
# Big Data bases and applications

## D3.2 Project database

31 August 2017

| Version | Date | Written by | Reviewed by | Approved by |
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## 1. EFFORTE project objectives

EFFORTE is a research and innovation project providing the European forestry sector with new knowledge and knowhow that will significantly improve the possibilities of forest enterprises to assemble and adopt novel technologies and procedures.

The project aims at enhancing the efficiency of silviculture and harvesting operations; increasing wood mobilization and annual forest growth; increasing forest operations' output while minimizing environmental impacts; and reducing fuel consumption in the forest harvesting process by at least 15%.

The project is based on three key elements of technology and knowhow:

1) Basic understanding of fundamentals of **soil mechanics and terrain trafficability** is a crucial starting point to avoid soil disturbances, accelerate machine mobility and assess persistence of soil compaction and rutting. The key findings and recommendations of trafficability related to EFFORTE can immediately be adapted in all European countries.

2) Due to decreasing Cost-competitiveness of manual work and maturity of technology it is now perfect time to realize the potential of **mechanization in silvicultural operations**. EFFORTE pursues for higher productivity and efficiency in silvicultural operations such as tree planting and young stand cleaning operations.

3) 'Big Data' (geospatial as well as data from forestry processes and common information e.g. weather data) provides a huge opportunity to increase the efficiency of forest operations. In addition it adds new possibilities to connect knowledge of basic conditions (e.g. trafficabillity), efficient silviculture and harvesting actions with demand and expectations from forest industries and the society. Accurate spatial information makes it possible for forestry to move from classic stand-wise management to precision forestry, i.e. micro stand level, grid cell level or tree-by-tree management. EFFORTE aims at achieving substantial influence to the **implementation and improved use of Big Data within Forestry** and through this increase Cost-efficiency and boost new business opportunities to small and medium size enterprises (SME) in the bioeconomy.

EFFORTE researchers will develop and pilot precision forestry applications that, according to the industrial project partners, show the greatest potential for getting implemented immediately after the project.

## 2. Project database

This report includes the description of structure, refining, accessibility and planned development of data sources for project performance. It is based on the Efforte D 3.1 report (Mapping and SWOT analyses of existing and foreseen Big Data sources for forest operations) with a focus on the actual method development and planned demonstrations within the Efforte project.

The Efforte project database is summarised in MS Excel worksheets including Big Data sources and Methods. As the method development continues new data sources and methods will be added to the project database. The project database as from August 2017 is included in annex 1.

## 3. Big Data sources

The worksheet on Big data sources (*Data*) consists of the following parameters collected for each dataset:

| Parameter | Description |
|---|---|
| Reference | Serial number of datasets |
| Dataset | Name of dataset |
| Description | Description of dataset |
| Source | Source of dataset |
| Extent | Area of interest for Efforte project (Including a Google Earth *.kmz file when applicable) |
| Efforte WP | Efforte WP using the dataset |
| Data access | How to access data (Freely, cost or restricted) |

## 4. Methods

The worksheet on *Methods* consists of the following parameters collected for each method or tool used in the project:

| Parameter | Description |
|---|---|
| Reference | Serial number of method |
| Method/tools | Name of method or tool |
| Description | Description of method or tool |
| Purpose | Purpose to use the method or tool |
| Data requirements | What data requirements are needed for the method or tool? Link to Data worksheet. |
| Publication | Reference to publication for the method or tool |

## 5. Planned development

The project database includes data sources and methods currently used in the EFFORTE project. As the project evolves new datasets and methods will be added. Updating of the project database will at the end include a summary of all data and methods used and further refined within the project.

## Annex 1. Project database August 2017

Data:

| Reference | Dataset | Description | Source | Extent (kmz) | Efforte WP | Data access |
|---|---|---|---|---|---|---|
| **D1** | Digital Elevation Model, DEM | Detailed digital elevation model, 2 m resolution accuracy. | www.lantmateriet.se, National Land Survey in Finland | Sollebrunn test site, western Sweden, Nationwide/partly in Finland | 3 | License fee (Sweden), Freely available (Finland) |
| **D2** | Forest stand database | Description of forest stand characteristics, site index, ground conditions, Sortiment, quantity, forwarder distance, priority, average stem size, type of cutting (thinning/final felling) | Forest companies | Gimo test site, eastern Sweden, Bredvik test site, eastern Sweden, County of Jämtland, Sweden | 3 | Restricted |
| **D3** | Industy order of wood | Quantity of different assortments by different industries | Forest companies | Gimo test site, eastern Sweden | 3 | Restricted |
| **D4** | Harvester teams | Performance, preferred areas, action radius, homebase, labour time, target volumes | Forest companies | Gimo test site, eastern Sweden | 3 | Restricted |
| **D5** | Seasonal trafficability conditions | Table with seasonal trafficability conditions | Forest companies | Gimo test site, eastern Sweden | 3 | Restricted |
| **D6** | Road database | Nationwide road database including both private and general roads | Swedish Transport administration | Gimo test site, eastern Sweden, County of Jämtland | 3 | Freely available |
| **D7** | Volume of growing stock | Lidar estimates of forest volume | Forest companies, Swedish Forest Agency | Sollebrunn test site, western Sweden, Bredvik test site, eastern Sweden | 3 | Freely available |

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|---|---|---|---|---|---|---|
| **D8** | Depth to water maps | Depth to ground water | Forest companies, Swedish Forest Agency | Sollebrunn test site, western Sweden, | 3 | Free Webb Map Services services, Restricted data access |
| **D9** | Environmental condsiderations | National databases of protected areas and other environmental considerations | Swedish Environmental Protection Agency, Swedish Forest Agency | Sollebrunn test site, western Sweden, | 3 | Freely available |
| **D10** | Cultural heritages | National databases on cultural heritage | Swedish Forest Agency, Swedish National heritage Board | Sollebrunn test site, western Sweden, | 3 | Freely available |
| **D11** | Harvester data | Database from harvesters in StanforD 2010 format | Forest companies | Nationwide (Sweden), Kuru test site/Nationwide (Finland) | 3 | Restricted |
| **D12** | National Forest inventory | Forest inventory plots | Swedish university of Agricultural Sciences www.ign.fr | Nationwide (Sweden) North East quarter of France, region Grand Est | 3 | Restricted location, Statistics freely available |
| **D13** | CadasterENV | Detailed land use data, 10 m resolution | Swedish Environmental Protection Agency | Bredvik test site, eastern Sweden | 3 | License fee |
| **D14** | Tree height map | Lidar derived forest height, 2 m resolution | Swedish Forest Agency | Bredvik test site, eastern Sweden | 3 | License fee |
| **D15** | Orthophoto | Resolution 0.25 m | www.lantmateriet.se | Bredvik test site, eastern Sweden | 3 | License fee |
| **D16** | DTM (called BD ALTI) | Resolution 75m (in version available for free) | www.ign.fr | North East quarter of France, region Grand Est | 3 | Costly for resolution down to 25m |
| **D17** | Orthophoto (called BD FORET) | Resolution 0,5 ha (in version 2 since 2007) | www.ign.fr | North East quarter of France, region Grand Est | 3 | License fee for Research only |
| **D19** | Soil description (Called BDGSF) | Resolution 1 point / 1km² | GIS Sol | North East quarter of France, region Grand Est | 3 | License fee for Research only |
| **D20** | Water catchment & hydraulogy (called BD CARTHAGE) | Resolution 10m | Agence de l'Eau | North East quarter of France, region Grand Est | 3 | Freely availible |

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| **D21** | Weather including Rainfall and Evapotranspiration | Weather recorded on the location of the weather station<br>uneven distribution over the country and very points in Forest area | Météo France | North East quarter of France, region Grand Est | 3 | Cost depend on frequency |
| **D22** | Ground pressure | Ground pressure metric typology according to Forest machine and logging operation categories | FCBA | North East quarter of France, region Grand Est | 1 | on-going further completion |
| **D23** | Topographic database | Base map objects in vector format | National Land Survey of Finland | Nationwide (Finland) | 3 | Freely available |
| **D24** | ALS datasets | Airborne laser scanning point clouds | National Land Survey of Finland | Nationwide/partly (Finland) | 3 | Freely available |
| **D25** | Soil map | Soil type estimates | Geological Survey of Finland | Nationwide/partly (Finland) | 3 | Freely available |
| **D26** | Weather data | Weather statistics | Finnish Meteorological Institute | Nationwide (Finland) | 3 | Freely available |
| **D27** | National Forest Inventory data (Finland) | Forest estimates | Natural resources institute Finland (Luke) | Nationwide (Finland) | 3 | Freely available |
| **D28** | Rut scanning data | Trail surface point cloud | Natural resources institute Finland (Luke) | Vihti test site, Kuru test site | 3 | Restricted |
| **D29** | Harvester data (CAN-bus) | Machine operating data | Natural resources institute Finland (Luke) | Vihti test site, Kuru test site | 3 | Restricted |
| **D30** | Field study data | Field measurements on soil, stand and rut properties | Natural resources institute Finland (Luke) | Vihti test site, Kuru test site | 3 | Restricted |
| **D31** | Field study data | Point and site specific trafficability class values | www.metsateho.fi | Pudasjärvi, Southern Päijänne, Ilomantsi and Kokkola test sites | 3 | Restricted |
| **D32** | Forest machine specifications | Technical characteristics of forest machines | Forest machine manufacturers, forest operators | Nationwide (Finland) | 3 | Restricted |

Methods:

| Reference | Method/tools | Description | Purpose | Data requirements | Publication |
|---|---|---|---|---|---|
| **1** | DTW (Depth To Water maps) | Depth to water maps use detailed digital elevation models to calculate depth to ground water | The method produce detailed maps showing depth to ground water and indicate areas to avoid or take special consideration in harvesting and forwarding operations | Detailed Digital elevation model (D1) | Arp, P., Ogilvie, J., Castonguay, M & Murphy PNC. 2008. Enhancement of operational forest management planning through water mapping. FRIAA'S FORWARD-UNB wet-area mapping project: Final Report 2008 |
| **2** | Sequencing in operational planning | Tool for optimization of Big Data in order for sequencing of harvester teams | The method produce detailed scheduling of harvesting teams on daily basis for the coming period (month) and more general scheduling for the coming year | Forest stand database (D2), Industry order of wood (D3), Harvester teams (D4), Seasonal trafficability conditions (D5), Road database (D6) | M., Flisberg, P. Rönnqvist, M. & Andersson, G. 2016. Detailed scheduling of harvest teams and robust use of harvest and transportation resources, *Scandinavian Journal of Forest Research*, 31:7, 681-690, DOI: 10.1080/02827581.2016.1206144 |
| **3** | Bestway | Optimized forwarder roads to minimize damage on soil | Propose candidate forwarder roads with respect to elevation, ground water and environmental and cultural considerations | Detailed Digital elevation model (D1), Depth to water maps D7), Forest volume (D8), Environmental considerations (D9), cultural heritages (D10) | Bestway – Decision support tool for proposing main base roads for forwarders. Method report. Skogforsk report 932-2017 |
| **4** | Forest yield prediction by imputation | Forest yield prediction using forest stand data and historical harvester data | To predict volumes/assortments of planned forest cuttings | Forest stand database (D2), Harvester data (D11), Forest volume (D8) | Evaluation of yield forecasts produced by forest laser estimations and harvester data – results from three case studies. Skogforsk report 937-2017. |

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| **5** | Hillshade | Hillshade from DEM | Be able to look at detailed terrain structures | Detailed Digital elevation model (D1) | www.arcgis.com |
| **6** | CRF | Calibrated RouteFinder | Calculating the best route in a road network | National road database (D6) | Svenson G., Optimized Route Selection for logging Trucks, Doctoral Thesis No 2017:7 Faculty of Forestry |
| **7** | RoadOpt | Road upgrading optimization | Find an optimal level of accessibility at a road network | National road database (D6) & Forest stand databases (D2) | Flisberg P., Frisk M. & Rönnqvist M. 2014. Integrated harvest and logistic planning including road upgrading, Scandinavian Journal of Forest Research, published online July 7, 2014, DOI:10.1080/02827581.2014.929733. |
| **8** | EnviMap | Models for mapping of environmental considerations to support mechanised forest operations | Use of Big Data sources to map considerations to include in trafficability maps | CadasterENV (D13), tree height map (D14), Orthophoto (D15) | Under development in Efforte WP 3 task 3-3 |
| **9** | Forest soil drainage model | Drainage model depending on forest soil type, weather and vegetation | Predict soil moisture at given depth after rainy episodes | DTM (D1), soil description (D19), Weather records (D20,D21), forest stand | under development in EFFORTE WP1 task 1-1 |
| **10** | Soil stress model | Soil damage risk depending on soil type, soil moisture and applied ground pressure | Predict potential damage at given depth under operational conditions | DTM (D1), soil description (D19), Weather records (D20, D21), forest stand, ground pressure metrics (D22) | under development in EFFORTE WP1 task 1-4 |
| **11** | Static trafficability map | Classification of terrain trafficability | Predicting soil bearing capasity for forest operations and planning | Digital elevation model (D1), topographic database (D23), ALS datasets (D24) | |

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| **12** | Dynamic trafficability map | Dynamic model of terrain trafficability | Predicting soil bearing capasity for forest operations and planning | Digital elevation model (D16), national forest inventory data (D27), weather data (D26), soil map (D25) | under development in EFFORTE WP3 |
| **13** | Post harvest quality control | Continuous rut measurement system | Harvest quality (rut depth) monitoring | Rut scanning data (D28), harvester data (D11), field study data (D30) | Ala-Ilomäki, J., Lamminen, S., Sirén, M., Väätäinen, K. & Asikainen, A. 2012. Using harvester CAN-bus data for mobility mapping. In: Special issue. Abstracts for international conferences organized by LSFRI Silava in cooperation with SNS and IUFRO. Mezzinatne 25(58): 85-87. |
| **14** | Regeneration aided by Big data | Decision making tool for forest regeneration operations using big data | Enhance successful and environment friendly forest regeneration chain | Harvester data (D11), Digital elevation model (D1), soil map (D25) | under development in EFFORTE WP3 |
| **15** | Ground pressure calculator | Calculation model for assessing dynamic ground pressure and rutting of forest machines | To find best solutions for defining machine characteristics on weak bearing conditions | Forest machine specifications (D32) | |