Chapter 2
Comparison of Wood Resource Assessment in National Forest Inventories

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2.1 Introduction

The main objective of COST Action Usewood was to improve and harmonise data and information on the potential sustainable supply of wood resources at European level based on NFIs. The question of availability of wood in Europe on a sustainable basis is highly relevant to define global change mitigation strategies and targets for biomass energy as adopted at national and European level, and to support the proposal of an increased use of wood as a post-Kyoto decision. NFIs were

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primarily developed to address national level policy needs, while also being widely used as source of information for international reporting processes. However due to the different historical backgrounds, national ecological processes, environmental conditions and objectives, NFIs adopted different basic definitions and methodologies, leading to inconsistencies and lack of comparability in international reporting (Gabler et al. 2012; Tomppo et al. 2010).

To satisfy the objectives of the COST Action it was necessary to first ascertain the current status of wood resources assessment in European NFI's, which would provide the basic information required for harmonisation. WG1 initially focused its efforts on the sampling designs and estimation techniques used to assess the status and changes in wood resources. The NFI harmonisation work achieved during COST Action E43 (2010) was built-on and further extended to focus more on the assessment of wood resources. Case studies were conducted to demonstrate harmonisation options and elaborate recommendations for remote sensing and field data collection. To address the specific objectives of COST Action Usewood, the activities of WG1 were organised into four sub-groups that would comprehensively address the assessment of wood resources. The four sub-groups dealt with the topics of; *Forest Available for Wood Supply*, *Stem Quality*, *Change Estimation* and *Other Wooded Land and Trees outside Forest.*

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2.2 Development of Wood Resource Assessment

Forest surveys were first commenced to address concerns surrounding the sustainable supply of wood resources within a defined area. The primary interest concerned the availability of wood for local needs e.g. mining. When wood resources became a limiting factor for societal needs, the need for long-term sustainability of forest management was highlighted. Forest owners or policy makers required detailed information on the status of forest areas to inform future management decisions at a more strategic level.

Many European countries firstly used Forest Management Planning (FMP) techniques to assess wood resources within forests. Forest Management Planning techniques involve the sub-division of forest areas into homogenous units on a map. The areas identified on the map are further described in associated tables, which provide attribute information such as tree species composition, stand age, growing stock volume per hectare, etc. The aggregation of this stand-level information facilitated the production of regional and national estimates. An important advantage of these inventories is that forest managers and owners have local level information to manage their forest areas. In many European countries the requirement to undertake a FMP is enshrined in national legislation. FMP techniques by their nature are extremely labour intensive and as such carry a significant burden in terms of time and financial resources. They cannot provide precise national data at a specified date due to the wide assessment timeframe of the management units.

Statistical based NFIs were first introduced in Nordic countries as a means of assessing the wood resources at a regional and national level. The sampling design applied in NFIs provide a very robust basis for the assessment of the national forest estate. Due to the lower resolution of forest sampling used in NFIs compared to FMP, the statistics generated are generally not suitable for local forest management. NFI's provide robust data to generate statistics at a national and regional level where the sampling intensity is high enough for the objectives at hand. However it is worth noting, that given the extent of forest resources, remote sensing techniques have been successfully incorporated into inventory and monitoring processes (Tomppo et al. 2008; McRoberts et al. 2006).

The main international requirements for forest information, are the Food and Agriculture Organization of the United Nations (FAO) Forest Resources Assessment (FRA), and the obligations following from the commitments towards sustainable forest management (FOREST EUROPE) and United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. NFIs are one of the main data sources for all these reporting processes.

The existing gap in harmonisation concerning data being reported to international processes has been highlighted in Chap. 1. To understand the reasons behind this lack of harmonisation the measurement and estimation techniques to assess the status and changes in wood resources were evaluated at a more strategic level in the this chapter.

2.3 Materials Used to Compare Wood Resource Assessment Techniques

Two separate mechanisms were used to collect information on the current status of wood resources assessment and change estimations in European NFIs during the COST Action Usewood: questionnaires and country reports. This combined approach of collecting information from NFIs was successfully applied during COST Action E43 (2010) and integrates the advantages of both survey techniques. While the questionnaire requested information using concisely formulated questions that can mostly be answered by "yes" or "no" or by giving values, the country reports offered an opportunity to describe the country-level assessment systems more freely and to bring in aspects that are of particular importance under the respective conditions in the individual countries.

2.3.1 Questionnaires

The questionnaire was conducted in order to ascertain the differences between the definitions and components that make up the definitions that are applied nationally by the various NFIs.

There were four questionnaires, each one covering the topics of the sub-groups. The questionnaire included two steps of information collection. In the first step, the essential questions were elaborated, delivered to the NFI experts as an online survey, their responses collected in a database, and the provided information analysed. In the second step the questionnaire was reviewed, refined and again sent to the NFI experts. This two-step approach was established as a robust method to collect good quality information during COST E43 (Vidal et al. 2008). Supporting information was also provided to avoid any misunderstanding. Plausibility checks were made at the first and second step of the enquiry which included cross-checks between corresponding questions and comparisons with additionally drafted country reports. The reliability of questionnaire results under the given survey conditions was discussed by Cienciala et al. (2008). The aims, contents and supporting information of the four thematic parts of the questionnaire are described in the following sections.

2.3.1.1 Sub-working Group 1: Forest Available for Wood Supply

The aim of the questionnaire was to assess whether NFIs in Europe evaluate forests available for wood supply (FAWS) and whether it is comparable to international definitions of FAWS. The objective was to build a common definition of FAWS for

European NFIs which allows for harmonised information on available wood resources. The questionnaire requested information on:

- The definition of FAWS
- Harvesting techniques and costs
- Estimation and assessment of FAWS
- Relevance of legal restrictions
- Relevance of physiographic restrictions
- Relevance of restrictions due to environmental conditions and biodiversity conservation (without legal restrictions)
- Use of International Union for Conservation of Nature (IUCN) categories
- Relevance of restrictions due to management, harvesting and silvicultural conditions.

Supporting information was provided on:

- The existing definition of FAWS
- Harvesting techniques and costs.

2.3.1.2 Sub-working Group 2: Stem Quality and Assortments

The questionnaire focused on the stem quality assessment of living trees in NFIs. The methods of stem quality assessment were of primary interest. Implementation of existing European standards on stem quality grading into national specifications was also of interest. The objective of the questionnaire was to identify how European NFIs assess and estimate stem quality and wood assortments. The questionnaire requested information on:

- Field assessment of stem quality
- Quality classification in field
- Product assortments.

Supporting information was provided in the form of a template presenting the application of stem quality assessment in Slovakia.

2.3.1.3 Sub-working Group 3: Change Estimation

This questionnaire focussed on the approaches of NFIs in Europe to estimate changes in forest resources. Particular attention was paid to the sampling design, sample tree assessments, the use of models, the change components included tree parts, and the produced estimates. The enquiry built on the work and information collected during COST Action E43 which included country-level descriptions of increment and drain estimation from 37 countries (Tomppo et al. 2010). The

information already available was complemented by an analysis of literature and by expert opinions of the members of WG1 of COST Action Usewood (2014) to reflect the current situation of change estimation in the questionnaire. The information was collected with a view to exploring the change components considered relevant by NFIs, and to facilitate the formulation of reference definitions in order to allow for the harmonisation and common reporting of increment and drain estimates. The questionnaire consisted of three sections:

- General questions with regard to change estimation
- Increment
- Fellings and natural losses.

Supporting information was provided on:

- International definitions, including UNECE/FAO (2000), FAO (2004, 2010, 2012), FOREST EUROPE, UNECE and FAO (2011), and IPCC (2006)
- Graphical representation of change components
- Relevant information from scientific literature.

2.3.1.4 Sub-working Group 4: Other Wooded Land and Trees Outside Forest

The aim of the questionnaire was to find out how NFIs in Europe define, measure and estimate tree resources outside forest as defined by the Food and Agriculture Organization of the United Nations (FAO), i.e. the Forest Resources Assessment (FRA) categories other wooded land (OWL) and other land with tree cover (OLwTC), as well as other (single) tree resources outside forest (TOF).

The objective was to review and to define reference definitions for such tree resources outside forest which allows for the harmonisation of information and common reporting on such tree resources from European NFIs. The way of working was to partition of the TOF category in order to discuss the possibility of creating a harmonised methodology of estimating tree resources in each class. The questionnaire requested information on:

- Other wooded land
- Trees outside forest
- Other land with tree cover.

Supporting information was provided on:

- International definitions
- Differences between trees and shrubs definitions in FRA and COST E 43
- Differences between OWL in FRA and E43.

2.3.2 Country Reports

In addition to the questionnaires, the second approach used to ascertain information about resource availability took the form of country reports. The country reports aimed to collate detailed information on NFI methods from countries in a descriptive manner and complemented the information collected through questionnaires. This turned out to be particularly useful in countries where methods had changed since the COST Action E43 (2010) and in countries where change estimation procedures are under development. Through consultation within WG1, a standardised Country Report (CR) template was created to act as a guide on the content that countries should include in their national report. As such the country reports include thematic sections on the history and objectives of NFIs, sampling methods, data collection, data processing, reporting and the use of results, the classification of land and forests, wood resources and their use, and the assessment of wood resources which focussed on the topics of the four sub-groups: forest available for wood supply, wood quality, assessment of change, and other wooded land and trees outside forest.

The valuable collection of CR information for 40 countries form a significant part of this publication. Non-COST member countries were also invited to submit country reports for publication. For European countries it was possible to follow the standardised layout. However, for countries outside of Europe certain concepts, such as FAWS, may not have been adopted. Thus, the country reports for the non-European countries deviate slightly from the above layout.

2.4 COST Action Framework

2.4.1 Working Group Meetings

The work of COST Actions is organised through Working Groups (WG), that aim to perform the necessary tasks required for the Action to fulfil its objectives as defined in the Memorandum of Understanding. The Management Committee (MC) appointed WG Leaders and Vice Leaders for each WG who were responsible for coordinating and managing the activities and tasks associated with the Action objectives relevant to the specific WG.

WG members are selected from amongst MC Members, or MC Observers from Near Neighbour Countries (NNC), International Partners Countries (IPC), Specific Organisations, as well as any researchers from participating COST Member Countries.

The WG meetings provided an important opportunity for the members to meet and discuss the activities and progress towards addressing the tasks associated with the Action objectives. During COST Action Usewood four WG meetings were held, the details of which are outlined in Table 2.1.

Table 2.1 COST Action Usewood WG meetings

WG meeting	Location	Host	Date
1	Vienna, Austria	Austrian Research Centre for Forests (BFW)	10–11 March 2011
2	Copenhagen, Denmark	European Environment Agency	12–13 June 2012
3	Riga, Latvia	Latvian State Forest Research Institute	12–14 March 2013
4	Dublin, Ireland	Department of Agriculture, Food and the Marine	28–29 April 2014

2.4.2 Short Term Scientific Missions

Short Term Scientific Missions (STSM) are COST instruments for supporting individual mobility, with the aim of strengthening new or existing networks and fostering collaborations by allowing scientists to visit research institutions in other Participating COST Countries. A STSM should contribute to the scientific objectives of the COST Action, while at the same time allowing applicants to learn new techniques or gain access to specific instruments and/or methods not available in their own institutions. During the course of the COST Action Usewood, 32 individuals partook in STSM.

STSMs proved to be very useful mechanism in terms of analysing the results of the questionnaires and allowing participants to learn new techniques and to broaden their knowledge. The activities of the STSM were ultimately aimed at completing tasks associated with the Action objectives relevant to the specific WG. Within WG1 eight STSM were undertaken, the details of which are outlined in Table 2.2.

2.5 Diversity and Similarities in the Assessment of Wood Resources

The information provided through questionnaires and country reports provided the raw materials required to understand the differences between the definitions and components that make up the definitions that are applied nationally by the various NFIs. Results from the four sub-groups are presented outlining the diversity and similarities among the assessment of wood resources between countries.

Table 2.2 Overview of WG1 STSM's

STSM details	Objectives of STSM
Change estimation Birmensdorf, Switzerland 7–21 Nov 2012	The purpose of this STSM was to carry out a comparitive analysis of the change estimation techniques implemented in the Bulgarian NFI compared to those in the Swiss NFI using Bulgarian data. The STSM included the following activities: (i) A study of the methodology of the Swiss NFI and the experience of its third application (ii) Compare the estimates from the Bulgarian software to those generated using the Swiss software (iii) Undertake field work for the calculation and evaluation of dead wood, and regeneration in forest
Change estimation Birmensdorf, Switzerland 12–21 Nov 2012	The purpose of this STSM was to: (i) Assess the different methods to estimate changes in forest resources like net increment, gross increment, fellings and losses, drain etc. (ii) Assess the different definitions and/or the understanding of these change estimate components
Change estimation Birmensdorf, Switzerland 12–16 Dec 2012	The purpose of this STSM was to: (i) Review the situation of current data availability (ii) Develop a questionnaire to evaluate the practices applied by NFIs, assess the means of distribution and analysis methods for the questionnaire results (iii) Prepare the structure of a template for country reports (iv) Collate and review the relevant definitions existing at the international level
OWL & TOF Nancy France 19–30 Nov 2012	The purpose of this STSM was to: (i) Analyse the responses of the WG1 questionnaires on Other Wooded Land (OWL), Other Land with Tree Cover (OLwTC) and Trees Outside Forest (TOF) (ii) Identify the main differences and discuss ways of definitions harmonisation
OWL & TOF Nancy, France 14–25 Oct 2013	The purpose of this STSM was to: (i) complete the model of partition of the territory and to name each category (ii) formulate reference definitions for each category (iii) prepare and discuss scientific paper structure
Stem quality Wexford, Ireland 11–17 Nov 2012	The purpose of this STSM was to: (i) Overview of assessed quality parameters on stem in NFIs using questionnaires and country reports (ii) Overview of European standards relevant to the assessment of stem quality (iii) Identify relevant parameters for stem quality assessment on standing Trees
FAWS Madrid, Spain 19–29 Nov 2012	The purpose of this STSM was to: (i) Evaluate the results from the questionnaires (ii) Further, the possibility to draft the outline of a scientific publication concerning harvesting COST calculations
FAWS Madrid, Spain 21 Oct –1 Nov 2013	The purpose of this STSM was to: (i) Evaluate the new results from the questionnaires (ii) To analyse restrictions relevance in case studies
WG1 Book edition Birmensdorf, Switzerland 15–30 Aug 2014	The purpose of this STSM was the following: (i) the revision, edition and homogenization of the different CRs information for the last chapter of the book (ii) to perform a partial analysis contrasting the diversity of FAWS assessment and estimation around Europe, and (iii) participation in the Editorial Board meeting held during the last week of the STSM (from 26th to 28th August)

2.5.1 FAWS Assessment

2.5.1.1 Differences in National Definitions

The main information source for estimating the FAWS as well as its growing stock and its change at national level are NFIs. FAWS is one of the basic characteristics collected through international forest reporting. The COST Action Usewood questionnaire regarding FAWS was answered by NFI delegates from 29 European countries.

Some countries have adopted the international definition from SoEF (FOREST EUROPE, UNECE and FAO 2011) while others have developed national definitions (Table 2.3). The SoEF international definition is the following: "*Forest where any legal, economic, or specific environmental restrictions do not have a significant impact on the supply of wood. Includes: areas where, although there are no such restrictions, harvesting is not taking place, for example areas included in long-term utilisation plans or intentions*".

Following the analysis of the questionnaire, it became apparent that the term "availability" (for wood supply) of FAWS was not equally interpreted by all countries. Some considered it as potential availability (future availability), current availability or even as a period of time (such as the rotation period). Table 2.4 shows that some countries even consider both the potential and current availability in their assessments.

The national definitions of FAWS differ considerably from country to country as summarised in Table 2.5, extracted from Alberdi et al. (2016). Generally, different restrictions and thresholds are considered by the countries to determine "forest not available for wood supply" (FNAWS) (such as protected areas or slope) and therefore FAWS is estimated by exclusion. The most prevalent restrictions are legal, environmental, and economic restrictions. A specified forest area can be subject to more than one and up to a combination of all three restrictions. However, economic restrictions are only considered within a few countries.

Table 2.3 Percentage of European countries according to the adopted FAWS definition (N = 29)

Definition adopted	Percentage of countries
SoEF 2011 definition	24.2
National definition	65.5
No definition adopted (but reported in SoEF 2011)	10.3

Table 2.4 Number of European NFIs according to the time frame of FAWS definition (N = 29)

FAWS time frame	Percentage of countries
Current	69.0
Potential	48.3
Time period	6.9

Table 2.5 National definitions of FAWS (Alberdi et al. 2016)

Country	National definition
Belgium	National forest area with the exception of the forest with slope above 15 %, non-productive forest land and additionally roads, mud, moors, pools and rivers which are part of the forest
Bosnia and Herzegovina	Forests with productive character
Czech Republic	Categorisation of forest according to forest law considering its prevalent function
Estonia	All forests not strictly protected
Finland	Very similar to SoEF definition. For each specific land use category, a protection programme is defined with the 3 categories (a) fully AWS, (b) semi-AWS (c) non-AWS
France	Forest where tree felling is physically and legally possible, even if it is difficult and not economically profitable. No condition on site productivity
Germany	Restrictions on use exist if the potential uses of the timber cannot be realised. This includes restrictions on the use of timber due to legal regulations or other external reasons. The reason for such restrictions is indicated: Restrictions on use: no restriction on the use of timber; restricted forest utilisation; use of timber not authorised or not expected; approx. 1/3 of the usual harvest to be expected; approx. 2/3 of the usual harvest to be expected External reasons for the restriction on use: no external restrictions on use; nature conservation; protection forest; recreational forest; other external reasons In the case of several external reasons, the most important reason is specified Internal reasons for the restrictions on use: no internal restrictions on use; split ownership of uneconomic size (e.g. if the system of land tenure provided for the equal division of land among all qualified heirs); stand-alone location insufficient accessibility; site characteristics, wet location; low yield expectation (mean total increment <1 m^3/year/ha); areas protected at owners discretion (e.g. natural forest reserves); and other internal reasons In the case of several internal reasons, the most important reason is indicated
Greece	Productive or Industrial forests
Ireland	Describes the likely availability of the forest area in terms of wood supply in three classes: 1. Available: Forest where any legal, economic, or specific environmental restrictions do not have a significant impact on the supply of wood. Includes: Areas where, although there are no such restrictions, harvesting is not taking place, for example areas included in long-term utilisation plans or intentions 2. Unlikely: Forest where physical productivity or wood quality is too low or harvesting and transport costs are too high to warrant wood harvesting, apart from occasional cuttings for autoconsumption. Areas include: (i) Forest Type is scrub; (ii) Height growth status is stagnating; (iii) Severe water logging; (iv) Excessive slope (>30°) 3. Not available: Forest with legal restrictions or restrictions resulting from other political decisions, which totally exclude or severely limit wood supply, inter alia for reasons of environmental or biological diversity conservation, e.g. protection forest and other protected areas, such as those of special environmental, scientific, historical, cultural or spiritual interest. Areas classified as National Parks and Nature Reserves are included in this class To date no consideration has been given to economic aspects

(continued)

Table 2.5 (continued)

Country	National definition
Latvia	Forests where forest management as such or specific measures are not limited by regulations, including environmental restrictions (like buffer zones), nature conservation restrictions or regional planning (like cultural heritage) related restrictions
Lithuania	Exploitable forest with usual environmental restrictions. Includes protective forest (protective forests, forests for soil, water, human living surroundings and infrastructure protection) and commercial forest (all forests excluding strict reserves, protected and protective forests). It excludes forests with natural features, key habitats, zones surrounding nests of rare birds, other valuable cultural, historical objects and forest stands of very low productivity
Netherlands	The classifications even-aged and uneven-aged standing forest, standing forest in transition (plantation appearance to more natural forest) and clearcuts are considered as productive and are for this reason considered as FAWS If actual harvesting takes place, it does not have any consequences for the allocation to FAWS
Portugal	It comprises all the forest area, with the exception of cork and holm oak areas, in which wood harvest has strict restrictions and the "Laurisilva" forest, and conservation areas where harvesting is strictly prohibited. Additionally burnt areas and harvested areas are excluded
Romania	Forest with production functions, situated at a distance smaller than 1.2 km from a (forest) road
Serbia	The FAWS category consists of all forests which are not in first regime of protection (rare species of flora and fauna, cultural and heritage areas) and also forests which are accessible for forest mechanisation
Slovenia	Forests are divided into multipurpose forests, special purpose forests with legal restrictions which exclude or limit wood production, forests with protective functions
Spain	Forest land where legal restrictions, site conditions and specific environmental restrictions have a significant impact on the supply of wood. Legal restrictions comprise specific protected areas (National parks, nature parks, reserves and others)
Switzerland	Forest where tree felling is physically and legally possible, even if it is difficult and not economically profitable. No condition on site productivity
Turkey	Very similar to SoEF definition

2.5.1.2 Differences in Methods

FAWS area assessment is done using two main sources of information: NFI sample plots and national maps. Sometimes other sources are employed as for example forest management plans. However, the source of information depends on the restriction that is being considered (Table 2.6). Accessibility, age or diameter classes, slope and expected wood quantity are mostly estimated using NFI plot information while protected areas and ownership are mainly estimated using map information.

Table 2.6 Percentage of European NFIs according to the main sources of information by restriction attribute considered for FAWS assessment (N = 29). Derived from Alberdi et al. (2016)

Restriction attribute	NFI plot (%)	GIS/Map (%)	Others (%)
Protected areas	48.3	55.2	6.9
Protected species	37.9	31.0	3.4
Ownership	24.1	31.0	0.0
Cultural	24.1	27.6	3.4
Slope	41.4	27.6	6.9
Accessibility	41.4	24.1	0.0
Erosion	27.6	24.1	3.4
Historical	24.1	24.1	13.8
Spiritual interest	20.7	24.1	0.0
Altitude	20.7	20.7	0.0
Flooded areas	27.6	17.2	0.0
Riverbank	17.2	17.2	3.4
Age or diameter classes	31.0	13.8	3.4
Harvesting technology	13.8	10.3	3.4
Expected silvicultural treatment	13.8	3.4	0.0
Expected wood quantity	20.7	0.0	3.4
Harvest cost	0.0	0.0	0.0

It is also noteworthy that Iceland and Italy include the FAWS assessment in the field plot survey. In Germany the information about FAWS is assessed as a preliminary detail generally, but if restrictions on the use are only detected during the field assessment they must be indicated too. All other countries conduct the FAWS assignation a posteriori (e.g. through the intersection of sample plot location with thematic maps of restricted areas to identify areas that should be excluded from FAWS).

2.5.1.3 Summary of the Main Findings

The objective of reporting on the availability for wood supply is to distinguish between areas where wood could be harvested from those where it cannot (UNECE/FAO 2000). However, European NFIs have different national definitions and different ways to apply the international definitions provided by FRA 2000 (FAO 2001) and SoEF (FOREST EUROPE, UNECE and FAO 2011). Therefore, the national estimations reported cannot be easily compared and European FAWS estimates cannot be obtained as an aggregation of national estimates. The differing interpretations are a result of the lack of clarity created by the reporting bodies requesting this indicator for reporting on the sustainability of wood production without specifying the timeframe, i.e. current or potential availability of timber. Two primary divergent interpretations of FAWS were identified by analysing the NFI definitions:

- Productive forest (e.g. Bosnia Herzegovina)
- All forest with the exception of those where harvesting is strictly forbidden (e.g. Estonia).

There are other national definitions that can be considered as intermediate variation between the two primary divergent interpretations. Although in general, national definitions of FAWS are close to the international ones, the available data, estimation methods and interpretation varies between countries. However, the majority of the countries in Europe classify forest land based on legal restrictions and forest functions. This is a positive finding, as these classifications set the necessary basis for the potential harmonisation of FAWS estimation. However, as Fischer et al. (2016) suggests that the thresholds of components describing these restrictions should be flexible to represent the particularities of the forest and management systems around Europe.

2.5.2 Stem Quality Assessment

The potential of the European NFIs for harmonised reporting of stem quality and assortment structure of the European forests, including national definitions, was comprehensively described in a recent study by Bosela et al. (2015). This study was supported and is the main result of the COST Action Usewood. In the following sections, the main results of this study are briefly presented.

2.5.2.1 Differences in National Definitions

National definitions regarding stem quality assessment can be split into two main groups: (i) definition of stem quality related parameters (such as diameter threshold, the part of stem to be assessed, damage type, etc.); and (ii) definition of stem quality classes (classification system including a number of classes used and definition of thresholds for each category). While the harmonisation of definitions of common tree parameters has been a matter of recent international activities, the harmonisation of parameters related to stem quality assessment has not yet been considered. In particular, the direct assessment of stem quality or assortment classification has been poorly addressed. This is due to the fact that only several European NFIs consider stem quality assessment. From 28 countries responding to the questionnaire released during the COST Action Usewood as many as 18 (64.2 %) directly classify or assess stem quality in their NFIs but as few as 8 countries use quality classes that are assessed in the field for subsequent quantification of timber assortments (Table 2.7).

Concerning the sampling strategy, 39.3 % of countries measure and record a set of stem quality parameters for all trees registered in the sample plots, while 53.6 % of countries use only a sub-sample of trees. The Austrian NFI assesses stem quality

Table 2.7 Stem quality and assortment assessment in European NFIs (N = 28)

Level of wood quality assessment	Percentage of countries
Assessment of some parameters related to stem quality	100
Stem quality assessment	64.2
Estimation of assortments	39.3
Visually assessed quality classes used to generate assortments	28.6

on sample trees with a dbh over 20.4 cm, while Bosnia and Herzegovina uses a minimum dbh of 5 cm. Czech Republic assesses quality parameters for all trees with dbh over 7 cm on the plot with a radius of 5 m and trees with dbh over 27 cm on the plot with a radius of 12.62 m (these thresholds are at the same time the registration thresholds for tree recording). The same strategy is applied in the Slovakian NFI, but the thresholds are different (trees with dbh in the range of 7–12 cm are sampled in the plot with the radius of 3 m while trees with dbh over 12 cm are recorded on the plot with a radius of 12.62 m). The Danish NFI applies random selection proportional to size, while Estonia generally selects every 3rd tree for this purpose.

Differences between European NFIs were also found in the portion of the tree that is used to assess stem quality (Table 2.8). As few as 6 NFIs (31.6 %), from the total of 18 that apply some stem quality assessment in their NFI, assess the stem quality on the whole stem of the tree (from the base to the tree top). Other NFIs do the assessment using a portion of the tree stem specified by height, top diameter or relative height.

2.5.2.2 Differences in Methods

Methods involve the application of different stem quality and assortment classification systems in European NFIs. Interestingly, eighteen countries distributed over Europe apply some kind of stem quality classification. However, a different number of classes are used among the countries (Table 2.9). In addition, six NFIs assess potential stem quality regardless the current tree size (Table 2.10).

Table 2.8 Number of European NFIs applying stem quality assessment for different portions of the tree stem (N = 18)

Portion of the stem to be assessed	Percentage of countries
Whole tree	33.3
Specific height	33.3
Specific top diameter	22.2
lower 1/3 of stem	11.1
Not specified	5.5

Table 2.9 Number of European NFIs using different number of stem quality classes (N = 18)

Number of stem quality classes	Percentage of countries
2	5.6
3	27.8
4	44.4
5	5.6
6	5.6
9	5.6
n.a.	5.6

Table 2.10 Number of European NFIs using different assessment time-frame (N = 18)

Reference point	Percentage of countries
Current	100
Potential	33.3

The largest number of classes, nine, is used in Finland, while only two quality classes are used in Lithuania. Moreover, differences are also in the classes definitions. A special case is the Swedish NFI, where estimates for timber quality or assortments are not directly from NFI data, but these data are used as an input to the "RegWise" forecasting system, in which projections for distributions of assortments are made for timber and pulp wood (Wikström et al. 2011). According to personal communication with Sweedish NFI staff, the question of stem quality and assortment assessment has been discussed since the first NFI (1923), but no system has fulfilled national requirements. Far fewer NFIs use some kind of assortment generation and quantification.

Concerning land use type, knowledge on stem quality or assortment structure is mostly important for the forest domain. However, as the importance of the timber resources located outside the forest domain has been increasing, the NFIs were also asked to specify on which land use types they collect data for stem quality assessment. Less than 40 % of NFIs record parameters for other wooded land, and very few countries have some information for other domains such as trees outside forest, other land with tree cover.

2.5.2.3 Summary of the Main Findings

The questionnaire on stem quality assessment shows that very few NFIs assess a number of timber quality parameters that could be used for developing harmonised timber quality classification (Table 2.11). Less than 50 % of NFIs assess parameters such as stem cavity, curvature, straightness, branching, branch angle or upper diameter. On the other hand, almost 80 % of NFIs assess occurrence of stem damage and more than 60 % even recognise sources of damage (abiotic, biotic, forking, etc.), which is a very promising base for future harmonisation. Usually,

Table 2.11 Proportion of European NFIs assessing individual stem quality related parameters

Stem quality parameter	Recorded in the field (N = 28) (%)	Used to stem quality assessment (N = 18) (%)	Used to assortments generation (N = 11) (%)
Tree status (dead, alive)	100	94	91
Tree dbh	100	100	100
Tree height	100	78	91
Stem damage source	64	72	45
Abiotic damage	64	72	36
Biotic damage	61	72	36
Stem damage	79	89	73
Forking	64	72	64
Tree break	75	83	73
Curvature	43	67	73
Splitting due to frost	61	67	64
Splitting due to lightening	50	67	64
Rottening	57	72	73
Stem cavity	46	61	55
Presence of fruiting body	36	56	55
Staining of discolouration on bark	11	33	18
Branching	36	56	45
Size of branches	29	50	45
Branching density	25	61	45
Branch angle	7	11	9
Base of crown	64	50	45
Base of living crown	68	56	45
Base of dead crown	11	17	18
Straightness	43	67	73
Crown projection or diameter	14	11	27
Artificial removal of branches	29	22	9
Upper diameter	25	22	55
Bark thickness	18	22	36
Stem taper	11	33	36
Other	21	33	36

stem quality-related parameters are assessed on all sample trees registered in the plot using different national thresholds for dbh ranging from 0 to 12 cm (Tomter et al. 2012). The NFIs that apply direct stem quality assessment in the field often apply different dbh thresholds (larger dbh) than that used for sample trees selection. For example, Austria uses a dbh threshold of 20.5 cm for stem quality assessment, but 5 cm for sample tree selection to assess common tree parameters such as height, dbh and other.

Only a few NFIs estimate the type of assortments present and the approaches employed differ considerably in the methodology.

The study showed large differences in stem quality assessment among European NFIs. Furthermore, very few countries go beyond the stem quality assessment to estimate timber assortments either by direct assessment in the field or by further application of a model developed in the country.

The inquiry showed that the current systems are not capable of reporting the stem quality of European forests in a harmonised manner at this stage. However, the quantity of wood resources alone will not be sufficient to satisfy policy needs and progressively steps should be taken to harmonise stem quality estimations. Considerable efforts will be required before the harmonised stem quality assessment or assortments estimation can be prepared.

2.5.3 Change Estimation

2.5.3.1 Differences in National Definitions

In terms of NFIs the estimation of change basically includes estimates of net changes, gains and losses. Changes in forest area, increment and drain are the main change estimates reported by NFIs. A change in growing stock is not necessarily identical to the balance of increment and drain as the first is a result of successional application of the growing stock definition while the latter are normally defined based on individual change components like survivor, ingrowth, cut and mortality trees. Estimates of change always refer to a specified time span between consecutive surveys at the time of t1 and t2.

Forest Area Change

The estimation of forest area changes usually involves the determination of afforestation and deforestation areas between the previous and present survey. The net forest area change can be obtained either as difference between the afforestation area and the deforestation area, or by subtraction of the forest areas at t1 and t2. Definitional differences between countries regarding forest area change are due to the applied forest definitions and the associated criteria and related quantitative thresholds and specifications (Vidal et al. 2008; Tomppo et al. 2010). Usually the

differently defined criteria in forest definitions are crown cover, minimum area, minimum width, and land use.

Increment and Drain

The change components are taken into account differently in the definitions of NFIs to estimate the increment and drain between the field plot assessments at t1 and t2.

Permanent plot sampling

The estimation of increment and drain relies on the distinction of sample trees into change components. Beers (1962) generally distinguishes between survivor growth, mortality, cut and ingrowth for fixed area plots. For horizontal point sampling (Angle Count Sampling, ACS) the additional components of ongrowth and nongrowth trees (e.g. Martin 1982; Van Deusen et al. 1986; Roesch et al. 1989; Eriksson 1995) have to be taken into consideration. Similarly, this is also the case for concentric circular plots (CCS). The components are defined by three criteria at the time points t1 and t2, the status of the tree (living or dead, present or cut), whether the minimum dbh is reached or not, and whether a tree is in the sample or out of the sample. Lying trees are handled like standing trees, while virtually the axis of the stem is repositioned vertical. Table 2.12 shows these groups of trees according to Martin (1982).

On permanent plots the sample trees are measured with calipers, diameter tapes and hypsometer for t1 and t2. The increment can thus be obtained as difference between the two measurements. Felled trees and mortality trees can be identified by comparing the sample trees present on the plots at t1 and t2.

Table 2.12 Components of growth as defined by Martin (1982) permanent plot sampling

Growth component	Definition	Relevant for
Survivor trees	Trees which are above the minimum dbh and in the sample at both measurements t_1 and t_2	All sampling schemes
Ingrowth trees	Trees which are below the minimum dbh and in the sample at the first measurement t_1 but exceed the minimum dbh at the second measurement t_2	All sampling schemes
Ongrowth trees	Trees which are below the minimum dbh and out of the sample at the first measurement t_1 but are above the minimum dbh and in the sample at the second measurement t_2	ACS, CCS
Nongrowth trees	Trees which are above the minimum dbh but out of the sample at the first measurement t_1 but are in the sample at the second measurement t_2	ACS, CCS
Cut trees	Trees which are above the minimum dbh and in the sample at the first measurement t_1 but are cut prior to the second measurement t_2	All sampling schemes
Mortality trees	Trees which are above the minimum dbh and in the sample at the first measurement t_1 but die prior to the second measurement t_2	All sampling schemes

Temporary plot sampling

Fixed area plot sampling, CCS and ACS can be applied in temporary plot sampling too. Therefore, the above given growth components play some role also in temporary plot assessments but their status is known for t2 only. The status at t1 needs to be reconstructed to allow for a classification into the change components. For increment estimation on temporary plots an increment borer and a device for year ring measurement is commonly applied to determine the dbh 5 or 10 years before. In some NFIs also the height increment is assessed visually to obtain the tree height at t1. The assessment of dead and cut trees on temporary plots is afflicted with large uncertainties, because of the difficulties in identifying the time of felling and mortality. For removed trees models based on stump measurements can be applied to derive estimates for t1.

2.5.3.2 Differences in Methods

As the estimation of change involves many methodological aspects also the differences in applied approaches are manifold.

Forest Area Change

There is an increasing trend to develop multisource European NFIs through the integration of data from additional digital sources like remote sensing material, land-use maps, and other cartographically mapped information. The estimation of afforestation and deforestation areas is either accomplished by terrestrial sampling alone or supported by remote sensing. Usually a first-phase land cover/land use classification is conducted to identify plots that are clearly forest and non-forest, but also check that may be forest. Forest and check plots are visited and verified in the field. Aerial photos are predominately used for the first-phase land classification of plots.

Increment and Drain

Three main forest inventory methods can be distinguished for increment and drain estimation, permanent plot designs, temporary plot designs, and the aggregation of data from stand-wise inventories. The use of permanent and/or temporary sample plots is a basic difference as it determines the feasibility of NFIs regarding change estimation (Kuliešis et al. 2016) and furthermore also the applicable measurement instruments, assessment methods and estimation procedures.

Apart from the differences between permanent and temporary plot designs, the distinguishable change components depend on the sample tree selection methods which are either angle-count sampling, concentric circles, or fixed-area plots in European NFIs (Table 2.13).

Table 2.13 Sampling methods applied by European NFIs (N = 17)

Sample tree selection	Permanency of sample grid (percentage of countries)		
	Permanent plots	Temporary plots	Combination
Angle count sampling	12	0	6
Concentric circles	82	12	35
Fixed area plots	6	6	12

Several of the NFIs using permanent plots have actually recently established a permanent sampling system having up to now completed only one sample-based NFI. These NFIs also rely on increment cores and height increments assessed on whorls as long as only one field assessment at t_1 is completed on the permanently established plots. Alternatively, in these countries increment estimates can be obtained by applying increment models, and calculations based on forest parameters such as species composition, growing stock, age, site productivity, or assumptions on increment percentages (default values). Many of the countries having recently established sample-based NFIs permanent sampling system run also stand-wise inventories at regular time intervals and offer an additional information source on country-level increments and drain. However, data obtained from stand-level inventories, especially those based on ocular estimates, are characterised by frequent systematic deviations (Kuliešis et al. 2016). Gross increment, including its components, can only be estimated in an indirect way and is of low reliability.

Apart from the basic difference between permanent and temporary plot designs, several other aspects related to methods are relevant for increment and drain estimation and their harmonisation. These include; sampling grid, sample tree selection methods and sub-sampling, dbh thresholds, the kind of used volume models and tree parts included in estimates. All of these may to some extent influence the national increment estimates.

2.5.3.3 Summary of the Main Findings

The enquiry on the sampling systems of European NFIs revealed temporary or permanent plots as basic difference regarding change estimation, because it determines identification of change components, the assessment methods, measurement instruments and estimation procedures. Definitions of increment and drain are formulated on the basis of change components as given by Martin (1982) which was further enhanced by Eriksson (1995). Changes in forest area involve the respective forest definition applied at national level, but are harder to assess from NFIs with only permanent plots. Ancillary information from Remote Sensing (RS) is required in a first phase for distinguishing between those areas which are clearly forest, non-forest and check plots. Forest and check plots are visited in second phase in the field for verification purposes. NFIs that do not conduct a first

RS phase assessment have to visit all plots to fully capture afforestation and deforestation over time.

NFIs based on temporary plots are capable of supplying reliable data with known accuracy on growing stock and gross annual increment as well. Nevertheless, data on the various increment components, fellings and dead trees, derived from temporary plots normally have lower accuracy. This lower accuracy is caused by a lack of feasibility to assess the time of felling or death of trees, using one single measurement of the sample plot only.

A combined use of permanent and temporary plots was introduced by the NFIs of Sweden and Norway in the eighties and later on followed by Finland and the Baltic countries. Also NFIs that are actually based on permanent plots sometimes include a sub-grid of temporary plots as part of their quality assurance purposes. If increment estimation is based on permanent and temporary plot data in order to take advantage of the totl number of plots, estimators that combine increments from re-measurements and increment cores are required to obtain overall increment estimates which is challenging. Initiated by Sweden in 1983, a new NFI method combining the use of both permanent and temporary plots in the same sampling design was introduced, with a view to estimating area change dynamics (particularly for area increase) as well as estimation of volume change at tree level. This system capitalises on the advantages of the permanent and temporary plots. Nevertheless, finding estimators to take advantage of the total number of plots in adding permanent and temporary ones is challenging and complicated. Countries using NFIs with permanent plots, can be divided into 3 groups: (1) countries that have at least two and more completed re-measurements; (2) countries having at least one repeated measurement; and (3) countries with ongoing establishment of a sample-based NFI or ongoing first re-measurement of permanent plots. Countries of the third group will have considerably improved information following re-measurement of the first cycle plots. On permanent plots the definition of increment and drain relies on the distinction and grouping of sample trees into change components like survivor, ingrowth, cut and mortality trees. Depending on the applied sample tree selection method the distinguishable change components vary.

Stand-level inventories are still in place in several countries but complemented or replaced by sample-based NFIs. The compilation of national inventory results by aggregating stand level data for all forests has survived under conditions of centrally planned economy (Brukas et al. 2002). Under other circumstances of forest ownership, it is problematic to ascertain the regularity and coverage of such inventories.

The increment and drain definitions of European NFIs reveal two basic strategies, either to produce conservative estimates on the "safe side", or to cover all possible growth components. About 40 % of the NFIs apply definitions that yield conservative estimates and usually include only survivors and ingrowth trees in the estimation, whereas 60 % of NFIs estimate according to definitions that are more encompassing and take the increment of other components like cut and mortality trees, ongrowth trees, non-growth trees into account. The number of ingrowth, cut

and mortality trees and their proportion related to the survivor trees increases as the time span between t1 and t2 increases, thus also the need for their inclusion in increment estimation becomes more relevant. A crucial criterion in definitions is the dbh-threshold since it specifies the part of the population that is included in the estimation of increment and drain. In European NFIs the minimum dbh ranges from 0 cm up to 12.0 cm. Based on the distinguished change components NFIs produce estimates for gross increment, net increment, and drain which comprises fellings and natural losses. While the understanding of gross increment is comparable, the definition of natural losses varies among NFIs and is in the range of international definitions with "trees dying naturally from competition" IPCC (2006) to "mortality from causes other than cutting by man" UNECE/FAO (2000).

The recent expansion of NFIs based on sampling methods opens new opportunities for European forestry and forest monitoring by facilitating efficient control of wood flow from forests, silviculture measures, the attained level of forest productivity and biodiversity, carbon storage in forest ecosystems, and the sustainability of forest management in general.

2.5.4 Other Wooded Land and Trees Outside Forest

2.5.4.1 Differences in National Definitions

NFIs are mainly focused on estimation of tree resources in forests. Nevertheless, due to recent political commitments at international and European level, it is more and more important to have an insight into tree resources coming from areas other than forests.

The first important area to investigate is "other wooded land" (OWL), when combined with forest is what the FAO refer to as "wooded lands". The rest of this wooded land category is called "Other Land" (OL). A further step of investigation was completed by the FAO and national correspondents to evaluate the land uses with tree cover (De Foresta et al. 2013). The FAO study focused first on "Other land with Tree Cover" (OLwTC) which has the same definition as forest except for the land use, because OLwTC contains a lot of tree resources where the main purpose of these areas is not the harvest of this tree resource. To go a step further FAO proposed the concept of "Trees outside Forest" (TOF) in order to classify OL in 2 parts (De Foresta et al. 2013). The FAO specified the following definitions:

Other land with TOF: "Land classified as Other Land—i.e. not classified as Forest nor Other Wooded Land-, spanning more than 0.05 ha with trees higher than 5 m and a canopy cover above 5 %, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 %. It includes land that is predominantly under agricultural or urban use. It also includes some land that is not predominantly under agricultural or urban use".

And **Other land with no TOF**: "Land classified as Other Land, with no tree and/or no shrub cover or with trees or shrubs but with an area is <0.05 ha, canopy cover <5 % if trees are present, or <10 % if combined trees, bushes and shrubs, or for linear structures a width <3 m or length <25 m".

This classification is a necessary step to investigate tree resources outside the forest. OLwTC is a subset of OLwTOF. Nevertheless, it apparent that the term TOF includes trees outside the wooded land instead of outside the forest and that the classification contains some imperfections because OL with no TOF includes large areas with scattered trees or shrubs and so could contain trees.

Concerning OWL, the situation is diverse from one country to another one concerning the attributes that describe OWL (Vidal et al. 2016). Despite the use of different definitions, they generally have the same structure, whereby a list of quantitative variables (Fig. 2.1) and associated threshold values are applied. Table 2.14 gives an overview of OWL definitions applied among the 21 countries that answered the questionnaire.

As described above the FAO defined "trees outside forest" (but this concept should in fact be called trees outside wooded land) to characterise the 2 subsets of OL. Within the OLwTOF category the FAO gives a priority to OLwTC which fulfils the same definition as forest, except with reference to the land use. In line with these FAO definitions our questionnaire focused on these 3 definitions OWL, OLwTC and TOF to assess how close the national definitions are to the international ones (Table 2.15).

Among the 24 responding countries to this part of the questionnaire, 83.3 % have a definition of OWL. Over half (54.2 %) of the countries adopted the definition of FRA or COST Action E43 (Tomppo et al. 2010). It is interesting to notice that 62.5 % of countries are reporting OWL according to FRA definition even if two of them don't have a definition in line with the FRA definition. Similarly for

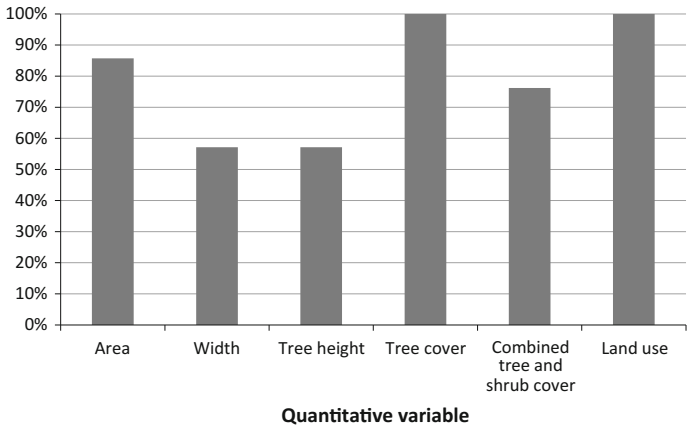

Fig. 2.1 Proportion of NFIs using quantitative variables to define OWL (N = 21)

Table 2.14 National OWL thresholds applied (N = 21)

Country	Minimum Area (>ha)[a]	Minimum width (>m)	Land use[b]	Minimum tree cover (%)	Minimum combined tree and shrub cover (>%)	Tree height (≥m)
Austria	0.05	10	1	0–9	30	0
Bosnia and Herzegovina		–	1	–	20	–
Belgium	0.1	10	1	5–10	–	–
Switzerland	0.5	25	1	20	20	3
Check Republic	0.5	20	1	5–10	10	5
Estonia	0.5	0	1	5–10	10	–
Greece	–	–	1	5–10	10	–
Spain	0.5	–	1	10	–	–
Finland	0.5	20	1	5–10	10	5
France	0.5	20	1	–	25	0
Hungary	0.5	20	1	5–10	10	5
Ireland	0.1	–	1	20	–	–
Iceland	0.5	20	1	–	10	0
Italy	0.5	20	1	5–10	10	5
Lithuania	0.1	10	1	n.r.	30	n.r.
Latvia	0.1	20	1	20	–	5
Norway	0.1	4	1	5–10	10	5
Portugal	0.5	20	1	5–10	–	5
Romania	0.5	20	1	5–10	10	5
Sweden	0.5	0	1	5–10	10	5
Slovenia	0.1	–	1	75	75	5

[a]The character "–" means variable not considered in the country definition
[b]The number "1" in the Land Use column means that the country has the land use criteria "predominantly not agricultural or urban land use"

TOF only 54.2 % countries have a definition and 66 % are collecting information on TOF and reporting TOF data to FRA.

Since TOF is defined for categories that are neither forest nor OWL, it can be assumed that countries with a forest and OWL definition have an implicit definition for the remaining category OL which contains all the TOF. Therefore 54.2 % of countries have a TOF definition in line with the FRA or COST E-43 definition. In total, 54.2 % countries apply some kind of definition for TOF and 66.6 % are at least partly assessing TOF. Seven countries (30 %) apply the FRA definitions of forest and OWL and also perform TOF assessment. Apart from Iceland, all land with TOF inventories (including OLwTC) are completed using the regular NFI sampling scheme.

Table 2.15 Summary of results from COST Action Usewood questionnaires about OWL, OLwTC and TOF (N = 24)

Wood Resources	Conclusions from questionnaires	Percentage of countries
OWL	NFIs with OWL definitions	83.3
	Of which according to FRA or COST E43 definitions	54.2
	NFIs reporting on OWL according to FRA definitions	62.5
OLwTC	NFIs applying a definition of OLwTC	45.8
	Of which according to FRA	33.3
	NFIs reporting on OLwTC according to FRA definitions	41.7
TOF	NFI's applying a definition for TOF	54.2
	Of which only for OLwTC	12.5
	NFI's collecting information on TOF	66.7
	Of which on TOF but not on OLwTC	16.7
	Of which only for OLwTC	8.3

2.5.4.2 Differences in Methods

OWL is normally assessed using the NFI forest sampling design, which generally uses 2 phase sampling, the first one using remote sensing and the second ones by field survey. The sampling effort is generally less onerous for OWL particularly for field survey due to reduced number of measurements required and the lower precision levels required for these areas and resources. Regarding the methodology for OWL assessment, it was concluded that 90 % of the countries are assessing OWL using field measurements while 65 % use remote sensing techniques. The use of aerial photos is the most common method followed by satellite imagery. Only a few countries (5 %) are using airborne LIDAR at the moment.

The techniques used for assessing TOF are less harmonised. Table 2.16 shows the methodologies used for collecting information on TOF by different countries that have some form of TOF assessment and in which the information is available. Nearly one-third (31.25 %) of the countries rely solely on remote sensing and 37.5 % solely on terrestrial methods, while 31.25 % use a combination of both. All countries making use of remote sensing techniques used aerial photo interpretation.

Table 2.16 Methods to assess TOF in European countries (N = 16)

Countries	Assessment method	Percentage of countries
Austria, Czech Republic, Ireland, Italy, Switzerland	Remote sensing	31.25
Bulgaria, Estonia, Finland, Latvia, Lithuania, Sweden	Terrestrial	37.50
France, Iceland, Norway, Romania, Slovenia	Combined	31.25

2.5.4.3 Summary of the Main Findings

The aim of the sub-working group was to build a reference definition for OWL and TOF categories. The analysis of the criteria and thresholds described above provided a framework to decide which criteria should be included in a common reference definition.

The main variables commonly used from the questionnaire for further analyses were: (i) size threshold (ii) crown cover threshold (iii) land use.

An area size threshold is applied by 85.7 % of the countries participating. Two thirds employ a 0.5 ha threshold value equivalent to the FRA 2015 (2012) definition. The exceptions to area size 0.5 ha are all smaller areas. Since a majority has adopted 0.5 ha threshold, it would be unwise to propose a change.

An area width threshold is applied by 57.1 % of the countries that responded, of which 75 % apply the minimum width of 20 m to distinguish between Other Wooded Land and Other Land categories. Since three quarters of the countries apply this threshold, it will be retained.

Tree height is adopted by 57.1 % countries, which is low considering the importance of this variable in defining forests. This is problematic since tree height is an essential variable not just classifying OWL but also forest. Eleven countries have the 5 m threshold and Switzerland has a minimum tree height of 3 m. The results demonstrated that harmonisation is essential but will be difficult to achieve.

The tree crown cover thresholds used are between 5 and 10 %. Seventeen countries (81 %) apply a "tree crown cover threshold" of which 12 are as defined by FAO, the others having slightly different thresholds (Table 2.15).

Combined tree and/or shrub crown cover is used by over three-quarters (76.2 %) of countries. The threshold "more than 10 %" used in international definitions (COST Action E43 and FAO) is adopted by over half (56.3 %) of the 16 countries.

Land use is the social and economic purpose for which land is managed (e.g. grazing, timber extraction, conservation) (IPCC 2006). Land use is widely recognised by all of the 21 countries as a main criterion to distinguish between the different categories including OWL.

2.6 Conclusion

In COST Action Usewood, the way of working established during COST E43 (Vidal et al. 2008; Gschwantner et al. 2009) proved to be a successful framework for the collection of information on the current status of wood resource assessment in European NFIs. The information provided by the questionnaires and country reports provided the raw materials required to understand the differences between the definitions and components that make up the definitions that are applied nationally by the various NFIs. This level of information is essential to inform

discussions on the choice of core variables and associated thresholds necessary to build robust reference definitions. It is also essential to highlight the lack of comparability between data in international reporting.

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