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A Web Based Program for Air Pollution Control and Health Risk Assessment

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Abstract

This website was designed to educate the populace about the dangers of pollution and suggested quick measure to temper the effects of the pollutants. Basically, oxides of Sulphur, Nitrogen, Carbon, Ozone and Particulate matters were area of focus because these are most popular environmental pollutants. Considerations were given to the health implication of all these pollutants on humans, the disease(s) they cause and how to identify harmful effects of these pollutants. The software written in Java script is capable of analyzing laboratory information from passive samplers and tell, the risk of exposure of that particular environment where data was take and suggest measures to combat these air pollutants.

Keywords: Air pollution, control, web based program, health assessment case studies.

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Introduction

Pollution has been a major source of concern in the 21st century, because increasing knowledge has shown that pollution can bring the entire earth to its knees by the gradual destruction of all its life forms and the entire ecosystem including man (Buchanan and Horiohz, 2005). Air pollution results from a variety of causes, not all are within human control such as dust storms in desert, smoke from forest volcanic activity and other means (Adegbe and Abdul, 2000). Air pollution may affect humans directly causing a smarting of the eyes or coughing. The effect of air pollution are experienced at considerable distances from the source, as for example, the fallout of tetraethyl lead from urban automobile exhausts, which has been observed in the oceans and on the Greenland ice sheet (Colls, 2002). Concentrations of gaseous air pollutants are expressed either as mass per unit volume or as volume per unit volume. In the non SI past the latter was usually expressed as parts per million (ppm) or parts per billion (ppb) but in SI terms these units are $\mu 1\ l^{-1}$ and $n1\ l^{-1}$ respectively. Unfortunately, neither gm^3 nor $\mu l\ l^{-1}$ is entirely satisfactory. It might be better if mass per unit mass (i.e. $\mu g\ g^{-1}$) were to be used which would then bring air concentration in line with conventional SI expression with concentration in solids or liquids. Unfortunately, it is difficult to conceive of what volume of corresponds to 1g and this varies with altitude. Since most air pollutants, behave for all practical purposes as ideal gases. Consequently, (Oniyiah, 2015) develop mathematical expression for these two sets of unit's relationship. Atmospheric testing of nuclear bombs was stopped in the United States and the Soviet Union, and radioactive fallout from this sources has declined concern countries however, over the dangers resulting from massive releases of radioactive materials from nuclear weapons, which, if used on a major scale, could seriously endanger all of humanity (Amagai *et al*., 2002). The disastrous fog and attendant high levels of Sulphur dioxide and particular late pollution (and probably also sulphuric acid) that occurred in London in the second week of December 1952 led to the death of more than 4,000 people, prized cattle at an agricultural show also died in the same period. Many, but not all the victims already had chronic heart or lung disease (Chimaroke, 2004). In 1952, a different kind of air pollution was characterized for the first time in Los Angeles. The large number of automobiles in that city, together with the bright sunlight and frequently stagnant air, leads to the formation of photochemical smog. This begins with the emission of nitrogen oxide during the morning commuting hour, followed by the formation of nitrogen dioxide by oxygenation, and finally, through a complex series of reactions in the presence of hydrocarbons and sunlight, to the formation of ozone and peroxyacelyl nitrate and other irritant compounds (Ifeanyichakai, 2002), Eye irritation, chest irritation with cough, and possibly the exacerbation of asthma occur as a result. It is now recognized that ozone is formed in many large cities of the world. Modern air pollution consists of some combination of the reducing form consequent upon Sulphur dioxide emissions, and the oxidant form, which begins as emission of nitrogen oxides Ozone is the most irritant gas known (WWPR, 2001). In controlled exposure studied, it reduces the ventilatory capability of healthy people in concentrations as low as 0.12 parts per million. These levels are commonly exceeded in many places, including Mexico City, Bangkok, and Sao Paulo, Nigeria where there is a high automobile density and the meteorology conditions favor the formation of photochemical oxidants (Builtjes, 2001). The effects of air pollution on plants and animals may be measured by the following factors: interference with enzyme systems, change in cellular chemical constituents and physical structure, retardation of growth and reduced production because of metabolic changes, acute, and immediate tissue degeneration (TE, 2008) The pollutants that enter the air from sources other than agriculture and that produce plant response are classified as: acid gases, products of combustion, products of reaction in the air acid miscellaneous effluents (Odigure, 1998). The acceptable standard stipulated by World Health Organization (WHO) is shown in table 1.

Table 1: WHO Air pollutant standards

Pollutants	**Concentration and Averaging Period.**
Carbon Oxides	9.0 ppm/8hrs
Nitogen dioxides Ozone	0.12 ppm average over one year period
	0.10 ppm over one hour period
	0.08 ppm over four hours period
Sulpur dioxides	0.20 ppm average over a one hour period
	0.08 ppm average over a 24 hours period
	0.02 ppm average over one year period
Lead	0.5 $\mu g/m^3$ average over one hour period
Particulate Matter PM_{10}	50 $\mu g/m^3$ average over a year period
Particulate Matter PM_{25}	25 $\mu g/m^3$ over one day period
	8 $\mu g/m^3$ an over one year period

Source: (Gwendolyn *et al*., 1993).

The study is basically on air pollution hazard control considering the effects of various pollutants on humans, the ecosystem, plant life and animals. Also individual pollutants e.g. SO, NO etc. were studied extensively to identify their individual characteristic and proposed methods of reducing them to acceptable level. This study in no doubt will increase the life expectancy of humans, plants and animals in densely air polluted areas. An overview of main health effects of these pollutants and their tolerance limits on humans is shown in table 2.

Table 2: Pollutants and health effects with their tolerable limit

Pollutants	Health Effects	Tolerable Limits
Carbonmoxide	Acute carbon monoxide poisoning. Impair, visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks The health impact of CO is more serious for those who suffer from cardiovascular disease, at sufficient concentrations, CO poisoning can cause death	Below 50 ppm (parts per Million)
Ozone	Irritation of the respiratory system, which can cause chest pain, coughing, nausa and lungs inflammation. Reduce lungs functions making it more difficult to breathe deeply. Inflame and damage the lining of the lungs, which may leads to permanent changes in lung tissues. Chronic exposure can cause permanent damage to lungs. Ambient ozone also affects crop yield, forest growth, and the durability of materials. Because ground-level ozone interferes with the ability of a plant to produce and store food, plants become more susceptible to disease, insect attack, harsh weather and other environmental stresses. Ozone chemically attacks natural rubber and certain synthetic polymers, textile fibers and dyes, and to a lesser extent, points. This makes natural rubber and polymers become brittle and crack, and dyes fade after exposure to ozone.	Below 0.1 ppm/8hrs (parts per Million 8 hours)
Sulphur oxides`	Temporarily breathing difficulty for people with asthma. Particulates cause respiratory illness and aggravate existing heart diseases. Premature death. Visibility impairment Acid rain Forest and crop Damages	Below 500 ppm (parts per million)
Nitroge oxides	Exposure to high industrial levels of nitric oxide and nitrogen dioxide can cause: Death Collapse, rapid burning and swelling of the throat and upper respiratory treat Difficult breathing, throat spasms, and fluid building in the lungs. It can interfere with the bloods ability to carry oxygen through the body, causing headache, fatigue, dizziness, and blue color to the skin and lips. Genetic mutilations, damage a developing feotus, and decrease fertility in women. Permanent lung damage. Unconsciousness, vomiting, metal confusion, and damage to the teeth Serious burns to skin or eye when come in contact with high concentration of nitrogen oxide gases or nitrogen dioxide liquid. Long-term exposure of nitrogen oxides in smog can trigger serious respiratory problems, including damage to lung tissue and reduction in lung function Eyes, nose, throat and lungs can be irritated when exposed to low Levels of nitrogen oxides in smog.	Below $\mu g/m^3$ 24 hrs.
Particulate matter	The effects of inhaling particulate includes: Asthma, Lung cancer, Cardiovascular issues, Premature death, The size of the particle is a main determinant of where the respiratory tract the particle will come to rest when inhaled.	Below 50 mg/Nm^3

Sulphate lignin recycling in air plasma was optimized by Karengin *et al*. (2016). And in India Ganguly Saltyartth. (2016) investigated interrelationships amongst pollutant and their productions in Shimla city. Batterman *et al*. (2016) worked on high resolution spartial and temporal mapping of traffic related and their pollutants while, effects of geocoding errors traffic related air pollutants exposure on concentrated estimated was investigated by Ganguly *et al*. (2015). Measurement of traces gases for four years were studied by Gaur *et al*. (2014) at urban location in Kanpur, Indian chemical characterization of summertime dust events at Kanpur with insight with the sources and level of mixing with anthropogenic emissions was alone by Gosh *et al*. (2014). While Jie *et al*. (2014) carried out comprehensive assessment grand of air pollutants based on human health results. The level of human health risks in national capital territory of Delhi due to air pollution was carried out by Nagpure *et al*. (2014). Pollution level or concentration, and degree of the air pollutant differs from community to community and country to country due to geographical location, ecosystem, human and industrial activities on going in each community. Hence the need for this research to be carried of which its results were analyzed and the people living in Hazardous area were educated as per the risk within the environment and pollution preferred.

Material and Methods

In this study, experiments were carried out in six locations in Lagos Nigeria namely: Apapa, Surulere, Oshodi, Mile 2, CMS and Ikeja. Two Passive Samplers were under examination by placing them in these locations and records were taken for 7 days. These Passive Samplers are: SKC Passive Sampler used for ppm level organic vapours shown in Figure 1 and UMEX 200 Passive Sampler for level of Sulphur dioxide and Nitrogen Dioxide determination, this is shown in figure 2.

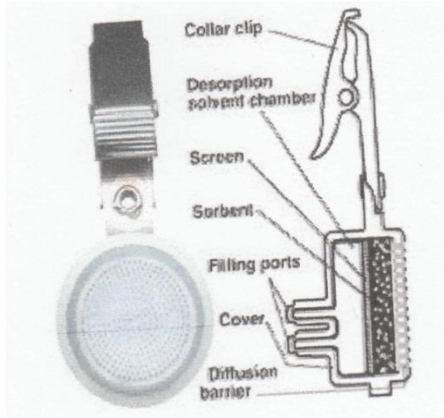

Figure 1: Skc passive sampler used for ppm level organic vapors. (Badge)

Passive Samplers

How to use the Passive Samplers, Pull from wrapper Indicate start time. Attach to employee or place in location Indicate stop time. The collected reading was taken and analyzed using the developed web-based programme.

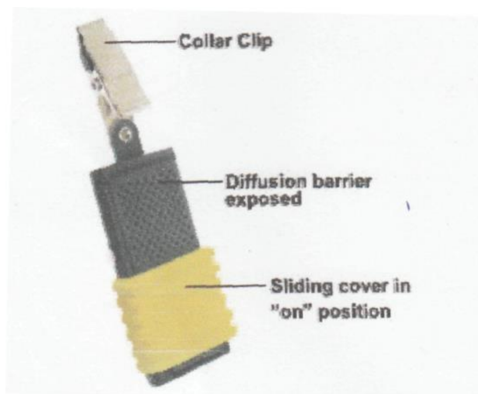

Figure 2: UMEx200 passive sampler used for sulphur dioxide and nitrogen dioxide

The interface for the developed web based program is shown in figure 3.

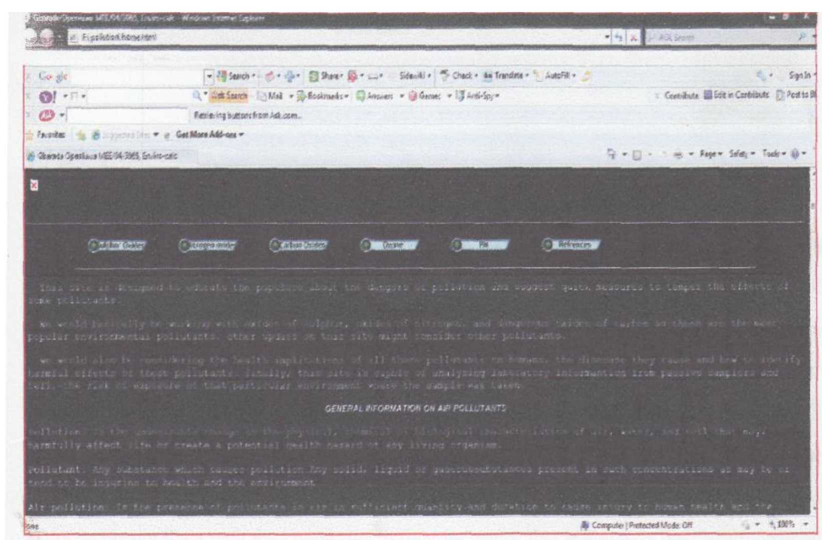

Figure 3: Web program Interface

Procedure for Prediction

Enter the environment name, and location correctly in the appropriate field provided Entre the sampler readings in the field just after the pollutants name Click on the compare button Results will be generated.

How to Make Decision

The environment with the lower total value is the less dangerous one. This is recommended for habitation over the environment with the higher total value. Incase total values are same in some environment decision is left to occupants base on other benefits and their interest concerning the environment. Positive values indicates danger to health. The sampler's readings as well as the results before analyses were shown in Table 3 under result.

Result and Discussion

The data collected as well as the analyzed results are shown in Table 3 and 4 respectively.

Table 3: Data collected from samplers' reading.

Pollutant	Location					
	A	B	C	D	E	F
Carbon II Oxides (CO) ppm	45	52	58	42	48	53
Ozone (O3) ppm / 8 hrs	0.2	0.01	0.02	0.13	0.06	0.12
Sulpur dioxides (SO_x) ppm	520	480	480	520	200	300
Nitogen dioxides (NO_x) ppm	140	147	200	143	152	160
Particulate Matter (PM)	52	48	40	12	52	43

The above collected data were analyzed, by developed web-based program using Java script. Result of the analysis is as shown in table 3 and its web program interface in figure 4 respectively. Table 4 show results of the analyzed Data in table 3 by the Web-based program.

Table 4: Results of data collected and analyzed

Pollutant	Location					
	A	B	C	D	E	F
Carbon II Oxides (CO) ppm	- 10	+10	+10	-10	-10	+10
Ozone (O3) ppm / 8 hrs	+ 8	- 8	- 8	+ 8	- 8	+8
Sulpur dioxides (SO_x) ppm	+ 6	- 6	- 6	+ 6	- 6	- 6
Nitogen dioxides (NO_x) ppm	- 4	- 4	+ 4	- 4	+ 4	+4
Particulate Matter (PM)	+ 2	- 2	- 2	- 2	+ 2	- 2
Total	+ 2	- 10	- 2	- 2	- 18	+14

Discussion

The Carbon Oxides pollution is high in locations B, C and F (Surulere, Oshodi, Ikeja) compare to locations A, D and E (Apapa, Mile 2 and CMS). Those learving in locations B, C and F (Surulere, Oshodi and Ikeja) were found exposed much to carbon oxides therefore were advised to:

Control carbon oxides from source Fossile fuel should be treated with catalytic converter Fire wood burning as fuel must be reduced particularly all the saw mills burning their saw dust in this area need to transport it out of the location The Ozone (O3) layers in A, D, and F (Apapa, Mile 2, and Ikeja are greater than that of location B, C, and E (Surelere, Oshodi and CMS). The humans in the ozone affected area. A, D, F (Apapa, Mile 2 and ikeja) were advised to:

Limit car use and ensure vehicle running efficiently to reduce emissions. When using solvent based products the lid must be kept on to minimize evaporation of hydrocarbons Temptation to light a bonfire or barbeque during still, sunny weather must be avoided. Always use water based or low solvent paints, flues and varnished for painting exercise. Avoid parking the car in sunlight when the engine is hot, and overfilling the tank or spilling petrol.

The Sulphuric Oxide in A and D (Apapa and Mile 2) is higher than that of locations B, C and E (Surulere, Oshodi, CMS, and Ikeja). The affected Sulphur oxide locations A and D (Apapa and Mile 2) were advised to:

Sources of this gas should be controlled as and under carbon oxides considering Nitrigen Oxides (NO_x), affected locations are C, E and F (Oshodi, CMS, and Ikeja) while locations A, B and D (Apapa, Surulere and Mile 2) are less affected. The affected nitrogen oxides area. A, B, and D (Apapa, Surulere and Mile 2) needs also to take to advise given to group affected by carbon oxides. Particulate matter (PM) affected locations. A and E (Apapa and CMS) than locations B, C, D and F (Surulere, Oshodi, Mile 2 and Ikeja). The location affected by particulate matters (PM) A and E (Apapa and CMS) were advised to:

Get involved with air quality improvement programs in their community Reduce travel on days with poor air quality. Industries in these environment should comply with local rules that apply to their operations. They should drive slowly on unpaved roads and other dirty surfaces. They should work with local agencies to develop strategies that will further reduce PM emissions. Avoid using leaf blowers and other dust producing equipment. Avoid vigorous physical activity on days that have poor air quality and avoid using wood stove and fire place on days that have poor air quality. Finally location E (CMS) is the best place to leave due to its high negative value, followed by location B (Surulere), then C (Oshodi) and D (Mile 2) respectively. While location F (Ikeja) is highly affected by pollutants due to its high positive value of +14 this is followed by location A (Apapa) of value +2.

Conclusion

This research was able to ascertain the hazardous air pollutants concentration in certain area of a community. Developed a web-based program (written in Java scripts) that analyzed data collected through the help of the samplers. The analyzed results were used to advice the inhabitants in each location examined as par type of air pollutant affecting them.

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