Land condition assessment tool (LCAT) — documenting land resources and condition.

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Abstract

The Queensland Department of Agriculture and Fisheries (DAF) has developed a land condition assessment tool (LCAT) using Esri, Survey 123.

The LCAT is an easy to use, fit-for-purpose and science-based assessment framework, combining simple and intuitive design with contemporary technologies. It enables the rapid and consistent collection of standardised land condition data and generation of objective results.

Operating on mobile devices, user's answer 'questions' related to long-term indicators of land condition, by selecting pictograms (stylised pictures) representing otherwise complex, science-based concepts and land condition values. An on-device scorecard presents results associated with grazing land condition, site and landscape 'hazards' and ecological processes.

Originally developed to meet DAF's Paddock to Reef program commitments, DAF Agriculture has supported the provision of the LCAT to more than 20 government and non-government organisations and Industry groups engaged in sustainable land management initiatives. LCAT data will also provide the foundation for a cross-agency program seeking to remotely measure and monitor rangeland condition across the state.

This paper describes the design and function of the LCAT and its application including supporting the evaluation of land management initiatives, providing data critical for research and development, capacity building and industry development.

Keywords: Data collection, grazing lands, productivity, land management, pictograms.

Introduction

Grazing is the most extensive land use across Australian and Queensland rangelands including within Queensland's Great Barrier Reef (GBR) catchments.

Across all levels of government and industry engaged in productivity gain and sustainable land management initiatives, varying methods, lack of consistency, lack of data and lack of capability and capacity have been identified as key limitations to success. For example, the development of a consistent and user-friendly tool to evaluate grazing land impacts was identified as the highest priority for program improvement for future iterations of the Reef 2050 Water Quality Improvement Plan.

The LCAT was developed by the DAF Management Practice Adoption program (MPA) (a component of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R)) to fill that gap and facilitate the capture of consistently collected land condition data and evidence-based results. Driven by the organisational and operational needs of others, DAF Agriculture and the MPA team has supported the provision of the LCAT to a range of

government and non-government organisations and industry engaged in sustainable land management initiatives.

Land condition indicators and framework

The condition of any thing is its particular mode of being; its situation with respect to circumstances; or its existing state or case. The definition of 'land' condition may vary depending on the purpose or outcome sought from an assessment e.g. productivity, landscape function or vegetation as a surrogate for biodiversity.

Land condition indicators and values framed within the LCAT, integrate a range of accepted science-based metrics, principles and concepts adapted from sources including Grazing land management (GLM) land condition framework (Chilcott *et al.* 2003); Stocktake (DPI&F 2004); Guidelines for determining land condition (DNR&M 2013); Landscape Function Analysis (Tongway and Hindley 1995); and the Australian soil and land survey field handbook (McDonald *et al.* 2009). Data collection frameworks, methods and pictogram concepts are adapted from unpublished works developed by the lead author over 30 years.

The assessment uses a framework of indicators, values, weightings, and algorithms to resolve the multitude of possible combinations of observed and recorded data inputs. The framework comprises more than 1080 weightings assigned to more than 380 indicators and associated values. Over 1450 plant species are presented, including more than 580 pasture species. Each pasture species is assigned one of five 'value' categories to six results adding another 3504 weightings. All weightings have been calibrated to reflect each indicator, value or pasture species' influence on land condition and other generated results. To generate the suite of 15 results presented by the LCAT, over 300 algorithms resolve the complexity and variability present in landscapes, however, caveats and limitations exist. Version 1 includes ten results—reviewed and endorsed by an expert panel. An additional five results have been developed for Version 2 and are labelled 'Prototype' until reviewed and endorsed.

Originally developed and calibrated using Microsoft Excel, the LCAT has been built within the Esri ArcGIS Survey123 Connect package and operates on the Esri Survey 123 field app. This app was chosen as a simple, cost-effective and easy to maintain and update solution. Previously not able to meet the LCAT functional requirements, recent updates to Survey123 have enabled the use of scalable vector graphic (SVG) images and complex calculations.

Design and function

The design objective was to: *develop a simple-to-use, robust, cross-stakeholder endorsed method to meet contemporary needs, capacity building, consistency, and provision of data.*

Available in Standard and Advanced versions, the LCAT operates on or off-line, on iOS, Android and Microsoft mobile and desktop devices, and as a printable field-form.

Indicators (presented as questions) within the Standard version represent a standardised minimum set of long-term land condition indicators from which more objective and repeatable results can be generated and data analysed. The more data-rich Advanced version is ideally suited to baseline assessments from which to measure change.

Indicators include pasture composition, density and 'quality'; groundcover and its components; detailed erosion processes; soil surface features; pest plant, understorey and overstorey composition density and management; native animals; total grazing pressure and site impacts such as from fire, flood and drought—a comprehensive land resource inventory.

Each indicator comprises an average of six values from which the user selects the value that is closest to describing what is observed. Indicator values are presented as pictograms

(stylised SVG pictures) that represent otherwise complex science-based land condition values and concepts. Over 180 pictograms have been designed to be simple, recognisable and have associated terms with foundations in published literature (Figure 1.). The use of pictograms and minimal list-based questions and text, significantly simplifies the assessment for both experienced and inexperienced users alike.

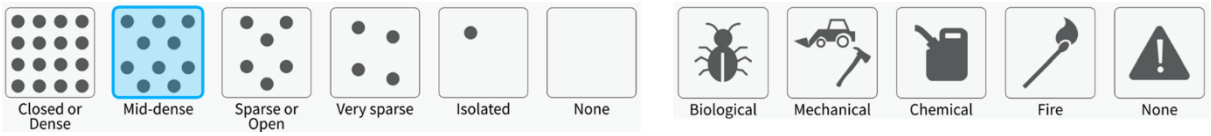

Figure 1. Example Scientific Values: Plant density. Concepts: Pest plant control methods.

User instructions and links to reference material are presented prior to capturing site details that include a point location, land type and up to five site photographs. A user progresses through the assessment by observing the landscape and tapping (selecting) a pictogram for each question. The assessment structure uses a cascading and conditional design, presenting mandatory and optional questions dependent on previous selections.

The LCAT determines the current state of the land—its condition—by evaluating key indicators of long-term land condition. Assessing more indicators ensures landscape variability is recorded resulting in greater consistency, repeatability and confidence in results.

On completion of an assessment, an on-device scorecard displays a suite of results related to GLM principles and 'hazards' associated with water quality, fire and ecological impacts. Generated results include Grazing ABCD, Indicative biomass (kg/ha), Erosion hazard, Grazing alert (pasture deficit), Water quality hazard, Water contamination hazard, Fire potential, Invasive pest plant hazard, Impact on natural state, Site score (out of 100), Drivers of reduced GLM land condition, Indicative landscape stability/function, Indicative riparian zone stability, Indicative natural capital potential, and Indicative carbon store potential.

The simplicity and immediate feedback allows users to develop their own capability, capacity and understanding of land condition drivers and the influence of management practice change. The framework and simple-to-use design allows users with minimal experience, to complete a Standard assessment in 3-10 minutes and an Advanced in 10-15 minutes.

LCAT data are automatically uploaded and securely stored in user-group partitioned, geodatabases in the Queensland Government cloud services (and other organisations if required). Queensland Government hosted data is periodically archived on a secure DAF server with limited user access. Data recorded by a user may be downloaded and analysed at site, paddock, land type, property, catchment, or regional scale.

Application

The LCAT is calibrated for use across northern Australia's perennially dominated, tropical, subtropical, semi-arid and arid vegetation communities including grasslands, shrublands, woodlands and open forests. It may be used in southern Australia and other vegetation communities as a data collection tool, and results used within known caveats and limitations.

In its first twelve months, the LCAT has more than 200 users in more than 20 organisations and business groups. Over 1500 land condition assessments have been completed,

supporting the evaluation of land management initiatives, and providing data critical for research, development and opportunities for capacity building and industry development.

The LCAT is currently used by Queensland's Natural Resource Management (NRM) groups, DAF, Department of Environment and Science (DES) and Department of Resources officers, the Great Barrier Reef Foundation (GBRF) delivery partners, Local government stock route officers, SEQ Water, Central Queensland University, private consultants and landholders. Interest in accessing the LCAT has been received from education institutions, Queensland Parks and Wildlife Service and the Department of Defence.

LCAT is used to capture contemporary, high quality on-ground land condition data. Data are used for wide-ranging purposes including: to plan and evaluate the effectiveness of projects and programs that aim to improve land condition, productivity and sustainability; validate 'practice change'; reduce soil erosion; develop condition benchmarks; account for and justify the expenditure of public monies; validate and improve products and services derived from remote sensing and modelling; support decision-making; identify and respond to emerging issues including natural disasters; support self-regulation and land stewardship; and conduct on-ground monitoring of land condition. Major programs utilising the LCAT data include the DAF P2R program, DAF Grazing Resilience and Sustainable Solutions (GRASS) program, and the Resources, Natural Resource Investment Program (NRIP).

A key program recipient of the LCAT data is the Queensland Land Condition Program (LCP)—a collaboration between DAF and DES developing first-of-its-kind, land condition models derived from on-ground data and remote sensing. Data collected from LCAT provide the means for collecting the high volumes of quality land condition data required to 'train' and validate remote sensing models. Products developed are planned to be made publicly available via VegMachine.net (Beutel et al. 2019) and other channels. The LCMP seeks to fill a priority gap in the DAF P2R Program to model (predict) land condition spatially and temporally (space and time) across grazing properties within the GBR catchments.

Interested in using the LCAT?

An ArcGIS Online account is currently required to access the LCAT. For more information, demonstration, access, or training, please contact the DAF MPA team (authors). As well as documenting current condition, your contribution of data will significantly benefit the sustainable and productive use and development of our valuable natural resources.

Acknowledgments

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