Feasibility Study Report

Pilot Project

Project Title: **Climate Change & Thunderstorm Trends in the Congo Basin**

Duration: 6 Months

Project Location: Democratic Republic of Congo

Project Partners: Cornerstone International
Save Congo

Executive Summary

The Democratic Republic of the Congo lies within the Congo Basin, the most lightning-active region on Earth. This study evaluates the feasibility of analyzing long-term changes in lightning frequency and thunderstorm intensity in relation to climate change variables such as temperature, humidity, and deforestation.

Scientific evidence indicates that:

- The Congo Basin consistently records the highest lightning densities globally
- Thunderstorm activity has increased in frequency and spatial extent over recent decades
- Climate variability and warming influence convection, moisture transport, and storm formation

This project is highly feasible with strong data availability, global relevance and opportunities for partnerships across academia, government and private sector organizations.

Objectives
Primary Objective

Assess whether lightning frequency and thunderstorm intensity in the Congo Basin are changing over time and how these changes relate to climate change drivers.

Secondary Objectives

- Correlate lightning trends with:
    - Surface temperature rise
    - Atmospheric humidity
    - Deforestation rates
- Develop predictive insights for future thunderstorm behavior
- Link findings to global climate change discussions and risk mitigation

Scientific Background

Why the Congo Basin?

- The region experiences extreme convective activity and rainfall (1500–2000 mm annually)
- Lightning flash densities exceed 50–100 flashes/km²/year, among the highest worldwide
- Thunderstorms are strongly linked to the Intertropical Convergence Zone (ITCZ) and moisture inflow

Observed Trends

- Long-term satellite data (1982–2016) shows increasing thunderstorm frequency and intensity
- Recent 18-year datasets (2005–2022) enable trend detection under modern global warming conditions
- Some projections suggest future shifts or even regional declines in lightning intensity due to changing moisture patterns

Interpretation: Climate change does not uniformly increase lightning—it alters where, when, and how storms occur.

Methodology

Data Sources

Lightning Data

- Worldwide Lightning Location Network (WWLLN)

Climate Data

- Temperature & humidity: ERA5, NOAA
- Rainfall: satellite datasets (TRMM, GPM)
- Deforestation: Global Forest Watch

Analytical Approach

Step 1: Trend Analysis

- Time-series analysis of lightning frequency (20–40 years)
- Identify seasonal and annual variability

Step 2: Correlation Modeling

- Regression models linking:

    - Lightning vs temperature
    - Lightning vs humidity
    - Lightning vs forest loss

Step 3: Spatial Mapping

- GIS-based mapping of lightning hotspots
- Overlay with deforestation and climate anomalies

Step 4: Predictive Modeling

- Machine learning models (Random Forest, Neural Networks)
- Scenario analysis under future climate pathways

Feasibility Assessment

Technical Feasibility — High

- Abundant satellite datasets (global, open-access)
- Established analytical tools (Python, GIS, AI models)
- Proven methodologies in atmospheric science

Operational Feasibility — Moderate to High

- Requires interdisciplinary collaboration (climate science + data science)
- Field validation may be limited due to infrastructure challenges

Financial Feasibility — Moderate

- Low cost for data (mostly free)
- Costs mainly in:
    - Computing resources
    - Personnel (data researchers, climatologists)

Risks and Limitations

- Data gaps in ground-based lightning detection
- Attribution challenge: isolating climate change from natural variability
- Regional complexity: ITCZ shifts and ocean-atmosphere interactions
- Deforestation uncertainty: indirect effects on convection

Expected Outcomes

- Quantified trends in lightning frequency over time
- Identification of key climate drivers
- Predictive models for thunderstorm risk

- Policy-relevant insights for:
    - Disaster preparedness
    - Agriculture planning
    - Infrastructure resilience

Connection to Global Climate Change

This study contributes to broader climate discussions by:

- Demonstrating how warming alters atmospheric instability
- Linking deforestation to regional weather extremes
- Supporting evidence that extreme weather systems are shifting globally

Example: Increased lightning in unusual regions (e.g., Arctic) has already been linked to warming trends, showing a global redistribution of storm activity.

Potential Partners
Private Sector

- Vaisala
    - Lightning detection systems and climate analytics
- Planet Labs
    - High-resolution satellite imagery (deforestation tracking)
- Google Earth Engine
    - Cloud-based climate and environmental data processing
- IBM (The Weather Company)

    - Climate modeling and AI

Government & Intergovernmental

- Ubimet
    - Lightning Imaging Sensor data
- NOAA
    - Climate and atmospheric datasets
- World Meteorological Organization
    - Policy and global coordination
- African Union
    - Regional climate initiatives
- Ministry of Environment of the DRC
    - Local implementation and policy integration

Academic & Research

- University of Kinshasa
- University of Oxford (Congo Basin research programs)
- International climate research institutes

Conclusion

This project is scientifically robust, data-accessible, and globally relevant. The Congo Basin offers a natural laboratory for understanding how climate change affects thunderstorms and lightning—key indicators of atmospheric instability.

The feasibility is strong due to:

- High-quality satellite datasets
- Increasing global interest in extreme weather
- Opportunities for cross-sector collaboration