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Recent developments in the production of inexpensive indoor air quality monitoring device

Ranadip Roy *, Ayani Nandi, Indranil Sarkar and Arupam Mishra

Department of Electrical Engineering, Sanaka Educational Trust's Group of Institutions, Durgapur, West Bengal, India.

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Abstract

The level of pollution has increased with times by lot of factors like the increase in pollution, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor quality of air-based system is purposed. Air quality plays very important role in safety, security, and health of the mankind. In this study, carbon monoxide (CO) and air quality (Qa) were measured using MQ135 and MQ7 sensors, respectively. Measuring air quality is a crucial step in raising awareness among the public about the need to ensure the health of future generations. Based on this, the Government of India has already taken some steps to outlaw motorcycles powered by single- and two-stroke engines, which are comparatively releasing significant levels of pollution. Using IoT platforms like Thingspeak or Cayenne, we are attempting to develop the same system so that we can educate everyone about the damage we are doing to the environment. New Delhi has already been noted as the most polluted city in the world with air quality readings over 300 ppm. The other papers have been fixed by us. We have updated the other publications where the sensor calibration and PPM projection were incorrect.

Keywords: MQ135 Gas sensor; Arduino Uno; Wi-Fi module ESP8266; Thingspeak

1. Introduction

The production of hazardous gases by companies, automobile emissions, and an increase in the amount of harmful chemicals and particulate matter in the atmosphere are all contributing to air pollution. Due to variables that can harm human health, such as industries, urbanisation, population growth, and automobile use, the level of pollution is rising quickly. One of the most crucial factors contributing significantly to the rise in air pollution is particulate matter [2]. This necessitates the measurement and analysis of real-time air quality monitoring in order to enable prompt decision-making. An independent real-time air quality monitoring system is presented in this paper. The Internet of Things is currently being used extensively in every industry and is essential to our system for monitoring air quality. The configuration will display the air quality in PPM on a webpage so that we can easily monitor it. With this IoT project, you may use your computer or mobile device to check the pollution level from anywhere [1]. Fig.1. shows the environmental pollution by industry. The configuration will display the air quality in PPM on a webpage so that we can easily monitor it. With this IoT project, you may use a computer or mobile device to check the pollution level from anywhere. There is a lot of air pollution. Automobile emissions, industrial chemicals, smoke, and dust have become commonplace in recent years. Because of this, air conditioning is currently very dirty. The effects of air pollution are particularly detrimental to human health, especially in areas where our bodies draw air for breathing. Some diseases, like asthma, coughing, and lung abnormalities, can affect our lungs [1]. This study helps people identify the pollutants in the air. Due to the Wi-Fi built inside the module node mcu esp8266, we are able to remotely monitor the air quality. This enables the air conditioning to be constantly checked.

* Corresponding author: Ranadip Roy

2. Literature review

Arduino Sanjana Tiwari, Ritik Gupta, Poonam Pal, and Ashutosh Sharma designed many factors, including population growth, increased vehicle use, industrialization, and urbanisation, have contributed to an increase in pollution levels throughout time, which has a negative impact on human wellbeing by adversely affecting the health of those exposed to it. [1] To keep an eye on in this project, we'll build an IOT-based air pollution monitoring system that will track the air quality via an internet-connected web server and sound an alarm when it drops below a certain threshold, which occurs when harmful gases like CO2, smoke, alcohol, benzene, and NH3 are present in sufficient quantities. On the LCD and on the website, the air quality will be displayed in PPM for easy monitoring. With this IOT project, you may use a PC or a mobile device to check the pollution level from anywhere.

Harsh N. Shah, Zishan Khan, Abbas Ali Merchant, Moin Moghal, Aamir Shaikh, and Priti Rane are listed in alphabetical order by last name. Student at BGIT in Mumbai Central, India, pursuing a diploma in computer engineering. 6Associate Professor at the BGIT in Mumbai Central, India [2]. The main issue facing all countries, developed or developing, is air pollution. Particularly in urban regions of emerging countries, where industrialization and an increase in the number of cars lead to the discharge of several gaseous pollutants, health issues have been escalating more quickly. In addition to certain significant issues, pollution can cause moderate allergic reactions such throat, eye, and nose irritation. such as bronchitis, cardiac conditions, pneumonia, lung, and worsening asthma. According to a survey, air pollution is responsible for 50,000 to 100,000 premature deaths annually in the United States alone. In contrast, there are over 3,000,000 people worldwide and 300,000 in the EU. When enough dangerous chemicals, such as CO2, smoking, alcohol, benzene, NH3, LPG, and NOx, are present in the air—as when the air quality drops below a specific threshold level—the IOT-based air pollution monitoring system, which tracks air quality over a web server utilising the Internet, will sound an alarm [3]. It will display the air quality in PPM on the LCD and on the website so that it can be readily monitored.

Figure 1 Environmental pollution by industry

Ch.V.Saikumar[1] M.Reji[2] P.C.Kishoreraja[3] Saveetha School of Engineering, Department of ECE, Chennai, India implemented this project's major goal is to keep an eye on the air quality in urban and industrial areas. In order to support both short-range real-time incident management and ongoing purposeful planning, the suggested framework contains a set of gas sensors (CO and NO2) that are mounted on the masses and framework of an IOT (Internet of Things) system and a dominant server. The data is communicated simply and fast using the Arduino platform in this case. The Trans receiver in this scenario is a WSN (Wireless Sensor Network). This offers a real-time low-rate monitoring system for the use of wireless communication technology that is low rate, low information rate, and limited control.

Different applications may transfer to or share the proposed monitoring system. We are able to visualise global values thanks to IOT. The issue with this study is that the sensor wasn't calibrated, and they didn't even translate the sensor output value into PPM. According to UN Data's recommendations, a safe number is 0–50, and a moderate value is 51–

100. With a 350PPM reading, Delhi is the most polluted city in the world. When utilising two sensors, the power consumption increases (P=VxI) since each sensor has an internal heat element. As a result, even when both sensors are turned ON, the output voltage levels fluctuate and display unexpected values because of insufficient drive. Therefore, for the CO sensor MQ7, we used a 9V battery and a REGULATOR from the 7805 family.

Christ University, Bangalore, India's Department of Computer Science with Karthik Krishnamurthi, Suraj Thapa, Lokesh Kothari, and Arun Prakash [4] In order to measure weather and environmental variables such temperature, humidity, light intensity, dew point, and heat index, this paper uses 3 sensors. The Arduino micro-controller processes the values read from the sensors and stores them in a text file that may be analysed later to generate analysis. For convenient viewing, the readings are also shown on an on-board LCD. The weather features of a certain location and the weather pattern can be determined by analysing all these information. These measured factors, which differ from location to location, are crucial.

3. Problem formulation

The derivations that specify the correct ppm on the screen with proper calibration were clearly developed using the Thingspeak IoT platform. By eliminating the need to view the result on an LCD, which increases project costs, we were able to implement it more affordably [1]. When aiming for IoT as a platform, our intention should be to expose the concept online utilising websites like thinger.io, thingspeak, or Cayenne, which are exquisitely created to present the output and even allow for the download of the dataset.

There is no need to use LPG or methane detecting sensors for air quality monitoring experiments because these devices are already used for home and office safety. Instead of employing a GSM or GPRS module, we have used WiFi to upload the data to the cloud [2]. The issue in the other research referenced at [3] is that neither the sensor's calibration nor its conversion of the sensor's output value into PPM has been done. According to UN Data criteria, 0-50 PPM is a safe amount, and 51-100 is considered moderate, as illustrated in figure 1. With an average PPM of 250, Delhi is the most polluted city in the world. Due to the fact that we are employing two sensors, each of which has an internal heat element that consumes more power (P=V*I), even when both sensors are turned ON, their output voltage levels fluctuate and display unpredictable values because of a lack of power. Therefore, for the CO sensor MQ7, we utilised a 9V battery and a 7805 family LM7805 Regulator. The Arduino Uno Development Kit, which includes an ATMega328P microprocessor, was used. WiFi Support for it has been provided using reasonably priced our connection to the ThingSpeak Platform is made possible by the ESP-01 WiFi module. The connections diagram describes the links between them. Fig.2. shows an air quality monitoring device.

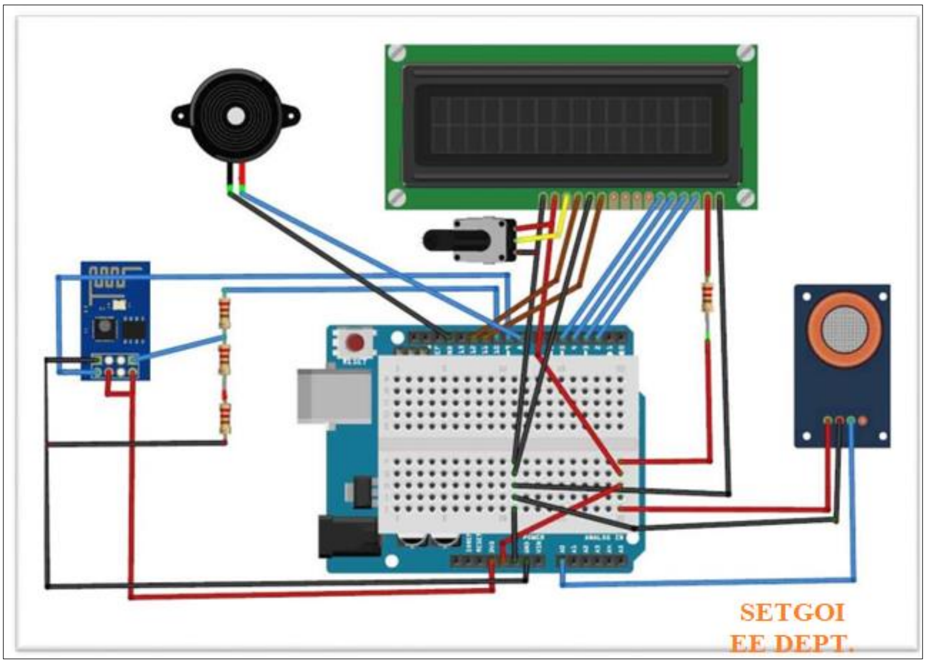

Figure 2 Air quality monitoring device

The most crucial stage is calibrating the sensor in clean air, after which you must create an equation to translate the output voltage value of the sensor into our simple units PPM (parts per million). The resulting mathematical computations are shown here [6]. Internal circuit schematic of the combined RS and RL MQ135 sensor, shown in **Fig. 3.** At a constant temperature, we can derive I as follows from Ohm's Law:

$$I = V / R \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Eqn.1 can be written as

$$I = V_c / R_s + R_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Using the value obtained for I and Ohm's Law at constant temperature, we can use to determine the output voltage at the load resistor. V = I*R

VRl = [Vc/ Rs + Rl] ∗ RL …………………(3)

VRl = [Vc ∗ Rl [Rs + Rl] ……………….. (4)

(VRl ∗ Rs) + (VRl ∗ Rl) = Vc ∗ RL ………………….. (5)

VRl ∗ Rs = (Vc ∗ Rl) − (VRl ∗ Rl) ………………….. (6)

Rs = (Vc ∗ Rl) − (VRl ∗ Rl) VRl …………………………….. (7)

Rs = (Vc ∗ Rl) VRl − Rl ……………….. (8)

Equation 9 help us to find the internal sensor resistance for fresh air

Rs = (Vc ∗ Rl)/ VRl − Rl ………………………….. (9)

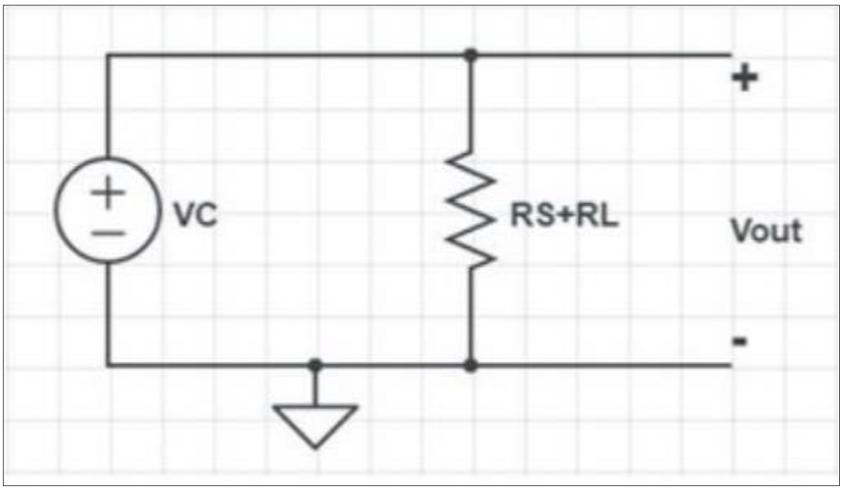

Figure 3 Internal circuit diagram of MQ135

From the datasheet shown in Fig. 6 and referenced here, Equation 10 is shown. We must determine the value of the Rs in fresh air in order to calculate R0. This will be accomplished by translating the sensor's analogue average readings to voltage. Then, to determine R0, we shall apply the Rs formula. We shall first consider the lines as though they were linear. In this manner, the ratio and the concentration can be related linearly using a single formula. So, even outside of the graph's limits, we can determine the concentration of a gas at any ratio value. The equation for a line, but on a log-log scale, is the one we'll be utilizing. A line has the following formula [9]: We attempt to obtain the following computations from Figure 3 above.

y = mx + b ……………. (11)

The formula for a log-log scale is as follows:

$$\log10y = m * \log10x + b$$

We can determine the y intercept now that we know the value of m. In order to do this, we must select one point from the graph (once again from the CO2 line). As for us, we went with (5000,0.9).

$$\log(y) = m * \log(x) + b \quad \text{.................} \ (12)$$

$$b = \log(0.9) - (-0.318) * \log(5000) \ (18) \ b = 1.13 \quad \text{...............} \ (13)$$

Now that we know m and b, we can use the following formula to get the gas concentration for any ratio:

$$\log(x) = \log(y) - b \ m \quad \text{...................} \ (14)$$

But to obtain the actual gas concentration as shown by the log-log plot, we must find the inverse log of x: x = 10/m

We will be able to convert the sensor output values into PPM using equations 9 and 21. Now that the code had been created, it was flashed into the Arduino Uno with the appropriate connections as mentioned.

4. Results and discussions

When the ESP-01's wifi connection is successful, the Thingspeak account is built with the aid of the supplied API key from our account. For Thingspeak to push the data, there must be a 15 second refresh interval. **Fig. 4** displays the field charts for the sensor data from the MQ135 and MQ7 that were converted to PPM [7] [8]. **Fig. 5** displays a graphical analysis of the data collected over time with AirQuality PPM on the Y axis.

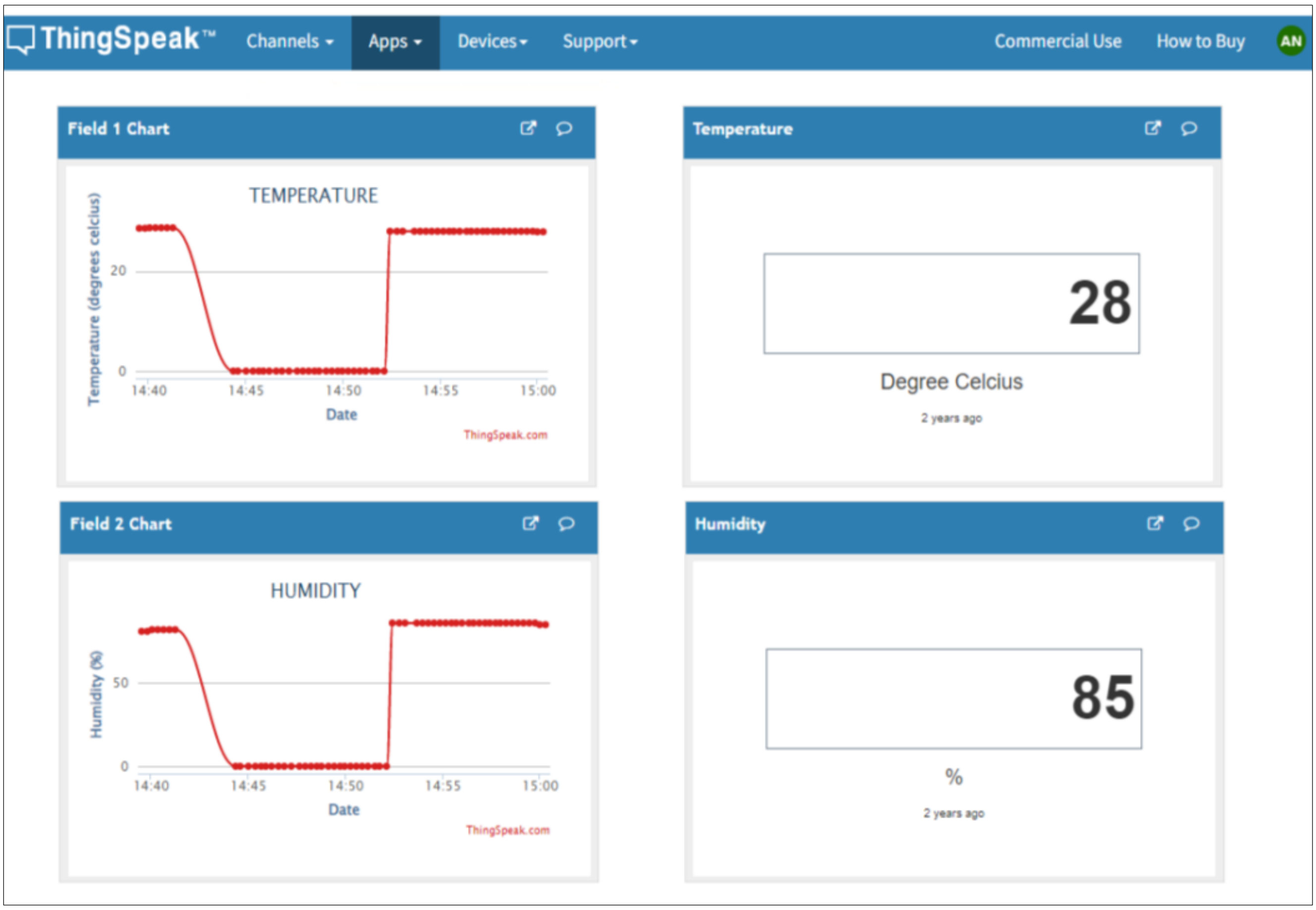

Figure 4 Output on Thingspeak

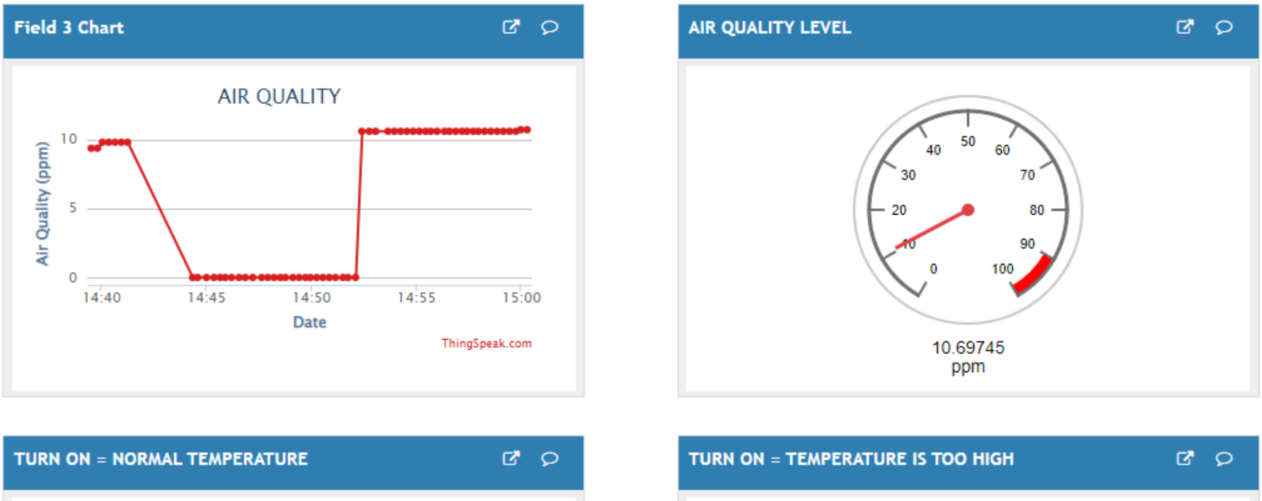

Figure 5 Air Quality

5. Conclusion

In earlier works, air quality monitoring systems were created employing various sensors for both indoor and outdoor air quality monitoring using Bluetooth, GPS, and GPRS wireless technologies. Previously, the pricey WASP module was employed. Different sensors can be used in place of it. The suggested method was created for remotely monitoring indoor air quality. Along with a combination of address- and data-centric protocols, request and response is a cost- and energy-efficient protocol. The paper provides a summary of the main air quality monitoring methodologies. In the study, these methods are thoroughly explained. One of the most popular techniques in the suggested system is a cloud-based air quality monitoring system.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

References

[1] Poonam Paul, Ritik Gupta, Sanjana Tiwari, Ashutosh Sharma, "IoT based Air Pollution Monitoring System with Arduino", IJART, May 2005.

[2] Zishan Khan, Abbas Ali, Moin Moghal, "IoT based Air Pollution using NodeMCU and Thingspeak", IRANS, pp. 11-16, March 2014.

[3] SaiKumar, M. Reji, P.C. KishoreRaja "AirQuality Index in India", IEEE conference Chennai, August 2014.

[4] Mohan Joshi, "Research Paper on IoT based Air and Sound Pollution monitoring system", IETS Journal, pp. 11-17, September 2015.

[5] "Malaya Ranjan, Rai kumar, "Understanding Parts per million in real time air quality index", Journal of Mathematics and advanced sciences, pp. 23-29, September 2009

[6] D. Bandyopadhyay and J. Sen, "Internet of Things: Applications and Challenges in Technology and Standardization," Wirel. Pers. Commun., vol. 58, no. 1, pp. 49–69, May 2011.

[7] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A Survey," Comput. Netw., vol. 54, no. 15, pp. 2787–2805, October 2010.

[8] H. Kopetz, Real-Time Systems: Design Principles for Distributed Embedded Applications. Boston, MA: Springer US, 2011, ch. Internet of Things, pp. 307–323.

[9] A. Gluhak, S. Krco, M. Nati, D. Pfisterer, N. Mitton, and T. Razafindralambo, "A Survey on Facilities for Experimental Internet of Things Research," IEEE Communications Magazine, vol. 49, no. 11, pp. 58–67, November 2011.

[10] J. Kim, J. Lee, J. Kim, and J. Yun, "M2M Service Platforms: Survey, Issues, and Enabling Technologies," IEEE Communications Surveys Tutorials, vol. 16, no. 1, pp. 61–76, January 2014.

[11] Jen-Hao Liu, Yu-Fan Chen, Tzu-Shiang Lin, And Da-Wei Lai ,Tzai-Hung Wen, Chih-Hong Sun, And Jehn-Yih Juang,Joe-Air Jiangdeveloped Urban Air Quality Monitoring System Based On Wireless Sensor Networks 2011 IEEE.

[12] Srinivas Devarakonda, Parveen Sevusu, Hongz Hang Liu, Ruilin Liu, Liviu Iftode, Badri Nath Urbcomp" Real-Time Air Quality Monitoring Through Mobile Sensing In Metropolitan Areas"13, August 2013 Acm.

[13] Fouzi Harrou, Mohamed Nounou,Hazem Nounou "Detecting Abnormal Ozone Levels Using Pca Based Glr Hypothesis Testing"2013 Ieee Symposium On Computational Intelligence And Data Mining.

[14] Elias Yaacoub,Abdullah Kadri,Mohammad Mushtaha,And Adman Abu-Dayya,"Air Quality Monitoring And Analysis In Qatar Using A Wireless Sensor Network Deployment"596-601,2013 IEEE.

[15] Parr, T. W., Ferretti, M., Simpson, I. C., Forsius, M., & Kovács-Láng, E. (2002). Towards a long-term integrated monitoring programme in Europe: network design in theory and practice. Environmental monitoring and assessment, 78(3), 253-290.

[16] Jerrett, M., Arain, A., Kanaroglou, P., Beckerman, B., Potoglou, D., Sahsuvaroglu, T., ... & Giovis, C. (2005). A review and evaluation of intraurban air pollution exposure models. Journal of Exposure Science and Environmental Epidemiology, 15(2), 185