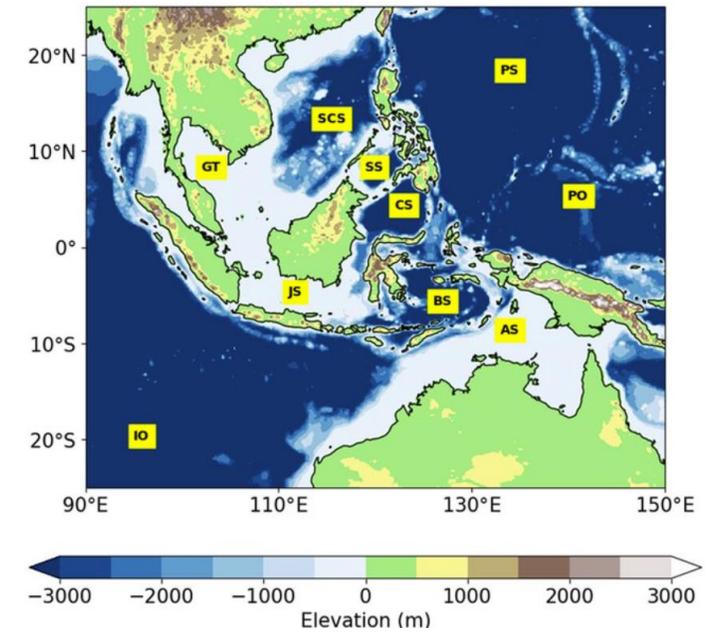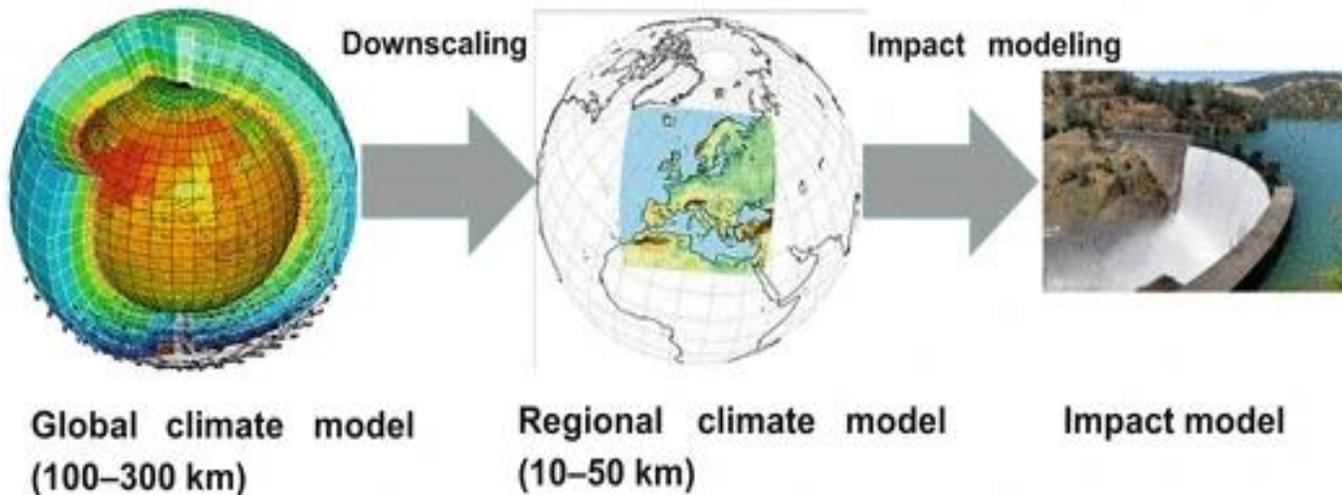# ACCELERATING CLIMATE UNDERSTANDING THROUGH AI:

FROM BIG DATA TO REAL-WORLD IMPACT

Arnida L. Latifah
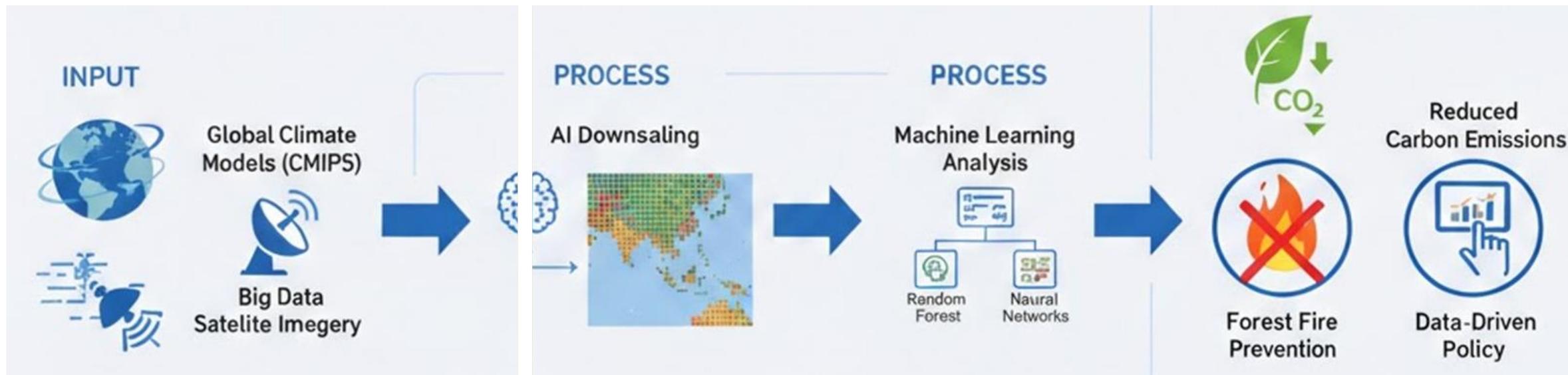
TECHNOLOGY AND INNOVATION CONCLAVE 2.0 | JAN 2026

Research Organization for Electronics and Informatics
National Research and Innovation Agency of Indonesia

THE CHALLENGE: CLIMATE COMPLEXITY

Global climate model (100–300 km) → Downscaling → Regional climate model (10–50 km) → Impact modeling → Impact model

https://doi.org/10.1007/978-3-319-68418-5_10

https://doi.org/10.1029/2024JD042606

RESEARCH FRAMEWORK

- **Input**: Big Data (Satellite, GCM, Reanalysis).
- **Process**: AI Downscaling & Machine Learning Analysis.
- **Output**: Actionable Insights for Fire Prevention & Policy.
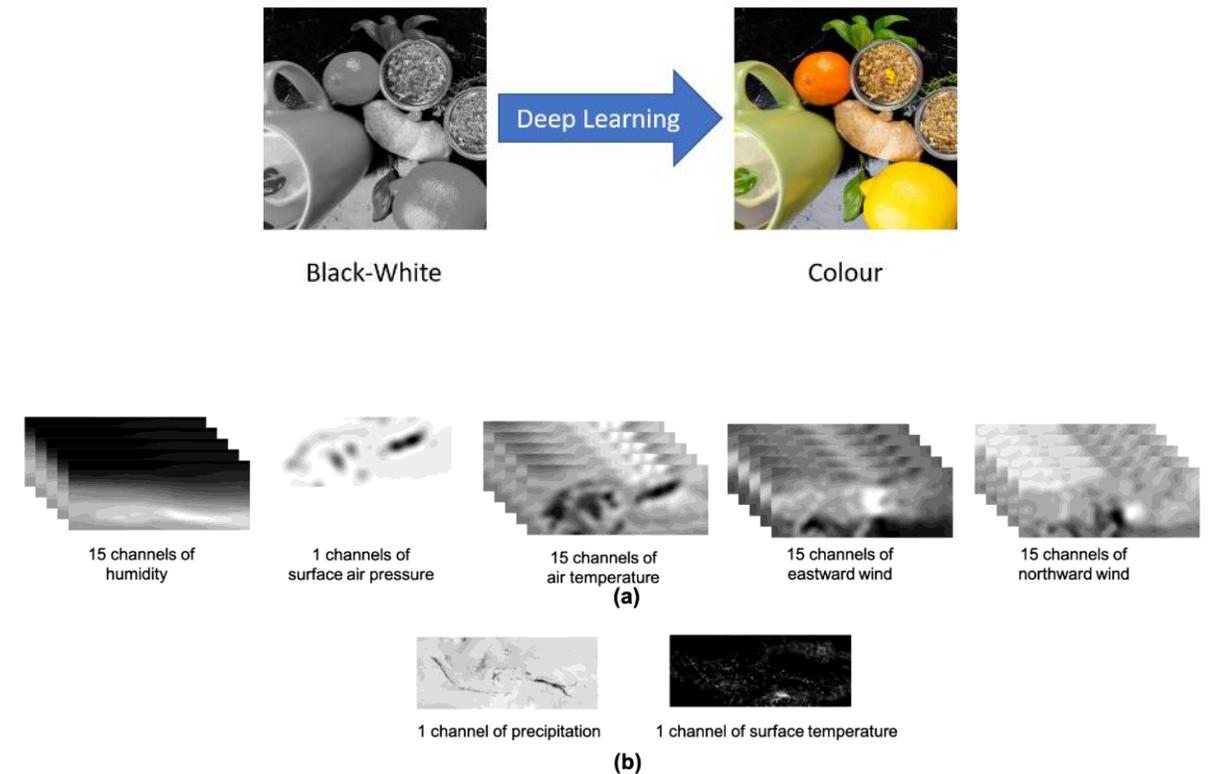
AI-BASED DOWNSCALING

- **What**: Transforming low resolution climate data into high resolution regional/ local grids.

- **Goal**: Providing "High-Definition" climate data, particularly for the Indonesian archipelago.

- **How**: Utilizing Deep Learning to bridge the gap between global models and local realities and to mimic expensive physical climate models.

- **Innovation**: Replacing computationally regional climate models with a lightweight Deep Learning Downscaling.

- **Efficiency Gains**:

  Speed: Near-instantaneous downscaling compared to days of supercomputer processing.

  Scalability: Allows for "Ensemble Downscaling" to account for uncertainty across multiple climate scenarios.

- **Result**: A robust tool for climate projection at the regional/ local scale.

IMAGE-TO-IMAGE TRANSLATION FOR CLIMATE DOWNSCALING

- **The Concept**: Treating climate downscaling as a super-resolution task, similar to enhancing a blurry photograph.

- **Architectural Approach**: Utilizing Generative Adversarial Networks (GANs) or U-Net structures to learn the mapping between low-resolution Global Climate Models (GCMs) and high-resolution observational data or dynamically downscaled data.

Black-White   Deep Learning   Colour

15 channels of humidity | 1 channels of surface air pressure | 15 channels of air temperature | 15 channels of eastward wind | 15 channels of northward wind

(a)

1 channel of precipitation   1 channel of surface temperature

(b)

RESULT

- Good results in downscaling surface temperature.

- The downscaling results for precipitation are still below expectations, but slightly better performance than the numeric result.

- The promising performance is achieved using fewer data and less computation time compared to a Regional Climate Model.
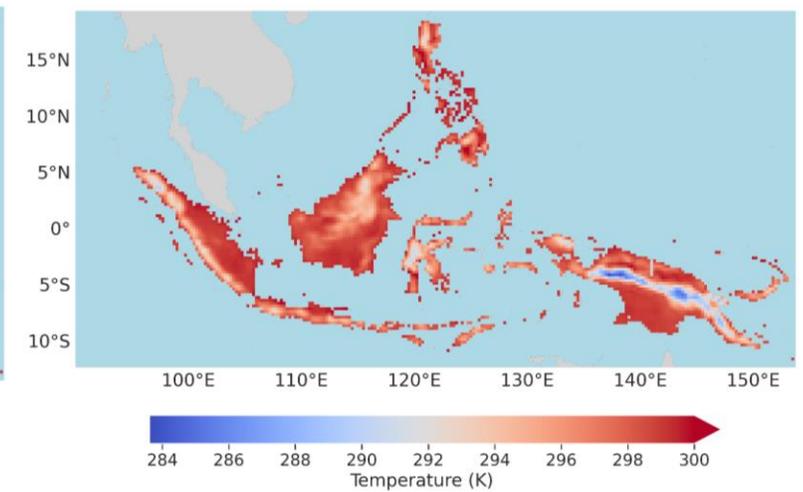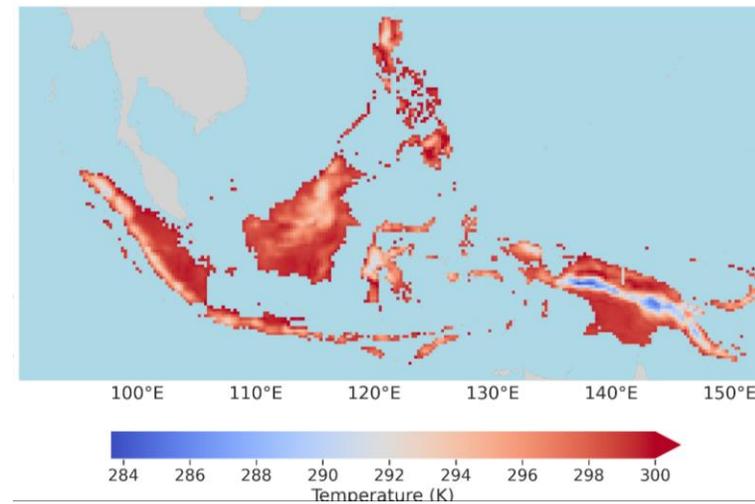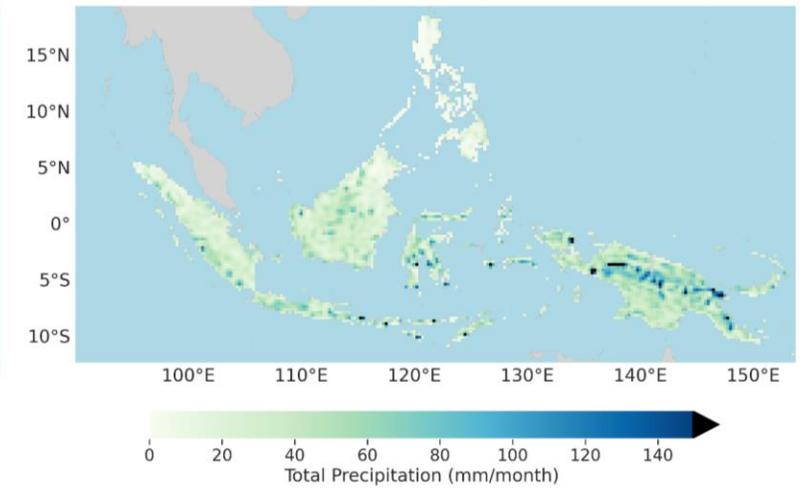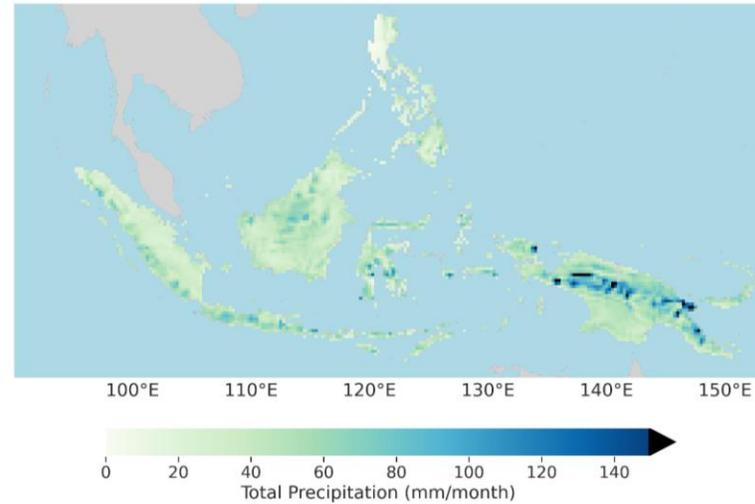
ADVANCED PREDICTIVE MODELING

- Transitioning from "Historical Analysis" to "Prediction" using integration of multi-variable factors: climate, environment, human

- **The System Architecture:** A multi-layered data fusion approach.

- **The Algorithm:** Utilizing machine learning for its ability to handle non-linear relationships and provide "Feature Importance" rankings—showing exactly which factor is driving the fire risk.
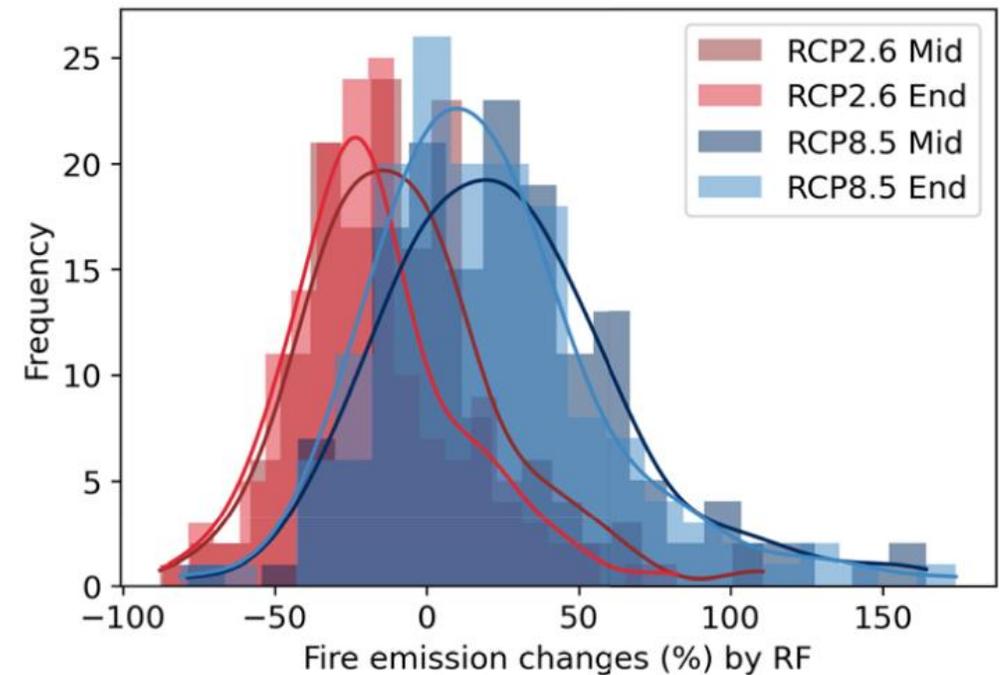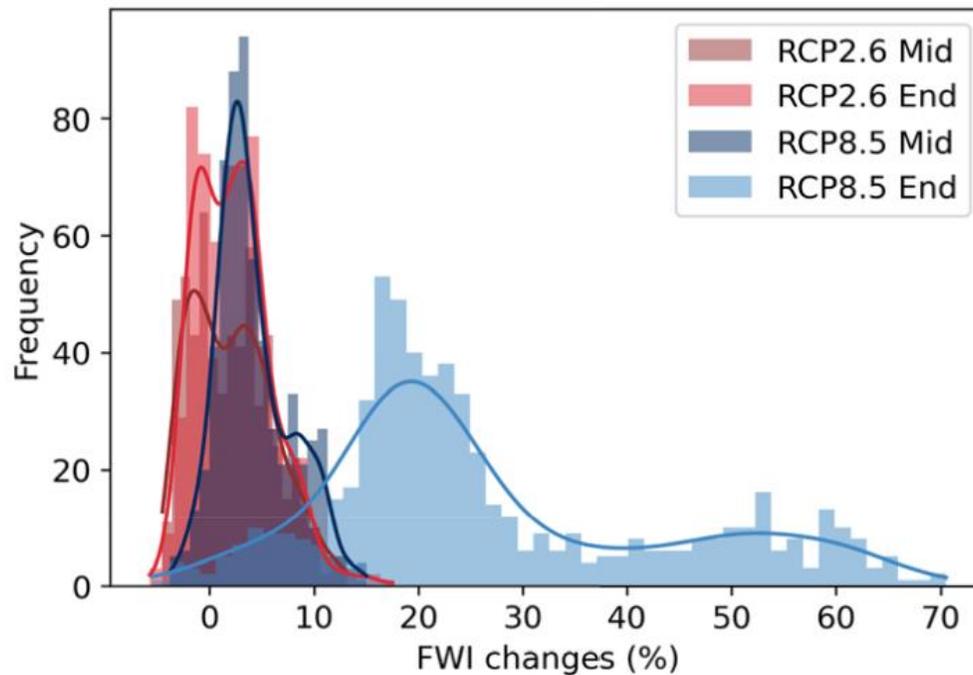
Future Climate over Sumatra
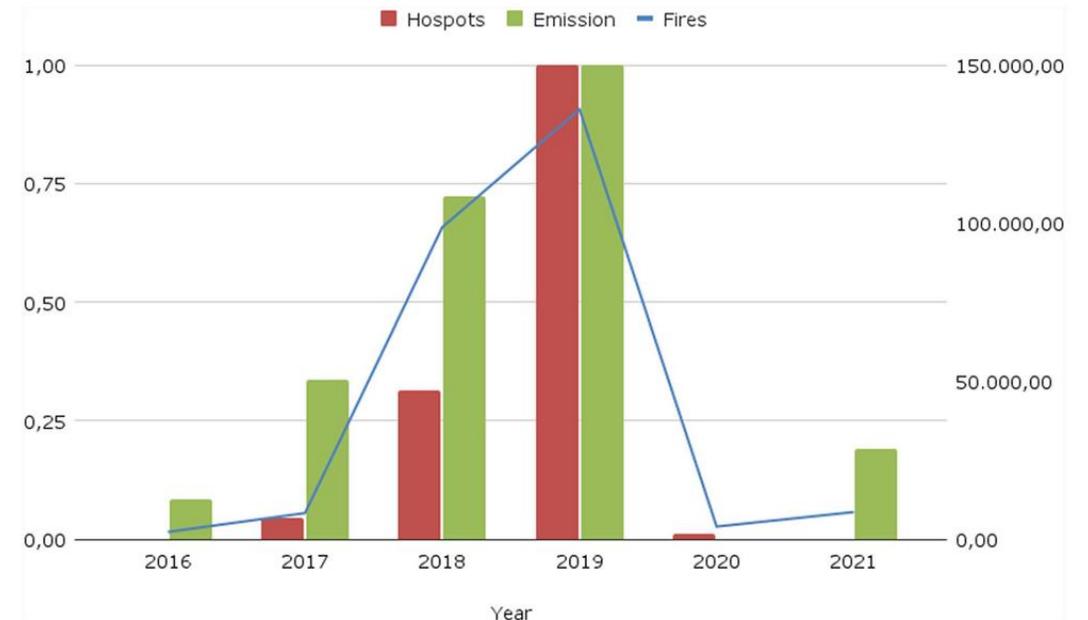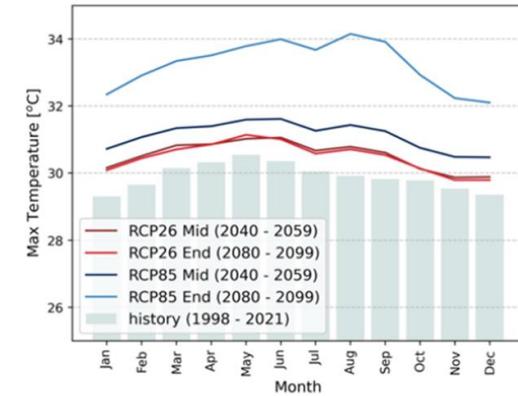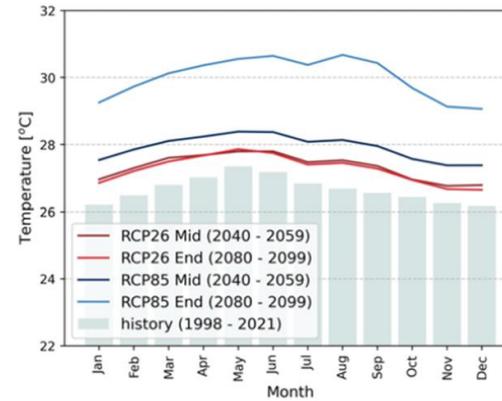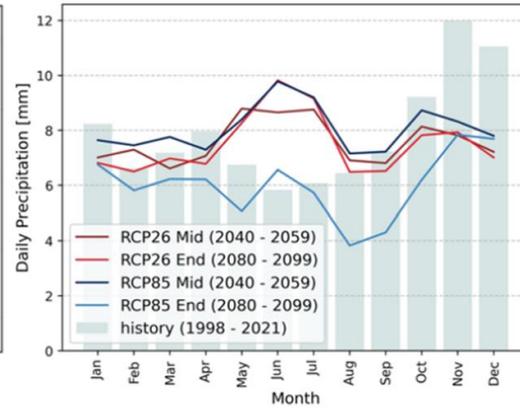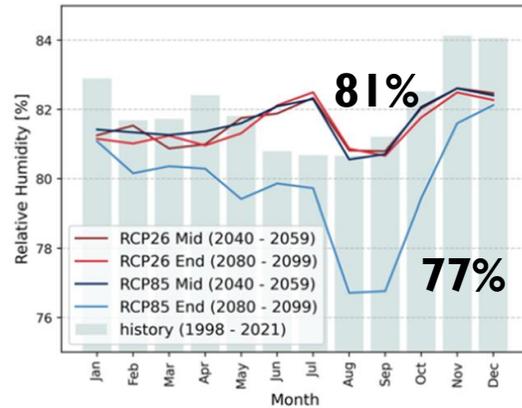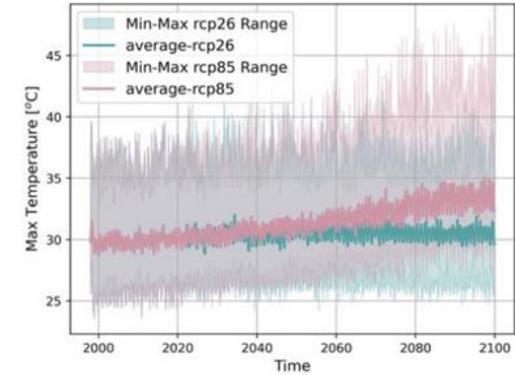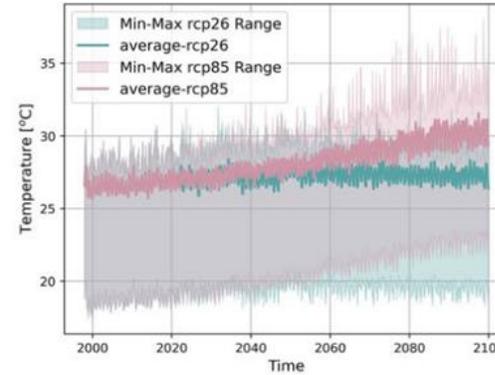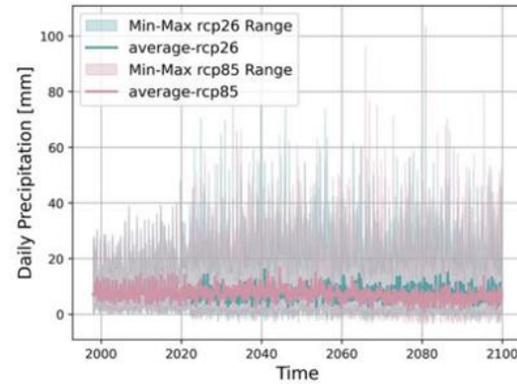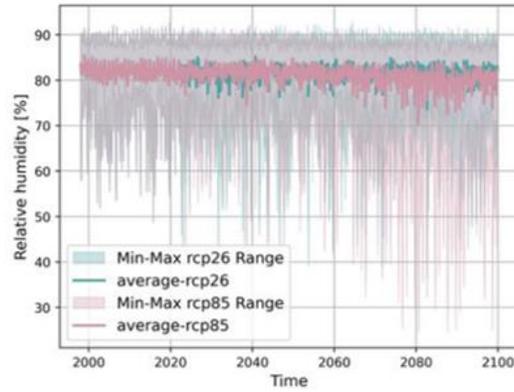
FIRE PROJECTIONS UNDER RCPS

Fire Danger Projections: Mapping future fire risks in Sumatra through 2050/2100 under global emission scenarios (RCPs) to inform long-term climate adaptation strategies.

SUMMARY & FUTURE OUTLOOK

From Big Data to Insight: Transforming massive climate datasets into actionable intelligence for disaster risk reduction.

Pioneering Resilience: By replacing slow and heavy computing with near-instantaneous Deep Learning-based Downscaling, we enable rapid-response climate adaptation.

Targeting Critical Thresholds: Our AI identifies specific tipping points, such as the projected drop to 77% relative humidity, to trigger early warning systems.

Policy Support: This research provides the scientific foundation for national haze mitigation and climate resilience frameworks in the Indonesian archipelago.

THANK YOU

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