

# 利用生程式 AI 加速氣候變遷大數據之應用

## Leveraging Generative AI to Accelerate Climate Change Big Data Applications

國家災害防救科技中心

助理研究員

劉子明

Tzu-Ming Liu

### 摘 要

在氣候變遷逐漸成為全球焦點的當下，對於氣候變遷如何影響水文與環境，必須透過科學數據的模擬與評估，了解未來的衝擊與風險，才能適當的擬定合適的氣候變遷調適計畫。而透過科學數據的模擬與評估來了解未來的衝擊與風險，意味著水文與環境領域的研究者，必須處理龐大的氣候模擬資料，並用來進行極端事件模擬、指標計算、情境評估以及數據分析與展示等大量計算工作，背後往往需仰賴預設的模式與工具，如 SWAT、TRIGRS、GWLFL、HBV Model 或 MIKE-SHE 等。然而這些工具在面對數百 TB 等級的氣候變遷資料與複雜場景時，如何處理上百種情境、數十年的模擬資料，成為了一大挑戰。

近年來生成式 AI 透過機器學習，自然語言的理解與轉換，搭配數十種程式語言編撰能力，使資料導向研究方式有了大幅度的轉移，讓過去以模式為核心的研究方式，漸漸改變成為資料導向搭配程式語言的快速模擬生成樣式，除了降低資料驅動模擬的門檻，也加速我們理解與分析氣候變遷的衝擊與風險。本研究以四個實際案例，具體說明利用生成式 AI 加速氣候變遷大數據研究流程的實務經驗與建議，這四個案例包括「高解析度氣候門檻指標自動化計算工具」、「風場資料可視化與網頁整合展示」、「崩塌風險雨量致災門檻系集分析」、「氣候變遷雲端資料下載工具開發」等，並歸納出五個利用生成式 AI 協助氣候變遷大數據研究要點，提供各界參考。

關鍵詞：氣候變遷、資料工具、生成式 AI

### Abstract

As climate change increasingly becomes a global focus, understanding how it affects hydrology and the environment requires scientific simulation and assessment of data to evaluate future impacts and risks. Only through this understanding can appropriate climate change adaptation plans be formulated. However, conducting scientific simulations and evaluations to comprehend future impacts means that researchers in hydrology and environmental fields must

process massive volumes of climate simulation data. These data are used for simulating extreme events, calculating indicators, assessing scenarios, and performing extensive data analysis and visualization. Traditionally, these tasks rely on predefined models and tools such as SWAT, TRIGRS, GWLF, the HBV Model, or MIKE-SHE ...etc. Yet, when faced with hundreds of terabytes of climate change data and complex scenarios involving dozens of years and hundreds of combinations, these traditional tools encounter significant limitations and challenges.

In recent years, generative AI has introduced a paradigm shift in data-driven research by leveraging machine learning, natural language understanding and transformation, and the ability to write in dozens of programming languages. This evolution has transitioned research practices from model-centric approaches to data-centric methods, where rapid simulation and generation using programming languages have become feasible. This not only lowers the barrier to entry for data-driven simulations but also accelerates our ability to understand and analyze the impacts and risks of climate change. This study presents four practical cases to demonstrate how generative AI can accelerate the climate change big data research process. The cases include “An automated high-resolution climate threshold index calculation tool”, “Visualization and web-based integration of wind field data”, “Ensemble analysis of rainfall-induced landslide risk thresholds”, “Development of a cloud-based climate data download tool”. From these cases, the study distills five key practices for using generative AI to support climate change big data research, providing actionable insights and guidance for the broader research community.

**Keywords:** Climate Change, Data Tools, Generative AI