# Queensland (Brisbane West–South) Gridded Climate–Soil Data Research Plan for Disaster Prevention

## Executive Summary

This research plan outlines the development of a deep-learning-based system to generate high-resolution (1 km) gridded climate and soil datasets for disaster prevention across Queensland’s Brisbane West–South region. The project integrates multiple data sources—including Bureau of Meteorology (BoM) weather stations, radar, and satellite data—to produce daily precipitation, temperature, and surface soil-moisture maps. The resulting products will strengthen early-warning systems for flood and bushfire risk management. Over 12 months, the project aims to deliver validated datasets, robust AI models, and a reproducible workflow that aligns with BoM’s Hydro-Informatics and Surface Observations framework.

## Background and Objectives

Queensland is vulnerable to extreme weather events such as floods, droughts, and bushfires. Although the Bureau of Meteorology operates a strong national observation network, certain inland and peri-urban areas—particularly the Brisbane West–South corridor—remain data-sparse. Developing a high-resolution gridded dataset will enhance the ability to detect, model, and mitigate disaster risk while supporting local decision-making.

Key objectives include:  
• Develop a practical, AI-driven workflow to produce daily gridded precipitation, maximum temperature, and soil-moisture data.  
• Fuse multi-source datasets (AWS, radar, GPM, Sentinel-1, SMOS) for higher spatial-temporal accuracy.  
• Validate outputs against BoM observations and historical flood and fire events.  
• Deliver open, CF-compliant datasets and shareable deep-learning models for operational use or BoM collaboration.

## Study Area Context

The Brisbane West–South region has been selected as the demonstration area due to its recurring exposure to flood and bushfire hazards, and its mixed landscape of agricultural, peri-urban, and forested environments. The area encompasses Lockyer Valley, Ipswich, and Logan districts, covering approximately 10,000 km². It includes critical hydrological catchments that drain into the Brisbane and Bremer Rivers. This diverse region offers an ideal testbed for refining gridded climate–soil models that can later scale to the state level.

## Data Sources and Quality Control

The model will integrate data from multiple open and collaborative sources, as detailed in Annex B (Data Source Characteristics). Data inputs include BoM AWS station data, GPM IMERG precipitation, radar mosaics (subject to BoM approval), Sentinel-1 SAR soil-moisture, SMOS global datasets, SRTM topography, and Copernicus Global Land Service land-cover information. Quality control procedures include bias-correction, outlier detection, spatial consistency checks, and the removal of noisy or incomplete records. Data gaps will be interpolated using spatio-temporal imputation and model-driven correction.

## Data Access Statement

This project uses both open-access and partnership datasets to construct gridded climate and soil products. Open-access sources include NASA’s GPM IMERG, ESA’s Sentinel-1 and Sentinel-2 missions, SMOS products, SRTM elevation, and Copernicus Global Land Service data. BoM Climate Data Online (CDO) and AGCD/AWAP gridded products will be accessed under academic-use conditions with proper attribution. Access to radar mosaics and high-frequency AWS data will be established through collaboration with the BoM Hydro-Informatics and Surface Observations Team. All outputs will comply with original data licences and attribution requirements, following BoM’s data-sharing guidelines.

## Methodology Overview

The model development follows a progressive approach combining classical interpolation and deep learning:  
• Baseline model: Regression-kriging using terrain, distance-to-coast, and land-cover covariates.  
• Deep Learning v1: U-Net-Light for 2D tile prediction using satellite and topographical layers.  
• Deep Learning v2: Temporal U-Net or ConvLSTM with 3–7 day context and uncertainty quantification.  
• Soil-moisture prediction: Multitask CNN head integrating Sentinel-1 and SMOS for 1 km super-resolution mapping.  
Detailed methodological steps, variables, and architecture designs are presented in Annex A (Detailed Methods).

## Work Plan and Deliverables

The 12‑month work plan includes six sequential phases:  
• Phase 0 (Weeks 1–2): Project setup and data pipeline definition.  
• Phase 1 (Weeks 3–8): Baseline regression-kriging for rainfall and temperature.  
• Phase 2 (Weeks 9–16): U‑Net‑Light model training and spatial cross‑validation.  
• Phase 3 (Weeks 17–24): Integration of temporal context and uncertainty layers.  
• Phase 4 (Weeks 25–36): Soil‑moisture module and event‑based validation (2022 floods, 2019 bushfires).  
• Phase 5 (Weeks 37–48): Documentation, CF‑compliant NetCDF packaging, and prototype delivery for BoM review.

Expected outputs include:  
• 1 km daily gridded datasets (rainfall, Tmax, soil‑moisture) for 2018–2022.  
• CF‑compliant NetCDF files with uncertainty metrics and quality flags.  
• Deep learning model repository and reproducible workflow (Docker environment).  
• Technical report and BoM data supplement.  
• Two peer‑reviewed journal submissions targeting Environmental Modelling & Software and IEEE JSTARS.

## Risk Management

Key risks and mitigations include:  
• Limited radar access → Mitigate via GPM bias correction and AWS augmentation.  
• Computational limits → Use Griffith HPC or cloud GPU with checkpointing.  
• Overfitting → Apply spatial cross‑validation and dropout regularization.  
• Time constraints → Maintain regression‑kriging baseline as fallback output.

## Collaboration and Expected Impact

This project supports BoM’s mission to advance observational science and resilience through improved data coverage and modelling. The gridded products will enhance precision forecasting, climate risk assessment, and data availability for Queensland’s emergency services. Outputs will be designed for interoperability with BoM’s ACCESS and AWRA systems, offering a transferable framework for other Australian regions. Collaboration opportunities include co‑validation with BoM’s Hydro‑Informatics and Surface Observations Team and integration of findings into BoM’s operational data‑assimilation pipeline.

**Annex A (Detailed Methods)**

**Annex B (Data Sources)**