

# Breathe

The Air Quality System a Real-Time Monitoring system



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Global air pollution crisis affecting 99% of population with 7 million annual deaths.

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AI-enhanced predictions, citizen networks, and integration with public policy initiatives.

# Challenge: From EarthData to Action

## Critical Health Impact

The World Health Organization estimates that over 99% of the world's population breathes air containing pollutant levels exceeding safe limits, leading to 7 million deaths annually from respiratory, cardiovascular, and neurological diseases.



## Key Pollutants

Nitrogen Dioxide ( $\text{NO}_2$ ), Formaldehyde ( $\text{HCHO}$ ), Aerosol Index, Particulate Matter ( $\text{PM}_{1.0}$ ,  $\text{PM}_{2.5}$ ,  $\text{PM}_{10}$ ), and ground-level Ozone ( $\text{O}_3$ ) pose immediate health risks.



## Sentinel-5 Precursor (TROPOMI) Mission

Provides near-real-time global monitoring of key atmospheric pollutants, including  $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{SO}_2$ ,  $\text{CO}$ , formaldehyde, and aerosols, with a spatial resolution of up to  $7 \times 3.5 \text{ km}^2$ .





# Breathe System Three-Layer Architecture

## Breathe Node IoT Layer

Portable ESP32-based sensing devices with MQ-131, MQ-4, and PMS5003 sensors for real-time environmental measurements.



## Python Server Processing

Flask REST API integrating Sentinel-5P TROPOMI and MERRA-2 atmospheric reanalysis data, OpenWeatherMap, and sensor readings for comprehensive analysis.



## Mobile Application Interface

MIT App Inventor-based app providing personalized AQI values, pollutant identification, and health recommendations to users.



## Web Platform Interface

Public portal for project dissemination, detailing the architecture, components, and long-term goals of the Breathe system.

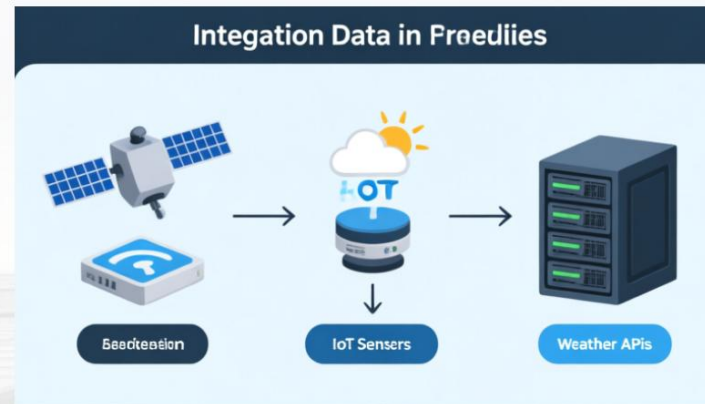


## Breathe Node Hardware Components

The Breathe Node is a portable IoT device built around ESP32-WROOM-32U microcontroller, designed to capture localized air quality data and complement satellite observations with high-resolution ground measurements.

Component	Function	Measured Variable	Precision	Range
ESP32-WROOM-32U	Microcontroller & Wi-Fi	Data Processing	32-bit	240MHz
MQ-131	Ozone Detection	O <sub>3</sub> (Ozone)	High	10-1000 ppb
MQ-4	Methane Sensor	CH <sub>4</sub> (Methane)	Medium	300-10000 ppm
PMS5003	Particulate Sensor	PM1.0, PM2.5, PM10	Laser-based	0-1000 µg/m <sup>3</sup>
Custom PCB	Integration Board	Signal Processing	Optimized	Multi-sensor

# Server Processing Workflow



## Data Reception

Receives JSON environmental measurements from Breathe Nodes including gas concentrations, particulate matter via HTTP requests.



## External Integration

Connects to Sentinel-5P TROPOMI and MERRA-2 atmospheric reanalysis data, OpenWeatherMap for meteorological conditions, and OpenAQ for urban air quality information.



## Analysis & Output

Processes data within 50km radius, computes AQI, identifies dominant pollutants, and generates personalized health recommendations for users.



# Mobile Application User Experience

The image shows a mobile application interface for 'BREATHE'. At the top, there's a status bar with the time 10:44 and signal icons. Below it, the app title 'BREATHE' is displayed in a stylized font. The main form consists of several input fields and buttons. The first section has a label 'Write your name:' followed by a text input field with placeholder text 'Write here' and a blue 'Send' button. The second section has a label 'Write your age:' followed by a text input field with placeholder text 'Write here' and a blue 'Send' button. The third section has a label 'Your physical condition:' followed by a dropdown menu with placeholder text 'Select here'. The fourth section has three labels: 'Latitude:', 'Length:', and 'Current address:', each followed by a text input field. Below these fields is a blue 'Get location' button. At the bottom of the form is a large blue 'SEND ALL' button. Below the 'SEND ALL' button, the word 'Status' is visible.

## Personalized Health Insights

Users provide personal details (age, weight, medical conditions, activity level) enabling the system to deliver customized health recommendations based on both air quality conditions and individual risk factors for optimal protection.

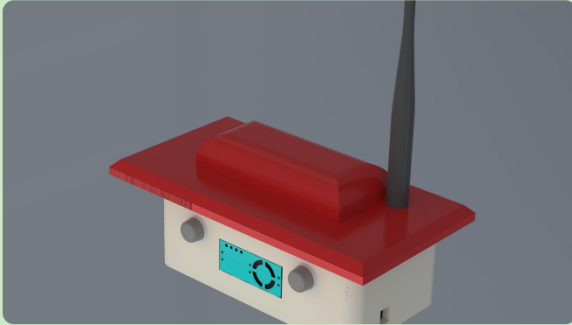
## Location-Based Monitoring

GPS integration allows real-time air quality assessment within a 50-kilometer radius, combining satellite data with nearby Breathe Node measurements for accurate local environmental conditions and safety guidance.

## AI Chatbot

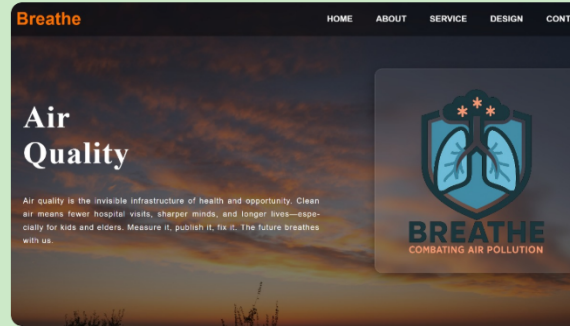
The app integrates an AI-powered chatbot that enables users to: Ask questions about air quality and pollutant levels in natural language, receive personalized protective advice according to their health profile, learn environmental concepts through simple explanations, get daily tips to reduce exposure and raise awareness

# Breathe Ecosystem Data Flow & Web Platform



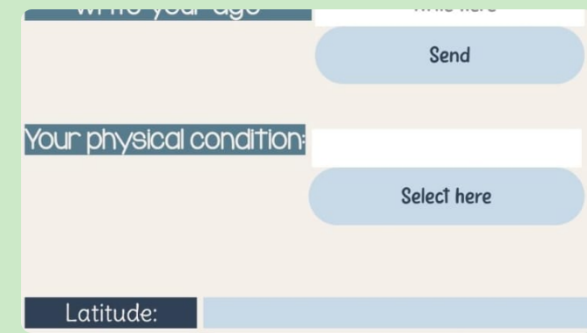
## Integrated Data Flow

- Breathe Node captures environmental data and transmits to server
- Python server processes data and retrieves external API information
- Mobile app receives response and updates interface with recommendations



## Public Outreach Platform

- HTML y CSS website for project promotion and education
- Documents integration of python server and IoT sensor technologies
- Raises awareness about citizen-driven environmental monitoring initiatives



## MIT App Inventor Application

- Displays real-time AQI values and identifies dominant pollutants in area
- Provides personalized health recommendations based on user profile
- AI-powered chatbot integrated with ChatGPT



## Future Vision and Potential Impact



### AI-Enhanced Predictions

Implement machine learning algorithms to analyze historical data and cross-reference satellite and meteorological information, developing models capable of predicting high-pollution events hours in advance for preventive action.

### Expanding Citizen Network

Promote Breathe Node adoption to create increasingly dense hyperlocal monitoring networks, improving global model accuracy and identifying street-level pollution hotspots invisible to satellite data alone.



### Public Policy Integration

Transform collected data into valuable resources for academic institutions, environmental organizations, and governments through open-data portals enabling scientific studies and informed public policy design for urban air quality improvement.

**Gitihub**



**SCAN ME**

An aerial photograph of a city skyline, likely Tokyo, featuring the Tokyo Skytree tower prominently in the center. The image is covered with a semi-transparent green overlay. Centered over the image is the text "Thank You For Your Attention" in a large, bold, white sans-serif font.

# **Thank You For Your Attention**

**Breathe represents the future of citizen-driven environmental monitoring for healthier communities worldwide.**