Probabilistic classification of infected palm trees using UAV-based multispectral imagery and machine learning

Enrique Casas[1], Rebecca Kropp[2], Jose A. Reyes[3], Francisco Díaz[2] and Manuel Arbelo[1]

(1) Departamento de Física, Universidad de La Laguna, 38200 San Cristóbal de La Laguna, Spain. **ecasasma@ull.edu.es**
(2) Departamento de Biología Animal, Edafología y Geología, Universidad de La Laguna, 38200 San Cristóbal de la Laguna, Spain
(3) Sección de Sanidad Vegetal, Dirección General de Agricultura, Consejería de Agricultura, Ganadería y Pesca, 47014 Santa Cruz de Tenerife, Spain

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MOTIVATION

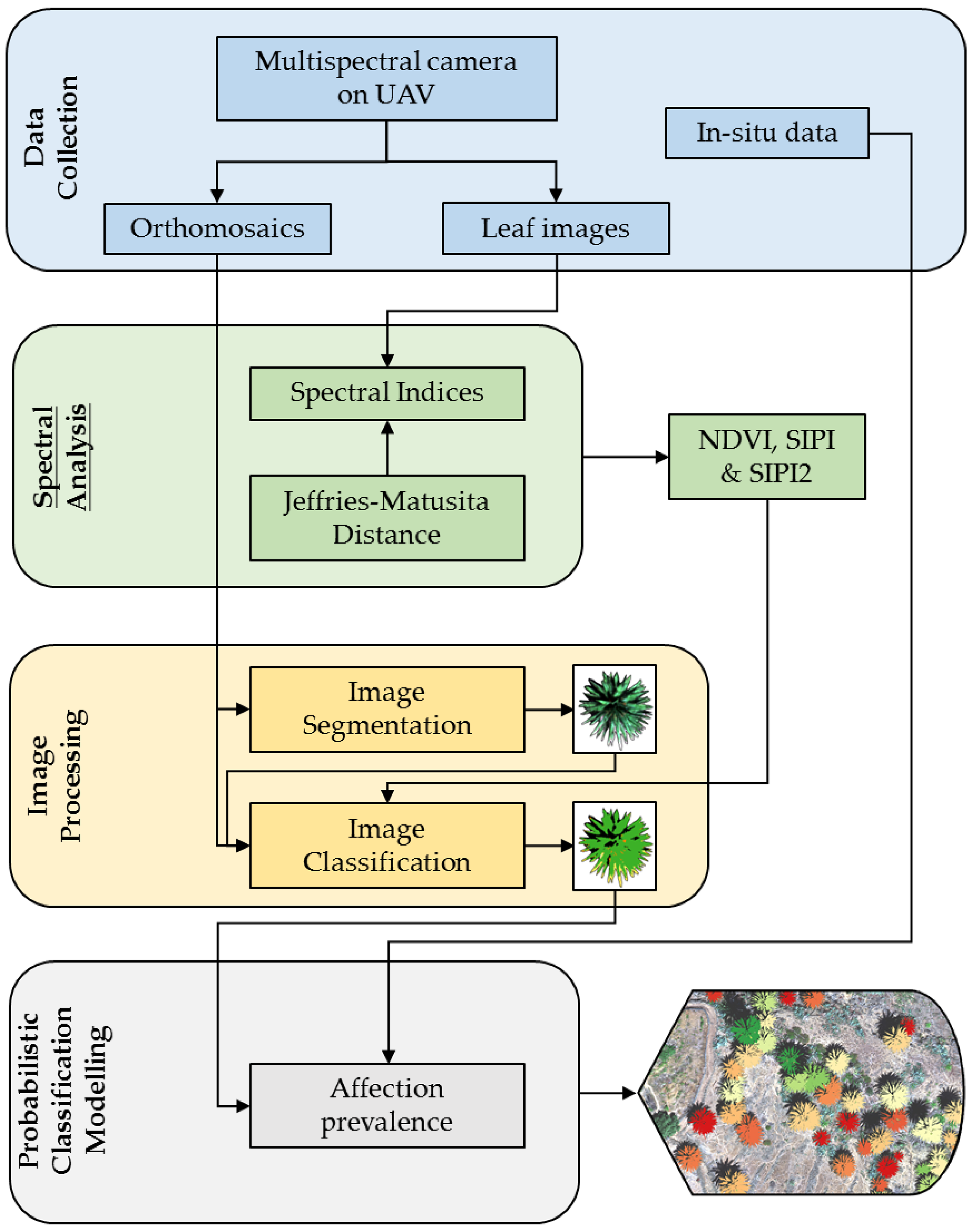
The Canarian archipelago, and its unique vegetation landscape shaped by Canarian palm tree (Phoenix canariensis) groves, is being affected by pests and diseases, being the most important *Serenomyces phoenicis* and *Phoenicococcus marlatti.* The European Union Natura 2000 protection areas have designated *P. canariensis* groves a priority habitat as an essential endemic Canary Islands plant species contributing to its identity and economy. In this context, new tools to monitor and treat the pathologies that affect and jeopardize the populations of *P. canariensis* are required.

OBJECTIVES

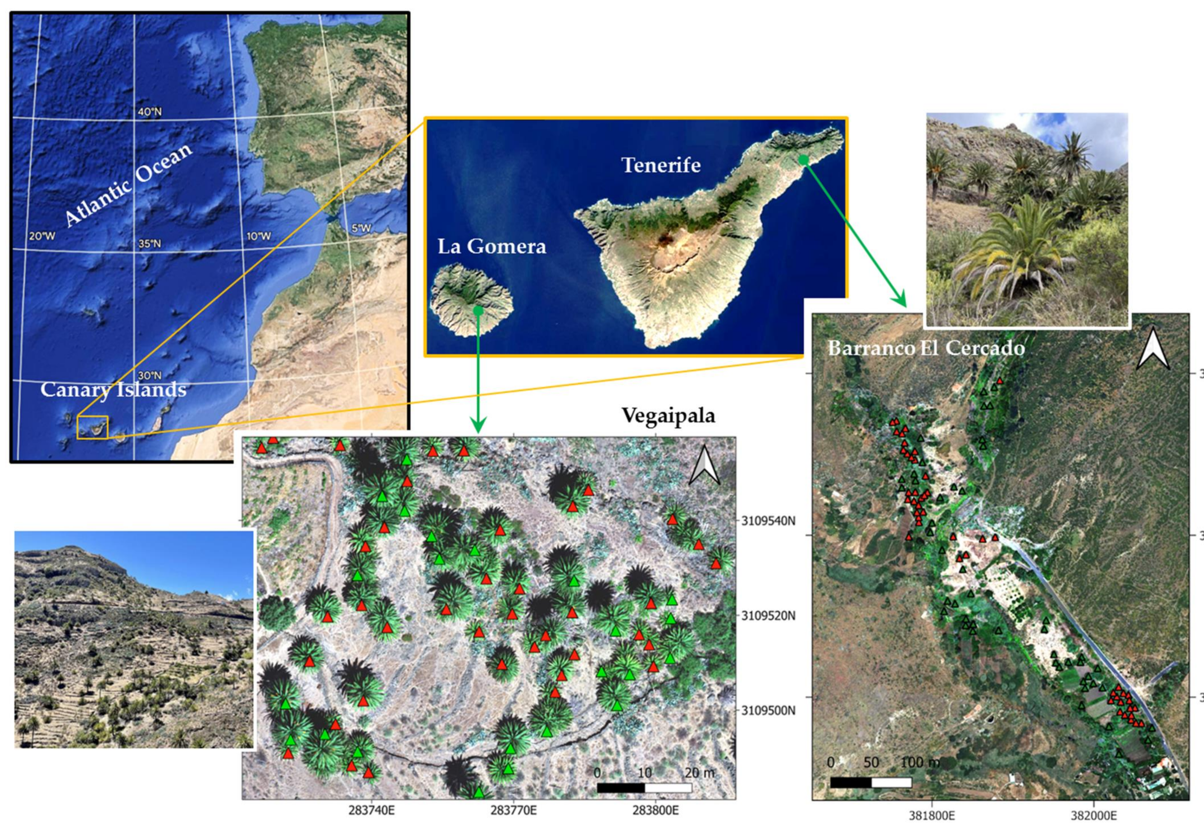
The development of tools for monitoring diseases using probabilistic classification models, high-resolution multispectral UAV images and ML techniques to identify infected *P. canariensis* specimens.

METHODS

A probabilistic classification model was developed to identify infected palm specimens based on the prevalence of affected leaves within each palm tree. First, the ability of different vegetation indices to discriminate between affected and healthy leaves was studied using a Jeffries-Matusita spectral separability analysis. Then, three different steps were followed, namely: (i) image segmentation, to detect and identify individual palm trees; (ii) pixel-level classification within each previously segmented palm tree, using ML and considering the reflectance of bands 1 to 5 of a Micasense Altum camera, where the spectral indices showed the highest spectral separability in the previous analysis; and (iii) calculation of the relative prevalence of pixels classified as affected leaves in each individual, which were later to be used as the predictor variable in the probabilistic classification model.

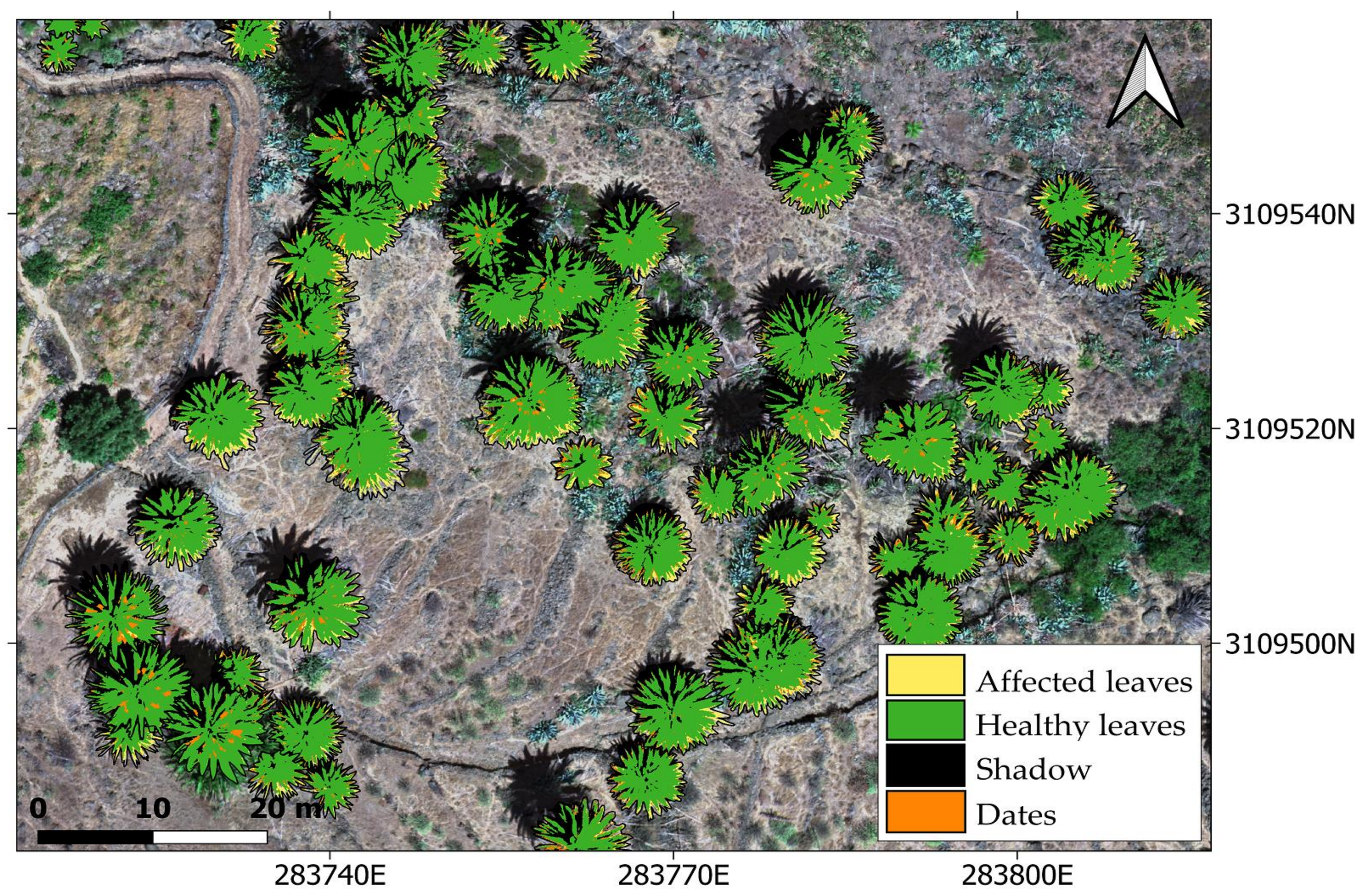


STUDY AREAS

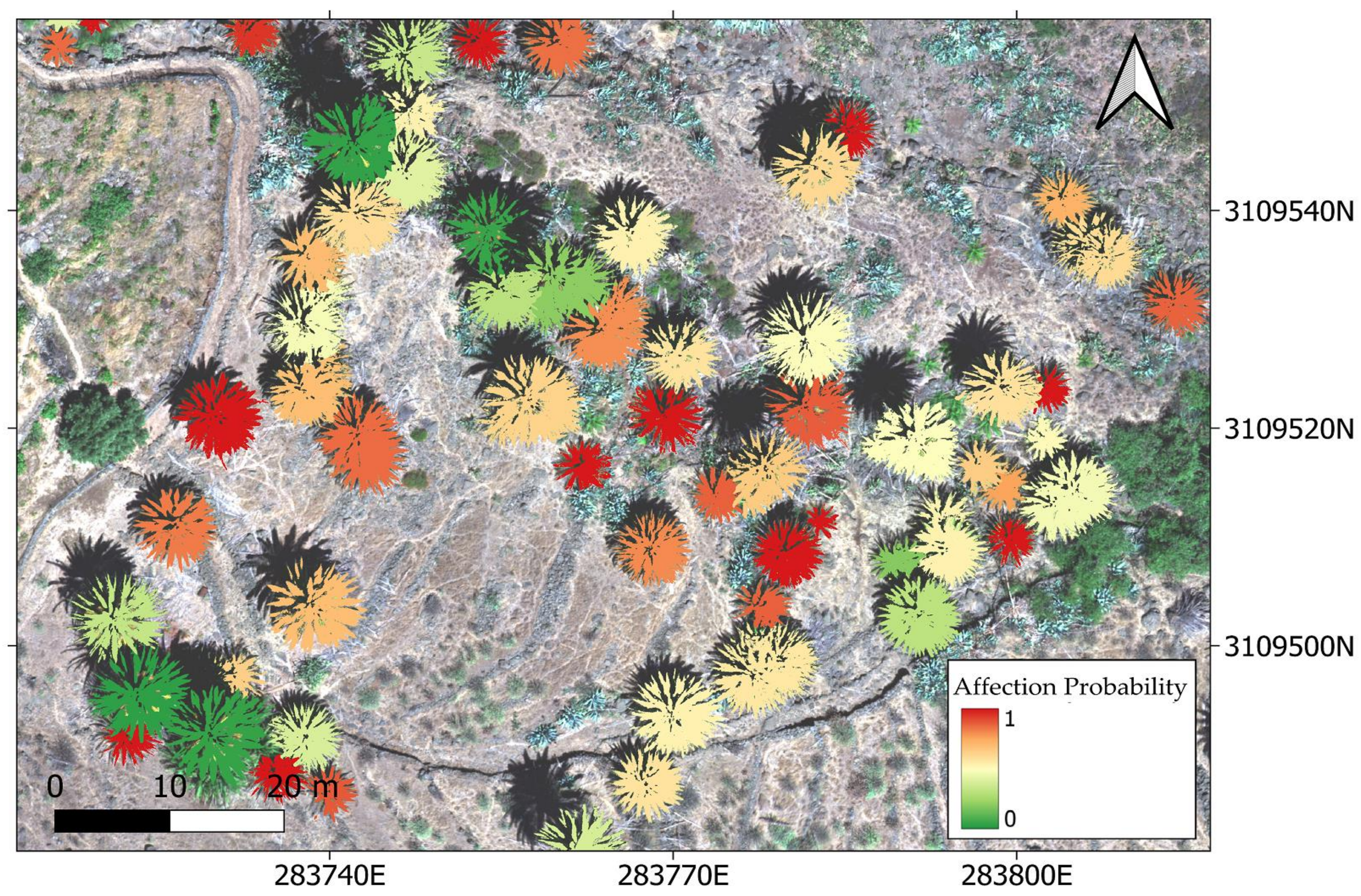


Two study areas were chosen: the Vegaipala area on the island of La Gomera and Barranco El Cercado on Tenerife, located in the Canary Islands archipelago.

RESULTS



	RF	SVM	ANN
Omission error	0.12	0.16	0.18
Commission error	0.14	0.19	0.17
Accuracy	0.83	0.69	0.71
Precision	0.89	0.72	0.76
Recall	0.91	0.77	0.73
F1-Score	0.88	0.74	0.78



Class	O. Error	C. Error	Accuracy	Precision	Recall	F1-Score
Infected	0.13	0.07	0.87	0.93	0.87	0.90
Healthy	0.13	0.23	0.87	0.77	0.87	0.82

CONCLUSIONS

The probabilistic classification model developed, based on the machine learning RF algorithm, is an efficient tool for identifying infected palm tree specimens using multispectral information captured with UAV onboard sensors. This tool showed performances similar, and even superior in some cases, to that of more complex and data-demanding techniques. Collecting new images and in situ data will allow, on the one hand, to further validate the proposed model and to construct more complex models based on DL architecture, such as Mask R-CNN. In addition, studying the palm groves at different times of the year will broaden our knowledge of the seasonal variations of *P. canariensis*.