

A study to estimate overall environmental pollution potential in second biggest city of Pakistan

Malik Muhammad Akhtar^{1*}; Tang, Zhonghua²

¹ PhD Researcher, School of Environmental Sciences,
China University of Geosciences (Wuhan),
388 Lumo Road, Wuhan, Hubei 430047, P.R. China.
P.R. China. Tel. +86(15807117444).
malikma_2012@yahoo.com

² Professor, School of Environmental Sciences,
388 Lumo Road, Wuhan, Hubei 430047, P.R. China.
China University of Geosciences (Wuhan),
P.R. China. Tel. +86(27) 67883037.
zhhtang@cug.edu.cn

* Corresponding author:

Malik Muhammad Akhtar

Email: malikma_2012@yahoo.com

Abstract

Regional Environment contains various factors to maintain ecosystem for living organisms. Human activities and natural adventures are affecting air, soil and water quality. It is challenging to ensure contamination free environment especially metropolitan cities due to rapid development and excessive consumption of natural resources.

Apart from the environmental current issues, municipal, industrial, and agriculture solid waste disposal is caused serious threat for air, soil and groundwater systems. Environmental deterioration can be seen globally, however it's much severe in the developing countries like Pakistan. Lahore city, one of the most populated cities in the world, is facing similar environmental issues. Several investigations reporting poor solid waste management, municipal and industrial effluent discharge into water. This article discourses present status of environmental level in Lahore city and also identifies various environmental problems. Considering said factors average environmental level was estimated. However, pollutants factors are high risky for human health directly and indirectly.

Keywords: Contamination, Environmental, Evaluation, Solid Waste, Lahore.

1. Introduction.

Pakistan is the sixth largest country of the world with a population of more than 175 million and a population growth rate of 2.1 percent (NIPS, 2002). Unfortunately, both human settlement development (demographic dynamics, ignorance, improper watershed and solid waste management, agricultural

production and industrial activities etc) and other conditions within the area geological setting of nearly all environmental sectors, public health and safety are threatened by environmental contamination due to increases pressures from settlement development, in particular urbanisation and indiscriminate rural agricultural practices; hence, monitoring and conserving this important resource is essential (Baalousha, 2010). These environmental changes can be associated with socioeconomic development in certain area.

Emília Silva depicted during a study that groundwater exposure to pesticides is determined by environmental or agricultural, geology, as precipitation, crops, soil and irrigation practices. Groundwater results show high pesticides contamination level during spring and autumn (Silva and Mendes, 2012). The total length of roads in Lahore is 365 km, and the number of vehicles registered with the city is 1.4 million. Lahore's population is growing at a rate of 4% a year. Air quality issues are among the most difficult environmental problems currently faced by societies as more and more studies report impacts of atmospheric pollution on human health and the environment (Desauziers, 2004). According to McDougall (2003) the definition of MSW is 'the solid waste collected and controlled by the local authority or municipality' (McDougall et al., 2008). Typically MSW consists of household waste, commercial waste and institutional waste. We know that the storage of any waste material in a landfill poses potential problems. One of the major problems is transport of leachate that causes contamination of soil, groundwater and surface water (Kadlec and Wallace, 2008). The qualitative and quantitative features of leachates are important to understanding the impact of a landfill in transferring leachate from surface to groundwater. Without a doubt existence of unorganised and non-scientific landfills are alarming in some part of the world including Pakistan (Longe and Balogun, 2010). With particular reference to Lahore, groundwater is suspected to be polluted (Karim et al., 2010) due to untreated waste water and the dumping sites (Karim et al., 2010). These three dumping site are unplanned and has no system to collect leachate, so it is expected whole leachate goes down and mix with groundwater.

The main objective of the study is to investigate the severity of environmental pollution in Lahore City, and findings would help city management to develop monitoring and mitigation measures to improve the overall environmental quality of the city. Study area is adversely affected by uncontrolled increasing urban population, industrialisation and commercialization.

2. Study Area.

The study area is Lahore City found between 31°-15' and 31°- 42' north latitude, 74°- 01' and 74°-39' east latitude. Having an altitude ranging between 208m to 213m ASL, it is located on the alluvial plain of the left bank of Ravi River. Lahore is bounded on the north and west by the neighbouring district of Sheikhpura, on the east by the country of India (international border) and on the south by Kasur district (Figure 1) with a population of over 6.5 million inhabitants in 2007. It is also the second largest urban centre of Pakistan and considered to be the 24th largest city in the world.

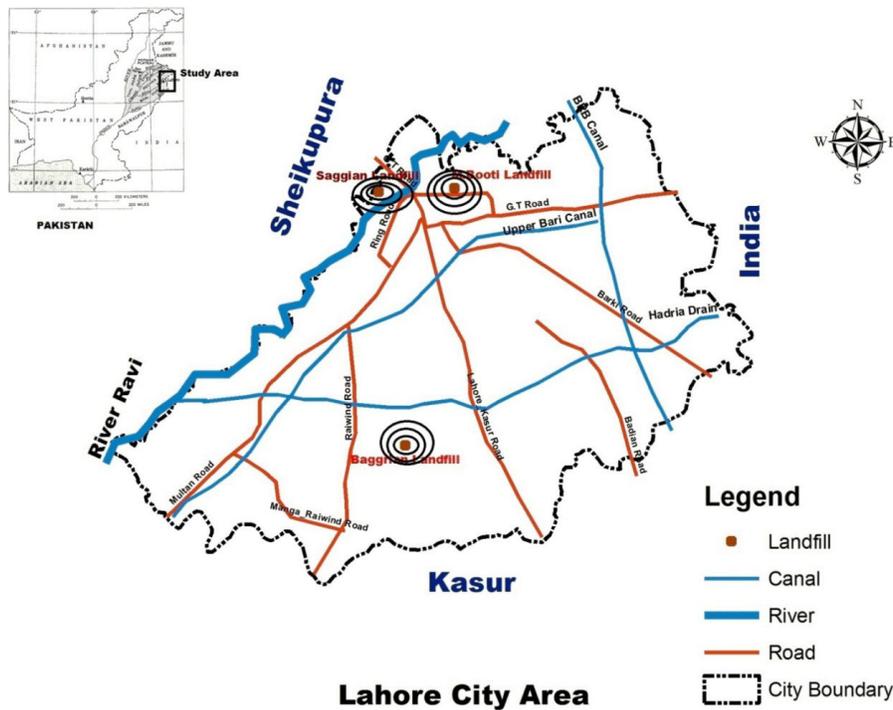


Figure 1. Locations of landfill sites around Lahore city.

Lahore is characterised by large seasonal variations in temperature and rainfall. Mean annual temperature is approximately 24 ranging from 34°C in June to 12°C in January, with average annual rainfall close to 575mm, which can vary from 300 to 1200mm.

Approximately seventy five percent of the annual total rainfall is from June to September and contributes approximately 40mm to groundwater recharge in a normal year. The annual potential evapotranspiration rate is 1750mm which greatly exceeds the rainfall, making irrigation for agriculture essential to supplement rainfall (NESPAK, 1993:Ref (Gabriel and Khan, 2010). Relative humidity throughout the day is higher in winter than in summer months.

3. Contamination Sources in Lahore City.

Currently, Lahore city is facing various environmental issues, because concerning departments are unable to enforcement of polices and laws. Following are main pollutants sources in the study area; 1) River Ravi, 2) Drain system, 3) Industrial sector, 4) Agriculture activities, 5) Municipal solid waste and landfills, and 6) Traffic. Previous studies in study area are depicted that air, soil and water are contaminated.

The Ravi River has always been the main recharge source for the aquifer but since 1960, increased consumption by India has seriously affected the recharge efficiency. In addition, the river presently receives municipal and industrial pollution. Hudiara drain receives effluents from India with high concentrations of pollutants and then collects additional contaminated waste water from Pakistan before flowing into the Ravi River. The waste water from various sources contains organic, inorganic, industrial, municipal and animal waste, as well as fertilizers and insecticides, which seep through the soil and significantly degrade the groundwater quality. The groundwater quality near the Ravi River is much poorer than that at a distance, and poses a serious public health hazard (Hasan et al., 1999; Dhakyanika and Kumara, 2010). At least three-fourths of the total waste generated in Lahore every day (3800 tons) is dumped at these sites without proper treatment. Landfill sites along the Ravi River are open dumps that continually pollute the soil, groundwater and river water.

The popular practice of heavy and indiscriminate use of fertilizers and pesticides by farmers, presents a significant source of underground water pollution, as these and other agrochemicals leach from the surface soil (Lapworth et al., 2006). The communities with poor sanitation and contaminated water supply are the risk of acquiring waterborne infection like water borne hepatitis A, E, cholera, diarrhea, dysenteries, typhoid and parasitic diseases, etc (Saeed and Bahzad, 2006). Air quality problems are the most difficult environmental issues presently faced by various societies as more and more researches report impacts of the atmospheric pollution on the human health and overall environment (Desauziers, 2004). We can say that it is not surprising to know 250,000 children die in Pakistan each year as a result of diarrheal disease caused by contaminated water (03 May 2011 by Local Press Report Khalid Hussain, Water resources Pakistan).

4. Methodology.

A best way to evaluate the environmental potential of an area is to measure pollution level in three primary media of environmental system air, soil and water. In this manuscript a technique has been develop to evaluate environmental be foulment status. ASW (Air, Soil and Water) is a technique that estimates overall environment contamination level into study area based on the three selected environmental factors of an area. Environmental factors used to classify the environmental applying the ranking method. The three factors (air, soil, and water) are considered most important for environmental evaluation. The factors are important to identify pollution potential of an area which will be provided a base to evaluate environmental degradation level according to chemical analysis results and contamination concentration strength of various parameters in each media.

A Air: Air must be safer from pollutants because human being are take air through Inhaling.

S Soil: Soil media exposes pollutants moving time from surface to other ingredients of environment.

W Surface water: It is source of contamination infiltrate into soil, groundwater and vegetation activities.

Groundwater: Groundwater can transmit pollutants directly to drinking water. So, it is most important factor.

Finally, Total ASW value needs to calculate by applying combination of all considering factors with the help of the equation. Higher concentration of parameters of ASW Index is identifying more deterioration level for environment.

$$\text{Total ASW Value} = \text{Air pollution level} + \text{Soil contamination level} + \text{Water deterioration level}$$

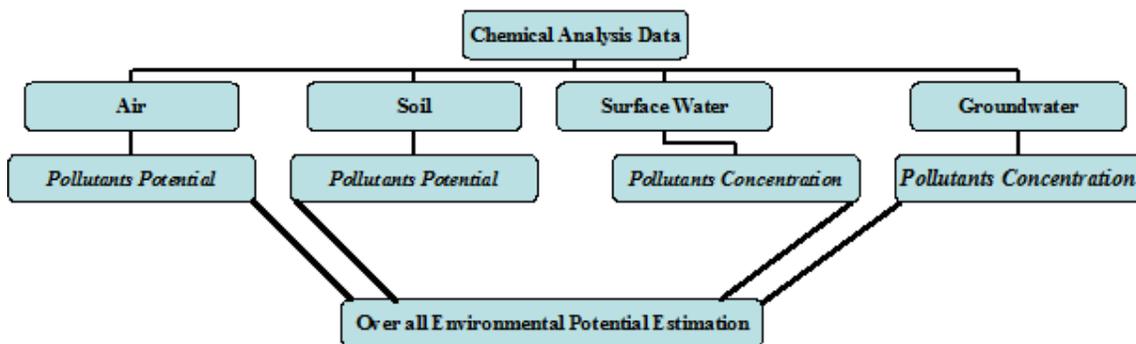


Figure 2. Methodology Flow Chart.

There are three categories are assigned for each factor according to contamination strength, which are “low”, “average”, and “high”. Overall level will be estimated with these assign level to each factor by counting

parameter pollution potential. After carefully evaluation all analysis parameters of each factors with regard world health organisation (WHO) and Pakistan Standards and Quality Control Authority (PSQCA) criteria, then overall environmental potential will be estimated of the study area.

5. Results.

In current study three primary factors of environment were considered, therefore it needed to investigate pollution potential of the factors to understand overall pollution status of the Lahore city. Soil, air, landfill leachate, surface water and groundwater chemical analysis data were used and selected parameters were analysed to investigate contamination level in each factor.

Karim (2010) conducted a study to identify soil contamination level, and explored that various heavy metals, microbes and other contaminants are the part of soil (Karim et al., 2010). These pollutants values are significant high as various standards. Through cultivation activities these pollutants are absorbed by plants and reach to human body. Table 1 shows soil quality in study area.

There was a study conducted to investigate air quality of Lahore city, ten locations was selected for this purpose. There were some important air pollutants evaluated in air composition, which are carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), particulate matter (TSP and PM₁₀) and lead (Pb). The Industrial areas contained higher pollutants concentration values such as Multan Road, Kot lakhpat industrial area, and G. T. Road. The table 2 depicts air average results and noise pollution values were found over 60 db on all selected locations.

Table 1: Test result of chemical analysis of soil sample (Karim 2010)

Parameters	Values
pH	6.6
Cd	8.7
Cr	28
Fe	937.6
Hg	0
Cu	17
Organic matter (%age)	2.2
Zn	58

Table 2: Typical air pollutants data (Mehboob Ali, 2010)

Parameters	Value
CO (ppb)	3.9
O ₃ (ppb)	18.14
NO ₂ (ppb)	17.85
SO ₂ (ppb)	19.3
TSP (µg/m ³)	87.52
PM ₁₀ (µg/m ³)	67.47
Lead (µg/m ³)	4.25

Several studies examining leachate samples from landfill sites (Table 3) showed that most of the parameters such as colour, conductivity, TSS, TDS, BOD, COD, NH₃-N, PO₄-P, SO₄ -₂, Cl- and Fe were at high

levels. The organic load was quite high since the COD concentrations were in the range of 2530-18000 mg/L. In addition, the low BOD/COD ratio (0.172-0.55) confirmed that the majority of this organic matter was not easily biodegradable. A survey conducted by Naeem et al. (2007) also indicated higher concentrations of various constituents (Naeem et al., 2007). The groundwater near the landfill sites were characterized as non-potable and not suitable for drinking or other domestic uses. Landfills are great source of deterioration for land, air and water.

Table 3: Typical analysis of leachate from landfills located in Lahore city.

Parameter	Values (Saggian Landfill Site)
pH	6.8
COD (mg/L)	2 563
BOD (mg/L)	4 4 2
Grease and oil (mg/L)	0. 5
Phenol (mg/L)	0. 0 4
Surfactant (mg/L)	1. 5 8
TDS (mg/L)	3 7 1 7
TSS (mg/L)	1 6 1. 7
Conductivity	5829
Pb (mg/L)	0. 6
Cu (mg/L)	2. 7
As (mg/L)	0. 2
Fe (mg/L)	9. 8
Younas et al., 1999	

Table 4: River Ravi water quality (2010)

Parameters	Values
pH	8.8
TDS	952
Ca	23
Mg	3.7
Chloride (Cl ⁻¹)	72
Sulphate (SO ₄) ⁻²	183
Total hardness	21

The Ravi River presently receives 47% of all municipal and industrial pollution load discharged into all the rivers of Pakistan (Sami F. 2001. Ref: (Gabriel and Khan, 2010). River Ravi water chemical analysis data shows that contamination level is high and source for groundwater deterioration. At Saggian dumping site location contamination from landfill is mixing with surface water, groundwater and soil.

Table 5 depicts groundwater contamination level of study area. Pakistan Standards and Quality Control Authority (PSQCA) and World Health Organization (WHO) drinking water standards are also presented in the table 5. Sample analysis results from selected locations indicate that water contamination level is high and some treatment to purify water before use is required. The pollutants have changed groundwater chemistry and various pollutants are making a significant contribution to it. According to our analysis and understanding the reason behind this is the formation of cone due to water extraction and movement of groundwater due to the cone has transmitted vicinity pollutants towards main business area of Lahore city.

Table 5: Groundwater quality in Lahore City (WASA, 2010)

Parameters	Values (Lahore Main City)	WHO	PSQCA
pH.	7.6	6.5-8.5	6.5-8.5
Tur.	1.28	5NTU	0.5NTU
Con.	867	-	-
TDS	738	1000mg/l	500mg/l
T.H.	282	500mg/l	250mg/l
Ca	41.6	250mg/l	100mg/l
Mg	38.5	-	-
Alk	208	-	-
Cl	29	250ppm	250ppm
NO ₂	Nil	-	-
CO ₃	Nil	-	-
HCO ₃	200	-	-
Fe	0.03	0.3mg/l	0.3mg/l
E.coli	Nil	0mg/l	0/250mg/l

Current study has verified that groundwater is continuously receiving toxic pollutants, therefore groundwater need to some treatment before use especially for drinking and domestic.

According to Daily newspaper (20 May, 2008), United Nations Environmental Programme (UNEP)'s reported that about 47% drinking water in Lahore city was contaminated due to presence of various hazardous toxic elements (Manan, 2008). A non-governmental organization (Al-Khidmat Foundation) conducted an investigation to compare bacteriological quality of groundwater and found 37.2% groundwater contaminated. During study they were collected water samples from 539 different parts of city in which most developed area Gulberg showed 64% water samples contamination, 57.1% in Multan Road, and Shadbagh area with 56.4% (Manan, 2008).

From above soil, air, landfills, surface water and groundwater chemical analysis results are explored that over all study area have great threat from all factors which are considered in this study. Table 6 depicts the adopted method, considering standards and estimated environmental level in Lahore city.

Table 6: Environmental Quality Estimation in Lahore City

Serial No.	Factor	Pollutants Level		Pollutants Potential
		WHO	PSQCA	
1	Air Quality	Within Criteria except Lead	Within Criteria except Lead	Average
2	Soil Quality	-----	Over Criteria	High
3	Surface water Quality	Within Criteria	Over Criteria	Average
4	Groundwater Quality	Within Criteria	Over Criteria	Average

Air Quality Overall= Average

Soil Quality Overall= High

Surface water Quality Overall= Average

Groundwater Quality Overall= Average

Total ASW Value = Air pollution level + Soil Contamination level + Water deterioration level

Total ASW Value= Average + High + (Average + Average)

Total ASW Value= Average

From this evaluation, it can be understand that currently Lahore city contains average level of environmental resources and risk for human beings. Therefore, it needs to improve, so that environment resources can prevent from future.

6. Conclusion and Recommendations.

Numerous and complex factors are affecting environmental resources in Lahore city but various activates are the prominent source of toxic gases, organic, inorganic, chemical and bacteriological contamination in air, soil and water. Unfortunately, government agencies have lack of effective planning, coordination and resources to protect scientifically. Alarming numbers of residents are facing health issue due to various pollutants. Lahore is currently faced a number of environmental issues, such as water shortages, high pollution concentration, unplanned solid waste management, air pollution, untreated industries and municipal effluents discharge.

Enforce existing environmental protection laws and introduce additional rules and regulations as necessary. Violators must be dealt with appropriately and incentive policies must be developed to ensure compliance with environmental rules and regulations. Most important step, which can be take immediate to inform and educate the general public and related governing officials about the growing pollution in air, soil, water and pertained problems. The concerning municipal and provincial departments should introduce desk to share information and with combine effort try to protect environment and groundwater resource for future.

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