C-Metrics: Real-Time Smart City Intelligence Dashboard

Comprehensive Urban Health Monitoring Powered by Open Data

Making Cities Smarter Through Real-Time Data Intelligence

C-Metrics is an open-source, production-ready solution designed to transform urban planning with accessible environmental data. Developed by Team 26 from Polaris School of Technology, C-Metrics aggregates 13 key metrics into a unified dashboard, providing critical intelligence for city planners, policymakers, and engaged citizens. Our vision is to enable data-driven municipal decisions for healthier, more efficient urban environments.

- 13 Metrics Tracked
- 200,000+ Cities
- Real-Time Updates
- <2s Load Time

Technology Foundation & System Architecture

C-Metrics is built on a robust, client-side architecture designed for speed and scalability. Our API-first approach ensures seamless data integration from diverse sources, while a modular code structure facilitates maintainability and future expansion.

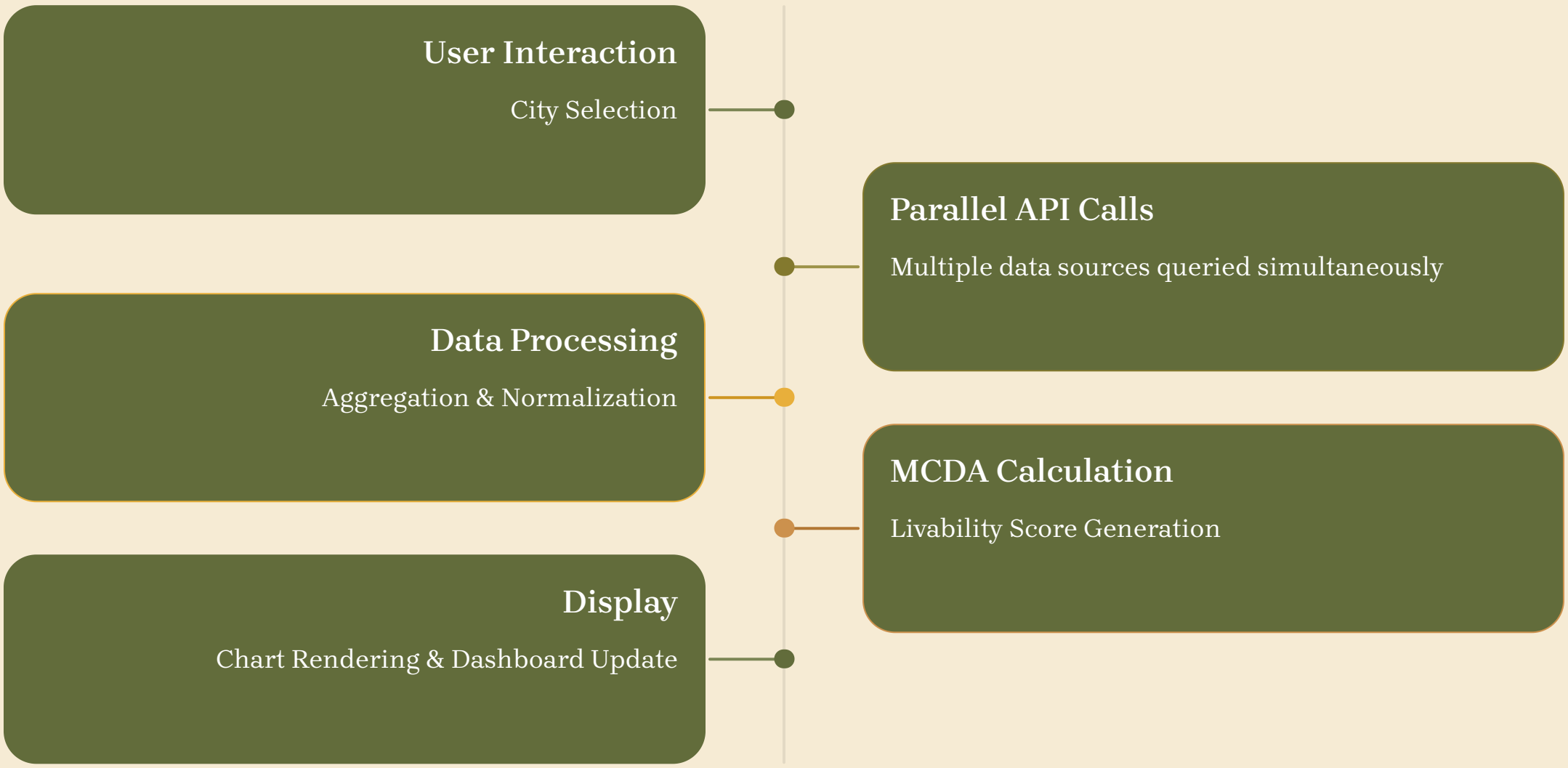
Core Tech Stack

- **Frontend:** HTML5, CSS3, JavaScript ES6+
- **Visualization:** Plotly.js, Leaflet.js (maps)
- **Key APIs:**
  - AQICN: Air quality (12K+ stations)
  - OpenWeatherMap: Weather, UV, wind (200K+ cities)
  - TomTom: Traffic (80+ countries)
  - Open-Meteo: Population & Geocoding (3M+ cities)

Architectural Principles

- **Zero Backend:** Pure client-side operation for simplicity and cost-effectiveness.
- **API-First Design:** Focus on external data integration.
- **Event-Driven Updates:** Responsive and dynamic data handling.
- **localStorage:** For persistence of user preferences and cached data.
- **Modular Code:** Enhances readability and future development.

Data Flow At A Glance



Comprehensive Urban Monitoring: 13 Integrated Metrics

C-Metrics provides a holistic view of urban health by integrating 13 distinct metrics, categorized for clarity and actionable insights. This multi-faceted approach ensures that city planners have access to a broad spectrum of data, from real-time environmental conditions to critical infrastructure and environmental indicators.

🟢 Real-Time Metrics

- Air Quality Index (AQI)
- Weather Conditions
- Traffic Congestion
- UV Index
- Wind Speed
- Daylight Hours

🔵 Infrastructure Metrics

- Energy Consumption
- Waste Management
- Water Quality

🟡 Environmental Metrics

- Soil Quality
- Groundwater Level
- Atmospheric Pressure

🌟 Special Metric

- Population Density

Feature-Rich Dashboard: 6 Advanced Capabilities

Our dashboard is engineered for intuitive use and powerful analysis, integrating six advanced features that enhance user experience and data interpretation. From real-time updates to customizable themes and responsive design, C-Metrics delivers actionable intelligence at your fingertips.

Auto-Refresh System

Real-time metrics update every 10 seconds with intelligent caching and error recovery, ensuring no blank data during updates.

Global City Search

Access data for 200,000+ cities worldwide with autocomplete, interactive maps, and favorite saving functionality.

Expandable Modal Charts

Visualize historical data with year/month/day granularity, full Plotly controls (zoom, pan, download), and smooth transitions.

Dynamic Theme System

Switch instantly between dark and light modes, with persistent settings and automatic chart updates via CSS variables.

Responsive Design

Optimized for all devices – mobile (1 column), tablet (2 columns), and desktop (3-column grid) – ensuring readability and touch-optimized controls.

Advanced Interactivity

Engage with hover effects, click-to-open modals, keyboard navigation, and full accessibility compliance for all users.

Deep Technical Dive: Algorithms & Performance

The C-Metrics platform is built on a highly optimized and robust technical foundation. Our data pipeline is designed for efficiency, handling multiple API calls in parallel and normalizing data to ensure consistency. This, combined with rigorous error handling and advanced performance techniques, guarantees a fast, reliable, and smooth user experience.

Data Pipeline & Processing

- **Parallel API Calls:** 5+ simultaneous requests for rapid data acquisition.
- **Data Normalization:** All metrics scaled 0-100 for consistent comparison.
- **Metric Storage:** Efficient global object for quick access and display.
- **Smooth Rendering:** Display updates with subtle animations for an enhanced feel.

Optimization Strategies

- **Response Caching:** 5-second cache for API responses to reduce redundant calls.
- **Historical Data Retention:** Stores last 100 data points for trend analysis.
- **Debounced Resize:** Prevents excessive re-rendering during window resizing.
- **Efficient Plotly Updates:** Uses `Plotly.react()` for minimal DOM manipulation.

Robust Error Handling

- **Graceful Degradation:** Displays "--" for unavailable data, maintaining dashboard integrity.
- **Automatic Retry Logic:** 3 retries with exponential backoff for failed API calls.
- **Fallback Mechanisms:** Utilizes static data when real-time feeds are problematic.
- **User-Friendly Alerts:** Clear messages for any issues encountered.

Performance Benchmarks

- **Initial Load:** <2 seconds
- **API Response Time:** <1 second per call
- **Chart Render Time:** <300 milliseconds
- **Memory Usage:** <50 MB
- **CPU Idle:** <1%
- **Animations:** Consistent 60 FPS

MCDA Algorithm for City Livability (0-100)

C-Metrics utilizes a sophisticated Multi-Criteria Decision Analysis (MCDA) algorithm to calculate a comprehensive City Livability Score, ranging from 0 to 100. This score aggregates all 13 integrated metrics, each assigned a specific weight based on its impact on urban well-being. This provides city planners with a single, actionable metric for quick assessment and informed decision-making.

Air Quality

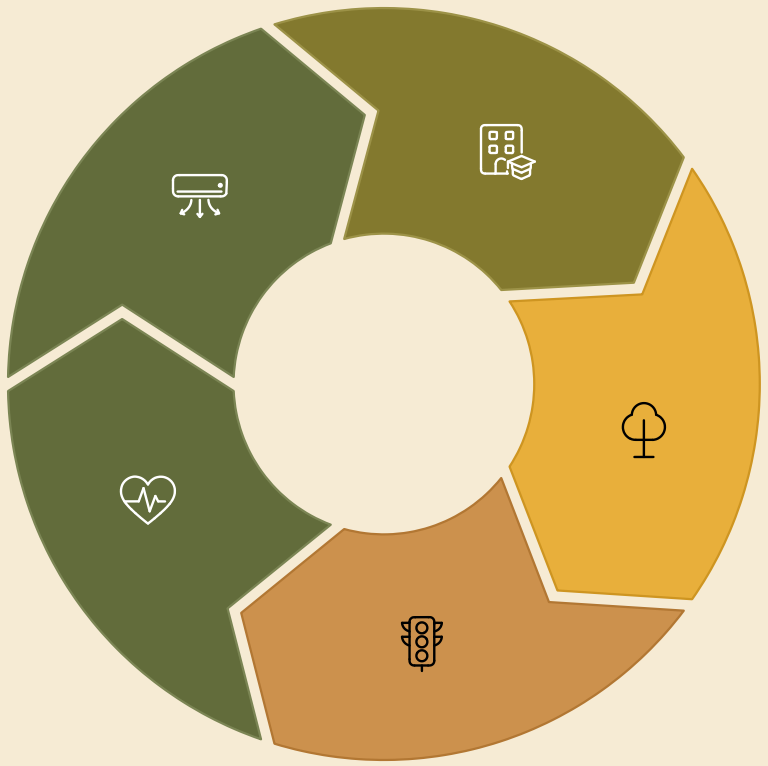
20% Weight

Respiratory health impact

Health Factors

15% Weight

Comfort & well-being indicators



Infrastructure

30% Weight

Basic services & utility access

Environment

20% Weight

Sustainability & natural resources

Traffic

15% Weight

Mobility & commute efficiency

> **Formula: Score = Σ(normalized_metric_i × weight_i)**
>
> The algorithm gracefully handles missing data by redistributing weights among available metrics, ensuring a robust score even with incomplete information.

81

Bangalore Example

Achieved a "Very Good" A grade

100

A+ Excellent

85-100

84

A Very Good

75-84

74

B+ Good

65-74

64

B Fair

55-64

Production Deployment & Future Evolution

C-Metrics is deployed for real-world use and poised for continuous evolution. Hosted on GitHub Pages, it benefits from seamless integration and automatic deployment. Our roadmap outlines ambitious plans to expand functionality, foster community contributions, and ultimately establish C-Metrics as a leading open-source solution for smart city intelligence.

Current Deployment & Testing

- **Platform:** GitHub Pages (free, auto-deployment pipeline)
- **Testing:** Comprehensive unit, integration, and performance tests, ensuring cross-browser compatibility.
- **Version History:** Rapid evolution from v1.0.0 (Aug 2025) to v2.0.0 (Nov 2025) with major feature additions.

Future Roadmap

- **Short Term:** Historical data export, city comparison tools, real-time alerts, PWA & offline mode.
- **Medium Term:** Dedicated backend API, advanced caching, user accounts, personalization features.
- **Long Term:** Predictive analytics, ML models for urban trends, city rankings, native mobile applications, international expansion.

Open Source & Community

- **License:** MIT License (enabling commercial use and broad adoption).
- **Contribution:** Actively welcoming Pull Requests (PRs) and community engagement via GitHub Discussions.
- **Guidelines:** Detailed contribution guidelines for seamless collaboration.

Success Metrics & Challenges

- **Goals:** 1000+ GitHub stars, 50+ configured cities, 10+ contributor PRs, 100K+ monthly users, 3+ municipality adoptions.
- **Challenges:** Mitigating API rate limits with intelligent caching; managing data quality variations through validation; ensuring global coverage with incremental expansion; optimizing real-time costs.

GitHub: https://github.com/thechillbasu/C-Metrics

Live Demo: https://thechillbasu.github.io/C-Metrics/