Berner Fachhochschule
Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften HAFL

Der Wald- und Holzforschungsfonds WHFF
Eine gemeinsame Förderung von Bund und Kantonen
www.bafu.admin.ch/whff

Drone generated data for skyline logging – which tree attributes are needed and which accuracy is possible

Course "Airborne Lidar and drone technology for forest inventory and management"

Agenda

- 1. Introduction
- 2. Methods
- 3. Results
- 4. Conclusions
- 5. Sources
- Questions

1. Introduction

1. Introduction

- State forest inventory of Switzerland (LFI4b 2009-13):
  ¼ of the forest area is skyline logging area.

Harvesting system	Total		Sum
	%	±	%
Felling motor-manual, logging with mobile crane	4.1	0.3	24.7
Felling motor-manual, logging with conventional crane	7.1	0.4	
Felling motor-manual, logging with mobile crane, fully mechanised processing	9.1	0.5	
Felling motor-manual, logging with conventional crane, fully mechanised processing	4.4	0.3	

© WSL, Schweizerisches Landesforstinventar, 18.04.2015
LFI4b – **forest area: method of timber harvest · production region** unit: %
unit of evaluation: accessible forest without shrub forest
grid: grid NFI4 2009-2013 state 2009/13

1. Introduction

	Switzerland			
Logging method	1000m³/a	± %	%	±
skidder	3501	7	59.9	2.7
forwarder	1300	10	22.3	2.2
mobile crane	618	19	10.6	1.9
conventional cable crane	261	29	4.5	1.2
helicopter	151	31	2.6	0.8
other	10	63	0.2	0.1
total	5841	5	100	.

annual yield of live bole wood: main type of harvest · biogeographical region
unit: % or 1000m³/a
unit of evaluation: accessible forest excluding shrub forest NFI1/NFI2/NFI3/NFI4 combined
grid: grid LFI4 2009 - 2013; change 2004/06-2009/13

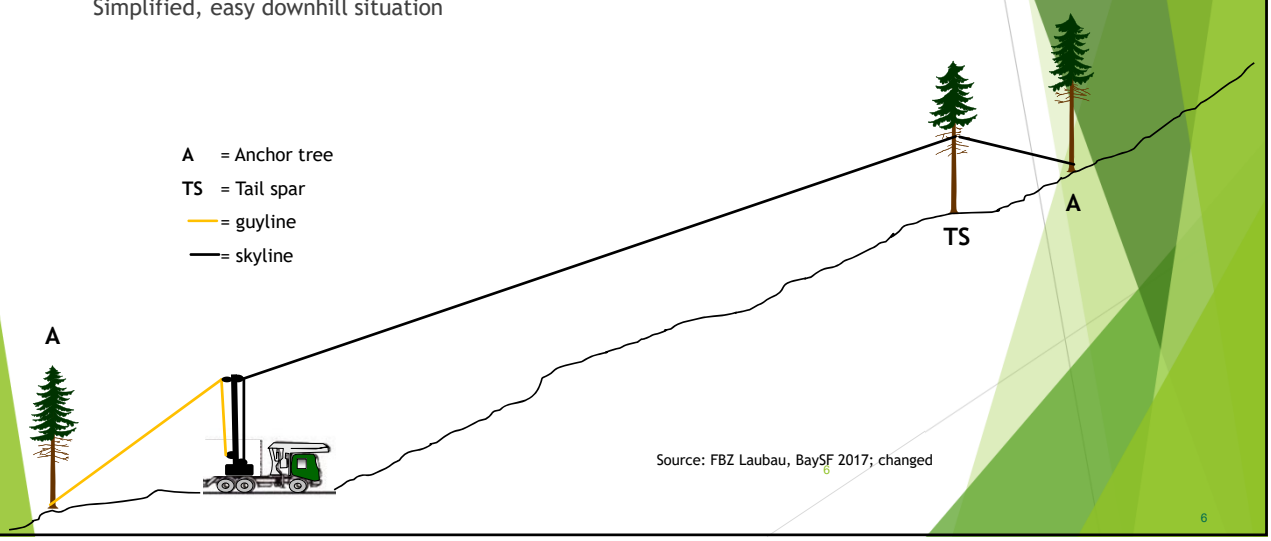
- With an assumed high productivity of 8 fm / h in cable crane operations this equals over 100'000 skyline logging PMH.
- Furthermore most of the unused wood potential is in cable yarding area. (BAFU 2015)

Cable yarding is important and will stay important.

1. Introduction

- A short recap on sky line logging

  Simplified, easy downhill situation



Source: FBZ Laubau, BaySF 2017; changed

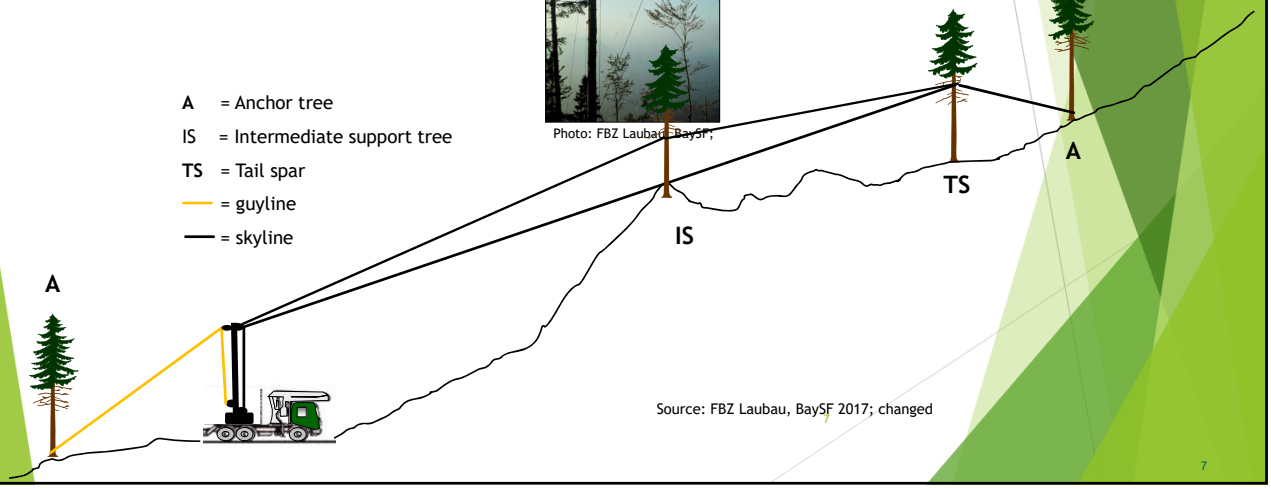
1. Introduction

- A short recap on sky line logging

  Multispan downhill situation

Photo: FBZ Laubau, BaySF;

A = Anchor tree
IS = Intermediate support tree
TS = Tail spar
= guyline
= skyline



Source: FBZ Laubau, BaySF 2017; changed

1. Introduction

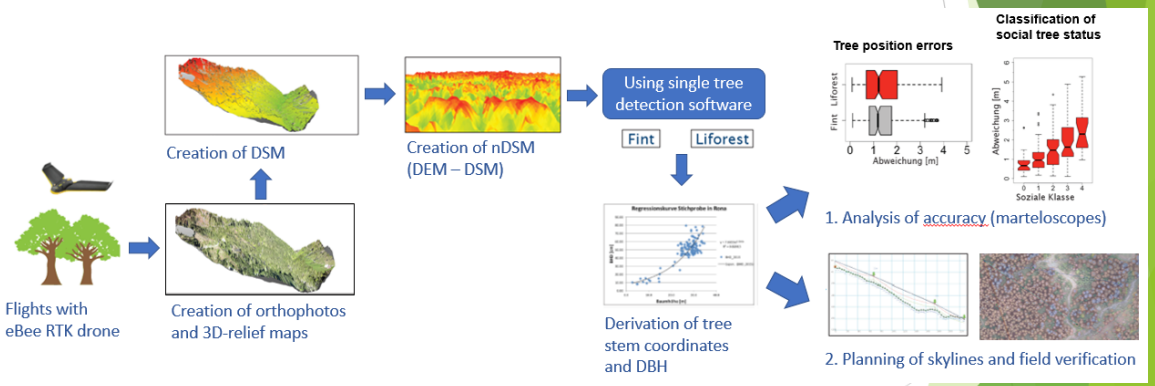
- Permanent need to increase the efficiency in cable crane operations
- Drone data are quickly available, precise and relatively cheap
- Therefore: 2 years project to examine the potential of drone date for skyline logging

  Main objectives:
  - to define the accuracy of coordinates and tree attributes created with drone data,
  - to test the practicability of using drone data for planning skylines.

2. Methods

Methods - Overview

- Overall approach for analysis of accuracy and field verification

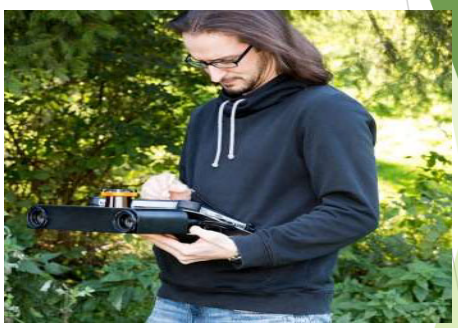


2. Methods - Overview

- The objective of the analysis of accuracy was to show that drone data are usable for skyline logging.
- With the field tests we planned to show the potential of drone data for sylvicultural and forest operational planning processes.
- The drone used for both parts of the project was an eBee RTK drone with a 18.2 megapixel camera, high-precision GPS and eMotion flight software.

2. Methods – Analysis of accuracy

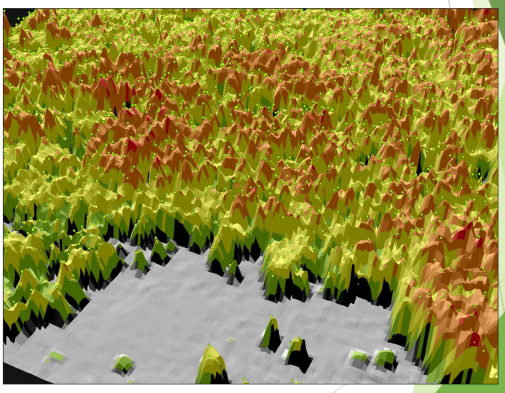
- We analysed the accuracy of tree stem coordinates first by using data from:
  - Classically terrestrial Marteloscope measurement
  - Position estimating by using drone data and:
    - FINT (ecorisQ)
    - an algorithm from RWTH Aachen
    - LiForest 2.1 (www.liforest.com)
  - IT-supported terrestrial measurements (localisation unit from RWTH Aachen)



Localisation unit (Source: Schluse 2016)

2. Methods – Analysis of accuracy

- The second part of the analysis of accuracy was to define accuracy of tree attributes (DBH, tree height, social status) by using:
  - Classically terrestrial marteloscope data
  - IT-supported terrestrial data (DBH)
  - Drone data and the following programs:
    - FINT (heigth, DBH)
    - LiForest 2.1



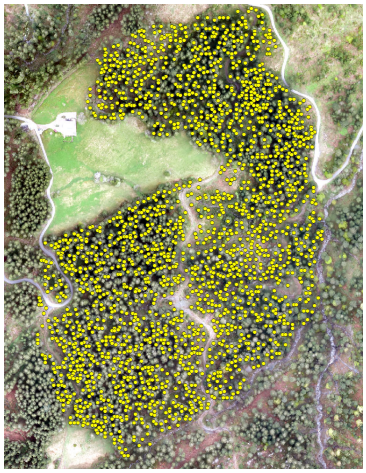
2. Methods – Field tests

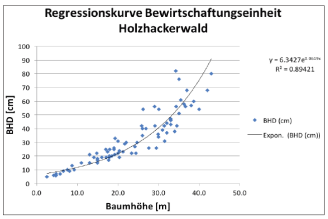
- Done in 3 harvesting units.

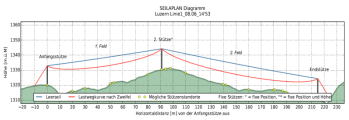
  The aim was to integrate the technique into the work flow, detect difficulties and opportunities.

  - Sylvicultural point of view: can we identify forestry structural elements (gaps, regeneration etc.)?
  - Forest operational point of view: are the logging lines and infrastructure trees locatable? (dimension, health status, position / distance to skyline).

2. Methods – Example of a field test

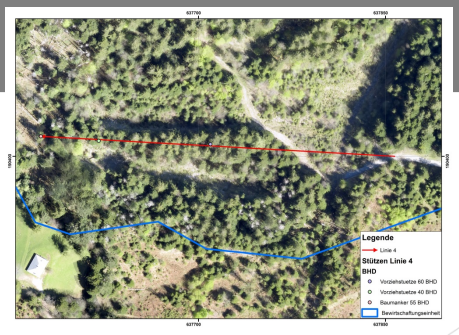




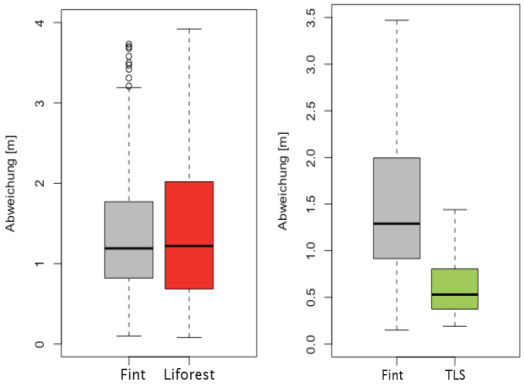


Field verification

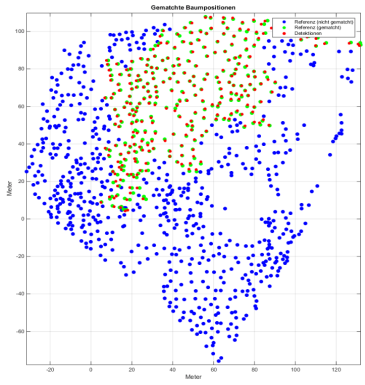
3. Results



3. Results – analysis of accuracy

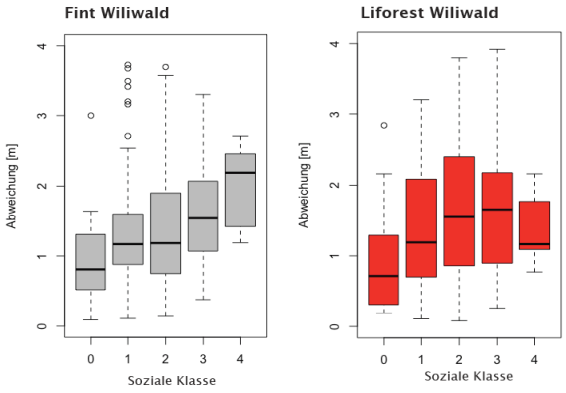


Difference between tree stem coordinates from FINT / LiForest / FINT and terrestrial IT-supported solution in comparison with classically terrestrial marteloscope measurement in marteloscope «Williwald»



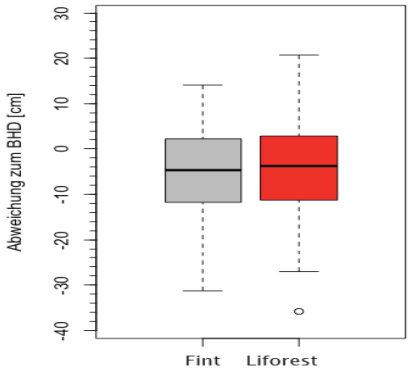
Matched tree positions (green), tree detections (red) and not matched reference trees (blue) by testing the IT-supported terrestrial solution (Source: RWTH Aachen 2017)

3. Results – analysis of accuracy



Difference between tree stem coordinates from classically terrestrial marteloscope measurement in marteloscope Williwald and results from FINT (grey) and LiForest (red) differenced in social tree categorys.

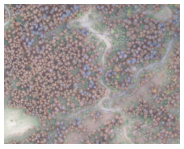
3. Results – analysis of accuracy

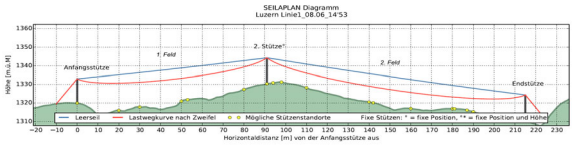


DBH differences in marteloscope Williwald compared with classically terrestrial marteloscope measurement

- Because of very similar results we decided to only use FINT for the field tests.

3. Results – field tests



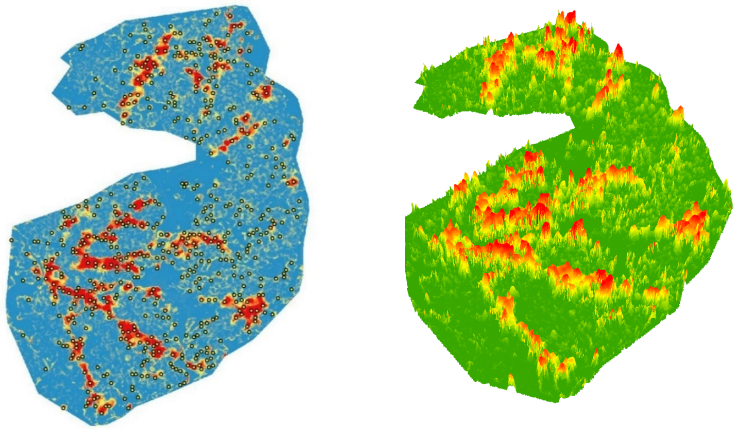


- It is possible to identify (with drone generated data):
  - anchor and intermediate support trees
  - these trees in the ground truth verification
  - sylvicultural elements (stand level).
- It's not possible or difficult to recognise:
  - if trees are damaged or rotted;
  - the rooting system of trees
  - if there's regeneration under structured canopies.
- Other limitations may be restrict flight of drones: weather (like rain, heavy wind), legal restrictions.

3. Results – field tests (before & after cutting)

Field test area before and after cutting and logging.

3. Results – field tests (extracted trees)



Visualisation of the used trees in a field test area (on the left side difference image, on the right side in 3D)

4. Conclusions

4. Conclusions

- The analysis of accuracy allows statements about the tree stem coordinates and DBH.
- It was possible to confirm the results with field tests.
  There is an added value by using drone data both for sylvicultural and forest operational planning.
- For different reasons it's still necessary to verify the defined logging skylines in a field survey, but the procedure is expedited.
- With better basic data a better modelling would be possible (for example with a LiDAR drone or velodyne laser scanner).

5. Sources

5. Sources

BAFU 2015:
BAFU (Bundesamt für Umwelt), 2015. Wald und Holz – das Wichtigste in Kürze - 3. Waldflächenzunahme, Waldgesundheit, Vorratsentwicklung, Holznutzungspotenzial (Zustand). Abgerufen am 12.02.2018, https://www.bafu.admin.ch/bafu/de/home/themen/wald/inkuerze.html#1047144245

FBZ Laubau, BaySF 2017:
Vorlesungsunterlagen des forstlichen Bildungszentrums Laubau zur Blockwoche Laubau, 117S, unveröffentlicht.

RWTH Aachen 2017:
RWTH Aachen, 2017. Automatisierte Baumerfassung (Zollikofen) – Ergebnisse. Rheinisch-Westfälische Technische Hochschule Aachen (RWTH Aachen), Auswertung vom 31.03.2017, 3S., unveröffentlicht.

RWTH Aachen 2016: Schluse, M. Der Einsatz der Lokalisierungseinheit

WSL, Schweizerisches Landesforstinventar, 18.04.2015:
Abegg M, Brändli U.B, Cioldi F, Fischer, C, Herold-Bonardi A, Huber M, Keller M, Meile R, Rösler E, Speich S, Traub B, Vidondo B, 2014. Schweizerisches Landesforstinventar - Ergebnistabelle Nr. 197880: Waldfläche Birmensdorf, Eidg. Forschungsanstalt WSL, abgerufen am 09.02.2018, https://doi.org/10.21258/1047730

WSL, Schweizerisches Landesforstinventar, 29.10.2014:
Abegg M, Brändli U.B, Cioldi F, Fischer, C, Herold-Bonardi A, Huber M, Keller M, Meile R, Rösler E, Speich S, Traub B, Vidondo B, 2014. Schweizerisches Landesforstinventar - Ergebnistabelle Nr. 144652: Nutzung von Schaftderbholz Birmensdorf, Eidg. Forschungsanstalt WSL, abgerufen am 09.02.2018, https://doi.org/10.21258/1014281

Ziesak et al. 2017:
Ziesak M, Dietsch P, Günter M, Thormann J.J, Dorren L, 2017. Verbesserte waldbaulich-forsttechnische Planung bei Seilkraneinsätzen mittels Drohnentechnik. WHFF-Projekt – Schlussbericht, 97S, noch nicht veröffentlicht.

Thank you for your attention!

Questions?