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# Climatic Risk Quantification for Water Resource Allocation Between Green Hydrogen and Cotton in Inland Australia

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## ABSTRACT

*The in-land production of green hydrogen and hydrogen derivatives as a low-emission fuel for long-haul transport and fertiliser in Australia must co-exist with other water-dependent agribusinesses that drives this regional and rural economies[1,2]. This coexistence requires careful assessment of water resource competition and evaluation of climatic risks[3], as inland production lacks access to desalinated seawater available at coastal facilities. Herein, process simulation and economic modelling was used to evaluate the value of economic return to water (ERTW) and quantify the climatic risks for co-located green hydrogen in cotton production areas of Gwydir and Murrumbidgee, New South Wales (NSW), Australia. Water demand forecasts were modelled using a previously published numerical model[4] using low-temperature multi-effect distillation and proton exchange membrane electrolysis (LT-MED-PEM) as the base model. A sensitivity analysis was conducted by varying water allocation (WA) between cotton and hydrogen production. Different climatic conditions were also considered using historical data, with 2019 (El Niño) representing dry conditions, 2011 (La Niña) representing wet conditions, and 2013 representing a typical meteorological year[5].*

*Green hydrogen production demonstrates significant climate sensitivity, with ERTW values more influenced by climatic variations than water allocation percentages. Figure 1 illustrates this relationship through contour plots where vertical climate gradients dominate horizontal WA gradients. At any fixed climate condition, ERTW maintains either positive or negative values across all WA ranges. Contrary to intuitive expectations, dry conditions yielded optimal ERTW as hydrogen production costs are primarily influenced by electricity costs rather than water costs. Gwydir consistently outperformed Murrumbidgee with ERTW increased by sevenfold in dry years (6.56E+04 vs 7.8E+03 A$/ML) and maintained positive returns in a*

*typical meteorological year (2.84E+04 A$/ML) while Murrumbidgee showed negative values (-2.45E+04 A$/ML). This regional disparity persisted even at WA%=0, indicating areas suitable for cotton production also favor hydrogen economics, intensifying resource competition. Preliminary estimate shows that under favorable climate conditions, even a modest reallocation of just 10% of water resources to hydrogen production yields ERTW values (approximately 800 - 8100 A$/ML) that significantly exceed cotton's ERTW (400 - 600 A$/ML). This indicates that, the implication is that if correctly managed an inland hydrogen industry could utilise a portion of water allocations to offset emissions associated with both road transport and fertiliser use.*

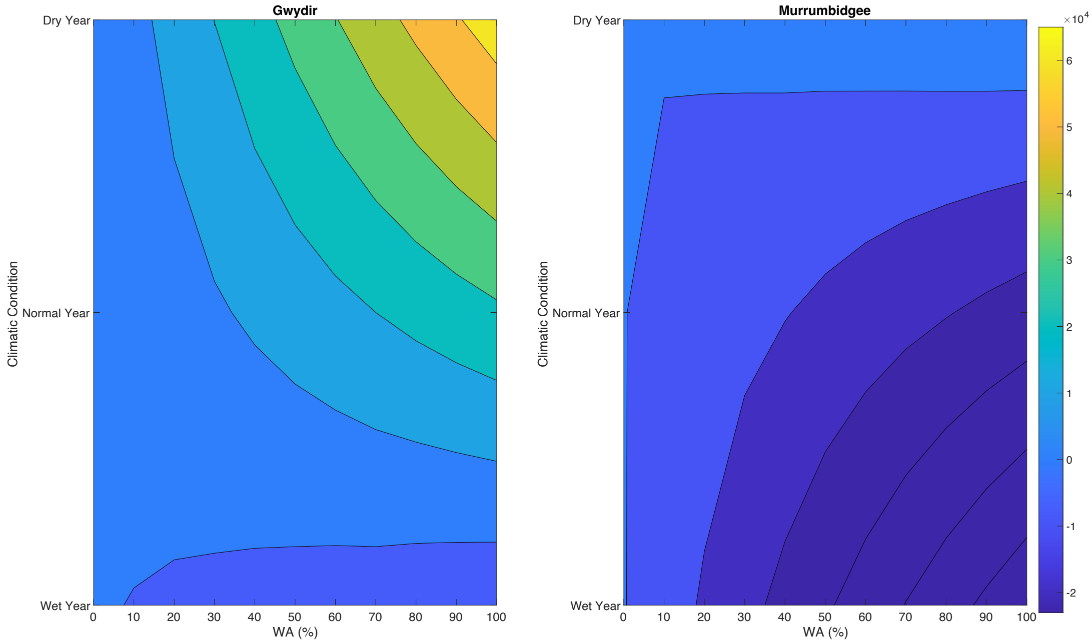


*Figure1: Comparison graph of ERTW (Unit: A$/ML) by location and climatic condition under different water allocation percentage.*

*In conclusion, the findings demonstrate that despite hydrogen's superior ERTW potential, complete water resource reallocation to hydrogen production proves suboptimal across varying climatic conditions. This research contributes strategic insights for inland hydrogen facility placement, underscoring the necessity of incorporating regional climatic variability into planning frameworks and implementing adaptive water allocation mechanisms that facilitate integration of hydrogen infrastructure within established agricultural ecosystems.*


## KEY WORDS

*Green hydrogen; Cotton; Inland; Climatic ricks; Economic Return to Water; Renewable energy; Water electrolysis.*


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