State, Challenges and Opportunities for Integrating detailed Big Data Information for Planning and Management with a particular focus on central European Conditions

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Content

- Background [Particular Conditions in Switzerland]
- **State**:
  - From Forest Machines and other Source
  - Projects examples
- **Opportunities** of having «Big Data»
- **Challenges** for application

«Big Data»

- The size of the data volume is not the problem, but the unstructured nature of the data.

- The great challenge lies in extract from streaming data features that say something about a system state
    - merge very different data sources
    - search for regime shifts in real time (dragon king problem)

[Heinimann 2018]

Basic parameters for wood harvesting (1)

Steep terrain

Natural hazards

Due to the steepness of the terrain, 70% of the forests are

- not driveable
  (gradient of > 60 %)

- restricted in driveability
  (30-60 % of slope, low soil bearing capacity)

Density of the forest road network in alpine regions: 12m/ha

Protection against natural hazards is very important

Percentage of forests that protect against nat. hazards:

Switzerland	49 %
Alpine regions only	50-90 %

Subsidies for protection forest management

Basic parameters for wood harvesting (2)

Increasing growing stock

Sophisticated sylviculture

Growing stock
Switzerland 374 m³/ha, conifers 68%

Net increment
Switzerland: 7.4 m³/ha > cutting 6.6 m³/ha

Alpine region: 5.1 m³/ha > cutting 2.7 m³/ha

➢ Underutilization

Management of uneven-aged forests, heterogeneous stand structures

Most frequent tree species: spruce and beech

Thinnings (clear cuttings are prohibited)

Small cuts (0.5-2 ha)

Basic parameters for wood harvesting (3)

Public forests

Sensitive population

1.3 Mio ha of forests (1/3 of Switzerland's surface)

75 % are public forests (community forests)

Around 700 public forest enterprises, therefrom 70% smaller than 1000 ha

Mechanized harvesting by private contractors

➢ Small scale forest management
➢ Little profit-oriented

People are sensitive to the use of forest machinery and soil damages

Soil protection is regulated by law

Ruts reaching to the mineral soil layer are prohibited

Consequences for timber harvesting

Expensive forest operations

Protection forests enable timber harvesting

Technically challenging situation
(terrain, opening-up, sylviculture)

Small scale forestry
(property, size of cutting areas, players)

High requirements of the society
(protection, biodiversity, recreation)

➢ High timber harvesting costs

Net harvest revenue (2016):
in protection forests   - 50 USD/m^3
in production forests   +10 USD/m^3

Timber harvesting in alpine regions is rarely cost-covering, need of subsidies

➢ Timber harvesting in alpine regions is motivated by the protective function of the forests

State

- Examples from «Big Data & Forest Machines» are quite rare
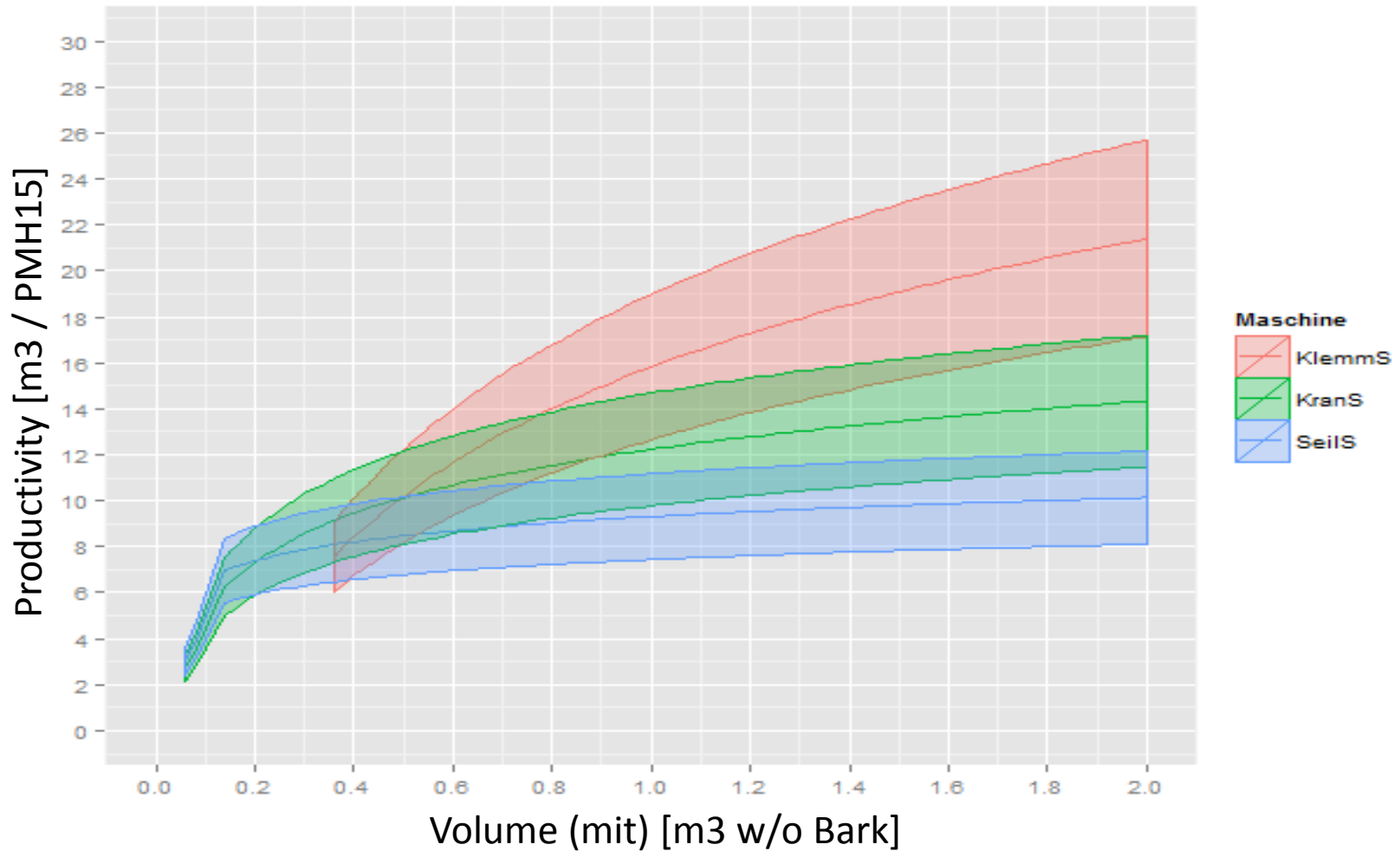
- More examples from Remote Sensing Data

«HeProMo»

Productivity Modells
WSL Programm Waldnutzung
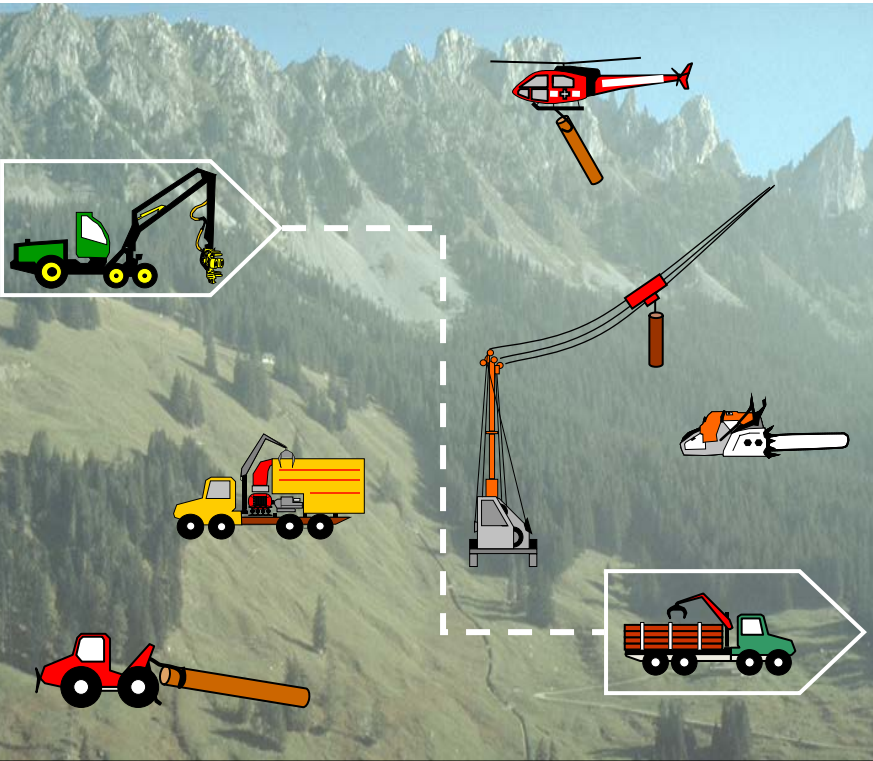
- Productivity Modells from Machine Data
- Between 20'000 and 1 mio. records per harvesting system

«HeProMo»

«smart chainsaw»
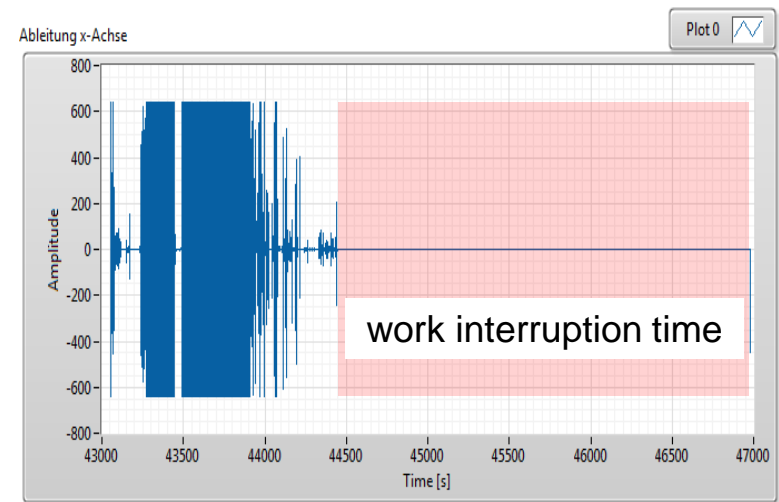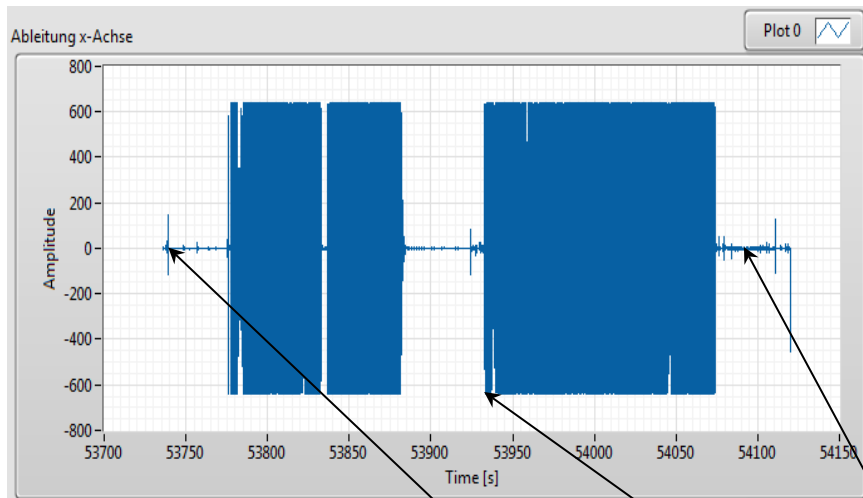
Measurement system Prototype II

A **dual-axis accelerometer** is used to measure the vibrations of the chainsaw:

x-axis: chainsaw engine runs or not

y-axis: position of the chainsaw blade

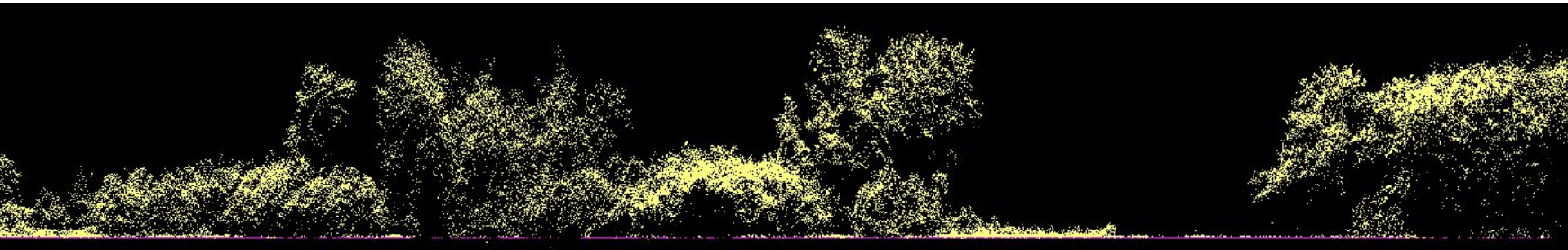# Data processing Working times and processes

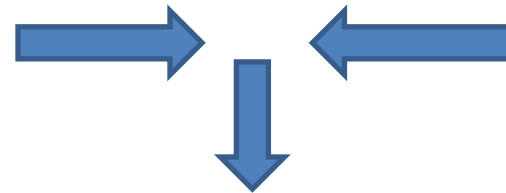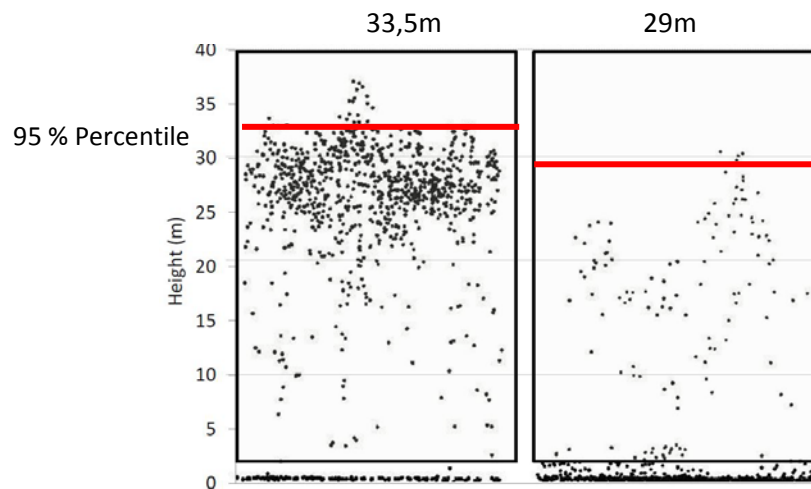chainsaw engine runs or not (amplitude)

cutting point between felling and processing
= start of processing

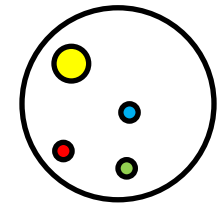starting point: tree number entered and confirmed
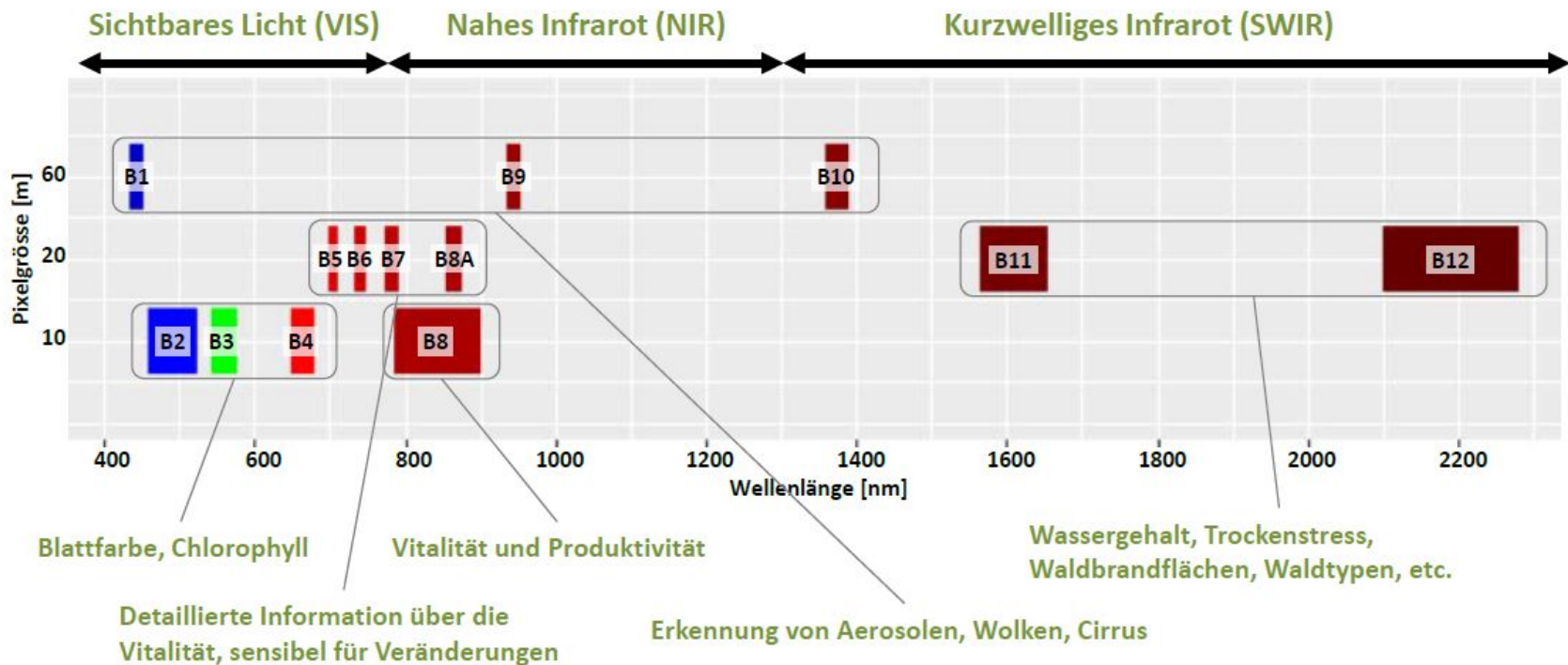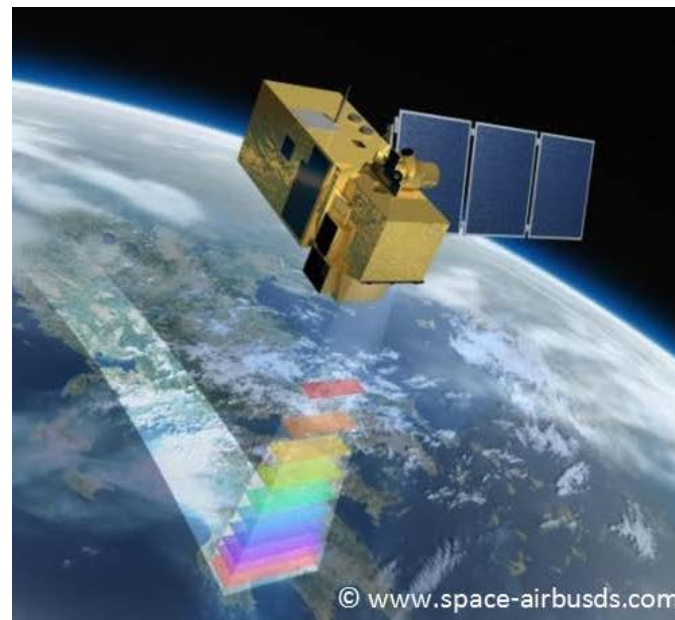
Remote Sensing (ALS & Satellite)

Auxiliaries

33,5m 29m

95 % Percentile

Terrestrial samples

Modell – assisted &
Modell – based Estimations

Sentinell 2

© www.space-airbusds.com

Sichtbares Licht (VIS) Nahes Infrarot (NIR) Kurzwelliges Infrarot (SWIR)

Pixelgrösse [m]

B1 B9 B10 60

B5 B6 B7 B8A B11 B12 20

B2 B3 B4 B8 10

400 600 800 1000 1200 1400 1600 1800 2000 2200

Wellenlänge [nm]

Blattfarbe, Chlorophyll

Vitalität und Produktivität

Wassergehalt, Trockenstress, Waldbrandflächen, Waldtypen, etc.

Detaillierte Information über die Vitalität, sensibel für Veränderungen

Erkennung von Aerosolen, Wolken, Cirrus

[Weber 2017]

«Smart Forwarder»
Project Forwarder 2020, (HAFL Berne)

FORWARDER 2020 SUSTAINABLE AND SMART LOGGING

Monitoring system: • • • • •

- Process data like machine data, static and dynamic load and position
- Accurate and easy to understand information of working area
- Follow up of the environmental impact

HSM 208F, 12T FORWARDER

Hybrid hydraulic system:
- Double recuperation of the potent
- Reduces by 30% the fuel consum loading and unloading
- Increases the speed for loading a
- Reduces engine speed and noise
- Increases number of movement

Hydrostatic mechanical transmission:
- Reduces by 30% the fuel consumption
- Enables longer hauling distances
- Reduces engine speed and noise emission
- Reduces need of refueling
- Reduces need for new forest roads

Hydropneumatic suspension
- Enables long hauling distances
- Reduces the need for additional forest roads
- Increases off-road driving speed
- Reduces the dynamic wheel load by 25%
- Reduces the dynamic load on the structure
- Reduces ruts
- Improves the ergonomics and comfort for the operator

Bogie axle with three driven wheels:
- Doubles the surface under the bogie-tracks
- More productive and environmental friendly timber harvest on wetlands
- Reduces rut depths by 50%
- Increases the payload on wetlands

Opportunities (1)

Forest Inventory / Management

Combine the following data for an entire region [Heinimann 2018]

1) stand maps / inventory data
2) StanForD2010 harvester data
3) sawmill data describing yield and quality

→ Estimate Assortments and Value in a Stand

Opportunities (2): Optimize Harvesting Layout in Steep Terrain

5x5m grid
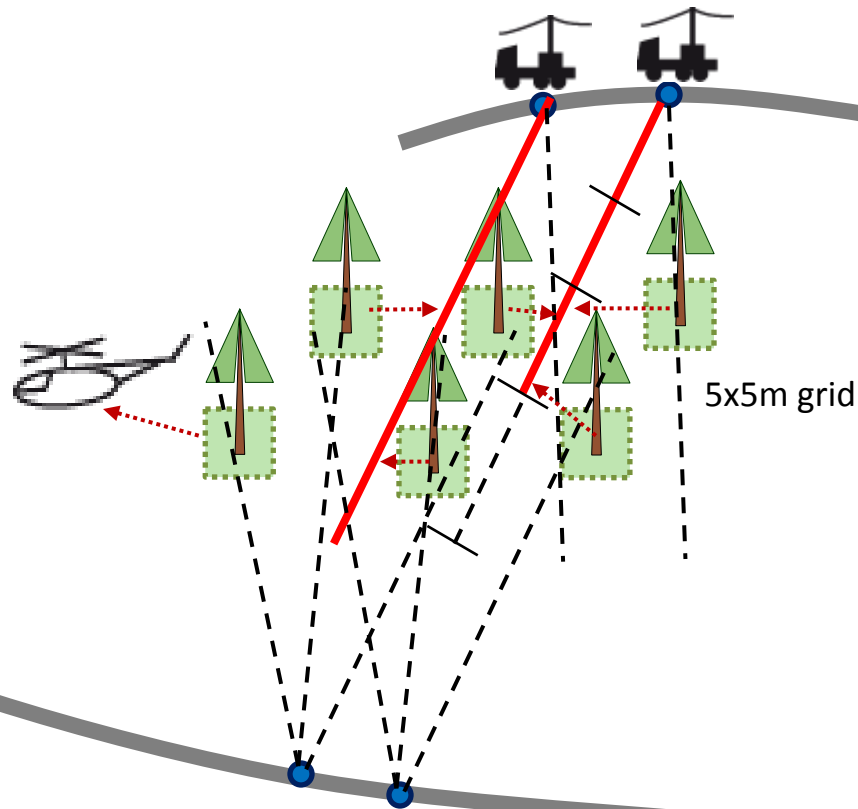
Decisions :
- Harvesting system
- Cable road section
- Landing
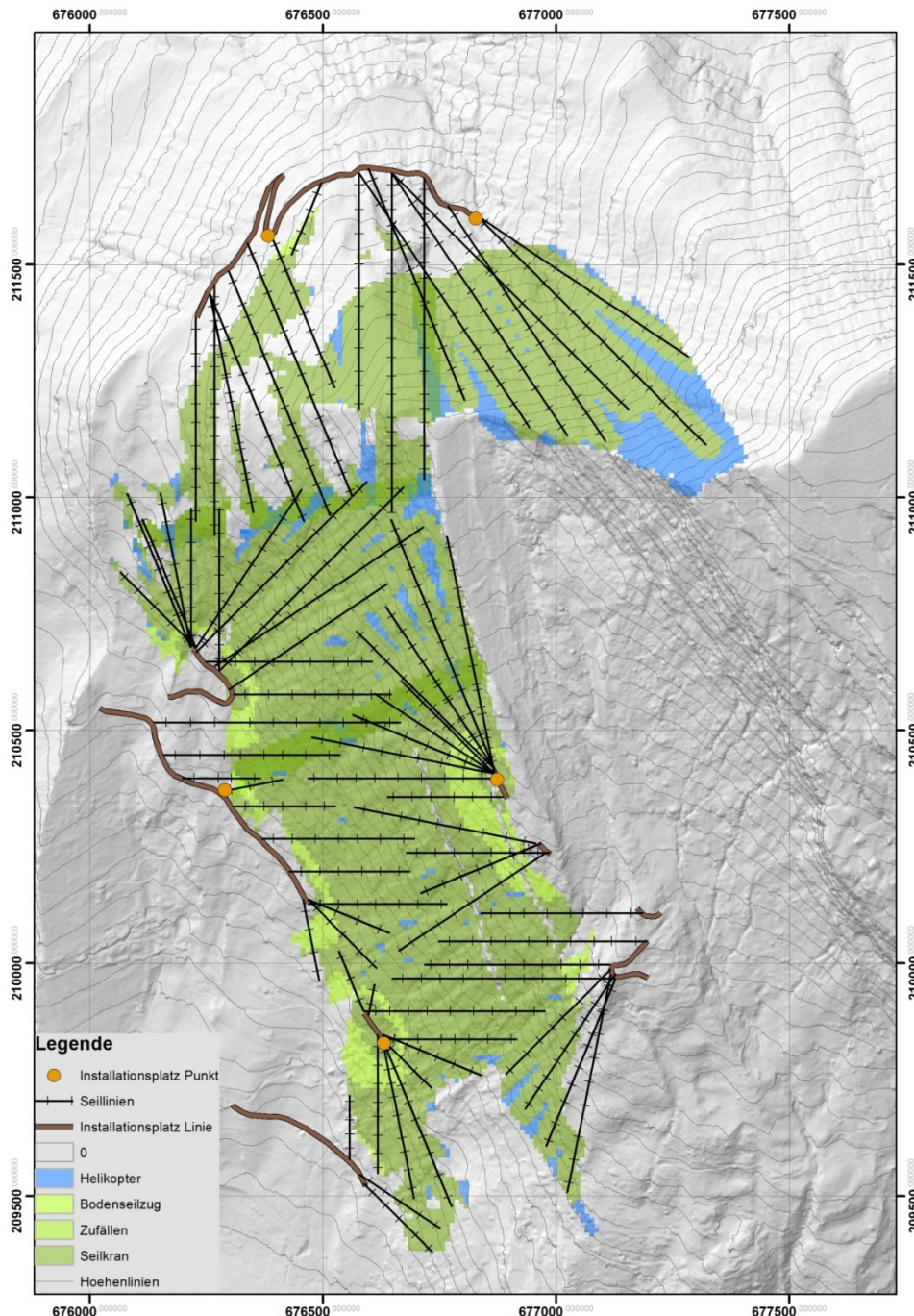
Objectives: Minimize…
- Harvesting Cost
- Environmental Impact (Stand Damages)

Constraint:
- Harvest each Parcel

Problem:

- Input: Harvesting Cost Models

- Problem: Existing cost-models are usually created to answer very specific research questions

- "Big Data": Developing more generic models with a broader range of application

Challenges

- Difficult to get machine data (needs close collaboration with forest enterprises)

- Still a hugh share is cut by chainsaw (steep terrain, large deciduous trees)

- Establish Standards & Tools to collect data (cable yarder, chainsaw)