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

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This National Forestry Accounting Plan (NFAP) has been prepared according to requirement by the *Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU.*

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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
MoEW	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	Forested 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 period 2021-2025

Forest reference level for the period 2021 - 2025	
A	B
-3021.11	-2723.19

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).

Carbon pools and greenhouse gases included in the FRL

The projected forest reference levels (FRL) include the following pools and greenhouse gases:

- Biomass – aboveground and belowground
- HWP
- Dead wood
- CH_4
- N_2O

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

Table 2 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. 73
a)	Description of how the criteria in LULUCF Regulation were taken into account.	p.12, 34, 40, 49, 57
b)	Identification of the carbon pools and greenhouse gases which have been included in the forest reference level.	p. 12, 80
b)	Reasons for omitting a carbon pool from the forest reference level determination.	p. 12, 80
b)	Demonstration of the consistency between the carbon pools included in the forest reference level.	p. 12, 87
c)	A description of approaches, methods and models, including	Chapter III

Annex IV B, № of para	Elements of the national forestry accounting plan	**Chapter or page number(s) in the NFAP**
	quantitative information, used in the determination of the forest reference level, consistent with the most recently submitted national inventory report.	
c)	A description of documentary information on sustainable forest management practices and intensity.	p.18, 18, 21, 49, Table 8, Table 9, Table 12
c)	A description on of adopted national policies.	p. 16
d)	Information on how harvesting rates are expected to develop under different policy scenarios.	p. 31
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. 73, p. 57, 40
e) 2	Emissions and removals from forests and harvested wood products as shown in greenhouse gas inventories and relevant historical data	p. 87
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. 22, 73, 71, Table 4,* Table 5, Table 6, Table 7
e) 4	Historical and future harvesting rates disaggregated between energy and non-energy uses	p. 83

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 forested 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 forested 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 forested 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 forested areas. The activities for management of protected sites and natural monuments in forested 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 forested areas; 4) guaranteeing and increasing the production of timber and non-timber forest products through natural management of forested 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 forested 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 forested 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 forested areas by limiting the disposal transactions leading to decrease of state-owned forested 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 forested areas, Ordinance No. 1/30 January 2011 concerning the control and protection of forested 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 forested areas, whatever their ownership, shall be carried out in order to establish the condition of the resources and to prepare an assessment thereof. All forested areas are covered by the scope of activities of the relevant SFEs and/or SHR. The forested 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 forested areas which are state and municipal property, as well as for private forested areas with land area of 50+ ha. Forestry programmes are prepared for forested areas owned by natural and legal persons with total land area of 2 – 50 ha. Private forested areas with land area under 2 ha are included in the forestry plans of state-owned forested 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 forested 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. **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.

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

<u>The intensity</u> 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%.

<u>The regularity</u> of thinnings 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 well as for the individual coppice beds. The felling is carried out with cutting-from-above bias.

Regeneration fellings are 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 and the condition of forest stands, the following final cuts 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.

Different types of regeneration fellings were applied in the forests in Bulgaria over the reference period (2000-2009) - **shelterwood cuttings, selective cuttings** and **clear cuts**. More information on the type of final cut and rotation period is provided in Table 10.

The application of clear felling on large areas (up to 5 – 10 ha) 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.

<u>Ordinance No. 8 / 05.08.2011 on fellings in forests</u> is passed in 2011. In general, it introduces additional restrictions (compared to Ordinance No. 33 (2005) when carrying out regeneration fellings in terms of the application of short-term shelterwood felling and clear cuts According to the new ordinance on fellings, <u>clear cuts are allowed only under the following rules</u>:

- clear felling in coppices, except for acacia forests, is limited to area 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 also introduced the following new (additional) types of felling:

<u>Obligatory cuttings</u> – 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.

<u>Fellings for individual production of high-quality timber</u> – 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 forested 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.

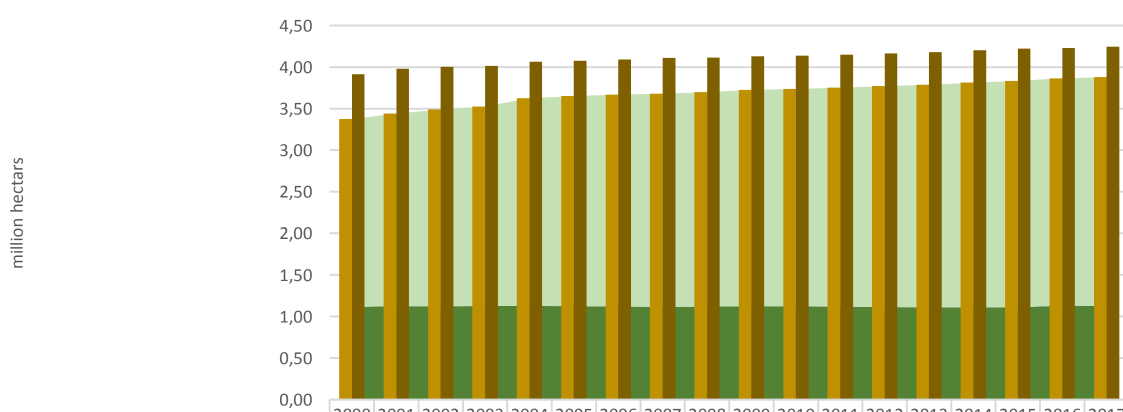
The provisions of FA and the Implementing Regulations of FA apply to all forests and forest land, whatever their ownership. The provisions do not apply only to forests and forest land in conservation areas that are exclusive state property. According to their main functions, forests are divided into 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

In 2017 forest territories in Bulgaria cover 4,24 million ha or 38,2% of the country's territory, including 3,88 million ha (91,0%) of forests. Compared to 2000 data, the total forested area of the country has increased by about 500 thousand ha (~ 15 %). This increase in forested area is not only due to natuaral regrwoth and afforestation but also due to formal inclusion of forested lands which were outside the forest fund at that time.

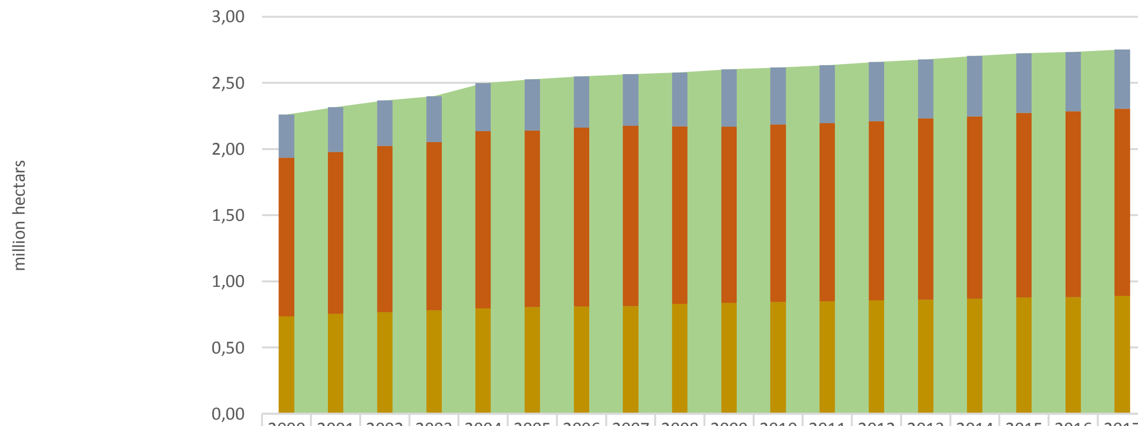


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
deciduous forests	2,26	2,32	2,37	2,40	2,50	2,53	2,55	2,57	2,58	2,60	2,62	2,63	2,66	2,68	2,70	2,72	2,73	2,75
coniferous forests	1,11	1,12	1,12	1,13	1,13	1,12	1,12	1,11	1,12	1,12	1,12	1,12	1,11	1,11	1,11	1,11	1,13	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 forest territories and forested areas 2000-2017, Source: EFA

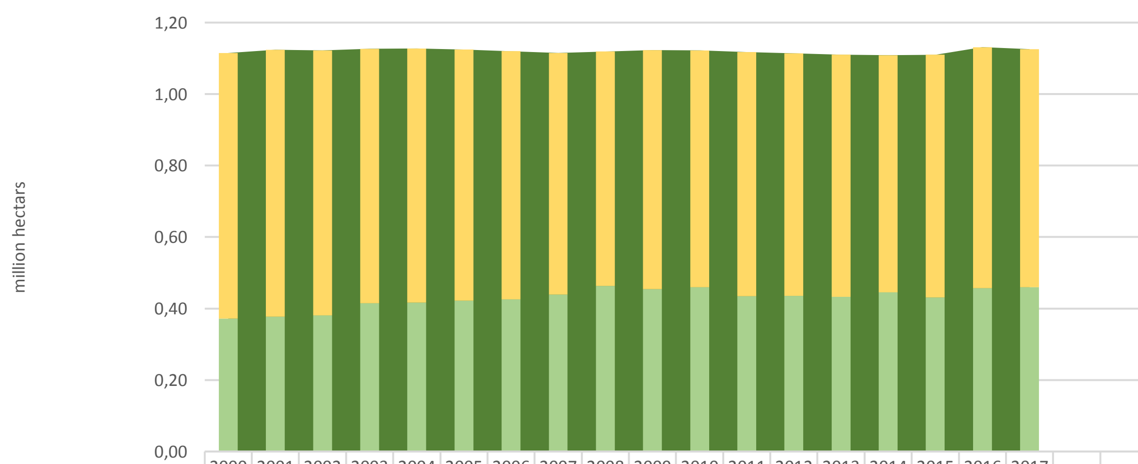
The area of conferous forests varies smoothly over the years. In 2017, their area was 1,11 million ha, similar to the area of coniferous forests in 2000. Coniferous plants cover about 60% of the total area of coniferous forests, but it is notable that they decrase smoothly over the years, making standing 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 forested area dynamics. In 2017, the area of deciduous forests registers increase by almost 22% agaisnt 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 forested areas.

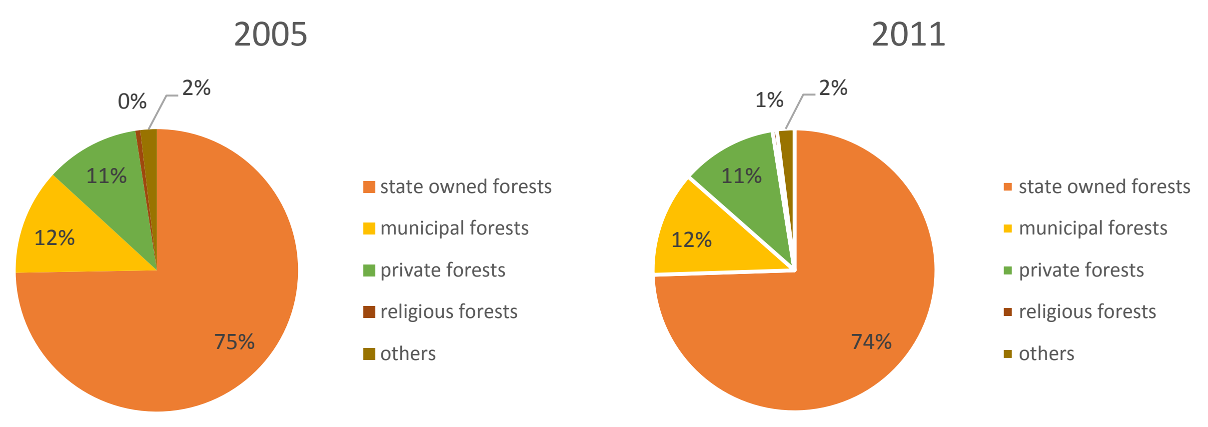


Figure 4 Breakdown of forest ownership in 2005 and 2011, Source: NSSDFSB 2013-2020

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.

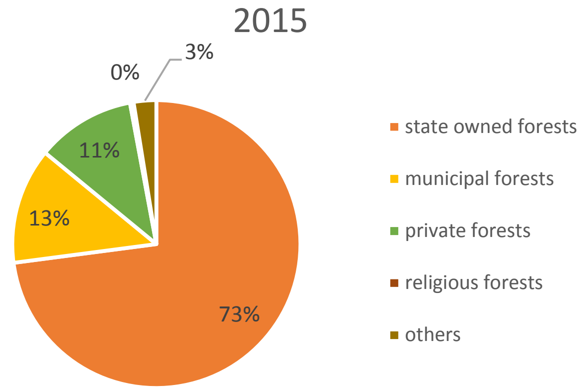
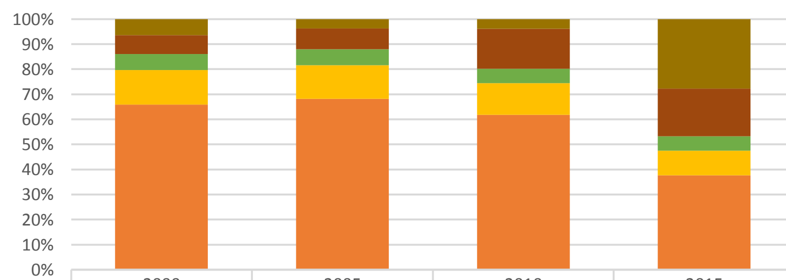


Figure 5 Breakdown of forest ownership in 2015, Source: EFA

Functions

The area breakdown of forested 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 forested 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.

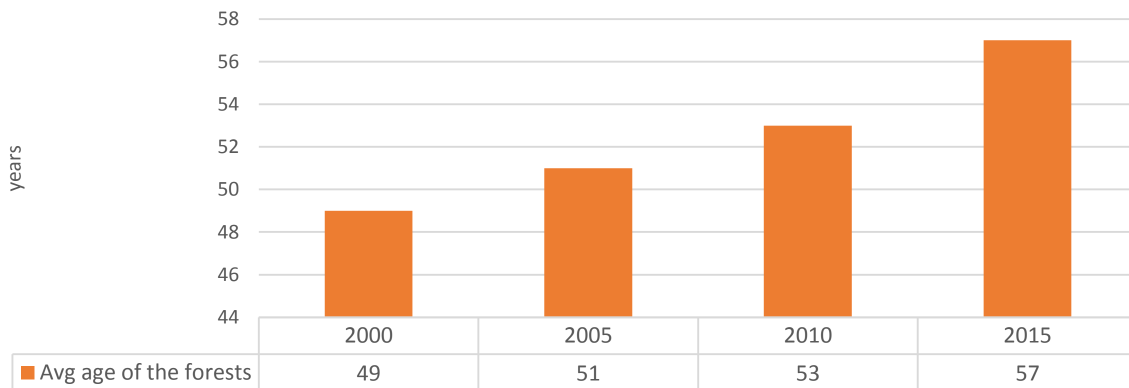


Figure 7 Average age of forests in Bulgaria, Source: EFA

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.

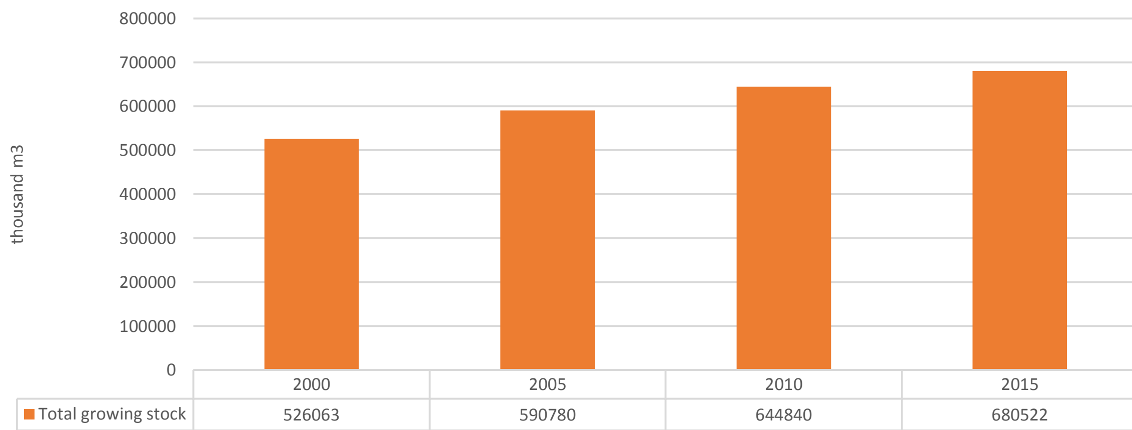


Figure 8 Total growing stock 1990-2015, Source: EFA

Harvesting

The dynamic of the harvest for the period 2000-2017 is presented in Figure 9. The values in the figure refer to the actual harvest (total and roundwood) and planned harvesting rates according to Forest Management Plans (total and roundwood). Two periods of timber use surge are noted in the respective period. In 2017, actual harvest 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 levels vary within 6.5 – 7.3 million m^3, with timber use remaining by 12% lower than the planned total harvest 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 the actual harvest 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 forested areas and to implement the forestry management plans.

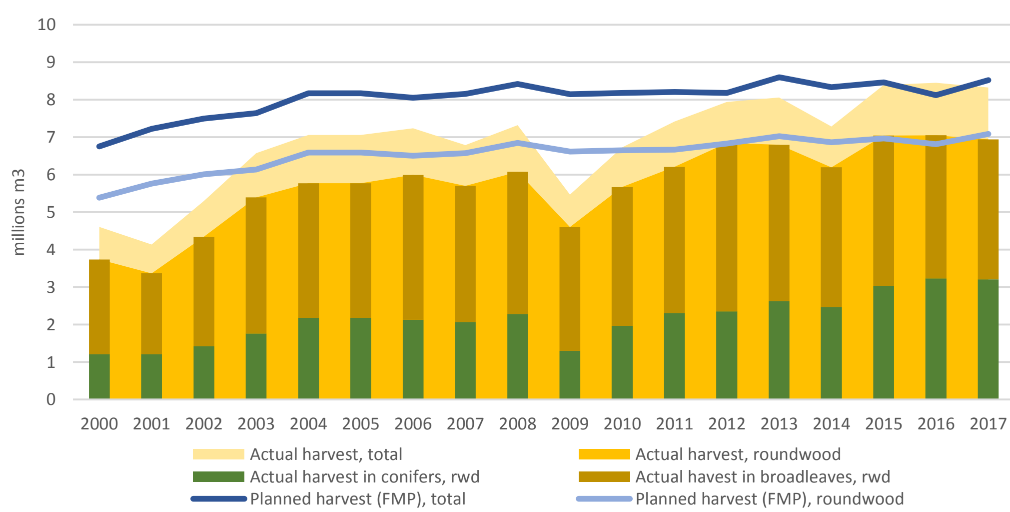


Figure 9 Harvest dynamics 2000-2017. Source: EFA

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 forested 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 forested 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 forested 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).

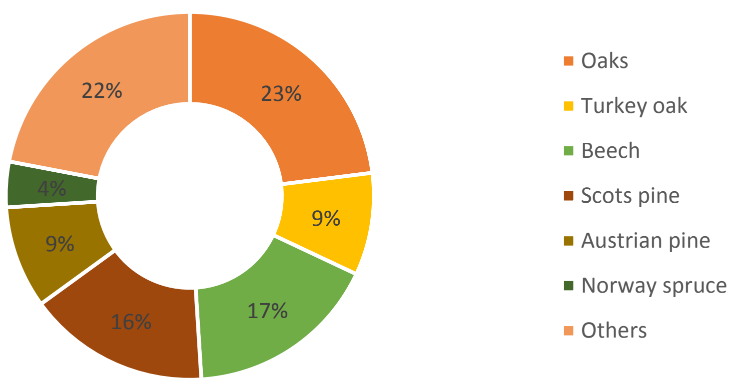
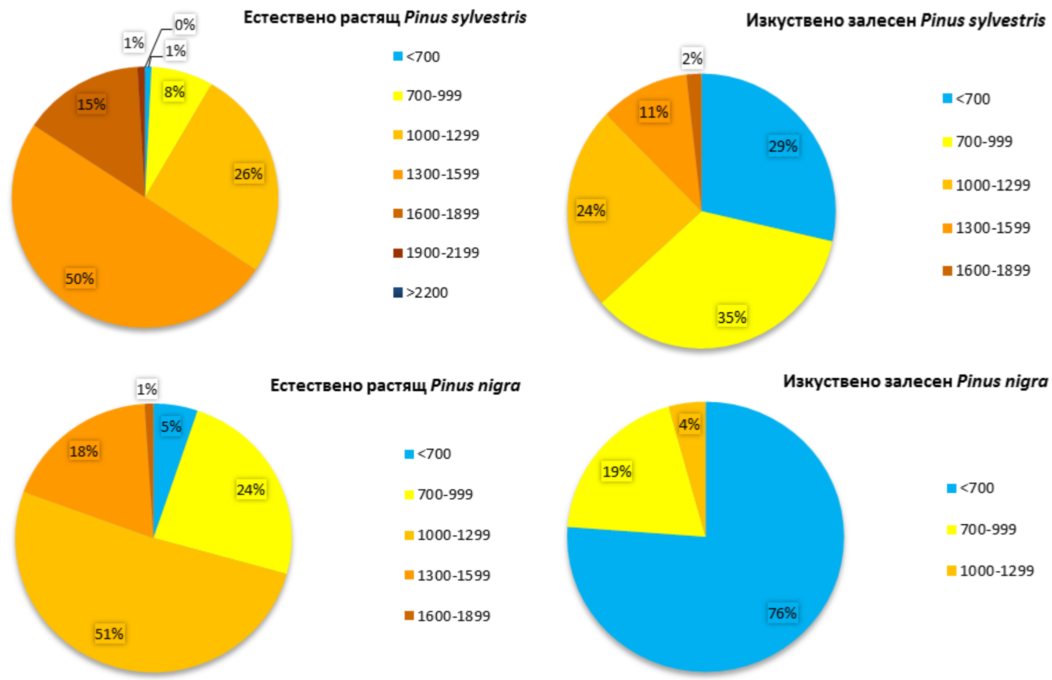


Figure 10 Percentage of the areas occupied by the main tree species

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.

Forest regeneration

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 forested 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 forested 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 forested 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 forested areas is 1 464 607 ha, or 34% of total national forested area (2017 Annual Report of Executive Forest Agency).

Control system on tracing of harvested timber

Since 2016 the electronic system for tracing of harvested timber of the Executive Forest Agency was significantly improved to meet the requirements of Regulation (EU) No 995/2010). The system allows to control the timber harvesting from the logging place to the end user and is obligatory for all operators in regardless the type of forest ownership. The system was activated from 01.01.2016 – first obligatory for the state forestry enterprises and with 6 months testing period for the private forest owners. The transportation ticket is issued by forest officer or licensed forester and has unique number. All data in the tickets is uploaded to a central server which allows easy control on all transport operations of harvested timber. The electronic ticket is valid for 12 h and contains information about harvesting place, tree species, assortment, volume, owner, number of the harvesting permit, vehicle, end use. From 01.01.2017 the permanent timber storages were also obliged to issue electronic tickets directly connected to the electronic system of the Executive Forest Agency. Every permanent storage is obliged to install cameras on all gates to allow monitoring of the timber flow. The process of tracing the harvested timber includes also legal requirement all transport vehicles to have GPS. The control on timber transportation from felling site to temporary storage and/or from permanent storages to end consumers is executed by the Regional Forest Directorates at the Executive Forest Agency.

The electronic system is publicly available on the following link: http://tickets.iag.bg/cgi-bin/index.cgi?lng=en

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 conversion coppice forests aged over 40 years and the difficult regeneration of these 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 forested 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 forested 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.

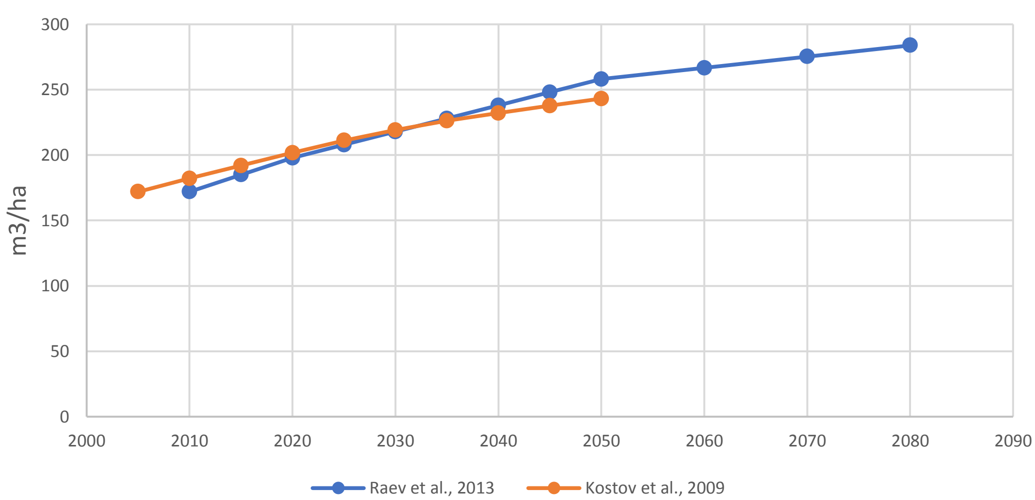
Conversion coppice forests make up 35% of forests in Bulgaria. 80% of them are aged over 40 years and 60% are over their rotation times. The silvicultural principle here is to leave the coppices to get old and to lose the ability to regenerate by sprouts (conversion by aging). This is an old (from 1960's) Bulgarian policy in place to convert these coppice forests into high-stem forests. In 1960 the rotation ages of these forests have increased up to 60-80-100 depending on yield class and tree species. This has put those forests on moratorium - cutting only damaged forests (dieback). By 2010 the conversion coppices started reaching their official rotation time - nowadays 60% of these forests are mature and over-aged. Beside this, they are in poor health – more often their roots are affected by fungi and they give signs of dieback in drought periods. Thus, their effective conversion into high forests is urgent. This forestry problem is yet to be settled and it is expected to affect harvesting levels. However, this will happen because of the legacy effect and not because of a new policy or change in practices.

Information on the expected development of the standing growing stock

Two independent studies (Kostov et al., 2009, Raev et al, 2013;) have been carried out in Bulgaria to project the dynamic of the forest resources – forest area, growing stock and harvesting rates. Despite the different purposes of these two studies and the difference of the methodologies applied, both studies project a continuation of the accumulation in the standing volume stock of the Bulgarian forests (Figure 12). This is mainly due to overexploitation in pre-war and early post-war years which led to predominance of young forest. The sustainable forest management since the late 1950's leads to gradual normalization of the age structure. This process involves accumulation of standing volume and gradual decrease of total increment.

Kostov et al, 2009 have applied EFISCEN in their simulation and have defined 4 scenarios – "basic", "maximum", "optimistic", "pessimistic". The basic scenario project the forest dynamics based on the current state of the forest (2000 for this study). The basic scenario considers the expected changes in forestry based on the development of forest area, changes in tree species composition and the expected increase in thinnings and final cuts based on the expected development of the forests stands. The maximum scenario is like the basic, but it projects the dynamic of the forest resources based on a theoretical (almost the maximum allowable) increase in harvesting. The optimistic scenario is like so called "handbook scenario", where the way of management of the forest resources targets the increase in productivity of the forest stands. The pessimistic scenario projects the development of forest resources in situation of stagnation in management and utilization. The development of the forest resources in all 4 scenarios is projected until the year 2050. The trend of accumulation of the growing stock is present in all scenarios except for the pessimistic one.

Raev et al., 2013 have developed their own model to project the development of the forest resources based on expected changes in climatic parameters – temperature and precipitation in Bulgaria. They defined 3 different scenarios – realistic, optimistic and pessimistic. In each scenario, temperatures everywhere in the country increase by the same degree and the precipitation decreases by the same percentage.



*Red line shows the trend of the basic scenario

Figure 12 Development of total growing stock in Bulgarian forests based on two independent studies.

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

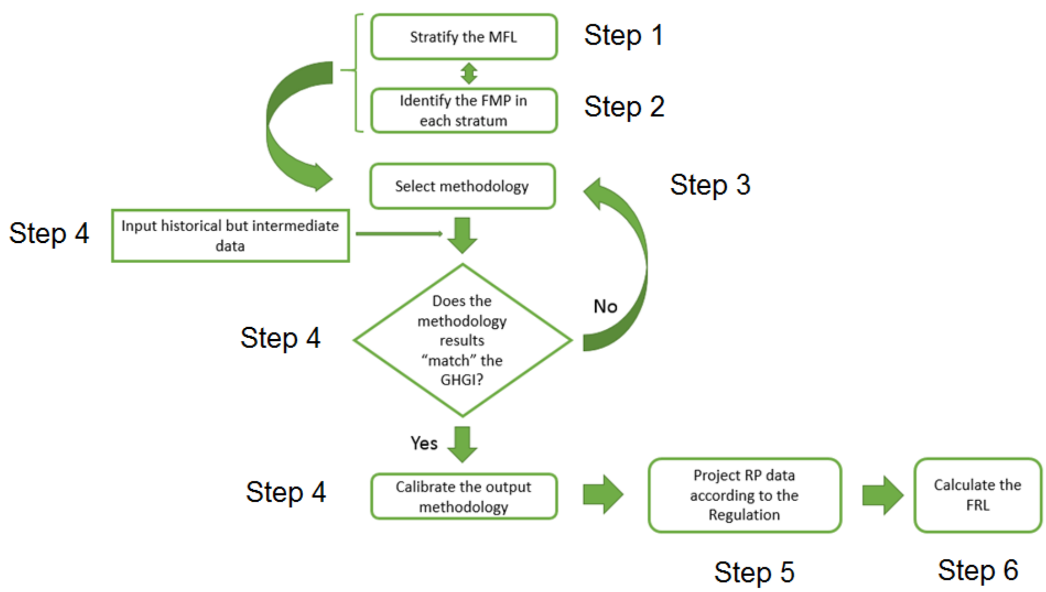


Figure 13 Graphical representation of the approach used. Source: Foresel et al. (2018)

<u>The first step</u> – 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

[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

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.40.

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

The main sources of quantitative information about forests in Bulgaria are the Forest Management Plans (FMP) and the forestry fund reporting forms (RF). Both data sources were used in elaboration of National Forestry Accounting plan of Bulgaria. Projections are based on the forest stand descriptions from FMP (dendrometrical description of forest stands) whereas the documentation of the strata and forest management practices during the reference period are done based on the reporting forms. 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.

Forest Stand Descriptions (Description sheets)

The Forest Management Plans (FMP) and its forest stand descriptions are the most detailed and accurate information on forests available in Bulgaria. The FMP are updated in a 10-years period – i.e. one tenth of the territory is surveyed each year. Practically all forest stands are surveyed once in every 10 years. The survey produces detailed maps, as well as description of the forest stands (e.g. species composition, age of the stand, yield class, mean height, volume of growing stock, stocking rate, etc.). The survey (stand-wise forest inventory) is made for each sub-compartment or each forest stand. According to the latest available data on forest management plans, the sub-compartments are currently 1.340 million with an average area of 3.15 ha. They are distributed into 176 territorial units or state forest enterprises for which a Forest management Plan is prepared. The data from forest stand descriptions are stored in national database which is publicly available on the website of the Executive Forest Agency. The current data from forest management plans refer, on average, to the year 2010.7, weighted by area. Although, the description sheets are the most detailed data on forest stands, they have drawback of being updated on a 10-years period. They also don't contain data on the current activities of the territorial units. The forest authorities, of course, document the activities in the forest stands, but that is their inside information.

The information in FMP serves as a basis for producing more aggregated data (statistics) for operational use such as reporting forms (RF 1-7) for the state of the forests in Bulgaria.

Aggregated data

Another source of data used in the estimation of FRL is forestry fund reporting forms (RFs) (Table 3). These are aggregated data (overview tables) that are updated and collected in a national database maintained by EFA. On basis of these reporting forms, 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) 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 sub-compartments. For example, the area of a sub-compartment 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" – i.e. 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, conversion coppices, conifers) and fellings (final fellings and thinnings). **In Bulgaria, RF5 is the only data source for actual timber harvesting**.

RF6 is a distribution of the area by forest types (conifers, etc.), stand age and stocking rate. 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. 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 forested 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 harvested wood (in m3) 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.**

Table 3 Description of the content of the forested 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 00-05-10
4	Forested area distributed by forest functions	Every 5 years since 1960; data used for the years 00-05-10
5	Harvested wood	Annually, separately for regeneration fellings and thinning
6	Forested area distributed by stocking rate and age classes	Every 5 years since 1960; data used for the years 00-05-10
7	Forested area distributed by age classes and yield classes	Every 5 years since 1960; data used for the years 00-05-10

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 land from 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 addition to the quantitative data used in our work, we have also referred to 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).

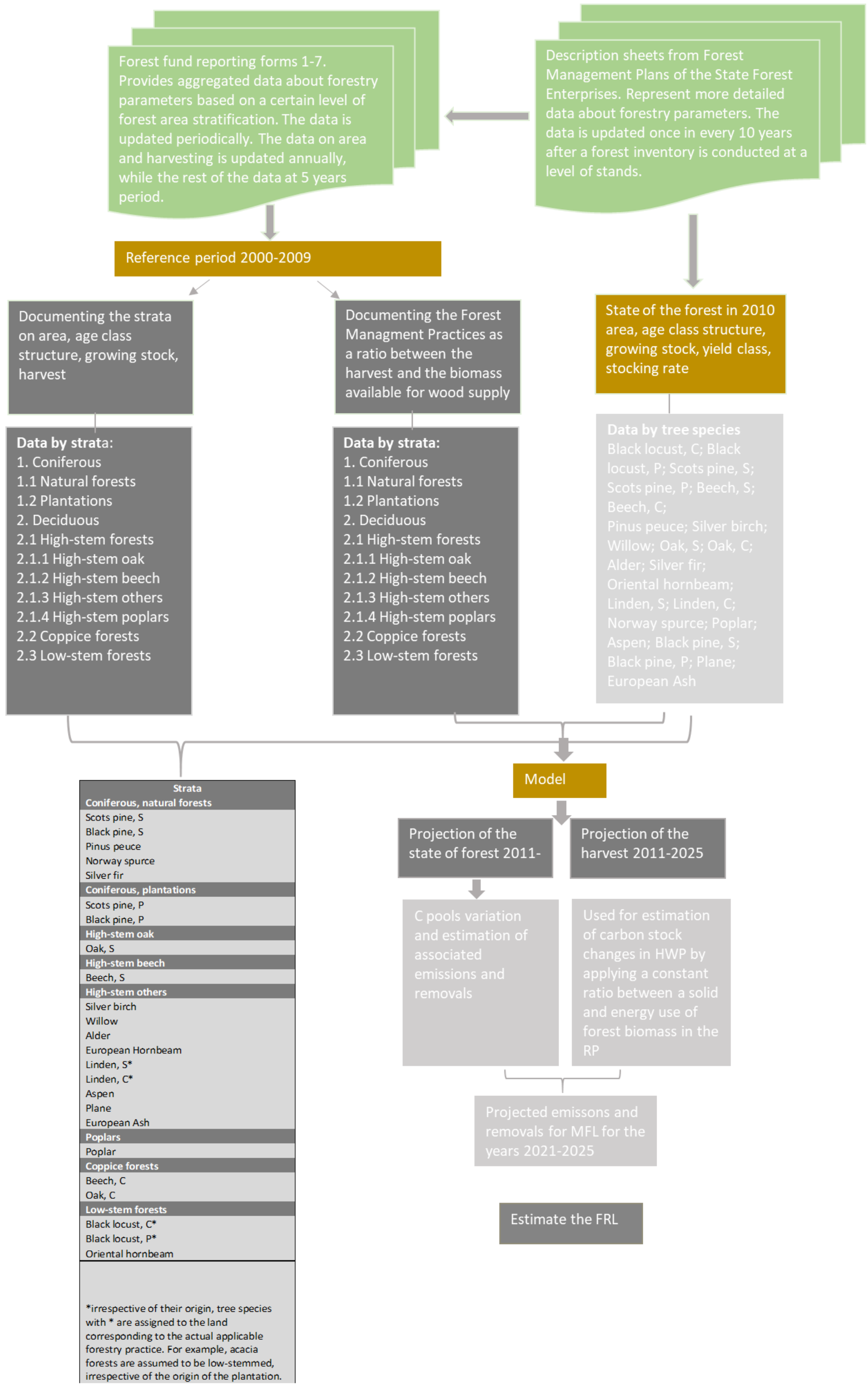


Figure 14 Interrelations between the different data sources used to calculate the reference levels

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. Possibility to differentiate forest management practices by stratum
3. Access to forest data and type of data
4. Possibility to project correctly the growth by tree species, yield classes, age classes and silvicultural system.

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 consider the forestry system and the way of regeneration as both influence the management practices.

Another important thing to consider when stratifying the MFL for the purpose of this work is the possibility **to properly define and document the forest management practices**. The only information on the actual timber harvesting in Bulgaria is the forestry fund reporting form №5 (RF-5). As it was mentioned that the RF-5 deals with simplified lists of tree species. For example, all the harvest from conifer tree species is reported under coniferous as total – no disaggregated information by tree species is provided. The same is valid for conversion coppices and low-stem forests. The adopted stratification of the managed forest lands follows to a great extent the information reported in RF-5. Thus, it is possible to quantitatively describe the forest management practices during the reference period, expressed as the percent of the harvest against the growing stock and the biomass available for wood supply for each stratum. Figure 15 presents a diagram of the adopted forest stratification which has been used to project the reference levels.

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 growing stock by age class, function, stocking rate, yield class and harvesting. However, the specifics of the forms make them difficult to use at the level of tree species. For example, despite the detailed information about forest area and growing stock by tree species and age class, the information about harvesting is more aggregated. Furthermore, the data from RFs could hardly be combined for the purposes of a more profound analysis or projection. For example, the data about forested 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 forest management plans (dendrometrical description sheets).** To reflect more precisely the difference in the growth rate of the different tree species, the forest management systems and the origin of stands in the model we further stratified the area of the adopted strata into sub-strata considering the tree species.

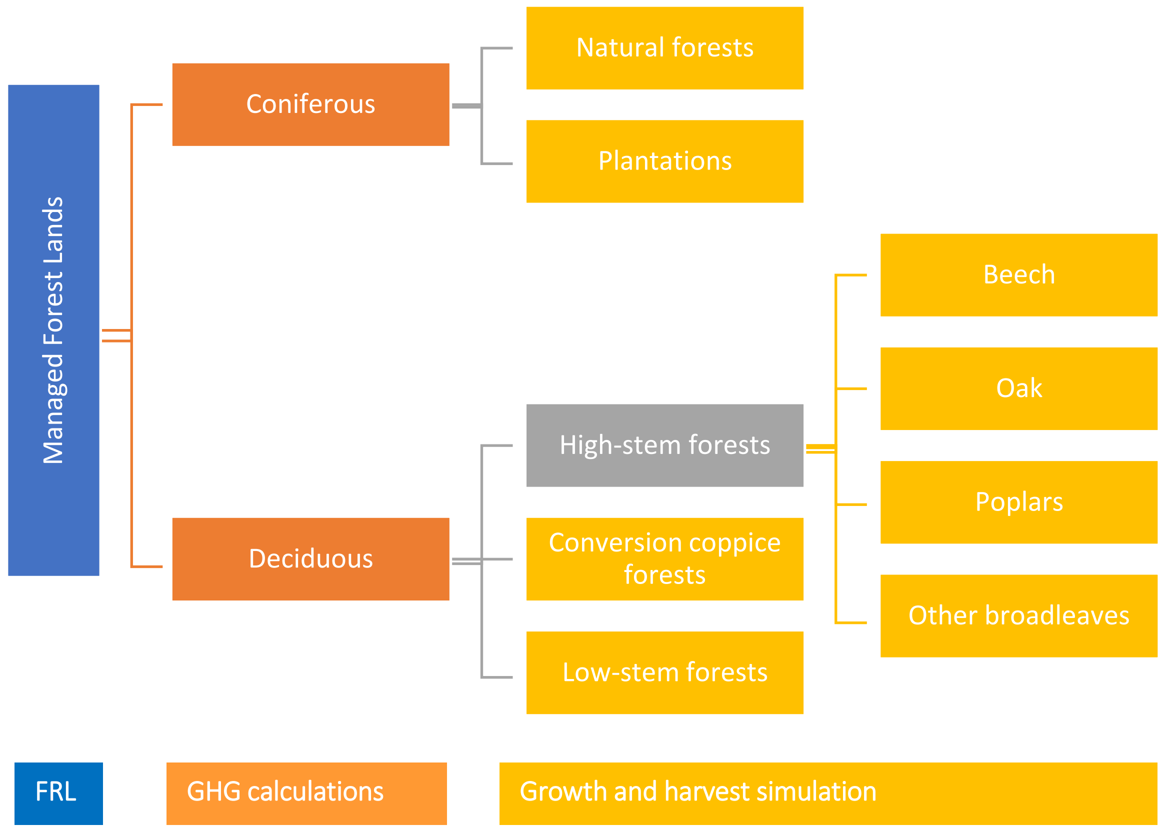


Figure 15 Scheme of the adopted stratification of forests

Documenting the strata. Information on the forest characteristics for the years of the reference period

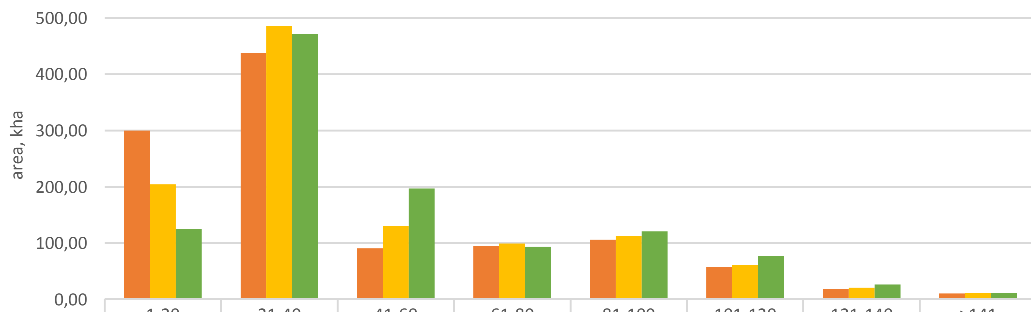
The following tables and figures present the data on forest characteristics, which describe the dynamics of the parameters for the years of the reference period. Note that the information provided below refers to the total forest area as this information is taken from official forest statistics (forest fund reporting forms – RF 1-7).

Table 4 Forested area by strata for the RP (2000-2009).

№ Strata	area, ha	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Coniferous	1115	1124	1122	1127	1127	1124	1120	1115	1119	1123
1.1	Natural forests	353	357	361	394	394	400	403	417	440	431
1.2	Plantations	762	767	761	733	733	725	717	698	679	692
2	Deciduous	2260	2317	2367	2400	2497	2527	2549	2566	2579	2603
2.1	High stem deciduous forests	736	755	767	781	797	805	810	814	830	838
2.1.1	*Oak - high stem*	205	211	214	218	223	227	228	230	234	236
2.1.2	*Beech - high stem*	373	382	389	396	404	400	403	405	412	416
2.1.3	*Poplar*	20	20	21	21	21	25	25	25	26	26
2.1.4	*Others - high stem*	138	141	144	146	149	153	154	154	157	159

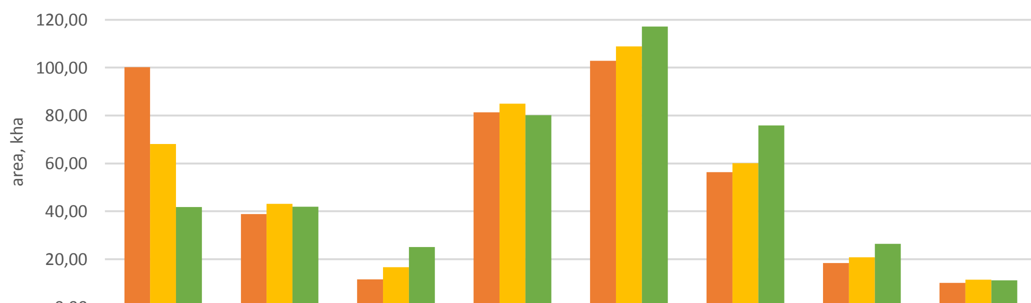
№ Strata	area, ha	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2.2	Coppice forests	1198	1223	1257	1273	1338	1336	1353	1361	1342	1332
2.3	Low-stem forests	327	339	342	346	362	386	387	390	408	433
		0	0	0	0	0	0	0	0	0	0
	Total Forested Lands	3375	3441	3489	3526	3625	3651	3669	3680	3698	3725

Coniferous

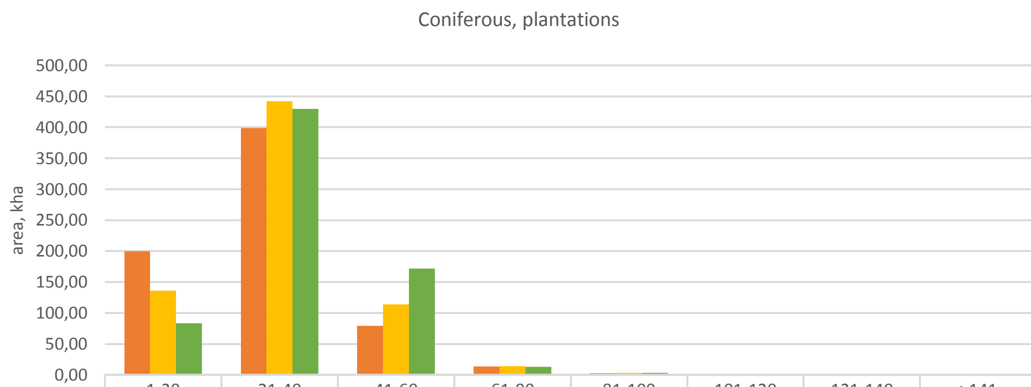


	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	299,777	437,729	90,725	94,815	105,745	57,306	18,392	10,158
2005	204,037	485,349	130,628	98,959	111,958	61,098	20,819	11,423
2010	124,922	471,669	196,720	93,269	120,564	77,188	26,507	11,185

Coniferous, natural forests

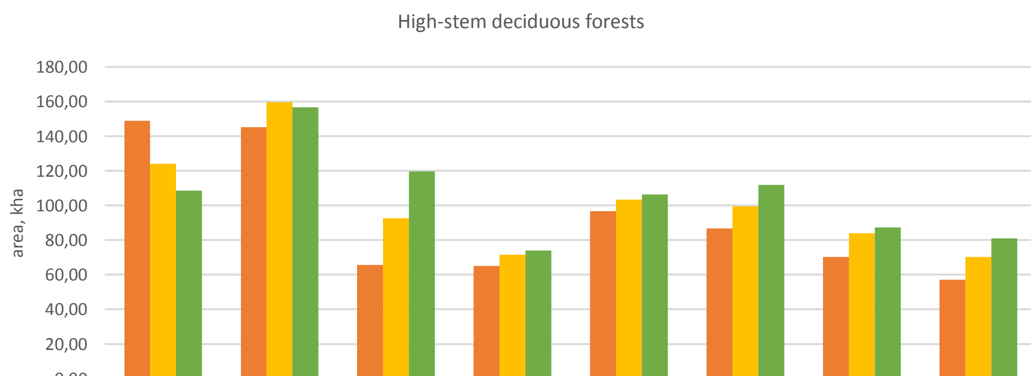


	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	100,151	38,902	11,568	81,416	102,824	56,342	18,339	10,158
2005	68,165	43,135	16,656	84,974	108,865	60,070	20,758	11,423
2010	41,735	41,919	25,084	80,088	117,233	75,888	26,430	11,185

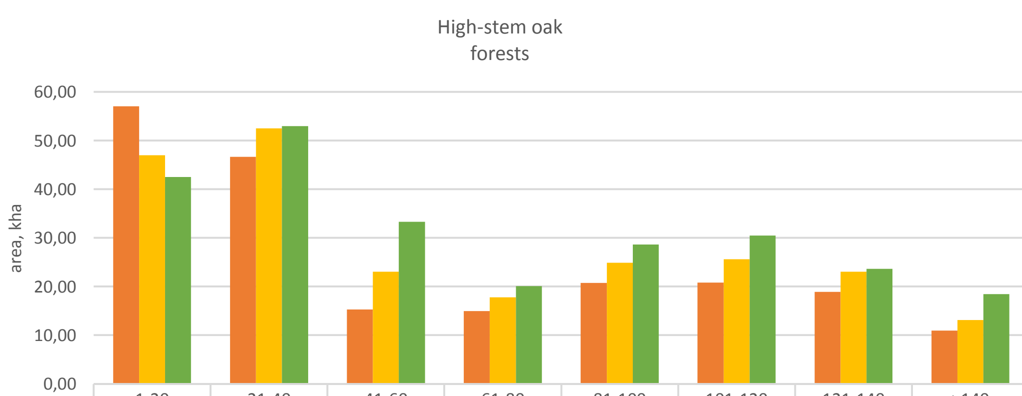


	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>141
2000	199,626	398,826	79,157	13,399	2,921	0,965	0,053	0,000
2005	135,872	442,214	113,972	13,985	3,093	1,028	0,060	0,000
2010	83,188	429,750	171,637	13,181	3,331	1,299	0,077	0,000

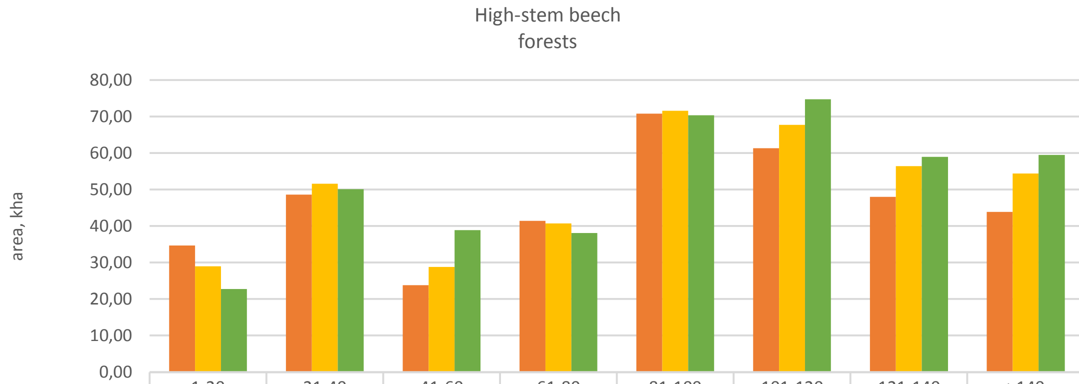
Figure 16 Distribution of area of coniferous forests by age classes (e.g natural forests and plantations)



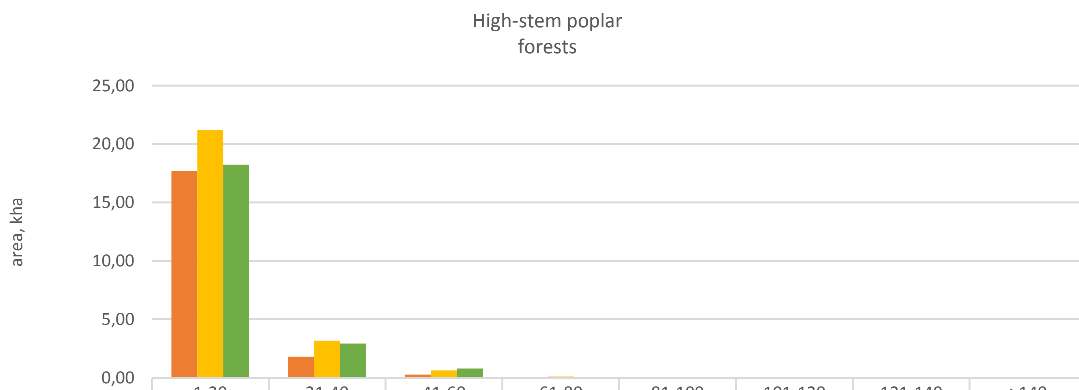
	1-20	20-40	41-60	61-80	81-100	101-120	121-140	>141
2000	148,851	145,152	65,710	65,034	96,732	86,699	70,225	57,117
2005	124,096	159,588	92,582	71,610	103,469	99,475	83,907	70,285
2010	108,642	156,641	119,705	73,880	106,410	111,929	87,363	80,979



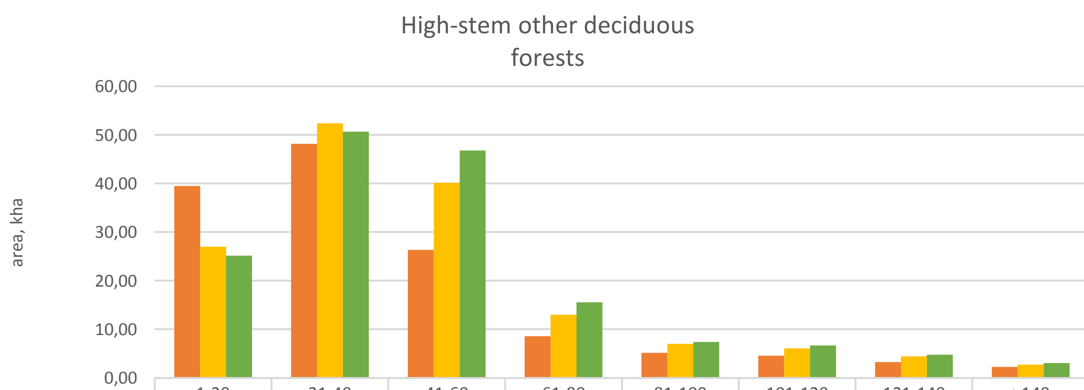
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Oak 2000	57,03	46,64	15,27	14,97	20,75	20,82	18,90	10,98
Oak 2005	46,95	52,50	23,02	17,77	24,88	25,62	23,07	13,14
Oak 2010	42,51	52,93	33,31	20,11	28,63	30,50	23,64	18,41



	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Beech 2000	34,68	48,59	23,84	41,44	70,79	61,31	48,04	43,87
Beech 2005	28,97	51,58	28,82	40,74	71,58	67,75	56,39	54,39
Beech 2010	22,74	50,11	38,84	38,12	70,38	74,75	58,93	59,46



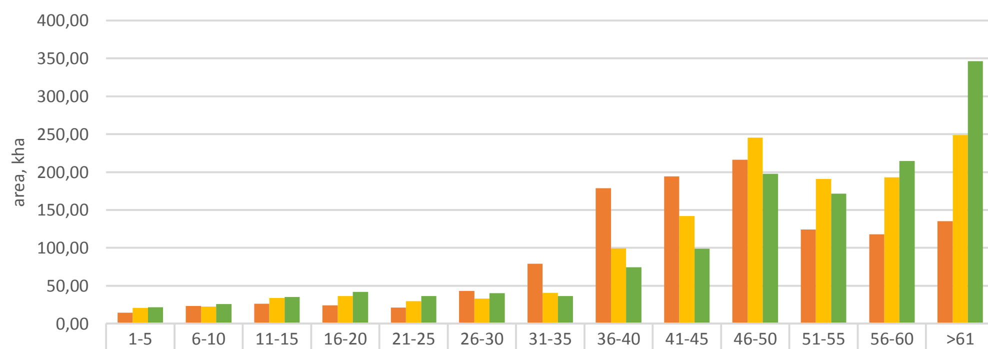
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Poplar 2000	17,69	1,79	0,27	0,02	0,03	0,00	0,00	0,00
Poplar 2005	21,21	3,16	0,61	0,09	0,01	0,00	0,00	0,03
Poplar 2010	18,24	2,92	0,78	0,07	0,00	0,00	0,00	0,02



	1-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
Others 2000	39,46	48,13	26,33	8,60	5,16	4,57	3,28	2,27
Others 2005	26,97	52,35	40,13	13,01	7,00	6,10	4,44	2,72
Others 2010	25,14	50,67	46,77	15,58	7,40	6,67	4,79	3,09

Figure 17 Area distribution by age classes for deciduous broadleaved oak, beech, poplar and others

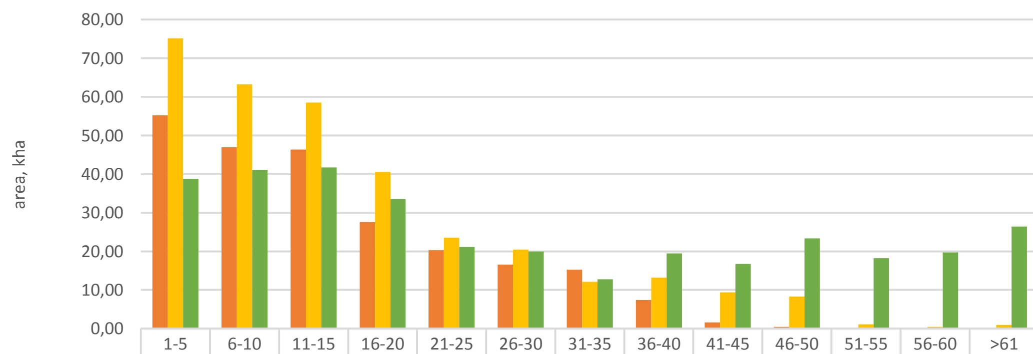
Conversion coppices



	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 18 Area distribution by age classes for conversion coppice forests

Low-stem 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 19 Area distribution by age classes for low-stem forests

Table 5 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

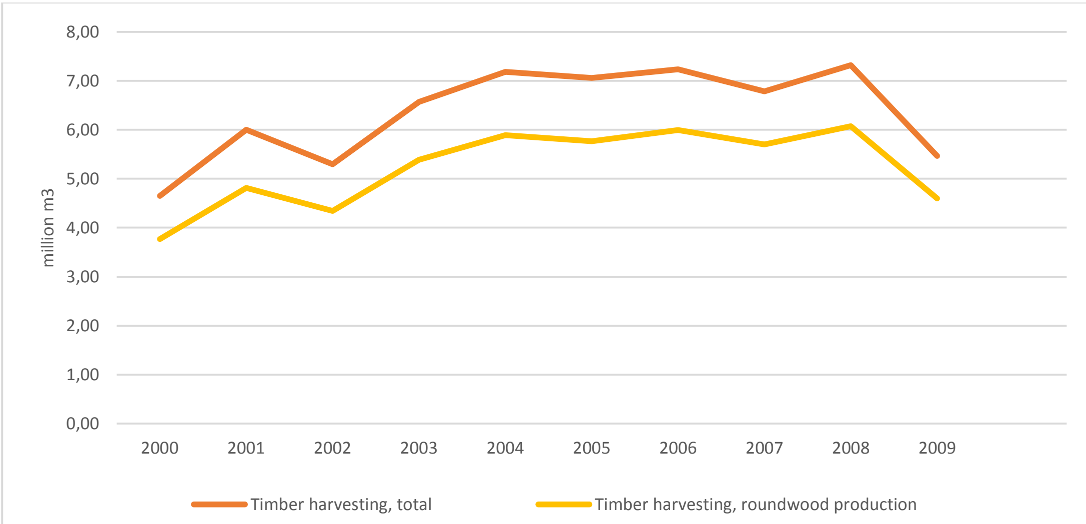
№	Name of starata	2000	2005	2010
2.2	Conversion coppices	44	47	48
2.3	Low-stem forests	15	17	29
	Total Forested Lands	51	53	57

№ 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 Forested Lands	525.56	538.68	551.8	564.92	578.04	591.16	601.84	612.52	623.19	633.87

Table 6 Growing stock by strata for the RP, million m^3

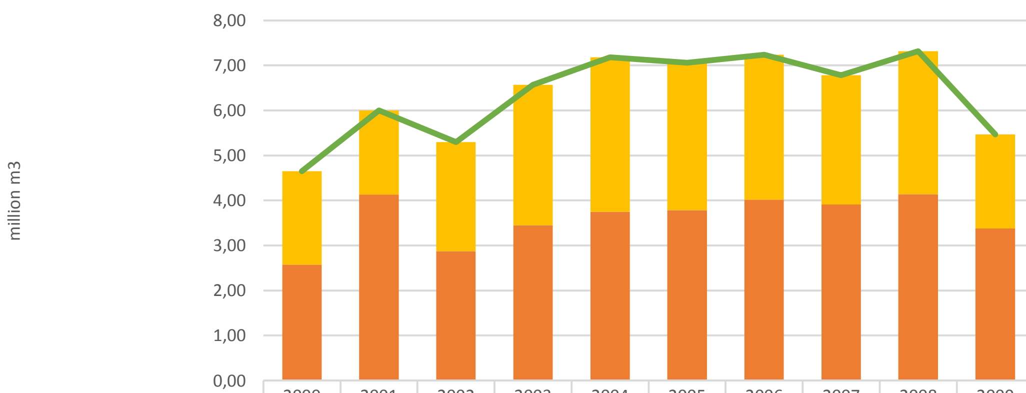
Table 7 Carbon stock of living biomass (as total for above- and belowground) by strata, tC/ha, calculated

№ 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 Forested Lands	53.30	53.59	54.14	54.84	54.59	55.42	56.15	56.97	57.69	58.24



**the total timber harvesting (red line) refers to the roundwood production plus the harvest waste or logging residues.*

Figure 20 Total timber harvesting for the RP, million m^3



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Thinning	2,07	1,87	2,42	3,12	3,44	3,27	3,22	2,88	3,18	2,09
Regeneration fellings	2,57	4,13	2,87	3,44	3,74	3,78	4,02	3,91	4,14	3,37
Total timber harvesting	4,65	6,00	5,29	6,57	7,18	7,06	7,23	6,79	7,32	5,46

Figure 21 Total timber harvesting from regeneration fellings and thinnings for the RP (2000-2009)

Table 8 Total timber harvesting by strata from regeneration fellings for the RP (2000-2009), m^3

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

Regeneration fellings	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Beech - high stem	436065	553065	444787	516861	594234	508027	528341	501485	483155	349198
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 9 Total timber harvesting by strata from thinning for the RP (2000-2009), m^3

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 actual harvest. That was necessary because the reconstruction class was eliminated. Reconstruction 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 reconstruction 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 reconstruction class was included in the low-stem and conversion coppices forests. That called for recalculating the data about forests by stratum for the deciduous forests in the period 2000-2010, because the reconstruction class is reported separately in the reporting forms for those years. Nevertheless, we have taken into account the reconstruction class (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 reconstruction rather than those applicable for the low-stem forests.

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 10 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 the biomass available for wood supply (BAWS) by stratum, calculated as an average value for the reference period. This information is presented in

Table 12. The potential of biomass subject to harvest (referred here as BAWS) was calculated for each stratum taking into account the different tree species, the origin of a stand (because the same tree species could have different rotation ages if it is with seed origin or plantation) and yield class. The information used to estimate the BAWS by strata and tree species is presented in the table below

Illegal cuttings are not considered explicitly 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. The official data on illegal logging refers only to the registered violations in the state forests as the seized wood in these cases vary between 0.1–0.9 % of the annual harvesting. However, since our model takes into account the observed reduction in the stocking rate during the RP, we could consider that at some extent, the impact of the illegal logging is considered in the projections. Usually a reduction in the stocking rate of a forest stand could be observed after natural disturbance, overexploitation or illegal logging. Detailed description on decrease in stocking rate is included in the model description.

Table 10 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
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

No.	Name	Short description of practice	Felling rotation, years	Data source
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 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.	120	Ordinance No.33/2003
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 Ist and IInd 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

No.	Name	Short description of practice	Felling rotation, years	Data source
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
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	Conversion coppices	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	Coppices of black locust are with rotation of 20-25 years. Conversion coppices from oak and beech have rotation lengths of >60 years. Seed trees are with rotation of 80-120 years	Article 50 (5) of the 1997 Forestry Act.; Ordinance No. 33/2004

No.	Name	Short description of practice	Felling rotation, years	Data source
		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		
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.
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 11 Rotation ages per tree species, stratum and yield class

Strata and tree species/rotation ages (years) per yield class	YC 1	YC 2	YC 3	YC 4	YC 5
Coniferous, natural forests					
Scots pine, S	120	120	100	100	100
Black pine, S	120	120	100	100	100
Pinus peuce	160	160	140	140	140
Norway spruce	120	120	100	100	100
Silver fir	120	120	100	100	100
Coniferous, plantations					
Scots pine, P	80	80	80	80	80
Black pine, P	80	80	80	80	80
High stem oak					
Oak, S	140	140	120	120	120
High stem beech					
Beech, S	140	140	120	100	100
Poplars					
Poplar	15	15	15	15	15
Other bradleaved, high forest					
Linden, S	90	90	90	90	90
Linden, C	90	90	90	90	90
Silver birch	60	60	60	60	60
Willow	15	15	15	15	15
Alder	100	100	100	100	100
European Hornbeam	100	100	100	100	100
Aspen	40	40	40	40	40
Plane	100	100	100	100	100
European Ash	100	100	100	100	100
Conversion Coppice forests					
Oak, C	100	100	60	60	60
Beech, C	100	100	60	60	60
Low coppices (Niederwald)					
Black locust, C*	30	30	20	20	20
Black locust, P*	30	30	20	20	20
Oriental hornbeam	40	40	40	40	40

S - seed origin

C - coppice

P - plantation

Table 12 Quantitative aspects of the Forest Management Practices, expressed as a percentage of the timber harvesting (total) from the BAWS for each stratum

FMP	Type of felling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	mean
High-stem beech	regeneration fellings	0.96%	1.19%	0.93%	1.06%	1.19%	1.00%	1.02%	0.95%	0.89%	0.63%	0.98%
High-stem beech	thinning	0.42%	0.29%	0.40%	0.46%	0.50%	0.37%	0.40%	0.37%	0.52%	0.46%	0.42%
High-stem oak	regeneration fellings	1.22%	1.38%	1.11%	1.16%	1.21%	1.15%	1.14%	1.21%	1.08%	0.72%	1.14%
High-stem oak	thinning	0.50%	0.42%	0.59%	0.37%	0.64%	0.58%	0.55%	0.49%	0.34%	0.40%	0.49%
Low stem, Oriental hornbeam	regeneration fellings	2.22%	1.81%	2.43%	2.87%	2.73%	1.99%	2.38%	1.97%	0.01%	0.00%	1.84%
Low stem, Oriental hornbeam	thinning	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-
Coniferous	regeneration fellings	1.76%	3.61%	1.55%	1.67%	1.72%	1.90%	1.73%	1.84%	2.07%	1.33%	1.92%
Coniferous	thinning	0.47%	0.49%	0.60%	0.79%	0.91%	0.94%	0.90%	0.79%	0.84%	0.42%	0.71%
Conversion coppices	regeneration fellings	1.08%	2.00%	1.31%	1.81%	2.18%	2.31%	2.67%	2.59%	2.77%	2.64%	2.14%
Conversion coppices	thinning	1.03%	0.74%	0.95%	1.26%	1.12%	0.89%	0.79%	0.63%	0.68%	0.56%	0.86%
Low stem, Black locust	regeneration fellings	7.36%	8.21%	10.67 %	12.02 %	11.17 %	10.10 %	8.98%	6.73%	7.17%	4.85%	8.73%
Low stem, Black locust	thinning	0.24%	0.41%	0.37%	0.11%	0.18%	0.18%	0.34%	0.15%	0.19%	0.08%	0.22%
Poplars	regeneration fellings	19.19 %	22.00 %	21.57 %	20.55 %	16.81 %	18.12 %	17.67 %	16.23 %	15.32 %	13.03 %	18.05 %
Poplars	thinning	0.93%	0.84%	1.01%	1.28%	0.61%	0.24%	0.37%	0.66%	0.38%	0.16%	0.65%
High-stem other broadleave s	regeneration fellings		-	-	-	-	-	-	-	-	-	1.91%
High-stem other broadleave s	thinning	-	-	-	-	-	-	-	-	-	-	0.68%

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

Materials and methods

Classical simulation (Fortschreiben) by yield table was used to model growth and harvesting (v. Gadow, 2005).

The harvesting is projected based on the average share of the harvest to biomass available for wood supply (BAWS) for the reference period 2000-2009. The ratio per strata was applied unchanged for the projection period 2010-2030.

Growing stock, growth and harvesting simulation is based on the state of the forest in 2010. Data on forest area, growing stock by tree species, yield class and age was extracted from the electronic models of the forest management plans, downloaded from the web site of EFA, which cover all forests. Thus, the method has no character of sampling.

Stratification

For the sake of simplicity, we distinguish only the so-called **tabular species**, i.e. the most important tree species for which yield tables have been developed. Area and growing stock of all other species are added to those of the appropriate tabular species, for example, all oaks are gathered, 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		Broadleaved, high forest, continuation
Scots pine, S		Alder
Black pine, S		European Hornbeam
Pinus peuce		Aspen
Norway spruce		Plane
Silver fir		European Ash
Coniferous, plantations		Poplar
Scots pine, P		Linden, C
Black pine, P		Conversion Coppice forests
Broadleaved, high forest		Oak, C
Oak, S		Beech, C
Beech, S		Low coppices (Niederwald)
Linden, S		Black locust, C*
Silver birch		Black locust, P*
Willow		Oriental hornbeam

**In the list, S is for seed natural stands, C is for coppice stands, and P is for plantations. Unmarked tables are used irrespective of stand origin.*

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 curve.

Data description

The distribution of area and 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 was measured in hectares and volume in solid cubic metres over bark (*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 to overstoreys and understoreys. Their age is dummy (not used in any calculation). It 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.

For every growing stock v_j its tabular or normal volume N_j is known, 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:

$$b_0, \quad b_1, \quad b_2, \quad ...., \quad b_M \text{ -}$$

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 volume $v_j = 0$. This is the case for age 0 as well as for young stands with height under 3 m, whose volume 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 wood removal (forest harvest, *Jahresnutzung*) in the sub-stratum is determined applying the formulas:

$$\begin{array}{c} E = PV \\ e = pv \end{array} \qquad (*)$$

,

where E *is annual wood removal from final cuts (*Endnutzung*),* P *is the average percentage of such removals relative to the mature growing stock for the RP (*

Table 12), V is the mature growing stock (inclusive overstory volumes), m is the minimal age of forests liable for final cut,

$$V = v_m + v_{m+1} + ... + v_M + v_{M+1},$$

e *is annual removal from thinnings,* p *is the average percentage of such wood removals relative to non-mature growing stock for the RP (*

Table 12), v non-mature growing stock (inclusive understory volumes).

$$v = v_1 + v_2 + ... + v_{m-1} + v_{M+1}$$

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 age of maturity m depends on official rotation age u (*Umtriebszeit*): it is $m = u - 20$ for high forests and $m = u - 5$ for coppices and fast growing poplar and locust plantations.

Harvesting percentages (harvest levels) were determined by strata as an average for the reference period,

$$P = \frac{E_5}{V_3}$$

$$p = \frac{e_5}{v_3}$$

where E_5 is final cuts removal in the stratum after RF5, V_3 is the mature growing stock in the stratum after RF3, e_5 is thinnings removal in the stratum after RF5, v_3 is the non-mature growing stock in the stratum after RF3.

The parameter V_3 is the value of the mature growing stock V established on the base of RF3.

Since RF3 and RF5 (Table 3) do not distinguish yield classes and some details about tree species and origin, a single percentage is established for each stratum (at the level of tree species), which is then applied to its sub-strata (a).

Simulation procedure

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 autumn and winter and growth occurs in spring and summer (growing season). Actually, many fellings are carried out in the growing season, 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 in Bulgaria, however, mature stands have negligible increment, so that felling one stand instead of another has limited impact on forest biomass accumulation.** Thus,

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

wherein $v_{n+1} + ... + v_M + v_{M+1}$ is the volume of the oldest 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 annual wood removal 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

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

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

$$b'_n = \frac{b_n}{1.002}$$

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 issues. 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.

$$a'_j = a_j$$

$$v'_j = v_j$$

$$b'_j = b_j.$$

As a next step, the growth in spring and summer 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. Each stocking rate is reduced with 0.2%, which is the average trend of stocking rate after RF6. 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

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

$$b_j = \frac{b'_j}{1.002}$$

$$v_j = b_j N_j a_j .$$

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 negligible (due to the old age of overstory, the suppression by the main stand of understorey) 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.

Special questions – the simulation of stocking rate

The assumption $b_0 = 0{,}75$ means that all young forests (in the 1st age class) have an average stocking rate of 0,75. This average, shown in Fig. 22, has been derived form RF6. It is obvious that this rate is rather independent of forest types.

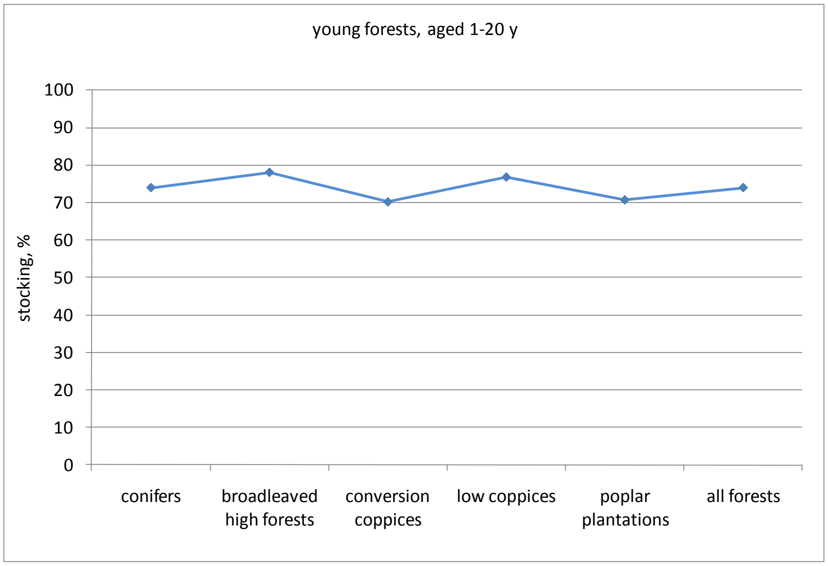


Figure 22 Initial stocking rate

RF6 also shows that during the first 20 years the stocking rate tends to increase slightly, after which it decreases consistently and steadily. The exception is poplar plantations and low coppices, whose stocking rate decreases from the very beginning.

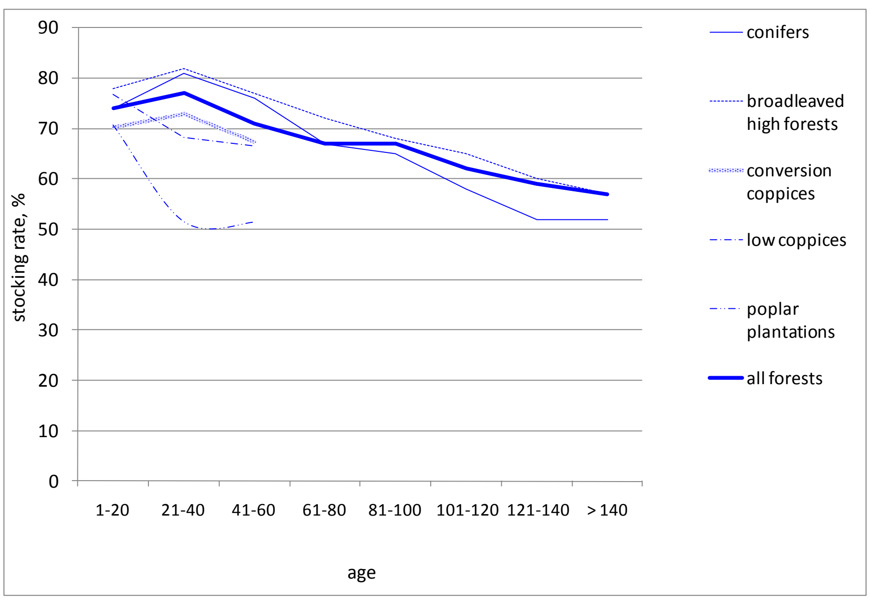


Figure 23 Decline of stocking rate

The gradual decrease in stocking rate is due to natural disturbances and excess use of thinnings. In the normal course of thinnings, the stocking rate should be maintained.

Figure 23 shows that the national average trend of stocking rate is well approximated by the exponential function. Its exponent shows that the average rate of decline of stocking rate is 0.2% per year.

Figures 21, 22, 23 were obtained from RF6.

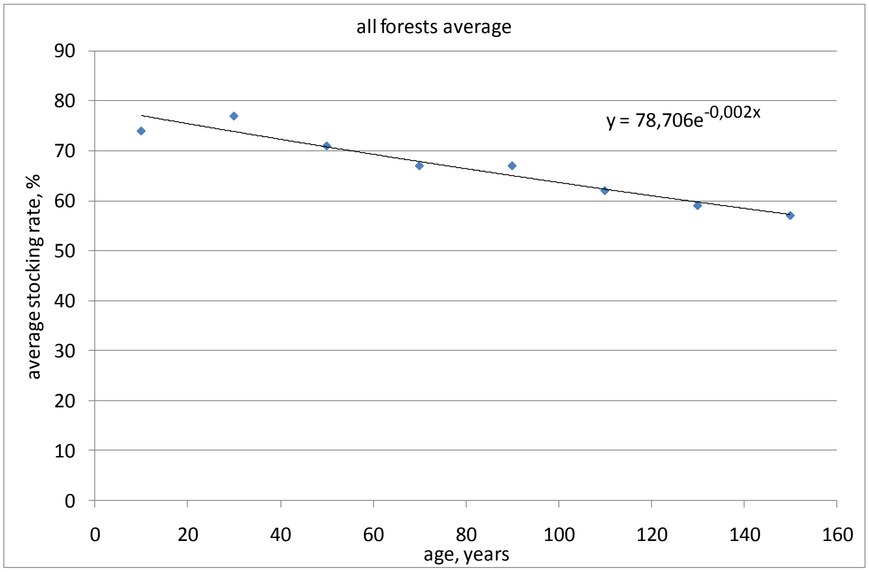


Figure 24 General decrease trend of stocking rate

Special questions – the simulation of forest harvest

Another possible approach to empiric harvest levels is to relate them to the total volume $v_3 + V_3$ of the sub-stratum, which is easier to read in RF3.

$$P' = \frac{E_5}{v_3 + V_3}$$

$$p' = \frac{e_5}{v_3 + V_3} .$$

In the NFAP submission from 2018, the yearly removals form final cuts were determined by these percentages using the formulas

$$E = P'V' \qquad (**)$$
$$e = p'V' ,$$

wherein $V' = v + V$ is the total stock of the sub-stratum, which is the sum of the mature growing stock and the volume of non-mature forests.

In the current report, formulas (*) based on mature growing stock V were adopted instead of formulas (**) based on the total growing stock V', because they are more in line with accepted forest management practices. In Bulgaria, forest harvest planning is mainly based on area methods (*Flächenweiser*), which start from the cutting area C (the area of the forests proposed for final cut) as an auxiliary parameter to determine the allowable cut. When C is given, the allowable cut E is determined by

$$E = C\eta$$

wherein η is the mean volume pro hectare of mature stands,

$$\eta = \frac{V}{A}$$

and A is their actual area. Area methods have the advantage to be cautious: it is easily seen, that $E = 0$ when mature growing stocks are absent, i.e. $V = 0$. The most common methods are “normal clearing area”

$$C = \frac{A'}{u}$$

and the “clearing by age”, known in the US as the method of the Black Hills

$$C = \frac{A}{20}$$

wherein A' is the total area of the sub-stratum, u is the official rotation age, A is the area of mature forests in the sub-stratum.

It is easy to see that for area methods described above the allowable cut is proportional to the mature stock, which is the essence of formula (*).

The use of formula (*) has the nontrivial consequence that it naturally accounts for the increased use of coniferous plantations and oak and beech coppice forests, which together account for about half of the forested territory in Bulgaria, over the coming decades.

These forests are characterized by a highly uneven "package" age structure (Figure 25) and poor health. Their packaging means that most of their stocks are concentrated in one class of age (20 years period). It is a consequence of the post-war policy of mass afforestation with coniferous species, mainly Scots pine and black pine, and the conversion of the coppice forests to high forest by aging. By 2010, 47% of the conversion coppices had reached maturity. During the period 2020-2030, this will happen with about 15% of the coniferous plantations which were subject of thinning until now.

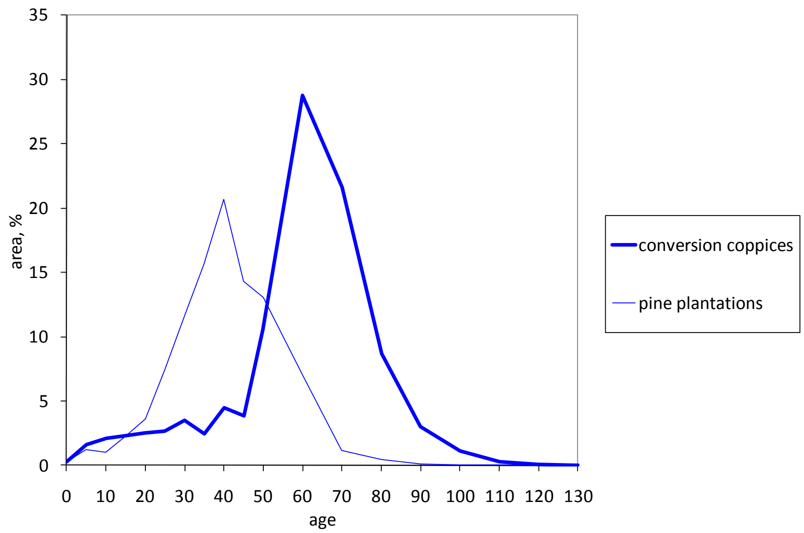


Figure 25 Distribution of pine plantations and conversion coppices by area, by 2010

In the final report, the percentages p' and P' are used as auxiliary results in determining p and P. It is easily seen, that

$$P = \frac{P'}{\mu}$$

$$p = \frac{p'}{1-\mu}$$

wherein

$$\mu = \frac{V_3}{V_3 + v_3}$$

is the share of mature volume. The parameter μ was determined for each stratum on the basis of forest management plans because it could not be determined accurately by RF3. Estimates of the values for 1990 and 2010 were obtained. Its value over the reference period was determined by interpolation between these values, the result being, naturally, closer to the 2010 estimate.

Special questions – use of growth and 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 compromise 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 26 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 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.

The figure also 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.

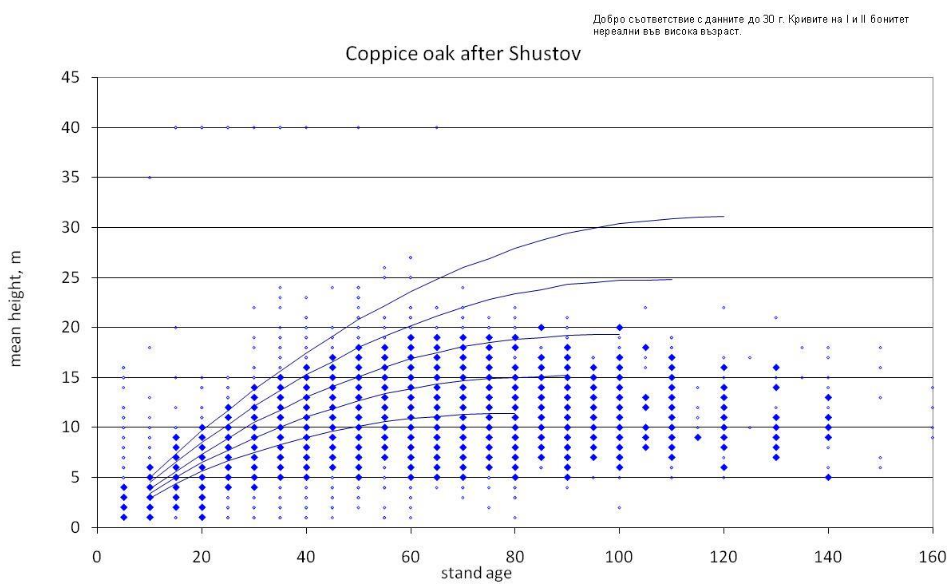


Figure 26 Comparison of the Shustov table with terrain data

The following table 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.

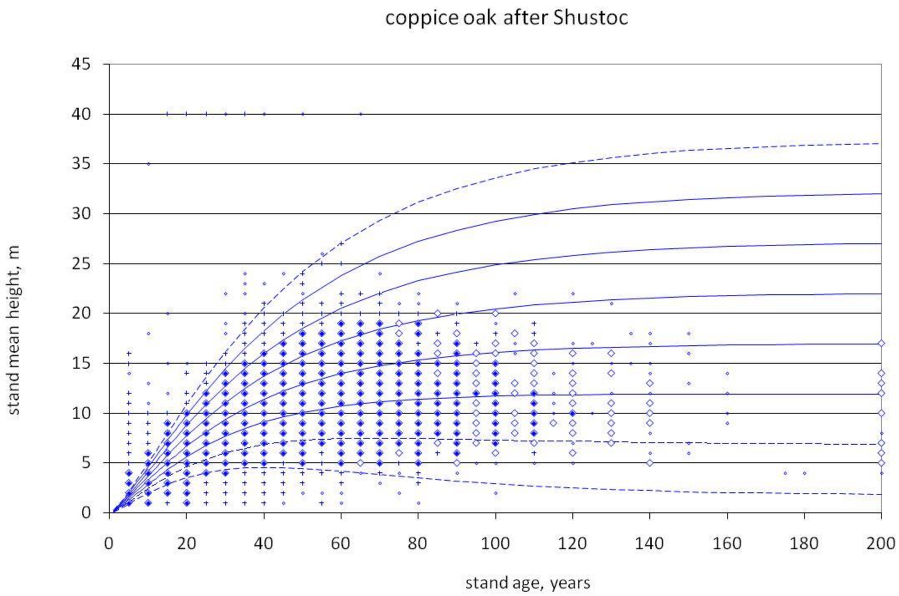


Figure 27 Extrapolation of the Shustov's growth table by yield class

The following figure 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 disadvantage 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 and rarely reached high age. 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.

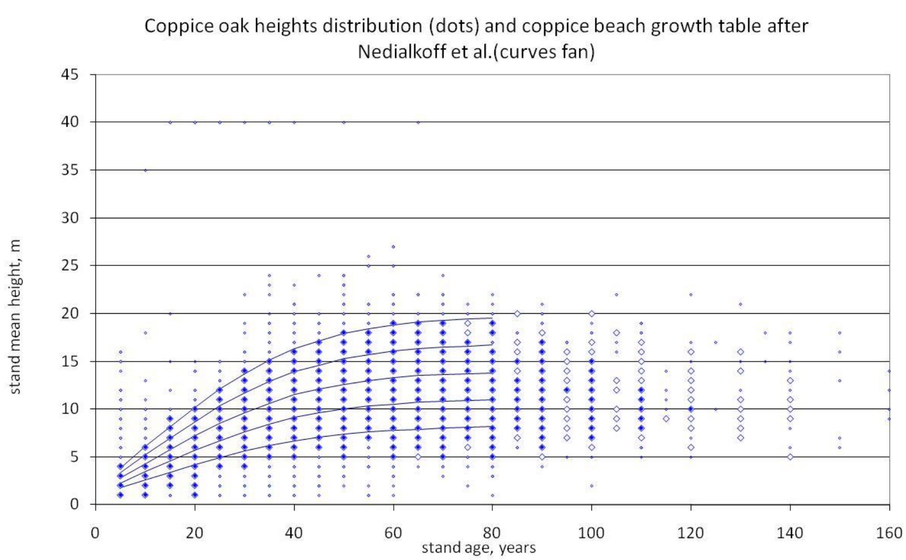


Figure 28 Comparison of the growth of the coppice oak with the yield table of Nedialkov et al. for the coppice beech

Figure 34 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. The Figure 30 shows that WImmenauer's table cannot be adapted to our conditions by extrapolation of the yield class. Figure 31 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 Peninsula. Wimmenauer is a rather old author no more cited in Germany, but Jütner's oak tables currently in use, which have been prepared through long-term monitoring of the development of pilot lands, fully confirm growth after Wimmenauer in their conditions. Figure 31 shows, however, that, on the peninsula, the height growth of oak is inhibited at the age of 40-50, 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.

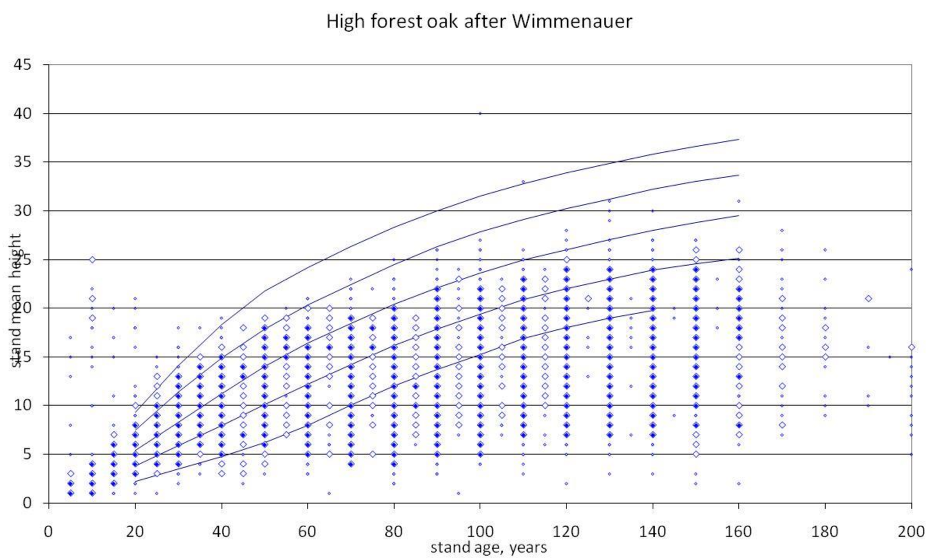


Figure 29 Comparison of the Wimmenauer's yield table with terrain data

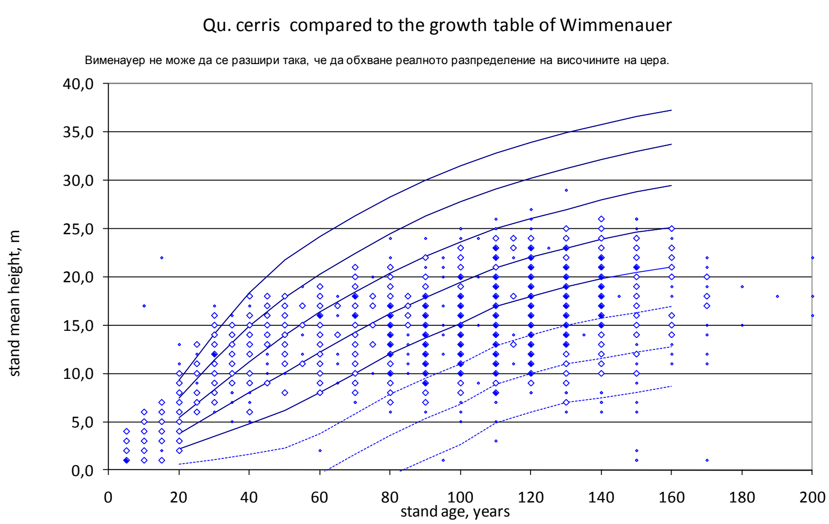


Figure 30 Extrapolation of the Wimmenauer's growth table by yield class

The terrain points on figure 31 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.

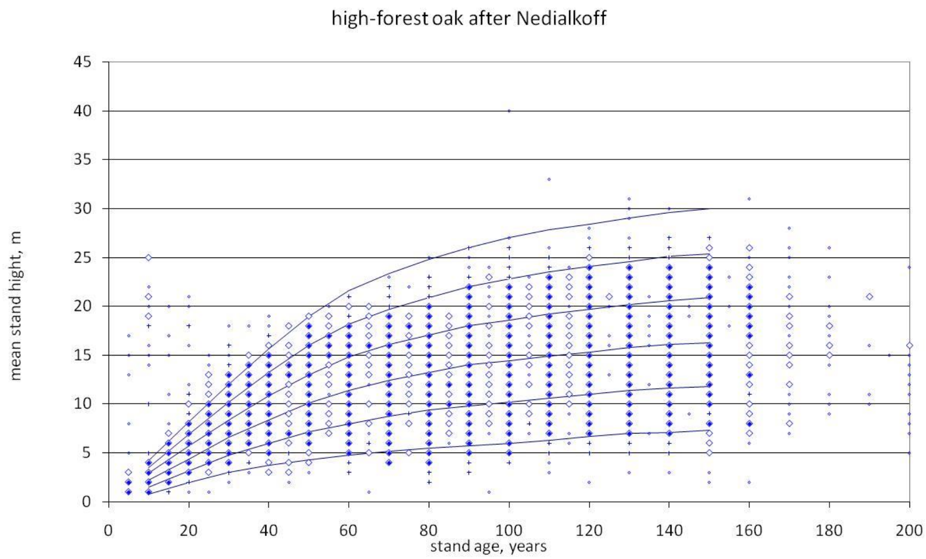


Figure 31 Comparison of Nedialkoff's growth table with terrain data

Nedyalkov's table for high-forest oak is not flawless but, luckily, the flaws are repairable. The lowermost 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.

Input data to the model

State of the forest

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 simulate the growth of the forests stands. However, in the GHGI we use the RF that's why we consider that it is worth to demonstrate the mutual consistency between these two data sets (description sheets and RF) for the year precedent the starting year of projection - 2010.

Table 14 State of the forest in 2010

		Description sheets			Reporting forms 1-3		
№	Strata	Area, kha	Growing stock, million m3	Growing stock m3/ha	Area, kha2	Growing stock, million m33	Growing stock m3/ha4
1	**Coniferous**	**1004**	**289.717**	**288.437**	**1122**	**287.118**	**255.893**
1.1	Plantations	554	149.593	-	687	162.435	-
1.2	Natural forests	450	140.124	-	435	124.683	-
2	**Deciduous**	**2750**	**357.628**	**130.069**	**2616**	**357.431**	**136.658**
2.1	High stem deciduous forests	852	176.851	-	846	186.234	-
2.1.1	Oak - high stem	254	31.985	-	250	34.365	-
2.1.2	Beech - high stem	408	113.018	-	413	121.931	-
2.1.3	Others - high stem	168	28.997	-	160	27.215	-
2.1.4	Poplar	22	2.851	-	22	2.723	-
2.2	Coppice forests	1404	158.621	-	1340	153.032	-
2.3	Low-stem forests	494	22.155	-	430	18.165	-
	Total Forest Lands	3754	647.345	172.443	3738	644.549	172.453

When investigating the table, the comparability of the data at the level of common woodland and total stock is very good - < 1%. . However, at the level of stratum it can be noted that there are some bigger differences between the datasets. For example, 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 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 in description sheets, as well as data in RF 2 (area by age class) and RF 3 (growing stock by age class), 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.

Forest management practices by strata

Table 15 Fixed values for FMP by strata

FMP	Type of felling	average (00-09) ratio H/BAWS
High-stem beech	regeneration fellings	0.98%
High-stem beech	thinning	0.42%
High-stem oak	regeneration fellings	1.14%
High-stem oak	thinning	0.49%
Low stem, Oriental hornbeam	regeneration fellings	1.84%
Low stem, Oriental hornbeam	thinning	-
Coniferous	regeneration fellings	1.92%
Coniferous	thinning	0.71%

FMP	Type of felling	average (00-09) ratio H/BAWS
Conversion coppices	regeneration fellings	2.14%
Conversion coppices	thinning	0.86%
Low stem, Black locust	regeneration fellings	8.73%
Low stem, Black locust	thinning	0.22%
Poplars	regeneration fellings	18.05%
Poplars	thinning	0.65%
High-stem other broadleaves	regeneration fellings	1.91%
High-stem other broadleaves	thinning	0.68%

Model results – development of age-related forest characteristics

The following figures and tables present the outcomes of the model simulation at the level of sub-strata. The simulation step is annual starting from 2011. The results are summarized within each year into the main strata – coniferous and deciduous. Like this the information is processed as an input data to the GHG emissions and removals calculations which are implemented in Excel spreadsheets.

The model works at the level of Total Forest Land, assuming a constant area and uses a comprehensive data – so the model simulates the development of forest characteristics in each and every forest sub-compartment under each sub-stratum. The model is not able to disaggregate the total forest land into forest land remaining forest land and lands converted to forest. However, all estimates related to GHG emissions/removals and elaboration of the FRL are made by applying the stock difference method based on the area of Managed Forest Land and by using the information on the development of the growing stock per ha during the simulation.

Area

The area of TFL remains constant over time and among the strata and sub-strata during the simulation.

Table 16 The area of Total Forest Land (TFL) disaggregated by strata in 2010 and over the simulation and compliance period

№	Strata	Model, kha
1	**Coniferous**	**1004.44**
1.1	Plantations	554.15
1.2	Natural forests	450.29
2	**Deciduous**	**2749.52**
2.1	High stem deciduous forests	852.28
2.1.1	*Oak - high stem*	*254.00*
2.1.2	*Beech - high stem*	*408.49*
2.1.3	*Others - high stem*	*167.63*
2.1.4	*Poplar*	*22.17*
2.2	Conversion coppices	1403.53
2.3	Low-stem forests	493.71
	Total Forest Land	3753.96

Growing stock

Table 17 Projected development of growing stock by strata, million m^3

№	Strata	2010	2015	2020	2021	2022	2023	2024	2025
1	**Coniferous**	**289.717**	**307.705**	**323.088**	**325.660**	**328.081**	**330.346**	**332.457**	**334.416**
1.1	Plantations	149.593	163.956	176.267	178.292	180.187	181.946	183.572	185.066
1.2	Natural forests	140.124	143.750	146.821	147.367	147.894	148.401	148.886	149.350
2	**Deciduous**	**357.628**	**360.796**	**362.527**	**362.602**	**362.564**	**362.454**	**362.258**	**361.985**
2.1	High stem deciduous forests	176.851	179.843	182.651	183.081	183.459	183.797	184.113	184.372
2.1.1	*Oak - high stem*	*31.985*	*32.742*	*33.398*	*33.513*	*33.624*	*33.732*	*33.836*	*33.937*
2.1.2	*Beech - high stem*	*113.018*	*114.291*	*115.161*	*115.280*	*115.379*	*115.459*	*115.518*	*115.559*
2.1.3	*Others - high stem*	*28.997*	*30.160*	*31.310*	*31.517*	*31.713*	*31.902*	*32.083*	*32.241*
2.1.4	*Poplar*	*2.851*	*2.649*	*2.782*	*2.772*	*2.742*	*2.704*	*2.675*	*2.634*
2.2	Conversion coppices	158.621	158.774	157.807	157.506	157.166	156.812	156.417	155.996
2.3	Low-stem forests	22.155	22.179	22.070	22.014	21.939	21.844	21.728	21.617
	Total Forest Lands	647.345	668.502	685.615	688.262	690.645	692.800	694.715	696.401

Table 18 Projected development of the growing stock by strata, m^3/ha

№	Strata	2010	2015	2020	2021	2022	2023	2024	2025
1	**Coniferous**	288.44	306.35	321.66	324.22	326.63	328.89	330.99	332.94
1.1	Plantations	269.95	295.87	318.09	321.74	325.16	328.33	331.27	333.96
1.2	Natural forests	311.19	319.24	326.06	327.28	328.45	329.57	330.65	331.68
2	**Deciduous**	130.07	131.22	131.85	131.88	131.87	131.83	131.75	131.66
2.1	High stem deciduous forests	207.50	211.02	214.31	214.82	215.26	215.66	216.03	216.33
2.1.1	*Oak - high stem*	125.93	128.91	131.49	131.94	132.38	132.81	133.22	133.61
2.1.2	*Beech - high stem*	276.67	279.79	281.92	282.21	282.45	282.65	282.79	282.89
2.1.3	*Others - high stem*	172.99	179.93	186.79	188.03	189.20	190.33	191.41	192.35
2.1.4	*Poplar*	128.62	119.51	125.47	125.04	123.70	121.98	120.67	118.81
2.2	Conversion coppices	113.02	113.13	112.44	112.22	111.98	111.73	111.45	111.15
2.3	Low-stem forests	44.87	44.92	44.70	44.59	44.44	44.25	44.01	43.79
	Total Forest Lands	172.44	178.08	182.64	183.34	183.98	184.55	185.06	185.51

Age structure

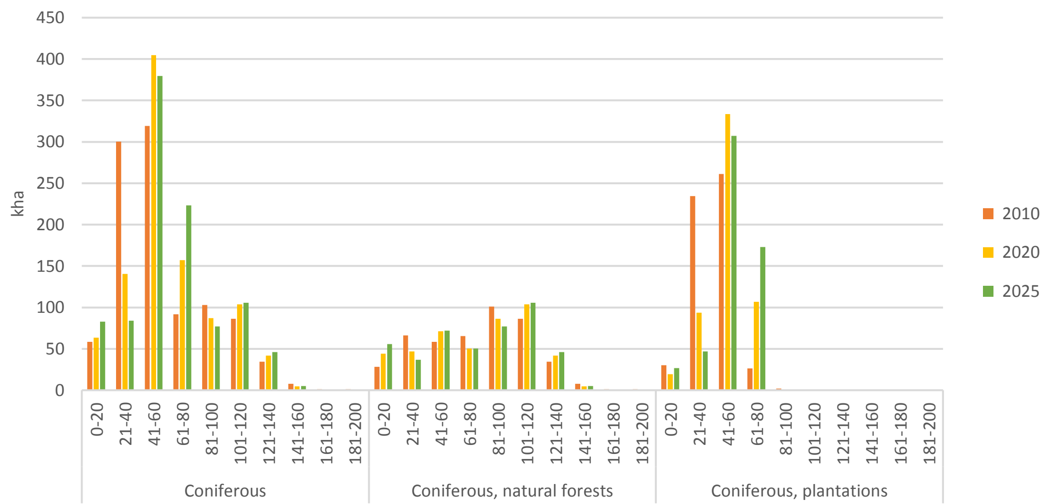


Figure 32 Dynamics of age structure of coniferous forests

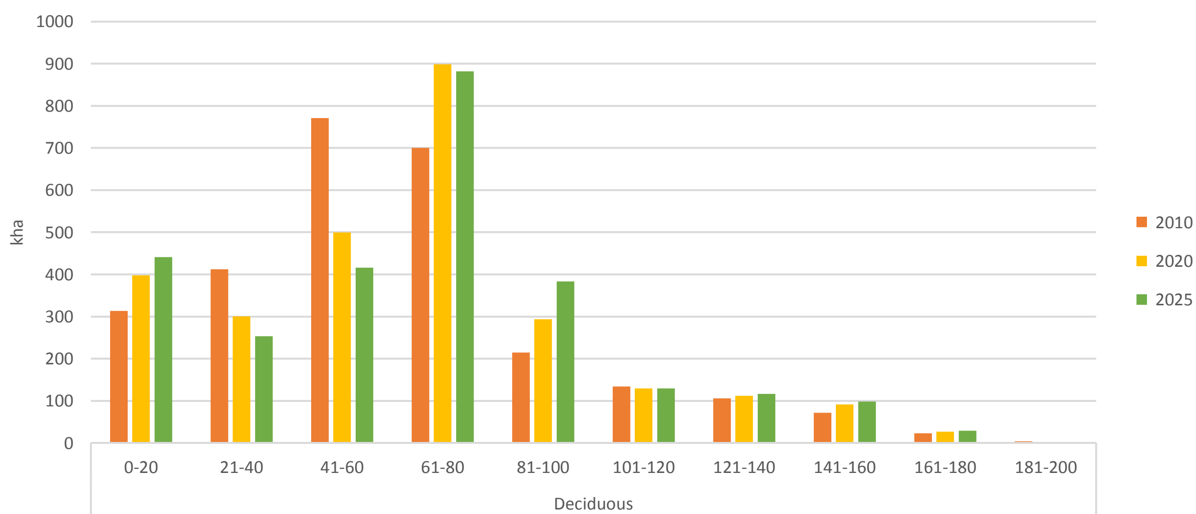


Figure 33 Dynamics of age structure of all deciduous forests

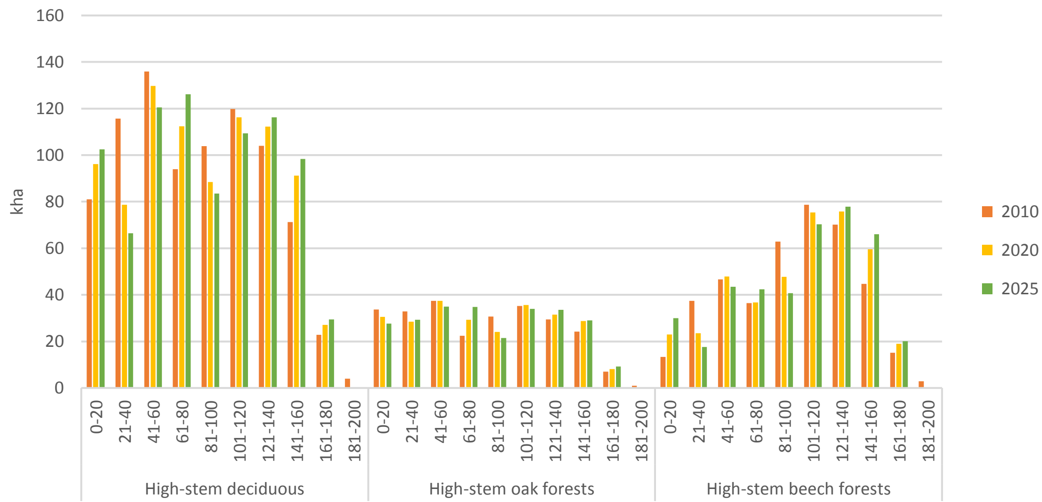


Figure 34 Dynamics of age structure of broadleaved high-stem, oak and beech

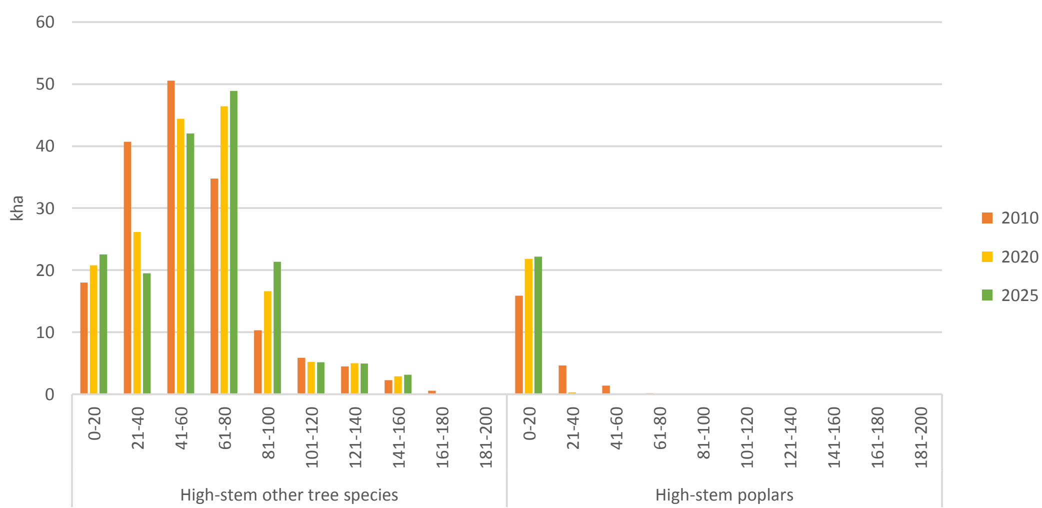


Figure 35 Dynamics of age structure of other deciduous high-stem forests and poplars

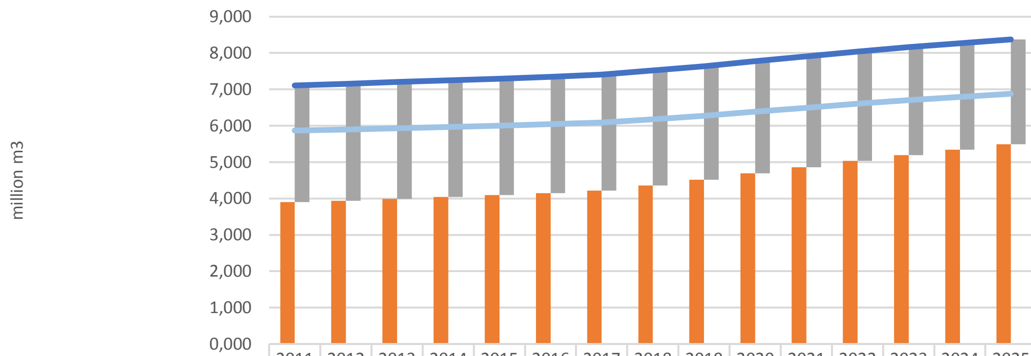
Figure 36 Dynamics of age structure of coppice and low-stem forests

Timber harvesting

Table 19 Projected harvest amount by strata (total), m^3

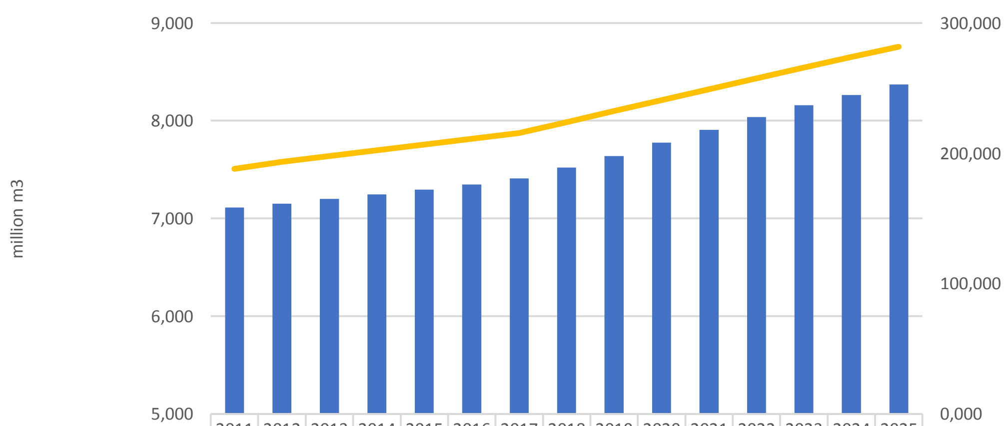
№	Strata	2011	2012	2013	2014	2015
1	Coniferous	2876715	2935782	2993793	3050770	3106727
1.1	Plantations	1192578	1230838	1268462	1305498	1341872
1.2	Natural forests	1684137	1704944	1725331	1745272	1764855
2	Deciduous	4234981	4214059	4206847	4195145	4188928
2.1	High stem deciduous forests	1761806	1737811	1721991	1701687	1687055
2.1.1	Oak - high stem	240721	242185	243613	245010	246363
2.1.2	Beech - high stem	754332	758572	762703	766716	770609
2.1.3	Poplar	407231	391371	379430	372721	367974
2.1.4	Others - high stem	359522	345683	336245	317240	302109
2.2	Coppice forests	1830834	1846485	1860080	1873014	1885231
2.3	Low-stem forests	642341	629763	624776	620444	616642
	Total	**7111696**	**7149841**	**7200640**	**7245915**	**7295655**
№	Strata	2016	2017	2018	2019	2020
1	Coniferous	3161592	3215458	3315057	3412476	3507717
1.1	Plantations	1377617	1412781	1497493	1580432	1661601
1.2	Natural forests	1783975	1802677	1817564	1832044	1846116
2	Deciduous	4186560	4194429	4205741	4226761	4267064
2.1	High stem deciduous forests	1675896	1675430	1678596	1683188	1707832
2.1.1	Oak - high stem	247700	249018	249971	250886	251762
2.1.2	Beech - high stem	774400	778095	782603	786976	791217
2.1.3	Poplar	364831	360782	359637	359543	361720
2.1.4	Others - high stem	288965	287535	286385	285783	303133
2.2	Coppice forests	1896716	1907363	1917479	1926809	1935580
2.3	Low-stem forests	613948	611636	609666	616764	623652
	Total	**7348152**	**7409887**	**7520798**	**7639237**	**7774781**
№	Strata	2021	2022	2023	2024	2025
1	Coniferous	3600693	3691545	3780316	3866988	3951538
1.1	Plantations	1740867	1818391	1894195	1968254	2040557
1.2	Natural forests	1859826	1873154	1886121	1898734	1910981
2	Deciduous	4305076	4346021	4379593	4397550	4418139
2.1	High stem deciduous forests	1731161	1753054	1762257	1757062	1778946

№	Strata	2011	2012	2013	2014	2015
2.1.1	Oak - high stem	252621	253437	254229	254997	255746
2.1.2	Beech - high stem	795323	799305	803149	806868	810451
2.1.3	Poplar	364411	367543	369596	372275	386540
2.1.4	Others - high stem	318806	332769	335283	322922	326209
2.2	Coppice forests	1943741	1951351	1961400	1971017	1979861
2.3	Low-stem forests	630173.9	641615.6	655935.5	669471	659332.2
	Total	7905769	8037566	8159909	8264538	8369677



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Thinning	3,215	3,212	3,209	3,206	3,203	3,199	3,194	3,159	3,123	3,086	3,047	3,007	2,965	2,922	2,879
Final cuts	3,897	3,938	3,992	4,040	4,093	4,149	4,216	4,361	4,516	4,689	4,859	5,030	5,195	5,342	5,491
Total harvesting	7,112	7,150	7,201	7,246	7,296	7,348	7,410	7,521	7,639	7,775	7,906	8,038	8,160	8,265	8,370
Roundwood production	5,866	5,892	5,930	5,963	6,001	6,041	6,089	6,179	6,275	6,388	6,496	6,606	6,707	6,792	6,879

Figure 37 Projected development of the harvest levels, million m^3



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total harvesting	7,112	7,150	7,201	7,246	7,296	7,348	7,410	7,521	7,639	7,775	7,906	8,038	8,160	8,265	8,370
BAWS	188,0	193,3	197,8	202,3	206,7	211,0	215,4	223,9	232,3	240,8	249,2	257,4	265,8	273,9	281,8

Figure 38 Projected development of the harvest levels compared to the development of the biomass available for wood supply, million m^3

Increment

The model projects the increments of growing stock based on yield tables, which specifies the increments in m^3 for the main tree species (Table 13), age and yield class.

Table 20 Projected total current net annual increment per strata, m3/ha

Strata	2010	2015	2020	2021	2022	2023	2024	2025	Trend
Coniferous	5.59	5.48	5.24	5.21	5.17	5.13	5.09	5.06	
Plantations	6.28	6.06	5.68	5.63	5.56	5.50	5.44	5.39	
Natural forests	4.74	4.78	4.71	4.70	4.69	4.68	4.66	4.65	
Deciduous	1.43	1.35	1.27	1.24	1.23	1.21	1.20	1.18	
High stem deciduous fo	2.54	2.50	2.38	2.35	2.32	2.29	2.26	2.22	
Oak - high stem	1.39	1.36	1.29	1.28	1.27	1.26	1.25	1.22	
Beech - hight stem	2.43	2.29	2.14	2.11	2.08	2.04	2.01	1.99	
Others - high stem	3.31	3.22	3.07	3.04	3.01	2.99	2.95	2.91	
Poplar	11.92	14.20	14.08	13.90	13.64	13.44	13.07	12.62	
Coppice forests	0.85	0.73	0.66	0.64	0.65	0.63	0.63	0.62	
Low-stem forests	1.17	1.12	1.05	1.04	1.03	1.01	1.01	1.01	

Development of Natural Disturbances under the FRL projections

The effects of the natural disturbances are included in the projections by taking into account the sanitary felling when estimating the harvest to biomass ratio as well as by extrapolating the trend of the decrease in the stocking rate observed during the RP. The share of the sanitary fellings from the harvest to biomass ratio as well as the reduction in stocking rate are unchanged during the model simulation. Like this we assume that the NDs would have the same effect on the FRL as in the reference period.

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 forested area 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, 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 ratio as calculated as an average for the RP is applied to the biomass available for wood supply.

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.

Description of the development of carbon pools

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 for 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 model simulation, regarding growing stock by strata and age classes, have been used. The results are summarized within each year into the main strata – coniferous and deciduous forests, consistent with the GHG Inventory 2018. Like this the information is processed as an input data to calculate the GHG emissions and removals which is implemented in Excel spreadsheets. After applying the emission factors listed in the table below, 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 by applying these changes to the MFL.

Table 21 Area of MFL during the simulation and compliance period

Strata	Area in 2010, kha
Coniferous	1086
Deciduous	2522
Pinus mugo	23
MFL	3631.375

Table 22 Projection of the growing stock by strata m^3/ha

Strata	2011	2015	2020	2021	2022	2023	2024	2025
Coniferous	288.44	306.35	321.66	324.22	326.63	328.89	330.99	332.94
Deciduous	130.07	131.22	131.85	131.88	131.87	131.83	131.75	131.66

Table 23 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
Deciduous	0.603	1.03	0.24	0.48

Table 24 Projection of the carbon stock in living biomass (ABG and BGB) in tC/ha

Strata	2011	2015	2020	2021	2022	2023	2024	2025
Coniferous	88.13	93.60	98.28	99.06	99.80	100.48	101.13	101.72
Deciduous	48.08	48.51	48.74	48.75	48.75	48.73	48.71	48.67

Table 25 Projections of emissions and removals from living biomass by strata, $GgCO_2$

Strata	2011	2015	2020	2021	2022	2023	2024	2025
Coniferous	-4546.08	-4169.65	-3318.32	-3115.94	-2933.52	-2745.24	-2557.88	-2373.39
Deciduous	-887.67	-683.17	-219.45	-93.26	47.18	136.99	243.97	339.43
Total MFL	-5433.75	-4852.82	-3537.77	-3209.20	-2886.34	-2608.25	-2313.91	-2033.96

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 26 Projections on emissions and removals from dead wood, $GgCO_2$

Dead wood	2000	2005	2010	2015	2020	2021	2022	2023	2024	2025
Coniferous	-56.81	-104.50	-64.22	-90.56	-108.90	-106.03	-103.17	-100.33	-97.51	-94.70
Deciduous	-138.58	-205.83	-165.75	-107.09	-68.78	-68.31	-67.72	-67.04	-66.26	-65.38
total DW emissions	-195.38	-310.33	-229.98	-197.65	-177.68	-174.34	-170.89	-167.37	-163.77	-160.09

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

Data source for the HWP commodities for 1990-2010 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 and roundwood production.

In order to fulfil 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.

Table 27 Projections on roundwood production, m^3

№	Strata	2011	2012	2013	2014	2015
1	Coniferous	2193245	2239545	2285019	2329691	2373569
2	Deciduous	3672692	3652785	3645253	3633616	3627062
	Total	**5865937**	**5892330**	**5930272**	**5963307**	**6000631**
№	Strata	2016	2017	2018	2019	2020
1	Coniferous	2416599	2458849	2538679	2616821	2693274
2	Deciduous	3624054	3630513	3640139	3658347	3694376
	Total	**6040653**	**6089362**	**6178818**	**6275168**	**6387650**

№	Strata	2021	2022	2023	2024	2025
1	Coniferous	2767974	2841025	2912456	2982261	3050408
2	Deciduous	3728383	3764897	3794408	3809630	3828515
	Total	**6496357**	**6605922**	**6706864**	**6791891**	**6878923**

Table 28 Projections on roundwood biomass, tC

№	Strata	2011	2012	2013	2014	2015
1	Coniferous	943095	963004	982558	1001767	1020635
2	Deciduous	2214633	2202629	2198088	2191070	2187118
	Total	**3157729**	**3165634**	**3180646**	**3192838**	**3207753**
№	Strata	2016	2017	2018	2019	2020
1	Coniferous	1039138	1057305	1091632	1125233	1158108
2	Deciduous	2185305	2189199	2195004	2205983	2227709
	Total	**3224442**	**3246504**	**3286636**	**3331216**	**3385817**
№	Strata	2021	2022	2023	2024	2025
1	Coniferous	1190229	1221641	1252356	1282372	1311675
2	Deciduous	2248215	2270233	2288028	2297207	2308595
	Total	**3438444**	**3491874**	**3540384**	**3579579**	**3620270**

Table 29 Average roundwood biomass production for 00-09, m^3 and rate of change during the projection

biomass, tC	Coniferous	Deciduous	Total roundwood production
average 00-09	788706	2068585	2857291
2011	1.20	1.07	1.11
2012	1.22	1.06	1.11
2013	1.25	1.06	1.11
2014	1.27	1.06	1.12
2015	1.29	1.06	1.12
2016	1.32	1.06	1.13
2017	1.34	1.06	1.14
2018	1.38	1.06	1.15
2019	1.43	1.07	1.17
2020	1.47	1.08	1.18
2021	1.51	1.09	1.20
2022	1.55	1.10	1.22
2023	1.59	1.11	1.24
2024	1.63	1.11	1.25
2025	1.66	1.12	1.27
2026	1.70	1.12	1.28
2027	1.73	1.12	1.29
2028	1.78	1.12	1.30
2029	1.82	1.13	1.32
2030	1.86	1.13	1.33

Table 30 Ratio between solid and energy use of forest biomass and its constant remaining during the projections

year	Rounwood prod, tC	HWP Inflow, tC	ratio
2000	2606588	229822	0.09
2001	2163612	262839	0.12
2002	2636481	265399	0.10
2003	2636481	261851	0.10
2004	3246665	338929	0.10
2005	3145943	320102	0.10
2006	3245551	388510	0.12

year	Rounwood prod, tC	HWP Inflow, tC	ratio
2007	3077097	520969	0.17
2008	3266200	459666	0.14
2009	2548297	380214	0.15
		Average 00-09	**0.12**
2011	3157729	378878	0.12
2012	3165634	379826	0.12
2013	3180646	381628	0.12
2014	3192838	383090	0.12
2015	3207753	384880	0.12
2016	3224442	386882	0.12
2017	3246504	389530	0.12
2018	3286636	394345	0.12
2019	3331216	399694	0.12
2020	3385817	406245	0.12
2021	3438444	412559	0.12
2022	3491874	418970	0.12
2023	3540384	424790	0.12
2024	3579579	429493	0.12
2025	3620270	434376	0.12

Table 31 Average carbon stock of HWP categories produced from domestic harvest, tC

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

Table 32 Emissions and removals from HWP, $GgCO_2$

Year	Sawnwood	Wood-based panels	Paper and Paperboard	HWP
1990	-415.89	-117.43	-53.52	-586.85
1991	-411.42	-47.65	16.25	-442.81
1992	262.31	67.04	43.66	373.01
1993	305.62	55.41	14.34	375.37
1994	299.92	54.21	-2.09	352.03
1995	293.75	52.42	-6.66	339.51
1996	288.02	51.02	22.21	361.25
1997	282.28	49.52	1.08	332.88
1998	276.70	48.11	-3.11	321.70
1999	215.01	66.23	71.00	352.23
2000	224.21	-174.81	31.47	80.88
2001	206.00	-225.06	-21.09	-40.16
2002	197.46	-227.35	-11.77	-41.66
2003	193.46	-208.08	-8.40	-23.03
2004	-4.85	-105.26	-161.98	-272.09
2005	-6.62	-36.61	-110.97	-154.20
2006	-100.16	-181.80	-85.22	-367.17
2007	-125.89	-568.32	-111.58	-805.78
2008	-45.96	-468.24	-27.51	-541.71
2009	96.84	-402.18	59.99	-245.36
2010	9.20	-499.91	35.04	-455.67
2011	19.36	-258.25	-1.55	-240.44
2012	17.86	-252.73	-1.76	-236.63
2013	15.39	-248.74	-2.52	-235.86

Year	Sawnwood	Wood-based panels	Paper and Paperboard	HWP
2014	13.37	-244.31	-2.81	-233.75
2015	11.01	-240.54	-3.25	-232.78
2016	8.44	-237.21	-3.71	-232.48
2017	5.16	-235.01	-4.49	-234.35
2018	-0.60	-236.40	-6.57	-243.57
2019	-6.88	-238.61	-8.42	-253.91
2020	-14.44	-242.71	-10.57	-267.73
2021	**-21.58**	**-246.32**	**-11.93**	**-279.83**
2022	**-28.70**	**-249.98**	**-12.96**	**-291.64**
2023	**-34.98**	**-252.59**	**-13.27**	**-300.83**
2024	**-39.82**	**-253.31**	**-12.70**	**-305.83**
2025	**-44.78**	**-254.30**	**-12.42**	**-311.50**

Non- CO_2 emissions from biomass burning

Emissions of CH_4 and N_2O from wildfires are projected as average of emissions and removals from wildfires during the RP:

CH_4 - 32.80 Gg CO_2 eq.
N_2O - 21.63 Gg CO_2 eq.
Total - 54.43 Gg CO_2 eq.

FRL and the national projections of anthropogenic greenhouse gas emissions reported under Regulation (EU) No 525/2013

The comparison between the FRL projections and the national projections under the Regulation (EU) No 525/2013 is presented in the figure below. The comparison is made at the level of biomass, because the national projections submitted by Bulgaria in 2017 under Regulation 525/2013 refer only to biomass pool from FL-FL. The trends of these projections occur because the projections of the FRL and those under Regulation 525/2013.

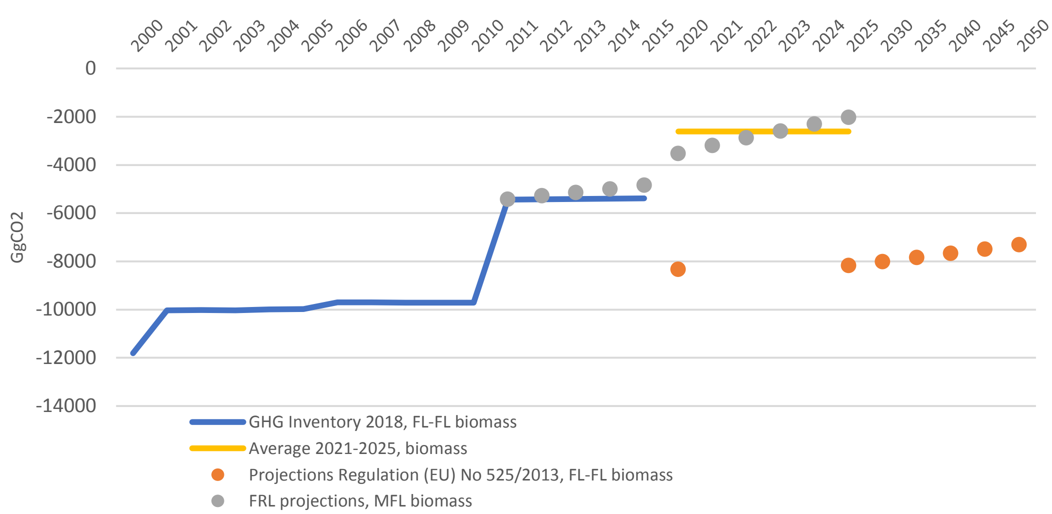


Figure 39 Consistency of FRL projections on biomass with national projections under Regulation 525/2013

The level of projected emissions and removals from biomass pool are different. Of course, there are many reasons for these differences as some are listed below:

1. Different concept – the FRL is based on extrapolation of the FMP as documented in the RP. The projection of the FRL takes into account also the maturity of the forests (dynamic age-related forest characteristics). The national projections under Regulation 525/2013, in the way they are elaborated in BG, do not consider from the age development of stands and at the same time include the effects of mitigation measures.
2. Different methodologies – FRL projections are elaborated based on detailed projections of the development of age-related forest characteristic and extrapolation of the FMP as documented during the RP based on model implementation while the national projections under 525/2013 are calculated by applying simple extrapolation of the trend on area development and carbon stock change
3. Different level of precision – the elaboration of the FRL projections are very detailed and considers the development of the age-related forest characteristics of the stratified managed forest lands. The national projections under the Regulation 525/2013 are elaborated at Grade 1 level in the L-PROJ tool at the level of FL-FL without any stratification.
4. Different assumptions regarding the area development – FRL assume constant area during simulation while the projections under Regulation 525/2013 extrapolate the observed trend of increase in forest areas.

Consistency between the forest reference level and the GHG Inventory 2018

According to the Annex IV, Part A (h) "*the reference level shall be consistent with greenhouse gas inventories and relevant historical data and shall be based on transparent, complete, consistent, comparable and accurate information. In particular, the model used to construct the reference level shall be able to reproduce historical data from the National Greenhouse Gas Inventory*"

Consistency in methodological elements

The FRL projections are made considering consistency in methodological elements with GHG Inventory 2018. The projections on the emissions and removals are estimated by applying identical with GHGI method – stock difference method, emission factors and area of MFL. The projected FRL considers all mandatory carbon pools (Table 32) and non-CO_2 emissions associated with wildfires.

Table 33 Carbon pools and gases included in FRL estimates

Carbon pools	Included in FRL	Reported under GHGI 2018	Reported under GHGI 2019	Planned for GHGI 2020
Biomass (above- and belowground)	Yes	Yes	Yes	Yes
HWP	Yes	Yes*	Yes	Yes
Dead wood	Yes	Yes*	No	Yes**
Soil	No	Yes*	No	No^
Litter	No	Yes*	No	No^
Non-CO2 emissions from biomass burning	Yes	Yes	Yes	Yes

** The carbon stock changes (CSC) in these pools where reported under 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 and Bulgaria should find another way to report emissions and removals from these pools.*

*** No data is available in the country to properly account for emissions and removals from DOM and soil. As an interim solution to report emissions and removals from DW, Bulgaria will estimate the carbon stock change in DW based on correlation of the DW stock to the standing volume stock. These changes could be implemented for the next GHGI Submission which is due to April 2020.*

^ In order to move to higher tier in reporting emissions and removals from soil and litter there is a need of further investigation of the reliability and representativeness of the data which is available in the country. The first possibility to report for these pools is in Submission 2021 if the data is representative.

GHGI of Bulgaria is in a constant track of improvements in the estimates, thus changes in EFs, strata or reporting of a carbon pools could be expected in its future submissions. If any of these happen, a technical correction will be applied.

Consistency in forest management practices and with GHG Inventory

The model used to project the development growing stock is not able to project backward. So, to check the consistency with GHG Inventory 2018 we run the model beginning with 2000. Everything else remains the same – constant area during simulation, constant ratio of the harvest to BAWS and dynamic age-related forest characteristics. The output of this simulation confirm that the model is adequate and able to reproduce historical data on growing stock and harvest. Regarding reproduction of historical data on growing stock it can be noticed that the model projects lower growing stock compared to the historical data. This is explained by the fact that the model uses a constant area while historically during the RP there is a sharp increase in forested area and more precisely in deciduous forests (Table 4). The increase in the area in that period is mainly due to inclusion of forest territories which were outside the forest fund before that time. In most cases it is about low productive forests which were at disposal of the agricultural cooperation during communist period. Since 2000 there is a process of inclusion of these lands into the forest fund. The model is not able to project this since we applied constant area during simulation.

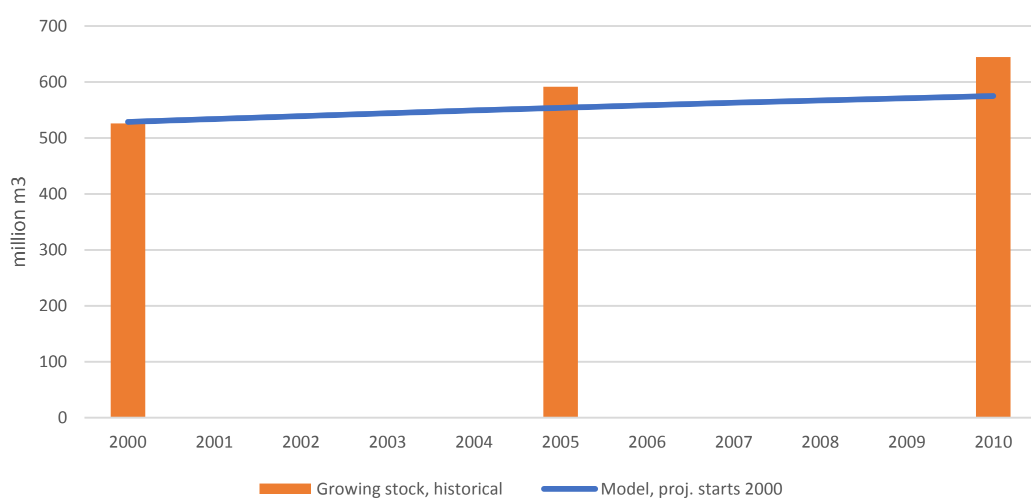
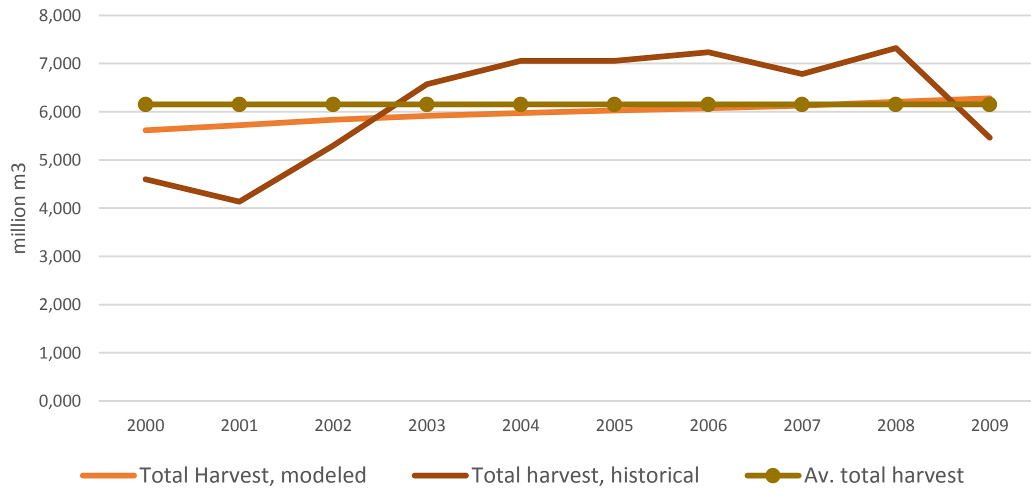


Figure 40 Model's reproduction of historical data on biomass.

The historical reproduction of harvesting levels is very good as it matches the average historical total harvest documented during the RP. This confirms the consistency of forest management practices.



The line with dots - *Average historical harvest

Figure 41 Actual harvest vs modeled harvest during the RP

When comparing the ability of the model to reproduce the emissions and removals from GHG Inventory, the consistency check was done by carbon pools first. As the model is not working with actual management practices but instead apply the constant ratio the trends of HWP and DW are not the same by default. However, when estimating the averages for the RP regarding HWP and DW, the consistency is very good.

C pool	Average emissions 2000-2009
DW, GHGI	-227.615
DW, model	-250.763
HWP, GHGI	-183.311
DW, model	-179.992

Regarding biomass, there is consistency in the trend but not in the level. This can be explained by two reasons:

1. The dynamic changes during the RP and especially the inclusion of forests from agricultural fund (old forest) into forest fund (please see Table 4).
2. Introduced systematic error in GHG Inventory when processing forestry data in relation to forest area and growing stock per ha estimation.

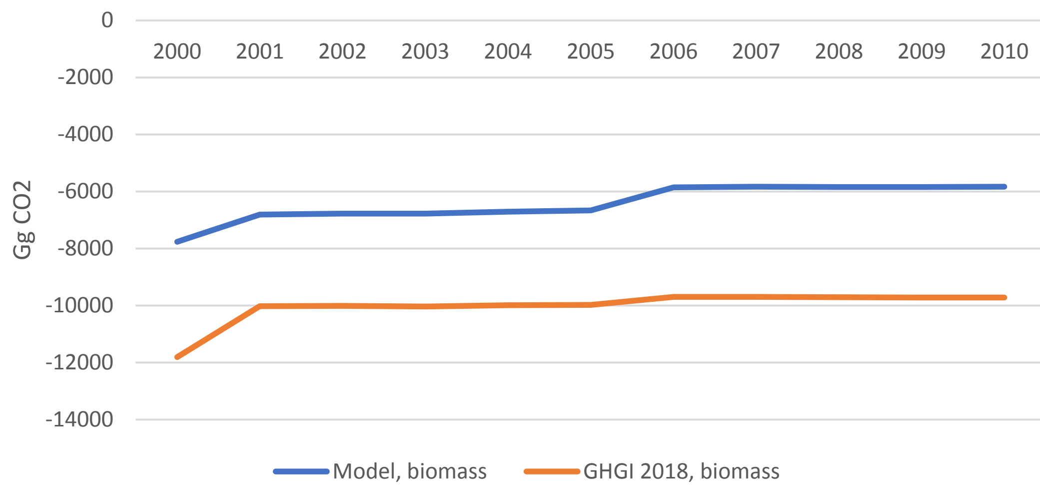


Figure 42 Comparison between the model results and the GHG Inventory

Calculated forest reference level

Table 34 Developments of carbon pools and proposed FRL

C pools and gases	2021	2022	2023	2024	2025	Average
biomass	-3209.20	-2886.34	-2608.25	-2313.91	-2033.96	-2610.33
DW	-174.34	-170.89	-167.37	-163.77	-160.09	-167.29
HWP	-279.83	-291.64	-300.83	-305.83	-311.50	-297.93
biomass burning	54.43	54.43	54.43	54.43	54.43	54.43
FRL incl. HWP	-3608.94	-3294.43	-3022.01	-2729.07	-2451.12	**-3021.11**
FRL excl. HWP	-3329.11	-3002.79	-2721.18	-2423.25	-2139.62	**-2723.19**

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