Crust. Any decrease in the thickness of these layers, eventually cause, the trapped heat inside the Earth, to escape at the earth's surface, leading to climate change, particularly in the regions, where such activities are intensely practiced. The climate change is, therefore, manifested by global warming gases, as well as the heat emanating from the surface of the earth.

Besides, quality of ambient air, the response of human ear to sound is also important. The noise has direct and specific effects on human health as described by Abbasi

et al [1]. WHO (1980) [14], recommendations of noise exposure, and guidelines for environmental quality standards are reproduced in Table 4. These guidelines are more specific about the environment, such as living areas, hospitals, industrial and commercial, as well as traffic congested areas, public address and music related activities.

The time of exposure and the duration of the specified level of sound, as well as the environment of work, are also significant in critical health effects Khan, et al [6].

The WHO Guidelines are more specific than Pakistan National Environmental Quality Standards, for Noise. The latter classifies the areas into residential, commercial, industrial and silent zones; but does not consider the time duration, as well as the critical health effects thereof. However in both the cases, the noise levels at day time does not exceed 65 accept in industrial and commercial areas where the maximum allowable limit varies between 65 and 75 dB. However, the acceptable limit for residential areas is 50 dB; but the allowable level for schools is 35 dB.

TABLE 4: WHO GUIDELINES FOR NOISE QUALITY STANDARDS

Specific Environment	Critical Health Effects		Allowable Noise Level (dB)	Time Duration (Hrs)
Outdoor living area	Serious Annoyance Day time		50	16
Indoor, Inside bed room	Moderate Annoyance	Day Time	35	16
		Night Time	30	08
Outside bed room	Sleep disturbance, windows open		45	08
Class room	Disturbance of information, message communication		35	During class
Hospital ward room	Sleep disturbance	Day Time	30	08
		Night Time	30	16
Industrial, commercial, shopping and traffic area	Hearing impairment		70	24
Public address	Hearing impairment		85	01
Music through head phone	Hearing impairment		85	01

4. GUIDELINES FOR DRINKING WATER & WASTEWATER POLLUTANTS

Water is important for the survival of all living organisms. There is a considerable variation in the amount of water in healthy human body; and it is generally agreed that 75% of the human body weight is composed of water. Besides being essential for survival, water is used for a variety of other purposes. This among others includes industrial, agricultural, municipal, as well as household purposes. Water quality standards for each purpose vary according to the purpose for which the water is put into use. The availability of drinking water cannot be over emphasized. But in many instances, the drinking water may contain a number of undesirable constituents. Therefore, most people in the developed countries of the world consume hygienically certified bottled water.

The presence of pollutants in drinking water is classified as Physical, Chemical, Organic and Bacterial, as well as Radio Nuclides (Table 5). The Physical Pollutants include color, odor, taste and turbidity in the form of suspended particles. There is a long list of Chemical Pollutants. It consists of pH, Alkalinity, Total Dissolved Salts, Ammonia, Arsenic, Barium, Boron, Cadmium, Chloride, Chromium, Copper, Iron, Lead, Manganese, Phosphorous, Selenium, Zinc, Nitrate & Nitrites, and Sulfate & Sulfide. The Organics include Pesticides and Phenolic compounds. Bacterial contaminants contain all forms of Coilform bacteria. The Radioactive materials essentially include Alpha Emitters.

The wastewater of untreated or partially treated wastes includes municipal, industrial and agricultural wastes. It includes several physical, inorganic, organic, biological and hazardous contaminants. Metcalf and Eddy [7] present a list of typical concentrations of Organics in untreated domestic wastewater. The list, as shown in Table 6, includes BOD, COD, TOC, O&G. The latter includes Oil & grease, which are insoluble in water. They and their byproducts, include a wide variety of contaminants. They can reduce aquatic organisms' ability to reproduce and survive. Dumped oil or oil spills, through breakup or overturning of oil tankers, in the sea, are an example of the turmoil that such a spill can create. Although a majority of oil spills occur occasionally, but they receive considerable attention on account of the obvious environmental damage. This is manifested by the

dead as well as oiled seabirds and marine mammals, together with acute impacts that such episodes leave particularly at the aesthetic and hygienic sense of the community living on the sea side. There are several industries that discharge specific oil and grease related and other hazardous effluents, the description of which is beyond the scope of this paper.

TABLE 5: NATIONAL STANDARDS FOR DRINKING WATER QUALITY

A. Physical

Properties / Parameters	Standards Values	Properties / Parameters	Standard Values
Colour	≤ 15 TCU	Total hardness as	< 500 mg/L
Taste	Non Objectionable/Acceptable	$CaCO_3$	
Odour	Non Objectionable/Acceptable	TDS	< 1000
Turbidity	< 5. NTU	pH	6.5 – 8.5

B. Chemical Parameters

• **Inorganic**	**mg/Litre**	**Inorganic**	**mg/Litre**
Aluminium (Al) mg/L	≤ 0.2	Cadmium (Cd)	0.01
Antimony (Sb)	≤ 0.005 (P)	Chloride (Cl)	< 250
Arsenic (As)	≤ 0.05 (P)	Chromium (Cr)	≤ 0.05
Barium (Ba)	0.7	Copper (Cu)	2
Boron (B)	0.3	Nitrate (NO_3)*	≤ 3 (P)
Cyanide (CN)	≤ 0.05	Nitrate (NO_2)*	≤ 3 (P)
Fluoride (F)*	≤ 1.5	Selenium (Se)	0.01 (P)
Lead (Pb)	≤ 0.05	Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source
Manganese (Mn)	≤ 0.5	Zinc (Zn)	5.0
Mercury (Hg)	≤ 0.001		
Nickel (Ni)	≤ 0.02		

• **Organic**	**mg/Litre**	**Organic**	**mg/Litre**
•			
Pesticides mg/L	Not found	Polynuclear aromatic hydrocarbons (as PAH g/l	Not found
Phenolic compounds (as Phenols) mg/L	Not found		

• **Radioactive**	**mg/Litre**	**Radioactive**	**mg/Litre**
Alpha Emitters bq/l or pCi	0.1	Beta emitters	1

C. Bacterial

Properties / Parameters	Standards Values	Properties / Parameters	Standard Values
All water intended for drinking (e.Coli or Thermotolerant Coliform bacteria)	Must not be detectable in any 100 ml sample	Treated water in the distribution system (E. coli or Thermotolerant Coliform and total Coliform bacteria)	Must not be detectable in any 100 ml sample

TABLE 6: TYPICAL ORGANICS IN DOMESTIC WASTEWATERS

Constituents	Unit	Typical Concentrations		
		Low	Medium	High
BOD (biochemical oxygen demand	mg/L	110	190	350
COD (chemical oxygen demand)	mg/L	250	430	800
TOC (total organic carbon)	mg/L	80	140	260
O&G (oil and grease)	mg/L	50	90	100

Since, wastewater may contain various potentially hazardous components, the municipal authorities must be observant of the collection and disposal of wastewater. Table 7, presents an alphabetically sorted list of these pollutants, together with, the proposed standards set by the National Environmental Quality Standards of Pakistan, as quoted by Ahmed [2] and Ejaz et al [3]. The latter give an assessment of effluent streams discharging into River Ravi in Lahore, Pakistan.

TABLE 7: LIST OF PROPOSED STANDARDS FOR WASTEWATER

Parameters	Proposed Standards
Ammonia (mg/L)	40
BOD Days (mg/L)	80
COD (mg/L)	150
Chloride as Cl (mg/L)	1000
Cadmium (mg/L)	0.1
Chromium (Trivalent & Hexavalent) (mg/L)	1.0
Copper (mg/L)	1.0
Chlorine (mg/L)	1.0
Detergents (mg/L) Modified Benzene Alkyl Sulphae MBAS	10.0
Fluoride as F (mg/L)	10.0
Iron (mg/L)	2.0
Lead (mg/L)	0.5
Manganese (mg/L)	1.5
Mercury (mg/L)	0.01
Nickel (mg/L)	1.0
Oil and Grease (mg/L)	10
Phenolic Compounds as Phenol (mg/L)	0.1
pH value	6.0-10.0
Suspended Solids (mg/L)	150
Sulphates (mg/L)	600
Sulphide (mg/L)	1.0
Temperature ^{0}C	40
Total Dissolve Solids (mg/L)	3500
Zinc (mg/L)	5.0

The River receives heavy loads of untreated domestic and industrial effluents; and is, therefore, acting as a wastewater carrier. Its waters are used for irrigation and livestock and other purposes. This is in contravention of the mandatory National Standards of Wastewater shown in Table 7. The same standards are also applicable to wastewater and industrial effluents discharged in Hyderabad and Karachi.

5. RESULTS & DISCUSSION

The areas around these two cities are affected by several air and water, as well as noise related environmental problems. River Indus is the main source of drinking, agricultural and industrial consumptions. It has three barrages, namely Guddu, Sukkur and Kotri in the Province of Sindh [5]. These barrages have several canals and water courses through which the water is diverted to various regions of Sindh including Hyderabad and

Karachi. The River Indus ultimately drains into the Arabian Sea, adjoining Karachi, which is the hub of industries of various kinds.

Hyderabad draws its waters from canals emerging from the Kotri barrage. However, the rural pollution, depends essentially on dug well or watercourses for drinking and domestic purposes. Similarly, the main source of water supply to Karachi is also a canal from the Kotri barrage. This canal, Known as the Kalri Baghar, feeds the famous Kenjhar Lake, which acts as a reservoir of water for Karachi.

Air & Water Pollution in Hyderabad: Most of the people **of** Hyderabad live and work in the rural areas of Sindh. For livelihood, they depend on agriculture, which is the backbone of the economy of Pakistan. River Indus, apart from scanty rain fall, is the main sources of their survival. The air in the rural areas is essentially clean and satisfies all environmental guidelines.

There is a shortage of surface water in general, and the groundwater is essentially saline, except in the neighborhood of river, and the water distributor channels spread over the area. However, the conditions of air and water in the urban areas of Hyderabad are a matter of great concern. Table 8 shows air quality data, in selected, urban areas of Hyderabad.

TABLE 8: AIR QUALITY DATA OF HYDERABAD, 2013

Site	Time	CO	CO_2	Oxides of Nitrogen			SO_2	O_3	$PM_{2.5}$	PM_{10}	Noise
				NO	NO_2	NO_x					
		(ppm)	(ppm)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ug/m^3)	(ug/m^3)	(dB)
Tilk Chari	Average	3.63	355.50	29.17	6.08	35.25	34.21	27.42	*44.54	*120.42	*70.29
	Max	4.8	372	35	11	42	38	36	*49	*128	82
	Min	2.5	329	24	0	31	30	22	*40	108	58
SITE Area	Average	1.98	294.54	18.17	5.50	23.67	18.08	15.25	*37.83	110.92	63.33
	Max	2.3	302	28	9	35	22	28	*44	*129	77
	Min	1.5	287	14	2	20	14	2	*30	95	52
Shahbaz Building	Average	2.20	294.21	22.96	5.50	28.46	17.92	15.38	*31.50	83.42	49.96
	Max	2.5	302	28	9	33	22	31	*38	89	55
	Min	1.8	287	17	3	21	14	1	*28	78	45

Comparing air quality of Hyderabad, as shown in Table 6, with the National Environmental Quality Standards for Ambient Air (Ministry of Environment, Government of Pakistan, 2010), it is noted that all except the presence of particulate matter are satisfied at all the three locations. The $PM_{2.5}$ values at Tilk Chari and Shahbaz Building are above the permissible levels. They major reason for the presence of this pollutant, is the gases emitted from heavy traffic of automobiles, consuming fossil fuels in the area. Similarly the MP_{10}, values at Shahbaz Building are also in excess of the acceptable levels. The traffic noise, particularly in the urban areas, is yet another matter of grave concern, particularly in the residential and office areas of Tilk Chari and Shahbaz Building. The highest noise level is at Tilk Chari, which is most congested residential and commercial area. However the limit of noise level at Shahbaz Building is very close to the upper limit, and needs to be reduced to an acceptable limit. Surprisingly, the level of noise at the Site Industrial area is acceptable.

The results of the chemical analysis of drinking and tap water, in the eight selected urban areas of Hyderabad, are presented in Table 9. This table clearly indicates that in most of the area, the values of chemical constituents, like Arsenic, Barium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium and Zinc are above the acceptable level. Similarly, the values of Nitrates and Fecal Coliforms are also not permissible. Furthermore, all the constituents, which do not satisfy the Waste Water Standards displayed in Table 9, are marked by an asterisk.

TABLE 9: DRINKING / TAP WATER TESTING DATA, HYDERABAD

	Site / Quality	Liaquat Colony	Memon Hospital	Tilk Chari, St .Mary's High School	Hali Road Opp. Police Station Site	Nazeer Hussain Hospital	Shah Gi Hotel Jail Road	Govt. Elementary College	Kali Mori
Physical Parameters	Taste	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
	Odour	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
	Turbidity (NTU)	*6.19	*11.6	0.95	*12	0.43	*14.5	3.39	*20.7
	TDS (mg/L)	462	472	489	467	495	480	590	*7280
	Conductivity (µS/cm)	764	787	815	778	825	799	903	*12140
	pH	8.15	8.11	8.03	8.04	7.7	7.82	8.36	*8.73
	Hardness (mg/L)	195	200	197	190	200	194	210	1778
Fecal CFU/100 ml	E.Coli	*4	*2	*5	*2	*4	*2	*5	*20
	Fecal Coliform	*10	*25	*10	*15	*35	*45	*54	*95
	Total Cliform	*14	*27	*15	*17	*39	*47	*59	*115
Misc. Mg/L (ppm)	Flouride	0.43	0.65	0.41	0.25	0.50	0.50	0.58	0.83
	Chloride	126.10	101.50	113.83	108.13	127.50	124.85	98.48	*6005.13
	Nitrate	*10.53	*4.03	*6.90	*5.13	*5.50	*4.90	*4.50	*151.35
	Sulphate	119.40	133.35	103.28	129.03	133.48	136.15	125.93	850.23
Chemical Constituents µg/l (ppb)	Arsenic (AS)	*16.50	*15.34	*16.34	*13.89	*15.63	*17.29	*16.92	*35.96
	Barium (Ba)	*122.23	*137.74	*108.37	*114.88	*149.29	*119.45	*128.05	*87.64
	Cadmium (Cd)	ND	ND	ND	0.14	ND	ND	ND	0.51
	Chromium (Cr)	ND	*8.07	ND	ND	ND	ND	ND	*8.84
	Copper (Cu)	*13.94	*12.85	*14.38	*47.77	*16.01	*3.29	*19.87	*39.34
	Iron (Fe)	8.32	19.03	13.42	8.81	9.67	10.96	7.92	22.53
	Lead (Pb)	*0.11	*1.61	*0.07	*187.56	*0.78	*0.24	*2.49	*0.57
	Manganese (Mn)	*30.35	*92.79	*49.65	*37.48	*36.14	*50.63	*28.78	*64.11
	Mercury (Hg)	*0.04	*0.16	*0.03	*0.81	*0.04	*0.05	*0.08	*0.11
	Nickel (Nil)	*3.86	*11.92	*5.63	*12.52	*4.83	*5.87	*19.58	*47.17
	Selenium (Se)	*7.27	*8.21	*10.38	*8.37	*8.94	*8.48	*7.41	*55.78
	Silver (Ag)	0.00	0.08	0.01	1.01	0.00	ND	0.03	0.60
	Zinc (Zn)	*8.77	*7.40	*8.79	*21.70	*10.34	*1.94	*2.08	*1.19

Similarly, Table 10 shows, the analysis of Wastewater, generally disposed of in the city. The values of most of the metal ions, such as Chromium, Nickel, Iron, Manganese, Lead and the Zinc are higher than the recommended concentrations specified by the National Environmental Quality Standards of Pakistan. The values of TSS, COD and BOD are also very high. All these constituents are identified by an asterisk in the table.

TABLE 10: WASTE WATER DATA OF SELECTED SITES IN HYDERABAD 2013

Site / Quality	Veterinary Hospital, Hyderabad	Sray Ghat,, Hyderabad
pH	8.22	8.14
TSS	*421	*270
TDS (mg/L)	1127	856
BOD	*292	*153
COD	*540	*260
Nitrate (NO_3^-) mg/L (ppm)	16	8
Sulphate (SO_4^{2-}) mg/L) (ppm)	254	193
Sulphide (S^{2-})	0.57	0.42
NH3	27	14
Oil/Grease	8	3
Chlorine	0.41	*0.62
Phenolic compounds (as Phenols)	0.07	0.01
Chloride	724	496
Fluoride	3.2	4.6
Silver (Ag) µg/l (ppb)	0.93	1.24
Copper (Cu) µg/l (ppb)	*254.5	*107.21
Nickel (Ni) µg/l (ppb)	*73.54	*21.79
Zinc (Zn) µg/l (ppb)	*35.62	*115.47
Iron (Fe) µg/l (ppb)	*42.58	*11.27
Manganese (Mn) µg/l (ppb)	*375.20	*112.16
Cobalt (Co) µg/l (ppb)	25.81	9.46
Barium (Ba) µg/l (ppb)	423.50	93.16
Chromium (Cr) µg/l (ppb)	*27.07	*42.33
Arsenic (As) µg/l (ppb)	12.01	2.37
Selenium (Se) µg/l (ppb)	82.14	ND
Cadmium (Cd) µg/l (ppb)	ND	*2.39
Mercury (Hg) µg/l (ppb)	*0.37	*0.62
Lead (pb) µg/l (ppb)	*77.68	*25.90

Air & Water Pollution in Karachi: Karachi is the port city of Pakistan. It faces the Arabian Sea in the southwest. It the capital of the Province of Sindh; and in terms of population, Karachi is the largest city of Pakistan; and is also the hub of socioeconomic activity, and industrial outfits. The air and drinking water, as well as the waste water together with industrial effluents are highly polluted. Table 11 depicts the Air Quality of Karachi.

TABLE 11: AIR QUALITY DATA OF KARACHI

Site	Time	CO (ppm)	CO_2 (ppm)	Oxides of Nitrogen			SO_2 (ppb)	Ozone (ppb)	PM_{10} ($\mu g/m^{-3}$)	$PM_{2.5}$ ($\mu g/m3$)	Noise (dB)
				NO (ppb)	NO_2 (ppb)	NO_x (ppb)					
Clifton	Mean	2.97	342.85	44.31	12.86	57.16	16.90	9.18	64.06	*26.72	56.56
	Max	4.66	395	89	18	103	25	30	78	*32	66
	Min	1.76	312	25	10	37	10	1	50	*20	50
II Chundrigar	Mean	3.50	309.47	20.27	9.86	30.12	24.74	15.43	81.93	*33.41	*68.64
	Max	5.2	338	43	16	50	39	30	101	*44	89
	Min	2.1	38	-1	5	12	8	6	65	*25	54
Garden Police HQ	Mean	3.50	338.61	38.85	10.24	49.08	26.82	20.93	97.86	*35.79	*69.08
	Max	4.6	375	48	19	63	32	38	128	*50	79
	Min	2	315	29	5	34	16	5	61	*26	55
SUPARCO	Mean	2.95	286.98	23.12	32.97	56.09	32.85	35.46	94.34	*30.74	58.89
	Max	35	378	35.3	52.8	73.7	51	60	118	*46	72
	Min	1.7	51	17.4	8.7	32.1	23	25	9	*22	50
Korangi	Mean	3.20	446.22	44.31	12.86	57.16	22.11	29.22	82.12	*25.28	68.18
	Max	4.3	521	89	18	103	37	39	*152	*36	80
	Min	2.3	398	25	10	37	10	20	52	*16	52
SITE Area	Mean	3.06	429.98	45.66	10.00	55.66	25.21	29.93	119.22	*57.53	67.30
	Max	4.3	524	85	16	95	46	236	*167	*130	78
	Min	2	325	31	5	37	8	3	75	*20	52
Nazimabad	Mean	3.30	344.43	80.41	14.04	94.45	24.57	13.28	94.33	*62.08	*68.46
	Max	4.1	395	203	19	220	41	33	*130	*130	81
	Min	2.8	308	20	7	31	12	0.8	62	*25	55
Civic Centre	Mean	3.11	348.23	21.91	14.42	36.33	15.69	61.24	4.39	*90.95	35.94
	Max	4.4	420	27	26	46	19	76	25.7	*127	55
	Min	2.3	325	19	10	30	12	50	0.4	*70	20
Baloch Colony	Mean	3.92	457.73	22.66	40.22	62.88	35.16	14.37	99.98	*43.94	*80.41
	Max	6.2	507	34.6	64.4	84.9	41.9	36	*123	*67	149
	Min	2.3	426	17.1	10.6	33.5	21	1	79	*24	51
Karimabad	Mean	3.86	334.37	42.49	11.45	53.82	19.92	14.64	117.40	*69.02	*66.52
	Max	5.2	398	85	16	98	30	29	*154	*156	79
	Min	2.5	312	24	6	36	12	6	73	*24	53

In comparison to Air Quality Standards specified in Table 3, it is observed that in all the sites of Karachi the $dB_{2.5}$ values related to respirable particulate matter are above the specified acceptable limits. However, the respirable MP_{10} particulate matter is high in Korangi, Site area, Nazimabad, Baloch colony and Karimabad. This and other studies [6] clearly indicates that Karachi has a serious problem of excessive amounts of traffic emitting smoke through vehicular and industrial sources. Furthermore the sources of traffic noise in Karachi are also damaging to ears, particularly in areas, such as Chundrigar Road, Garden Police HQ, Nazimabad, Baloch colony and Karimabad

Table 12, presents a summary of the drinking and tape water supplied to the residents of Karachi. There are altogether 9 locations, well spread over Karachi, from which the samples were selected.

TABLE 12: DRINKING / TAP WATER TESTING DATA, KARACHI

Quality \ Site		Civic Center	Jaccob Lines	Sector-33 Korangi	Saudabad, Malir	Rashedabad	North Nazimabad	Kemari	Bin Qasim	Orangi Town
Physical Parameters	Taste	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
	Odour	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
	Turbidity (NTU)	0.62	0.44	0.89	1.09	1.39	2.3	2.1	0.92	1.49
	TDS (mg/L)	542	*1112	565	802	412	556	515	734	840
	Conductivity (µS/cm)	902	*1852	942	1335	689	927	856	1267	1350
	pH	8.02	7.36	7.65	7.32	7.24	8.25	7.68	7.8	7.8
	Hardness (mg/L)	210	350	201	411	206	208	262	190	280
Fecal CFU/100 ml	E.Coli	*3	*5	*8	0	*3	*5	*3	*4	*12
	Fecal Coliform	*22	*35	*65	*35	*32	*10	*12	*15	*35
	Total Cliform	*25	*40	*73	*35	*35	*15	*15	*19	*47
Misc. Mg/L (ppm)	Flouride	0.7	*1.85	0.6	0.42	0.58	0.53	0.42	0.48	0.35
	Chloride	*305.5	*588.1	*360.6	*424.5	*256.9	*340.4	206.73	142.65	*250.36
	Nitrate	2.57	*125.25	2.65	*85.53	*20.17	*4.87	*9.03	1.70	2.47
	Sulphate	256.65	396.4	267.08	332.78	335.73	245.68	149.28	197.38	65.47
Chemicals Constituents µg/l (ppb)	Arsenic (AS)	ND	ND	ND	ND	ND	ND	*13.77	*13.06	ND
	Barium (Ba)	*51.28	*31.36	*46.38	*50.45	*59.12	*36.74	*156.28	*195.53	*60.24
	Cadmium (Cd)	*0.74	*0.16	*0.00	ND	ND	ND	ND	*0.11	*1.11
	Chromium (Cr)	*37.69	ND	ND	ND	ND	ND	ND	ND	ND
	Copper (Cu)	*239.61	*291.16	*31.02	*158.58	*13.12	*14.55	*115.13	*83.61	*80.23
	Iron Fe)	38.33	11.18	3.98	3.28	1.31	0.59	11.13	8.43	5.27
	Lead (Pb)	*4.07	*0.23	*0.22	ND	ND	ND	ND	*1.21	*0.83
	Manganese (Mn)	ND	*32.50	*86.90	*183.01	*152.69	*159.76	*32.60	*28.79	*89.68
	Mercury(Hg)	*0.44	*2.11	*0.55	*0.07	*0.19	ND	*0.10	*0.18	*0.12
	Nickel (Ni)	*33.28	*6.30	*2.03	*92.56	*6.54	ND	*7.49	*22.71	*11.99
	Selenium (Se)	*8.78	*14.03	*6.52	*10.81	*7.34	*5.10	*10.18	*6.02	*0.89
	Silver (Ag)	ND	0.02	ND	ND	0.78	ND	ND	0.09	0.07
	Zinc (Zn)	*1074.1	*197.58	*21.40	*44.37	*5.20	*10.88	*71.93	*39.10	*16.22

The presence of Ecoliforms and Arsenic in drinking water supplies are a matter great hygienic concern. The same is true for excessive concentrations of metallic elements. All these are marked b an asterisk in the table.

Similar situation is depicted by the analysis of wastewater. The results of the analysis are shown in Table 13. The amounts of BOD, COD, and TSS are exceedingly high. Similarly, the concentrations of metallic elements of Copper, Chromium, Nickel, Manganese, Mercury, Nickel, Cadmium, Lead, and Zinc are also above the acceptable limits. Mostly, the wastewater is discharged directly into the sea. However, some of the effluents are partly treated, while the others are untreated, and eventually find their way to coastal waters. This causes coastal pollution, and degradation of the natural ecosystem of the area.

TABLE 13: WASTEWATER ANALYSIS OF KARACHI

Site / Quality	Essa Nagri	Rashedabad	Quaidabad, Bin Qasim Town	Kalaboard, Malir Town	Muzafrabad Colony Landhi Town	Drig Road Shahfaisal Town	Power House Chorangi, New Karachi	Shadman Town, North Nazmabad	Golimar, SITE	Ayesha Manzil, Gulberg Town	Zaman Town, Korangi	Maripor, Kemari Town	Akhtar Colony, Jamshed Town	Islam Chock, Orangi Town
pH	6.14	8.75	8.42	6.73	8.19	8.36	8.2	7.83	7.95	8.9	6.5	8.53	7.76	8.09
TSS	321	*452	*167	805	245	*521	*193	56	*264	42	89	*158	*203	140
TDS	590	832	478	1284	932	1393	750	802	1077	605	911	620	480	691
BOD	*215	*432	*248	*877	*389	*663	*397	*184	*309	*113	*175	*356	*278	*320
COD	*740	*1570	*670	*3300	*1100	*2250	*1420	*670	*1230	*260	*440	*760	*940	*830
Nitrate (NO_3^-)	4.6	3.2	8.4	53.7	11.9	25.6	0.9	5.7	14.2	1.6	2.4	9.8	21.5	17.3
Sulphate (SO_4^{2-})	217	396	420	*742	187	337	402	156	267	95	59	167	356	240
Sulphide (S^{2-})	0.81	0.72	0.5	*1.23	*1	0.94	0.65	0.27	0.11	0.13	0.72	0.87	0.7	0.43
NH3	9	11	17	37	*40	25	24	3	6	7	11	15	8	21
Oil/Greace	7	5.4	2.1	*14.2	3.7	*11	6.4	1.7	3	2.9	5.3	1.1	1.8	3.7
Chlorine	0.53	0.16	0.2	0.94	0.71	0.17	0.19	0.19	0.45	0.73	0.17	0.1	0.1	0.24
Phenolic compounds as Phenols	*0.08	*0.13	*0.04	*0.27	*0.1	0.05	0.04	0.07	0.09	0.09	0.08	*0.12	0.07	0.01
Chloride	659	720	503	*2770	*1240	*1510	320	456	720	291	360	624	398	510
Fluoride	1.7	2.4	1.3	5.7	2.1	5.6	0.9	0.83	3.7	1.9	1.2	2.4	1.6	0.4
Silver (Ag)	0.05	2.29	1.07	0.80	0.92	0.02	ND	0.87	0.03	0.35	0.13	0.16	ND	ND
Copper (Cu)	*168	*224	*2656	*2786	*2638	*256	*34.9	*40.3	*105	*105	*41.	*60.	*66.8	*63.
Nickel (Ni)	*9.9	*63.	*288.	*352.0	*372.5	*58.7	*11.4	*8.55	*50.	*30.	*20.	*21.4	*11.9	*11.
Zinc (Zn)	*103	*109	*1634	*1634	*1747.	*173.	*170.	*24.5	*60.	*51.	*86.	*27.2	*37.5	*34.
Iron (Fe)	*22	*174	*72.93	*205.1	*86.24	*50.1	*22.3	*21.2	*47.4	*39.6	*19.5	*20.1	*10.5	*6.5
Manganes (Mn)	*365	*360	*791.0	*2751.	*447.3	*149	*447.	*352.	*582	*603	*283	*298	*106.	*77.0
Cobalt (Co)	8.61	9.55	49.05	49.92	54.42	6.84	1.87	1.86	8.57	4.31	3.76	3.95	2.33	1.06
Barium (Ba)	78.7	294.	1653.	156.7	172.6	99.25	1828	107.	2947	106.	9069	68.6	61.6	51.9
Chromium (Cr)	*133	*834	*2954	*3135	*3338	*2629	*100.	*58.1	*124.	*127.	*102.	*100.	*53.	*37.8
Arsenic (As)	ND	0.59	8.61	8.11	10.19	ND	ND	ND	ND	ND	1.35	1.91	ND	ND
Selenium (Se)	316.	971.	751.1	589.4	615.5	289.4	842.	1054	674.	540.	922.	891.	596.	404.
Cadmium (Cd)	*5.0	*1.6	*5.74	*8.18	*10.6	*6.58	*6.46	*9.9	*7.9	*1.8	*2.8	*3.2	*5.25	*2.7
Mercury (Hg)	*2.2	*2.62	*4.28	*4.41	*4.61.	*1.57	*1.48	*7.38	*1.08	*1.9	*1.4	*1.4	*0.35	*1.75
Lead (Pb)	*124	*66.0	*189.8	*224.0	*226.2	*28.2	*15.3	*9.08	*20.7	*34.	*14.	*10.	*8.49	*36.3

The above analysis reveals that there is a mix up of municipal and industrial wastewaters in the sewerage system of Karachi. The high concentration of metallic elements signifies closeness to metal extraction industries, as well as processing of the famous leather tanneries in Karachi.

6. CONCLUSIONS & RECOMMENDATIONS

This paper, which is essentially based on the secondary data collected from reliable and authentic sources of information, scattered in files of relevant organizations; and draws conclusions on the quality of environmental pollution in the light of National and World Standards.

All kinds of pollution, witnessed in Sindh, are also common in many parts of Pakistan [9]. Suggestions for remedies for this nuisance are well spread in the international literature. For Hyderabad and Karachi, which are polluted to various degrees of deleterious elements, are of particular interest in both the places, it is pertinent to keep the air clean, devoid of excessive amounts of respirable particulate matter, and other harmful pollutants. Reducing annual average particulate matter (PM_{10}) concentrations from levels of 70 $\mu g/m^3$, to the WHO guideline level of 20 $\mu g/m^3$, could reduce air pollution-related deaths by around 15%. Furthermore, this would also reduce emissions of CO_2, the greenhouse gas, which traps the heat; and is the chief cause of climate change. It may be noted that the main source of this gas is manifested by coal power generating plants, which are the biggest source of greenhouse gas emissions.

Limitation of particulate matter and the control of green house gases will also make progress for development

goals related to sustainable development in cities and the energy sector. In this regard, WHO has projected reduction in air pollution indicators as markers of development; and further suggests on sharing information on successful approaches, on methods of exposure assessment and monitoring of health impacts of pollution. The same needs adherence in all parts of Pakistan.

Attention should, also be focused on the nuisance of harmful noise in some areas. The effect of noise varies according to working environment, in a particular area. However, some people or more sensitive than others. Normal conversation is about 55 dB. In general sounds above 85 are harmful. The severity depends on how long and how often one is exposed to them. In commercial and industrial area, the noise level ought to be restricted between 65 and 75 dB; and these limits must not be exceeded.

The drinking water ought to be hygienically safe. It should be free from Ecoliform bacteria, excessive amounts of Nitrates, Chlorides, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury Nickel, Selenium, Zinc and so forth.

The wastewater including industrial waste should be treated, and the deleterious substances be removed before disposing off the effluent. The municipal wastewater, after treatment can be used for gardening, tree plantation or agriculture. However, under no circumstances, the industrials effluents should be directly disposed of into the sea.

It is recommended that in order to circumvent some of the environmental concerns, efforts must be made to legislate and implement regulations in this context. However, in adverse conditions, the latest National Standards of Pakistan Environmental Protection Agency should be followed. But, in the absence of specific standards in this regard, the guidelines of World Health Organization, and/or United States Environmental Protection Agency should be consulted for further guidance.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the help provided by Space & Upper Atmosphere Research Committee (SUPARCO), National Environmental Information Management System (NEIMS), and many other agencies, in sharing the data on chemical analyses, for the research, on environmental pollution, conducted at Isra University, Hyderabad.

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