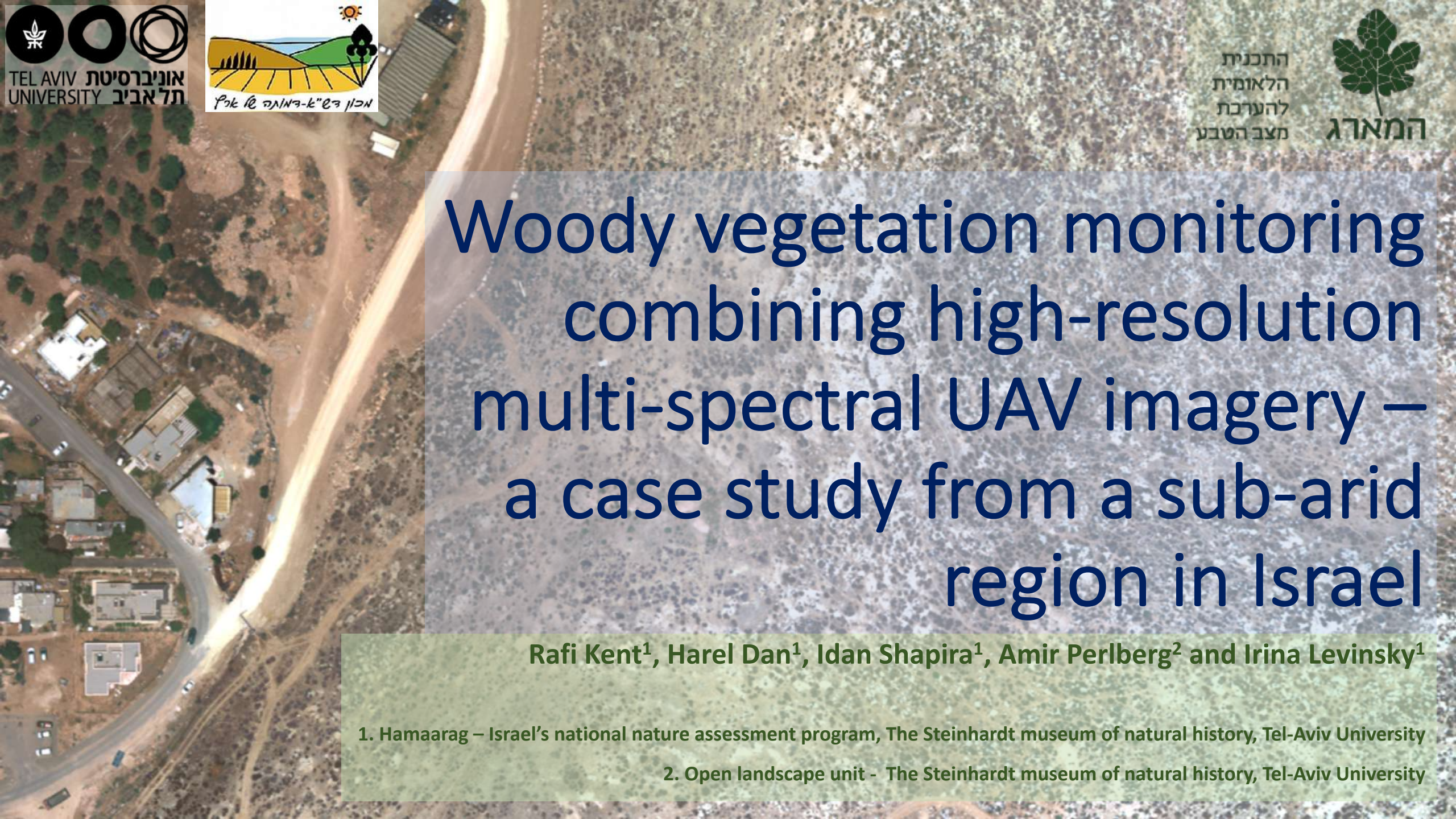

Woody vegetation monitoring combining high-resolution multi-spectral UAV imagery – a case study from a sub-arid region in Israel

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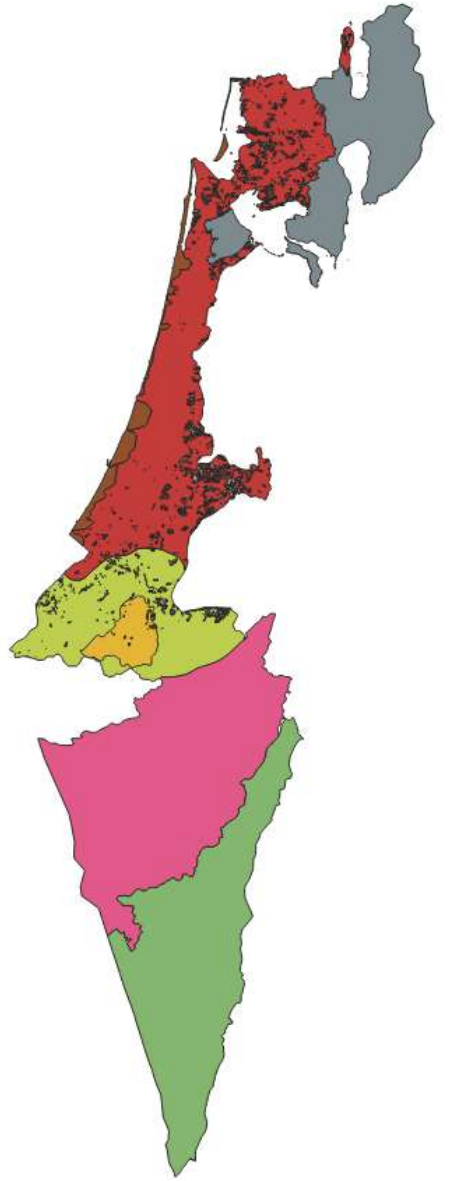
The Monitoring program

- The Maarag is responsible for monitoring Nature's status in Israel. Founded and funded by INPA, JNF and MoEP
- Divided Israel into 9 monitoring units
- Woody vegetation is an indicator of human impact – direct and indirect



Methods of monitoring woody vegetation

- Manual identification and repeated measures of individual plants in permanent plots
- High inter-observer and inter-annual variability
- Combining remote-sensing techniques reduces subjectivity
- Introducing new challenges

UAV imagery

- UAV multi-spectral imagery allows identification and quantification of woody vegetation patches, with high repeatability and precision*
- Further, it allows quantifying vegetation cover over larger areas
- Depends on flight and light conditions
- Here I show a pilot of incorporating UAV images to improve spatial and temporal coverage, as well as improve precision in monitoring vegetation cover in the Mediterranean-Desert transition zone of Israel as part of the national monitoring program carried out by the Maarag

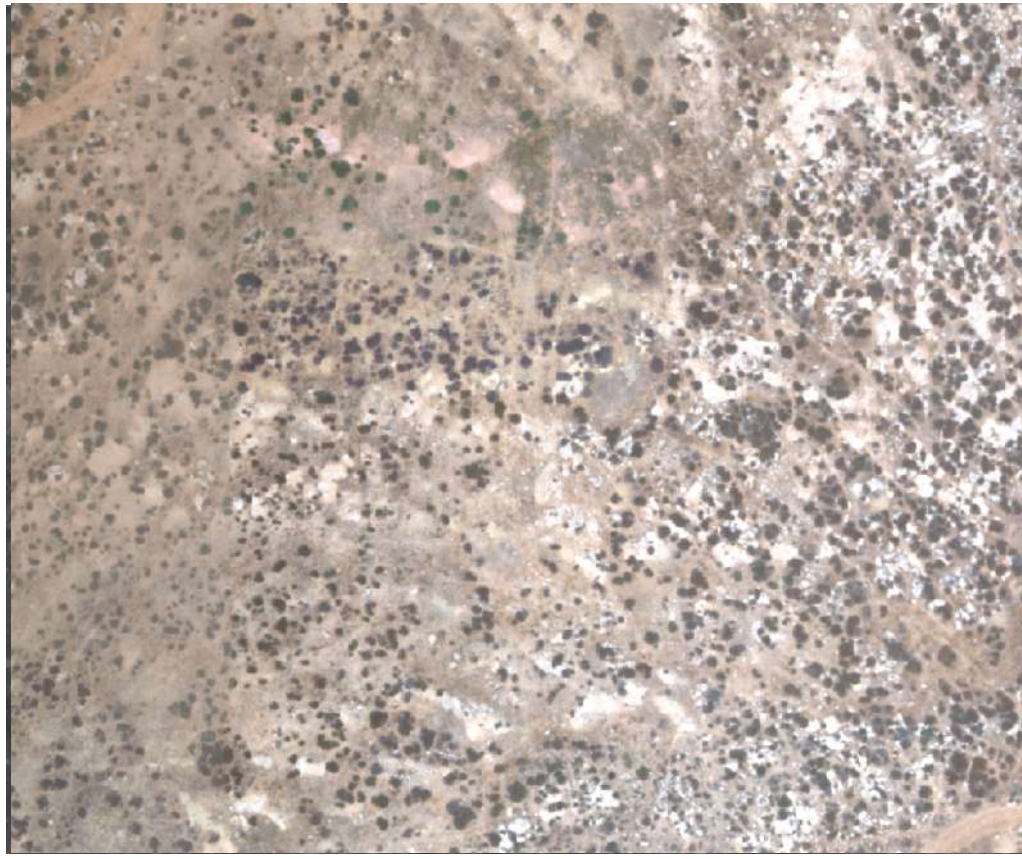
The unit, the site and the plots

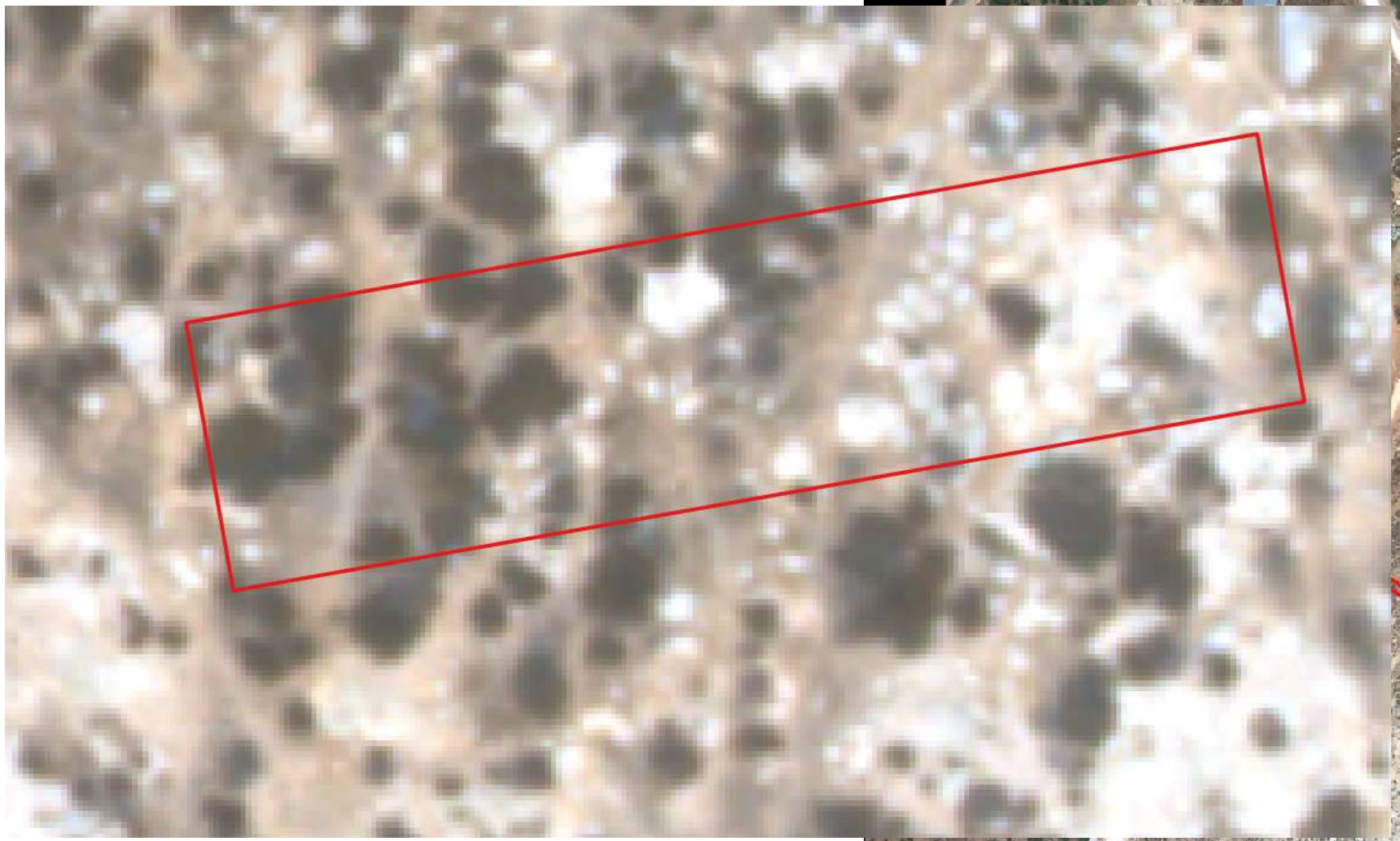
- The Med-arid transition zone (hereinafter Sfar) is characterized by relatively low precipitation (150-400 Mm per year). It is heavily impacted by human settlements as well as a concentration of intensive crop agriculture. It also contains several planted coniferous forests
- The sites where the monitoring took place are near Jewish rural settlements, testing for human impacts on species composition and vegetation cover
- Sampling design includes three plots near the settlement (‘near’ – 0-100m) and three away from the settlement (‘far’ – 500 – 2000m)

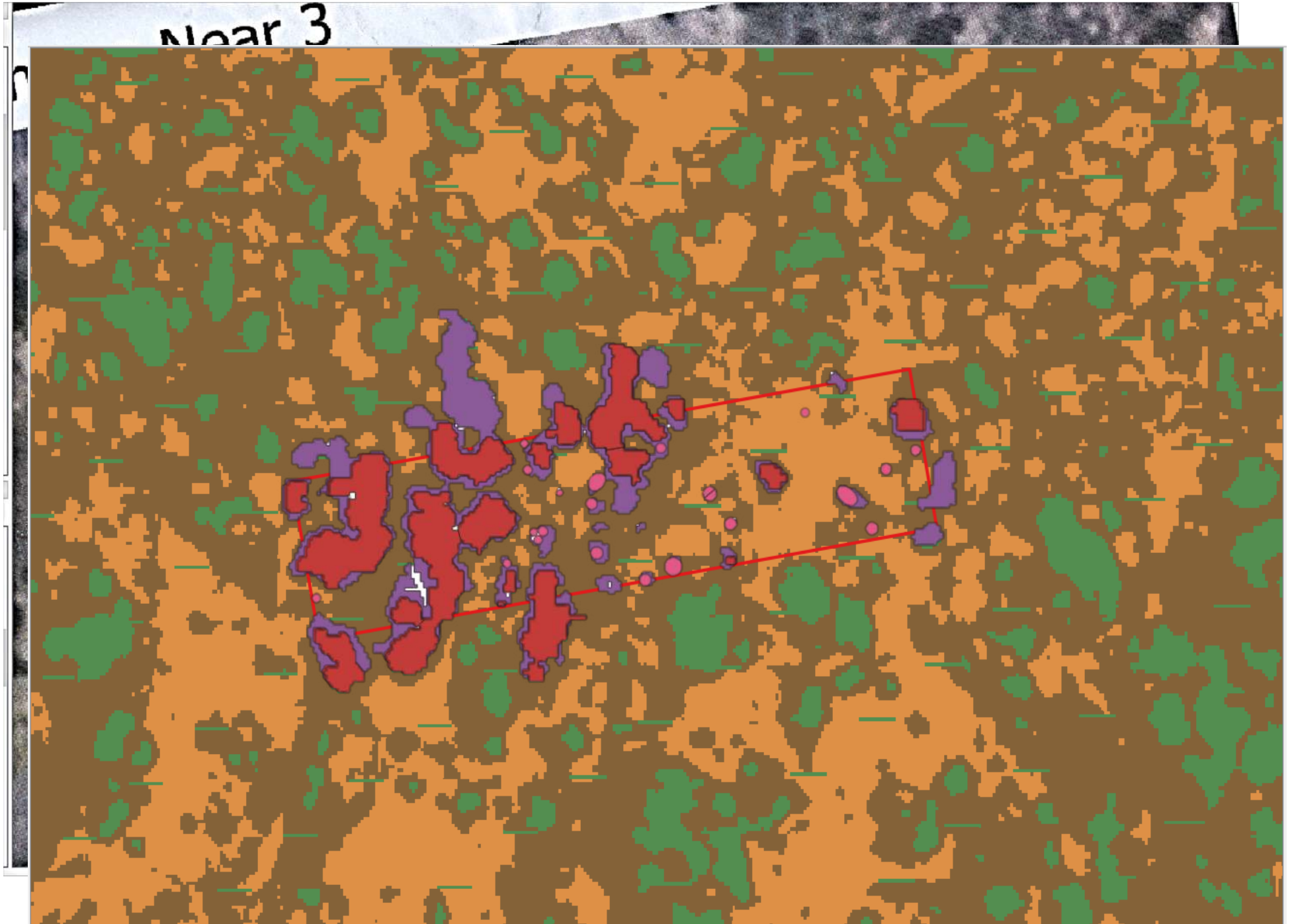
- Each plot is sampled every two years. A plot consists of a 4X4m fixed plot (in the 3rd monitoring round plots size was increased). All individual woody plants were identified and measured (two diameters)
- In the 2017-2018 monitoring, we added UAV imagery, and used it to increase plot size (5X20m, all analyses in this presentation relate to the larger plots)

UAV and sensors

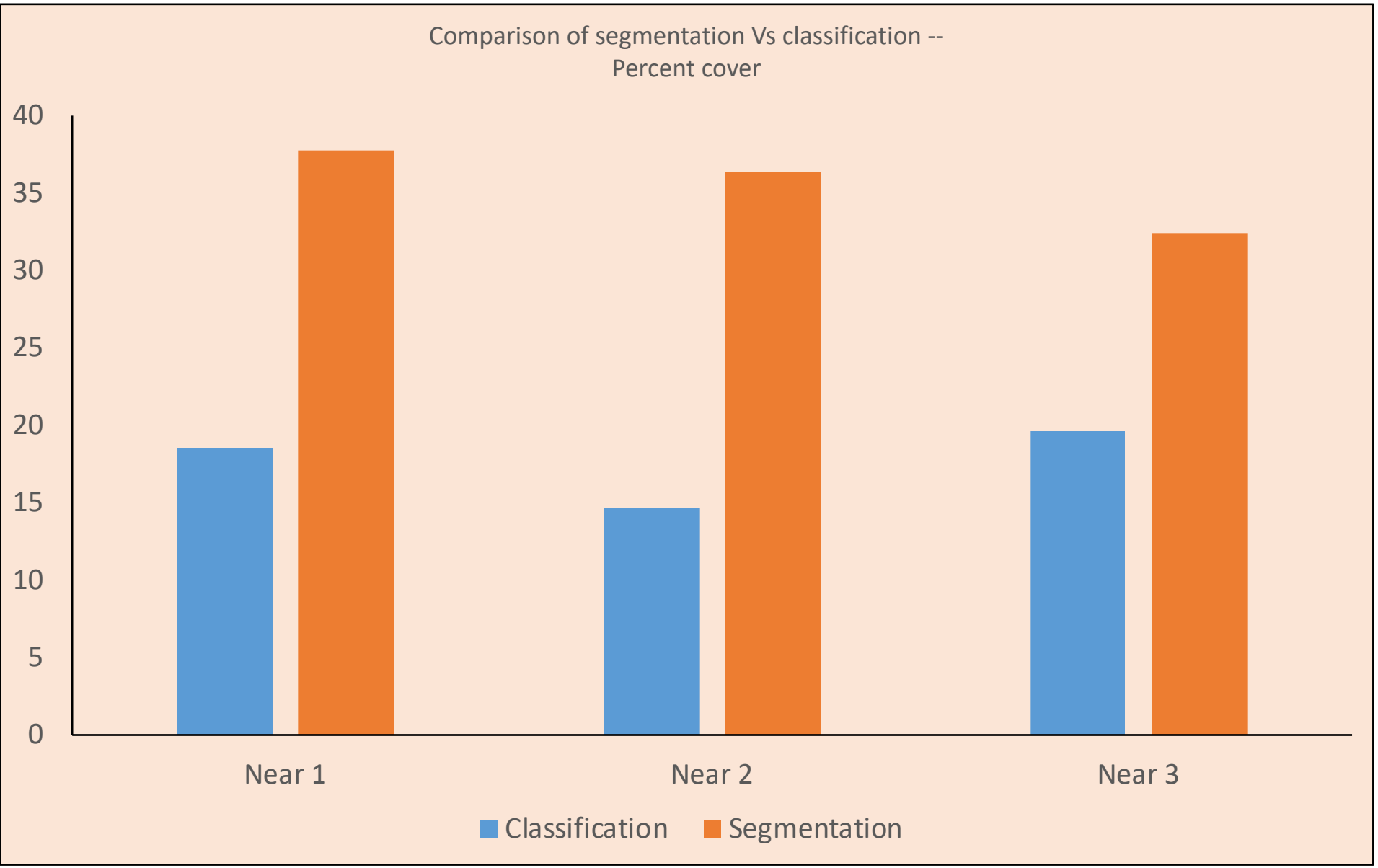
- The UAV is a multi-copter, taking 10cm resolution images
- Micasense sensor with 5 spectral bands – Red, Green, Blue, RedEdge, NIR
- Analyses included segmentation using a NDVI threshold (hereafter ‘segmentation’ and maximum likelihood classification using 5 spectral bands, as well as NDVI and REDVI (hereafter ‘classification’)
- Ground data were collected by experienced “Deshe” surveyors, based on identified woody vegetation patches






Near 3

Some results



Percent cover, as well as mean patch size was overestimated by segmentation compared to classification

False negative identification (missed patches of woody vegetation by the classification) constituted only a marginal added cover (0.34 m^2, equaling 0.34% of the plot total area)

False positive (misidentification of herbaceous plants as woody) constituted 0.48% of the plot area, combined

Species by plot

Common/latin name	Hebrew name	Near 1	Near 2	Near 3
Bindweed	חבלבל זיתני	+	-	-
Jerusalem Spurge	חלבלוב מגובשש	+	+	+
Prickly Burnet	סירה קוצנית	+	+	+
African Fleabane	צמרנית הסלעים	+	+	+
Astragalus bethlehemiticus	קדד בית הלחמי	+	+	-
Carlina curetum	קיצנית כרתית	+	-	-
Convolvulus auricomus	חבלבל מגובב	+	-	-
Noaea mucronata	נואית קוצנית	+	+	+
Jerusalem Sage	שלהבית קצרת שיניים	+	-	-
Pink Sun-rose	שמשון הדור	+	+	-
Cat-thyme Germander	געדה מצויה	+	+	-
Common Ballota	גלונית מצויה	-	+	-
Asparagus horridus	אספרג ארוך עלים	-	+	-
Artemisia sieberi	לענת המדבר	-	+	-
UK	בלתי מזוהה	+	-	-
Total		**12**	**11**	**4**

Conclusions

- UAVs are a useful tool for woody vegetation monitoring, especially in low productivity environments
- Fast and easily automated methods (i.e., segmentation based on thresholds) are sensitive, and might result in over- or under-estimates of vegetation cover
- Supervised classification offers a more robust solution, however it is more time consuming
- A combination of methods is probably optimal to improve accuracy, while maintaining a semi-automatic process

Thanks for listening

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