

Coastal Urban Microclimate Observatory

Comprehensive Project Proposal and Technical Blueprint

1. Introduction

Rapid urbanization in coastal regions significantly modifies local atmospheric processes. Urban heat storage, reduced vegetation, altered surface roughness, and proximity to marine air masses interact to create complex microclimatic behavior often underrepresented in national-scale meteorological networks. This observatory aims to establish a research-grade, high-resolution, long-term atmospheric monitoring system within an urban coastal environment.

2. Rationale

Large-scale meteorological models typically operate at grid resolutions of 5–10 km or greater. Within this scale, significant variability occurs due to local surface properties and built environment effects. Hyperlocal monitoring is necessary for model validation, urban climate adaptation planning, and extreme weather analysis.

3. Aims

- Establish a continuous, research-grade urban coastal weather monitoring station.
- Quantify urban heat island intensity and nocturnal heat retention.
- Characterize sea-breeze onset timing and wind transitions.
- Measure cyclone-related pressure fall rates and gust dynamics.
- Analyze short-duration extreme rainfall bursts.
- Develop an open-access, high-quality dataset suitable for scientific use.

4. Research Questions

- How does nocturnal temperature retention vary seasonally?
- What is the variability of sea-breeze onset timing?
- Are short-duration rainfall intensities increasing?
- What are micro-scale pressure drop signatures during cyclones?
- Does urbanization amplify humidity-related heat stress?

5. Methodology

5.1 Site Selection

- Open sky exposure (minimum 120° horizon clearance).
- Natural ground surface for temperature sensor.
- 10 m mast installation capability.
- Distance from reflective walls and AC exhausts.

5.2 Instrumentation

- Ultrasonic anemometer at 10 m height (1-second gust capture).
- Aspirated radiation-shielded temperature and humidity sensor at 1.5–2 m.
- High-resolution tipping bucket rain gauge (0.1–0.2 mm).
- Barometric pressure sensor (0.1 hPa resolution).
- Optional pyranometer for solar radiation measurement.

5.3 Data Logging

- 1-minute interval recording.
- UTC timestamping.
- Local and cloud backup.
- Annual archival in standardized CSV format.

6. Data Management Plan

- Precise metadata documentation (latitude, longitude, elevation).
- Sensor model and calibration logs.
- Data gap annotation protocol.
- Public repository hosting (e.g., GitHub, Zenodo).
- Version-controlled dataset updates.

7. Calibration Protocol

- 7-day cross-check with nearest official station.
- Rain gauge volume verification tests.
- Pressure sensor comparison with official sea-level pressure.
- Annual recalibration schedule.

8. Long-Term Vision

- Develop 3–5 year continuous dataset.
- Produce annual microclimate summary reports.
- Conduct cyclone and extreme rainfall case studies.
- Prepare peer-reviewed publication submissions.
- Enable collaboration with atmospheric scientists.

9. Ethical and Scientific Commitment

- Maintain raw data integrity.
- Avoid silent data manipulation.
- Clearly annotate anomalies and instrument failures.
- Ensure transparent documentation and reproducibility.