MEDDOCS Open Access Publisher

Environmental Sciences: Open Access

Open Access | Research Article

Assessment of Air Pollution Level in Selected Areas of Asmara, Eritrea

Aron Haile michael[1]*; Khalid Siraj[1]*; Robel Kbrom[2]; Teame Tekleab[2]; Simon Brhane[1]; Akberet Kibreab[1]; Milen Eyob[1]; Yosief Salih[1]; Zebib Tekelhaymanot[1]

[1]Department of Chemistry, Mai Nefhi College of Sciences, P.O. Box 12769, Asmara, Eritrea.

[2]Water Resource Department, Ministry of Land, Water and Environment, P.O. Box 976, Asmara, Eritrea.

***Corresponding Author(s): Aron Haile Michael & Khalid Siraj**

Department of Chemistry, Mai Nefhi College of Sciences, P.O. Box 12769, Asmara, Eritrea.

Tel: +2917755678; Email: khalid.chemprof@gmail.com

Received: Feb 17, 2026

Accepted: Apr 06, 2026

Published Online: Apr 13, 2026

Journal: Environmental Sciences: Open Access

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Keywords: Air Pollution; AQI; Health Risk; Pollutant Gases; Particulate Matter.

Abstract

This study investigates the concentration levels of ten common air pollutants CO, CO_2, NO_2, CH_2O, VOCs, O_3, SO_2, H_2S, $PM_{2.5}$, and PM_{10} along with two meteorological parameters (temperature and humidity) in Asmara, Eritrea, and its surrounding areas. Measurements were carried out at seven locations: Med Eber (L1), Edgar Elke (L2), Marcato (L3), Edgar Hamas (L4), Park Sem aetat (L5), Skariko (L6), and Maekiel Ketema (L7). Pollutant concentrations were recorded using the Aeroqual Series 500 and the Air Quality Detector YF-8600. The findings indicate that, except for CO, $PM_{2.5}$, and PM_{10}, all monitored pollutants were below WHO standard limits. Notably, Markato (L3) exhibited the highest VOC levels, likely attributable to fossil-fuel-powered generators, biofuel use, and incomplete biomass combustion. Medeber (L1) and Edgar Hamus (L4) recorded the highest H_2S concentrations, possibly due to natural gas consumption in these areas. The average temperature and humidity across Asmara were 27.5 °C and 35.8%, respectively. The results further suggest a relationship between pollutant levels, meteorological conditions, and anthropogenic activities, with human sources being the primary contributors to elevated concentrations. Overall, nearly 70% of the pollutants studied were within WHO guidelines, indicating that the air quality in Asmara is generally safe for breathing, provided that emission sources are controlled.

Introduction

Air pollution is the presence of substance in the atmosphere that are harmful to the health of humans and other living things, or cause damage to climate or materials [1]. Air pollutants exist in various forms, including gases (such as ammonia, carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen oxides, methane, volatile organic compounds, formaldehyde, hydrogen sulphide, ozone, and chlorofluorocarbons), particulate matter (organic and inorganic), and biological molecules [2]. Exposure to these pollutants poses a major risk factor for several pollution-related diseases, including respiratory infections, cardiovascular disease, Chronic Obstructive Pulmonary Disease (COPD), stroke, and lung cancer [3].

Major stationary sources of pollution include chemical manufacturing plants, coal-fired power stations, oil refineries, petrochemical facilities, nuclear waste disposal sites, incinerators, large-scale livestock farms (such as those for dairy cattle, pigs, and poultry), PVC (polyvinyl chloride) production units, metal processing plants, plastic manufacturing industries, and other heavy industrial operations [4,5].

Cite this article: Haile Michael A, Siraj K, Kbrom R, Tekleab T, Brhane S, et al. Assessment of Air Pollution Level in Selected Areas of Asmara, Eritrea. Environ Sci Open Access. 2026; 1(1): 1008

Approximately 2.4 billion people rely on polluting fuels for cooking and heating, leading to 3.2 million premature deaths annually from household air pollution. Over 99% of the global population resides in areas where air pollution exceeds WHO air quality standards, and ambient air pollution is linked to about 4.2 million deaths each year [6,7].

Ambient fine Particulate Matter (PM2.5) levels vary significantly across Africa, ranging from 80.1 μg/m³ in Niger to 14.9 μg/m³ in Mauritius (Figure 1). In many African nations, the average annual concentration of PM2.5 surpasses the World Health Organization's recommended threshold of 10 μg/m³ [8]. L. Saah et al. reviewed and analysed recent literature, emphasizing the effects of lockdown on major air pollutants and the resulting impact on air quality. Their findings indicate that global levels of air contaminants declined compared to previous decades, leading to a notable improvement in the Air Quality Index (AQI) worldwide. Many urban areas also experienced slight enhancements in overall air quality. Furthermore, evidence suggests a correlation between reduced pollution levels and a decrease in COVID-19 transmission and mortality rates across several cities [9].

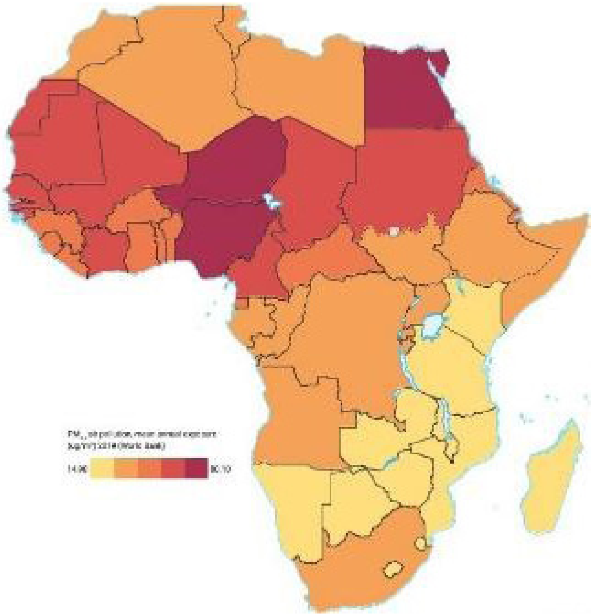

Figure 1: Annual Mean Concentration of Airborne Particulate Pollution (PM2.5) [μg/m3] in Urban Areas, Africa, 2019.

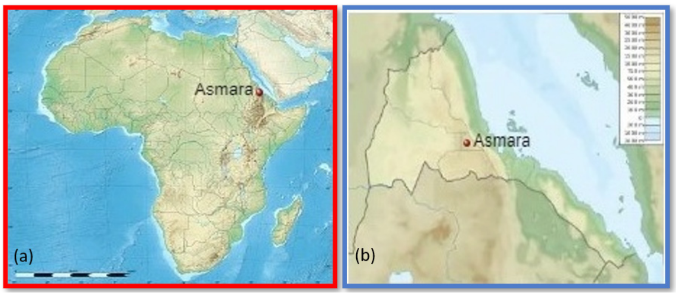

Figure 2: **(a)** Location of Asmara within Africa; **(b)** Location of Asmara within Eritrea.

Due to the growing industries and increasing vehicles, proper monitoring of air pollution is necessary so that we can have a data for implementation of law for pollution control. Timely monitoring of air pollution will also help to make aware to the society about its cause and effect so that they can take care of their environment.
The goal of this study is to quantify the impacts of air pollution (both household air pollution and ambient air pollution) on health, human capital, and the economy in a rapidly changing Asmara, Eritrea.

Eritrea is one of the countries in the Horn of Africa region in Eastern Africa (Figure 2 **(a)**), with its capital Asmara. It is bordered by Ethiopia in south, Sudan in the west, and Djibouti in the southeast. This nation has a total area of approximately 117,600 km^2. Eritrea lies between latitude 12^0 and 18^{0}N, and longitude 36^0 and 44^{0}E. Asmara found at an elevation of 2,325 meters (7,628 ft.). This elevation makes Asmara the sixth highest capital in the world by altitude (Figure 2 **(b)**).

Due to the growing industries and increasing vehicles, proper monitoring of air pollution is necessary so that we can have a data for implementation of law for pollution control. Timely monitoring of air pollution will also help to make aware to the society about its cause and effect so that they can take care of their environment.

The goal of this study is to quantify the impacts of air pollution (both household air pollution and ambient air pollution) on health, human capital, and the economy in a rapidly changing Asmara, Eritrea.

Materials And Methods

Study Sites: The sites that this research conducted were Medeber, Edaga Ekli, Markato, Edaga Hamus, Skariko, Maekel Ketema and Park Semaetat (Figure 3 & 4). These areas are found in and around the city Asmara which is the capital city of Eritrea.

Medeber, located within Asmara, is a large working hub where people from various areas gather to meet their domestic needs. The site is heavily equipped with power generators, used during electricity outages, and numerous grinding machines. As a result, the area is likely to experience significant environmental pollution.

Skariko, situated about 8 kilometres from Asmara, serves as the city's primary waste disposal site. It accommodates a wide range of refuse, including food scraps, market waste, yard waste, plastics, packaging materials, and other solid wastes from residential, commercial, institutional, and industrial sources. The collected waste is frequently burned, releasing harmful gases such as CO, SO_2, NO_2, VOCs, CH_4, and Particulate Matter (PM) into the atmosphere. Although the site was chosen for its distance from the capital, the emissions still pose environmental and health risks to Asmara and nearby towns. Therefore, this area has been selected for study due to its considerable impact on the surrounding region.

Markato, situated in the capital city of Asmara, is a major marketplace primarily for vegetables and fruits. The area experiences heavy traffic, the operation of generators, and large crowds of people engaged in buying and selling, all of which contribute to the release of harmful gases. Edgar Ekli, another significant marketplace, is known for cereals and houses cereal-grinding machinery, which emits smoke. This site was selected due to its dense human activity and pollution from the grinding processes. Maekel Ketema, commonly referred to as Harnet Avenue or Comishtato, is the downtown centre of Asmara and records the highest movement of vehicles among all sites, resulting in substantial emissions of pollutant gases that pose risks to both health and the environment. Edgar Hamus, on the other hand, is the city's largest bus station.

Every day, a large number of people and motor vehicles pass through this area. The emissions from these vehicles are likely a contributing factor to air pollution in Edgar Hamus. Particulate matter is considered the primary pollutant, as soil in this region can easily become airborne due to the movement of buses and pedestrians. In contrast, Park Semaetat, located in the southern part of Asmara, is densely covered with trees. Trees play a significant role in absorbing carbon dioxide and releasing oxygen, thereby serving as a natural carbon sink. For this reason, we regard Park Semaetat as a relatively clean and unpolluted area, making it a suitable reference site.

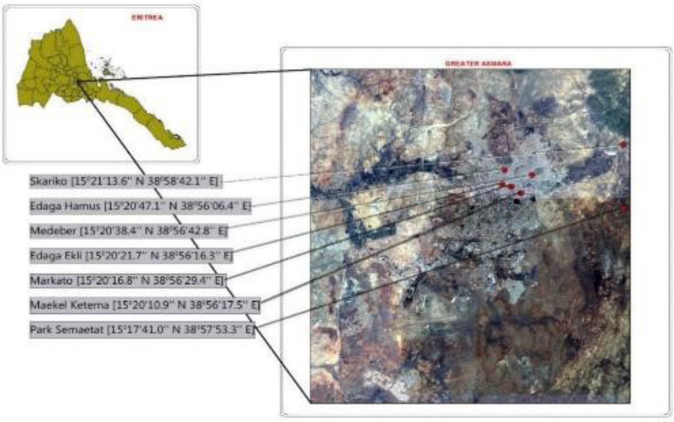

Figure 3: Location of sites with in Asmara.

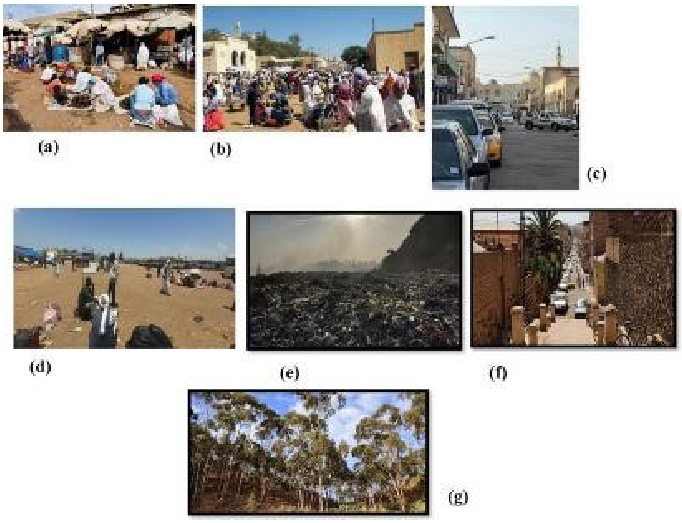

Figure 4: Images of the study sites; **a)** Medeber, **b)** Edaga Ekli, **c)** Markato, **d)** Edaga Hamus, **e)** Skariko, **f)** Maekel ketema, **g)** Park Semaetat.

Materials

One of the instruments used for measuring the concentration of the pollutant gases was Aeroqual Series 500, with swappable sensor heads such as CO, CO_2, NO_2, SO_2, and PM (PM_{10} and $PM_{2.5}$). Sensors are housed within an interchangeable cartridge (head) that attaches to the monitor base. The head can be removed and replaced in seconds. Monitor ID identifies the monitor uniquely and ensures that all data from it are tied to that monitor. Location ID used to tag measurements to a specific location. Data was stored on board. To download the data a USB cable is supplied for connection to PC. Free PC software provided with the series 500 takes the data and presents it in a table view. Fully charged battery for the monitor worked about eight (8) hours only and hence eight (8) hours reading had taken throughout the entire data collection.

The second instrument was Air Quality Detector YF-8600. Air Quality Detector YF-8600 is air quality detector which can detect parameters such as temperature (^{0}C), humidity (%), CO, CO_2, NO_2, formaldehyde (CH_2O), VOC, O_3, SO_2, H_2S, $PM_{2.5}$, and $PM_{10.}$ This instrument uses high-performance rechargeable lithium batteries with capacity 2000mAh.

Data Collection and Analysis

Data logging (using Aeroqual series 500) was set for a time interval of 15 minutes with minimum, maximum and average values. The data collection for each pollutant gases conducted for four days for a single location and it took 28 days to cover in seven (7) locations. The collected data were analyzed in comparison with WHO standard. The data obtained were subjected to basic statistical analyses.

After Air Quality Detector YF-8600 turned on, the sensors were first preheated. During this time the instrument do not conduct measuring until the countdown timer ends and then begun to measure.

Result and Discussion

Table 1, table 2, table 3 and table 4 displays the mean concentration values for pollutant gases and metrological parameters on first, second, third and fourth day respectively measured from March to May. The average data of all four days also given on table 5.

Table 1: Data collected on the first day [mid-March].

	DAY ONE	Location ID	CO_2 [ppm]	CH_2O [mg/m^3]	VOC [mg/m^3]	CO [mg/m^3]	SO_2 [mg/m^3]	NO_2 [mg/m^3]	O_3 [ppm]	H_2S [ppm]	$PM_{2.5}$ [µg/m^3]	PM_{10} [µg/m^3]	Temperature [^{0}C]	Humidity [%]
1	**Medeber**	L1	407	0.106	0.103	0.00534	0.013	0.0146	0.049	0.040	20	62	30.4	27
2	**Edaga Ekli**	L2	368	0.027	0.040	0.00098	0.011	0.0125	0.038	0.011	15	44	26.2	38
3	**Markato**	L3	407	0.108	0.200	0.00320	0.014	0.0147	0.040	0.020	17	58	29.2	31
4	**Edaga Hamus**	L4	432	0.104	0.101	0.00570	0.013	0.0137	0.045	0.045	23	120	27	35
5	**Park semaetat**	L5	317	0.020	0.028	0.0006	0.012	0.0092	0.038	0.008	7	13	25.2	46
6	**Skariko**	L6	440	0.066	0.101	0.00464	0.015	0.0152	0.039	0.039	45	156	21.6	49
7	**Maekel ketema**	L7	420	0.030	0.006	0.00877	0.014	0.0110	0.038	0.008	89	97	22.3	56

Table 2: Data collected on the second day [late-March to early-April].

	DAY TWO	Location ID	CO_2 [ppm]	CH_2O [mg/m^3]	VOC [mg/m^3]	CO [mg/m^3]	SO_2 [mg/m^3]	NO_2 [mg/m^3]	O_3 [ppm]	H_2S [ppm]	$PM_{2.5}$ [µg/m^3]	PM_{10} [µg/m^3]	Temperature [^{0}C]	Humidity [%]
1	Medeber	L1	410	0.100	0.098	0.00313	0.011	0.0154	0.037	0.030	27	70	29	32
2	Edaga Ekli	L2	400	0.033	0.035	0.00018	0.009	0.0109	0.042	0.023	17	51	27.1	34
3	Markato	L3	401	0.111	0.195	0.00292	0.012	0.0127	0.033	0.018	21	62	31.3	29
4	Edaga Hamus	L4	420	0.100	0.092	0.00324	0.010	0.0140	0.040	0.030	64	113	29	31
5	Park semaetat	L5	336	0.030	0.067	0.0008	0.010	0.010	0.040	0.007	1	5	26.4	44
6	Skariko	L6	426	0.120	0.078	0.00312	0.013	0.0167	0.038	0.020	40	133	24.1	45
7	Maekel ketema	L7	416	0.07	0.008	0.00963	0.011	0.0122	0.040	0.010	77	84	27	34

Table 3: Data collected on the third day [end-April].

	DAY THREE	Location ID	CO_2 [ppm]	CH_2O [mg/m^3]	VOC [mg/m^3]	CO [mg/m^3]	SO_2 [mg/m^3]	NO_2 [[mg/m^3]	O_3 [ppm]	H_2S [ppm]	$PM_{2.5}$ [µg/m^3]	PM_{10} [µg/m^3]	Temperature [^{0}C]	Humidity [%]
1	Medeber	L1	414	0.109	0.107	0.00368	0.009	0.0109	0.044	0.052	23	59	31	29
2	Edaga Ekli	L2	380	0.022	0.039	0.00084	0.007	0.0186	0.035	0.015	11	19	28.7	35
3	Markato	L3	423	0.115	0.225	0.00357	0.010	0.0140	0.058	0.013	18	50	30.5	26
4	Edaga Hamus	L4	400	0.107	0.098	0.00366	0.008	0.0124	0.037	0.047	85	128	27.9	36
5	Park semaetat	L5	340	0.005	0.008	0.0006	0.011	0.004	0.040	0.008	7	20	25.7	43
6	Skariko	L6	433	0.117	0.016	0.00384	0.012	0.0147	0.039	0.024	47	148	24.9	42
7	Maekel ketema	L7	407	0.100	0.024	0.00772	0.013	0.0114	0.038	0.021	69	93	29.2	31

Table 4: Data collected on the fourth day [early-May].

	DAY THREE	Location ID	CO_2 [ppm]	CH_2O [mg/m^3]	VOC [mg/m^3]	CO [mg/m^3]	SO_2 [mg/m^3]	NO_2 [[mg/m^3]	O_3 [ppm]	H_2S [ppm]	$PM_{2.5}$ [µg/m^3]	PM_{10} [µg/m^3]	Temperature [^{0}C]	Humidity [%]
1	Medeber	L1	406	0.108	0.105	0.0044	0.008	0.0111	0.041	0.036	33	78	29.2	32
2	Edaga Ekli	L2	395	0.029	0.044	0.0011	0.013	0.0101	0.048	0.020	12	36	26	39
3	Markato	L3	410	0.102	0.210	0.0038	0.012	0.0149	0.039	0.010	22	71	28.3	33
4	Edaga Hamus	L4	455	0.089	0.105	0.0042	0.010	0.0133	0.049	0.040	36	100	30.1	27
5	Park semaetat	L5	315	0.022	0.006	0.0009	0.007	0.006	0.037	0.005	5	26	28	34
6	Skariko	L6	463	0.100	0.111	0.0047	0.015	0.0138	0.038	0.033	95	167	26.8	40
7	Maekel ketema	L7	410	0.094	0.084	0.0156	0.010	0.0117	0.042	0.014	88	102	27.5	36

Table 5: Average data collected from all four days.

	Average	Location ID	CO_2 [ppm]	CH_2O [mg/m^3]	VOC [mg/m^3]	CO [mg/m^3]	SO_2 [mg/m^3]	NO_2 [mg/m^3]	O_3 [ppm]	H_2S [ppm]	$PM_{2.5}$ [µg/m^3]	PM_{10} [µg/m^3]	Temperature [^{0}C]	Humidity [%]
1	Medeber	**L1**	409.25	0.10575	0.10325	0.0041375	0.01025	0.0130	0.04275	0.0395	25.75	67.25	29.9	30
2	Edaga Ekli	**L2**	385.75	0.02775	0.02775	0.000775	0.010	0.013025	0.04075	0.01725	13.75	37.5	27	33.5
3	Markato	**L3**	410.25	0.109	0.2075	0.0033725	0.012	0.014075	0.0425	0.01525	19.5	60.25	29.825	29.75
4	Edaga Hamus	**L4**	426.75	0.100	0.099	0.00420	0.01025	0.01135	0.04275	0.0405	52	115.25	28.5	32.25
5	Park semaetat	**L5**	327	0.01925	0.02725	0.000725	0.010	0.0073	0.03875	0.007	5	16	26.325	41.75
6	Skariko	**L6**	440.5	0.10075	0.0765	0.004075	0.01375	0.0151	0.0385	0.029	56.75	151	24.35	44
7	Maekel ketema	**L7**	413.25	0.0735	0.0305	0.01043	0.012	0.011575	0.0395	0.01325	80.75	94	26.5	39.25

Air quality guidelines have been widely used as a reference tool to help decision-makers across the world in setting standards and goals for air quality management [9]. We also applied those standards on this work to find rate on which increased or decreased. Normally by observing on table 6 we cannot conclude whether the concentration rate is increase or decrease. But table 7 shows the rate (%) of concentration of pollutant gases. Rate can be calculated using this formula.

Rate=[(recent dat-standard)/(standard)]x100

Gases which are green colour in table 4.7 are below the standards, similarly gases with red colour above the standards.

Table 6: Comparison between guideline standards and average recent data.

Location ID	Who Standard										Average Recent Data									
	CO_2 [ppm]	CH_2O [[µg/m³]	VOC [µg/m³]	CO [µg/m³]	SO_2 [µg/m³]	NO_2 [µg/m³]	O_3 [µg/m³]	H_2S [ppm]	$PM_{2.5}$ [µg/m³]	PM_{10} [µg/m³]	CO_2 [ppm]	CH_2O [µg/m³]	VOC [µg/m³]	CO [µg/m³]	SO_2 [µg/m³]	NO_2 [µg/m³]	O_3 [µg/m³]	H_2S [ppm]	$PM_{2.5}$ [µg/m³]	PM_{10} [µg/m³]
L1	410	100	300	4	40	25	100	0.13	15	45	409.25	105.75	103.25	4.1375	10.25	13	83.92	0.0395	25.75	67.25
L2	410	100	300	4	40	25	100	0.13	15	45	385.75	27.75	27.75	0.775	10	13.025	80	0.01725	13.75	37.5
L3	410	100	300	4	40	25	100	0.13	15	45	410.25	109	207.5	3.3725	12	14.075	83.4	0.01525	19.5	60.25
L4	410	100	300	4	40	25	100	0.13	15	45	426.75	100	99	4.2	10.25	11.35	83.9	0.0405	52	115.25
L5	410	100	300	40	40	25	100	0.13	15	45	327	19.25	27.25	0.725	10	7.3	76	0.007	5	16
L6	410	100	300	4	40	25	100	0.13	15	45	440.5	100.75	76.5	4.075	13.75	15.1	75.6	0.029	56.75	151
L7	410	100	300	4	40	25	100	0.13	15	45	413.25	73.5	30.5	10.43	12	11.575	77.5	0.01325	80.75	94

Table 7: Rate with respect to guideline standards.

Location ID	Rate (%) with respect to WHO standard									
	CO_2	CH_2O	VOC	CO	SO_2	NO_2	O_3	H_2S	$PM_{2.5}$	PM_{10}
L1	-0.18	5.75	-65.6	3.44	-74.38	-48	-16.1	-69.61	71.6	49.4
L2	-5.9	-72.25	-90.75	-80.63	-75	-47.9	-20	-86.7	-8.3	-16.7
L3	0.06	09	-30.8	-15.69	-70	-43.7	-16.6	-88.27	30	33.9
L4	4.09	**0.0**	-67	05	-74.45	-54.6	-16.1	-68.8	246.7	156.1
L5	-20.24	-80.75	-90.9	-81.88	-75	-70.8	-24	-94.61	-66.7	-64.44
L6	7.44	0.75	-74.5	1.88	-65.6	-39.6	-24.4	-77.7	278.3	235.6
L7	0.79	-26.5	-89.8	160.7	-70	-53.7	-22.5	-89.8	438.3	108.9

Similarly figure 5 explain the rate of the pollutant gases with respect to standards. Those above zero are higher than standard and those below zero are lower than standard. $PM_{2.5}$ and PM_{10} are above standards in all locations except L2 and L5 [10].

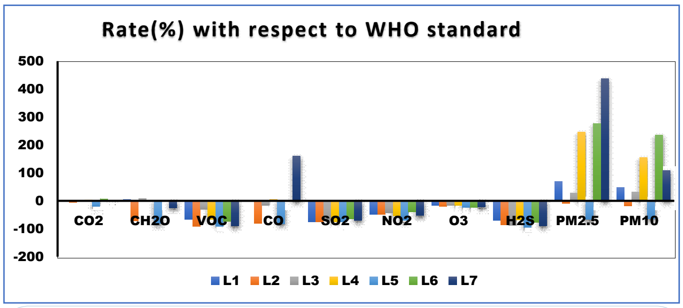

Figure 5: Rate (%) with respect to WHO standard.

Carbon Dioxide (CO_2): All current concentration of carbon dioxide having risen from pre-industrial levels of 280 ppm [11]. All locations have concentration level almost equal to WHO standard (410 ppm), except L2 and L5. Figure 6, reflects the level of concentration precisely. The possible reason could be combustion of wood, peat, wastes and other organic materials and fossil fuels such as coal, petroleum and natural gas.

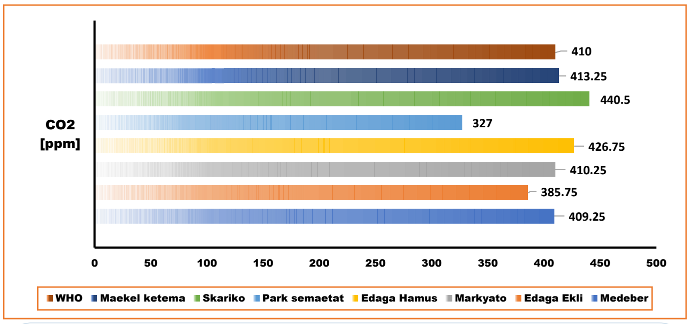

Figure 6: Graph explaining CO2 with WHO standard.

Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Particulate Matter ($PM_{2.5}$ and PM_{10}): The term Particulate Matter (PM), denote a mixture of liquid droplets and solid particles that can be found in the air. PM is not a pollutant by itself but a complex and dynamic combination of compound particles with biological and chemical origins. The main components of PM are primarily sulphites, ammonia, nitrates, sodium chloride, mineral dust, black carbon, and water [12].

Figure 7, showing the data of different pollutants, except L2 and L5 the value of concentration of $PM_{2.5}$ and PM_{10} is higher than WHO standard (15µg/m³ and 45µg/m³ respectively). The mean concentration of SO_2 and NO_2 are less than WHO standard. Skariko (L6) has highest value in both gases, the reason might be continuous burning of wastes. Highest concentration of CO is noted down in Maekel Ketema. The possible reason for this high concentration of CO in this area is high vehicle movement and its emission [10,12].

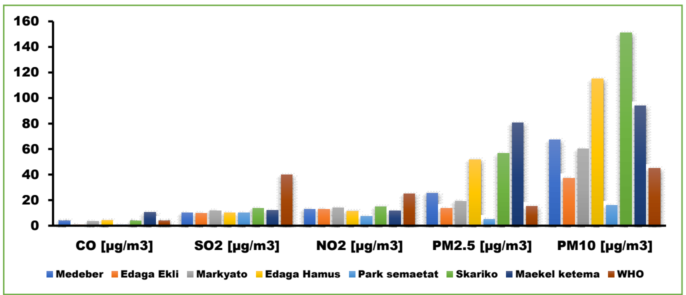

Figure 7: Bar graph explaining CO, SO_2, NO_2, $PM_{2.5}$ and PM_{10} with WHO standard.

Ozone (O_3), Formal Aldehyde (CH_2O) and Volatile Organic Compounds (VOC): Ground-level ozone (O_3), also known as tropospheric ozone, is among the most dangerous photochemical pollutants since people exposed to this type of pollutant are more at risk for the development of breathing problems, asthma, reduced lung function, and respiratory diseases [12].

Data depicting all locations have almost the same amount of concentration which is less than WHO standard. Figure 7, illustrate except L2 (Edaga Ekli), L5 (Park Semaetat) and L7 (Maekel Ketema) all sites have CH_2O higher than Standard. Main sources of CH_2O are building materials including carpeting and plywood [10], forest fires, automobile exhaust, and tobacco smoke. So out of those automobile exhaust, and tobacco smoke could be reason for increase in concentration of CH_2O in L1 (Medeber), L3 (Markato), L4 (Edgar Hamus), and L6 (Sariko). Figure 8 also exhibit VOCs are below standard in all location. L3 (Markato) is only place with highest level of VOC, which attribute to the possible use of fossil fuel generators [13], biofuel and incomplete biomass combustion.

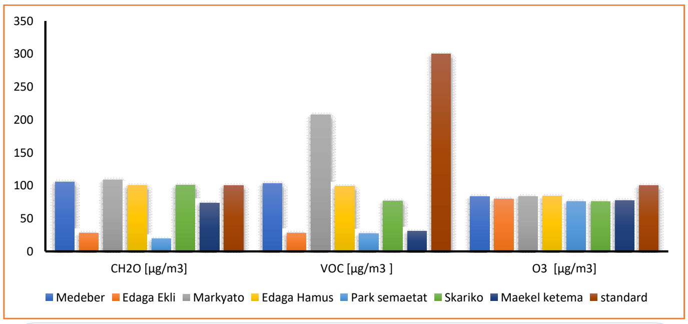

Figure 8: Bar graph displays concentration of Ozone (O3), Formal Aldehyde (CH2O) and Volatile Organic Compounds (VOC) with standard.

Hydrogen Sulphide (H_2S): H_2S causes the disease like eye irritation, a sore throat and cough, nausea, shortness of breath, and fluid in the lungs (pulmonary edema). Figure 9, shows the obtained data for H_2S. The obtained data suggest that the concentration of H_2S is below standard in all locations. L1 (Medeber) and L4 (Edaga Hamus) have highest concentration among all locations (which is still below the WHO standard). This could be as a result of consumption of natural gas in these areas [14,15].

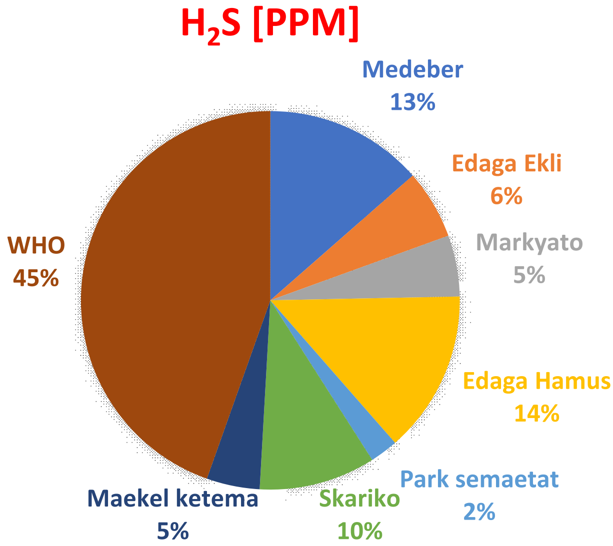

Figure 9: Pie chart explaining concentration of H_2S in ppm in all locations and standard.

Temperature And Humidity: Temperature is a physical parameter that indicates the degree of hotness or coldness. The lowest average temperature was recorded at L6 (Skariko) with 24.35 °C, while the highest was at L1 (Med Eber) with 29.9 °C. These results also highlight the relationship between temperature and humidity. As shown in Figure 9, the area with the highest temperature (L1) corresponds to the lowest humidity. Humidity refers to the concentration of water vapor in the air, which, being in its gaseous state, is usually invisible to the human eye. It is an important factor in determining the likelihood of precipitation or fog. The overall average temperature and humidity in Asmara are 27.5 °C and 35.8%, respectively.

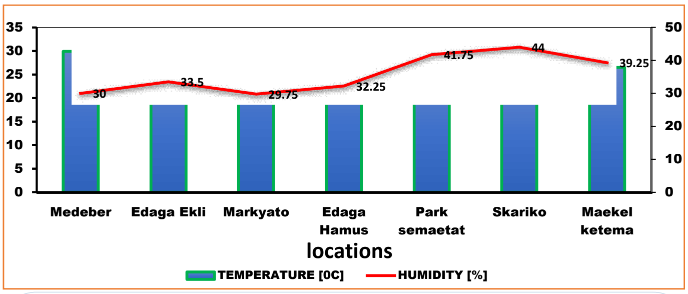

Figure 9: Graph shows temperature and humidity in all locations.

Conclusion

The present study was conducted to raise awareness regarding air quality among the residents of Asmara and its surrounding areas. Pollution in general, and air pollution in particular, cannot be overlooked as it affects everyone and will continue to do so unless effective measures are taken to reduce the release of pollutants into the air, water, and land. Preventing air pollution requires individuals and industries to eliminate the use of toxic substances, which implies the discontinuation of fossil fuel combustion in activities ranging from industrial production to domestic energy use. Thus, air pollution control must be treated as a top priority by the government. Findings from this project indicate that nearly 70% of the analysed pollutant gases were within the permissible limits set by WHO. However, it cannot be conclusively stated that the air in Asmara is entirely safe for breathing unless the sources of emissions are significantly reduced.

Acknowledgement: We would like to thanks Department of Chemistry, Mai-Nefhi College of Sciences and Ministry of Land, Water and Environment for providing the necessary facilities to carry out this work.

Declarations

Funding Sources: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest: The author(s) do not have any conflict of interest.

Data Availability Statement: The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Statement: This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Author Contributions

AH, RK, TT and KS: Conceptualization Supervision Review and Editing.

SB, AK, ME, YS and ZT: Methodology Data Curation Formal Analysis and Writing - Original Draft.

Permission to Reproduce Material from other Sources: Not applicable.

References

1. D E Newton. Chemistry of the Environment, imprint of InfoBase Publishing: United States of America; p IX. 2007.
2. Lee Y G, Lee P H, Choi S M, An M H, Jang AS. Effects of Air Pollutants on Airway Diseases. Int. J. Environ. Res. Public Health. 2021; 18: 9905.
3. "7 million premature deaths annually linked to air pollution". WHO. Retrieved. 2024.
4. Buiarelli F, Di Filippo P, Massimi L, Pomata D, Riccardi C, et al. Ultrafine, fine and coarse airborne particle mass concentration in workplaces. Atmos. Pollut. Res. 2019; 10: 1685-1690.
5. Beychok, Milton R. 'Aqueous wastes from petroleum and petrochemical plants', 1st ed., John Wiley & Sons. 1967.
6. United States Environmental Protection Agency. Guidelines for Developing an Air Quality (Ozone and PM2.5) Forecasting Program; Publication No.EPA-456/R-03–002; U.S. Environmental Protection Agency: Research Triangle Park, NC, USA. 2003.
7. Health Effects Institute. State of Global Air 2019: Air Pollution a Significant Risk Factor Worldwide; Health Effects Institute: Boston, MA, USA,2019.
8. Samantha Fisher, David C. Bellinger, 2021. "Air Pollution and Development in Africa: Impacts on Health, the Economy and Human Capital"; United Nations Avenue, Gigiri, Nairobi, Kenya. p 30
9. L Saha, et al. 'The impact of the COVID-19 lockdown on global air quality': A review, Environmental Sustainability. 2022; 5: 5-23.
10. Karimi A, Shirmardi M, Hadei M, Birgani Y T, Neisi A, et al. Concentrations and health effects of short- and long-term exposure to PM2.5, NO2, and O3 in ambient air of Ahvaz city, Iran (2014-2017). Ecotoxicol. Environ. Saf. 2019; 180: 542-548.
11. Law J, Watkins S, Alexander D. "In-Flight Carbon Dioxide Exposures and Related Symptoms: Associations, Susceptibility and Operational Implications" (PDF). NASA Technical Report. TP-2010-216126. Archived from the original (PDF) on 27 June 2011. Retrieved. 2024.
12. World Health Organization. WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide: Global Update 2005: Summary of Risk Assessment; World Health Organization: Geneva, Switzerland, 2006.
13. Gakidou E, Afshin A, Abajobir A A, Abate K H, Abbafati C, et al. Global, Regional, and National Comparative Risk Assessment of 84 Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990 2016: A Systematic Analysis for the Global Burden of Disease Study 2016. Lancet. 2017; 390: 1345-1422.
14. Betty J Locey, Hydrogen Sulfide, Encyclopedia of Toxicology (Second Edition). 2005: 545-551
15. Lindenmann J, Matzi V, Neuboeck N, Ratzenhofer-Komenda B, Maier A, et al. "Severe hydrogen sulphide poisoning treated with 4-dimethylaminophenol and hyperbaric oxygen". Diving and Hyperbaric Medicine. 2010; 40(4): 213-217.