SEX DISCRIMINATION OF INDIVIDUAL TREES USING UAV IMAGERY

M. Miraki[1], H. Sohrabi[2] *, O. Esmailzadeh[3]

[1]Department of forest science and engineering, Faculty of Natural Resources, Tarbiat Modares University, Jalal Ale Ahmad Highway, P.O. Box: 14115-111, Tehran, Iran. m.miraki@modares.ac.ir
[2]Department of forest science and engineering, Faculty of Natural Resources, Tarbiat Modares University, Jalal Ale Ahmad Highway, P.O. Box: 14115-111, Tehran, Iran, hsohrabi@modares.ac.ir, Corresponding author
[3]Department of forest science and engineering, Faculty of Natural Resources, Tarbiat Modares University, Jalal Ale Ahmad Highway, P.O. Box: 14115-111, Tehran, Iran. oesmailzadeh@modares.ac.ir

KEY WORDS: UAV, RGB images, Random forest classification, Caspian poplar, Sex discrimination, Dioecious trees

ABSTRACT:

The sex ratio is the proportion of male to female trees, which has a substantial impact on reproductive success and conservation status. Appropriate sex-related differences in dioecious trees commonly result in leading to a robustly structured population. Fieldwork for sex discrimination is time-consuming and labor-required. Benefiting from the unmanned aerial vehicle (UAV) and SfM techniques, the present study aims to detect male and female Caspian poplar (*Populus caspica*) trees. In March 2021, a heterogeneous forest in Noor city located in Mazandaran province was photographed, then 3D point clouds were extracted from the images using structure from motion algorithm (SfM) to generate an orthomosaic and a point cloud. The field survey was carried out to record the species, sex, and position of the overstory trees which were identifiable on the orthomosaics. A random forest classification algorithm was applied using R software to classify the trees into male and female. By assessing the producer's accuracy, user's accuracy, and overall accuracy, the classification accuracy for identified trees was computed using 10-fold cross-validation. The results showed an accuracy of 83% for identifying Caspian poplar trees and 52% accuracy for Sex discrimination. Overall, our effort to evaluate sex discrimination of dioecious trees using UAV imagery represents a promising preliminary step in forest data collection.

1. INTRODUCTION

Flowering trees have a wide range of sexuality. Some dioecious trees (for example ginkgo, holly, yew, willow and Caspian poplar) have male and female parts on distinct trees, with one tree being exclusively female and the other male. In dioecious trees, females devote more resources to sexual reproduction and spend less on growth and maintenance than males (Matsushita et al., 2016). The sex ratio (SR) of these trees is the ratio of male to female trees, which has a substantial impact on reproductive success and conservation status.

The sexes' geographical distribution, which is typically impacted by environmental variation, is particularly crucial for reproductive success. In hostile situations with limited resources, environmental variables are accountable for the sexes' spatial segregation. The reproductive biology may also contribute to dioecious trees' sensitivity to global change, as females require more resources for reproduction than males and thus develop more slowly. On the poorer sites, males dominate. On the other hand, climate change may affect the availability of resources, resulting in a concentration of females in climatically advantageous areas (Garbarino et al., 2015). This issue shows the importance of determining the male and female trees distribution.

Populus caspica Bornm (Caspian poplar) is a dioecious tree that contributes significantly to Hyrcanian forest biodiversity especially in the lowland area. It is an endangered and endemic tree species that are declining due to land use changing as well as its habitat fragmentations (Fallah et al., 2011; Yousefzadeh et al., 2018). This species is endemic to the Hyrcanian forests which are identified as a refuge for many Arco-Tertiary relict plants (Sagheb Talebi et al., 2014)

Sex determination of these tree is very difficult due to the high trees height and the short flowering season. That's why a gender study of this species has never been performed. Because fieldwork efforts are costly and time-consuming, some activities on providing the required data for plants evaluation has been carried out by remote sensing (Rominger & Meyer, 2019).

Compared to fieldwork, remote sensing puts out data for mapping and monitoring at reduced costs. While RS based mapping can cover larger and inaccessible areas, it can be done at a less cost and faster (Gülci, 2019; Madera et al., 2019) which intrigues the search for more suitable data sources.

In recent years, unmanned aerial vehicles (UAVs) have risen in popularity, in particular in forestry management. Because of the fine spatial (achieved by the low flying height) and temporal resolution, RGB cameras placed on UAV platforms are becoming cost-effective tools for forest monitoring and conservation projects. Light UAVs fitted with consumer-grade cameras have recently attracted a lot of attention for forest monitoring due to their low cost and operating flexibility (Guerra-Hernández et al., 2017; Rees et al., 2018). Various studies have shown UAV potential for forest trees classification and identification (Gini et al., 2018; Kampen et al., 2019; Kuzmin et al., 2017; Onishi & Ise., 2018; Sadeghi & Sohrabi., 2018).

One of the prominent traits that are widely used for classification is the tree species color. Success in detection, identification, and classification generally depends on the main color differences between the species (Kuzmin et al., 2017; Rominger & Meyer., 2019; Sadeghi & Sohrabi., 2018).

Therefore, color can be used as a phenotypic trait to classify tree species. The color of flowers has been studied in estimating the volume and flowering rate of plants (Carl et al., 2017; Wan et al., 2018), but the study of this trait in dioecious trees to discriminate male and female trees has not been performed so far. In this study, the discrimination of male and female trees of Caspian poplar based on RGB-UAV images was.

* Corresponding author: hsohrabi@modares.ac.ir

2. MATERIAL AND METHOD

2.1 Study Area

The test site is in Noor, Mazandaran Province in northern Iran, in an area of Hyrcanian forests (Figure 1). With a mean elevation of -27 meters, the area is situated in an eastern latitude of 36°34′43.96′ and a northern longitude of 52°02′29.14″. The forest is described as a deciduous and temperate forest with multi-layered stands and high tree species diversity. The research region has slopes ranging from 0 to 4 percentage, and the climate is humid (Hadiani., 2015). The average annual precipitation is 997 millimetres, and the average annual temperature is 16.4 °C. Different tree species such as *Populus caspica* (Caspian Poplar), *Parrotia persica* (Persian ironwood), *Ulmus minor* (Common Elm), and *Quercus castaneifolia* (Chestnut-leaved oak) can be found in this area.

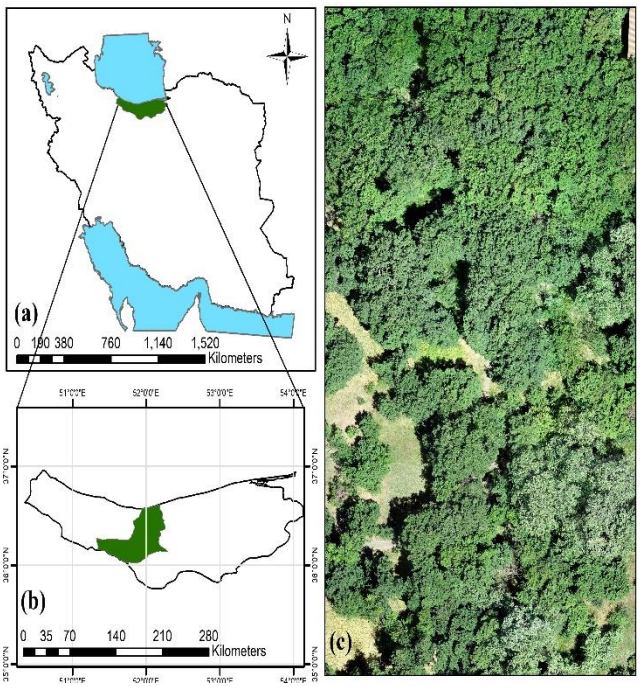

Figure 1. Location of studied site. a) Iran, b) Noor city located in the Mazandaran province, c) landscape of Studied forest (Download of the location link: https://www.scribblemaps.com/maps/view/Study-area/dsw6MkzjkT)

2.2 Field Data

Species, crown diameter, and the gender of Caspian poplar trees were recorded for all the trees that their crowns were visible on the orthomosaic. The trees' geographic positions were determined using an RTK GPS (Gintec G10) or if the GPS signal was too weak, an azimuth–distance technique utilizing a laser distance meter and a hand-bearing compass were used. Male and female Caspian poplar trees were also identified using binoculars and observing the shape and color of flowers (Figure 2).

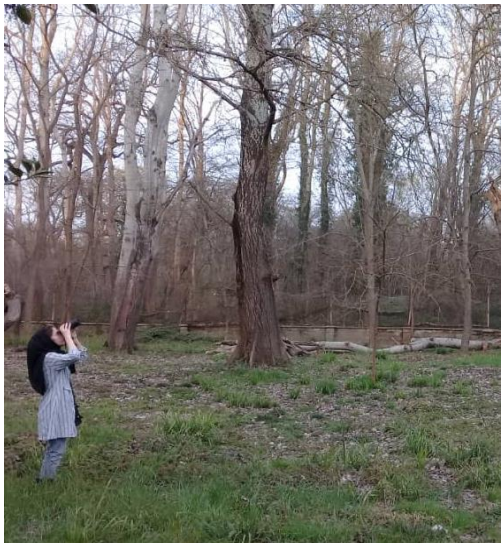

Figure 2. Observation of trees flowers for their sex determination

Floral time in dioecious species of poplars (*Populus spp.*) depending on seasonal timing is different (Cronk et al., 2020). The mature male and female inflorescences of Caspian poplar are detected in middle-March to early April. Therefore, the best time to the sex discrimination of the Caspian poplar trees is mid to late March.

The Caspian poplar flowers mostly appear before the leaves in the early spring which long, and drooping catkins are produced. The male flowers are shorter and yellow, but anthers are purple or red. The female flower is long and green (Figure 3).

Figure 3. Caspian poplar flowers: right) Female flower, left) Male flower

2.3 UAV Image Acquisition and Processing

The raw images were taken in March 2021 with a UAV Phantom 4 PRO equipped with a mechanical shutter, capable of recording a 20-megapixel RGB image in JEPG format (focal length of 8.8 millimetres). With a clear sky and no wind, the image acquisition was accomplished within a half-hour of the solar zenith (Cardil et al., 2019). The summary of flight parameters is shown in Table 1.

Parameters	Value
Flight altitude	60 m
GSD	2 cm
Forward overlap	80%
Side overlap	60%
Flight speed	8 m/s

Table 1. Summary of flight parameters

First, the quality of images was checked manually. As a result, images with evident artifacts, blurring with a high level, or images are taken too near to the ground were not processed (Brovkina et al. 2018). Then, processing the UAV images was performed by Agisoft Metashape v1.6.3 using the structure from motion (SfM) technique. Based on 2D overlapping pictures, the SfM approach generates 3D point clouds. It uses key points in each image in accordance with the same points in other sets of images over the same region (Otero et al., 2018). The parameters setting used for processing are shown in Table 2.

Processing Step	Parameter Name	Parameter Value
Alignment	Accuracy	High
Dense cloud generation	Quality Depth filtering Max angle (◦)	High Moderate 10
Ground classification	Max distance (m) Cell size (m)	1 50
Build Orthomosaic	Surface: DEM	-

Table 2. The most substantial processing stages and parameters

The RGB orthomosaic provided the spectral features for classification by selecting pixels within crowns by the one-meter buffer. Statistical indices were calculated for raw bands (Red, Green, Blue) and vegetation indices (NRB, NGB) from RGB orthomosaic. The following formulas were applied:

$$\mathrm{NGB} = \frac{\mathrm{green}-\mathrm{blue}}{\mathrm{green}+\mathrm{blue}} \quad (1)$$

$$\mathrm{NRB} = \frac{\mathrm{red}-\mathrm{blue}}{\mathrm{red}+\mathrm{blue}} \quad (2)$$

Finally, the Random Forest algorithm was applied in the randomForest package in the R environment (3.6.0) for classification.
Random Forest classification is an ensemble learning method that generates many decision trees from a randomly selected subset of training samples and variables. The RF classifier has become well-known in the field of remote sensing due to its performance and precision in classifying (Zhang et al., 2019). We used default parameters (i.e., number of trees (ntree) set to 500) to run the RF classifier because prior research have shown that default settings produce decent results (Daryaei et al., 2020; Immitzer et al., 2012, 2016).
A k-fold cross-validation method was used to validate the classification models with a set of k = 10. When there are a minimal number of samples, the k-fold approach is a dependable and robust method that does not rely on a specific collection of samples (Sothe et al., 2019; Nevalainen et al., 2017). The overall accuracy (OA), producer's accuracies (PA), and user's accuracies (UA) were calculated using the confusion matrix. In this method, all data are considered as test data and training data. In such a way that the process is repeated 10 times. In each repetition, 9 parts of the data are used as training data and one part as test data.

3. RESULTS AND DISCUSSION

As can be seen in Figure 4, Caspian poplar trees were identified from other trees i.e., Persian ironwood, Chestnut-leaved oak, and Common elm with an overall accuracy of 83%. The reason for this high accuracy can be considered in the different color, Caspian poplar due to having five-lobed with silver-green colored leave are quitley recognizable by the other trees, and geometry of Caspian poplar trees (Miraki et al., 2021). Because, the success of detection generally depends on a major color difference between target species (Kuzmin et al., 2017; Rominger & Meyer, 2019; Sadeghi & Sohrabi, 2018).

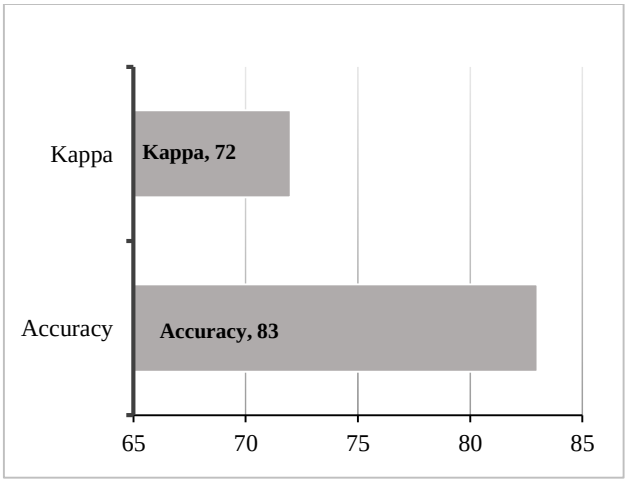

Figure 4. Accuracy of Caspian poplar trees identification compared to other trees

To evaluate the results of RF classification calculated the producer's and user's accuracies for each class.
Caspian poplar class producer's accuracy is 97% which is lower than other trees class accuracy (99%). Also, the Caspian poplar class user's accuracy is 48% (Figure 5).

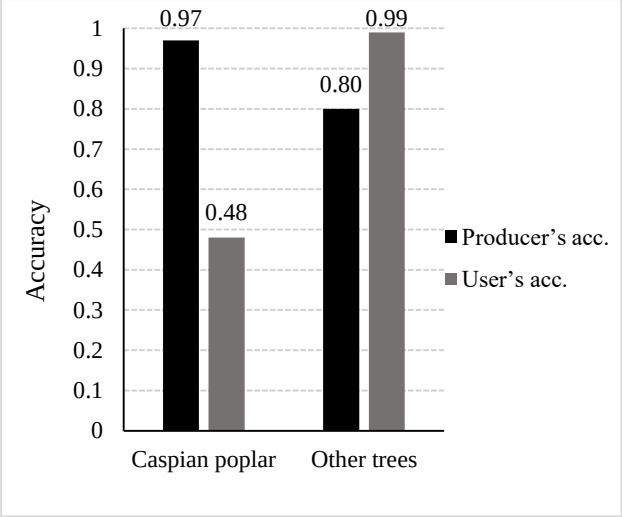

Figure 5. Producer's and User's accuracy of Caspian poplar and other trees classes

Many studies have been conducted to identify tree species using UAV images (Feng et al., 2015; Gini et al., 2018; Leduc et al., 2018; Maschler et al., 2018; Nevalainen et al., 2017).

All of this research has shown that the spectral signeture of each species is different from the other, which helps to differentiate the species using remote sensing data. Therefore, the difference in the leaf optical properties, i.e., color of the flowers at the crown level of the dioecious trees also causes a different spectrum of those species and they can be used to the sex discrimination.

In this study, the sex discrimination of dioecious trees i.e., Caspian poplar was tested as a pilot. Caspian poplar trees were identified into two classes i.e., male and female trees with a total of 7 female trees and 14 male trees. 3 out of 7 female trees and 8 out of 14 male trees were correctly identified. This result showed that there is a relationship between vegetation indices (RGB indices) and flowers spectral reflectance of a tree and it can be used to discriminate male and female trees of the same species. (Wan et al., 2018) also showed a relationship between vegetation indices and number of flowers.

Class	Female	Male	Sum	Users acc.
Female	3	6	9	0.33
Male	4	8	12	0.67
Sum	7	14	Overall Accuracy = 52%	
Prod. acc.	0.43	0.57		

Table 3. Confusion matrices for random forest (RF) classification. Columns show ground truth and rows show classification results

The identification of male and female trees was performed with a small number of trees (unexpected quarantines associated with COVID-19 pandemic constrained the possibility of providing a large data set), for this reason, the results may not have the necessary generalizability. Overall, taking of images time is very important in gender segregation, and the pandemic made it difficult to collect the data with the best timing of flower densities on trees.

Also, at the time of flowering of Caspian poplar trees, there were no leaves on the trees, and in crown polygons for sex identification, spectral mixing is observed due to a combination of branches, flowers, herbaceous plants of forest floor and soil, which reduced the accuracy of identification.

To our knowledge, this is the first time that the sex discrimination of male and female trees has been performed, so this method can be improved in future research. In the further studies, the following cases can also be studied to improve results.

1. Taking images at different flights altitude to determine the appropriate flight altitude for the sex discrimination of the trees
2. Sex discrimination evaluation by the multispectral data
3. Estimating biochemical properties using UAV imagery and examining its relationship with the sex of trees
4. Sex discrimination of evergreen dioecious trees, i.,e, *taxus bacata*

4. CONCLUSION

This paper demonstrated the usefulness of the RGB-UAV imagery for the detection of sex of Caspian poplar individuals in a mixed broadleaf forest. The results showed that UAV-based RGB imagery gives enough information to detect trees. Also, the random forest classification produced acceptable accuracies, indicating that this is a viable method for detecting individual trees. But it did not provide high accuracy for identifying the male and female individuals.

ACKNOWLEDGEMENTS

We would like to express our thanks to the Tarbiat Modares University for the financial support. We wish to thank Sima Sadeghi for her valuable help in data collection.

REFERENCES

Brovkina, O., Cienciala, E., Surový, P., & Janata, P. (2018). Unmanned aerial vehicles (UAV) for assessment of qualitative classification of Norway spruce in temperate forest stands. *Geo-Spatial Information Science*, *21*(1), 12–20. https://doi.org/10.1080/10095020.2017.1416994

Cardil, A., Otsu, K., Pla, M., Silva, C. A., & Brotons, L. (2019). Quantifying pine processionary moth defoliation in a pine-oak mixed forest using unmanned aerial systems and multispectral imagery. *PLOS ONE*, *14*(3), e0213027. https://doi.org/10.1371/journal.pone.0213027

Carl, C., Landgraf, D., van der Maaten-Theunissen, M., Biber, P., Pretzsch, H., Carl, C., Landgraf, D., van der Maaten-Theunissen, M., Biber, P., & Pretzsch, H. (2017). Robinia pseudoacacia L. Flower Analyzed by Using An Unmanned Aerial Vehicle (UAV). *Remote Sensing*, *9*(11), 1091. https://doi.org/10.3390/rs9111091

Cronk, Q., Soolanayakanahally, R., & Bräutigam, K. (2020). Gene expression trajectories during male and female reproductive development in balsam poplar (Populus balsamifera L.). *Scientific Reports 2020 10:1*, *10*(1), 1–14. https://doi.org/10.1038/s41598-020-64938-w

Daryaei, A., Sohrabi, H., Atzberger, C., & Immitzer, M. (2020). Fine-scale detection of vegetation in semi-arid mountainous areas with focus on riparian landscapes using Sentinel-2 and

UAV data. *Computers and Electronics in Agriculture*, *177*, 105686. https://doi.org/10.1016/j.compag.2020.105686

Fallah, H., Tabari, M., Azadfar, D., & Jalali, S. G. A. (2011). Distribution and Ecological Features Endangered Species Populus Caspica Bornm in the Hyrcanian Forest. *Natural Ecosystems of Iran*, *2*, 41–53. https://www.sid.ir/en/journal/ViewPaper.aspx?ID=259824

Feng, Q., Liu, J., & Gong, J. (2015). UAV Remote Sensing for Urban Vegetation Mapping Using Random Forest and Texture Analysis. *Remote Sensing*, *7*(1), 1074–1094. https://doi.org/10.3390/rs70101074

Garbarino, M., Weisberg, P. J., Urbinati, C., Bagnara, L., & Urbinati, C. (2015). Sex-related spatial segregation along environmental gradients in the dioecious conifer, Taxus baccata. *Forest Ecology and Management*, *358*, 122–129. https://doi.org/10.1016/J.FORECO.2015.09.009

Gini, R., Sona, G., Ronchetti, G., Passoni, D., Pinto, L., Gini, R., Sona, G., Ronchetti, G., Passoni, D., & Pinto, L. (2018). Improving Tree Species Classification Using UAS Multispectral Images and Texture Measures. *ISPRS International Journal of Geo-Information*, *7*(8), 315. https://doi.org/10.3390/ijgi7080315

Guerra-Hernández, J., González-Ferreiro, E., Monleón, V. J., Faias, S. P., Tomé, M., Díaz-Varela, R. A., Guerra-Hernández, J., González-Ferreiro, E., Monleón, V. J., Faias, S. P., Tomé, M., & Díaz-Varela, R. A. (2017). Use of Multi-Temporal UAV-Derived Imagery for Estimating Individual Tree Growth in Pinus pinea Stands. *Forests*, *8*(8), 300. https://doi.org/10.3390/f8080300

Gülci, S. (2019). The determination of some stand parameters using SfM-based spatial 3D point cloud in forestry studies: an analysis of data production in pure coniferous young forest stands. *Environmental Monitoring and Assessment*, *191*(8). https://doi.org/10.1007/s10661-019-7628-4

Hadiani, M. O. (2015). Uncertainty of Climate Change and Synoptic Parameters and modeling the trends. *Environmental Resources Research*, *3*(2), 179–190.

Immitzer, M., Atzberger, C., & Koukal, T. (2012). Tree Species Classification with Random Forest Using Very High Spatial Resolution 8-Band WorldView-2 Satellite Data. *Remote Sensing 2012, Vol. 4, Pages 2661-2693*, *4*(9), 2661–2693. https://doi.org/10.3390/RS4092661

Immitzer, M., Vuolo, F., & Atzberger, C. (2016). First Experience with Sentinel-2 Data for Crop and Tree Species Classifications in Central Europe. *Remote Sensing 2016, Vol. 8, Page 166*, *8*(3), 166. https://doi.org/10.3390/RS8030166

Kampen, M., Vienna, L. S., Immitzer, M., & Vienna, L. S. (2019). UAV-Based Multispectral Data for Tree Species Classification and Tree Vitality UAV-Based Multispectral Data for Tree Species Classification and Tree Vitality Analysis. *Dreilandertagung Der DGPF, Der OVG Und Der SGPF in Wien, Osterreich – Publikationen Der DGPF, Band 28, January*, 623–639.

Kuzmin, A., Korhonen, L., Manninen, T., & Maltamo, M. (2017). Automatic Segment-Level Tree Species Recognition Using High Resolution Aerial Winter Imagery. *European Journal of Remote Sensing*, *7254*, 238–259. https://doi.org/10.5721/EuJRS20164914

Leduc, M.-B., Knudby, A. J., Leduc, M.-B., & Knudby, A. J. (2018). Mapping Wild Leek through the Forest Canopy Using a UAV. *Remote Sensing*, *10*(2), 70. https://doi.org/10.3390/rs10010070

Madera, P., Volarík, D., Patocka, Z., Kalivodova, H., Divín, J., Rejzek, M., Vybíral, J., Lvoncík, S., Jeník, D., Hanacek, P., Amer, A. S., & Vahalík, P. (2019). Sustainable Land Use Management Needed to Conserve the Dragon's Blood Tree of Socotra Island, a Vulnerable Endemic Umbrella Species. *Sustainability*, *11*(13), 3557. https://doi.org/10.3390/su11133557

Maschler, J., Atzberger, C., Immitzer, M., Maschler, J., Atzberger, C., & Immitzer, M. (2018). Individual Tree Crown Segmentation and Classification of 13 Tree Species Using Airborne Hyperspectral Data. *Remote Sensing*, *10*(8), 1218. https://doi.org/10.3390/rs10081218

Matsushita, M., Takao, M., & Makita, A. (2016). Sex-different response in growth traits to resource heterogeneity explains male-biased sex ratio. *Acta Oecologica*, *75*, 8–14. https://doi.org/10.1016/J.ACTAO.2016.06.009

Miraki, M., Sohrabi, H., Fatehi, P., & Kneubuehler, M. (2021). Individual tree crown delineation from high-resolution UAV images in broadleaf forest. *Ecological Informatics*, *61*, 101207. https://doi.org/10.1016/j.ecoinf.2020.101207

Nevalainen, O., Honkavaara, E., Tuominen, S., Viljanen, N., Hakala, T., Yu, X., Hyyppä, J., Saari, H., Pölönen, I., Imai, N., & Tommaselli, A. (2017). Individual Tree Detection and Classification with UAV-Based Photogrammetric Point Clouds and Hyperspectral Imaging. *Remote Sensing*, *9*(3), 185. https://doi.org/10.3390/rs9030185

Onishi, M., & Ise, T. (2018). Automatic classification of trees using a UAV onboard camera and deep learning. *CoRR*, abs/1804.10390. http://arxiv.org/abs/1804.10390

Otero, V., Van De Kerchove, R., Satyanarayana, B., Martínez-Espinosa, C., Fisol, M. A. Bin, Ibrahim, M. R. Bin, Sulong, I., Mohd-Lokman, H., Lucas, R., & Dahdouh-Guebas, F. (2018). Managing mangrove forests from the sky: Forest inventory using field data and Unmanned Aerial Vehicle (UAV) imagery in the Matang Mangrove Forest Reserve, peninsular Malaysia. *Forest Ecology and Management*, *411*, 35–45. https://doi.org/10.1016/j.foreco.2017.12.049

Rees, A., Avens, L., Ballorain, K., Bevan, E., Broderick, A., Carthy, R., Christianen, M., Duclos, G., Heithaus, M., Johnston, D., Mangel, J., Paladino, F., Pendoley, K., Reina, R., Robinson, N., Ryan, R., Sykora-Bodie, S., Tilley, D., Varela, M., … Godley, B. (2018). The potential of unmanned aerial systems for sea turtle research and conservation: a review and future directions. *Endangered Species Research*, *35*, 81–100. https://doi.org/10.3354/esr00877

Rominger, K., & Meyer, S. (2019). Application of UAV-Based Methodology for Census of an Endangered Plant Species in a Fragile Habitat. *Remote Sensing*, *11*(6), 719. https://doi.org/10.3390/rs11060719

Sadeghi, S., & Sohrabi, H. (2018). Tree species discrimination using RGB vegetation indices derived from UAV images. *UAV Small Unmanned Aerial System for Environmental Research-6th Edition*, *1*, 5.

Sagheb Talebi, K., Sajedi, T., & Pourhashemi, M. (2014). *Forests of Iran* (Vol. 10). Springer Netherlands. https://doi.org/10.1007/978-94-007-7371-4

Sothe, C., Dalponte, M., Almeida, C. M. de, Schimalski, M. B., Lima, C. L., Liesenberg, V., Miyoshi, G. T., & Tommaselli, A. M. G. (2019). Tree Species Classification in a Highly Diverse Subtropical Forest Integrating UAV-Based Photogrammetric Point Cloud and Hyperspectral Data. *Remote Sensing*, *11*(11), 1338. https://doi.org/10.3390/rs11111338

Wan, L., Li, Y., Cen, H., Zhu, J., Yin, W., Wu, W., Zhu, H., Sun, D., Zhou, W., He, Y., Wan, L., Li, Y., Cen, H., Zhu, J., Yin, W., Wu, W., Zhu, H., Sun, D., Zhou, W., & He, Y. (2018). Combining UAV-Based Vegetation Indices and Image Classification to Estimate Flower Number in Oilseed Rape. *Remote Sensing*, *10*(9), 1484. https://doi.org/10.3390/rs10091484

Yousefzadeh, H., Hosseinzadeh, A., Effat, C., Badbar, M., & Kozlowski, G. (2018). Phylogenetic relationship and genetic differentiation of Populus caspica and Populus alba using cpDNA and ITS noncoding sequences. *Journal of Forestry Research*. https://doi.org/10.1007/s11676-018-0785-4

Zhang, M., Gong, P., Qi, S., Liu, C., & Xiong, T. (2019). Mapping bamboo with regional phenological characteristics derived from dense Landsat time series using Google Earth Engine. *International Journal of Remote Sensing*, *40*(24), 9541–9555. https://doi.org/10.1080/01431161.2019.1633702