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Integrated assessment and modelling for water management: lessons from transdisciplinary research

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Abstract: Water resource management is often a complex problem involving diverse stakeholders with conflicting goals. Integrated assessment and modelling (IAM) can help address such problems by integrating data, knowledge, and perspectives across disciplines *as well as* by providing a structured process to foster trust, shared understanding, and collaboration. Key barriers include limited resources, rigid institutional requirements and entrenched team cultures. Enablers include flexibility, mutual respect, openness to uncertainty, and adequate support. Two One Basin CRC projects in the Murray Darling Basin are used to illustrate how modelling process aimed at enhancing integration outcomes can improve water delivery and climate risk assessments.

Keywords: *transdisciplinarity, integrated modelling, uncertainty, water resources management*

1. CONTENT

Water resource management problems are complex problems that are ill-defined with no clear or single optimal solution. They also involve diverse stakeholder groups from multiple sectors, often with conflicting objectives and perspectives, which adds another layer of complexity to the problem. It is also increasingly recognised that knowledge held by individuals about such complex problems is partial and situated (Norstrom et al., 2020). Understanding and resolving such problems requires integrative or transdisciplinary approaches that draw on the concerted effort and collaboration of various stakeholders, including technical experts from multiple disciplines, water managers, water users, policy makers, and/or the community.

Integrated assessment and modelling (IAM) provides a systematic process to gather and organise data, assumptions and knowledge about complex environmental problems that cross disciplinary and sectoral boundaries (Jakeman and Letcher, 2003). Models used in IAM exercises are often pervaded by high uncertainties, stemming from a plethora of assumptions and by model non-identifiability, where data and knowledge limitations restrict precise estimation of model parameters. Characterisation of uncertainty becomes essential but is not amenable to standard probabilistic techniques. It is best viewed as the level of confidence one has about outputs emanating from various plausible modelling assumptions. The integrated modelling process, therefore, must go beyond just technical outputs by focusing efforts on modelling as a social and learning process that links all participants.

The process of IAM itself can promote outcomes such as building trust and relationships, shared understanding, co-production of knowledge and joint commitment to action. There are, however, several barriers that emerge at the individual, team, and organisational levels that can hinder the integrated modelling process and the subsequent achievement of such integration outcomes. From the transdisciplinary research literature, we review major barriers and enablers of effective integration. The key barriers identified relate to: insufficient time, resources and skills; rigid institutional requirements and aversion to uncertainty; and team culture, in particular, entrenched beliefs and practices of members. Enablers to effective integration include: flexibility in research process; a team culture of mutual respect and learning; shared goals; openness to uncertainty in the research processes, structure and outputs/outcomes; eclectic approaches in addressing the uncertainties; adequate time and resources for integration and co-learning; and capacities within the team to facilitate integration (Bryman 2007; Lang et al. 2012; Pahl-Wostl 2020; Merritt et al. 2022).

We then draw on the learnings from transdisciplinary research to examine how modelling processes for water management can be developed to improve integration outcomes. We consider two One Basin CRC projects that adopt IAM to address different water management problems in the Murray–Darling Basin, Australia's largest river system and considered the most complex from an environmental and sociopolitical perspective. The 'Reducing uncertainties and enabling multiple benefits in water delivery operations' project (the Multiple Benefits project) aims to improve information systems and processes that underpin water delivery decisions, to enhance multiple environmental, social, cultural and productive benefits. The 'Putting people at the centre: towards transforming climate risk assessment' project (the People at the Centre project) aims to transform climate risk assessments from 'science-centric' to 'people-centric' approaches that provide actionable information tailored to the needs and values of partner stakeholder groups. We provide practical guidance on designing and implementing integrated modelling projects that cultivate an enabling environment to achieve positive social and learning outcomes amongst collaborators.

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