REPUBLIC OF BULGARIA

MINISTRY OF ENVIRONMENT AND WATER

National Forestry Accounting Plan of Bulgaria, including Forest Reference Levels for the period 2021-2025

Photo by Markus Spiske

SOFIA

31/12/2018

Authors:

Lora Stoeva – Forest Research Institute - BAS

Ivailo Markoff – Forest Research Institute - BAS

Miglena Zhiyanski – Forest Research Institute - BAS

Contents

Figures:

Tables:

Glossary terms

Name	Description	Reference
Accounting	Reporting on the impact of greenhouse gas emissions and sinks over a given accounting period according to certain rules. The impact is accounted for by comparing the actual carbon emissions and sinks of carbon for a given category during the accounting period with the opposite value of emissions and sinks of carbon, calculated in accordance with approved rules for accounting. Accounting rules for LULUCF should reflect the efforts made in the agricultural and forestry sectors to enhance the contribution of land-use change to reducing emissions. In the context of this plan, the reported period is for the years 2021-2025 and 2026-2030, and the accounting rules provide for the use of reference quantities to exclude the impact of natural and forest-specific dynamic characteristics associated with forest age, as well as past and present management practices that differ significantly between Member States.	
Afforested land	According to art.2(1) means *land use reported as cropland, grassland, wetlands, settlements or other land, converted to forest land*. It should be noted that the meaning and definition of "afforested area" in the context of Regulation 841/2018 differs from the definition of "afforestation" in the 2006 Guidance of the Intergovernmental Panel on Climate Change (IPCC 2006).	*Art. 2 (1), Regulation 841/2018*
Background level	In the context of Article 10 of Regulation 841/2018, the background level means the average emissions caused by natural disturbances in a period 2001—2020, excluding statistical outliers.	
Canopy of the stand	The degree of closeness of tree crowns. The determination shall be made by determining the area of the horizontal projection of the tree crowns as a percentage of the total horizontal projection of the area of the plantation. It is expressed in tenth parts of the unit.	
Carbon pool	*Means the whole or part of a biogeochemical feature or system within the territory of a Member State and within which carbon, any precursor to a greenhouse gas containing carbon, or any greenhouse gas containing carbon is stored.*	*Art. 3 (1), Regulation 841/2018*
Carbon stock	*Means the mass of carbon stored in a carbon pool*	*Art. 3 (1), Regulation 841/2018*

Dead wood	Aggregate of non-living tree biomass in the stands, excluding the forest litter, which accumulates as result of natural drop off and decay or residues by forest management activities. The deadwood is composed by dead standing timber (withered standing trees and broken stems as result of natural drop off), dead fallen timber (fallen and eradicated trees, stems and branched result of natural processes and harvesting activities) and stumps (parts from the stem base, after tree cutting).	
Deforested land	Land use reported as forest land converted to cropland, grassland, wetlands, settlements or other land.	
Felling intensity	The ratio of the volume of the foreseen timber cutting to the total volume of the stand, expressed as a percentage.	
Forest	*Means an area of land defined by the minimum values for area size, tree crown cover or an equivalent stocking level, and potential tree height at maturity at the place of growth of the trees as specified for each Member State in Annex II. It includes areas with trees, including groups of growing, young, natural trees, or plantations that have yet to reach the minimum values for tree crown cover or an equivalent stocking level or minimum tree height as specified in Annex II, including any area that normally forms part of the forest area but on which there are temporarily no trees as a result of human intervention, such as harvesting, or as a result of natural causes, but which area can be expected to revert to forest*	*Art. 3 (1), Regulation 841/2018*
Forest litter	A set of fallen leaves, twigs and small branches, seeds, bark, decayed grasses and animal remains with different degree of decomposition.	
Forest management	*Means any activity resulting from a system of practices applicable to a forest that influences the ecological, economic or social functions of the forest*	*Art.2 (1) of Decision № 529/2013/EC*
Forest management practice(s)	Refers to a set of management activities being carried out at different phases of the stand development. FMP can thus be seen as a set of activities carried out and aimed at fulfilling specific functions assigned to a forest (production, protection, etc.), including, e.g., the regeneration, intensity of thinning, type of regeneration felling etc. In the context of this document, also “no management” is considered as a possible FMP option.	
Forest management system	Planned long-term program of forestry activities throughout the life of the stand.	

Forest reference level	*Means an estimate, expressed in tonnes of CO_2 equivalent per year, of the average annual net emissions or removals resulting from managed forest land within the territory of a Member State in the periods from 2021 to 2025 and from 2026 to 2030, based on the criteria set out in this Regulation 841/2018.* Forest reference levels take account of the future impact of dynamic age-related forest characteristics in order not to unduly constrain forest management intensity as a core element of sustainable forest management practice, with the aim of maintaining or strengthening long-term carbon sinks. From the point of view of accounting the reference levels are so called the opposite value of emissions and / or sinks that would be emitted as a result of forest management activities in the absence of future changes to the management practices that were applied during the reference period (2000-2009).	*Art. 3(1), Regulation 841/2018*
Half-life value	*Means the number of years it takes for the quantity of carbon stored in a harvested wood products category to decrease to one half of its initial value*. Default half-life values shall be as follows: paper - 2 years, wood panels - 25 years, sawn wood - 35 years.	*Annex V, Regulation 841/2018*
Harvested wood product	*Means any product of wood harvesting that has left a site where wood is harvested.*	*Art. 3 (1), Regulation 841/2018*
Instantaneous oxidation	*Means an accounting method that assumes that the release into the atmosphere of the entire quantity of carbon stored in harvested wood products occurs at the time of harvest.*	*Art. 3 (1), Regulation 841/2018*
Managed cropland	*Land use reported as:* *— cropland remaining cropland,* *— grassland, wetland, settlement or other land, converted to cropland, or* *— cropland converted to wetland, settlement or other land.*	*Art. 2 (1), Regulation 841/2018*
Managed forest land	*Land use reported as forest land remaining forest land*	*Art. 2 (2 Regulation 841/2018)*
Managed grassland	*Land use reported as:* *— grassland remaining grassland,* *— cropland, wetland, settlement or other land, converted to grassland, or* *— grassland converted to wetland, settlement or other land;.*	*Art. 2 (1), Regulation 841/2018*
Mature stand	Stands reaching the age of felling (rotation period) according to the objectives.	

Mixed stands	Stands, where more than one tree species occurs with a stock over 10% of the total stock of the whole stand.	
Natural disturbances	*Mean any non-anthropogenic events or circumstances that cause significant emissions in forests and the occurrence of which is beyond the control of the relevant Member State, and the effects of which the Member State is objectively unable to significantly limit, even after their occurrence, on emissions*	*Art. 3 (1), Regulation 841/2018*
Pure stands	Stands, where there are trees of only one species or trees of other species have a stock of less than 10% of the total stock of the whole stand.	
Quantitative maturity age	The age at which the stand produces a maximum quantity of wood.	
Reference period	The period from 2000 to 2009.	
Regeneration period	The period from starting of the regeneration felling to the final felling of the mature growing stock. It is defined in years.	
Rotation	The period between two consecutive cuts of all trees in a coppice stand.	
Salvage logging	*Means any harvesting activity consisting of recovering timber that can still be used, at least in part, from lands affected by natural disturbances*	*Art.2 (1) of Decision № 529/2013/EC*
Sink	*Means any process, activity or mechanism that removes a greenhouse gas, an aerosol, or a precursor to a greenhouse gas from the atmosphere.*	*Art. 3 (1), Regulation 841/2018*
Source	*Means any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor to a greenhouse gas into the atmosphere.*	*Art. 3 (1), Regulation 841/2018*
Stand	Part of the forest which is homogenous in all forestry parameters – composition, form, origin, age, canopy density, yield class, etc.	
State of the forest	Set of data and information that describe the forest, such as total area of Managed Forest Land; as well as stratum-specific variables, e.g. area, increment, biomass, age-related information.	
Strata	In the context of this work, stratum (in plural: strata) is a part of forest, homogeneous for all the criteria applied to the stratification process. For the chosen stratification method applied in Bulgaria, the criteria are - forest type, management system, tree species. Each stratum differs from other strata by at least one of the criteria of stratification.	
Sustainable forest management	Rational, ecological and responsible management and use of forests and forest lands in a way and to a degree that maintains their biodiversity, productivity, resilience, vitality and potential to fulfil, now and in the future, relevant environmental, social-economical functions at local, national and global levels, and which does not cause damage to other ecosystems.	*Ministerial Conference on the Protection of Forests in Europe, 1993*

Abbreviations

CMs	Council of Ministers
EC	European Commission
EC	European Commission
ECE/FAO/UN	Economic Commission for Europe / Food and Agriculture Organization / United Nations
EEA	Energy Efficiency Act
EFA	Executive Forestry Agency
EU	European Union
EU	European Union
EUFS	EU Forest Strategy
ExEA	Executive Environment Agency
FA	Forestry Act
FI under BAS	Forest Research Institute at the Bulgarian Academy of Sciences
FMP	Forest management plan
FMPs	Forest Management Practices
FRL	Forest Reference Level
FSC	Forest Stewardship Council
FU	Forestry University
HGPA	Hunting and Game Protection Act
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LULUCF	Land Use, Land Use Change and Forestry
MAFF	Ministry of Agriculture, Food and Forestry
ME	Ministry of Economy

MoE	Ministry of Energy
MoE	Ministry of Environment and Water
MF	Ministry of Finance
MoI	Ministry of the Interior
MRDPW	Ministry of Regional Development and Public Works
MRD	Ministry of Regional Development
NAPCC	National Action Plan on Climate Change
NDCs	Nationally Determined Contributions
NDP BG 2020	National Development Programme: Bulgaria 2020
NFSP	National Forest Strategy and Policy
NPA	Nature Protection Act
NPD	Nature park directorates
NSDFS	National Strategy for Development of the Forest Sector in the Republic Bulgaria
NSI	National statistical institute
NSSDFS	National Strategy for the Sustainable Development of the Forest Sector
PA	Paris Agreement
RDE	Research, Development and Extension
REA	Renewable Energy Act
RFBs	Regional forest boards
RFDs	Regional forest directorates
RP	Reference period (2000-2009)
SFC	State forest companies
SFE	State forest enterprises
SFU	State forest unit

SHR	State game breading unit
SHR	State hunting reserve
SPDFS	Strategic plan for the development of the forest sector
UNFCCC	United Nations Framework Convention on Climate Change
UNO	United Nations Organisation
WAR, RF	Wooded area report

Chapter I General Introduction

General description of the forest reference levels of Bulgaria

Table 1 Forest Reference Level (FRL) of Bulgaria for the period2021-2025

Forest reference level for the period 2021 - 2025	
A	B
-5905.70	-5589.17

Where:

A – including the carbon pool of HWP when applying the first order decay function and predefined half-lives values
B – assuming instantaneous oxidation of the HWP pool

The reported values are averages of the projected emissions by sources and removals by sinks from Managed Forest Lands (MFL) for the period 2021-2025. The projections are done based on an extrapolation of forest management practices (FMPs) and intensity from a reference period (RP) (2000-2009). The projected forest reference levels (FRL) include the following pools as listed in the table below.

Table 2 Carbon pools included in FRL estimates

Carbon pools	Included in FRL	Reported under GHGI
Biomass (above- and belowground)	Yes	Yes
Dead wood	Yes	Yes*
HWP	Yes	Yes*
Soil	No	Yes*
Litter	No	Yes*

* The carbon stock changes (CSC) in these pools where reported under GHG inventory (GHGI) 2017 and 2018 by extrapolating the CBM results from JRC's study (Pilli et al. 2016). The direct use of the results from these study under the GHGI leads to a lack of comparability of approaches and methods of calculating carbon stock changes in biomass (national estimates) and the other pools - soil and dead organic matter - dead wood and litter (modelled results from CBM). Therefore, we believe that the use of these results in the future GHGI Submissions cannot continue. Given the fact that we do not have the resources and the capacity to provide country specific estimates concerning these pools, only dead wood pool is included in the FRL because it is a mandatory pool.

Consideration to the criteria as set in Annex IV of the LULUCF Regulation

Table 3 Information on consideration to the criteria set out in Annex IV of the LULUCF Regulation

Annex IV B, № of para	Elements of the national forestry accounting plan	Chapter or page number(s) in the NFAP
a)	A general description of the determination of the forest reference level.	p. 12, p. 69
a)	Description of how the criteria in LULUCF Regulation were taken into account.	p.13, 39, 43,55,60,73-82
b)	Identification of the carbon pools and greenhouse gases which have been included in the forest reference level.	p. 12, 73
b)	Reasons for omitting a carbon pool from the forest reference level determination.	p. 12, 73
b)	Demonstration of the consistency between the carbon pools included in the forest reference level.	p. 12
c)	A description of approaches, methods and models, including quantitative information, used in the determination of the forest reference level, consistent with the most recently submitted national inventory report.	Chapter III
c)	A description of documentary information on sustainable forest management practices and intensity.	p.18, 18, 26, 55, Table 9, Table 10,Table 12
c)	A description of adopted national policies.	p. 16
d)	Information on how harvesting rates are expected to develop under different policy scenarios.	p. 37
e)	A description of how the following element was considered in the determination of the forest reference level:	Chapter III
e) 1	The area under forest management	p. 69, p. 60, 43
e) 2	Emissions and removals from forests and harvested wood products as shown in greenhouse gas inventories and relevant historical data	p. 78, 82
e) 3	Forest characteristics, including: - dynamic age-related forest characteristics - increments - rotation length and - other information on forest management activities under 'business as usual'	p. 27, 69, 73, Table 5, Table 6, Table 7, Table 8
e) 4	Historical and future harvesting rates disaggregated between energy and non-energy uses	p. 78

Chapter II Description of the forestry policy and practice

Description of forestry in Bulgaria and of the policies in place in the forestry sector

Forestry background in Bulgaria. Fundamental principles of the organisation of forestry

The forests of Bulgaria are perceived by the Bulgarian society as part of national wealth and national identity. This perception has its own explanation and lies in the over hundred years old traditions related to the administration and management of forests and afforestation.

The stages of forestry development, forestry policy and the relevant legislation are inextricably linked to the political system and direction of state governance during the periods of country's development after the Liberation (1878).

The first forestry act was passed in 1883. With this law, the State made an attempt to end the processes of mismanagement, plundering and destruction of forests (Vachovski, Hr., 2003), which were typical for the period before and shortly after the Liberation of Bulgaria. The law regulates the ownership of forests and divides them into state, municipal and private by type of ownership.

The forestry development policy from the beginning of the 20th century up to the years of the Second World War was characterized by the first attempts to identify the subject of forestry and build the forest resources. The legislation and practice in those years set out the first inklings of an organized fight against erosion and of nature conservation. In addition, the concept of using forests according to a business plan or program was developed, while at the same time the forestry management processes were triggered. Forests were organised and managed based on the principle of permanence and stability, but the period was actually characterised by irregular felling and overexploitation of coppices and forest stands near settlements. There was basically main felling in a situation of natural regeneration.

The forest economy and policy in the post-war period (1945-1989) reflect the socio-political life of the country at that time. In the years of the communist regime forests became public property and were managed in a centrally planned economy. Typical of those years were the significant investments in improving the condition of forests, the productivity thereof and in preserving their special functions. The forestry policy was aimed at rational use of wood, development of the forestry industry and foreign trade. The period was characterised by mass afforestation and, accordingly, increase in the afforested areas in the country.

In consequence of post-1989 political and economic changes in Bulgaria, the forestry sector went into a period of reforms aimed at its functioning in a market economy and pluralism of ownership environment. In the years up to the beginning of the XXI century, the old structures of management and the directions of forestry organisation were preserved to a large extent. At the same time, a new forestry policy was outlined, underpinned by the principles of sustainable and multifunctional forest management which were also reflected in the regulatory documents developed at that time. A significant point in the years of transition was the passing (in 1997) of the law for restoration of ownership of forests and forest land entirety and the subsequent land restitution procedures. Worth noting is also the passing of the Forestry Act (SG, No. 125, 1997), which states that "the purpose of the law is the preservation of the Bulgarian forests as national wealth … to the interest of the owners and the society". The provisions of the law apply to all forests, as well as to the lands of the forest fund regardless of their ownership. The law also brought structural changes in the management of wooded areas by fully separating the state functions from the economic functions through restructuring of the state forest enterprises. Another point in the years of transition, which is of significance for the forests, is the passing of the Conservation areas Act (SG, No. 133, 1998). Under this act, about 7,5% of the forests and lands in the forest fund were declared conservation areas – nature reserves, national parks, natural monuments, natural parks and conservation areas (Vachovski, Hr., 2003). Their intended purpose is conservation of biological diversity in forest ecosystems and of the natural processes occurring therein. Those purposes determine the method of use – for example, prohibition of clear felling and of the introduction of plant and animal species that are alien to the region, and the method of management which is assigned to the Ministry of Environment and Water (MoEW). As regards the forestry economic activity, the years of transition were characterised by decreasing investment in the forestry sector, lower utilisation of the available forest resources consisting in decreased afforestation activities and utilisation of forests.

Forests today. Major challenges and policies in the sector

The factors, which have the greatest impact on the development of the forestry sector in the first years of the 21st century, are Bulgaria's accession to the EU, the ongoing globalisation processes, the economic crisis, and the passing of the new forestry act (SG, No. 19, 2011). That called for rethinking the objectives and priorities of the sector. Those years were characterised by updating the legal framework concerning the forestry sector and passing a number of strategic documents having relevance to forests.

Definition of forest

For defining forest, Bulgaria uses the definition in the Bulgarian Forest Act (last amendment 18.12.2015, SG №100):

"Area over 0.1 ha, covered with forest tree species higher than 5 meters and tree crown cover over 10% or with trees which can reach these parameters in natural environment".

Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests.

According to their functions, forests are divided in: forests for timber production, protective and recreation forests and forests in protected areas.

All forests in Bulgaria, are managed.

Forest is also:

- area which is in a process of recovering and is still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters
- area, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested
- protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters
- cork oak stands.

Institutional framework

The national forestry policy is implemented by the Council of Ministers through the minister of agriculture, food and forestry. It is the single central body of the executive power that directs, coordinates and controls the implementation of the government policy in the field of agriculture, rural areas, forestry, fisheries and aquacultures. The other institutions concerned with the implementation of the forestry policy include the Ministry of Finance (MF), MoEW, the Ministry of Interior (MoI), the Ministry of Economy (ME), the Ministry of Energy (MoE) and the Ministry of Regional Development and Public Works (MRDPW).

The Forestry Act (passed in 2011) redistributed functions between MAFF and Executive Forest Agency (EFA). On one part, a state forestry administration with control functions was formed – EFA - and, on the other part – state forestry enterprises under Article 163 of FA to pursue economic activities in the state-owned wooded areas. EFA has a two-level structure – a central office, 16 regional forest directorates (RFD) and specialised territorial units, including national park directorates

The state-owned wooded areas are managed by six state forest companies (SFC) which include as regional units 164 state forest enterprises (SFE) and state hunting reserves (SHR) (NSDFSRB 2013 – 2020, 2013). The responsibility for the management of conservation areas is shared by MAFF/EFA and MoEW, under the 1998 Conservation areas Act. MoEW provides control of the management of all protected areas (PA) and directly manages the national parks and reserves. EFA is responsible for the management of natural parks and for the protected sites and natural monuments located in state-owned wooded areas. The activities for management of protected sites and natural monuments in wooded areas are carried out by SFC, SF and SHR to the territory whereof the protected area belongs.

Legislative framework on forests and international commitments

The policy for sustainable management of forests is laid down in a set of documents subordinated in a strict hierarchical structure. These are the Constitution, the national strategic documents and action plans thereof, laws, regulations, rules, methodologies, orders and decisions.

In terms of the legislative framework and the adopted international documents, the past 10-15 years can be notionally divided into two periods – before and after the new forestry act was passed in 2011.

The period before 2011 was characterised by two major events that had a strong impact on the development of the Bulgarian economy – preparation for and joining the structures of the European Union in 2007 and the 2007-2008 financial crisis which had its reverberations in Bulgaria in 2009. The main forestry policy document in force in those years was the National Strategy for Sustainable Development of the Forestry Sector 2006 - 2015 (NSSDFS) and the Strategic Plan for Development of the Forestry Sector 2007 - 2011 (SPDFS). The national policy framework outlined in the above strategic documents reflects the main processes related to the sustainable and multifunctional management of forests in Bulgaria. NSSDFS and SPDFS are aligned with the 1998 European Forest Strategy and the 2006 – 2011 EU Forest Action Plan adopted on 15 June 2006. This framework is supplemented by a number of strategic documents, including the Biological Diversity Conservation Strategy, the 2008 – 2020 Long-term Programme to Encourage the Use of Biomass, the Second Action Plan on Climate Change 2005 - 2008, etc. The Forestry Act in force at that time (1997) set as its main purpose the preservation of the Bulgarian forests as national wealth – the main environment forming factor, through the reproduction, sustainable development and multi-purpose use thereof to the interest of the owners and the society.

The most significant change in the main legal instruments since 2011 was the passing of a new Forestry Act in 2011 (promulgated, SG, No. 19/08.03.2011). The law sets out as major objectives to protect and increase the forest area and prevent the decrease of areas under forest in the country. The purposes of the new Forestry Act are updated and aligned with the sustainable forest management criteria and include: 1) protection and increase of the forest area; 2) maintaining and improving the condition of forests; 3) guaranteeing and maintaining the ecosystems, the social and economic functions of the wooded areas; 4) guaranteeing and increasing the production of timber and non-timber forest products through natural management of wooded areas; 5) maintaining the biological and landscape diversity and improving the condition of the populations of wild flora and fauna and mycota species; 6) providing opportunities for relaxation of the population and improving the recreation conditions; 7) achieving a balance of the interests of the society and of forest area owners; 8) supporting and encouraging owners of land in wooded areas; 9) implementation of international and European commitments for conservation of forest habitats.

Furthermore, the new forest act regulated the public relations relating to the protection, management and use of wooded areas, with a view to ensuring multifunctional and sustainable management of forest eco-systems, achieving a balance of the interest of the society and of the owners of wooded areas by limiting the disposal transactions leading to decrease of state-owned wooded areas, while giving preference to renting, leasing and establishing building right without reclassification. The implementation of the law is supported by a number of subordinate legal instruments, including Ordinance No. 8/05 August 2011 on felling in forests and Ordinance on the evaluation of land in wooded areas, Ordinance No. 1/30 January 2011 concerning the control and protection of wooded areas.

Another important document adopted after the new forestry act was passed is the National Strategy for Development of the Forestry Sector in the Republic of Bulgaria, 2013 - 2020 (NSDFSRB 2013 - 2020). NSDFSRB 2013 - 2020 is an integrated document on the development of the forestry sector up to 2020, which formulates the national priorities in line with the European planning framework for the sector. The following European strategic documents have been taken into account when designing NSDFS 2013 – 2020: Resolutions of the Ministerial Conference on the Protection of Forests in Europe (FOREST EUROPE), Oslo, 2011; Improved pan-European Criteria and Indicators for Sustainable Forest Management (2002 г.); Commission's Green Paper on Forest Protection and Information: Preparing Forests for Climate Change, EC (2010); Commission's White Paper on Adapting to Climate Change: Towards a European Framework for Action, EC (2009), the European Biodiversity Strategy, EC (2011), and other strategic and programming documents related to the long-term and sustainable management of forests in Europe.

The fundamental principles adopted in designing NSDFS 2013 -2020 are adhered to in the implementation of NSDFS. They are aligned with the new EU Forest Strategy 2014 - 2020, namely: 1) sustainable forest management; 2) multifunctional role of forests; 3) sustainable use of wood and non-wood forest products and services; 4) supporting the overall process of creating added value in the forestry sector; 5) fostering coordination in designing and implementing the EU forestry-related policies.

The following principles also have a key role: consistency with the national legislation; broad stakeholder involvement; cross-sectoral approach; integration with the National Development Programme:

Bulgaria 2020 and the National Economic Development Plan; consistency with the international commitments, initiatives and conventions related to forests; partnership in implementation; increased public ownership.

Forest planning. Forestry plans and programmes.

Under the Forestry Act (2011), inventory of the wooded areas, whatever their ownership, shall be carried out in order to establish the condition of the resources and to prepare an assessment thereof. All wooded areas are covered by the scope of activities of the relevant SFEs and/or SHR. The wooded areas within a SFEs or a SHR are divided into sections and sub-sections. The sub-section is the smallest territorial unit which is the basis for inventory taking of resources and management. Sub-sections are created in non-state units only if their area is more than 0.1 ha. It has had only one type of ownership in a sub-section.

Forests in Bulgaria are managed according to forestry plans and programmes. The latter provide the legal basis for pursuing economic activities and utilising forests. The forestry plans and programmes set the permissible level of use of forest resources and the guidelines for attainment of the forest area management objectives for a period of 10 years.

Forestry plans are prepared for all wooded areas which are state and municipal property, as well as for private wooded areas with land area of 50+ ha. Forestry programmes are prepared for wooded areas owned by natural and legal persons with total land area of 2 – 50 ha. Private wooded areas with land area under 2 ha are included in the forestry plans of state-owned wooded areas.

The forestry plans and programmes are subject to assessment for conformity with the subject-matter and objectives of conservation of the relevant conservation areas under the Biological Diversity Act, in the absence of an approved district plan for the relevant wooded areas.

Forest management systems – types of felling, intensity, etc.

For the purposes of this work, the description of the forestry practices covers the years after 2000. The felling and the method of carrying it out described hereunder refer to the period 2000 – 2011 and to the years after 2011. This division is related to the Forestry Act (1997, 2011) and the accompanying subordinate legal instruments.

In the period 2000-2011, the types of felling carried out in the Bulgarian forests and the methods of their implementation were determined by the following regulatory documents:

- Regulation on fellings in the forests of the Republic of Bulgaria (1997) – effective from 1997 till 2005.
- Ordinance No. 33 on the types of felling and the methods of implementation (2005) – effective from 2005 till 2011.

The provisions of both regulatory acts applied to all forests in Bulgaria, whatever their ownership. The provisions of those acts are aligned with the scientific and practical experience, the prescriptions of the General Guidelines of the Resolutions of the Helsinki Ministerial Conference (1993), X World Forestry Congress in Strasbourg (1995) and the International Conference in Rio de Janeiro (1992), as well as with the resolutions of a number of National Meetings on various forestry issues.

The main types of felling carried out in Bulgaria include **thinnings and regeneration (final) fellings**.

Thinnings are carried out in the period from origination of the forest stand until maturity for regeneration is reached. Their main purpose is to:

- Regulate the forest stand composition;
- Regulate the forest stand origin;
- Regulate the growing and development of the forest stands depending on the functions thereof and the economic objectives set;
- Select the trees in the forest stands;
- Improve the protective and recreation functions of forests;
- Improve the health and sustainability of the forest stands;
- Improve the quality (assortment) structure of the forest stands;
- Create and maintain a diversity of habitats and protect the biological diversity in forests;
- Lower the risk of fires in forests;
- Reducing the time for production of large timber;
- Gain additional timber yield;
- Prepare the forest stands for regeneration.

Thinnings include lightning, clearing, opening and removing cutting phases. They are applied in all types of forests (coniferous, deciduous, high-stem forests and coppice forests). There are some differences in the methods of carrying them out in the period before and after 2005, which are related to the methods of carrying out thinning and selective cutting and the carrying out of schematic selection fellings. However, those differences do not have high economic importance or significant influence on the end use.

Lightning is carried out from the origination of the forest stands until the canopy formation. Removal cutting regulates the composition and origin of the forest stands. The task is to protect the young trees of the economically or environmentally desired tree species against the crowding influence of associates, understory, land cover and coppice. Removal cutting is carried out in the following ways:

- Cutting or breaking of undesired tree species or coppices;
- Tending of the damaged deciduous understory (stump undercutting).

Clearing is carried out from the canopy formation of the forest stands up to the age when the trees begin to intensively grow in height. They control the composition, origin, quality structure and health of the stand of trees. During the felling, the density of the stand is not decreased below 0,8.

Opening is carried out in the period when the trees intensively grow in height. It controls the number of trees having the desired qualities, creates conditions for their growing in height and at the same time improves and maintains the stability of the forest stands. During the felling the density of the forest stands is not reduced to less than 0,7-0,8.

Removal cutting is carried out in the period of intensive growth of trees in diameter until the start of regeneration felling. The selective cutting creates conditions for threes to grow in diameter and for improving their individual stability. During the felling the density of the stand is not decreased below 0,7.

Over the reference period, removal cutting, and disengagement cuttings were carried out in any of the following ways:

- On the whole area – all reliable trees of the desired tree species are tended on the whole area of the stand. It is applied when the number of trees is limited and there is a need to support the survival of each one of them;

- On a portion of the area - thinning is carried out in strips, in nests or in a combination thereof, covering an area of not less than 30% of the whole area of the stand. It is applied when there is enough density of the trees of the desired species and when their associates considerably prevail in the area of the stand.

However, the Regulation on fellings in the forests of the Republic of Bulgaria (1997) and Ordinance No. 33 on the types of felling and the methods of carrying these out (2005) lay down different methods (rather variations of methods) of carrying out thinning and selective cutting. Until 2005 (under the Regulation) they were carried out applying the following methods:

- Cutting-from-below method – the process of natural self-thinning is followed, with trees removed from the lower part of the canopy during the tending. It is applied mainly in coniferous forests, where, due to the monopodial embranchment of the heads, the trees with good trunk forms are usually in the upper and middle part of the canopy. In deciduous forests, it is applied during sanitary fellings, in shelter belts, in the upper border of the forest, on very steep terrains. The cutting-from-below method gives rise to simple forms of (single-storeyed) forest stands;
- Cutting-from-above method – it is applied in deciduous forest stands, when the last cleating and opening phases are carried out, as well as in seed-coppices and coniferous-deciduous forest stands, the first storey whereof is dominated by trees of undesired tree species. The cutting-from-above method is carried out on the principle of individual selection. The trees of the future are determined and the trees that hinder them are eliminated;
- Combined method – it is applied in homogenous and mixed deciduous and coniferous forest stands. It is the main method for tending of two-storeyed forest stands. In this case, thinnings applying the cutting-from-below or cutting-from-above method are carried out in the separate storeys, depending on their composition.

After 2005 (according to Ordinance No. 33) opening and removing phases were carried out applying only the combined method, with prevailing cutting-from-below or cutting-from-above, depending on the tree composition of forest stands. They were carried out in this way from 2005 till 2009. Basically, the difference is only terminological. In practice, none of the cutting-from-below and the cutting-from-above method is carried out in its pure form. Every thinning has the nature of combined-method felling but it is important to highlight the prevailing method – cutting-from-above or cutting-from-below.

Until 2005 it was also admissible to apply schematic-selection fellings. They pursue a specific objective and are carried out according to a pre-set scheme, cutting whole rows, clearings or areas at intervals. Selective felling is carried out in the untouched areas, applying nay of the above tending methods. After 2005, Ordinance No. 33 permits only one-off application of a schematic method of thinning, only during clearing and opening phases. It involves felling part of the stand according to a pre-set scheme (corridors, rows, groups) with mandatory carrying out of disengagement cutting or thinning in the remaining portion of the stand.

Different intensity and regularity of intermediate fellings is allowed, depending on the composition, age and condition of forest stands.

The intensity of felling is determined as a percentage of the total stock or the total circle area of the stand. The intensity levels are:

- low: up to 15%;
- moderate: 15-25%;
- high: 25-35%;
- very high: over 35%.

The regularity of intermediate fellings is:

- at intervals of 4-8 years in case of low or moderate felling intensity;
- at intervals of 10-12 years in case of high and very high felling intensity.

Thinning in coppice forests is the same as in high-stem forests. The main task is to prepare the stand for becoming a high-stem forest with seed origin. Fellings are carried out on a selection principle, with determining the trees of the future for the stand as a whole, as well as for the individual coppice beds. The felling is carried out with cutting-from-above bias.

A wide variety of regeneration fellings was used in the management of forests in Bulgaria in the period 2000-2011. They were carried out in mature forest stands to achieve the following main objectives:

- ensuring the regeneration and creation of a new generation of forest;
- production and procurement of high-quality timber;
- guiding the forest regeneration processes;
- regulating the change of species;
- protecting the biological diversity in forests;

The type of regeneration fellings, the intervals at which they are carried out and the duration of the regeneration period are determined depending on the forestry system, the growth conditions, the quantity and the height of the undergrowth and/or the planted saplings, the composition and condition of forest stands.

Depending on the type of regeneration, the type and condition of forest stands, the following are carried out:

- regeneration fellings with preliminary natural regeneration – they are applied in forest stands where the regeneration process has begun, and the available undergrowth is sufficient;
- regeneration fellings to combine natural with artificial regeneration – they are applied in forest stands with reduced canopying and impeded natural regeneration, in which the quantity of quality seed undergrowth is insufficient;
- regeneration fellings with subsequent regeneration – they are applied in non-regenerated forest stands, in forests of fast-growing species for accelerated production of timber and biomass, as well as in forest stands designated for coppice system management and reconstruction.

The following types of regeneration fellings were applied in the forests in Bulgaria over the reference period (2000-2011): **shelterwood, selective** and **clear**.

Shelterwood fellings are regeneration fellings with preliminary natural regeneration, where the tree stand is cut in two or more stages in a regeneration period that is longer than a year. Gradual fellings are short-term and long-term, depending on the regeneration period of the stand.

Short-term shelterwood fellings are those where the regeneration period is no longer than 20 years. In protective and recreation forests short-term gradual fellings are carried out with prolongated regeneration period and/or regeneration felling is carried out on small areas. The short-term shelterwood fellings applied include: short-term-shelterwood, gradual-gap and group –gap shelterwood felling.

Short-term-shelterwood felling is carried out in beech, oak and pine forests, as well as in spruce and mixed coniferous forests in the lower edge of the mid-mountain zone, when the regeneration process goes regularly across the whole area of the stand. It is carried out by cutting trees regularly across the area of the stand in 2, 3 or 4 felling stages.

The preparatory phase is carried out in forest stands with canopying above 0,8, under the following rules: trees of retarded growth, trees with overgrown head, with poor-quality or crooked trunks, are cut; if there are shrubs that prevent regeneration, they are cut out; the canopying of the stand is decreased to 0,6 - 0,7.

It is desirable to carry out the seed spreading phase in a seed breeding year. The canopying of the stand is decreased to 0,4-0,6, depending on the tree composition. Conditions for the emergence of seedings and development of undergrowth are thus created. The undergrowth and the suppressed trees that prevent regeneration are necessarily cut. The natural regeneration is supported, if necessary.

The opening phase of felling is carried out after the seed producing stage, where minimum 50% of the area of the stand is covered with undergrowth. The canopying of the stand is decreased to 0,2-0,4 by cutting up to 50% of its stock, depending on the tree species, the progress of the regeneration process and the growth of the undergrowth. This stage is not carried out if there was no regeneration for some reason. In accordance with the specific conditions, this felling stage can be carried out once or several times, to protect the soil, the tree stand or the undergrowth.

The final phase is carried out after the removal cutting stage if the area of the stand is covered with a sufficient quantity of quality and strong undergrowth at minimum 75%.

The regeneration period is up to 20 years.

The **gradual-gap felling** is carried out in forest stands of heliophilous tree species - oak, pine, etc., pursuant to the following rules:

- after the first and second stage of four-stage short-term -gradual felling have been carried out, gaps with an area of up to 0,25 ha are opened in the places with the highest amount of undergrowth;
- gaps are widened once or twice until final felling of the mature tree stand and complete regeneration of the stand.

The regeneration period is up to 20 years.

Gap shelterwood felling is applied in forest stands with impeded natural regeneration, in which it is possible to combine natural with artificial regeneration or in which there is a need to improve the tree composition. Gaps with an area of up to 0,3 ha are established in the stand, which cover up to 40% of the area of the stand. The gaps are established in empty, non-regenerated places, in places with damaged stand of trees and in naturally regenerated places. Simultaneously with the opening of the gaps, in a band around them with a width of up to 20 m, the seed producing stage of short-term-gradual felling is carried out. Sanitary felling with intensity up to 15% is carried out in the remaining portion of the stand, whereas the canopying is not decreased to less than 0,7. Gaps are widened, whatever the progress of regeneration, when the saplings therein reach the height of 60-100 cm. The felling is carried out three times in a regeneration period up to 15 years. *Since 2005 (when Ordinance No. 33 took effect) the use of gap shelterwood felling has been terminated in Bulgaria.*

Long-term gradual regeneration fellings are those where the regeneration period is longer than 20 years. They include: group-gradual and irregular-gradual felling.

Group-selective felling is applied in homogenous and mixed coniferous and deciduous forests, as well as in spruce, fir and pine forests in the high-mountain zone. Felling is carried out by cutting the mature tree stand in the form of openings which are gradually widened. Group-gradual felling is applied when the undergrowth is in groups in different parts of the stand and there is no regeneration in the other parts of the stand, as well as in case of all-aged forest stands. The following rules are adhered to when carrying out the felling:

- openings are established in places where natural regeneration has started, or openings are opened once or twice in stand or parts thereof with canopying higher than 0,7;
- not more than 6 openings with a diameter of up to 30 m are established per 1 ha. After 2005, their number was limited to up to 3 openings per 1 ha;
- the stand of trees around the openings, on a strip about 20 m wide, is regularly thinned up to canopying of 0,5 by cutting sick, crooked and over-mature trees;
- openings are widened when the undergrowth is in a sufficient quantity and is strong;
- Simultaneously with the regeneration, the understory in the openings is tended by carrying out the relevant intermediate fellings;
- If the natural regeneration in the openings is not successful, it is supported by afforestation.

The regeneration period is up to 40 years.

Gradual uneven felling was introduced in the forestry practice in Bulgaria after 2005. It is with a regeneration period of indefinite duration (long-term at any rate). It is to be used in mixed forest stands, for all-age management, pursuant to the following rules:

- regeneration felling starts by establishing one to three openings per hectare inside the stand, with a diameter of up to 30 m, according to a pre-determined technological scheme of log-removal routes and with intensity of up to 15%;
- in the next stages of regeneration felling the existing openings are widened and new openings are established depending on the degree of regeneration and on the technological scheme;
- thinnings are carried out in the regenerated parts of the stand throughout the whole regeneration period.

Selection fellings combine simultaneous tending and regeneration of forest stands. They are used to form and maintain all-aged forests with balanced age structure. They are carried out at intervals of 8-10 years. Selection fellings include: single-selection felling and group-selection felling.

Individual-selective felling is carried out in all-aged forest stands comprising shade-tolerant tree species, pursuant to the following rules:

- felling is carried out across the whole area of the stand, cutting single trees or small groups of trees of all degrees of density, whereby openings with a diameter of not more than half the height of the tree stand are opened;
- the openings are not widened;
- the canopying of the stand is not decreased to less than 0,6;
- the felling intensity may not be more than 20% of the stand stock before the felling.

Group-selective felling is carried out in forest stands of heliophilous tree species by cutting groups of trees across the whole area of the stand in order to establish gaps with a diameter that is 1 to 1,5 times the height of the stand of trees. The gaps are not widened when the next felling is carried out.

Clear cuttings are regeneration fellings with subsequent regeneration. They are carried out in:
- forest stands with impeded natural regeneration;
- thinned, non-regenerated forest stands;
- forests of fast-growing species created for accelerated production of timber and biomass (poplar, willow, acacia, aspen, etc.);
- forests for simple coppice (offshoot);
- forests for reconstruction. The reconstruction economic class was closed after 2007. The predominant part of the forest stands for reconstruction (coppice oak forests at higher yield class) were transferred into seed forests by overgrowing. They are managed in the same way as high-stem forests, i.e. by some of the above types of felling. The remaining part of the forest stand for reconstruction (including coppice oak forests grown at low quality site and all oriental hornbeam and flowering ash forests) is managed as simple coppice (by clear felling with subsequent coppice regeneration);
- the case of fire-protection and hunting reserve events.

Over the reference period (2000-2009) clear fellings were carried out in small areas, in narrow strips and in large areas.

In forest stands with impeded natural regeneration, clear felling in small areas and in narrow strips is carried out, the size depending on the light requirements of the tree species which will be used for afforestation. The size is:
- for shade-tolerant tree species up to 0,5 hectare, up to 30 m accordingly;
- for heliophilous tree species up to 1 hectare, up to 50 m accordingly.

Clear felling on small areas is carried out in forest stands on monotonous and rugged terrains. The form of the clear areas is determined depending on the configuration of the terrain. An unfelled area which must be twice bigger than the felling area is left between the fellings.

Clear felling on narrow strips is carried out in forest stands on monotonous terrains, pursuant to the following rules:
- for terrain slope up to 30 degrees the strips are perpendicular or sideways to the horizontals, in a direction contrary to prevailing winds;
- for terrain slope above 30 degrees the strips are along the horizontals, top-down.

The minimum distance between the strips is twice their width. The area of the clear felling is widened when the height of the young forest stand has reached 50-100 cm, depending on the tree species and the growth conditions.

In clear fellings with subsequent offshoot regeneration (in forests for simple coppice) the felling is carried out from 1 September till 1 April.

Clear felling on large areas (all-area clear felling; up to 5-10 ha) is applied in thinned, non-regenerated forest stands with canopying up to 0,3 inclusive; in mature poplar, aspen, willow and acacia forests; in forests designated for reconstruction (including those designated for rejuvenation); in forest stands for coppice system management; and for carrying out fire-protection and hunting reserve events.

In clear felling on large areas the felling area is up to 5 (10) ha. The fellings are merged immediately after the plants therein have grown strong and canopied and their average height has reached 60-100 cm, depending on the tree species and the growth conditions. *The application of clear felling on large areas was interrupted after 2005. After that (according to Ordinance No. 33) it is permitted only in hunting reserve areas with an area of up to 5 hectares, when there is a need to create game foraging fields and game logging grounds.*

Conditional clear cutting is applied in coppice forests being grown into seed stand through coppice with standards. 85-95% of the tree stand is cut during the first felling, leaving 100-150 seed trees per hectare. In each subsequent felling, new 60-70 seed trees are selected per hectare and the remaining tree stand is again as simple coppice with rotation of 20-25 years. Seed trees are managed with rotation period of 80-100 years. Forest stands are managed as coppices until their transformation to high-stem stands. Notional clear felling was terminated after 2005. It proved unsuccessful because the first seed trees were selected at high age. They had small heads and unstable trunks and when opened they went into edaphic stress. In consequence, they suffered from dry top-end, grew water shoots, abiotic factors were damaged. Ultimately, they failed to fulfil their predetermined functions and died.

Ordinance No. 8 / 05.08.2011 on fellings in forests was passed in 2011. In general, it introduces additional restrictions (compared to Ordinance No. 33 (2005) when carrying out regeneration fellings. The restrictions introduced include, by type of felling:

Short-term-shelterwood felling:

Clear cuttings are allowed only under the following rules:

- clear felling in coppices, except for acacia forests, is limited to are fellings of up to 2 ha. The width of the unfelled strip between the area fellings may not be less than 20 m;
- clear cuttings with artificial regeneration are carried out in poplar forests as well as in stand of oriental hornbeam and flowering ash growing in medium-rich and rich growth conditions, and in acacia coppice stands, to restore their production potential;
- clear fellings with coppice natural regeneration are carried out in poplar, acacia, Gleditsia, oriental hornbeam, flowering ash, willow and lime forests or mixed forests of said tree species;
- clear fellings in lime forests are carried out in forest stands with minimum 90% of lime in their composition.

Ordinance No. 8 introduced the following new (additional) types of felling:

Obligatory cuttings – These are carried out in case of damages caused by abiotic impacts. In this case, damaged and/or fallen trees are cut in order to utilize the timber. The intensity of salvage cutting depends on the volume of damaged or fallen wood, leaving 3 to 5 biotopic trees per hectare. After the damages caused by biotopic and/or abiotic impacts are established and if the condition of the stand meets the criteria for carrying out thinning or regeneration felling, the damaged trees are cut during the relevant felling.

Fellings for individual production of high-quality timber – they are applied in forest stands in good growing conditions. Fellings are carried out in the following stand development stages:

- stand origination stage – young trees with a height of up to 3 m;
- differentiation stage – young forest stands with a height between 3 and 12 m, up to 15 m as an exception;

- accrual stage – self-thinning of trees has reached 25% of the expected trunk height in mature age;
- maturity phase.

The individual interventions make use of the biological specifics of the tree species ("biological automation") and the natural succession processes to ensure environmental production of quality timber. In this case, the classical terminology of intermediate felling events (removal cutting, disengagement cutting, thinning and selective cutting) is not used because it is more appropriate in the management by stand. In fellings for individual tending of quality timber all interventions are focused on the individual tree. The implementation of this concept enables production of quality, expensive, knotless timer in a shorter period, while preserving all environmental functions of the forest. When certain target diameters are reached by tree species and growth condition, trees of the future can be used.

Technical fellings – they are applied for:

- creating and maintaining game foraging fields, game traces, game gaps, felling sites for game foraging, hunting tracks, game clearings, game meadows;
- fire-protection events in wooded areas;
- building and maintaining the sites, facilities and items under Article 54 (1) and Article 153 (1) of the Forestry Act;
- utilisation of timber from lands with changed purpose, lands with established building rights, user rights and rights of way under the Forestry Act and the Energy Act;
- management of forest shelter belts;
- protection of the banks and isles of the Danube, as well as of the created hydro-reclamation systems and facilities for protection against the harmful impact of water;
- clearing permanent forest roads;
- carrying out
- activities other than the above.

Generally, each subsequent ordinance limits the areas of felling grounds and increases the regeneration period. Three ordinances on fellings were adopted over a period of 14 years (1997 – 2011). This is illogical from a purely forestry point of view because the biology of forests in Bulgaria has not changed in such a short period. Amendments are rather explainable by the changing socio-economic views and attitudes on the management of forests. In a relatively short period of time the attitude of the world-wide community to forests changed radically. Today forestry is built as an environmental science the main priority whereof is the sustainable management of forests. Bulgarian forestry keeps pace of global ideas and concepts for an ecosystem approach in forestry. Timber production is no longer the only purpose of the forest management. The priority is also shifted towards protection of forest habitats and the immaterial benefits therefrom.

Principles of the sustainable forest management – practical implementation

When designing the regulations in the field of forest management, the basic principles enshrined in the Resolution of the Ministerial Conference in Helsinki (1993) were adopted, according to which *"sustainable management"* means management and use of forests and forest land in a way and to an extent that preserve and maintain their biological diversity, productivity, regeneration capacity, vitality and potential to fulfil, now and in the future, the relevant environmental, economic and social functions at the local, national and global level. In that light, forest management in Bulgaria is based on a policy for reproduction and use of forests over a long period of time, in an environment of different forms of ownership, with the primary intention to keep the forest ecosystems in a good functional condition. The criteria adopted in the management of forests include the preservation of the Bulgarian forests as national wealth – the main environment forming factor, through the reproduction, sustainable development and multi-purpose use thereof to the interest of the owners and the society.

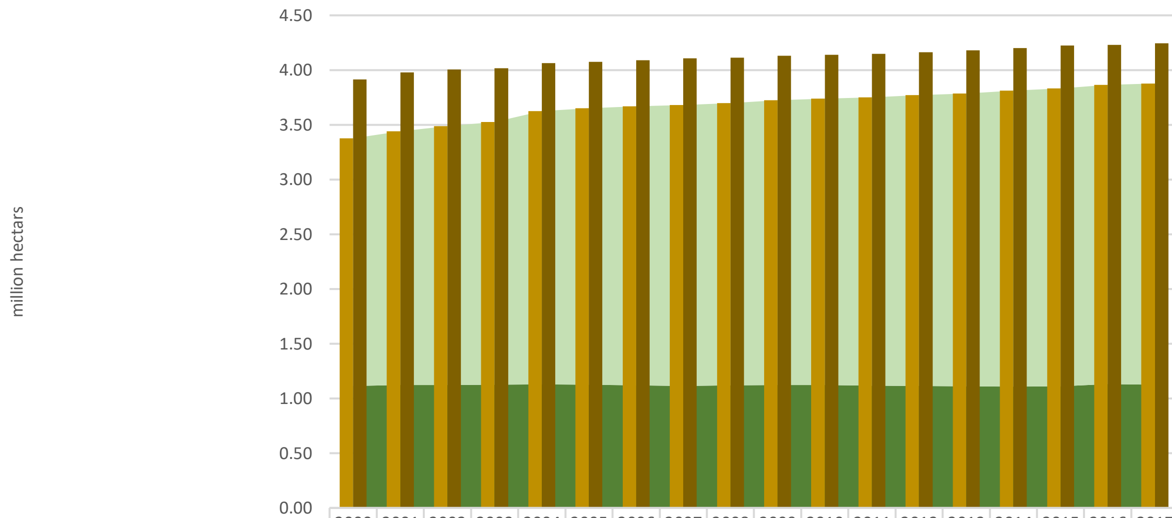
The provisions of FA and the Implementing Regulations of FA apply to all forests and forest land, whatever their ownership. The provisions do not apply only to forests and forest land in conservation areas that are exclusive state property. According to their main functions, forests are divided into forests with mainly timber harvesting and environment forming functions, protective and recreational forests and forests in conservation areas (Article 4 of FA). The main purpose of forest management is their reproduction which covers different forestry management systems and fellings. The priority of regeneration fellings is to use to the maximum the regeneration potential of forest stands with a view to ensuring their natural seed or vegetative regeneration during their use. Events to support natural regeneration are envisaged in forests with impeded natural regeneration and in the absence of conditions for that or where it is impossible to naturally regenerate the root stand of trees, artificial regeneration is carried out.

The requirements to the carrying out of different types of thinning, apart from their distinction by age, which is one of the main forestry indicators, are supplemented with indicators like density, canopying and height of the stand of trees and are aligned with the biological specifics of the tree species. The thinnings laid down by type and intensity aim to conserve and develop the biological diversity in forests, to improve the quality and productivity thereof as a result of creating optimal growth conditions.

State of the forestry sector

Area

Wooded areas in Bulgaria cover 4,24 million ha or 38,2% of the country's territory, including 3,88 million ha (91,0%) of forests. The area not covered by forest woody vegetation is 302 thousand ha. Compared to 2000 data, the total wooded area of the country has increased by about 330 thousand ha (~ 8 %). At the same time, the territory covered by forest is almost 480 thousand ha (14%). The main factors conductive of the dynamics of this process include self-afforestation of non-forested areas and abandoned land outside wooded areas and afforestation of non-forested wooded areas. Notable is the lower increase in the total area compared to the increase in the afforested area, which is due mainly to the increase in forest emerging on long-uncultivated brownfield land outside wooded areas.

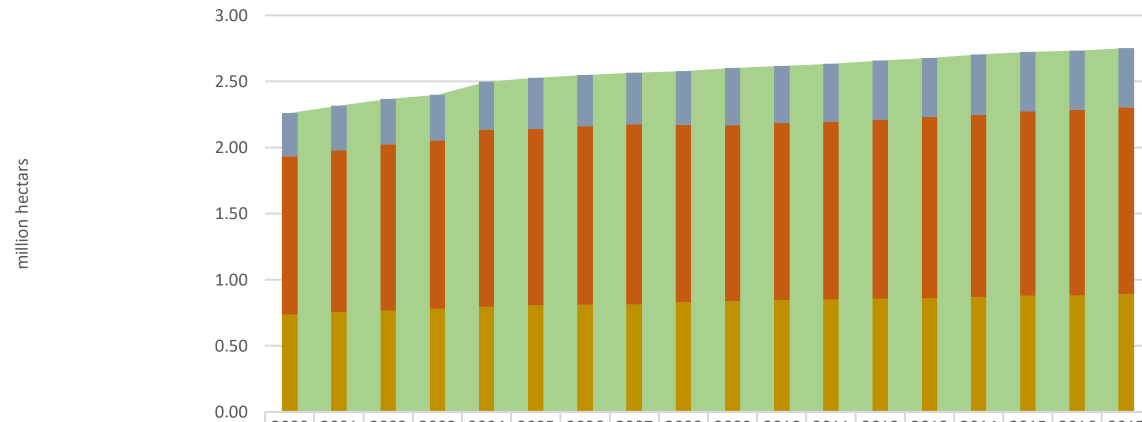


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
deciduous forests	2.26	2.32	2.37	2.40	2.50	2.53	2.55	2.57	2.58	2.60	2.62	2.63	2.66	2.68	2.70	2.72	2.73	2.75
coniferous forests	1.11	1.12	1.12	1.13	1.13	1.12	1.12	1.11	1.12	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.13	1.13
afforested area without (Pinus mugo)	3.38	3.44	3.49	3.53	3.62	3.65	3.67	3.68	3.70	3.73	3.74	3.75	3.77	3.79	3.81	3.83	3.86	3.88
forest fund	3.91	3.98	4.00	4.02	4.06	4.08	4.09	4.11	4.11	4.13	4.14	4.15	4.16	4.18	4.20	4.22	4.23	4.24

Figure 1 Area of forests and wooded areas 2000-2017, Source: EFA

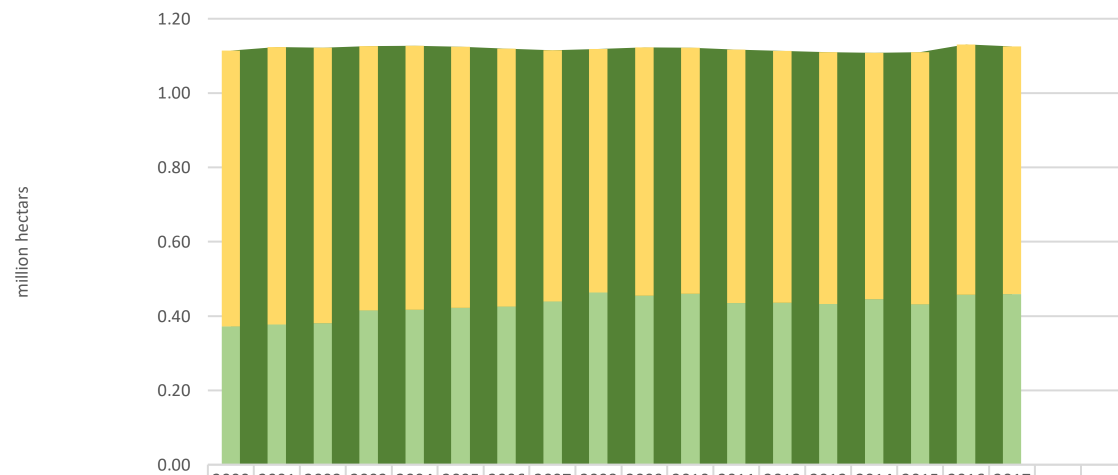
The area of conferous forests varies smoothly over the years. In 2017, their area was 1,11 million ha, similar to the area of coniferous forests in 2000. Coniferous plants cover about 60% of the total area of coniferous forests, but it is notable that they decrase smoothly over the years, making standing at 660 thousand ha in 2017, or by 10% less. At the same time, there is increase in the share of natural coniferous forests.

Deciduous forests feature stronger wooded area dynamics. In 2017, the area of deciduous forests registers increase by almost 22% agaisnt 2000. High increase is registered in coppices (+16.6%) and low-stem (+36%), which is the result of the growing of forests for reconstruction into the mentioned types of deciduous forests. High-stem deciduous forests increased by 20% in area compared to 2000.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
deciduous forests	2.26	2.32	2.37	2.40	2.50	2.53	2.55	2.57	2.58	2.60	2.62	2.63	2.66	2.68	2.70	2.72	2.73	2.75
low-stem deciduous forests	0.33	0.34	0.34	0.35	0.36	0.39	0.39	0.39	0.41	0.43	0.43	0.44	0.45	0.45	0.46	0.45	0.45	0.45
coppice for transformation	1.20	1.22	1.26	1.27	1.34	1.34	1.35	1.36	1.34	1.33	1.34	1.35	1.35	1.37	1.38	1.39	1.40	1.41
high-stem deciduous forests	0.74	0.75	0.77	0.78	0.80	0.81	0.81	0.81	0.83	0.84	0.85	0.85	0.86	0.86	0.87	0.88	0.88	0.89

Figure 2 Area of deciduous forests by forestry system 2000 - 2017, Source: EFA



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017		
coniferous forests	1.11	1.12	1.12	1.13	1.13	1.12	1.12	1.11	1.12	1.12	1.12	1.12	1.11	1.11	1.11	1.11	1.13	1.13		
conif. plantations	0.74	0.75	0.74	0.71	0.71	0.70	0.69	0.68	0.66	0.67	0.66	0.68	0.68	0.68	0.66	0.68	0.67	0.67		
natural conif. forests	0.37	0.38	0.38	0.41	0.42	0.42	0.43	0.44	0.46	0.45	0.46	0.43	0.44	0.43	0.45	0.43	0.46	0.46		

Figure 3 Area of coniferous forests – plantations and natural 2000 - 2017, Source: EFA

The following trends and perspectives can be outlined on the basis of the above:

- Permanent increase in the area of forests, mainly through afforestation and natural succession.
- Decrease in the area of forests created as a result of afforestation.
- Decrease in the area of coniferous forests and coniferous plants. The area thereof is expected to continue to decrease under the influence of a couple of factors: (1) the process of natural regeneration which is conductive of deciduous tree species, (2) secondary succession which accompanies the regeneration of the areas covered by coniferous plants that have reached

maturity and time for regeneration, (3) influence of forest fires and increase in the afforestation with deciduous species.

- Sustainable increase in the area of high-stem deciduous forests is envisaged as a result of coppice forests being grown into high-stem forests.

Ownership

The state holds the highest ownership share in the Bulgarian forests – 76.8% in 2005 and 74.5% in 2011. State-owned forests include forests managed by SFC (SFEs and SHR) – 72.5-70.2%, forests within the borders of national parks and reserves – 4%, and forests within the borders of experimental forest farms (EFF) – 0.3%. The share of non-state forests is respectively 22-24%. They include municipal forests, religious forests and private forests. The remaining ownership share (1.2- 2%) is held by forests created on former agricultural land. Over the past period (2005-2011), notable increase is registered in the area of non-state forests, mainly as a result of self-afforestation of bare land within forests and the development of abandoned land outside wooded areas.

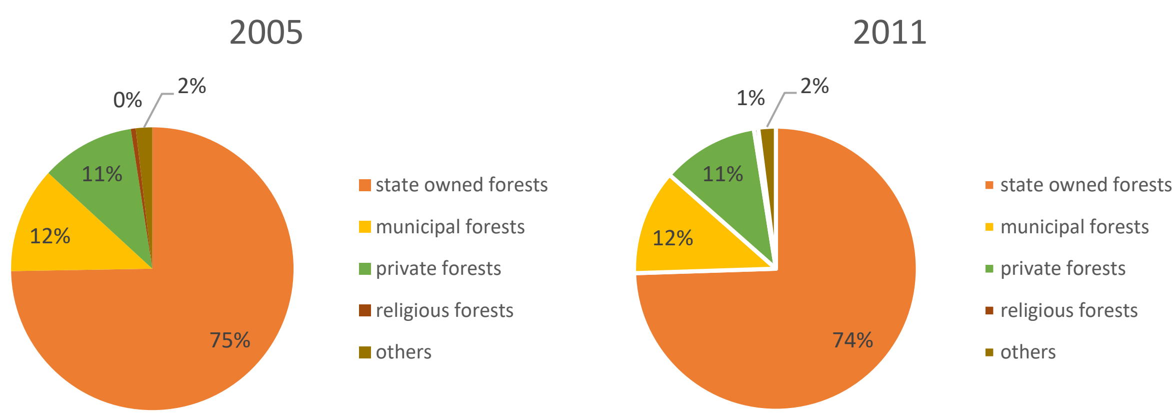


Figure 4 Breakdown of forest ownership in 2005 and 2011, Source: NSSDFSB 2013-2020

2015 forest ownership data show a sustainable upward trend in the share of non-state forests, including municipal, private, religious, etc., with the share of state-owned forests persisting at over 70%. The process of fragmentation of private forests continues, with 94% of private forest landed properties having an area of up to 2,0 ha. The average area of an individual forest landed property is less than 1,0 ha.

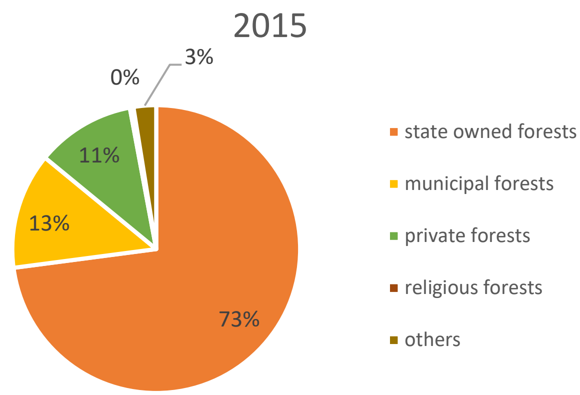
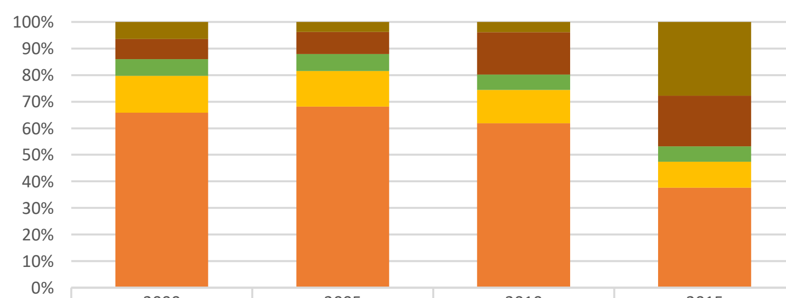


Figure 5 Breakdown of forest ownership in 2015, Source: EFA

Functions

The area breakdown of wooded areas by forest category is presented in Figure 6 It is notable that between 2000 and 2010 the forests with timber production and environment forming function hold the highest share (62-68%). The share of those forests decreased dramatically in 2015 due to the inclusion of a large portion of wooded areas in the European Environmental Network Natura 2000. The new redistribution of functions is, to some extent, of a purely administrative nature because a large part of those forests is administered and managed in accordance with the practices adopted so far and on the basis of forestry plans and programmes. The forestry plans and programmes of forests which are part of Natura 2000 specify the reasons for declaring the conservation areas and the purposes of protection, giving also specific prescriptions for the management of the territories in accordance with the protection purposes. Not all plans for management of conservation areas in Natura 2000 have been developed yet. A manual "Modes of sustainable forest management in Natura 2000" has been drafted and adopted. It provides guidance on best forestry practices which maintain the favourable conservation status of forest habitats.



	2000	2005	2010	2015
Others protective forests (e.g Natura 2000)	6%	4%	4%	28%
Protected forests (e.g National and Nature Parks, Reserves etc.)	8%	8%	16%	19%
Recreational forests ()	6%	6%	6%	6%
Protective forests	14%	13%	13%	10%
Timberland	66%	68%	62%	38%

Figure 6 Breakdown of forests by function and category of land, in percent, 2000-2015, Source: EFA

Age

In the period 2000 – 2015, the average age of forests increased from 49 to 57 years (Figure 7). According to 2015 age structure figures, forests aged 21 – 40 years account for the highest share of coniferous forests (36%), followed by middle-aged and maturing forests (41 – 80 years) – 33%. Coniferous forest stands aged 80+ account for 22% of the area of coniferous trees. Age structure figures for high-stem deciduous forests show increase in the share of middle-aged and mature forest stands. Coppice forests and coppices feature irregular age structure. 80% of the area of coppice forests are over the age of 40 years and almost 40% of the total area of coppice forests is aged over 61 years. As regards coppices, 46% of the forest area are aged over 40 years and forests over 61 years of age make up 17% of the total area. More detailed information about the age structure by type of forest is given in Chapter III.

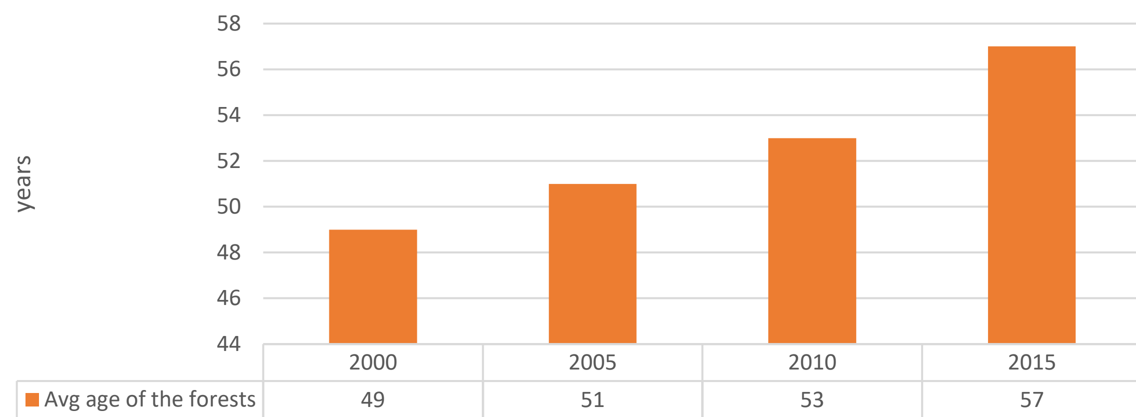


Figure 7 Average age of forests in Bulgaria, Source: EFA

Total growing stock

The total growing stock in the forests of Bulgaria as at 31.12.2015 is estimated at 680.52 mil. m^3 (RF data, 2015). The 2015 average stock is 177 m^3/ha. There is an upward trend in the growing stock per unit area, with stronger dynamics of coniferous forests. On the other hand, there is a downward trend in average stock per hectare in coppice forests, as a result of the increased age. The average annual growth rate of growing stock increases from 14,1 mil m^3 to 14,4 mil m^3.

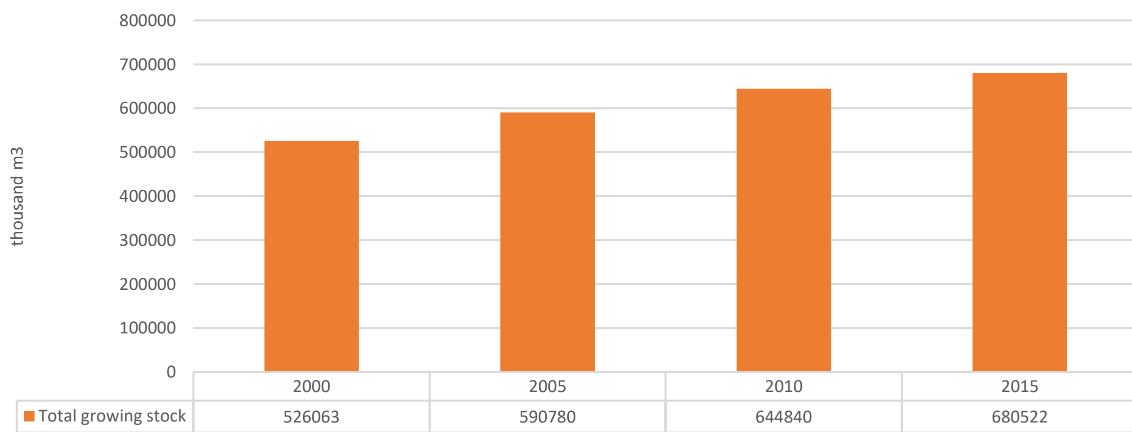


Figure 8 Total growing stock 1990-2015, Source: EFA

Harvesting

The timber use dynamic for the period 2000-2017 is presented in Figure 9. The values in the figure refer to the net timber harvesting rates compared to the planned harvesting rates according to Forest Management Plans. Two periods of timber use surge are noted in the respective period. In 2017, actual timber use is by 85% higher than its 2000 levels. The first period of increased harvesting is registered in 2003 when the harvest increased at almost 44% against 2000. In the period 2003 – 2008, the actual total harvest (net harvest) levels vary within 5.5 – 6.0 million m^3, with timber use remaining by 12% lower than the planned levels under the forestry plans. The decline in harvesting in 2009 is associated with the global economic crisis which was most strongly felt in Bulgaria in 2009. The increase in net timber harvesting in the years after 2011 against the period before 2009 is attributable mainly to the forestry restructuring in relation to the 2011 Forestry Act and the establishment of 6 State Forest Companies (SFC) tasked to manage state-owned wooded areas and to implement the forestry management plans. Information on timber harvesting by group of materials – industrial timber (including large, medium and small) and wood (e.g fuelwood and pulpwood) is presented in Figure 9.

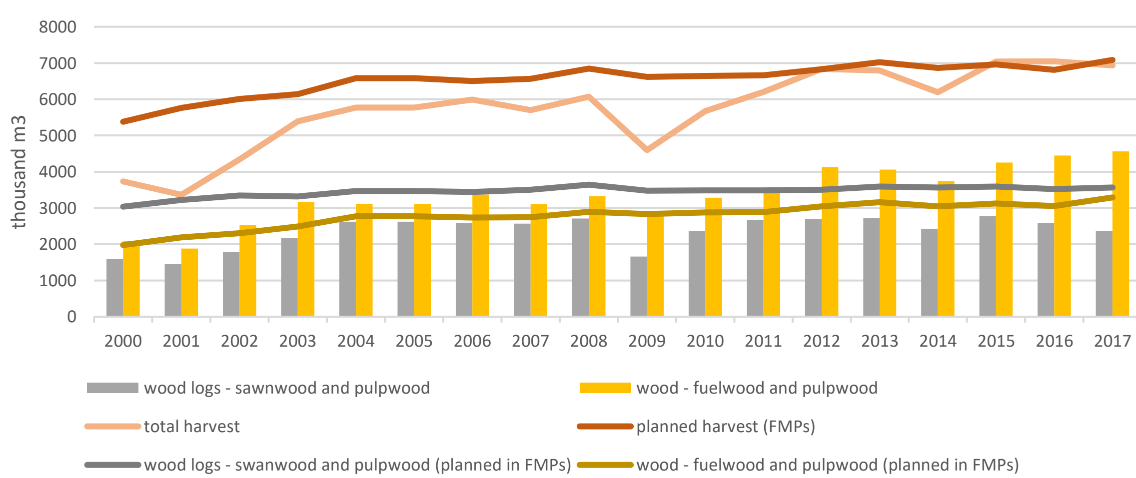


Figure 9 Timber use dynamics 2000-2017. The presented figures represent the net timber amounts, Source: EFA

Biological diversity of forest ecosystems

Bulgaria is characterised by a relatively high variety of tree species, which is determined by its very rough terrain (from sea level to an altitude of almost 3000 m) and its location at the intersection of different climatic zones and vegetation zones. The high flora of Bulgaria comprises 4102 species (Assyov et al, 2012), including over 10% of trees, shrubs and lianas. There is a large number of endemic species which are met only in the Balkan Peninsular or in certain places in Bulgaria, which ranks the country among those with the highest biological diversity in Europe. For the conservation of those species, a wide network of conservation areas has been established and developed over the years, including 11 natural parks, 3 national parks and 55 nature reserves. The area of protected forests increases over the years, making up 19% of wooded areas in 2015 against 11% on 2000. (Figure 6). Natura 2000 zones were mapped and fully declared in 2010. As at 2015, 48% (2.04 million ha) of the wooded areas (including also no-forested lands within the forest territories) are included in the European Natura 2000 ecological network. In relation to the establishment of the Natura 2000 conservation area network, the first specialised scientific research aimed at assessment of the impact of forestry activities on biological diversity was approved and integrated in the system of regimes for management of forest habitats included in the National Natura 2000 ecological network. In 2016, in relation to the fulfilment of the conservation commitments under Natura 2000, MAFF categorized 100 000 ha as old-growth forests. These are ancient forests that are almost undisturbed by man and preserve valuable genetic and biological diversity. Their categorization as old-growth forests call for a special regime of management thereof and timber harvesting therein is prohibited.

Dead wood and dying trees play a key role in the functioning and productivity of forest ecosystems by influencing ecosystems' biological diversity, preservation of carbon dioxide, cycle of matter and energy, hydrological processes, protection of soil and regeneration of tree species. Maintaining certain quantities of dead wood has been recognized as one of the most important conditions for sustainable management of certified forest enterprises and hunting reserves and of Natura 2000 forest ecosystems and has been included as a regulatory requirement in the Ordinance on fellings (promulgated, SG, No. 64 / 19.08.2011). Maintaining certain minimum quantities of dead wood is regulated in the national guidelines on "Assessment, management and monitoring of forests with high conservation value in Bulgaria" and "Achieving and maintaining favourable conservation status of forest habitats and species habitats in forests included in the European Natura 2000 ecological network".

Systematic studies at national level to establish the availability of dry and fallen wood in wooded areas were not carried out before 2011 due to the absence of regulatory requirements for the conservation of and inventory on dead wood in Bulgaria. By expert judgement, the availability of dead wood in forests is very irregular because dead wood is removed from the more accessible forest stands as a sanitary measure for protection against insect pests and fungal pathogens or as firewood for the local population.

Diversity of tree species

As regards tree species, most forested area is covered by species of the Beech family (*Fagaceae*, 52% of forest areas), followed by Pine (*Pinaceae,* 27%), Birch (*Betulaceae,* 10%), Bean (*Fabacea*e, 4%), etc. The *Fagaceae* family is represented by the genera oak, beech and chestnut (Figure 10). The oak genus is the most important one in the low-lying lands of the country. It prevails in lowlands, downlands and low hillsides up to an altitude of about 800 m. There are eight naturally growing species of the oak genus in

Bulgaria. From a purely practical point of view, Turkey oak (*Quercus cerris*) is often classified in a separate category due to the lower value of its wood. Beech species (*Fagus sylvatica и Fagus orientalis*) cover about 17% of total forest and prevail on many mountainsides at an altitude of 900 to 1500 m. *Fagus orientalis* is represented in Strandzha and in certain small areas in the easternmost part of the Balkan Mountain, whereas *Fagus sylvatica* prevails throughout the Balkan Mountains, Sredna Gora, Osogovo, Vithosa and Belasitsa mountains and is met in combination with coniferous species (mainly European silver fir) in Rila, Pirin and the Rhodopi Mountains. The *Pinaceae* family is represented in Bulgaria by 5 pine species, one spruce species and one fir species. Pine species include Scots pine (*Pinus sylvestris*) which makes up 47% of natural coniferous forests, black pine (*Pinus nigra*) which makes up 8% of natural coniferous forests, Heldreich's pine (*Pinus heldreichii*) (limitedly met in Pirin and Slavyanka), Macedonian pine making up 2% of natural coniferous forests, and mountain pine (*Pinus mugo*) which forms large shrub communities above the tree line, mainly in Pirin and Rila national parks. Spruce (*Picea abies*) makes up 22% of natural coniferous forests, European silver fir (*Abies alba*) - 5%, and 12% are mixed beech-coniferous forests where mainly beech, fir and spruce grow. Those coniferous forests prevail on the mountainsides and are the main tree species in the high mountain chains in South Bulgaria (Rhodopi Mountains, Rila, Pirin and Vitosha) (Panayotov et al, 2016b).

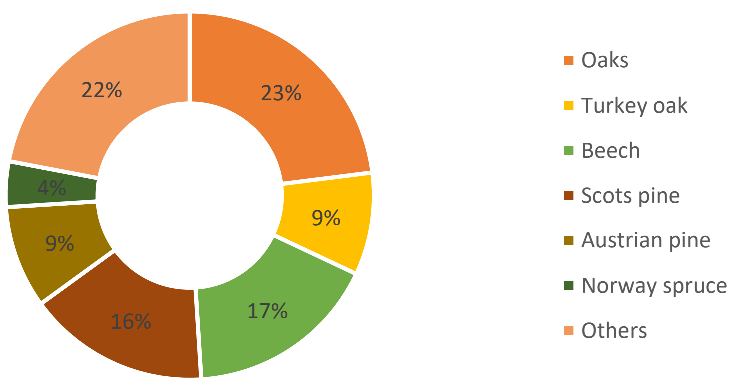
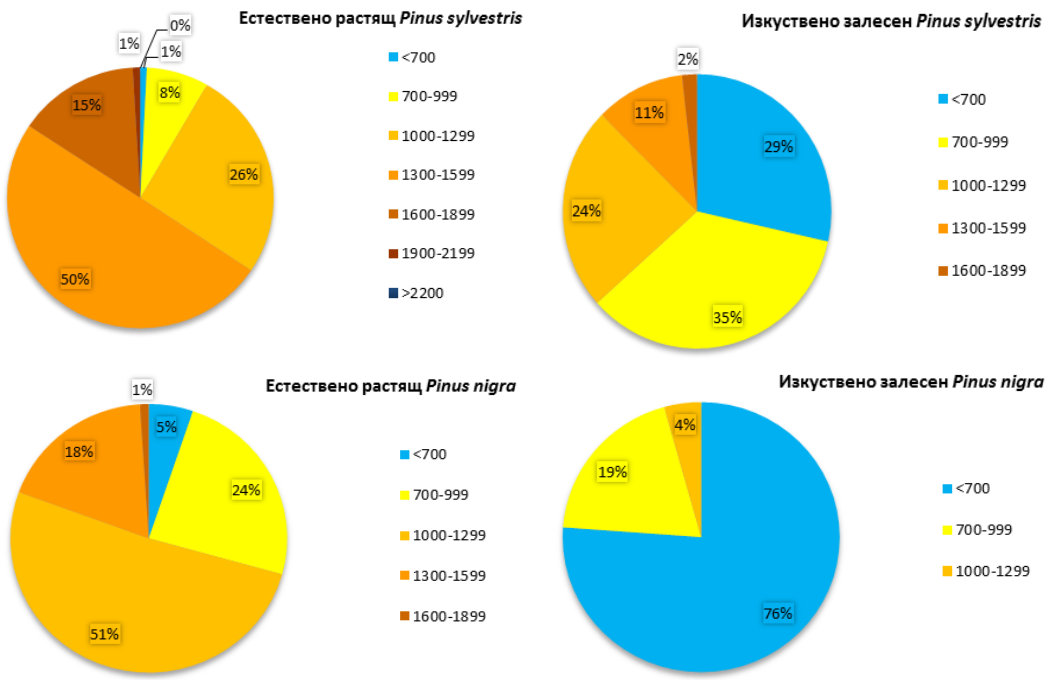


Figure 10 Percentage of the areas occupied by the main tree species

In addition to natural pine forests, there are also large plantations (over 1.5 million hectares), created mainly in mid-XX c with anti-erosion purpose and for regeneration of degraded forests. They comprise mainly Scots pine (48%) and black pine (41%). About 30% of those Scots pine plantations are at an altitude that is lower than their natural range in Bulgaria (Figure 11). Other 35% are at an altitude between 700 and 1000 m where only 8% of the natural forests of those species are met. The range of black pine trees by altitude is similar, with 76% covering territories at an altitude lower than 700 m, where only 5% of the natural forests of those species are met. There are several reasons for that: 1) black pine and Scots pine are relatively easy to plant and grow in various types of soil, including eroded soil; 2) coniferous species decrease erosion and deposition all year round, which is important for the zones around dam lakes; 3) those two species have valuable wood which is widely used in the woodworking industry and in construction. However, significant drought stress is registered over the last decades due to higher temperatures and long periods without precipitation in the summer and in the autumn. This leads to lower growth and impaired health of many plantations, in particular Scots pine ones at low altitude.



Source: Panayotov et al data, 2016b.

(On the left site - Naturally growing *Pinus sylvestris* and *Pinus nigra*; On the right site - Artificially created plantations of *Pinus sylvestris* and *Pinus nigra*)

Figure 11 Breakdown of altitudinal belts (meters above sea level) of natural forests and afforested areas (coniferous plantations) of Scots pine (Pinus sylvestris) and Austrian (black) pine (Pinus nigra) in Bulgaria

The wider use of irregular-gradual felling and of selection fellings – single-selection and group-selection, as well as of selective cutting, in the past decade bring about toleration of local forest tree species and origins and conservation of the natural habitats of the flora and the fauna when carrying out forestry activities.

According to 2010 EFA data, a significant part of the Bulgarian forest regenerates naturally – 79,6%, including in offshoots, and 20,4% - by afforestation or plantation. In 2005, naturally regenerating forests accounted for 76,4% of total forest area. The share of regeneration fellings with natural seed regeneration, carried out in state-owned wooded areas, in the area of all regeneration fellings moved up from 87% in 2006 to 95,7% in 2011. The upward trend in the share of natural seed regeneration is observed also in the last few years. Afforestation is applied less and less in state-owned forests due to lack of financing, low wages, absence of sufficient number of workers etc.

Certification of forests in Bulgaria

The Forestry Act (2011) regulates the certification of forests as an ongoing process which endures that wooded areas are managed in a responsible manner that strikes the right balance between environmental, economic and social benefits. The development of this process opens up opportunities to establish of a national market of certified Bulgarian forest products – wood and non-wood, ensure equal access to the ecologically sensitive European markets and obtain economic benefits therefrom. Certification of forests in Bulgaria started in 2003 on the basis of the FSC standard. As at 31.12.2011, the area of FSC-certified state-owned wooded areas is 216 455 ha or 7% of the total area thereof. According to WWF – Bulgaria data, as at 2015, certified forests exceed 800 000 ha or 19% of total forest area. According to the FSC Annual Newsletter (Facts & Figures, January 3, 2018) as at December 2017, the area of certified wooded areas is 1 464 607 ha, or 34% of total national wooded area (2017 Annual Report of Executive Forest Agency).

Information on the expected development of harvesting levels under the different policy scenarios

The future development of the forestry sector depends to a large extent on several concurrent processes – the overall government policy on the role and management of forests, the climate change effect, the timber production industry and the market development. The policy commitments at the national level are reflected in different legislative instruments, in particular in the **National Strategy for Development of the Forestry Sector, 2013–2020,** which is the milestone document on the key role of forests and the increasing importance thereof for the national economy and the environment in Bulgaria. The 20 operational objectives of the strategy aim to increase forest areas, the growing stock and the carbon stock, to improve the management strategies, to conserve genetic and biological diversity and, to increase the resistance of forests as a whole to various biotic and abiotic challenges they are faced with.

Bulgarian forests are managed in accordance with forest management plans and programmes which provide guidance on management and set the quantity of wood from forests to be used over a period of 10 years ahead. The design of forestry plans and programmes follows the principles of sustainable forest management. Recently, the annual utilisation rate (harvest rates) of forests has reached the planned levels as set out in the forest management plans and this tendency is expected to continue. Decrease or dramatic increase in harvesting should not be expected in the next 10-15 years. However, it is also important to highlight a couple of factors that are important and have relevance to the utilisation of forests. These include:

- The Energy Strategy of Bulgaria till 2020 and the targets for increased share of renewable energy sources (RES);
- Lack of mechanisation and underdeveloped forest road network
- High percentage of coppice forests aged over 40 years and the unsuccessful growing of those forests into seed forests

With reference to the energy strategy which sets a target for a 16% share of RES, including woody biomass, and the potential investor interest in forest resources, a number of measures have been taken to avoid any negative impact on forests. Within this context, a number of conditions and requirements that refocus the investor interest in using woody biomass to areas with no risk of adverse ecological effects have been introduced in order to ensure the conservation of sensitive areas, including Natura 2000 areas. In that light, NSDFSRB 2013 - 2020 envisages: 1) exploring, analysing and assessing the potential of wooded areas in Bulgaria in terms of the opportunities for wood biomass energy production; 2) developing a National Scheme for the Sustainable Production and Use of Wood Biomass for Energy Uses, containing relevant sustainability criteria.

The lack of mechanisation in the forestry sector and the underdeveloped forest road network open the way to excessive utilisation of timber in certain wooded areas. This leads to decrease in the exploitable volume of open-access forests – near settlements, in plain and hilly country. At the same time, it's getting harder and harder to procure qualified labour. This calls for prompt forestry retrofitting and expansion of the forest road network. This process started in Bulgaria in the past few years and is expected to continue, but in the time horizon of the next 10-15 years it is not expected to have a significant effect on harvesting levels.

Coppice forests make up 35% of forests in Bulgaria. 80% of them are aged over 40 years and 40% are over 60 years of age, which is the result of being unsuccessfully grown into seed forests. Many of those forests have lost their ability to regenerate through offshoots, and seed undergrowth is often crowded by the shrub vegetation under the canopy of coppice forests. This forestry problem is yet to be settled and it is expected to affect harvesting levels, but not so much as total quantities but as quantities at forest stand level.

Chapter III Calculation of Forest Reference Levels for 2021-2025

Description of the approaches, methods and models for calculating the forest reference level in Bulgaria

The approach we have chosen to calculate the forest reference levels follows the basic approach proposed by Forsell et al (2018)[1], which consists of six steps:

1. Stratifying managed forest lands according to pre-defined criteria. This stratification should be applied in a consistent manner over time, when projecting, as well as when describing the dynamic characteristics of forests in the reference period (2000 - 2009)
2. Identifying and documenting Forest Management Practices (FMP) for the reference period (2000-2009) by the defined strata of forest land and based on defined quantifiable criteria
3. Selecting the appropriate methodology to project the development of carbon pools, based on available data and national circumstances
4. Calibrating the methodology based on real data
5. Project the future development of anthropogenic emissions and sinks from forests for the commitment period (2021-2025)
6. Calculating the reference level as average of GHG emissions and removals during 2021-2025

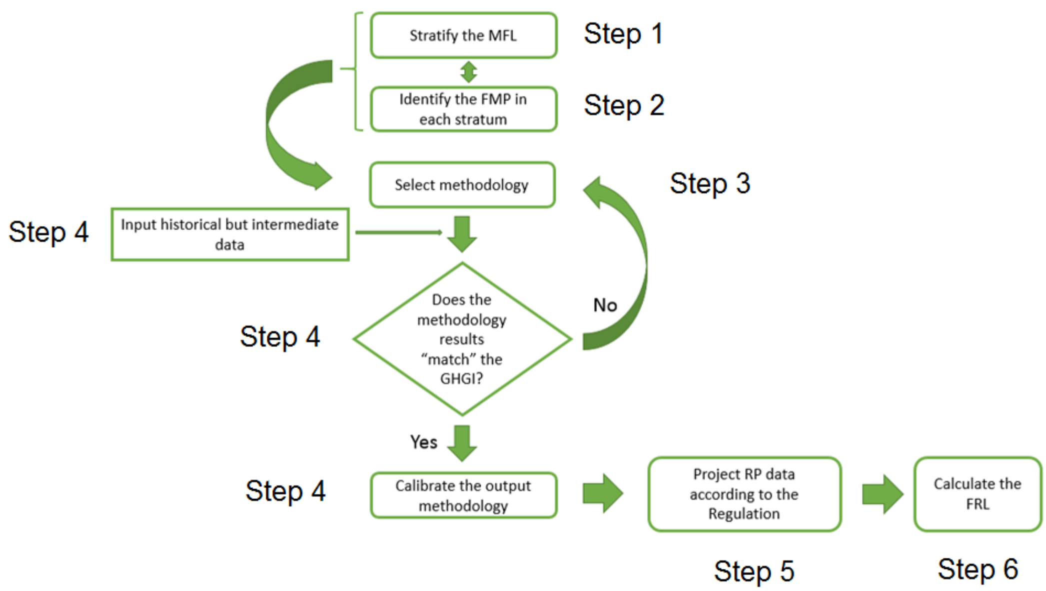


Figure 12 Graphical representation of the approach used. Source: Foresel et al. (2018)

[1] Forsell N, Korosuo A, Federici S, Gusti M, Rincón-Cristóbal J-J, Rüter S, Sánchez-Jiménez B, Dore C, Brajterman O and Gardiner J. (2018). Guidance on developing and reporting Forest Reference Levels in accordance with Regulation (EU) 2018/841. https://ec.europa.eu/clima/policies/forests/lulucf_en

The first step – stratification of Managed Forest Lands, seeks primarily to define the level of projection and to collect and analyse information about the characteristics of forests for the reference period. The purpose of this stratification is to distinguish between different forest management practices. The number of the different strata and their significance depend on the type of data and the selected methodology. A good practice is to demonstrate consistency between the strata used to develop the National Greenhouse Gas Inventory (NGHGI) and those used to project the reference levels. Since Bulgaria stratifies its forests into coniferous and deciduous in the national GHG inventory, we decided that further stratification of forest land was necessary in order to reduce the uncertainty and increase the accuracy of projections. When selecting the further stratification of forest land, we have also taken into account the chosen method of projection of the dynamic characteristics in forests, the national forest statistics and the information contained therein, the type of forestry systems and the origin of the stands. More information on the stratification of forest land is available on p.43.

The second step – identifying and documenting the Forest Management Practices (FMP) for the reference period, seeks to provide qualitative and quantitative description of the actual forest management practices in the period 2000-2009. The information thus collected and analysed will be the input to the designed reference level projection model. The information about the forest management practices that is input in the projection model will remain constant throughout the simulation. The reference level projections for the commitment period will thus follow from the forest management practices in the reference period.

The third step – selecting the appropriate methodology, seeks to select a method to project the future development of carbon pools in a commitment period. The method selected should be in line with the adopted forest land strata and the described forest management practices, which are observed at each level. As a result of applying the projection method, the future development of the growing stock by age class is obtained. Sprouting is a function of the growth of tree species less projected annual harvesting, calculated on the basis of the documented practices in the reference period. The growing stock development by strata is simulated based on defined criteria for constant and variable parameters. For example, the total area of each stratum and the amount of harvesting expressed as a percentage of the growing stock, are constant parameters, whereas the growing stock by tree species and age class are time-varying.

The fourth step – calibrating the model, seeks to prove the adequacy of the projection method selected. It is necessary to demonstrate consistency with data actually measures and/or documented, as well as with the results of the national greenhouse gas inventory.

The fifth step – projecting the emissions and removals, aims to estimate the future development of emissions and removals by carbon pool from the starting year of projections up to 2025. Emissions and removals are calculated based on reported changes in the carbon stock by pool. The projection for Bulgaria is made for the following carbon pools – biomass (total below-ground and above-ground), dead wood and harvested wood products. Emissions and removals from soils and litter are not included in the projections, it being accepted that they are in equilibrium. Projections are prepared based on the selected methodology and the key input data collected in steps 1 and 2.

The sixth step – calculating the reference level using the results from Step 5. The forest reference level is calculated as the 5-year average of the estimates for commitment period 2021-2025.

It should be noted that the approach described was used as the basis for projections, but we were also guided by a number of other principles which include the criteria the reference level has to satisfy according to the LULUCF Regulation, the type of input data, the forestry and forest inventory specifics in Bulgaria, etc.

Describing and documenting the information sources used to calculate the reference level

When making the projections and calculating the Forest Reference Level for the commitment period (2021-2025) we have used different information sources, including forest statistics, regulatory documents, strategic documents, etc.

The main sources of quantitative information about forests in Bulgaria include the Wooded Area Report (WAR) and the Forestry Plans (FP) under the existing Forestry Act. In the present report we call them by their traditional names Wooded Areas Reporting Form (RF) и Forestry Management Plans (FMP), which are the preferred names in the scientific publications.

Forest Stand Descriptions (Description sheets)

The Forest Management Plan (*Betriebsregelung, Forsteinrichtungsplan*) includes the Forest Stand Descriptions ("the descriptions"), which are its information base, plus tables, lists, text and maps. The plan is a public data which is available on the website of the EFA. For our work, we mainly use the descriptions. A description is made for each subcompartment (*Unterabteilung*), i. for each forest stand or bare forest area. The description contains the parameters of the site (*Standort*) and the forest stand (the living trees), as well as the planned measures - felling and afforestation. According to the latest available data, the subcompartments are currently 1,340,797 with an average area of 3.15 ha. They are divided into 176 territorial units (*Forstbetriebe, Forstämter*).

The plan of a unit is executed for 10 years, after which the unit goes through inventory and a new plan is prepared. Each year the plans of 1/10 of the territorial units are updated. At any time in the country there are units that are just out of inventory or are just coming in, so the average age of the data should be about 5 years. In fact, it is slightly larger, because for various reasons the inventory can be postponed. In the end, the current plans refer, on average, to the year 2010.7, weighted by area.
The descriptions are the most complete and most accurate information available to forests. It has the drawback of being updated to the 10-year periods mentioned above. It also does not contain data on the current activities of the territorial units. They, of course, document their activity, but that is their inside information.

Aggregated data

Another source of data to this development is the Wooded area report (RF). These are aggregated data (overview tables) that are updated and collected in a national database maintained by EFA. On their basis, data for the national statistics and for the internal use of EFA are provided.

The RF represents 7 reporting forms (tables), prepared by the territorial units, which have been collected since 1960 in the same format. Since 1991, they are collected via an electronic data bank and are available electronically.

Forms are known with the traditional designations RF1, RF2, ..., RF7. Forms RF1 and RF5 (area report and harvesting report) are collected annually. The other forms are collected over 5 years. In electronic form, they are available for the years 1995, 2000, 2005, 2010 and 2015.

RF1 is the distribution of the area by land types (forested land, bare land for afforestation and non-productive bare land, *Nichtholzboden*) and forest types (conifer forests, broadleaved high-stem forests, conversion coppice forests and low-stem forests). RF1 also gives some other details about the site and vegetation. The aggregated data in RF 1 is the sum of the data at the level of subcompartments. For example, the area of a subcompartment in which the conifers predominate will be added in the row of "conifers", although it may contain some deciduous species. The main purpose of RF1 is to monitor the "development of the forest fund" - ie. the inclusion of new forests in the forest territory and the transfer of land from one territorial unit to another.

RF2 and RF3 are distributions of area and growing stock according to forest types, tree species and age. Areas in RF2 and volumes in RF3 are parcelled - each tree species in a forest stand is assigned area and stock to and in RF2 and RF3 they are added to the row of these tree species. RF2 and RF3 do not provide information about the site and do not provide some necessary details about the origin, in particular, what part of the areas are on the natural stand, and what are the plantations. Since RF1 works with the area of whole stands, and RF2 - with parcelled areas, there are unavoidable differences in the area of the conifers according to RF1 and RF2, and also of the other forest types.

RF4 is a distribution of area and stock by function (wood production land, protective forests, recreation forests, protected forests).

RF5 is a comparison of the planned wood removals with the actual wood removals throughout the year. It gives the total the cutting areas and the quantity of wood extracted. For state forests EFA also has more detailed data that feeds RF5, but for non-state forests RF5 is the only source. RF5 works with simplified lists of tree species (high-stem beech, oak and poplar, coppices, conifers) and fellings (final fellings and thinnings). For us, RF5 is the only data source for actual wood removals.

RF6 is a distribution of the area by forest types (conifers, etc.), stand age and stocking rate (*Bestockungsgrad*). It served as information on the average stocking rate of the renewed areas.

RF7 is the distribution of the area by tree species composition (pure pine stands, mixed stands dominated by beech, mixed stands dominated by the broad-leaved, etc.) and site index (Höhenbonität). Its aim was to monitor a practice that is currently abandoned - the replacement of non-productive stands with productive ones in order to improve productivity.

RF4, RF6 and RF7 work with the area of whole stands and their areas are aligned with RF1.

Updating RF is done manually, without taking into account the increment. In the year of a forest inventory, the reporting forms of wooded area report for a given territorial unit are taken from its plan. In the course of the year, the employees register their activity - there is a letterhead for each purpose in each description sheet. Based on the recorded data, they subtract from the RF tables the cut-off cubic meters and hectares and add the afforested hectares to them. They do not measure nor calculate any increment. **Therefore, all growing stocks in the RFs are slightly underestimated - they should be added to about 9/10 of the 5-year current increment.**

Reconciliation of the data sources

Since the aggregated RF data is derived from the description sheets, our two major sources should give the same results, which in most cases is approximately so. Some differences are observed already for the start-up year 2010. They are mainly due to the "development of the forest fund" – including of land to the forest territory and, to a lesser extent, excluding of land form the forest territory, and transfer of land between territorial units. Particularly many transfers occur in the course of the administrative changes that are made, with the aim to agree the boundaries of the territorial units with the municipal boundaries.

In the simulation, when using RF for verification, some differences are also inevitable because the manual update of the RF does not take into account the increment over the 10-year implementation period as mentioned above.

The use of the data sources

The main results of growing stock simulation are obtained on the basis of a distribution of area and volume by tree species, origin, site index and age, that obtained directly from the descriptions. It is close to RF2 and RF3, with the difference that it takes into account the site index and the origin of the plantations from artificial afforestation. RF2 and RF3 themselves were not used for simulation because of the known difficulties in handling aggregated data - once collected, they are almost impossible to restructure.

RF were used to derive the main parameters of the reference period and for approbation of the model: if it is realistic, for 2015 it should give results similar to the known RF2 and for RF3.

Table 4 Description of the content of the wooded area reports (RF)

Reporting form №	Description	Update period
1	Forest area (forested and non-forested lands inside the forest fund)	Annually
2	Forested area distributed by age classes	Every 5 years since 1960; data used for the years 00-05-10
3	Growing stock by age classes	Every 5 years since 1960; data used for the years 00-05-11
4	Forested area distributed by forest functions	Every 5 years since 1960; data used for the years 00-05-12
5	Harvested wood	Annually, separately for regeneration fellings and thinning
6	Forested area distributed by canopy cover and age classes	Every 5 years since 1960; data used for the years 00-05-12
7	Forested area distributed by age classes and yield classes	Every 5 years since 1960; data used for the years 00-05-13

In addition to the quantitative data, we have also used in our work different information sources, such as ordinances and laws, to supplement the description of the forest management practices and to provide information on the fulfilment of the criteria which the reference levels should meet. These documents include Ordinance No. 33 on fellings in forests, the 1997 Forestry Act, which were in force in the reference period (2000 - 2009).

Stratification of the managed forest areas. Documentation of the strata.

When selecting the level of detail of the stratification of the forest land (stratum) to prepare the projections and determine the reference levels, we have been guided by the following criteria:

1. Comparability with the adopted stratification of forest land in the GHGI
2. Access to forest data and type of data
3. Possibility to differentiate forest management practices by stratum
4. Possibility to project correctly growth by tree species in order to reflect the differences in the growth rates of the different tree species and depending on their way of regeneration.

In GHGI the forest land is stratified into coniferous and deciduous forests. We think that for the purposes of the present work it should be further stratified. For example, coniferous forests should be stratified into natural stands and coniferous plantations. This is necessary because a large portion of the plantations are created outside their natural area and, therefore, their growth rate is different from that of natural stands which develop under conditions that are optimal for the species. For deciduous forests, on the other hand, it is necessary to take into account of the forestry system and the way of regeneration as both influence the management practices.

The type of forest data is also important for determining the strata of forest land. RFs contain information about the major characteristics of forests such as land and stock by age class, function, canopy cover, yield class and harvesting. It should be noted, however, that although some of the reporting forms contain information by tree species, the specifics of the forms make them difficult to use at the level of tree species. For example, despite the detailed information about land by tree species and about growing stock by age class, the information about harvesting is more aggregated, for example harvesting of all coniferous species, whether plantations or natural stand, is presented as an aggregate. Furthermore, the data from RFs could hardly be combined for the purposes of a more profound analysis or projection. For example, the data about afforested land by yield class is presented by tree species and give information only about the land of a given tree species for a given yield class, while not linking the yield class to the growing stock and the age classes. For a more detailed growing stock development projection, however, it is necessary to take into account the site conditions or the yield class. It is this necessity that calls for using data from the description sheets (inventory descriptions) and explains why the input data for the projection of growth and harvesting are from the inventory descriptions and not from the RFs. On the other hand, the description sheets cannot be used to document the characteristics of forests in the reference period by stratum, because they are updated on a regular basis. Thus, our approach in determining the reference levels includes both data sets – RFs and description sheets of forest management plans. RFs have been used to describe the strata in the RP, whereas the description of the condition of the forests in the year before the simulation (2010 in our case) is based on description sheets.

Figure 13 presents a diagram of the adopted forest stratification which has been used to project the reference levels. The adopted strata actually coincide with the forest land strata under RF 5 (on the amount of wood removals in forests). We can thus collect (depending on forest data) quantitative information about forest management practices in the years of the reference period, expressed as the percent of the harvest against the growing stock for each stratum. The criteria applied to determine the strata include: forest type (coniferous and deciduous), type of forests. High-stem deciduous forests are further stratified into major species: beech, oak, poplar, other, as this is also the stratification in RF 5.

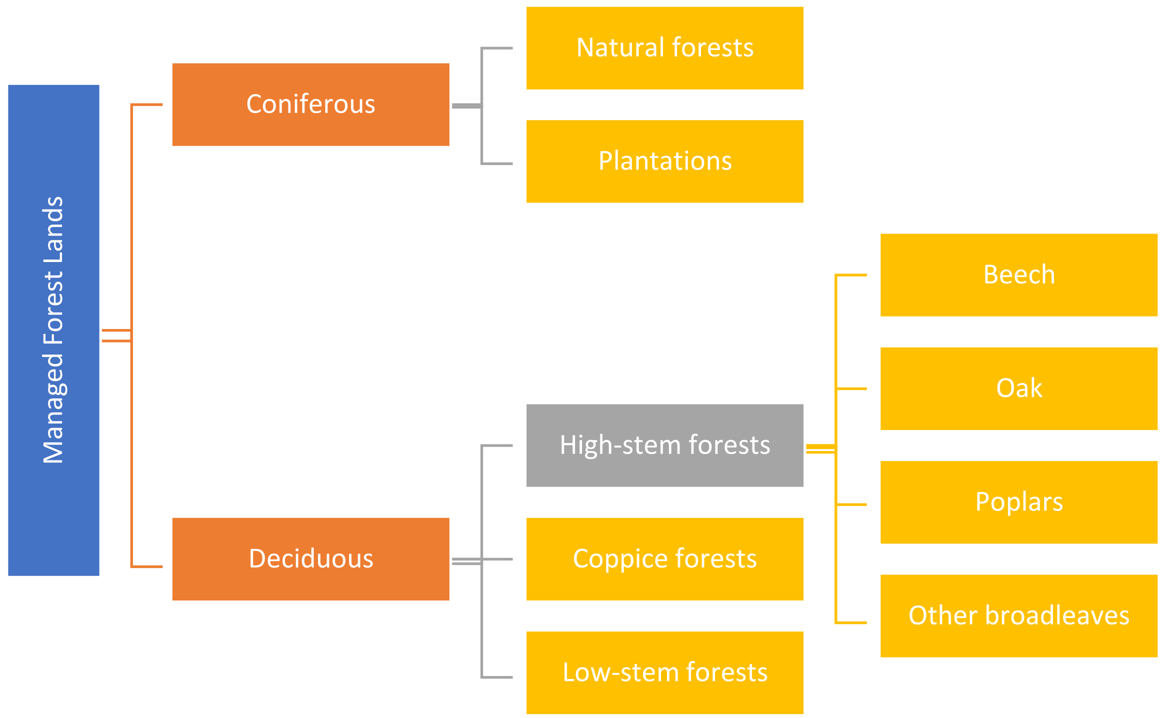


Figure 13 Scheme of the adopted stratification of forests

It should be noted that we have used further stratification by tree species in the model to simulate growth and to project the development of the age structure and the growing stock, with a view to reflecting more precisely the differences in the growth rate of the different tree species, the forest management systems and the origin of stands. Figure 14 presents a diagram of the way in which we have combined the different data sources and of the relation of the substrata to the relevant stratification level. Information on the projection model is contained in Chapter II on p. 60.

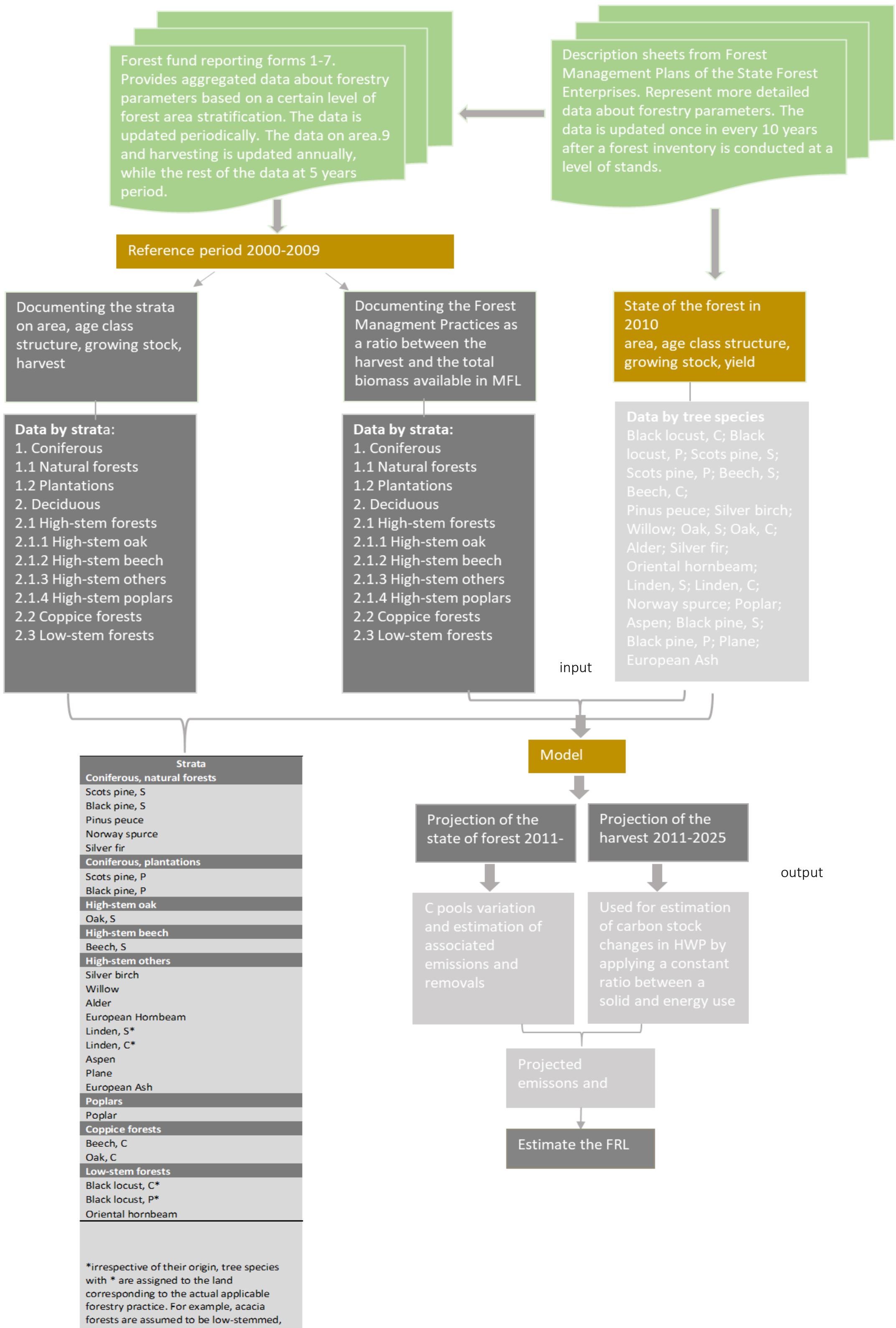


Figure 14 Interrelations between the different data sources used to calculate the reference levels

We have used data from RF 1, 2, 3 and 5 to document the strata. RF 1 is the main information source for forest land in Bulgaria. The reporting form is updated annually and the information about land therein is for whole stands. RF 1 gives information about the land by type of forests, both for forested land and total for wooded areas, which include also woodless land within the wooded areas. For the purposes of this work, we have considered only forested land. Given that all forests in Bulgaria are managed, total forested land is considered Managed Forest Lands.

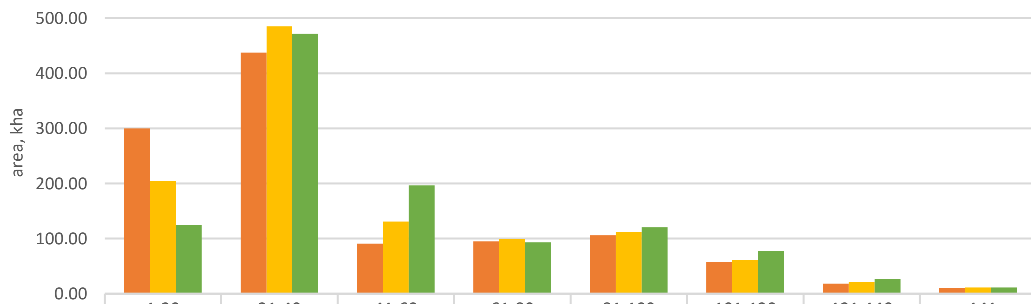
RF 2 and 3 contain mode detailed data about forests, presenting information about the land by age class (RF 2) and growing stock (RF 3) by tree species and type of forests. These forms are updated at intervals of 5 years, therefore the information about the age structure by stratum is given only for 2000, 2005 and 2010. Growing stock data by stratum for the missing years have been interpolated.

The following tables and figures present the data on forest characteristics, which describe the dynamics of the parameters for the years of the reference period.

Table 5 Forested area by strata for the RP (2000-2009).

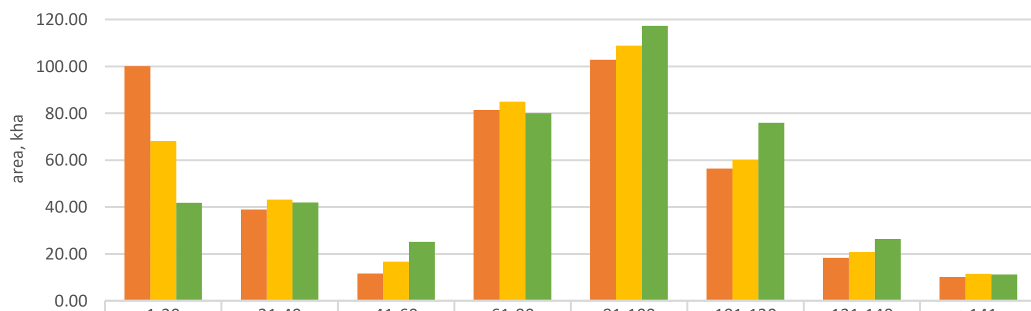
№ Strata	area, ha	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	**Coniferous**	1115	1124	1122	1127	1127	1124	1120	1115	1119	1123	1122
1.1	Natural forests	353	357	361	394	394	400	403	417	440	431	435
1.2	Plantations	762	767	761	733	733	725	717	698	679	692	687
2	**Deciduous**	2260	2317	2367	2400	2497	2527	2549	2566	2579	2603	2616
2.1	High stem deciduous forests	736	755	767	781	797	805	810	814	830	838	846
2.1.1	*Oak - high stem*	205	211	214	218	223	227	228	230	234	236	250
2.1.2	*Beech - high stem*	373	382	389	396	404	400	403	405	412	416	413
2.1.3	*Poplar*	20	20	21	21	21	25	25	25	26	26	22
2.1.4	*Others - high stem*	138	141	144	146	149	153	154	154	157	159	160
2.2	Coppice forests	1198	1223	1257	1273	1338	1336	1353	1361	1342	1332	1340
2.3	Low-stem forests	327	339	342	346	362	386	387	390	408	433	430
		0	0	0	0	0	0	0	0	0	0	0
	Total Managed Forest Lands	3375	3441	3489	3526	3625	3651	3669	3680	3698	3725	3738

Coniferous



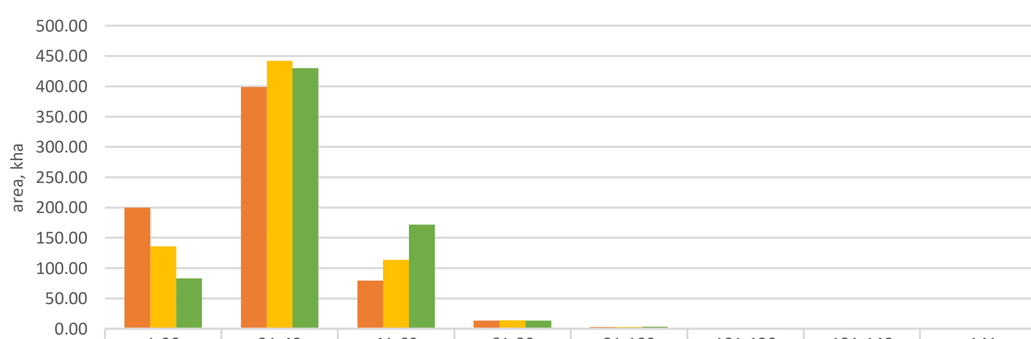
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	299.777	437.729	90.725	94.815	105.745	57.306	18.392	10.158
2005	204.037	485.349	130.628	98.959	111.958	61.098	20.819	11.423
2010	124.922	471.669	196.720	93.269	120.564	77.188	26.507	11.185

Coniferous, natural forests



	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	100.151	38.902	11.568	81.416	102.824	56.342	18.339	10.158
2005	68.165	43.135	16.656	84.974	108.865	60.070	20.758	11.423
2010	41.735	41.919	25.084	80.088	117.233	75.888	26.430	11.185

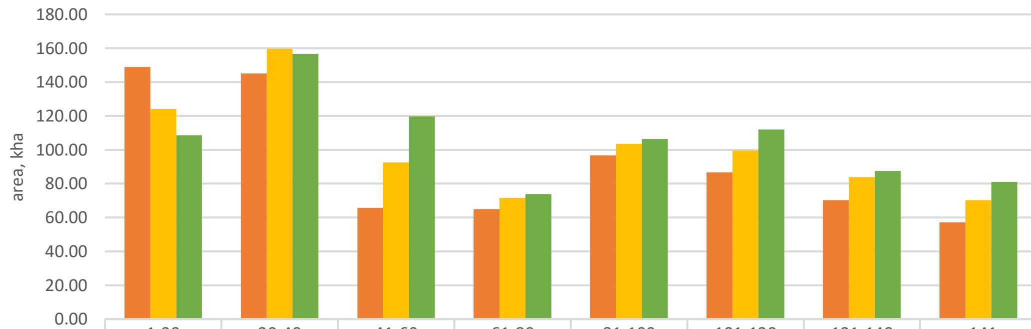
Coniferous, plantations



	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	199.626	398.826	79.157	13.399	2.921	0.965	0.053	0.000
2005	135.872	442.214	113.972	13.985	3.093	1.028	0.060	0.000
2010	83.188	429.750	171.637	13.181	3.331	1.299	0.077	0.000

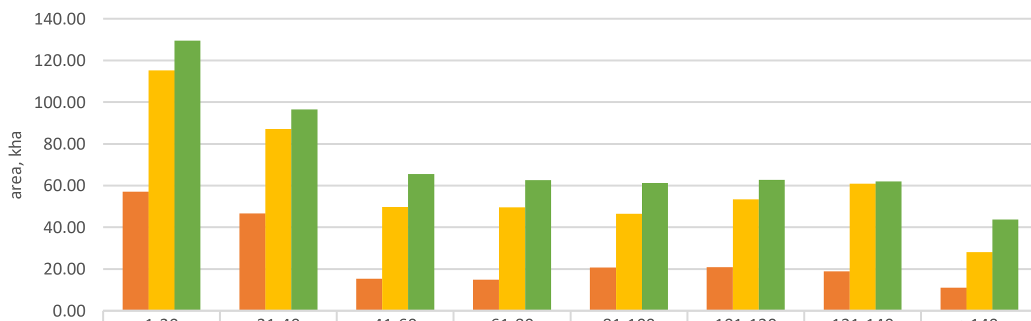
Figure 15 Distribution of area of coniferous forests by age classes (e.g natural forests and plantations)

High-stem deciduous forests



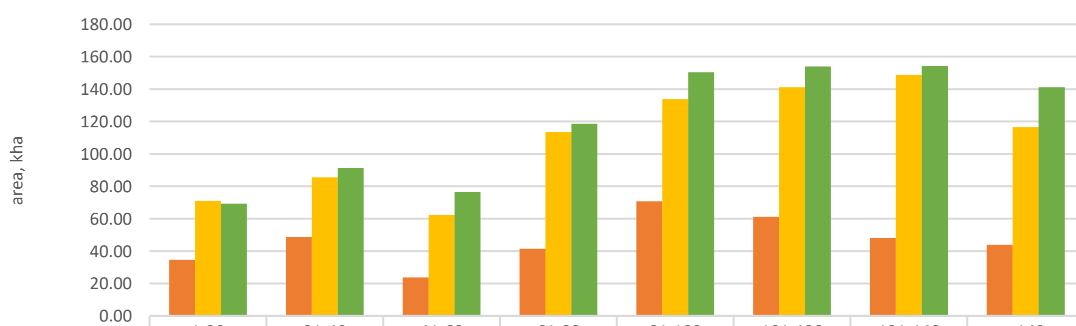
	1-20	20-40	41-60	61-80	81-100	101-120	121-140	>141
2000	148.851	145.152	65.710	65.034	96.732	86.699	70.225	57.117
2005	124.096	159.588	92.582	71.610	103.469	99.475	83.907	70.285
2010	108.642	156.641	119.705	73.880	106.410	111.929	87.363	80.979

High-stem oak forests



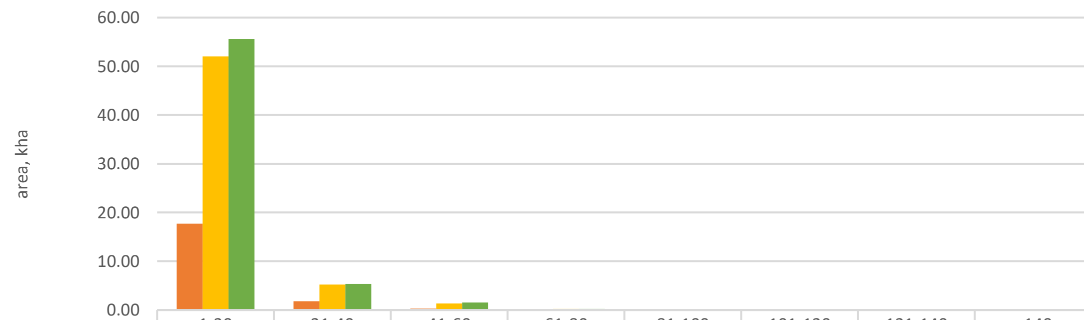
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Oak 2000	57.027	46.635	15.274	14.966	20.752	20.819	18.904	10.981
Oak 2005	115.238	87.111	49.785	49.557	46.561	53.411	60.877	28.146
Oak 2010	129.485	96.560	65.490	62.621	61.201	62.787	61.933	43.713

High-stem beech forests



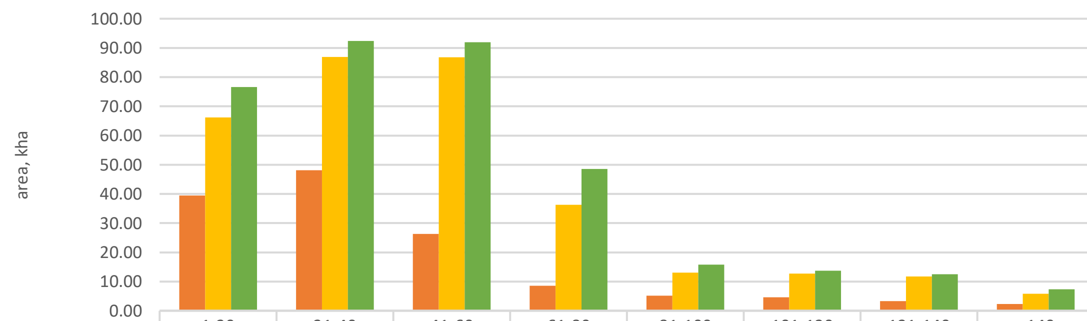
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Beech 2000	34.676	48.593	23.840	41.443	70.785	61.311	48.042	43.869
Beech 2005	71.110	85.594	62.310	113.621	133.927	141.224	148.771	116.487
Beech 2010	69.264	91.416	76.359	118.721	150.460	153.881	154.354	141.170

High-stem poplar forests



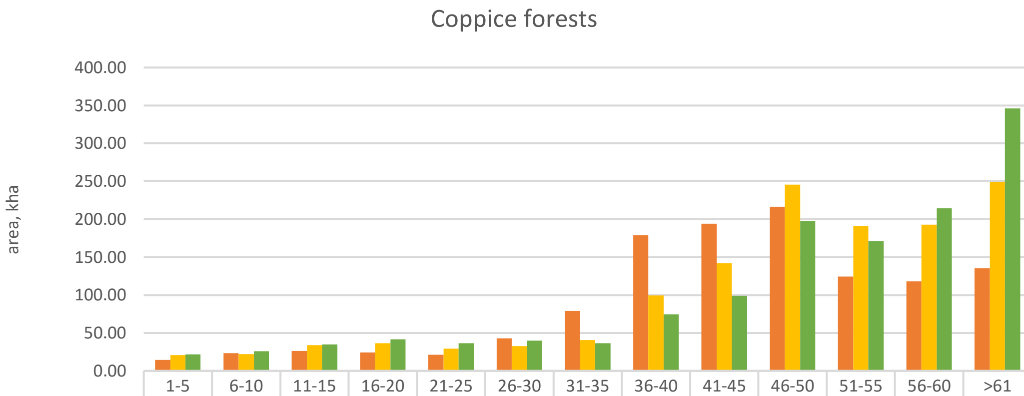
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Poplar 2000	17.690	1.792	0.266	0.022	0.035	0.001	0.000	0.000
Poplar 2005	52.048	5.239	1.328	0.257	0.018	0.006	0.000	0.075
Poplar 2010	55.566	5.334	1.532	0.228	0.004	0.004	0.000	0.038

High-stem other tree species



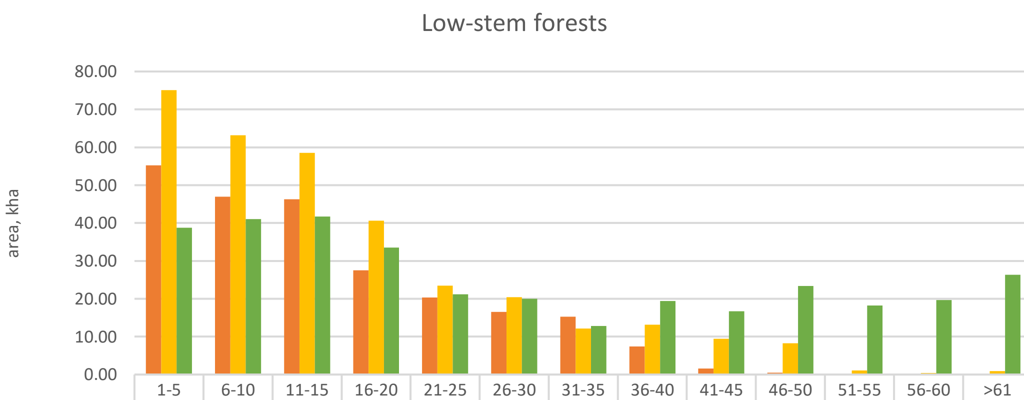
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Others 2000	39.458	48.133	26.329	8.604	5.160	4.568	3.279	2.267
Others 2005	66.183	86.868	86.772	36.300	13.097	12.715	11.727	5.818
Others 2010	76.571	92.428	91.938	48.537	15.818	13.740	12.552	7.332

Figure 16 Area distribution by age classes for deciduous broadleaved oak, beech, poplar and others



	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	>61
Coppice 2000	14.422	23.286	26.278	24.032	21.323	42.884	79.137	178.701	194.166	216.446	124.219	117.951	135.097
Coppice 2005	20.634	22.202	33.839	36.449	29.474	32.832	40.692	99.443	141.997	245.367	191.095	192.834	248.974
Coppice 2010	21.471	25.772	34.969	41.722	36.483	40.034	36.429	74.284	98.867	197.827	171.348	214.457	346.254

Figure 17 Area distribution by age classes for coppice forests



	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	>61
Others 2000	55.202	46.944	46.309	27.532	20.316	16.549	15.261	7.403	1.621	0.445	0.257	0.258	0.000
Others 2005	75.093	63.203	58.492	40.592	23.504	20.455	12.134	13.182	9.399	8.273	1.084	0.403	0.937
Others 2010	38.721	41.062	41.706	33.522	21.142	19.979	12.795	19.431	16.715	23.374	18.186	19.699	26.375

Figure 18 Area distribution by age classes for low-stem forests

Table 6 Mean age of the forests by strata

№	Name of starata	2000	2005	2010
1	Coniferous	42	46	50
1.1	Natural forests	66	71	78
1.2	Plantations	28	31	34
2	Deciduous	49	53	56
2.1	High stem deciduous forests	73	78	82
2.1.1	Oak - high stem	59	64	67
2.1.2	Beech - high stem	85	89	91
2.1.3	Poplar	13	14	14
2.1.4	Others - high stem	40	46	48
2.2	Coppice forests	44	47	48
2.3	Low-stem forests	15	17	29
	Total Managed Forest Lands	51	53	57

Table 7 Growing stock by strata for the RP, m^3

№ Strata	Strata	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Coniferous	231	237	242	248	253	259	264	270	276	281
1.1	Natural forests	100	103	105	108	110	112	115	117	120	122
1.2	Plantations	131	134	137	140	143	146	150	153	156	159
2	Deciduous	294	302	309	317	325	332	337	342	347	352
2.1	High stem deciduous forests	150	154	158	162	167	171	174	177	180	183
2.1.1	Oak - high stem	27	28	29	29	30	31	32	32	33	34
2.1.2	Beech - high stem	101	103	105	107	110	112	114	116	118	120
2.1.3	Poplar	2	2	2	2	2	3	3	3	3	3
2.1.4	Others - high stem	20	21	22	23	24	25	26	26	26	27
2.2	Coppice forests	133	137	140	143	146	149	150	150	151	152
2.3	Low-stem forests	11	11	12	12	13	13	14	15	16	17
	Total Managed Forest Lands	525.56	538.68	551.8	564.92	578.04	591.16	601.84	612.52	623.19	633.87

Table 8 Carbon stock of living biomass (as total for above- and belowground) by strata, tC/ha

№ Strata	Strata	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Coniferous	63.42	64.39	65.99	67.20	68.63	70.30	72.15	74.01	75.31	76.58
1.1	Natural forests	87.09	88.07	89.18	83.52	85.19	85.91	87.05	85.94	83.15	86.61
1.2	Plantations	52.48	53.38	55.01	58.43	59.72	61.70	63.77	66.89	70.23	70.33
2	Deciduous	48.11	48.16	48.34	48.86	48.08	48.64	48.94	49.34	49.80	50.06
2.1	High stem deciduous forests	75.46	75.56	76.27	76.88	77.22	78.34	79.31	80.31	80.21	80.81
2.1.1	Oak - high stem	48.78	48.94	49.49	49.97	50.28	50.60	51.37	52.16	52.23	52.76
2.1.2	Beech - high stem	100.00	99.59	100.01	100.32	100.29	103.21	104.48	105.78	105.65	106.43
2.1.3	Poplar	33.29	35.19	37.31	39.32	41.12	37.37	37.69	38.02	37.84	37.99
2.1.4	Others - high stem	54.92	56.04	57.57	58.99	60.17	61.16	61.74	62.34	62.10	62.41
2.2	Coppice forests	41.19	41.26	41.04	41.41	40.23	41.14	40.85	40.85	41.68	42.22
2.3	Low-stem forests	11.94	12.08	12.55	12.99	12.95	12.65	13.58	14.38	14.67	14.67
	Total Managed Forest Lands	53.30	53.59	54.14	54.84	54.59	55.42	56.15	56.97	57.69	58.24

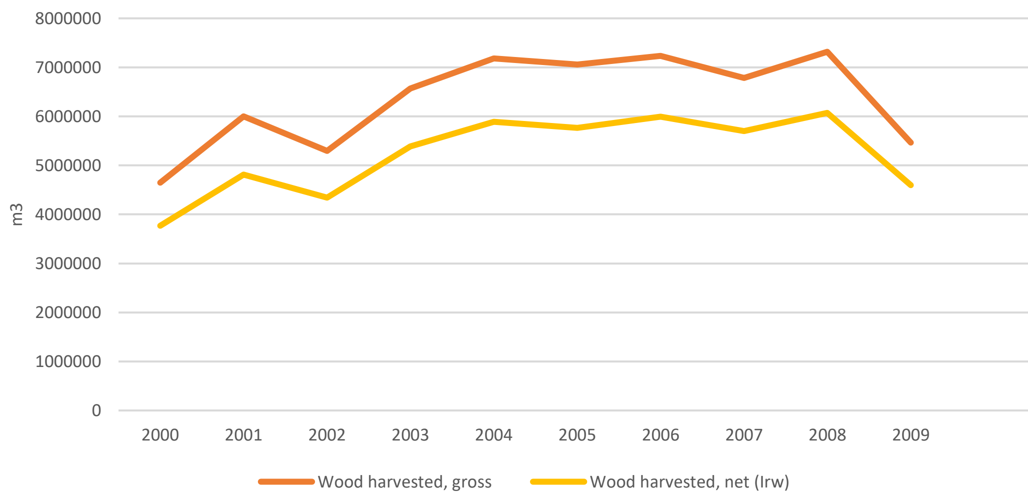
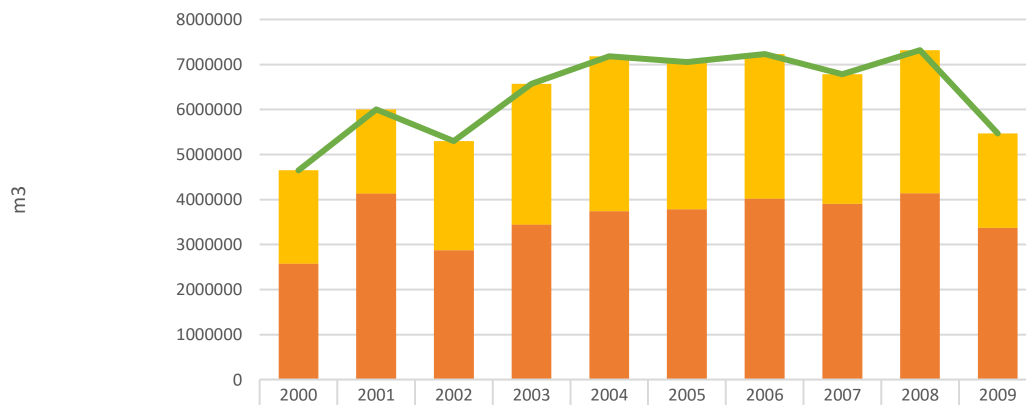


Figure 19 Total wood removals for the RP. Difference between the gross and net amount (logs), m³



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Thinning	2072518	1865578	2422852	3124842	3437160	3273410	3216521	2877235	3181080	2090282
Regeneration fellings	2574920	4132856	2872041	3444996	3743208	3782475	4017331	3907773	4136479	3374684
Harvest amount, gross	4647438	5998434	5294893	6569838	7180368	7055885	7233852	6785008	7317559	5464966

Figure 20 Wood removals (gross amount) from regeneration fellings and thinnings for the RP (2000-2009)

Table 9 The amounts of wood removals by strata from regeneration fellings for the RP (2000-2009)

Regeneration fellings	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coniferous	**775886**	**1626225**	**712357**	**787792**	**827325**	**931245**	**867771**	**944626**	**1084114**	**710885**
Natural forests	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Plantations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Deciduous	**1799034**	**2506631**	**2159684**	**2657204**	**2915883**	**2851230**	**3149560**	**2963147**	**3052365**	**2663799**
High stem deciduous forests	808091	1076563	860011	973695	1048472	985242	1037038	993552	961624	737988
Oak - high stem	140234	162895	135041	144884	156387	152562	154605	167313	151953	103808
Beech - high stem	436065	553065	444787	516861	594234	508027	528341	501485	483155	349198

Regeneration fellings	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Poplar	145302	180862	191306	195616	170885	195988	194214	181250	173828	150081
Others - high stem	86490	179741	88877	116334	126966	128665	159878	143504	152688	134901
Coppice forests	485078	932489	629047	898460	1116984	1218396	1446223	1434018	1576103	1536085
Low-stem forests	505865	498262	670626	785049	750427	647592	666299	535577	514638	389726

Table 10 The amount of wood removals by strata from thinning for the RP (2000-2009)

Thinning	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coniferous	**726705**	**536384**	**717569**	**975262**	**895343**	**731271**	**664193**	**543606**	**606639**	**508474**
Natural forests	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Plantations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Deciduous	**1196503**	**923814**	**1237876**	**1546589**	**1570317**	**1308265**	**1299839**	**1147061**	**1311974**	**1122407**
High stem deciduous forests	461474	2854817	3757534	4734069	5119495	4682960	4614824	4114310	4556782	3288742
Oak - high stem	76508	1865578	2422852	3124842	3437160	3273410	3216521	2877235	3181080	2090282
Beech - high stem	252308	65425	95526	61635	109751	100772	97780	88923	63728	76053
Poplar	9334	923814	1237876	1546589	1570317	1308265	1299839	1147061	1311974	1122407
Others - high stem	123324	0	1280	1003	2267	513	684	1091	0	0
Coppice forests	726705	15396	14710	4589	8126	8570	19502	9697	14264	6705
Low-stem forests	8324	950939	1196884	1594433	1875047	1968615	1922112	1740014	1874775	970296

It should be noted that some data about forests by stratum are estimates. As previously explained, RF data are difficult to combine. For example, the information about coniferous plantations and natural coniferous stands is raw data from RF 1, whereas the information about them in respect of land by age class, as well as the information about the growing stock are estimates based on the respective share of coniferous plantations and natural forest stands on the land by age class and growing stock. We have taken the information about the share of plantations and natural stands, used to calculate some of the characteristics for the forests, from the description sheets. For deciduous forests the information about the forested land in RF 1 is given only by type of forests – high-stem, coppices and low-stem. The land of high-stem forests by tree species is calculated based on the proportion of the relevant tree species, as specified in RF 2 (parcelled land by age class). Furthermore, for the deciduous we had to recalculate the time series for all characteristics of the forests except for the harvested mass report form. That was necessary because the conversion coppices class was eliminated. Conversion coppice forests comprise mainly by Oriental hornbeam. In the past those forests were managed by clear fellings with subsequent artificial afforestation. Due to the low efficiency and expensiveness of this practice, the conversion coppice of forests was abandoned at the end of the 20 c, but that fact was administratively reflected in the post-2010 reporting forms when the conversion coppices class was included in the coppice class. That called for recalculating the data about forests by stratum for the deciduous forests in the period 2000-2010, because the conversion coppice class is reported separately in the reporting forms for those years. Nevertheless, we have taken into account the conversion coppice (under the name Low-stem Oriental hornbeam) as a percentage of harvesting in total growing stock by stratum when describing the forest management practices. After that, when simulating the growth and harvesting of Oriental hornbeam (part of the low-stem stratum) we have applied the forest management practice typical for the conversion coppice.

Description of the documents containing information about sustainable forest management practices applied in the reference period (2000-2009). Forest management intensity in the reference period

According to Article 8, 5) of Regulation (EU) 841/2018, "the forest reference level shall be based on the continuation of sustainable forest management practices, as documented in the period from 2000 to 2009". For the purposes of documenting the practices applied during the RP, we have presented qualitative (Table 11 Description of the types of fellings, conducted in Bulgaria during the RP (2000-2009)) and quantitative (Table 12) information about the sustainable management practices. The qualitative information about the management practices includes description of the types of felling and the adopted felling rotation, as described in Ordinance No. 33/2003 on fellings in Bulgaria. The ordinance was in force during the RP. The qualitative information about practices thus presented covers the variety of the types of fellings applied in the forests and describes their application in the forest management practice in Bulgaria.

To project the harvesting in the commitment period (2021-2025) we have used the quantitative description of the sustainable management practices, expressed as the wood harvesting percentage of total growing stock by stratum, calculated as an average value for the reference period. This information is presented in Table 12.

Illegal cuttings are not considered in our projections although they might have a significant share in Bulgaria. Some studies suggest that the illegal cuttings in Bulgaria could have an amount of 20% of the total harvest in the country but there is no official data to confirm this.

Table 11 Description of the types of fellings, conducted in Bulgaria during the RP (2000-2009)

No.	Name	Short description of practice	Felling rotation, years	Data source
1	Coniferous, high yield class, with natural regeneration, even-aged	Homogenous or mixed stands of Scots pine, European silver fir, black pine, etc., relatively even-aged. Regeneration felling is carried out when the regeneration process goes regularly across the whole land of the stand. Short-term gradual felling is applied in which trees are cut in several stages – the so-called felling stages, in the course of not more than 20 years. The adopted rotation for high-yield-class coniferous species is 120 years.	120	Ordinance No.33/2003

No.	Name	Short description of practice	Felling rotation, years	Data source
2	Coniferous, high yield class, with natural regeneration, uneven-aged	Homogenous or mixed uneven stands of Scots pine, spruce, European silver fir, black pine, etc., uneven-aged. Regeneration felling is carried out when the regeneration process goes regularly across the whole land of the stand. Short-term gradual felling is applied in which trees are cut in several stages – the so-called felling stages, in the course of not more than 20 years. The adopted rotation for high-yield-class coniferous species is 120 years.	120	Ordinance No.33/2003
3	Coniferous, selective management, high yield class	Uneven-aged stands managed in a selective form of management. Felling is carried out across the whole land of the stand, cutting separate trees or groups of trees of all diameter levels. The felling intensity is up to 20% of the growing stock. The rotation is at intervals of not less than 10 years.	>10	Ordinance No.33/2003
4	Coniferous plantations	Artificially created plantations, mainly of Scots pine and Black pine in the lower forest edge. Plantations may be homogenous or mixed. They are manged mainly through intermediate and sanitary fellings. The adopted rotation is 80 years.	80	Ordinance No.33/2003
5	Coniferous, medium- and low-yield class	Homogenous or mixed of Scots pine, spruce, European silver fir, black pine, etc., with low productivity and yield class from III to VI. They are managed by gradual fellings – regularly across the land or by opening gaps, in several stages. The adopted rotation for medium- and low-yield-class coniferous species is 120 years.	100	Ordinance No.33/2003
6	Mixed coniferous	Mixed stands of Scots pine, spruce, European silver fir, black pine, etc., with low productivity and yield class from III to VI. They are manged by gradual fellings – regularly across the land or by opening gaps, in several stages. The adopted rotation for medium- and low-yield-class coniferous species is 120 years.	120	Ordinance No.33/2003

No.	Name	Short description of practice	Felling rotation, years	Data source
7	Mixed coniferous-deciduous stands, high-yield class	In the most part, these are partially failed trees. They are managed by gradual fellings – regularly across the land or by opening gaps, in several stages. The adopted rotation of the felling is 100 years.	100	Ordinance No.33/2003
8	Mixed coniferous-deciduous stands, medium- and low-yield-class	In the most part, these are partially failed trees. They are managed by gradual fellings – regularly across the land or by opening gaps, in several stages. The adopted felling rotation is 100 years.	100	Ordinance No.33/2003
9	High-stem forests of oak, high-yield-class	Homogenous stands of oak with high productivity, mainly of I^{st} and II^{nd} yield class. They are managed by gradual fellings – regularly across the land (in case of short-term gradual felling) or by opening gaps (in case of gradual-group felling), in several stages. The regeneration period is no longer than 20 years. The adopted felling rotation is 140 years.	140	Ordinance No.33/2003
10	High-stem forests of high-stem forest of beech stands, high-yield-class	Homogenous beech stands with high productivity, mainly of I and II yield class. Short-term gradual fellings are applied when regeneration is regular or when gaps are opened, in case of group regeneration (group-gap felling). Fellings are carried out in several stages in the course of no more than 20 years in case of short-term gradual felling and of more than 20 years in case of group-gradual felling (gap felling). The adopted felling rotation is 140 years.	140	Ordinance No.33/2003
11	High-stem forests of oak, medium- and low-yield-class	Homogenous oak stands with low productivity, mainly of III to VI yield class. They are managed by gradual fellings – regularly across the land or by opening gaps, in several stages. The adopted felling rotation is 120 years.	120	Ordinance No.33/2003

No.	Name	Short description of practice	Felling rotation, years	Data source
12	High-stem forests of beech, medium- and low-yield-class	Homogenous stands of oak with low productivity, mainly of III to VI yield class. They are managed by gradual fellings – regularly across the land or by opening gaps (gradual-gap felling, in several stages. The adopted felling rotation is 100-120 years.	100-120	Ordinance No.33/2003
13	High-stem deciduous stands	Homogenous or mixed stands of deciduous species, including hornbeam, linden, ash-tree, etc., with high productivity, mainly of I and II yield class. They are managed by gradual fellings – regularly across the land or by opening gaps, in several stages.	-	Ordinance No.33/2003
14	Coppice for transformation	Homogenous or mixed stands of different deciduous species, including beech, oak, hornbeam, linden, etc. The stands are relatively even-aged, originating as a result of natural regeneration through sprouts. When sprout stands are grown into seed stands, natural regeneration through seeds can be artificially aided. Coppice management by notional clear felling is applied, in accordance with the following rules: 1. 85 - 95 % of the stand is felled, leaving 100 – 150 seed trees per hectare, with good trunk shape, in good health, distributed regularly across the land; 2. Felling is repeated at intervals of 20 - 25 years, selecting new 60 - 70 seed trees per hectare, and the remaining portion is managed as coppice system with rotation of 20 - 25 years; 3. Seed trees are managed up to the age of 80 - 120 years	Sprouts are with rotation of 20-25 years and seed trees are with rotation of 80-120 years	Article 50 (5) of the 1997 Forestry Act.; Ordinance No. 33/2004
15	Low-stem forests	Homogenous or mixed stands of different deciduous species, including beech, oak, hornbeam, lime, etc. They are managed in a way ensuring their coppice regeneration.	44	Article 50 (5) of the 1997 Forestry Act.

No.	Name	Short description of practice	Felling rotation, years	Data source
16	Poplar stands	Mainly plants of vegetation origin created for accelerated production of biomass. They are managed by clear fellings with rotation of 15 years. Intermediate fellings are not carried out.	15	Article 50 (5) of the 1997 Forestry Act.
17	Creeping pine stands	No fellings other than sanitary are carried out	0	Article 52 (2) the 1997 Forestry Act.
18	Stands in protected areas	The plot method (management by stand) is applied in the development of protective and recreation forests, as well as forests in protected area, with all forestry events related to forest harvesting and management being selected according to the forestry and the health condition of the different stands, as well as based on the assessment of the performance of their special functions	Differs depending on the conditions of the stand, its composition and the protection regime	Ordinance No.6/2004

Table 12 Quantitative aspects of the Forest Management Practices, expressed as a percentage of the wood removal (gross) from the total growing stock for each stratum

FMP	Type of felling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	mean
High-stem beech	regeneration fellings	0.41%	0.51%	0.40%	0.46%	0.51%	0.43%	0.44%	0.41%	0.38%	0.27%	**0.42%**
High-stem beech	thinning	0.24%	0.17%	0.23%	0.26%	0.29%	0.21%	0.23%	0.21%	0.30%	0.26%	**0.24%**
High-stem oak	regeneration fellings	0.52%	0.59%	0.48%	0.50%	0.52%	0.50%	0.49%	0.52%	0.46%	0.31%	**0.49%**
High-stem oak	thinning	0.29%	0.24%	0.34%	0.21%	0.37%	0.33%	0.31%	0.28%	0.19%	0.23%	**0.28%**
Low stem, Oriental hornbeam	regeneration fellings	1.09%	0.89%	1.19%	1.41%	1.34%	0.98%	1.17%	0.97%	0.00%	0.00%	**0.90%**
Low stem, Oriental hornbeam	thinning	0.00%	0.00%	0.01%	0.00%	0.01%	0.00%	0.00%	0.01%	0.00%	0.00%	**0.00%**
Coniferous	regeneration fellings	0.34%	0.69%	0.29%	0.32%	0.33%	0.36%	0.33%	0.35%	0.39%	0.25%	**0.36%**
Coniferous	thinning	0.38%	0.40%	0.49%	0.64%	0.74%	0.76%	0.73%	0.64%	0.68%	0.34%	**0.58%**
Coppice	regeneration fellings	0.42%	0.78%	0.51%	0.71%	0.85%	0.90%	1.04%	1.01%	1.08%	1.03%	**0.83%**
Coppice	thinning	0.63%	0.45%	0.58%	0.77%	0.68%	0.54%	0.48%	0.38%	0.42%	0.34%	**0.53%**
Low stem, Black locust	regeneration fellings	3.61%	4.02%	5.23%	5.89%	5.47%	4.95%	4.40%	3.30%	3.51%	2.38%	**4.28%**
Low stem, Black locust	thinning	0.12%	0.21%	0.19%	0.05%	0.09%	0.09%	0.18%	0.08%	0.10%	0.04%	**0.11%**
Poplars	regeneration fellings	8.25%	9.46%	9.27%	8.84%	7.23%	7.79%	7.60%	6.98%	6.59%	5.60%	**7.76%**
Poplars	thinning	0.53%	0.48%	0.58%	0.73%	0.35%	0.14%	0.21%	0.38%	0.21%	0.09%	**0.37%**
High-stem other broadleaves	regeneration fellings	0.61%	0.83%	0.70%	0.84%	0.90%	0.86%	0.93%	0.87%	0.88%	0.76%	**0.82%**
High-stem other broadleaves	thinning	0.41%	0.31%	0.40%	0.49%	0.51%	0.39%	0.39%	0.34%	0.38%	0.32%	**0.39%**

Detailed description of the calculation and projection model used to determine the reference level

Classical simulation (Fortschreiben) by yield table was used to model growth and harvesting. The removals were presented as average percentages for the reference period 2000-2009, which were applied unchanged for the projection period 2010-2030. Growing stock, growth and harvesting simulation is based on the distribution of forest area and growing stock by tree species, yield class and age as at 2010. For the sake of simplicity, we distinguish only the so-called **tabular species**, i.e. the most important tree species for which yield tables are developed. Area and growing stock of all other species are added to those of the appropriate tabular species, for example, all oaks are gathered together, etc. Coppice beech, oak, linden and locust are considered separate tree species because their growth is different from that of high-forest beech, oak, linden and locust and is modelled with separate yield tables. The same is true also for plantations of Scots and black pine, whose growth is different from that of natural Scots and black pine.

Table 13 List of the tree species for which a country-specific yield table is available and their correspondence to the stratification of MFL

Coniferous, natural forests
Scots pine, S
Black pine, S
Pinus peuce
Norway spruce
Silver fir
Coniferous, plantations
Scots pine, P
Black pine, P
High-stem oak
Oak, S
High-stem beech
Beech, S
High-stem others
Silver birch
Willow
Alder
European Hornbeam
Linden, S*
Linden, C*
Aspen
Plane
European Ash
Poplars
Poplar
Coppice forests
Beech, C
Oak, C
Low-stem forests
Black locust, C*
Black locust, P*
Oriental hornbeam

S - seed origin
C - coppice
P - plantations
*irrespective of their origin, tree species with * are assigned to the land corresponding to the actual applicable forestry practice. For example, acacia forests are assumed to be low-stemmed, irrespective of the origin of the plantation.

In the list, S is for seed natural stands, C is for coppice stands, and P is for plantations. Every combination of tabular species and yield class defines one sub-stratum – a subdivision of the strata described above. The sub-stratum includes lands and growing stock under one growth table.

The structure of the land and the growing stock in a sub-stratum is presented with the values

$$a_0, \quad a_1, \quad a_2, \quad ...., \quad a_M$$

$$0, \quad v_1, \quad v_2, \quad ...., \quad v_M, \quad v_{M+1}, \quad v_{M+2}$$

wherein a_j is the sum of partial area of this tree species and yield class with age j (*Jahre*), and v_j is the sum of the respective partial growing stock. Area is in hectares and volume is in solid cubic metres (*Vorratsfestmeter!*). M is the maximum age of a stand which is set at 204 years. v_{M+1} is the volume of overstory trees and v_{M+2} is the stock of trees in the second storey of the two-storeyed stands which are rare in Bulgaria. No area is assigned here to overstoreys and understoreys. Their age is dummy (not used in any calculation). Their actual age is ignored because it is considered that they do not grow. a_0 is the hectares of the cutting areas emerging during the year. Cutting areas do not have growing stock, of course.

Every growing stock v_j can be collated to its tabular or normal stock N_j, which is measured in cubic metres per 1 ha.

$$0, \quad N_1, \quad N_2, \quad ...., \quad N_M$$

The normal stock N_j can be used to calculate the average stocking rate (Bestockungsgrad) b_j of each growing stock v_j:

$$b_0, \quad b_1, \quad b_2, \quad ...., \quad b_M -$$

The average stocking rate is determined applying the formula:

$$b_j = \frac{v_j}{a_j N_j}.$$

The formula is not applied when the stock $v_j = 0$. This is the case for age 0 as well as for young stands with height under 3 m, whose stock is ignored in forestry. In those cases

$$b_j = b_0,$$

where $b_0 = 0{,}75$ is a constant corresponding to the average stocking rate of 1st age class under RF6. This constant reflects the average success of regeneration or the average percentage of plants taking roots.

The annual removal (*Nutzung*) in the sub-stratum is determined applying the formulas:

$$E = P(v + v_{M+1}),$$

$$V = p(v + v_{M+2}),$$

where E is annual removal from final cuts (*Endnutzung*), P is the average percentage of such removals relative to total growing stock, v is the sum of growing stock (without overstory and understory volumes).

$$v = v_1 + v_2 + ... + v_M ,$$

V is removal from thinningss, p is the average percentage of such removals relative to total growing stock. The formulas show that only final cuts are carried out in the overstorey, whereas only thinnings are carried out in the lower storey below the canopy of the main stand.

The harvesting percentages are determined by strata as an average for the reference period.

$$P = \frac{E_5}{v_3} ,$$

$$p = \frac{V_5}{v_3} ,$$

where E_5 is final cuts removal under RF5 in the stratum, v_3 is the growing stock of the stratum under RF3, V_5 is thinnings removal in the stratum under RF5. Since RF3 and RF5 do not distinguish the yield classes (Bonitäten o. Ertragsklassen) and some details about tree species and origin, a single percentage is established for each stratum, which is then applied to its sub-strata.

The harvesting percentages thus calculated are significantly different from the use percentage, a figure within 15% to 100%, which can be read in the description sheet of each stand where cutting is planned. They are on average much lower because, for economical and accessibility reasons, not all forest stands are brought to use. Nevertheless, the use percentages we have derived and applied, at least for the final cuts, strongly correlate to the usual rotation ages (*Umtriebszeiten*) and are around 5-10% for short rotation plantations (around 15-25 years) and around 0,5% for the prevailing rotations of 50 to 150 years, i.e. in almost all cases.

Based on the values defined above, the development of the sub-stratum over a period of 20 years is simulated, as follows:

- It is conventionally assumed that fellings are carried out in the autumn and in the winter and growth occurs in the spring and in the summer, including the vegetation period of forest tree species. Actually, many fellings are carried out in the vegetation period, but with a ten-year time horizon this does not affect the results.
- It is assumed that the oldest stands are used for final cuts. In practice, there are deviations from this assumption for the various well-known reasons. With the usual long rotations, however, stands with negligible increment are used, so that using one stand for felling instead of another has limited impact on the development and storing of the forest biomass.

Consequently,

$$E = \varepsilon v_n + v_{n+1} + ... + v_M + v_{M+1} ,$$

wherein $v_{n+1} + ... + v_M + v_{M+1}$ is the volume of the mature forest stands which covers approximately the annual cut and ε is the portion of the volume v_n which has to be cut in order to fulfil the planned use E.

As a result of the fellings, the spring state of the area a'_j, the volume v'_j and the stoking rate b'_j, changes as follows:

The growing stock aged above *n* is cut down, resulting in setting to 0 the respective areas, volumes and stocking rates:

$$a'_{n+1} = a'_{n+2} = ... = a'_M = 0,$$

$$v'_{n+1} = v'_{n+2} = ... = v'_M = 0,$$

$$b'_{n+1} = b'_{n+2} = ... = b'_M = 0,$$

The volume v_n is cut only partially, while the stoking rate of the remaining portion is preserved

$$a'_n = (1-\varepsilon)a_n$$

$$v'_n = (1-\varepsilon)v_n$$

$$b'_n = b_n .$$

All cleared areas are immediately afforested and converted into stands of the same tree species and yield class and with age 0. The volume of these stands is 0, and their stocking rate is equal to the average stocking rate b_0, defined above.

$$a'_0 = \varepsilon a_n + a_{n+1} + ... + a_M + 0$$

$$v'_0 = 0,$$

$$b'_0 = b_0,$$

The immediate regeneration of the cleared lands with the same tree species is a quite common convention. In Bulgaria, it is very probable due to the prevailing natural regeneration of stands by seed. The preservation of the sprout origin of the existing coppices is also probable because their conversion into seed stands runs into difficulties of silvicultural, technical and financial nature. Conversion of coniferous plantations outside their natural area into broadleaved high forests is also ignored because the implementation of this decision has not started yet and it will undoubtedly have the same problems as the conversion of oak coppices.

All other spring areas, volumes and stocking rates remain unchanged because it is assumed that the forest does not grow in the autumn and in the winter.

$$a'_j = a_j$$

$$v'_j = v_j$$

$$b'_j = b_j .$$

The growth in the vegetation season is reflected by increasing the age of all forests by 1 year. This is reflected by shifting all areas and stocking rates one year ahead. The growing stock is then recalculated, based on area, stocking rate and normal volume. As a result of the growth in the vegetation season, autumn growing stock, lands and densities are determined on the basis of the spring ones, as follows

$$a_j = a'_{j-1}$$

$$b_j = b'_{j-1}$$

$$v_j = b_j N_j a_j \, .$$

Area and volume of the forests aged $M-1$ are added to area and volume aged M : thus, the stopping of growth at high age is modelled by stopping the passage of time. The density of this age is ignored because it does not participate in the calculations. Ultimately,

$$a_M = a'_M + a'_{M-1}$$

$$b_M = 0$$

$$v_M = v'_M + v'_{M-1}$$

The growing stock of overstorey and of lower storeys is not changed because their increment is weak (due to the old age, the suppression by the main stand, accordingly) and is conventionally ignored.

$$v_{M+1} = v'_{M+1}$$

$$v_{M+2} = v'_{M+2}$$

Lands at the age of 0 are cleared, i.e., it is assumed that $a_0 = 0$ и $v_0 = 0$.

Thinnings participate implicitly in the simulation. Bulgaria continues to apply thinnings from below, which are included in the yield tables.

The same yield tables used for decades in forestry in Bulgaria have been used to model the development of the growing stock, with the exception that the tables for oak stands (of the German author Wimmenauer for oak high forest and of the Russian author Shustov for oak coppices) were replaced by the local Nedyalkov's tables (one for high forests and one for coppices), which are published but are not put into common use.

Foresters have been long aware of the defects of the tables of Wimmenauer and Shustov as a growth model for oak in Bulgaria. The tables are considered tolerable for short-term decisions. However, they could be compromised in a relatively long-term prognosis. To justify their replacement, we compared them to real data. For the purpose, the growth curves of height were compared to the actual distribution of afforested land by age and height made using the database of forest stands. To this purpose, early records of this base were used, made in 1995, i.e. before the most severe economic crisis of transition. All forest stands, which at that time were 750 000 in number, are included in the comparison, i.e. this is not a sample survey involving statistical risk.

The comparison with real data shows that the tables of Wimmenauer and Shustov do not match the growth of oak in Bulgaria – they highly overestimate the increment of height, whereas Nedyalkov's tables reflect the growth of local oak quite accurately.

Figure 21 compares Shustov’s table to the distribution of oak coppices by age and height. Like in the subsequent figures, the combinations of age and height, which are represented in at least 10 forest stands and can be considered reliable, are marked with tightly shaded diamonds. Rare and isolated cases, which are more likely to be burdened by serious measurement and keyboard errors, are marked with hollow diamonds or dots and are not taken into account in the considerations. The curve fans represent the growth of height for different yield classes according a yield table.

Figure 21 shows that stands, which are much lower than the curve of the last yield class 5, are widely represented in the forests. As stands are assigned to the nearest yield class curve for the calculations, Shustov’s table obviously overestimates the increment of those forests. The situation is no better for high yield classes. For ages above 30 years, Shustov’s curves are obviously steeper than the clearly outlined upper limit of the actual distribution, which also shows that they predict unrealistically high increment.

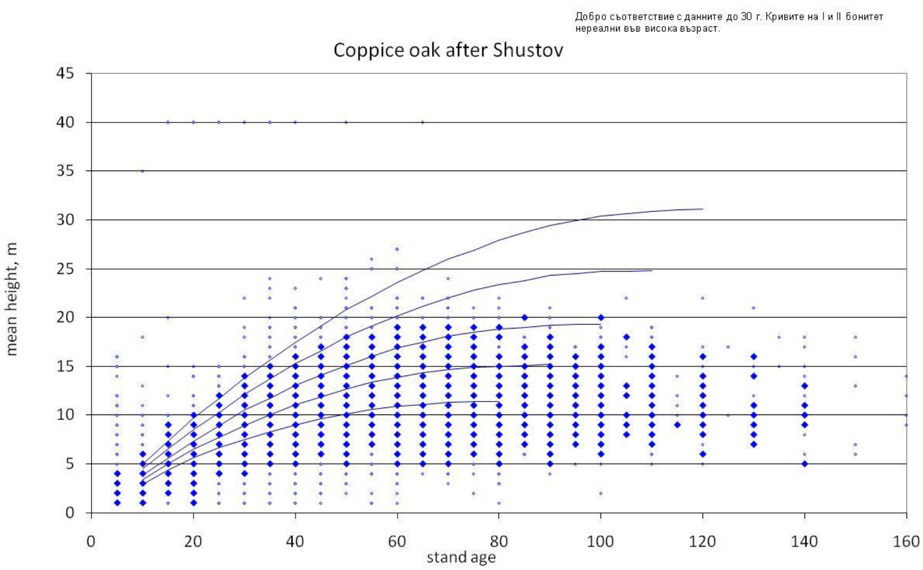


Figure 21 Comparison of the Shustov table with terrain data

The following Figure 22 shows that Shustov’s table cannot be adapted to reality by extrapolation. In this case the idea is to add two other low yield classes in order to cover the actual range of heights. However, the additional curves obtained by extrapolation are decreasing, i.e. they have incorrect behaviour and that renders them unusable.

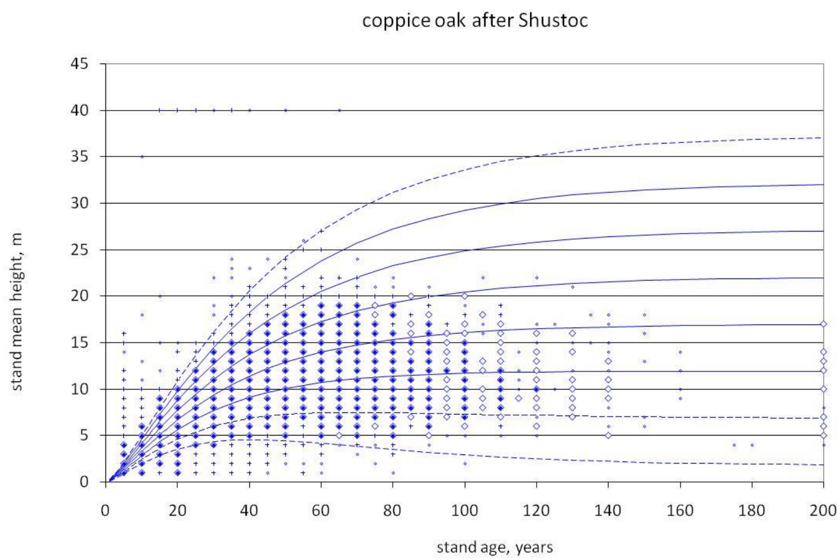


Figure 22 Extrapolation of the Shustov's growth table by yield class

The following Figure 23 shows that Nedyalkov's table for beech coppices, although referring to another tree species, matches quite well the actual structure of coppice oak. Publications contain several local tables for coppice oak, which also match well the field data, but their drawback is that they are not developed for age above 40 years. This circumstance is explainable by the fact that at the time those tables were created, coppice oak was managed mainly as simple coppice in which it rarely reached high age and up to the 1970ies there were no data about its growth at higher age. However, the decision to manage oak with a view to converting coppice forests into seed forests through natural seed regeneration has been implemented since post-war years and currently the average age of oak stands is 70 years.

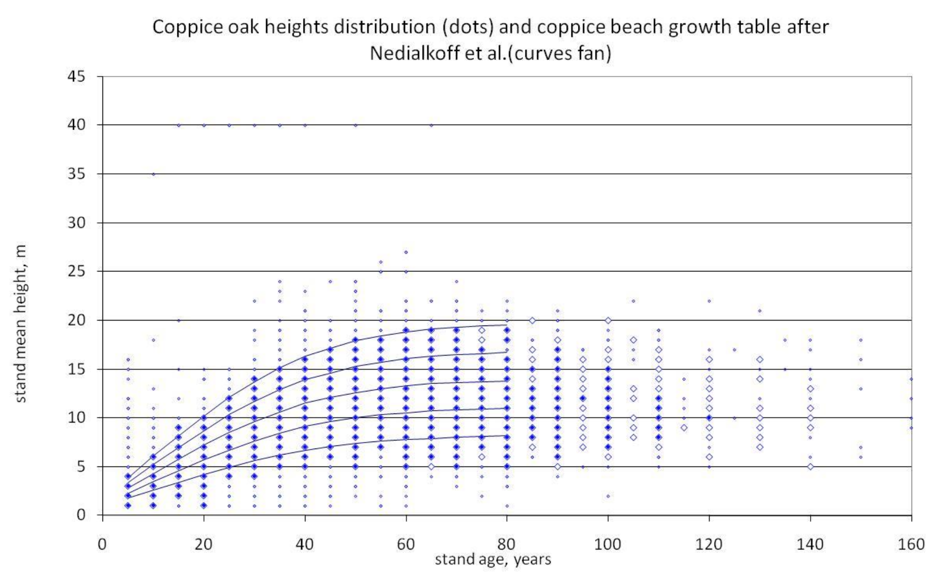


Figure 23 Comparison of the growth of the coppice oak with the yield table of Nedialkoff et al. for the coppice beech

Figure 24 presents a comparison of Wimmenauer's tables to the growth of high-forest oak in Bulgaria. The figure shows that after the age of 30-40 years growth according to Wimmenauer quickly loses grip on the of Bulgarian forests. Figure 5 shows that WImmenauer’s table cannot be adapted to our conditions by extrapolation of the yield class. Figure 6 shows that, on the other hand, Nedyalkov’s table for high-forest oak is in very good agreement with local data.

The mismatch is most probably due to the difference between the growth of oaks in Central Europe and on the Balkan Peninsular. Wimmenauer is a rather old author which is now almost not cited in Germany, but Utner’s oak tables currently in force, which have been prepared through long-term monitoring of the development of pilot lands, fully confirm growth after Wimmenauer in their conditions. Figure 24 shows, however, that, on the peninsular, the elongation growth of oak is inhibited at the age of 40, which is taken into account in Nedyalkov’s table. This growth pattern is also confirmed by the tables for high-forest oak in Romania of Armasescu et al.

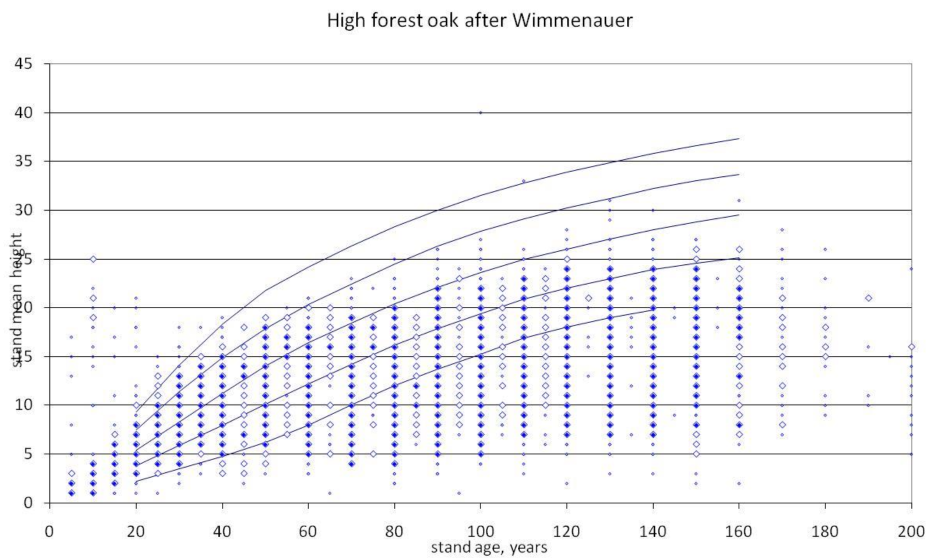


Figure 24 Comparison of the Wimmenauer’s yield table with terrain data

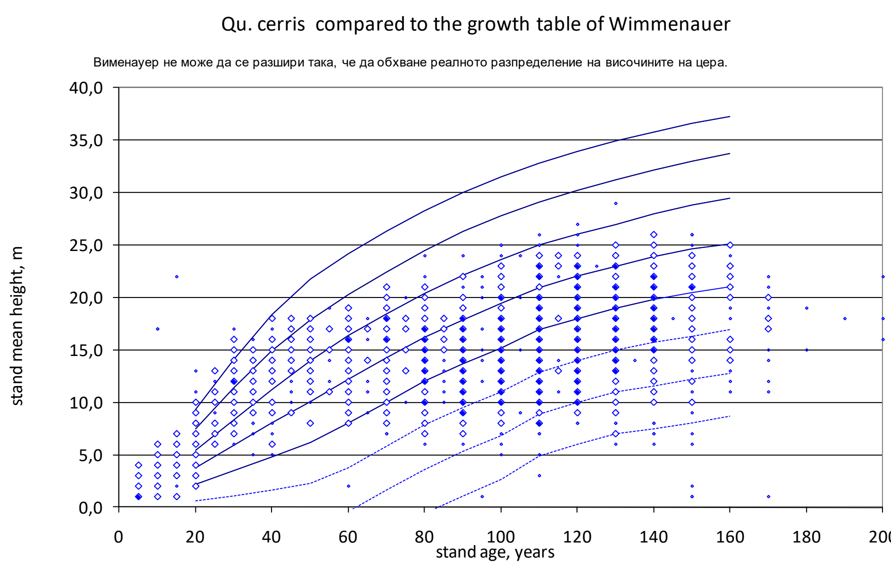


Figure 25 Extrapolation of the Wimmenauer’s growth table by yield class

The terrain points on Figure 25 refer only to Turkey oak, not to all oaks. That does not compromise the figure because the range of values for the structure of Turkey oak fully coincides with that of other oaks.

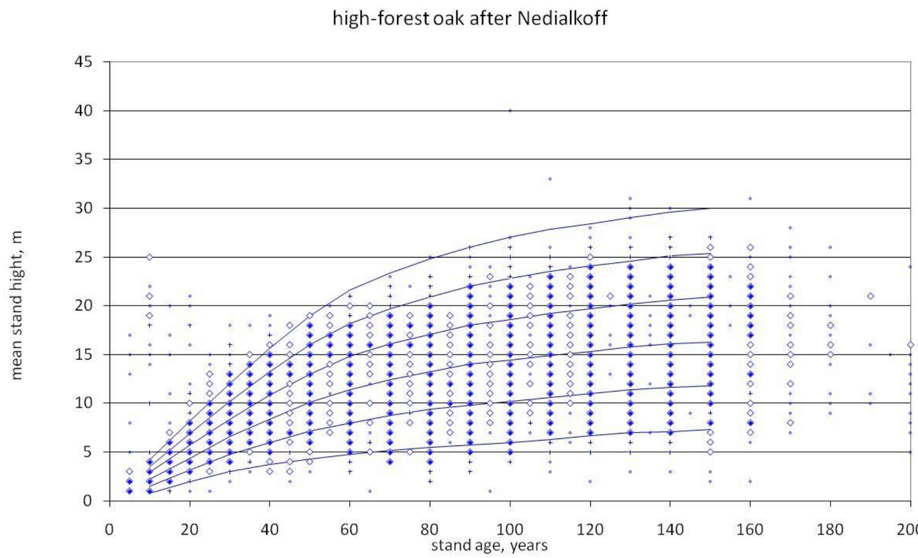


Figure 26 Comparison of Nedialkoff's growth table with terrain data

Nedyalkov's table for high-forest oak is not flawless but, luckily, the flaws are repairable by calculations. The bottom curve, which is necessary in order to represent the growth of the least-productive stands, was added by us by extrapolation of the yield class. By contrast, the top curve which, coming to the age of 40 years, goes into the range of rare and isolated cases, was abandoned. Thus, some stands aged under 40 years, which in Nedyalkov fall under yield class 1, will be referred to yield class 2, which underestimates their increment. The analysis shows that this is not a mistake because these are most probably stands of mixed origin from sprouts and seed with significant coppice element. It is typical for coppice stands that at an early age they grow faster than seedling stands ones but afterwards they quickly retard.

Development of Natural Disturbances under the FRL projections

Bulgaria chooses to use the provision on Natural Disturbances (NDs) and in case of major disturbances during the commitment period to exclude from the accounting emissions caused by ND up to the background level. That is way in the estimates of the projected FRL of Bulgaria, any effects of the natural disturbances are not taken into account. The background level (as an average emission from NDs for the period 2001-2020) would be estimated according to the methodology described in Annex VI of the LULUCF. The information of the background level of emissions will be submitted once the reference period for its estimation ends.

Forest Reference Level for 2021-2025.

The following assumptions have been taken into account when drawing up the forecasts of reference forest levels in Bulgaria:

1. Impact of expected change in climatic conditions - our model does not take into account the future effects of climate change when forecasting forest growth and use for the reporting period.
2. Changes in forest areas - Despite the trend of continuous increase of wooded land in Bulgaria, the level of the forest area is assumed to not change over time, both as an amount and between strata, when setting the reference level.
3. Starting year of projections - the first projected year is 2011. This is because the input data we used in the model are from the description sheets (inventory descriptions) from forest management plans whose data are average for 2010.
4. The 2010-2020 period - the defined area, as well as the assumption of a given tree species to the relevant area (shown in Figure 14), remain from the first forecast year until 2025. The area by strata does not change during this period. In terms of forest management practices, the same harvesting rate as an average for the RP is applied to the total growing stock of each strata.
5. Harvested wood products - a constant ratio between solid and energy use of forest biomass is assumed as documented in the period from 2000 to 2009

As an input data to the model, we used the description sheets from forest management plans database. As described above this enables us to consider the yield and origin of the stands when making the projections. The following tables and figures provide information on state of the forest in 2010 (input to the model) based on data from description sheets (Table 14) and based on RF (Table 15). The comparison between the two sources of data is provided in Table 16.

When investigate the tables the comparability of the data at the level of common woodland and total stock is very good - 0.33% for the areas and 7% for the stock. However, at the level of stratum it can be noted that for some stratum the differences are large between the data from description sheets and these from RF. In terms of the area, it can be seen that large differences exist in coniferous and low-stem forest. These discrepancies are explained by the fact that for the data coming from description sheets, the areas are partial, whereas for the RF 1 (Table 15), the areas are at the level of stands. Like this, in RF 1 the area of mixed (coniferous and deciduous) forest stands goes under the respective species of forests according to the predominant tree species in the stands. This explains why disparities are significant in coniferous and low-stem forests. Many of the coniferous plantations are afforested at an altitude that is lower than their natural range in Bulgaria, where they form mixed stands with deciduous trees. The data coming from description sheets, as well as data from RF 2 and 3, refer to the parcel area. Thus, in a mixed forest stands, the area of the tree species is distributed among the respective tree species and/or forest types they correspond.

In terms of growing stock, the observed variations between the two sets of data are large in broad-leaved species. This is explained by the fact that in the projections of the FRL we use different growth tables for high-stem oak forests and coppice oak forests. The justification for this change is given on p. 60, Figure 21-Figure 26. To confirm that there is a good match between the data from description sheets and RF, we compared the data on growing stock for all strata except for those where oak tree species are present and the comparability of data is quite good (-1%).

Table 14 State of the forest in 2010 based on latest available data from description sheets

State of the forest, 2010. Data from Forest Magement Plans			
№	Strata	Area, ha	Growing stock, m^3
1	**Coniferous**	**1002373**	**289327160**
1.1	Natural forests	448519	139741005
1.2	Plantations	553854	149586155
2	**Deciduous**	**2747369**	**404139172**
2.1	High stem deciduous forests	851091	185825869
2.1.1	Oak - high stem	253945	40995266
2.1.2	Beech - high stem	407747	113014700
2.1.3	Others - high stem	22158	28964468
2.1.4	Poplar	167240	2851435
2.2	Coppice forests	1403212	192789694
2.3	Low-stem forests	493066	25523609
	Total Forest Managed Lands	**3749742**	**693466332**
	Total Forest Managed Lands, without 2.1.1, 2.2, 2.3		**434157763**

Table 15 Stratum-specific data on area and growing stock for 2010 based on data from wooded area reporting forms (RF; RF1 and RF 3)

Forest data based on RF 1 and 3, 2010			
№	Strata	Area, ha	Growing stock, m^3
1	**Coniferous**	**1122024**	**287118426**
1.1	Natural forests	434793	124683183.1
1.2	Plantations	687231	162435242.9
2	**Deciduous**	**2615518**	**357430984**
2.1	High stem deciduous forests	845549	186233686
2.1.1	Oak - high stem	250053	34364712
2.1.2	Beech - high stem	413338	121930799
2.1.3	Others - high stem	160117	27215324
2.1.4	Poplar	22041	2722851
2.2	Coppice forests	1339917	153032341
2.3	Low-stem forests	430052	18164957
	Total Forest Managed Lands	**3737542**	**644549410**
	Total Forest Managed Lands, without 2.1.1, 2.2, 2.3		**438987400**

Table 16 Differences, expressed in %, between the two sources of data by strata (description sheets and RF)

Difference, in % between SoF and RF 1 and 3, 2010			
№	Strata	Area	Growing stock
1	**Coniferous**	**-11%**	**1%**
1.1	Natural forests	3%	11%
1.2	Plantations	-19%	-9%
2	**Deciduous**	**5%**	**12%**
2.1	High stem deciduous forests	1%	0%
2.1.1	Oak - high stem	2%	16%
2.1.2	Beech - high stem	-1%	-8%
2.1.3	Others - high stem	4%	6%
2.1.4	Poplar	1%	5%
2.2	Coppice forests	5%	21%
2.3	Low-stem forests	13%	29%
	Total Forest Managed Lands	**0%**	**8%**
	Total Forest Managed Lands, without 2.1.1, 2.2, 2.3		**-1%**

Description of the development of carbon pools

As set out in Chapter I, the forest reference level in Bulgaria is calculated for the following carbon pools – biomass (total above- and belowground), dead wood and HWP. Carbon stock changes in the soils and litter are not taken into account due to a lack of data and capacity to calculate carbon stock changes these pools for land remaining in the same land use category. According to the LULUCF Regulation, emissions and removals from these pools may be disregarded if information to justify that the pool is not a source is provided. For this purpose, we reviewed the current national scientific literature on the subject of soil and litter carbon stock in forests (Zhiyanski et al , 2008, 2009,2011, 2013, 2016, Sokolovska et al., 2007, 2009 and others). The soils in Bulgaria are mostly mineral soils and are characterized by the presence of carbon accumulation processes. Natural disturbances are common for Bulgaria but at relatively small areas, where we consider that cannot cause emissions in soils in particularly high dimensions. In addition, in the forestry practice in Bulgaria the soil preparation through scarification is not applied. Significant part of Bulgarian forest regenerates naturally (79%, p. 24). In support of the above, there are also scientific publications confirming that changes in the management of forest ecosystems do not cause significant changes in soil organic carbon stock. However, changes in carbon stock in litter due to forest management and natural disturbances are reported in the literature, but the data are insufficient (Zhiyanski et al., 2008) and we assume that there is no change in litter's carbon stock at this stage.

Biomass

For the calculation of emissions and removals from biomass, the results of the calculation and projection model, regarding growing stock by strata and age classes, have been used. After applying the emission factors listed in Table 5, we calculated the carbon stock in biomass – together for above- and belowground. The emission factors used are identical to these used in the GHG inventory. The annual change in carbon stock in living biomass serves to calculate emissions and removals from this pool.

.

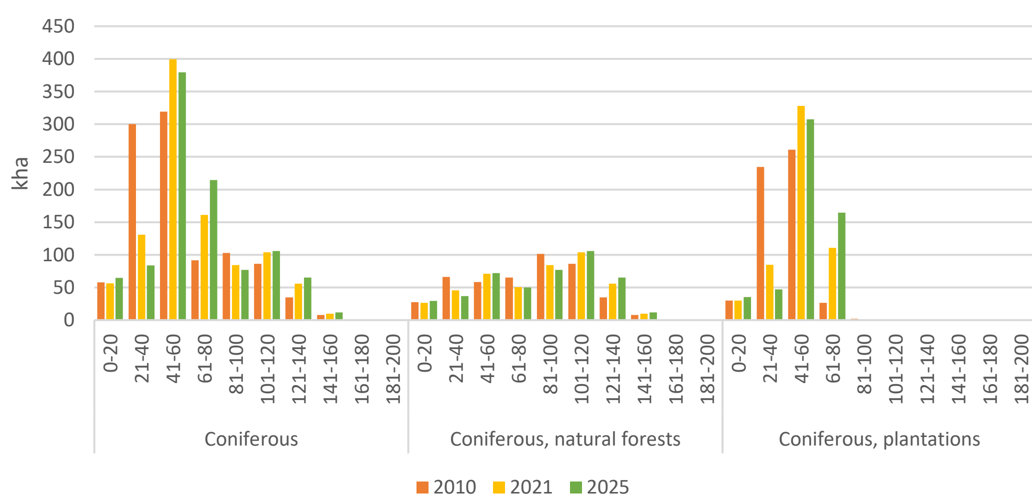


Figure 27 Dynamics of age structure of coniferous forests

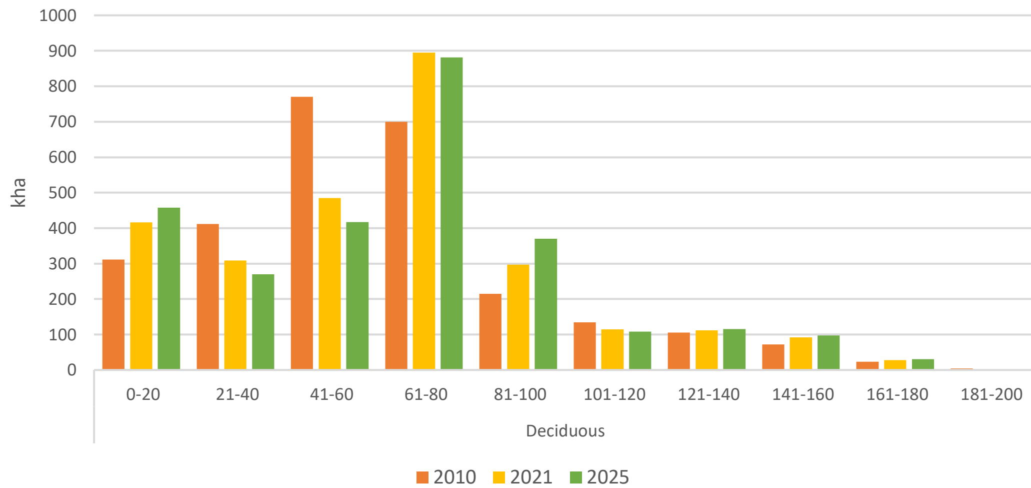


Figure 28 Dynamics of age structure of all deciduous forests

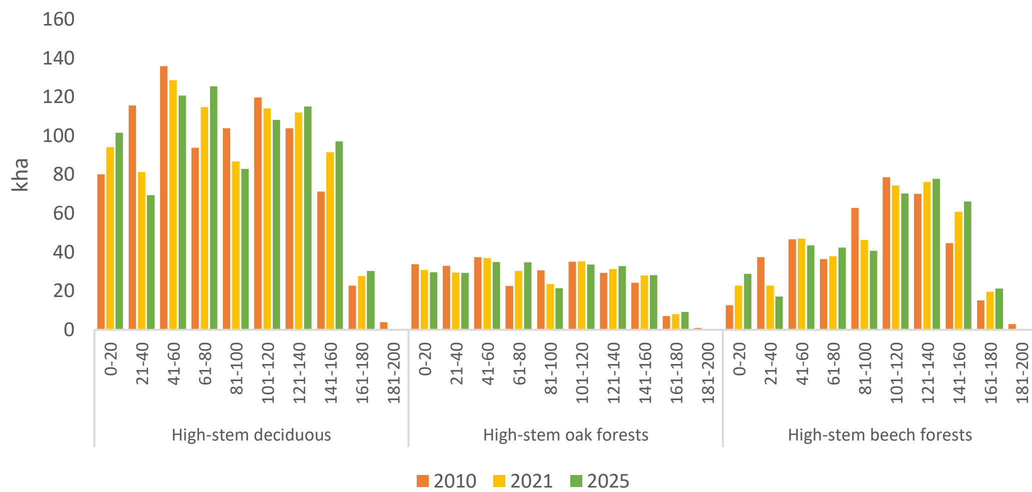


Figure 29 Dynamics of age structure of broadleaved high-stem, oak and beech

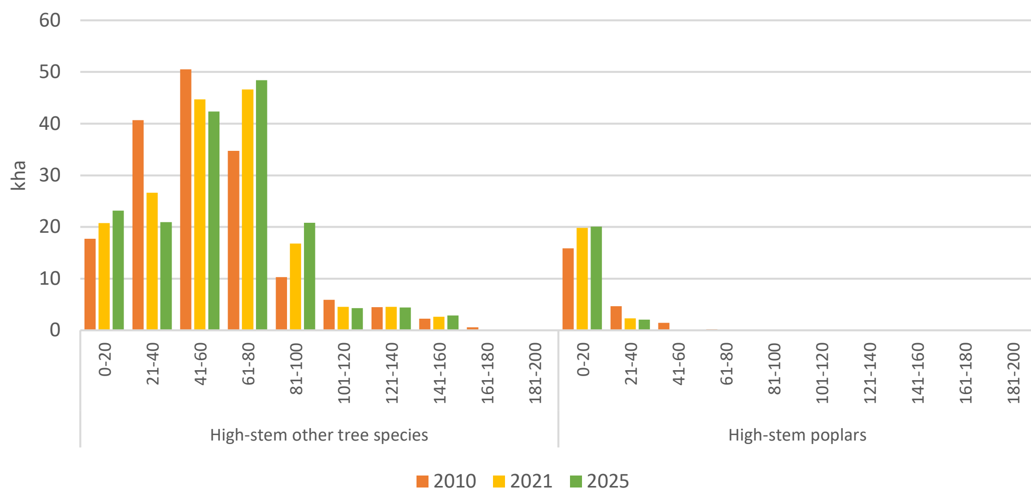


Figure 30 Dynamics of age structure of other deciduous high-stem forests and poplars

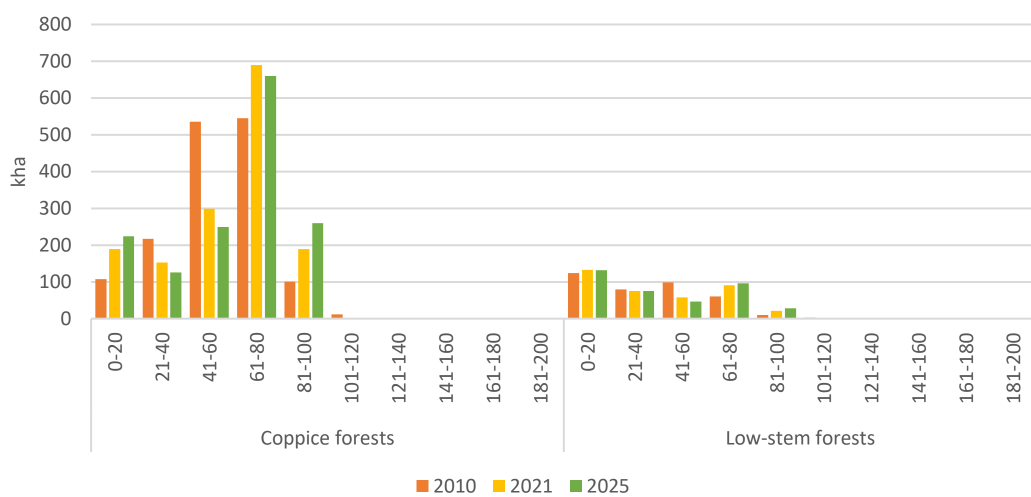


Figure 31 Dynamics of age structure of coppice and low-stem forests

Table 17 Projection of the growing stock by strata, millions m^3

№	Strata	2010	2015	2020	2021	2022	2023	2024	2025
1	**Coniferous**	**288.64**	**311.31**	**333.07**	**337.26**	**341.42**	**345.54**	**349.62**	**353.65**
1.1	Natural forests	311.56	330.04	348.42	352.04	355.65	359.23	362.79	366.33
1.2	Plantations	270.08	296.14	320.63	325.29	329.90	334.46	338.95	343.39
2	**Deciduous**	**147.10**	**149.19**	**150.75**	**151.01**	**151.23**	**151.44**	**151.63**	**151.81**
2.1	High stem deciduous forests	218.34	224.99	231.05	232.15	233.22	234.24	235.24	236.19
2.1.1	Oak - high stem	161.43	166.51	171.10	171.95	172.78	173.60	174.39	175.16
2.1.2	Beech - high stem	277.17	283.52	289.21	290.25	291.26	292.24	293.19	294.10
2.1.3	Poplar	128.69	143.10	156.56	158.16	159.34	160.23	160.84	161.10
2.1.4	Others - high stem	173.19	181.92	190.16	191.72	193.24	194.73	196.19	197.62
2.2	Coppice forests	137.39	136.96	136.12	135.92	135.69	135.48	135.24	135.01
2.3	Low-stem forests	51.77	53.13	53.81	53.88	53.93	53.96	53.97	53.97

Table 18 Emission factors used

Emission factors by strata	Density, GHGI 2018	BEF, GHGI 2018*	R, GHGI 2018	CF, IPCC 2006
Coniferous	**0.430**	**1.08**	**0.29**	**0.51**
Coniferous plantations	0.430	1.08	0.29	0.51
Natural coniferous forest	0.430	1.08	0.29	0.51
Deciduous	**0.603**	**1.03**	**0.24**	**0.48**
High-stem deciduous	0.603	1.03	0.24	0.48
High-stem oak forests	0.603	1.03	0.24	0.48
High-stem beech forests	0.603	1.03	0.24	0.48
High-stem others	0.603	1.03	0.24	0.48
Poplars	0.603	1.03	0.24	0.48
Coppice forests	0.603	1.03	0.24	0.48
Low-stem forests	0.603	1.03	0.24	0.48

Table 19 Projection of the carbon stock in living biomass (ABG and BGB) in tC/ha

№	Strata	2010	2015	2020	2021	2022	2023	2024	2025
1	**Coniferous**	**88.19**	**95.11**	**101.76**	**103.04**	**104.31**	**105.57**	**106.82**	**108.05**
1.1	Natural forests	95.19	100.84	106.45	107.56	108.66	109.76	110.84	111.92
1.2	Plantations	82.52	90.48	97.96	99.39	100.80	102.19	103.56	104.92
2	Deciduous	**54.41**	**55.15**	**55.73**	**55.82**	**55.91**	**55.98**	**56.05**	**56.12**
2.1	High stem deciduous forests	80.68	83.17	85.41	85.82	86.21	86.59	86.96	87.31
2.1.1	Oak - high stem	59.58	61.56	63.25	63.56	63.87	64.17	64.47	64.75
2.1.2	Beech - high stem	102.46	104.81	106.91	107.30	107.67	108.03	108.38	108.72
2.1.3	Poplar	47.57	52.90	57.88	58.47	58.90	59.23	59.46	59.56
2.1.4	Others - high stem	64.02	67.25	70.30	70.87	71.44	71.99	72.53	73.05
2.2	Coppice forests	50.85	50.63	50.32	50.24	50.16	50.08	50.00	49.91
2.3	Low-stem forests	19.15	19.64	19.89	19.92	19.94	19.95	19.95	19.95

Table 20 Projections of emissions and removals from living biomass by strata, $GgCO_2$

№	Strata	2011	2015	2020	2021	2022	2023	2024	2025
1	**Coniferous**	**-5147.29**	**-5032.74**	**-4763.87**	**-4710.66**	**-4672.76**	**-4626.02**	**-4578.07**	**-4528.97**
1.1	Natural forests	-1846.07	-1862.66	-1829.11	-1819.21	-1811.12	-1800.76	-1789.08	-1776.40
1.2	Plantations	-3301.22	-3170.08	-2934.76	-2891.45	-2861.64	-2825.26	-2788.99	-2752.57
2	**Deciduous**	**-1674.68**	**-1421.82**	**-1011.98**	**-933.76**	**-834.42**	**-796.36**	**-709.91**	**-652.99**
2.1	High stem deciduous forests	-1567.81	-1493.96	-1319.53	-1272.47	-1227.78	-1186.39	-1143.39	-1099.43
2.1.1	Oak - high stem	-365.19	-335.19	-301.97	-293.35	-287.59	-280.13	-272.09	-264.58
2.1.2	Beech - high stem	-731.98	-671.86	-594.74	-578.02	-559.51	-541.34	-520.98	-504.21
2.1.3	Poplar	-65.25	-98.06	-62.47	-47.92	-35.45	-26.81	-18.43	-7.84
2.1.4	Others - high stem	-405.39	-388.85	-360.34	-353.18	-345.23	-338.11	-331.88	-322.81
2.2	Coppice forests	114.22	218.51	364.17	386.87	424.44	411.43	439.83	443.78
2.3	Low-stem forests	-221.10	-146.36	-56.62	-48.16	-31.09	-21.40	-6.35	2.66
	Total Forest Managed Land	-6821.97	-6454.56	-5775.85	-5644.42	-5507.19	-5422.38	-5287.98	-5181.97

Dead wood

Dead wood is a mandatory carbon pool, which shall be reported under the LULUCF Regulation. In Bulgaria, the quantity of deadwood is not measured systematically and there is no official data (see also FAO FRA 2015). This is expected to change as in 2018 a methodology for measuring the quantity and characteristics of dead wood is adopted. In addition to data on the amount of dead wood in Bulgarian forests, there are also no data of most of the parameters that are needed to calculate the changes in carbon stock in dead wood pool.

To project the development dead wood carbon pool, the following approach was applied:

1. We collected information in order to calculate the annual flow of dead wood (D_{in}) for the period from 1991 to 2017 for coniferous and broad-leaved forests. We have assumed that the annual flow of dead wood is the sum of the transfer of biomass to dead wood pool due to mortality and slash. Data on the mortality rate as a fraction of the above-ground biomass is not directly available in Bulgaria. So, we estimated a proxy by using data from RF 5 on harvest amounts. In this form there is information on the wood removals from dried and fallen mass. Over the years there has been a steady decrease of the amount of extracted (harvested) dried and fallen mass due to financial and environmental reasons. This is because the harvesting and removal of this wood is economically unprofitable. In addition, there is a regulatory requirement on the minimum amount of dead wood in forests to maintain biodiversity. To calculate the annual transfer to dead wood due to mortality, we used the trend of decreasing the extraction of dry and fallen mass from the forest. We assumed the dried and fallen woods, extracted in 1991, as a substitute for biomass transferred to dead wood due to mortality for 1991. Thus, the change in the harvested quantity of dried and fallen wood compared to extracted amount in 1991 (decreasing trend) represents an increase transfer to dead wood pool, because these dried and fallen wood is not extracted from the forests. In addition to the calculated transfer from mortality, we added also the transfer to slash. Information on the quantity of the slash we obtain from the RF 5 as the difference between the gross and net wood removals.

2. The estimated figures for the annual transfer to deadwood from mortality and slash are in m^3. To convert these amounts into biomass, we applied wood density coefficients. For this purpose, we used literary data from L. Di Cosmo et al, 2013. In this paper there is information on wood density in the different stages of decomposition (5 stages). We applied linear correlation of the wood density in the individual decomposition phases. We applied this linear function on the wood density coefficients used in the calculation of the GHG inventory. Since in our calculations we lack information on the dead wood stock in different decomposition phases, we used an average of the recalculated density in the individual decomposition phases, which is 0.114 t/m^3 for conifers and 0.293 t/m^3 for broadleaf.
3. In order to estimate the carbon amount in the stock we applied the carbon content coefficient according to Table 4.3 of the 2006 IPCC Guidelines (0.47 for broadleaf and 0.51 for conifers)
4. There is no country specific data on decomposition rates of dead wood. To obtain data on the decomposition rates we used literature data from J. Rock et al, 2008. The applied decomposition rates are 0.0521 deciduous and 0.0712 for coniferous.
5. To estimate the carbon stock of dead wood in t_0 we estimated the average of D_{in} for the first 5 years divided by the rate of decomposition separately for coniferous and deciduous.
6. Then, applying one-factor negative exponential function, we calculated the C deadwood losses.
7. The difference between gains and losses of dead wood represents the change in the carbon stock and corresponding emissions and removals
8. To project the levels of emissions and removals from dead wood pool, data from the projected growing stock was used. We calculated the rate of the D_{in} from the growing stock for the years 2010-2017. The average rate for this period (0.0225%) was applied as a constant to the projected growing stock in order to project the D_{in} for 2021-2025. All other coefficients remain the same in the projection.

The approach described above brings a lot of uncertainty as there are no baseline data and several assumptions have been adopted to produce estimates. If better data available or a model is implemented more accurate estimates will be presented.

Table 21 Projections on emissions and removals from dead wood, $GgCO_2$

Dead wood	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	2025
coniferous	-48.99	-56.81	-104.50	-64.22	-90.56	-112.49	-110.16	-107.87	-105.64	-103.46	-101.32
broadleaves	-113.27	-138.58	-205.83	-165.75	-107.09	-73.90	-74.23	-74.51	-74.74	-74.92	-75.06
total DW emissions	-162.27	-195.38	-310.33	-229.98	-197.65	-186.39	-184.39	-182.38	-180.39	-178.38	-176.38

Harvested Wood Products

For the calculation of the projected development of carbon stock changes in harvested wood products, it is necessary to trace the carbon stock changes in the pools since 1990. When forecasting the development of the carbon stock in harvested wood products under the LULUCF Regulation, a constant ratio between the solid and energy use of forest biomass, as documented in the period 2000-2009, was applied. To estimate the annual carbon inflow to the HWP pool we follow the production approach as set out in the LULUCF Regulation. Changes in the C stock in harvested wood products are tracked for the following product categories:

1. Swanwood
2. Wood-based panels
3. Paper and paperboard

HWP from solid waste disposal sites and HWP used for energy purpose are accounted on the basis of instantaneous oxidation.

For the calculation of carbon stock changes, a first-order decomposition function is applied using the carbon half-life values described in Annex V of the LULUCF Regulation, namely:

1. Swanwood – 35 years
2. Wood-based panels - 25 years
3. Paper and paperboard - 2 years

Data source for the HWP commodities for 1990-2017 is the FAO Stat. The applied methods and emission factors in the calculations are in line with the IPCC 2013 Guidelines (KP Supplement, 2013). For the forecasting period (2018-2025), data on harvested timber products by category is calculated using data on projected harvest amount (*Table 22*).

In order to fulfill the requirement for a constant ratio between the solid and energy use of forest biomass when estimating the HWP contribution to FRL, the following was implemented:

1. We calculated the rates of change of the projected harvest as compared to the average of the historic harvest within the period 2000-2009
2. We applied these annual change rates to the same time period average (2000-2009) of historic carbon inflow to the HWP pool in order to project the future carbon inflow to HWP
3. We estimated future emissions and removals from HWP applying first order decay function and defined half-lives. The future emissions and removals from HWP are presented in *Table 26*

Table 22 Projections on the harvest amounts, m³

№	Strata	2011	2012	2013	2014	2015
1	**Coniferous**	**2693789**	**2738127**	**2781312**	**2824029**	**2866523**
1.1	Natural forests	1288563	1305152	1320941	1336530	1352173
1.2	Plantations	1405226	1432975	1460371	1487499	1514350
2	**Deciduous**	**4807481**	**4823924**	**4839433**	**4855185**	**4870404**
2.1	High stem deciduous forests	1634435	1645626	1656871	1668862	1681321
2.1.1	Oak - high stem	311354	313716	315758	317769	319678
2.1.2	Beech - high stem	725090	729235	732756	736179	739516
2.1.3	Poplar	231135	235070	239856	245308	251250
2.1.4	Others - high stem	366856	367605	368501	369606	370877
2.2	Coppice forests	2612200	2611126	2609759	2608167	2606247
2.3	Low-stem forests	560846	567172	572803	578156	582836
	Total MFL	**7501270**	**7562051**	**7620745**	**7679214**	**7736927**
№	Strata	2016	2017	2018	2019	2020
1	**Coniferous**	**2908752**	**2950777**	**2992259**	**3033259**	**3073789**
1.1	Natural forests	1367803	1383455	1399041	1414538	1429956
1.2	Plantations	1540949	1567322	1593218	1618721	1643833
2	**Deciduous**	**4884870**	**4898207**	**4910563**	**4921554**	**4931751**
2.1	High stem deciduous forests	1693861	1706281	1718340	1730224	1741698
2.1.1	Oak - high stem	321583	323452	325288	327081	328830
2.1.2	Beech - high stem	742788	746006	749149	752214	755198
2.1.3	Poplar	257132	262827	268053	273044	277629
2.1.4	Others - high stem	372358	373996	375850	377885	380041
2.2	Coppice forests	2604054	2601296	2598409	2595070	2591637
2.3	Low-stem forests	586955	590630	593814	596260	598416
	Total MFL	**7793622**	**7848984**	**7902822**	**7954813**	**8005540**
№	Strata	2021	2022	2023	2024	2025
1	**Coniferous**	**3113756**	**3153285**	**3192493**	**3231309**	**3269718**
1.1	Natural forests	1445300	1460567	1475763	1490871	1505879
1.2	Plantations	1668456	1692718	1716730	1740438	1763839
2	**Deciduous**	**4940288**	**4947425**	**4952865**	**4957432**	**4960748**
2.1	High stem deciduous forests	1752192	1761735	1770400	1778429	1785859
2.1.1	Oak - high stem	330544	332210	333843	335437	336981
2.1.2	Beech - high stem	758095	760909	763634	766267	768805
2.1.3	Poplar	281375	284248	286375	287985	289088
2.1.4	Others - high stem	382178	384368	386548	388740	390985
2.2	Coppice forests	2587982	2584097	2579840	2575714	2571300
2.3	Low-stem forests	600114	601593	602625	603289	603589
	Total MFL	**8054044**	**8100710**	**8145358**	**8188741**	**8230466**

Table 23 Average carbon stock of HWP categories produced from domestic harvest, tC

HWP categories	Average 00-09
swanwood	111011.82
wood based panels	153782.46
paper and paperboard	78035.83

Table 24 Average amount of total harvest for 00-09, m³

m ³	Average 00-09
Total harvest	6354824.10

Table 25 Rate of change in total harvest, estimated

rate of change in total harvest	2011	2012	2013	2014	2015
Total harvest	1.18	1.19	1.20	1.21	1.22
	2016	2017	2018	2019	2020
Total harvest	1.23	1.24	1.24	1.25	1.26
	2021	2022	2023	2024	2025
Total harvest	1.27	1.27	1.28	1.29	1.30

Table 26 Emissions and removals from HWP, $GgCO_2$

Wood commodities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Swanwood, DH	-415.89	-415.89	-411.42	262.31	305.62	299.92	293.75	288.02	282.28	276.70
Wood-based panels, DH	-117.43	-117.43	-47.65	67.04	55.41	54.21	52.42	51.02	49.52	48.11
Paper and Paperboard, DH	-53.52	-53.52	16.25	43.66	14.34	-2.09	-6.66	22.21	1.08	-3.11
Total emissions, MFL	**-586.85**	**-586.85**	**-442.81**	**373.01**	**375.37**	**352.03**	**339.51**	**361.25**	**332.88**	**321.70**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Swanwood, DH	215.01	224.21	206.00	197.46	193.46	-4.85	-6.62	-100.16	-125.89	-45.96
Wood-based panels, DH	66.23	-174.81	-225.06	-227.35	-208.08	-105.26	-36.61	-181.80	-568.32	-468.24
Paper and Paperboard, DH	71.00	31.47	-21.09	-11.77	-8.40	-161.98	-110.97	-85.22	-111.58	-27.51
Total emissions, MFL	**352.23**	**80.88**	**-40.16**	**-41.66**	**-23.03**	**-272.09**	**-154.20**	**-367.17**	**-805.78**	**-541.71**
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Swanwood, DH	96.84	9.20	-10.97	-14.61	-18.05	-21.40	-24.64	-27.75	-30.72	-33.53
Wood-based panels, DH	-402.18	-499.91	-300.10	-297.21	-294.22	-291.29	-288.38	-285.46	-282.50	-279.48
Paper and Paperboard, DH	59.99	35.04	-19.74	-16.27	-13.74	-11.94	-10.64	-9.68	-8.95	-8.38
Total emissions, MFL	**-245.36**	**-455.67**	**-330.82**	**-328.10**	**-326.01**	**-324.64**	**-323.66**	**-322.89**	**-322.17**	**-321.39**
	2020	2021	2022	2023	2024	2025				
Swanwood, DH	-36.17	-38.68	-41.00	-43.15	-45.14	-47.01				
Wood-based panels, DH	-276.39	-273.27	-270.04	-266.74	-263.36	-259.95				
Paper and Paperboard, DH	-7.90	-7.52	-7.16	-6.84	-6.54	-6.27				
Total emissions, MFL	**-320.47**	**-319.47**	**-318.20**	**-316.74**	**-315.03**	**-313.23**				

Comparison between the projections of emissions and removals from MFL with the estimates from GHGI 2018

In fact, in order to assess whether the model can reproduce historical emissions and removals a comparison of the projected carbon emission and removals with GHGI estimates should be done only for biomass pool and for the years 2011-2016. This is because the model we use for the projections cannot reproduce estimates for the past period, so the model cannot reconstruct the time series before 2011. It will be correct to compare the projections with the reported figures only for biomass. As it was explained on p.12, the reported emissions and removals from dead wood, litter and soils from forest lands in GHGI Submissions 2017 and 2018 were based on the direct use of the results from the JRC study (Pilli et al., 2016). There is a need to change the way CSC from DOM and soils is reported in GHGI of Bulgaria. The use of the results from JRC study for some of the pools (DW, L, S) and reporting estimates for the rest of the pools (biomass) leads to lack of comparability within methods used to estimate the CSC in different pools. Comparison between the projections and reported emissions and removals is presented in *Table 27*

Table 27 Comparison between the projected reported emissions and removals

Carbon pools	2011	2012	2013	2014	2015	2016
Biomass, ABG+BGB projections	-6821.97	-6730.86	-6659.99	-6552.25	-6454.56	-6330.85
DW, projections	-271.91	-138.94	-197.76	-126.24	-197.65	-201.59
HWP, projections	-455.67	-330.82	-328.10	-326.01	-324.64	-323.66
Biomass, ABG+BGB, GHGI 2018	-5436.79	-5421.68	-5409.66	-5398.71	-5393.23	-5393.65
DW, GHGI 2018	-239.02	-411.99	-381.27	-346.59	-347.20	-347.82
HWP, 2018	-607.14	-647.35	-545.01	-545.01	-545.01	-545.01

References

Въчовски Хр. Горите и горското стопанство на България през XX век, 2003

Годишен отчетен доклад на Изпълнителна агенция по горите за 2017 г.

Закон за горите, 1997

Закон за горите, 2011

НАРЕДБА № 33 ОТ 30 ЮЛИ 2004 Г. ЗА ВИДОВЕТЕ СЕЧИ И МЕТОДИТЕ ЗА ТЯХНОТО ПРОВЕЖДАНЕ ИЗДАДЕНА ОТ МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО И ГОРИТЕ, Обн. ДВ. бр.70 от 10 Август 2004г.

НАЦИОНАЛНА СТРАТЕГИЯ ЗА РАЗВИТИЕ НА ГОРСКИЯ СЕКТОР

В РЕПУБЛИКА БЪЛГАРИЯ ЗА ПЕРИОДА 2013 - 2020 Г."

Национална стратегия за устойчиво развитие на горския сектор в България 2006-2015 г.

РЕЖИМИ ЗА УСТОЙЧИВО УПРАВЛЕНИЕ НА ГОРИТЕ В НАТУРА 2000

Ръководство за участие на заинтересовани страни в процеса на горска сертификация по FSC, 2016

Соколовска, М., Жиянски, М., Петрова, Л.. Сравнително проучване върху органичната материя в почви от клас Метаморфни (Cambisols) от района на Рила планина. ИП " Н. Пушкаров", Сб. доклади Национална конференция с международно участие "Управление, използване и опазване на почвените ресурси", ИП "Н.Пушкаров" 16-19 май 2005, 2005, 304-307

Соколовска, М., Стоянова, Н., Жиянски, М., Йорданов, Й.. Съдържание на въглерод в горски почви от района на Северна Рила. Международна конференция "Почвознанието – основа за устойчиво земеделие и опазване на околната среда", 13-17 май 2007 г., ИП "Н. Пушкаров", София, 1, 2007, 205-210

Assyov, B., Petrova, A., Dimitrov, D., Vassilev, R., 2012. Conspectus of the Bulgarian vascular flora. Distribution maps and floristic elements. - Fourth revised and enlarged edition. Bulgarian Biodiversity Foundation, Sofia.

Di Cosmo, Lucio & Gasparini, Patrizia & Paletto, Alessandro & Nocetti, Michela. (2013). Deadwood basic density values for national-level carbon stock estimates in Italy. Forest Ecology and Management. 295. 51–58. 10.1016/j.foreco.2013.01.010.

Forsell N, Korosuo A, Federici S, Gusti M, Rincón-Cristóbal J-J, Rüter S, Sánchez-Jiménez B, Dore C, Brajterman O and Gardiner J. (2018). Guidance on developing and reporting Forest Reference Levels in accordance with Regulation (EU) 2018/841. https://ec.europa.eu/clima/policies/forests/lulucf_en

Grassi G, House J, Dentener F, Federici S, den Elzen M, Penman J. The key role of forests in meeting climate targets requires science for credible mitigation. Nat Clim Chang. 2017;7(3):220–6.

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland.

Menichetti, L., Leifeld, J., Kirova, L., Szidat, S., Zhiyanski, M.. Consequences of planned afforestation versus natural forest regrowth after disturbance for soil C stocks in Eastern European mountains. Geoderma, 297, Elsevier, 2017, DOI:https://doi.org/10.1016/j.geoderma.2017.02.028, 19-27. ISI IF:2.855

Panayotov, M., Tsvetanov, N., Gogushev, G., Tsavkov, E., Zlatanov, T., Anev, S., Ivanova, A., Nedelin, T., Zafirov, N., Aleksandrov, N., Dountchev, A., Vasileva, P., Shishkova, V., Stoyanov, B., Sotirova, N., Vatov, A., Bebi, P., Yurukov, S., 2016b. Mountain coniferous forests in Bulgaria – structure and natural dynamics. University of Forestry, Sofia.

Rock, Joachim & Badeck, Franz-W & Harmon, Mark. (2008). Estimating decomposition rate constants for European tree species from literature sources. European Journal of Forest Research. 127. 301-313. 10.1007/s10342-008-0206-x.

Rodeghiero, M., A. Rubio, E. Díaz-Pinés, J. Romanyà, S. Marañón- Jiménez,, G.J. Levy, A.P. Fernandez-Getino, M.T. Sebastià, T. Karyotis, C. Sirca, A. Martins, M. Madeira, M. Zhiyanski, L. Gristina,. Soil carbon in Mediterranean ecosystems and related management problems. Soil Carbon in Sensitive European Ecosystems: From Science to Land Management, John Wiley & Sons, 2011, ISBN:9781119970255, DOI:10.1002/9781119970255.ch8, 175-218

Zhiyanski, M., Glushkova, M., Ferezliev, A., Menichetti, L., Leifeld, J.. Carbon storage and soil property changes following afforestation in mountain ecosystems of the Western Rhodopes, Bulgaria. iForest, 9, SISEF - Italian Society of Silviculture and Forest Ecology, 2016, ISSN:1971-7458, DOI:10.3832/ifor 1866-008, 626-634. SJR:0.518, ISI IF:1.318 Линк

Zhiyanski, M., Glushkova, M.. Carbon storage in European chestnut ecosystems in Belasitsa, SW Bulgaria. Silva Balcanica, 14, 1, 2013, ISSN:1311-8706, 61-75. SJR:0.135

Zhiyanski, M., Kolev, K., Hursthouse, A., Sokolovska, M.. Land-use change effects on soil organic carbon and nitrogen contents in ecosystems from Central Balkan Mountains, Bulgaria. Journal of Balkan Ecology, 4, 2008, 397-411

Zhiyanski, M., Sokolovska, M., Dimitrova, T.. SOC stock in different forest related land-uses in central Stara Planina Mountain, Bulgaria.. LANDCON Conference 05, 2009, Tara Mountain, Serbia. UDC 911.2:63(23) (497.2), 99-107, TOME LXXXIX-, 4, Bulletin of Serbia Geographical Society, 2009, 99-107

Zhiyanski, M, Sokolovska, M., Glushkova, M.. Management of carbon sequestration in Bulgarian forest soil. COST FP0803 Conference “Carbon balance after disturbances and drought”, Barcelona, Spain, 2011, 38