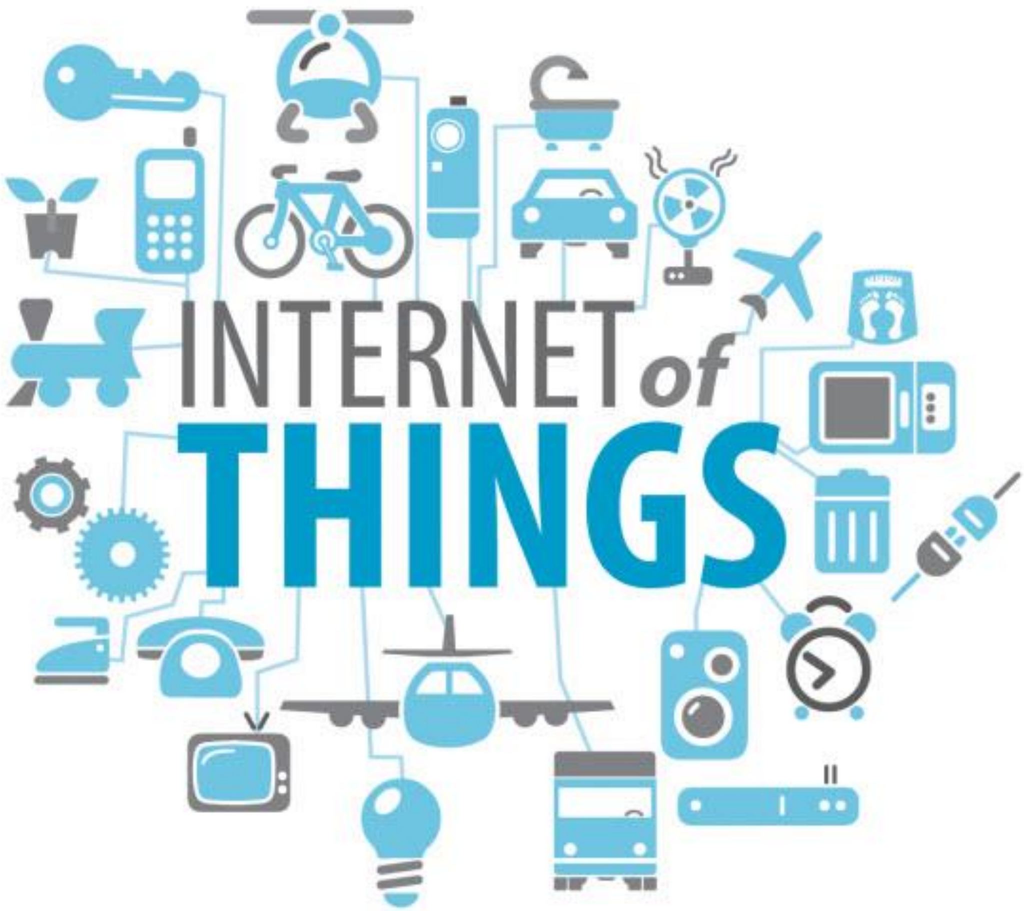
# AIR QUALITY MONITORING

## PHASE-4

## DEVELOPMEN-II




**TEAM LEADER: DINESH BOOPATHY C**

**TEAM MEMBER: SUNIL KUMAR P**

**TEAM MEMBER: JAYAKUMAR N**

**TEAM MEMBER: DHANUSH P**

## INTRODUCTION:

- Air quality monitoring using the Internet of Things (IoT) is a cutting-edge approach to continuously and accurately assess the quality of the air we breathe. IoT technology has revolutionized the way we collect, analyze, and share real-time data on air pollution, making it more accessible and actionable for individuals, communities, and governments. This innovative method of monitoring and managing air quality has numerous benefits and is becoming increasingly crucial in the face of growing environmental concerns.

## OVERVIEW OF AIR QUALITY MORNITERING:

- Air quality monitoring is the systematic process of measuring, analyzing, and assessing the concentration of various pollutants and gases present in the Earth's atmosphere. This comprehensive approach is essential for understanding the quality of the air we breathe, identifying sources of pollution, and implementing measures to mitigate its impact on human health and the environment.

**Key Components of Air Quality Monitoring:**

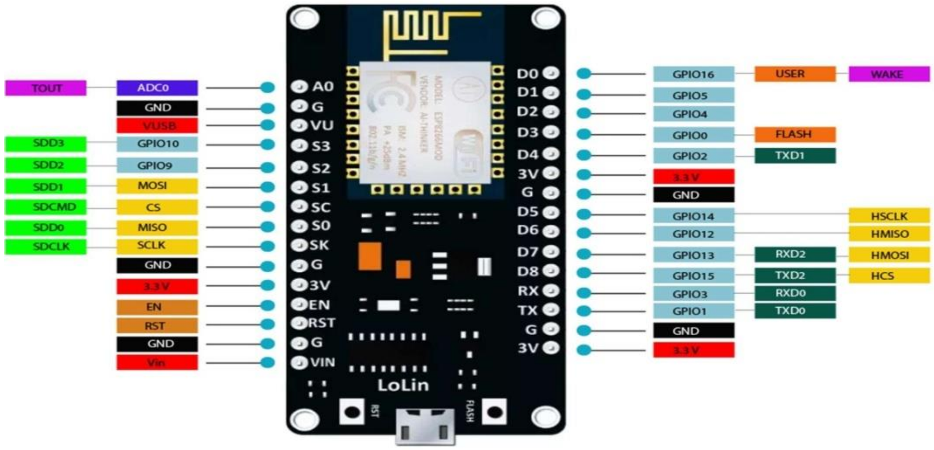
- **Pollutant Detection**: Air quality monitoring systems employ a variety of sensors and instruments to detect and measure air pollutants. These can include particulate matter (PM2.5 and PM10), gases such as carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), ozone ($O_3$), volatile organic compounds (VOCs), and more. Each sensor is designed to measure specific pollutants accurately.

- **Monitoring Stations**: Air quality monitoring stations are strategically located in urban, suburban, industrial, and rural areas to capture data representing different environmental conditions. The number and distribution of these stations depend on the specific monitoring objectives and regulatory requirements of a region.

- **Data Collection**: Monitoring stations continuously or intermittently collect data on pollutant concentrations. Some stations operate in real-time, providing immediate data updates, while others may record data at set intervals (e.g., hourly or daily). Collected data is sent to a central database for analysis.

- **Data Analysis**: Air quality data is processed and analyzed to understand pollutant levels, trends, and variations over time. This analysis can reveal patterns, sources of pollution, and the impact of air quality on human health and the environment.
- **Air Quality Index (AQI)**: To simplify the communication of air quality information to the public, many regions use the Air Quality Index (AQI). The AQI is a numerical scale that categorizes air quality into different levels, ranging from "Good" to "Hazardous," based on the concentration of key pollutants. Each level corresponds to specific health recommendations.
- **Health and Environmental Impact Assessment**: Air quality monitoring provides data that helps assess the potential health and environmental impacts of air pollution. This information is critical for understanding the risks associated with exposure to specific pollutants.
- **Regulatory Compliance**: Governments and environmental agencies establish air quality standards and regulations to limit pollutant concentrations. Air quality monitoring is crucial for ensuring compliance with these standards and for enforcing environmental laws.
- **Policy Development and Public Awareness**: The data collected through air quality monitoring informs the development of policies, regulations, and strategies to improve air quality. It also serves as a tool to raise public awareness about air pollution, its effects, and the importance of reducing emissions.
- **Research and Innovation**: Air quality monitoring supports ongoing research and innovation in the field of environmental science and technology. Researchers use this data to study air quality trends, develop new pollution control methods, and assess the effectiveness of pollution abatement measures.

## PIN DIAGRAM:




## BENEFITS OF AIR QUALITY MONITORING:

➢ **Protection of Public Health**:

❖ Air quality monitoring helps identify harmful pollutants in the atmosphere, allowing for early detection of elevated levels. This information enables individuals to take precautionary measures, such as staying indoors on days with poor air quality, reducing exposure to pollutants, and protecting their respiratory health.

❖ **Risk Assessment**: Monitoring data provides valuable insights into the potential health risks associated with air pollution. This information is crucial for assessing the impact of pollution on public health and can be used to guide healthcare and emergency response strategies.

❖ **Environmental Protection**: Monitoring air quality helps track the environmental impact of pollutants on ecosystems, soil, and water bodies. It allows for a better understanding of how pollution affects wildlife, vegetation, and aquatic life.

❖ **Data-Driven Policies**: Governments and regulatory bodies use air quality data to develop and implement effective environmental policies and regulations. These policies aim to limit emissions, reduce air pollution, and improve overall air quality.

- **Compliance with Standards**: Air quality monitoring ensures that industries and businesses comply with environmental regulations and standards. This is crucial for holding polluters accountable and reducing harmful emissions.
- **Public Awareness**: Air quality monitoring helps raise public awareness about the importance of clean air and the health risks associated with air pollution. This awareness can lead to increased support for environmental protection measures.
- **Research and Innovation**: Air quality data supports ongoing research and innovation in the field of environmental science and technology. Researchers use this data to study air quality trends, develop new pollution control methods, and assess the effectiveness of pollution abatement measures.
- **Emergency Response**: Air quality monitoring can serve as an early warning system for environmental disasters, industrial accidents, or events that lead to sudden increases in pollution levels. Timely alerts enable swift emergency responses and measures to protect public safety.
- **Urban Planning**: Urban planners use air quality data to make informed decisions about land use, transportation, and the location of residential and industrial areas. This helps create healthier, more sustainable cities with reduced air pollution.
- **Community Empowerment**: Access to real-time air quality data empowers individuals and communities to make informed decisions about outdoor activities, exercise, and daily routines. It allows people to take personal actions to reduce exposure to pollutants.
- **Improvement of Air Quality**: Over time, air quality monitoring can lead to improvements in air quality as regulatory measures and public awareness campaigns encourage the reduction of emissions and the adoption of cleaner technologies.
- **Accountability and Transparency**: Air quality data ensures transparency and accountability by providing concrete evidence of pollution levels. It

enables stakeholders to hold governments and industries responsible for their environmental impact.

- **Healthcare Planning**: Healthcare providers can use air quality data to anticipate and manage increased healthcare needs during periods of poor air quality, particularly for individuals with pre-existing respiratory conditions.

## PROCEDURE FOR AIR QUALITY MONITERING:

- The procedure for air quality monitoring involves a series of steps and considerations to ensure accurate and reliable data collection. Here's a general overview of the process:

  - **Site Selection**:

    - Determine the locations for monitoring stations: Select sites that represent different environmental conditions, including urban, suburban, rural, and industrial areas.
    - Consider proximity to pollution sources: Stations should be strategically located near potential pollution sources, such as factories, highways, or areas with high traffic.

  - **Equipment Setup**:

    - Install air quality monitoring equipment at selected sites. This equipment typically includes sensors, analyzers, and data loggers to measure and record air quality parameters.
    - Ensure that the equipment is properly calibrated to provide accurate measurements.

  - **Data Collection**:

    - Sensors and instruments continuously or periodically collect data on various air pollutants, such as particulate matter, gases, and volatile organic compounds.
    - Data can be collected in real-time or at specified intervals (e.g., hourly or daily).

- **Data Transmission**:
    - Data collected by monitoring stations can be transmitted using various communication technologies, including wired connections, cellular networks, Wi-Fi, or satellite communication.
    - Ensure data transmission reliability to avoid data loss.
- **Data Storage**:
    - Set up a central database or server to store the collected data securely. Cloud-based platforms are often used for remote data storage and accessibility.
- **Data Analysis**:
    - Analyze the collected data to assess air quality parameters, identify trends, and understand variations over time.
    - Implement algorithms and statistical methods to process and interpret the data effectively.
- **Air Quality Index (AQI) Calculation**:
    - Convert pollutant concentrations into an AQI to provide a simple and understandable measure of air quality for the public.
    - AQI levels typically range from "Good" to "Hazardous," each corresponding to specific pollutant concentration ranges.
- **Data Reporting**:
    - Develop user-friendly interfaces, such as websites, mobile apps, or public displays, to provide air quality information to the public.
    - Generate reports and data visualizations, including maps and charts, to communicate air quality data effectively.
- **Alerts and Notifications**:

- Configure the system to send alerts and notifications to relevant authorities, stakeholders, and the public when air quality levels exceed predefined thresholds or become hazardous.

❖ **Quality Assurance and Calibration**:

- Regularly maintain and calibrate monitoring equipment to ensure accurate measurements.
- Implement quality assurance and quality control procedures to identify and address any issues with data collection and equipment performance.

❖ **Public Awareness and Education**:

- Develop educational campaigns to raise public awareness about air quality and the health risks associated with air pollution.
- Provide guidance on protective measures during days of poor air quality.

❖ **Policy Development and Decision-Making**:

- Use the collected air quality data to inform the development of environmental policies, regulations, and decision-making processes aimed at reducing pollution and improving air quality.

❖ **Research and Innovation**:

- Share data with researchers and environmental organizations to support ongoing studies and innovations in pollution control and environmental protection.

❖ **Maintenance and Upkeep**:

- Regularly maintain and inspect monitoring equipment to ensure its proper functioning.
- Update equipment and software as necessary to stay current with technological advancements.

## IMPLEMENTATION OF AIR QUALITY MONITERING:

- The implementation of an air quality monitoring system involves a series of steps and considerations to establish an effective and reliable system. Here's an overview of the process:

- **Define Objectives and Scope**:
  - Clearly define the goals and objectives of the air quality monitoring program. Determine what you want to achieve, such as assessing urban air quality, identifying pollution sources, or ensuring regulatory compliance.

- **Select Monitoring Locations**:
  - Choose monitoring locations strategically to capture a representative sample of air quality conditions. Consider urban, suburban, rural, and industrial areas.
  - Take into account proximity to pollution sources and population centers.

- **Select Monitoring Parameters**:
  - Determine which air pollutants and parameters you will measure. Common pollutants include particulate matter (PM2.5 and PM10), gases (CO, NO2, SO2, O3), and VOCs.
  - Select the appropriate sensors and instruments for measuring the chosen parameters.

- **Acquire Monitoring Equipment**:
  - Procure air quality monitoring equipment, which includes sensors, analyzers, data loggers, and communication devices.
  - Ensure that the equipment is of high quality and properly calibrated.

- **Setup Monitoring Stations**:

- Install monitoring equipment at selected sites, ensuring that it is secure and protected from environmental factors like weather and vandalism.
- Establish power sources, including mains power or renewable energy options.

❖ **Data Collection and Transmission**:

- Set up data collection mechanisms. This can be continuous or periodic data collection, depending on the monitoring goals.
- Choose the appropriate communication technology for data transmission, such as wired connections, cellular networks, or satellite communication.

❖ **Data Management**:

- Establish a central database or server to store the collected data securely. Cloud-based platforms can be used for remote access and storage.
- Implement data management and storage best practices to ensure data integrity.

❖ **Data Analysis and Reporting**:

- Develop data analysis procedures to interpret air quality data effectively.
- Generate reports and data visualizations, such as maps and charts, to communicate air quality information to stakeholders and the public.

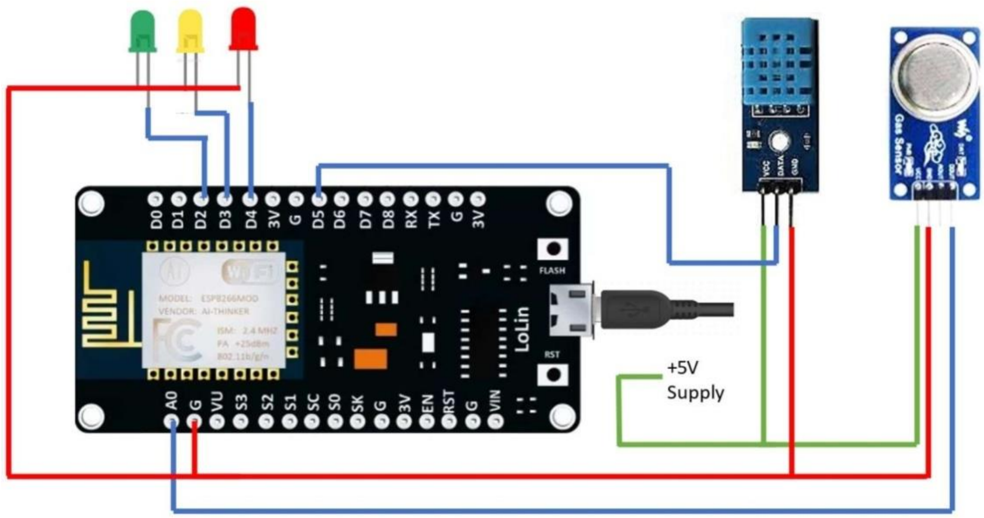
❖ **Air Quality Index (AQI) Calculation**:

- Convert pollutant concentrations into an AQI to provide a simplified, understandable measure of air quality.
- Define AQI levels, such as "Good," "Moderate," "Unhealthy for Sensitive Groups," and "Hazardous."

❖ **Alerts and Notifications**:

- Configure the system to send alerts and notifications when air quality levels exceed predefined thresholds or pose health risks. These alerts can be sent to relevant authorities and the public.

## CIRCUIT DIAGRAM:




## CODE:

```
import network
import time
from machine import Pin,ADC
import dht
import ujson
from umqtt.simple import MQTTClient

# MQTT Server Parameters
MQTT_CLIENT_ID = "micropython-weather-demo"
MQTT_BROKER    = "broker.mqttdashboard.com"
MQTT_USER      = ""
MQTT_PASSWORD  = ""
MQTT_TOPIC     = "wokwi-weather"

sensor = dht.DHT22(Pin(15))
MQ7=ADC(Pin(35))
MQ8=ADC(Pin(32))
button=Pin(34,Pin.IN)
led=Pin(33,Pin.OUT)
min_rate=0
max_rate=4095
```

```python
print("Connecting to WiFi", end="")
sta_if = network.WLAN(network.STA_IF)
sta_if.active(True)
sta_if.connect('Wokwi-GUEST', '')
while not sta_if.isconnected():
  print(".", end="")
  time.sleep(0.1)
print(" Connected!")

print("Connecting to MQTT server... ", end="")
client = MQTTClient(MQTT_CLIENT_ID, MQTT_BROKER, user=MQTT_USER, password=MQTT_PASSWORD)
client.connect()

print("Connected!")

prev_weather = ""
while True:
  CO_sensor=(MQ7.read())*100/(max_rate)
  print("CO Sensor value: " + "%.2f" % CO_sensor +"%")
  Hydrogen_sensor=(MQ8.read())*100/(max_rate)
  print("Soil Sensor value: " + "%.2f" % Hydrogen_sensor +"%")
  button_value=button.value()
  if button_value == True:
    led.value(000)
    print("It's Raining")
  else:
    led.value(0)
  print("Measuring weather conditions... ", end="")

  sensor.measure()
  message = ujson.dumps({
    "temp": sensor.temperature(),
    "humidity": sensor.humidity(),
  })


  if message != prev_weather:
    print("Updated!")
    print("Reporting to MQTT topic {}: {}".format(MQTT_TOPIC, message))
    client.publish(MQTT_TOPIC, message)
    prev_weather = message
  else:
    print("No change")
  time.sleep(1)
```

C++:

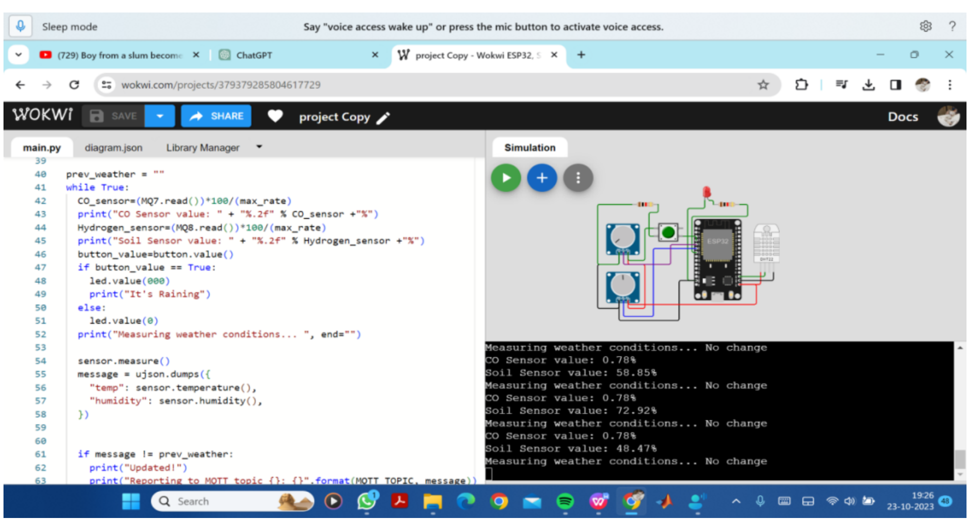
```cpp
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <ESP8266WiFi.h>
#include <Adafruit_MQTT.h>
#include <Adafruit_MQTT_Client.h>

// Replace these with your Wi-Fi credentials.
const char* WIFI_SSID = "YourWiFiSSID";
```

```
const char* WIFI_PASS = "YourWiFiPassword";

// Replace with your Adafruit IO credentials.
#define ADAFRUIT_IO_USERNAME "YourAdafruitUsername"
#define ADAFRUIT_IO_KEY "YourAdafruitAIOKey"

// Define the DHT sensor.
#define DHT_PIN 2           // The pin where your DHT sensor is connected.
#define DHT_TYPE DHT22      // DHT sensor type (DHT11, DHT22, AM2302, etc.)

DHT dht(DHT_PIN, DHT_TYPE);

WiFiClient client;

Adafruit_MQTT_Client mqtt(&client, "io.adafruit.com", 1883, ADAFRUIT_IO_USERNAME,
ADAFRUIT_IO_KEY);

// Define MQTT feeds.
Adafruit_MQTT_Publish temperature = Adafruit_MQTT_Publish(&mqtt, ADAFRUIT_IO_USERNAME
"/feeds/temperature");
Adafruit_MQTT_Publish humidity = Adafruit_MQTT_Publish(&mqtt, ADAFRUIT_IO_USERNAME
"/feeds/humidity");

void setup() {
  Serial.begin(115200);

  // Connect to Wi-Fi.
  WiFi.begin(WIFI_SSID, WIFI_PASS);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.println("Connecting to WiFi...");
  }

  Serial.println("Connected to WiFi");

  // Connect to Adafruit IO.
  mqtt.connect();
  Serial.println("Connected to Adafruit IO");
}

void loop() {
  // Read temperature and humidity data from the DHT sensor.
  float temperatureValue = dht.readTemperature();
  float humidityValue = dht.readHumidity();

  // Publish data to Adafruit IO.
  if (!isnan(temperatureValue)) {
    temperature.publish(temperatureValue);
    Serial.print("Temperature: ");
    Serial.println(temperatureValue);
  } else {
    Serial.println("Failed to read temperature");
  }
```

```
  if (!isnan(humidityValue)) {
    humidity.publish(humidityValue);
    Serial.print("Humidity: ");
    Serial.println(humidityValue);
  } else {
    Serial.println("Failed to read humidity");
  }

  delay(60000); // Delay for 60 seconds (adjust as needed).
}

C program:
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <ESP8266WiFi.h>
#include <Adafruit_MQTT.h>
#include <Adafruit_MQTT_Client.h>

// Replace these with your Wi-Fi credentials.
const char* WIFI_SSID = "YourWiFiSSID";
const char* WIFI_PASS = "YourWiFiPassword";

// Replace with your Adafruit IO credentials.
#define ADAFRUIT_IO_USERNAME "YourAdafruitUsername"
#define ADAFRUIT_IO_KEY "YourAdafruitAIOKey"

// Define the DHT sensor.
#define DHT_PIN 2           // The pin where your DHT sensor is connected.
#define DHT_TYPE DHT22      // DHT sensor type (DHT11, DHT22, AM2302, etc.)

DHT dht(DHT_PIN, DHT_TYPE);

WiFiClient client;

Adafruit_MQTT_Client mqtt(&client, "io.adafruit.com", 1883, ADAFRUIT_IO_USERNAME,
ADAFRUIT_IO_KEY);

// Define MQTT feeds.
Adafruit_MQTT_Publish temperature = Adafruit_MQTT_Publish(&mqtt, ADAFRUIT_IO_USERNAME
"/feeds/temperature");
Adafruit_MQTT_Publish humidity = Adafruit_MQTT_Publish(&mqtt, ADAFRUIT_IO_USERNAME
"/feeds/humidity");

void setup() {
  Serial.begin(115200);

  // Connect to Wi-Fi.
  WiFi.begin(WIFI_SSID, WIFI_PASS);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.println("Connecting to WiFi...");
  }

  Serial.println("Connected to WiFi");
```

```
  // Connect to Adafruit IO.
  mqtt.connect();
  Serial.println("Connected to Adafruit IO");
}

void loop() {
  // Read temperature and humidity data from the DHT sensor.
  float temperatureValue = dht.readTemperature();
  float humidityValue = dht.readHumidity();

  // Publish data to Adafruit IO.
  if (!isnan(temperatureValue)) {
    temperature.publish(temperatureValue);
    Serial.print("Temperature: ");
    Serial.println(temperatureValue);
  } else {
    Serial.println("Failed to read temperature");
  }

  if (!isnan(humidityValue)) {
    humidity.publish(humidityValue);
    Serial.print("Humidity: ");
    Serial.println(humidityValue);
  } else {
    Serial.println("Failed to read humidity");
  }

  delay(60000); // Delay for 60 seconds (adjust as needed).
}
```

## OUTPUT:



## CONCLUSION:

- In conclusion, air quality monitoring is a critical endeavor with far-reaching implications for public health, environmental sustainability, and policy development. The assessment and management of air quality have become increasingly vital in our rapidly urbanizing world, where pollution sources are diverse and ever-evolving. Monitoring air quality, whether through traditional methods or using the power of the Internet of Things (IoT), offers a range of benefits and plays a crucial role in addressing the challenges associated with air pollution.