ICARDA

Science for resilient livelihoods in dry areas

VegMeasure® Software User Evaluation Report

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CGIAR RESEARCH PROGRAM ON Livestock

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Introduction

Vegetation cover is a measure of the percentage of a land surface area covered by vegetation. It is an important indicator of the site ecological processes and management effectiveness (Wang et al., 2015). Vegetation cover provides a measure of the area occupied by plant matter and the amount of soil, water and nutrients plant can be captured to produce biomass (Launchbaugh, 2012; Caselli et al., 2021). Furthermore, vegetation cover is very important attribute to equally evaluate the plant species with different life forms on a comparable basis.

Vegetation cover is a useful indicator on erosion potential, wildlife habitats, forage availability, plant community information and range conditions and trends and plays a key role in evaluating hydrological processes. For example, vegetation cover influences the amount of rain intercepted by leaf surfaces, ground cover and litter, resulting in the redistribution of water flow and increasing the amount of stored water through infiltration and decreasing erosion potential (Petersen and Stringham; 2008; Zuazo and Pleguezuelo., 2009). Vegetation cover provides data land managers need to make informed decisions. Because vegetation cover is expressed as a percent of an area, measurements are applicable for nearly all types of plants. Vegetation cover is highly dependent on climate and grazing and browsing behavior of herbivores.

Conventional field methods have been used to estimate vegetation cover based on visual estimation, points, lines, or plots. However, these methods are labor intensive, costly and highly dependent on individual judgment (Ko et al., 2017). This often results in low sample numbers and imprecise data.

With the invent of geoinformatics techniques, assessing and monitoring the changes in vegetation characteristics is becoming more reliable in terms of time saving, lower cost and with higher accuracy (Louhaichi et al. 2010). More recently, in association with GIS, digital cameras have been shown to be affordable, repeatable and reliable tool to closely track vegetation changes and plant development stages under different ecosystems (Toomey et al., 2015; Moore et al. 2016), resulting in more routine and consistent monitoring procedures.

VegMeasure software is a tool intended to provide information about field images that can be converted to quantitative indices for measuring several key vegetation characteristics that can help land managers to assess ecosystem processes and to meet environmental and utilization goals.

How does VegMeasure® work?

The limitations of traditional methods inspired researchers to seek new methods for monitoring ecosystem health and trends that are rapid, precise, cost-effective and non-subjective by taking advantage of recent technological advances in digital photography, Global Positioning Systems (GPS), computer processing and digital information storage.

The software analyzes digital images by classifying colors into categories such as green leaves, bare ground. It can be used to monitor vegetation on rangelands/grasslands and even croplands especially when monitoring early growth. VegMeasure® can quantify vegetation using low-altitude aerial photographs and over-story cover using vertically upward photos from ground level. VegMeasure® speeds up the classification of aerial or ground-level photographs by allowing the user to determine the color thresholds between objects in the image by using range of classification algorithms such as green leaf, red band, green band, blue band, brightness, hue extractor, K-Means and a user-defined manual algorithm.

All algorithms, except for the hue extractor and k-means, select pixels when some criteria exceed a specified threshold and assign them to a class. This threshold can be adjusted with a slider in the preview pane. However, in most cases it is preferable to use automatic threshold calibration, which can then be applied to all images for a target site. Moreover, VegMeasure® allows users to create a custom classification scheme where each pixel in the input image will be classified into user-specified groups or classes.

Supervised classification allows for customization of ranges, values and categories in the images. This technique allows a researcher to guide the classification process by looking at sample pixels in an image that are representative of specific classes and then VegMeasure® will identify all other pixels in the image with the same intensity values and categorize them in the same class (Figure 1).

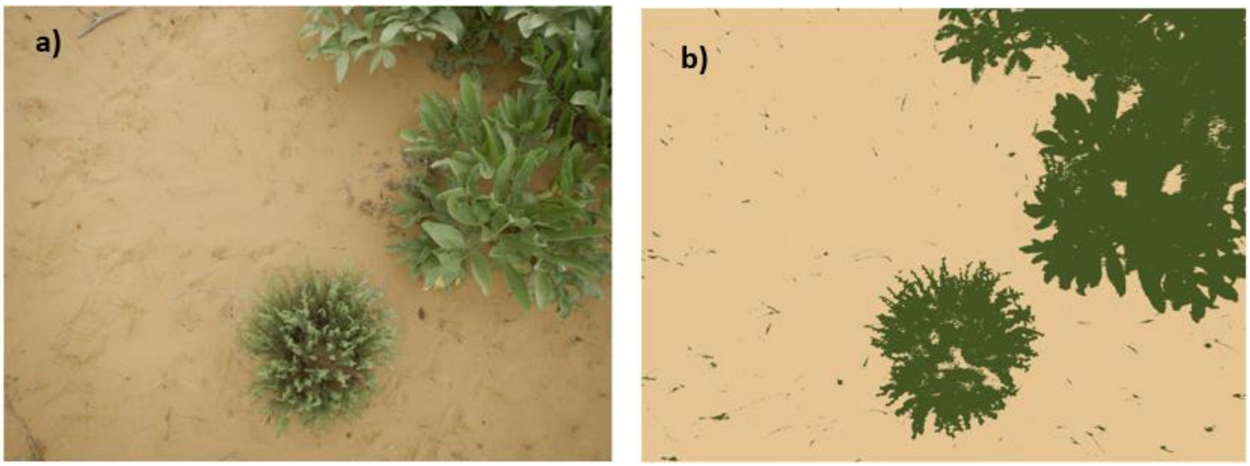

Figure 1 Digital image before (a) and after processing (b)

Image classification helps identify trends that inform monitoring and the effect of climate and management techniques. The decision about what types of classifications to use depends on what the data will be used for or what trend in the experimental site is being observed. The automatic classification feature allows hundreds of images to be classified with the same settings once the classification method is determined. The results of image processing can be compared with those of other sites or with images of the same site over time. This can help managers, researchers and decision makers determine if the applied management intervention is meeting the target objectives.

Software users

Originally VegMeasure® was developed for use in rangelands which are characterized by a complex and mosaic (heterogeneity) landscape. Its robustness made it easy for applications in monoculture setting (cropland). Currently several disciplines are using the software including rangelands, grasslands, forests, croplands, coastal vegetation and mining reclamation.

Though the software was developed by a research institution, its use is not limited to research purposes only. In fact, several developing agencies, private sector consultants and non-governmental organizations showed interest in using VegMeasure. Thus, the software can serve a wide range of users including researchers, advisors, policymakers, extensionists, development specialists and farmers.

Scope of user evaluation

The scope of this user evaluation is to assess the functionality and usability of VegMeasure® from a user perspective. An online survey was conducted to assess performance® in terms of its efficiency and effectiveness and to document the actual results and impact of VegMeasure® applications in research publications. The survey also explored pros and cons to offer recommendations for product development.

Method

A qualitative research method with a descriptive analytical approach was used in this evaluation. Data were collected using an online questionnaire survey using Microsoft Teams form tool. The survey targeted VegMeasure® users and comprised 20 questions covering general information about the user and multiple choice, multipoint scale and ranking questions. The data was collected in June 2021–August 2021. A total of 100 respondents took approximately eleven minutes to complete the survey. The collected responses were analyzed using IBM SPSS Statistics ver. 20.0.4.

Results

Demographic characteristics of respondents

Software users from 30 countries took the survey. The highest percentage (30%) were from Tunisia, followed by Pakistan with 8% (Figure 2).

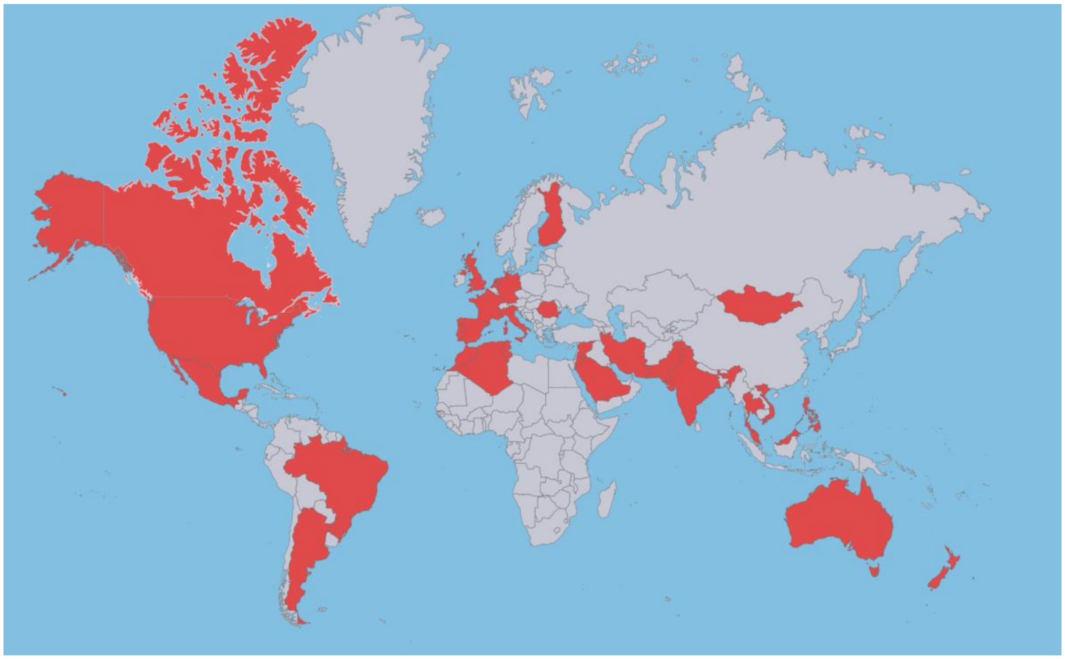

Figure 2 VegMeasure® survey respondents by country

The frequency analysis of the respondents' demographic characteristics showed that there was a higher percentage of male participants, 62% were male and 38% were female (Figure 3).

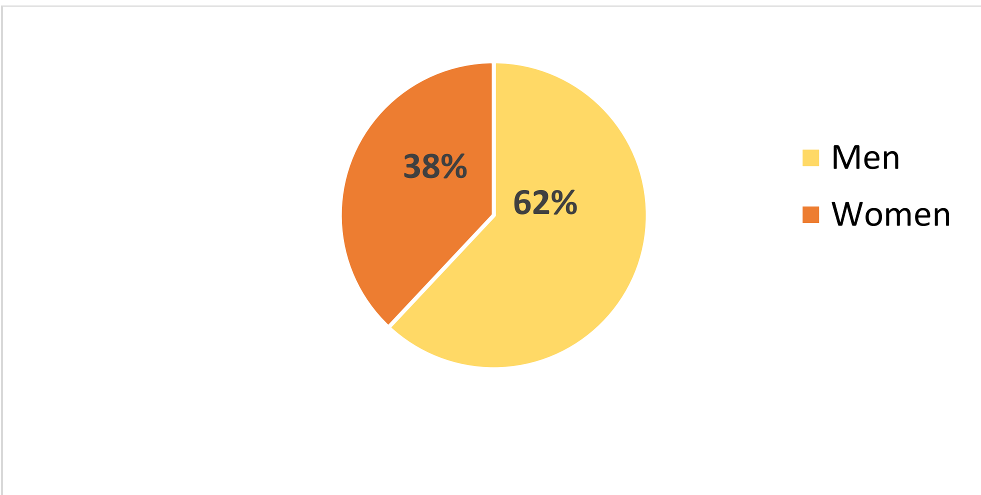

Figure 3 Respondents by gender

Respondents with a PhD degree accounted for 36% of the sample. Furthermore, 50% were scientists and researchers, 21% students, 15% consultants and 14% technical support staff (Figure 4).

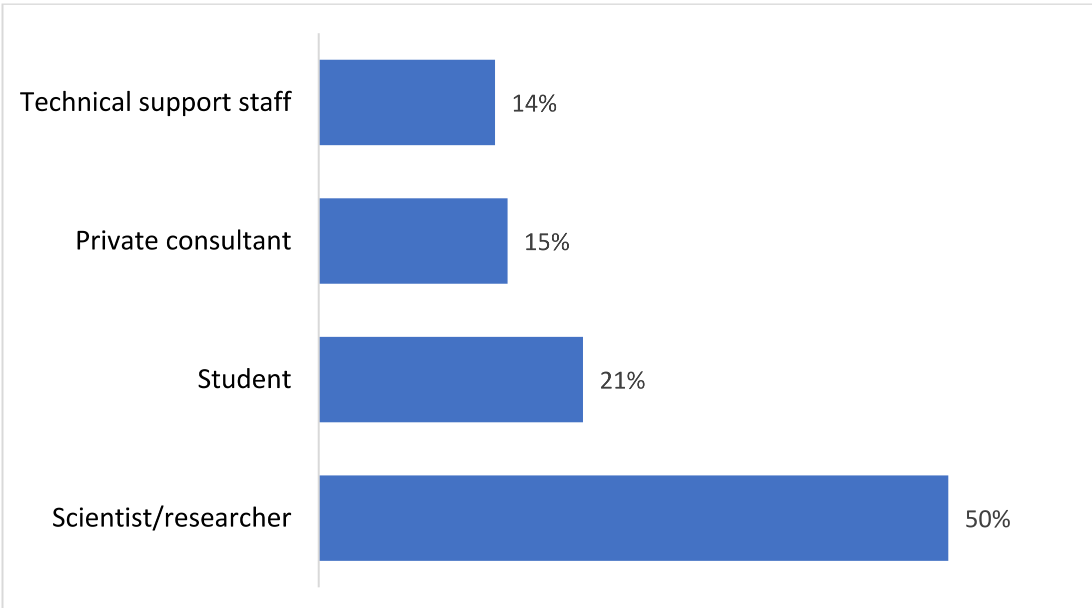

Figure 4 Respondents title

Software user acquisition

The most effective channels for creating interest in VegMeasure® were:

I. scientific publications (50%)
II. communication among friends and colleagues (16%)
III. professors' advice 11%

The majority of VegMeasure® users are scientists and students. These results indicate that the user's background is an important factor influencing the most effective channels (Figure 5).

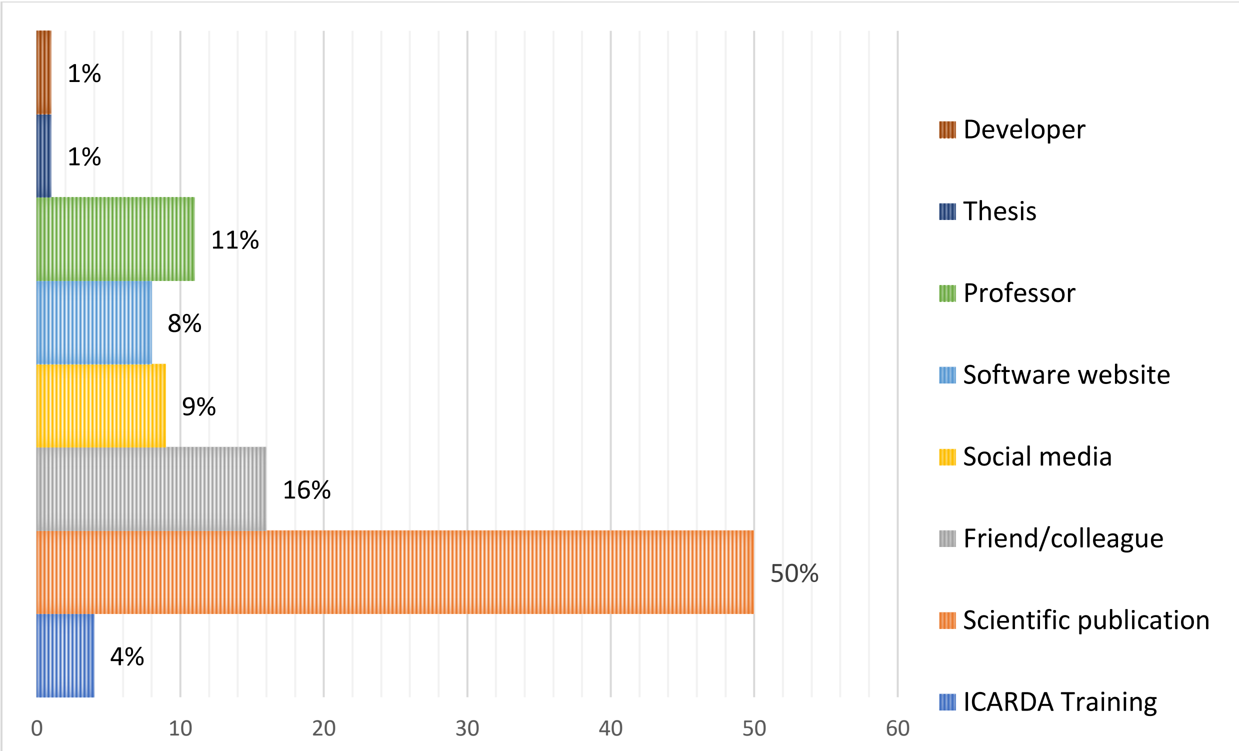

Figure 5 Channels influencing interest in VegMeasure®

VegMeasure® software use

Most users applied VegMeasure® in rangelands (33%) followed by use in croplands and grasslands (29% and 16% respectively). Fewer than 6% of users applied the software in forests and costal vegetation ecosystems (Figure 6).

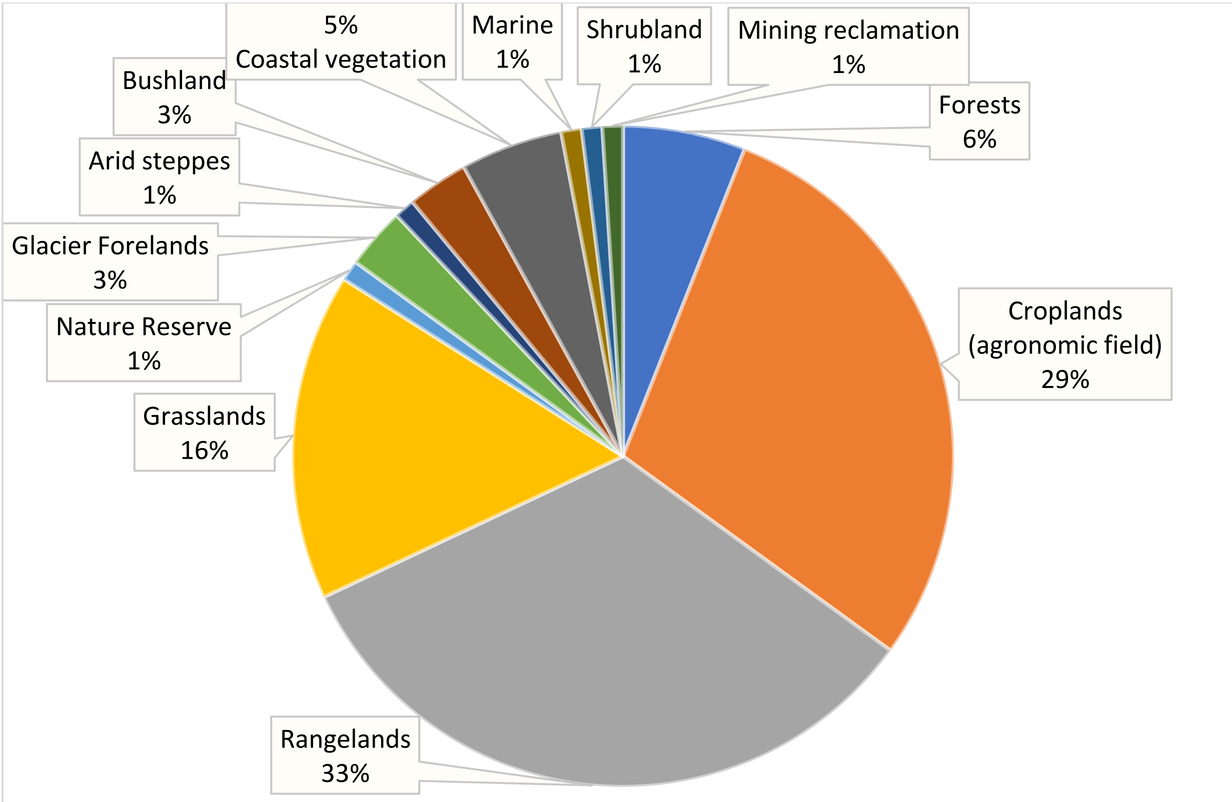

Figure 6 VegMeasure® software use

User satisfaction

User satisfaction was assessed with a 6-point Likert scale. Respondents were asked to rank ease of obtaining the software access key, software installation, software use, clarity of documentation and support. Most users were satisfied with the documentation and support experience. In general, the survey suggests that users are satisfied with VegMeasure® and found it easy and convenient to use. The results are shown in Figure 7.

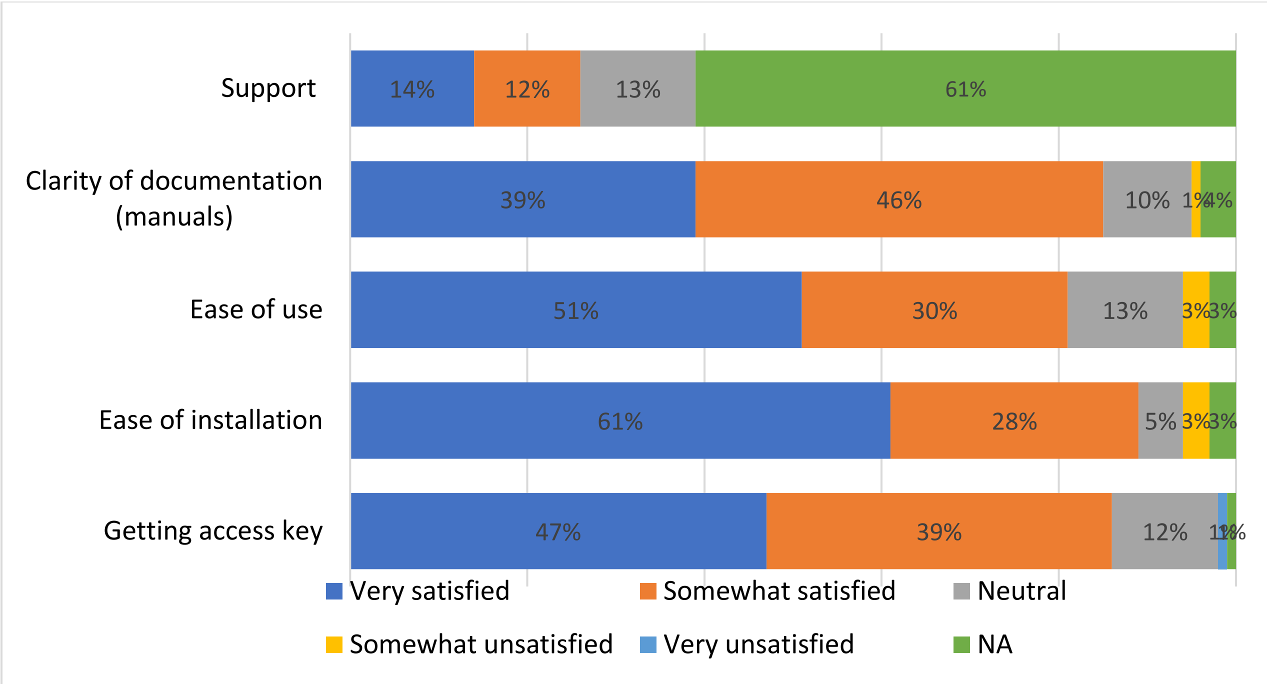

Figure 7 Users' level of satisfaction

Accuracy assessment module use

Nearly two thirds of users (67%) used the accuracy assessment tool, which is an important feature for image classification as it quantifies the reliability of the classified image. In general, a minimum accuracy of 90% should be obtained.

Scientific publications

Although most users are scientists and students, the average number of publications was low. Most publications (83%) were scientific papers and technical reports, however, only 67% of the publications acknowledge the software developer (Figure 8).

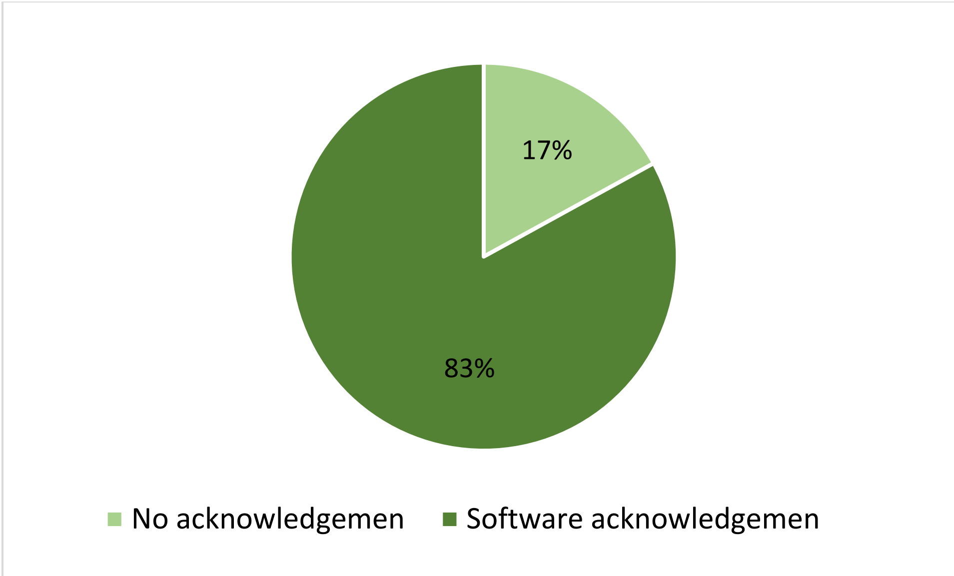

Figure 8 Type of published scientific paper using VegMeasure®

Willingness to pay

Generally, users of most software would prefer to pay little or nothing. However, when there is a high need for a software package, users are more willing to pay. Although VegMeasure® is currently free of charge, the survey indicates that users would be willing to pay if it was no longer available for free (Figure 9).

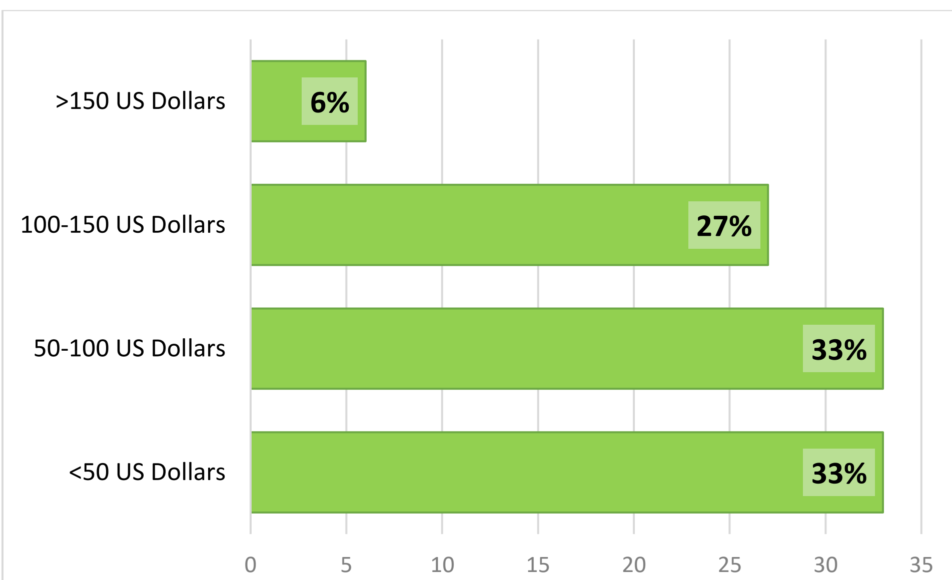

Figure 9 The maximum amount a customer is willing to pay for VegMeasure software

User recommendations

The majority of VegMeasure® users said they would recommend the software to their peers. Only 2% said they would be unlikely to recommend it. A considerable number of users suggested improvements such as enhancing the user interface for more clarity and a better user experience. Some users mentioned the need to improve the tutorials and a few suggested adding a density estimation function. The results indicate changes need to be made to make it more user-friendly.

Google Scholar Search engine results

A search using [Google Scholar]() found mentions of VegMeasure® in over 100 publications. Most of these were published in the USA, followed by Tunisia and Australia (Figure 10).

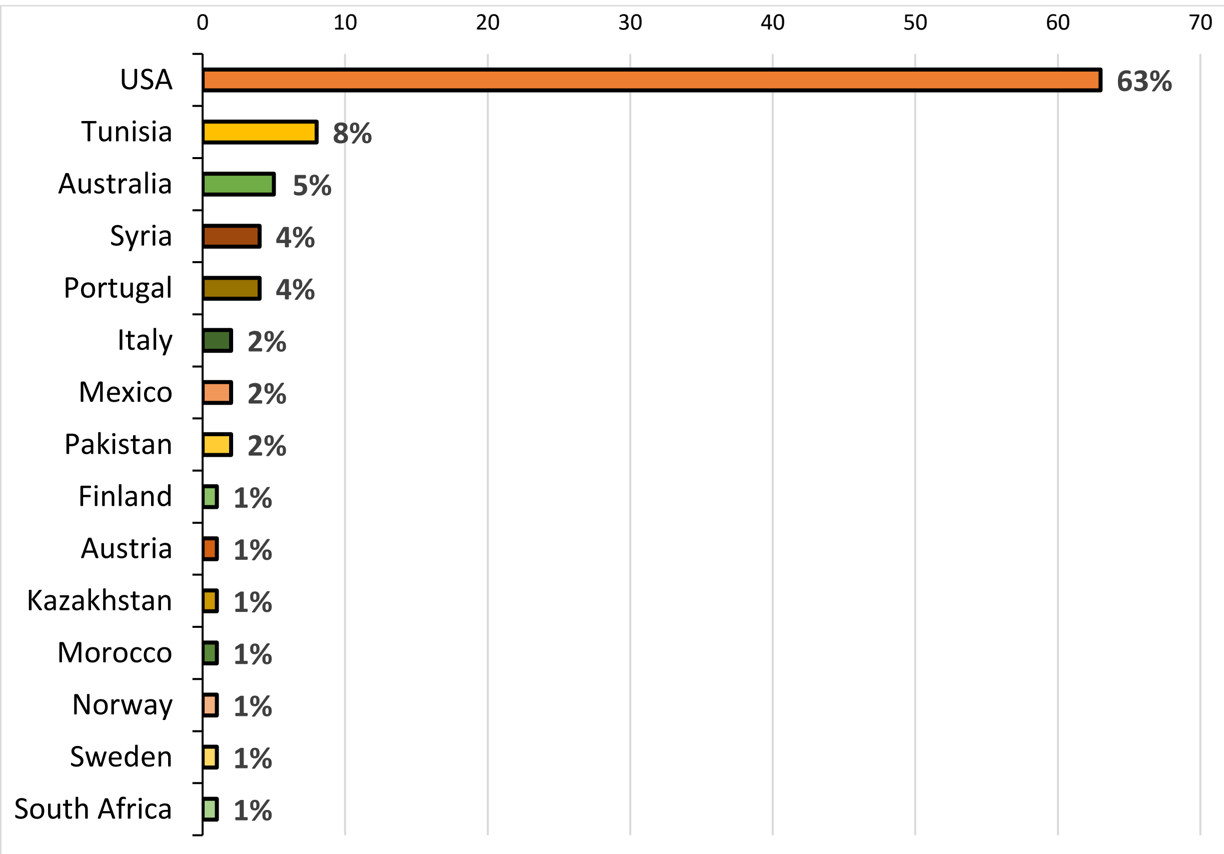

Figure 10 Publications by country

Most VegMeasure® users found in publications applied the software in rangeland ecosystems followed by croplands, grasslands, forests and shrublands and coastal vegetation (Figure 10).

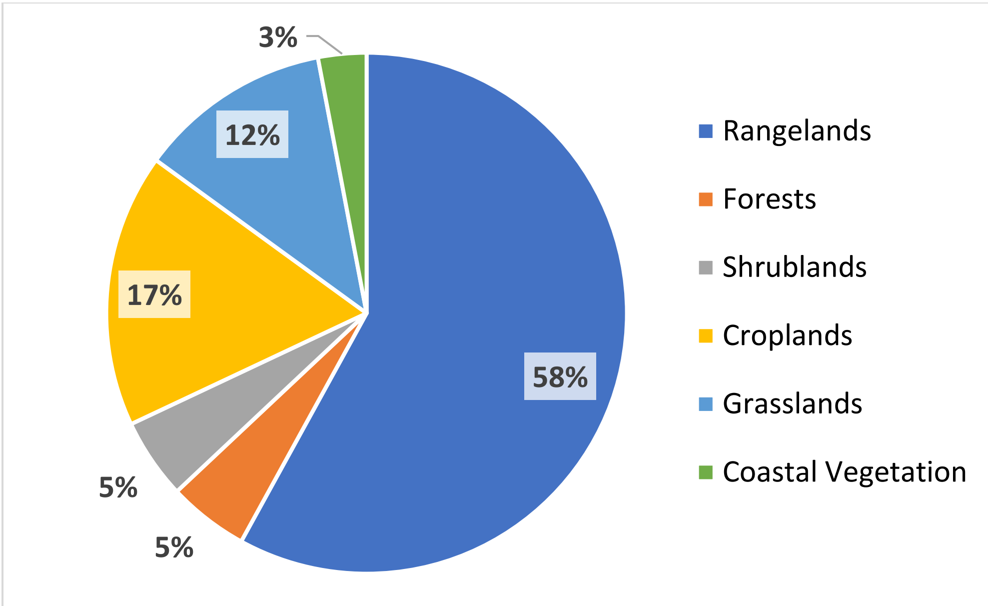

Figure 10 Applications of VegMeasure®

Most publications were scientific journal articles and theses (Figure 11).

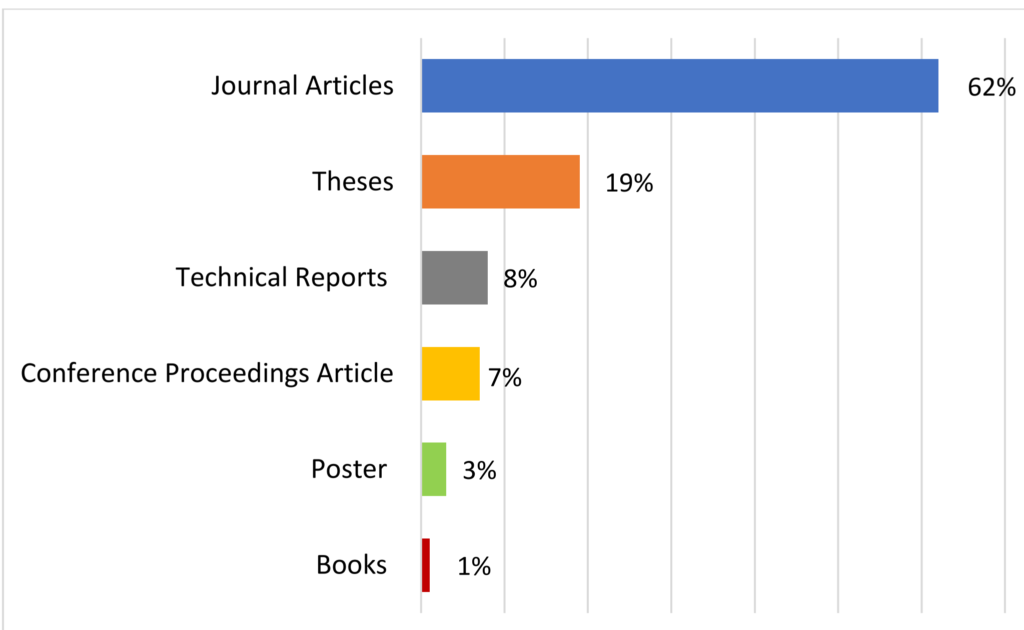

Figure 11 Type of publications found using Google Scholar

Conclusion

VegMeasure® offers a replicable, non-destructive, and objective method for estimating percentage of ground cover using digital images. The number of publications that mentioned VegMeasure® indicate its reliability and adoption by a wide spectrum of users. Most users indicated a high level of satisfaction. For future enhancement of the software, the users suggested developing VegMeasure® app, whereby the software and image-capturing would be integrated on a smartphone and users could get an instant estimate of vegetation cover while in the field. This could considerably streamline decision making processes.

Publications mentioning VegMeasure® software

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