REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENT AND ENERGY
MINISTRY OF AGRICULTURE

NATIONAL FORESTRY ACCOUNTING PLAN FOR THE REPUBLIC OF CROATIA

Zagreb, December 2018

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FIGURES

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ABBREVIATIONS

ARR	Annual Review Report
CRONFI	Croatian National Forest Inventory
DOM	Dead Organic Matter
DW	Dead Wood
EK	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
FMP	Forest Management Practices
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
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 B: 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 which 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 FRL for Croatia was determined based on the implemented and documented Forest Management Practices (FMPs) during the Reference period 2000-2009 on the forest areas on which the influence of the War and post-War circumstances **was assumed to be negligible** (detailed information presented in Chapter 2).

In the FRL estimation following pools are included:

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

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

The data coming from the below listed General FMAPs and plans/programs for the management of specific forest management units 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 databases (UNECE/FAO) were used as well as data available at the national level (State Bureau of Statistics data).

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 determined 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) is not comparable with the intensity of the survey used for the preparation of forest management plans (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, during the CRONFI design process, the reporting requirements for the UNFCCC and the KP were not taken into account and all forest parameters are defined according to the national legislation and definitions, thus they cannot be directly applied for the UNFCCC reporting purposes.

It has been realized that two consecutive CRONFIs should be conducted before the data collected through this process can be used for the UNFCCC reporting purposes. Since the CRONFI data are assessed from the point of its usability for UNFCCC reporting, it was concluded that CRONFI data cannot be considered as the best available data for the purpose of FRL development.

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 first-order decay function for the HWP pool. Carbon stock changes in the dead wood pool are estimated to be zero, the same as in the NIR 2018. New estimation of carbon stock changes will be performed in following years and afterwards FRL technical correction will be performed.

By using the same methods, the same data sources for the estimation of carbon stock changes in mentioned pools for FRL determination as in NIR 2018 the consistency between the FRL and the estimation of emission/removals on the forest areas on which War influence was considered to be negligible was secured (detailed information presented in Chapter 4.2).

The Law on forests[1] regulates the activities in the 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:

- General Forest Management Plan for the Republic of Croatia (General 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 areas
- Programmes for management of forest with special purpose
- Annual forest management plans
- Annual operative plans

Forest Management Plan for management units are developed on 10 years cycles and according to the Law on forests each year 10% of the total forest area is in process of renewal of the plan. This process presents the forest inventory conducted on the stand level that has been implemented in Croatia for many decades.

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

The General FMAP, among others, appoints activities which 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 General FMAPs have been prepared:

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

Based on the forest management type, according to the Ordinance on Forest Management[2] forest stands are managed either as even-aged or uneven-aged forests.

[1] (OG 66/2018)
[2] (OG 97/18)

In case of uneven-aged forests two types of selection systems are performed, but for the FRL purposes and presentation of the Forest Management Practices (FMP) conducted under the defined strata, these two types of forests are presented as uneven-aged forests.

Even-aged forest stands make regular forests with a share of about 52% of the total growing stock (excluding maquis and shrub forests). Uneven-aged forests take a share of 30 % of the total growing stock (excluding maquis and shrub forests). State forests are managed either by "Croatian Forests Ltd." or by other legal bodies.

Through the years private forests were under the jurisdiction of different state/public bodies but the development of the forest management plans/programs for these forests is a continuous process and these documents are at the moment adopted for more than more than 50% of the private forest. All forests regardless the ownership type are considered for FRL development since the General FMAPs addresses all forests in Croatia.

Croatia decided to the use 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 (areas, increment, total harvest, rotation length, harvest intensities according to the age or dbh structure) were extracted from the official forest-database *HS Fond* in the RP. This database contains all forestry data relevant for the General FMAPs development and it has been used also each time when other forest plans/programs are developed. For the modelling purposes 135 176 forests stands were examined. After the all relevant parameters from the Reference period were defined Croatia decided to perform modelling starting with the year 2016.

Regarding the stipulation of Article 10 of the Regulation: "*At the end of each of the periods from 2021 to 2025 and from 2026 to 2030, Member States may exclude from their accounts for afforested land and managed forest land greenhouse gas emissions, resulting from natural disturbances, that exceed the average emissions caused by natural disturbances in the period from 2001 to 2020, excluding statistical outliers ('background level')*" emissions due to the natural disturbances are not accounted under the FRL. These emissions will be accounted when all data needed for the background and margin level determination will be available, after the end of the period 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 forest land.

The background and margin levels will be determined and submitted by Croatia in **order to enable Croatia to exclude** from its accounts for managed forest land greenhouse gas emissions resulting from natural disturbances that exceed the average emissions caused by natural disturbances in the period from 2001 to 2020.

The provisional estimation of the background and margin levels of the emissions due to natural disturbances on managed forest land using the currently available data (for period 2000-2017) are presented in Annex 2 of this document.

Estimation performed using the **Tier 1** and accounting the HWP based on the instantaneous oxidation method, leads to the FRL of **4091 Gg CO_2 per year in period 2021-2025**.
The FRL equals **4553 Gg CO_2 per year** using the first order decay for the estimation of carbon stock changes in HWP.

Annex IV, part A, point f of the Regulation

Croatia secured that its FRL is in line with the requirements of the Annex IV, part A, point 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 Forest Reference Level should be consistent with EU strategies and principles of sustainability. In that sense, they are evaluated with principles of the FOREST EUROPE process, New EU Forest Strategy 2013 and the EU Biodiversity Strategy to 2020.

Europe has a king tradition of sustainable forest management, reflected in the principles of FOREST EUROPE process, which apply policies of the member states and support the EU, particularly through rural developments policy. As part of the FOREST EUROPE process, member states are obligated to manage their own forests in a sustainable manner, in accordance with national policies and forestry legislation. The implementation of this strategy should focus on the reference values of sustainable forest management, improved information exchange and propagation of good practice. In the forest sector, the efficient use of resources means usage of forest resources in a way that reduces the impact on the environment and climate as much as possible. Also, it gives priority to forestry production with the higher added value that opens up more jobs and contributes to a better carbon balance.

According to FOREST EUROPE, forest management is defined sustainable if it maintains:

- Forest biodiversity
- Productivity
- Regeneration capacity
- Vitality
- 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

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 an 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) biodiversity is highlighted in Article 3 which defines sustainable forest management just as FOREST EUROPE does. In addition, Nature Protection Act (OG 80/13, OG 15/18) in its Article 4 highlights the goals and tasks of nature conservation, as well as 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.

Regarding the productivity issue, 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, „close to nature" management, the productive capacity of forest ecosystems does not diminish but is continuously increasing. Proof of this is data from Forest management plans that are renewed every 10 years and according to which, at the level of the Republic of Croatia (FMAP 1996-2005, FMAP 2006-2015, FMAP 2016-2025), there is an increase in the stock of wood.

Regeneration capacity
Of the three modes of management applied in forestry of the Republic of Croatia (even-aged, selection and uneven-aged), each itself maintains regeneration capacity of forests. In even-aged management based on achieving the normal proportion of age classes, the sustainability of regeneration is planned in the long term. Selection forests represent an area where regeneration is a permanent process that occurs simultaneously with other management activities. Similarly, uneven-aged management in private-owned forests can be considered as a transient form between the first two modes of management.

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. Over the years since initial crown condition monitoring, the program has developed and is still developing and expanding into multidisciplinary monitoring of the impacts of pollution on the vitality of the entire forest ecosystem. The Republic of Croatia is an active participant in the program, with a regulated legal basis in this area, and its experts contribute to the development of methods and tools.

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 FSC certificate also confirms that forests are to be managed according to strict ecological, social and economic standards.

The EU Biodiversity Strategy by 2020 represents the answer to two major obligations of the EU leaders from March 2010, more precisely to stop the loss of biodiversity in the EU by 2020 and to protect, evaluate and restore biodiversity and ecosystem services in the EU by 2050.
The European Union (EU) has adopted EU Biodiversity Strategy by 2020 to protect and improve the biodiversity situation in Europe for the next decade. The goal of the strategy is to prevent the loss of biodiversity and the collapse of the EU's ecosystem by 2020 by identifying six targets:

1. The full implementation of the EU nature legislation
2. Better protection and restoration of ecosystems and the services they provide, and greater use of green infrastructure
3. More sustainable agriculture and forestry
4. Better management of EU fish stocks and more sustainable fisheries
5. Tighter controls on Invasive Alien Species
6. A greater EU contribution to averting global biodiversity loss.

The basic legal act regulating the use of forests and forest land in the Republic of Croatia is the Law on Forests (OG 68/18). 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 are listed in the first 3 articles. Implemented sub-legitimate act which regulates the content, deadline for issuing and method of making forest management plans as the basic conditions for the continuous and sustainable management and control of forests (state ones as well as private, economic forests and forests of a special purpose) is the Forest Management Plan (OG 97/2018). In addition to other sub-legitimate acts related to forestry issues, it is used in

operational forestry for specific management activities. Alongside the forestry sector, the environment and nature protection sector and the related law acts are inseparable. In the first place, it is the Nature Protection Act (OG 80/13 and OG 15/18) as it regulates the system of protection and integral preservation of nature and its parts, thus the forest themselves. Its basic settings and visible compliance with the EU Directives are contained in the first six articles of the Act.

Taking into account all the above, and the fact that in the Republic of Croatia forestry plans are being implemented regularly and completely implemented in practice, the conclusion is that forest management in the Republic of Croatia is sustainable and that the continuation of management practices in the future will ensure this sustainability.

The Forest Reference Level set by the Republic of Croatia is in line with the New EU Forest Strategy 2013 and the EU Biodiversity Strategy to 2020 and with sustainable forest management as defined by FOREST EUROPE.

1.2. CONSIDERATION TO THE CRITERIA AS SET IN ANNEX IV OF THE LULUCF REGULATION

All criteria as set in Annex IV of the LULUCF Regulation are considered in Croatian National Forestry Accounting Plan (NFAP) and described in Chapters of the NFAP as presented in Table 1.2-1 and 1.2-2.

Table 1.2-1 Criteria

Annex IV A paragraph item	**Criteria of Annex IV A**	**Chapters or page number(s) in the NFAP**
(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;	3.2.2
(b)	the reference level shall ensure that the mere presence of carbon stocks is excluded from accounting;	5.3.3
(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;	5
(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;	5.3.1
(e)	a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 shall be assumed;	5.3.2
(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;	5.1.1; Annex1;
(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;	5.3.4
(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.	2.1;2.2;2.3; 4.1;4.2;4.3

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)

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

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 bring establishment of the new Croatia, and on 22 December the Republic of Croatia gets its new Constitution act. Croatia started to be recognized by the international community on 15th January 1992 and 22nd of May the Republic of Croatia became 178 member of the United Nation Organization.

18th of August 1990 was proclaimed as an official date of the aggression on the Republic of Croatia. Conclusions of the Croatian Parliament of 7th and 8th of May 1992 defines the aggressor of the Republic of Croatia as "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 The Republic of Croatia is the only EU Member State faced with the War and post-War circumstances in the recent past.

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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" rebelian, from mid-August 199Up to June 25, 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 January 15, 1998.

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

37 119 679 000 US$

The damage was 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.

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 were the main reasons for deviations from full, normal forests management practices since 1991 and up to date. Without taking these special circumstances into the consideration the determination of FRL for Croatia would not be possible because the determination of FRL on any other way would not reflect a real situation in Croatian forests and consequently would not present its real removal capacities. 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 the Reference period.

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 the 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 exists. 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 experiences on damage assessment after the 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 forest 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 forestry units, and 11 forest districts were more or less affected by the War and were not available for forest management.

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 **1) direct** and **2) indirect** damages on forests caused by the War in Croatia.

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 lost amounts to 20,6% of the total number of employees. Adding to this number the number of employees that joined the rebelian forces, the company was faced with the loss of more than 30% of employees at the beginning of the War.

1. The Assessment of direct damage 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 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 **18 103 000 DEM**.

The direct War damage of forestry equipment was estimated to be **42 443 000 DEM**. 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 **13 408 000 DEM**.

In the case of War damage on forests and game, it was estimated that this damage equals **133 377 000 DEM**. 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 damage 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 **3 690 935 000 DEM** of which 177 536 000 DEM 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 28th of May 1998 and submitted its initial transparency report on 3rd 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[3] (HA) size and estimated financing needed for the demining, extension for the clearance tasks will be needed.

Croatia had a deadline until 1st 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**. Now, 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

[3] Hatardous areas (HA) implies confirmed hazardous areas and suspected hazardous areaa (CHA + SHA)

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. Overall, Croatia has obtained more than €153.7 million from international donors and EU funds. Nevertheless, it should be emphasized that **Croatia 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 many 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 Law on forests (OG 66/18) 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 they 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 requests and received the extension for the clearance task. In its request, Croatia emphasized it is capable of clearing 56 km2 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 km2 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 km2 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.

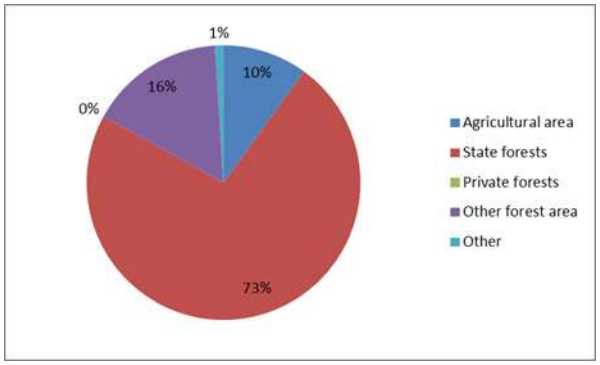

Figure 2.1-1 Hazardous area (HA) structure according to allocation of areas.

Detailed structure of the remaining HA according to the allocation of areas in counties is presented in Table 2.1-1 and in Figure 2.1-2 is presented HA in forest areas in 2018.

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**
	km^2	% 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

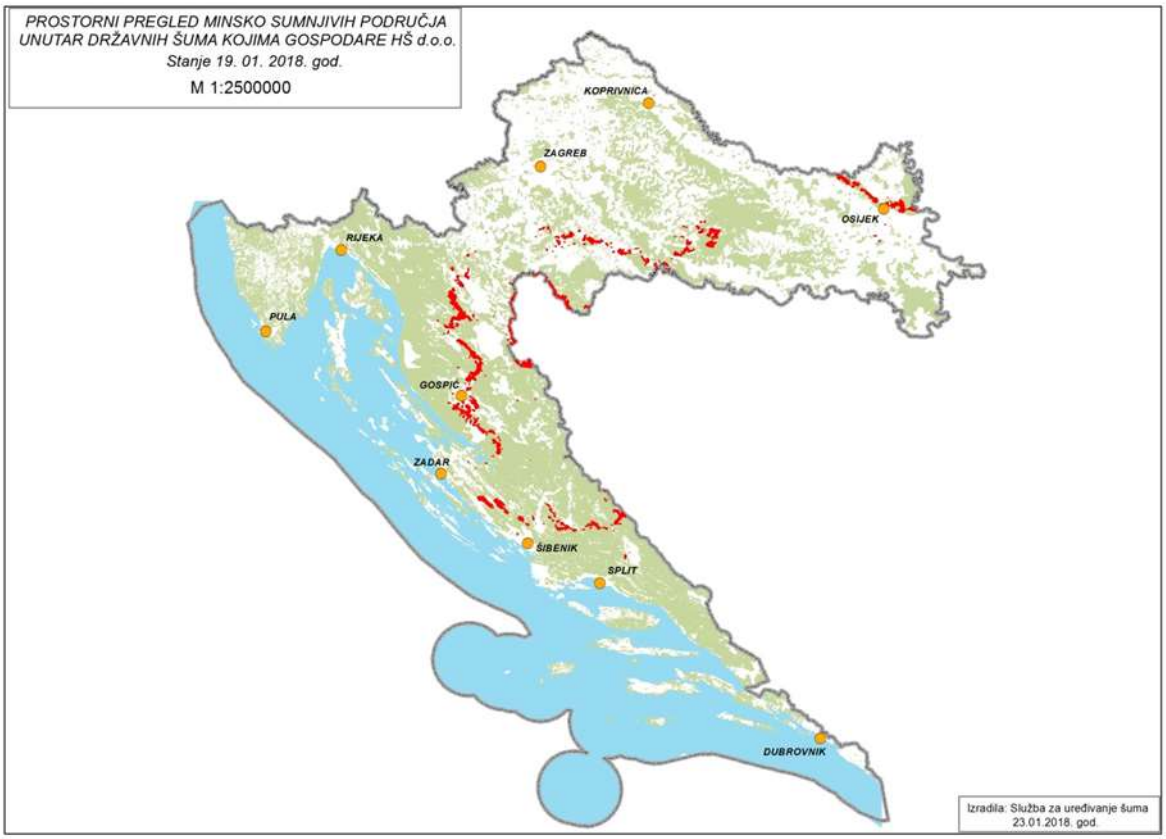

Figure 2.1-2 HA in forest areas in 2018 spatial representation of the mine suspected areas (red colour) in state forests managed by Croatian Forests Ltd. on the date 19 January 2018

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 (up to 1st 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) is 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 that separates areas in the Forest districts (FDAs) 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. Bearing in mind that there is possibility that the clearance of forest areas in period up to 2026 will not be executed as planned (i.e. due to the lack of financial sources or giving the advantage to the clearance of agricultural areas because of gaining financial resources through the EU Rural Development Programme), conservative approach was used to model forest areas in period 2021-2025. Areas detected as mine poluted, within each of the defined strata in 2016, are kept unchanged in period 2021-2025 (Table 2.1-2). For them the intensity of harvest was zero.

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

Forest type	**Main tree species**	**2000**	**2009**	**2016**	**2025**
Deciduous	Pedunculate oak	12.56812	8.01918	6.5492	6.54920
	Sessile oak	36.84531	23.90684	10.7286	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 the fact that that during the Reference period of the Regulation, all EU Member States that had the similar social system to Croatia (communist regime) were faced with the transition from the social economy to the market economy during the 1990s and that all EU Member States 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 the separate, detailed analysis conducted by Croatia for the purposes of FRL development and 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 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 25th 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 a market economy or of the year 2008 economic crises.

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 counties 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.

Figures 2.3-1 to 2.3-3 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 1st January 1993. Closer look at the GDP of Czechoslovakia

and Yugoslavia, and from 1990[4] for Checzia, Croatia and Slovakia, shows noticeable similarities in both size and the dynamics of *per capita* GDP (Figure 2.3-4)

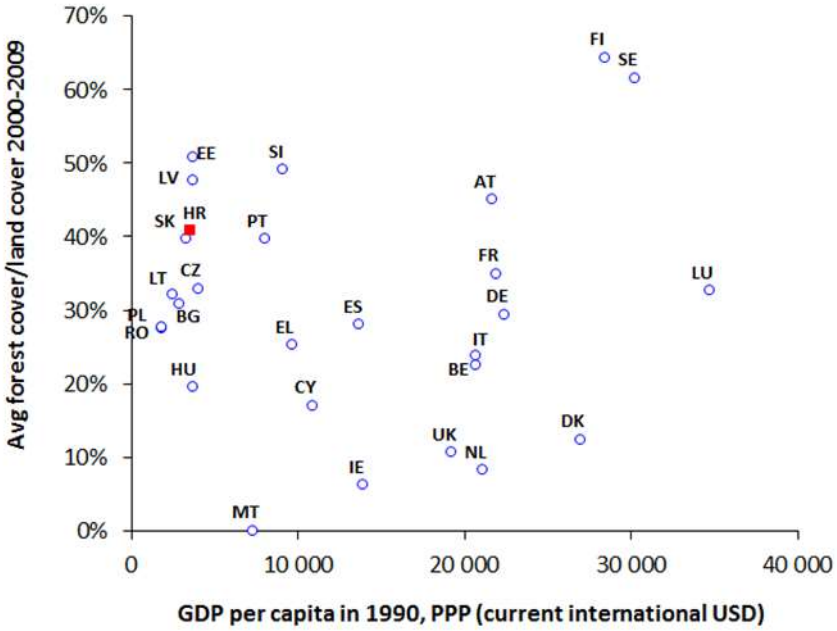

Figure 2.3-1 Average forest cover/land cover 2000-2009 (Source: Materials provided during Regulation negotiations) versus Per capita GDP (Source: UNdata 2018) for the EU countries.

[4] UNdata provides GDP data for Czechia, Croatia and Slovakia separately from the year 1990. (URL: http://data.un.org/)

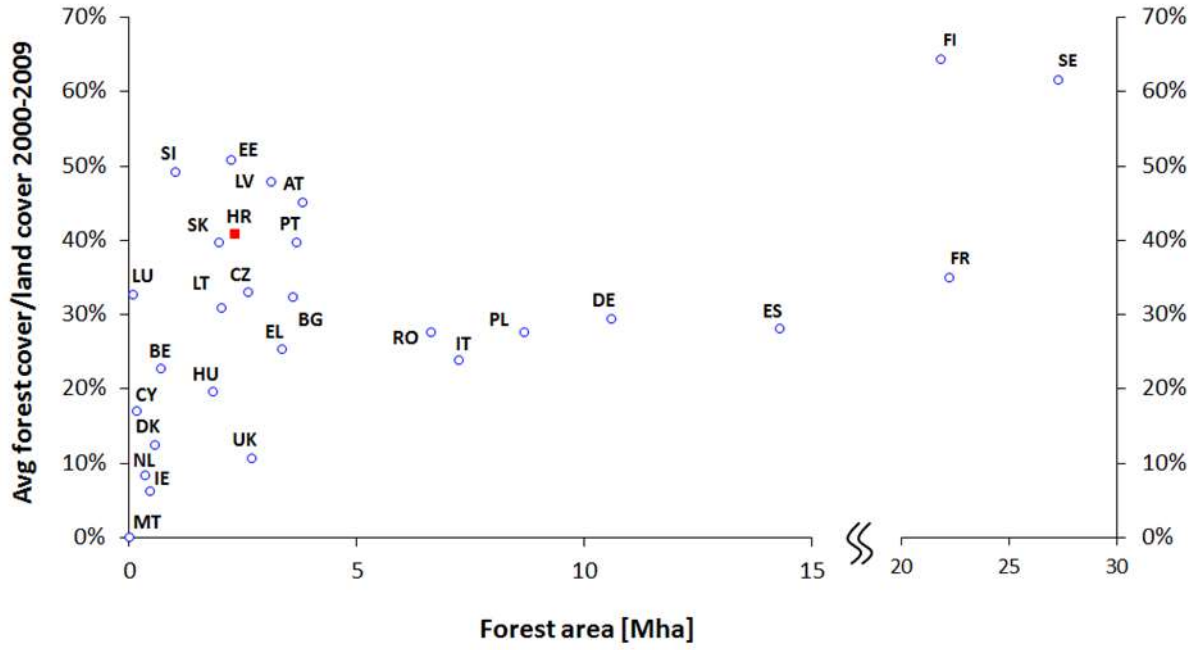

Figure 2.3-2 Average forest cover/land cover 2000-2009 (Source: Materials provided during Regulation negotiations) versus forest area for the EU countries (Source for countries' areas: Eurostat, Area by NUTS 3 region [demo_r_d3area]).

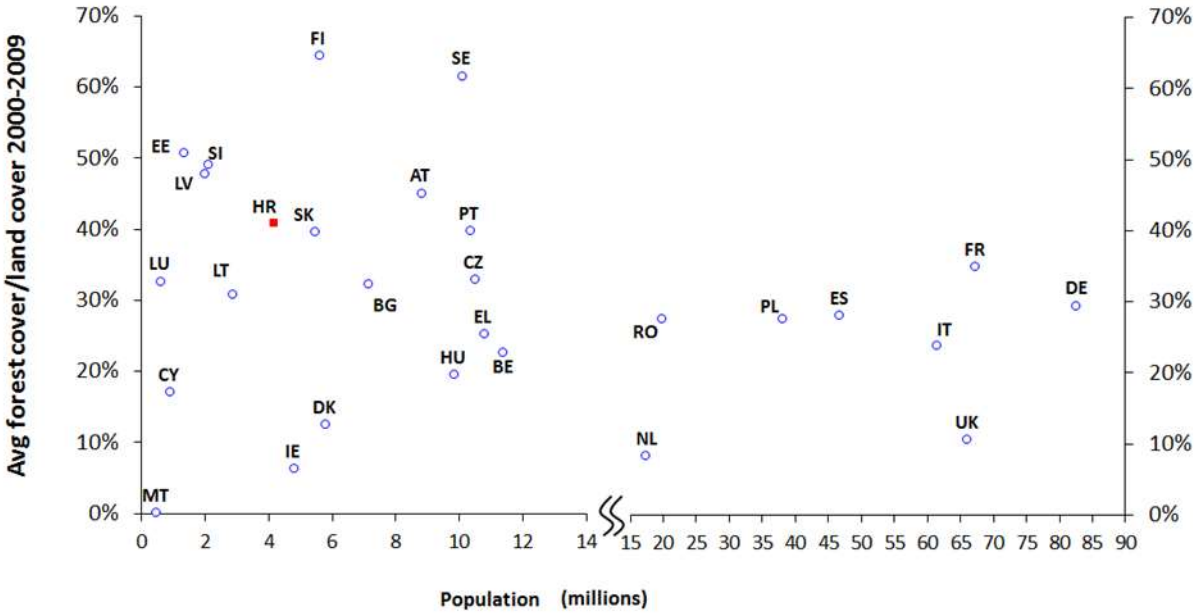

Figure 2.3-3 Average forest cover/land cover 2000-2009 (Source: Materials provided during Regulation negotiations) versus the population of the country (Source: Eurostat)

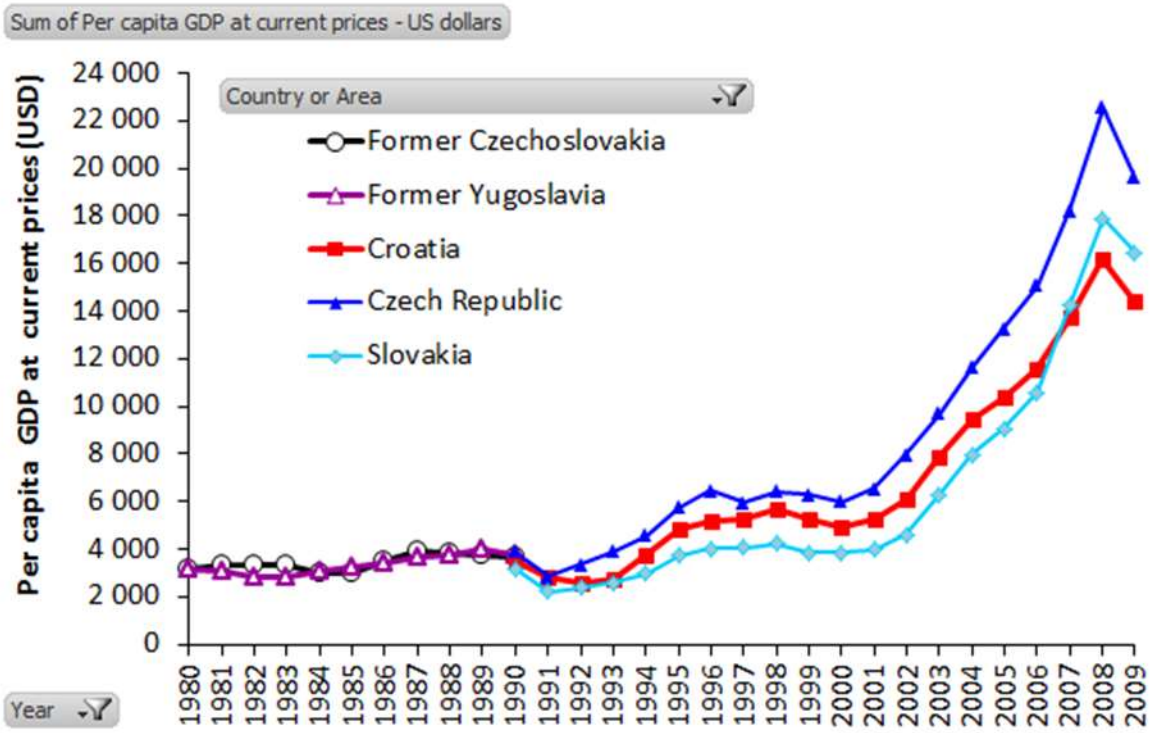

Figure 2.3-4 Per capita GDP for the countries the Czech Republic and Slovakia, having some historic similarity to Croatia (dissolution of Czechoslovakia vs. breakup of Yugoslavia. Source: UNdata 2018).

Observed similarities between Croatia and Czechia 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 only for Czechoslovakia and Yugoslavia, but not separately for Czechia, 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 Czechia and Slovakia (since 193). 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.

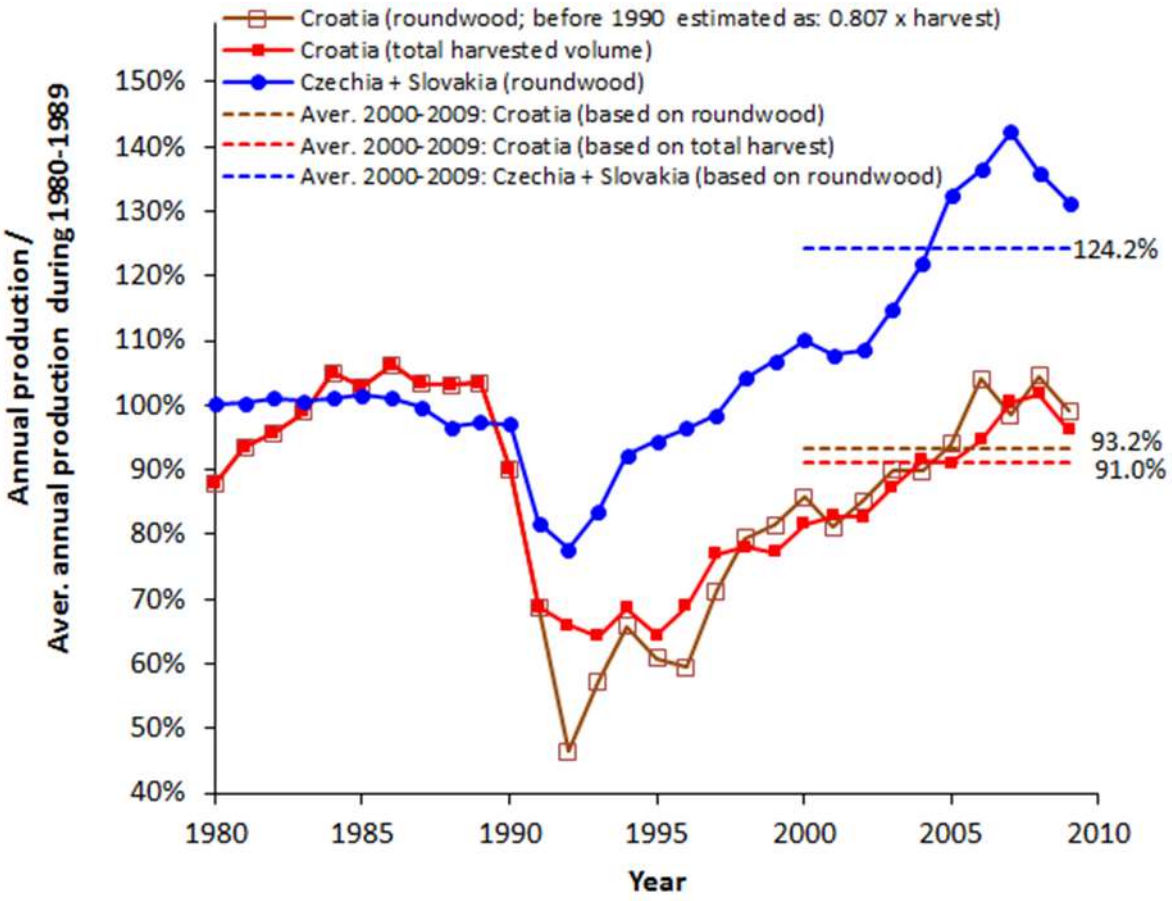

Figure 2.3-5 The ratio of Annual Roundwood production and Average annual Roundwood production during 1980-1989 (Source: FAOstat). Dashed lines denote average annual Roundwood/harvest production during the reference period 2000-2009 as a share of the average annual production during 1980-1998. NOTE: Before 1990 data on Roundwood production for Croatia, Czechia 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 Czechia and Slovakia (Figure 2.3-5) showed a very distinguished 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 Czechia 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 2.3-5 for Croatia shows similar dynamics (the fall in production at the beginning of the 1990s), but unlike combined production of Czechia 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 Czechia 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 Figure 2.3-6. The general national forest management plan (Forest Management Area Plan – 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 relies on accurate forest management planning which **has to be implemented**. If there is evidence that the planed harvest will not be realised at the level of at least 90% the plan must be revised. Article 93 of the Ordinance on Forest Management (OG 111/2006) stipulates: "**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 was (see chapter 2.1). Assuming that harvests in Croatia would, had there been no war, exhibit a similar pattern as the harvests in Czechia and Slovakia, we constructed a model of harvest "Without war". The model uses the average annual harvest in Croatia during 1980-1989 of 5.3 Mm^3 and correction factor based on the relative combined production of Roundwood in Czechia and Slovakia (see figure 2.3-5 and Chapter 5).

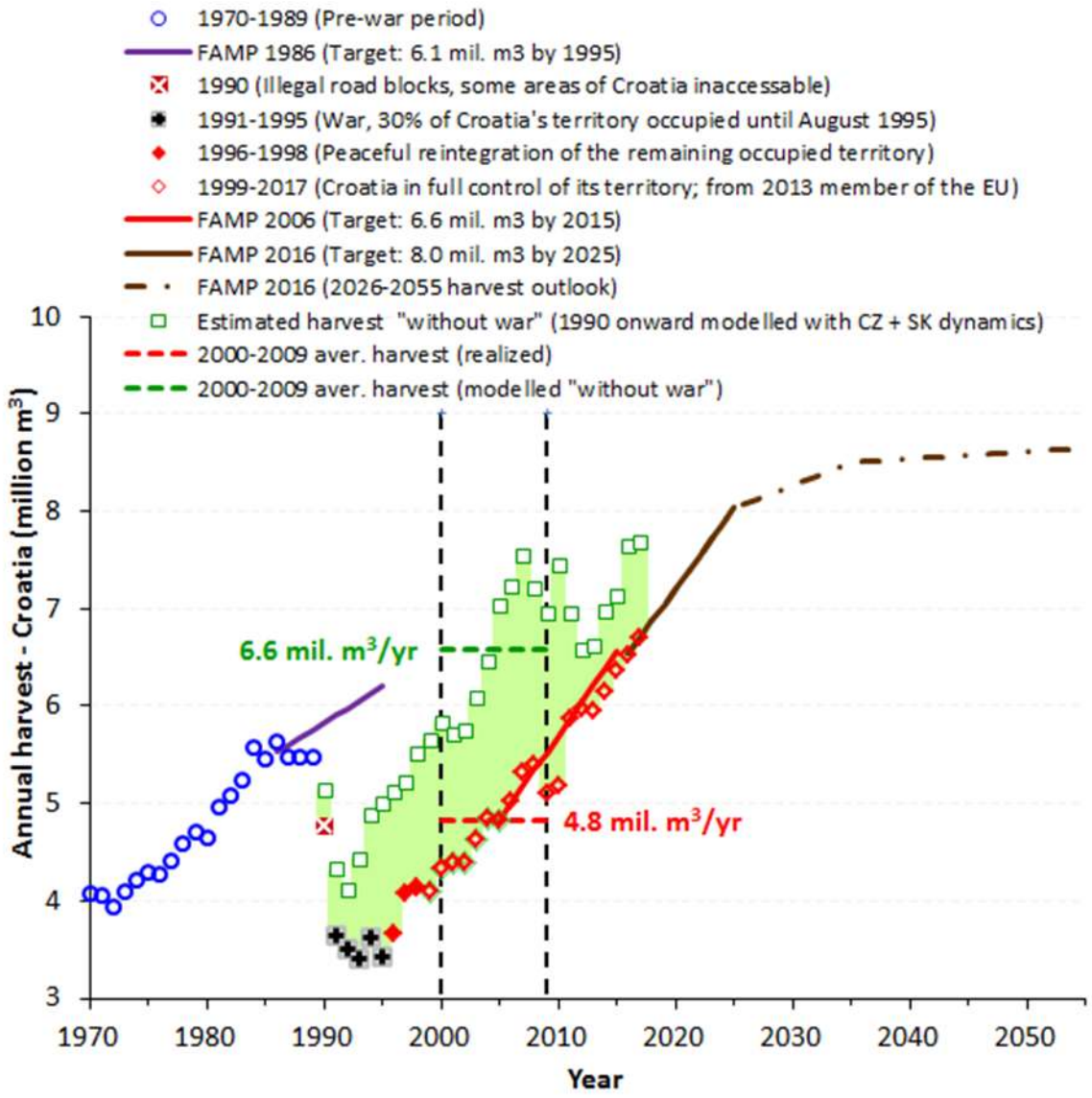

Figure 2.3-6 Comparison between the actual harvest and the "Without war" harvest (green squares), estimated using FAOstat data on roundwood production dynamics in Czech Republic and the Republic of Slovakia. The green shaded area represents the estimated amount of harvest that has not been realized in Croatia due to the war; the modelled harvest "Without war" during the reference period 2000-2009 amounts to 6.6 Mm3, compared to the actually harvested 4.8 Mm3. The modelled 6.6 Mm^3 is only 0.4 Mm^3 (6.5%) larger than the target for 1996 that was prescribed in the FMAP 1986.

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 level:

1. above-ground biomass
2. below-ground biomass
3. harvested wood products
4. 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:

a) 2 years for paper,
b) 25 years for wood panels,
c) 35 years for sawn wood.

The carbon stock change in the dead wood pool is estimated to be zero. The new carbon stock change estimation will be performed in due time and the corresponding technical correction of the FRL will be reported.

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 from the FRL estimation. These two pools are considered to be not the sources of emission in managed forest lands, as elaborated below.

Pursuant to existing legislation (Ordinance on Forest Management, OG 97/18), collection of data on dead wood during forest stand inventory and drafting of management plans 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 management plans 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.

According to available national scientific research carbon stock in litter pool in common oak stands increases with the age of the stand and reaches the maximum (10.34 tC/ha) in 137th year. The greatest areas are taken by common oak stands of the sixth (100 years) and seventh (120 years) age class. Pursuant to the Ordinance on Forest Management, rotation period is 140 years, which implies constant carbon accumulation in common oak in the listed forest stands. Seeing as how oak is one of the main species in Croatian forests, and there is no change in forest management in Croatia, the assumption is that in all forests the carbon stock in the litter pool is increasing. Additionally, estimates show that biomass stocks in Croatian forests have increased in the last several decades. It is obvious that litter is greater in forests with more biomass. In parallel, increased logging in Croatian forests over the last decade is linked to greater volume of dead organic matter from logging remains (for example: branches, sawdust, stumps, roots) on the ground. Also, this trend is linked to the increase of litter on the ground.

Pursuant to the above-mentioned legislative framework which forbids taking peat, litter and humus out of the forest, and the data shown in the report which clearly show an increase in biomass stock and logging, it can be concluded that reduction in carbon stock in the litter pool is not likely. Additionally, under the legislative framework using humus is allowed under exceptional circumstances, but only if it is in accordance with forest management plans and special legal provisions. Taking the afore-mentioned into account, and the fact that carbon stock in litter pools and soil is increasing due to the increase in biomass stock and increased logging leading to carbon influx due to logging remains and production in the forest, it can be concluded that the litter pool in Croatian forests is not an emission source.

There has been no change in the forest management method in the Reference period. At this time in Croatia there is no expert and scientific literature or research of the hypothesis whether the forest soil is an emission source. Increase in biomass stock and increased logging is linked to inflow of litter into the soil and, consequently, to increase in carbon stock in litter pools and the soil. Following this fact and the explanation given in the dead wood litter pool, it can be concluded that the carbon stock in the soil of the managed forests is not an emission source.

3.2. DEMONSTRATION OF THE CONSISTENCY BETWEEN THE CARBON POOLS INCLUDED IN THE FOREST REFERENCE LEVEL – IV B (B)

Estimation of carbon stock changes on areas of forest management in Croatian NIR 2018 are perform using the available data on areas, increment and harvest as they were 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.

It was not possible for Croatia to set up FRL based on the intensities of harvest during the reference period of the LULUCF Regulation due to the War and post-war effect on forest management in Croatia. Because of that management intensities are derived from the selected, seven Forest Administrations for which the war and post-war is assumed to be negligible. Since the estimation of emission/removals in NIR 2018 is conducted for the whole forest areas in Croatia (areas that are fully and partially affected by the war and post-war effects), and modelling was performed only using the data that area coming from forest areas for which the war and post-war is assumed to be negligible, it was not feasibly to demonstrate consistency between the carbon pools included in the FRL.

3.3. DESCRIPTION OF THE LONG-TERM FOREST STRATEGY (IV B (D))

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

Forest management plan for the Republic of Croatia (General FMAP) is a general forest management plan for appointing activities which will be performed in the forests and forest land within the whole 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 adoption of the general FMAP is defined in Article 21, paragraphs 1 and 2 of the Law on forests, and the same is the interest of the Republic of Croatia referred to in Article 6, paragraph 3 of the Law on forests.

Purpose of determining 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 Forest management plan for the Republic of Croatia for the period 2016-2025 (General FMAP) 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), in accordance with the article 66 paragraph 3 of the Environmental Protection Law (OG 80/13,

153/13 and 78/15), based on the Decision on Implementation of the Strategic Environmental Impact Assessment of the FMAP.

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

The Law on forest 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 which 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 forest land 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 forest land with and without 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 can be performed. In these forests two types of uneven-aged forest management are applied:

- a group-tree-selection system (Type 1 of the uneven-aged forest management), or
- 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 3.3-1). This division was established in 1996.

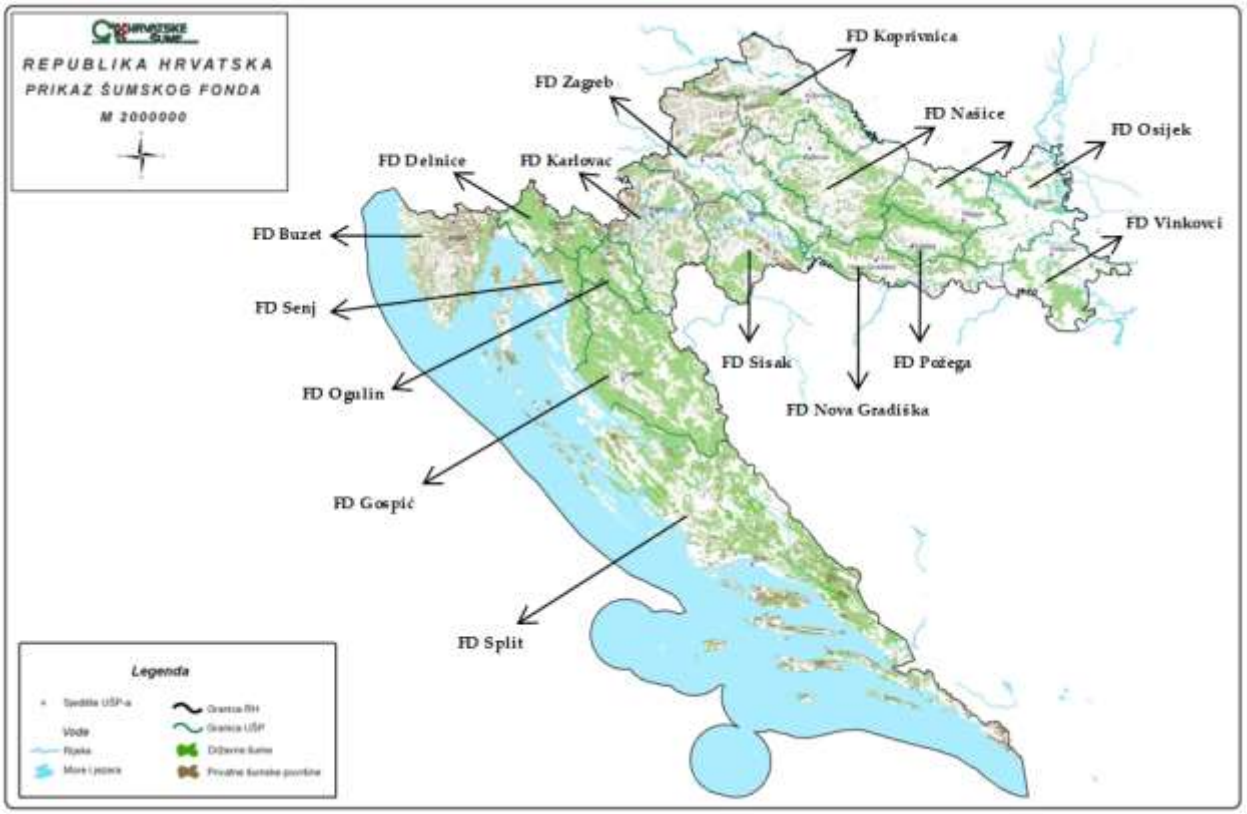

Figure 3.3-1 Spatial division of the Republic of Croatia on forest administrations (Legend: red dots represent the seat of the forest administrations; red lines are the spatial borders of the forest administrations; state forests are represented in green and private forests in brown colour)

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 unit 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.

Management unit is divided into compartments and sub-compartments. 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, maquis, garigue and barren wooded land, in general can not 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, mixture ratio 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 3.3.-2.

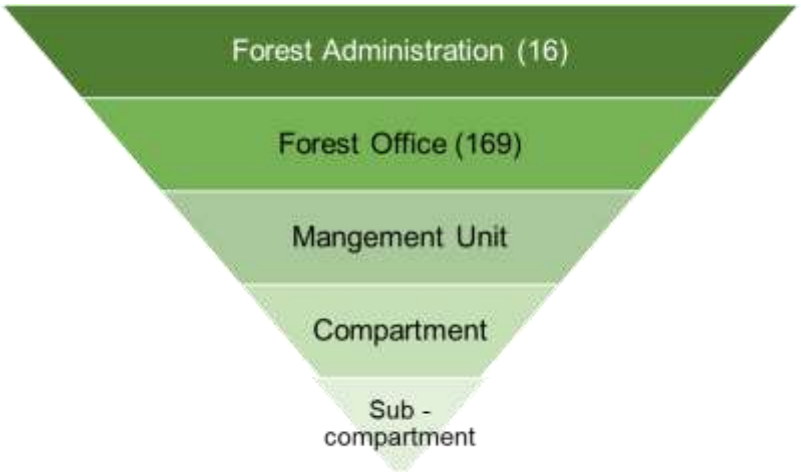

Figure 3.3-2 The scheme of the national system's structure

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 rule 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 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 is divided as follows:

- High forests
- Plantations
- Forest cultures
- Coppice
- Maquis
- Shrub
- Garigue
- Scrub.

The share of forest land with tree cover in the forest land with tree cover is shown in Figure 3.3-3.

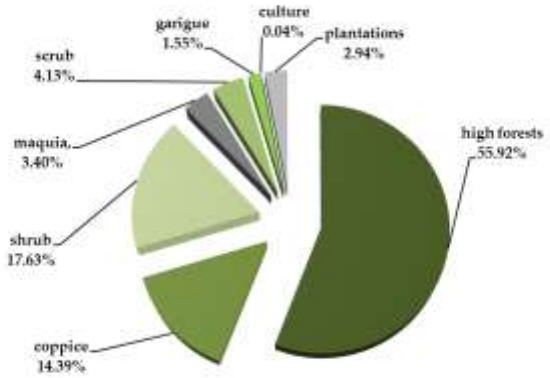

Figure 3.3-3 The share of each forest stand in forest land with tree cover, year 2016

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

- management forests (which made about 52 % of total forest area in 2016)
- protection forests (which made about 30 % of total forest area in 2016)
- forests with special purpose (which made about 18 % of total forest area in 2016).

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

a) State forests owned by the state and managed by
   1. the public enterprise “Hrvatske šume d.o.o.” (Croatian Forests Ltd.)
   2. legal bodies owned by the state (e.g. national parks, Faculty of Forestry, Ministry of Defence, “Croatian Waters” etc.)

b) Private forests

State forests make about 76% of total forest area, while the remaining 24% are privately owned (Figure 3.3-4).

Figure 3.3-4 The ownership structure of forest area in Croatia, year 2016

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:

(1) by using the ortophoto (scale 1:5,000)
(2) by using the satellite images (scale 1: 1,000,000)
(3) by using the CORINE data.

- The FMAP 2016-2025 determines total growing stock of about 418 mil. m^3 in 2016 (shares shown in Figure 3.3-5 and 3.3-6) by calculation based on the following measured data:
- diameters at breast height
- height of living trees above the taxation level (10 cm in breast height diameter).
- 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 in the report. In case of maquies and shrub forests estimation was performed using the expert judgement on increment in these forests.

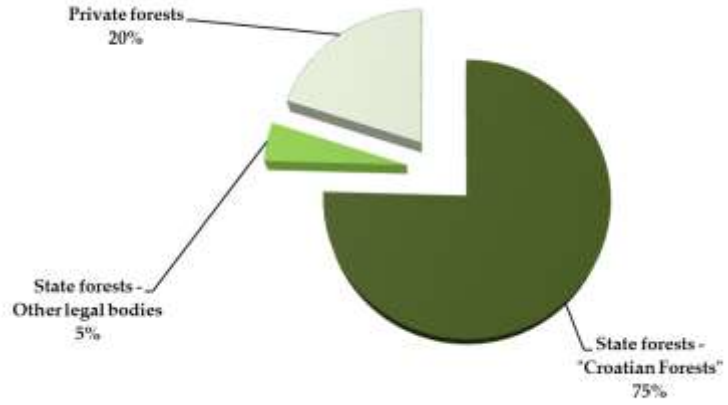

Figure 3.3-5 The share of growing stock in state and private forests, year 2016

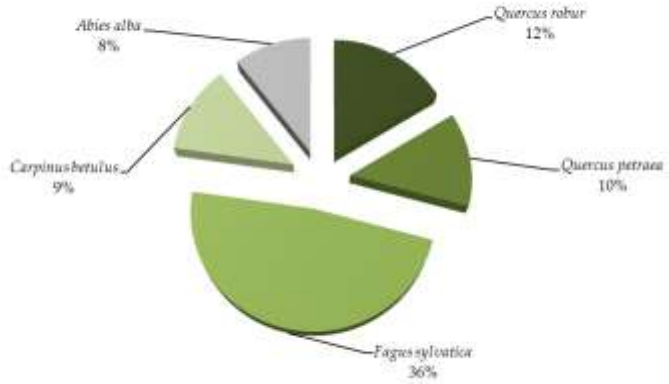

Figure 3.3-6 Share of main species in total growing stock, year 2016

At least 2% in even-aged stands of the second age class regarding the high forests in area that is subject of FMAP, forests with limited management, coppices, protection forests and private forests.

At least 5% in even-aged stands of high forests (age classes above the second age class) in area that is subject of FMAP and in uneven-aged forests.

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

- Extracting the sub-compartment at 143,000 ha
- 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
- Measurements of 123,000 tree heights
- Taking 43,000 bores.

Based on the legislation[5], when preparing the FMAPs, the increment value is determined based on the volume tables and measured diameter increment. 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 their origin and stand quality and age, and in uneven-aged stands on management classes and stand quality. In case of coppice forests only mean total increment of growing stock has to be determined. The increment cores are taken at breast height (1,30 m) with Pressler’s borer.

The share of increment in state and private forests is presented in Figure 3.3-7.

[5] Ordinance on Forest Management (OG 111/2006; OG 97/2018)

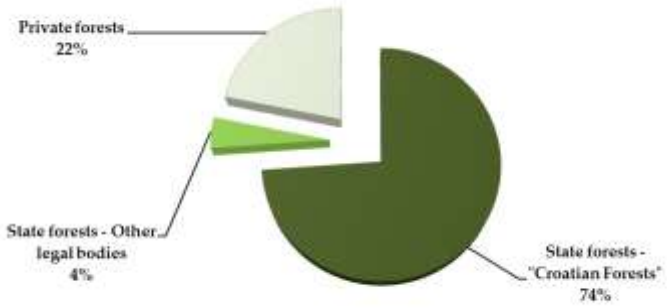

Figure 3.3-7 The share of increment in state and private forests, year 2016

The related data have been obtained from the General FMAP 2016-2025 and forests in Croatia are presented by forest type as broadleaved and coniferous forests and out of yield forests (maquies and shrub forests) in NIR 2018. This stratification is kept for FRL development.

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

Law on forests (OG 66/2018) and Ordinance on Forest Management (OG 97/18) 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 forest land 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 principle 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 that harvest has to be realized based on the forest area independently whether this harvest was prescribed as regular harvest or part of the harvest is result of some disturbances (i.e. windbreaks, snowbreaks, illegal felling, icebreaks etc). This means that prescribed, regular harvest has to be decreased for non-prescribed harvest that occurred from natural disturbances or other types of disturbances in order to be in line with the allowed harvest of m^3/ha.

All documents which Croatia is currently developing with regard to harvesting rates and renewable sources of energy (i.e. 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) 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. 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 harvest projected ranged from 7,3 Mm^3 in 2021 and 7,9Mm^3 in 2025.
From the above presented information Croatia recognizes only one possible, additional harvest scenario up to 2025. This scenario assumes that the average value of harvest is realized each year in period 2021-2025 in the same amount (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 Mm3 per year as registered and reported in the Reference period to predicted harvest of 8,03 Mm3 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 (i.e. by 2.3%, average increment from 6.95 to 6.79 m3/ha in case of pedunculate oak) due to the absence of timely implementation of silvicultural works.

The fact that all forests in Croatia make one, unique forest area and that the official policy prescribed by General FMAPs is consider in all relevant strategical documents also secure and preserve sinks 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

In forestry sector data that available in General Forest Management Plan for Croatia (General FMAPs) as well as other plans/programs for the management of forest management units in Croatia are found to be the best available data for the FRL development (detailed information provided in Chapter 1).

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. Although the planning and execution of both plans were highly influenced by the War and post-War circumstances, it was concluded that General FMAP for the period 2006-2015 should be used for the FRL purposes.

The War influence on forest management can be seen from the Figure 4.1-1 that shows planned and realized harvest influenced by the War and post-War period in Croatia. The graph also presents harvest projections developed assuming that War did not occur and that the forest management practices are implemented in full and in normal circumstances.

During the preparations of both, General FMAP 1996-2005 and 2006-2015, War influence was taken into account to the degree that was possible, based on the information and situation in Croatia in until 1995 and , respectively. As can be seen in Figure 4.1-2, it was not possible to realize harvest as it was planned in General FMAPs 1986-1995 and 1996-2005 due to the and 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 units (out of 169) 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.

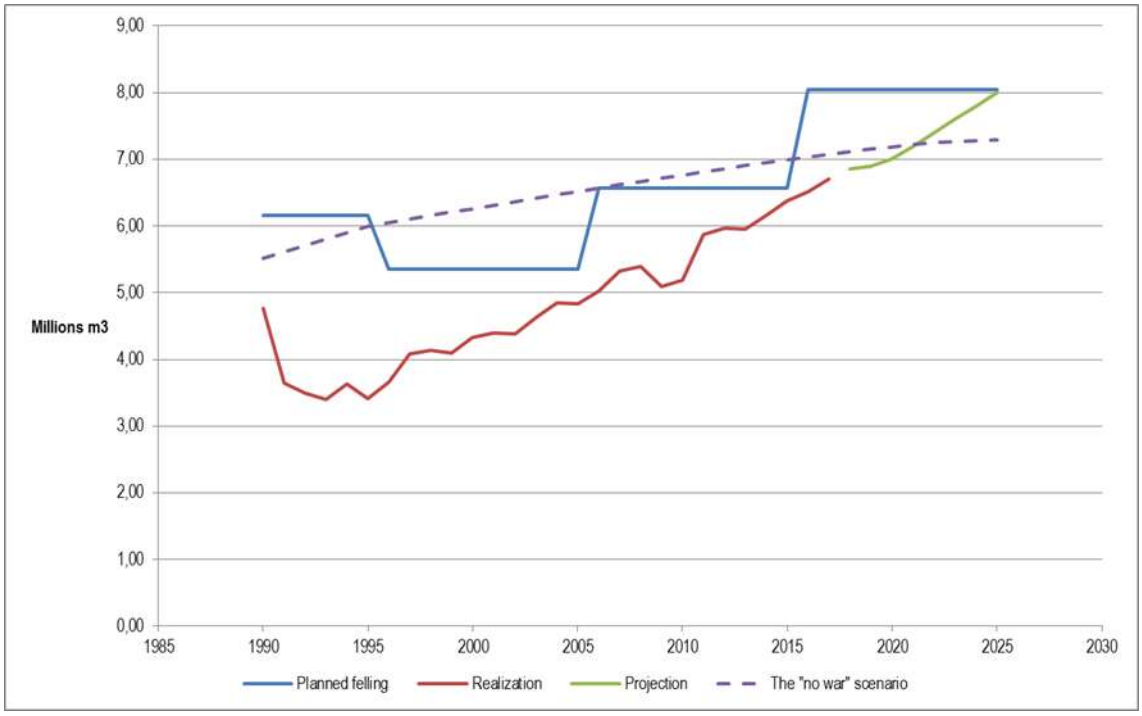

Figure 4.1-1 Amount of harvest planned, realized and projected in Croatia in period 1990-2025

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 executeed as it was originally planned in General FMAP 1996-2005, the revision had to be made. The revised document was approved by the Ministry of Agriculture according to the officially prescribed procedures.

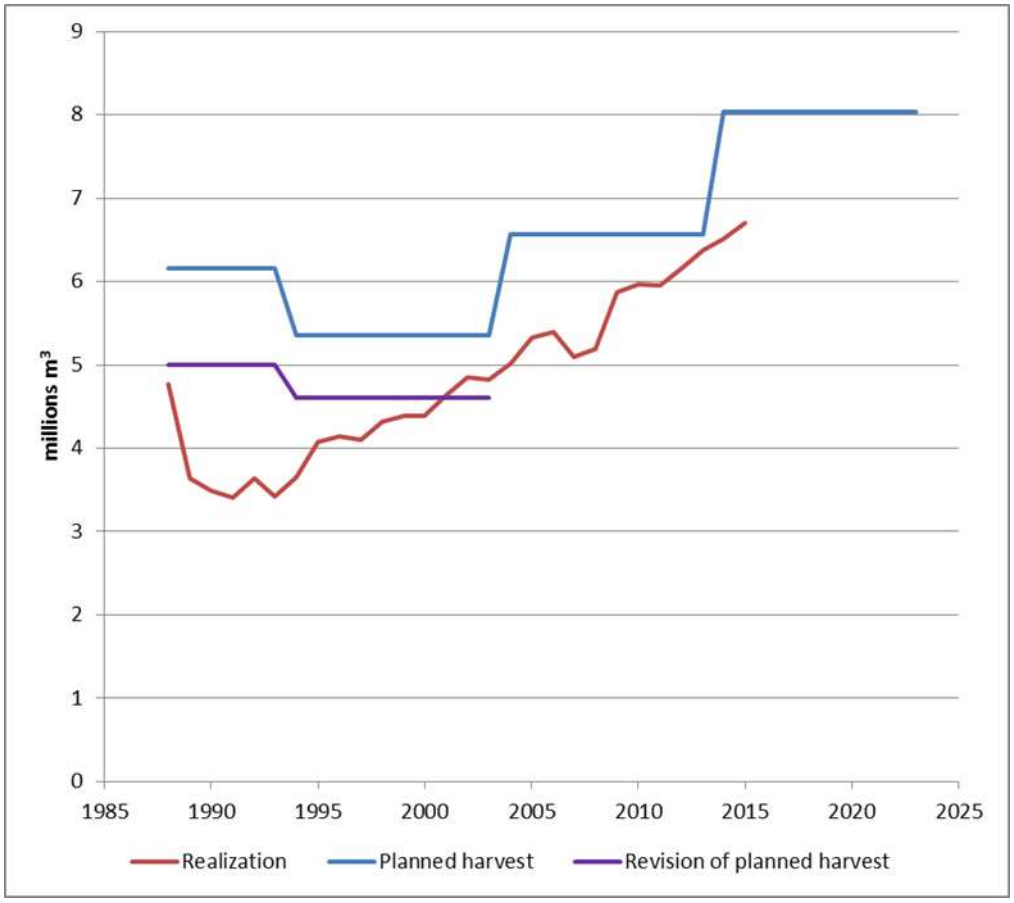

Figure 4.1-2 Amount of harvest prescribed in the FMAPs 1986-1995, 1996 2005, 2006 2015, 2016 2025 (blue line), the revised FMAPs 1986-1995 and 1996 2005 harvests due to war and post-war circumstances (purple line) and realized harvest (red line).

Amount of un-realized harvest due to the inability of implementing harvest as it was planned during the General FMAP 1986-1995 and General FMAP 1996-2005 resulted with on average 26% of the total value of harvest predicted for realization during the Reference period of the LULUCF Regulation (Figure 4.2-3, see Chapter 5).

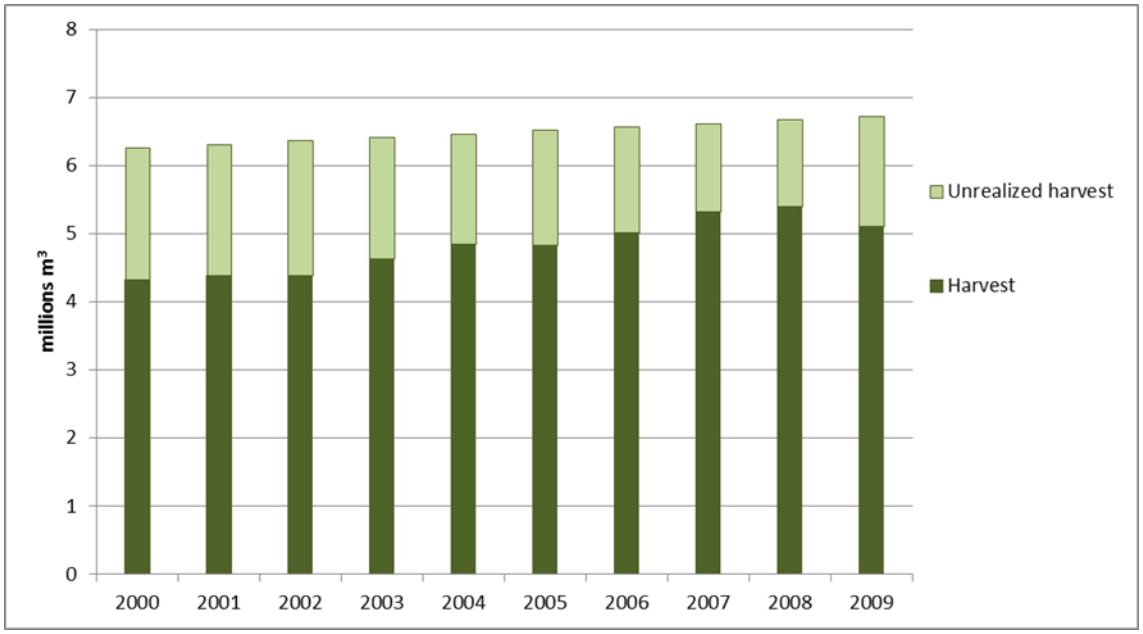

Figure 4.1-3 Amount of realized and unrealized harvest in Croatia during the Reference period

After deciding that General FMAP 2006-2015 will be used for the FRL estimation, seven Forest Administrations were selected as areas with so-called normal management practices during the War and post-War period ("NORMAL FM"). For these areas, it is assumed the negligible impact of the War and post-War events on management practices during the Reference period of the LULUCF Regulation. Stratification and management intensities were determined on these areas based on the forest plans/programs valid in Reference Period and applied for modelling and projection purposes for entire forests areas in Croatia.

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 3 criteria:

1. the type of forest
2. the main function of the forest
3. 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 4.2-1). 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 commercial forests, protective forests, and forests with special purpose. Commercial forests 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 4.2-2)

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 Short description of the conducted FMPs in Croatia during the Reference period

Forest Management Practices				
FMP Index	**Name of Management Practice**	**Short Description of Management**	**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.	Represented in the Table 4.3-1.	Law on Forests (OG 68/18) and Ordinance on Forest Management (OG 97/18).
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.	Represented in the Table 4.3-2).	Law on Forests (OG. 68/18) and Ordinance on Forest Management (OG 97/18).
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 Law (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.	Law on Forests (OG 68/18) and Ordinance on Forest Management (OG 97/18).

The detailed description of each above listed FMPs implemented in Croatia is presented in Annex 1 of this document.

Table 4.2-4 Forest areas according to the stratification proposal

Forest type	Forest function	Main tree type	Stratum ID	2000	end of 2009	2016	2025
Deciduous	Commercial forests	Common oak	**1**	215,98	220,69	223,94	223,94
		Sessile oak	**2**	186,49	193,18	197,37	197,37
		Common beech	**3**	656,02	678,44	695,54	695,54
		Other deciduous	**4**	580,78	537,26	456,25	456,25
	Strictly protected areas	All types	**5**	36,03	44,91	44,91	44,91
Coniferous	Commercial forests	Fir	**6**	88,56	90,71	94,19	94,19
		Other coniferous	**7**	100,71	99,06	104,12	104,12

	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	428,30	474,27	474,27
	Strictly protected areas	All types	**10**	9,42	9,42	10,46	10,46
FOREST AREA TOTAL (kha)				2.315,29	2.311,95	2.311,03	2.311,03

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

Forests in Croatia are managed using 10-year forest management plans at the level of management units (typically several thousand hectares, e.g. Forest management plan for the Management unit "Jastrebarski lugovi" for period 2004-2013). Also, every 10 years a national-level Forest Management Area Plan for the Republic of Croatia (General FMAP, i.e. General FMAP 1996-2005, General FMAP 2006-2015, General FMAP 2016-2025) is compiled from all valid management unit plans. Considering that individual management unit plans have different year when they were made and approved (i.e. became valid), for the purpose of compiling a General FMAP it is necessary to recalculate the state of all stands to the desired year. For the currently valid General FMAP the state of all stands in Croatia are recalculated to the year 2016. Compiling is performed using an inventory-based model for the projection of stocks, increment and harvest named **HS-MODEL**. It is developed in Croatian Forests Ltd., and it is used for forest management planning in Croatia for almost 30 years.

For the estimation of FRL the adjusted HS-MODEL was used (see model diagram) and following definitions are applied:

AGE CLASS is a group of stands in a certain range of age, e.g. third age class includes stands of age 41 to 60 years.

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

EVEN-AGED STAND is a stand where all main tree species trees are in the same age.

HARVESTING SEQUENCE is a process of assigning a year when harvest will be performed in each stand based on the record of the year when previous harvest occurred in the specific stand. In normal forest management thinning of a single stand is performed every 10 years.

MANAGEMENT CLASS is a group of all stands (in all age classes) of a single main tree species, e.g. management class of pedunculate oak includes all stands in all age classes where pedunculate oak is a main tree species. Stratum criteria Main tree species is mainly based on this classification, therefore in a certain degree stratum can be equalized with management class.

MODELLING UNIT is a unit (e.g. a stand or a group of stands with similar characteristics) at which the model run is performed. It is a basic unit for which all input data needed for the modelling are available.

REGENERATION CUT is a final cut performed in old even-aged stands. It consists of 2-3 cuts in the last 10 years of the rotation period.

ROTATION is a minimum age at which certain management class will undergo final cut.

STATE OF THE MODELLING UNIT includes all basic information on specific modelling unit that are needed as model inputs (i.e. age, age class, growing stock, increment and harvest). In the model description we distinguish current state and new state. Current state is a state of a modelling unit in the first year of the modelling (i.e. input data) and new state is a state of the modelling unit in the next year of the modelling (i.e. output data).

THINNING is a cut performed in an even-aged stands every 10 years during their development.

UNEVEN-AGED STAND is a stand of trees with different age, spanning from young saplings to mature and old trees.

Input data for the model are stand age, age class, growing stock, increment rate and harvest rates. Data required for modelling are obtained from 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, age class, dbh (diameter at breast height) class, basal area, crown cover, elevation, etc.

It was not possible to use HS Fond data directly for the FRL determination without considering the fact that Croatia was faced with the War and post-War circumstances in its recent past (detailed information provided in Chapter 2).

A special map developed by the Croatian forests (collecting the detailed information on the field in 169 forest units in Croatia) 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 (Figure 4.3-1). Since the all forest areas were not impacted by the War in the same way an additional, detailed map was developed by the Croatian forests **that separates areas in the Forest districts (FDAs) into two general categories** (Figure 4.3-2):

- FDAs where forest management has been directly and significantly affected by the War, occupation of territory and post-War circumstances (defined as “WAR AFFECTED FM” and marked in red, pink and orange colour on the map in Figure 4.3-2):
- FDAs 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 (defined as “NORMAL FM” and marked in green colour on the map in (Figure 4.3-2):)

FDAs considered to have NORMAL FM during the Reference period are: FDA Koprivnica, FDA Zagreb, FDA Delnice, FDA Buzet, FDA Senj, FDA Bjelovar and FDA Našice. These seven FDAs 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 FDAs are considered under the "WAR AFFECTED FM" category.

Identification of areas for which War effects on forest management **is assumed to be negligible** during the Reference period 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 the Reference period (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 FDAs for which War effects on forest management **is assumed to be negligible during the Reference period** 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**.

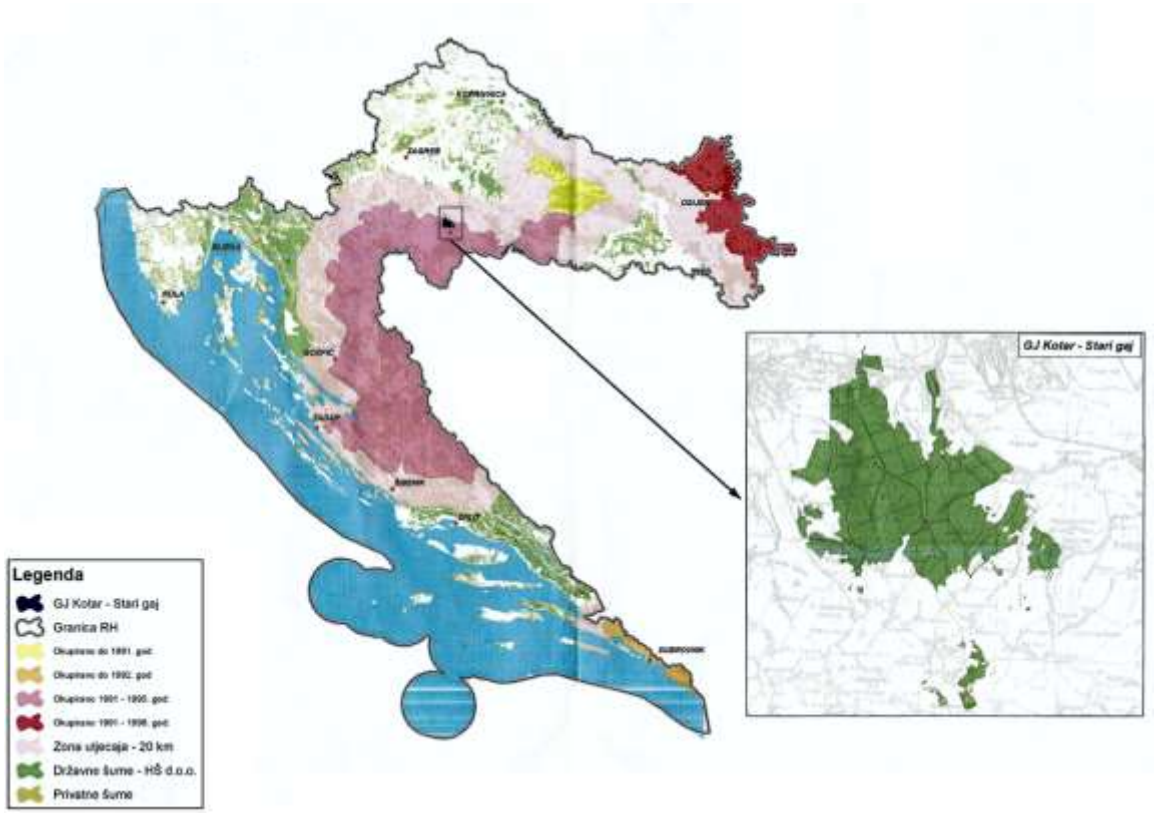

Figure 4.3-1 Map of the Republic of Croatia with the indicated categories of impact of the war on the forests (Legend: Management Unit Stari gaj (black); national border of the Republic of Croatia (black line); occupied areas until 1991 year (yellow); occupied areas until 1992 (orange); occupied areas 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)

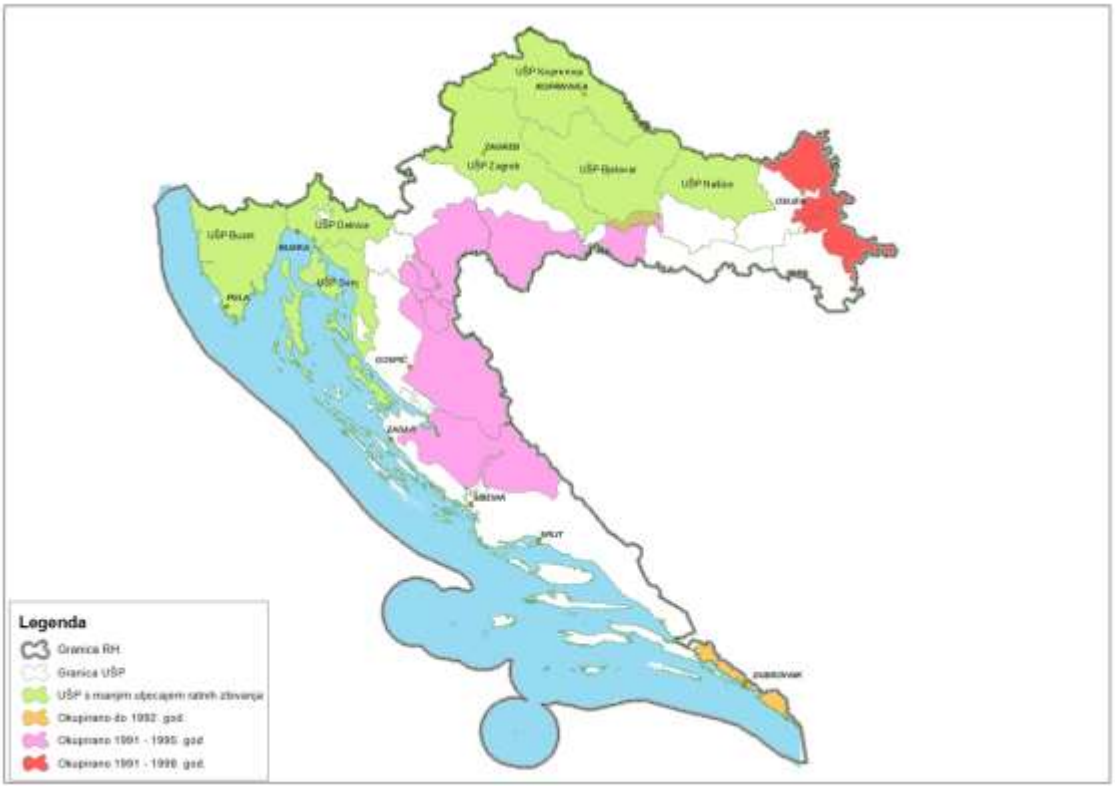

Figure 4.3-2 Map of the Republic of Croatia according to the War impact on FDAs (Legend: border of the Republic of Croatia (dash line); borders of the forest administrations (light green line); forest administrations less affected by War (green); areas occupied until 1992 year (yellow); areas occupied in the period 1991-1995 (pink); areas occupied I the period 1991-1998 (red))

It is important to emphasise that harvested rates (variable Hr in the model diagram), used in the calculation of FRL, are obtained **from the records of harvested volume in the period 2000-2009 on the area of 7 Forest Districts** for which War **is assumed to be negligible during the Reference period** (green colour on the map in figure 4.1-2).

Increment rate is estimated on the same FDAs 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 (tables) 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.

For future projections (i.e. FRL calculation) the model was run **at the stand level** using best available data, i.e data from the last General FMAP (valid for the period 2016-2025). Modelling is performed for each stand for every following year up to 2025 according to the decision flow presented in the diagram (**Figure 4.3-3**). Starting from the year 2016, model first creates harvesting sequence and defines so called *NORMAL AREA*.

NORMAL AREA (A_{norm}) is a targeted area on which regeneration cut can be performed in a period equal to the age class width. It is calculated for each management class or stratum and

its main purpose is to (re)establish normal (balanced) proportion of age-classes within the area. It is calculated using following equation:

$$\mathbf{A_{norm}\ [ha] = (A_{stratum}\ [ha] / ROTATION\ [year]) \times AGE\ CLASS\ WIDTH\ [year]}$$

Then, model decides if the stand is even-aged or uneven-aged based on the fact that for even-aged stand there is information on the age class. For uneven-aged stands calculation of new state (see definition below) is simple and straightforward. In the case of even-aged stands, if the stand enters second (II) age class a new state is assign to that specific stand according to similar stand in the second (II) age class (i.e. same main tree species, same site class). For older stands (age class > II), model decides does stand needs to undergo thinning or regeneration cut, based on the information on the stand age. All stands older then rotation-10 years (e.g. for pedunculate oak all stands older then 130 years) are subjected to regeneration cut, while in all other stands thinnings are performed. In the case of thinning, for every year in every stand that is assigned for thinning in that specific year according to harvesting sequence, thinning is modelled based on the defined harvesting rates and stand growing stock. In the case of regeneration cut, it is performed on all stands that are assigned for regeneration cut, taking into account that the total sum of area of those stands can maximum be up to the previously estimated normal area.

Flowchart presenting the way of model work is shown if Figure 4.3-3

The labels used in the Flowchart have a following meaning:

H_n – harvest in the year *n* (m^3)
V_n – growing stock in the year *n* (m^3)
Hr – harvesting rates (%)
in – increment in the year *n* (m^3)
F – factor of age-dependant decrease of increment rate
YTr_n – yield table increment rate in the year *n* (%)
AGE_n – age of a modelling unit at a year *n* (years)

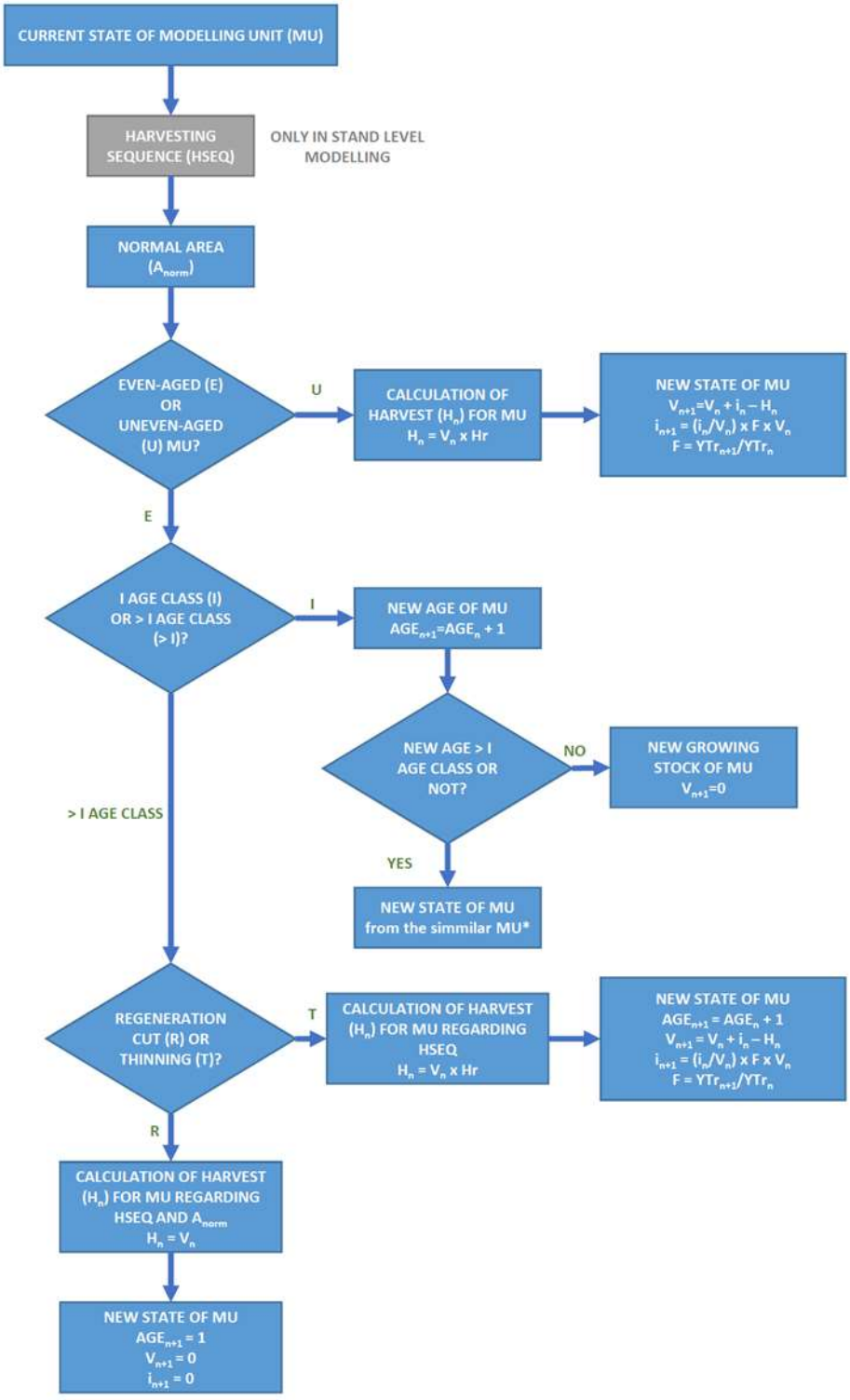

Figure 4.3-3 Flowchart of the model run

Stands on which the final cut will be performed are selected on the basis of the following criteria:

1. Determination of stands in the last age class
2. Determination of stands of the penultimate age class when the age class of the large forest complexes of the same class of forests are significantly disturbed, namely:

- When the main tree species of trees have a mean diameter equal to or greater than the mean diameter of the normal stand of the corresponding productivity class in the age of rotation period according to the yield tables of the domestic authors;
- in mixed stands of oak and ash with a share of ash greater than 1/3 when it is determined that further management would be economically ineffective.

3. Stands of poor quality and health status (share between actual and normal (theoretical) tree basal area is below 0.4)

The volume that will be cut as final is defined by the area which according to Croatian legislation means that the final cut cannot be greater than 60% of normal area (definition provided above). The width of the age class of even-aged forests depends on the species and it is defined by the Ordinance on Forest Management.

It should be noted that in practice no more than half of the normal area (definition provided above) of the last age class is cut in the 10-year period. This means that the maximum area of the stands (in case of pedunculate oak), which is renewed in 10 years, is 10/140 = 7.41% of the total area, despite the fact that the area of the stand is more than 140 g higher than 7.41%.

An example of age evolution according to the usual practice in the Reference period on the hypothetical stratum whose rotation period is 140 years, the range of age class equals 20 years is presented in Figure 4.3-4.

It should be emphasized that in actual management there are fewer deviations in case of areas that are subject of reestablishment. The reasons for the deviations are, for example, because the share of the surface of the old age class in specific forest management units differs from normal; due to the need of salvage loggings in the penultimate age class and so on.

In strictly protected areas and out of yield forests (maquies and shrub) cuttings equal 0%.
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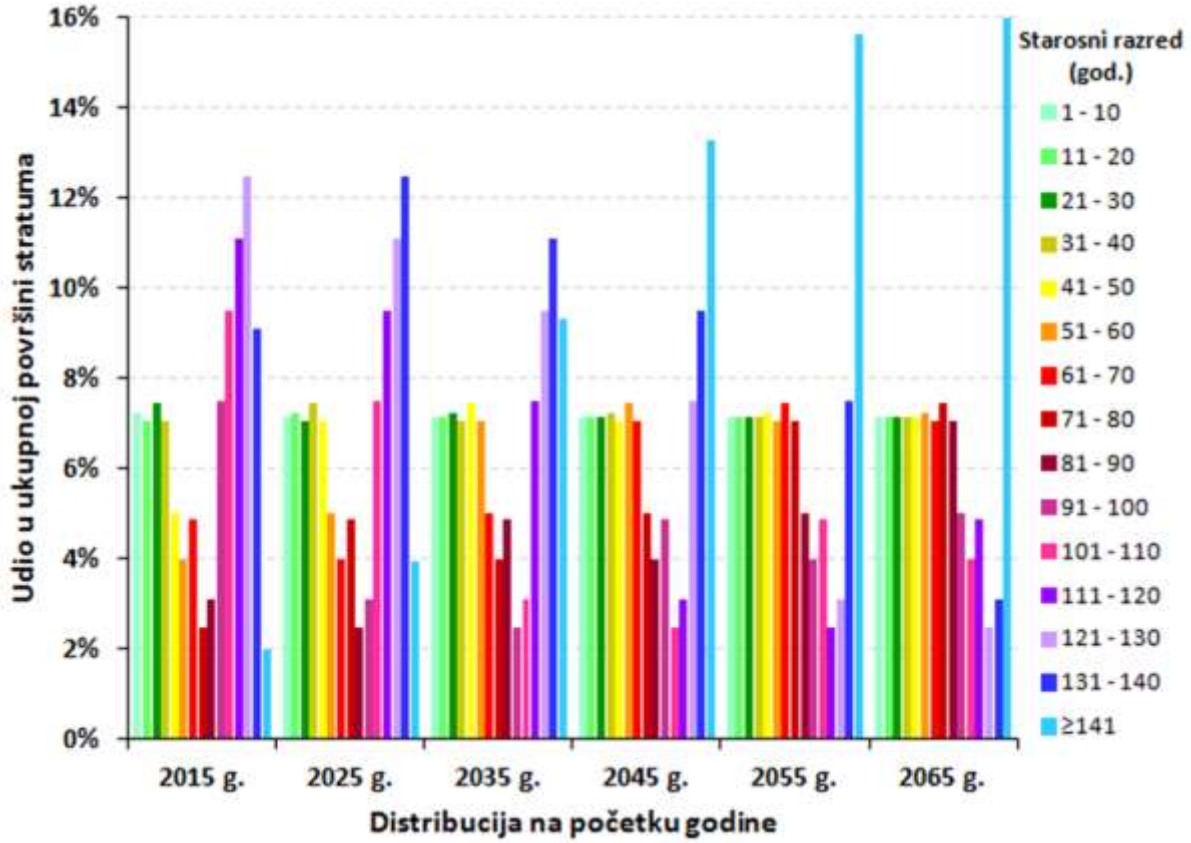

Figure 4.3-4 An example of 10-year age class evolution which is consistent with the usual practice in the Reference period on a hypothetical stratum whose rotation period is 140 years and the width of age class equals 20 years (Legend: age classes (different colours); % on the y axis (share in the total stratum area)

The difference between age class distribution according to the measured areas and normal areas (prescribed area that serves for (re)establishing of normal (balanced) proportion of age-classes) for penduculate oak and sessile oak through the years is presented in Figures 4.3-5 – 4.3-12 below. For the modeling purposes the age class distribution for the each strata used for FRL is defined based on the same principle. The example of pedunculate oak age-class distribution in different points of time (2000,2009 and 2016) compared with normal age class distribution (balanced, prescribed) defines intensities of harvest.

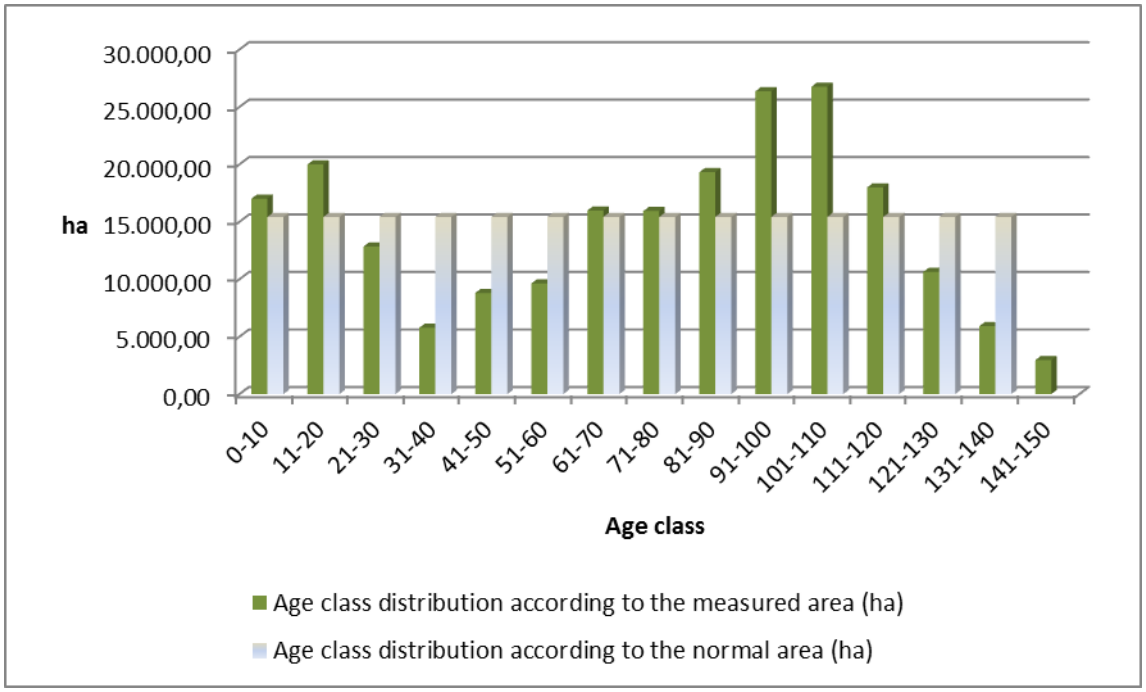

Figure 4.3-5 Age class distribution of Pedunculate oak in 2000

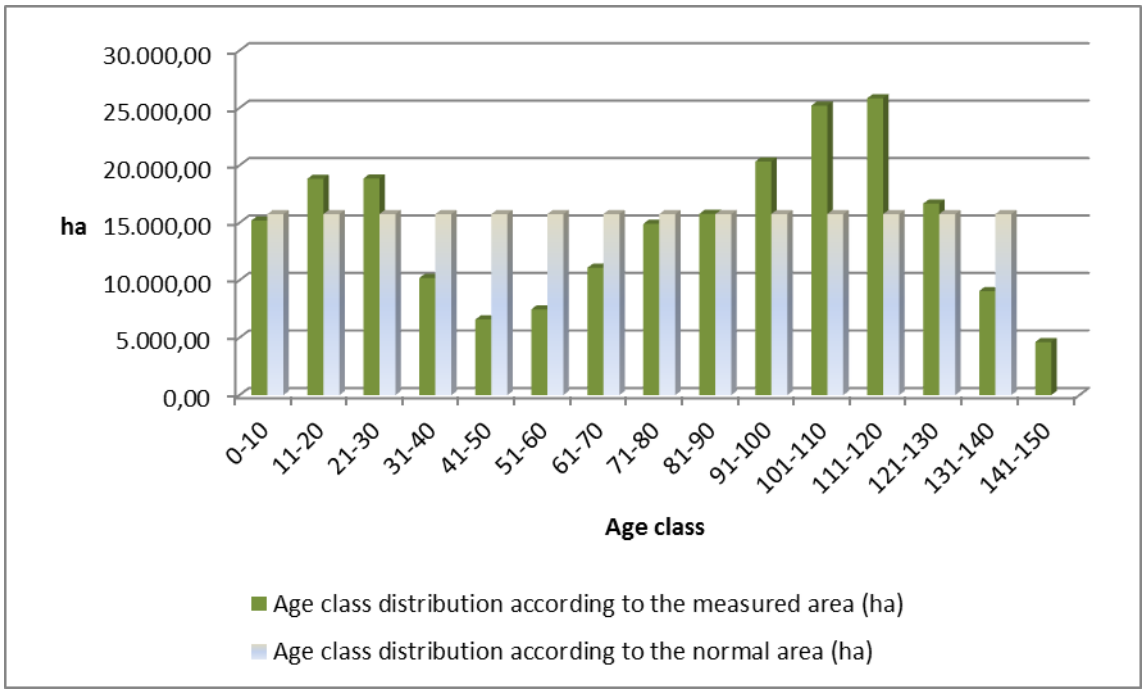

Figure 4.3-6 Age class distribution of Pedunculate oak in 2009

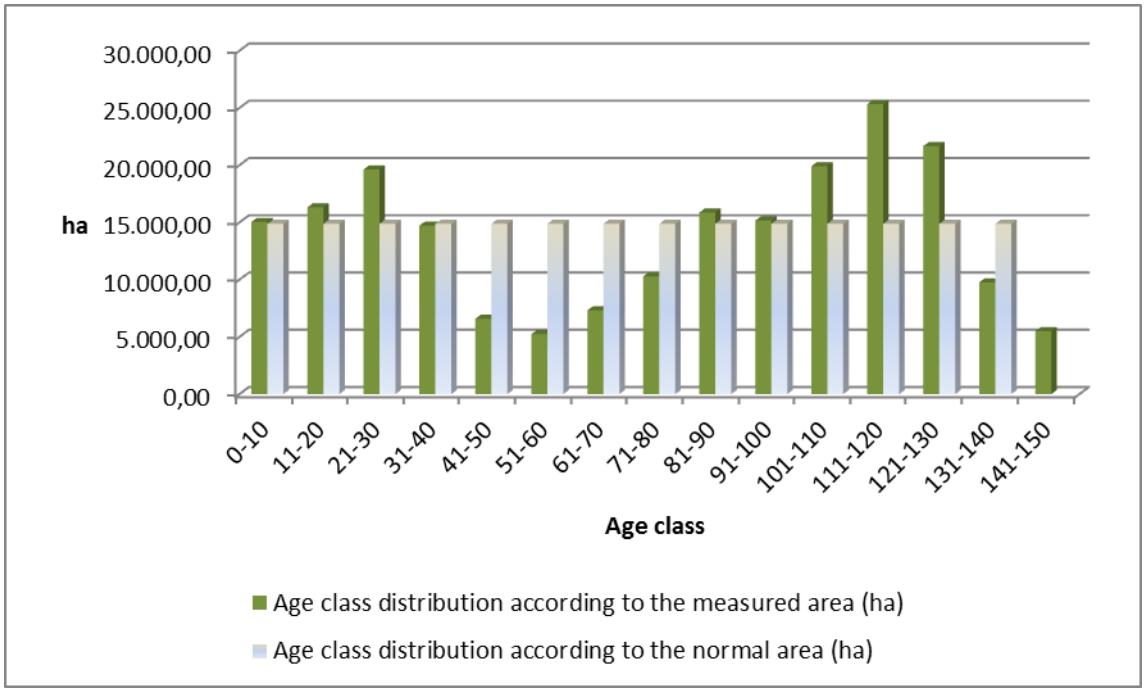

Figure 4.3-7 Age class distribution of Pedunculate oak in 2016

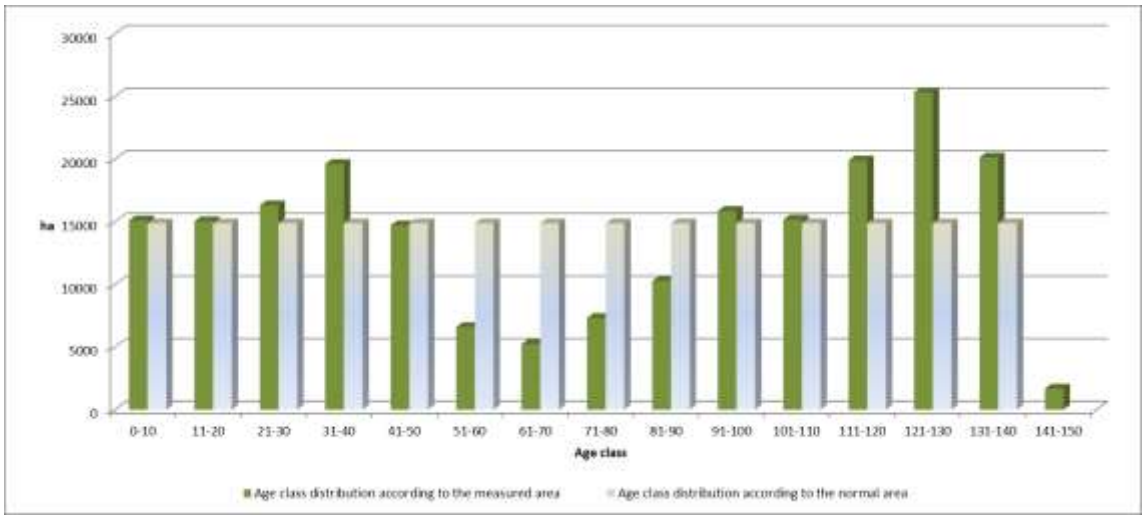

Figure 4.3-8 Age class distribution of Pedunculate oak in 2025

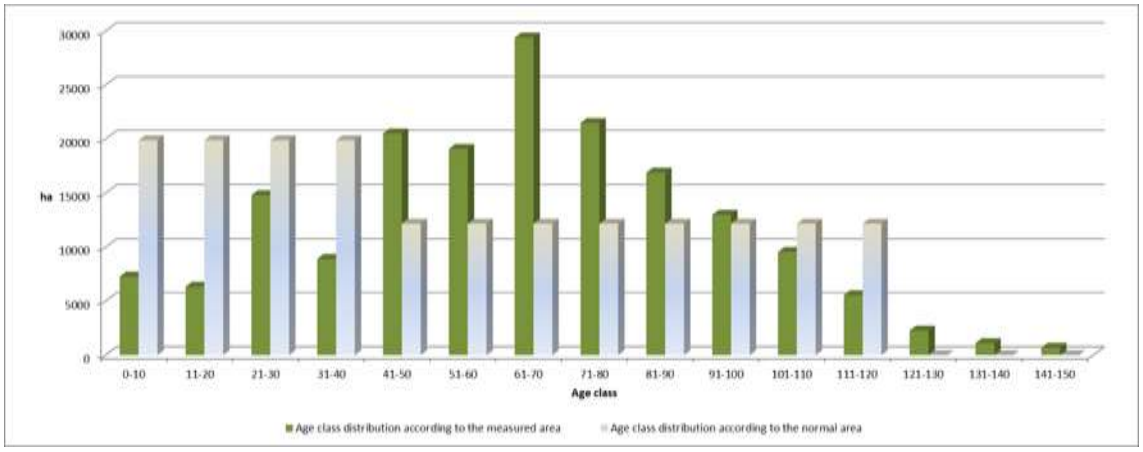

Figure 4.3-9 Age class distribution of sessile oak in 2000

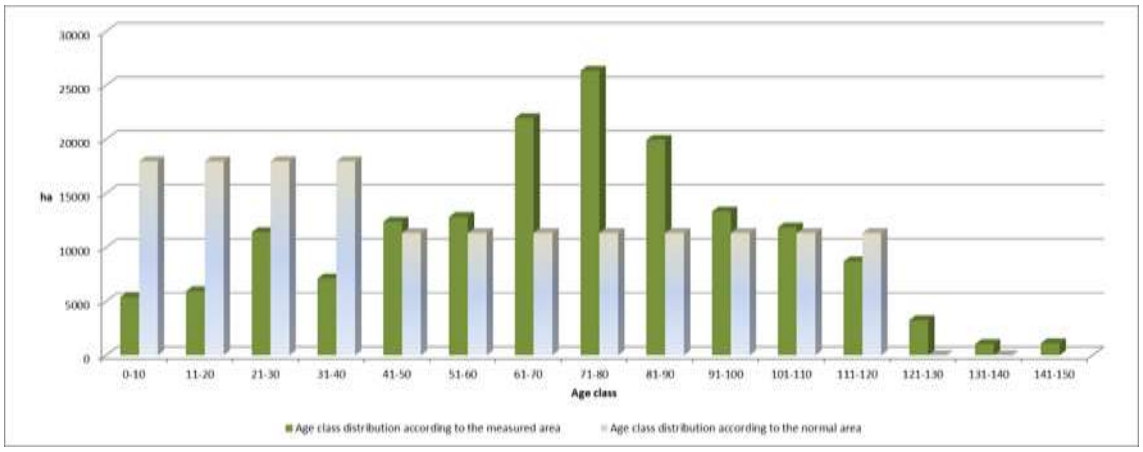

Figure 4.3-10 Age class distribution of sessile oak in 2009

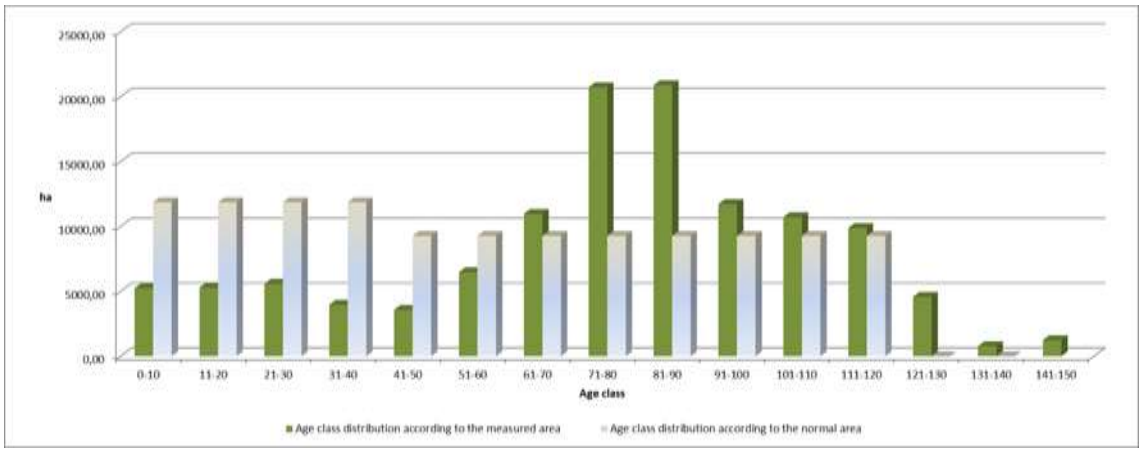

Figure 4.3-11 Age class distribution of sessile oak in 2016

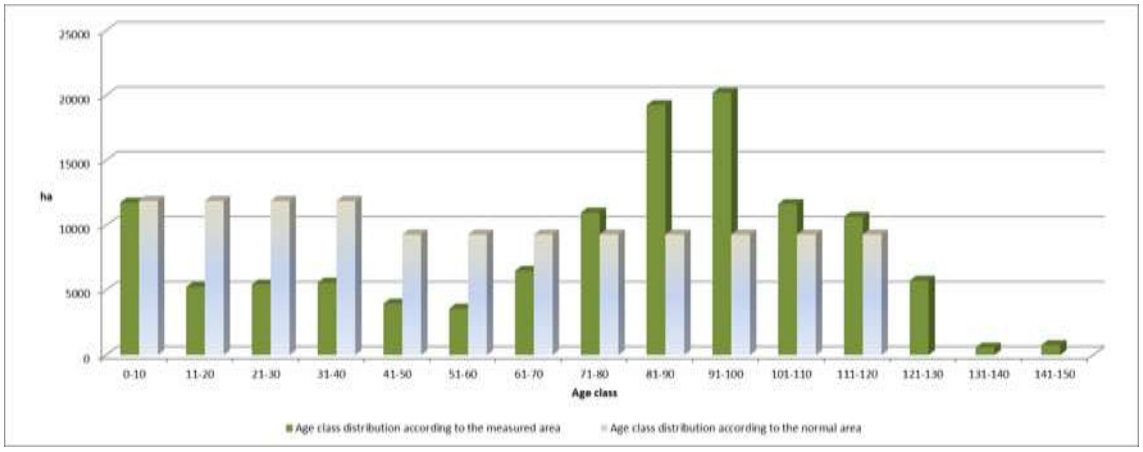

Figure 4.3-12 Age class distribution of sessile oak in 2025

The management intensity derived through the model in even-aged forests is given in terms of age (Table 4.3-1), while in the uneven-aged forests the management intensity is expressed throughout the surface (Table 4.3-2)

Table 4.3-1 Thinning intensities in even-aged forests

Thinning intensities (% of biomass removal) for all age classes in even-aged forests							
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 biomass removal) in **uneven-aged forests***

FMP Indeks	**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%

5. FOREST REFERENCE LEVEL (REGULATION; ANNEX IV B: 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 this values for reporting, MFL includes the following forest stands: high forests, plantations, forest cultures, coppice, maquia and shrub forests.

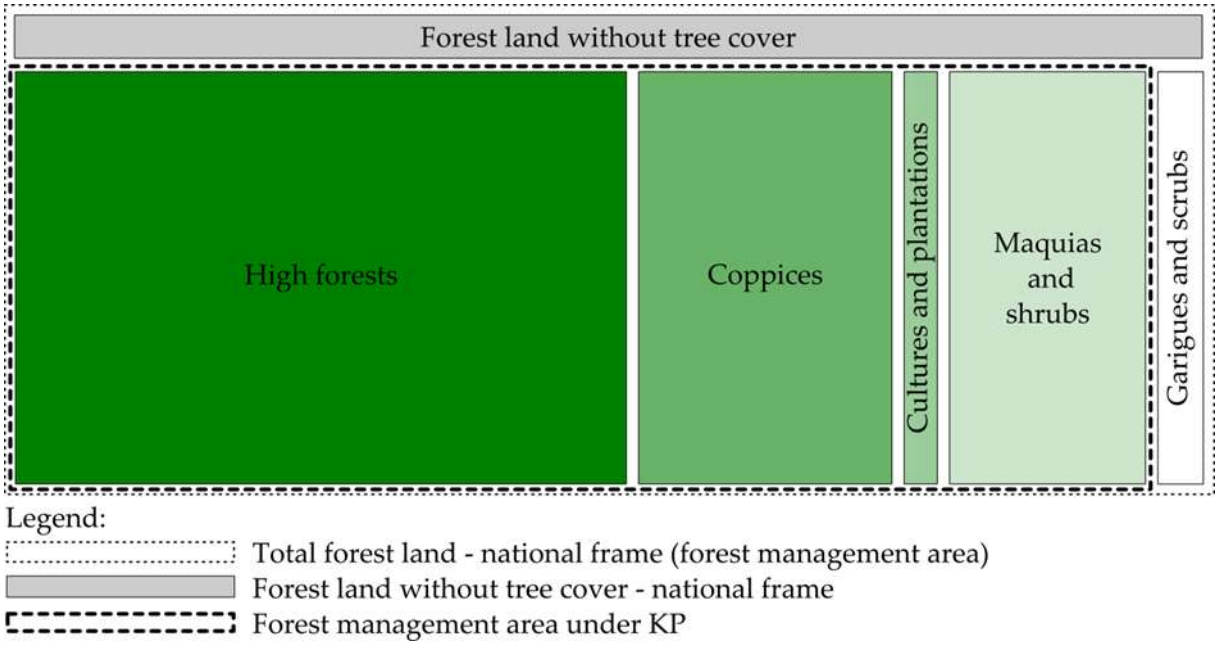

Figure 5.1-1 Managed Forest area under the KP and within the national framework (based on the relative share of forest types in total forest management area in Croatia)

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 therefore exclude afforested area. Definition of area under KP Activity Forest management from Croatian greenhouse gas emission report perfectly fits to MFL area modelled for purpose of FRL estimation.

The forest areas disaggregated as Deciduous, Coniferous, and Out of yield forests (maquies and shrub) and reported in NIR 2018 are kept constant during the period 2021-2025. Changes in areas due to the deforestation and rules for accounting the land converted to forest land in period of 20 years will be examined for the necessity of FRL technical correction.

Annex IV, part A of the LULUCF Regulation prescribes that "The reference level shall ensure that the mere presence of carbon stocks is excluded from accounting". Croatia believes that applying the Gain-Loss method that accounts harvest and increments in forests which are result of human influence on forests growth, the mere presence of carbon stocks is excluded from the

accounting. The activities planned in General FMAP 2016-2025 other forestry plans/programs in its prediction for forestry sector after 2025 secure maintenance of sinks in forests up to 2050.

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

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

The simulation for the validation purposes should run from the year 2000 onward in order to estimate model agreement with the emission and removal values reported in country's NIR. For Croatia such approach is not achievable. In line with Article 8.4 of the Regulation, Croatia may take into account the impact of war and post-war circumstances on forest management. Therefore, the simulation has to exclude the effects of war on forest management. The exclusion of war effects on forest management during the reference period 2000-2009 would imply that the resulting modelled emissions from harvests would, by the very definition, deviate from the harvest actually realised, and emissions and removals reported in NIR, during the reference period.

An additional issue related to modelling the harvests and increment in the reference period with the HS-MODEL is the problem of missing data. During the reference period, for some forests, forest management plans did not exist. Table 5.2-1 shows the share of production forest for which forest management plans have not been made. Forests without forest management plans in place were primarily private forests. It should be emphasized that although the forest management plans were not in place, General FMAPs regularly reported area, estimated increment and prescribed and realized harvest for forests not included in operational forest management plans. Furthermore, the owners/proprietors of the forests are binds by the law to report the realized harvests to the Forestry office of the Croatian forests Ltd. in charge for that area. Those harvests are recorded, even if the forest where the harvest had occurred does not have an officially adopted forest management plan. From 2006, with the new Law on Forests, all forests are required to have a forest management plan in place. Croatian Agriculture and Forestry Advisory Service is in charge for the organization of the preparation of forest management plans.

Table 5.2-1 Estimated share of production forests with no forest management plans in Croatia.*

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Forests w/o management	21.6%	21.6%	21.6%	21.6%	21.6%	21.6%	21.2%	21.3%	20.6%	19.4%	18.1%
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2000-2009**
Forests w/o management	16.6%	14.0%	12.5%	10.4%	8.2%	5.8%	3.4%	2.0%	1.0%	0.0%	21.20%

* Sources: FMAP 2006 (Annex ŠGO1), FMAP 2016 (p. 458, Table 188.; Annex ŠGO1)

By the beginning of the year 2016, the estimated share of production forests without forest management plan was approximately 8%. Having data for the forests with the first-time forest management plan, enabled modelling in the future (i.e. after 2016), while the missing 8% were extrapolated. Modelling could be initiated from 2000 but in such case, in addition to the issue of war-effects, additional assumptions would have to be made. But, even if the modelling was made with the properly and (presumably) accurately estimated initial conditions, we could still expect a difference between the model results and the observed removals and losses as a result of the exclusion of the war effects.
Taking into account all mentioned above, and the time limitations, we decided to use a validation approach by proxy (see chapter 2). The underlying idea is that different indicators could be used for the validation of the modelling results and calculated FRL.

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 dynamic observed in the countries, most similar to Croatia, to assess harvests under “no-war” scenario. In Table 5.2-2 we present the source data and the results from the modelling-by-proxy of the consequences of war on harvests in Croatia.

The effect of war, and post-war circumstances, on harvests in Croatia during the reference period 2000-2009, were quantified using the correction factor (Table 5.2-2, column I).

Table 5.2-2 Model by proxy for the estimation of the impact of war on harvests in Croatia.

Row	Year	Croatia (harvests - Mm^3)	Croatia * (roundwood - Mm^3)	Czechoslovakia (roundwood - Mm^3)	Czechia (roundwood - Mm^3)	Slovakia (roundwood - Mm^3)	Czechia + Slovakia (roundwood - Mm^3)	production relative to 1980-1989 average Czechia + Slovakia	Croatia** WAR correction factor	Croatia*** (harvests - Mm^3) "NO WAR" estimate
	A	B	C	F	D	E	G	H	I	J
1	1970	4.08	*3.29*	15.03	n.a.	n.a.	15.03	0.80	1.000	4.08
2	1971	4.05	*3.27*	15.09	n.a.	n.a.	15.09	0.81	1.000	4.05
3	1972	3.95	*3.18*	15.22	n.a.	n.a.	15.22	0.81	1.000	3.95
4	1973	4.09	*3.30*	15.52	n.a.	n.a.	15.52	0.83	1.000	4.09
5	1974	4.22	*3.40*	15.78	n.a.	n.a.	15.78	0.84	1.000	4.22
6	1975	4.30	*3.47*	16.55	n.a.	n.a.	16.55	0.88	1.000	4.30
7	1976	4.27	*3.45*	17.33	n.a.	n.a.	17.33	0.93	1.000	4.27
8	1977	4.41	*3.56*	17.62	n.a.	n.a.	17.62	0.94	1.000	4.41
9	1978	4.58	*3.70*	18.51	n.a.	n.a.	18.51	0.99	1.000	4.58
10	1979	4.70	*3.80*	18.76	n.a.	n.a.	18.76	1.00	1.000	4.70
11	1980	4.65	*3.76*	18.77	n.a.	n.a.	18.77	1.00	1.000	4.65
12	1981	4.96	*4.00*	18.80	n.a.	n.a.	18.80	1.00	1.000	4.96
13	1982	5.07	*4.09*	18.93	n.a.	n.a.	18.93	1.01	1.000	5.07
14	1983	5.24	*4.23*	18.83	n.a.	n.a.	18.83	1.01	1.000	5.24
15	1984	5.57	*4.49*	18.91	n.a.	n.a.	18.91	1.01	1.000	5.57
16	1985	5.45	*4.40*	19.00	n.a.	n.a.	19.00	1.02	1.000	5.45
17	1986	5.63	*4.55*	18.93	n.a.	n.a.	18.93	1.01	1.000	5.63
18	1987	5.48	*4.42*	18.68	n.a.	n.a.	18.68	1.00	1.000	5.48
19	1988	5.47	*4.41*	18.10	n.a.	n.a.	18.10	0.97	1.000	5.47
20	1989	5.48	*4.43*	18.23	n.a.	n.a.	18.23	0.97	1.000	5.48
21	1990	4.77	*3.29*	18.18	n.a.	n.a.	18.18	0.97	1.000	4.77
22	1991	3.64	2.94	15.29	n.a.	n.a.	15.29	0.82	1.189	4.33
23	1992	3.50	1.99	14.56	n.a.	n.a.	14.56	0.78	1.180	4.12
24	1993	3.41	2.45	n.a.	10.41	5.25	15.66	0.84	1.302	4.43
25	1994	3.63	2.82	n.a.	11.95	5.32	17.27	0.92	1.346	4.89

Row	Year	Croatia (harvests - Mm^3)	Croatia * (roundwood - Mm^3)	Czechoslovakia (roundwood - Mm^3)	Czechia (roundwood - Mm^3)	Slovakia (roundwood - Mm^3)	Czechia + Slovakia (roundwood - Mm^3)	production relative to 1980-1989 average Czechia + Slovakia	Croatia** WAR correction factor	Croatia*** (harvests - Mm^3) "NO WAR" estimate
	A	B	C	F	D	E	G	H	I	J
26	1995	3.42	2.60	n.a.	12.37	5.32	17.69	0.94	1.466	5.01
27	1996	3.65	2.54	n.a.	12.60	5.46	18.06	0.96	1.400	5.11
28	1997	4.08	3.05	n.a.	13.49	4.95	18.44	0.98	1.281	5.22
29	1998	4.14	3.40	n.a.	13.99	5.52	19.51	1.04	1.336	5.53
30	1999	4.10	3.49	n.a.	14.20	5.80	20.00	1.07	1.382	5.66
31	2000	4.52	3.67	n.a.	14.44	6.16	20.60	1.10	1.292	5.84
32	2001	4.55	3.47	n.a.	14.37	5.79	20.16	1.08	1.255	5.71
33	2002	4.51	3.64	n.a.	14.54	5.78	20.32	1.09	1.275	5.76
34	2003	4.74	3.85	n.a.	15.14	6.36	21.50	1.15	1.285	6.09
35	2004	4.92	3.84	n.a.	15.60	7.24	22.84	1.22	1.314	6.47
36	2005	4.87	4.02	n.a.	15.51	9.30	24.81	1.33	1.442	7.03
37	2006	5.04	4.45	n.a.	17.68	7.87	25.55	1.36	1.435	7.24
38	2007	5.33	4.21	n.a.	18.51	8.13	26.64	1.42	1.415	7.54
39	2008	5.28	4.47	n.a.	16.19	9.27	25.46	1.36	1.364	7.21
40	2009	5.11	4.24	n.a.	15.50	9.09	24.59	1.31	1.363	6.96
41	2010	5.22	4.48	n.a.	16.74	9.60	26.34	1.41	1.428	7.46
42	2011	5.85	5.26	n.a.	15.38	9.21	24.59	1.31	1.191	6.97
43	2012	5.90	5.71	n.a.	15.06	8.20	23.26	1.24	1.116	6.59
44	2013	5.90	5.44	n.a.	15.33	8.06	23.39	1.25	1.123	6.63
45	2014	6.17	5.00	n.a.	15.48	9.17	24.64	1.32	1.131	6.98
46	2015	6.46	5.18	n.a.	16.16	8.99	25.16	1.34	1.103	7.13
47	2016	6.64	5.17	n.a.	17.71	9.27	26.97	1.44	1.150	7.64
48	av. 1980-1989	5.30	4.28				18.72	1.000	1.000	5.30
49	av. 2000-2009	4.89	3.99				23.25	1.242	1.344	6.58
50	av. (1980-1989) / av. (2000-2009)	0.92	0.93				1.242	1.242	1.344	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.

** Period 1970-1989: no correction needed, War correction factor ≡ [column J] = 1; 1990-2016: [column J] = [column I] x [column B row 48] / [column B];

*** [column J] = [column B] x [column I]

The results presented in Table 5.2-2 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 would be 6.58 Mm^3, a value that was reached only in 2016. On the other hand, due to the war and post-war circumstances, only 4.89 Mm^3 was the average annual harvest during the reference period.

Due to war, the reduced harvest leads to 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. This value is larger than the average annual harvest estimated with HŠ-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, implying that planned intensity has been increased by approx. 6.5% with respect to the management practices in the reference period.

In conclusion, we believe that the annual harvest of 7.54 Mm3 in the commitment period 2021-2025, modelled with HŠ-FOND is a realistic representation of the activities necessary for maintaining the sustainability of sink in forests of the Republic of Croatia. Harvesting intensity that would be lower than the modelled harvest would imply negative deviation from the long-term-sustainable forest management. Realizing the annual harvest during the commitment period at the levels that are below the modelled 7.54 Mm^3 could, in short-term, have a positive impact on the forests sink. However, reducing the harvest below what is set by the optimal practices (such that are used in modelling) would incentivise forest management focused on cost reduction at the expense of the best forest management practices. In commercially less attractive forest stands, it could promote decision that the thinning is skipped or that regeneration of the stand in need of regeneration is postponed. The optimal forest management, aimed at sustaining the carbon sink (while looking how to best prepare and mitigate the threats of climate change and the related increase in salvage logging and forced stand regeneration / species-substitution cost), should not, in our opinion, be additionally penalized. Harvesting intensities that were realized in the reference period when forests were, on average younger, and the consequences of climate change were less pronounced should be re-evaluated and aligned with the clauses of specified in Annex IV.

Setting the Croatian FRL at the level, corresponding annual harvest to less than 7.54 Mm^3 during the commitment period, would imply neglecting the stipulations of Article 8, paragraph 4 of the Regulation. It would hinder the efforts to achieve a uniform distribution of age-class structure and maintain the sustainable, close to nature, production of high-quality timber.

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

5.3.1. Living biomass

For reporting purposes, Croatian forests delivered data about increment and harvest presented as per ha value for all types of forests ownership. Increment is presented per broadleaved, coniferous and 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 gain/loss calculation for living biomas in MFL

	$tonnes_{d.m} \cdot m^{-3}$	**dimensionless**	**dimensionless**	**dimensionless**	**$tonnes_{d.m} \cdot m^{-3}$**
	D	BEF1	R/S	BEF2	CF
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

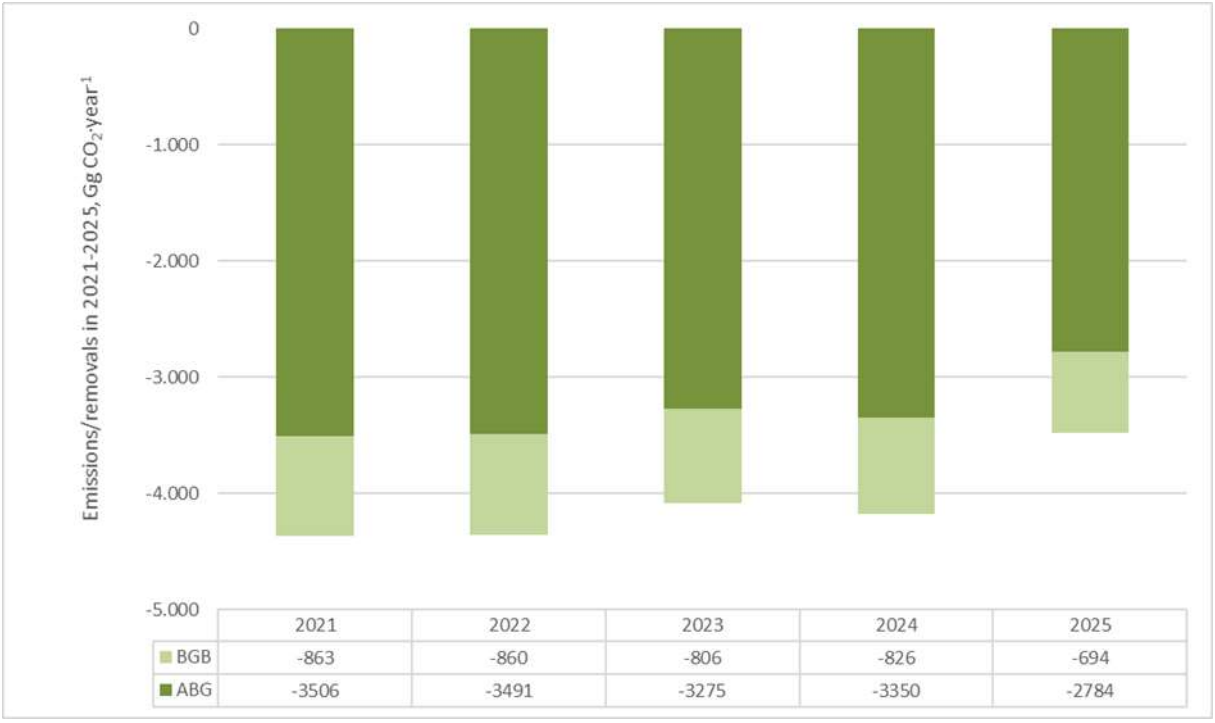

Figure 5.3-1 Removals of GHG for living biomass in CP1 (Legend: BGB (belowground biomass in light green); ABG(aboveground biomass in dark green))

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. Same factors as for GHGI have been used.

The activity data for CO_2 emission/removal calculation of living biomass includes data on forest area, increment and harvest. Removals in living biomass in CP 2021-2025 are slightly decreasing, varies from -4368 Gg CO_2eq in the 2021 to -3479 Gg Co_2eq in the 2025.

Estimation performed using the **Tier 1** and estimating the **HWP based on the instantaneous oxidation method**, leads to the average value of **4091 Gg** CO_2eq·year^{-1}. As expected the largest part of removals in living biomass goes from aboveground biomass.

Shortly, the calculation can be presented as follows

$$\Delta C_{MFLLB} = \Delta C_{MFLGj} - \Delta C_{MFLLj}$$

Where:

	ΔC_{MFLLB}	=	annual change in carbon stocks in living biomass (includes above and below ground biomass) in the *Managed Forest*, Gg C · year^{-1}
	ΔC_{MFLGj}	=	annual increase in carbon stock due to biomass growth, Gg C · year^{-1}
	ΔC_{MFLLj}	=	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 third pool, harvested wood products (HWP), Croatia used Tier 2 (first order decay) applying the production approach. For the purpose of the NIR activity data for the period 1990-2015 were used. This is official data from Central Bureau of Statistics (CBS). Same data had been delivered to the UNECE/FAO/EUROSTAT international databases, and that data were used for the purpose of the Regulation 841/2018. After the data were collected for all HWP's types for the period between 1990 to 2015 the share of domestic products in total production were determined.

Since data on total harvested volume in Croatia refers to the wood harvested on areas under the category managed forests and since these areas were subject to deforestation, in order to comply with the requirements of the Regulation, the special ratio was determined to define volume harvested only on managed forest areas for each type of forests (deciduous, coniferous, out of yield (maquies and shrubs). In Croatia, harvest in category Out of yield (maquies and Shrub) forests is considered to be negligible (zero) and the exact data on harvested volume of coniferous as well as deciduous forests on deforested areas are well known. The timber volumes cut in these types of forests due to deforestation were subtracted from the total volume cut in Croatia and shares of volume harvested on forest management areas in total harvest in corresponding years were defined.

For the necessity of Regulation and modelling of HWP that will be produced in Croatia in period 2021-2025 average ratios from the Reference period for deciduous and coniferous forests were then defined and they are: 99.67% and 99.35%respectevely.

Modelling projections of activity data for all HWP types were performed by the use of linear regression model ($y_i=\beta_0+\beta_1 \cdot x_i$) based on the activity data for each HWP type in the reference period 2000-2009 and amount of fellings.

Amounts of fellings until 2015 were taken from NIR 2017 and harvest projections for the period 2016-2025 were in line with those developed for aboveground biomass pool on basis of the forest management model previously described. Total harvest amount is an explanatory variable in every case, except for sawnwood where we use harvest by species type (coniferous or deciduous). There is no intercept (β_0=0) as it is assumed that there is no production of harvesting wood products in case of no harvest. Variables, parameters and correlation coefficients are presented in the Table 5.3-2.

After modelling production and summarizing data into main HWP categories, large inconsistency in time series showed up. High variations are for last several years (2012-2015), especially for sawnwood and paper and paperboard. Before the modelling of HWP inflow and outflow in period 2021-2025 the correction in HWP data in period 2012-2015 needed to be performed since data from this period were found inconsistent with the same activity data from the period 1990-2011.

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

y_i **Dependent variable**	x_i **Explanatory variable**	**R (corelation coeficient)**	β_1 **(parametar/slope)**	**Standard Error**
Sawnwood coniferous	Fellings – coniferous	0,971	148,79	24852,68
Sawnwood non-coniferous	Fellings – non-coniferous	0,998	124,10	33482,38
Veneer Sheets	Fellings - total	0,980	4,75	5117,17
Plywood	Fellings - total	0,718	0,58	2982,31
Particle Board	Fellings - total	0,939	19,68	38019,52
Paper and Paperboard	Fellings - total	0,997	100,22	40476,60
Industrial Roundwood - Production	Fellings - total	0,999	625,72	166715,24
Industrial Roundwood - Import	Fellings - total	0,866	10,48	31924,21
Industrial Roundwood - Export	Fellings - total	0,992	89,14	59863,78

As it is presented in table, the correlation between amount of harvest and harvesting wood products are extremely high. This simple validation supports the usage of developed model.

To be in line with GHG “good practice”, Croatia decided to perform correction of time series by applying model not from year 2016, yet starting from the year 2012. Result of this approach by HWP categories are show in Fig ure 5.3-2. As a result of this process corrected and non-corrected data can be found in figure, in order to avoid time series inconsistency.

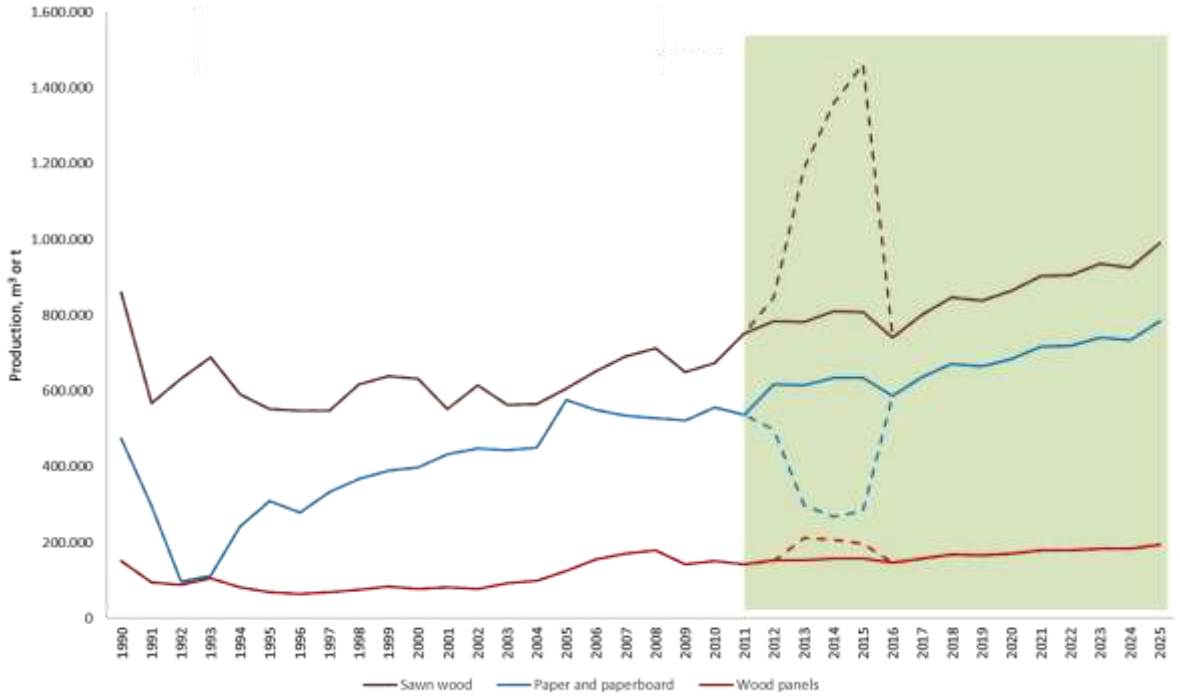

Figure 5.3-2 Projection of HWP Activity data and corrected data (dashed line) of time series for the period 2012-2015

Described approach, when HWP products depends on fellings in reference period, ensures planned constant ratio of wood for energy purposes on one side, and solid wood on the other side in period 2021-2025 (Anex IV, A, point [e]). Best available data on ratio of the energy wood in total harvest are official data from Croatian forests' business reports[6], General Forest management plans[7] and timber productions reports[8]. According to mentioned documents and sources, in reference period there was average of 40% of energy wood in total roundwood production during reference period. In figure it can be seen that there is a trend of increase in fuelwood production during whole time series.

[6] Annual business report of the Croatian Forests Ltd (1991-2017)
[7] Forest Management Area Plan for the Republic of Croatia for the period 1996-2005 (FMAP 1996-2005) (Form ŠGO-9); Forest Management Area Plan for the Republic of Croatia for the period 2006-2015 (FMAP 2006-2015) (Form ŠGO-9); Forest Management Area Plan for the Republic of Croatia for the period 2016-2025 (FMAP 2016-2025) (Form ŠGO-12)
[8] Intranet HŠ d.o.o. - online reports on the production (www.hrsume.hr)

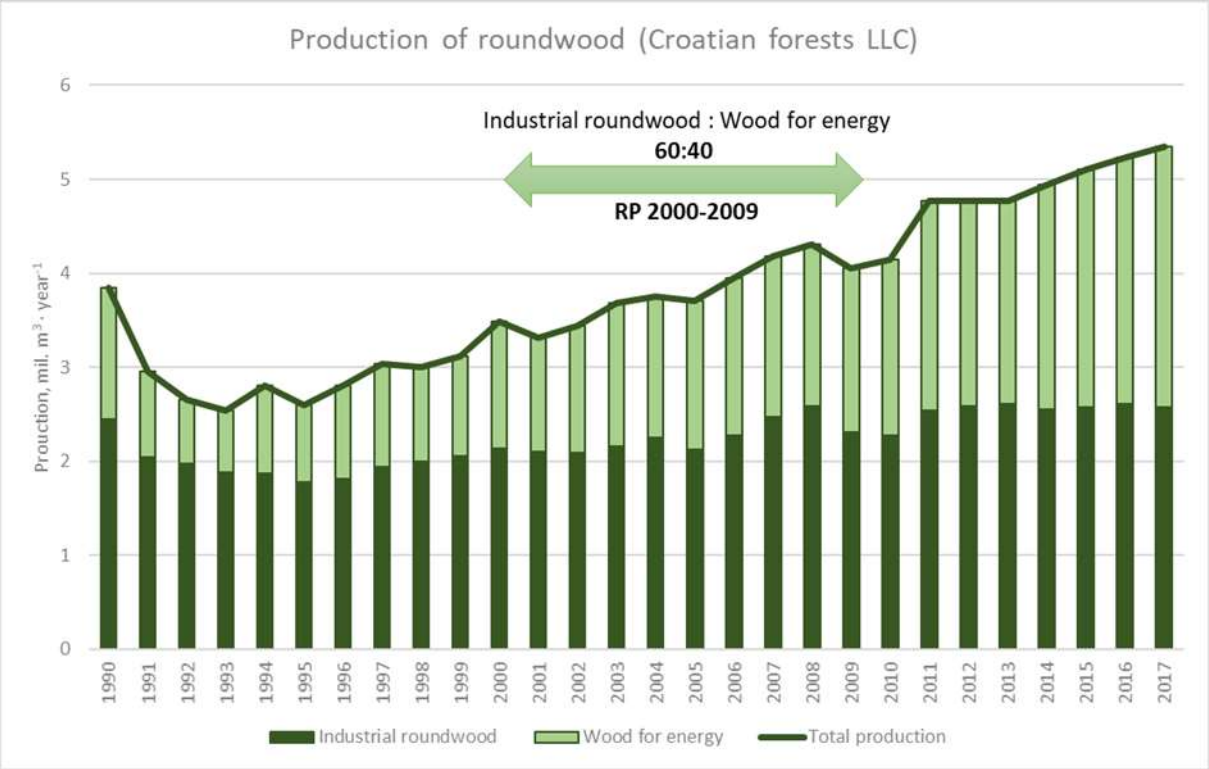

Figure 5.3-3 Ratio of energy wood production in RP

All factors needed for conversion of activity data (production amount) were taken from KP Supplement, page 2.119, 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):

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

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 half-life values were used when applying first order decay in estimation as follows: Sawn wood – 35 years, Wood panels – 25 years and Paper and paperboard – 2 years

Then the carbon stock change is calculated as the difference of *C*(i+1) and *C*(i).

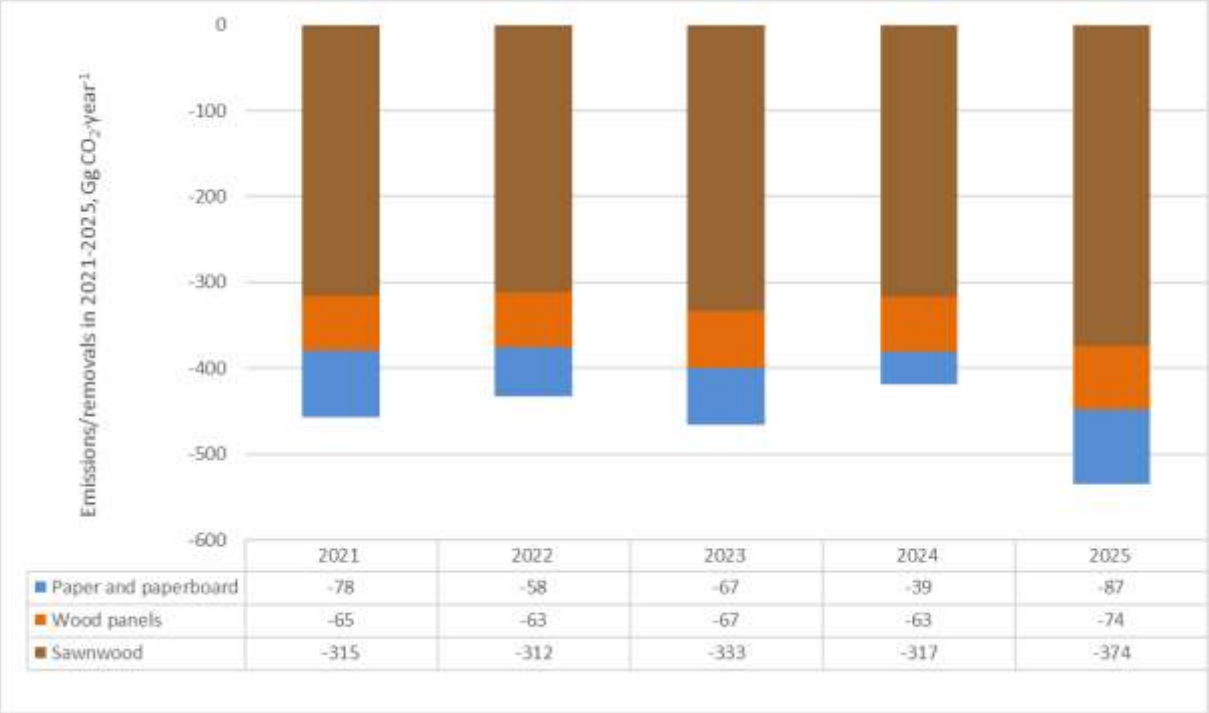

Figure 5.3-4 Removals of GHG for HWP pool by product types

Table 5.3-3 Contribution of HWP carbon pool in CP1 2021-2025

				2021	2022	2023	2024	2025
saw wood	**half lives**	**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
	35		stock change	85,93	85,00	90,74	86,50	101,98
wood panels	**half lives**	**Gg C**	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
		Gg C	outflow	-29,88	-30,37	-30,86	-31,35	-31,87
	25		stock change	17,64	17,30	18,26	17,28	20,10
paper	**half lives**	**Gg C**	stock	746,32	762,03	780,28	790,78	814,59
			inflow	276,40	277,24	285,69	282,85	302,23
		Gg C	outflow	-255,19	-261,53	-267,44	-272,35	-278,43
	2		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

5.3.3. Forest reference level

Summarizing all three values per year total changes in HWP pool were 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·year^{-1}**.

Removals from aboveground biomass, belowground biomass and harvested wood products are taken into account in order to estimate Forest reference level, **and final value of FRL is -4553 Gg CO_2·year^{-1}**.

	2021	2022	2023	2024	2025
BGB	-863	-860	-806	-826	-694
ABG	-3506	-3491	-3275	-3350	-2784
HWP	-458	-433	-467	-419	-535
FRL(2021-2025)	-4.553	-4.553	-4.553	-4.553	-4.553

Figure 5.3-5 Removals of GHG in CP1 and FRL (Legend: BGB (belowground biomass in light green); AGB (aboveground biomass in dark green); HWP (harvested wood products in brown); FRL in the period 2021-2025 (red line))

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

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 (Anex IV, A, point [g]). When comparing projections from latest submission on projections[9] there is slightly difference in addition to FRL. In the 'with existing measures' scenario, for all sectoral components, the Projections Guide (A: General Guidelines and B: Sectoral Guide[10]) was used. The most of sub-categories of this sector in the Report of the National Inventory of Croatia for 2017 have been recognized as the key ones, whether the trend or level. If possible, for the aforementioned sub-categories it is recommended to use Grade 2 or 3 when making projections. However, because of insufficient capacities in the system for

[9] Report on Projections of Greenhouse Gas Emissions 2017, CAEN, Croatia, 2017
[10] GHG Projection Guidelines, 2012, EC

making projections in the LULUCF sector at the national level, Grade 1 was applied. Emissions and removals are calculated by multiplying the projected activity data on and implied emission factors based on historic for the period from 2005 to -2014 for each carbon pool. Alternative 1 was used, whereat the activity data (in this case the size of the sub-categories of land) and emission factors for the period from 2015 to 2035, in this case the size of the sub-categories of land, were estimated using the linear extrapolation (or average values – e.g. for Wildfires) within the past ten years, from 2005 to 2014. For estimation of the projections for the biomass pool under subcategory Forest land remaining Forest land data on increment and wood removals from Forest management area plan[11] were taken into account. We need to clarify that this document was still in draft version. Also, for Harvested wood products pool, reference historical period for projection estimate was changed, because of large fluctuation in input activity data. Some pools (e.g. dead wood) have been omitted because of insufficient data (same as in NIR 2017 also). Croatia is planning significant improvements in estimation of projections of GHG emissions/removals in the future period. Main steps of planned projects and activities should be oriented in modelling of projections estimation for key source subcategories and pools mentioned above. Results should decrease uncertainty in estimation and further use of Grade 2.

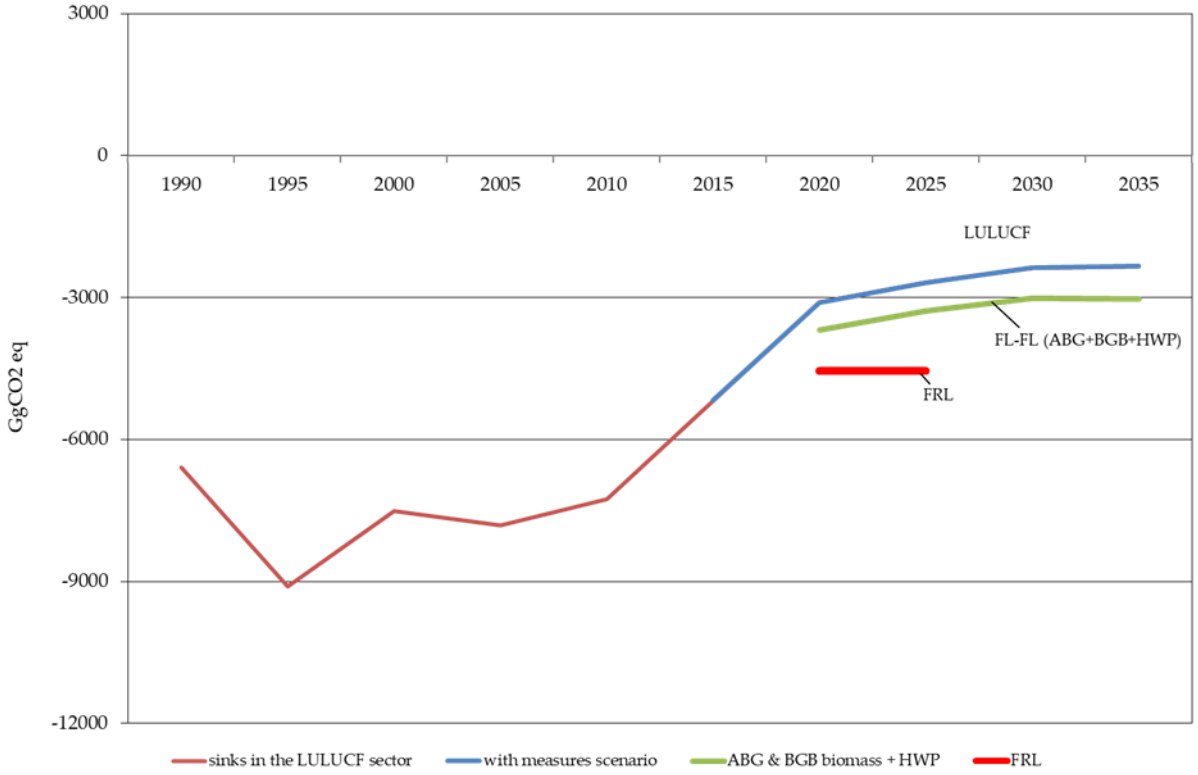

Figure 5.3-6 Comparison of FRL and LULUCF projections in line with Regulation 525/2013[12]

[11] Forest management area plan for the period 2016-2025 (draft)
[12] Acc to Report on Projections of Greenhouse Gas Emissions 2017, CAEN, Croatia, 2017

6. ANNEX 1

6.1. THE DETAILED DESCRIPTION OF FOREST MANAGEMENT PRACTICES IN CROATIA

1. 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 o 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.

2. 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 heliophiliac type of tree (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 unfavorable 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 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 heliophiliac type of tree (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 unfavorable 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 favor of common fir and common beech.

3. 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 and Samarske rocks, and Hajdučki and 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 originilaty 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.

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 meaning 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 remain forest area. Consequently, this means that the partially burnt wood is a subject of regular forest works and 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 disturbances 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 the natural disturbances only in special circumstances, and that this can happen only in case of:

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

The additional analyses performed in Croatia showed that other types of 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 in the future also. This is a 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 and presenting the data in the Initial repor, 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.

However, since then Croatia initiated a separate project in order to determine emissions due to natural disturbances selected in the Initial report and defining BL and ML in FM areas. 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 (decidous, coniferus maquies and shrub), volume and areas affected. The questionnaire refered 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 determing wood volume left on the site after the disturbance made 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 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 refers 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 with 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 to the following types of natural disturbances:

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

Since Croatia already disposes with the data about forest fire emissions that are recently revised (through the LULUCF 1 project implemented in period 2014-2015) 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:

i. A consistent and complete time series containing annual emissions from selected ND types (Table 2) for the calibration period 2001 – 2017 was set.
ii. The arithmetical mean and standard deviation of the emissions were calculated.
iii. Any emissions that were larger than the arithmetic mean plus twice the standard deviation (outlier) were removed from the time series.
iv. The process mentioned in points 2. and 3. above was iterated until no further outliers were identified.
v. 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:

1. Background level: 63.45Gg CO_2eq.
2. Margin: 132.83Gg CO_2eq.
3. Background level plus margin: 196.28 Gg CO_2eq.
4. Total number of years: 17
5. Number of excluded years: 6
6. Years excluded: 2017, 2012, 2003, 2007, 2001, 2011

The total emissions associated with the disturbances for the calibration period for the land under the forest management are presented in Table 7-1 while defined BL and ML on these areas are presented in Figure 7-1.

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

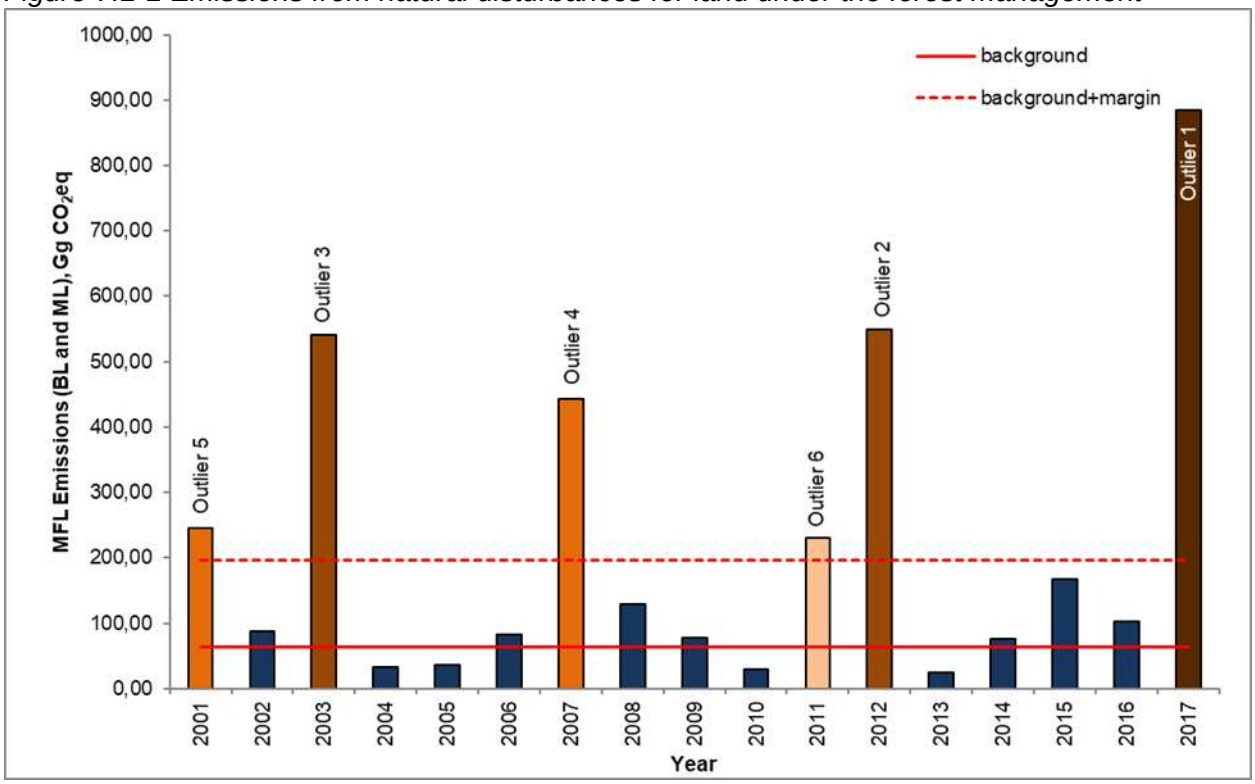

Table 7.1-1 Estimated emissions from natural disturbances for managed forest land (MFL) (2001-2017)

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

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