Digging up into windstorms aftermath: understanding the effect of harvesting systems on salvage logging wood residues spatial distribution

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Scan for Abstract

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1. Introduction

Extreme disturbance events, such as climate change-driven ones, have increased their frequency, upsetting the ordinary management of forests.

Salvage logging operations represent the common way to recover part of the economic loose.

Commonly, in the European Alps, salvage logging operations in largely damaged forest areas can be referred generally to as two harvesting systems: i) Cut-to-Length (CTL) and ii) Full-Tree (FT) extraction systems.

The application of the two harvesting systems can have a different effect on the type and quantity of logging residues on site, affecting the quantity and distribution of organic carbon and nutrients in the soil.

Precision forestry using machine learning (ML), UAV-borne data and structure from motion (SfM) technique can gather more detailed information to deliver more complete information on the effects of forest operations.

Objective: The aim of this study is comparing two salvage logging areas using SfM technique and ML to find any difference in terms of logging residue type, quantity, and spatial distribution according to the used harvesting system.

2. Study areas

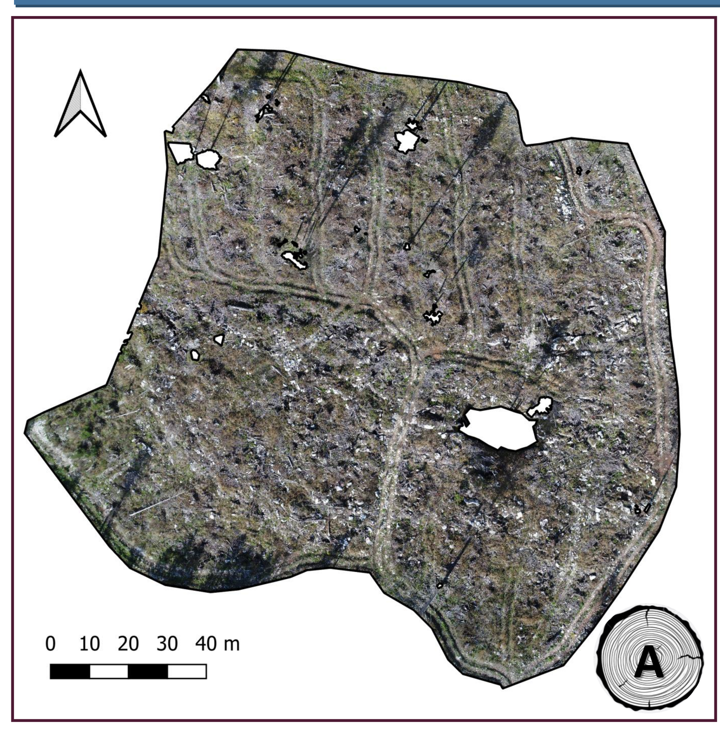


Figure A1. Orthomosaic for site HF obtained from SfM in Metashape.

Harvester-Forwarder site (HF)	
Surface (ha)	1.819
Harvesting system	CTL
Altitude range (m)	1,387-1,488
Average slope	20-25%
Ground Control Points error (m)	0.25
Orthomosaic res. (m)	0.010
DEM res. (m)	0.020

Scan to see Site HF

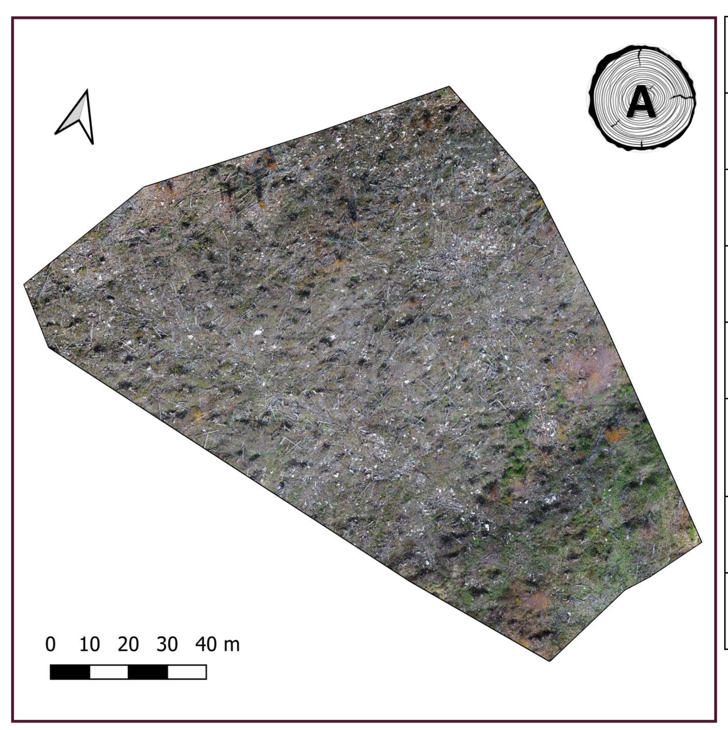
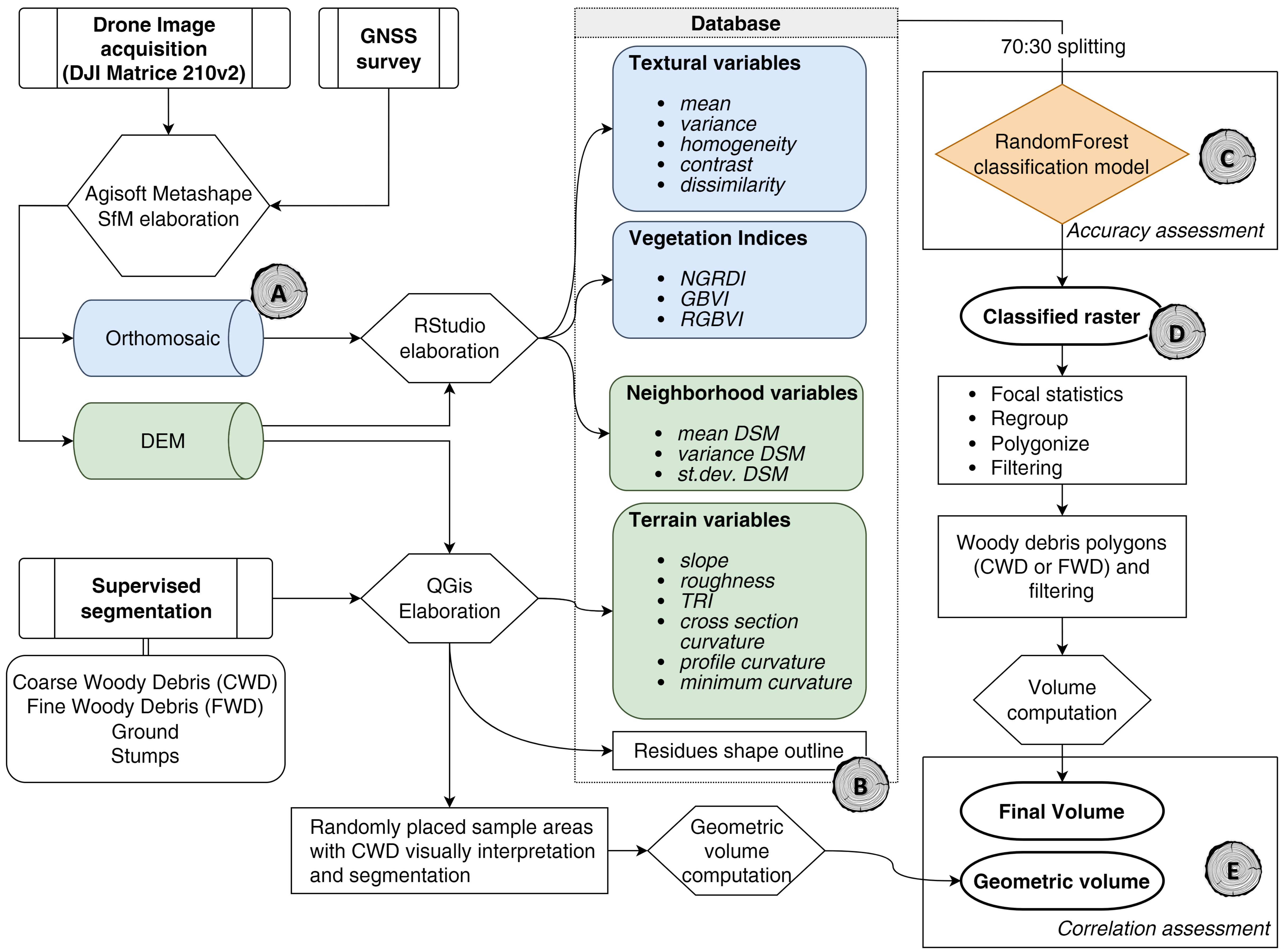


Figure A2. Orthomosaic for site CC obtained from SfM in Metashape.

Cable crane site (CC)	
Surface (ha)	1.389
Harvesting system	FT
Altitude range (m)	1,316-1,395
Average slope	~ 50%
Ground Control Points error (m)	0.32
Orthomosaic res. (m)	0.012
DEM res. (m)	0.024

Scan to see site CC

3. Materials and Methods



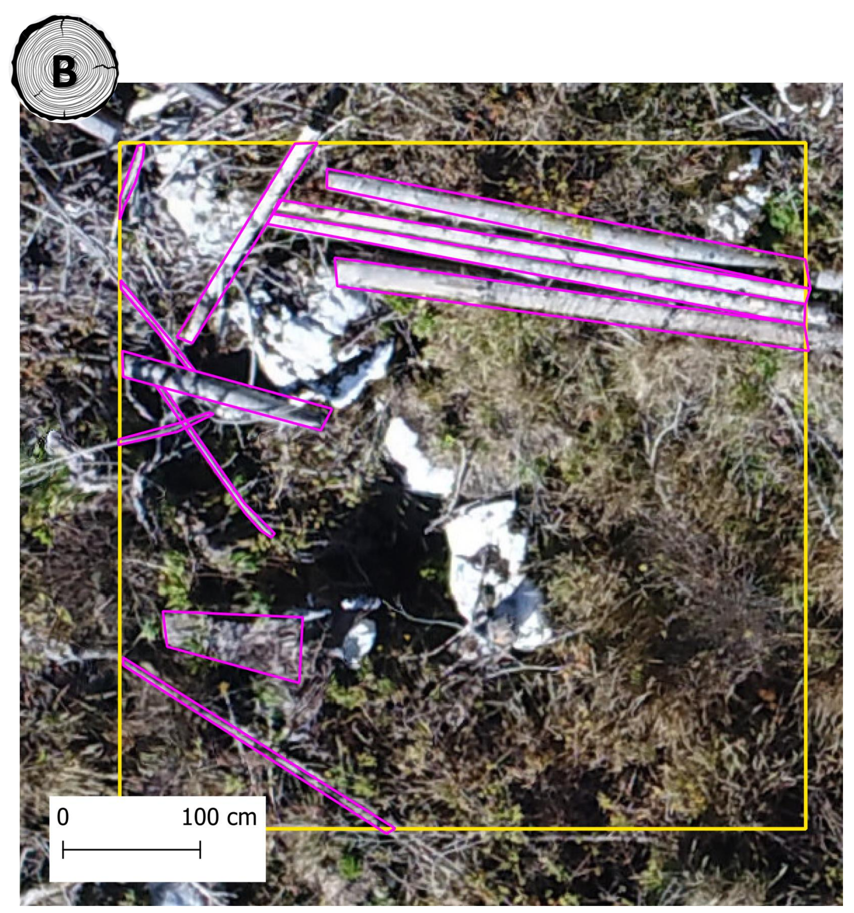


Figure B. Example of supervised segmentation of CWD for the model training.

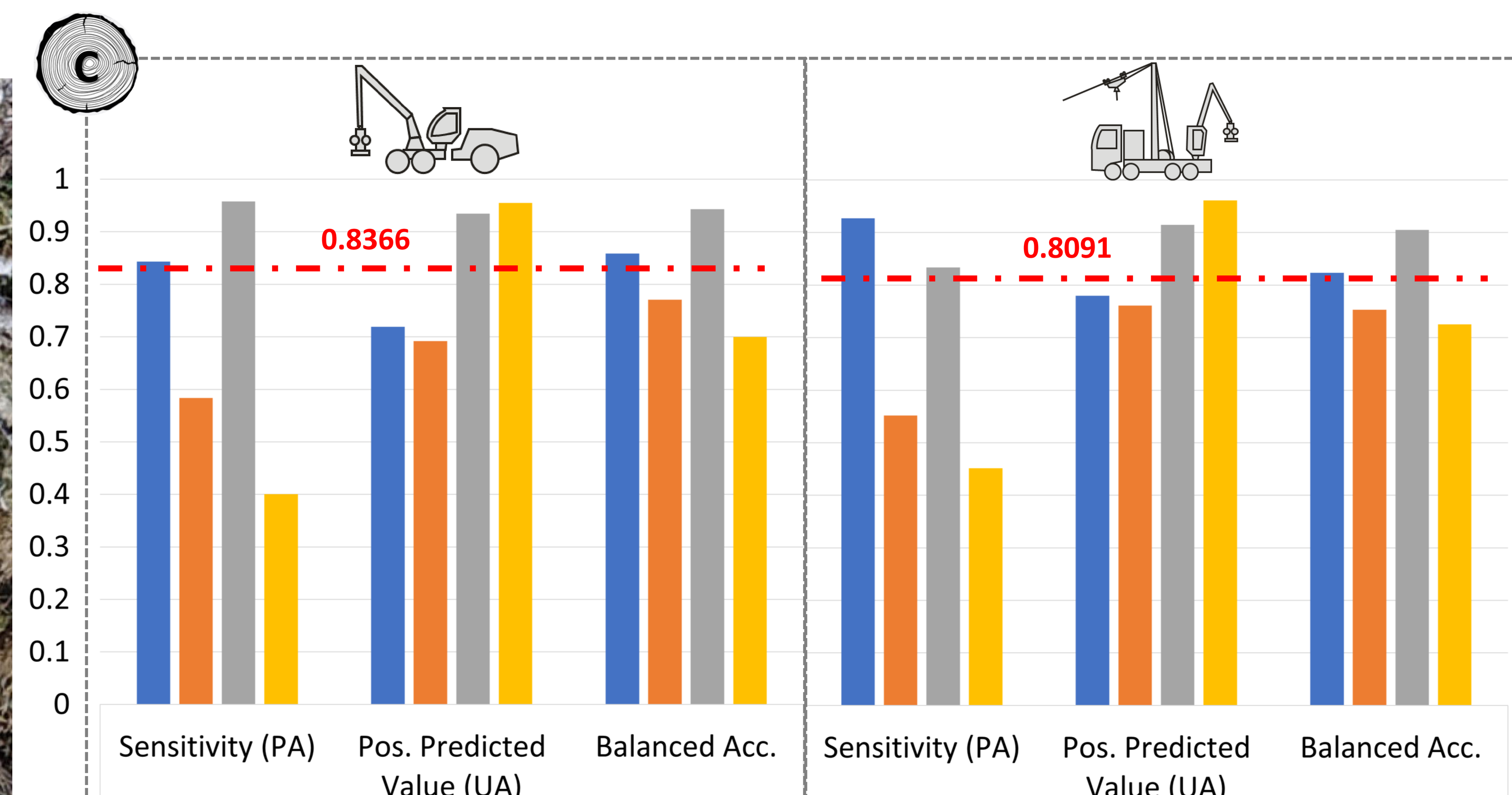


Figure C. Accuracy assessment for the RandomForest model adopted for the classification for (left) the HF site and (right) the CC site. The red dashed line refers to the overall accuracy of the model.

4. Results

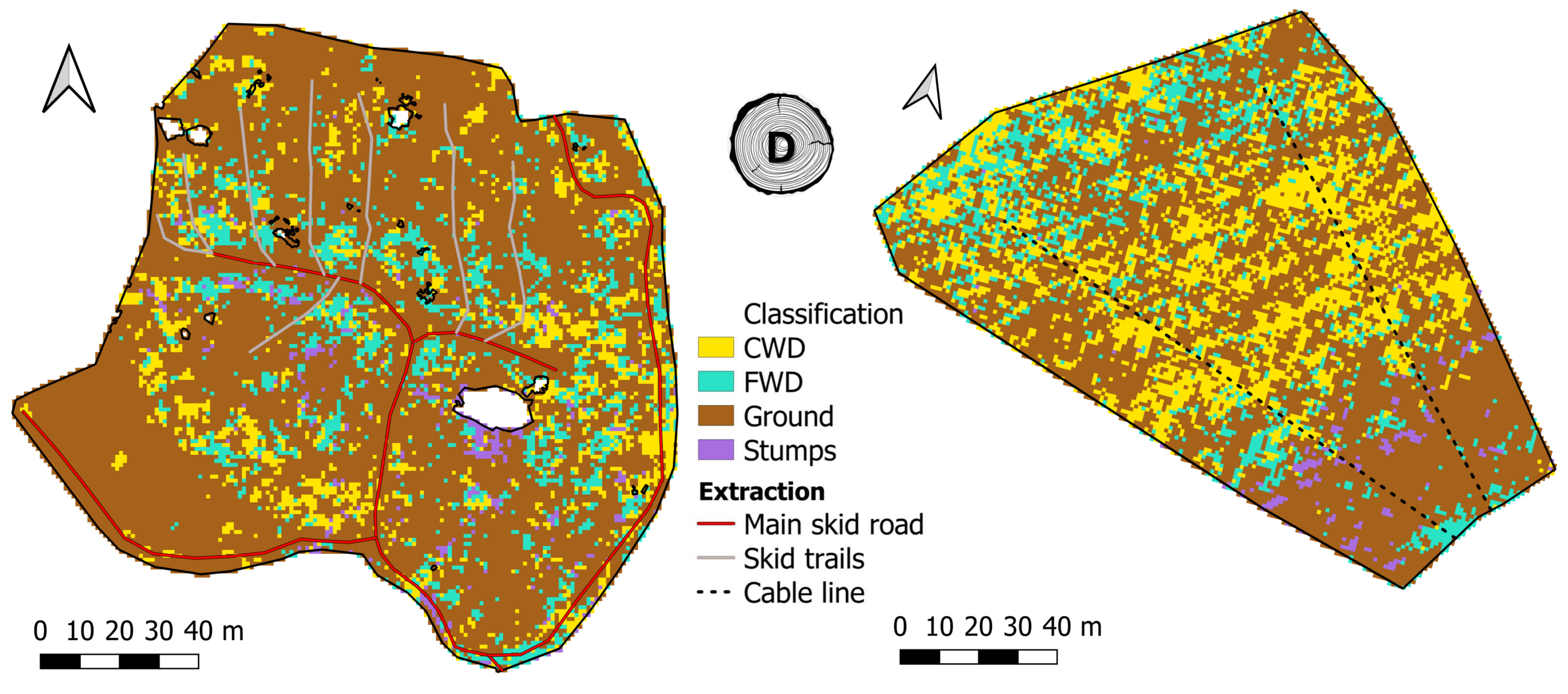


Figure D. Classified raster with residues spatial distribution in relation to the extraction system adopted. Images resolution have been resampled to 1m.

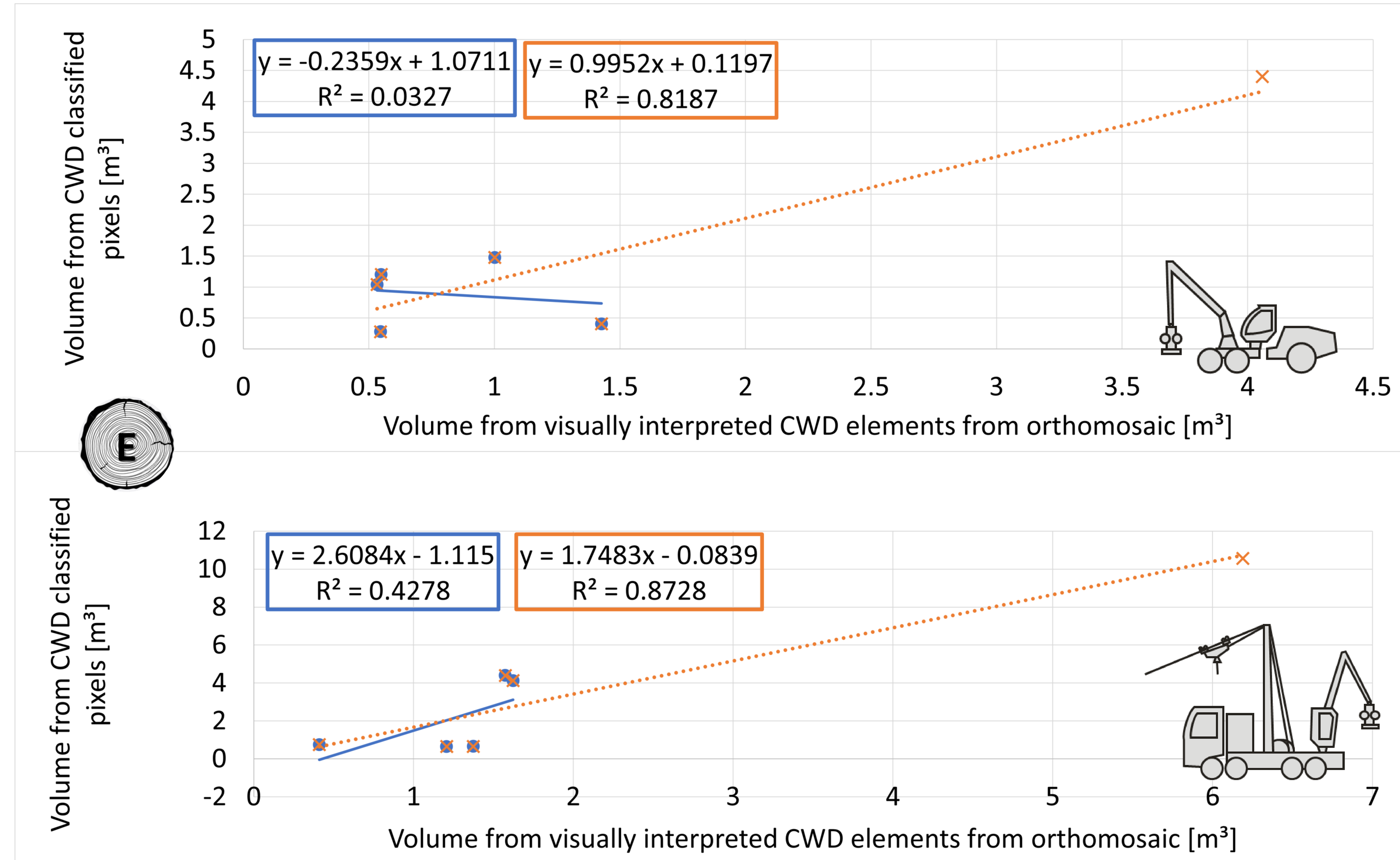


Figure E. Volume correlation for CWD considering the random placed plots (blue) without the sum of volume in the plots and (orange) with the total.

5. Conclusions

- The accuracy assessment confirmed the validity of the method for classification.
- The volume correlation for CWD depicts the high variablity in the considered areas, showing the limitations of the adopetd model in terms of correcting classified pixels and therefore true-positive volume.
- The method, with solid overall accuracy (HF = 0.84; CC = 0.80), shows the spatial distribution of residues that concentrate along the main extraction lines for the HF site, whereas for the CC site are mainly concentrated in the middle part of the area.

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Acknowledgments

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