



Monitoring Bee Diversity in Natural Systems Novel Aerial and Classical Ground Methods to Evaluate Biotic and Abiotic Indicators

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BEEM project

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Monitoring Bee Diversity in agricultural or Natural Systems

Development and implementation of innovative Novel **Aerial** and Classical Ground Methods to
technologies/methods for ecological monitoring: Evaluate Biotic and Abiotic Indicators

Geomatics role

acquisition, processing, restitution and management of metric and thematic data relating to
natural environment, identified by its spatial position and qualified by the precision of the survey.

- accurate spatial and spectral information
- rapid and low cost

perform ground cover classification

Sites and Data acquisition

Alexander Stream National Park

- Costal sand ecosystem
- Subject of ecosystem restoration policies



3 areas of about 10 ha
8 flights
65 GB (raw data)

The Judean foothills

- Shrublands / maquis ecosystem with
vertisol soil
- Mosaic of agricultural fields and planted
pine forest



3 areas of about 10 ha
11 flights (cross)
77 GB (raw data)



Photogrammetric processing

Blue : center 470 nm, width 120 nm
Green : center 520 nm, width 110 nm
Red : center 620 nm, width 110 nm

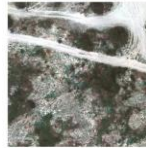
Red-W: center 650 nm, width 40 nm
Red Edge: center 715 nm, width 30 nm
Near IR: center 850 nm width 70 nm

Digital Product	Parameters	Dataset 1	Dataset 3	Dataset 4
Aerial images	number	4.446	3.918	5.022
DPC	point number	171.888.469	130.377.749	170.992.083
	processing time	28 min	38 min	38 min
DSM	map			
	size	10.127x11.511	11.317x6.440	8.813x12.910
	dim pixel	2,57 cm/pix	2,86 cm/pix	2,75 cm/pix
	processing time	3 min	2 min	24 min
Orthomosaic	map			
	band number	6	6	6
	size	19.870x27.002	22.623x12.27	17.569x25.85
	dim pixel	1,28 cm/pix	1,43 cm/pix	1,38 cm/pix
	processing time	27 min	15 min	43 min

Digital Product	Parameters	Dataset 1	Dataset 2	Dataset 3
Aerial images	number	1.450	6.846	4.722
DPC	point number	98.452.320	194.483.854	82.769.132
	processing time	37 min	3 hours	1 hour 40 min
DSM	map			
	size	9.595 x 10.824	13.979 x 13.852	7.042 x 8.467
	dim pixel	1,61 cm/pix	1,9 cm/pix	2,01 cm/pix
	processing time	2 min	27 min	2 min
Orthomosaic	map			
	band number	6	6	6
	size	19.190 x 21.648	27.904 x 27.096	13.929 x 16.893
	dim pixel	0,08 cm/pix	0,09 cm/pix	1,01 cm/pix
	processing time	22 min	3 hours	115 min

Object Based Image Analysis (OBIA)

Mean Shift Algorithm



Large-Scale Mean-Shift segmentation



Vectorization

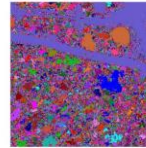
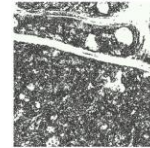
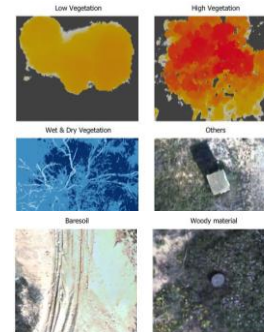


Table 3. Features selected for the classification input dataset. They were computed using ORFEO toolbox.

Category	Features
Spectral-based	Color Index
Statistical-based	Variance
	Mean
	Skewness
	Kurtosis
Elevation	Digital Elevation Model
Geometric	Extension (Number of Pixels)
	Flat
	Roundness
	Longness
	Perimeter

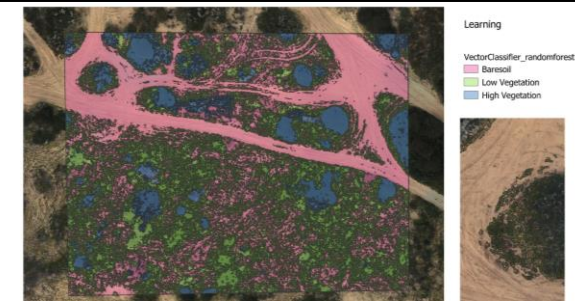
ID	Name	Code
01	Bare soil	11
02	Wet Low Herbaceous plants	22
03	Wet High Herbaceous plants	33
04	Dry Low Herbaceous plants	44
05	Dry High Herbaceous plants	55
06	Woody plants	66
07	Rock	77



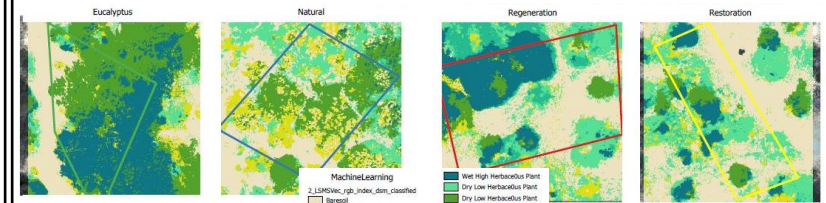
RANDOM FOREST

A set of random decision trees. Majority voting between all random trees.

	11	22	33	44	55	66
Precision	0.966	0.969	0.911	0.887	0.883	0.919
Recall	0.976	0.856	0.93	0.923	0.933	0.888
F-score	0.971	0.909	0.920	0.905	0.907	0.903



Ground Cover Results



ID	Name	Code	# Pixel	Area (m²)	Ground Cover (%)
01	Bare soil	11	674683	151,80	19,39
02	Wet Low Herbaceous plants	22	94517	21,27	2,72
03	Wet High Herbaceous plants	33	291825	65,66	8,39
04	Dry Low Herbaceous plants	44	211854	47,67	6,09
05	Dry High Herbaceous plants	55	518092	116,57	14,89
06	Woody plants	66	1687902	379,78	48,52

ID	Name	Code	# Pixel	Area (m²)	Ground Cover (%)
01	Bare soil	11	1071724	241,14	33,67
02	Wet Low Herbaceous plants	22	334780	75,33	10,52
03	Wet High Herbaceous plants	33	663552	149,30	20,85
04	Dry Low Herbaceous plants	44	184572	41,53	5,80
05	Dry High Herbaceous plants	55	349951	78,74	10,99
06	Woody plants	66	578280	130,11	18,17

Conclusions

Bees provide essential pollination services to natural ecosystems and agricultural crops. However, managed and wild bee populations are in decline worldwide. Direct bee monitoring is costly and requires high expertise. Therefore, cost-effective indicators for bee diversity are essential. Here we propose to test novel aerial techniques along with classical ground methods to collect biotic and abiotic indicators. Multispectral sensors and photogrammetry can provide huge information to describe better the features of different classes in natural environment. Therefore, geomatics techniques could be helpful in monitoring bee diversity.

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