

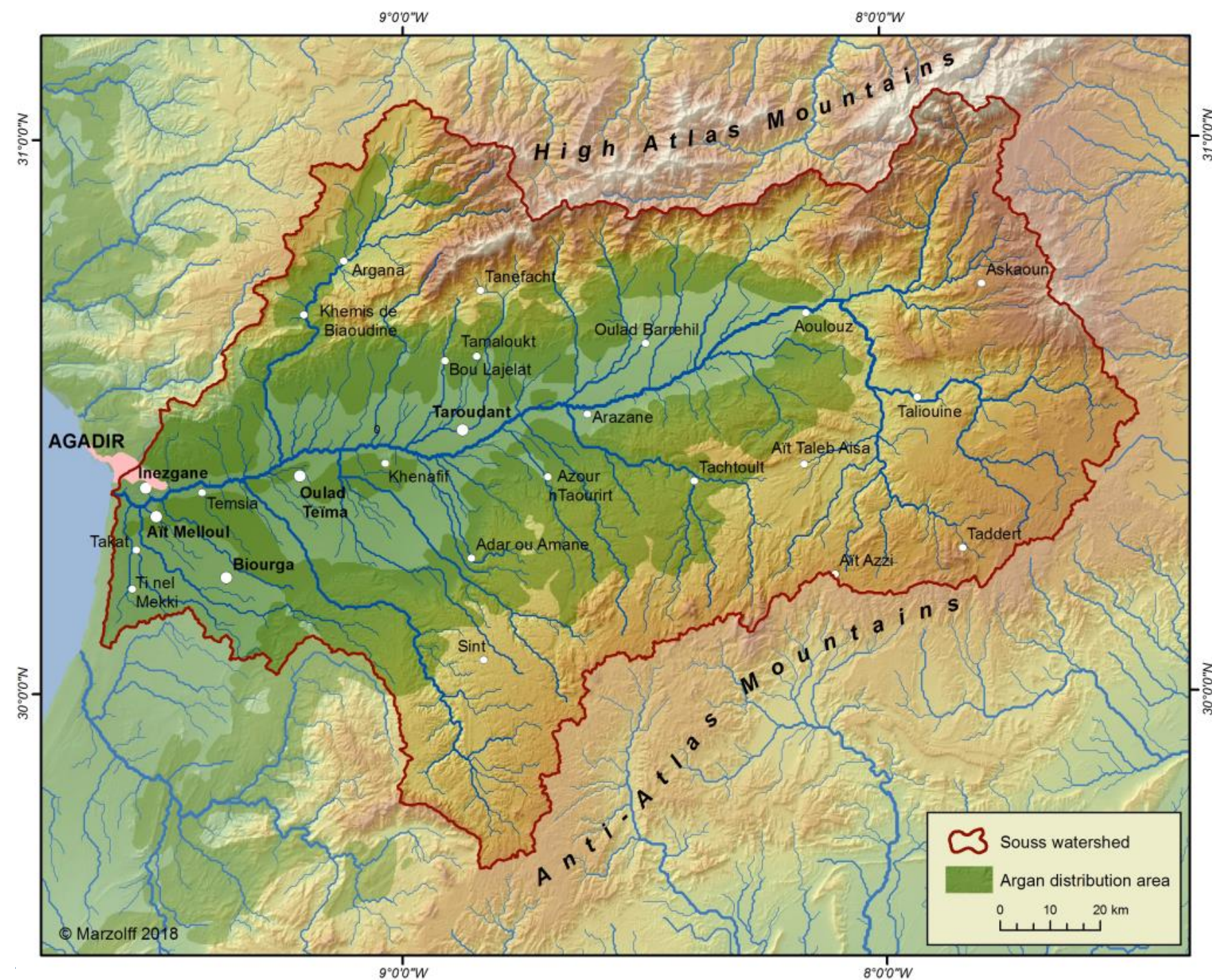
# UAV-based classification of tree-browsing intensity in open woodlands

*An illustrated abstract as contribution to the EGU 2020*

Irene Marzolff<sup>1</sup>, Robin Stephan<sup>1</sup>, Mario Kirchhoff<sup>2</sup>, Manuel Seeger<sup>2</sup>, Ali Ait Hssaine<sup>3</sup>, Johannes B. Ries<sup>2</sup>

<sup>1</sup> Institute of Physical Geography, Goethe University Frankfurt am Main, Germany

<sup>2</sup> Physical Geography, Trier University, Germany, <sup>3</sup> Geography Department, Ibn Zohr University, Agadir, Morocco



In semi-arid to arid South-west Morocco, the endemic argan tree (*Argania spinosa*) forms open woodlands ...

*The argan tree (Argania spinosa) is an endemic species of South Morocco, part of the Mediterranean Acacia-Argania dry woodlands ecoregion*

*Argan woodland covers ~950,000 ha (in 2010) with densities of 30-80 trees/ha*

*UNESCO Man and Biosphere Reserve since 1998*



... that are the basis of a traditional agroforestry system involving rain-fed agriculture, pasturing of goats, sheep and camels, and oil production.

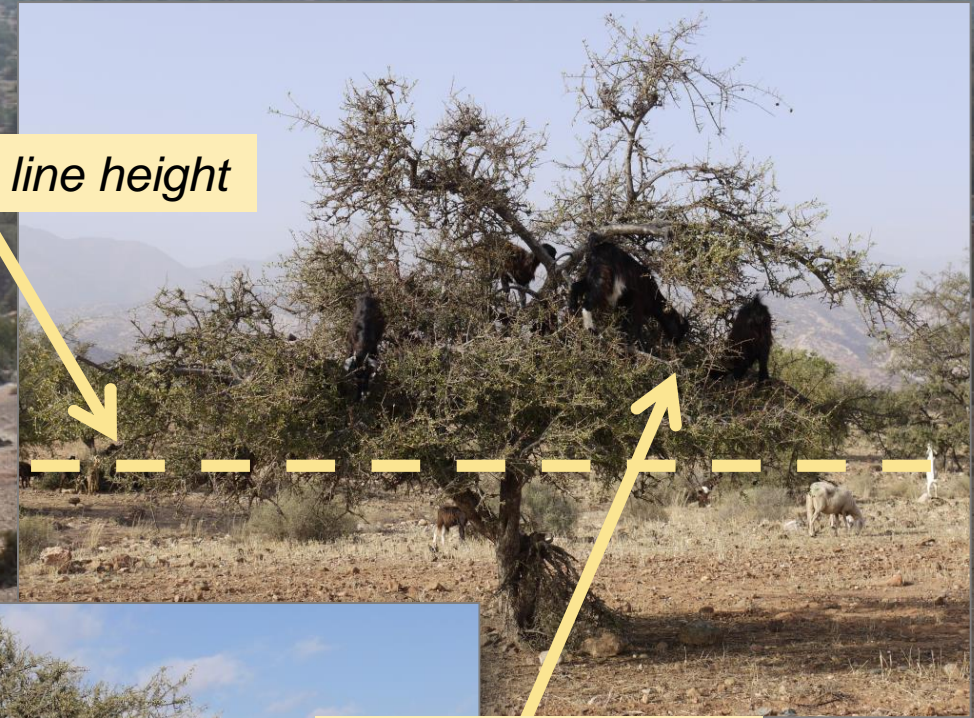


*Practices and know-how concerning the argan tree have been declared a UNESCO Intangible Cultural Heritage in 2014*

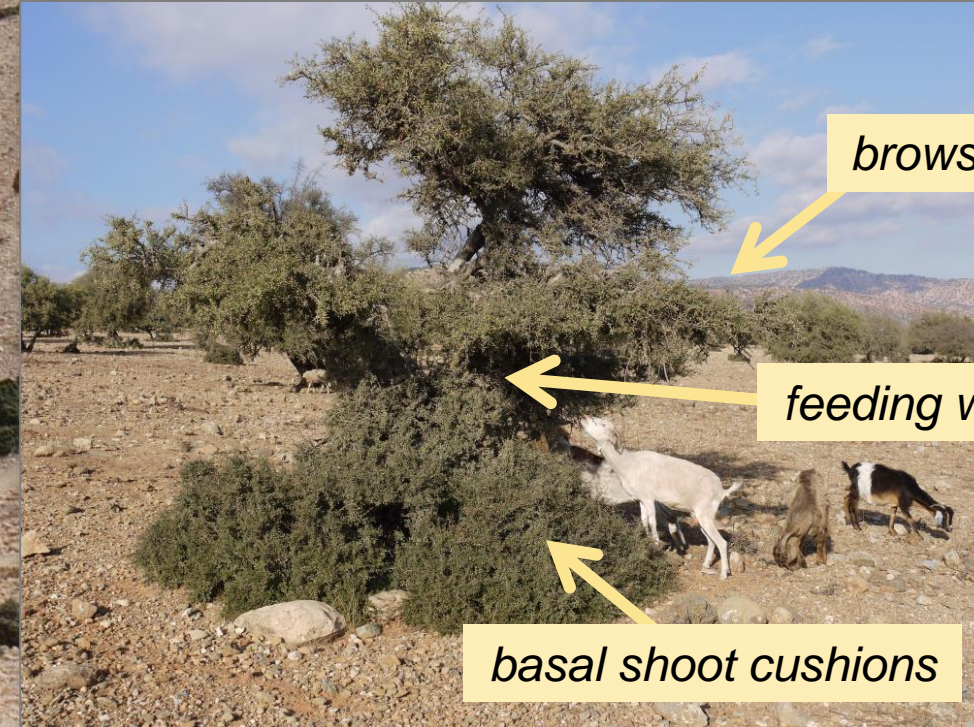


Due to the high grazing pressure, the trees show various morphological traits and growth forms that are strongly related to browsing intensity.

*browse line height*



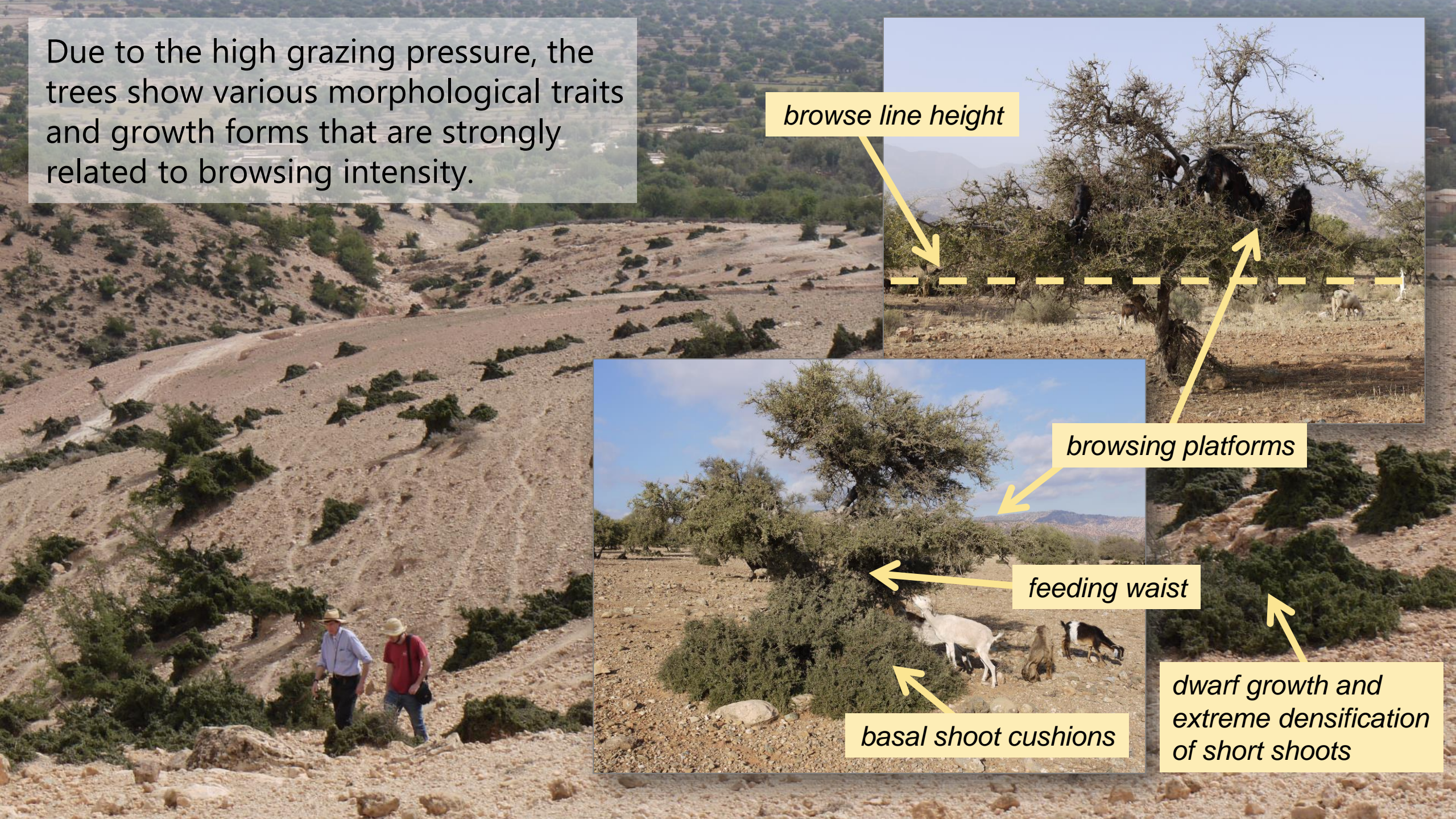
*browsing platforms*



*feeding waist*

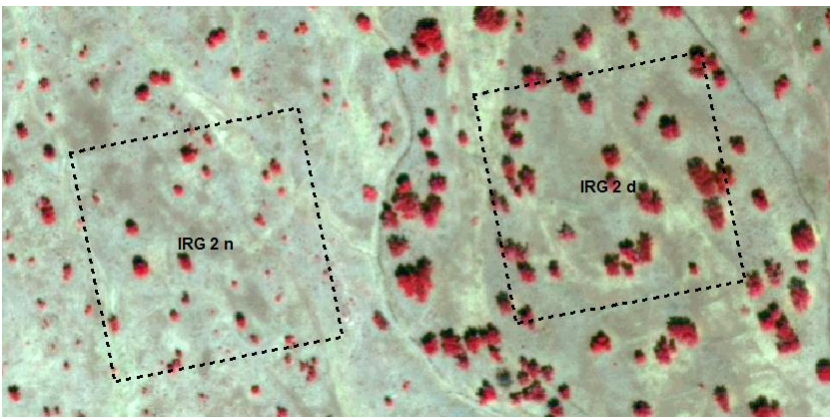
*basal shoot cushions*

*dwarf growth and extreme densification of short shoots*





The overall appearance of *Argania spinosa* ranges from trees with a large, round crown and single trunk, over multi-stem, umbrella-shaped and hourglass-shaped trees to heavily condensed cone-shaped cushions.



30 test sites of 1 ha each in argan woodlands of different degradation stages were surveyed with an unmanned aerial vehicle (UAV) and RGB optical camera ...



... using a dedicated flight scheme for capturing full 3D tree shape at approx. 1.3 cm resolution.

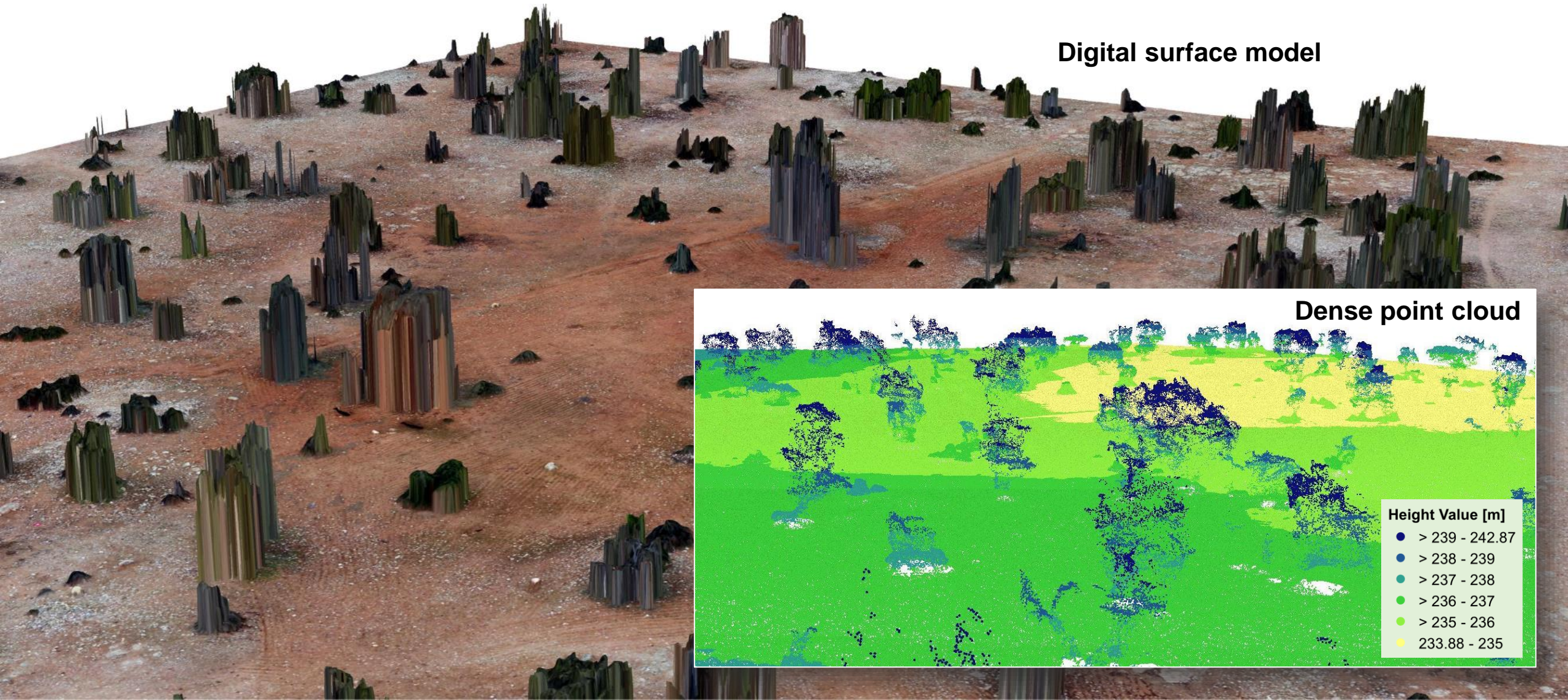
**UAV:** DJI Phantom 4 Advanced+ quadcopter

**Survey:** 50 m flying height, approx. 80% overlaps, vertical and oblique imagery in rows, convergent oblique imagery in two concentric circles

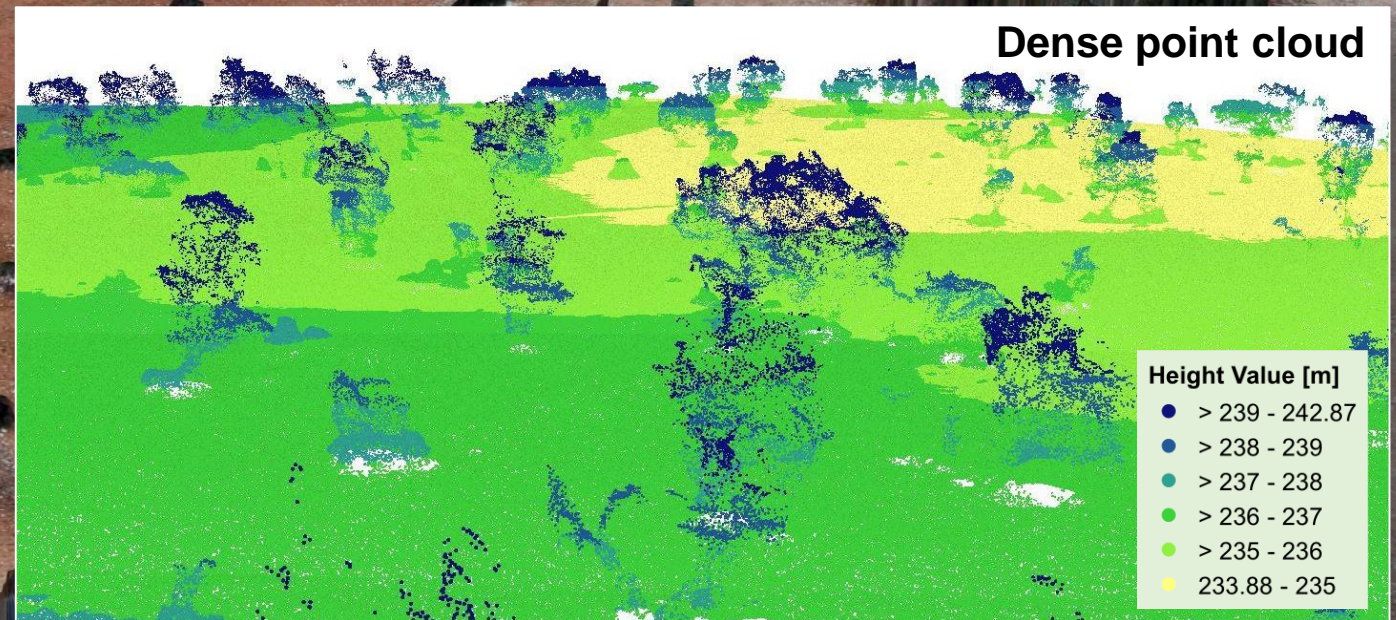
**Ground control:** 14 marked GCPs measured with RTK GNSS



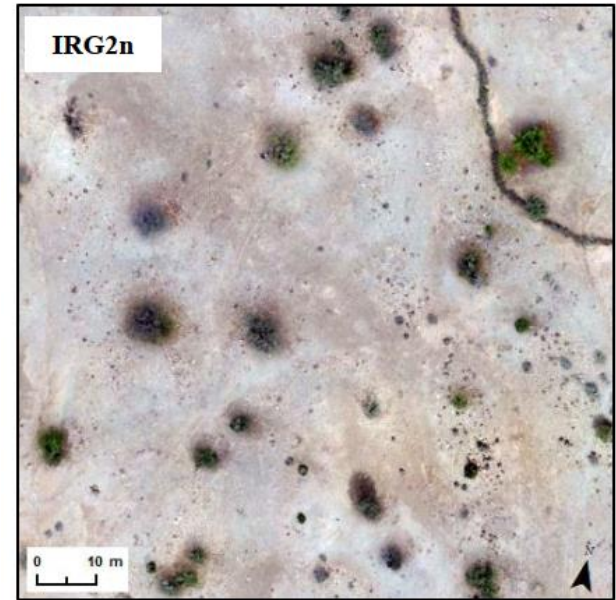
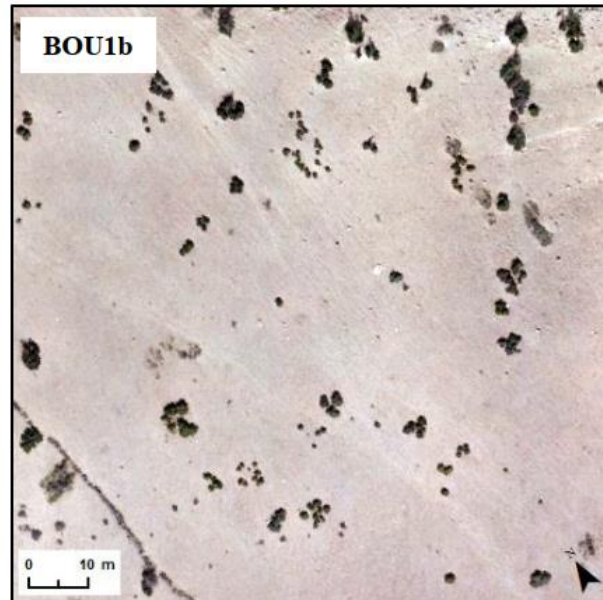
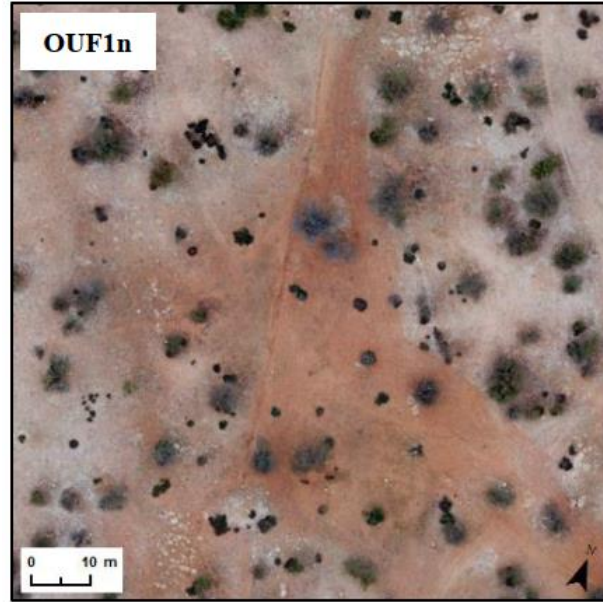
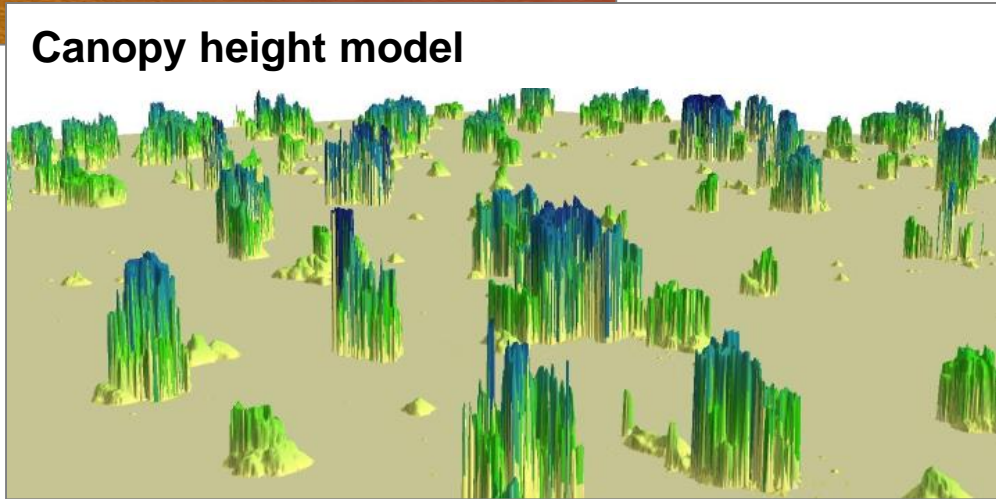
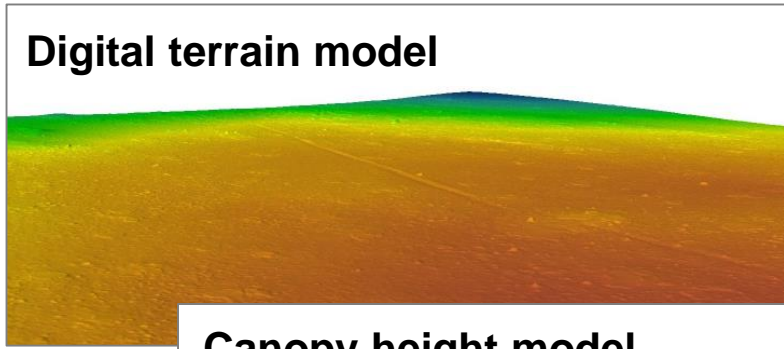
Structure-from-Motion (SfM)-photogrammetric processing yielded dense 3D point clouds as well as ultra-high resolution (1.5 cm) digital surface models (DSMs)...



Digital surface model

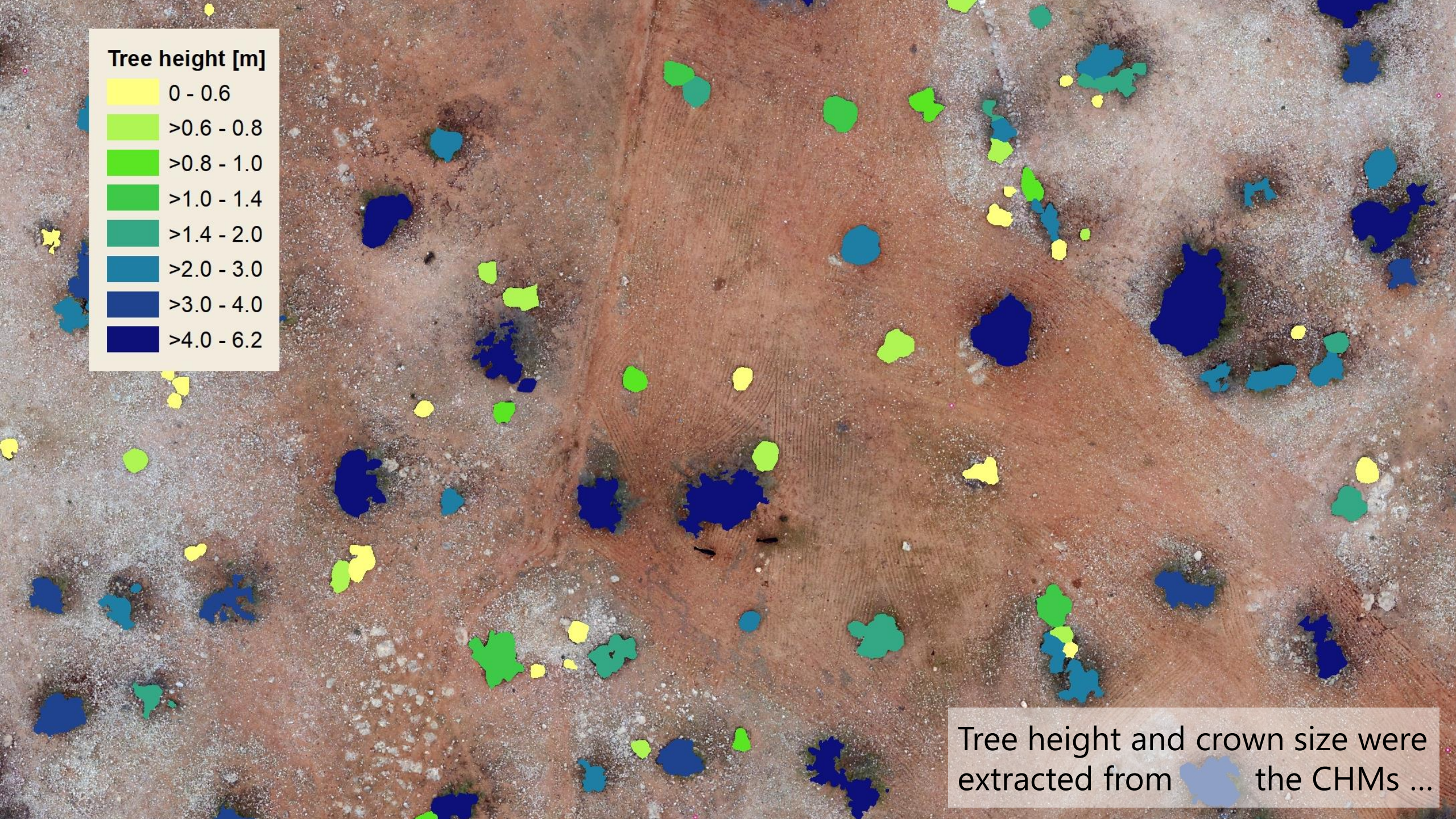
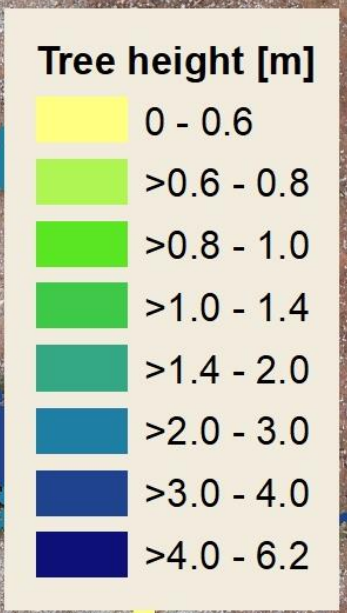


... digital terrain models (DTMs), crown-height models (CHMs) and orthophoto mosaics.



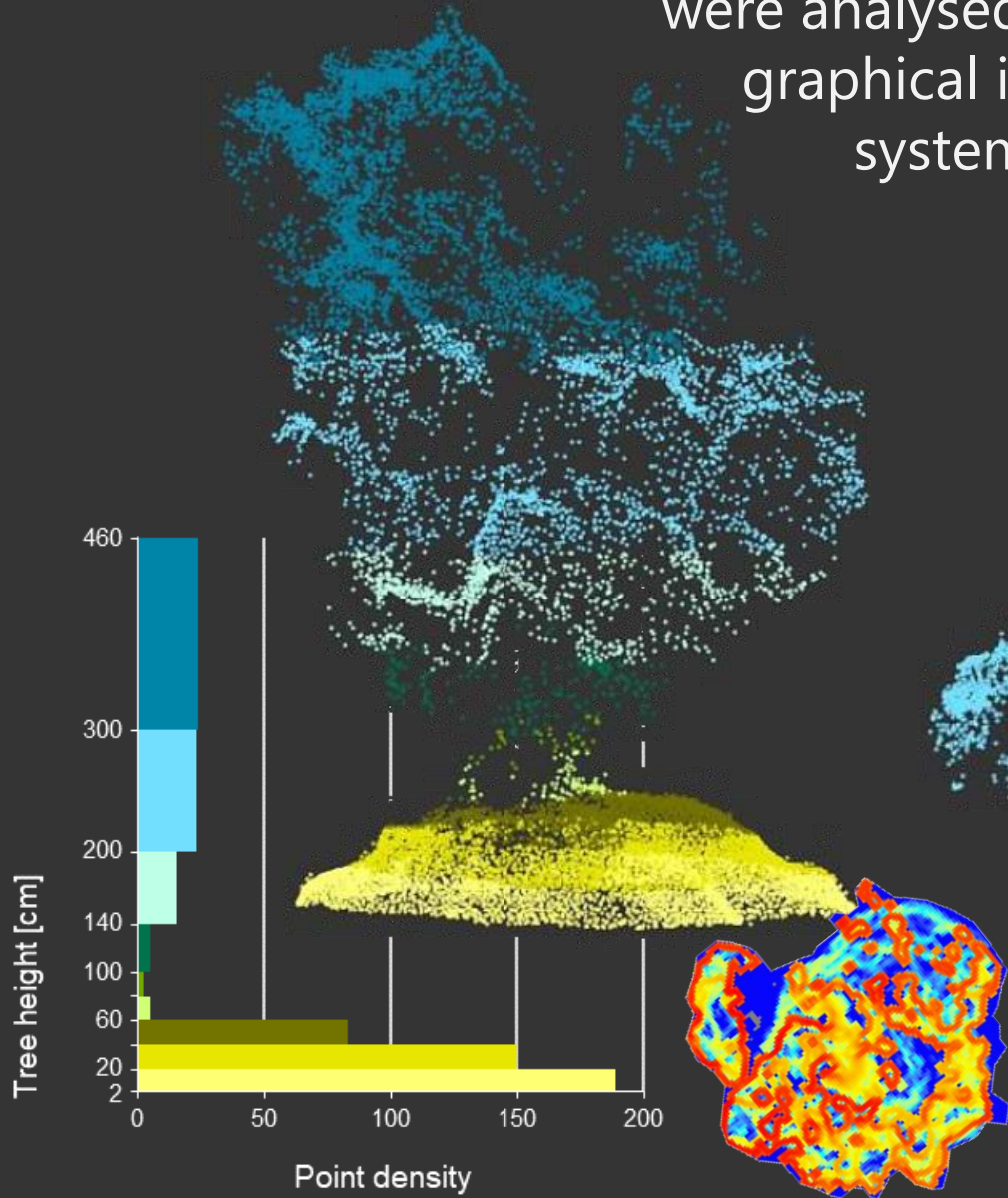
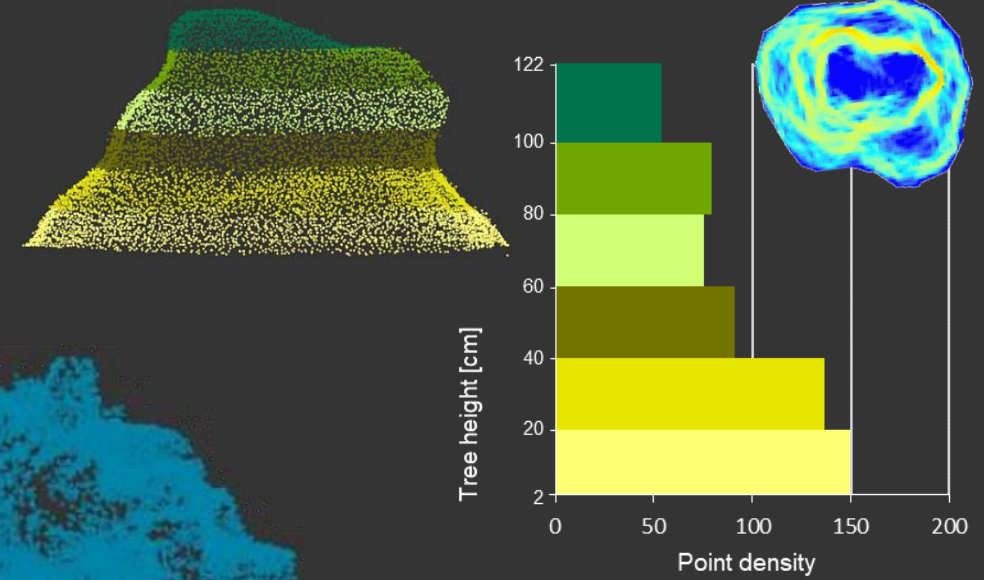
***SfM processing, point cloud classification,  
DSM/DTM/orthophoto generation:  
Agisoft PhotoScan/Metashape  
CHM computation, crown-area extraction,  
point cloud analysis: ESRI ArcGIS***





Tree height and crown size were extracted from the CHMs ...

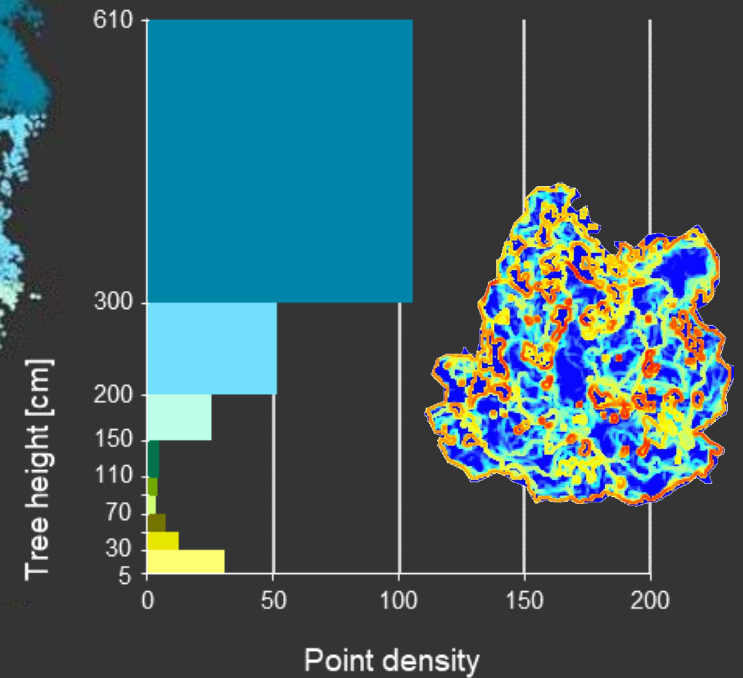
... and 3D point-cloud characteristics (point density, profile shape/layer structure) and canopy structures were analysed within a geographical information system (GIS).



Tree crown roughness

high

low



Using field-based reference data on tree architecture and browsing features of 2494 trees...

**Main class characteristics:**

**Browsing intensity 1 (low):**

- compact round crown
- tree height > 4 m
- no basal cushion, no feeding waist

**Browsing intensity 2 (medium):**

- fragmented crown with gaps
- umbrella-shaped crown
- diffuse shrub-like shape
- diffuse basal cushions, no feeding waist

**Browsing intensity 3 (high to extreme):**

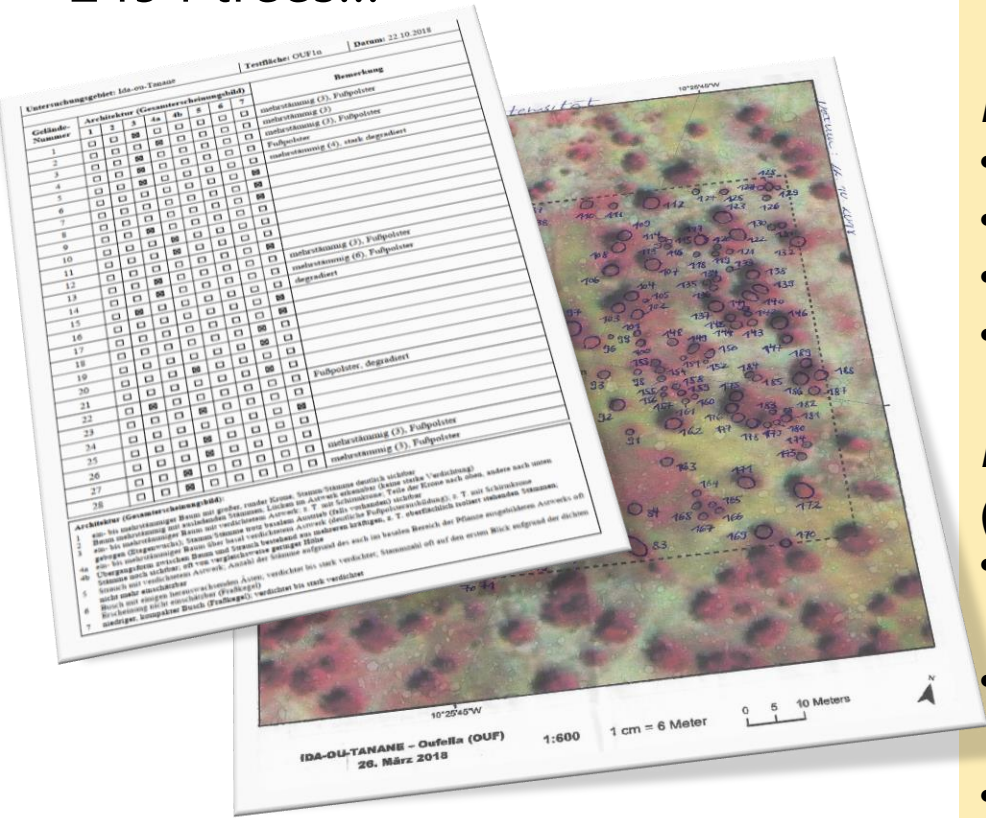
- well-developed basal cushions
- hourglass-shaped tree with feeding waist
- cushion shrubs < 2 m

**Structural parameters queried for classification, for example:**

- max. point height
- relative change of point density with point-layer height
- point density in crown layer
- crown area/perimeter ratio
- CHM roughness

```

if max_point_height < 2
and if
PDlayer1 > PDlayer2 >> PDlayer3
and if
mean CHM_roughness < 0.03 AND
StD CHM_roughness < 0.02
→ compact cushion shrub,
extreme browsing intensity
    
```

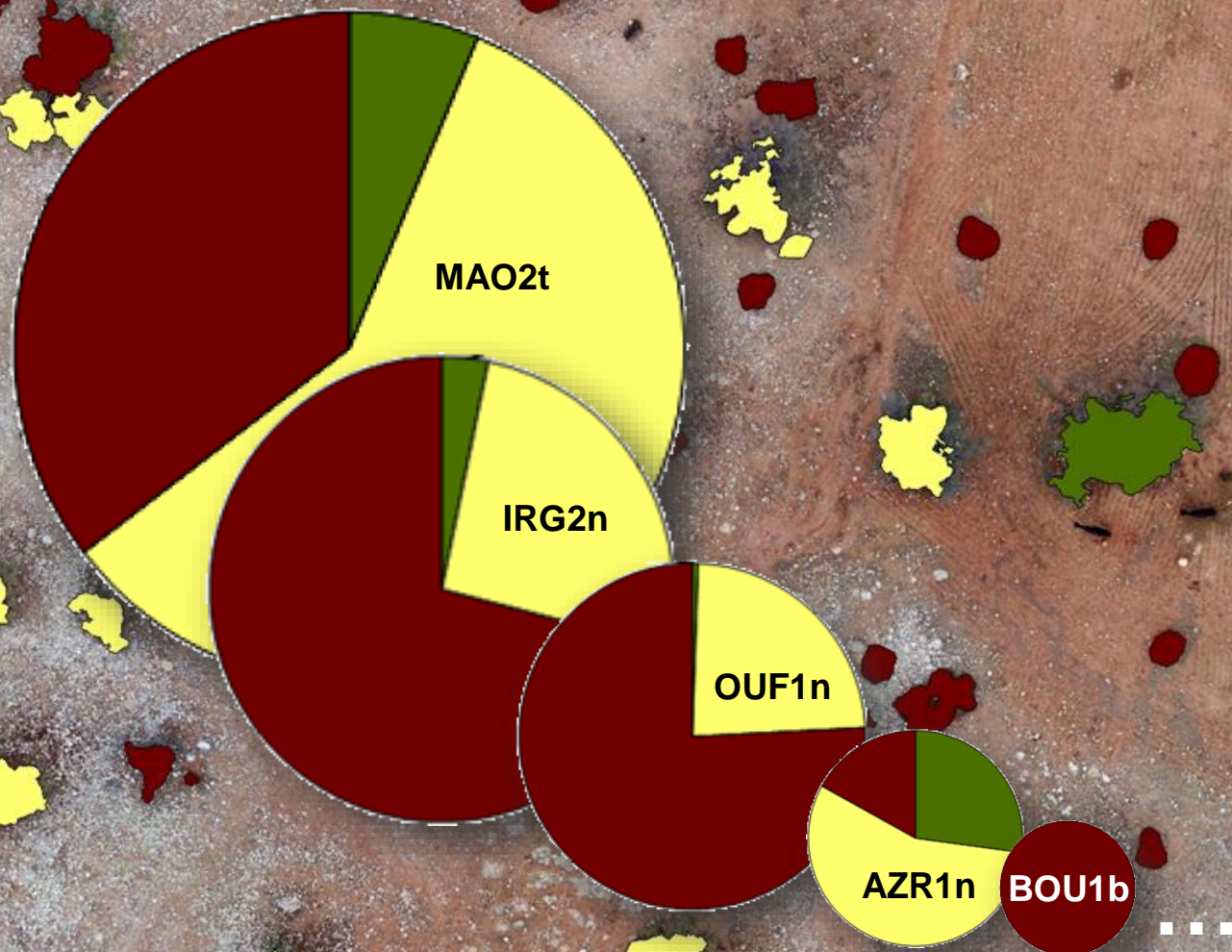


... we were able to assign characteristic combinations of the GIS-derived structural parameters to three browsing-intensity classes and thus classify each argan tree via the architectural shape captured in its UAV-based 3D point cloud.

### Browsing intensity



We found that the majority of argan trees at the study sites are characterized by high browsing intensities. The small percentage of trees in the minimum browsing class are mostly inaccessible to grazing livestock.



We conclude that UAV-based remote sensing has a high potential for mapping structural indicators of tree degradation by herbivore browsing in open woodland environments.



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