A PRELIMINARY ASSESSMENT OF AIR QUALITY IN KABUL

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A. Introduction:

The city of Kabul suffers from poor air quality and overcrowding. In recent years, the ambient air quality in the city has deteriorated so much that it can be ranked among the dirtiest cities in the world. The once unlimited visibility in the 1980s is down to less than a hundred meters in most days. The Qurugh, Paghman and Shomali Plain mountains that once were part of the beautiful snow caped landscape of the city are very rarely visible. For the residences of the city, a breath of fresh air can not be purchased for any price in most days of the year. To watch the city landscape from an advantage point, it looks like it has caught fire. There are numerous carcinogenic compounds that are emitted to the air as a result of burning tires, plastic, used motor oil, and other substances.

The main causes of air quality deterioration are:

- Very dusty roads
- The use of many old and smoking vehicles
- Burning plastic, used motor oil, and tires as a source of fuel
- Urban sprawl
- The bowl shaped landscape of the city surrounded by the mountains which trap air pollutants and promote inversion
- The use of leaded gasoline
- The use of 2-cycle electric generators
- Generation of electricity by firing diesel generators
- Using coal and wood for heating and cooking
- Cutting trees, shrubs, and native bushes
- Lack of care from the public

Population density in Kabul is high and most of the hills and mountain tops are occupied by houses that are lacking sanitation and access to clean water. During the rain and snow, the urban runoff saturated with human waste, dirt, and soil is transported down the hills to the streets below. The mix is ground by passing traffic to a very fine powder and once dry, it is airborne by the wind and moving traffic.

This study estimates the levels of air pollutants from several sources in Kabul by using the United States and other developed nations environmental protection agencies guidelines. In the absence of adequate air quality monitoring stations in Kabul to collect air pollution data, this approach seems to be useful for strategizing and implementing a sound air quality improving program. Numerical values on air pollutants obtained from this study should help the policy makers and the international organizations involved in reconstruction of Afghanistan. Also, this study will hopefully facilitate the officials of the Afghan government in comprehending the magnitude of deterioration of ambient air quality in Kabul. This decreasing air quality is leading to a significant detrimental health effect on the community. Estimating air pollutants level was undertaken by using actual

statistical data on the sources of air pollution and reasonably estimating other parameters. Calculations show dangerous levels of $PM_{2.5}$, PM_{10}, Pb, and other pollutants. The calculated level of lead in Kabul, where almost one fifth of the Afghan population live and a large international community is present, reaches dangerous levels and can adversely affect the learning capabilities of the children and future generations of the country. A higher concentration of Pb used in leaded gasoline and emitted from burning used motor oil, is more dangerous than any war and is capable of causing learning disabilities among the Afghan children. Because children's developing bodies absorb lead much easier than adults, lead exposure is more serious and they are much more susceptible to its harmful effects. Even at low or moderate levels, lead exposure may harm the intellectual development, behavior, growth and hearing. At high levels, lead can cause permanent brain damage and even death .The impact is going to be devastating by further widening the gap between the population of Afghanistan and the rest of the world in progress and advances in science and technology. The following is a brief discussion of major sources of air pollution in Kabul, the health effects of air pollutants, and as much as it is possible, estimate of air pollutants concentrations.

Details of calculation are not discussed because the scope of this paper was to raise the public awareness and draw attention of policy makers on the dangers that air pollution can pose on public health. However, the author is open to share all the facts, formulas, and methods used in this study with interested parties and individuals and will welcome any suggestions and critical comments.

B. Air Emissions Calculations

1. Particulate Emissions from Road Traffic

According to the Kabul Traffic Administration and Afghanistan's National Environmental Protection Agency (NEPA) there are more than 300,000 passenger cars and 100,000 trucks operating in Kabul. The United States Environmental Protection Agency (US EPA) guidelines and US Department of Transportation (USDOT) calculation methods were used to calculate emissions of particulate matter from traffic on public roads in Kabul (1) and (2) . Furthermore, a 250, 500, m thickness of the polluted air and an area of 4082 Km^2 for the Kabul air shed were assumed (data from NEPA) and concentrations of $PM_{2.5}$ and PM_{10} were calculated for different atmospheric levels (Table 1). For simplicity, distribution of air pollutants within the air strata was assumed uniform.

Table 1. Particulate Emissions Attributed to Moving Traffic in Kabul

Polluted Atmosphere Thickness, m	**Air Pollutants Concentrations µg/m^3**	
	$PM_{2..5}$	**PM_{10}**
500	39.46	396.32
250	78.92	792.67

The reason for selecting different levels in the model is that the polluted air vertical distribution is not knows in Kabul and even on higher mountains surrounding the city, air pollution is present. As it is seen from Table 1, the yearly average concentrations of

$PM_{2.5}$ is calculated at 39.46 µg/m^3, two and half times more than the EPA Annual Standard of 15 µg/m^3 (3). If a 250 m thick layer for distribution of $PM_{2.5}$ is assumed, then the yearly exposure level will be 78.92 µg/m^3, five times more than the EPA standard. Generally, particulate matter of 10 µm and smaller are readily inhaled and due to their very fine sizes, the upper respiratory defense mechanism can not scrub them and they penetrate deeply into the alveolar section of the lungs and eventually to the cardiovascular system where they can cause adverse health effects such as stroke, lung cancer, brain damage, respiratory, cardiovascular, heart, circulatory diseases, and damage to the unborn child.

To appreciate the magnitude of estimated particulate matter emissions in Kabul by moving traffic, refer to Table 2.

Table 2. Total annual emissions of Particulate Matter Triggered by Moving Traffic

Particulate Emissions Attributed to Moving Traffic in Kabul			
$PM_{2.5}$ Emissions		**PM_{10} Emissions**	
t/y	t/day	t/y	t/day
24564.41	80.53	246724.5	808.92

2. Pollution from the Tail Pipes of Passenger Vehicles and Trucks

The 300,000 passenger cars and more than 100,000 trucks on narrow streets of Kabul create severe gridlocks and traffic jams. The traffic congestion is so bad that very often there is no room for the pedestrians to cross the streets or just walk on the poorly maintained side walks which are also overtaken by angry drivers. Bikes which were once the popular mean of transportation for a good portion of the citizens now are extremely risky to ride because of the danger of being overrun by a vehicle. Meanwhile, most vehicles are old and around 25-30 % of them smoke heavily due to un-tuned engines, excessive oil burning, incomplete combustion of fuel due to poor quality of the fuel, plugged up air filters by rapid accumulation of particulate matter present in the air, and decreased partial pressure of oxygen in Kabul because of high elevation of the city (1800m). Emissions from tail pipe of all cars and truck operating within the city of Kabul were calculated using the United States EPA factors (4)and are shown in Table 3.

Table 3. Air Emissions from Vehicles Tail Pipe

Air pollutants	Emissions, t/y	Emissions, t/day
Hydro carbons (HC)	10257.14	28.10
Carbon Monoxide (CO)	77067.92	211.14
Nitrogen Oxides (NOx)	4942.01	13.54
Carbon Dioxide ($CO_{2)}$	769066.75	2107.03
Lead (Pb)	227.74	0.62
Fuel consumed	325348.81	1730.00

As it can be seen from the table, a significant amount of lead, carbon monoxide, nitrogen oxides, unburned hydrocarbons and others are emitted into Kabul air from automobile

sources. Based on the information from the United Nations Environmental Program (UNEP), most of the fuels used in Afghanistan do not comply with international standard and contain from 0.6 - 0.7 g/l lead (5). This is consistent with the study carried by the NEPA and the Afghan Ministry of Public Health (2009) who found that 80% of blood taken randomly from 200 residence of Kabul, contained lead (6). The lead is released into the air during combustion in the engine. The deposited lead along the road sides is air borne repeatedly and people especially children are exposed continuously during playing walking and even at home.

The health effects of primary air pollutants released from the automobile exhaust range from eye and upper respiratory irritation to many other serious health problems (Table 9). A good portion of the primary pollutants undergo photochemical reaction under the influence of the sunlight, the product of the of which are known as secondary pollutants such as ozone and free radicals that along with other pollutants contribute to smog which is observed in late spring, summer and early fall in Kabul. Among tail pipe emissions and byproducts, carbon monoxide, diesel soot (from diesel vehicles), nitrogen dioxide, ozone, sulfur dioxide, benzene, aldehydes, and lead are very toxic that can induce respiratory illness, cancer and even morbidity. Health effects of most of these pollutants are described in Table 9.

Because of the bowl shaped topography of the city, high elevation, and weak prevailing winds during the late fall and winter months, especially during the evening and early morning hours, Kabul is strongly affected by the thermal and topographical stagnation regime and high levels of air pollution. Under these conditions, the emissions from the previous day can add significant amounts of air pollution with those of the current day.

3. Emissions from Burning Tires

Burning shredded scrap tires in Kabul and in the suburbs of the city is a common practice. Tires are burnt in brick furnaces, public bath facilities, and lime kilns. Tires are made of natural and synthetic rubber and the later in turn is made of petrochemical compounds, carbon black, steel wire, heavy metals, and chlorine. Synthetic rubber contains styrene and butadiene. Styrene, a benzene derivative, is a suspected human carcinogen. Butadiene is known to cause cancer in laboratory animals and is also a suspected human carcinogen. Burning scrap tires can release benzene, heavy metals and produce dioxin (7). The thick black oil and black smoke that can be seen when tires are burnt outdoors is due to the release of aromatic compounds (8). The aromatic and polyaromatic compounds make up almost 25% of most tires and are known to cause cancer in lab animals as well as being suspected human carcinogens.

Metals such as lead and others that are in tires do not break down in the environment and they accumulate steadily increasing concentrations in the soil. Assuming that every year a complete set of tires are replaced with a new set, approximately a total of 1,600,000 tires are discarded as waste and they are usually burnt. Air emissions from burning 1.6 million tires are shown in Table 4 by using factors from a California study (9).

Table 4. Emissions of air pollutants from burning tires

Air Pollutants	Emissions t/y	Emissions t/day
Total Organic Gases	7.35	0.02
Reactive Organic Gases	4.54	0.01
Oxides of Nitrogen	990.27	2.71
Oxides of Sulfur	109.19	0.30
Carbon Monoxide	714.38	1.96
Cabon Dioxide	33311.82	91.26
Total Particulate Matter	37.84	0.10
Particulate Matter (<10 Microns)	30.92	0.08
Acetaldehyde	0.01	$1.99x10^{-5}$
Benzene	0.01	$1.80x10^{-5}$
Formaldehyde	0.03	$7.66x10^{-5}$
Hydrogen Chloride	5.00	$1.37x10^{-2}$
Total Metals	0.03	$9.32x10^{-5}$
PAH	$5.68x10^{-4}$	$1.61x10^{-6}$
Hexavalent Chromium	$1.05x10^{-5}$	$2.88x10^{-8}$
Dioxin	$9.30x10^{-9}$	$2.55x10^{-11}$
Furans 59	$1.28x10^{-8}$	$3.50x10^{-11}$

4. Emissions from burning Wood and Coal

In Kabul, fire wood and coal serve as important source of energy for cooking and heating. Approximately 2500 tons of wood is imported into Kabul daily for cooking and heating needs. However, in the winter for four months, approximately 1000 tons of coal is brought into Kabul every day. Based on calculations (10) the total quantity of air pollutants from burning wood and coal is included in Table 5.

Table 8. Air Emissions from Burning Wood and Coal in Kabul

Fuel/ Pollutants	Air Emssions t/y	Air Emissions t/day
Particulates Total	21681.25	59.40068
PM_{10}	8372.75	22.93904
$PM_{2.5}$	6296	17.24932
Carbon Monoxide	67345	184.5068
Polycyclic Aromatic Hydrocarbons (PAHs)	69.7175	0.191007
Furans and dioxins	1.37225	0.00376
PCB's	$2.538x10^{-9}$	$6.95x10^{-12}$
Benzo(a) pyrene	$2.26x10^{-6}$	6.18E-$^{-9}$
Benzene	4636.66	12.70318
Sulfur dioxide	2977.6375	8.157911

Fuel/ Pollutants	Air Emssions t/y	Air Emissions t/day
Nitrogen dioxide	420.00	1.150685
Carbon dioxide (carbon)	300000	821.9178

As can bee seen from the table, burning wood and coal can emit harmful concentrations of carcinogenic air pollutants such as benzene, PCBs, poly aromatic hydrocarbons (PAHs), furans and other harmful pollutants as carbon monoxide, sulfur dioxide, and nitrogen oxides in the close vicinity of people.

5. Emissions from Diesel Fired Electric Generation

Although in Kabul electric generation from burning diesel is phasing out due to import of electricity from the Central Asian Republics, nevertheless, it is estimated that around 50,000-100,000 Kw power is generated in various parts of the city by using diesel as fuel. Assuming that generators operate for 6 hours per day, 365 days per year, emissions of air pollutants were estimated (11) and are shown in Table 6.

Table 6. Emissions from a 200,000 Kw diesel power generators

Pollutants	Air Emissions t/y	Air Emissions t/day
PM2.5	105.07	0.29
PM10	105.07	0.29
SO2	98.29	0.270
NOx	1,494.65	4.095
VOC	118.62	0.325
CO	321.98	0.8825
CO2	216,372.00	592.8

As it is obvious from the above table, the potential emissions of electric generators are significant.

6. Emissions from Burning Plastic bags, plastic bottles, and styrofoam

A few years ago, the people in Kabul and other parts of Afghanistan were using paper bags for shopping. Unfortunately, in recent years they have been replaced with plastic bags which have created serious environmental problems. It is a common practice in Kabul to burn plastic in public baths and houses for heating, and sometimes simply for getting rid of plastic waste. It is conservatively estimated that each person in Kabul uses about 35 g of plastic bags, bottles, and Styrofoam packing per week that eventually discarded and burnt. Assuming a million persons handle plastic, around 5 t/day of plastic is used in Kabul and later incinerated. Total CO_2 emissions i estimated at 30 tons/day. Annual emissions from plastic burning are estimated at 10,950 tons of CO_2. Other emissions could be dioxin (from PVC based plastic), styrene, CO, particulate matter, and others depending on the composition of the plastic and the catalyst used during the manufacturing of plastics compounds (12).

7. Emissions from Burning Used Motor Oil

Around 400 thousand motor vehicles of various engine capacities are operated in Kabul and based on interview with drivers, oil change workshops, and individual car owners, as an average, about 6-12 times per year the automobile oil is changed (at approximately 1000 km interval). Assuming conservatively that around 5 liters of oil is changed each time, at a minimum a total of 20 million liter of oil waste is generated in Kabul which all is burned for heating. It is clear that as a result of engine wear and tear toxic metals such as barium, lead, chromium, nickel, cadmium, and zinc is mixed with the engine oil and as a result of burning used motor oil, metal aerosols into the air are released that can contaminate the environment and impact human health. Assuming in the city of Kabul 30% of motor vehicles use diesel and 70% gasoline, the estimated emissions of toxic metals as a result of used oil burning into the atmosphere (13) is given in Table 7.

Table 7. Estimated Emissions of Toxic Metals as a result of oil incineration

Oil Type /Pollutants	Emissions t/y	Emissions T/day
Barium	0.165	0.0004
Cadmium	0.249	0.00068
Chromium	0.489	0.001
Lead	11.386	0.031
Nickel	0.099	0.0003
Zinc	163.548	0.448
CO2	52,724	144.447

As it is clear from the above discussions, depending on the duration of exposure and concentration of pollutants (14), the effect to air pollution can be from a minor irritation to sickness and premature death (Table 12). The emission inventory is an important tool for diagnosis and planning, and offers a prudent approach for decision-making. However, in Kabul the emission inventory data is accompanied by wide margin of uncertainty and deficiencies. Although calculation in this paper is not based on air monitoring information, nevertheless, it can serve as a starting point for development of strategies for air pollution control. All calculations in this study are based on EPA and other developed countries standards.

C. Emissions Inventory (Total Emissions)

It is clear from the above discussions and calculations that motor vehicles make the greatest contribution to the emission of $PM_{2.5}$ and ozone precursors (Tables 1-3) followed by tire, used motor oil, coal and wood burning. Sulfur dioxide is related to fuel quality while carbon monoxide, nitrogen dioxide and hydrocarbons arise mainly from vehicles

emissions (Table 9). A similar finding was indicated by a study funded by the Asian development Bank (ADB) but their inventory numbers differ from those from this study. The daily concentration of most chemicals emitted into the air is calculated based on 4084 Km^2 area and 500 m thickness of the polluted layer. However, this approach is not a refined method, because different pollutants can segregate based on their vapor density and specific gravity. There is no safe limit for cancer causing chemicals such benzene, PCB's, dioxin, and others.

Table 8. Total Calculated Air Emissions in Kabul

Pollutants	t/year	t/day	At 250 m thick layer, $\mu g/m^3$	Source
Acetaldehyde	0.01	$2.74x10^{-5}$	$2.68X10^{-5}$	Burning coal and wood
Barium (ppm)	0.165	$4.52x10^{-4}$	$4.43X10^{-4}$	Burning used oil
Benzene	4636.67	12.703	1.24	Burning used oil
Benzo(a)Pyrene	0.00186	$5.096x10^{-6}$	$4.99X10^{-6}$	Burning used motor oil
Cadmium (ppm)	0.248	$6.79x10^{-4}$	$6.66X10^{-4}$	Burning used oil
Carbon dioxide	1382424.09	3787.463	3710	Combustion of organic matter
Carbon Monoxide	145449.275	398.491	390	Combustion of organic matter
Chromium (ppm)	0.489	$1.34x10^{-3}$	$1.31X10^{-3}$	Burning used oil
Dioxin	$9.3x10^{-9}$	$2.54x10^{-11}$	$2.50X10^{-11}$	Burning coal and wood
Formaldehyde	0.03	$8.22x10^{-5}$	$8.05X10^{-5}$	Burning tires
Furans and dioxins	$1.53x10^{-8}$	$4.203x10^{-11}$	$4.12X10^{-11}$	Burning coal and wood and tires
Hexavalent Chromium	$1.05x10^{-5}$	$2.87x10^{-8}$	$2.82X10^{-8}$	Burning tires
Hydrogen Chloride	5.00	$1.37x10^{-2}$	$1.34X10^{-2}$	Burning coal and wood
Lead (ppm)	239.12	0.655	0.642	Vehicle exhaust, burning oil
Nickel (ppm)	0.099	$2.71x10^{-4}$	$2.66X10^{-4}$	Burning used oil
Organic Gases Total	10383.115	28.446	27.9	Automobile exhaust
Oxides of Nitrogen	7846.93	21.49	21.1	Automobile exhaust, combustion process
Oxides of Sulfur	3185.12	8.73	8.55	Automobile exhaust, combustion process
PAHs	69.72	0.191	0.187	Burning coal and wood
PCB's	$2.26E^{-6}$	$6.19x10^{-9}$	$6.07X10^{-9}$	Tire, wood and cool burning
PM_{10}	255592.3	700.25	852	Traffic movement, combustion processes
$PM_{2.5}$	30972.39	101.54	99.5	Traffic movement, combustion processes
Zinc	163.55	0.448	0.42	Burning used oil

D. Control Strategies

In contrast to many other big cities of the world, Kabul has not made any major effort to reduce air pollution. Recognizing that transportation is a major pollution source in Kabul, any strategy that geared to reduce or control atmospheric pollution has to include a transportation improvement program. The main programs to combat air pollution in the Kabul that need to be considered but not limited to include:

1. Transportation improvements

a. control the number of private cars
b. prohibit the import of old cars,
c. impose high tax on gas guzzlers,
d. promote public transportation,
e. encourage car pooling and telecommuting
f. strictly control quality of imported fuels, promote the use of low sulfur diesel,
g. Introduce the use of catalytic convertors to reduce exxhaust emissions
h. control engine conditions. Since incomplete combustion in old or poorly maintained engines is a direct cause of carbon monoxide and unburned hydrocarbon emissions, the enforcement of engine maintenance standards should be another goal of traffic. The major compulsory program implemented in this direction in other countries for example the United Sates is called the Inspection and Maintenance Program. It is a costly program, however, in Kabul this process can be simplified by authorizing traffic inspectors to stop smoking vehicles until they have been repaired and do not smoke any longer. Reduction of lead and sulfur in fuels and finally the introduction of catalytic converters will drastically reduce pollution.

2. intensify pavement of dirt roads,
3. populate the dusty roads, vacant areas, and parking lots by those trees and shrubs that are native to the area this should significantly reduce emissions of dust by traffic and winds.
4. prohibiting the burning of scrap tires, used motor oil and plastic (impose a bounty on plastic bags, for example, 2 afs/bag.) will result in better air quality for the people of Afghanistan.
5. pass legislation to obligate the mass media to launch extensive environmental campaign on pollution prevention topics for free. After all, they make money by using public air space.
6. Institute a dynamic program in schools of the country at all levels and educate the future generation of the country on the health effects of air pollution and pollution prevention, conservation, and recycling

E. Conclusion

Kabul was known for its clear air and spectacular views of snow-capped Mountains even in the 1980s. Today, the city's mountains are only rarely visible due to very severe deterioration of ambient air by pollutants, specially, suspended particulates and ozone which are caused by cutting trees, increased number of gas guzzling and smoking old vehicles driven on severely dusty roads and sidewalks, population increase, low quality fuel, burning scrap tires, plastic, used motor oil, wood, and coal, intense sunlight promoting photochemical reactions, low humidity levels, and lack of environmental responsibility and oversight . The number of motorized vehicles is now reaching almost one million in the city. Increased demand for purchase of personal vehicles is triggered by concentrations of wealth through legal and illegal means, money laundering and enhanced employment opportunities in Afghanistan, population boom from 300,000 in 1977 to roughly 5 million today. The city sits in a basin 1800 meters above sea level, and

is surrounded by mountains that rise two to three kilometers or more above the basin. High elevation and intense sunlight trigger ozone formation. In addition, due to inversion, air pollution is generally worse in the winter, when thermal inversions are more common. Factors such as the indifference attitude of the public and private interests, corruption, indulgence of having big cars, have obstructed the fight against air pollution. In light of the latest election, the international community and the government should realize that the worst enemy of Afghanistan is air pollution, not the Taliban. It is the lead in the environment that poisons the brains of the Afghan children living in urban sprawls and reduces their learning ability and other air pollutants that are threatening the pubic health every day killing many citizen every day (Table 9).

Table 9. Health Effects of Major Air Pollutants

Air Pollutants	USA EPA Standard	Source	Health Effects on the Community
$PM_{2..5}$	24 hr 35 $\mu g/m^3$ Yearly 15 $\mu g/m^3$	Moving traffic, diesel auto exhaust, wood, tire, plastic burning	8% increase in overall mortality for each 10 $\mu g/m^3$ increase in $PM_{2..5}$ concentration in the air, death from respiratory illnesses cardiovascular diseases, and cancer, hospital admissions and emergency room visits, surgery for respiratory and cardiovascular conditions, hospital admissions due to asthma attacks, pneumonia, bronchitis and chronic, obstructive pulmonary disease, respiratory symptoms in both the lower and upper respiratory tract, decreased lung function. increased risk of premature births and infant mortality, pneumonia, neonatal mortality respiratory diseases and sudden infant death syndrome increased incidences of rhinitis, increased absenteeism and increased number of days of restricted activity (15) (16).
CO	1 hr 40 $\mu g/m^3$	Automobile tail pipe, wood, tire, and plastic burning electric generators	Affects the brain, cause changes in pulmonary and cardiac functions, headache, fatigue, sleepiness, respiratory problems, can form carboxyl hemoglobin and even can cause death (17).
Nitrogen Oxides	Annual 100 $\mu g/m^3$	Automobile exhausts, electric generators	Damage to upper respiratory system and lungs, lowers body resistance, reacts with water to form nitric acid in the eyes, respiratory system, and lungs (18).
SO_2	Annual	Automobil	Irritation of eyes, nose, throat and lungs, reacts with

Air Pollutants	USA EPA Standard	Source	Health Effects on the Community
	0.03 ppm	es, coal and wood burning	water to form sulfuric acid (19)
Ozone	8 hrs 0.12 ppm	Automobile emissions	Increased mortality, impaired lung function, increased asthma attacks in children, elderly, and sick(20).
Pb	3 month 1.5 $\mu g/m^3$	Automobile exhaust, tire burning, used motor oil burning	Learning disability, malformation of the fetes, severe brain defect in children, adverse reproductive effects in man (impotence), reduced sperm count and abnormal sperm, adverse reproductive effects and reduced fertility, still-birth, or miscarriage in women (2!).
Benzene	No safe level	Automobile exhaust, tire burning, used motor oil burning	Carcinogen and mutagen, causes anemia and leukemia (22).
Benzo(a)pyrene	No safe level	burning, wood, tail pipe emissions	Mutagen when metabolized, can cause cancer (23).
Dixon	No safe level	Burning PVC, tire burning, used motor oil burning	Human carcinogen causes chloracne a skin disease, lesions on the face and upper body, rashes, discoloration, and excessive body hair, cancer of fatty tissue and muscle (24).
PCBs	No safe level	Burning PVC, tire burning, used motor oil burning	Possible human carcinogen, can cause skin rash. liver cancer, low birth weight and brain damage in infants (25).
PAHs	No safe level	Combustion of wood and coal	Probable human carcinogen and mutagen, reacts with ozone to produce more potent compounds(26).
Cd	No safe level	Burning used oil	Carcinogen that causes kidney cancer (27).
Cr^{+6}	No safe level	Tire burning	Possible human carcinogen, mouth and nose cancer, skin irritation (28).

Air Pollutants	USA EPA Standard	Source	Health Effects on the Community
Acetaldehyde	No safe level	Tire burning	Possible human carcinogen (29).
Formaldehyde	No safe level	Tire burning	Probable human carcinogen, may cause nasal cancer (30).

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