Chapter 8
Czech Republic

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8.1 Development of the Czech National Forest Inventory

Information on forests and forestry in the former Czechoslovakia (the Czech Republic since 1993) was traditionally based on stand-wise forest inventories usually conducted as a part of forest management planning procedures. The first country level reporting was performed prior to World War II and provided data on standing volume and forest condition. However the quality of the source data varied because they were often based on estimates. After World War II, the forest inventory was initiated by the project called Forest Inventory 1950. During the war, forest management plans were neither revised nor renewed and so there was an urgent need to do so. Based on Decree No. 3021 of the Ministry of Agriculture of November 8, 1948, forest management plans were renewed. A limited additional field survey was conducted, and country level data for 1950 were produced. In the following decades, country level data were collected using an aggregation of data for local stand-wise inventories.

Together with Forest Inventories conducted at 10-year intervals, data for so-called Permanent Forest Inventories were collected every year. Permanent Forest Inventories included the main parameters characterizing forest condition and were also based upon stand-wise inventories conducted as a part of forest management planning. Hence, the aggregated data were produced annually from actual, valid management plans. The management plans were renewed every 10 years.

In 1979, the preceding inventories were succeeded by the Comprehensive Forest Management Plans (presently referred to as Comprehensive Information on Forest),

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based on the same principles as the Permanent Forest Inventories. These were updated on an annual basis by summarizing the data from individual forest management plans. Comprehensive Forest Management Plans were in operation until 1998, when they were replaced by "Information on the Status of Forests".

In 1995, the new Forestry Act of the Czech Republic (Act No. 289/1995 Sb.) adopted an option for a new inventory that would be based upon an independent survey with no direct link to forest management plans.

In 1994 the Institute of Forest Ecosystem Research Ltd. (IFER) began developing and testing methods for a new statistical forest inventory. The project was funded by the Czech Ministry of Agriculture, lasted until 2000, and ended with the complete methodology for a statistical forest inventory based upon international experience and national requirements. IFER tested the methodology in two pilot experiments covering 80,000 ha. During the following years IFER complemented the methodology with comprehensive technology supporting field data collection and other forest inventory activities.

In June 2000, the preparatory period was finished by Government Regulation No. 193/2000 Sb., declaring the execution of a forest inventory for the period from 2001 to 2004. This regulation shifted the context of the forest inventory to a new level – the inventory approaches treating forests as an integral part of the environment within its ecosystem relations. Together with the production function the new forest inventory would also deal with other characteristics of the forest environment.

The new forest inventory is the responsibility of the Czech Ministry of Agriculture and is carried out by the Forest Management Institute, Brandýs nad Labem (FMI), which covers fieldwork, data processing and reporting.

With the new forest inventory the time series of country level data, based upon aggregated data from forest management plans, has ended. The new inventory data cannot be directly compared with data from the previous inventories resulting in a whole range of factors that must be considered when comparing the results of these inventories.

The field survey of the new forest inventory took place during 2001–2004.

In 2006, IFER finished a project for the Ministry of Agriculture aiming at preparation of methodology for the second cycle of forest inventory. That project was carried out in co-operation with FMI. Currently there is no official decision regarding repeated inventories but it is expected that it will be in a 10-year cycle.

8.2 The Use and Users of the Results

8.2.1 General Use

The National Forest Inventory (NFI) based on statistical sampling (2001–2004) delivered information that is substantially different from information collected

previously. As a consequence of new methodological approaches the data differ in structure, spectrum of forest indicators and in some cases also in estimates. Therefore the incorporation of the new forest inventory data into various national and international reporting processes is laborious and difficult to link to previously reported information on forests.

Forest inventory data serves as a valuable information source for national policy makers and the regional state administration of forests. Additionally the NFI results served as a basis for formulation of the new National Forest Program – the key national strategic document on forest development.

The NFI data have been directly used for reporting in the European System of National and Regional Accounts, for the "Report on forestry of the Czech Republic". So far, NFI data have not been used for international reporting to the Food and Agriculture Organization of the United Nations (FAO), Ministerial Conference on the Protection of Forests in Europe (MCPFE) nor United Nation's Framework Convention on Climate Change (UNFCCC).

8.2.2 The Use of NFI Data in UNFCCC Inlcuding Kyoto Reporting

Emission reporting under the UNFCCC and its Kyoto Protocol is the responsibility of the Czech Ministry of Environment. The technically responsible body for compiling emission inventory data for the Land Use, Land-Use Change and Forestry (LULUCF) sector is IFER. IFER is a part of the National (Emission) Inventory System, which is coordinated by the Czech Hydrometeorological Institute. So far, NFI data has not been used for UNFCCC and Kyoto reporting. With data for only one inventory cycle available (2001–2004), this resource is not directly usable for detecting carbon stock change in forests. Nonetheless, the data for the first cycle would be suitable for several other purposes, such as constructing better country-specific biomass expansion factors for individual tree species. Unfortunately, FMI, which is responsible for conducting the NFI in this country, blocks release of tree-level data for the analyses needed. Effective utilization of statistical forest inventory data in the near future would also require several methodological adjustments, taking into account the specific needs of the carbon (emission) inventory. These plans are under consideration. So far, no decision has been made on NFI2, as of October 2007. Undoubtedly, once the data of the repeated NFIs are available, IFER will insist on a full utilization of this resource for the use in emission inventory.

Currently, the primary source of activity data on forests for the purpose of UNFCCC and Kyoto reporting remains the stand-level data of Forest Management Plans (FMP), which are administered centrally by FMI. With a 10-year cycle of forest management plans, the annual update of the FMP database is related to 1/10 of the total forest area scattered throughout the country. The information in FMP represents an ongoing national stand-wise type of forest inventory. This resource

provides information on both growing stock and forest area. The latter is an inherent part of the annually updated cadastral information system of the country, which is used to detect areas of all land use categories and land use change as required under UNFCCC and Kyoto Protocol.

8.2.3 The Role of NFI in Assigning the Biodiversity Status

Until now, NFI data has not been used for any international reporting, which also includes biodiversity. Information on forests provided in the reports of the Czech Republic to the Convention on Biodiversity (CBD), as well as to MCPFE, is based on the database of Forest Management Plans (FMP) administered by FMI which was described above.

The Czech NFI program aims at providing information usable for biodiversity assessment. For this purpose, the first NFI cycle (2001–2004) included tens of indicators. These indicators will be also used in the future NFI campaigns.

8.3 Current Estimates

Tables 8.1a and b present the basic area and volume estimates from the first cycle of the Czech NFI conducted from 2001 to 2004. All estimates correspond to the national definitions given in those Tables. It is expected that harmonization of definitions with COST Action E43 will be considered for the next NFI.

Digitized and orthorectified aerial photographs were used for preliminary estimates of land cover and decisions about forest/non-forest. Those inventory plots clearly outside forests were not visited.

The technical specifications of the photos are:

- Scale of image: 1:23,000
- Ground resolution: 50 cm
- Year of flight: 1998–2001
- Position accuracy of aerial photos: ±5 m
- Color depth: 8 bit of gray shades
- Interpretation: manual using visualization by geographic information system (GIS, software Topol)

The Czech NFI covers the whole area of the Czech Republic, and estimation of forest cover is one of its key aims.

The forest border line is characterized by the trees taller than 1.3 m with spacing less than 12 m. Forest stand is defined by the minimum canopy closure (0.2) and minimum area (400 m^2). The categories of non-stocked forest land are explicitly defined.

Table 8.1a Basic area estimates from the years 2001–2004

Quantity	Estimate (1,000 ha)	Description	SE[a]
Forest land	2,752	The category comprises forest land pursuant to the Forestry Act 289/1995 Coll., Sec.3, par.1a and Decree No.84/1996 Coll., of the Ministry of Agriculture, where the forest land is divided into timber land and non-stocked forest land. This category includes also land that resembles forests and is not defined in the aforementioned legislation, e.g. forest stands on agricultural land.	n.a[c]
Forest stands area	2,705	Land with forest stands with boundaries with other land, made up by connecting lines of trees higher than 1.3 m and situated not further than 12 m from each other. Should these trees be shorter than 1.3 m, then it is the connecting line of trees situated not further than 5 m from each other that is considered to be the forest boundary. A piece of land with a forest stand at least 10 m wide and of an area of at least 400 m^2 must be located behind these boundary lines. A forest stand is considered to be a community of tree species with canopy closure of at least 20%.	10
Non-stocked forest land	47	The category is defined as follows: forest aisles wider than 4 m, unpaved forest roads wider than 4 m, paved forest roads not wider than 4 m, forest nurseries on forest land, seedling nursery, etc.	3.7
Forest roads (m/ha)	14.9	The basic criteria for determining the class of forest roads are the parameters given by ČSN Forest Roads Network (1996), mainly the type of road pavement, width of the road crown, road gradient and the radius of the horizontal curve.	n.a.[c]
Total land area	7,887	Total land area of the Czech Republic includes all types of land.	–[b]

[a]Standard error.
[b]Assumed to be error free.
[c]Not available.

Table 8.1b Basic volume estimates for the years 2001–2004

Quantity	Estimate	Description	SE[a]
Growing stock million cubic metre	900	This category includes the stock of timber to the top of 7 cm over bark, including dead trees (m^3 under bark)	10
Mean growing stock m^3/ha	332.7	This category represents the stock of timber to the top of 7 cm over bark, including dead trees, per 1 ha (m^3/ha under bark)	3.5
Dead wood million cubic metre	18	This category comprises the wood mass of dead trees lying on the ground, of broken tree tops, branches, harvest residues, unprocessed old timber, etc.	0.7

[a]Standard error.

8.4 Sampling Design

Field data collection methodology was developed within a pilot project conducted by IFER. This methodology was then used and adjusted by FMI, which described the methodology in two manuals, "Methodology of Field Data Collection" and "Work Procedures". The handbook "Methodology of Field Data Collection" has two Appendices: "Natural Forest Species Composition by Forest Types and Natural Forest Areas" and "Field-Map Project Structure". "Work Procedures" has two parts, namely "Office Work" and "Field Work".

8.4.1 Sample Plots

Inventory plot:

- Grid size: 2 × 2 km
- Two circular plots in each grid cell
- The position of the first inventory plot is randomly shifted a maximum of 300 m from the center of the inventory grid cell; the distance between inventory plots of the same cell is 300 m, and the direction from the first to the second plot is random (Fig. 8.1)
- Number of plots: approximately 39,000 of which approximately 14,000 are in forests
- Number of primary (field) variables per plot: approximately 150
- Stratification within a plot: segments according to the specific classes of the land cover; minimum segment size 10% of the area of inventory plot; no shift of plot

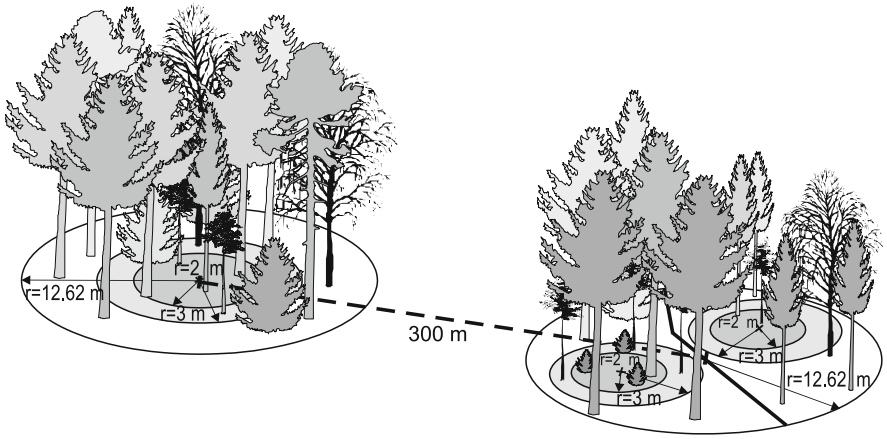

Fig. 8.1 A 300 m transect between plots with a duplex

center when plot is intersected by the forest edge; plot is established when the plot center is located within the category of forest
- Type of plots: permanent (both position of trees and boundary of plot segments are mapped)
- Plot size: fixed circle size 500 m^2; for trees with diameter at breast height (dbh) $\geq$12 cm; additional two concentric circles are established in the center of gravity (location of maximum distance to segment boundaries) of each polygonal segment of the plot; circle with the radius 3 m for the trees with *dbh* between 7 and 11.9 cm, circle with the radius 2 m for the regeneration with height $\geq$10 cm
- Number of trees: approximately 25 per plot
- Number of trees with height measurement: first 50 trees of each species per plot
- Forest regeneration: tree counts by species and height classes
- Deadwood on the ground: length and mid-diameter of all dead logs within the plot with minimum diameter of 7 cm at the smaller end; coverage of dead branches and smaller debris; number and size of stumps
- Forest site: several variables describing growing conditions, ecosystem structure etc.
- Damage: several stand and tree attributes
- Lichens: occurrence of epiphytic lichens
- Soil sampling: mixed soil sample at every first plot of the duplex is analyzed for basic nutrients, C/N, pH
- Inventory of forest roads, forest edges and small water streams is performed using the survey on 300 m transect between plots within a duplex. Shapes which intersect transect line are recorded i.e. mapped and described

8.5 Management

8.5.1 Management and Personnel

The NFI in the Czech Republic is set by Act No. 289/1995 Sb., on Forests and Amendments to some Acts (The Forestry Act) and the Government Regulation No. 193/2000 Sb. They declared the implementation of the forest inventory for the period from 2001 to 2004.

The NFI in the Czech Republic is conducted by FMI which is also responsible for NFI data management and data processing.

The first NFI cycle was conducted over 4 years, using 18 four-member field crews. Two additional inventory teams were established for field checks.

8.5.2 Measurement Technology

Data collection in the field was based on the Field-Map technology described below. The technology set-up was equipped by the Field-Map software with data

exchange to the central database server using MS SQL. Field-Map software was developed by the IFER. Field-Map is a comprehensive tool for collecting field data using electronic measurement devices. The following electronic measurement devices were used in the first NFI cycle:

- Field Computer Hammerhead P-233
- MapStar – an instrument for measuring absolute horizontal angles used for sighting tree location and navigation
- Forest Pro – laser rangefinder designed for measuring horizontal distances, inclination, tree height, etc.
- Global positioning system (GPS) Trimble Geoexplorer 3 for providing geographic coordinates
- Mantax electronic caliper for measuring tree diameters
- Handheld data collector PSION for descriptive information on trees
- Metal detector GARRETT to locate inventory plot position for control or repeated sampling

8.5.3 Quality Assurance

NFI employees participating in the NFI were trained prior to the first NFI cycle. Every field worker passed an examination on NFI methodology and working processes. During the practical examination, field workers had to demonstrate the practical operation of field technology. Training and verification of NFI workers during the whole first NFI cycle was conducted annually. A special program for data verification was developed to control formal and logical accuracy of measured data directly after the measurement. It also permitted immediate corrections. Another thorough quality control phase took place after sending data to FMI.

Two special teams carried out the quality control measurements. One team was composed of FMI employees who checked 5% of all inventory plots. The second team was represented by an independent company which checked another 5% of sites. Altogether, measurements of 10% of the inventory plots were verified.

8.6 Estimation Procedures

The whole estimation procedure used by FMI is described in detail in the NFI of the Czech Republic 2001–2004 (FMI 2007).

8.6.1 Area Estimation

The total area of the Czech Republic was taken from the Real Estate Cadastre system. The area of forest (forest stands according to methodology NFI and non-stocked

forest land) was located by scanning the forest borders. For scanning forest borders, orthophotomaps from years 1998–2001 were used.

8.6.2 Volume Estimation

Growing stock volume includes all trees with $dbh > 7$ cm including dead trees. The estimated volume is over bark. Merchantable volume under bark is then calculated using the conversion factors for coniferous and broadleaved tree species. Tree volume was calculated using the volume tables of the FMI based on tree *dbh* and tree height. The heights of trees that were not directly measured (approximately 15% of trees in inventory plots) were predicted using height models calibrated on a species/plot/region level.

Growing stock volume z on sub-plot is estimated as

$$z = \sum_{j=1}^{m} v_j \tag{8.1}$$

where V_j is tree volume on the sub-plot and m is the number of trees on the sub-plot.

8.6.3 Estimation of Average Volume per Hectare

Average volume per hectare, denoted $\overline{zh}$ is estimated as,

$$\overline{zh} = \frac{\sum_{i=1}^{n} z_i}{\sum_{i=1}^{n} p_i}, \tag{8.2}$$

where z_i is volume on the sub-plot, p_i is the sub-plot area and n is the number of sub-plots.

8.6.4 Estimation of Total Volume (Czech Republic, Districts)

Total volume, denoted Z, is estimated as

$$Z = \overline{zh} \cdot P \tag{8.3}$$

where $\overline{zh}$ is the estimate of average volume per hectare and P is area.

8.6.5 Volume per Hectare on Sub-plot

Volume per hectare on a sub-plot, denoted zh_i is estimated as,

$$zh_i = \frac{z_i}{p_i} \tag{8.4}$$

where z_i is the volume of trees on the sub-plot and p_i is the sub-plot area.

8.6.6 Error Estimation

A confidence interval is calculated for all assessed variables ($\alpha = 0.95$).

8.6.7 Estimation of Scatter and Standard Deviation of Total Volume per Hectare on Sub-plot

The standard deviation of total volume per hectare on a sub-plot, denoted s, is estimated as,

$$s = \sqrt{\frac{\sum_{i=1}^{n} p_i \left(zh_i - \overline{zh}\right)^2}{\sum_{i=1}^{n} p_i} \cdot \frac{n}{(n-1)}} \tag{8.5}$$

where zh_i is total volume per hectare on the sub-plot, $\overline{zh}$ is the average volume per hectare estimate and p_i is the sub-plot area.

8.6.8 Average Volume per Hectare – Error Estimation

The width, d, of an α-level confidence interval is calculated as,

$$d = \pm\, t_{1-\alpha;n-1} \cdot \frac{s}{\sqrt{n}} \tag{8.6}$$

where n is the number of sub-plots, s is the standard deviation of the total volume per hectare on the sub-plot and $t_{1-\alpha;n-1}$ is the student t-distribution value for level $\alpha = 0.95$.

8.6.9 Increment and Drain Statistics Estimation

Because only one inventory cycle has been conducted, evaluation of methods for increment and drain has not been finalized.

8.7 Harmonized Estimates

The possibilities to give the estimates on one hand on the basis of national definitions and on the other hand on the basis of COST Action E43 reference definitions are presented in Table 8.2.

8.8 Current Status and Future Prospects

The first cycle of the NFI was conducted during 2001–2004. No decision on a repeated NFI cycle has been made. Although the date for the initiation of NFI2 is not known, preparations for NFI2 are underway. The pilot project aimed at repeated inventories was realized in cooperation with IFER. Other projects aimed at methodological and technological processes should follow.

Table 8.2 The availability of estimates based on national definitions (ND) and reference definitions (RD)[a]

Estimate	ND	RD	Responsible	Remark
Forest Area	Yes	No	NFI	ND ≠ RD Different land cover criteria (area, width, crown cover, tree height) and land use criteria (legislative criteria in use)
Growing stock volume	Yes	No	NFI	ND ≠ RD Missing: trees below 7 cm *dbh*; stem top, Included: dead stems
Above-ground biomass	No	No	NFI	
Below-ground biomass	No	No	NFI	
Dead wood volume	Yes	Yes	NFI	Can be derived from NFI data
Dead wood volume by decay stage classes	Yes	Yes	NFI	Can be derived from NFI data
Afforestation Reforestation Deforestation (Kyoto 3.3)	No	Yes	Ministry of Environment	Applied in emission inventory
Forest type	No	Yes	NFI	Can be derived from NFI data

[a]RD is understood as either in use in the country, or easily derived from the national definition and activity data.

References

Forest Management Institute (FMI) (2007) National Forest Inventory in the Czech Republic 2001–2004. Introduction, Methods, Results. 224 p