ABSTRACT

In the face of escalating environmental challenges such as climate change, air pollution, and ecosystem degradation, the need for real-time, scalable monitoring solutions is more urgent than ever. EcoZync is an innovative environmental monitoring system designed to empower users and administrators with accurate, actionable insights into surrounding environmental conditions.

Built with IoT-enabled devices and supported by mobile and web applications, EcoZync collects real-time data on air quality, UV radiation, gas concentrations, temperature, humidity, and atmospheric pressure. This data is crucial for improving public health outcomes, advancing urban sustainability, and supporting scientific research. Our system enables users to view environmental conditions in real-time, while administrators manage devices, oversee user access, broadcast alerts, and download environmental reports for further analysis.

EcoZync is designed to be scalable — from individual community-level deployments to city-wide implementations. The system supports real-time alerts for sudden environmental anomalies, helping reduce health risks related to air pollution and UV exposure. In addition, EcoZync strengthens efforts towards achieving multiple United Nations Sustainable Development Goals (SDGs) such as Climate Action (SDG 13), Good Health and Well-Being (SDG 3), Sustainable Cities and Communities (SDG 11), Clean Water and Sanitation (SDG 6), Affordable and Clean Energy (SDG 7), Industry, Innovation and Infrastructure (SDG 9), Responsible Consumption and Production (SDG 12), and Life on Land (SDG 15).

By integrating cutting-edge sensor technologies with user-friendly digital platforms, EcoZync builds a bridge between environmental data and meaningful action. Whether for personal health decisions, academic research, or urban planning, EcoZync delivers reliable, real-time data that enables better environmental stewardship today, and a cleaner, safer planet for tomorrow.

LIST OF TABLES

Table No	Title	Description	Page
3.1	User Table	Stores user information linked to AWS Cognito authentication	32
3.2	Infrastructure Table	Tracks environmental monitoring infrastructures created by users	33
3.3	Complaints Table	Manages user complaints and feedback about environmental concerns	35
3.4	Devices Table	Records Arduino Mega + ESP8266 IoT device deployments and sensor configurations	35
3.5	Infrastructure Members Table	Tracks user memberships in environmental monitoring infrastructures	36
3.6	Infrastructure Invitations Table	Stores invitations to join infrastructures and their statuses	37
3.7	Group Chat Messages Table	Manages real-time communication within infrastructure groups	37
3.8	Sensor Cache Table (Django/SQLite)	Optimizes DynamoDB operations by caching sensor data locally	38
3.9	DynamoDB SensorData Table	Stores high-frequency environmental telemetry from IoT devices	39

LIST OF FIGURES

Figure No.	Title	Page
3.1.1	DFD Level 0	23
3.1.2	DFD Level 1	24
3.1.3	DFD Level 2 Admin	26
3.1.4	DFD Level 2 User	27
3.2.1	Admin Use Case Diagram	29
3.2.2	User Use Case Diagram	31
3.6.1	System Architecture Diagram	43
3.6.2	IOT Architecture Diagram	45
A.1	Home Page	68
A.2	Register Page	68
A.3	User Dashboard	69
A.4	Admin Grafana Dashboard	69
A.5	Mobile Login Screen	70
A.6	Mobile Registration Screen	70
A.7	Mobile User Home Screen	71
A.8	Mobile Sensor Dashboard Screen	71

LIST OF ABBREVIATION

No.	Abbreviation	Meaning
1	AI	Artificial Intelligence
2	API	Application Programming Interface
3	AWS	Amazon Web Services
4	BME688	Bosch Sensortec Environmental Sensor (Temperature/ Humidity/Pressure)
5	CI/CD	Continuous Integration/Continuous Deployment
6	CO	Carbon Monoxide
7	DFD	Data Flow Diagram
8	ESP 8266	Wi-Fi Microcontroller
9	GCP	Google Cloud Platform
10	GDPR	General Data Protection Regulation
11	GIS	Geographic Information System
12	GPS	Global Positioning System
13	HVAC	Heating, Ventilation and Air Conditioning
14	HTTP	Hypertext Transfer Protocol
15	HTTPS	Hypertext Transfer Protocol Secure
16	I2C	Inter-Integrated Circuit
17	IDE	Integrated Development Environment
18	IoT	Internet of Things
19	JWT	JSON Web Token

20	LLM	Large Language Model
21	MQTT	Message Queuing Telemetry Transport
22	MQ7	Carbon Monoxide Gas Sensor
23	MQ135	Air Quality Sensor
24	OAuth	Open Authorization
25	PPM	Parts Per Million
26	Polyglot	Multi-language Programming Architecture
27	REST	Representational State Transfer
28	SDG	Sustainable Development Goal
29	SPI	Serial Peripheral Interface
30	UX	User Experience