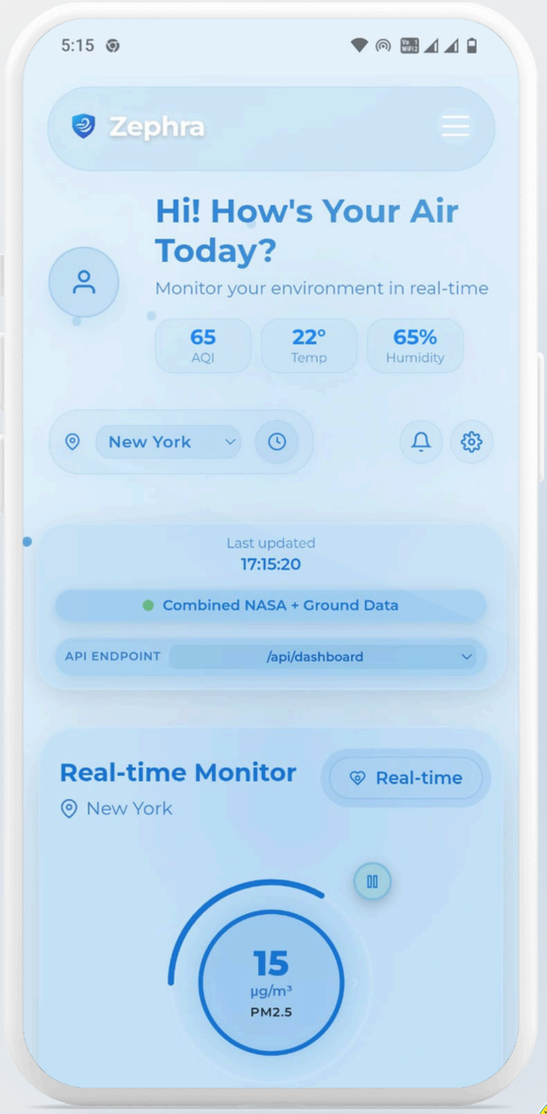
Zephra

Clean Air Forecasting Platform

Team Name : NameLess
Challenge : From EarthData to Action: Cloud Computing with Earth Observation Data for Predicting Cleaner, Safer Skies



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NASA SPACE APPS 2025

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NASA Challenge

Air pollution is a major threat to urban health and safety. Citizens often lack actionable, localized forecasts of air quality that combine satellite, ground, and weather data. Current systems are either too technical for the public or too coarse for day-to-day decisions.

Our Solution

Zephra is a comprehensive real-time environmental monitoring web application that combines cutting-edge satellite data from NASA with machine learning forecasting to provide accurate air quality insights and health recommendations. The project successfully integrates multiple technologies to create a user-friendly, scientifically-accurate platform for environmental awareness.

01. NASA TEMPO Satellite Data – for NO_2, O_3, aerosols.

02. Ground-Based Sensors (OpenAQ, AirNow, Pandora, CPCB) – localized PM2.5, PM10, SO_2, CO data.

03. Weather APIs (OpenWeather/NOAA) – temperature, wind, humidity, rainfall for dispersion modeling.

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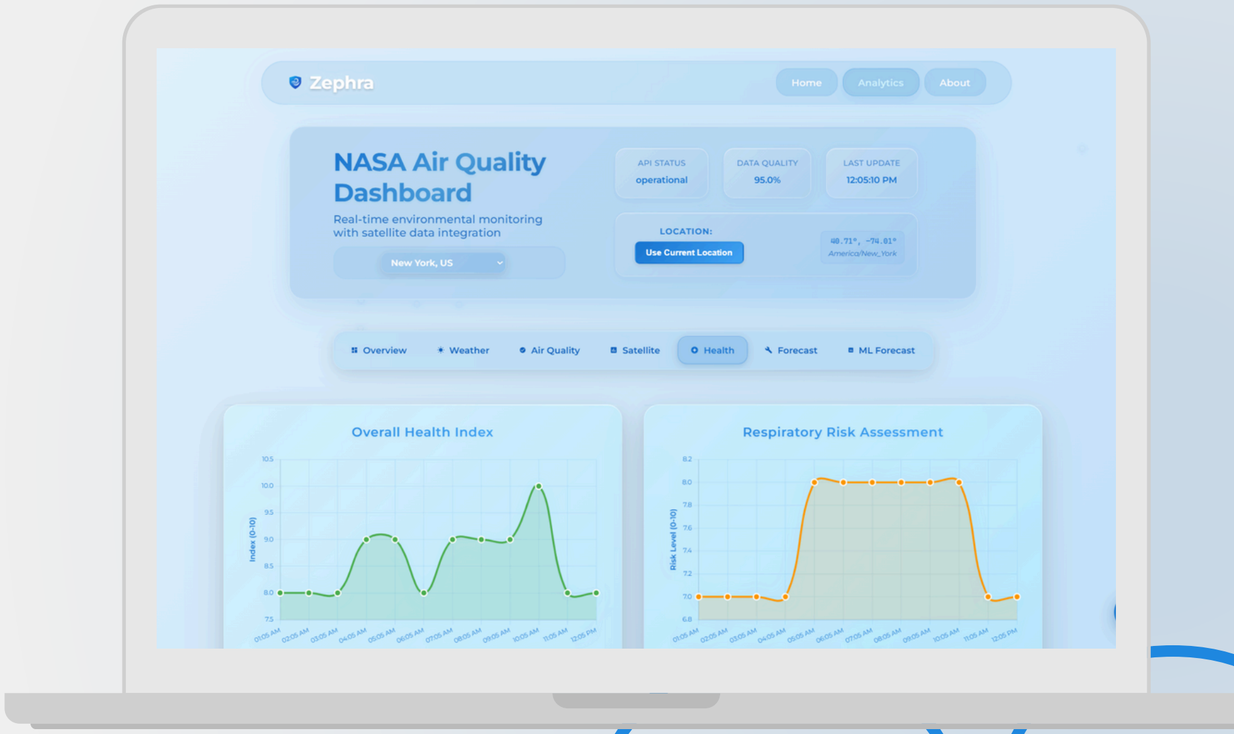
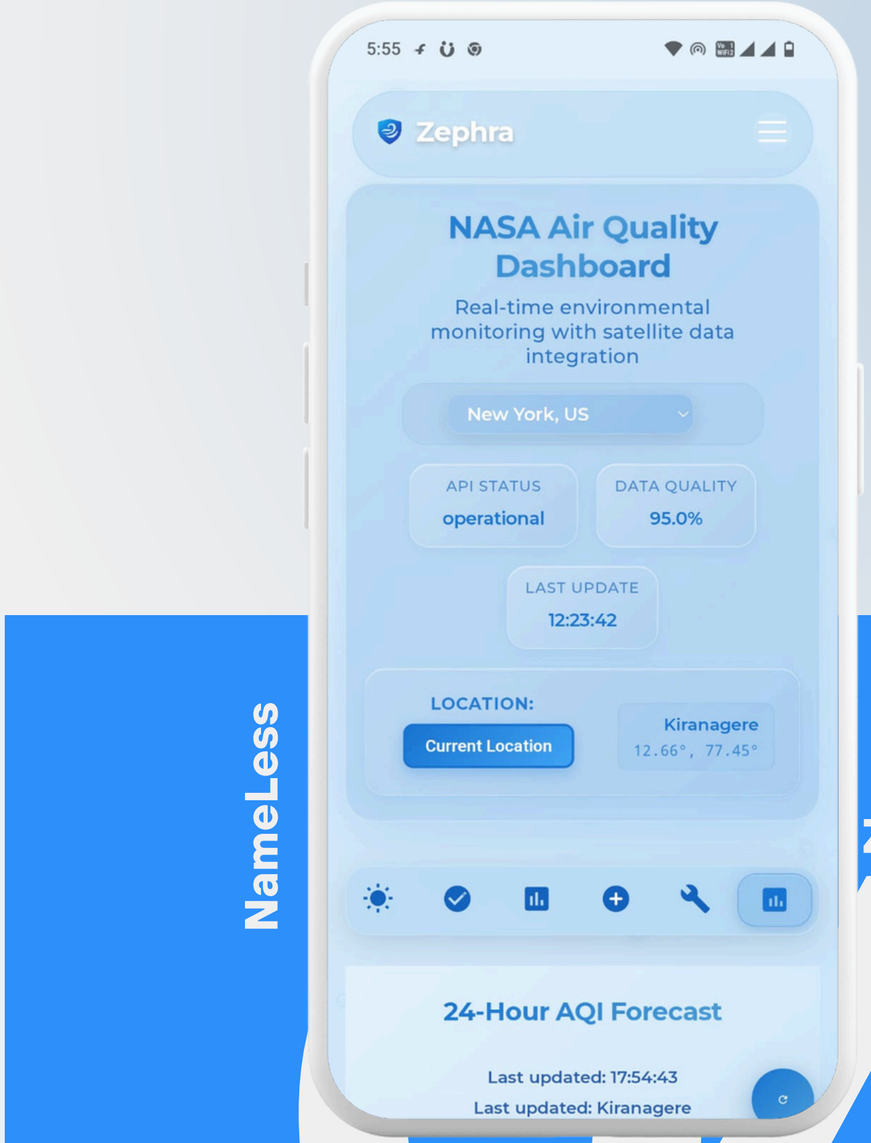
Our Features

- Shows real-time air quality using NASA satellites and local sensors.
- Predicts AQI for the next 24 hours (easy hourly view).
- Uses a machine-learning model that learns from weather and past pollution to make forecasts.
- Interactive dashboard with simple charts for AQI and pollutants (PM2.5, PM10, NO2, O3).
- Health tips shown based on current and forecast AQI.
- Mobile friendly and installable as an app (PWA).
- Works offline for short periods using cached data.



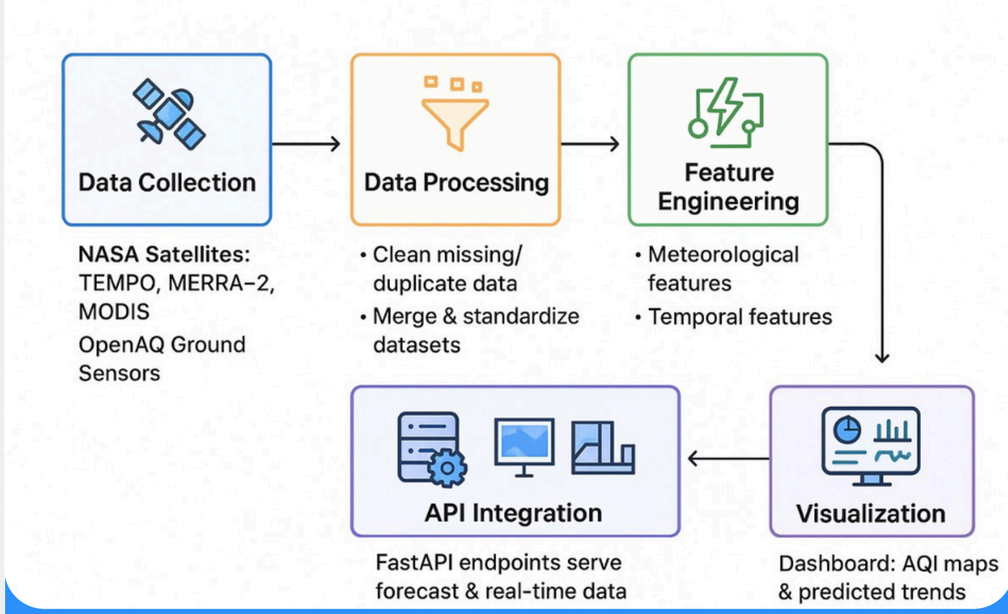
Impact

- Protect public health — Deliver timely, localized 24-hour AQI forecasts and alerts so vulnerable people (asthma, heart conditions, elderly) can avoid high-exposure periods.
- Enable data-driven policy — Provide municipalities and planners with exportable time-series, heatmaps and model insights to target pollution mitigation and zoning decisions.
- Improve operational safety — Help outdoor businesses (construction, logistics, events) plan work windows using hourly forecasts to reduce worker exposure and downtime
- Raise community awareness — Turn NASA satellite telemetry and sensor data into simple charts, tips and explanations that teach people about PM2.5, ozone and health impacts.
- Increase resilience and equity — Offline caching, graceful ML fallbacks and location-specific predictions ensure reliable guidance even when external APIs or networks fail



Methodology

- Data & Processing – Ingest NASA (TEMPO, MERRA-2, MODIS), OpenAQ, and geolocation feeds; clean, align, and unify into location based time series.
- Features & Model – Engineer 100+ temporal, meteorological, and pollutant features; train Gradient Boosting Regressor with time-series CV and persist pipeline.
- Inference & Integration – FastAPI backend serves /api/predict, dashboard, and location endpoints and ML API provides 24-hr AQI forecasts with confidence.
- UI & Reliability – React + Chart.js frontend shows AQI trends/forecasts; PWA offline support, fallbacks on failures, and deployment on Render for ease to access .



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Future Scope

- Interactive Maps: Full implementation of satellite overlay maps
- Smart Notifications: AI-powered alert optimization
- Historical Analysis: Long-term trend visualization
- Global Expansion: Support for more locations
- Enhance ML Model: Deep learning for longer forecasting horizons
- Industrial Monitoring: Support for specific pollution sources

Conclusion

- Localized foresight: 24-hour AQI forecasts + health alerts to help communities act early.
- Robust stack: NASA satellites + sensors fused via Gradient Boosting ML, deployed with FastAPI + React PWA (offline ready).
- Actionable now: Live demo + open repo — ready for use, review, and collaboration.

Thank You