摘要

本計畫主要目的為評估氣候變遷下可能水文情境造成之供需影響與經濟影響，並藉由考慮可能水文情境之發生機率搭配供需影響與經濟影響，以量化枯旱風險值，提供決策者不同調適策略下客觀之風險評估結果，可作為後續水資源政策之效益評估參考。針對氣候變遷下可能水文情境資料產製，係藉由綜合考慮氣候變遷情境與可能水文情境之影響，其定義如下：

$$\text{氣候變遷下可能水文情境} = \text{氣候變遷情境} + \text{可能水文情境} \quad (1)$$

其中，氣候變遷情境資料係採用「臺灣氣候變遷推估資訊與調適知識平台計畫」(簡稱 TCCIP)所提供之 AR5 降尺度資料，而可能水文情境則係考慮梅雨與颱風之水文變異，例如：梅雨與颱風之偏少、延遲以及正常情況。面對氣候變遷下可能水文情境資料之不確定性，本計畫參考決策理論中期望值準則，整合機率概念進行水源枯旱風險之計算，提供決策者客觀之量化風險值，以作為後續水資源政策之效益評估參考，水源枯旱風險定義為枯旱影響(供需影響或經濟影響)之期望值：

$$\text{水源枯旱風險} = \sum_{i=1}^{N} \text{枯旱影響}_i \times \text{水文情境發生機率}_i \quad (2)$$

其中，i 為水文情境之編號，而 N 則為水文情境之總數量。依據 RCP4.5 情境下可能水文情境之調適策略評估結果顯示：臺南未來推動調適策略中，以再生水工程(S4)、臺南高雄水源聯合運用(S2)以及南化水庫加高工程(S5)之綜合效益較高，可分別減少枯旱經濟影響約 18.03、13.73 以及 8.34 百億元/年。此外，氣候變遷下可能水文情境之供需影響分析結果顯示：「梅雨偏少+颱風偏少」與「梅雨延遲+颱風偏少」造成之供需影響較為顯著，為能夠進一步舒緩極端枯旱水文情況造成之供需影響，建議臺南未來可參考國際上水資源調適經驗，強化再生水與海淡水等替代水源之發展，以穩定枯旱時期供水。

關鍵詞：氣候變遷、水文情境、枯旱風險、經濟分析

Abstract

This project aims to assess the impact of hydrological variation under climate change scenarios on water supply and economy. The assessment results are used to quantify drought risk for various adaptation strategies. Then, the quantitative values of drought risk can be used as a basis for water policy assessment or decision making. In this project, the hydrological variation under climate change scenarios (HVCCS) is defined as below:

$$\text{HVCCS} = \text{climate change scenarios} + \text{hydrological variation} \quad (3)$$

where, climate change scenarios are the AR5 downscaled data from Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) and hydrological variation is the variation of mei-yu and typhoon such as below normal, delay and normal conditions.

For decision problems under uncertainty (climate change scenarios and hydrological variations), the expected value criteria of decision theory is applied to provide decision maker a quantitative estimation of drought risk. The drought risk is defined as below:

$$risk = \sum_{i=1}^{N} impact_i \times occurance \ \ probability_i \quad (4)$$

where, i stands for ith HVCCS and N is the total number of HVCCS.

The results of policy evaluation show that: (1) the reclaim water project, (2) the conjunctive water use between Tainan and Kaohsiung project and (3) raising of Nanhua Dam are recognized as high overall-benefits projects, they are estimated to reduce economic loss by 180.3, 137.3 and 83.4 billion dollars per year, respectively. The results of water supply analysis show that: “below normal mei-yu and below normal typhoon condition” and “delay mei-yu and below normal typhoon condition” will cause significant water shortage. To mitigate the water shortage, it is suggested that the Tainan city should promote reclaim water and desalination project to further stabilize water supply during drought periods.

Keywords：climate change, hydrological scenario, drought risk, economic analysis.