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FORAGE – A WEB-BASED FRAMEWORK FOR GENERATING AND DISTRIBUTING DECISION SUPPORT INFORMATION FOR SUSTAINABLE GRAZING LAND MANAGEMENT

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ABSTRACT

FORAGE is a web-based facility which provides information relating to climate and pasture condition at user-specified locations. The system receives requests from web pages, processes those requests and generates the requested information which is then emailed back to the user.

FORAGE currently offers: a) a *Rainfall and Pasture Report*; b) a *Ground Cover Report;* and c) products based on satellite imagery of ground cover. The *Rainfall and Pasture Report* provides 30-year time series of: interpolated annual rainfall; model-simulated annual pasture growth; pasture biomass (i.e. total standing dry matter); and pasture-litter cover. *The Ground Cover Report* provides time-series (~ 20 years) of pasture ground cover derived both from model calculations and satellite imagery. The satellite imagery products are sourced from the QNRW Statewide Landcover And Trees Study (SLATS) project (http://www.nrw.qld.gov.au/slats/).

FORAGE is currently used by a range of clients such as government agencies, extension officers and land managers to assess climate risk and land condition and to support their decision making in sustainable natural resource management.

INTRODUCTION

A demand exists for information concerning climate, pasture growth and land condition in grazing land and environmental management, particularly for information which details changing seasonal conditions and is relevant at a property scale. Various interest groups include policy makers, extension officers and land managers.

It was recognised that an information system which could provide clients with this information would need to be: a) low maintenance; b) capable of performing customised reports 'on-the-fly'; c) able to access data from a wide range of sources; and d) able to reliably deliver quality products to clients in reasonable time (Aisthorpe *et al.* 2004). FORAGE provides a web-based solution and is an information delivery system designed to provide customised climate, pasture and land condition reports and information. FORAGE is dynamic, stand-alone and requires little everyday maintenance and technical support. The delivery mechanism is email-based and both data acquisition and processing of reports are executed remotely. Thus users with reasonably slow internet connections can receive products in a reasonable time-frame (between 2 and 60 minutes depending on circumstances).

This paper introduces the technical structure of FORAGE and its component systems, describes current reports and products and discusses how the system might be improved to better service needs for property-scale information and to provide critical decision-support information for improving natural resource management in grazing lands.

FORAGE STRUCTURE

FORAGE consists of a web-based interface, an information processing system and an information delivery system (Figure 1). The web-based interface comprises a series of web pages that sit on the Long Paddock website (http://www.longpaddock.qld.gov.au/FORAGE) which allow users to request

reports for different locations (latitude and longitude or lot on plan). The information processing system comprises: 1) a core DOT.NET (http://msdn2.microsoft.com/en-au/netframework/default.aspx) windows service which runs on a Windows 2003 server and processes incoming requests from web pages; and 2) a series of utilities which perform data processing including processing of satellite imagery and production of maps using UMN Mapserver (http://mapserver.gis.umn.edu/)). The information delivery system customises the requested report using Crystal Reports (http://www.businessobjects.com/) and emails the report back to users as a one-page PDF document.

FORAGE obtains data from a number of databases including the SILO enhanced climate database (http://www.longpaddock.qld.gov.au/AboutUs/ResearchProjects/SILO/index.html), AussieGRASS (Carter *et al.* 2000) model outputs (such as pasture biomass, pasture growth and ground cover) and the SLATS (http://www.nrw.qld.gov.au/slats/) repository of satellite imagery (tree and ground cover). The reports are generated using report templates which can be adjusted outside the programming framework.

FORAGE PRODUCTS

The FORAGE framework currently offers a *Rainfall and Pasture Report*, a *Ground Cover Report* and a means to request satellite imagery products on ground cover.

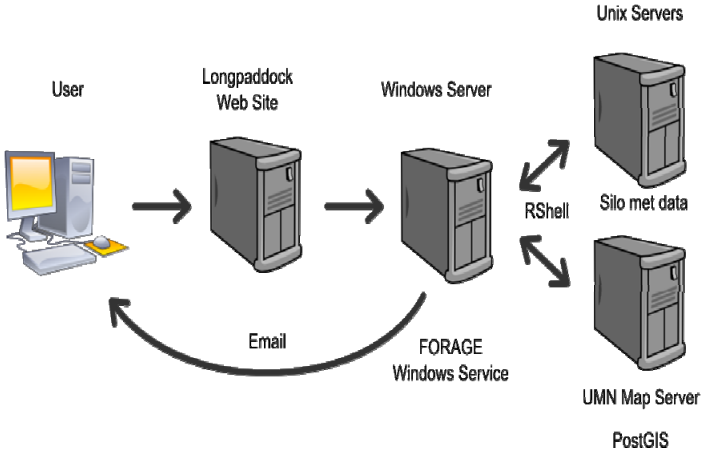

Figure 1. FORAGE workflow diagram

Rainfall and Pasture Report

The *Rainfall and Pasture Report* has two major parts. The first part provides users with estimates of rainfall and pasture growth over the last twelve months at a user-specified location as well as placing this information within an historical context by providing long-term rainfall and pasture growth statistics, in particular the long-term average, long-term median and historical extremes i.e. wet years (80th percentile rainfall and growth) and dry years (20th percentile rainfall and growth).

The second part of the report is a 30-year time series of annual rainfall, pasture growth, pasture biomass and ground cover for a user-specified location. By comparing pasture biomass, pasture growth and ground cover with rainfall over a long (30-year) time period, users can analyse how climate variability influences pasture growth and cover, and whether low ground cover in a time period is more influenced by climate (*i.e.* drought) or management (high grazing pressure) or a combination of both.

Ground Cover Report

The *Ground Cover Report* (Figure 2) also has two parts. The first part is a map showing: a) the property boundary; b) areas where ground cover is less than or greater than a threshold value (specified when requesting the report), and areas masked off due to high cloud or tree cover.
The second part of the report is a figure showing time-series of the ground cover values both calculated by the AussieGRASS model and derived from SLATS satellite imagery. Calculated ground cover from AussieGRASS (Carter *et al.* 1996) can also substitute for time periods when there is no satellite imagery available.

Satellite imagery product

FORAGE also provides a means to request SLATS ground cover imagery. When a request is submitted, FORAGE clips the ground cover image for the specified location (e.g. lot plan) from a "scene" and sends an email to users with a link for downloading. The requested imagery is in ERDAS Imagine Format.

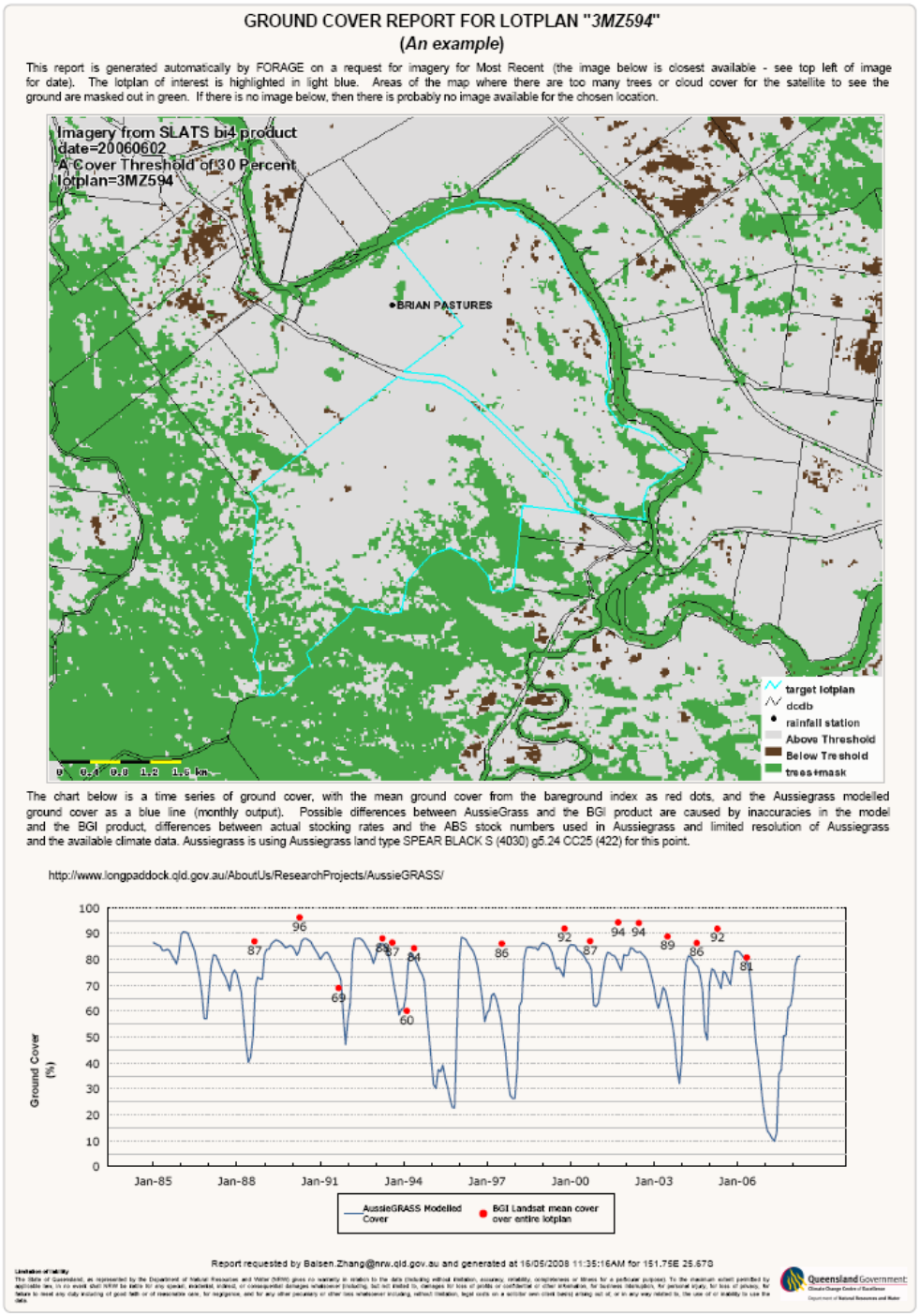

Figure 2. An example of the Ground Cover Report

DISCUSSION

Past experience has shown that, for a stand-alone decision support tool to be successful, post-development support is required both for a range of users and computing platforms (Aisthorpe *et al.* 2004). Web-based decision support requires little 'hands-on' support and provides a means to reach a large number of clients. Whilst FORAGE requires skilled programming to create a new service, less effort is required to maintain the operation once the new service has been developed.

Development effort for FORAGE has focused on provision of climate, pasture and land condition information at a local (property) scale. Information at this scale is relevant for on-site decision making and as a context for local observations and monitoring programs. There are, however, limitations to

the output from FORAGE given the general nature of model inputs. For example, the interpolated rainfall data that FORAGE provides is interpolated from nearby official rainfall reporting stations (Jeffrey *et al.* 2000) and accuracy of this information is dependent on the number of nearby rainfall reporting stations and distance from those stations. In turn, model outputs such as pasture growth, pasture biomass and ground cover are strongly influenced by rainfall. Other model inputs such as soil and land type may not be mapped at sufficiently high resolution for detailed analysis. However current ground cover imagery, which has a resolution of 30 m, is adequate for paddock scale ground cover and land condition assessment. As such, satellite imagery with its high spatial resolution, can complement model derived calculations which may have poorer spatial resolution but longer history and a wider range of outputs.

A future development envisaged for FORAGE is a property or paddock level report providing projections of estimated grazing days, ground cover and risk of pasture degradation which may facilitate refinement of stock numbers. For such a product, the user would be required to specify the mix of land-types on a paddock basis, relative usage of land-types by stock as well as estimates of current stocking rates and pasture biomass. Seasonal forecasts could also be incorporated in such an analysis.

The existing FORAGE system could also be run automatically as a subscription service with regular updates of reports being sent via email. The envisaged property level system, as described above, could operate in the same manner, once initial information was provided by the user. Such a system would indeed be a useful real-time reference for graziers so long as the task of providing model inputs in the first instance was not too onerous. Such an analysis, being a forward projection, is not so dependent on accurate real-time and historical rainfall information which presently limits the usefulness of FORAGE in its current form i.e. as a purely retrospective analysis.

The FORAGE framework has been tested since 2005 and has proved to be flexible and robust in meeting requests for information from a range of clients. In time, with user-feedback and further development, FORAGE may prove to be a standard tool for many interested parties to assist in decision making in grazing land and environmental management.

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