The AussieGRASS Environmental Calculator: its application in Australian grasslands

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Keywords: modelling; climate change impacts; emissions

Abstract

The AussieGRASS Environmental Calculator is a national simulation framework for Australian grasslands. It was developed by the Department of Environment and Resource Management in Queensland in collaboration with agencies from New South Wales, South Australia, Western Australia and the Northern Territory and with funding from Land & Water Australia (LWA) through its Climate Variability in Agriculture Program (CVAP). AussieGRASS was initially developed as a tool to assess drought conditions and has been used extensively for this purpose leading to its inclusion in the Commonwealth's National Agricultural Monitoring System (NAMS – now decommissioned). This paper describes the AussieGRASS modelling framework and outlines a range of other AussieGRASS applications.

Introduction

The AussieGRASS Environmental Calculator is a national simulation framework for Australian grasslands developed by the Department of Environment and Resource Management in Queensland in collaboration with agencies from New South Wales, South Australia, Western Australia and the Northern Territory with funding from Land & Water Australia (LWA) through its Climate Variability in Agriculture Program (CVAP).

AussieGRASS was initially developed as a tool to assess drought conditions and has been used extensively for this purpose leading to its inclusion in the Commonwealth's National

Agricultural Monitoring System (NAMS – now decommissioned). This paper describes the AussieGRASS modelling framework and outlines a range of other AussieGRASS applications.

The AussieGRASS modelling framework

The AussieGRASS modelling framework (Carter et al. 2000, 2003) comprises a grazing systems model known as GRASP, which operates on a 5km, by 5km grid across Australia. The model calculates the soil water balance and pasture growth on a daily time-step and requires daily climate inputs (rainfall, temperature, radiation, humidity, evaporation and vapour pressure deficit) for each grid cell (Jeffrey et al. 2001) as well as parameter layers for soil and pasture types. Variables such as tree basal area and animal numbers are also required for each grid cell.

Updating stock numbers from the Australian Bureau of Statistics (ABS) is a major task in maintaining AussieGRASS. Grazing pressure from kangaroos and feral animals such as rabbits are also important inputs to the system, although accurate maps of feral animal numbers are more difficult to obtain and update.

The AussieGRASS model is calibrated against satellite imagery (NDVI from NOAA) and the output has been extensively ground-truthed based on 600,000 field observations of pasture biomass, mainly from northern Australia (Hassett et al. 2000). Information including field and satellite-derived soil moisture measurements, plant nitrogen content, tree litter fall and tree litter biomass has also been considered in developing, calibrating and validating the AussieGRASS modelling framework. Pasture biomass is reset after burning according to fire scar imagery.

AussieGRASS output includes simulations of the soil water balance, pasture growth and total standing dry matter. More recently a curing index for fire hazard analysis has been added to the standard model outputs. The probabilities of future rainfall and pasture growth are assessed using historical years classified according to state of the El Niño-Southern Oscillation (ENSO).

AussieGRASS is run in the first week of each month for the past four years to capture updates in recent climate data. The outputs are expressed both as absolute and relative values (i.e. ranked against historical years in terms of percentiles). Expressing the output in relative terms allows current conditions (e.g. pasture growth, pasture yield, green cover, soil moisture, flow to stream) to be assessed in an historical context. Pasture biomass and pasture growth maps, fire products and seasonal probabilities of pasture growth are publicly available on the Long Paddock web site (http://www.longpaddock.qld.gov.au/).

AussieGRASS Applications

Apart from its original application in drought assessment, AussieGRASS has been used more widely both as a research tool and to provide information to a range of users. Major developments have included grass fire risk products for rural fire services; reporting on rangeland condition change to ACRIS (Australian Collaborative Rangelands Information System); analysis of greenhouse emissions; and provision of information to the Queensland Rural Leasehold Land Strategy (Delbessie Agreement) process.

In response to a demand from the New South Wales and Queensland rural fire services, AussieGRASS has been used to calculate daily fuel loads (green and dead grass biomass, and tree and grass litter), grass fire risk and a curing index. Fuel curing forecasts are also calculated for the season ahead (next three months). These products are highly valued and made available as gridded data via FTP.

ACRIS is a coordinating mechanism that collates rangeland information from state, Northern Territory and Australian Government agencies and other sources. To assist ACRIS reporting AussieGRASS outputs have been averaged at IBRA (Interim Bio-geographical Regionalisation of Australia) and sub-IBRA scales. Time series of pasture biomass, pasture cover and grazing pressure are provided to ACRIS at these scales.

The Delbessie Agreement (also known as the State Rural Leasehold Land Strategy) is a framework of legislation, policies and guidelines supporting the environmentally sustainable, productive use of rural leasehold land for agribusiness in Queensland. AussieGRASS products support the assessment of leasehold lands via a web-based portal known as FORAGE (Timmers et al. 2008). FORAGE integrates AussieGRASS information and remote sensing of ground cover in customised reports, which provide an historical context for current observed conditions on individual properties. Delbessie officers also access time series of AussieGRASS outputs and climate information which are updated monthly for all sub-IBRA regions in Australia on the Long Paddock website.

AussieGRASS has been used to calculate the carbon content of grasslands for use in carbon stock calculations. Methane emissions by livestock and uptake by soils can now been calculated in AussieGRASS. Pasture production information from AussieGRASS has also been used to assess methane mitigation options from northern Australian grasslands (Charmley et al. 2008). In addition, nitrogen in fuel consumed by fires has been estimated under current and simulated rangeland burning regimes (Carter et al. 2010, in press).

The GRASP model has recently been used to study potential changes to livestock carrying capacity under climate change (McKeon et al. 2008, 2009). The version of GRASP used in these studies had been specifically parameterised to account for likely ecological responses (e.g. shift from C3 to C4 species) and physiological responses (e.g. increased transpiration use efficiency) to elevated CO_2 and increasing temperature under enhanced greenhouse conditions. Similar functionality, including an equation which accounts for observed increases in sub-daily rainfall intensity (Fraser, these proceedings), is now being incorporated in AussieGRASS. AussieGRASS, which runs GRASP for every 5km by 5km grid cell across Australia, provides an ideal framework for undertaking such studies.

A major limitation for using AussieGRASS to conduct climate change analyses has been the lack of spatially gridded, daily climate change projections data for incorporation in AussieGRASS. This limitation will soon be overcome with the Queensland Climate Change Centre of Excellence, in collaboration with CSIRO, currently undertaking a project to modify the historical daily rainfall and climate surfaces used as input to AussieGRASS. These modifications will initially be based on climate change factors from CSIRO's OzClim climate change scenario generator. This project, sponsored by the Department of Agriculture, Fisheries and Forestry (DAFF), will provide climate change projections data not only for GRASP and AussieGRASS but also for other biophysical models such as APSIM. This new capacity will both enhance existing AussieGRASS products (e.g. enables calculation of climate change impacts on bushfire hazard and assist long-term leasehold land assessments) as well as support new initiatives such as the Risk Management Matrix approach (e.g. Cobon et al.

2009) to help the grazing industry better understand and adapt to climate change.

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Stone, G.S., Day, K.A., Carter, J.O., Bruget, D.N. and Panjkov, A.A. (2010). The AussieGRASS Environmental Calculator: its application in Australian grasslands**.** In: *Proceedings of the 16th Biennial Conference of the Australian Rangeland Society*, Bourke (Eds D.J. Eldridge and C. Waters) (Australian Rangeland Society: Perth).