REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENT AND ENERGY
MINISTRY OF AGRICULTURE

NATIONAL FORESTRY ACCOUNTING PLAN FOR THE REPUBLIC OF CROATIA

Zagreb, December 2019

CONTENTS:

FIGURES

TABLES

ABBREVIATIONS

AGB	Aboveground Biomass
ARR	Annual Review Report
BGB	Belowground Biomass
CRONFI	Croatian National Forest Inventory
DOM	Dead Organic Matter
DW	Dead Wood
EC	European commission
ERT	Expert Review Team
EU	European Union
FA	Forest Administration
FAO	Food and Agriculture Organization
FMP	Forest Management Practices
FRA	Global Forest Resources Assessment
FRL	Forest Reference Level
FSC	Forest Stewardship Council
General FMAP	Forest Management Plan for the Republic of Croatia
HA	Hazardous Areas
HWP	Harvested Wood Products
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LRTAP	Convention on Long-range Transboundary Air Pollution
LULUCF	Land use, land use change and forestry
MFL	Managed Forest Land
MSs	EU Member States

ND	Natural Disturbances
NIR	National Inventory Report
PA	Paris Agreement
RP	Reference Period
UNFCCC	United Nations Framework Convention on Climate Change

1. GENERAL INTRODUCTION (REGULATION, ANNEX IV, PART B, POINT A)

1.1. GENERAL DESCRIPTION OF THE FOREST REFERENCE LEVEL FOR CROATIA

The Forest Reference Level (FRL) for the Republic of Croatia for the period 2021-2025 was developed taking into the consideration stipulations of the Regulation (EU) 2018/841 and giving the due attention to the Article 8, paragraph 4. This Article defines: “For Croatia, its forest reference level may also take into account, in addition to the criteria set out in Section A of Annex IV, the occupation of its territory, and wartime and post-war circumstances that had an impact on forest management during the reference period”.

The War in Croatia started in 1990 and it is considered to be finalized with the peaceful integration of the eastern part of Croatia in 1998. During that period, the intensity of the War activities and areas affected by it differentiated depending on the period of the War and the parts of Croatian territory. Although some areas of Croatia were not directly exposed to the War activities (such as hostile destruction of households, industrial facilities and infrastructure), the whole Croatia was affected and suffered greatly because of the War. The areas not directly affected by the War had to contribute to the Croatian defence through the human resources as well as any other kind of resources. These parts of Croatia were also faced with the losses and damages in economy due to the War. Because of that fact, it is considered **that there is no area in Croatia that can be excluded from the influence of the War and post War circumstances**. For the necessity of NFAP **an assumption that the War and post War influence is negligible for the Croatian areas that were not directly exposed to the War activities was used**.

FRL for Croatia was determined based on the implemented and documented Forest Management Practices (FMPs) during the Reference period 2000-2009 (RP) on the forest areas on which the influence of the War and post-War circumstances was assumed to be negligible (forest areas under the management of seven Forest Administrations (FAs) from the total number of 16 FAs). Detailed information about selecting the approach to address the War influence on forest management in Croatia during the RP and performing the modelling required for the FRL definition are presented in Chapters 2 and 4.3 in this document.

In the FRL estimation the following pools are included:

- Aboveground biomass
- Belowground biomass
- Harvested Wood Products (HWP)
- Dead wood pool

The Forest Act (OG 68/18, 115/18) regulates the activities in the forestry sector in Croatia. It should be emphasized that the legislation governing the principles and goals of forest management in Croatia has not changed significantly in the past 40 years. The changes in the forestry legislation since the World War II were primarily aiming to introducing additional

biodiversity and nature protection measures[1]. The forest management plans/programs determine conditions for harmonious usage of forests (and land under the forest management) and procedures in that area, necessary scope regarding the cultivation and forest protection, possible utilization degree and conditions for wildlife management. The detailed information about the types of forest management plans/programs existing in Croatia are presented in Chapter 3.3.1.

Before starting to develop the FRL, Croatia was considering stipulations of the Article 5 of the Regulation regarding the obligation to use the best available data during the FRL development process.

In FRL developing process the data coming from the General Forest Management Plans (General FMAPs) and plans/programs for the management of specific forest management unit are considered to be **the best available data** for the estimation of carbon stock changes in the pools of aboveground and belowground biomass. For estimating carbon stock changes in HWP pool, data available in international database (UNECE/FAO) were used as well as data available at the national level (State Bureau of Statistics data). Croatia uses the same data sources for the UNFCCC reporting.

When determining the best available data for the FRL, the data collected through the first National forest inventory conducted in period 2005-2009 on the plot level (CRONFI) were also examined. It was realised that the majority of methods used for the collection of relevant data during the CRONFI process differed from the methods used for forests plans/programs development (i.e. the intensity of forest measurements for the CRONFI purpose (a grid 4 x 4 km)). Therefore, the results are not comparable with the survey used for the preparation of forest management plans/programs (measurement on 2-5% of the total forest area or the measurement of all trees in stands that are subject of final cutting). In addition, the General FMAPs as well as other forest programs/plans are developed every ten years regularly since many decades while CRONFI was performed once so far.

Consequently, it was concluded that CRONFI data cannot be used and considered as the best available data for the purpose of FRL development.

Regarding the stratification issues relevant for the FRL determination, Croatia uses the same stratification as in NIR 2018 in a way that all forests are presented in 10 strata under the three major forest types – Deciduous, Coniferous and Out of yield forests (maquis and shrub).

For the modelling purposes, all relevant forestry data and parameters in the RP (areas, increment, total harvest, rotation length, harvest intensities according to the age or DBH structure) were extracted from the State official forestry database (official name of the database is *HS Fond*). This database contains all forestry data and it has been used each time when the new forest plans/programs are developed. During the FRL development process, the total number of 135,176 forest stands from this database were examined (100% of forest stands in Croatia). After extracting all relevant parameters Croatia decided to perform modelling starting with the year 2016.

[1] Meštrović, Š., 1978, *See References*

The same methods were applied for the estimation of carbon stock changes in above-listed pools as in the latest National inventory report (NIR 2018). For the biomass pool Gain-Loss method prescribed by the IPCC Guidance was used and the first-order decay function for the HWP pool. In case of estimation of losses in biomass pool in Out of yield forests (maquies and shrub) Croatia reports that losses do not occur. The same approach was applied in case of this forest type when developing FRL. Since corrections for this pool in this forest type was performed for NIR 2019 Resubmission the **FRL Technical correction** is predicted to be performed later on to address this changes in FRL estimate.

Carbon stock changes in the dead wood pool for FRL are reported as zero, the same as in the NIR 2018. **New estimation of carbon stock changes of dead wood** will be performed in the following years and afterwards **FRL technical correction** will be performed.

The same methods and data sources are applied for the estimation of carbon stock changes in mentioned pools for FRL determination as in NIR 2018. Emissions of CO_2, CH_4 and N_2O due to the forest fires are taken into the account. These emissions are predicted using the average value of each gas emissions' in period 2000-2009 from NIR 2018. When real data on forest fire emissions for the period 2021-2025 will be available they will be used to perform FRL technical correction. However, the consistency between the FRL and the related GHG inventory was not achievable due to the application of Article 8, point 4 of LULUCF Regulation and the fact that War in Croatia had influence on forest management (detailed information presented in Chapters 2 and 5.2).

Regarding Article 10 of the LULUCF Regulation and natural disturbance provisions Croatia intends to use the option of excluding emissions from natural disturbances from the accounting. **The baseline and margin for natural disturbances emissions** will be determined when corresponding data will be available, which means after the end of the period set up in the LULUCF Regulation (2001-2020). **Technical correction of the FRL** will be performed in order to secure consistency between FRL and the estimation of emissions/removals on managed forestland in the GHG inventory.

At this moment only a provisional estimation of the background and margin levels of the emissions due to natural disturbances on managed forestland has been performed. However, these emissions are not accounted for FRL. This provisional estimation was done using the currently available data (period 2000-2017) and it is presented in Annex 2 of this document.

Estimation performed using the instantaneous oxidation method when estimating emissions/removals in HWP pool and adding the emissions due to forest fires leads to the **FRL of -3906 $GgCO_{2eq}$** per year in period 2021-2025.

The FRL equals -4368 $GgCO_{2eq}$ per year using the Production Approach and the first order decay function for the estimation of carbon stock changes in HWP.

The estimation of removals by sinks according to the pools accounted under the FRL is presented in *Table 1.1-1*.

Table 1.1-1 Removals according to the pools included into the FRL and forest fires' emissions

Pools	Years				
	2021	**2022**	**2023**	**2024**	**2025**
AGB ($GgCO_2$)	-3510	-3495	-3279	-3354	-2788

BGB ($GgCO_2$)	- 864	- 861	- 807	- 827	- 695
HWP ($GgCO_2$)	- 458	- 433	- 467	- 419	- 535
DW ($GgCO_2$)	0	0	0	0	0
Forest fires emissions					
CO_2 (Gg)	157.295				
CH_4 (Gg CO_{2eq})[2]	19.63				
N_2O (Gg CO_{2eq})	12.95				
FRL 1* ($GgCO_{2eq}$)	- **3906**				
FRL 2** ($GgCO_{2eq}$)	- **4368**				

FRL 1* – the estimation performed using the instantaneous oxidation method for HWP
FRL 2** - the estimation performed using the first order decay function for HWP

1.2. CONSIDERATION OF ANNEX IV, PART A OF THE LULUCF REGULATION

Below is a description of how the criteria for determining the FRL as set in Annex IV of the EU LULUCF Regulation have been taken into consideration. Requirements of the Regulation are presented in *italic*.

(a) the reference level shall be consistent with the goal of achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, including enhancing the potential removals by ageing forest stocks that may otherwise show progressively declining sinks.

Obligation of the EU Member States (MSs) to account of Managed Forest land (MFL) against a FRL has been interpreted in Croatia in line with the stipulations of Decision No 529/2013/EU[3] Article 10, first paragraph that refers to the forest. This paragraph obliges MS on providing information about their current and future LULUCF actions to limit or reduce emissions and maintain or increase removals resulting from the activities related to forest[4].

According to the Forest Act, all forests in Croatia (regardless the ownership type) have to be managed in a sustainable way. The sustainability concept has been implemented in forests in Croatia for many years and it was kept as such irrespective of the changes in political system (communist regime, democracy).

Several activities are/will be implemented through the Rural Development Program for Croatia in order to maintain or increase sinks in forests (i.e conversion of maquies and shrub forests to high forests, forests roads reconstruction that will enable better execution of all forest management practices especially in no easily accessible areas etc) as it is prescribed by LULUCF Decision. New activities for sink's enhancement in forests in Croatia will be examined under the new programing phase for Rural Development Program.

The activities planned in General Forest Management Plan for the Republic of Croatia in period 2016-2025 (General FMAP 2016-2025) and other forestry plans/programs in their prediction for

[2] Global Warming Potentials used for CH_4 and N_2O emissions as in NIR 2018

[3] Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities

[4] Deforestation, afforestation, reforestation and forest management

forestry sector after 2025 secure maintenance of sinks in forests up to 2050. Based on the General FMAP 2016-2025 and 2016 data, projections of increment and harvest are developed predicting the increase of increment from 10.15 million m^3 in 2016 to 11.50 million m^3 in 2055 and felling from 6.01 million m^3 in 2016 to 8.30 million m^3 in 2055. Since the felling ranges from 59% to a maximum of 72% of the increment up to 2055 and Croatia will continue to increase the area of forest through the afforestation and conversion of lower forests' types (i.e shrub) to higher forest types, removals by sinks in forests until 2055 are secured. Long-term planning and demonstrated implementation of planned forest management activities, which aim at establishing a uniform distribution of age classes (see Figures 4.3-1 to 4.3-7), guarantee the systematically and carefully rejuvenated forests. The execution of the planned, sustainable, and close to nature forest management activities in Croatia will result in a significant share of relatively young forests in total forest area with the maximum potential for growth in the second half of 21st century.

National Integrated Energy and Climate Action Plan (NCAP) recognizes possibilities for emission reductions in ETS, non-ETS and increase of removals in LULUC sector until 2030 in part of the document dealing with decarbonisation goals. In addition, the draft Low Carbon Development Strategy for Croatia (LCDS) prescribes measures for emission reduction and increase of removal until 2050. LCDS also recognizes a need for Land Management Strategy (LMS) development in Croatia. The main task of LMS will be a detailed analysis of all LULUCF land categories and all pools in order to define additional measures for emission reduction and increase of removals until 2050 by examining possibilities in respect to land cover, land use and land management. With the implementation of LMS, LCDS and NCAP Croatia intends to secure achievement of a balance between anthropogenic emissions by sources and removals by sinks in the second half of this century.

The FRL for Croatia was developed without taking into the consideration effects of climate change on forest management.

(b) the reference level shall ensure that the mere presence of carbon stocks is excluded from accounting.

The Gain-Loss method that accounts for harvest and increments in forests ensure that the mere presence of carbon stocks is excluded from the accounting.

(c) the reference level should ensure a robust and credible accounting system that ensures that emissions and removals resulting from biomass use are properly accounted for.

In order to account properly for the emissions from biomass use the emissions are estimated using the instantaneous oxidation. The future increases in demand for fuel wood from the FRL was excluded from the estimation. To improve the fuel wood harvest estimations the corrections in data set available in Croatia and FAO database are conducted.

(d) the reference level shall include the carbon pool of harvested wood products, thereby providing a comparison between assuming instantaneous oxidation and applying the first-order decay function and half-life values.

The forest reference level has been calculated using the assumption of instantaneous oxidation for the harvested wood products as well as estimating the harvested wood products using the Production Approach and the first-order decay function (see Chapter 5.3.2)

(e) a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 shall be assumed.

A constant ratio between the different HWP categories as documented in the RP has been applied for the allocation of felling to the different HWP categories and fuel wood (energy use of forest biomass).

Thus the ratio between solid and energy use of forest biomass remains constant between the reference period and the FRL.

(f) the reference level should be consistent with the objective of contributing to the conservation of biodiversity and the sustainable use of natural resources, as set out in the EU forest strategy, Member states' national forest policies, and the EU biodiversity strategy.

Forest management in the Republic of Croatia and the calculated FRL is consistent with the relevant EU strategies and principles of forest management sustainability. In that sense, FRL was evaluated with the principles of FOREST EUROPE process, New EU Forest Strategy 2013 and the EU Biodiversity Strategy to 2020.

According to FOREST EUROPE, forest management is defined sustainable if it maintains: forest biodiversity, productivity, regeneration capacity, vitality and forest potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and does not cause damage to other ecosystems

Croatia implements the above listed sustainability criteria in a following way:

Forest biodiversity

In respect of Forest biodiversity in Croatian legislation of the forestry sector, but also in the management of forest resources, biodiversity is of great importance. The Statute of the ecological network (OG 124/12 and 105/15) established the ecological network of the Republic of Croatia, which currently also includes Natura 2000 sites. The ecological network of the Republic of Croatia comprises 36.73% of the land territory and 15.42% of the coastal sea. Furthermore, all state forests in Croatia since 2002 have a FSC certificate which states that forests are managed according to strict ecological, social and economic standards which include conservation and enhancement of biodiversity. Regular renewal of FSC certificate is also a confirmation that all the required standards have been met in the previous period. In the Forest Act (OG 68/18,118/18) biodiversity is highlighted in Article 3 which defines sustainable forest management just as it was defined by FOREST EUROPE process. In addition, Nature Protection Act (OG 80/13, OG 15/18) in its Article 4 highlights the goals and tasks of nature conservation. It also regulates preserving and/or restoring biodiversity by preserving natural habitat types, wild species and their habitats (including all types of birds naturally occurring on Croatian territory, as well as bird eggs and nests), by establishing an appropriate protection, management and control system.

Productivity

Regarding the productivity parameter, the climatic zone and geographical distribution of forests in Croatia on predominantly high-yielding forest soils are the basis for ensuring constant growth and production of biomass. With sustainable forest management, the productive capacity of forest ecosystems is continuously increasing. Proof of this are data from the forest management plans/programs that are renewed every 10 years. According to forest management plans referring

to the entire Croatia (General FMAPs), there is a continuous increase in the wood stock since the 1950s.

Regeneration capacity

Each of the forest management practices applied in Croatia maintains and promotes natural regeneration capacity of forests. In case when the even-aged management practices are applied the sustainability of forest regeneration capacities is planned in the long term through the achievement of uniform distribution of age classes. The natural regeneration is a permanent process that occurs simultaneously with other management activities in the case of uneven-aged forests. Two types of selection systems are applied in these forests 1) a group-tree-selection system and 2) a single-tree selection system.

Vitality

Monitoring vitality of Croatian forests has been systematically implemented since 1986 as a part of the International Cooperative Program on Assessment and Monitoring of Air Pollution Effects on Forests operating under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) - ICP FORESTS. The Republic of Croatia is an active participant in the program and its experts contribute to the development of methods and tools. The obligation of the Croatian participation in this program is prescribed by the separate legislative act. According to the last report under this program[5] the vitality of forests in Croatia is improving trough the monitoring years.

Forest potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels

Fulfilment of ecological, economic and social functions at all levels in the Republic of Croatia is ensured by long-term planning (FMAPs), but also by the Forest Act defining general forest functions in its Article 4. Similarly, fees for the use of environmental services of the forests paid by economic operators in Croatia are also regulated, and they are strictly used for a range of sustainable forest management activities as regulated by a special Ordinance (OG 22/15). In addition, possession of the FSC certificate also confirms that forests are managed according to the strict ecological, social and economic standards.

The basic legal act regulating the use of forests and land under the forest management (land without real forest cover) in the Republic of Croatia is the Forest Act. Description of its scope of activity and the basic settings in line with the definitions of the New EU Forest Strategy and EU Biodiversity Strategy by 2020 is included in the first three articles. Ordinance on Forest management (OG 97/18, 101/18) defining the content, deadline for issuing and method of making forest management plans/programs presents the basic national framework that secures continuous and sustainable management and control of forests (all forests in Croatia regardless the ownership type). General Forest Management Plan (General FMAP) presents the umbrella forest document based on which the forest management activities are performed. The main goal of this document is to secure that the ecological, economic and social functions of the forests are kept and that the forest production is increased through the natural (self-sustaining) improvement of forests.

[5] https://www.icp-forests.org/pdf/TR2018.pdf

Besides the Forest Act, legislative acts from the field of environment and nature protection are relevant for the forest management in Croatia. For example, Nature protection Act (OG 80/13, 5/15) defines the system for protection and lifelong preservation of nature and its parts and consequently refers to the forests. The first six articles of this law prove its compatibility with the relevant EU legislative acts.

Taking into the consideration above mention and the fact that forest management plans/programs have to be implemented on regular basis it can be concluded that the forest management in Croatia is performed in sustainable way and that the present forest management practices secure sustainability of forests in the future.

Because Croatian legislative acts in forestry sector fully address forest sustainability issues as defined in relevant EU acts and because the General FMAPs as well as any other forest related programs/plans in Croatia are developed based on national legislation, it can be concluded that also the FRL is consistent with the requirements of Annex IV, part A, point f.

(g) the reference level shall be consistent with the national projections of anthropogenic greenhouse gas emissions by sources and removals by sinks reported under Regulation (EU) No 525/2013;

Croatia was not able to develop FRL without addressing the War issues recognized in Article 8, paragraph 4 of the LULUCF Regulation. Because of that, a specific model that predicts harvest rates based on so called “No War” scenario was used for FRL determination. As a starting point, projections developed by Croatia under the Regulation (EU) No 525/2013 use the real data as they are recorded since 1990. These data reflect influence of the War and post-War circumstances in Croatia. This is most important reason for a discrepancy between the projections and FRL in Croatian case.

(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.

This provision in case of Croatia could not be met explicitly because it is in a disagreement with the stipulation of Article 8, point 4. To address correctly the removal capacities in forests in Croatia it was necessary to consider stipulation of Article 8, point 4 of the LULUCF Regulation and the influence of War and post-War period on forest management in Croatia during the Reference Period of the Regulation. A proxy approach was derived to prove that the Croatian FRL would be in line with the National GHG Inventory if there was no War in Croatia.

Following the above presented information it can be understood that all criteria as set in Annex IV, part A of the LULUCF Regulation are considered in National Forestry Accounting Plan (NFAP) for Croatia.

Regarding the information on the elements of the NFAP the

Table 1.2-1 indicates where the information required from Annex IV.B can be found in this document.

Table 1.2-1 Equivalence table indicating where the information required from Annex IV.B can be found in this national forestry accounting plan

Annex IV B. paragraph item	**Elements of the national forestry accounting plan according to Annex IV B.**	**Page number(s) in the NFAP**
(a)	A general description of the determination of the forest reference level.	1-4; 68-74
(a)	Description of how the criteria in LULUCF Regulation were taken into account.	4-9
(b)	Identification of the carbon pools and greenhouse gases which have been included in the forest reference level.	1; 28
(b)	Reasons for omitting a carbon pool from the forest reference level determination.	28
(b)	Demonstration of the consistency between the carbon pools included in the forest reference level.	65-68
(c)	A description of approaches, methods and models, including quantitative information, used in the determination of the forest reference level, consistent with the most recently submitted national inventory report.	38-44
(c)	A description of documentary information on sustainable forest management practices and intensity.	45-49; 63; 77
(c)	A description of adopted national policies	30-35
(d)	Information on how harvesting rates are expected to develop under different policy scenarios	35-37
(e)	A description of how the following element was considered in the determination of the forest reference level:	
(i)	The area under forest management	20; 39-41; 48-49;64
(ii)	Emissions and removals from forests and harvested wood products as shown in greenhouse gas inventories and relevant historical data	69-74
(iii)	Forest characteristics, including:	
	• dynamic age-related forest characteristics	45-49; 54-60
	• increments	50-63
	• rotation length and	50-63; 77
	• other information on forest management activities under ‘business as usual’	50-63
(iv)	Historical and future harvesting rates disaggregated between energy and non-energy uses	74

In addition the information regarding the influence of the War and post-War period on forest management in Croatia are provided on **pages 10-27** in this document.

2. THE RELEVANCE OF ADDITIONAL CRITERIA FOR DEVELOPMENT OF FOREST REFERENCE LEVEL FOR THE REPUBLIC OF CROATIA (ARTICLE 8, POINT 4 OF THE REGULATION EU/2018/841)

The Republic of Croatia is the only EU Member State faced with the War and post-War circumstances in the recent past.

In mid-June 1990, the first democratic elections in the Republic of Croatia brought the establishment of the new Croatia, and on 22 December the Republic of Croatia got its new Constitution Act. Croatia started to be recognized by the international community on 15 January 1992 and on 22 May the Republic of Croatia became 178th member of the United Nation Organization.

The 18 August 1990 was proclaimed as an official date of the aggression on the Republic of Croatia. Conclusions of the Croatian Parliament of 7 and 8 May 1992 defined the aggressor of the Republic of Croatia. It stipulated: "The aggravated aggression of the Republic of Serbia and Montenegro, the army of former Yugoslavia, the irregular Serbian-Montenegrin units whose consequences are the destruction of Croatian towns and villages, killing and suffering of a civilian population, thus achieving the ultimate endurance limit."

The period of aggressive action, which had various forms, followed the events of the creation of a sovereign and independent Croatian state, and they are presented as follows:

1. Special War Period, by mid-1990 (Monetary Damage)
2. The period of the "Greater Serbian" rebellion, from mid-August 1990 up to 25 June 1991 (rebellion, traffic blockade)
3. Military Conflict Period, from 26 June 1991, to 15 January 1992 (most significant direct damages)
4. The period of "Peace and War" from 15 January 1992 to mid-August 1996 (damage, negotiations)
5. The period of peaceful reintegration of Eastern Slavonia, Western Srijem and Baranja until 15 January 1998.

On 30 August 1991, the Government of the Republic of Croatia established a special commission for the registering and assessing war damage, named since 1994 the State Commission for the Registering and Assessing the War Damages (hereinafter: State Commission). This commission carried out its task in the period 1991-1999 and concluded that the total value of damages caused by the War, occupation and costs because of the War in Croatia equals:

US$[6] 37,119,679,000

According to the existing categorizations, three types of damages occur and are present in Croatia:

[6] This equalled DEM 65,330,635,000 at the time of estimation

1. **Direct War damages** (present the market value of destroyed goods at the time of destruction and it does not include the purchase price of new goods as a substitute for old destroyed goods)
2. **Indirect War damages** (i.e. losses caused with absence of production due to the displacement of refugees and exiled population, losses due to disturbances caused by the War in development of key economic areas and business activities etc.).
3. **War expenses and losses** (i.e. costs connected with the mobilization of people, evacuation of people, care of refugees, repurpose of production facilities etc.).

The damages were registered and assessed on immovable and movable property, loss of gross domestic product, war expenses, lost profits, environmental damage, personality, life and health integrity, freedom and human honour and all other types of damage. The forestry sector in Croatia was included in this assessment since it suffered considerable damages and the value of damages in forestry sector is included in the above figure.

Although the Commission followed strictly defined methodology in its work, the existing estimation of War damages in Croatia cannot be considered final since all types of War damages are not assessed for whole Croatia for the whole time of the War and post War period. One of the recent assessments of War damages reports that Croatia **lost 7.5 to 9 of its Gross Domestic Product** (GDP) by 2015 (based on the GDP in 2004) due to the War[7].

[7] Nazor, A., Pušek, T. 2018. *See References*

2.1. THE INFLUENCE OF WAR AND POST-WAR EVENTS ON FOREST MANAGEMENT IN THE REPUBLIC OF CROATIA

2.1.1. Introduction

Article 8, paragraph 4 of the Regulation EU 2018/841 stipulates “Member States shall determine their forest reference level based on the criteria set out in Section A of Annex IV. For Croatia, its forest reference level may also take into account, in addition to the criteria set out in Section A of Annex IV, the occupation of its territory, and wartime and post-war circumstances that had an impact on forest management during the reference period”.

War and post-War circumstances in Croatia caused significant deviations from full, normal forests management practices since 1991 until up to date. Developing FRL for Croatia without taking into consideration the influence of War and post War period on forest management would be misleading because FRL defined on such way would not reflect real removal potential of forests in Croatia. War influence and consequences of War activities are still present in forests in Croatia. They are the reason for the lack of implementation of full management practices which can be seen in the interruption in pre-commercial tinning, thinning and harvesting operations on time and on full scale, decreasing of increment, deteriorating of age structure of the stands and declining of quality in wood products. Declining of quality in wood assortments is presented in *Figure 2.1-1.*

Figure 2.1-1 *Quality of the wood assortments derivered after demining*

Although the stipulation of paragraph 5 of the same article recognizes the influence of dynamic age-related forest characteristics on the FRL, this dynamic alone (the shift in age class

distribution) in Croatian case could not and would not lead to the FRL that would reflect normal, full forest management practices in RP.

All information regarding the War and post-War circumstances on forest management in Croatia are taken from the official documents of the Croatian Government on War damages in Croatia in period 1991-1999 and the current post-War conditions (please see a list of References).

The registering and assessing the war damages in the Republic of Croatia was conducted based on the methodology established by the Law on Assessment of War Damage (OG 61/91), which is called "Instructions for Application of the Law on Assessment of the War Damage " (OG 54/93). An integral part of the methodology was the State Commission's Bulletin which elaborated the methodology and removed the doubts. A total of 10 issues of the Bulletin were printed on a total of 200 pages. Upon completion of the work, the results of the State Commission were validated by an officially designated institution - the Croatian Construction Institute (IGH).

A uniform methodology for assessing the war damage that would be agreed on the level of some international organization still does not exist. The Croatian methodology was based on German experience on assessing the damage after the World War II, as well as data on war damage assessment in Iraqi-Iranian and Iraqi-Kuwait war, and Croatian own experience on damage assessment after major natural disasters. When assessing the war damage, the good practice is to express the value of damage in national currency as well as in one of the so called stable currencies. The German currency valid at that time (DEM) was used in order to present the Croatian war damages. When Germany was introducing € as its official currency, the exchange rate was DEM 1 = € 0.51.

Registering and assessing the War damages in Croatia was organized through 21 county commissions and 12 special commissions. Special commissions were set up to address the impact of war damage on large-scale economic systems. This special commission was also established for the company responsible for forest management in Croatia - Croatian Forests Ltd (hereinafter: Forestry Commission) and this Commission prepared a forest War damage report for the period 1991-1997.

2.1.2. The extent of War damage in forests in the period 1991-1997

The registration and assessment of War damage in forests was conducted in three periods, according to the War events associated with the state of forests and the process of releasing individual areas, access possibilities and recording and assessing of War damage.

The first period covers the period from 15 August 1990 to 30 June 1993, the time when the hostile army was beaten and expelled from most of the Republic of Croatia. Parts of Croatia were still under the occupation (Knin region and Podunavlje region).

Temporary occupied forest areas accounted for 29.3% of the total area of forest and land under the forest management administrated by the Croatian Forests Ltd. On this surface, there were 12% of the nursery areas, 39% of the hunting ground and 29% of the total wood stock. The 44 forest offices were occupied and cut off from Croatian forest administration while 11 of total 16

forest administrations (FAs) were more or less affected by the War and forced on partial application of normal forest management practices.

The second period of assessment is from 1 July 1993 to 31 December 1995.

That was the time when most of the occupied area was liberated. In Western Slavonia 36,315 ha of forest areas have been released and 486,119 ha in Knin region.

Under the enemy occupation after these actions, in the Croatian Danube Region remained another 3% of forests areas (60,292 hectares), which were managed by the Forestry Districts Vinkovci and Osijek, with a total wood stock of 6 952 000 m3. It should be noted that it is this very significant part of the area of Croatian forests where the natural reserves of the Danube Ada, Baranja flooded forest with Nature Park Kopački rit are located, and part of the Spačva Forest Pool, which is the core of the famous Slavonian oak forests. The areas of the Forestry Districts of Nova Gradiška, Sisak, Karlovac, Ogulin, Gospić and Split were completely liberated. For this area, the war damage assessment was conducted in the second period for the whole territory, except the parts polluted with the landmines.

The third period of the assessment relates to the assessment of war damages conducted in the period from 1 January 1996 to 31 December 1997 and the entire territory of the Republic of Croatia was covered. The assessment of damages was performed for the areas that were not covered with previous assessments due to the impossibility of access (due to the mines, denied access by various United Forces of local Serbian forces).

The Forestry Commission assessed two of three types of damages on forests caused by the War in Croatia: **1) direct War damages and 2) indirect War damages**.

At the beginning of the War there were around 15,000 employees that worked in the state-owned company responsible for the management of state-owned forests - Croatian Forests Ltd. Since the War started 2,500 employees joined the rebelled forces in fight against Croatia, and additional 2,500 of employees did not want to work for Croatian state and were failing to appear at work. Compared to the period before the War (1990), the structure of the employees was disturbed in a way that during the War 18.8% of forestry professionals (engineers and technicians) as well as 25.8% workers in the direct forest production (loggers) decided to support the enemy side and did not want to work for the Croatian state. To this number the employees working as economists, lawyers, mechanics, tractor drivers etc. needs to be added so that the final figure of employees who did not want to work for Croatian state amounts to 20.6% of the total number of employees. Adding to this number the number of employees that joined the rebelled forces, the company was faced with the loss of more than 30% of total number of employees at the beginning of the War.

1. **The Assessment of direct damages of the War on forests**

The assessment of direct damage of the War was conducted in a way that damages on forest facilities, forestry equipment, forests and game were performed. In addition to this, costs due to the engagement of the company's employees in defence of the Republic of Croatia, support to the refugees and the elimination of War consequences were assessed.

In the troops of the Croatian Army and the Ministry of Interior, there were constantly around 2,500 forestry employees with 500 vehicles during the War years, and 3,550 employees during the liberation operations.

During the War, a large number of Croatian Forests Ltd. employees were affected by the War (45 killed, 15 disappeared or captured, 96 military armed disabled, 3 retired disabled, 8 disabled civilians). The consequences of the War were immediately felt by 485 families of forestry employees who had been expelled from their homes.

Regarding the damages on forest facilities these refer to damages on commercial forestry buildings, bridges, forestry roads, hunting houses etc. with the aim of preventing the organization of production, transport to the forestry sites and production processes. The list of damaged forestry facilities contains 142 objects with the total damage of DEM 18,103,000.

The direct War damage of forestry equipment was estimated to be DEM 42,443,000. The greatest damage was made on transport vehicles with a share of 43.1 %. Quantitative damage to equipment is as follows: 27 energy-related machinery, 567 forestry machinery, 8,684 special machinery, 610 road vehicles, 94 connection devices, 37 other equipment, 1,673 tools and instruments destroyed, 20 special machines damaged, 42 road vehicles and 14 other connection devices damaged. Here is also accounted the damage made on two castles and other objects under the jurisdiction of Croatian Forests Ltd with works of arts which were stolen and which value was assessed of DEM 13,408,000.

In the case of War damage on forests and game, it was estimated that this damage equals DEM 133,377,000. Damage to forests had to be observed separately for the Croatian Danube Region and for all other parts of the occupied area. In the areas of Western Slavonia, Banovina and Knin region forests did not suffer the damage that was expected with regard to the behaviour of the enemy in all other areas of activity. In this area most damage was done due to not conducting the prescribed silvicultural works in forests such us: pre-commercial thinning, thinning, preparation of habitats, afforestation, firefight protection and others.

2. The Assessment of indirect damages of the War on forests

Given all the peculiarities of forests as biocenosis and a significant part of the ecosystem it was not possible to express all consequences of War damages to forests in terms of disrupting the ecological balance and all the factors related to the environmental services of forests in sense of money. The indirect damages were handled from the point of view of lost profits of Croatian Forests Ltd, damage to all types of unrealized works in normal and extended forest reproduction, lost game gain, and damages due to the shrapnel. The damage to the shrapnel was only accounted for by the forest districts that already had complaints from the wood industry.

This type of War damage was assessed of DEM 3,690,935,000 of which DEM 177,536,000 refers to the lost income of the Croatian Forests Ltd. in period 1991-1997.

2.1.3. The relevance of the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction for Croatia

Croatia ratified the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (hereinafter: the Convention) on 28 May 1998 and submitted its initial transparency report on 3 September 1999, providing information on areas that contain or are suspected to contain anti-personnel landmines (APLs).

In 1996, the United Nations Mine Action Centre (UNMAC) estimated that there were over 13,000 km² of the potentially dangerous area in Croatia. Based on the checks conducted by the Croatian Mine Action Center (CROMAC) this area was reduced to 5,980 km^2 and reported in the Initial report. In the same report, Croatia signalled to the states-parties of the Convention that due to the Hazardous area (HA) size and estimated financing needed for the demining, extension for the clearance tasks will be needed.

Croatia had a deadline until 1 March 2009 for destroying or ensuring the destruction of all APLs emplaced within HA. In June 2008 Croatia submitted the First request for the extension of the deadline for completing the destruction of all anti-personnel mines in mined areas in accordance with Article 5, paragraph 1, for period March 2009 - March 2019.

Since 2004, Croatia has precisely defined HA, considerably reduced these areas and reported a reduction of mine accidents and mine incidents which resulted in a reduction of a number of mine victims.

In addition to the direct humanitarian impact of mines, Croatia suffered from a multitude of socio-economic impacts. The first priority from the beginning of the systematic process of demining was a clearance of land for the reconstruction of houses and clearance of transport infrastructure, power lines and water supply system. In 2018 this problem is solved in the sense that there is no HA near houses, house yards, close to the vital roads and roads of any kind.

The next priority was to demine all destinations important for tourism which is one of the main economic activities in Croatia. In order to do that, areas along the tourist road communications were demined. In this way, HA has been moved away from the above-mentioned road communications that made it possible for tourists to safely travel to their destinations. Parts of national parks and parks of nature have also been demined. The problem which continental counties are now facing is HA that had been used, prior to the war, for hunting tourism because it was one of the most important sources of income for certain towns and municipalities. Out of total demined areas in the period from the Convention entrance into force, 1/3 of demining activities took place in the four tourist counties along the coast of the Adriatic Sea.

Demining of agricultural areas was also a priority from the viewpoint of a sustainable return of war-affected people. However, in the early years, due to limited and insufficient funds, the emphasis was put on the above-mentioned priorities. In the last years, the share of agricultural areas in the total realization of planned demining operations increased and now agricultural land participates with 9.9% in the entire HA.

By 2018, Croatia reduced the hazardous area to 411.5 km² through demining and the application of improved survey methods. In period 2008-2017, there were 37,326 mines detected and destroyed out of which 19,815 APLs and 17,911 anti-tank mines and 47,894 miscellaneous unexploded ordnances.

Since the Convention had entered into force, an amount of over **€727.3 million** has been invested in humanitarian demining activities in Croatia. Although Croatia has obtained more than €153.7 million from international donors and EU funds up to now, EU supported Croatian demining activities with only €1.5 million[8] in period 1991-2000. **It should be emphasized that Croatia**

[8] SAFU, 2009. *See References*

itself has provided the most of funding for the purpose of Article 5 implementation, with over €417 million having been obtained from Croatia's State Budget. In addition, Croatia has been ahead in using funds for demining from the World Bank, state companies and the EU funds.

It is expected that in the following years the biggest investor until the end of the demining program (2026) in Croatia will be Croatian Forests Ltd, because of the fact that the largest HA is in the forest area. Since a significant amount of money is predicted to be spent by Croatian Forest Ltd on the clearance activities in future, this reduces potentials of investing all financial means for the normal forest management activities.

Clearance activities are financed based on the Forest Act through the financial means collected by companies in Croatia charged for the so-called environmental services provided by the forests (green tax). According to the Law, legal and natural persons who are taxpayers (and natural persons who are taxpayers of income tax while in the Republic of Croatia perform a registered activity) are obliged to pay 0.00265% of their income for the environmental services provided by the forests. This tax was introduced in 1990s and used for the financing of typical forest management activities (i.e. afforestation works, rehabilitation and restoration of forests damaged by biotic and abiotic factors, protection of forests from harmful organisms and fire etc.) and demining was not predicted as the activity for financing. Since forests areas were at the bottom of the list of clearance priorities, this new obligation was introduced in the forest law. At the same time, the tax percentage has a decreasing trend with the years (at the beginning it was 0.007%). This type of damage was not taken into consideration by the Forestry Commission and it seeks further scientific investigations regarding the detailed assessment of the war influence on forest management in Croatia.

In March 2018 Croatia submitted to the Convention second request and received the extension for the clearance task. In its request, Croatia emphasized it is capable of clearing 56 km^2 per year HA with the currently available capacities. The main reason for submitting the second extension request is that still some agricultural areas, **forest complexes** and protected areas remain inaccessible due to the presence or suspicion of the presence of mines and explosive remnants of War (ERW).

From the remaining HA, forest areas with 369 km^2 or 89% of the total HA have the largest portion in HA of the Republic of Croatia (while in 2017 forest areas made 95.3% of HA). Agricultural arable areas cover 40.9 km^2 or 10% of the total HA and other areas with 1.6 km^2 or 1% of the total HA. Parts of that forest area under a certain level of the protection. National parks, Parks of Nature or Natura 2000 area confine the efficiency of demining methods.

Detailed structure of the remaining HA according to the allocation of areas in counties is presented in Table 2.1-1 and Figure 2.1-3 presents HA in forest areas in 2018.

Figure 2.1-2 Hazardous area (HA) structure according to allocation of areas.

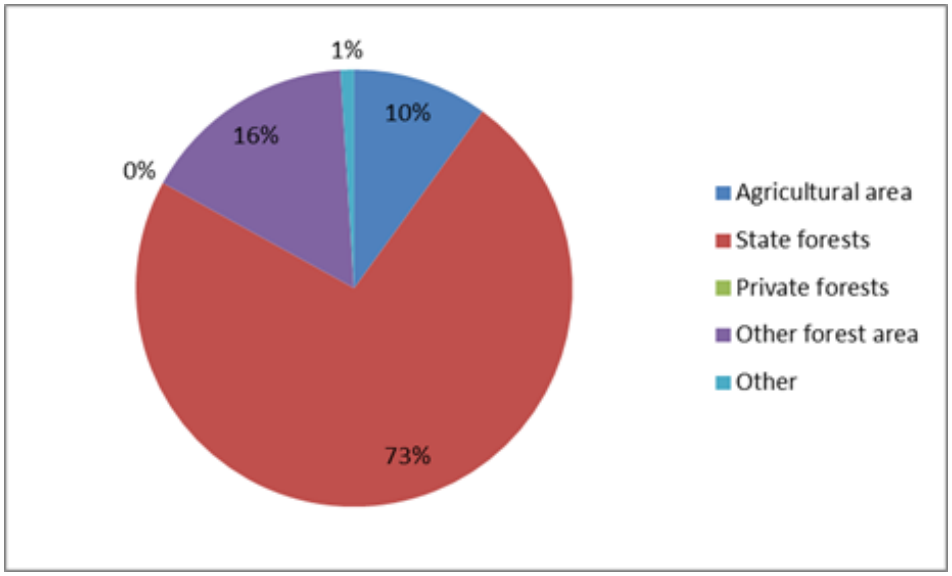


Table 2.1-1 Structure of HA according to counties

County	**Total HA**	**Agricultural area**	**Forest land and land under the forest management - TOTAL**	**Other land**
	km²	% of the total HA		
Karlovačka	49.8	0.8	98.8	0.2
Ličko-senjska	138.2	18.7	80.8	0.5
Osječko-baranjska	55.7	4.8	94.8	0..5
Požeško-slavonska	24.0	15.1	64.6	0.1
Splitsko-dalmatinska	20.1	5.2	94.5	0.4
Sisačko-moslavačka	70.6	9.3	90.1	0.6
Šibensko-kninska	22.2	2.3	97.7	0.1
Zadarska	30.9	0.6	99.3	0.0
TOTAL	411.5	9.9	89.7	0.4

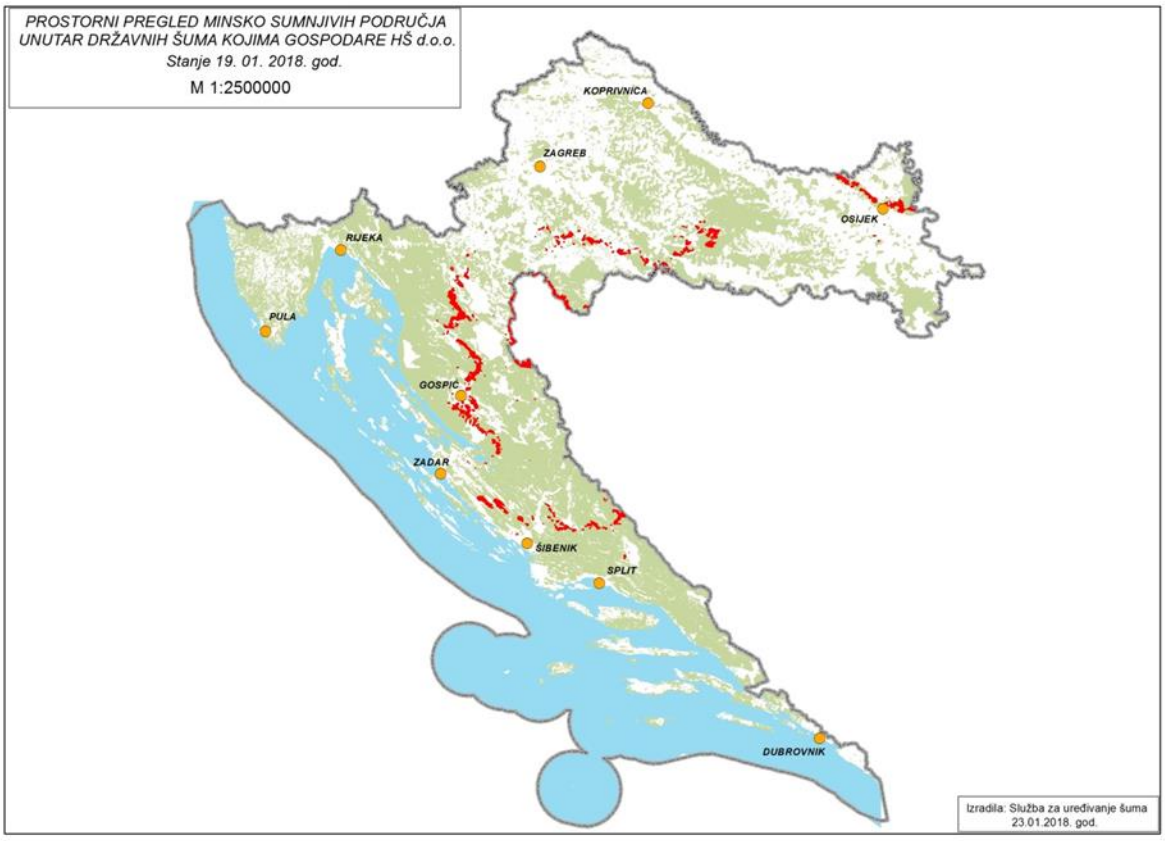


Figure 2.1-3 HA in forest areas in 2018 spatial representation of the mine suspected areas (red colour) in state forests managed by Croatian Forests Ltd. on 19 January 2018

According to the submitted extension request, humanitarian, economic, social and environmental implications remain and it is expected that these will be addressed during the extension period (until 1 March 2026):

- HA continue to be found in 59 municipalities in 8 out of 21 Croatian counties. A total of 488,984 inhabitants – 11.3% of the population of Croatia – continue to live in the vicinity of HA.
- Mined agricultural areas and forest areas represent a significant problem for the economy. According to the Croatian Forests Ltd. calculation the total loss because of mined areas (mostly areas under the forest management) and the value of forest wealth that cannot be used (because of mines) equals approximately €13.5 million per year. These losses occur due to i.e. unrealized wood harvest, unrealized silvicultural works (which cause a lower forest increment and decrease in the quality of wood assortments), not produced and delivered harvested wood products, losses in tourism, recreation and ancillary forest products.
- While Croatia has placed a priority on creating safe conditions for tourism, some subsectors continue to be affected, particularly hunting tourism given the nature of the remaining HA.

- HA account for nearly 45.5 km^2 of national parks or nature reserves (forests make significant part of it).

When defining FRL a detailed map was developed by the Croatian Forests Ltd. that separates areas in the Forest administrations (FAs) into two general categories, areas with WAR AFFECTED FM and areas with NORMAL FM (detailed description provided in Chapter 4.2).

Croatia defined 10 strata with corresponding 13 Forest Management Practices (FMP) for the FRL determination. The conservative approach was used to model forest areas in period 2021-2025 since there is a possibility that the clearance of forest areas in period up to 2026 will not be executed as planned. Deviations in execution of the plan can happen from many reasons including the lack of needed financial sources or giving the advantage to the clearance of agricultural areas because of gaining financial resources through the EU Rural Development Programme. Because of that areas detected as mine polluted, within each of the defined strata in 2016 are kept unchanged in period 2021-2025 (*Table*). For them the intensity of harvest was zero.

Table 2.1-2 Area of forests polluted with mines, kha

Forest type	Main tree species	2000	2009	2016	2025
Deciduous	Pedunculate oak	12.56812	8.01918	6.54920	6.54920
	Sessile oak	36.84531	23.90684	10.72860	10.72860
	Common beech	179.80560	71.05792	47.98879	47.98879
	Other deciduous	109.14874	74.57066	14.75667	14.75667
Coniferous	Silver fir	8.63299	4.45538	2.73686	2.73686
	Other coniferous	13.29677	5.92611	3.22655	3.22655
Total		360.29753	187.93609	**85.98667**	**85.98667**

2.2. ADDITIONAL INFORMATION REGARDING THE INFLUENCE OF WAR AND POST-WAR EVENTS ON FOREST MANAGEMENT IN THE REPUBLIC OF CROATIA

In addition to the information presented in Chapter 2.1 for the purposes of FRL development Croatia was examining two additional facts:

- During the RP of the Regulation all EU MSs that had the similar social system to Croatia (communist regime) were faced during the 1990s with the transition from the social economy to the market economy
- All EU MSs were faced with the economic crises in 2008

However, these two facts had insignificant influence on the forest management in Croatia before, during the Reference period and afterwards comparing it to the impact of War and post-War events, as proved by a separate, detailed analysis conducted by Croatia for the purposes of FRL development and as presented in Chapter 2.3.

2.3. DISAGGREGATION OF THE EFFECTS OF THE BREAKUP OF YUGOSLAVIA, THE TRANSITION TO MARKET ECONOMY, AND ECONOMIC CRISES OF 2008 FROM THE EFFECTS OF WAR AND POST-WAR CIRCUMSTANCES ON THE FOREST MANAGEMENT IN CROATIA

At the end of the 1980s, deep structural changes in the political and economic systems began to unfold in the countries of Eastern Europe, members of the Warsaw Pact. A collapse of the Soviet Union and the fall of the Berlin wall may be considered a marking point for the end of the planned economy and the beginning of the transitional period to the market economy. The transition to a market economy took place during the large part of the 1990s. Such fundamental changes in the countries' political and economic systems inevitably reflected on forest management in those countries.

The Republic of Croatia (at the time named "The Socialist Republic of Croatia") was until 1991 a part of Socialist Federal Republic of Yugoslavia (SFRY). Although SFRY was not a member of the Warsaw Pact, it was also a country with the economic system based on the planned economy. The Republic of Croatia declared independence from the SFRY on 25 June 1991 (the Republic of Slovenia did the same on that date). Even before the declaration of independence, in August 1990, groups of Croatian citizens of Serbian nationality, backed by the regime in Serbia led by Slobodan Milošević and Yugoslav National Army, initiated and orchestrated the rebellion by setting the road blockades in certain areas of Croatia. The rebellion led to the full-fledged aggression and War.

It is evident that the forest management in the Republic of Croatia has been influenced by two major events of seismic proportions: the war and a transition to market economy, both of which likely had a large impact on the forest management in the reference period. Extrapolation of trends based on the data before 1990 to a period after 1990, in this case would not be a valid approach. Furthermore, the economic crises in 2008 also had an influence on forest management, albeit not as significant as the former two.

In line with Article 8.4 of the Regulation, Republic of Croatia may take into account the effects of war and post-war circumstances on forest management. However, this means that the effects of war have to be somehow quantified and disaggregated from the effects which might be considered to be consequences of the transition to the market economy or of the economic crises in 2008.

Since the war and the transition to market economy occurred simultaneously in Croatia, disaggregation of their effects on forest management is difficult. Therefore, we decided to analyse the dynamics of forest production, more precisely Roundwood production, during the period 1970-2009 in countries of the EU. In addition, we analysed other variables such as forest area, the share of forest area in land area, the population of the country and GDP per capita in order to identify the countries which might be comparable with Croatia. Our hypothesis is that the harvest and Roundwood production in countries similar in size, forest area, the share of forest, population and GDP which are also relatively close geographically, should exhibit similar dynamics.

Pogreška! Izvor reference nije pronađen. to *Figure 2-1* show comparison of Croatia with other countries in the EU. The most similar country to Croatia, with respect to all of the above-mentioned criteria, is the Republic of Slovakia. Furthermore, the Czech Republic and The Republic of

Slovakia have one more characteristic in common with Croatia. Namely, unlike the bloody breakup of Yugoslavia in 1991, with war in Croatia, those two countries emerged after the peaceful and orderly dissolution of Czechoslovakia on 1 January 1993. Closer look at the GDP of Czechoslovakia and Yugoslavia, and from 1990 for Czech Republic, Croatia and Slovakia, shows noticeable similarities in both size and the dynamics of per capita GDP (*Figure*)

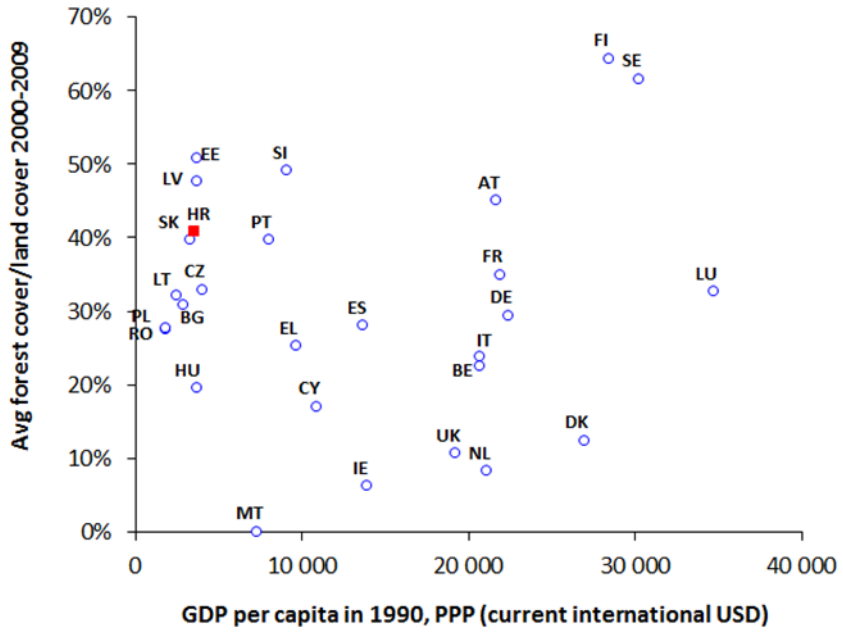


Figure 2.3-1 **Average forest cover/land cover 2000-2009 (Source: Materials provided during Regulation negotiations) versus Per capita GDP (Source: UNdata 2018) for the EU countries.**

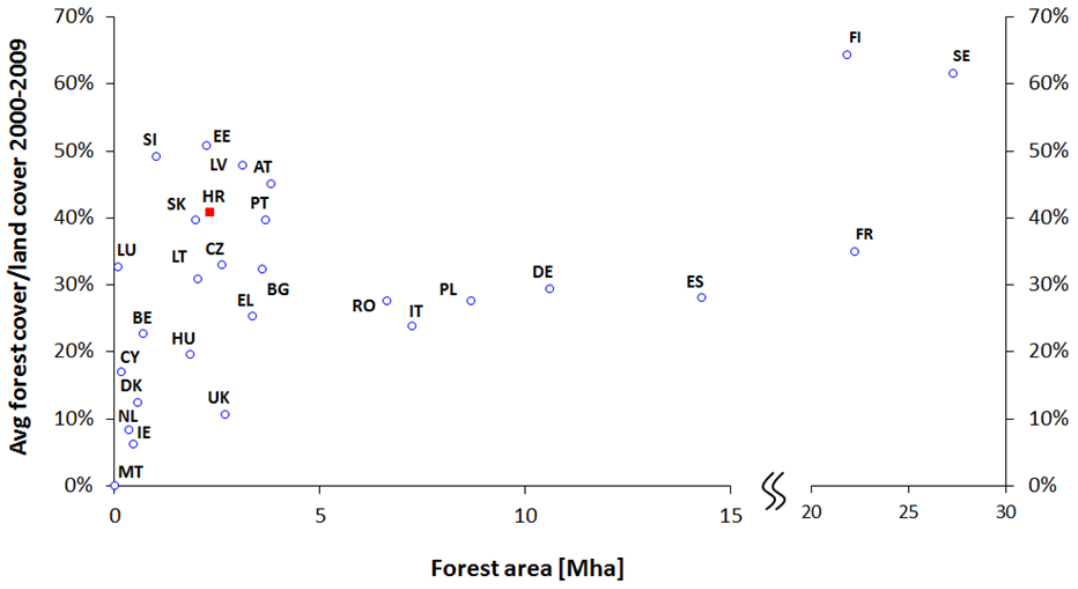
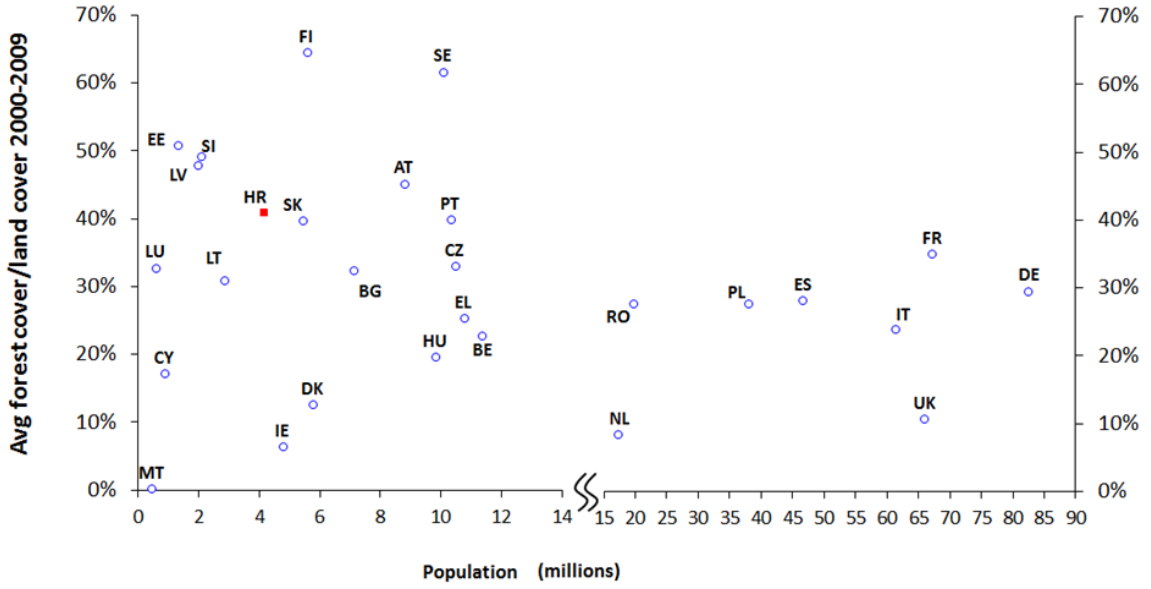


Figure 2-1 Average forest cover/land cover 2000-2009 (Source: Materials provided during Regulation negotiations) versus the population of the country (Source: Eurostat)

Eurostat, Area by NUTS 3 region [demo_r_d3area]).



Observed similarities between Croatia and Czech Republic and Slovakia lead us to believe that the dynamics harvest rates following the year 1990 could have been similar if the war had not occurred in Croatia. Due to the fact that data in the FAOstat database before 1990 are available

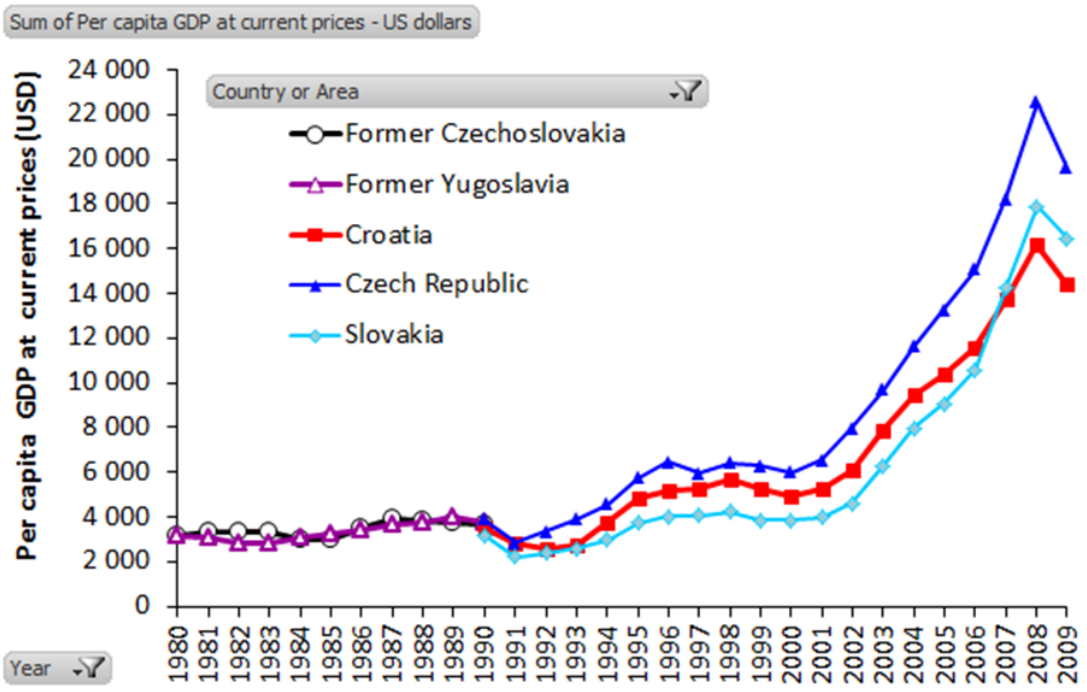


Figure 2.3-2 Per capita GDP for the countries the Czech Republic and Slovakia, having some historic similarity to Croatia (dissolution of Czechoslovakia vs. breakup of Yugoslavia. Source: UNdata 2018).

only for Czechoslovakia and Yugoslavia, but not separately for Czech Republic, Slovakia and Croatia, it was not possible to use only data from Slovakia as the country most similar to Croatia.

Instead, we used data on Roundwood production for Czechoslovakia (before 1993) and summed data for Czech Republic and Slovakia (since 1993). The Roundwood production was expressed in relative to the average annual production during 1980-1989. The period 1980-1989 was selected as the period closest to the beginning of the transition to market economy and the war in Croatia. Also, a ten-year average was used to avoid anomalies which might result from selecting a single year (a possible outlier) as the reference year.

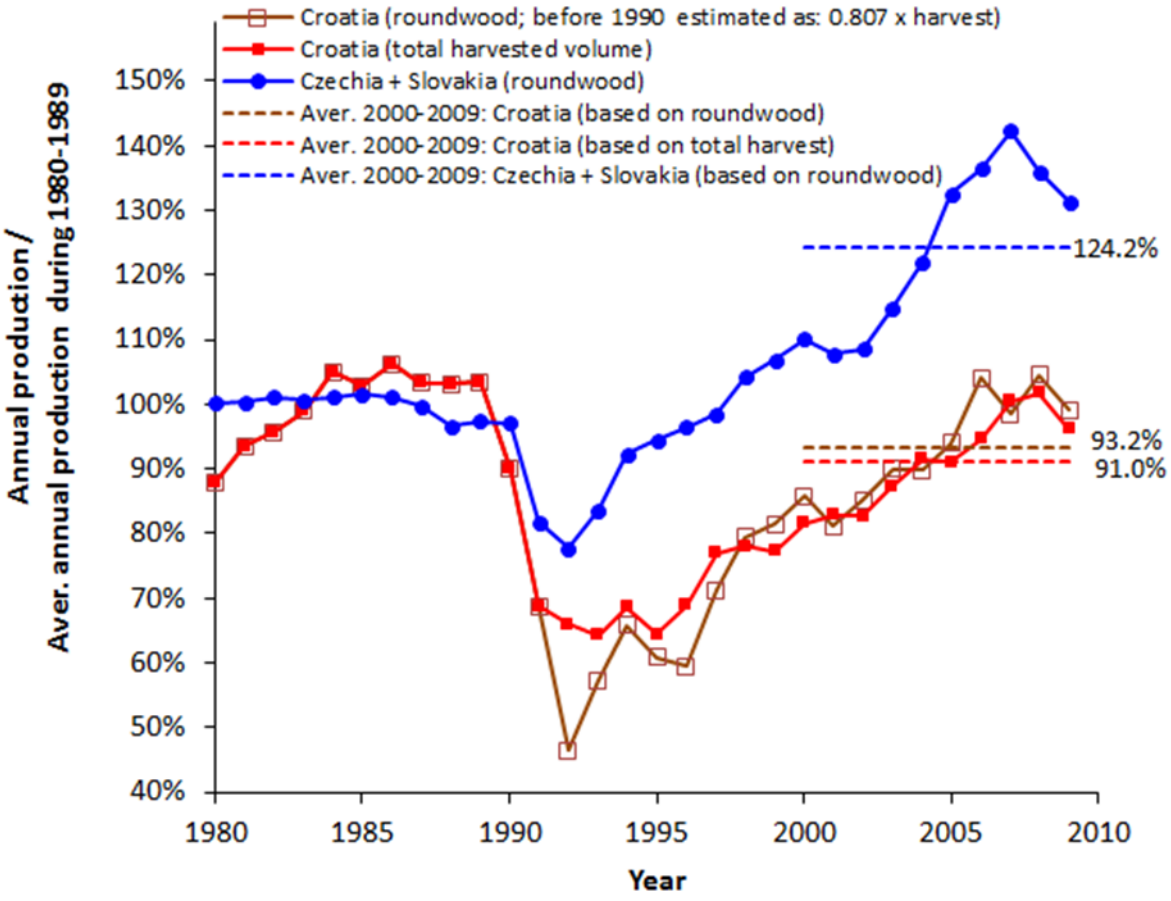


Figure 2.3-3 The ratio of Annual Roundwood production and Average annual Roundwood production during 1980-1989 (Source: FAOstat). Dashed lines denote average annual Roundwood/harvest production during the reference period 2000-2009 as a share of the average annual production during 1980-1998. NOTE: Before 1990 data on Roundwood production for Croatia, Czech Republic and Slovakia are not available from FAOstat database, but are only data for Czechoslovakia. Roundwood production for Croatia before 1990 was estimated using data on total harvest and the median of the share of Roundwood in the harvest.

The dynamic of Roundwood production in for Czech Republic and Slovakia (*Figure*) showed a very distinct impact of the transition to market economy and dissolution of Czechoslovakia at the beginning of the 1993 which resulted with a drop in the production. Only in 1998, the production exceeded the levels before the transition. It should also be noted that combined Roundwood

production of Czech Republik and Slovakia also exhibited a decline in 2008 and 2009, probably as a result of the economic crises of 2008.

Since data for the Roundwood production for Croatia are not available in the FAOstat database before 1992, Roundwood production for Croatia before 1992 was estimated using data on total harvest and the median of the share of Roundwood in harvest during the period 1992-2009. In addition, data on the total harvest in Croatia (Source: 1980-1989, Federal Bureau of Statistic, Belgrade, Yugoslavia; 1990-2009 HŠFOND database of Croatian Forests Ltd., Zagreb, Croatia) are also used to in the analysis of the dynamics of Roundwood production/harvest in Croatia

Figure for Croatia shows similar dynamics (the fall in production at the beginning of the 1990s), but unlike combined production of Czech Republic and Slovakia, the decline in the production for Croatia is much deeper due to the war. In addition, due to consequences of war, the levels of production (both Roundwood and total harvest), by the end of 2009, still have not reached the levels of production before the war. During the reference period, the combined annual Roundwood production of Czech Republic and Slovakia was 124.2% of the average annual Roundwood production during the period 1980-1989. On the other hand, the same production in Croatia during the reference period was only 92.2%, while total annual harvest was only 91.0% of the average harvest during 1980-1989.

The changes in total harvest in Croatia during 1970-2017 are shown in *Figur*. The general national forest management plan (Genaral FMAP) from 1986 prescribed average annual harvest of 6.14 million m^3 by 1996. Due to the War, the plan was not realized. The FMAP from 1986 was therefore revised in 1993 and the target average annual harvest for the period 1986-1995 was reduced from the original 6.14 Mm^3 to 4.82 Mm^3. It should be emphasized that the Croatian national regulation on forest management relied in past as well as now on accurate forest management planning which has to be implemented. If there was and evidence that the planed harvest could not be realised at the level of at least 90% the plan must have been revised. Article 93 of the previous Ordinance on Forest Management (OG 111/2006) stipulated: "*Extraordinary revision of the Forest Management Plan should be made when the deviation from the prescribed harvest or from the prescribed works on the biological regeneration exceeding 10% has been identified*").

The war in Croatia, and to some extent other factors (transition), have caused the reduction of annual harvest from 5.5 Mm^3 in 1989 to 3.4 Mm^3 in 1993. The recovery was gradual and slowed down by the destruction of infrastructure and social consequences of wars (see chapter 2.1). Assuming that harvests in Croatia would, had there been no war, exhibit a similar pattern as the harvests in Czech Republic and Slovakia a so called "No War" model of harvest **for the FRL validation purposes only** was constructed. The model uses the average annual harvest in Croatia during 1980-1989 of 5.3 Mm^3 and the annual roundwood production index based on the relative combined production of Roundwood in Czech Republic and Slovakia during 1980-1989 (see *Figure* and Annex 3).

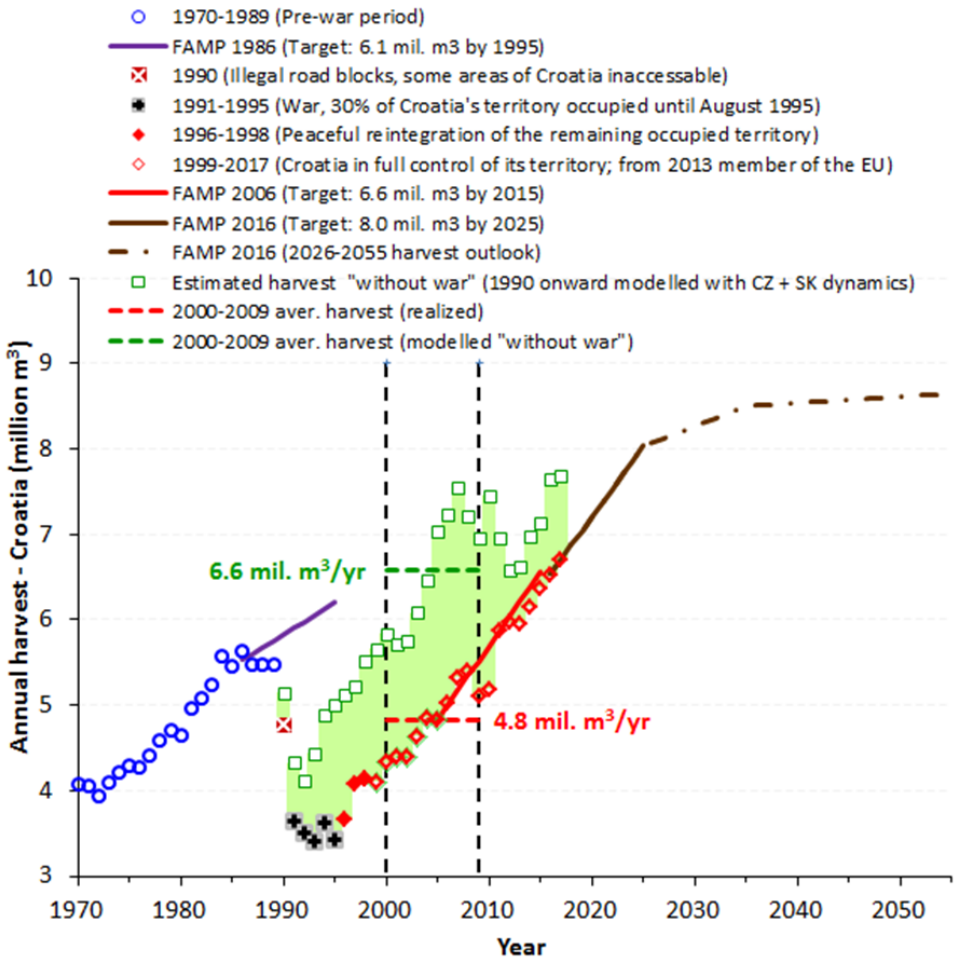


Figure 2.3-4 Comparison between the actual harvest and the "No War" harvest (green squares), estimated using FAOstat data on roundwood production dynamics in Czech Republic and the Republic of Slovakia. The green shaded area represents the estimated amount of harvest that has not been realized in Croatia due to the War; the modelled harvest "No War" during the reference period 2000-2009 amounts to 6.6 Mm3, compared to the actually harvested 4.8 Mm^3. The modelled 6.6 Mm^3 is only 0.4 Mm^3 (6.5%) larger than the target for 1995 that was prescribed in the General FMAP 1986-1995.

3. INTRODUCTION TO THE FOREST REFERENCE LEVEL (REGULATION, ANNEX IV, PART B, POINT B AND D)

3.1. CARBON POOLS AND GREENHOUSE GASES INCLUDED IN THE FOREST REFERENCE LEVEL

The national forestry accounting plan, submitted in accordance with Article 8, paragraph 3 of the Regulation, must contain, among other things, identification of carbon sinks and greenhouse gases included in the forest reference level, reasons for leaving carbon sinks out of the forest reference level establishment, and a display of consistency among carbon sinks included in the forest reference level.

Republic of Croatia includes the following pools in accounting in the forest reference level encompassing managed forest land:

- above-ground biomass
- below-ground biomass
- harvested wood products
- dead wood

Above-ground and below-ground biomass of the managed forest land is spatially divided in three basic strata: deciduous, coniferous, and out of yield forests (maquies and shrubs). This division is in accordance with the divisions in the NIR, comparable to it, but more detailed for the purposes of defining the forest reference level.

Harvested wood products are divided into sawn wood, wood panels, and paper and paperboard. Wood products at solid waste landfills and wood products made for energy production are accounted on the basis of immediate oxidation. For calculation of annual emissions/sinks first order decay method function is used, with the following half-lives:

- 2 years for paper,
- 25 years for wood panels,
- 35 years for sawn wood.

The carbon stock change in the dead wood pool is estimated to be zero, the same as in NIR 2018. Pursuant to existing legislation (Ordinance on Forest Management), collection of data on dead wood during the development of forest stand inventory (General FMAPs) and drafting of forest management plans/programs is mandatory. This is a relatively new obligation, according to which data on growing stock of dry standing and lying trees above the measurement limit is collected, which encompasses 10% of forest management plans/programs each year. When over time the sample increases to a more representative level, information on dead wood from these sources will be used for the technical correction of the FRL.

In line with the Article 5, paragraph 4 of the Regulation, and to be consistent with the carbon stock changes estimated in the NIR 2018, Croatia decided to omit litter and soil pools from the FRL estimation. These two pools are considered not to be sources of emission in managed forest lands.

3.2. DEMONSTRATION OF THE CONSISTENCY BETWEEN THE CARBON POOLS INCLUDED IN THE FOREST REFERENCE LEVEL (REGULATION, ANNEX IV B, POINT (B)

Estimation of carbon stock changes on areas of forest management in Croatian NIR 2018 were performed using the available data on areas, increment and harvest as they **were actually realized** during the period 1990-2016. These data refers to the entire forest area in Croatia based on the selected criteria for the forest definition under the Kyoto Protocol. The main data sources for the UNFCCC and KP reporting in Croatia are General FMAPs and other plans/programs in forest sector. All these documents are developed taking into the consideration the fact of War in Croatia and consequences of the War in post War period (i.e. mined areas, inadequate capacities for full forest management in whole Croatian territory throughout years). This means there is no official document in Croatia in forestry sector that reflects forest condition and provides information on basic forest parameters (i.e. areas, increment, harvest) without influence of the War and post War period in Croatia.

In order to define FRL Croatia performed estimation of carbon stock changes in pools of aboveground biomass, belowground biomass, dead wood and Harvested wood products. Litter and soil pools are omitted from the estimation. The same estimation methods are applied as in NIR 2018.

In order to appropriate address the stipulation of Article 8, point 4 of the LULUCF Regulation when deriving management intensities in the RP, Croatia decided that these intensities should be derived from the selected, seven Forest Administrations (FAs) for which the War and post-War **is assumed to be negligible**. While the estimation of emission/removals in NIR 2018 is conducted for the whole Croatia using the data that accounts for War and post-War consequences, the modelling for the Commitment Period 2021-2025 was performed using only the data that area coming from seven FAs for which the War and post-War is assumed to be negligible.

Because of the above mentioned, it was not feasible to demonstrate consistency between the carbon pools included in the FRL and NIR 2018 although the same methods are applied for the FRL determination and NIR 2018 (see Chapter 5.2)

3.3. DESCRIPTION OF THE LONG-TERM FOREST STRATEGY (REGULATION, ANNEX IV B, POINT D)

3.3.1. Overall description of the forests and forest management in Croatia and the adopted national policies

The Forest management plan for the Republic of Croatia (General FMAP) is a general forest management plan for appointing activities that will be performed in the forests and forestland within the complete Croatian forest management area. The FMAP provides ecological, economic and social support for the biological improvement of forests and the increase of forest production in the forest management area. The development of the General FMAPs is defined in Article 27of the Forest Act while the Article 6, paragraph 3 of the same law defines the development of General FMAPs as one of the measures relevant for achieving interests of the Republic of Croatia in forest ecosystems.

Purpose of determining the general FMAP is to ensure the sustainable forest management through conservation of the natural structure and diversity of forests, including the permanent increase of the stability and quality of the economic and general forest ecosystem functions.

Since 2016 the forest management area of Croatia is divided into 684 management and forest land units owned by the Republic of Croatia and 407 management units in the private ownership. Out of total number of management units owned by the state, 649 units are managed by the public enterprise “Hrvatske šume d.o.o.” (Croatian Forests Ltd.) and 35 are used or administered by legal administration bodies owned by the state.

According to the General FMAP 2006 - 2015, 625 management units had a valid forest management plan (96%) out of the 649 management units of state forests that were referred to the Croatian Forests Ltd.

24 management units did not have prepared plan. Forest management plans were not made for 23 units in karst region and one management unit close to the border with Bosnia and Herzegovina due to unresolved territorial issues.

Currently, more than 70% of - privately owned forests have valid management plans.

All forest management plans and programs developed for management of each forest management unit should be in line with the General FMAP.

The Ministry of Agriculture has implemented the procedure of the Strategic Environmental Impact Assessment of the General FMAP 2016-2025. This was performed in accordance with Article 4 paragraph 2 of the Regulation on the strategic assessment of the impact of the Plans and Programs on the environment (OG 64/08) and in accordance with Article 66 paragraph 3 of the Environmental Protection Act (OG 80/13, 153/13, 78/15).

The General FMAP 2016-2025 is developed based on the Forest Act and Ordinance on Forest management and must be consistent with the provisions of the Nature Protection Act (OG 80/13, 15/18) and the Regulation on proclamation of the Ecological network (OG 80/13).

The Forest Act regulates the activities in forestry sector in Croatia. The forest management plans determine conditions for harmonious usage of forests and forest land and procedures in that area,

necessary scope regarding the cultivation and forest protection, possible utilization degree and conditions for wildlife management. The forest management plans are as follows:

- Forest Management Area Plan for the Republic of Croatia (FMAP)
- Forest Management Plan for management units
- Programmes for management of management units on karst
- Programmes for management of private forests
- Programmes for forest renewal and protection in specially endangered area
- Programmes for management of forest with special purpose for the defence of the Republic of Croatia
- Annual forest management plans
- Annual operative plans.

The Ministry of Agriculture supervises the decision making process of management plans as well as their renewal and revision.

The FMAP, among others, appoints activities that will be performed in the forests for the next 10 years but also, to some extent, describes the former management (management in the previous 10-year period) and the status of forests at the beginning of the new 10-year period. So far, four FMAPs have been prepared:

- FMAP encompassing the period from 1986-1995 (FMAP 1986-1995)
- FMAP encompassing the period from 1996-2005 (FMAP 1996-2005)
- FMAP encompassing the period from 2006-2015 (FMAP 2006-2015)
- FMAP encompassing the period from 2016-2025 (FMAP 2016-2025)

Summarized, the total forestland in Croatia constitutes of one, unique forest management area which is established in order to ensure the unique and sustainable management of the forest land. Therefore, according to the national criteria, both forestland and land under the forest management (without real tree cover) is sustainably managed regardless of their ownership, purpose, forest stand etc.

Based on the forest management type, according to the Ordinance on Forest Management forest stands are managed either as even-aged or uneven-aged forests. In case of uneven-aged forests two types of selection systems are applied:

- a group-tree-selection system (Type 1 of the uneven-aged forest management)
- a single-tree selection system (Type 2 of the uneven-aged forest management)

In case of Type 1 a group of trees of the same age and development stages within (sub)compartment, needs to be larger than 0.2 ha and up to maximum of the 2.0 ha.

Even-aged forest stands make regular forests with a share of about 52% of total growing stock (excluding maquis, shrub, garigue and scrub). Uneven-aged forests take share of 30 % of total growing stock (excluding maquis, shrub, garigue and scrub). Type 1 uneven-aged forests take share of about 18 % of total growing stock.

State forests are managed either by “Croatian Forests Ltd.” or by other legal bodies.

Furthermore, detailed information on the system within state forests managed by “Croatian Forests” is provided.

The system is divided in 16 organizational and territorial units – regional forest administrations (*Figure*). This division was established in 1996.

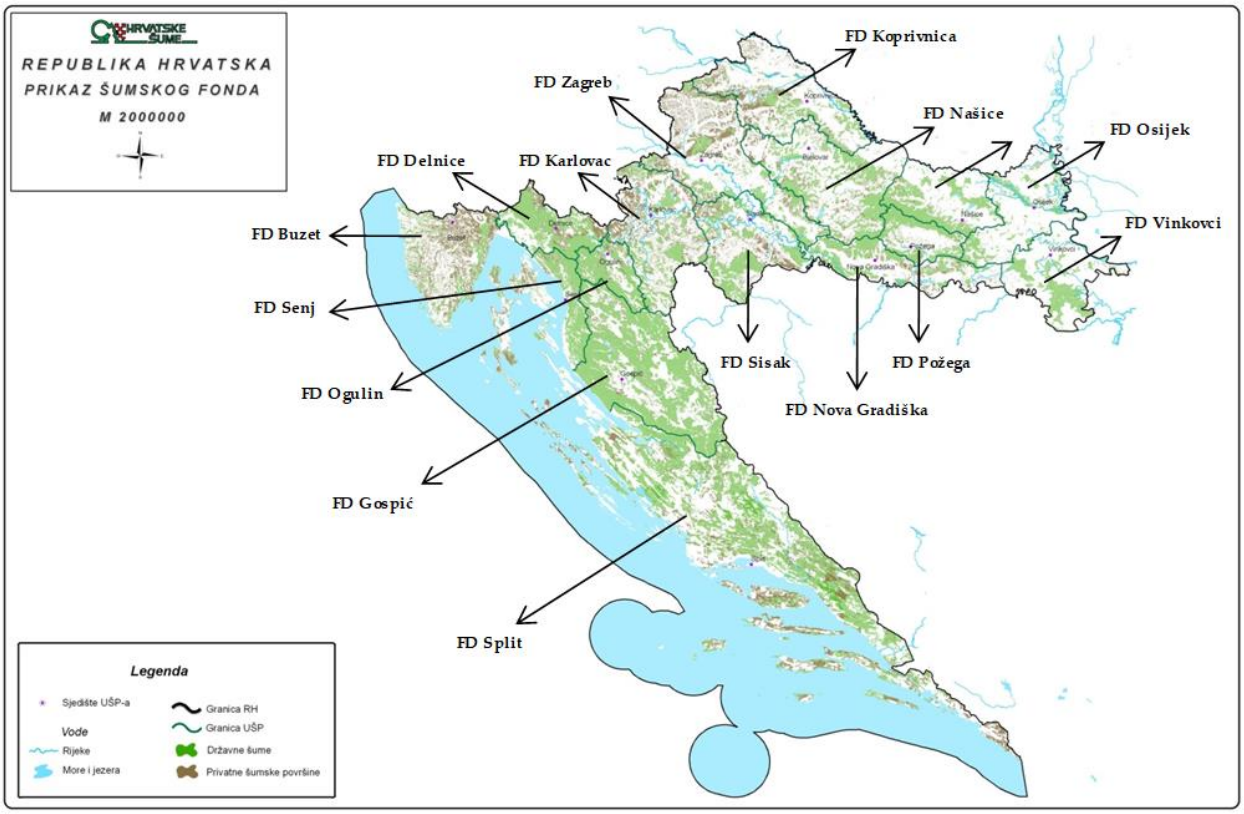


Figure 3.3-1 *Spatial division of the Republic of Croatia on forest administrations (Legend: red dots represent the seat of the forest administrations; red lines are the spatial borders of the forest administrations; state forests are represented in green and private forests in brown colour*

Regional forests administrations consist of regional forest offices. Croatian area is divided into 170 regional forest offices. The forest office is the basic organizational unit for performing all expert and technical activities in forest management and they are directly supervised by the regional forest administration. Forest management in forest units is based on forest management plans for individual management units approved by the Ministry of Agriculture.

Each forest office manages a certain number of management units. The division of forest management area on management units is performed to facilitate the implementation of forest management plans. The area of a management unit is usually between 1,000 and 3,000 ha. The area of management units is determined by the Forest Management Area Plan and usually they are not changed (now there is about 653 management units). The number of management units governed by a certain forest office is variable.

A Management unit is divided into compartments and sub-compartments. A compartment is considered as the permanent and basic unit regarding the management forest division. They are established in order to facilitate the management, inspection and field orientation. The compartment area, except for first age class, shrub, scrubs, maquies, garigue and barren wooded land, in general cannot be larger than 60 ha.

Compartments are divided into smaller areas (sub-compartments) and a sub-compartment is the smallest variable, basic area regarding the management division of forests which is specially managed as a stand. Stands are included in sub-compartments depending on their stand origin, stand form, development stage, tree species, age, management goal, species share by volume and tree coverage. The smallest area of a sub-compartment is 1 ha except in private forests and separated forest area when it can be even smaller and the largest sub-compartment area is determined by the compartment size. However, the sampling is performed within the sub-compartment on a 0.05 ha grid.

Short scheme of the system's structure is presented in *Figure* .

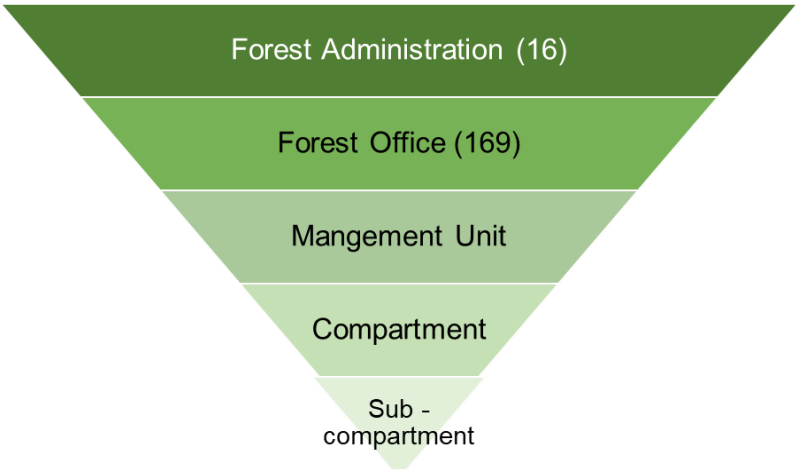


Figure 3.3-2 The scheme of the national system's structure

Therefore, it should be emphasized again that the basic unit for forest management in Croatia is the sub-compartment for which, based on field measurements on a 0.05 ha grid and the analysis of the related results, data on area, land category, growing stock and increment on diameter class (above 10 cm in diameter at 130 cm above ground, classes by 5 cm), age, ecological and management type, crown cover, height above sea level, the level of fire vulnerability, tree species and related number of trees etc. are determined. Furthermore, for each sub-compartment a felling and silvicultural treatment plan is prepared which is recorded each year.

Forest land

The Forest Act regulates the growing, protection, usage and management of forest land as a natural resource aimed to maintain biodiversity and to ensure management based on principles of economic sustainability, social responsibility and ecological acceptability. It prohibits the renewal of forests by clear cutting, thus natural rejuvenation is the principal method for renewal of all natural forests.

The following figures are based on data for 2016 provided in General FMAP 2016-2025 and present forest area in Croatia as defined by Forest Act and Ordinance on Forest management.

Based on the forest stands, forest land with tree cover are divided as follows (share in year 2016 is given in brackets):

- High forests (55.92%)
- Plantations (2.94%)
- Forest cultures (0.04%)
- Coppice (14.39%)
- Maquis (3.40%)
- Shrub (17.63%)
- Garigue (1.55%)
- Scrub (4.13%).

According to the Forest Act forests are classified in three categories:

- productive forests (which made about 55 % of total forest area in 2016)
- protective forests (which made about 28 % of total forest area in 2016)
- forests with special purpose (which made about 17 % of total forest area in 2016).

Based on the ownership, there are two types of forests in Croatia:

- State forests owned by the state and managed by:
    - The public enterprise “Hrvatske šume d.o.o.” (Croatian Forests Ltd.)
    - Legal bodies owned by the state (e.g. national parks, Faculty of Forestry, Ministry of Defence, “Croatian Waters” etc.)
- Private forests

State forests make about 74% of total forest area, while the remaining 26% are privately owned.

The area of forests is determined based on all available cadastral maps in various scales. However, while preparing the FMAP 2016-2025, it was noticed that cadastral data on forest area did not match real conditions – private forests were larger than those presented in the cadastre. Since private forests are highly fragmented and scattered over the entire Croatian territory, most precise determination of their area and their spatial position was accomplished by applying the remote sensing methods for the forest area extraction and field work to determine forests’ condition. The forest area was extracted in three ways:

- by using the ortophoto (scale 1:5,000)
- by using the digital cadastral maps
- by using other available forest maps

Ordinance on forest management defines a size of the forest area that has to be measured when developing forest plans/programs. Measurement intensity of at least 2% of the forest area that is subject of plan/program is prescribed for even-aged stands of the second age class, forests with

limited management, coppices forests, protection forests and private forests. In addition, measurement intensity of at least 5% of the forest area that is subject of plan/program in even-aged stands of high forests above the second age class and in uneven-aged forests is determined.

The FMAP 2016-2025 determines total growing stock of about 418 mil. m^3 in 2016 calculated based on the measured diameters at breast height and height of living trees above the taxation level (10 cm in breast height diameter). Out of total growing stock 75% is under state forest owned by Croatian Forests Ltd and ten most common tree species make common beech (37% of total growing stock), pedunculate oak (12%), sessile oak (9%), common hornbeam (8%), european silver fir (8%), narrow-leafed ash (3%), spruce (2%), black locust (2%), black alder (2%) and turkey oak (2%).

Private forests hold 20% of total growing stock, while only 5% is under state forests owned by other legal bodies.

The growing stock is not measured for the first age class of even-aged forest and this is why carbon stock changes in these forests are not taken into consideration for modelling purposes. This is also in line with the approach applied in Croatian NIR regarding the determination of carbon stock in even-aged forest. In case of maquies and shrub forests estimation was performed using the expert judgement on increment in these forests.

For example, planned work normative for state forests managed by „Croatian Forests“ for the year 2010 included:

- Measurements of breast diameters at 69,000 sample plots of the 5% sample trees
- Measurements of breast diameters at 25,000 sample plots of the 2% sample trees
- Measurements of breast diameters of all trees at 6,000 ha

Based on the legislation, when preparing the FMAPs, the increment value is determined based on the volume tables and measured diameter increment from increment cores. The increment cores are taken at breast height (1,30 m) with Pressler’s borer. Measuring of the diameter increment has been performed for the main tree species. In even-aged stands, samples for diameter increment measuring are grouped for each tree species according to the main tree species in the stand, their origin, yield class, stand quality and age, and in uneven-aged stands on management classes and stand quality.

3.3.2. Description of future harvesting rates under different policy scenarios (Regulation, Annex IV, part B, point d)

Forest Act and Ordinance on Forest Management (OG 97/18, 101/18) are two main legislative acts based on which forest management in Croatia is conducted.

According to the law, Forests and land under the forest management are of great interest to the Republic of Croatia and they have its special protection. Forests and land under the forest management are of special natural wealth, and the environmental services and economic functions of forests requests a special way of planning, management and use based on the principle of sustainable forest management.

Sustainable forest management means the use of forests and land under the forest management in a way and to the extent that it maintains their biodiversity, productivity, regeneration capacity, vitality and potential to meet, at the present and in the future, the appropriate ecological, economic and social functions at local, national and global level and which does not cause damage to other ecosystems.

The application of the principles of sustainable forest management for the purpose of the immediate and future fulfilment of appropriate ecological, economic and social functions at local, national and global levels, taking into account the socioeconomic importance of forests and their contribution to rural development, is achieved through:

- Sustainable forest management and the multifaceted role of forests, whereby many goods and services are supplied and / or provided in a balanced manner and forest protection is ensured
- Efficient use of resources, optimizing the contribution of forests, forestry sector and forest-related sectors to rural development, growth and job creation
- Responsibility for forests on a global scale, promoting sustainable production and consumption of forest products.

The implementation of the defined sustainable management of forests is secured through the development and implementation of different type of forest plans and programs. For each forest management unit (more than 1000 in Croatia) the plan/program has to be defined. By these documents, all types of work (silvicultural as well as harvest) have to be determined and activities need to be implemented in period of validity of plan (10 years). In addition to this, all plans/programs have to be in line with the General Forest Management Plan for the Republic of Croatia which is also developed every 10 years (currently General FMAP 2016-2025 is valid).

The forest management principle grounded on the sustainability with the carefully defined and obliged registration of the prescribed work do not allow that harvest rates will be additionally significantly increased in period up to 2025. This is also confirmed by the Ordinance on Forest Management. Article 65 prescribes harvest rates for even-aged and uneven-aged forests as well as allowed deviations from the prescribed harvest rates for different types of harvest operations (thinning, regeneration cut). The harvest has to be realized based on the so called uniform area (definition provided in Chapter 4.3). In cases where harvest due to the natural disturbances make significant part of the total harvest realized on the area, the prescribed harvest from thinning and regeneration cut has to be performed based on the uniform area. However, in this case the revision of the existing forest management plan/program has to be developed and approved taking into account the area that was harvested due to natural disturbance.

All documents that Croatia is currently developing which concern harvesting rates and renewable sources of energy are taking into consideration data from the General FMAP and the prescribed harvest of total amount of 80,371,636 m^3 in period 2016-2025. Among them are: Proposal of the Low Carbon Development Strategy of the Republic of Croatia for the period up to 2030 with a view to 2050, Analysis and Fundamentals for the Development of the Energy Strategy of the Republic of Croatia, First Draft of Integrated Energy and Climate Plan for the period 2021-2030. By these documents it is predicted that additional biomass for bioenergy use will be coming from the agricultural areas (cropland area).

When developing FRL the average value of the harvest in period 2021-2025 was projected of 7.5 Mm^3. The value of projected harvest ranged from 7.3 Mm^3 in 2021 and 7.9 Mm^3 in 2025.

Thanks to the strict law prescriptions that secure sustainable forest management in Croatia, the felling in areas of seven FAs (for which War influence was assumed to be negligible) was executed in line with the forest management plans. No additional felling were allowed and performed in areas of seven FAs even during the War and post War period in Croatia when felling on other forest areas were enabled.

In addition, the obligation of performing extraordinary audits of valid forest management plans is regulated by the Ordinance on Forest management. Each time when the deviation in execution of prescribed forest management plan happens due to a change in forest purpose, natural disturbances, pests' infestation, drying of forests etc. the audit has to be performed and the new forest management plan issued. This new plan takes into consideration the current state of the forest area on which deviation occurred and defines corrective measures at the level of whole forest management unit.

From the above presented information, Croatia recognizes only one possible, additional harvest scenario up to 2025. This scenario assumes that the average annual harvest is realized each year in period 2021-2025 in the amount of 8.03 Mm^3 as prescribed in general FMAP 2016-2025. This would present 6.2% increase of the total harvest in period 2021-2025 comparing to the value as represented by for the FRL projection.

Annex IV A of the LULUCF Regulation prescribes "The reference level shall be consistent with the goal of achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, including enhancing the potential removals by ageing forest stocks that may otherwise show progressively declining sinks". Croatia believes that implementing the current forest management practices on its whole territory, for each type of forest ownership and creating its policy primarily based on the criteria of sustainable forest management it secures enhancing sinks on the long term in LULUCF sector. Although, the impact of War and post-War circumstances on forests ecosystem will be present for decades (due to the indirect effect of War on forests, detailed description provided in Chapter 2) with the careful planning that consider the dynamics of changes in age structure of the all species in forests in Croatia forest sinks potentials will be secured and enhanced. The increase in harvest from (in average) 4.8 Mm^3 per year as registered and reported in the RP to predicted harvest of 8.03 Mm^3 per year in period of the General FMAP 2016-2025 validity will help to establish balanced age class distribution in forests of Croatia. Removing the accumulated biomass will positively affect the increment in forests which shows decreasing trend (e.g. by 2.3%, average increment from 6.95 to 6.79 m^3/ha per year in the case of pedunculate oak) due to the absence of timely implementation of silvicultural works caused by the War and post-War circumstances.

The fact that all forests in Croatia make one, unique forest area and that the official policy prescribed by General FMAPs is considered in all relevant strategical documents secures and maintains the continuation of the carbon sink in forests.

4. DESCRIPTION OF THE MODELLING APPROACH (REGULATION, ANNEX IV, PART B, POINT C)

4.1. DESCRIPTION OF THE GENERAL APPROACH AS APPLIED FOR ESTIMATING THE FOREST REFERENCE LEVEL

As reported in Chapter 1 data available in General FMAPs and in forest management plans/programs valid during the RP are considered to be the best available data for the FRL purposes. In order to appropriately address the stipulation of Article 8, point 4 of the LULUCF Regulation when deriving management intensities in the RP, Croatia decided that these intensities should be derived from the selected, seven Forest Administrations (FAs) for which the War and post-War **is assumed to be negligible**. While the estimation of emission/removals in NIR 2018 is conducted for the whole Croatia using the data that accounts for War and post-War consequences, the modelling for the Commitment Period 2021-2025 was performed using only the data that on harvesting rates that area coming from seven FAs for which the War and post-War is assumed to be negligible.

During the Reference period 2000-2009 defined by the LULUCF Regulation, two General FMAPs were valid: General FMAP for the period 1996-2005 and General FMAP for the period 2006-2015. The planning and execution of both plans were highly influenced by the War and post-War circumstances. The data from General FMAP 2016-2025 are therefore considered as the best available data for the modelling and projection purposes.

Since all forestry related data are recorded in official, state database named HS FOND this database was a core element for defining FRL. When developing General FMAPs HS FOND is used as data source in driving a forest stand development model (official name is HS-MODEL) for predicting forest stand distribution by age, area, increment and harvest in the following ten year period. Data from individual stands are then aggregated at different level, up the entire forest area of the country (see chapter 4.2). Temporal and spatial framework of forest management planning in Croatia is presented in *Figure* .

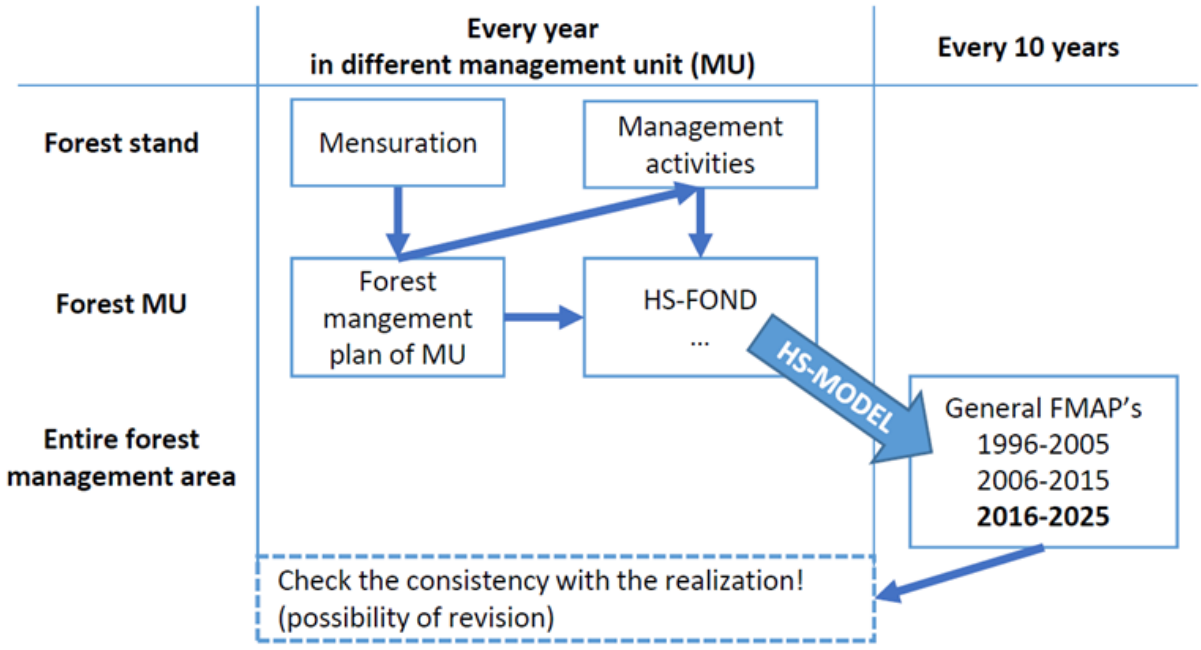


Figure 4.1-1Temporal and spatial framework of forest management planning and activities in Croatia

The existing HS-MODEL was used for the estimation of FRL. **The model required some adjustments in order to be in line with stipulations of the LULUCF Regulation.** This means that model for FRL purposes was running using the **realized harvest intensities** determined on seven FAs, in line with Article 8, point 4 on which War and post-War influence were assumed to be negligible.

The Forest reference level of the Republic of Croatia was estimated through the five steps:

STEP 1: Deciding on forest's stratification

When deciding on forest's stratification for FRL Croatia it was concluded that all forests should be stratified on Deciduous, Coniferous and Out of yield forests (Maquies and shrub) in order to secure consistency with the stratification used for GHG Inventory. These three distinct forests categories were further stratified into (in total) 10 strata and 13 FMPs are defined (see Chapter 4.2.2).

STEP 2: Selection of the Forest administration areas (FAs) for which War effects on forest management is assumed to be negligible during the Reference period (RP)

Considering the fact that Croatia was faced with the War and post-War circumstances in its recent past (detailed information provided in Chapter 2) it was not possible to use data from General FMAP and HS-FOND database directly for the FRL determination without preliminary analysis. Based on the detailed field information on the years and duration of occupation of Croatian territory, a spatial map defining forest areas that were directly affected by the War and forest areas less affected by the War was developed (*Figure*).

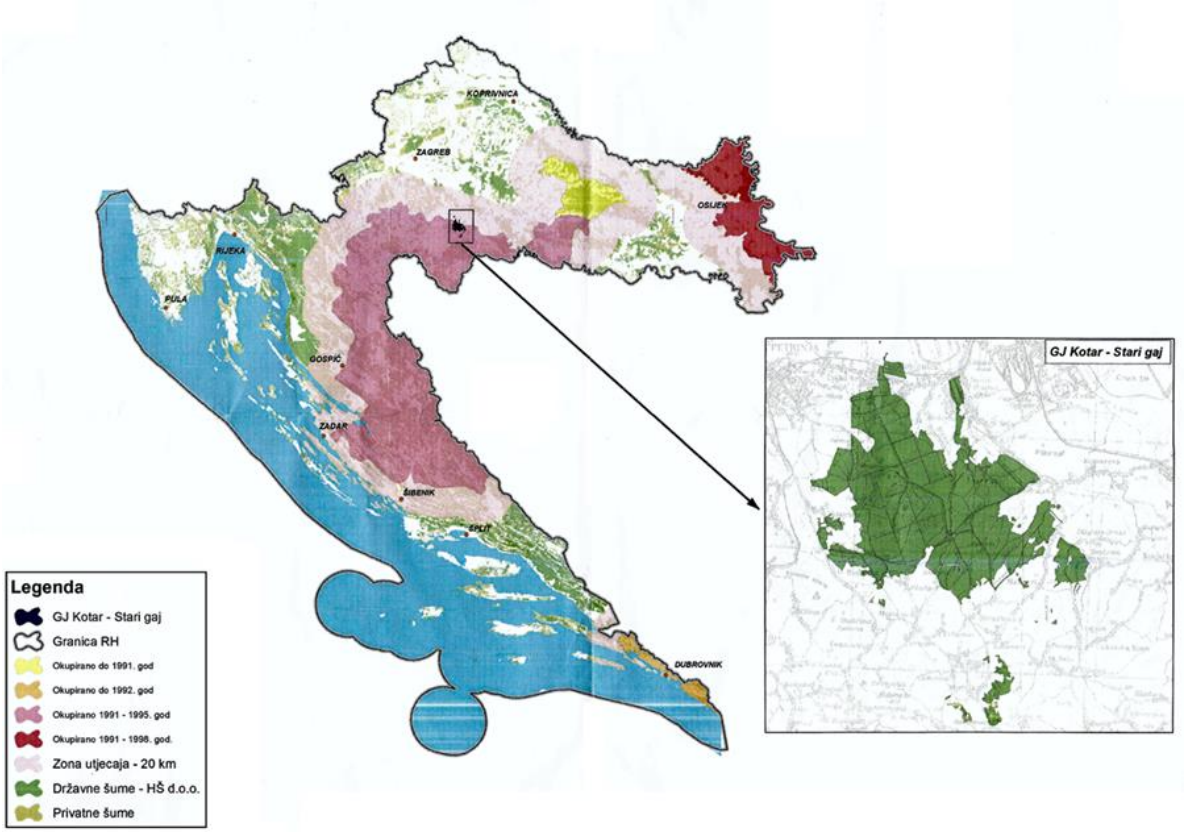


Figure 4.1-2 Map of the Republic of Croatia with the indicated categories of impact of the war on the forests (Legend: Management Unit Kotar stari gaj (black); national border of the Republic of Croatia (black line); occupied areas until 1991 year (yellow); occupied areas until 1992 (orange); occupied areas in the period 1991-1995 (pink); occupied areas 1991-1998 (red); 20 km zone of influence of the war (light pink); state forests (green); private forests (olive green)

This special map was developed by the Croatian Forests Ltd. collecting the detailed information on the field in 169 forest offices in Croatia. This map was used to perform the first analyse of the forest areas that are directly affected by the War and forest areas influenced by the War (20 km buffer zone) based on the years and duration of occupation of Croatian territory. Since all forest areas were not impacted by the War in the same way an additional, additional detailed map was developed by the Croatian Forests Ltd. that separates total of 16 Forest administrations **(FAs) into two general categories** regarding the forest management (*Figure*):

- **"WAR AFFECTED FM"** - FAs where forest management has been directly and significantly affected by the War, occupation of territory and post-War circumstances (marked in red, pink and orange colour on the map), and

- **"NORMAL FM"** - FAs where forest management has been indirectly affected by the War, but the effect of War on forest management, for the purpose of calculation of FRL, is assumed to be negligible during the Reference period (marked in green colour on the map)

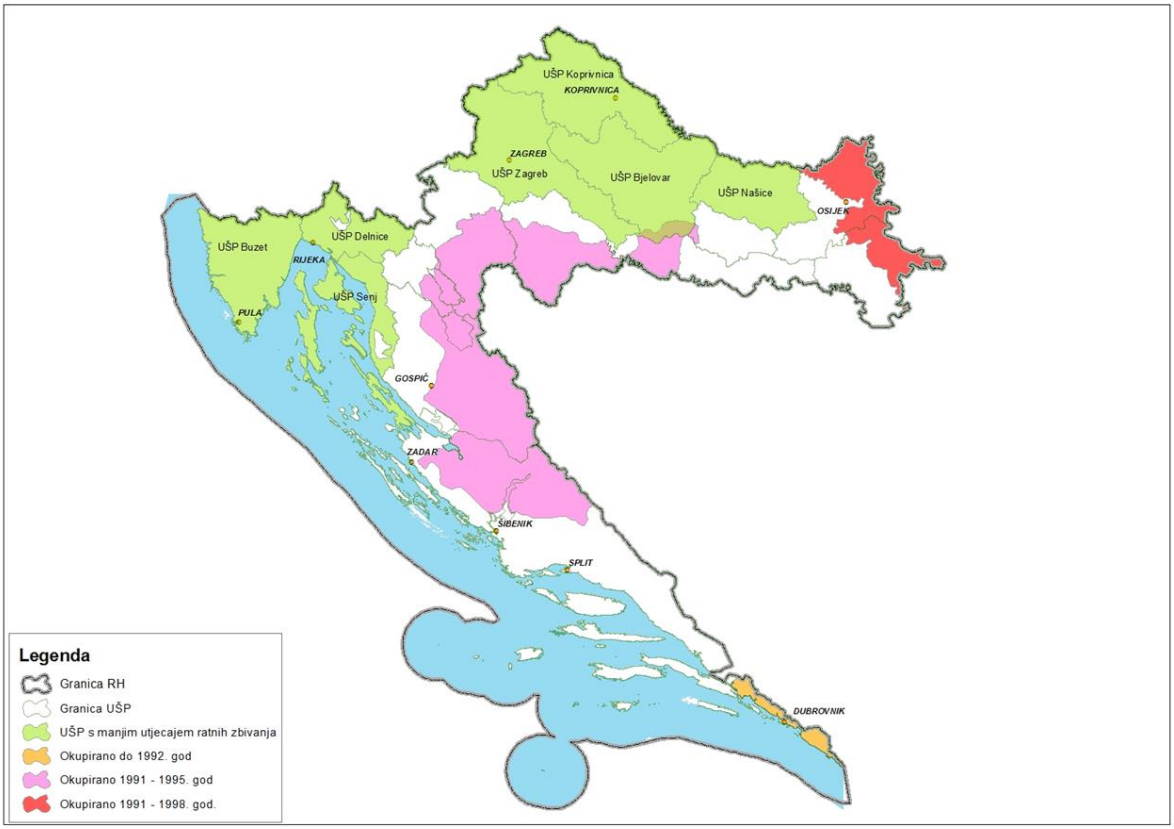


Figure 4.1-3 Map of the Republic of Croatia according to the War impact on FAs (Legend: border of the Republic of Croatia (dash line); borders of the forest administrations (light green line); FAs for which War influence is assumed to be negligible (green); areas occupied until 1992 year (yellow); areas occupied in the period 1991-1995 (pink); areas occupied I the period 1991-1998 (red))

FAs considered to have NORMAL FM during the RP are: FA Koprivnica, FA Zagreb, FA Delnice, FA Buzet, FA Senj, FA Bjelovar and FA Našice. These seven **FAs represent 39% of the total managed forest area in Croatia, 47% of the total growing stock and 49% of the total wood harvested during the Reference Period.** Remaining nine FAs are considered under the "WAR AFFECTED FM" category.

STEP 3: Assessment of Forest Management Practices (FMPs) and harvesting intensities during the RP at FAs selected in step 2

Identification of areas for which War effects on forest management is assumed to be negligible during the RP enabled the assessment of FMPs and harvesting intensities as they would be in

the case if the War had not occurred. Based on **realized harvest** on seven selected FAs (NORMAL FM category) during the RP, harvesting intensities for specific FMP were derived (*Figure* and *Figure*).

The validity of the forest management plans for these seven FAs were checked in order to secure that plans' validity is compatible with RP. In cases where two forest plans were valid for the same FA during the RP (i.e. first forest management plan valid in period 1994-2003 and second valid for 2004-2013) data on **realized harvest during the RP** available in valid plan were taken out. These data were used for determining the forest management intensities and projection of harvest amount in period 2021-2025. Detailed description of FMPs and harvesting intensities are given in section 4.2.

STEP 4: Selection of starting year of projection based on best available data and modelling future forest parameters by applying harvesting intensities assessed in step 3

During the RP 2000-2009 two General FMAPs were valid: General FMAP for the period 1996-2005 and General FMAP for the period 2006-2015. *Figure* shows planned harvest, realized harvest, and projected harvest. During the preparations of both plans the War influence was taken into account to the degree that was possible, based on the information and situation in Croatia until 1995 and 2005. Consequently, it should be noted that even the planned harvests in the FMAPs take the war impact into consideration (e.g. see planned harvest for the period 1996 to 2005 in *Figure 4.1-4*) and do not represent a normal forest management situation. Nevertheless, as it can be further seen in *Figure 4.1-4*, it was not possible to realize harvest as it was planned in General FMAPs 1986-1995 due to the War and in General FMAP 1996-2005 due to the fact that after the War the demining activities on forest areas have been executed slower than it was predicted during the development of the plan in 1995. In addition, the reconstruction of 44 Forests offices (out of 169) that were completely out of Croatian forest administration during the War period and re-establishment of forest operations and work was not an easy task that could have been performed in the period of 10 years with the available resources. The return of the population and the professional staff to the occupied territories did not take place with the predicted dynamics, and the consequences of the War are present in these areas even today.

Figure 4.1-4 Amount of harvest planned, realized and projected in Croatia in period 1990-2025

According to the Article 92 of the Ordinance on Forest Management, revision of the adopted forests plans/programs needs to be performed each time when the forest management deviates from the prescribed management rules in plans/programs due to: the change of purpose according to special regulations, natural disturbances, pests' infestation, drying, forest decay, natural renewal etc. Since the harvest and also other forest operations were not possible to be executed as it was originally planned in General FMAP 1996-2005 due to the War operations in Croatia, the revision had to be made. The Ministry of Agriculture approved the revised document according to the officially prescribed procedure. Furthermore, General FMAP 2006-2015, although did not undergo revision procedure, also shows presence of unrealized harvest.

Having all that in mind, Croatia decided to start with projections from the year 2016, using best available data from General FMAP 2016-2025. FMPs and harvesting intensities derived in step 3 are considered representative for the entire forest area of the Republic of Croatia and are used in modelling of forest parameters (i.e. harvest and increment) for period 2021-2025. More details on the modelling approach is given in section 4.3.

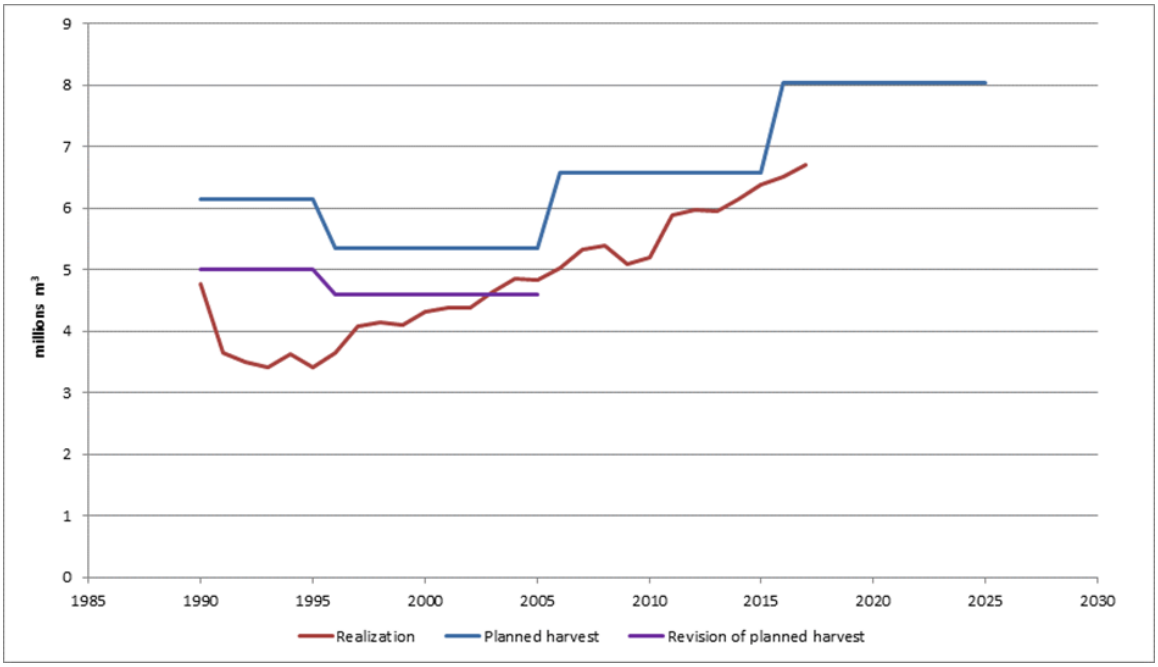


Figure 4.1-5 Amount of harvest prescribed in the FMAPs 1986-1995, 1996-2005, 2006-2015, 2016-2025 (blue line), the revised FMAPs 1986-1995 and 1996-2005 harvests due to War and post-War circumstances (purple line) and realized harvest (red line).

STEP 5: Calculation of FRL from forest state estimated in step 4 using a methodology consistent with NIR

Calculation of FRL for the period 2021-2025 based on harvest rates obtained in step 3, initial stocks and increment data obtained in step 4 is performed based on methodology described in NIR 2018. More details on FRL calculation is given in section 5.3.

To conclude, identification of areas for which War effects on forest management is assumed to be negligible during the RP enabled the assessment of Forest Management Practices (FMPs) and harvesting intensities, as they would be in the case if the War had not occurred. Those FMPs, as they were implemented in seven FAs during the RP (NORMAL FM) are considered representative for the entire forest area of the Republic of Croatia and are used in modelling and calculation of FRL for the period 2021-2025.

By using the intensities and FMPs that are derived from the seven FAs for which War effects on forest management is assumed to be negligible during the RP for projecting forest parameters needed for the FRL estimation in period 2021-2025, Croatia believes it implements stipulations of the LULUCF Regulation as prescribed in the Article 8, paragraph 4.

4.2. DOCUMENTATION OF DATA SOURCES AS APPLIED FOR ESTIMATING THE FOREST REFERENCE LEVEL

4.2.1. Documentation of stratification of forest management land

Stratification of forests is a process of distribution of forests into areas (strata) according to the selected criteria. Stratum is a part of the forest homogeneous to all the criteria used in the stratification process. For the purpose of FRL determination, the stratification of forests has been carried out with respect to three criteria:

- the type of forest
- the main function of the forest
- the main tree species

The main goal when selecting the stratification criteria was to achieve transparency and consistency with the used data disaggregation and estimation of emission/removals performed in the NIR 2018. A total of 10 strata were defined (*Table*). In both cases the same data source was used (HS FOND database).

Table 4.2-1 Forest stratification

Region	Forest type	Main function of the forest	The main tree species	Stratum ID
Croatia	Deciduous	Production forests	Pedunculate oak	**1**
			Sessile oak	**2**
			Common beech	**3**
			Other deciduous	**4**
		Strictly Protected Areas	All species	**5**
	Coniferous	Production forests	Common Fir	**6**
			Other coniferous	**7**
		Strictly Protected Areas	All species	**8**
	Out of yield (maquies and shrub)	Protective forests	All species	**9**
		Strictly Protected Areas	All species	**10**

4.2.2. Documentation of sustainable forest management practices as applied in the estimation of the Forest Reference Level

Forest management primarily depends on the function of the forest. In Croatia, regarding function, there are productive forests, protective forests, and forests with special purpose. Productive are even-aged and uneven-aged, and the purpose of management is to secure forest sustainability through the maintaining a maximum level of environmental, ecological, social, and economic benefits over time. Protective forests are, among others, maquies and shrubs. Maquies and shrubs are degraded forests, and the purpose of their management is primarily soil protection.

Forests with special purpose are national parks, strict reserves and special reserves (so-called strictly protected areas), where the purpose of management is primarily protection of biodiversity. In view of the conducted stratification, 13 forest management practices (FMP) are defined (*Table*) and described (*Table*)

Table 4.2-2 Forest management practices (FMP) in view of the stratification

Stratum ID	Even-aged	Uneven-aged	Biodiversity protection	Soil protection
1	FMP 1	FMP 6		
2	FMP 2	FMP 7		
3	FMP 3	FMP 8		
4	FMP 4	FMP 9		
5			FMP 12	
6		FMP 10		
7	FMP 5	FMP 11		
8			FMP 12	
9				FMP 13
10			FMP 12	

Table 4.2-3 Qualitative description of FMPs in Croatia during the Reference period

Forest Management Practices (FMP)				
FMP Index	**Name of Practice**	**Short description of Practice**	**Determination of the actual biomass removal rates**	**Reference**
FMP 1	Pedunculate Oak even-aged	Protection and tending of young growth and thinning of young stands. Natural regeneration under the canopy of older trees, including regeneration cuts done in 2 to 3 cuts (preparatory, seeding and finishing). The final cut is done after 3 to 5 years, when the new generation is developed enough not to need protection, in which biomass removal should not exceed 200 m3/ha. 140-year rotation period.	The biomass removal data, calculated in accordance with NIR 2018, and used in the FRL calculations are based on the records of harvested volume in the period 2000 2009. The harvested volume, expressed as a % of growing stock, is determined for each age class	Forest Act (OG 68/18, 115/18) and Ordinance on Forest Management (OG 97/18, 101/18).
FMP 2	Sessile Oak even-aged	Protection and tending of young growth and thinning of young stands. Natural regeneration under the canopy of older trees, with regeneration cuts that in general are done in 2 to 3 cuts (preparatory, seeding and finishing). 120-year rotation period. Biomass removal in the final cut shouldn't exceed 200 m3/ha (optimum is 150-180 m3/ha). One to two subsequent cuts should be made.		

FMP 3	Beech even-aged	Protection and tending of young growth and thinning of young stands. Natural regeneration under the canopy of older trees, with regeneration cuts that in general are done in 2 to 3 cuts (preparatory, seeding and finishing), with a rejuvenation period of no more than 15 years. 100-year rotation period		
FMP 4	Other broadleaves even-aged	Protection and tending of young growth and thinning of young stands. Management as for common oak, sessile oak and common beech. Care, cleaning and thinning growing activities stimulate the arrival of more valuable tree species that naturally appear. Rotation periods differ for individual species.		
FMP 5	Other conifers even-aged	Protection and tending of young growth and thinning of young stands stimulate the growing of indigenous deciduous trees, so that natural plant community can be more easily rejuvenated after the rotation period Rotation periods differ for individual species.		
FMP 6	Pedunculate Oak uneven-aged	Group structure of the stand. Management aims to achieve a mosaic structure formed by groups of areas up to 1 ha of different development stages, where trees within one group have the same dimensions. Interventions are done according to the state and age of that group. All regeneration and care interventions can be represented.	The biomass removal data, calculated in accordance with NIR 2018, and used in the FRL calculations are based on the records of harvested volume in the period 2000 2009. The harvested volume, expressed as a % of growing stock (Table 4.2.5)	Forest Act (OG 68/18, 115/18) and Ordinance on Forest Management (OG 97/18, 101/18).
FMP 7	Sessile Oak uneven-aged	Group stand structure. Management aims to achieve a mosaic structure formed by groups of areas up to 1 ha of different development stages, where trees within one group have the same dimensions. Interventions are done according to the state and age of that group. All regeneration and care interventions can be represented.		
FMP 8	Beech uneven-aged	Selection forests - common beech and common fir trees in a horizontal group or single structure, and in three vertical structure layers Selection forest cuts are done primarily for rejuvenation. Cutting is done in certain intervals needed for the stand to recover and achieve optimal growing stock. The interval between 2 cuts is called a small-		

		rotation and general is done very 10 years.		
FMP 9	Other broadleaves uneven-aged	Management of these stands is the same as for common oak, sessile oak and common beech, with a difference being that care, cleaning and thinning growing activities stimulate the arrival of more valuable tree species that naturally appear in a certain habitat, thus increasing the structure and ratio of the composite.		
FMP 10	Fir uneven-aged	Selection forests - common beech and common fir trees in a horizontal group or single structure, and in three vertical structure layers. Management cuts are primarily done for rejuvenation. Cutting is done in certain intervals needed for the stand to recover and achieve optimal growing stock. The interval between 2 cuts is called a small-rotation and generally is done every 10 years.		
FMP 11	Other conifers uneven-aged	Mixed selection forests. Management interventions serve the purpose of improving the composite ratio in favor of common fir and common beech.		
FMP 12	Nature and biodiversity protection	Forest with management oriented to nature and biodiversity protection. Commercial use of natural resources is forbidden in national park and strict reserve areas. Only interventions and activities that do not pose a threat to the originality of nature are allowed (e.g. limited interventions of tree cutting in visitor zones strictly for safety reasons).	No biomass removal.	Nature protection Act (OG 80/13, 15/18).
FMP 13	Soil protection	Degraded stands of out of yield forest with trees under the measurement limit in Mediterranean and sub-Mediterranean areas. Cutting is not performed in such stands, they are rather left to the natural development, with limited silvicultural activities.	No biomass removal.	Forest Act (OG 68/18, 115/18) and Ordinance on Forest Management (OG 97/18, 101/18).

Additional information of each above listed FMPs implemented in Croatia is presented in Annex 1 in this document.

For each stratum the corresponding forest areas are determined (*Table*). Areas correspond to the category Forest Land remaining Forest land as defined in NIR 2018. For the modelling purpose, the forest areas for 2016 are kept unchanged and constant during the period 2021-2025.

Table 4.2-4 Forest areas (k ha) according to the stratification proposal

Forest type	Forest function	Main tree type	Stratum ID	Beginning of 2000	End of 2009	Beginning of 2016	2025
Deciduous	Productive	Common oak	**1**	215.90	220.69	224.01	224.01
		Sessile oak	**2**	186.42	193.18	197.44	197.44
		Common beech	**3**	656.02	678.44	695.54	695.54
		Other deciduous	**4**	580.69	537.33	457.07	457.07
	Strictly protected areas	All types	**5**	36.03	44.91	44.91	44.91
Coniferous	Productive	Fir	6	88.56	90.71	94.19	94.19
		Other coniferous	7	99.25	99.12	104.47	104.47
	Strictly protected areas	All types	8	10.93	9.98	9.98	9.98
Out of yield (maquies and shrub)	Protective forests	All types	9	430.36	428.52	474.15	474.15
	Strictly protected areas	All types	10	9.42	9.42	10.46	10.46
FOREST AREA TOTAL (kha)				2313.58	2312.30	2312.22	2312.22

4.3. DETAILED DESCRIPTION OF THE MODELLING FRAMEWORK AS APPLIED IN THE ESTIMATION OF THE FOREST REFERENCE LEVEL

For the estimation of FRL Croatia used HS-MODEL, developed in Croatian Forests Ltd and used for forest management planning in Croatia for almost 30 years. It is an inventory-based model for the projection of stocks and increment at the stand level. It is mainly used for the compilation of a General FMAPs from all valid forest management plans/programs for the individual forest management unit. Considering that individual forest management unit plans/programs have different year when they were made, approved and became valid, it is necessary to recalculate the state of all stands to the desired year of General FMAP. For the currently valid General FMAP (General FMAP 2016-2025) the state of all stands in Croatia are recalculated to the year 2016.

Data from all individual forest management unit plans, as well as data on the realization of planned activities, are archived in state official central database, named **HS-FOND**. This database contains following forest stand (i.e. forest sub-compartment) level inventory data: area, tree species, growing stock, increment, yield class, prescribed and realized harvest, prescribed and realized silviculture treatments, forest function, management class, stand age and age class (for even-aged stands), dbh (diameter at breast height) class (for uneven-aged stands), basal area, crown cover, elevation, etc.

For **FRL calculation** the model was run at the stand level, starting from the year 2016, using best available data, i.e. data from the last General FMAP (valid for the period 2016-2025), archived in the HS-FOND database. **Input data** for the model are: stand age, age class, growing stock, increment and harvest rates. Here is important to emphasise that harvest rates used in the calculation of FRL are obtained from the records of realized harvested volume in the period 2000-2009 on the area of seven selected FAs for which War effects are assumed to be negligible during the RP (see Chapter 4.1). Modelling is performed for each stand for every year in period 2017-2025 according to the decision flow presented in the Flowchart (*Figure 4.3-8 Flowchart of the model run. Hn – harvest in the year n (m3), Vn – growing stock in the year n (m3), Hr – harvesting rates (%), in – increment in the year n (m3), F – factor of age-dependant decrease of increment rate, AGEn – age of a modelling unit at a year n (years)*). The Main outputs of the model are new growing stock, new increment and new harvest. New values of these parameters are derived by model as follows:

- **New growing stock** (V_{n+1}) is calculated as a sum of previous growing stock (V_n) and previous increment (i_n) minus estimated harvest (H_n).
- **New increment** (i_{n+1}) is estimated by multiplying previous increment rate ($ir_n = i_n/V_n$) with factor of age-dependant decrease of increment rate (F) and with previous growing stock (V_n). Factor F is calculated as ratio of yield table increment rates between two consecutive years ($F = YTr_{n+1}/YTr_n$).
- **New harvest** (H_{n+1}) is calculated by multiplying previously defined harvest rates (Hr) and new growing stock (V_{n+1}).

Model performs following steps:

Step 1. Generates harvesting sequence

It is a process of assigning a year when the harvest will be performed in each forest stand based on the record of the year when previous harvest occurred in the specific stand. According to the forest management practices applied in Croatia the harvest of a single stand is performed every 10 years.

Step 2. Checks if the stand is even-aged or uneven-aged, based on whether there is an information about the age-class of stands. If yes, model treats forest stand as even-aged and performs following operations:

A. Calculates so-called **Uniform area (A_{norm})**

One of the goals of sustainable forest management is to secure the sustainability and stability of timber supply and of forest carbon sink. For a given type of even-aged forest, which is managed with even-aged management, achieving this goal is linked with the goal of achieving a **uniform distribution of forest area with respect to age**, or more commonly, with respect to age classes. In other words, the ideal distribution of a forest area, with respect to age classes, is such when all age classes have the same or **UNIFORM area**[9]. In national language, in forestry sector, such area of an age class is called “normal area” and the distribution is referred to as the “normal distribution” of forest area. It must be emphasized that the term “normal”, in the above sense, **is in no way** related with the Gaussian normal distribution.

Uniform area is calculated for each *Management class* (Mclass) using the equation:

$$A_{norm}\ (ha) = (A_{Mclass}\ (ha) / ROTATION\ (year)) \times AGE\ CLASS\ WIDTH\ (year);$$

Where:

A_{Mclass} is an area of specific management class

MANAGEMENT CLASS represents a group of all stands in all age classes of a single main tree species. Its main purpose is to (re)establish uniform (balanced) proportion of age-classes within the area.

ROTATION is a prescribed minimum age at which certain management class will undergo a FINAL CUT

FINAL CUT is considered to be the last phase in cutting performed in REGENERATION CUT

AGE CLASS WIDTH is a number of years within one age class, e.g. 20 years.

B. Checks the age of the stand

B.1. If stands are in the first age class, the age increases by one and stand volume remains zero. If stands enters a second (II) age class from the first age class (I) a new state is assigned to that specific stand according to similar stand in the second (II) age class (i.e. same main tree species, same site class).

[9] E.g. In case of 1000 ha large forest that has rotation of 100 years and age-classes that are 10 years wide, a uniform (or normal) area is 100 ha. In other words, in 10 years (width of an age class), 100 ha should be regenerated. In real life, the distribution of areas with respect to age is frequently not uniform. Forest management system in Croatia aims to establish a uniform distribution of forest areas with respect to age classes.

B.2. If the stands are in the second age class or older (age class > I) model checks if stand needs to undergo **thinning or regeneration cut**, based on the information on the stand age. All stands older then „rotation minus 10 years“ (e.g. for pedunculate oak all stands older than 130 years) are sorted by age in descending order. Starting from the oldest stands, the stand is marked for the regeneration cut in the current year until the sum of the areas of the marked stands reaches the limit of uniform area. The limit is defined as the area of Management class divided by the number of years in rotation. For all remaining stands the time since the last thinning is checked. Stands which have been thinned 10 years (or more) ago are marked for thinning in the current year. Stands of the second age class that have never been thinned are thinned for the first time at the age of „width of the age class + 5 years“.

B.3. **In the case of thinning**, harvest is performed every year in all stands that are assigned for thinning in that specific year according to harvesting sequence. Harvest is estimated as a product of stand volume (Vn) and harvest rate (Hr). New state is calculated for all stands

B.4. **In the case of regeneration cut**, harvest is performed every year in stands that are assigned for regeneration cut, but taking into account the limit given by the previously estimated uniform area. Regeneration cut is implemented as a single cut and Hr is assumed to be 100%, i.e. $H_n = V_n$. New state is calculated for all stands.

Regarding the regeneration cut it is important to emphasise two constraints that originate from national legislation. First, the volume that will be cut through **regeneration cut is defined by the area**. It means that the area on which regeneration cut is performed cannot be greater than 60% of uniform area, considering that regeneration is performed during last 10 years of the rotation period (half period of the age class width). Width of age class of even-aged forests depends on the species and it is defined by the Ordinance on Forest Management.

Second, **selection of stands for regeneration cut** is based on the following criteria:

- stands in the last age class or older
- stands of the penultimate age class, in the case of significantly disturbed i.e. non-uniform proportion of age-classes within the area
- stands of poor quality and health status

This described modelling approach reflects the management practices in Croatia used in the reference period (as well as before and after the reference period) which aim at achieving uniform distribution of stands by age with respect to the stand area. Information on age class distribution for each defined stratum of even aged forests in different points in time (2000, 2009, 2016, 2025 and 2055) as well as aggregated on national level are presented in Figure 4.3-1 to Figure 4.3-7 below.

The Ordinance on forest management is a subject of regular changes in order to secure that forests in Croatia are managed on sustainable way. While 1994 Ordinance recognized regular selection forest management as most appropriate for the majority of forests in Croatia, later changes (Ordinance from 1997 and 2006) enabled non-regular selection management system, which since then has been performed on a much wider scale than before. This had impact on forest species that sometimes required management as even-aged and sometimes as uneven-

aged forests (depending on ecological conditions) and can be observed on figures below in case of some strata (description of FMPs presented in Table 4.2-3).

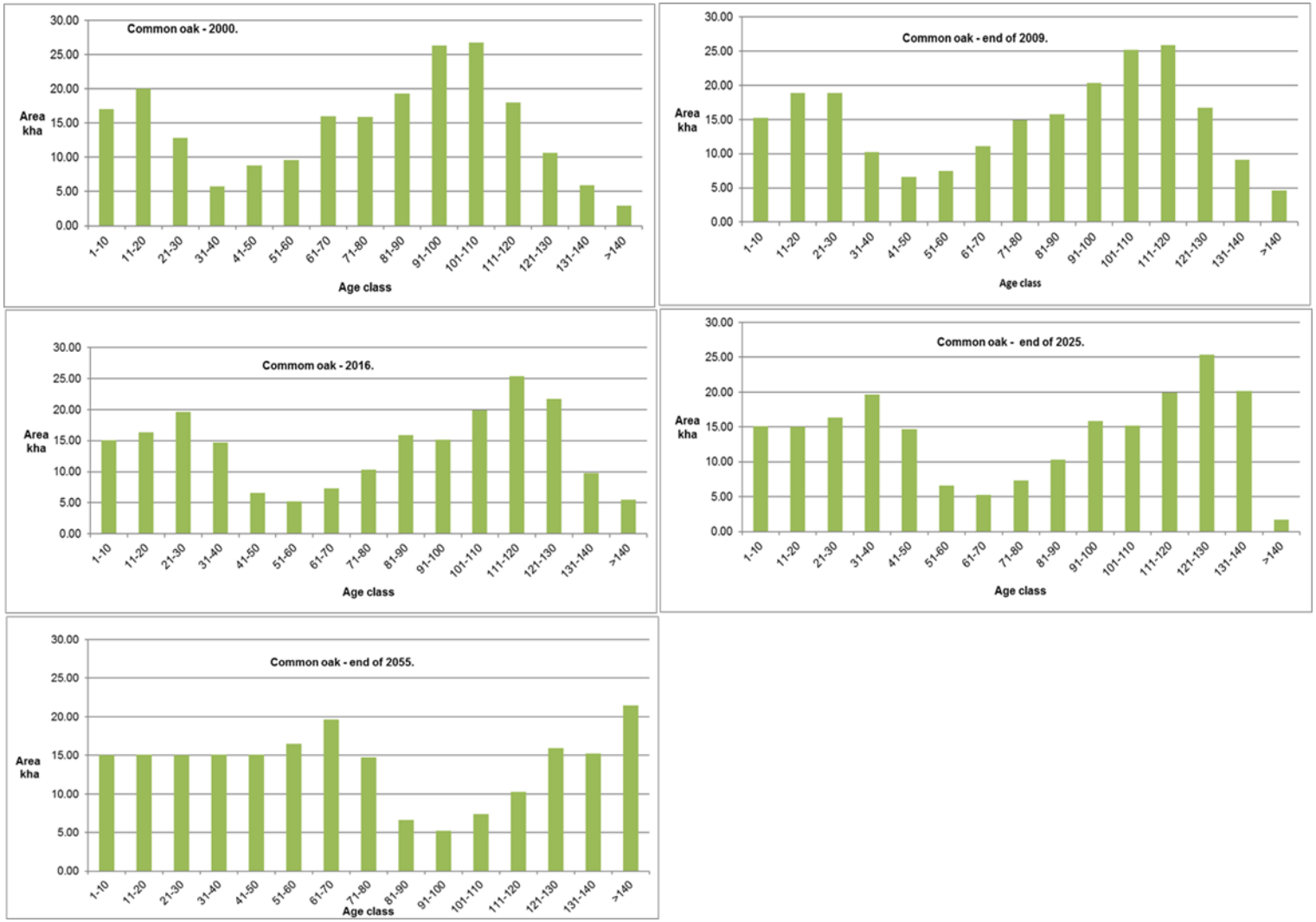


Figure 4.3-1 Common (pedunculate) oak age class distribution

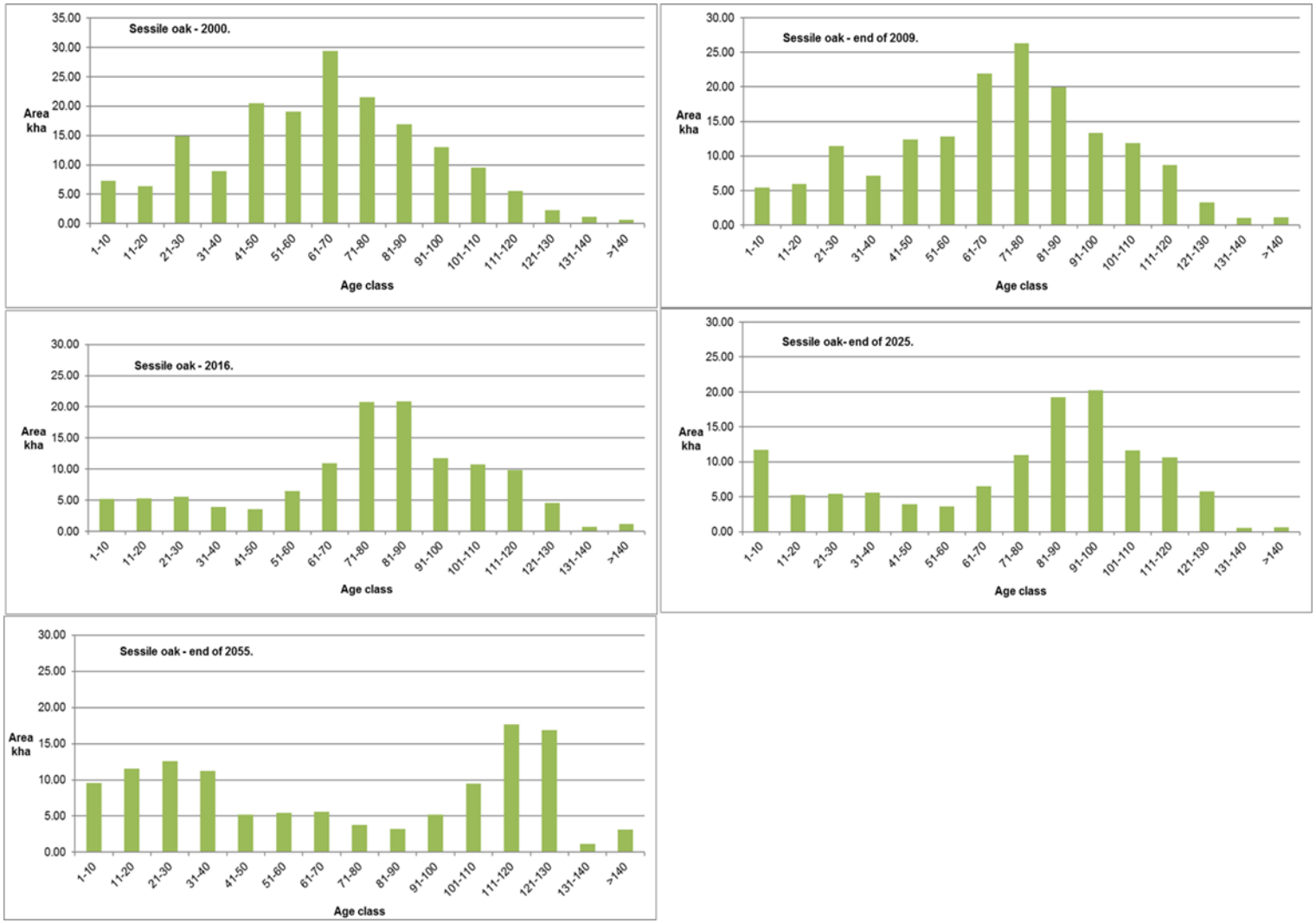


Figure 4.3-2 Sessile oak age class distribution

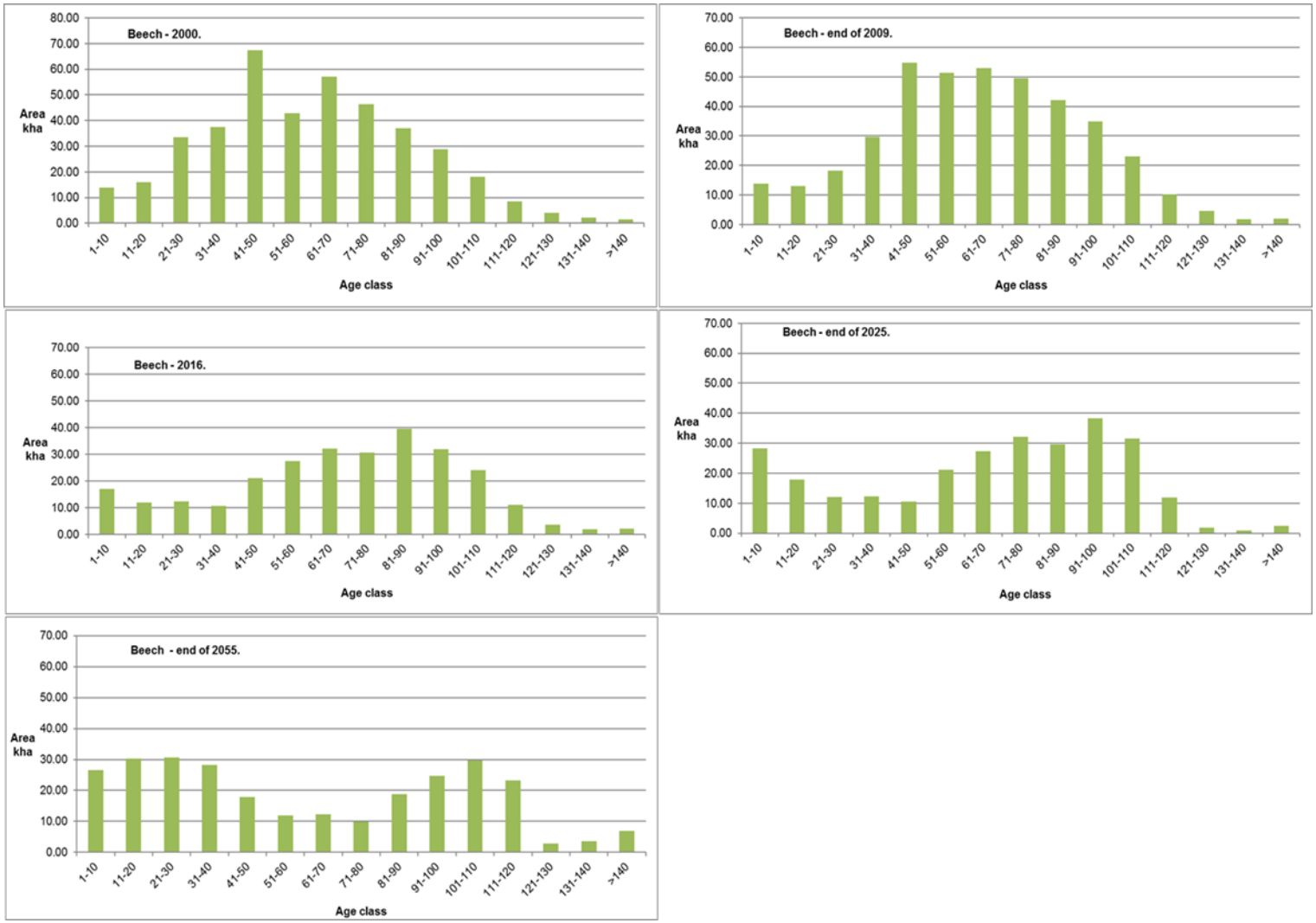


Figure 4.3-3 Beech age class distribution

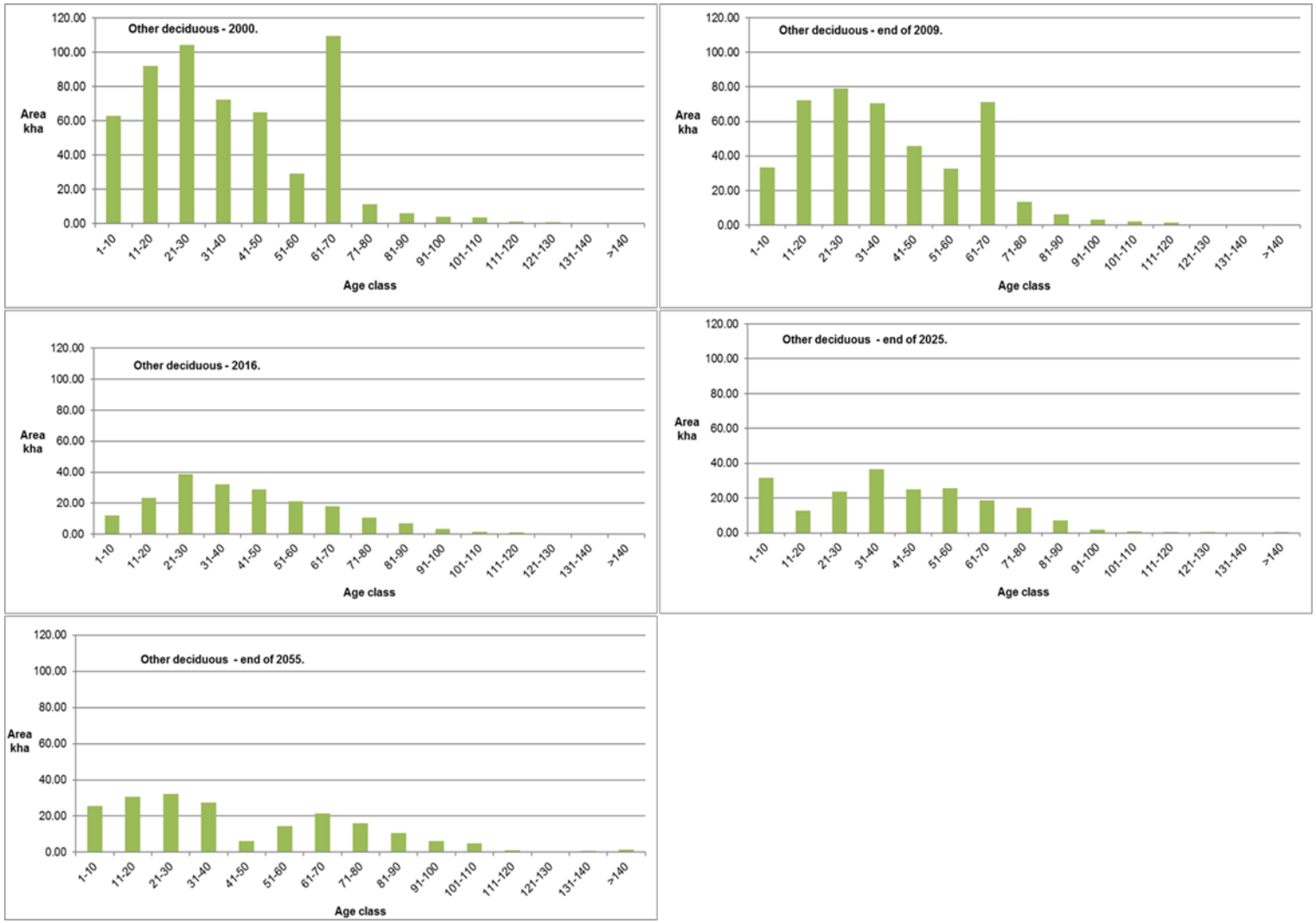


Figure 4.3-4 Age class distribution of stratum Other deciduous

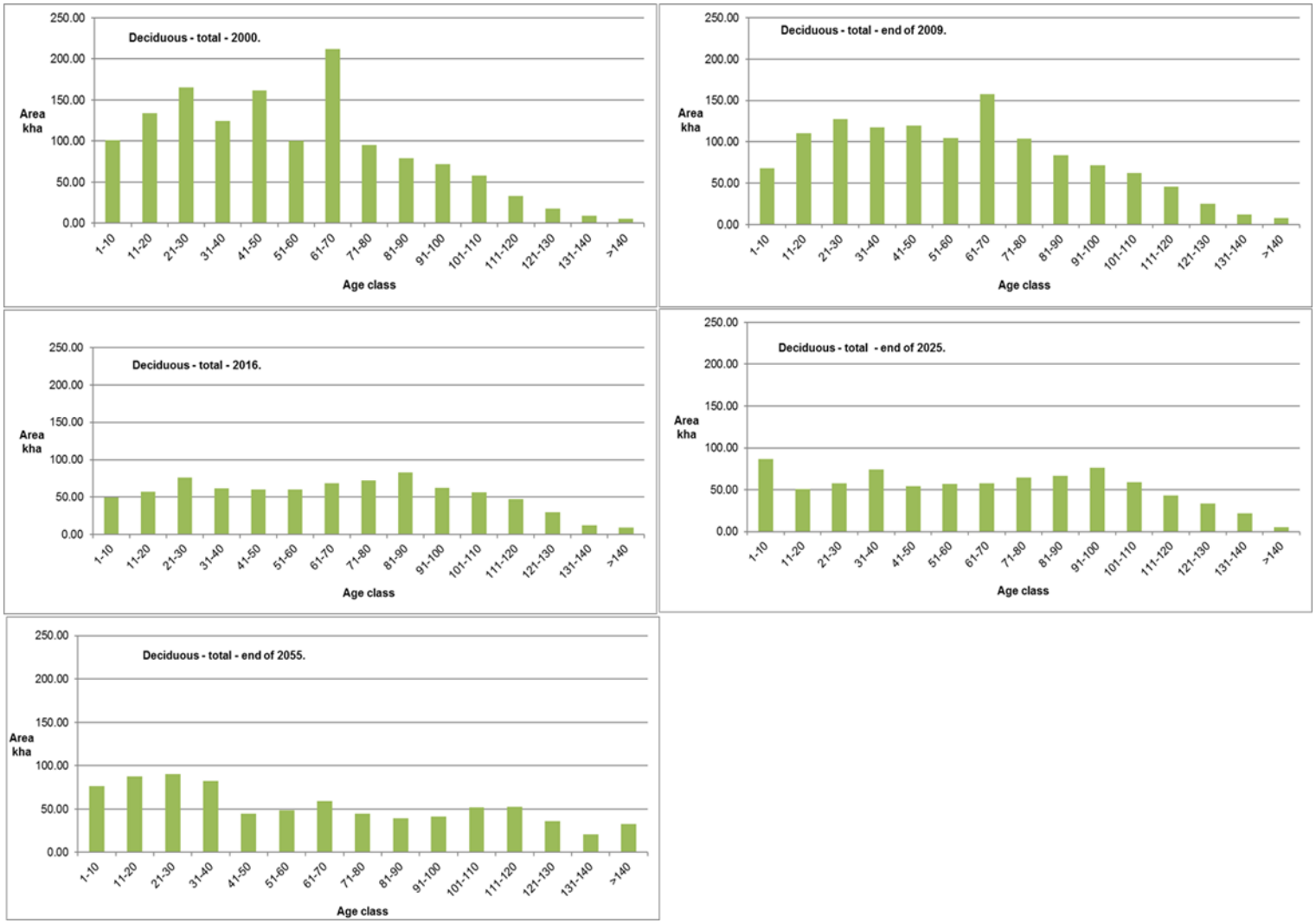


Figure 4.3-5 Age class distribution for all deciduous species

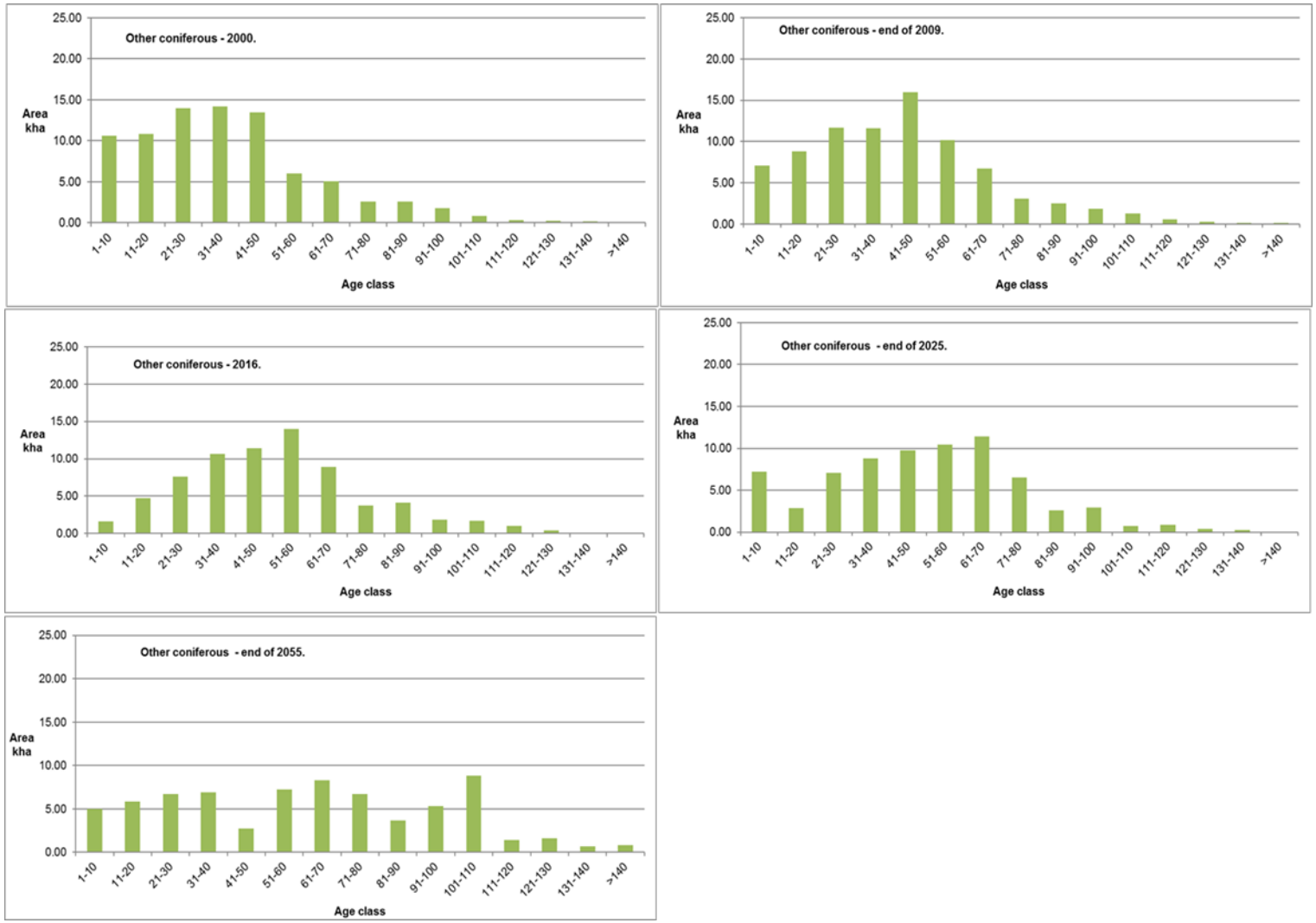


Figure 4.3-6 Age class distribution for stratum Other coniferous

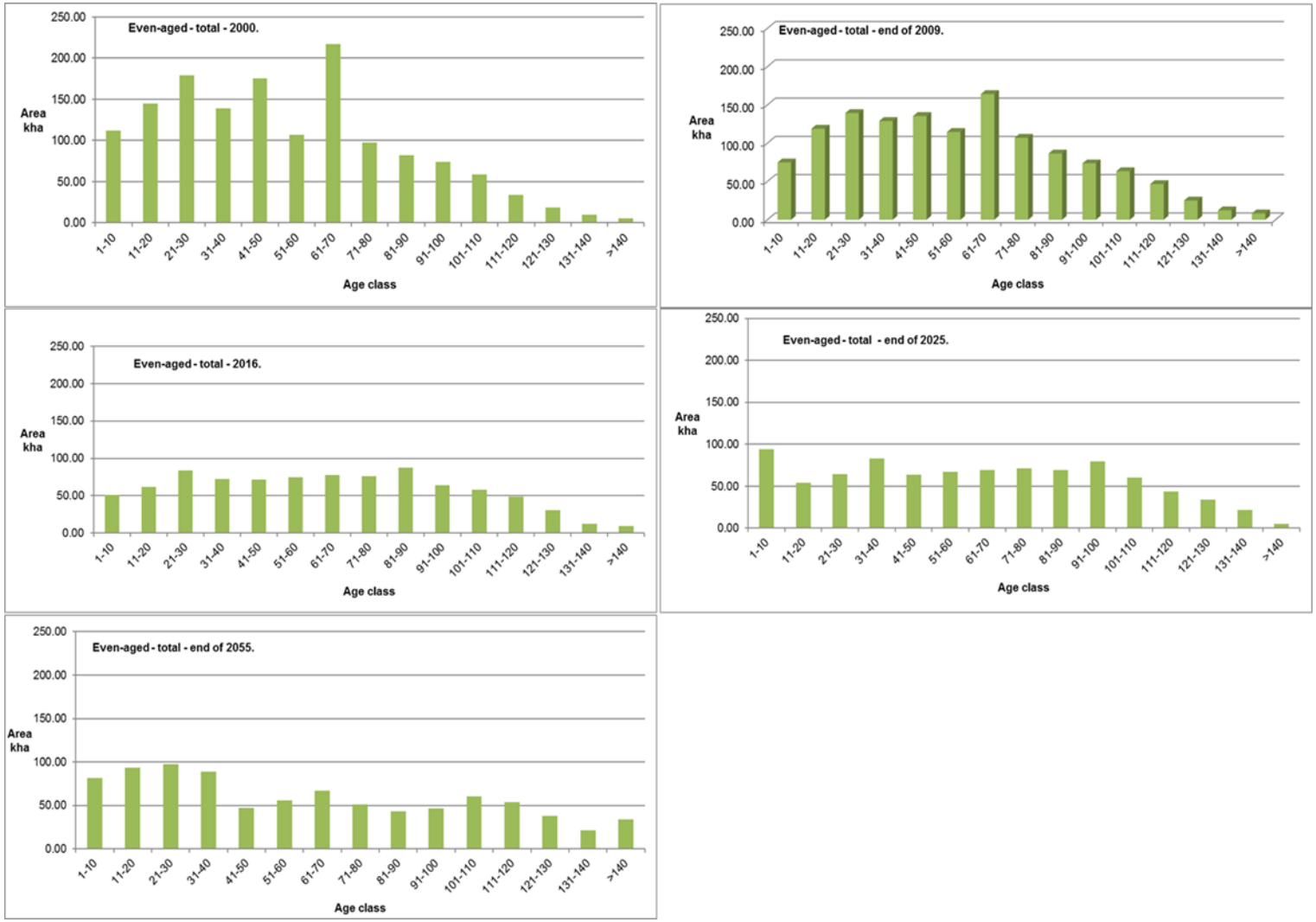


Figure 4.3-7 Age class distribution of even aged forests (aggregated level)

Step 3. If the stand is recognized by model as uneven-aged stand the new state is calculated for all stands using the equations presented in the Flowchart below (Figure 4.3-8).

According to the forest management practices applied in Croatia in uneven-aged forests the harvest is performed every year in all stands that are assigned for cutting in that specific year according to harvesting sequence.

Based on the Ordinance on forest management the harvest intensity in uneven-aged forests is determined on the level of sub-compartment based on the comparison between real (determined by measurement) growing stock structure and so called normal (theoretical, calculated) growing stock structure. Normal growing stock presents the mass which should be permanently present in the forests and by its size and structure it should be necessary and sufficient (neither too large nor too small) to allow permanent forests regeneration and that provides optimal and sustainable income[10].

Step 4. The model finds **Strictly protected areas** based on the recorded information in HS-FOND.

These areas are kept for modeling purpose as strictly protected which means that harvest rates were set to 0%. Therefore, only future growing stock and increment were modelled.

Step 5. The model finds **Out of yield forests** (maquies and shrub) based on the recorded information in HS-FOND.

The harvest rates for these forests were also set to 0% and increment to 0.2 m^3 ha^{-1} (same as in NIR 2018). Fixed increment value was used throughout the modelling period 2016-2025.

[10] Šumarski list 5-6: *See References*

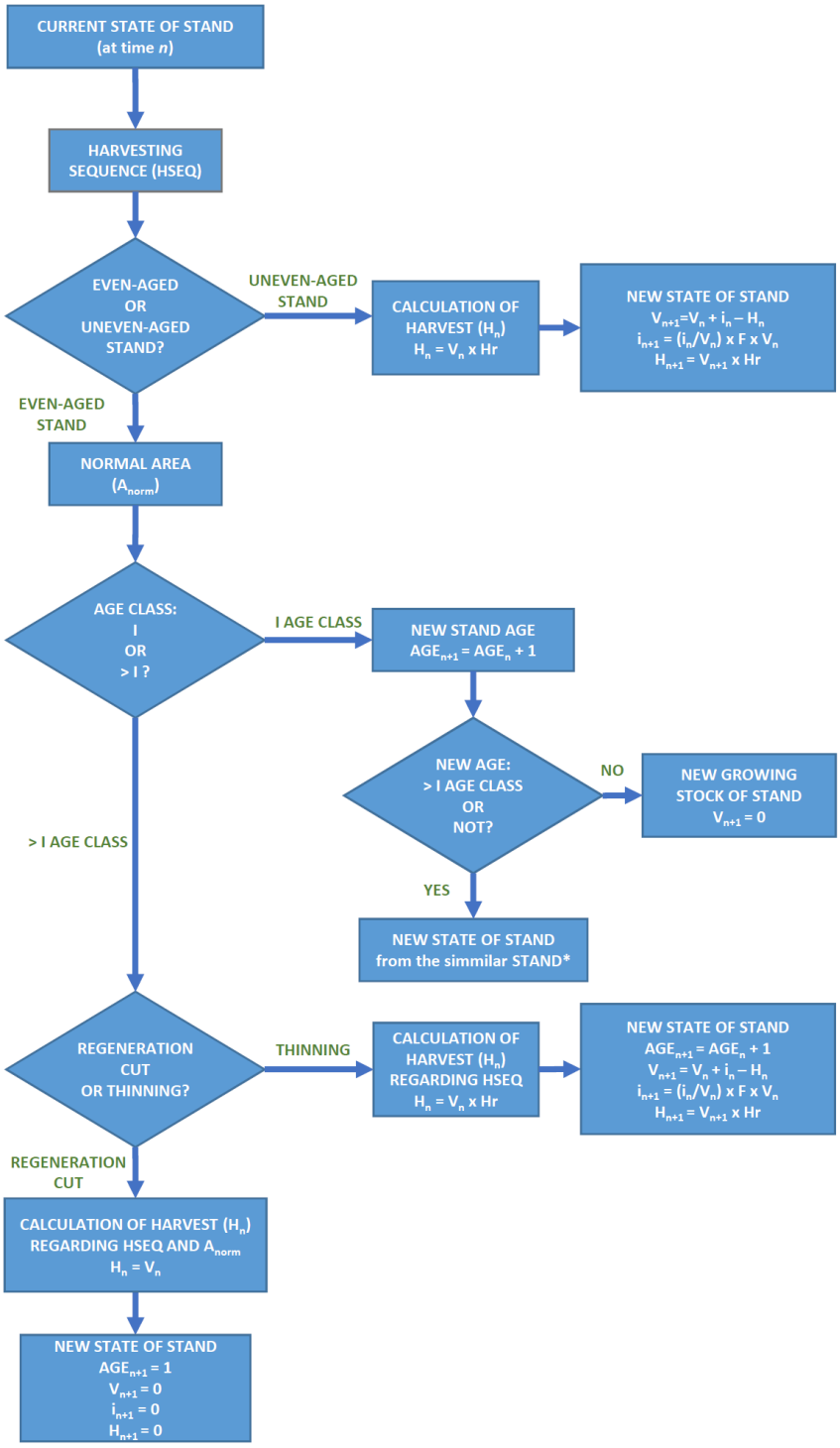


Figure 4.3-8 Flowchart of the model run. H_n – harvest in the year n (m^3), V_n – growing stock in the year n (m^3), H_r – harvesting rates (%), in – increment in the year n (m^3), F – factor of age-dependant decrease of increment rate, AGE_n – age of a modelling unit at a year n (years)

The management intensity derived through the model in even-aged forests is given in terms of age (*Table*), while in the uneven-aged forests the management intensity is expressed throughout the surface (*Table*).

Table 4.3-1 Thinning and harvest intensities (% of total growing stock per age class) realized during RP in even-aged forests in the seven FAs without war impact

FMP Index	**Age class**						
	0-10	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**
FMP 1			16.9%	13.3%	10.9%	10.8%	9.2%
FMP 2			14.7%	14.5%	11.9%	10.1%	10.3%
FMP 3			15.7%	14.8%	12.7%	11.2%	10.4%
FMP 4	19.9%	17.5%	14.4%	13.5%	12.6%	11.4%	10.6%
FMP 5		9.1%	12.1%	10.0%	9.4%	10.0%	9.5%
FMP Indeks	**Age class**						
	71-80	**81-90**	**91-100**	**101-110**	**111-120**	**121-130**	**131-140**
FMP 1	8.5%	7.5%	7.6%	7.0%	6.6%	6.8%	6.2%
FMP 2	9.6%	9.0%	9.2%	8.2%	7.0%		
FMP 3	9.6%	9.3%	9.3%	9.2%	10.1%		
FMP 4	10.0%	8.5%	9.4%	8.5%			
FMP 5	10.7%	10.2%	10.6%	13.6%	13.4%		

Table 4.3-2 Harvest intensities (% of total growing stock) realized in RP in uneven-aged forests in the seven FAs without war impact

FMP Index	**All stands**
FMP 6	9.7%
FMP 7	11.3%
FMP 8	13.1%
FMP 9	5.9%
FMP 10	11.9%
FMP 11	12.5%

The defined management intensities presented above are applied for projecting harvest of corresponding strata in period 2021-2025.

Regarding the modelling of increment in period 2021-2025, the increment rate in RP is estimated on the same FAs for each forest stand by categorization of the trees into groups defined by species, DBH class, age class and stand yield class. For each group, increment rate arrays (presented in national forest tables and used for forest planning) are estimated from tree cores which are drilled for that purpose. In case when increment rate arrays from tree cores have been developed in the past (e.g. in the making of the previous management unit plan) existing increment rate arrays are used.

In modelling process, the new increment for each stand was projected in period 2021-2025 using the equations described above and presented in the Flowchart.

5. FOREST REFERENCE LEVEL (REGULATION; ANNEX IV, PART B, POINT E)

5.1. FOREST REFERENCE LEVEL - DETAILS ON CARBON POOLS

5.1.1. Area of Managed forests

According to Regulation (Annex II) in Croatia for category Managed forests definition is as follows: forest land spanning more than 0.1 hectares with trees higher than 2 meters and canopy cover more than 10 percent, or trees able to reach these thresholds. In pursuit of these values for reporting, MFL includes the following forest stands: high forests, plantations, forest cultures, coppice, maquia and shrub forests.

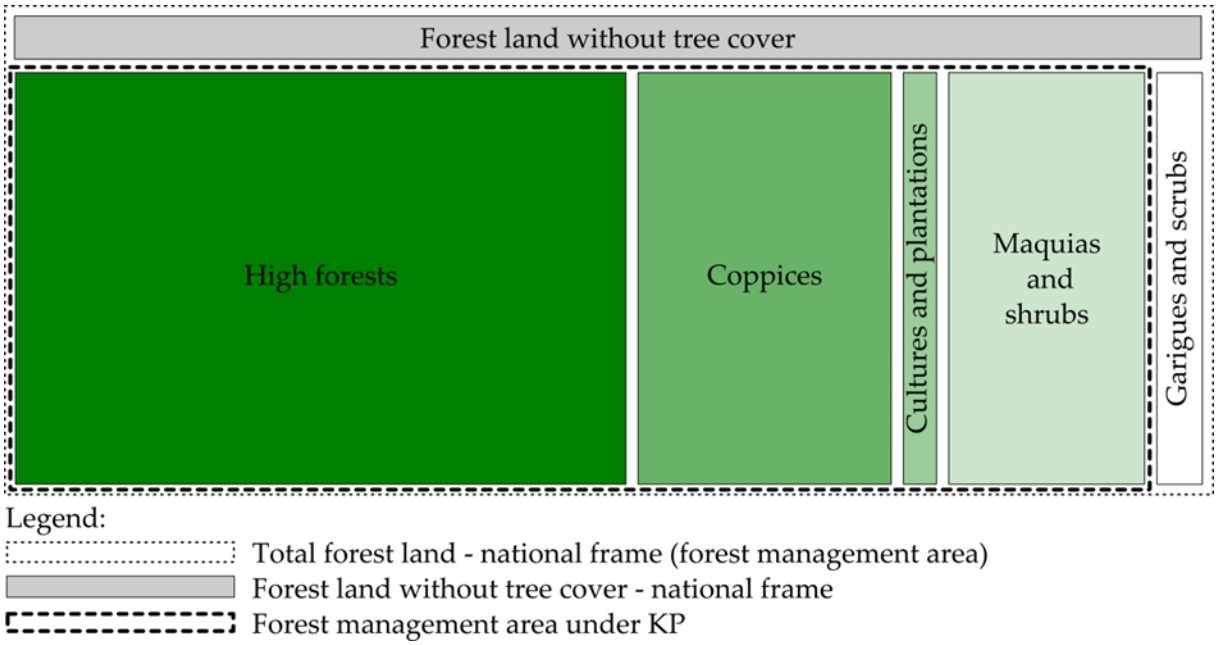


Figure 5-1 Managed Forest area under the KP and within the national framework (based on the relative share of forest types in total forest management area in Croatia)

All forests lands are assessed by Croatian Forests' forest land assessment system. Croatian Forests have a legal duty to assess the total area of forest land of Croatia every ten years. Thus, estimations provided in this report are based on reliable data referring to the total territory of Croatia and irrespective to the type of forest or ownership. Data on forest area are in line with the relevant definitions and refers to the areas of Forest land remaining Forest land category from NIR 2018.

The forest areas disaggregated as Deciduous, Coniferous, and Out of yield forests (maquies and shrub) at the beginning of year 2016 are kept constant during the period 2021-2025.

5.2. CONSISTENCY BETWEEN THE FOREST REFERENCE LEVEL AND THE LATEST NATIONAL INVENTORY REPORT

The HS-MODEL used for the estimation of FRL, described in Chapter 4, is a stand level model that used existing best available data, archived in the state official forest database named HS-FOND. The start date of modelling was 1 January 2016.

For demonstrating the consistency between FRL and NIR 2018 the simulation for the validation purposes should run from the year 2000 onward in order to estimate FRL model agreement with the emission and removal values reported in country's NIR. However, **such a demonstration is not applicable for Croatia.**

In line with Article 8, point 4 of the Regulation, Croatia may take into account the impact of War and post-War circumstances on its forest management for modelling the FRL. Therefore, performed FRL simulation excludes the effects of War and post-War period on forest management during the RP. The exclusion of War effects on forest management during the RP leads to the fact that the resulting modelled emissions/removals from harvests in 2000 onward deviate from the harvest and emissions/removals reported in NIR, during the RP and period post 2000.

Croatian GHG Inventory has been performed following the relevant decisions of the Conference of the Parties to the UNFCCC, Kyoto Protocol (KP) and IPCC Guidelines. The estimation on carbon stock changes in forestry sector in Croatia is performed for all forest that meets thresholds defined by Croatia for forests under the KP. This implies that there is no forests areas in Croatia that are omitted from the estimation due to the War and post-War circumstances. Since sustainable forest management practices were applied for all forest areas in Croatia for many decades before the War, it was concluded that disruption in the implementation of full forest management practices over specific period of time cannot be considered as a reason for omitting the temporary occupied forests (War) from the accounting and reporting them as unmanaged forests. Thus, Croatian GHG Inventory report provides information for all forests starting from 1990. These reports containing estimation for all forests in Croatia (regardless the War occurrence) are subject of regular revision under the UNFCCC process.

In Table 5.2.1 information about the harvest and increment used by Croatia for KP purposes (estimation than accounts impact of War and post-War circumstances) and FRL determination (parameters collected from seven FAs on which War influence is assumed to be negligible). As it can be seen, during the RP the increment is 5% and 9% higher in case of areas of the seven FAs (so called "No War" scenario) than reported under the deciduous and coniferous forest types in the NIR 2018. At the same time, in RP the harvest is 8% and 22% higher in forests under the seven FAs areas than in NIR 2018. Decrease of increment for 4% has been recorded on the level of whole Croatia when comparing the General FMAP 2016-2015 and General FMAP 2016-2025 (from 10.53 Mm^3/year to 10.15 Mm^3/year). Since there is an increase of increment in forest areas under the seven FAs, this means that the decrease in increment in remaining nine FAs that were directly influenced by the War is much higher than 4%. Information provided in Chapter 1 and Chapter 2 prove that the transition period in economy did not have a major influence on forest management intensities during the RP and that forest retained their productivity and vitality.

From the above provided information, it can be concluded that only the War and the impacts of post-War period on forest management in combination with the aging forests significantly influenced the increment in forests in Croatia. This negative influence will continue to be present in forests for many years in future since the implementation of full forest management practices for all forests in Croatia is a task that still has to be achieved (mined areas, lack of human capacities to resolve accrued work accumulated through the years).

Above presented information explain why “No War” scenario would lead to the considerably lower removals in historic period than estimated in the NIR 2018. This is a reason that results from FRL model (which is defined as “No War”) cannot be applied for proving consistency between emissions/removals presented for historic period in NIR 2018 and emissions/removals derived from the FRL model for the same period.

If the results from the “No War” model needed to be implemented for the validation of historic emissions/removals presented in Croatia NIR 2018, that could be done only by testing the model on emissions/removals calculated for the seven FAs during the historic period. However, estimation of emissions/removals that covers only forest areas of these seven FAs has not been performed in Croatia. If this would have been done in the past it would imply that this subset (area of seven FAs) of full emission/removal (whole forest area in Croatia) estimation was subject of revision under the UNFCCC process. However, this is not the case. Since the Regulation stipulates that consistency has to be proven with the GHG Inventory (GHG Inventory which is a subject of UNFCCC revision and its approval) the specific exercise of estimating emissions/removals only for area of seven FAs would not be justifiable.

Table 5.2-1 **Forest parameters used in NIR 2018 and derived for FRL**

Parameters used in NIR 2018										
Increment (m^3/ha)										
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Deciduous	5.5	5.6	5.6	5.6	5.6	5.6	5.7	5.6	5.6	5.6
Coniferous	5.7	5.7	5.6	5.6	5.5	5.5	5.5	5.5	5.5	5.6
Out of yield	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Harvest (m^3/ha)										
Deciduous	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.7	2.7	2.6
Coniferous	2.5	2.7	2.9	3.0	3.4	3.2	3.8	3.9	3.8	3.6
Out of yield	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parameters from seven FAs used in FRL										
Increment (m^3/ha)										
Deciduous	5.7	5.7	5.8	5.8	5.9	5.9	6.0	5.9	5.9	5.9
Coniferous	5.9	5.9	6.0	6.0	6.1	6.2	6.2	6.2	6.2	6.2
Out of yield	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Harvest (m^3/ha)										
Deciduous	2.6	2.6	2.6	2.6	2.7	2.7	2.7	3.0	2.9	2.9
Coniferous	3.3	3.5	3.4	3.7	3.8	3.9	4.2	4.5	4.8	4.8
Out of yield	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Based on the listed arguments it was concluded that only **a validation approach by proxy** can be used for proving consistency between FRL and NIR 2018. For that purpose, we applied the

same method as for providing evidences of influence of economy crises on forest management intensity in Croatia during the RP (see Chapter 2). In this specific case of Croatia, the underlying idea is that different indicators could be used for the validation of the modelling results (the proxy approach presented in Annex 3).

However, for information purposes only, Croatia performed estimation of removals by sinks for the period 2000-2009 by using two different scenarios ("No WAR scenario" and "WAR scenario") comparing them with the NIR 2018 figures.

With the "No WAR scenario" the harvest intensities which would have occurred if the War had not happened was applied on the whole forest area in Croatia in period 2000-2009. This scenario implied: **a)** the use of harvesting intensities from seven FAs (Tables 4.3-1 and 4.3-2); **b)** an assumption of entire forest area accessibility for the execution of all and full forest management practices (i.e. there were no mines present during 2000-2009 or before); **c)** an assumption that there was no War-related devastation to forestry infrastructure affecting the forest management.

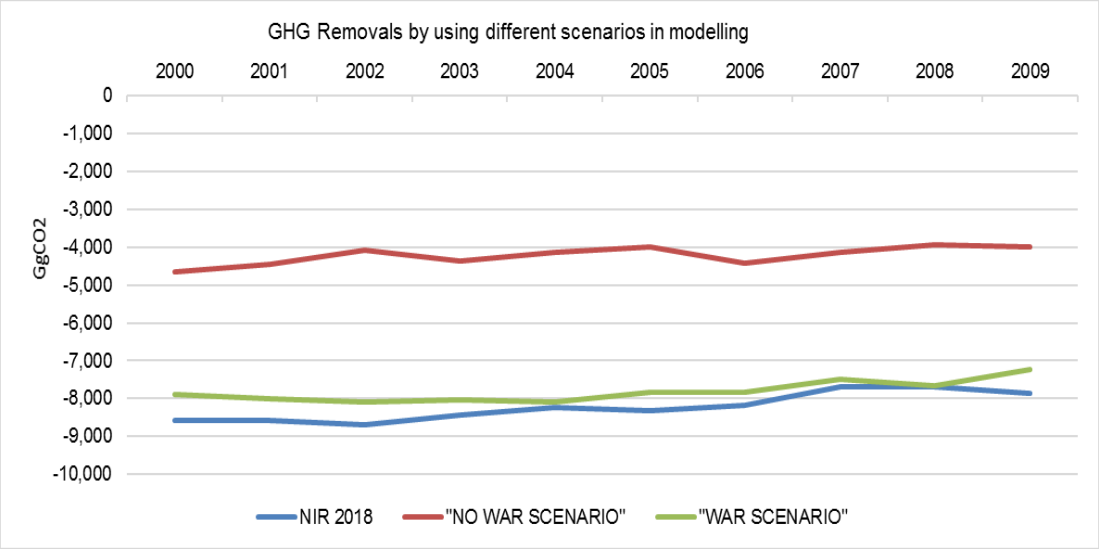
The settings of the "WAR scenario" model run included: **a)** the use of average, actual harvesting intensities on the whole forest areas **b)** limitations in availability of some forest areas due to mines, forestry infrastructure devastation and other consequences related to the War influencing harvest and increment in forests.

For the estimation of removals by sinks by applying "No WAR scenario" and "WAR scenario" in the historic period, the same parameters as in NIR 2018 are used (i.e. BEFs, R/S etc.). Comparison of these estimations with NIR 2018 figures is presented in *Table 5.2-2* GHG removals by using different scenarios in modelling.

When comparing the removals during 2000-2009 reported in NIR 2018 with the model "WAR scenario" using the paired t-test on the equality of means, the result shows no statistically significant difference ($P < 0.05$). This indicates that this model performance is satisfactory.

The difference between removals reported in NIR 2018 and estimated using the "No WAR scenario" confirms relevance of Article 8, point 4 for Croatia in regards to the obligation of defining FRL that reflects the real potentials of forests in the country for CO_2 removal until 2030.

Table 5.2-2 GHG removals by using different scenarios in modelling



5.3. CALCULATED CARBON POOLS AND GREENHOUSE GASES FOR THE FOREST REFERENCE LEVEL

5.3.1. Living biomass

For reporting purposes, Croatian Forests Ltd. delivered data about increment and harvest presented as per ha value for all types of forests ownership. Increment is presented per Deciduous, Coniferous and Out of Yield (maquies and shrub) forests for all type of forest ownerships. Croatia uses national values for wood densities for coniferous, deciduous and maquies and shrub species based on the scientific papers and published data. More detail information can be found in latest official NIR 2018.

Table 5.3-1 Data used in the carbon stock change calculation for living biomass in MFL

	D (tonnes d.m / m^3)	BEF1 (dimensionless)	R/S (dimensionless)	BEF2 (dimensionless)	CF (tonnes d.m / m^3)
Deciduous	0.56	1.20	0.23	1.197	0.48
Coniferous	0.39	1.15	0.29	1.0387	0.51
Out of Yield	0.68	1.1	0.46	1.15	0.47

For the purposes of estimating FRL, results of the model (increment and harvest rates) per strata and years have been taken into account for the CP, and calculation has been performed. The same factors as for GHG Inventory have been used.

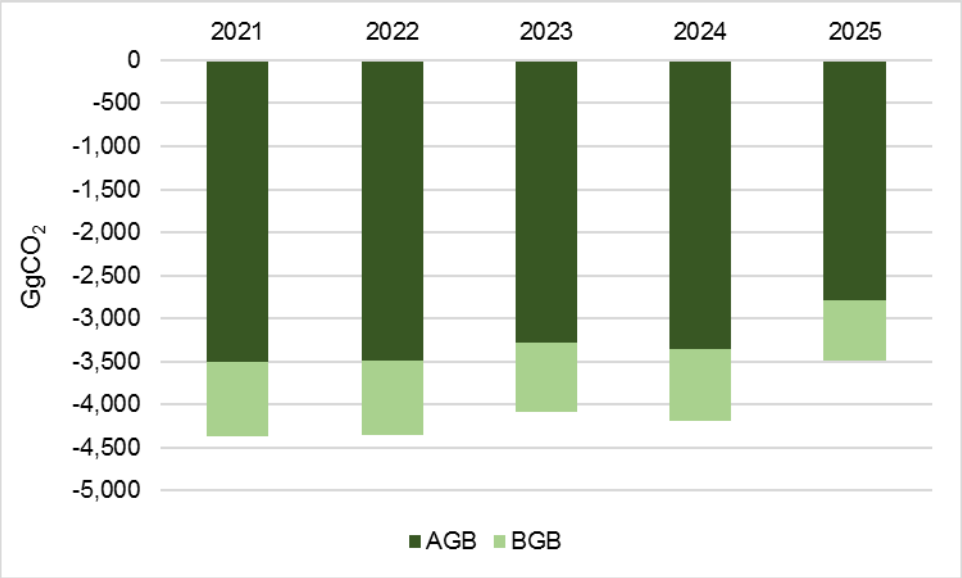


Figure 5.3-1 Removals of GHG for living biomass in CP1 (Legend: BGB (belowground biomass in light green); ABG (aboveground biomass in dark green))

The activity data for CO_2 emission/removal calculation of living biomass includes data on forest area, increment and harvest. Net removals in living biomass in CP 2021-2025 are slightly decreasing, varies from - 4374 Gg CO_{2eq} in the 2021 to - 3482 Gg CO_{2eq} in the 2025.

Estimation performed using the instantaneous oxidation for carbon stock changes in the HWP pool including the emissions from forest fires leads to the average value of FRL – 3906 Gg CO_{2eq}·year-1. As expected the largest part of removals in living biomass comes from aboveground biomass.

Shortly, the calculation can be presented as follows

$\Delta CMFLLB = \Delta CMFLGj - \Delta CMFLLj$

Where:

ΔCMFLLB = annual change in carbon stocks in living biomass (includes above and below ground biomass) in the Managed Forest, Gg C · year-1

ΔCMFLGj = annual increase in carbon stock due to biomass growth, Gg C · year-1

ΔCMFLLj = annual decrease in carbon stock due to biomass loss, Gg C · year-1

Where j = 1 - deciduous

2 - coniferous

3 - out of yield

5.3.2. Harvested wood products

For the estimation of emissions/removals from the harvested wood products (HWP) pool, Croatia uses Tier 2 (first order decay) applying the Production approach. For the purpose of NIR 2018

the activity data from the Central Bureau of Statistics (CBS) were used for the period 1990-2016. The same data are delivered to the UNECE/FAO international database. HWP data for the RP from these sources were used for the purpose of FRL and the LULUCF Regulation.

When assessing the available HWP data for the FRL projection purposes the inconsistency between total solid wood produced in period 1990-2011 and period 2012-2016 were recorded. For the FRL determination and projections of HWP types in period 2021-2025, it was concluded this inconsistency issue needs to be resolved although the correction in time series 2012-2016 was not performed in NIR 2018. Thus, for projecting amounts of HWP types in Croatia in period 2021-2025, following steps were applied:

1. In order to resolve inconsistency in HWP data by types that comes from domestic harvest in period 2012-2016 linear regression model was developed and used ($y_i=\beta_0+\beta_1 \cdot x_i$)
2. From the total amount of wood harvested in Croatia in period 1990-2016 the amount of harvested wood that comes from deforested areas were exempt.

Based on the Ordinance on forest management amount of wood that is harvested due to the deforestation purposes have to be well recorded in Croatia. Thus, since 1990 these data are well known. Performed analyse showed that from the total amount of harvest recorded in Croatia in period 1990-2016, more than 99% is realized on **managed forest land** (in average 99.67% in case of deciduous forests and 99.35% in case of coniferous forests in period 1990-2016). The remaining quantity of wood produced for both types of forests belong to the harvest realized on deforested areas.

In Croatia in period 1990-2016 there are no HWP types that are coming from the afforested areas. In addition, there is no harvest in Out of yield forests in Croatia (maquies and shrub forests) since these forests are forests with the protective role.

3. UNECE/FAO HWP data on total industrial roundwood (IRW) in period 1990-2016 were analysed and a share of IRW from domestic harvest was determined using the equation:

$$\text{IRW share from domestic harvest} = \frac{\left(\text{IRW}_{\text{Production}} - \text{IRW}_{\text{Import}}\right)}{\left(\text{IRW}_{\text{Production}} + \text{IRW}_{\text{Import}} - \text{IRW}_{\text{Export}}\right)}$$

4. IRW data related to domestic harvest on each HWP types were corrected using the percentages defined under the point 1 to secure that these IRW data corresponds to harvest on managed forest land only (securing the subtraction of IRW originating from the deforested land from the total IRW data)
5. HWP data related to domestic harvest as corrected in point 4 are recalculated to Gg of carbon using the methodology and parameters prescribed by the KP Supplement
6. HWP data presented as Gg of carbon according to the specific types (i.e. veneer sheets, plywood etc.) were aggregated under the corresponding HWP types - saw wood, wood panels and paper and paperboard
7. Linear regression model from point 1 was also used for projecting harvest amounts and HWP types in period 2021-2025. Basis for projecting HWP types in period 2021-2025 were harvest amounts from the RP as stipulated by LULUCF Regulation. The harvest

projections for the period 2016-2025 were those developed for aboveground biomass pool on basis of the forest management model described in Chapter 4.

Total harvest amount is an explanatory variable for each HWP subcategory, except for sawnwood where we use harvest by species type (coniferous or deciduous). There is no intercept (β0=0) as it is assumed that there is no production of harvesting wood products in case of no harvest.

Results of the applied regression model are presented in *Figure 5.3-2* and model parameters for projecting activity data in relation to harvest in period 2021-2025 are presented in *Table 5.3-2*.

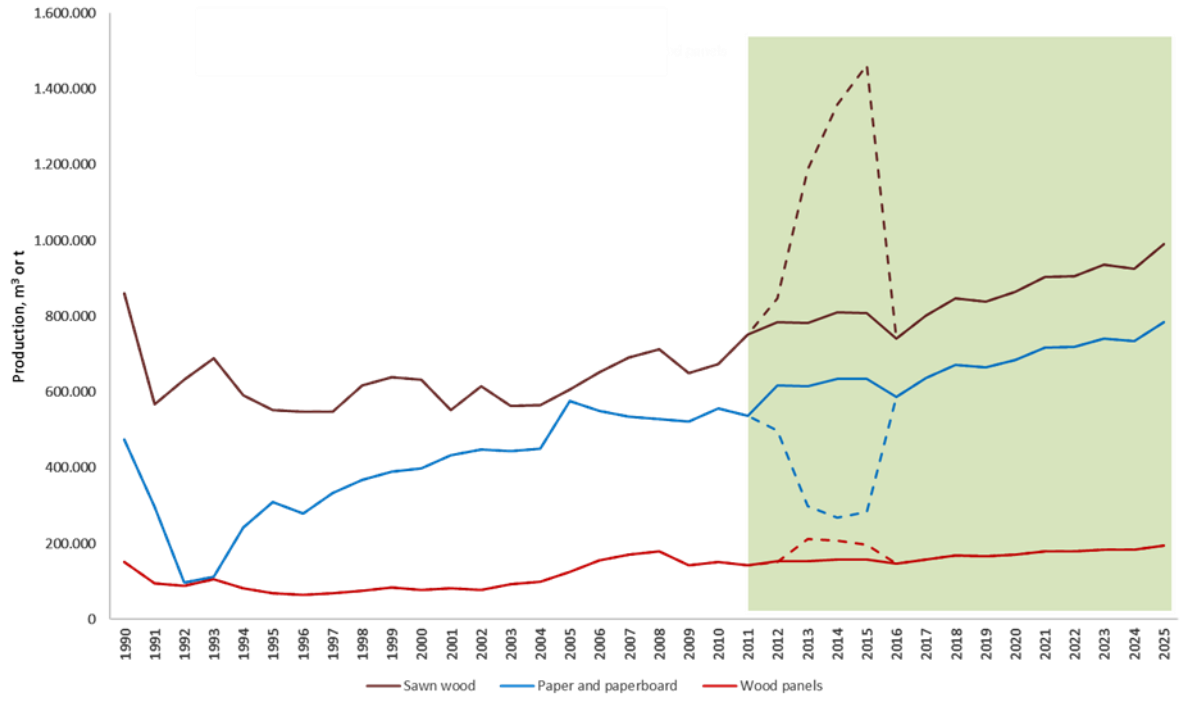


Figure 5.3-2 Historic and projected HWP Activity data (solid line) for period 1990-2025 and un-corrected data (dashed line) of time series for the period 2012-2015

Table 5.3-2 Model parameters for projecting activity data in relation to harvest for FRL

y_i (Dependent variable)	x_i (Explanatory variable)	**R** (correlation coefficient)	β_1 (parameter/slope)	**Standard Error**
Sawnwood coniferous	Harvest– coniferous	0.971	148.79	24852.68
Sawnwood non-coniferous	Harvest – non-coniferous	0.998	124.10	33482.38
Veneer Sheets	Harvest - total	0.980	4.75	5117.17
Plywood	Harvest - total	0.718	0.58	2982.31

Particle Board	Harvest - total	0.939	19.68	38019.52
Paper and Paperboard	Harvest - total	0.997	100.22	40476.60
Industrial Roundwood - Production	Harvest - total	0.999	625.72	166715.24
Industrial Roundwood - Import	Harvest - total	0.866	10.48	31924.21
Industrial Roundwood - Export	Harvest - total	0.992	89.14	59863.78

As presented in table, the correlations between amount of harvest and harvesting wood products are extremely high. This fact supports the usage of the developed model.

8. For the carbon stock changes estimation in HWP types in period 2021-2025 all factors needed for conversion of activity data (production amount) were taken from KP Supplement, separated by product type.

Multiplying factors by production amount per product type gives inflow in the carbon stock for the year y+1. Carbon stock for the year i+1 is calculated according to equation 12.1 (IPCC 2006 Guidelines) and depends on inflow for the year i+1, carbon stock for the year i and half-life value. Stock change for the year i+1 are difference between carbon stock in year i+1 and year i. Outflow of the carbon from carbon pool are difference between inflow and stock change for the year i+1.

Finally, the changes in the carbon stock of HWP products in use are estimated by using equation 12.1 (IPCC 2006 Guidelines, Chapter 12):

$$\boldsymbol{C(i+1) = e^{-k} * C(i) + \left[\frac{(1 - e^{-k})}{k}\right] * Inflow(i+1)}$$

Where:

i = year

C(i) = the carbon stock of the HWP pool in the year i [Gg C]

k = decay constant of first-order decay for each HWP category given in units, yr-1

(k = ln(2)/HL where HL is half-life of the HWP pool in years)

Inflow (i+1) = the inflow to the HWP pool during year i+1 [Gg C/yr]

Following Regulation recommendations, the following half-life values were used: Sawn wood – 35 years, Wood panels – 25 years and Paper and paperboard – 2 years

Finally, the carbon stock change in HWP is calculated as the difference of C(i+1) and C(i).

The results of the model used for the stimation for HWP types in period 2021-2025 are presented in *Table 5.3-3* and *Figure 5.3-3 Removals of GHG for HWP pool by product types*

Table 5.3-3 **HWP carbon pool in CP1**

HWP type	half lives	unit		2021	2022	2023	2024	2025
sawn wood	35	Gg C	stock	8,200.86	8,285.86	8,376.61	8,463.11	8,565.09
			inflow	247.49	248.26	255.74	253.25	270.60
			outflow	-161.56	-163.26	-165.00	-166.75	-168.62
			stock change	**85.93**	**85.00**	**90.74**	**86.50**	**101.98**
wood panels	25		stock	1,086.55	1,103.85	1,122.11	1,139.40	1,159.50
			inflow	47.53	47.67	49.12	48.64	51.97
			outflow	-29.88	-30.37	-30.86	-31.35	-31.87
			stock change	**17.64**	**17.30**	**18.26**	**17.28**	**20.10**
paper	2		stock	746.32	762.03	780.28	790.78	814.59
			inflow	276.40	277.24	285.69	282.85	302.23
			outflow	-255.19	-261.53	-267.44	-272.35	-278.43
			stock change	**21.21**	**15.71**	**18.25**	**10.51**	**23.81**
Wood products in use	Gg C		stock	10,033.73	10,151.74	10,279.00	10,393.29	10,539.17
			stock change	**124.79**	**118.01**	**127.26**	**114.29**	**145.88**
	$GgCO_2$		stock	36,790.33	37,223.05	37,689.65	38,108.71	38,643.63
			stock change	**-457.55**	**-432.72**	**-466.60**	**-419.06**	**-534.91**

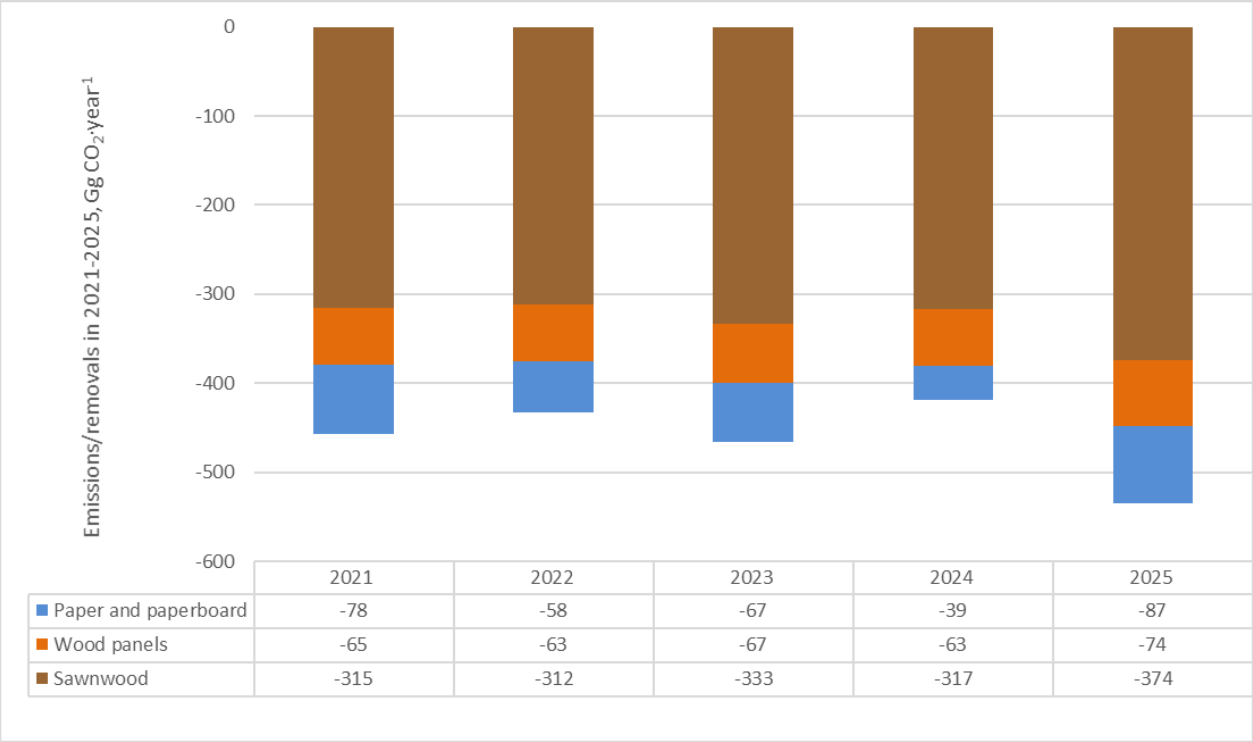


Figure 5.3-3 Removals of GHG for HWP pool by product types

In order to comply with the requirement of LULUCF regulation of keeping constant ratio between solid and energy use of forest biomass as documented in the period 2000-2009 during the CP, the above mention model and data on felling were used. Model provides coefficient for sawn wood coniferous, sawn wood non-coniferous and every other HWP type. Using the felling data projected

for period 2021-2025 and multiplying it with corresponding model coefficient, the amount of each HWP type was determined.

National data shows that 20.1% of the total volume cut in case of coniferous and 14.5% of deciduous forests remain on forests sites after the felling operations are performed. Wood removed from the forest sites (harvested volume) is used either for HWP production or for energy purposes. Since data on wood residues left on felling sites and HWP data are known, remaining quantity belongs to the wood for energy purposes.

The results of the model proving that the ratio between felling and HWP types during the RP has been fixed during the CP1 period are presented in *Table **5.3-4*** and *Table* **5.3-5**. Consequently, the ratio between wood for energy and solid wood use in RP and CP 1 is also constant.

Table 5.3-4 Shares of HWP types in felling in RP

Reference Period											
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**
Felling (million m^3)	4.49	4.56	4.55	4.81	5.03	5.01	5.20	5.52	5.59	5.28	
SW_WP (thousand m^3)	720.00	659.00	721.00	681.00	685.00	752.00	830.00	877.00	902.00	796.00	
Ratio (SW_WP/Felling)	16%	14%	16%	14%	14%	15%	16%	16%	16%	15%	15%
Paper (thousand t)	406.00	451.00	467.00	463.00	464.00	592.00	564.00	545.00	535.00	524.00	
Ratio (PP/Felling)	9%	10%	10%	10%	9%	12%	11%	10%	10%	10%	10%

Table 5.3-5 *Shares of HWP types in felling in CP1*

CP 1						
Year	**2021**	**2022**	**2023**	**2024**	**2025**	**Average**
Felling (million m^3)	7.31	7.34	7.56	7.48	8.00	
SW_WP (thousand m^3)	1,107.64	1,110.61	1,146.19	1,133.76	1,211.48	
Ratio (SW_WP/Felling)	15%	15%	15%	15%	15%	15%
Paper (thousand t)	732.92	735.14	757.55	750.03	801.41	
Ratio (PP/Felling)	10%	10%	10%	10%	10%	10%

5.3.3. Forest reference level

Summarizing all three values per year total changes in HWP pool was calculated. As result of calculation for the purpose of requirements defined in LULUCF Regulation, and using the Tier 2 for the HWP carbon stock changes Croatia provides contribution of HWP pool as removals in the amount of -462,17 Gg $CO_2 \cdot year^{-1}$.

Removals from aboveground biomass, belowground biomass and harvested wood products are taken into account in order to estimate Forest reference level for the period 2021 to 2025.

Predicted forest fire emissions are accounted for the FRL determination. The FRL assuming instantaneous oxidation equals -3906 Gg CO_2·$year^{-1}$.

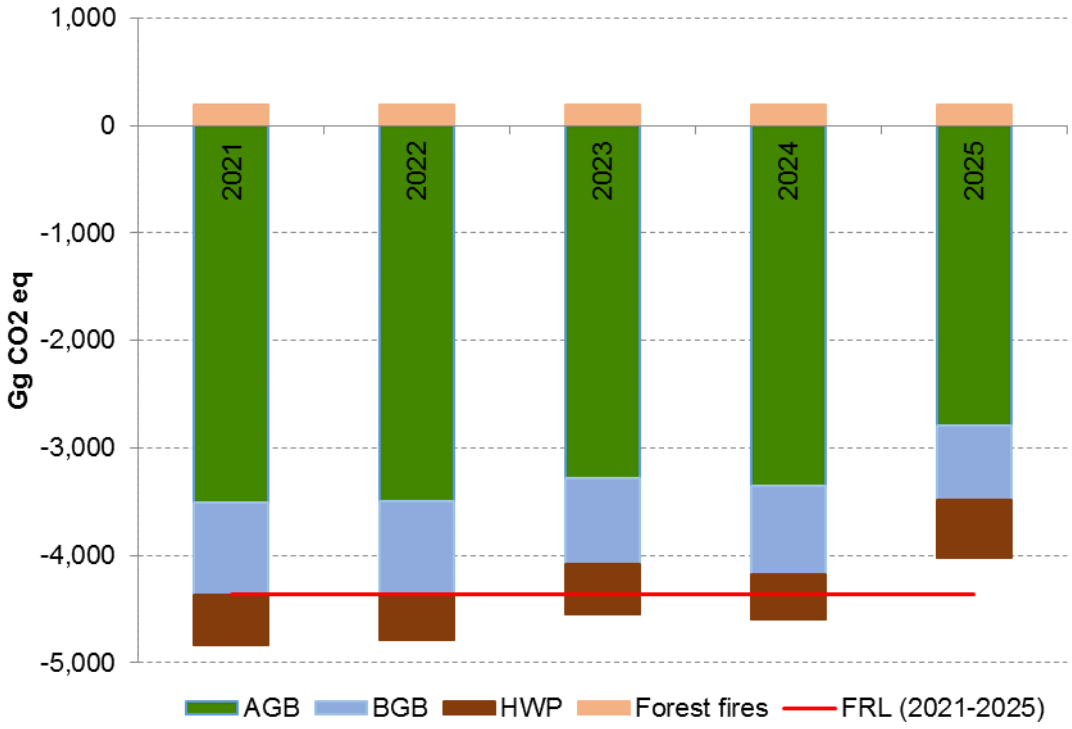


Figure 5.3-4 Projected removals estimated in line with the LULUCF regulation and FRL (red line) for Croatia including aboveground biomass (AGB), belowground biomass (BGB), forest fires emissions and HWPs

5.3.4. Comparison with projections in line with Regulation 525/2013

Croatia applied the same methods for the estimation of carbon stock changes in biomass pool and HWP pool when defining FRL and developing projections required under the Regulation 525/2013. Two reasons are recognized why the FRL and projections developed in 2017 under the Regulation 525/2013 differ. These are:

1. FRL in Croatia is developed based on specially design model so (call “No War” model). The model predicts harvest intensities based on harvest intensities from seven FAs on which negligible influence of the War was assumed. This model is defined based on the stipulation of Article 8, paragraph 4 of the LULUCF Regulation that recognizes particularities for Croatia in defining FRL.
2. Requirements of the LULUCF Regulation for FRL development that differ from the rules applicable for the development of projections required under the Regulation 525/2013. LULUCF Regulation requires that FRL has to be developed keeping the forest management practices and intensities in period 2021-2025 as applied during the period 2000-2009. In addition, Regulation stipulates omitting any further policies in FRL

estimation than those valid in RP and use of constant ratio between solid and wood used for energy purposes in CP1 as during the RP.

6. ANNEX 1

6.1. ADDITIONAL INFORMATION OF FOREST MANAGEMENT PRACTICES IN CROATIA

A. FOREST MANAGEMENT PRACTICES APPLIED IN EVEN-AGED FORESTS

FMP 1 (Common oak – even-aged)

Common oak even-aged stands are managed by 140-year rotation period. Management includes: habitat preparation (tillage on compacted soil, clearing the soil of brambles and other weed vegetation), care and protection of sprouts from plant diseases and pests (powdery mildew), filling in of insufficiently rejuvenated spots in seedling stands of common oak, narrow-leafed ash and alder (and, if need be, cherry and wild pear), cleaning of sprigs by removing phenotypically bad trees and undesirable species (so-called negative selection), and culling which removes direct competitors to selected trees carriers of the future generation (so-called positive selection), maintains the desired ratio of the composite (maintaining the undergrowth level of the common hornbeam) and removes stronger common hornbeam trees with tree tops. Regeneration (rejuvenation) is natural, under the curtain of tree tops of older trees, with regeneration cuts that in general are done in two to three cuts (preparatory, seeding and finishing). Preparatory cut removes phenotypically bad and supernumerary trees, thus regulating the ratio of the composite of tree types and achieving the regular array of trees across the area. Seeding cut comes after the seed harvest, and it removes all trees of large dimensions and brings enough light into the stand for good development of seedlings and sprouts. Common hornbeam undergrowth level is also used for light regulation. After three to five years, when the new generation is developed enough not to need protection of the stem stand, comes the finishing cut in which wood mass should not exceed 200 m^3/ha.

FMP 2 (Sessile oak – even-aged)

Sessile oak even-aged stands are managed by 120-year rotation period. Management includes: habitat preparation (tillage on compacted soil, clearing the soil of brambles and other weed vegetation), care and protection of sprouts from plant diseases and pests (powdery mildew), filling in of insufficiently rejuvenated spots in stands with sessile seedlings and beech, cherry and fruit trees if there are none from natural rejuvenation, cleaning of sprigs by removing phenotypically bad trees and undesirable species (so-called negative selection), and culling which removes direct competitors to selected trees carriers of the future generation (so-called positive selection) and maintains the desired ratio of the composite. Regeneration (rejuvenation) is natural, under the curtain of tree tops of older trees, with regeneration cuts that in general are done in two to three cuts (preparatory, seeding and finishing). The most sensitive and demanding is the preparatory cut due to the lack of the undergrowth level as the regulator of light in the stand. Selection must carefully be done in the preparatory cut, in a way that prevents direct sun from effecting the seedlings and the weeds. Sessile oak seedlings are very sensitive to direct sun exposure, and if the stand is opened too much the soil swiftly goes to weeds and the seedling perishes. The seeding cut comes after the seed crop year, and stand carriers are taken out of the

stand as they have done their task – fertilisation. Undergrowth, if possible, should be made into an undergrowth level. For the finishing cut, thinner trees are left, to reduce harm to sprouts during cutting. Wood mass in the finishing cut shouldn't exceed 200 m^3/ha (optimum is 150-180 m^3/ha). One to two subsequent cuts should be made, if needed.

FMP 3 (Common beech – even-aged)

Common beech even-aged stands are managed by 100-year rotation period. Management includes: habitat preparation (tillage of soil in the crop year, treating the brambles with a systemic agent and, if needed, protecting the seeds from rodents), care and protection of sprouts from plant diseases and pests, filling in of insufficiently rejuvenated spots in stands of sessile seedlings and beech, but also cherry and other fruit trees if there are none from natural rejuvenation, cleaning of sprigs by removing phenotypically bad trees and undesirable species (so-called negative selection), and culling which removes direct competitors to selected trees carriers of the future generation (so-called positive selection) and maintains the desired ratio of the composite. During thinning it is especially important to save the lower level, guiding by the principle that you can take from the lower level only as much as its share is in the stand, and from the main level at least as much as its share is. Regeneration (rejuvenation) is natural, under the curtain of tree tops of older trees, with regeneration cuts that in general are done in two to three cuts (preparatory, seeding and finishing), with a rejuvenation period of no more than 15 years. Preparatory cut removes trees with weak tree tops and brings more light into the stand, regulating the array of trees in the area and the ratio of the composite. In the sub-compartment with no undergrowth levels the preparatory cut must be done carefully and with low intensity (up to 20%) to prevent possible spreading of the brambles. It would be ideal to do the preparatory cut in a seed crop year. Seeding cut is done after seedlings and sprouts appear in most of the sub-compartment area. In the seeding cut seed trees are cut where they have completed their task, so that trees of weaker dimensions are left for the finishing cut to reduce the damage to the sprouts. As needed, the seeding cut is done with seeding of at least 70% of the area, at a time when the sprouts are capable of independent development (height of approximately 50 cm).

FMP 4 (Other deciduous – even-aged)

Other deciduous are even-aged stands of the following species: narrow-leafed ash, common hornbeam, sweet chestnut, acacia, downy, turkey oak, holm oak, black alder, willow and poplar. Due to the relatively small area they take, stands of individual species are not divided into special strata. Management in these stands is the same as for common oak, sessile oak and common beech, with a difference being that care, cleaning and thinning growing activities stimulate the arrival of more valuable tree species that naturally appear in a certain habitat. Rotation periods differ for individual species.

FMP 5 (Other coniferous – even-aged)

Other coniferous are even-aged stands of the following species: Aleppo pine, black pine, common juniper, weymouth pine, larch, scots pine and douglas fir. Aleppo and black pine stands are natural stands that are mostly found in the Mediterranean and sub-Mediterranean areas, while stands of the remaining species are mostly planted as cultures on forest land without tree cover.

Rotation periods differ for individual species. For all stands of the listed coniferous the rule is that care, cleaning and thinning growing activities stimulate the arrival and growing of indigenous deciduous trees, so that natural plant community of a certain area can be more easily rejuvenated after the rotation period.

B. FOREST MANAGEMENT PRACTICES APPLIED IN UNEVEN-AGED FORESTS

FMP 6 (Common oak – uneven-aged)

Uneven-aged common oak stands have a so-called group structure. In these stands the aim is to achieve a mosaic structure formed by groups of areas up to 1 ha of different development stages, where trees within one group have the same dimensions. Appropriate growing interventions in a group are done according to the state and age of that group, so all regeneration and care interventions can be represented in such a stand. Normality of these stands is based on a normal structure of the growing stock. Common oak is a heliophyte (it loves light), so uneven-aged forest management for these stands poses a significant limitation on achieving wood-productive function of these forests. Common oak stands are uneven-aged managed only in cases of unfavourable habitat conditions and pronounced environmental function of the forest, i.e. for proprietary forest where no other method of planning of sustainable management is possible.

FMP 7 (Sessile oak – uneven-aged)

Uneven-aged sessile oak stands have a so-called group structure. In these stands the aim is to achieve a mosaic structure formed by groups of areas up to 1 ha of different development stages, where trees within one group have the same dimensions. Appropriate growing interventions in a group are done according to the state and age of that group, so all regeneration and care interventions can be represented in such a stand. Normality of these stands is based on a normal structure of the growing stock. Sessile oak is a heliophyte (it loves light), so uneven-aged forest management for these stands poses a significant limitation on achieving wood-productive function of these forests. Sessile oak stands are uneven-aged managed only in cases of unfavourable habitat conditions and pronounced beneficial function of the forest, i.e. for proprietary forest where no other method of planning of sustainable management is possible.

FMP 8 (Common beech – uneven-aged)

These are selection forests, where common beech forms the majority part of the composite ratio. Selection forests are forests where common beech and common fir trees of different heights and thickness are located per area unit, in a horizontal group or single structure, and in three vertical structure layers. On steep and rocky terrain these stands are area arrayed, while on flat terrain with deeper soil and less surface rock the stands tend to be group arrayed. Selection forest management means cuts primarily meant for rejuvenation. Normality of selection forests is based on normal, optimal structure of stands with regard to growing stock, diameter distribution and number of trees. Cutting is done in certain intervals needed for the stand to recover and achieve optimal growing stock. The interval between two cuts is called a rotation and in general it is 10 years. In case of achieved normality the cut equals a 10-year increment. The cut seeks to form a selection stand of optimal structure, which will in its composite ratio have species with the largest

and most valuable increment, which will use the production capability of the soil to the maximum capacity, and at the same time will create plentiful natural offspring. The main goals of management are: constant rejuvenation, stands care, constant maintenance of the selection structure, stand usage, sanitary-hygienic function.

FMP 9 (Other deciduous – uneven-aged)

Other deciduous are uneven-aged stands of the following species: common hornbeam, sweet chestnut, acacia, downy, turkey oak, holm oak, black alder, willow and poplar. Due to the relatively small area they take, stands of individual species are not divided into special strata. Management of these stands is the same as for common oak, sessile oak and common beech, with a difference being that care, cleaning and thinning growing activities stimulate the arrival of more valuable tree species that naturally appear in a certain habitat, thus increasing the structure and ratio of the composite.

FMP 10 (Common fir – uneven-aged)

These are selection forests, where common fir forms the majority part of the composite ratio. Selection forests are forests where common beech and common fir trees of different heights and thickness are located per area unit, in a horizontal group or singe structure, and in three vertical structure layers. On steep and rocky terrain these stands are area arrayed, while on flat terrain with deeper soil and less surface rock the stands tend to be group arrayed. Selection forest management means cuts primarily meant for rejuvenation. Normality of selection forests is based on normal, optimal structure of stands with regard to growing stock, diameter distribution and number of trees. Cutting is done in certain intervals needed for the stand to recover and achieve optimal growing stock. The interval between two cuts is called a rotation and in general it is 10 years. In case of achieved normality, the cut equals a 10-year increment. The cut seeks to form a selection stand of optimal structure, which will in its composite ratio have species with the largest and most valuable increment, which will use the production capability of the soil to the maximum capacity, and at the same time will create plentiful natural offspring. The main goals of management are: constant rejuvenation, stands care, constant maintenance of the selection structure, stand usage, sanitary-hygienic function.

FMP 11 (Other coniferous – uneven-aged)

Other coniferous are mostly made up of mixed selection forests, where common juniper forms the majority. Management of these stands is the same as management of fir and beech selection forests, with a difference being that management interventions serve the purpose of improving the composite ratio in favour of common fir and common beech.

C. FOREST MANAGEMENT PRACTICES APPLIED IN STRICTLY PROTECTED AREAS

FMP 12 (Strictly protected areas – all species)

Strictly protected areas are strict reserves, national parks and special reserves, and the main goal of management of these areas is protection of biodiversity.

Article 112 of the Nature Protection Act (Official gazette 80/13, 15/18) defines strict reserve as: "… land and/or sea area with unchanged or insignificantly changed overall nature, intended exclusively for preservation of original nature". Commercial and other activities are forbidden in a strict reserve. There are 2 strict reserves in Croatia: Bijele i Samarske stijene, and Hajdučki i Rožanski kukovi.

Article 113 of the Nature Protection Act (Official gazette 80/13, 15/18) defines national park as: "… broad, mostly unchanged land and/or sea area of exceptional and multiple natural values, which encompasses one or more preserved or insignificantly changed ecosystems, and is primarily intended for preservation of original natural and landscape values". Commercial use of natural resources is forbidden in national park areas. Only interventions and activities that do not pose a threat to the originality of nature are allowed (e.g. limited interventions of tree cutting in visitor zones strictly for safety reasons). There are 8 national parks in Croatia: Brijuni, Kornati, Krka, Mljet, Paklenica, Plitvička jezera, Risnjak and Sjeverni Velebit.

Article 114 of the Nature Protection Act (Official gazette 80/13, 15/18) defines special reserve as: "… land and/or sea area of special significance due to unique, rare or representative natural values, or an endangered habitat, or a habitat of an endangered wild species, primarily intended for preservation of those values". Interventions and activities that could endanger the properties for which it became a reserve are not allowed in a special reserve. There are 78 special reserves in Croatia.

The goal of strictly protected area management is primarily preservation of biodiversity and protection of the underlying phenomenon.

FMP 13 (Protective forests of maquies and shrubs)

Forest management practice of maquies and shrubs primarily means soil protection. Maquies and shrubs are degraded stands that do not have stated growing stock and other structure elements in official records, even though they are included in forest management plans. These are mostly stands with trees under the measurement limit in Mediterranean and sub-Mediterranean areas, with no economic role, and their significance must be viewed through achievement of generally beneficial functions of the forest. As a rule, cutting is not performed in such stands, they are rather left to the natural development, with perhaps limited silvicultural activities in the areas where that is justified.

At the time of drafting of the new General FMAP 2016-2025 a new stand structuring was done, related to silvicultural form and purpose. New stand distribution resulted in an increase in the Maquies and Shrubs category, at the expense of the remaining two categories. It must be emphasized here that there wasn't an actual degradation of forests, only a more detailed distribution of forested area. This mostly relates to the fragmented forest area in the Mediterranean and sub-Mediterranean, where it was established that management oriented towards logging wood in these stumps was unprofitable, while at the same time the environmental services provided by these forests, primarily in the form of soil protection, was extremely significant.t

7. ANNEX 2

7.1. NATURAL DISTURBANCES

Republic of Croatia intends to use natural disturbances provision as stipulated in the Article 10 of the Regulation (EU) 2018/841 on the managed forest land.

In accordance with footnotes 7 and 9 of Annex Decision 2/CMP.7 and the guidance provided by the KP Supplement, Republic of Croatia estimated provisional the background level of emissions associated with annual natural disturbances using the currently available data for the period 2001-2017.

For determining the background and margin level of emissions associated with annual natural disturbances in FM areas due to natural disturbances, Croatia intends to apply the ND provisions in respect to: (i) forest fires; (ii) extreme weather events (additionally presented as: 1) windbreaks; 2) snow-breaks and ice-breaks (presented together)).

After the conducted consultation with the forest experts, it was concluded that 60% of the biomass is fully burnt during the forest fires, while the remaining 40% is only partially burnt. It was assumed that 60% of areas correspond to 60% of wood (fully) burnt. According to the Ordinance on forest management (OG 79/15) provisions, all areas subject of natural disturbances need to be remediated and prescribed forest activities have to be performed securing that forest area remains forest area. Consequently, this means that the partially burnt wood is a subject of salvage logging operations. This 40% of wood affected by fires are removed from the forest. This is a reason for reporting emissions from only 60% of forest areas affected by forest fires for the necessity of determining the background and margin level in FM areas. The estimation of forest fires emissions are performed using the equation 2.27 from the 2006 IPCC Guidelines and Tier 1 method. For this estimation Croatia uses only data about areas affected by forest fires that are determined on national level.

In order to use natural disturbances provision as defined in Annex I to decision 2/CMP.8 natural disturbance areas on which wood have been left on site needed to be determined. Taking into consideration provisions of national legislation regarding the natural disturbances in forests (remediation prescribed and requested), it was concluded that damaged wood has been left on site after natural disturbances only in special circumstances, namely:

- Forest areas that are strictly protected on which any kind of forest practices are forbidden (i.e. strict forest reserves)
- Areas with forest which diameter breast height (DBH) is under the measurement limit (i.e. first age class forests)
- High mountains forest areas without access by forest roads
- Areas still under the mines as a consequence of War in Croatia in 1990’s

The additional analyses performed in Croatia showed that ND (except the forest fires) also occurred on above listed areas during the calibration period, and it is reasonable to expect these ND types will repeat also in the future. This is the reason that Croatia decided to report emissions from extreme weather events as part of its ND provisions. This ND type (extreme weather events) has been additionally presented as: (i) Windbreaks; (ii) Snow-breaks and ice-breaks (presented together).

In order to perform the emission estimation due to extreme weather events, a proxy was used. The emission estimation arising from the above listed ND (sub)types are calculated for FM areas using the Gain-Loss method from the IPCC 2006 Guidelines and Tier 2.

Croatia initiated a separate project in 2017 order to determine emissions due to selected natural disturbances and define their supporting background level (BL) and margin level (ML) in areas under the forest management. Within the project a specially designed Questionnaire was sent out to all forest units in Croatia (169) with the request to check areas affected by natural disturbances in period 1990-2015 and deliver data on forest types (deciduous, coniferous maquies and shrub), volume and areas affected. The questionnaire referred to all forests in Croatia, regardless the forest ownerships. Detailed results of the project and conducted survey are presented in a separate, official document.

The basis for determining wood volume left on the site after the disturbance are data on the so called salvage logging (refers to volume cut due to natural disturbance and which is removed from the site) on FM areas and the spatial shares between FM and the ND areas without salvage logging. Through this project Croatia collected detailed data on natural disturbances by type, year of its occurrence and species (deciduous, coniferous, maquies and shrub) affected by it. The data collected refer to areas listed in point B of this paper (forest areas that are strictly protected on which any kind of forest practices are forbidden, areas of forest which dbh is under the measurement limit, high mountains forest areas that are not adequately accessible by forest roads, areas still under the mines) and for the following types of natural disturbances:

- Windbreaks
- Snow-breaks and ice-breaks (presented together)

The data about forest fire emissions have been regularly collected in Croatia and recently revised (through the LULUCF 1 project implemented in period 2014-2015). Thus, there was no need for additional check about data on this type of natural disturbance.

After the relevant new data were collected through the project, and using the already existing data on forest fire emissions, Croatia performed a new estimation of emissions from listed (sub)types of NDs (windbreaks, snow-breaks and ice-breaks) on defined areas (forest areas that are strictly protected, areas with forest which DBH is under the measurement limit, high mountains forest areas without access by forest roads, areas still under the mines as a consequence of War in Croatia in 1990s). After that, the corresponding background and margin level were defined in accordance with footnotes 7 and 9 of annex Decision 2/CMP.7 and the guidance provided by the KP Supplement, as follows:

- A consistent and complete time series containing annual emissions from selected ND types (Table 2) for the calibration period 2001 – 2017 was set.
- The arithmetical mean and standard deviation of the emissions were calculated.
- Any emissions that were larger than the arithmetic mean plus twice the standard deviation (outlier) were removed from the time series.
- The process mentioned in points 2. and 3. above was iterated until no further outliers were identified.
- The arithmetic mean and twice the standard deviation estimated in the last step of this process (no outliers remain) define the background level and the margin, respectively.

The results of the performed estimation are as follows:

- Background level: 63.45Gg CO2eq.
- Margin: 132.83Gg CO2eq.
- Background level plus margin: 196.28 Gg CO2eq.
- Total number of years: 17
- Number of excluded years: 6
- Years excluded: 2017, 2012, 2003, 2007, 2001, 2011

The total emissions for the calibration period for the land under the forest management associated with the disturbances are presented in Table 7.1-1 while defined BL and ML on these areas are presented in Figure 7.1-1.

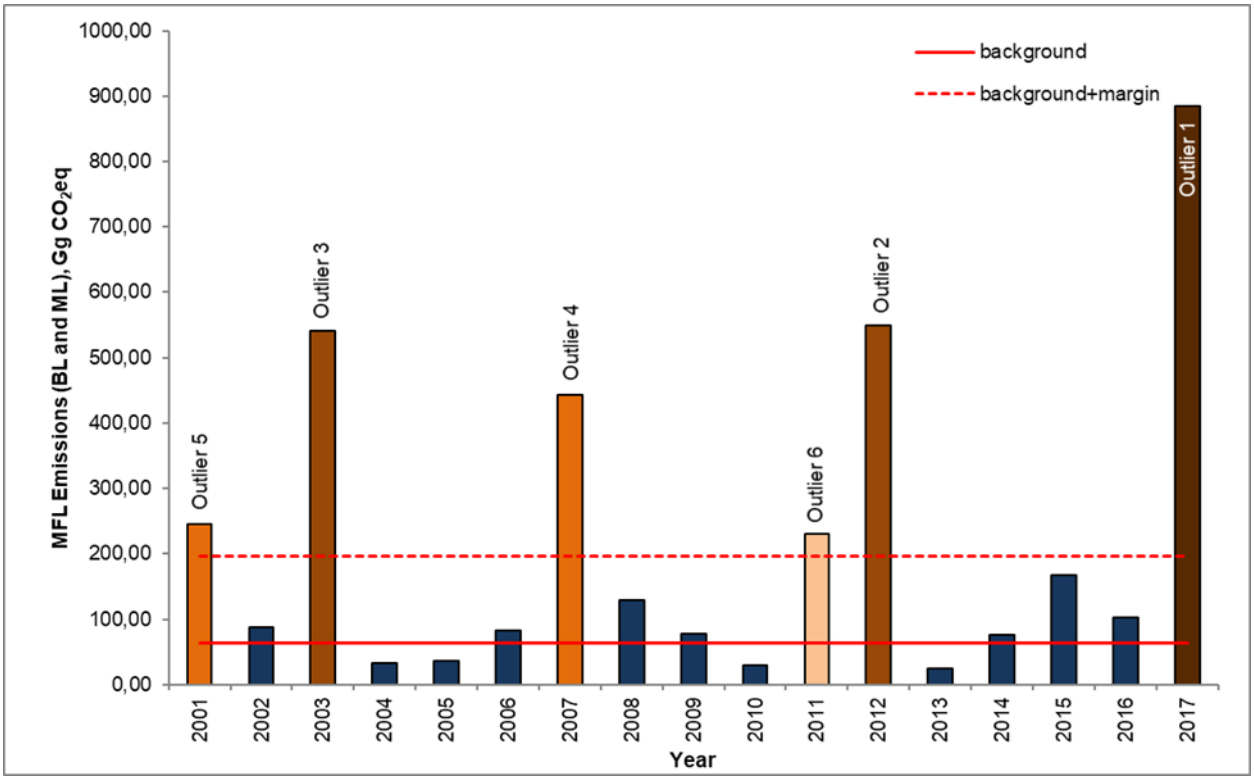


Figure 7.1-1 Emissions from natural disturbances for land under the forest management

Table 7.1-1 *Estimated emissions from natural disturbances for managed forest land (MFL) (2001-2017)*

Total and area specific emissions from disturbances for the calibration period for MFL																	
	Inventory year during the calibration period																
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
	Total annual emission [Gg CO_2 eq.]																
Wildfires	240,291	84,299	537,714	29,304	31,871	81,100	439,193	127,224	71,376	24,018	226,265	533,335	21,479	2,753	142,080	98,808	882,736
Insect attacks and disease infestations																	
extreme weather events(total, all)	5,637	3,457	2,904	4,242	3,708	1,346	3,699	2,184	6,366	5,626	4,849	15,834	3,195	73,467	25,131	4,437	2,269
1. windbreaks	5,018877	3,37782	2,825718	3,90538	3,708	1,275	3,681	2,184	6,155	4,713	4,472	5,830	2,819	70,907	24,404	4,435	2,176
2.snowbreaks and icebreaks	0,617738	0,07952	0,078583	0,33691	0,000	0,071	0,018	0,000	0,211	0,913	0,376	10,004	0,376	2,560	0,727	0,002	0,093
geological disturbances																	
other																	
SUM	245,928	87,757	540,618	33,546	35,579	82,446	442,892	129,407	77,742	29,645	231,114	549,169	24,674	76,220	167,211	103,245	885,004
For all managed forest land	Total area [kha]																
	2.314,93	2.314,70	2.314,60	2.314,26	2.313,89	2.313,54	2.313,31	2.312,90	2312,299	2.311,95	2.311,76	2.311,51	2.311,35	2.311,30	2.311,06	2.311,03	2.311,02
	Area-specific emissions (Emissions per unit of land area under FM, Mg CO_2 eq. ha-1)** (= t CO_2eq/ha)																
	0,106	0,038	0,234	0,014	0,015	0,036	0,191	0,056	0,034	0,013	0,100	0,238	0,011	0,033	0,072	0,045	0,383

8. ANNEX 3

8.1. A PROXY VALIDATION APPROACH

In Chapter 2 we described how effects of war were estimated by analysing the dynamics of roundwood production in countries of European Union, and then applying the harvesting dynamics observed in the countries, most similar to Croatia (i.e. Slovakia), to assess harvests under “No-War” scenario. In

Table we present the source data and the results from the modelling-by-proxy of the consequences of war on harvests in Croatia.

Due to the fact that during 1980-1989 Slovakia was part of Czechoslovakia and data on harvest were not available to us, we used data from FAO roundwood production for Czechoslovakia until 1992, while from 1993 we summed reported values for Czech Republic and Slovakia. Results presented here were not used in the modelling and calculation of the Croatian FRL. The purpose of this exercise is to provide argumentation on the plausibility of the calculated value for the Croatian FRL, since direct validation of modelled data and values reported in Croatian NIR is not possible due to the application of Article 8.4 of the Regulation.

We hypothesised that, had there been no war in Croatia, due to the similarities between Croatia and Slovakia (i.e. Czech Republic and Slovakia combined), harvesting dynamics in those countries would be similar in the reference period 2000-2009. Harvesting dynamics was expressed with a value (i.e. an index id; column H in table 5.2-2) which is calculated as the ratio of the annual harvest (or in this case roundwood production from FAO database) in a given year i divided by the average harvest (roundwood production) during the period 1980-1989. The period 1980-1989 was selected as it is a 10-year-period before the war in Croatia. Formula for the index id is:

$$id(i)_{CZ+SK} = \frac{(\text{Annual roundwood production in year i})_{CZ+SK}}{(\text{Average annual roundwood production during 1980-1989})_{CZ+SK}}$$

Assuming “NO WAR” scenario, the annual harvest in year i in Croatia, for the years since 1990, was modelled as:

$$\text{Annual harvest}(i)_{HR} = id\ (i)_{CZ+SK} \cdot (\text{Average annual harvest during 1980-1989})_{HR}$$

Values of the actual annual harvests in Croatia are given in the column B of the

Table . Modelled harvests estimated with the above formula assuming NO WAR scenario, are marked in bold in the column I of the

Table

Table* 8.1-1 *Model by proxy for the estimation of the impact of war on harvests in Croatia.

	Year	**Croatia (harvests - Mm³)**	**Croatia * (roundwood - Mm³)**	Czechoslovakia (roundwood - Mm³)	Czech Republic (roundwood - Mm³)	Slovakia (roundwood - Mm³)	Czech Republic + Slovakia (roundwood - Mm³)	Annual roundwood production index - id (relative to 1980-1989 aver.) Czech Republic + Slovakia	**Croatia (annual harvests - Mm³) "NO WAR" estimate**
	A	B	C	D	E	F	G	H	I
1	**1970**	4.08	3.29	15.03	n.a.	n.a.	15.03	0.80	**4.08**
2	**1971**	4.05	3.27	15.09	n.a.	n.a.	15.09	0.81	**4.05**
3	**1972**	3.95	3.18	15.22	n.a.	n.a.	15.22	0.81	**3.95**
4	**1973**	4.09	3.30	15.52	n.a.	n.a.	15.52	0.83	**4.09**
5	**1974**	4.22	3.40	15.78	n.a.	n.a.	15.78	0.84	**4.22**
6	**1975**	4.30	3.47	16.55	n.a.	n.a.	16.55	0.88	**4.30**
7	**1976**	4.27	3.45	17.33	n.a.	n.a.	17.33	0.93	**4.27**
8	**1977**	4.41	3.56	17.62	n.a.	n.a.	17.62	0.94	**4.41**
9	**1978**	4.58	3.70	18.51	n.a.	n.a.	18.51	0.99	**4.58**
10	**1979**	4.70	3.80	18.76	n.a.	n.a.	18.76	1.00	**4.70**
11	**1980**	4.65	3.76	18.77	n.a.	n.a.	18.77	1.00	**4.65**
12	**1981**	4.96	4.00	18.80	n.a.	n.a.	18.80	1.00	**4.96**
13	**1982**	5.07	4.09	18.93	n.a.	n.a.	18.93	1.01	**5.07**
14	**1983**	5.24	4.23	18.83	n.a.	n.a.	18.83	1.01	**5.24**
15	**1984**	5.57	4.49	18.91	n.a.	n.a.	18.91	1.01	**5.57**
16	**1985**	5.45	4.40	19.00	n.a.	n.a.	19.00	1.02	**5.45**
17	**1986**	5.63	4.55	18.93	n.a.	n.a.	18.93	1.01	**5.63**
18	**1987**	5.48	4.42	18.68	n.a.	n.a.	18.68	1.00	**5.48**
19	**1988**	5.47	4.41	18.10	n.a.	n.a.	18.10	0.97	**5.47**
20	**1989**	5.48	4.43	18.23	n.a.	n.a.	18.23	0.97	**5.48**
21	**1990**	4.77	3.29	18.18	n.a.	n.a.	18.18	0.97	**4.77**
22	**1991**	3.64	2.94	15.29	n.a.	n.a.	15.29	0.82	**4.33**
23	**1992**	3.50	1.99	14.56	n.a.	n.a.	14.56	0.78	**4.12**
24	**1993**	3.41	2.45	n.a.	10.41	5.25	15.66	0.84	**4.43**
25	**1994**	3.63	2.82	n.a.	11.95	5.32	17.27	0.92	**4.89**
26	**1995**	3.42	2.60	n.a.	12.37	5.32	17.69	0.94	**5.01**
27	**1996**	3.65	2.54	n.a.	12.60	5.46	18.06	0.96	**5.11**
28	**1997**	4.08	3.05	n.a.	13.49	4.95	18.44	0.98	**5.22**
29	**1998**	4.14	3.40	n.a.	13.99	5.52	19.51	1.04	**5.53**
30	**1999**	4.10	3.49	n.a.	14.20	5.80	20.00	1.07	**5.66**
31	**2000**	4.52	3.67	n.a.	14.44	6.16	20.60	1.10	**5.84**
32	**2001**	4.55	3.47	n.a.	14.37	5.79	20.16	1.08	**5.71**
33	**2002**	4.51	3.64	n.a.	14.54	5.78	20.32	1.09	**5.76**
34	**2003**	4.74	3.85	n.a.	15.14	6.36	21.50	1.15	**6.09**

	Year	Croatia (harvests - Mm^3)	Croatia * (roundwood - Mm^3)	Czechoslovakia (roundwood - Mm^3)	Czech Republic (roundwood - Mm^3)	Slovakia (roundwood - Mm^3)	Czech Republic + Slovakia (roundwood - Mm^3)	Annual roundwood production index - id (relative to 1980-1989 aver.) Czech Republic + Slovakia	Croatia (annual harvests - Mm^3) "NO WAR" estimate
	A	B	C	D	E	F	G	H	I
35	**2004**	4.92	3.84	n.a.	15.60	7.24	22.84	1.22	**6.47**
36	**2005**	4.87	4.02	n.a.	15.51	9.30	24.81	1.33	**7.03**
37	**2006**	5.04	4.45	n.a.	17.68	7.87	25.55	1.36	**7.24**
38	**2007**	5.33	4.21	n.a.	18.51	8.13	26.64	1.42	**7.54**
39	**2008**	5.28	4.47	n.a.	16.19	9.27	25.46	1.36	**7.21**
40	**2009**	5.11	4.24	n.a.	15.50	9.09	24.59	1.31	**6.96**
41	**2010**	5.22	4.48	n.a.	16.74	9.60	26.34	1.41	**7.46**
42	**2011**	5.85	5.26	n.a.	15.38	9.21	24.59	1.31	**6.97**
43	**2012**	5.90	5.71	n.a.	15.06	8.20	23.26	1.24	**6.59**
44	**2013**	5.90	5.44	n.a.	15.33	8.06	23.39	1.25	**6.63**
45	**2014**	6.17	5.00	n.a.	15.48	9.17	24.64	1.32	**6.98**
46	**2015**	6.46	5.18	n.a.	16.16	8.99	25.16	1.34	**7.13**
47	**2016**	6.64	5.17	n.a.	17.71	9.27	26.97	1.44	**7.64**
48	**aver. 1980-1989**	5.30	4.28				18.72	1.000	**5.30**
49	**aver. 2000-2009**	4.89	3.99				23.25	1.242	**6.58**
50	**aver. (1980-1989) aver. (2000-2009)**	0.92	0.93				1.242	1.242	**1.242**

n.a. - not available/applicable;
* Before 1992 estimated using data on total harvest and the median (80.7%) of the share of Roundwood in the harvest.

The results presented in

Table indicate that the impact of war and post-war circumstances during the reference period resulted with harvests lower than expected. The average estimated annual harvest in case of “NO WAR” scenario is 6.58 Mm3 for the reference period, a value that was reached only in 2016 (Table 5.2-2, column B). In reality, due to the war and post-war circumstances, the average annual harvest during the reference period was only 4.89 Mm3.

As a consequence of the war, the reduced harvest led to the accumulation of biomass beyond planned optimal forest management. The intensity of the harvesting should, therefore, be restored to the optimal levels – a path that Croatian Forests Ltd. as a state company for managing state forests has been doing for almost 30 years.

Assuming the “NO WAR” scenario, the annual harvest in Croatia in 2016 would be 7.64 Mm^3 (see Table 5.2-2). This value is larger than the average annual harvest estimated with HS-MODEL (7.54 Mm^3) for the commitment period 2021-2025. Last, but not least, the current General FMAP, prescribes harvest of 8.04 Mm^3 during the commitment period, implying that planned intensity has been increased by approximately 6.5% with respect to the management practices in the reference period.

In conclusion, this exercise showed that the annual harvest of 7.54 Mm^3 in the commitment period 2021-2025, modelled with HS-MODEL is plausible. Harvesting intensity that would be lower than the modelled harvest would imply negative deviation from the existing, long-term-sustainable forest management in Croatia (Meštrović 1978). It would imply neglecting the stipulations of Article 8, paragraph 4 of the Regulation. It would also hinder the efforts to achieve a uniform distribution of age-class structure and maintain the sustainable, close to nature, production of high-quality timber as well as potentially jeopardize the stability of forest carbon sink.

9. REFERENCES

Air Protection Act (Official Gazette, No. 130/11, 47/14, 61/17)

Annual business report of the Croatian Forests Ltd (1991-2017)

Anon, 1991-2018: Godišnja izvješća o poslovanju Hrvatskih šuma d.o.o. (1991-2017)

Anon, 1996: Šumskogospodarska osnova područja 1996-2005 (obrazac ŠGO-9)

Anon, 2006: Šumskogospodarska osnova područja 2006-2015 (obrazac ŠGO-9)

Anon., 1989. Zbirka Jugoslovenskih standarda za drvo. . Novinsko-izdavačka ustanova Službeni list SFRJ, Beograd.

Anon., 1995. Hrvatske norme proizvoda iskorištavanja šuma (II izdanje). Državni zavod za normizaciju i mjeriteljstvo, Zagreb.

Anon., 2000. Tablica odbitaka kore – HsPro 2000. „Hrvatske šume“ d.o.o., Zagreb.

Anon., 2012. Tranzicija sa JUS-a na BAS EN standarde šumskih drvnih sortimenata u BiH. Finalni izvještaj. USAID, Sida, FIRMA Project.

Anon: 2016: Šumskogospodarska osnova područja 2016-2025 (obrazac ŠGO-12)

Bojanin, S., 1966a. Debljina kore na raznim visinama od tla kod jelovih stabala. Drvna Industrija 17, 76–85.

Bojanin, S., 1966b. Debljina kore kod jelove oblovine raznih debljina i njen odnos prema debljini stabala od kojih oblovina potječe. Drvna Industrija 17, 187–195.

Bojanin, S., 1972. Debljina i postotak kore oblovine poljskog jasena (Fraxinus angustifolia Wahl). Šumarski list 96, 267–277.

Božić, M., Čavlović, J., Vedriš, M., Jazbec, M., 2007. Modeliranje debljine kore stabala obične jele (Abies alba Mill.). Šumarski list 131, 3–12.

Brežnjak, M. 1997. Pilanska tehnologija drva, 1. dio. Izdavač: Šumarski fakultet Sveučilišta u Zagrebu. Zagreb.

Croatian Forests - a public forest and forestry management company in the Republic of Croatia, p.o., Zagreb, 1998. War Damage 15.08.1990-31.12.1997.

Croatian Forests Ltd. Extraordinary revision of Forest Management Plan 2004

Croatian greenhouse gas inventory for the period 1990-2016. NIR 2018 - Submission under the United Nations Framework Convention on Climate Change and Kyoto Protocol, 2018. Order: Croatian agency for the environment and nature. URL: https://unfccc.int/documents/65671.

Čavlović, J., Božić, M., 2008. Nacionalna inventura šuma u Hrvatskoj – metode terenske procjene i izmjere. Šumarski fakultet Zagreb. pp.146.

Čavlović, J., 2010: Prva nacionalna inventura šuma Republike Hrvatske. 300 p. Ministarstvo regionalnog razvoja, šumarstva i vodnoga gospodarstva i Šumarski fakultet Sveučilišta u Zagrebu. Zagreb.

Decision 2/CMP.7 Land use, land-use change and forestry

Decision 24/CP.19 Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention

Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities

FAO, Global Strategy & UN, 2015. Guidelines on International Classifications for Agricultural Statistics. Food and Agricultural Organization and the United Nations (Statistics Division, Department of Economic and Social Affairs).

FAO, Global Strategy & UN, 2016. Forest Products Classification and Definitions, Global Strategy Working Papers.

Food and Agriculture Organization of the United Nations (FAO), 2017. Joint FAO/ECE/EUROSTAT/ITTO Questionnaire - Joint Forest Sector Questionnaire Definitions. URL: http://www.fao.org/forestry/7800-0f3bd783f4d81da943d201e3c40aaf887.pdf

Food and Agriculture Organization of the United Nations (FAO), Global Strategy for Improving Agriculture and Rural Statistics (Global Strategy), United Nations (UN), 2016. The Forest Products Classification and Definitions (FPC&D). Working Paper No.14. Publisher: Food and Agriculture Organization of the United Nations.

Forest Law (Official Gazette No. 68/2018)

Forest Management Area Plan for the Republic of Croatia for the period 1996-2005 (FMAP 1996-2005)

Forest Management Area Plan for the Republic of Croatia for the period 2006-2015 (FMAP 2006-2015)

Forest Management Area Plan for the Republic of Croatia for the period 2016-2025 (FMAP 2016-2025)

Intergovernmental Panel on Climate Change (IPCC), 2006. IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. URL: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

Intergovernmental Panel on Climate Change (IPCC), 2013. IPCC 2014 - Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds) Published: IPCC, Switzerland. URL:

https://www.ipcc.nggip.iges.or.jp/public/kpsg/pdf/KP_Separate_files/KP_Chapter_2_Methods_estimation_Measurement_Monitoring_Reporting.pdf

Intranet HŠ d.o.o. - online reports on the production. URL: www.hrsume.hr

Klepac, D., 1957. Istraživanja o debljini kore u šumama hrasta lužnjaka i kitnjaka. Šumarski list 81.

Klepac, D., 1958. Funkcionalni odnos između debljine kore i prsnog promjera za naše važnije listopadno drveće. Šumarski list 82, 251–267.

Krpan, A.P.B., 1984. Kora bukve sa stanovišta eksploatacije šuma, in: Krpan, A.P.B. (Ed.), Presented at the Kolokvij o bukvi, Šumarski fakultet Sveučilišta u Zagrebu, pp. 77–88.

Nazor, A., Pušek, Tomislav, 2018. Domovinski rat – pregled političke i diplomatske povijesti, Nakladni zavod Globus – HMDCDR, Zagreb.

Meštrović, Š., 1978. Pravilnik o izradi šumsko-privrednih osnova, osnova gospodarenja i programa za unapređenje šuma u svijetlu šumarske znanosti (Osvrt) – (Rulebook on preparation of forestry-economic plans, forest management plans and programs for the promotion of forests in the light of forestry science (A review) – in Croatian). Šumarski list 102(8-10), 352-364. URL: https://www.sumari.hr/sumlist/gootxt.asp?id=197808&s=66&s2=78

Ordinance on Forest Management (Official Gazette No. 111/2006)

Ordinance on Forest Management (Official Gazette No. 97/2018)

Perković, Ž., 2010. Kakvoća bukovih stabala i sortimenata u prebornim šumama Gorskog Kotara (Magistarski rad). Sveučilište u Zagrebu, Zagreb.

Poršinsky, T., Vujeva, J., 2007. Gubici obujma izrađene smrekove oblovine zbog propisanoga načina izmjere. Nova mehanizacija šumarstva 28, 37–47.

Prka, M., 2004. Debljina kore obične bukve (Fagus sylvatica L.) u sječinama Bjelovarske Bilogore. Šumarski list 128, 391–403.

Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC Text with EEA relevance

Regulation on monitoring of greenhouse gas emissions, policies and measures for their reduction in the Republic of Croatia (Official Gazette No. 5/17)

Republic of Croatia, 2018. 2nd REQUEST for an extension of the deadline for completing the destruction of antipersonnel mines in mined areas in accordance with Article 5, paragraph 1 of the Convention on the Prohibition of the Use, Stockpiling, Production, and Transfer of Anti-Personnel Mines and on Their Destruction. Period requested 2019-2026. Submitted to the Convention on the Prohibition of the Use, Stockpiling, Production, and Transfer of Anti-Personnel Mines and on Their Destruction Committee on Article 5 Implementation.

SAFU, European Funds For Croatian Projects, 2009. A Handbook on Financial Cooperation and European Union Supported Programmes in Croatia, 2009. URL: http://www.safu.hr/datastore/filestore/10/European_Funds_for_Croatian_Projects.pdf

Stankić, I., Kovač, S., Poršinsky, T., 2010. Značajke kore Podravske crne johe. Nova Mehanizacija Šumarstva 31, 27–36.

State Commission for War Damage Assessment of the Government of the Republic of Croatia, 1999. War Damage of the Republic of Croatia – Final Report.

Šumarski list 5-6, 1963. pp. 29. URL: https://www.sumari.hr/sumlist/196305.pdf

Šušnjar, M., 2002. Neke značajke kakvoće stabala obične jele (Abies alba, Mill.) u gospodarskoj jedinici Belevina Nastavno-pokusnog šumskog objekta Zalesina (Magistarski rad). Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.

United Nations Economic Commission for Europe (UNECE), 2010. Geneva Timber and Forest Discussion Paper 49 - Forest Product Conversion Factors for the UNECE Region. Published: United Nations Publication, ISSN 1020 7228.

Vusić, D., 2013. Pogodnost sustava pridobivanja drvne biomase u smrekovoj šumskoj kulturi (Disertacija). Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.

World Bank, FAO, UN, 2010. Global Strategy To Improve Agricultural Global Strategy To Improve Agricultural. World Bank, FAO, UN.