PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE
Official publication of The Australian Rangeland Society

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The reference for this article should be in this general form;

Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

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USING THE SAVANNA.AU MODEL TO UNDERSTAND THE FUNCTIONING OF AUSTRALIA'S NORTHERN RANGELANDS

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INTRODUCTION

Computer simulation modelling provides a valuable means of understanding the functioning of Australia's rangelands and predicting the outcomes of various management strategies. Models are particularly useful when outcomes need to be determined over extended periods of time which exclude the use of field measurements (eg. simulating the effect of changing fire regimes on trees), or when hypotheses need to be tested under conditions that are not currently realised such as increases in temperatures as a result of global warming. They are also useful to test the outcome of management practices that would incur economic costs to test by field trials such as the effect of changes in stocking rates.

Ecological models are developed based on currently known relationships relating to the functioning of a system. All key processes are incorporated into the model code and the model runs on a given time-step performing all calculations and keeping track of values over time. All models are a trade-off between mechanistic detail and model simplicity. Highly mechanistic models can be notoriously difficult to implement and parameterise and often require expert assistance to use. They can also be computationally demanding which limits the spatial and temporal extent that can be modelled. These models do however provide a very detailed understanding of the processes occurring and become excellent research tools. On the other hand, aggregated or simplified models are easy to use, but less realistic, less generalisable and less able to explain the reasons for particular model outcomes.

THE SAVANNA.AU MODEL

The Savanna model was developed to study a 10,000 sq km nomadic pastoral ecosystem in arid east Africa by Mike Coughenour (Colorado State University, USA). It can be considered as intermediate on the continuum of model complexity running on a weekly time step and allowing for large areas to be simulated. Savanna is a spatially explicit, process-orientated model designed to simulate savanna ecosystems exposed to grazing and fire.

Savanna.au is a version developed specifically for Australia's tropical and sub-tropical savannas using modern programming languages and concepts. This version incorporates a number of additional aspects considered important in simulating Australian systems. While some processes are modelled on a weekly or monthly time-step, highly dynamic processes such as soil water and infiltration are modelled on a daily time-step. The ever increasing power of computers means the average personal computer is quite capable of handling the level of complexity built into the model over annual to decadal time scales. The model has also been designed to use the minimal number of variables possible to capture the important processes and use parameters that can be obtained by ecologists and land managers in the field or from published literature.

By default, Savanna.au is set up to simulate a hectare cell and is capable of modelling a group of cells representing a paddock, hillslope or catchment. Interactions between cells are considered which accounts for movement of water between cells based on overland flow and the movement of seeds.

Savanna.au also includes a user interface to facilitate data entry, parameter checking, running the model and graphing and exporting results.

MODEL COMPONENTS

The components of any model determine what questions can be asked and what situations can be simulated. The Savanna.au model includes a comprehensive range of processes operating in the savannas which include:

- Eco-hydrology (soil water, infiltration, run-off, macropore development, topography).
- Soils (depth and textural properties, water and nutrients).
- Plant processes (photosynthesis, assimilation, phenology, transpiration, CO_2 exchange, seeding, mortality).
- Nitrogen cycling.
- Litter (decomposition).
- Climate (rainfall, temperature, radiation, CO_2 levels).
- Grazing (species preferences, spatial grazing effects, distance to water, offtake).
- Fire (weather conditions, fuel dynamics, plant mortality).

CURRENT AND FUTURE APPLICATIONS

While development of the model continues, Savanna.au is currently being tested and validated using a number of case studies. Plant growth and pasture production are being simulated for the Victoria River Research Station (Kidman Springs, NT). Nutrient cycling and plant competition are being tested with studies of invasive grassy weeds in the Top End (Darwin, NT). Infiltration and hillslope runoff are being simulated at Virginia Park (Charters Towers, Qld). Future developments and studies will investigate preferential grazing, the effect of water points on grazing distributions and the effects of fire on trees and grasses.