



Assessing infrastructure development pathways in areas with complex resource system interdependencies

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System wide assessments are needed where multiple water resource system components can work in coordination (have synergy) or where different development projects impact each other's performance (involve trade-offs). Given the dependence of infrastructure performance on its operating policies (e.g., reservoir release rules), evaluating alternative infrastructure options requires exploring how each option would perform under a variety of operating policies. Explicitly considering trade-offs between many objectives can be helpful in defining acceptable compromise plans in water systems planning problems characterised by conflicting performance objectives and opposing stakeholder interests. When using many objective optimization methods, the Pareto-front does not discriminate between infrastructure and management choices, thus ignoring that assets are relatively unchangeable, while policies can be changed with relatively less political and financial cost). To tackle this problem, we propose an automated 'robustness mapping' process (using multi-objective robust optimization) that reveals efficient interventions and their performance trade-offs explicitly considering a large set of possible infrastructure expansion paths and full flexibility of reservoir operating rule to meet different objectives. This paper investigates the proposed hydropower and irrigation options in the Rufiji basin in Tanzania, where trade-offs between capital costs, total and firm energy output, environmental flow and irrigation water supply for the best performing designs are evaluated. It proposes an approach to evaluate large scale water resource options when land and water use are also highly uncertain, and not fully under the control of planning authorities.