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

Leo Bont, WSL, Switzerland
NB Nord Workshop
19. / 20. June 2018
Content

• Background [Particular Conditions in Switzerland]
• State:
  – From Forest Machines and other Source
  – Projects examples
• Opportunities of having «Big Data»
• Challenges for application
The size of the data volume is not the problem, but the unstructured nature of the data.

The great challenge lies in extracting features from streaming data that say something about a system state.

- merge very different data sources
- search for regime shifts in real time (dragon king problem)

[Heinimann 2018]
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 %
Basic parameters for wood harvesting (2)

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)

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

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/m³
- in production forests +10 USD/m³

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

Expensive forest operations

Protection forests enable timber harvesting
State

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

- Productivity Modells from Machine Data
- Between 20’000 and 1 mio. records per harvesting system
Productivity [m³ / PMH15] vs Volume (mit) [m³ w/o Bark] for different machines:
- KlemmS
- KranS
- SeilS

The graph shows the productivity of each machine as the volume increases.
«smart chainsaw»
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

- Cutting point between felling and processing = start of processing
- Chainsaw engine runs or not (amplitude)
- Starting point: tree number entered and confirmed
- Work interruption time
Remote Sensing (ALS & Satellite)

Auxiliaries

Terrestrial samples

Modell – assisted & Modell – based Estimations
Sentinell 2

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

Pixelgröße [m]

Blattfarbe, Chlorophyll
Vitalität und Produktivität
Detaillierte Information über die Vitalität, sensibel für Veränderungen
Erkennung von Aerosolen, Wolken, Cirrus
Wassergehalt, Trockenstress, Waldbrandflächen, Waldtypen, etc.

[ Weber 2017]
«Smart Forwarder»
Project Forwarder 2020, (HAFL Berne)

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

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

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

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

**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 huge share is cut by chainsaw (steep terrain, large deciduous trees)
• Establish Standards & Tools to collect data (cable yarder, chainsaw)