



Scenario modelling to support industry strategic planning and decision making[☆]



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ABSTRACT

The Pastoral Properties Futures Simulator (PPFS) is a dynamic systems model, developed within a participatory action research partnership with the pastoral industry of Australia's Northern Territory. The model was purpose-built to support the industry's strategic planning capacity in the face of environmental, market and institutional uncertainty. The mediated modelling process sought to maximise social learning of industry stakeholders. Simulations were conducted using scenarios representing combinations of climatic, market, institutional and technological assumptions. Stochastic parameters included rainfall and product prices. Economic and environmental performance of model farms, including greenhouse gas emissions, were estimated. A critical evaluation of the tool finds the PPFS fit for purpose. However, limitations include lack of output validation, small number of scenarios and simplistic treatment of environmental impact dimensions. With further development, the PPFS can provide a platform (a) to assist with industry planning across the whole of Northern Australia and beyond, and (b) for policy analysis and development in the context of the Australian pastoral industry.

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1. Introduction

Participatory scenario planning has become an important tool to help governments, industries and communities to prepare and plan for the future, manage risks and harness opportunities. Models are commonly used to assist the planning process and can help reduce collective biases while promoting ownership and action (Andersson et al., 2008; Bryant and Lempert, 2010; Kwakkel and Pruyt, 2012; Jones et al., 2010a; Salter et al., 2009; Volkery et al., 2008). Models can help explore complex systems in a structured manner, stimulate imagination, visualise likely direction and magnitude of change, and reveal crucial trade-offs associated with choices.

The use of dynamic systems modelling as a tool for strategic decision making has been embraced by the tourism industry and for regional planning (Griffon et al., 2010; Jamal et al. 2004; Jones et al. 2010a,b; O'Connor et al., 2005; Schianetz and Kavanagh,

2008; Valencia-Sandoval et al., 2010; Walker et al. 1998). In an agricultural context, there have been many production models, bio-economic models at the farm scale (for a review see: Janssen and van Ittersum, 2007) and risk management models at the farm scale (Stewart and Fortune, 1995; Zeigler et al., 2000). However, there appear to have been relatively few industry-level applications (e.g. Sharma et al., 2006; Berger, 2006) despite early recognition of the potential (Anderson, 1974). In particular, there is an apparent paucity of applications of systems models designed to support strategic planning and participatory scenario planning in agriculture.

In 2009, the Northern Territory Cattlemen's Association (NTCA), the peak body for the pastoral sector in Australia's Northern Territory (NT), initiated the 'Futures Project', which aimed to identify risks and opportunities for the industry over coming decades in order to develop an industry strategy to ensure industry prosperity into the future. The NTCA embarked on a participatory action research partnership with Charles Darwin University to develop a modelling tool which could support the Futures Project. It was envisaged that the model would integrate best available information about the industry, its production systems and natural resource base, input and product markets and the institutional (policy) context. It would explore a number of scenarios into the medium-term future against the backdrop of climate change and

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market uncertainty to explore what might be in store for the NT pastoral industry. This paper showcases the result of the joint endeavour, the Pastoral Properties Futures Simulator (PPFS). The purpose of the model as platform and structure for industry stakeholders to communicate, negotiate and integrate their perspectives defines it as a tool for ‘participatory integrated assessment’ (De Kraker et al., 2011).

The paper contributes to the literature by exemplifying and reviewing a model-assisted participatory scenario planning process, which assisted industry strategic planning and decision making in the face of complexity and uncertainty. While modelling results have been published previously (Puig et al., 2011), this paper focuses on the conceptual foundation and model architecture before illustrating the model capabilities and applications as a planning tool and critically reviewing its merit. In doing so, the paper responds to the standards of reporting recommended by Jakeman et al. (2006), including (1) clear statement of the objectives and clients of the modelling exercise; (2) documentation of the nature (identity, provenance, quantity and quality) of the data used to drive, identify and test the model; (3) strong rationale for the choice of model families and features, (4) justification of the methods and criteria employed in calibration; (5) thorough analysis and testing of model performance as resources allow and the application demands; and (6) a resultant statement of model utility, assumptions, accuracy, limitations, and the need and potential for improvement.

The paper describes the context in Section 2 and provides a detailed description of methodology with focus on the model heuristic in Section 3. Section 4 provides an appraisal of the model and illustrates key outcomes of the model-assisted industry strategic planning process. The concluding comments in Section 5 include ideas for further model development and application.

2. Context

Agriculture in the NT is dominated by the pastoral industry, which produces grass-fed cattle on typically vast pastoral properties, which cover up to 24,000 square kilometres of land. There are 216 pastoral stations in the NT, of which more than 90 per cent are members of the NTCA. The combined herd is approximately two million cattle (NTCA, 2009). Cattle sales contributed AUD 344 million to the NT economy in the year 2008–09 (DRDPFIR, 2009a) and the industry employed more than 1800 people (NTCA, 2009). Tenure is mostly pastoral leasehold¹ land (NTG, 2011) with some freehold. Among the many risks and challenges the industry faces (Ash and Stafford Smith, 2003) are:

- Market risk: The industry is vulnerable to the economic circumstances of both international and interstate markets (DRDPFIR, 2009a; Martin et al., 2007). It has a very high exposure to live cattle export to south-east Asian countries. During 2009, Indonesia purchased approximately 90% of live exported cattle but cut import quotas for live cattle in 2010 and imposed narrow import specifications as part of its drive towards self-sufficiency in beef production. As there are no abattoirs in the NT, all other cattle go to interstate markets. Transport costs are high due to long distances and fuel prices.
- Climate risk: Climate change is anticipated to result in an increase in temperatures in northern Australia and more intense cyclonic activity (CSIRO and BOM, 2007; Hughes, 2003).

¹ There are two principal types of land tenure in Australia, freehold and leasehold (Crown land). Freehold landholders have indefeasibility of title and are not subject to land use constraints under state and territory pastoral land acts.

Direction of change in rainfall remains unclear for the north of Australia, while for central Australia it is considered likely that rainfall will decline (CSIRO and BOM, 2007). Climate change is a known uncertainty, with changes likely to affect pastoral production systems in different directions and various ways, including through changes in forage production and palatability, cattle reproduction and productivity, fire risk, plant composition and ecosystem functioning (DPIFM, 2008; Howden et al., 2008; Cobon et al., 2009; McKeon et al., 2009).

- Institutional risk: Much of the land in the NT is pastoral leasehold land and subject to land use and development restrictions. The industry is likely to be affected in various ways by climate-change related government policy, e.g. the introduction of the Carbon Pollution Reduction Scheme in July 2012. Institutional risk also compounds market risk as evidenced in June 2011, when the Australian Government temporarily suspended the trade of live cattle to Indonesia on the basis of animal ethics concerns.
- Other challenges: Environmental sustainability, land management and animal welfare are issues attracting the concern of agencies and consumers (Ash and Stafford Smith, 2003; DRDPFIR, 2009b; Garnett et al., 2010; Kutt et al., 2009; Petherick, 2005; Phillips et al., 2009).

Industry leaders know they need to address the risks and put strategies in place that enable the industry to prosper in the future. The NTCA implemented the *Futures Project* with the intention to (i) scope the views of members and other pastoral industry stakeholders about risks and opportunities for the industry, (ii) facilitate understanding of members and stakeholders about the complexity of factors that will shape the future of the industry and (iii) develop an agreed strategy for the industry to prosper in future (Puig et al., 2009).

3. Methods

Models tend to pursue a general purpose, including prediction, forecasting, management and decision-making under uncertainty, social learning and/or developing system understanding (Kelly et al., 2013). The primary purpose of the PPFS was to be a social learning tool, a tool which would help facilitate discussion and discourse among NT pastoral industry members and stakeholders and, it was hoped, might lead to improved decision-making under uncertainty (Puig et al., 2009). To truly support strategic planning, the PPFS would not be a ‘black box’, but would be transparent. It would be developed for the pastoral industry in association with pastoral industry experts and stakeholders. It would have to be able to capture key facets of the industry, explain relationships among multiple factors affecting the pastoral industry, illustrate potential industry trends and likely impacts of external shocks. Industry stakeholders—pastoralists and industry representatives in strategic positions alike—would be able to play and explore and visualise what the future may hold. In the process, it would challenge assumptions, remove prejudice, stimulate debate and improve communication (Antunes et al., 2006; Kassa et al., 2009; Sandker et al., 2007; Wollenberg et al., 2000). The assumption was that the PPFS could support a facilitated discussion process among groups of industry members and stakeholders and help deliver a consensus position. This, in turn, would critically inform the formulation of industry strategies which would improve the resilience and sustainability of the pastoral industry (Antunes et al., 2006; Costanza and Ruth, 1998). This purpose was reflected in both the design process and model architecture and achieved within the 9-month project time frame.

3.1. Stakeholder input into model design

The design process of the PPFS broadly followed the generic framework for effective decision support through integrated modelling and scenario analysis proposed by Liu et al. (2008, p.854) and the chronology is detailed in Puig et al. (2011). The following summarises the key considerations.

The PPFS was developed in collaboration with the pastoral industry for the pastoral industry to help facilitate industry strategic planning. Modelling with stakeholders has been shown to enhance ownership of and trust in models (Voinov and Bousquet, 2010; Lagabrielle et al., 2010). The social process of modelling is a learning process, which enables participants to better grasp the scale and operation of complex systems (Krueger et al., 2012) and helps modellers to build, parameterise

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