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„Forest Inventories – Status Quo in Ukraine, record of Germany and guidelines by FAO“

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About the Project “German-Ukrainian Agricultural Policy Dialogue” (APD)

The project German-Ukrainian Agricultural Policy Dialogue (APD) started 2006 and is supported up to 2018 by the Federal Ministry of Food and Agriculture of Germany (BMEL). On behalf of BMEL, it is carried out by the mandatary, GFA Consulting Group GmbH, and a working group consisting of IAK AGRAR CONSULTING GmbH (IAK), Leibniz Institute of Agricultural Development in Transition Economies (IAMO) and AFC Consultants International GmbH. Project executing organization is the Institute of Economic Research and Policy Consulting in Kyiv. The APD cooperates with the German land use and management society (BVVG) on the implementation of key components related to the development of an effective and transparent land administration system in Ukraine. Beneficiary of the project is the Ministry of Agrarian Policy and Food of Ukraine.

In accordance with the principles of market economy and public regulation, taking into account the potentials, arising from the EU-Ukraine Association Agreement, the project aims at supporting Ukraine in the development of sustainable agriculture, efficient processing industries and enhancing its competitiveness on the world market. With regard to the above purpose, mainly German, but also East German and international, especially EU experience are provided by APD when designing the agricultural policy framework and establishing of relevant institutions in the agriculture sector of Ukraine.



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List of abbreviations

CNFI	Centre of National Forest Inventory
ENFIN	European National Forest Inventory Network
EU	European Union
FAO	Food and Agriculture Organization
FMSC	Forest Management Scientific Centre
ha	hectare
IFER	Institute of Forest Ecosystem Research
km	kilometer
KP	Kyoto Protocol to UNFCCC
LULUCF	Land Use, Land Use Change and Forestry
m	meter
m ³	cubic meter
mio.	Million
NAAS	National Academy of Agricultural Science of Ukraine
NFM	National Forest Monitoring
NFTUU	National Forest Technical University of Ukraine
No.	Number
p.	page
PA "Ukrderzhlisproekt"	Ukrainian Forest Management Planning Association
PFS	Primary Forests Survey
r	radius
RFHA	Regional (oblast) Forestry and Hunting Administration
SFC	State Forest Cadaster
SFC	State Forestry Committee of Ukraine
SFRA	State Forest Resources Agency of Ukraine
SFS	State Forest Survey
SLC	State Land Cadaster
thou.	Thousand
UAH	Ukrainian Hrywnia
UNFCCC	United Nation Climate Change Convention
URIFFM	Ukrainian Research Institute of Forestry and Forest Melioration

1. Review of experience, resources and public interest in the forest inventories in Ukraine, by Vitaliy Storozhuk

1.1. Experience of creation of information base on forest resources of Ukraine

1.1.1. State Forest Survey and State Forest Cadaster

Ukraine has an integrated system of State Forest Survey and State Forest Cadaster. Forest Code of Ukraine stipulates that State Forest Survey and State Forest Cadaster include a system of information and documents on legal regime of forest fund, its distribution between forest users, qualitative and quantitative state of forests, its division into groups and belonging to protection categories, economic evaluation and other data [1].

Order of conducting of State Forest Survey and State Forest Cadaster is regulated by Decrees of the Cabinet of Ministers of Ukraine [2, 3]. Content of works and requirements for reporting documentation are approved by the relevant instructions, issued for development of governmental Decrees [10, 11]. State Forest Cadaster is formed by forest users, executive power entities, for administrative units as a complex of five tabular forms (Annex 1). Primary Forests Survey that "involves collecting and summarizing information that characterize each forest plot by area, quantitative and qualitative indicators" is performed in a form of the first two tabular forms of State Forest Cadaster [11].

There is no significant statutory distinction between accounting information of State Forest Cadaster and State Forest Survey. However, the approval procedure is different: documentation of State Forest Cadaster is specified annually and updated every five years; in a year when State Forest Survey is conducted, forestry enterprises coordinate documentation of Primary Forest Survey with land management entities [4].

State Forest Survey information is available in Ukraine as of 01.01.1996 and 01.01.2011. There is also information on the forests of the former State Forestry Committee of Ukraine as of 01.01.2002. The results of State Forest Surveys generally indicate an increase in forest area and accumulation of total growing stock of stands (Annex 2). Due to a lack of budget financing, State Forest Survey as of 01.01.2015 was not held, even though it was envisaged by the State Program "Forests of Ukraine" for years 2010-2015 [7].

State Forest Survey of the year 2011 included satisfactory information on forests subordinated to the State Agency Forest Resources of Ukraine [1*], but was notable for a weak interagency cooperation, because a part of ministries and agencies did not provide information about the changes that took place in forests of the subordinated enterprises. Not all permanent forest users and forest owners produced the State Forest Cadaster documentation according to the tabular forms of the relevant Instruction in the year when State Forest Survey was held. As a result, State Forest Cadaster does not contain a comprehensive list of small private forest owners and users.

In order to prepare a new State Forest Survey, it is necessary to expand technological capabilities of State Forest Cadaster and improve organizational requirements for provision of information by permanent forest users and owners to the state forest cadaster. By analogy with the State Land Cadaster, the object of which is a separate land plot – a subject of State Forest Cadaster should be represented by a separate forest plot, and consolidated tabular forms shall remain as an object of State Forest Survey. In this sense it is advisable to develop a new proce-

ture of State Forest Cadaster in a form of state geographic information system of data on forests [2*].

Responsible organizations: State Forest Resources Agency of Ukraine, Regional Forestry and Hunting Administration, PA "Ukrderzhlisproekt".

1.1.2. Forest management planning

The Forest Code of Ukraine defines content of stand-wise forest management planning [1]. Activities are carried-out by state forest management planning organizations¹ in a form of a unified system according to the Instruction for forest management planning of the forest fund of Ukraine as of 2004 [19]. By law, forest management planning in state forests is financed from the state budget, in communal forests – at the expense of local budgets, in private forests – at the expense of private forest owners [1]. In 2016 there were no state budget funding to conduct stand-wise inventory and planning operations. Currently it is still unknown from what sources will be forest planning further financed in budget-dependent forest enterprises.

The general scheme of forest management planning includes basic and continuous forest planning (Annex 3). Audit period (repetition time) of basic forest planning is not legally defined², which affects the planning, conducting and financial support of the relevant activities. All the enterprises of State Forest Resources Agency are covered by continuous forest planning, which is carried out to provide annual updates (actualization) of stand-wise inventory database. Overall, the regulatory framework of forest management planning has to be improved, – which requires approval of the new Instruction for forest management planning of forest fund of Ukraine.

Territorial and strategic planning of stand-wise inventory works was carried out in programmatic way. Conceptual program of development of forest management planning for the period up to 2010 [12] and the next program for the period up to 2015 [13] had the goal to provide information and support of the relevant State Program "Forests of Ukraine" for years 2002-2015 [5] and the State Program "Forests of Ukraine" for years 2010-2015 [6]. Despite unevenness of the planned volumes, during implementation of these Programs, the average amount of activities on basic stand-wise forest inventory was close to 1 Mio. ha (Annex 4). On behalf of the State Forest Resources Agency, PA "Ukrderzhlisproekt" has drafted a Program of perspective development of forest management planning for years 2017-2021.

Responsible organization: PA "Ukrderzhlisproekt".

1.1.3. Forest monitoring

Ukraine, as a member of the Pan-European Process for Protection of Forests in Europe, has signed, among others, the Strasbourg Resolution S1 (1990) for mandatory monitoring of forest ecosystems in accordance with the International Program on assessment and monitoring of air pollution on forests in the region of UN Economic Commission for Europe (ICP Forests). Implementation of environmental monitoring of forests is provided by the Forest Code of Ukraine [1].

¹ All forest management planning organizations are united in Ukrainian Forest Management Planning Association PA "Ukrderzhlisproekt"

² For planning purposes, length of revision period of base forest management planning is traditionally set to be equal to 10 years

Measures on development of forest monitoring in Ukraine were included in a number of governmental State Programs. State Program of environmental monitoring provided annual (during 2008-2012) allocation of funds for monitoring of forests and enhancement of observations network throughout the forest fund (Table 1) [8]. State Program "Forests of Ukraine" for 2002-2015 projected monitoring throughout the whole forest territory with an appropriate level of funding [5]. Coverage of forests subordinated to the former State Forestry Committee by forest monitoring plots network of I level was achieved in 2008. Expansion on the territory of other forest users that was projected by the follow-up State Program "Forests of Ukraine" for 2010-2015, has not happened [6].

Table 1: Financing of forest monitoring activities

Activities	Units	Years								
		2008	2009	2010	2011	2012	2013	2014	2015	
State Program of environmental monitoring (2007)										
Monitoring of state of forests	mio. UAH	3,44	3,68	3,68	3,59	3,61				
State Program "Forests of Ukraine" for 2002-2015 (2002)										
Monitoring of state of forests	mio. ha	9,4	9,4	9,4	9,4	9,4	9,4	9,4	9,4	9,4
	mio. UAH	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6
Factual expenditures for examination of I level monitoring plots	Thou. plots	1,56	1,54							
	mio. UAH	0,45	0,51							
State Program "Forests of Ukraine" for 2010-2015 (2009)										
Monitoring of state of forests	mio. ha			6,93	7,57	8,21	8,85	9,49	9,49	
	mio. UAH			-	-	-	-	-	-	-

According to the Regulation on the State System of Environmental Monitoring: "Monitoring of forest vegetation (damage caused by biotic and abiotic factors, biomass, biodiversity, radiological measurements, content of pollutants) is conducted by the State Forestry Committee (currently – State Agency of Forest Resources of Ukraine)" [7].

Forest monitoring is carried out as a joint activity of production and research institutions of State Forest Resources Agency of Ukraine. As a part of this activity, fieldwork (survey on plots) is conducted by specialists of forestry enterprises. PA "Ukrderzhlisproekt" is responsible for formation of databases of forest monitoring. Ukrainian Research Institute of Forestry and Forest Melioration serves as the national focal point of forest monitoring, whose specialists develop methodology and software for forest monitoring.

Observations of forests state on monitoring plots is carried out in accordance with "Methodical recommendations on monitoring of forests of Ukraine of I level" [24]. The total number of established plots of monitoring network of I level is over 1.5 thousand (Annex 5).

Responsible organizations: forestry enterprises, PA "Ukrderzhlisproekt", URIFFM.

1.1.4. Experience of preparing and carrying-out regional sampling forest inventory (Ivano-Frankivsk and Sumy oblasts)

Discussion on the need for national forest inventory started in Ukraine after a group of Ukrainian experts has attended the international seminar "National Forest Inventory – a source of reliable information on forest resources", held in Lithuania [3*]. The first response to a perspective idea of national forest inventory was from scientific organizations: URIFFM, NFTUU, FMSC and PA "Ukrderzhlisproekt".

URIFFM has organized a joint Ukrainian-Czech project "TekhInLis"³, which was focused on implementing application of software and system complex for forest inventory data collection 'Field Map', which was developed by the Institute of Forest Ecosystem Research (IFER, Czech Republic). During the field season of 2005 within the TekhInLis project, a pilot inventory of the national park "Homolshanski Lisy" with an area of 3.4 thou. ha was carried-out in Kharkiv region (Fig. 1) [4*]. Later in the TekhInLis project, specialists of laboratory of forest monitoring and certification of URIFFM have developed a first draft Methodology of National Forest Inventory (2007) [23].

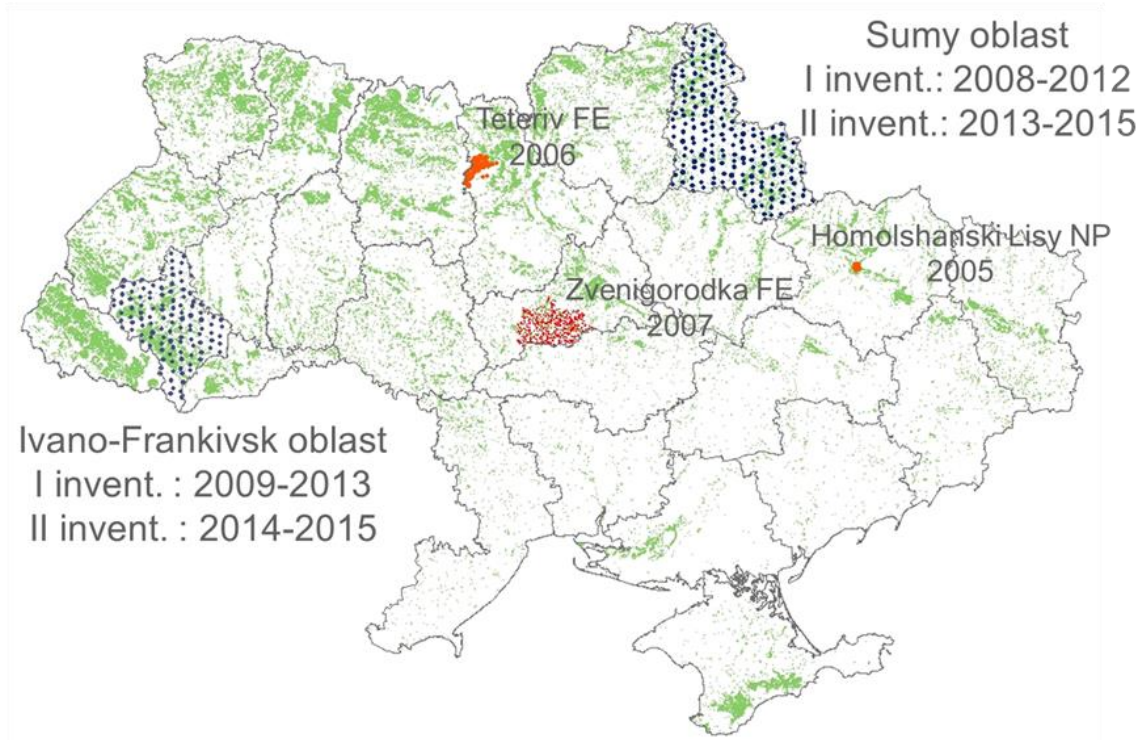
During a series of research of the National Forestry Technical University of Ukraine, a sampling-based inventory of forest fund of Verkhniodnistrovsky and Skole Beskydy on an area of 21.3 thou. ha was conducted [5*, 6*].

Forest Management Scientific Center and PA "Ukrderzhlisproekt" under the Ukrainian-Swedish project «Ukraine Forest Reform Program - II» have carried-out an inventory of 48.9 thou. ha of forest lands of Teteriv state forest enterprise of Kyiv region in 2006 (Fig. 1). The results of the pilot inventory were presented in the final project report [7*]. They indicate an excess of the calculated mean growing stocks of forest stands over those reported by stand-wise forest inventory. For the pilot inventories, experts of project have prepared a draft "Guidelines for fieldwork on forest inventory in Polissya region of Ukraine" (2006) [22].

In 2007, pursuant to the order of the State Forestry Committee of Ukraine, the Centre of National Forest Inventory (CNFI) was established within the structure of PA "Ukrderzhlisproekt" [16]. At the same year, CNFI has conducted a sampling inventory of Zvenigorodka forestry enterprise of Cherkasy region on an area of 24.4 thou. ha in order to improve methodology of fieldwork, working out logistics skills of inventory groups, and attaining skills of operating the field complex 'Field-Map' by personnel (Fig. 1).

³ https://www.ifer.cz/page/index.php?page=project_running_detail&id=42004

Figure 1: Territories of pilot and regional forest inventories



In order to discuss opportunities and challenges in implementing NFI in Ukraine several scientific seminars and conferences were held. In 2006, the final workshop of the project TekhInLis was attended by representatives of European National Forest Inventory Network (ENFIN). Prior to the seminar "National forest inventory in Ukraine: issues, challenges and prospects" in 2008 an analytical review "National Forest Inventory in Ukraine: conceptual framework and sample design" was produced [8*].

Ukrainian experts with the support of international projects have participated in the study tours to Sweden, Czech Republic and Lithuania. A significant influence on preparation of Ukrainian inventories was provided by international experts from those countries – Ulf Soderberg, Martin Cerny, Andrius Kuliešis. Discussion on design of the inventory, possibilities of combining national forest inventory and monitoring network were accompanied by a number of publications [9*, 10*] and methodological guides [25]. The field geoinformation system 'Field-Map' was administratively prescribed as a core technology for NFI [15].

From 2008 to 2015 CNFI was carrying-out sampling forest inventory in Sumy oblast (2008-2012 – first inventory cycle, since 2013 – second inventory cycle, re-measurements); from 2009 to 2015 – in Ivano-Frankivsk oblast (2009-2013 – first inventory cycle, since 2014 – second inventory cycle, re-measurements). Since 2016 National Forest Inventory is not being carried-out because CNFI was wound up due to lack of state budget funding.

Design of forest inventory of Sumy region as of 2008 was projected as a scheme of random placement of a separate tract consisting of 4 plots on a territory of a square 2,7 by 2,7 kilometers in size. Conducting the regional inventory during the first year has shown that the amount of fieldwork is significantly influenced by scope of fieldwork, actual territorial location of forest stands and logistics arrangements.

In order to optimize labor costs during the National Forest Inventory, CNFI has performed divergent calculations of amount of fieldwork for different sampling network size while maintaining design structure and minimum accuracy level of estimates. The calculations for sampling network 4.05 by 4.05 km were submitted to the TAIEX mission in early 2009. Later calculations for sampling network 4.95 by 4.95 km have shown possibilities for maintaining the accuracy of estimates and reduction of labor costs during NFI [12*]. For the specified sampling network size, an error of the estimated total growing stock of forest stands in the country does not exceed 1 %.

The results of calculations of funding and personnel demand during a phased introduction of National Forest Inventory were summarized in the document "Development of national forest inventory in Ukraine" [12*] and presented to SFC of Ukraine in 2009 [17].

According to the document, it was intended to implement National Forest Inventory throughout the country in 2011. For this purpose a national sampling network of size 4,95 by 4,95 km was proposed. The network of NFI plots had to be established separately from the network of Level I environmental forest monitoring plots. The total projected amount of NFI plots was 16.7 thousand. Every year during the National Forest Inventory about 3.3 thou. plots would have to be established, at a rate of 20 % of their total amount. According to the calculations, for carrying-out NFI activities throughout the country 17 field teams had to be organized.

In accordance with the National Forest Inventory design described above, regional inventories in Sumy and Ivano-Frankivsk oblasts were carried out since 2009. Each year, two field inventory teams secured the necessary activities on forest area of 996 thou. ha. Overall, between 2008 and 2012 in Sumy region 1118 forest sample plots were laid, and in 2013-2015 during the second inventory cycle re-measurements were done on 662 forest sample plots. In Ivano-Frankivsk region from 2009 to 2013 there were established 1106 forest inventory plots, and in 2014-2015 re-measurements were conducted on 385 of them. In general, in the two regions 46.3 thou. trees were measured, of which 4.4 thou. were model trees [14*].

Responsible organizations: CNFI in the structure of PA "Ukrderzhisproekt".

1.2. National Forest Inventory of Ukraine – state requirements, public interest

1.2.1. Demand of National Forest Inventory by the state and the public

For the first time on state level National Forest Inventory issues were raised in the Decree of President of Ukraine Leonid Kuchma "On additional measures for development of forestry", which obliged "the State Forestry Committee of Ukraine to organize continuous forest inventory during 2004 – 2007" [2]. Despite physical impossibility of organizing and conducting NFI in such a short term, executive bodies' officials certainly have acquired some understanding of the need for inventory.

State Program "Forests of Ukraine" for years 2010-2015 included a plan to conduct inventory of forest fund using statistical methods as one of measures for increasing efficiency of forest management [6]. Thus, the government recognized the need for a National Forest Inventory and the need for an adequate financial support.

Awareness of the need for reliable information on state of forests and forest resources is always there when the government considers state of forest management. However, due to lack of

funds, there is a year after year occurring delay in conducting the State forest survey. Furthermore, measures of the State Program on conducting National Forest Inventory are not implemented, and interests of concerned ministries and departments in support of NFI are still not structured and not articulated.

Interests of society and the state in carrying-out National Forest Inventory coincide in a question of the need for establishing criteria for sustainable forest use. However, there is a lack of understanding of content and purpose of NFI among forest professionals and the society – due to sous-professional⁴ approach of the first group and lack of translations of specialized literature, and due to generally low awareness in the second group (Fig. 2).

Figure 2: Matrix of stakeholders identification

Power	Support	Neutral	Opponents
3		<div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">Ministry of Agriculture</div> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-top: 10px;">Ministry of Ecology</div>	
2	<div style="border: 1px solid black; padding: 2px; display: inline-block; background-color: #90EE90;">SFRA</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block; background-color: #FFFF00;">Oblast Councils</div>	
1	<div style="border: 1px solid black; padding: 2px; display: inline-block; background-color: #FFB6C1;">Scientific Institutes</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block; background-color: #90EE90;">State Enterprises</div>	
		<div style="border: 1px solid black; padding: 2px; display: inline-block; background-color: #FFB6C1;">NGO</div>	

Therefore, the ways of application of NFI data by different stakeholders listed below reflect rather potential possibilities than real means of management or social activity:

Ministry of Agrarian Policy and Food of Ukraine (central executive body that shapes state forest policy) – for preparing proposals on forest policy.

State Forest Resources Agency of Ukraine (central executive body that implements state policy in sphere of forestry) – for planning of sustainable forest management, provision of information to State Forest Survey and international reporting. The results of the conducted inventories were partially taken into account while preparing the data for Global Forest Resources Assessment by FAO on assessment of indicators of standing and lying deadwood.

Ministry of Ecology and Natural Resources of Ukraine (central executive authority, which shapes state policy in the sphere of environmental protection) – for planning of nature conservation and biodiversity protection, environmental monitoring of environment, planning of climate

⁴ Sous-professional – a professional of the adjacent specialization.

change mitigation measures. There is a particular interest in possibility of providing data for improvement of reporting to the UNFCCC and KP in the LULUCF sector, for example, to clarify parameters of biomass increments.

Scientific and research institutions – for purposes of their own research and analysis. During the period 2010-2014 URIFFM was performing a state-funded scientific research project "To improve methods of forest inventory and monitoring in accordance with the requirements of sustainable forest management". However the results of the project have not significantly influenced the process of carrying-out pilot and regional inventories.

Non-governmental environmental organizations – for independent assessment of the effect of public policy on nature use and land use.

1.2.2. Demand at central, regional and local level

Among the measures of State Program "Forests of Ukraine", the following are conducted at the national level: National Forest Inventory, environmental monitoring and State Forest Survey. Reporting the results of the NFI is planned at the state level and at level of selected administrative units.

An example of representing inventory data at the regional level is inclusion of consolidated results of forest inventory in Ivano-Frankivsk oblast (formula of forest balance, intensity of forest resources use, presence of standing dead trees) in the Information Note prepared by Ivano-Frankivsk Regional Forestry and Hunting Administration for the meeting of Regional Council in October 2016. Significance of the results of inventory for the regional authorities was justified by assessment of sustainability of forest management and possibility to draw attention of public to the progressive accumulation of dead standing trees and dieback of stands. However, the Program of development of forestry and hunting in Ivano-Frankivsk oblast for the period 2017-2021 approved by Regional Council does not include carrying-out inventory measures at the expense of the regional budget⁵ [14].

Interest in carrying-out sampling inventories at the local level is maintained solely for the purpose of scientific research. There was no interest in conducting inventory in order to clarify existing growing stocks and stand growth patterns from the side of state forestry enterprises that were previously covered by the pilot inventory.

1.3. Regulatory, legislative and technological basis for carrying-out National Forest Inventory in Ukraine

1.3.1. Guidance and methodological support

Forest Code of Ukraine and other primary legislation in the sphere of forestry does not contain provisions for regulation of conducting National Forest Inventory.

Regional Forest Inventories of Sumy and Ivano-Frankivsk regions were performed in accordance with the Instruction for carrying-out National Forest Inventory (2009, draft updated 2014) [20].

The Instruction regulates requirements for forest inventory using a unified system for all forests of Ukraine, and consists of five sections: "General Provisions", "Organization of forest inventory

⁵ Currently there is no State Program which would include conducting National Forest Inventory at the expense of state budget

activities”, “Conducting of forest inventory activities”, “Composition of documentation and procedure for preparation of documents” (Annex 6).

As a development of the Instruction, the Methodology of forest inventory fieldwork was prepared [26]. The Methodology describes in detail the technology of application of field complex ‘Field-Map’ by field inventory teams (Annex 7).

Under the provisions of the Instruction: National Forest Inventory – is a system of annual selective surveys of forests, which is conducted to obtain statistically reliable estimates of quantitative and qualitative indicators of state and dynamics of forests and forest resources of Ukraine.

The main objectives of National Forest Inventory are:

- collecting and summarizing information on state and dynamics of forests and forest resources using statistical methods;
- providing timely information about state of forests and forest resources to public authorities;
- providing data and materials to the state forest survey, state system of environmental monitoring and for needs of international reporting of Ukraine on forests.

For further development of the existing Instruction, URIFFM has prepared new Instruction for carrying-out forest inventory (2015) [21, 28, 29].

Definition of forest. According to the Forest Code, forest fund includes forested plots with an area of at least 0.1 hectares [1]. Regulative documents of the State Land Cadaster states that subgroup “forest land plots covered by forest vegetation” includes land plots, occupied by trees and shrubs vegetation, with density in young stands of 0.4 or more, in other age groups - of 0.3 or more (i.e. crowns evenly occupy at least 40 % (30 %) of land plot area) [9].

For the purposes of forest inventory the definition of forest adopted by Ukraine for the purposes of Kyoto Protocol is used [13*] (Fig. 3):

- minimum area of forest plot – 0.1 ha;
- minimum crown coverage (or equivalent stocking) – 30 %;
- minimum height of trees at maturity age – 5 m;
- minimum width – 20 m.

Inventory design. To lay the primary network of inventory sampling plots in the country there was formed a grid of inventory squares sized 4.95 by 4.95 km (Fig. 4). Each inventory square is designed to contain a group of four inventory sample plots, combined in an inventory tract. Each tract is randomly placed within an inventory square, each inventory tract and sample plot are assigned to one of five temporal panels (Fig. 5). Inventory tracts are measured according to the order of assigning them to a certain temporal panel, which corresponds to intensity of annual sampling of 20 % from the total amount of inventory tracts given that length of inventory cycle is 5 years.

Figure 3: Comparison of definition of forest for Ukrainian NFI and FAO definition

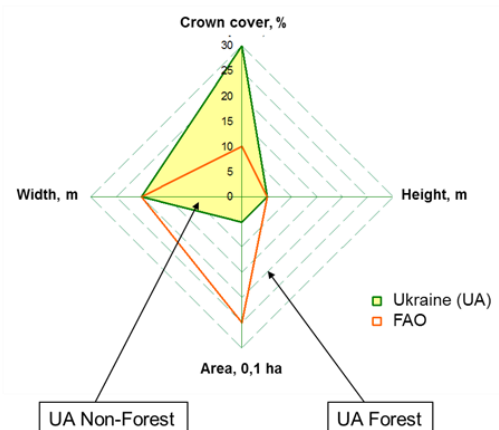


Figure 4: Network of inventory squares and system of five temporal panels

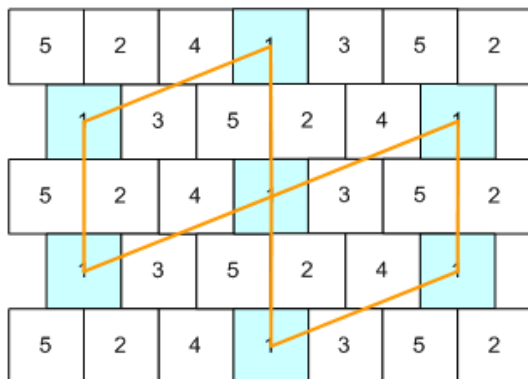
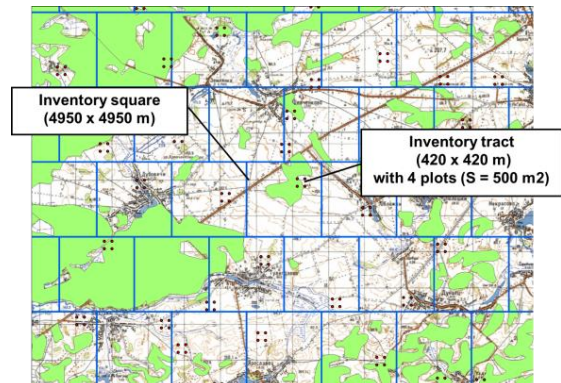


Figure 5: Structure of national sampling design



1.3.2. Software and technological support

For preparation of national forest inventory database and during field work software and field equipment complexes of Field-Map system were used [15, 26*].

Programmers of CNFI have developed their own software for forest inventory – “GreenSurvey”. Versions of GreenSurvey were prepared for computer calipers Haglof DigiTech Pro, mobile devices on basis of Windows Mobile operating system, for PCs and mobile devices on basis of operating systems Windows XP and Windows 7. However, their practical application has shown a need for significant time and financing provide support and to bring the software capabilities closer to those of Field-Map software.

The database structure (of Field-Map Projects), which was used during regional inventories is shown in Annex 8.

1.3.3. Requirements to reporting and structure of reporting data

The Instruction for carrying-out National Forest Inventory provides obtaining over 70 tables that are grouped into eight groups: forest area; total growing stock of stands; volume and number of trees; increment, harvest and dieback; mean mensurational indices of stands; indices of biodiversity and biological sustainability of forests; indicators of sanitary condition of stands; state of tree seedlings and natural regeneration of forests [20] (Annex 9). National forest inventory may provide annual clarifying information for State Forest Cadaster.

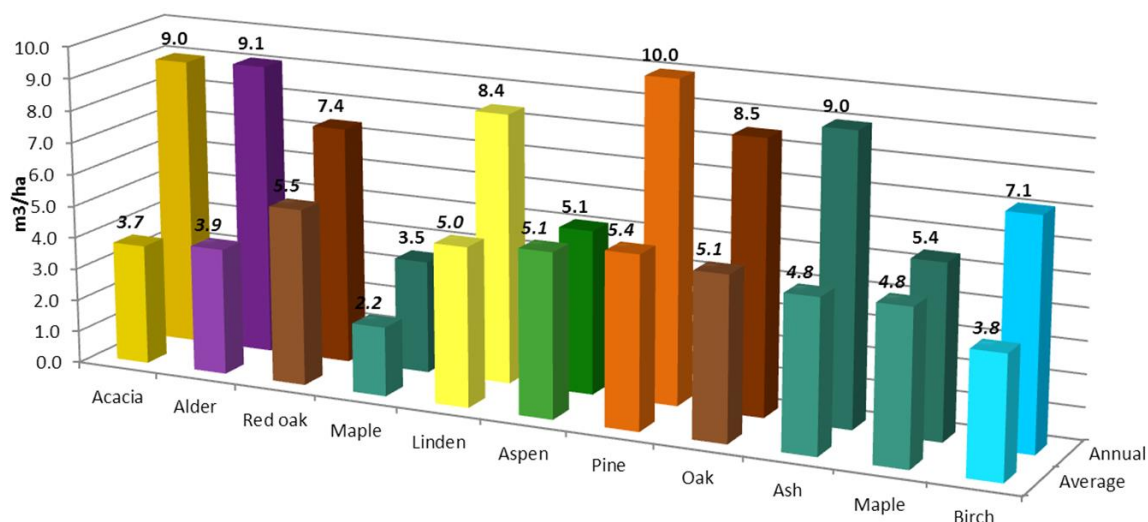
The obtained results of inventory during 2008-2013 have shown that interval estimates of area covered with forest vegetation and total growing stock of stands in Sumy and Ivano-Frankivsk oblasts are statistically in line with those reported by State Forest Survey as of 2011 (Table 2) [15*, 16*, 17*].

Table 2: Comparison of estimates of area and total growing stock of stands reported by National Forest Inventory and State Forest Survey

Object of account/ inventory	Data sources	Total growing stock of stands, Mio. m ³	Total area covered with forest vegeta- tion, thou. ha	Mean growing stock of stands, m ³ /ha
Forests of Sumy oblast	SFS, 2010	109.23	425.0	257
	NFI, 2008-2012	106.97 (95.99 – 117.95)	404.9 (370.0 – 439.7)	264
Forests of Sumy RFHA	SFS, 2010	74.88	255.7	293
	NFI, 2008-2012	79.79	264.8	301
Forests of Ivano- Frankivsk oblast	SFS, 2010	156.26	571.0	274
	NFI, 2009-2013	154.79 (135.72 – 173.86)	530.6 (481.0 – 580.0)	292
Forests of Ivano- Frankivsk RFHA	SFS, 2010	118.85	426.5	279
	NFI, 2009-2013	130.22	423.9	307

Periodic inventory is the only reliable method of determining the value of current increment of stands. For the first time in Ukraine there was conducted such a large-scale research on repeated re-measurement of sample plots located within a single administrative region. For example, forest inventory in Sumy region has shown that current annual increment of pine stands is equal to 10.0 m³/ha per year. At the same time, the mean increment (mean annual increment), used for comparing harvest volumes in Ukraine is 5.4 m³/ha per year (Fig. 5) [15*, 16*].

Figure 6: Average and annual increments of stands of selected forest-forming tree species in Sumy oblast



Results of forest inventory using statistical methods in Sumy and Ivano-Frankivsk oblasts in the years 2008-2013 were discussed at the Board Meeting of State Agency of Forest Resources of Ukraine in April 2014 [16*, 28]; the main results of forest inventory in Ivano-Frankivsk oblast

during 2009-2015 were presented at the field Board Meeting of State Agency of Forest Resources of Ukraine in September 2016 [17*].

For scientific and practical application of the inventory results, and for its improving, the Board meeting of State Agency of Forest Resources of Ukraine in 2014 has decided to expand the NFI using statistical methods in a new State Program "Forests of Ukraine" for 2016-2020, to update and improve the Guidelines for carrying-out National Forest Inventory and submit it for approval in a due course [28]. According to the resolution of the board meeting, results of the inventory were provided to applied-research institutions - URIFFM, UkrERIMF, NFTUU – for use in scientific research.

1.4. Potential resources for carrying-out National Forest Inventory

1.4.1. Organizational structure (entities)

Forest inventory using statistical methods over the years 2007-2015 was being conducted by the Center of National Forest Inventory within the structure of PA "Ukrderzhlisproekt". Organizationally, the CNFI was not a separate entity, and due to termination of budget financing for PA "Ukrderzhlisproekt", the Center was liquidated. Maximum number of CNFI employees was reaching 11 specialists; the Center always included engineers of two field inventory groups (Table 3). According to the designed network and work plan, one group performed inventory survey of inventory plots for one field season in one oblast.

Table 3: Specialization of CNFI personnel

Specialization	Years of activity								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Administration	1	1	1	1	1	1	1	1	1
GIS. Remote sensing data analysis	-	-	0,5	-	-	-	-	-	-
Field support	-	1	1	1	-	-	-	-	-
Data collection. Fieldwork	6	4	4	3	2	4	4	4	4
Quality control	-	-	-	-	-	-	-	-	-
Software	0,5	0,5	0,5	0,5	0,5	0,5	-	-	-
Data analysis	-	-	0,5 +0,5	0,5 +0,5	0,5 +0,5	0,5 +0,5	0,5	0,5	0,5
Technological support	-	1	1	1	1	1	1	1	1
TOTAL	7,5	7,5	9	7,5	5,5	7,5	6,5	6,5	6,5
Drivers	2	2	2	2	1	1	1	2	2

In 2010, proposals on creation of Center for National Forest Inventory and Monitoring (CNFIM) for preparation and holding of first national forest inventory, conducting environmental monitoring of forests, acting as national reporting entity and managing an information system on forests were presented to the State Forest Resources Agency of Ukraine [18, 14*]. The proposals were taken note of but did not turn into any kind of subsequent development. An important condition of these proposals, which should be take note of in case of continuation of work on

the National Forest Inventory, is a need for organizational and financial independence of the entity which performs the activities.

Later, in 2013, the issue of organizational structure and options for development of National Forest Inventory and monitoring were considered at a meeting of the Scientific Council on Forestry of National Academy of Agricultural Science of Ukraine. The Council formed the "Concept of development of national forest inventory and monitoring" [27]. The Concept was sent to interested parties, but no development action was taken.

1.4.2. Staffing (human resource capacity)

Forest inventory specialists are very rarely found in Ukraine. The system of statistical data processing and presenting the inventory results is developed by a single specialist. After liquidation of CNFI, human resources for national forest inventory are not only limited, but rather practically absent.

To launch a National Forest Inventory it is necessary to select or educate people able to think on the national scale.

1.4.3. Budget financing

State Program "Forests of Ukraine" for 2010-2015 provided allocation of 30.3 Mio. UAH from the state budget of to conduct forest inventory based on statistical methods for the entire duration of the program. In fact, only 3.89 Mio. UAH were allocated, which equals 12.8 % of the planned amount (Table 4). This has led to conducting of inventory on the territory of only two administrative regions on the area of 996 thou. ha of forests, representing 10.4 % of the total forest area of Ukraine.

Table 4: Planned and factual amounts of financing of inventory of forest fund and utilization of costs within the State Program "Forests of Ukraine" during 2010-2015

Objective	Activity	Units	Years					
			2010	2011	2012	2013	2014	2015
Increasing efficiency of forest management	Inventory and assessment of forest fund by means of statistical methods	mio. ha	1,0	2,0	3,0	3,0	10,8	10,8
		mio. UAH	1,3	5	7	7	5	5
	Factual expenditures on inventory	mio. ha	0,98	0,98	0,98	0,98	0,98	0,98
		mio. UAH	0,55	0,55	0,58	0,68	0,72	0,81

Cost of establishing (re-measurement) of one sample plot in the hryvnia equivalent gradually increased, reflecting increase of wage fund of employees and increase of fuel costs, combined share of which in total costs amounted to 60-70 % (Fig. 7).

Figure 7: Costs per 1 ha of forested land, UAH

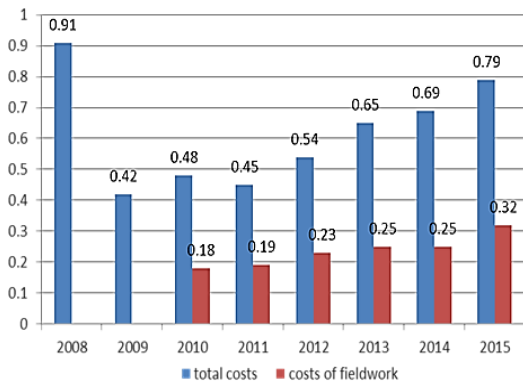
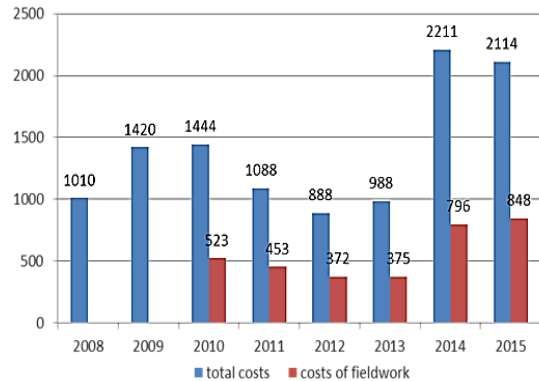


Figure 8: Costs per 1 sample plot, UAH



1.4.4. Other

In the case of initialization of a new project aimed at improving the system of accounting information on forests and/or national forest inventory, all stakeholders should understand the reasons for liquidation of previously operational inventory system.

Currently, the inventory database has accumulated a significant amount of information that needs to be processed. An important part of a new project should also be processing of that data, and improving data processing system.

1.5. Regulatory and legislative documents, guidelines and methodological publications

1. Law of Ukraine « On amendments to the Forest Code of Ukraine» dated 08.02.2006 №3404
2. Decree of the President of Ukraine «On additional measures for development of forestry» dated 07.02.2004 №171/2004
3. Decree of Cabinet of Ministers of Ukraine « On approval of procedure of State Forest Survey and State Forest Cadaster» dated 27.09.1995 №767
4. Decree of Cabinet of Ministers of Ukraine «On approval of procedure of State Forest Cadaster and State Forest Survey » dated 20.06.2007 №848
5. Decree of Cabinet of Ministers of Ukraine «On approval of State Program «Forests of Ukraine» for 2002-2015» dated 29.04.2002 № 581
6. Decree of Cabinet of Ministers of Ukraine «On approval of State Program «Forests of Ukraine» for 2010-2015» dated 16.09.2009 №977
7. Decree of Cabinet of Ministers of Ukraine «On approval of Regulation on the state system of environmental monitoring» dated 30.03.1998 №391
8. Decree of Cabinet of Ministers of Ukraine "On approval of State Program of environmental monitoring" dated 05.12.2007 №1376
9. Decree of Cabinet of Ministers of Ukraine «On approval of Procedure of State Land Cadaster» dated 17.10.2012 №1051

10. Order of Ministry of Forestry of Ukraine «On approval of Instruction on conducting of State Forest Cadaster and State Forest Survey» dated 15.11.1995 №134 / Registered in Ministry of Justice of Ukraine on 23.11.1995 with №422/958
11. Order of State Committee of Forestry of Ukraine «On approval of Instruction on procedure of State Forest Cadaster and primary forest survey» dated 01.10.2010 №298 / Registered in Ministry of Justice of Ukraine on 16.12.2010 with №1267/18562
12. Conceptual program of forest management planning development for the period up to 2010. Approved by Order of State Committee of Forestry of Ukraine dated 14.09.2006 №206
13. Conceptual program of forest management planning development for the period up to 2015. Approved by Order of State Agency of Forest Resources of Ukraine dated 30.03.2011 №60
14. Program of development of forestry and hunting in Ivano-Frankivsk oblast for 2017-2021. <http://www.ifforestry.gov.ua/tsilovi-programi>
15. Order of State Forestry Committee of Ukraine №86 dated 05.03.2007
16. Order of State Forestry Committee of Ukraine № 156 dated 28.04.2007
17. Order of State Forestry Committee of Ukraine №365 dated 29.12.2008
18. Order of State Forestry Committee of Ukraine №3 dated 21.01.2010
19. Instruction on forest management planning of forest fund of Ukraine. – SFC of Ukraine, Ukrainian Forest Management Planning Association – Irpin. 2006. – 74 p. http://lisproekt.gov.ua/fileadmin/user_upload/files/docs/instructions/Instrukciya-z_vporyad.pdf
20. Instruction for National Forest Inventory (draft), - compiler – Storozhuk V.F. – Kyiv, 2009 – 45 p.
21. Instruction on carrying-out forest inventory (draft) / Buksha I.F., Storozhuk V.F., Pasternak V.P., Pyvovar T.S., Buksha M.I., Yarotsky V.Yu. – Kharkiv, Irpin, 2014. - 80 p.
22. Guidelines for fieldwork on forest inventory in Ukrainian Polissya – Irpin, Forest Management Scientific Center, 2006. – 72 p.
23. Methodology for National Forest Inventory (draft) – URIFFM, - Kharkiv, 2007
24. Methodological guide for Level I forest monitoring in Ukraine. – Kharkiv, 2008 – 47 p.
25. Methodological guide for forest inventory and monitoring on basis of advanced technologies. Compilers – I.F. Buksha, V.P. Pasternak, T.S. Pyvovar, M.I. Buksha, V.Yu. Yarotsky – Kharkiv, 2009
26. Methodology for National Forest Inventory – Part 1. Fieldwork, CNFI, 2008 – 82 p.
27. Concept of building-up national forest inventory and monitoring (draft) // Considered on meeting of the Scientific Council on silvics and silviculture of NAS of Ukraine on October 10, 2013 http://uriffm.org.ua/sites/default/files/news_files/project_concept20131009.pdf
28. Protocol of Board Meeting of State Agency of Forest Resources of Ukraine dated 24.04.2014
29. Order of State Committee of Forestry of Ukraine №344 dated 07.07.2014

Appendix on Forest Inventories in Ukraine

Appendix 1: Forms of State Forest Cadaster and State Forest Survey

Form №1 - Form №1 - Distribution of forest plots by categories within the categories of forests [covered by forest vegetation, not covered by forest vegetation] – ha

Державний лісовий кадастр станом на 1 січня 2011 року

РОЗПОДІЛ ЛІСОВИХ ДІЛЯНОК ЗА КАТЕГОРІЯМИ В МЕЖАХ КАТЕГОРІЙ ЛІСІВ **Форма № 1**

ДЕРЖАВНЕ АГЕНТСТВО ЛІСОВИХ РЕСУРСІВ УКРАЇНИ

Рельєф Гірський-Рівнинний площа, га

Категорії лісів	Код	Вкриті лісовою рослинністю лісові ділянки		Не вкриті лісовою рослинністю лісові ділянки										Загальна площа лісових ділянок	Грошова оцінка
		усього	в т.ч. лісові культури	незімкнуті лісові культури	лісові розсадники, плантації	рідколісся	згарища, загиблі і насадження	зруби	галявини	біогаліявини	лісові шляхи, просіки, п/п розривні, осушув. канали	усього не вкритих лісовою рослинністю лісових			
A	Б	1	2	3	4	5	6	7	8	9	10	11	12	13	
Усього лісів	1	6293548.2	3243331.4	203805.9	14643.2	4115	7040.8	86536	73420.5	49185.4	108090.9	546837.7	6840385.9		
із них															
Ліси природоохоронного, наукового, історико-культурного призначення	2	970553.5	401278	15552.8	2370.7	490.1	1683.4	7113.4	6269	8441	17009.1	58929.5	1029483		
у тому числі:															
– розташовані в межах територій та об'єктів природно-заповідного фонду	3	932506.8	382294.5	13274.6	1990.5	489.6	1667.5	6174.1	5928.3	8103	15491.1	53118.7	985625.5		
– із них можливі для експлуатації	4	142433.2											142433.2		

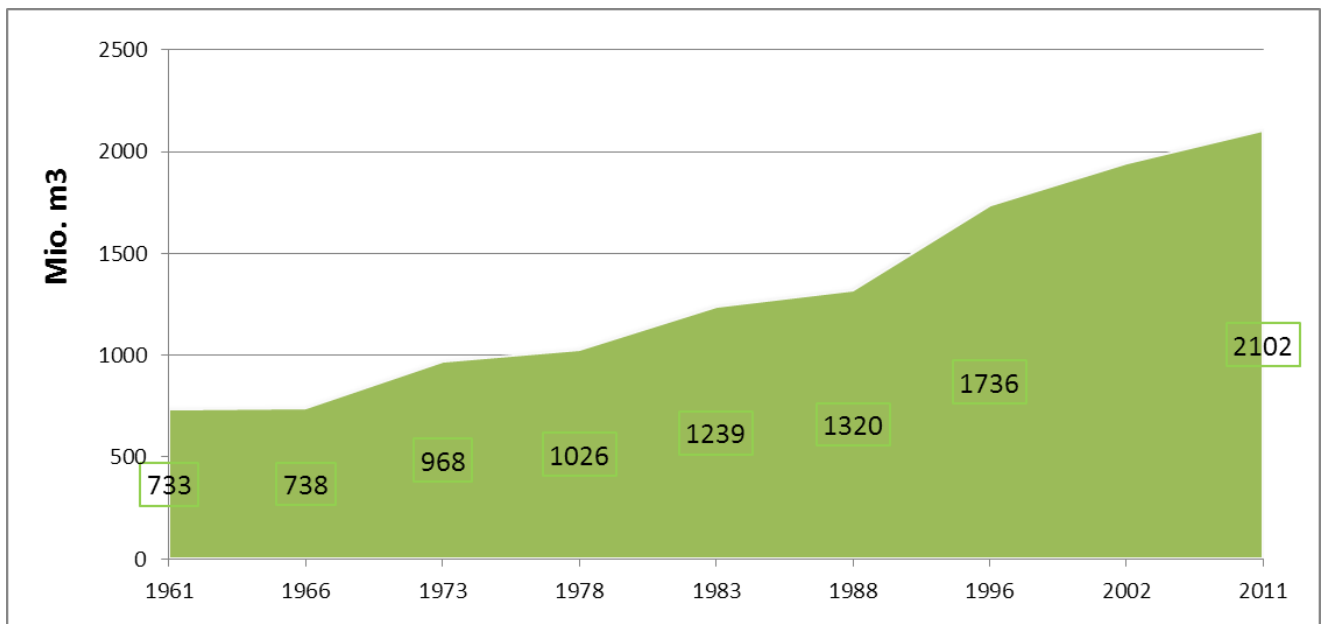
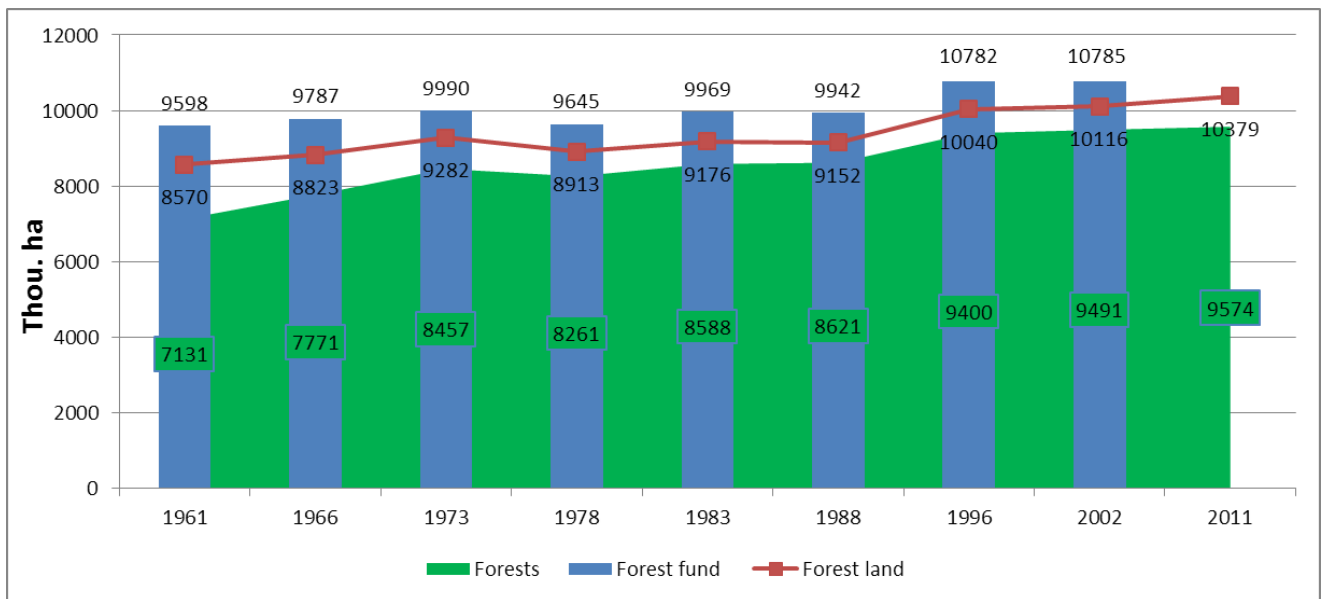
Form №2 - Distribution of forest plots covered by forest vegetation for dominant species and age groups - ha, thou. m3

Form №3 - General information on forest fund in the context of administrative units -- ha, thou. m3

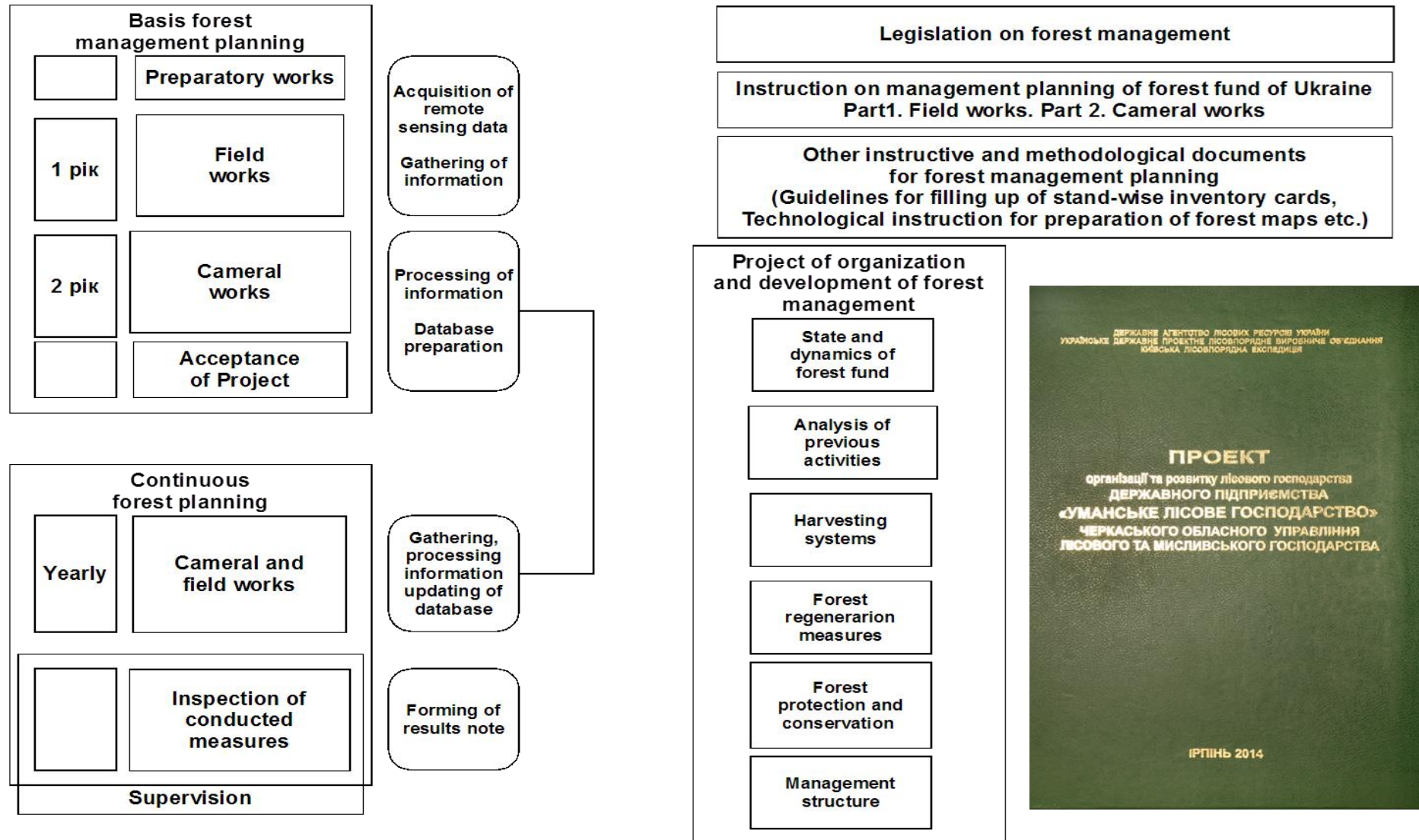
Form №4 - Distribution of forest plots covered by forest vegetation [area of deciduous, coniferous stands] for the density and site index classes [age groups] (administrative unit, executive body, forest user) - ha

Form №5 - Distribution of forest plots covered by forest vegetation [categories of forests, economy units, dominant tree species] for 10-year age periods (executive body, forest user) - ha, thou. m3

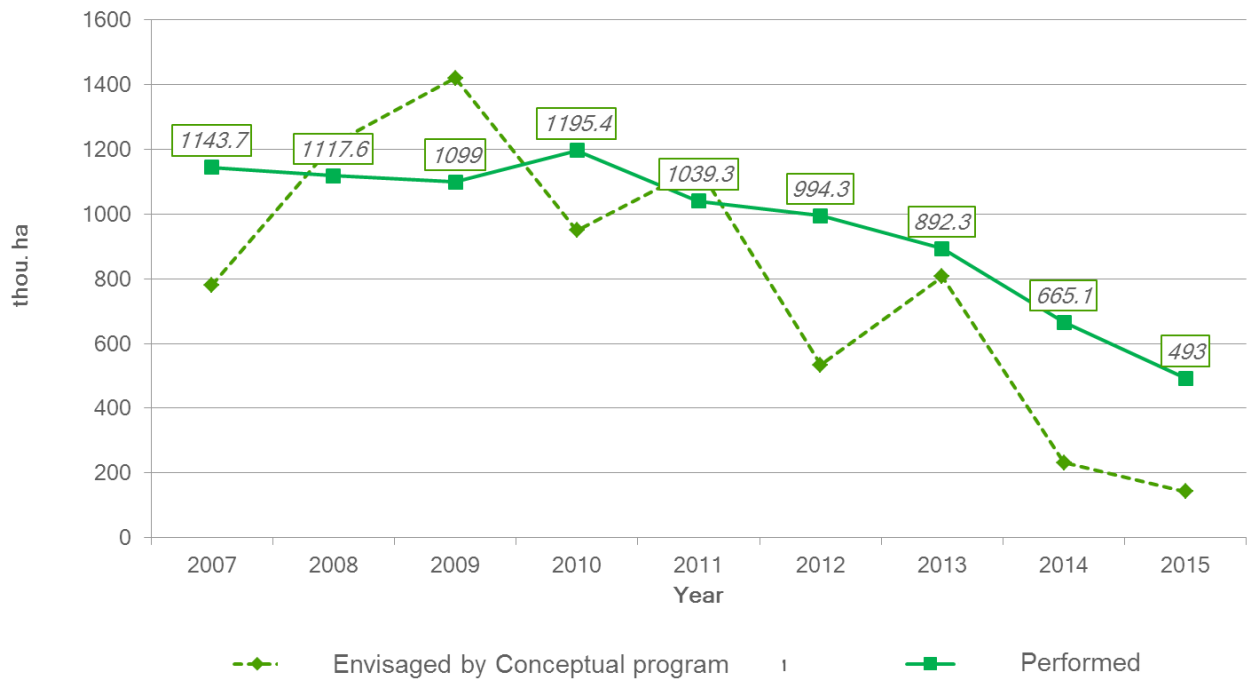
Appendix 2: Dynamics of forest fund area and total growing stock of stands (according to State Forest Surveys of Ukraine at 1961-2011 years)



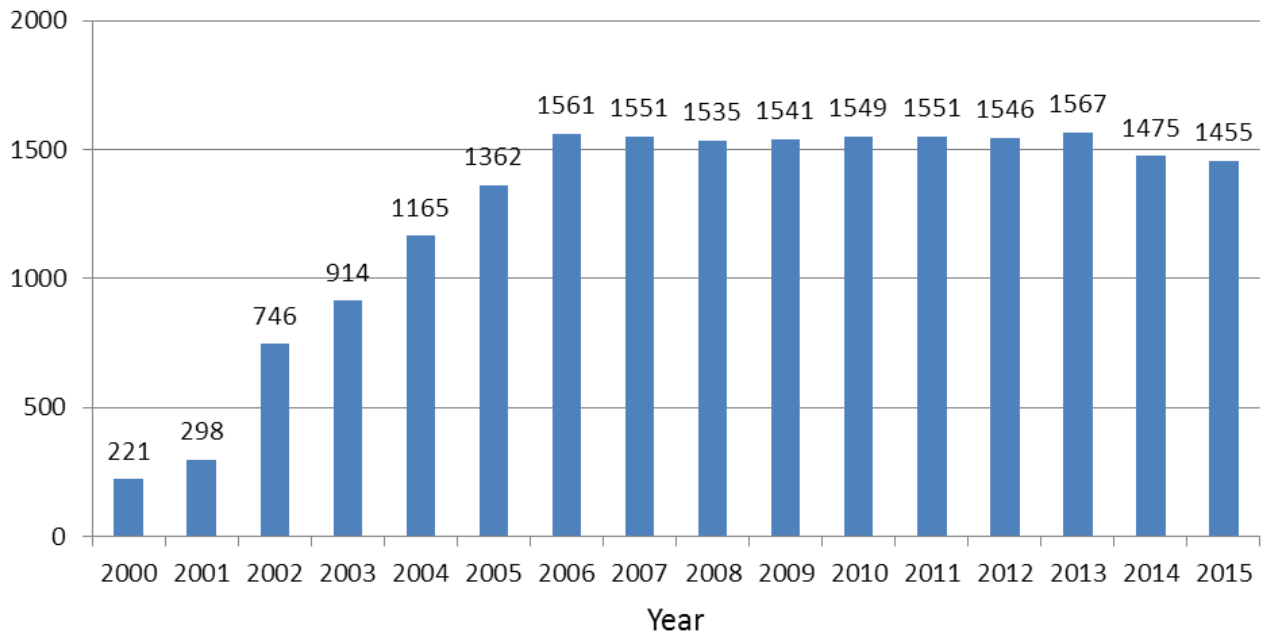
Appendix 3: Overall scheme of forest management planning



Appendix 4: The dynamics of basic forest planning activities



Appendix 5: Number of surveyed plots of ICP Level I monitoring



Appendix 6: Content of the Instruction for the National Forest Inventory (2009, updated 2014)

INTRODUCTION

CHAPTER 1 - GENERAL PROVISIONS

- 1.1. Goals and objectives of forest inventory
- 1.2. Usage of outputs of forest inventory
- 1.3. Objects of forest inventory
- 1.4. Contents of work on forest inventory
- 1.5. Forest inventory methods
- 1.6. Stages of forest inventory
- 1.7. The structure of the national sample design
- 1.8. Accuracy standard of forest inventory
- 1.9. National standard of shape, size and numbering of sample units

CHAPTER 2 - ORGANIZATION OF FOREST INVENTORY ACTIVITIES

- 2.1. Planning of inventory work
- 2.2. Organizations that perform forest inventory
- 2.3. Regulation of forest inventory organization relations with local forestry enterprises, forest owners and users
- 2.4. Inventory and technical works meetings
- 2.5. Control of forest inventory works

CHAPTER 3 – CONDUCTING OF FOREST INVENTORY ACTIVITIES

- 3.1. Objectives, content and organization of preparatory
- 3.2. Providing by cartographic materials and data for remote sensing
- 3.3. Selection of inventory and other regulatory and reference materials
- 3.4. Conducting of collective and individual training
- 3.5. Drafting of tasks for field inventory work
- 3.6. Laying down of inventory sample plots
- 3.7. Protocol of mapping of inventory sample plots
- 3.8. The definition of forest
- 3.9. The procedure of works on inventory sample plots
- 3.10. National set of key indices
- 3.11. Standards of accuracy indices
- 3.12. Special cases
- 3.13. The procedure for data transfer and field work quality control system

CHAPTER 4 - COMPOSITION OF DOCUMENTATION AND PROCEDURE FOR PREPARATION OF DOCUMENTS

- 4.1. Composition of forest inventory documentation
- 4.2. Procedure for preparation of forest inventory documents

4.3. General requirements for forest inventory documentation

ANNEX 1 – PASSPORT OF FOREST INVENTORY PLOTS

ANNEX 2 - TARGET ACCURACY / VALUE / MEASUREMENT UNITS FOR NATIONAL SET OF KEY INDICIES

ANNEX 3 - LIST OF MAIN RESULTS TABLES OF FOREST INVENTORY

Appendix 7: The content of Methodology of field work with Field-Map

1. Preparatory works before field season
2. The stages of field work
 - 2.1. Cameral work prior field investigation
 - 2.1.1. Calculation of magnetic declination
 - 2.2. Checking of equipment
 - 2.3. Compass check
 - 2.4. Compass calibration
 - 2.5. Installation of equipment height
3. Work on the tract
 - 3.1. Moving to the sample plot
 - 3.2. Fixing of sample plot center
 - 3.3. Dividing of sample plot
 - 3.4. Segmentation and polygonization
 - 3.4.1. Mapping the extent of segments of plot
 - 3.4.2. Polygonization of segment (Converting lines to polygons)
 - 3.4.3. Creating of concentric circles
 - 3.5. Description of sample plot
 - 3.5.1. ID of sample plot
 - 3.6. Subplots
 - 3.6.1. Stand description
 - 3.6.2. Soil description
 - 3.6.3. Soil horizons
 - 3.6.4. User description
 - 3.6.5. Treatment
 - 3.6.6. Disturbance
 - 3.6.7. Undergrowth
 - 3.6.8. Vegetation
4. Trees enumeration
 - 4.1. Numbering of trees
 - 4.2. Coordinates of tree
 - 4.3. Measuring position of tree (Mapping of tree)
 - 4.3.1. Change of pole position changes during of tree measurement

- 4.4. Diameter measurement at a height 1.3M
 - 4.5. Tree height
 - 4.5.1. Modes of height measurement in Field-Map program
 - 4.6. Basis of living and dead crowns
 - 4.7. Tree forks
 - 4.8. Tree age
 - 4.9. Deadwood
 - 4.10. Damage
 - 4.11. Model tree
 - 4.12. Tariff tree
 - 5. Micro plots
 - 5.1. Natural regeneration
 - 6. Stumps
 - 7. Coarse woody debris
 - 8. The completion of work on plot
- ANNEXES

Appendix 8: NFI database structure in Field-Map program

The screenshot shows the 'Field-Map Project Manager' interface. The left pane displays a tree view of the project structure under 'Шари' (Layers), with 'Sub_Plots (Субпроби)' selected. The main window is divided into two tabs: 'Атрибути шару' (Layer Attributes) and 'Опції шару' (Layer Options). The 'Атрибути шару' tab is active, showing a table of attributes for the 'Sub_Plots (Субпроби)' layer.

Ім'я атрибута	Тип атрибута	б/в'язкое	Видиме	Мітка
<Area_m2>	<Число>	Так	Лише для чит	Площа, м2
<Area_share_perc>	<Число>	Так	Лише для чит	Площа, %
<Perimeter_m>	<Число>	Так	Лише для чит	Периметр, м
<Num_polyg>	<Число>	Ні	Не відображає	Num of polyg
Land_Categories_	Список категорій (числовий ID)	Так	Відображає	Група катег
Land_Categories_1	Залежний список категорій (числовий ID)	Так	Відображає	Категорія зе
List_Main_Species	Список категорій (числовий ID)	Так	Відображає	Список голс
Main_Species	Залежний список категорій (числовий ID)	Так	Відображає	Головна пор
Site_Index	Список категорій (числовий ID)	Так	Відображає	Клас боніте
Forest_Type_Conc	Список категорій (числовий ID)	Так	Відображає	Тип умов мі
Forest_Type	Залежний список категорій (числовий ID)	Так	Відображає	Тип лісу
Mezo_Relief	Список категорій (числовий ID)	Так	Відображає	Мезорельєф

Below the attribute table, there is a section for 'Список категорій: {xLand_Categories_Group} (локальні)'. This section contains a table with the following data:

ID	Value	Активне	Order
11	Вкриті лісовою рослинністю землі	Так	
12	Незімкнуті лісові культури	Так	
13	Лісові розсадники, плантації	Так	
14	Не вкриті лісовою рослинністю землі	Так	

The interface also shows a 'Шари' (Layers) pane on the left with a tree view of the project structure, including 'Plots (Проба)', 'Sub_Plots (Субпроби)', and various sub-layers like 'Stand_Description', 'Soil_Profile', etc. The status bar at the bottom indicates the project path: 'Проект: D:\BackUp\Лєня\24.12.08\NFI_Sumy_2008'.

Appendix 9: NFI reporting tables

1. Area of forests, [oblast], [year]
 - 1.1. Area of forest and non-forest lands
 - 1.2. Area of forest lands by categories
 - 1.3. Area of forests by agencies [users]
 - 1.4. Area of stands of main tree species by agencies [users]
 - 1.5. Area of stands of main tree species by age classes
 - 1.6. Area of stands of main tree species by site indexes
 - 1.7. Area of stands of main tree species by density
 - 1.8. Area of stands of main tree species by forest type conditions
 - 1.9. Area of stands of main tree species by origin
 - 1.10. Area of stands of main tree species by mean diameter classes
 - 1.11. Area of stands of main tree species by mean height classes
 - 1.12. Area of stands [of main species] by site indexes and age classes
 - 1.13. Area of stands [of main species] by density and site indexes
 - 1.14. Area of stands [of main species] by forest type conditions and site indexes
 - 1.15. Area of stands [of main species] by origin and growing stock groups
 - 1.16. Area of stands [of main species] by forest type conditions and growing stock groups
 - 1.17. Area of stands [of main species] by density and management types
 - 1.18. Area of stands [of main species] by forest type conditions and types of disturbance
 - 1.19. Area of stands [of main species] by forest type conditions and growing stock groups
2. Total growing stock of stands [oblast], [year]
 - 2.1. Total growing stock of stands by main tree species
 - 2.2. Growing stock of stands of main tree species by agencies [users]
 - 2.3. Growing stock of stands of main tree species by age classes
 - 2.4. Growing stock of stands of main tree species by site indexes
 - 2.5. Growing stock of stands of main tree species by density
 - 2.6. Growing stock of stands of main tree species by forest type conditions
 - 2.7. Growing stock of stands of main tree species by origin
 - 2.8. Growing stock of stands of main tree species by mean diameter classes
 - 2.9. Growing stock of stands of main tree species by mean height classes
 - 2.10. Growing stock of stands [of main species] by site indexes and age classes
 - 2.11. Growing stock of stands [of main species] by density and site indexes
 - 2.12. Growing stock of stands [of main species] by forest type conditions and site indexes
 - 2.13. Growing stock of stands [of main species] by origin and growing stock groups

- 2.14. Growing stock of stands [of main species] by forest type conditions and growing stock groups
- 2.15. Growing stock of stands [of main species] by density and management types
- 2.16. Growing stock of stands [of main species] by forest type conditions and types of disturbance
- 2.17. Growing stock of stands [of main species] by forest type conditions and growing stock groups
- 3. Volume and number of trees [oblast], [year]
 - 3.1. Total [mean] volume [number] of forest-forming tree species
 - 3.2. Total [mean] volume [number] of living trees [of forest-forming species] by age classes
 - 3.3. Total [mean] volume [number] of living trees [of forest-forming species] by Kraft classes
 - 3.4. Total [mean] volume [number] of living trees [of forest-forming species] by height classes
 - 3.5. Total [mean] volume [number] of living trees [of forest-forming species] by diameter grades
 - 3.6. Total [mean] volume [number] of living trees [of forest-forming species] by stem quality and diameter grades
- 4. Increment, mortality, cuttings [oblast], [year]
 - 4.1. Annual increment [per 1 ha] of stands of forest-forming tree species by age classes
 - 4.2. Annual increment [per 1 ha] of living trees of forest-forming species by age classes
 - 4.3. Annual mortality [per 1 ha] of stands of forest-forming tree species by age classes
 - 4.4. Annual mortality [per 1 ha] of living trees of forest-forming species by age classes
 - 4.5. Annual cuttings [per 1 ha] of stands of forest-forming tree species by age classes
 - 4.2. Annual cuttings [per 1 ha] of living trees of forest-forming species by age classes
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 - 5.1. Mean growing stock per 1 ha of stands of forest-forming tree species by age classes
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 - 5.5. Mean diameter of stands of forest-forming tree species by age classes
 - 5.6. Mean diameter [of living] trees of forest-forming species by age classes

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 - 6.1. Area of stands of forest-forming tree species by structure of stand [%]
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 - 6.4. Percentage of number of trees of stands of forest-forming species by defoliation rates
 - 6.5. Percentage of number of trees of stands of forest-forming species by dekhromatation rates
- 7. Sanitary condition of stands [oblast] [year]
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 - 7.6. Percentage of number of [living] trees of forest-forming species by types of stem damage
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 - 8.1. Area of artificial regeneration of forest-forming tree species by age classes
 - 8.2. Area of stands of forest-forming species by presence of natural regeneration
 - 8.3. Mean number per 1 ha of seedlings of forest-forming tree species
 - 8.4. Mean number per 1 ha of natural regeneration of forest-forming tree species
 - 8.5. Percentage of number of natural regeneration of forest-forming tree species by ages
 - 8.6. Percentage of number of natural regeneration of forest-forming tree species by height classes

References

1. V. Gulchak. State Forest Survey in Ukraine – results and prospects / «Forestry and hunting magazine» №2 2012 <http://www.lisproekt.gov.ua/materialy-ta-zvity/derzhavnyj-oblik-lisiv>
2. V. Storozhuk. On harmonization of regulatory basis of forest and land survey: development of proposals on improvement of system of procedures of state forest cadaster / FLEG-II Analytical report, 2014 http://www.enpi-fleg.org/site/assets/files/2124/report_storozhuk_improvement_state_forest_cadaster.pdf
3. V. Storozhuk, M. Rekovets. Source of reliable information, - "Forestry and hunting magazine" № 5-6. - 2003 <http://www.lesovod.org.ua/?q=node/199>
4. Buksha I.F., Pasternak V.P., Meshkova T.S., Russ R., Cerny M. Sampling statistical inventory of forest stands of National Park 'Gomilshansky' // Silviculture and forest melioration. 2006, Vol. 109. – Kharkiv: 2006. – P. 111–116.
5. S. Myklush, R. Vytseha, M. Cerny. Statistical inventory of Verkhniodnistrovsky and Skole Beskydy // Silviculture and forest melioration. 2006, Vol. 109. – Kharkiv: 2006. – P. 117-126.
6. R. Vytseha. Selective inventory of forest stands of Verkhniodnistrovsky Beskydy // Abstract of dissertation for the degree of Candidate of Agricultural Sciences. 06.03.02 – Forest inventory and forest mensuration. - Kyiv – 2008
7. Ukraine Forest Reform Programme - Phase 3B. Final Report. «4.1 Methodology for forest inventory» http://www.lesovod.org.ua/webfm_send/22
8. V. Storozhuk. National inventory of Ukrainian forests: conceptual framework and sampling design http://www.lesovod.org.ua/dmdocuments/NFI_Concepts_and_Design.pdf
9. Cerny M. Determination of density of the network of sample plots of national forest inventory of Ukraine / M. Cerny, P. Vopenka, N.P. Levkivsky, I.F. Buksha // Scientific bulletin of NAU, 2006. Vol. 103. – P. 163–172
10. V. Storozhuk, I. Buksha. Combining designs of national forest inventory and monitoring. Article preprint, 2008 – P. 9
11. Recommendation of expert mission of TAIEX on questions of development of national forest inventory in Ukraine. A.Z. Shvidenko (IIASA, Austria), M. Cerny (IFER, Czech Republic) <http://www.lesovod.org.ua/node/3185>
12. V. Storozhuk. Development of national forest inventory in Ukraine // CNFI. - Irpin, 2009, - P. 16
13. Ukraine's initial report under Article 7, paragraph 4, of the Kyoto Protocol Ministry of Environmental Protection of Ukraine - Kiev 2006
14. V. Storozhuk. Forest monitoring for Ukraine // CNFI. - Irpin, 2010, - P. 9
15. V. Storozhuk. National forest inventory: assessment of forest fund of Sumy and Ivano-Frankivsk oblasts, - "Forestry and hunting magazine" №3 2014 http://www.academia.edu/29610342/National_Forest_Inventory_Assessment_of_Sumy_and_Ivano-Frankivsk_Oblasts_Ukraine
16. V. Gulchak. On results of statistically-based forest inventory in Ivano-Frankivsk and Sumy regions in 2008-2013 // Report at Board meeting of State Agency of Forest Resources of Ukraine on April 24, 2014
17. V. Storozhuk. Main results of forest inventory in Ivano-Frankivsk region // Report at field board meeting of State Agency of Forest Resources of Ukraine on September 7-8, 2016

2. Methodical experiences from the National Forest Inventory in Germany and conceptual proposals for the realization of forest inventories in Ukraine, by Dr. Heino Polley

2.1. National Forest Inventories in Germany

2.1.1. Public interest and needs

For the sustainable forest management and its political support, knowledge about state, structure, dynamics and performance of forests at the levels of companies, regions and country is needed. In addition, this information is necessary to meet Germany's growing commitments to international climate protection and to represent forestry concerns in the European Union. The National Forest Inventory provides this important information about the large-scale forest conditions and forestry production possibilities at the national and partly at the regional level. It does not provide information on the company level.

In detail, the National Forest Inventory has following goals:

- creation of a comprehensive source on German forests through a methodologically coherent procedure,
- description of the forest through classical inventory results like forest surface, occurrence of tree species, wood stocks, wood use, growth.
- representation of development of forest surface, percentages of tree species, wood stocks
- assessment of ecological stability of the forest,
- assessment of the conservation of widespread forest habitat types as a contribution to EU-wide habitat monitoring according to the Habitats Directive,
- estimation of the carbon storage and its change,
- provision of reference values for forest research, research on climate effects and environmental monitoring of forest ecosystems,
- underlying data for the estimation of the raw wood potential for the next decades as well as for the development of forest development scenarios,
- presentation of results for Germany and for the individual countries, possibly also statements on other spatial units.

Concretely, the results of the National Forest Inventory were in the last decades used for purposes mentioned below.

2.1.2. Politics

- Charta for wood: support of wood use
- Cluster study forest & wood: presentation of economic importance
- National Biomass Action Plan for Germany: contribution of biomass to a sustainable energy supply
- Forest strategy 2020: communication of forest policy goals
- National Forest Report: policy report on forests and forestry
- Image discussion on forestry: sustainability, dead wood, damage caused by game, closeness to nature

- International report obligations: Forest Resources Assessments, Forest Europe, Framework Convention on Climate Change, Kyoto protocol, Habitats directive
- Association policy and lobbying: German Forestry Council, German Wood Industry Council, working group of German raw wood consumers, working group of German associations of forest owners, hunting associations...

2.1.3. Economy

- Information on future raw wood supply within the national framework
- Chances of forestry growth
- Analysis of potential supply of raw wood for existing or planned plants (cellulose, slab, sawmill, biomass to liquid)
- Effects of environmental policy for forestry and wood industry
- Data on wood as an energy resource

2.1.4. Science

- „Ground truth“ for remote sensing projects (monitoring)
- Modeling "critical loads" (pollution load)
- Forest development scenarios (e.g. carbon sequestration)

2.1.5. Historical development

2.2.5.1. Prehistory

The first forest surface survey was conducted in German Reich in 1878 that is seven years after its founding. In 1892, the Federal Council of the German Reich adopted a repetition of the forest surveys every ten years, and by the year 1961, seven forest surveys were carried out by questioning the owners. These surveys were expensive and time-consuming, and the comparability was limited because of changes in method.

2.2.5.2. "Forest dieback" as an impulse for a forest monitoring

Since 1979 forest scientists in Germany warned of a forest dieback. In the following years the topic was widely discussed in the media, and in the first half of the 1980s the federal government in addition to air pollution reduction measures also adopted research and monitoring programs for forests. For example, in 1983 a federally unified systematic forest damage survey was introduced on a sample basis. Since 1985 it has been extended to other countries of the European Community within the framework of the Geneva Convention on Air Pollution and has been repeated annually in its basic elements (crown defoliation, yellowing).

But soon it became clear that the forest damage survey cannot give responses to many questions about state and development of forests. That's why in 1984 the federal government decided the implementation of a federal forest inventory, which was introduced in the Federal Forest Law as §41a. It should "provide information on the use of the forest, about the structure and extent of admissible wood supply and about the hazards, damage and undesirable developments of the forest" as well as "help to assess the production conditions of the forest as a result of new kinds of forest damage". Until that time, such national forest inventories had been introduced by eleven European countries.

2.2.5.3. Forest inventories in divided Germany

In 1948-1950 forests surveys were carried out in all occupation zones on the orders of the Allied Control Council. In 1949-1990 forest inventories in the two German states developed differently.

In the German Federal Republic in 1961 for the last time a survey of forest land owners was conducted. Until the first Forest Inventory of 1987 it was the last federal data source on forests.

In the German Democratic Republic in 1961 a large-scale forest inventory was introduced on a sample basis. It was abandoned again, when since 1970 almost the entire forest area was managed by state forestry enterprises and comprehensive stand-wise forest planning data were available in the "Forest Funds Database".

2.1.6. National Forest Inventory and forestry environmental monitoring

Up to now three National Forest Inventories have been conducted: 1986-1988, 2001-2002 and 2011-2012. In 2008 and 2017 special carbon inventories with a limited range of attributes were carried out at a subsample of the Forest Inventory.

Since 1983 the Forest Condition Survey of the state of forests (earlier "Forest Damage Survey") is conducted yearly. In 1987-1993 and 2006-2008 Forest Soil Surveys were carried out. In 1994 began an intensive forest monitoring (Level II).

2.1.7. Legal framework for the Federal Forest Inventory

In Germany, federal states are responsible for the forestry (art. 30 of the Constitution). In case of a concurrent legislation, the federal government has a legal competence in forestry. It makes use of this competence according to art. 72(2) of the Constitution, if there is a need of a federal regulation. The concurrent law extends, among others, to the promotion of agricultural and forestry production (art. 74 no. 17 of the Constitution). Because of common forestry goals of the federal government and federal states and because of the need to base on a reliable database, the federal government and the states decided to carry out a large-scale inventory.

In 1984 §41a "National Forest Inventory" was new implemented into the Federal Forestry Act. So the National Forest Inventory is located in the order of paragraphs between "Promotion" (§41) and "Disclosure obligation" (§42). In 2010 §41a was changed. The most important innovations for the National Forest Inventory are that a 10-year cycle is now mandatory and an option for further surveys has been opened for the intervening years. In addition, legal foundations for other surveys of environmental forest monitoring which exist for many years were introduced.

§41a in the actual version (with the insertions *[italics]* and deletions from the law change of 2010):

~~“§ 41a National Forest Inventory~~ *Forest surveys*

- (1) For the purposes of fulfilling the tasks of this Act, *as well as of legal acts of the European Union or binding international agreements within the scope of this Act*, subject to paragraph 3, a large-scale forestry inventory on a sample basis is to be carried out *every 10 years*. It is intended to provide an overview of the large-scale forest conditions and forestry production facilities. The necessary measures and descriptions of the forest state (basic data) are to be carried out according to a standardized procedure. *In doing so, the usability of the basic data must also be taken into account within the scope of the observation according to § 6 of the Federal Nature Conservation Act. If necessary, the inventory must be repeated.*
- (2) The federal states collect the basic data mentioned in paragraph 1; The Federal Ministry for Food and Agriculture collects and evaluates them.
- (3) *If necessary, for the fulfillment of reporting requirements based on binding international agreements for climate protection, the Federal Ministry of Food and Agriculture collects data on the carbon stock in the forests in the years between two National Forest Inventories.*
- (34) The persons responsible for preparation and realization of ~~Federal Forest Inventory~~ *forest surveys mentioned in paragraphs 1, 3 and in ordinances from paragraph 6* have a right to enter land plots with the goal of fulfillment of their obligations, as well as carry out necessary inventory works on these plots.
- (45) The Federal Ministry for Food and Agriculture is authorized ~~to define the date of Federal Forest Inventory~~ and to issue by ordinance more detailed provisions on the sampling procedure to be applied ~~according to paragraph 1~~ *for the National Forest Inventory* and the basic data to be determined.
- (6) *The Federal Ministry for Food and Agriculture can stipulate by ordinance with the consent of the Federal Council that the data can be collected*
- 1. about the nutrient supply and pollution loads of the forest soils (soil condition survey),*
 - 2. about the vitality of forests,*
 - 3. about interdependencies in forest ecosystems*
- and issue more detailed norms about the date, the procedures to be applied and the basic data to be collected. In the case of an ordinance pursuant to sentence 1, paragraph 2 shall apply accordingly.”*

On the basis of the authorization referred to in paragraph 5, the Federal Ministry for Food and Agriculture issues for each cycle of the National Forest Inventory a National Forest Inventory Regulation, specifying the time frame, the sample network and the most important basic data. In the statement about the regulation, the costs are estimated as well. With the consent of the Federal Council to the National Forest Inventory Regulation, the federal government and the federal states commit themselves to finance the National Forest Inventory.

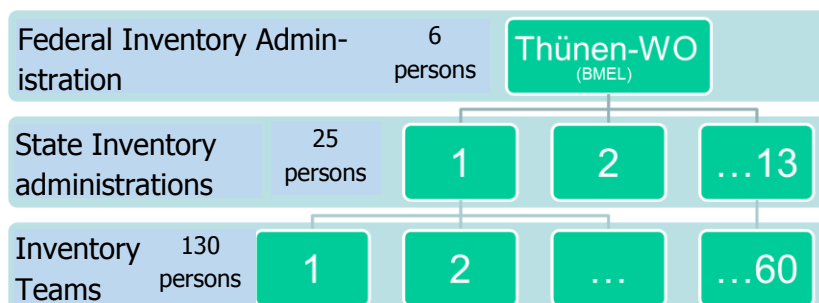
Detailed specifications on the conduct have been described for the first and second National Forest Inventories in an administrative provision by the Ministry for Food and Agriculture and further specified in a recording instruction. In the third National Forest Inventory, the Ministry has waived the legal form of an administrative provision.

2.2. Experiences from the Federal Forest Inventory

2.2.1. Competences, organization and planning

2.2.1.1. Organization

Figure 4: Organizational structure of the Administration of National Forest Inventory



The organization of the National Forest Inventory is derived from the federal structure of the Federal Republic of Germany, where forestry falls within the jurisdiction of the federal states. The National Forest Inventory is a common task of the federal government and the states. The states are responsible for the collecting of data and therefore for its financing. The authority responsible for the collecting of data in each state (state inventory administration) has the following tasks:

- planning and coordination of the use of the recording groups,
- preparation of documents for the recording groups,
- guaranteeing of the proper data collecting, including inventory control,
- check and correction of the data in coordination with the National Inventory Administration,
- release of the controlled data in the central database for use in the National Inventory Administration,
- providing information about the timetable of the realization of inventory for the National Inventory Administration,
- providing information about state specific data assessment to the National Inventory Administration.

The compilation of the data and the resulting coordination tasks are carried out by the Federal Ministry for Food and Agriculture. It makes use of the Thünen-Institute (National Inventory Administration), which cooperates directly with the state inventory administrations when it carries out entrusted tasks.

Coordination tasks include in particular:

- discussion of all issues relevant for the ensuring of a unified realization of the Federal Forest Inventory, including the results of inventory control with the state inventory administrations,
- examination of data for plausibility and correction of implausible data,
- data analysis,
- clarification of doubtful questions of transregional importance.

If the coordination of the National Forest Inventory requires insight into the realization of a local inventory, it is provided by the state administration.

The National Inventory Administration provides for the state inventory administrations all the data of previous National Forest Inventories necessary for the renewed assessments as well as the software for the following work steps:

- data collection and data control,
- data management (data selection, data import and export for field crews and inventory administrations),
- site plans of sample trees from the angle count sample.

2.2.1.2. Planning

The ten-year inventory cycle can be divided into five partly overlapping phases of about two years each.

Figure 5: Cycle Federal Forest Inventory



In the *conception phase* the federal government and the states agree on the inventory goals and on the characteristics to be recorded. For this purpose, inventory administrations agree with their respective ministries. In addition, forestry and wood industry associations as well as nature conservation associations are being listened to. The National Inventory Administration develops variants and decision bases tools for the field manuals as well as evaluation tools. This includes a cost estimation as well as the timetable. The inventory concept is a compromise of desirable and feasible. The inventory has to be carried out coherently in the whole Germany. However, additional state-specific characteristics are possible. The concept phase ends with the issuance of the National Forest Inventory Regulation.

In the *preparatory phase*, the immediate prerequisites for carrying out of the data collection are created. This includes the completion of the field manual of the software for the data collection

as well as of the entire IT infrastructure, the procurement of devices and the hiring of the necessary personnel. It ends with the training of the inventory groups.

During the *survey phase*, the inventory teams record the data on the inventory plots, control teams check recording samples and the state inventory administrations compile data which cannot be recorded in the forest. For this purpose, all teams and inventory administrations use a central database and the database clients provided by the National Inventory Administration. The data are regularly synchronized with the central database and checked for plausibility and completeness. Meanwhile, the National Inventory Administration adjusts the evaluation software and tests it with the incoming data. The survey phase ends with data verification and plausibility. After that, corrections of the data are impossible, because they would harm the consistency of the results.

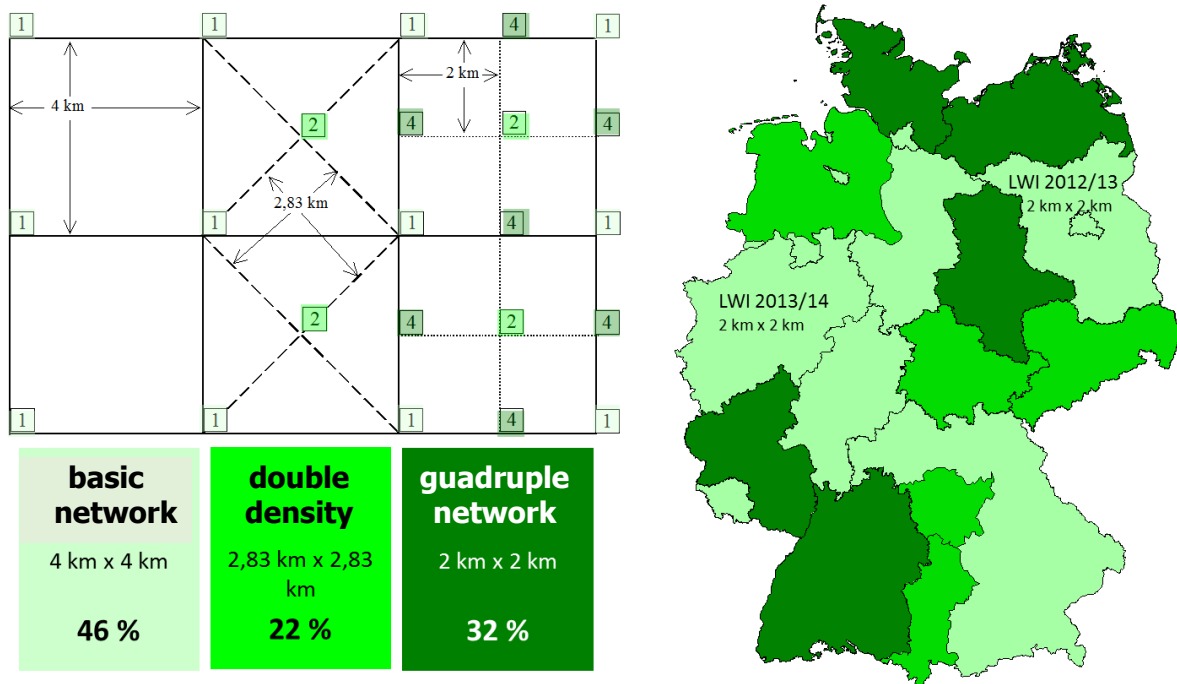
During the *evaluation phase*, the National Inventory Administration makes an extrapolation of sample data and stores the results in a results database, which is initially accessible only to an internal user group. State institutions and ministries inspect, assess and evaluate the results. In addition to the actual inventory evaluation, a forest development and wood supply modelling is calculated as soon as possible. For this purpose, scenarios are agreed with the state inventory administrations and ministries and the results are jointly analysed and evaluated. The forest development and wood supply model has already been developed for the first National Forest Inventory and has been adapted and further developed for the next inventories.

In the *publication phase*, the National Inventory Administration, together with the Federal Ministry, prepares the inventory reports and agrees them with the state inventory administrations and state ministries. After that, the Federal Ministry presents the results to the public at a press conference. At the same time, the National Forest Inventory homepage of the Federal Ministry (www.bundeswaldinventur.de) and the results database of the National Inventory Administration (www.bwi.info) are released and an inventory report with the most important results is published. After that press statements and press conferences of the state ministries follow. Some states publish their own inventory reports as well. The National Inventory Administration calculates further assessments and publishes them in professional journals. In addition, it publishes methods of inventory and assessment.

2.2.2. Inventory procedure

The inventory is a permanent, one-phase, stratified tract sample. The samples are distributed in a systematic network in the whole Germany. The basic sample has grid density of 4 km x 4 km. Some states have additionally condensed the sample so that currently sample density is doubled on 22 % of the area and quadrupled on 32 % of the area.

Figure 6: Structure of inventory procedure



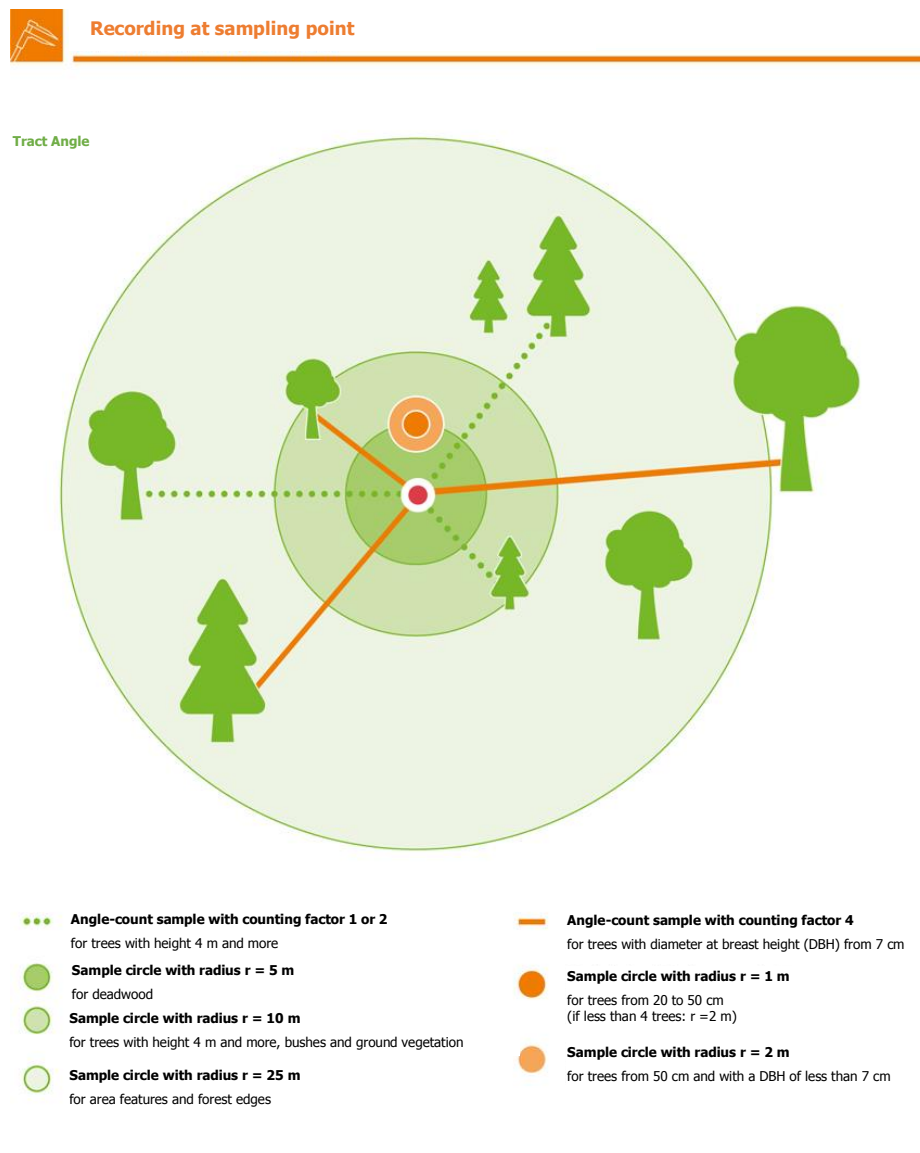
Each sample, also called tract, is a square with side length of 150 meters. At the angle of each square, the sample points (= plots), the inventory groups collect the data. The plots are marked with a metal bar sunk in the ground.

The plot design is decisively influenced by the inventory goals.

Table 5: Goals and procedures of inventory

Objective	Procedure
Growing stock, biomass and carbon stocks, increment, use of wood, area of tree species	Angle-count sample with basal area factor $k = 4 \text{ m}^2$
Forest structure	Angle-count sample with basal area factor $k = 1 \text{ m}^2$ as well as sample circle $r = 10 \text{ m}$
Ground vegetation	Sample circle $r = 10 \text{ m}$
Forest regeneration, browsing by game	Sample circles $r = 1 \text{ m}$ or $r = 2 \text{ m}$
Deadwood	Sample circle $r = 5 \text{ m}$
Topographic features, forest edges, damages of forest habitat types	Sample circle $r = 25 \text{ m}$

Figure 12: Specification of sample point and information acquisition

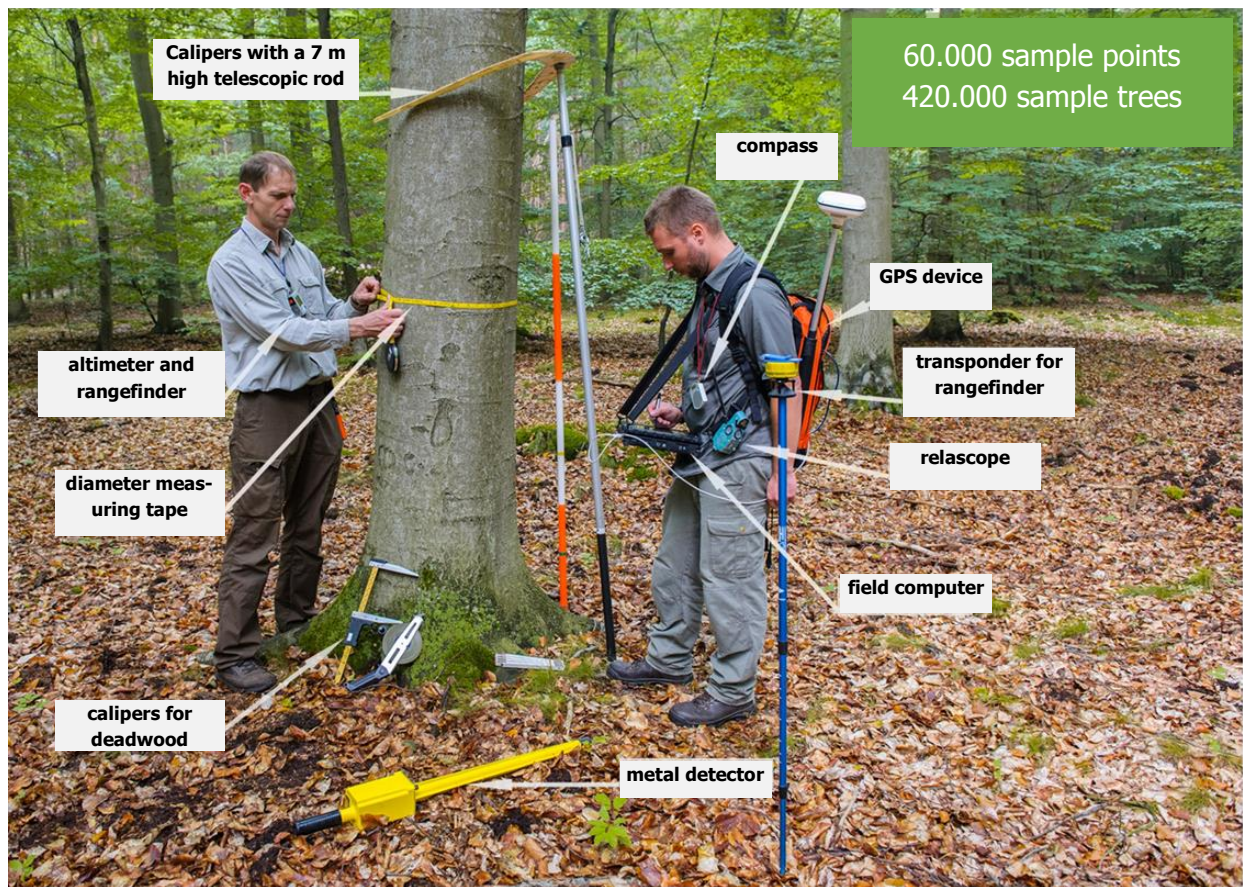


Source: BMEL

At each sample point, the inventory administrations assemble information which is not recognizable on the ground. Using forest distribution maps, aerial maps, cadastral maps, information from local forestry authorities and other forestry information, they identify features such as property type, protected areas or restrictions on the use of wood.

Equipped with field computers and measuring devices, the inventory teams record more than 150 attributes at each sampling point according to a standardized procedure. These include, for example, tree species, height and diameter of the sample trees as well as type and quantity of deadwood. The recording procedure is described in a field manual. The inventory teams are trained in one-week training courses.

Figure 13: Specification of sample point and information acquisition, practical realization



The informative value of an inventory depends on data quality. The quality control therefore begins when the data are collected in the forest. It is based on a three-stage control system:

Control at the data entry: The inventory groups record the data with mobile field computers. Plausibility checks in survey software takes place in the forest and calls attention to potential data errors. E.g., the inventory staff can correct the collected data on the spot through re-measuring or can collect and record forgotten values.

Control of data collection: At least five percent of the sampling points are controlled by the state inventory administrations on the spot.

Plausibility control: The data of the control database are taken into the central database. Through test runs with error logs, the inventory administrations of the federal government and the states control the quality of the collected data. The state inventory administrations correct errors themselves or ask respective inventory teams for correction.

A documentation of the inventory and evaluation methods of the current Federal Forest Inventory 2012 is currently being published⁶. An English version is planned.

⁶ FFI 2002 here:
http://www.bundeswaldinventur.de/fileadmin/SITE_MASTER/content/Dokumente/Downloads/Arbeitsbericht_VTI_Inventur_Auswertungsmethoden_BWI2.pdf

2.2.3. Costs and financing

With the consent to the National Forest Inventory Regulation, the federal government and the federal states commit themselves to finance the National Forest Inventory. Therefore, the National Forest Inventory Regulation must be finalized at an early stage so that the costs can be included into the budgets. An important basis for this is the cost estimate generated in the conception phase. It is based on an estimate of the time required for each inventory plot and on the number of expected plots.

In general, it is required that the time required for data collection on the inventory plot should not be bigger than during the previous inventory. Therefore, in order to compensate for additional surveys of new attributes, rationalization possibilities are always sought. Inflation-induced cost increases are usually accepted.

The average time taken for field recordings is as follows:

Table 6: Time required for field recordings

Traveling time to the tract	60 minutes	Average tract with 3 plots in the forest: 4 hours
Location of the inventory plot	15 minutes	
Data collecting per plot	45 minutes	

This results in an average daily performance of two inventory tracts.

The costs are particularly sensitive to the sample density. The federal base sample is based on a 4 km x 4 km sample network and the states can opt for a double or quadruple sample density according to their information needs and financial possibilities. The states have chosen these options more and more often from inventory to inventory.

The third National Forest Inventory (2012) cost in total about € 21.4 m € 15.1 m of this amount belong to the states and 6.3 m to the federal government. It is equivalent to € 1.87 per forest hectare per a ten year cycle.

Costs per forest plot:

- Inventory team in case of subcontracting = € 113
- Total costs in the state = € 252
- Total costs federal government + state = € 357

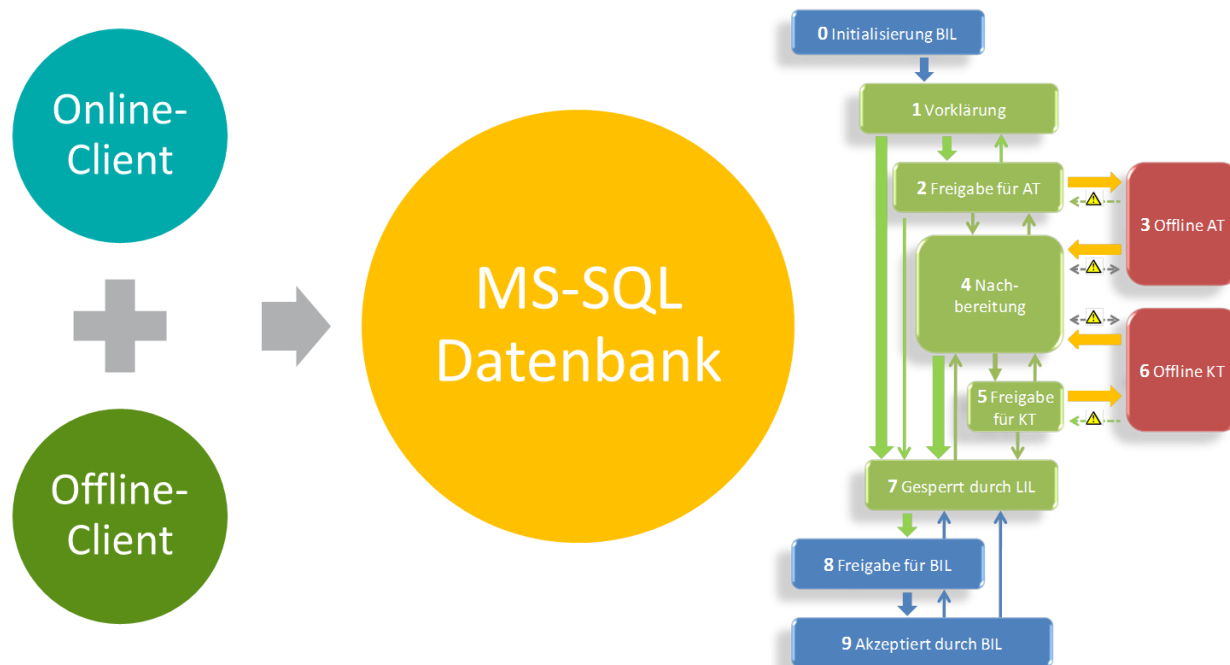
2.2.4. Data management and evaluation

An efficient and secure data management is an important prerequisite for the success of a national forest inventory. All National Forest Inventory data are stored in central MS-SQL databases of the National Inventory Administration, where the state inventory administrations have access to their own data. In addition to the factual data, extensive metadata are also included. Database clients were programmed for the routine tasks of the inventory teams and administrations. A management of rights and workflow is used to define who is allowed to edit which data.

The online client is mainly used in inventory administrations. This is used, among other things, to assign tracts to the teams, to monitor the work progress, and to enter and check the data.

The offline client is needed for the data collection in the forest. It contains input masks for all attributes to be included, plausibility checks and a navigation module for finding the plots. The data stored in the offline client are regularly synchronized with the central database via the Internet. Program updates may also be transmitted.

Figure 7: Data management



(Online client, offline client, MS-SQL database, 0. Initializing National Inventory Administration, 1. preliminary clarification, 2. release for field crews, 3. offline field crews, 4. postprocessing, 5. release for control crew, 6. offline control crews, 7. locked by state inventory administration, 8. release for National Inventory Administration, 9. accepted by National Inventory Administration)

After completion of the data collection, the data are processed for the projection. For this purpose, values are calculated (e.g. shaft volume or growth of the sample trees) and the data are converted into a structure suitable for the projection.

In the projection, aggregated data are estimated from the sample data for the population. In doing so, various target attributes (e.g. area, stocks, growth) are calculated and the results are classified according to classification attributes (e.g. tree species, age classes, owner types). For this purpose, a self-developed software is used, which writes its output together with the metadata necessary for understanding in result databases. At the moment, the result databases contain several hundred millions data records. www.bwi.info serves for search, selection and presentation of the results.

2.2.5. Publication

In principle, the results of the National Forest Inventory are public. All aggregated data are available in an online database at www.bwi.info in German and English and can be displayed and downloaded as tables, graphs or maps. In addition, the results are prepared, explained and

interpreted at www.bundeswaldinventur.de. News about National Forest Inventory are communicated at https://twitter.com/BWI_INFO.

The most important results are also published as brochures of the Federal Ministry. These are usually a brochure with selected results and a tabulation volume. They are available for the National Forest Inventory as well as for the wood supply modelling in German and English. The field manual and a description of the inventory and evaluation methods are also printed⁷. Moreover, special results are published in the specialized press and the mass media are used to make the inventory and its results known.

According to the Geodata Access Act (Geodatenzugangsgesetz) and the Environmental Information Act (Umweltinformationsgesetz), the survey data must also be published. Therefore, the National Inventory Administration also offers a download of all plot and tree data. Only the exact plot coordinates are not published to protect the anonymity of the sample. They are only passed upon request and then with a data usage contract.

2.3. Discussion “cost vs. accuracy”

The accuracy of the sample is characterized by the sampling error. It depends on the variance of the tract values and the sample size. With a given variance, a quadrupling of the sample size leads to a halving of the sample error. An improvement in accuracy is thus obtained with exponentially increasing costs.

The variance of the values depends on the size of the sample elements. For example, the larger the sample area, where an average wood stock is determined, the smaller the variance of the wood stocks of the sample surfaces. There is no general rule of whether enlargement or multiplication of the sample surfaces is advantageous.

The sampling error can also be reduced by means of a multi-phase sample, by providing a preceding remote sensing phase to the terrestrial survey. However, a cost advantage is obtained only if the savings in the second phase are greater than the additional effort in the first phase. The National Forest Inventory was created as a single-phase sample. This has remained so up to now. The terrestrial sample should not be thinned because many of its attributes cannot be replaced by remote sensing data.

A relatively big effort is necessary for traveling and search for the sampling points in the area. In order to reduce costs, cluster sampling is applied to most of the forest inventories. Several sample points close to each other are grouped together according to a specific pattern. In the National Forest Inventory, it is a square with a length of 150 m (tract). The recordings are carried out at its four corners (plots). The closer the plots to each other, the greater time saving (smaller distances). At the same time, the intracluster correlation tends to increase because the situation on the 2nd, 3rd, 4th plot is similar to the first and in an extreme case one can refuse the former.

When designing a national forest inventory, sample design and plot design must be developed in such a way that the inventory goals are achieved and the budget is met. There are usually no clear guidelines for inventory targets and budget, and several solutions are possible for sample and plot design. Besides, a maximum of information with minimal costs is always expected. Therefore, a forest inventory will never be able to meet all the requirements. It is also necessary to expect in the future new demands, of which nobody thinks today. So the development

⁷ <https://www.bundeswaldinventur.de/index.php?id=421&L=3%252527A%2525253D0>

of inventory design is an optimization task with many unknown values for which there is no clear solution.

Therefore, the inventory process must be jointly developed by inventory specialists and by future data users. The best possible fulfilment of the user expectations as well as transparency and acceptance are important prerequisites for the long-term survival of the forest inventory.

Despite increasing cost pressure, more and more federal states have decided to densify the sample when carrying out the National Forest Inventory and thus to multiply costs. This is an expression of the high appreciation of the data.

2.4. Trends and challenges

2.4.1. Trends

- More content (deadwood, closeness to nature, forest habitat types, usage restrictions)
- Increasing publicity and establishment as a source of information for politics, business, science, and media
- Increasing willingness to invest (intensification of the surveys at the regional level [network density, feature spectrum, survey period] and more personnel capacity at the federal level)
- Technical progress in data collection (mobile data acquisition, Internet access, electronic measuring devices, GPS navigation)
- Technical progress in data management (high-performance databases [centralization, rights management, division of labor], online data access, GIS)
- Search for links to other surveys
- Increasing networking in Europe, growing expectations of harmonization and data delivery at European level
- Increasing complexity

2.4.2. Challenges

- Actuality: shorter periodicity, shorter survey period, shorter time of evaluation
- Regional resolution: higher sampling density, forest inventories in federal states, inclusion of additional information sources (remote sensing)
- Harmonized at the European level: forest definition, stock components
- Clear description: for forestry / wood industry, environmental protection, politics, science, interested citizens
- Improve political efficiency: media presence

2.5. International networking

National forest inventories have been developed in different countries at different times and are largely independent of each other. They are always characterized by national conditions and interests. That is why hardly a national forest inventory in Europe resembles another. In their core areas, however, they have the same goals and challenges. Besides, international organizations, such as EU or FAO, are highly interested in the harmonization of inventory results. From this background, a core group of 17 countries established in 2003 the "European National Forest Inventory Network" (www.enfin.info), which some other countries have joined later. The

professional exchange in the ENFIN provides impulses for the further development of the National Forest Inventory. Moreover, the ENFIN Group, as a consortium, has successively obtained financial resources of EU projects for harmonization activities and published joint reports.

Figure 8: Map of Europe



Source: www.enfin.info

2.6. Factors of success

The following ten factors of success base on personal experiences from the coordination of Federal Forest Inventory in Germany in 1992-2017 as well as on a self-reflexion with the aid of „Voluntary Guidelines on National Forest Monitoring“ by FAO (see Chapter 4).

1. *Politicians recognize the need for information*

The realization that comprehensive information on forests at the national level is indispensable for a successful forest policy is a crucial prerequisite for the establishment of a national forest inventory as a state task. The necessary political backing and the corresponding readiness to provide financing arise only if the information requirements are recognized by the decision-making bodies. For that, support of the project by different interest groups is beneficial. Therefore, the National Forest Inventory must be situated in as large a context as possible. Its data is important not only for the forestry, it is relevant for many other social spheres. These include, for example: woodworking industry, jobs and income in the countryside, bioenergy, biodiversity and nature conservation, climate protection and international agreements.

In Germany, a broad social dispute over forest decline at the beginning of the 1980s was a major impulse for the establishment of a national forest inventory. Nowadays, problems of climate change, illegal logging, and sustainable development could foster the motivation for a national forest inventory.

2. Scholars and stakeholders develop concepts

At the same time, it must be shown how the required information can be obtained. Conceptions for the national forest inventory should be developed. For this task, experiences from other countries can be helpful. However, the national conditions must be taken into account. Different solutions are possible. The concepts are to be developed together with future data users in order to meet their needs at the best. In addition, their lobbying can support the realization of the national forest inventory. The chances of realization increase if the communicated concepts are scientifically sound and have political support.

3. Legalization, institutionalization, financing

As a state task, the national forest inventory needs a legal basis. It should be specific, but at the same time allow some freedom of content development. A public body should be commissioned and equipped with a dedicated budget. The budget will be mostly too small. Then the right priorities must be set and all the rationalization possibilities must be used. The continuity of personnel, at least in the core sphere, is necessary to maintain the know-how in the long term.

4. Forest inventory provides relevant information

When the data are collected, the forest inventory must provide the expected information. Their continuation will find the necessary support only if it meets the expectations.

For the final data check, the evaluation as well as examination, analysis and preparation of the results, sufficient time is to be planned. But after that, timetables should be respected. Since all the results must match each other, the results can be published only if all the essential evaluations have been completed.

For some questions, the inventory will come to its limits. Then it is important to use the information content of the data with much creativity. Conflicts between scientific precision and need for information can arise. They should be clarified on a case-by-case basis. Uncertainties are to be communicated sincerely.

5. Public relations for the dissemination of the results

The information must get where it is needed. Therefore, the results of the forest inventory have to be prepared for professional world, politics, broad public and scientific community in a targeted and comprehensible way.

Various channels are to be used for the dissemination of the results: print media, internet, own symposia, contributions to stakeholder events, media work.

6. Trustworthiness, objectivity, neutrality

The trustworthiness of the forest inventory is very important for its maintaining in the long term. There will be doubts and criticism of the results, especially if statistics differ from other data. Therefore, the methods must be scientifically correct and published.

Forest Inventory scholars are commissioned to provide consultations for the politics on a scientific basis. Therefore, the results of the inventory must be presented neutrally and objectively. Science must be free of political interests.

7. React to new information needs

If the national forest inventory is established, it must respond to new information needs. To this end, social processes must be closely observed in order to recognize new trends in time. This is best done if a close contact with the stakeholder groups has been established. The forest inventory must propose solutions.

8. Development of scientific cooperation

External knowledge must be developed and used, where the own expertise is not sufficient. To this end, networks should be developed and maintained. The forest inventory should become well-known and look for suitable partners with whom joint projects with third-party funding can be initiated. They are a good way to broaden the scientific horizon and to provide young scholars with opportunities for career development.

9. Development of capacities

With the repeated samplings and increasing recognition of the inventory, the scope and the complexity of the tasks increase. Therefore, personnel resources must be expanded in the medium term.

10. Methods should be developed carefully

Where necessary and possible, the methods must be developed further. This applies to measurement technology, software and data processing, statistical methods, remote sensing. However, comparability with previous surveys should always be ensured.

3. Voluntary Guidelines on National Forest Monitoring⁸

A working group coordinated by FAO has developed "Voluntary Guidelines on National Forest Monitoring" on the basis of experiences from many countries.⁹ Principles and elements described in this document can be very useful for the evaluation of past developments and for the identification of actions necessary for the establishing of a national forest inventory in Ukraine. They also give interesting suggestions for a reflection on the development in Germany.

Part A describes 12 principles for the development of a national forest inventory and monitoring system. Part B contains technical information on the various elements.

Part A: Principles

Governance principles

Principle 1: Country ownership and responsibility

Principle 2: Legal and policy basis

Principle 3: Landscape view

Principle 4: Institutionalization of NFM

Principle 5: Research infrastructure and capacity building

Scope principles

Principle 6: Participatory discussion process

Principle 7: Satisfaction of national information needs

Design principles

Principle 8: Integration of and consistency with existing information sources

Principle 9: Flexible approach

Principle 10: Multi-purpose approach

Principle 11: Feasibility including cost-efficiency

Data principles Principle 12: A well-defined data and information-sharing policy

Overall principles

Principle 13: Credibility through transparency and quality

Principle 14: Collaboration at the international level

Part B: Elements

Foundation elements

1. institutionalization;
2. developing national capacity;
3. developing partnerships and collaboration;
4. strengthening research and research institutions

Strategic elements

1. Mandate
2. Identification of information needs

⁸ To avoid misunderstandings due to a double translation (English → German → Ukrainian) we report only the English original.

⁹ Voluntary Guidelines on National Forest Monitoring, FAO, Rome, 2017; Internet: <http://www.fao.org/3/a-I6767e.pdf>

3. Stakeholder identification and engagement
4. Communication and dissemination
5. Integration of young experts
6. Data management and archiving
7. Impact assessment

Operational elements

1. Preparation

- a) Population of interest and sampling frame
- b) Identification and specification of variables to be recorded
- c) Review of existing data and information
- d) Uncertainty levels for the expected products
- e) Assessment and optimization of available expertise and human resources development

2. Statistical design

- a) Integration of field and remote-sensing data
- b) Sampling design
- c) Plot design
- d) Estimation design
- e) Model selection
- f) Errors in forest inventories and quality assurance
- g) Design of control measurements

3. Operational design

- a) Producing the field manual
- b) Design of the information management system
- c) Building the teams
- d) Training
- e) Fieldwork planning
- f) Fieldwork implementation
- g) Supervision of fieldwork
- h) Auxiliary data collection and supervision

4. Data management, data analyses, documentation and reporting

- a) Data entry and management
- b) Data quality control
- c) Data analyses
- d) Documentation
- e) Reporting
- f) Communication and dissemination
- g) Dialogue on the NFMS and its results
- h) Evaluation and impact analysis

- (i) the technical and scientific dimension of producing relevant, high-quality and credible data,
- (ii) the policy dimension.

When designing and implementing a national forest monitoring system, both dimensions must be kept in equal focus. Technology-driven approaches to comprehensive data collection should be avoided, unless their effectiveness can be proven. Planners of national forest monitoring systems must understand the policy processes that they support, and must be able during the planning phase to translate the information requirements of these processes into attributes that can be measured or observed in forest inventory systems. Likewise, during the analysis and reporting phase they should be able to communicate the implications through key messages that are relevant and meaningful for those who drive related policy processes.

Establishing and running a NFMS is a complex task for governments that serves to better inform forest related decisions and, thus, supports the sustainable development of forests at the national level. It requires a long-term vision and interdisciplinary collaboration, and is both a demanding and exciting endeavour. Typically, a NFMS will be implemented using a step-by-step approach with continuous enhancements made in line with feedback from user experience and the available resources.