A flexible technology solution for multiple NFI programmes

Martin Černý[1], Igor Buksha[2], Leen Govaere[3], László Kolozs[4], John Redmond[5], Vladimír Šebeň[6], Arnór Snorrason[7]
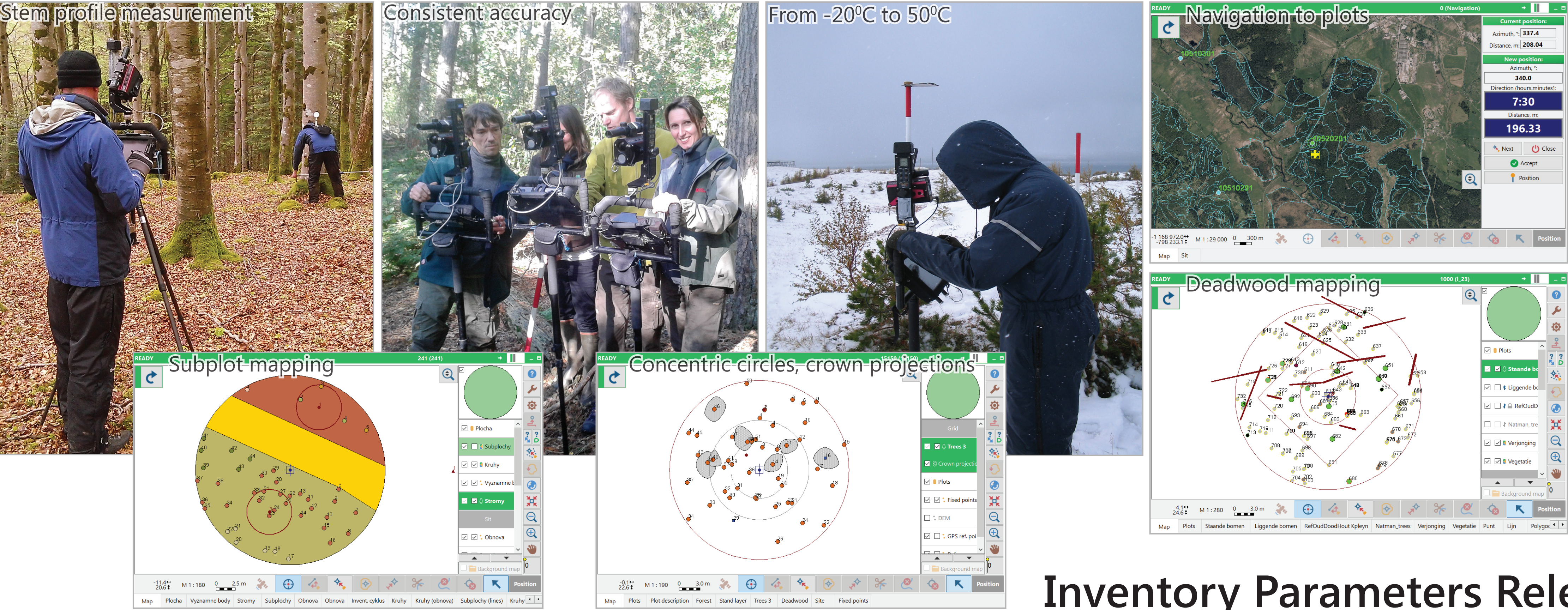
[1]IFER - Institute of Forest Ecosystem Research, Jilove u Prahy, Czech Republic; [2]Ukrainian Research Institute of Forestry and Forest Melioration, Kharkiv, Ukraine; [3]Agency for Nature and Forests, Brussels, Belgium; [4]National Food Chain Safety Office Forestry Directorate, Budapest, Hungary; [5]Forest Service - Department of Agriculture, Food and the Marine, Wexford, Ireland; [6]National Forest Centre - Forest Research Institute, Zvolen, Slovakia; [7]Icelandic Forest Service - Icelandic Forest Research, Reykjavik, Iceland

Technological Solution Supporting NFI: Field-Map

NFI programmes have a lot of common features but also a lot of variations related to project aims, natural conditions, scope of the inventories and periodicity. The workflow of any NFI programme requires various software and hardware components. Technology is crucial for field data collection but also for preparatory phases, data processing and reporting. Field-Map is a software and hardware technology that has been developed for computer-aided field data collection and data processing.

Field-Map is a generic framework which offers a solution applicable for many countries, and yet, provides flexibility to individual countries to incorporate their special requirements. The Field-Map product line combines flexible real-time GIS software with electronic equipment for navigation, mapping and dendrometric measurements. It allows the end-user to build up a data collecting environment without the help of the software developer. The technological solution offered by Field-Map encompasses the various requirements of NFI workflow, but at the same time retains flexibility that allows the integration of other software and hardware tools.

The development of Field-Map has been led a small team of software developers at IFER for more than 15 years in close collaboration with NFI experts and others from various projects in more than 40 countries. This sharing of experiences has created in Field-Map, a common technical solution which simplifies practical project implementation. For users it is very important that the specific requirements of a NFI methodology can be implemented quickly. Field-Map has shortened the time required to create an integrated data collection platform from months and years to days and weeks.

Stem profile measurement

Consistent accuracy

From -20°C to 50°C

Navigation to plots

Subplot mapping

Concentric circles, crown projections

Deadwood mapping

Field-Map Software Components

Preparation

Component		Description
Field-Map Project Manager	FMPM	Creating relational database, data handling
Field-Map Sampling	FM Sampling	Various sampling methods for NFI designs
Field-Map Import	FM Import	Batch import of data from external sources

Implementation

Component		Description
Field-Map Data Collector	FMDC	Navigation, data collection, calculations, validation
Field-Map Scripting	FM Scripting	Open system for adding custom functionality
Field-Map Database Query Tool	FM DQT	Querying Field-Map database
Field-Map Synchronization	FM Synchronization	Bi-directional synchronization with central data store

Processing

Component		Description
Field-Map Stem Analyst	FMSA	Stem profile modeling for volume and assortments
Field-Map KNN	FM KNN	K-nearest neighbors for increment estimate
Field-Map Inventory Analyst	FMIA	Calc secondary attributes, statistical analysis, reporting

Inventory Parameters Relevant for Technological Solution

Feature	Units/Options	Belgium Flanders	Czechia CZECHTERRA	Czechia NFI	Hungary	Ireland	Iceland	CapeVerde	Russia	Slovakia	Ukraine Pilot experiment
Forest area	th. ha	139	2 905	2 905	2 142	770	200	90	800 000	2 211	9 574 total, 2 pilot regions 996
Number of inventory plots	number	2 763	1 600	NFI1 39 432 (14 523 FL) NFI2 19 727 (7 153 FL)	5 355	1 923	1 154	2 083		3 069 total, 1 442 FL in NFI2	2 224 FL in pilot NFI
Year of FM implementation	year	2009	2008	1998	2008	2004	2005	2008	2008	2005	2008
Year of the first NFI finished	year	1997	2010	2004	2014	2006	2009	2006	2018	2005-2006	2008-2013
N of NFI cycles finished	number	2	2	2.6	1	3	2	1	1	2	1.5 pilot cycle
N of field teams/N of team members	number	4/5	2/2	21/4 (NFI1), 20/3 (NFI2),13/3 (NFI3)	5/2	3/2	3/2	3/3		6/3	2/3
Working season within a year	months	12	7	8	7	12	2.5	12		7	12
Continous/periodic inventory	continous/periodical	Continous	Periodical/Continous	Continous	Continous	Periodical	Periodical/Continous	Periodical	Periodical	Periodical	pilot NFI in 2 regions
Plot revisitation	years	10	5-7	10 (NFI1 and NFI2) 5 from 2016	10	5	5	-	10	10	5
Random component in plot loc.	yes/no	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Primary stratification of survey area	yes/no	Yes	No	No	No	No	Yes	Yes	Yes	No	No
Post stratification of inventory data	yes/no	Yes	Yes	Yes/Optional	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Permanent/temporary plots	permanent/temporary/both	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Fixed/variable sized plots	yes/no	Fixed	Fixed	Fixed	Fixed	Fixed	Variable	Variable	Fixed	Fixed	Fixed
Number of plots per cluster	1	4	1	2 (NFI1), 1 (NFI2 and NFI3)	4	1	1	1	1	1	4
Plot size	m^2	1 018	500	500	500	500	200	1 000/500	500	500	500
Plot shape		Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Plot center fixation	mechanical, virtual	Mechanical	Virtual	Mechanical, Virtual	Mechanical	Virtual	Mechanical	Virtual	Virtual	Mechanical	Mechanical
Segmented plot by tree dimensions	radius/diam limit	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Polygonal subplots	yes/no	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes
Remote sensing element	yes/no	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Indicators with spatial reference	names of layers	Plots, Trees	Plots, Subplots, Trees, Regeneration	Plots, Trees, objects on transects	Plots, Trees, Deadwood	Plots, Trees	Plots, Trees	Plots, Trees	Plots, Trees, Regeneration	Plots, Trees, Deadwood	Plots, Subplots, Trees
Use of NFI results for international reporting	list of activities	FAO FRA, UNFCCC, EU Habitats directive Report	UNFCCC	UNFCCC	FAO FRA, State of Europe's Forests, UNFCCC	FAO FRA, State of Europe's Forests, UNFCCC, ICP Forest	FAO FRA, State of Europe's Forests, UNFCCC				UNFCCC

Elements of Technological Workflow and Tools of Technological Solution

	Belgium Flanders	Czechia CZECHTERRA	Czechia NFI	Hungary	Ireland	Iceland	Cape verde	Russia	Slovakia	Ukraine
Defining of NFI aims *Inventory design and methodology*										
Defining and implementation of the database structure	FMPM/Firebird	FMPM, Firebird & MS SQL	Dia, PostgreSQL, FMPM	FMPM, Firebird	FMPM, Firebird	FMPM, Firebird	FMPM, MS Access	FMPM, Paradox	FMPM, MS Access	FMPM, MS Access, Firebird/MSSQL
Compilation of background maps (remote sensing imagery, existing maps, strata)	ArcView, FMPM, FMDC	FMPM, FMDC	PostgreSQL/PostGIS, PhoTopol, Grass, QGIS, eCognition	ArcView, FMPM, FMDC	ArcView, FMPM, FMDC	ArcGIS Pro	ArcView, FMPM, FMDC	FMPM, FMDC	ArcView, FMPM, FMDC	ArcGIS/ArcMap/ Geospatial Modelling Environment
Generation of inventory plot centers	ArcView	FM Sampling	PostgreSQL/PostGIS	ArcView	ArcView	ArcGIS Pro	FM Sampling	FM Sampling	ArcView	ArcGIS/ArcMap/ Geospatial Modelling Environment
Pre-classification based on remote sensing data	ArcView	FMDC	PhoTopol based custom app (PhoNIL)	ArcView	ArcView	ArcGIS Pro	FMDC		ArcView	ArcGIS/ArcMap/ Geospatial Modelling Environment
Special research for volume models		FMDC, FMSA	FMPM, FMDC, PostgreSQL, R		FMSA		FMDC, FMSA			
Navigation to inventory plots	GNSS or FMDC	FMDC	GNSS/FMDC, analogue maps	GNSS or FMDC	GNSS or FMDC	ArcGIS Collector	FMDC	GNSS or FMDC	GNSS or FMDC	GNSS or FMDC
Restoration of plot center	GNSS or FMDC	FMDC	GNSS/FMDC	GNSS or FMDC	GNSS or FMDC	ArcGIS Collector	FMDC	GNSS or FMDC	GNSS or FMDC	GNSS or FMDC
Field survey at inventory plots	FMDC, FM Scripting	FMDC, FM Scripting	FMDC, FM Scripting, external custom apps	FMDC, FM Scripting	FMDC, FM Scripting	FMDC, FM Scripting	FMDC, FM Scripting	FMDC, FM Scripting	FMDC	FMDC
Mapping of tree position	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Mapping of subplots	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Restoration of tree IDs	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Measurement of trees	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Descriptive attributes	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Data validation	FMDC	FMDC	FM Scripting, external custom app	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC	FMDC
Data pre-processing	FMIA, FM Scripting	FMIA, FM Scripting, FM DQT	FMDC, PostgreSQL, custom ETL app	FMIA, FM Scripting	FMIA, FM Scripting	FMPM	FMIA, FM Scripting	FMIA, FM Scripting	FMDC, FMPM	FMIA
Compilation of central database	FMPM	FMPM, FM Synchronization	PostgreSQL, custom ETL app	FMIA	FMIA	MS Office	FMPM	FMPM	MS Access	FMPM
Independent quality checks (validation, remeasurement)	FMDC, FM Scripting	FMDC, FM Scripting	external custom apps, PostgreSQL custom logic, Mediawiki	FMDC, FM Scripting	FMDC, FMIA, MS Access	FMDC	FMDC, FM Scripting	FMDC, FM Scripting	FMDC, MS Access	FMDC
Calculation of secondary attributes	FMIA & R	FMIA, FM KNN	custom ETL app, PostgreSQL custom extensions	FMIA	FMIA and MS Access, FM KNN	FMDC, FMPM, MS Office	FMIA	FMIA	MS Access	MS Access
Post stratification, classification, reclassification	FMIA & R	FMIA	custom PostgreSQL extensions	FMIA	FMIA	MS Office	FMIA	FMIA	MS Access	MS Access
Statistical data processing	FMIA & R	FMIA	custom PostgreSQL extensions e.g. nFIESTA, C++ library (estimators4nfi)	FMIA	FMIA	MS Office	FMIA	FMIA	MS Access	R
Reporting	FMIA & R	FMIA	PostgreSQL, R, QGIS, Mediawiki, LaTex, nil.uhul.cz (Joomla)	FMIA	FMIA	MS Office	FMIA	FMIA	Individual approach	FMIA, MS Office

Dense forest

Multiple team support

High humidity

Steep slopes