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Evolving VegMachine.net: enhancing a successful tool for Australian rangeland cover analysis

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Abstract

VegMachine.net is a free online platform for analysing long-term vegetation trends across Australian landscapes. Since its launch in 2016, the platform has been used for thousands of site-specific cover analyses, been a feature of numerous NRM and extension projects, and contributed to more than 30 peer reviewed studies. While VegMachine® has proven valuable to land managers, scientists, and environmental organizations, user feedback has highlighted potential improvements around more reliable data access, better mobile access and improved interface stability of the platform.

A recent upgrade to VegMachine has addressed these user requests by prioritising mobile accessibility and user experience. This upgrade includes a responsive mobile-first design, new tools for efficient data collection of user features, and data persistence for seamless use across sessions and when offline. Additionally, the backend infrastructure has been overhauled, resulting in improved data stability and robust access through a revamped Application Programming Interface (API) and improved data storage.

This paper discusses the improvements to the interface, backend API and improved data storage in detail. These changes will significantly improve the VegMachine user experience and make the application more accessible to a broader user base across Australia.

Introduction

Remote sensing provides land managers and researchers with a potentially useful source of time series vegetation data. However, accessing and interpreting these massive datasets requires specialised skills and processing capability. VegMachine is an online platform that simplifies this process by extracting and summarising subsets of these datasets, in a non-commercial, user-friendly way. Users can define an area of interest and then receive many years of vegetation cover data for that location without being required to download or process any datasets themselves.

After initial development in 2002 (Beutel et al., 2004), an expanded online version, VegMachine.net was launched in 2016 (Beutel et al., 2019). Since then, the number and variety of datasets provided has expanded to include a variety of monthly and seasonal vegetation cover products, persistent green cover, fire scars and rainfall. As well as supporting land managers to easily access data, the online version of VegMachine has been utilised for research projects in areas as diverse as grazing, ecology, hydrology and primary productivity. VegMachine has also been identified as a key digital resource for earth observation data by various state and national agencies.

VegMachine's success has occurred despite ongoing data service interruptions, outdated data access methods and limitations with the interface design. In recent years, VegMachine has been upgraded to address these issues. A new version of VegMachine will be released in 2025 with significant improvements.

Methods

Data Storage and Service Improvements

All datasets available through VegMachine are provided under the Queensland Government's open data policy. These valuable datasets are delivered via Terrestrial Ecosystem Research Network (TERN) infrastructure (TERN Queensland Node) on a non-commercial basis.

The infrastructure has undergone significant updates in recent years. The time series datasets have been transitioned onto a more stable platform and are now stored as Cloud Optimised GeoTIFFs (COGs) within an OpenStack Swift object-based storage system. Additionally, the GeoServer instance, providing Web Mapping Services (WMS), has been reconfigured to improve stability and data discoverability. Web Mapping Service Tiles (WMST) have also been implemented for scalability. This new architecture enables efficient data access within the updated VegMachine API and will significantly improve the stability and reliability issues previously experienced by VegMachine users.

Application Programming Interface (API) Redevelopment

The VegMachine API specialises in extracting vegetation data from time series raster files. Upon receiving a polygon, and a specified time series dataset, the API rapidly returns spatial summary statistics for each date, including monthly rainfall (Scarth et.al, 2017). The API is hosted on Digital Ocean virtual machines, supported by the Joint Remote Sensing Research Program (JRSRP). The machines have fixed capacity and lack scalability, so the speed of the API depends on efficient asynchronous data access rather than computing power.

The previous API relied on the use of WMS to enable asynchronous access. In a significant redevelopment, the API has been implemented as a custom Python package (JRSRP, 2024 (https://gitlab.com/jrsrp/sys/asyncog)) designed to asynchronously extract information directly from the COG files via an HTTP session. HTTP range requests minimise the amount of data transferred by spatially constraining the data. Directly accessing the underlying COGs additionally eliminates restrictions on data types that are inherent in WMS.

The VegMachine API also utilises raster overviews to reduce the volume of data read and processed. Overviews are resampled versions of the data at coarser resolutions. While employing overviews typically yields an unbiased estimate of the spatial mean, reducing raster resolution can also decrease variance within the data, as extremes in pixel values tend to be averaged out (see Figure 1). This smoothing effect may obscure the variability present in the original data, especially for larger regions. The level of resampling is determined by an input parameter in the API, which users can adjust. Currently, the API does not provide users with information about overviews or the resampling level, but this functionality will be made available

to advanced users with the 2025 release of VegMachine. The VegMachine developers are also considering adapting the interface to allow users to opt for increased precision at the cost of processing speed.

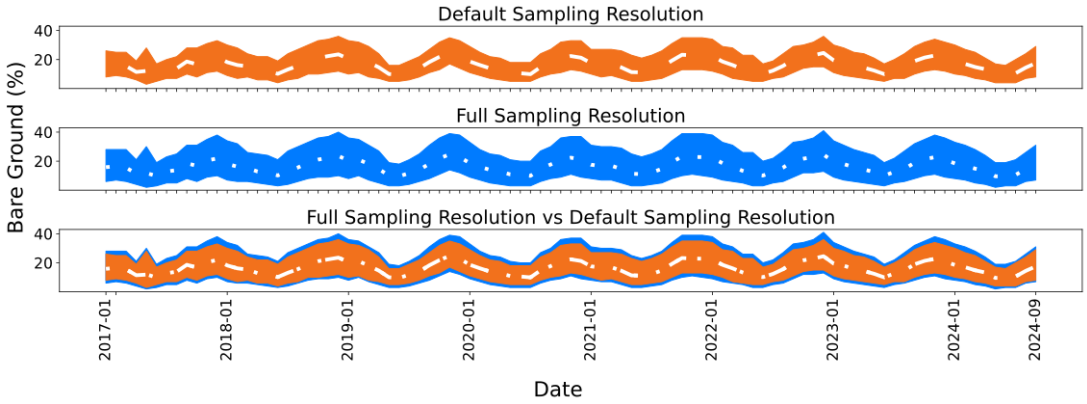


Figure 1. The effect of raster resampling in VegMachine on the bare ground minimum-maximum range (blue and orange regions) for a larger property (~90,000 ha) is shown. Data variability reduces with increasing site area because VegMachine utilises coarser resolution rasters for large-scale analyses to ensure timely processing. Mean values remain unbiased (represented by the dashed and dotted lines).

Interface redesign

To enhance the accessibility of the VegMachine site, the interface has been redesigned as a responsive mobile-first web application. This redesign will enable users to access the full suite of VegMachine tools on any device. The desktop interface retains all previous functionality (Beutel et al., 2019), and existing users should find the transition to the new site straightforward.

In response to user feedback, a wide variety of additional features have also been incorporated into the updated version of VegMachine (Table 1).

Table 1. Major additional functionality for new VegMachine.net version release.

New Functionality	Description
Interactive Digital Cadastral Database (DCDB) overlay	Allows Queensland users to select a lot on plan to use as an assessable feature.
Enhanced download capacity	Downloads now include the assessed features as a vector file.
Persistent data storage	Vector map features from previous sessions are retained on refreshing the application, until manually deleted.
Advanced custom chart	Allows users to select three data series statistics from all available product statistics and create a custom chart.
'Point' features	Instant 1 ha circle feature creation, in addition to user drawn polygons.
GPS logger with offline capability (mobile only)	Allows users to record location as a point using device GPS. Functions offline for users out of internet range.

Results

The improvements have significantly stabilised the VegMachine platform, while the redesign of the interface has provided considerable additional functionality.

While most additional interface features are aimed at simply improving user experience, the advanced custom chart (Figure 2) and mobile interface (Figure 3) are significant additions to VegMachine functionality.

The advanced custom chart feature allows users to create a chart specific to their analysis from all available data products. Map and chart are synchronized, which facilitates the easy interrogation of the chart series against the underlying raster data. Figure 2 illustrates an example chart.

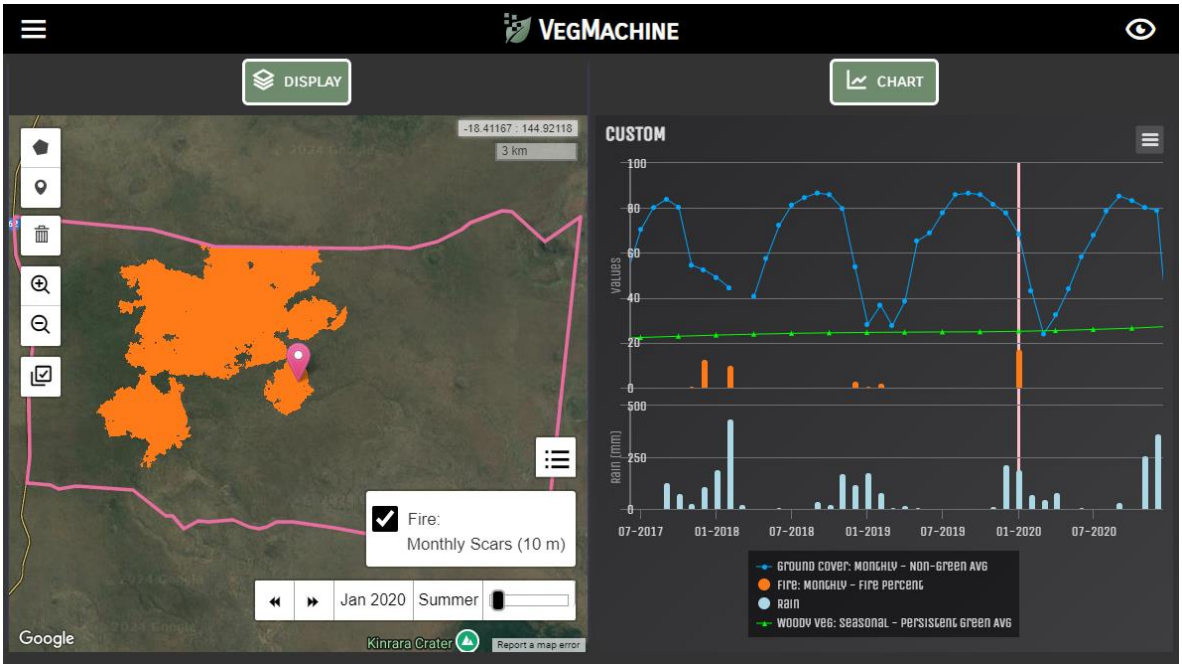


Figure 2. A screenshot of the updated VegMachine interface, showing output from the advanced custom chart feature, displaying three time series statistics (average non-green ground cover (blue), fire scar percentage (orange) and average persistent green (green)). Rainfall is also shown (light blue). By clicking on an observation in the chart, the synchronized map displays the relevant product for that date. In this instance a fire occupying 17 percent of the property for January 2020 is displayed.

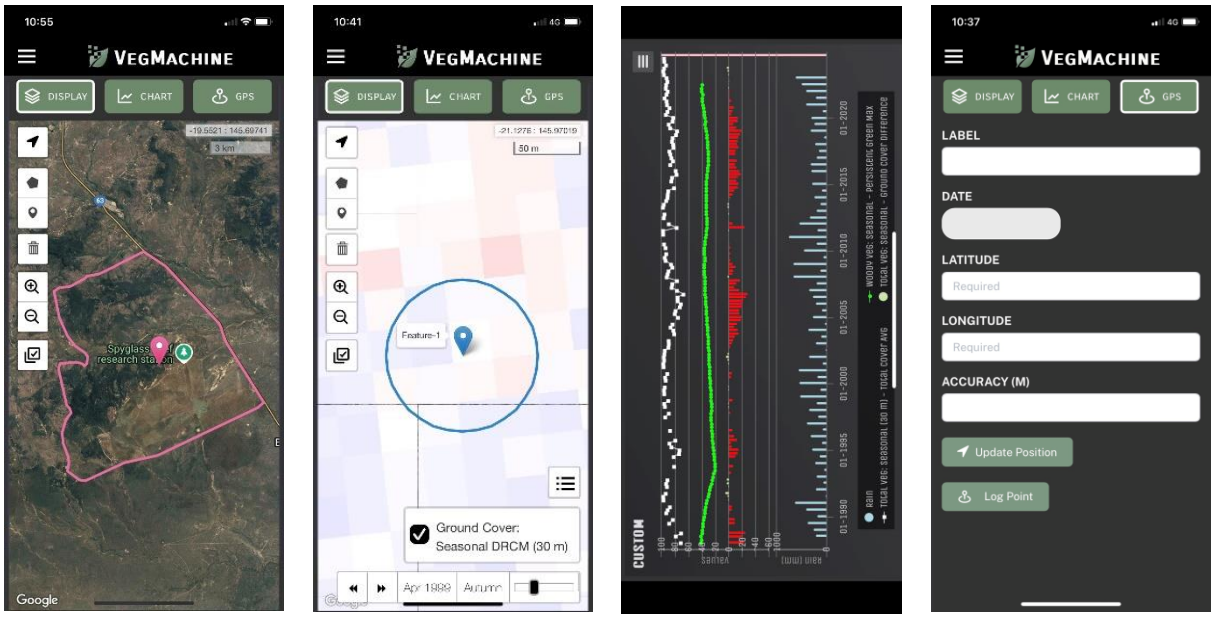
Two specific features have been added with mobile use in mind. The addition of point features (1 ha circles) will be useful for site assessments using mobile devices. The point features are optimised for straightforward application and 1 ha is a common site size. The GPS logger, with offline functionality, allows for easy point capture at locations even when out of internet range.

Discussion and Conclusion

VegMachine is a dynamically evolving platform undergoing continuous improvement. While major changes to its function and design are not anticipated for some time, incremental changes will continue to occur. Additional time series datasets will be considered for inclusion in the API and VegMachine interface if suitable. Additional publicly available APIs are expected to be developed, to meet user demand. These

APIs will be incorporated into VegMachine as additional tools and be made available for use in other 3rd party applications.

With these recent improvements, user demand is expected to increase. The degree to which the VegMachine API can scale to support additional demand, including the use of the API for 'batch' processing, is uncertain. However, VegMachine will continue to make valuable remote sensing time series data as easily accessible as possible to a broad cross section of users at no cost to them.



Map screen with a lot on plan displayed, selected from an interactive DCDB vector overlay.

Image time series overlay with time slider and point feature displayed.

Advanced custom chart with output optimised in landscape view.

GPS logger screen.

Figure 3. Selected screen shots from the VegMachine mobile interface.

Acknowledgements

VegMachine currently exists as a collaborative project between Queensland Government (Department of Primary Industries (DPI) and Department of Environment, Tourism, Science and Innovation (DETSI)), The Joint Remote Sensing Research Program (JRSRP) and the Terrestrial Ecosystem Research Network (TERN).

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