Linear modeling with the Air Quality Index of Carbon Monoxide Environmental pollutant


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A vast number of individuals live in territories where air contamination induces terrible health and medical conditions as environmental air quality influences our everyday lives. The Environmental Agency (EPA) air pollution or quality index (API/AQI) make data accessible to the health implications of air contaminants, and how to evade those impacts. The air pollution or quality index (API/AQI) is usually applied to declare the degree of air contamination amongst the general population. Despite the various techniques that were formulated in the past by different organizations for the assurance of AQI or API yet there is no all-around acknowledged strategy that exists, which is suitable for all circumstances. The distinctive technique utilizes a diverse collection of work in computing AQI or API with regards to quantities of these pollutants. The planned objective of AQI or API is to recognize the vulnerable air quality zones and publicly disseminate the significance and severities to the allowance of poor air quality. Web-based (Air now) AQI calculator was adopted in modeling \((y=0.1028x-1.4203)\) at \(R^2=0.9926\) the AQI/concentration of carbon monoxide \((1, 3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, \text{and } 55 \text{ ppm});\) one of the most toxic gaseous pollutant in the atmosphere. This eventually established a linear model with a direct approach in the detection of the concentration and AQI of carbon monoxide under standard conditions.

Introduction

The air is the vaporous envelope that encompasses the earth and establishes the progress between its surface and the vacuum of the room with nitrogen (N2), oxygen (O2), and numerous layers of air [1]. Life on earth is upheld by the layers of air, sun-powered energy, our planet’s attractive fields, and the nature of air is extremely basic to its stability [2]. Air contamination is a worldwide natural issue that impacts generally the strength of the metropolitan populace. In recent years, epidemiological examinations have shown unfriendly wellbeing impacts because of higher surrounding levels of air contamination. Studies have demonstrated that rehashed introductions to surrounding air contaminations throughout a delayed timeframe raise the danger of being defenseless to airborne illnesses, such as cardiovascular sickness, respiratory infection, and cellular interruption within the lungs [3]. The most widely recognized air toxins in the metropolitan climate incorporate sulfur dioxide (SO2); oxides of nitrogen NOx, in terms of nitrogen dioxide (NO2); nitrogen oxide (NO); carbon monoxide (CO); volatile organic carbon (VOCs); oxygen (O3); suspended particulates
and lead (Pb) [4]. Air contaminants can be as strong particles, fluid beads, or gases with characteristics of being natural or man-made [5]. Origins of air contamination incorporate traffic and vehicle fumes, modern industrial activities areas with enormous energy demands [6]. Air contamination is turning into a subject of extreme studies at all levels due to the expanded degree of anthropogenic outputs and climatic changes.

Contamination in the metropolitan residence has expanded quickly because of high population strength, expanded quantities of engine vehicles, utilization of energizes with poor natural execution, inadequate control measures with transportation frameworks, and above all, weak ecological guidelines and strategies [7]. Air contamination is accepted to execute a bigger number of individuals worldwide than HIV/AIDS, tuberculosis, and malaria [8]. Airborne particulate materials are particularly hindering the wellbeing and have recently been assessed to be somewhere in the range of 3 and 7 million casualties consistently, by deteriorating cardio-respiratory illness [9]. In particular, the monoxide of carbon is a dull combustible gas that is somewhat less thick than air. It is heavily toxic to organisms with hemoglobin, an oxygen mobilizer when experienced above 35 ppm, even though it is biochemically generated in typical digestion at a insignificantly low amounts with ordinary natural capacities. It is comprised of one carbon and oxygen molecules associated with triple bonds with net dual pi bonds with a single sigma bond. It is the easiest oxocarbon with piezoelectricity with other triply reinforced diatomic species having 10 valence electrons, including the cyanide anion, the nitrosonium cation, boron monofluoride, and sub-atomic nitrogen. [10].

Symptoms are frequently portrayed as "influenza-like" and generally incorporate migraine, wooziness, weakness, chest irritation, and confusion as large dosages can bring about loss of awareness, arrhythmias, seizures, or death.[11] Long-term complexities may induce severe tiredness, loss of memory, and development issues [12]. Poisoning due to carbon monoxide can happen inadvertently, as an attempt to terminate life [13]. This can happen from engine vehicles, radiators, methylene chloride exposure, or cooking gear that suddenly spike in demand for carbon-based fills [14]. Carbon monoxide principally makes unfavorable impacts by interacting with hemoglobin structure as carboxyhemoglobin (HbCO) keeping the blood from conveying oxygen [15]. Also, myoglobin and mitochondrial cytochrome oxidase are influenced [15]. Actions to forestall harming combine carbon monoxide sensors, legitimate venting of gas apparatuses, keeping smokestacks clean, and keeping fumes frameworks of vehicles in a significant measure [16]. The poisoning treatment or management incorporates the supply of 100% oxygen alongside strong consideration until the side effects are not, at this point present and the HbCO level is under 10% [17]. Meanwhile, as the hyperbaric oxygen treatment is utilized for extreme poisonings, the advantage over standard oxygen conveyance remains unclear. [17]. Hence, the air quality file (AQI) is adopted by government organizations and systems to communicate the society on how contaminated the air presently is or how speculated to become [18]. The general wellbeing is practically threatened as the air quality escalates. Consequently, various nations recognize their air quality proceedings, comparing to their public air quality principles. AQI estimation requires air contamination fixation over a predetermined averaging period, acquired from the model or the framework. Meanwhile, the health impacts relating to a given fraction are set up by epidemiological exploration [19]. Air contaminations change by concentration, and the capacity for such change fluctuates by the nature of the gaseous contaminants. Its air quality list reverences are ordinarily grouped into ranges with a shading code descriptor with the general health implications. The essential goal of any air quality file is to change the deliberate groupings of individual air contaminants into a solitary mathematical file through an appropriate instrument. Preferably, every list ought to reflect both the deliberate and openly perceived air condition for the time-frame it covers. Accordingly, air quality lists endeavor to normalize and blend air contamination data and assigned correlations to be promptly embraced and to fulfill public requests for precise, simple to decipher the information. This study, therefore, models the air quality indices of carbon monoxide pollutants against concentrations as the sole factor and
fraction of the atmospheric gaseous pollutants and to further buttress the health-associated problems. It is equally hoped that the AQI rating and modeling for carbon monoxide air quality will support further research on air quality control and management.

![Figure 1. A school boy moving across the fumes and smoke being generated from waste incineration in the city of Port Harcourt, North East Nigeria [20].](image)

**Methodology**

Air now web based simulator was adopted for the direct computation and generation of AQI data with respect to carbon monoxide atmospheric concentrations (1, 3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 and 55 ppm).

**Results and discussion**

The computed outputs (AQI) with the concentration level in part per million were declared concerning the category of the quality indices, the sensitive fraction of individuals, the health disadvantages, and the respective technical precautions to the supervision of carbon monoxide environmental poisoning. It is apparent that the permissible limits range between 11-56 AQI (1-5 ppm of Carbon monoxide) while from 109 AQI (10ppm of carbon monoxide) triggers very unhealthy conditions with the heart impaired group of individuals (Table 1). Subsequently, the established linear model declares a direct approach in the detection of the concentration and AQI of carbon monoxide.
Table 1. The simulated air/pollution quality indices for carbon monoxide.

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>AQI</th>
<th>AQI Category</th>
<th>Sensitive Group</th>
<th>Health Implication</th>
<th>Cautionary statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>Good</td>
<td>People with heart disease are the group most at risk.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>Good</td>
<td>People with heart disease are the group most at risk.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>56</td>
<td>Moderate</td>
<td>People with heart disease are the group most at risk.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>109</td>
<td>Unhealthy for Sensitive Groups</td>
<td>People with heart disease are the group most at risk.</td>
<td>Increasing likelihood of reduced exercise tolerance due to increased cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.</td>
<td>People with cardiovascular disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.</td>
</tr>
<tr>
<td>15</td>
<td>193</td>
<td>Unhealthy</td>
<td>People with heart disease are the group most at risk.</td>
<td>Reduced exercise tolerance due to increased cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.</td>
<td>People with cardiovascular disease, such as angina, should limit moderate exertion and avoid sources of CO, such as heavy traffic.</td>
</tr>
<tr>
<td>20</td>
<td>231</td>
<td>Very unhealthy</td>
<td>People with heart disease are the group most at risk.</td>
<td>Significant aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.</td>
</tr>
<tr>
<td>25</td>
<td>264</td>
<td>Very Unhealthy</td>
<td>People with heart disease are the group most at risk.</td>
<td>Significant aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.</td>
</tr>
<tr>
<td>30</td>
<td>297</td>
<td>Very Unhealthy</td>
<td>People with heart disease are the group most at risk.</td>
<td>Significant aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.</td>
</tr>
<tr>
<td>Value</td>
<td>AQI</td>
<td>Status</td>
<td>People with heart disease are the group most at risk.</td>
<td>Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.</td>
</tr>
<tr>
<td>-------</td>
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<td>-----------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>35</td>
<td>346</td>
<td>Hazardous</td>
<td>People with heart disease are the group most at risk.</td>
<td>Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.</td>
</tr>
<tr>
<td>40</td>
<td>396</td>
<td>Hazardous</td>
<td>People with heart disease are the group most at risk.</td>
<td>Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.</td>
</tr>
<tr>
<td>45</td>
<td>446</td>
<td>Hazardous</td>
<td>People with heart disease are the group most at risk.</td>
<td>Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.</td>
</tr>
<tr>
<td>50</td>
<td>496</td>
<td>Hazardous</td>
<td>People with heart disease are the group most at risk.</td>
<td>Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.</td>
<td>People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td>Values above 500 are considered Beyond the AQI. Follow recommendations for the Hazardous category.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The modeled plot for the concentrations and corresponding air quality indices of environmental carbon monoxide pollutant.
Conclusion

Environmental pollution by air is a phenomenon that cannot be ignored as there have been significant impacts on public health with adverse effects on the respiratory and cardiovascular biological mechanisms. Carbon monoxide as an agent of air pollution has been modeled and designed to the advantage of the public knowledge and determination of carbon monoxide at any point of its concentration to the magnitude of its AQI. These developments, however, portray the need to enhance the monitoring mechanisms, regulations and enforcement measures by relevant regulatory bodies as national development and drive should focus more on renewable energy, clean energy, and cleaner air initiatives.

Acknowledgement: The authors appreciated and commend the efforts with the data generation from the U.S. Air Quality Index.

References