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Analysis of Air pollution Level in Major Cities of Pakistan

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ABSTRACT

Ironically, air pollution is one of the most serious environmental issues of Pakistan. In this study, different cities including Lahore, Islamabad, Karachi, Peshawar, and Quetta were selected to analyze the relationship of different gases in air such as carbon monoxide CO, nitrogen dioxide NO2, sulphur dioxide SO2, methane CH4, ozone O3, and particulate matter PM. The automatic ambient air data of the above mentioned cites were obtained from air quality monitoring stations installed in Pakistan Environmental Protection agency (Pak-EPA) and as well as provincial EPAs. Therefore, the results of air gases were quite alarming such as Lahore was found to be SO2 (200 µg/m3) and PM 2.5 (85 µg/m3) compared with the standard ambient air geese values. Subsequently, in Peshawar city CH4 gas was analysed (7510.29 µg/m3) was ten times higher than Pakistan National Environmental Quality Standard (NEQS) values. This conclusive evidence of air pollution in Pakistan cities will lead many diseases, such as cardiovascular, cancer, and many respiratory diseases. In conclusion, if no suitable and efficient ways are adopted at government level the situation will very worst in the nearly future.

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INTRODUCTION

Anthropogenic activities alter the interaction of humans towards their atmosphere (Manisalidis *et al*., 2020). Air pollution originate from hazardous chemicals in the atmosphere, having adverse effects on animals, plants, and humans (Priyadarshanee *et al*., 2022). Ultimately, air pollution effect ozone layer which increase global temperature. Commonly, air pollutants are a mixture of sulfur oxides, nitrogen oxides including NO and NO_2, volatile organic compounds and oxide of gaseous compound (Saxena and Sonwani, 2019). Furthermore, air pollutants such as carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2) or sulfur dioxide (SO_2) are released from industrial units. Air pollution effect on the human health causes respiratory problem, cancer, and cardiovascular diseases. In short term exposure to air pollutants led to asthma, cough, and shorten breath and wheezing (Konduracka & Rostoff, 2022). Therefore, long term exposure of air pollution causes chronic asthma,

heart disease and serious respiratory diseases. From 21 century air pollution air pollution is considered a global environmental problem (Zhang *et al*., 2022). In Pakistan air pollutants data is higher above the WHO guidelines increasing health risks cardiovascular diseases, eye discomfort and respiratory disorder (Organization, 2022). In Karachi, PM 2.5 concentration was found higher than WHO standard (Moyebi *et al*., 2022). Presentably, Lahore city is also polluted because of rapid urbanization, industrialization, and extensive uses of private vehicles. According to previous studies, Lahore city was at peak of PM2.5, because of traffic movement (Abdullah *et al*., 2020). Several other reports show extreme air pollution in Lahore city during winter, as results of excessive burning of crops remnants (Rana *et al*., 2015). One study data revealed that all sample have higher percentage of PM than (NEQS) National Environmental Quality Standards (Di *et al*., 2017). However, in this current research, data of different sites were collected on monthly basis to conform the exact level of air pollution in the major cites of Pakistan. The objectives of this study were as follows: (1) determination of air quality. (2) to evaluate the SO_2, NO_2, O_3, CO and CH_4 concentrations in air. (3) determination of air pollution in Pakistan.

MATERIAL AND METHODS

Research description

Air pollution originate from hazardous chemicals in the atmosphere, having adverse effects on animals, plants and humans. Commonly, air pollutants are a mixture of sulfur oxides, nitrogen oxides including NO and NO_2, volatile organic compounds and oxide of gaseous compound. The ambient air quality was monitored by a fixed air monitoring station figure 1. The gas analyzers were placed in an air-conditioned laboratory and teflon lines were used as a sampling inlet to isolate ambient air and mitigate reactivity with monitoring species. The ambient air was passed through the distribution system where humidity is trapped prior to entering the sample through the sample bulkhead of the individual analyzers.

Sample collection

The ambient air quality was monitored by a fixed air monitoring station figure 1. The gas analyzers were placed in an air-conditioned laboratory and teflon lines were used as a sampling inlet to isolate ambient air and mitigate reactivity with monitoring species. The ambient air was passed through the distribution system where humidity is trapped prior to entering the sample through the sample bulkhead of the individual analyzers. The principles of measurement and the method for calibration are common and have already been discussed in a few reports (Maji *et al*., 2021). For the best execution of trace gas analyzers, daily zero settings and weekly span controls have been conducted. The trace gas data of the analog waveform is transformed into digital values through the method of data acquisition and stored in the computer. The average value was recorded over a time period of 15 minutes. The raw data files are then extracted into individual time series and separated.

In this study, samples were collected from major cities of Pakistan (Karachi, Lahore, Peshawar, Islamabad, and Quetta). In present research, 10 specific areas were selected for sample collection two from Lahore (Lahore metro area and sunder industrial area) two from Karachi (Karachi city area and Korangi industrial area) two from Peshawar (Islamia college BRT station and industrial estate Hayatabad Peshawar) two from Quetta (Quetta pak town and Quetta industrial & trading estate) and two from Islamabad city (Islamabad-Rawalpindi metro Politian area and Rawat industrial estate Islamabad).

Data collection

From February (2021) to January (2022), secondary data of air pollution along with meteorological parameters such as temperature, relative humidity, and radiations, were obtained from Central Laboratory for Environmental Analysis and Networking (CLEAN) of Pak-EPA.

Data analysis

CO ambient concentration was measured using a CO Monitor which used the nondispersive infrared ray method (Yi, 2020). NOx, NO, and NO_2 concentration levels were measured using a chemiluminescence method through a NOx monitor. SO_2 was analyzed using a U.V. fluorescence method through SO_2 monitor. O_3 ambient concentration was measured using an Ozone Monitor which used the principle of UV photometry. PM2.5 is assessed using the β-ray absorption method by a dust analyzer. For hydrocarbon monitoring, converter oven method applied in Hydrocarbon Monitor (Wang *et al*., 2011). Thermometer is an instrument used to measure temperature (Dils, 1983). Geiger counter is electronic instrument used to detect and measure radiation (Quraishi, Hoque, Begum, and Alam, 2014). Relative humidity was measured by hygrometer (Dyer, 2012). Wind speed is measured by anemometer and wind direction shown by the wind vane instrument (Can and Karsh, 2007).

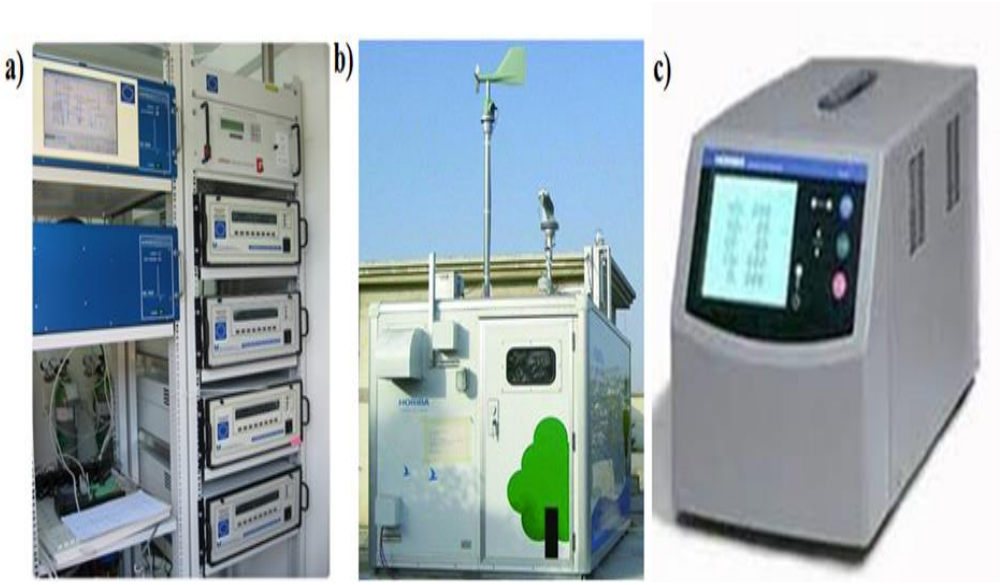

Figure 1. Inside photo of fix air monitoring station, a), outside picture b), PG-250 analyzer c).

RESULTS AND DISCUSSION

Sample collections sites

In the current study, ambient air quality data of Lahore, Quetta, Karachi, Peshawar and Islamabad was obtained from (EPA) Pakistan Environmental Protection Agency to determine high concentration of six air pollutants including SO_2, NO_2, O_3, PM, CO and CH_4. Analysis of various pollutants to find out the possible emission sources, origin, and its concentrations.

Nitrogen Dioxide (NO_2)

This study shows the annual average concentration of nitrogen dioxide (NO_2) was at highest level in Peshawar (272 µg/m3) (72hr). Moreover, air quality of other cities has also high values above NEQS. These results are similar with the findings of Tabinda *et al*. (2020). Figure 2 demonstrate the nitrogen dioxide level in different cities.

Sulfur Dioxide (SO_2)

The highest concentration of sulfur dioxide (SO_2) was found (250µg/m3) in Lahore as compared to other cities whereas in Islamabad the SO_2 concentration was (9.38 µg/m3) non-hazardous as illustrated in (Figure 3). Paraschi *et al*. (2022) also mentioned this range of concentrations as non-hazardous in their study.

Methane (CH_4)

The annual mean concentration of methane CH_4 was found (7610 µg/m3) in Peshawar above the NEQS values. Additionally, figure 4 illustrates the CH_4 concentration was at dangerous level was in Lahore (4800 µg/m3), Karachi (6400 µg/m3), Quetta (3269 µg/m3) and Islamabad (5200 µg/m3). Methane (CH_4) is a significant contributor to global warming, considered the second most impactful greenhouse gas (GHG) after carbon dioxide (CO_2). It has been responsible for almost 20% of the direct radiative forcing since 1750 (Forster *et al*., 2021). As a result, the latest findings highlight the concerning methane levels in these cities, which pose a threat to climate change.

Ozone (O_3)

The annual mean concentration of O3 level in Islamabad was (180 µg/m3) as compared to other cities such as Lahore (150 µg/m3), Karachi (90 µg/m3), Quetta (110 µg/m3) and Peshawar (148 µg/m3). Figure 5 demonstrate the monthly trend of ozone from February 2021 to January 2022.

Carbon Monoxide (CO)

Figure 6 shows the average concentration of carbon monoxide was (3.62 mg/m3) that was highest while in other cities Karachi (1.51 mg/m3), Quetta (2.41mg/m3), Peshawar (3.23 mg/m3) and Islamabad (3.45 mg/m3).

Mass Concentration ($PM_{2.5}$)

The annual average mass concentration of $PM_{2.5}$ was in Lahore 25µg/m3. $PM_{2.5}$ in other cities was Quetta (76.75 µg/m3), Karachi (121.34 µg/m3), Peshawar (147.47 µg/m3), and Islamabad (128.38 µg/m3) as shown in figure 7.

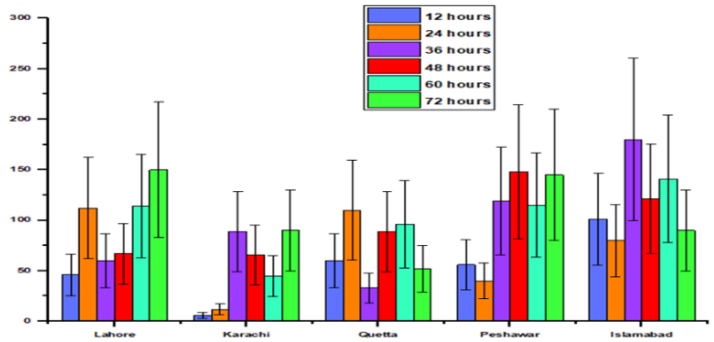

Figure 2. Concentration of NO2 in Major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar, and Islamabad).

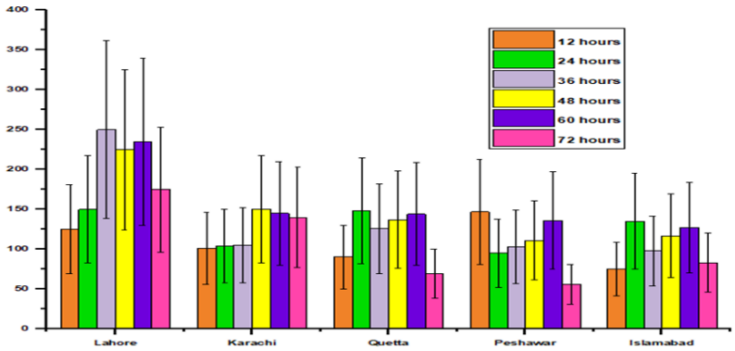

Figure 3. Concentration of SO2 in Major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar, and Islamabad).

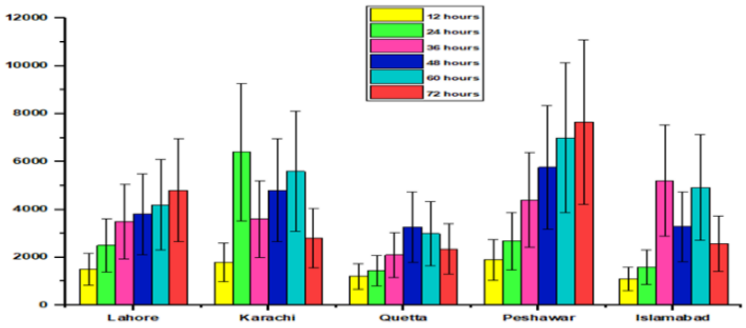

Figure 4. Concentration of CH4 in Major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar, and Islamabad.

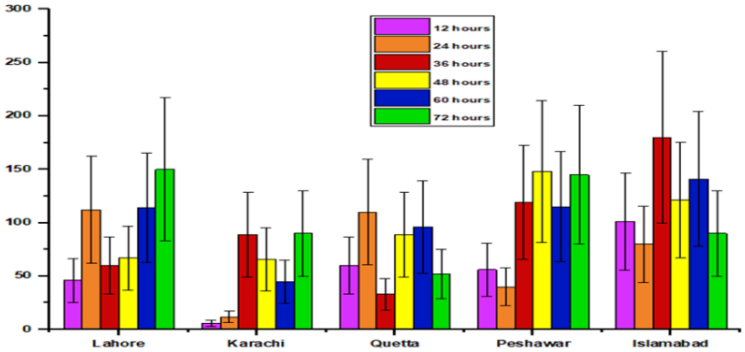

Figure 5. Concentration of O3 in major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar, and Islamabad).

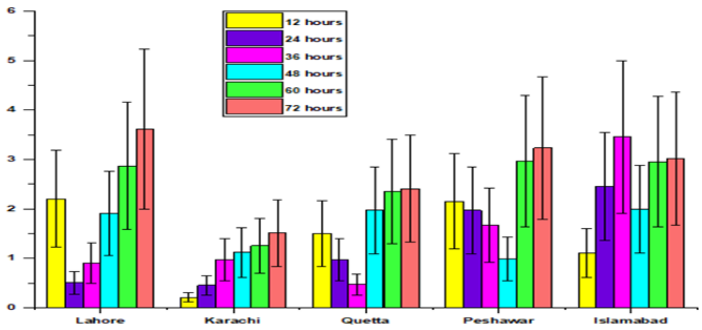

Figure 6. Concentration of CO in major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar and Islamabad).

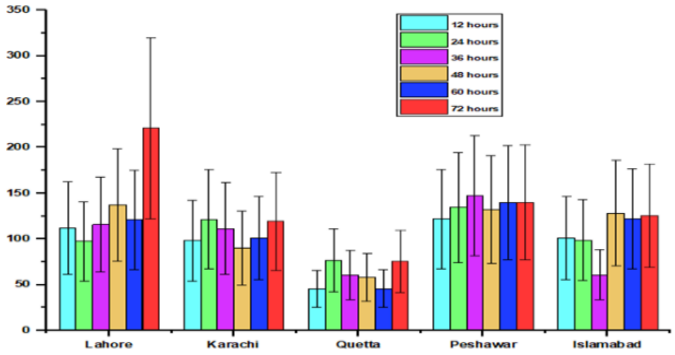

Figure 7. Concentration of MC in Major cities of Pakistan (Lahore, Karachi, Quetta, Peshawar and Islamabad.

CONCLUSION

This study indicates the hazardous level of ambient air pollution in Lahore, Karachi, Quetta, Peshawar, and Islamabad. The results of different air gases such as methane, carbon monoxide, nitrogen dioxide, Sulphur dioxide, ozone, and particulate matter were found to be higher in the cities Lahore and Peshawar. This research will provide a better foundation for ambient air monitoring system and to resolve the issue associated with climate change and its effects on the country like Pakistan.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

M. Ullah; H. Ullah determine nitrogen dioxide, sulphur dioxide and methane concentration, M. U. Khan; M. S. Khan, A. Umar and H. Nawaz determine the ozone and CO_2 concentrations. H. Ullah and M. Ullah wrote the first draft of the paper while R. Iqbal, Z. Ulfat, M. Sarfraz and S. Khan wrote the revised manuscript.

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