

CROATIA

– Forestry report in the context of CEEC 16+1 –

Brief Country Profile

Croatia, officially the Republic of Croatia (Croatian: Republika Hrvatska), is a country in Central and Southern Europe, on the Adriatic Sea. Its centrally positioned capital, Zagreb, represents one of the country's primary subdivisions, along with its twenty counties. Croatia has a **total area of 56.594 square kilometers** (21,851 square miles) and a **population of 4.28 million**.



Geopolitical position of the Republic of Croatia (dark green) within the Europe (light green + dark grey) and European Union (light green). Source: Wikipedia CC BY-SA 3.0

Politically, Croatia is a republic governed under a parliamentary system and a developed economy with a very high Human Development Index. Croatia is a member of the European Union (EU), United Nations (UN), the Council of Europe, NATO, World Trade Organization (WTO) and a founding member of the Union for the Mediterranean.

Capital and largest city	Zagreb 📍 45°48'N 16°0'E
Official language	Croatian
Ethnic groups (2011 ^[1])	90.42% Croats 4.36% Serbs

	5.22% others
Religion (2011)	91.06% Christians
Demonym	Croatian
Government	Unitary parliamentary
President	Kolinda Grabar-Kitarović
Prime Minister	Andrej Plenković
Speaker of Parliament	Gordan Jandroković
Chief Justice	Đuro Sessa
Legislature	Sabor
Establishment	
Duchy	early 7th century
Kingdom	925
Personal union with Hungary	1102
Joined Habsburg Monarchy	1 January 1527
Secession from	29 October 1918
Creation of Yugoslavia	4 December 1918
Decision on independence	25 June 1991
Joined the European Union	1 July 2013
Area	
Total	56,594 km ² (21,851 sq mi)
Water (%)	1.09
Population	
2017 estimate	4,154,200 ^[2]
2011 census	4,284,889 ^[3]
Density	75.8/km ² (196.3/sq mi)
GDP (PPP)	
Total	2017 estimate
	\$100.006 billion ^[4]
Per capita	\$24,053 ^[4]
GDP (nominal)	
Total	2017 estimate
	\$51.945 billion ^[4]
Per capita	\$12,405 ^[4]
Gini (2017)	▼ 29.7 ^[5]
HDI (2015)	▲ 0.827 ^[6]
Currency	Kuna (HRK)
Time zone	CET (UTC+1)
Summer (DST)	CEST (UTC+2)
Date format	dd/mm/yyyy (CE)

Drives on the	right
Calling code	+385
ISO 3166 code	HR
Internet TLD	.hr and .eu

As an active participant in the UN peacekeeping forces, Croatia has contributed troops to the NATO-led mission in Afghanistan and took a non-permanent seat on the UN Security Council for the 2008–2009 term. The service sector dominates Croatia's economy, followed by the

industrial sector and agriculture. International tourism is a significant source of revenue during the summer, with Croatia ranked the 18th most popular tourist destination in the world. The state controls a part of the economy, with substantial government expenditure. The European Union is Croatia's most important trading partner. Since 2000, the Croatian government has constantly invested in infrastructure, especially transport routes and facilities along the Pan-European corridors. Internal sources produce a significant portion of energy in Croatia; the rest is imported. Croatia provides a universal health care system and free primary and secondary education, while supporting culture through numerous public institutions and corporate investments in media and publishing.

Geographically, Croatian territory consists of 56,414 square kilometers of land and 128 square kilometers of water. It is the 127th largest country in the world. Elevation ranges from the mountains of the Dinaric Alps with the highest point of the Dinara peak at 1,831 meters (6,007 feet) near the border with Bosnia and Herzegovina in the south to the shore of the Adriatic Sea which makes up its entire southwest border. Insular Croatia consists of over a thousand islands and islets varying in size, 48 of which are permanently inhabited. The largest islands are Cres and Krk, each of them having an area of around 405 square kilometers.

Tabular data taken from Wikipedia and the following sources:

1. *"Population by Ethnicity, by Towns/Municipalities, 2011 Census"*. *Census of Population, Households and Dwellings 2011*. Zagreb: Croatian Bureau of Statistics. December 2012.
2. *"EU population up to almost 512 million at 1 January 2017 - Europa EU"*. Eurostat. 1 January 2017. Retrieved 5 October 2017.
3. *"Population by Age and Sex, by Settlements, 2011 Census"*. *Census of Population, Households and Dwellings 2011*. Zagreb: Croatian Bureau of Statistics. December 2012.
4. *"World Economic Outlook Database, April 2017 – Croatia"*. International Monetary Fund. Retrieved 25 April 2017.
5. *"First Results"*. Croatian Bureau of Statistics, Retrieved 21 July 2017.
6. *"2016 Human Development Report"*. United Nations Development Programme. 2016. Retrieved 25 March 2017.

Forestry And Forests

Republic of Croatia has a long-standing tradition of sustainable forest management that dates back over 250 years. Already in 1769, the first Forest Order recognized that forest management should be based on the principles of sustainability. As a result, Republic of Croatia has some of the most extensive, healthy and naturally self-sustaining forests in Europe today. Croatian forests represent a rich biodiversity concentrated on its relatively small territory. 4500 plant species and subspecies, 260 autochthonous tree species and more than 100 forest plant communities exist on over 2.7 million hectares of forest and other forested land. In the Republic of Croatia, **forests cover almost half of the land territory**. Their value has been recognized a long time ago. Most of this valuable resource is owned by the State, and managed in a “close to nature” practice with the objective of natural regeneration. Furthermore, **clear cuts are prohibited by the law**, which helps to maintain the forest stands in optimal condition and provides continuous cover over large areas. Consequently, all state forests, managed by state owned enterprise („Croatian forests“ Ltd), are accredited with the prestigious Forest Stewardship Council’s certificate (FSC). Republic of Croatia has made an ambitious plan for having 100% of forests under sustainable forest management. Reaching this goal is accomplished through the development of the Forest Management Plans for private forests. Republic of Croatia has developed sustainable forest management financing mechanism in the form of “green tax”. It is based on the charging of Public Used Non-timber Forests Services to all economic entities in the State.

Funds collected in this way are strictly designated and used only for implementation of activities supporting and executing sustainable forest management. Forests in Republic of Croatia have not been changed substantially in the last hundred years, but this does not mean they have not been managed and harvested. On the contrary, many areas have been and will continue to be, used sustainably for wood production or as hunting reserves, which not only bring in economic gains, but also provide employment and additional income to thousands of people.

Forest area

Total area of forests and forest land in Croatia amounts to **2,759,039.05 hectares which is close to 47% percent of land area**. State owned forest area amounts to roughly three quarters of total (2,097,318.16 hektara or 76%) while one quarter (661,720.89 hectares or 24%) is under the private ownership.

(Source: Croatian national forest Inventory and Forest Management plan for the Republic of Croatia 2016-2025)

Forest coverage and its change

Today's forest coverage of the Republic of Croatia is a result of long term efforts to sustain and even enlarge the area covered with high valued forest cover, both in terms of high forests, plantations and coppices but also other types of protective and landscape valuable forest types. Changes in a 30-year period are shown in the following table.

National class	Area (hectares)		
	1986	1996	2006
Forest (stocked forest land) <i>land covered by forest trees formed as forest stand over an area larger than 10 ars (1 ar = 100 square meters). Separate forest tree groups over an area up to 10 ars, forest nurseries, wind barrier belts, tree avenues, and parks in settlements are not considered forests.</i>	2,061,509	2,078,289	2,402,782
<u>a) high forest, plantation and coppice</u>	1,825,543	1,748,343	1,889,638
<u>b) scrubland</u>	236,166	329,946	513,144
Other forest land (unstocked forest land) <i>wooded land is defined as the land upon which forest is grown, or, owing to its natural characteristics and management conditions, is assigned as the most appropriate for forest cultivation</i>	396,139	407,322	285,904
<u>a) Productive wooded land without vegetation cover</u>	315,166	331,334	208,465
<u>b) Non-productive wooded land</u>	16,961	14,618	32,952

<u>without vegetation</u>			
c) Barren wooded land	64,012	61,370	44,487
Other land	3,138,352	3,110,389	2,907,314
Other land with tree cover	n.a.	n.a.	2,050,65
Inland water bodies	63,000	63,000	63,000
Total for country:	5,659,000	5,659,000	5,659,000

Table data source: Global Forest Resources Assessment 2015, Country Report Croatia, FAO Rome, 2014.

Category	Year				
	2012	2013	2014	2015	2016
	1,000 ha				
Forest	1,921	1,921	1,922	1,922	1,925
Other wooded land	563	565	567	569	614
Forest and other wooded land	2,484	2,486	2,489	2,491	2,539

Area of forest and other wooded land (according to FRA definition). Source: Ministry of Agriculture of the Republic of Croatia

Category	Year				
	2012	2013	2014	2015	2016
	%				
Forest	34%	34%	34%	34%	34%
Other wooded land	10%	10%	10%	10%	11%
Forest and other wooded land	44%	44%	44%	44%	45%

Forest coverage in relation to the total land surface of the country. Source: Ministry of Agriculture of the Republic of Croatia

Actual change of all the main forest types for the whole territory of Croatia are broken down into three categories (managed/commercial, protective and special purpose forests) are shown in the following table. Figures represent factual data recorded at the beginning of the former Forest Management period (2006) and data recorded at the beginning (2016) of the actual one valid until the end of 2025. Differences in plus or minus thus represent the changes in the last 10 years (2006-2016).

Forest type	Year of inventory	Forests and forest land (hectares)				
		Forested	Barren		Unfertile	Total
			Productive	Unproductive		
Managed forest	2006	2,168,874.05	181,658.50	27,037.89	38,536.73	2,416,107.17
	2016	1,353,810.97	44,430.71	11,839.80	15,727.98	1,425,809.46
	Difference	-815,063.08	-137,227.79	-15,198.09	-22,808.75	-990,297.71
Protection forests	2006	130,629.85	18,781.14	1,503.61	3,623.98	154,538.58
	2016	710,137.96	99,449.75	8,403.54	14,104.57	832,095.82
	Difference	+579,508.11	+80,668.61	+6,899.93	+10,480.59	+677,557.24
Special purpose forests	2006	103,278.33	8,026.90	4,410.27	2,325.99	118,041.49
	2016	428,727.40	55,266.30	4,712.40	12,427.67	501,133.77
	Difference	+325,449.07	+47,239.40	+302.13	+10,101.68	+383,092.28
Total	2006	2,402,782.23	208,466.54	32,951.77	44,486.70	2,688,687.24
	2016	2,492,676.33	199,146.76	24,955.74	42,260.22	2,759,039.05
	Difference	+89,894.10	-9,319.78	-7,996.03	-2,226.48	+70,351.81

Table data source: Forest Management plan for the Republic of Croatia 2016-2025

Forest classification

Forests are classified according to their structural features, composition, growing types, origin, management approach, purpose or use and ownership. Classification of forest cover based on the satellite imagery distinguishes total area of forest land on stocked forest area (2378 thousand ha) and permanently or temporarily unstocked forest land (203 thousands ha). The assessment includes shrub and macchia land as forest land. Using the assessed stocked forest area and field assessments on sample plots, forest land can be further sub-divided according to the forest management system, the forest function, and origin and type of forest cover. About 78 % of the forest area is covered with high forest while the remaining area includes relative high share of coppice forest (15 %) and shrub and macchia land (7 %). Subdividing the forest area according to forest function is relevant with regard to availability of wood resources. Based on the field assessment, three categories of forest function are defined as follows:

1. Productive

Forest areas with primary economic function and fully available for wood supply. This category includes also multipurpose forests with significant ecological and social functions, in which commercial harvests are allowed.

2. Protective

Forests located in poorly accessible or inaccessible locations, on very poor productivity sites. They have significant role in soil protection and are not available for wood supply.

3. Nature protection and biodiversity

Forests protected by law for ecosystem services, nature protection and conservation of biological diversity. In the following table, the structural composition of main forest types in Croatia are given.

National class	Area (hectares)		
	1986	1996	2006
1. Naturally regenerated forest <i>Forests emerged by restoration after fertilizing and selection fellings. They compose of trees mostly emerged by natural restoration (from seeds or from stumps), and by their origin they can be high forest forms (from seeds) or low forest forms (coppice – stump forests).</i>	1,777,915	1,777,292	1,870,378
<u>1.1 High forests</u>	1,113,234	1,259,253	1,321,094
<u>1.1.1.Stocked forest land</u>	1,084,343	1,227,541	1,283,561
<u>a) primary forest</u> <i>Naturally regenerated forest of native species where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed</i>	6,730	6,730	6,730
<u>b) other</u>	1,077,613	1,220,811	1,276,831

<u>naturally regenerated forest</u>			
<u>1.1.2. Unstocked area that according to FRA counts into forest area</u>	28,891	31,712	37,533
<u>1.2. Low forests (coppice)</u>	664,681	518,039	549,284
<u>1.2.1. Stocked forest land</u>	647,053	504,901	533,829
<u>1.2.2. Unstocked area that according to Forest Resource Assessment (FAO) counts into forest area</u>	17,628	13,138	15,455
2. Planted forests <i>Forest predominantly composed of trees established through planting and/or deliberate seeding</i>	96,395	16,354	74,456
<u>2.1. Cultures and plantations</u>	96,395	16,354	74,456
<u>2.1.1. Stocked forest land</u>	93,947	15,901	72,248
<u>a) planted with autochthonous species</u>	66,356	0	46,054
<u>b) planted with introduced species</u>	27,411	15,901	26,194
<u>2.1.2. Unstocked area that according to FRA counts into forest area</u>	2,448	453	2,208
Total:	1,874,310	1,793,646	1,944,834

Table data source: Global Forest Resources Assessment 2015, Country Report Croatia, FAO Rome, 2014.

Category	Year				
	2012	2013	2014	2015	2016
	1,000 ha				
Primary forest (undisturbed by man)	7	7	7	7	7
Other naturally regenerated forest	1,840	1,840	1,841	1,840	1,844
Planted forest	74	74	74	75	74
Total	1,921	1,921	1,922	1,922	1,925

Classification of forests towards naturalness. Source: Ministry of Agriculture of the Republic of Croatia

Forestry structure

In total, 94 tree species occur in Croatian forests, while only 5 main tree species have share larger than 5 %. The predominant tree species is European beech with a share of almost one third of productive forest area (29.8 %), followed by common hornbeam which covers one tenth of productive forest area (10.0 %).

Besides beech and hornbeam, three other less common tree species are highly valuable: pedunculate oak (7.5 %), sessile oak (7.1 %) and silver fir (5.4 %). The remaining 89 tree species together cover 36.6 % of the forest area. The age-classes are assessed in intervals of 10 and 20 years. The highest age class includes all tree ages above 140 years. Considering the total even-aged forests in Croatia, the second and third age classes have the largest coverage while the two last have smallest coverage among all age classes. This is related to the presence of forest types of short rotation and the fact that high rotation forest types compose part of total even-aged forest area. Selection and uneven-aged forests cover almost 600 thousand ha. Small trees (dbh 10 – 30 cm) have highest coverage of the area (40 %) followed by medium large trees (dbh 30 – 50 cm) with coverage of 30 %, while large trees (dbh ≥ 50 cm) and young trees (< 10 cm dbh) cover 22 % and only 8 %, respectively.

Tree species	Area in hectares (ha)	Area in percentage (%)
European beech (<i>Fagus sylvatica</i>)	708,000	29.8
Pedunculate oak (<i>Quercus robur</i>)	189,000	7.9
Sessile oak (<i>Quercus petraea</i>)	170,000	7.1
Other oaks (<i>Quercus</i> spp.)	140,000	5.9
Common hornbeam (<i>Carpinus betulus</i>)	238,000	10.0
Narrow-leaved ash (<i>Fraxinus angustifolia</i>)	61,000	2.6
Other broadleaved hardwood	341,000	14.3
Other broadleaved softwood	118,000	5.0
Silver fir (<i>Abies alba</i>)	129,000	5.4
Norway spruce (<i>Picea abies</i>)	49,000	2.1
Black pine (<i>Pinus nigra</i>)	41,000	1.7
Aleppo pine (<i>Pinus halepensis</i>)	37,000	1.6
Scots pine (<i>Pinus sylvestris</i>)	14,000	0.6
Other conifers	28,000	1.2
Young even-aged stands	115,000	4.8
Total productive forest land	2,378,100	100.0

Table data source: Čavlović, J., Božić, M., Teslak, K., Vedriš, M., 2016: Chapter 15: Croatia (in Vidal, C., Alberdi, I., Hernandez, L., Redmond, J.: National forest inventories, Assessment of Wood Availability and Use, Springer, 845 pp.

Forest stock volume, increment and logging

Standing stock estimation is based on the sample plot tree measurements (i.e. tree diameters and heights) and available volume tables for several tree species. **The total standing volume of 566.4 million m³ on the productive forest land in Croatia is composed of 552.1 million m³ of growing stock and 14.3 million m³ (2.5 %) of standing dead wood.** The productive forest area produces about 13 million m³ of volume increment each year, of which 8.4 million m³ are harvested annually. During the last two decades the drain represented two-thirds of the increment. The need for a higher intensity of stand thinning and regeneration, an increased demand of fuel wood, storm damage events, are facts that should lead to more intensive utilisation of wood resources in the future. European beech contributes to the standing stock/growing stock volume with largest share (34.8 %). The second third of the growing stock is composed of the following four tree species: pedunculate oak (13.0 %), sessile oak (9.2 %), common hornbeam (9.2 %) and silver fir (6.2 %). The remaining 89 tree species altogether account for the remaining 27.6 % of the standing volume. **For all tree species the harvest are lesser than the increment**, except for the silver fir, which is characterized by greater harvest (164 % of increment) as a result of the diameter structure (high share of large trees) and the intention of encouraging more intensive silver fir regeneration. Over three quarter (75–85 %) of pedunculate oak, beech and black locust (*Robinia pseudoaccacia* L.) increment has been harvested, while sessile oak, hornbeam and narrow-leaved ash are characterized by harvesting of only half of the volume increment. Low drain/increment ratio, below one third or even one fifth is characteristic for other tree species (conifer plantations, plantations of broadleaved softwood tree species,

Mediterranean tree species). The estimates of standing stock, growing stock, increment, and drain on productive forest land by tree species are shown as tabular data (according to: Čavlović et al 2016).

Definition

Standing stock Volume of standing trees (alive and dead) with dbh \geq 10 cm over bark, including the bole (wood and bark), and stem top, and including the above-ground part of the stump. In uneven-aged forests, Mediterranean forests and young even-aged stands volume of trees with dbh 5-10 cm can also be provided

Increment Volume increment of surviving trees with dbh \geq 10 cm over bark as average estimation of growth period. Final definition and proper approach, considering method of concentric plots sample (nongrowth trees), will be defined after completion of second National Forest Inventory

Drain Volume of trees with dbh \geq 10 cm over bark as average estimation of tree volumes felled over a given period. After completion of second National Forest Inventory: volume of trees with dbh \geq 10 cm over bark at the first measurement that were found to be harvested in the subsequent National Forest Inventory

Tree species	Standing stock (thousands m ³)	Growing stock (thousands m ³)	Increment (thousands m ³ /year)	Drain (thousands m ³ /year)
European beech (<i>Fagus sylvatica</i>)	196,135	192,283	4,360	3,543
Pedunculate oak (<i>Quercus robur</i>)	73,019	71,830	1,477	1,118
Sessile oak (<i>Quercus petraea</i>)	51,881	50,597	1,127	537
Downy oak (<i>Quercus pubescens</i>)	7,014	6,634	153	29
Turkey oak (<i>Quercus cerris</i>)	11,460	11,318	246	114
Holm oak (<i>Quercus ilex</i>)	2,235	2,140	51	5
Ash (<i>Fraxinus angustifolia</i>)	17,761	17,619	496	243
Hornbeam (<i>Carpinus betulus</i>)	50,930	50,526	1,365	675
Hop hornbeam (<i>Ostrya carpinifolia</i>)	3,733	3,567	88	10
Black locust (<i>Robinia pseudoaccacia</i>)	13,648	13,172	400	342
Maple (<i>Acer pseudoplatanus</i>)	8,417	8,298	204	48
Other maples (<i>Acer</i> spp.)	8,845	8,583	211	38
Sweet chestnut (<i>Castanea sativa</i>)	6,990	5,849	171	48
Alder (<i>Alnus glutinosa</i>)	10,248	9,915	332	119
Linden (<i>Tilia</i> spp.)	7,086	7,014	230	71
Poplar (<i>Populus</i> spp.)	5,255	4,946	167	29
Willow (<i>Salix</i> spp.)	3,828	3,519	163	57
Other broadleaved hardwood	14,148	13,672	392	53
Other broadleaved softwood	1,878	1,759	57	10
Silver fir (<i>Abies alba</i>)	35,951	34,191	559	918
Norway spruce (<i>Picea abies</i>)	13,719	13,244	337	233
Black pine (<i>Pinus nigra</i>)	7,371	7,204	213	52
Aleppo pine (<i>Pinus halepensis</i>)	5,683	5,492	162	19
Scots pine (<i>Pinus sylvestris</i>)	3,376	3,162	93	62
Eastern white pine (<i>Pinus strobus</i>)	2,877	2,758	81	19
Other conifers	2,948	2,853	128	29
Total	566,437	552,146	13,263	8,418

Table data source: Čavlović, J., Božić, M., Teslak, K., Vedriš, M., 2016: Chapter 15: Croatia (in Vidal, C., Alberdi, I., Hernandez, L., Redmond, J.: National forest inventories, Assessment of Wood Availability and Use, Springer, 845 pp.

Value	Year	
	2012	2016
	million m ³ over bark	
Growing stock	406,29	418,62
Increment	10,3	10,15
Felling	5,97	6,51

The dynamic variation of the forest stock volume, increment and logging. Source: Ministry of Agriculture of the Republic of Croatia

Felling operation

Considering the quantity and increment share, pedunculate oak, sessile oak, European beech and silver fir are the most economically important tree species in Croatia and are mainly used for the production of sawlog, veneer and other industrial roundwood. According to the Croatian bureau of statistics (2013), of the total harvested wood in Croatian forests, 52 % is used as sawn logs and veneer logs, 21 % as pulpwood and other industrial roundwood, and 27 % is fuel wood including wood for Charcoal. The share of coniferous wood amounts only to 18 %, which is structured as: sawlog and veneer (85 %), industrial wood (11 %) and energy production (4 %). Nearly half of the broadleaved wood is used for sawlog and veneer (45 %), energy production (32 %) and pulpwood and other industrial wood (23 %). Broadleaved wood includes species with high wood quality and unique properties (e.g. sycamore maple, sweet cherry, black walnut). There is an increasing trend towards the use of wood for energy production in recent years in Croatia. Wood harvested for energy in 2008 was 0.76 million m³ which increased to 1.56 million m³ in 2012.

Source: Krajter Ostoić, S., Posavec, S., Paladinić, E., Županić, M., Beljan, K., Curman, M., Čaleta, M., Šimunović, N. (2015) Forest Land Ownership Change in Croatia. COST Action FP1201 - FACESMAP Country Report, European Forest Institute Central-East and South-East European Regional Office, Vienna. 40 pages.

The total volume of timber felled in recent 10 years: 57,84 million m³ over bark (period 2007-2016).

The planned felling volume in the next 10 years: 80,00 million m³ over bark (period 2017-2026).

Source: Ministry of Agriculture of the Republic of Croatia

Forest Management

Even-aged forest management is a dominant management system in Croatia, covering 75 % of total forest area (78 % in state and 63 % in private forests), while different uneven-aged management systems and irregular (transitional) stand structures represent the remainder. Selection management, primarily single stem selection covers almost 6 % of the total forest area and mostly relates to the spatial distribution of silver fir. Sub-Mediterranean forests, protected forests, coppice forests and small-scale private forests are characterized by different uneven-aged and irregular structures. Recently, uneven-aged forest management forming of stands composed of mosaic of developmental stages, stage size between 0.25 and 1.00 ha has been applied in small private forests and forests within nature parks ((Regulations for forest management planning 2006), which will gradually lead to an increased share of uneven-aged forest stands. The development of even-aged stands and their regeneration usually include the following management activities: stand establishment with natural regeneration or planting, enlargement of growing space and cleaning, thinning and regeneration felling. Selection management of silver fir stands is characterized by single stem and small group felling of mature trees and thinning in gaps of small and medium sized trees, every 10 years, with average 10-year cutting intensity of 21 %. The design of uneven-aged stands is based on regenerating up to 10 % of stand area by harvesting of small areas, up to 1 ha, and thinning of remaining stand area on a 10 year interval. Rough estimates of harvested wood volume are available. These can be distinguished by the type of harvesting through the stratification of plots and assessed harvest (amount and structure), by forest types, owner categories, management systems, diameter classes and age classes.

The harvested wood volume can be distinguished as: regeneration felling and thinning in even-aged stands, single stem and small area felling in uneven-aged stands, clear cuts and sanitary (salvage) felling. Harvested wood volume in broadleaved plantations, coppice stands with vegetative regeneration and high intensive felling in non-mature even-aged stands and uneven-aged stands are assessed as clear cuts. Regeneration felling including final cutting of remaining trees (44 %) and thinning (25 %) account more than two thirds of total harvested wood volume, while cutting of single stems and of small areas in uneven-aged forests amounts about 20 % of the total harvest. About 6 % of harvested wood is felled in clear cuts, and the remaining 5 % is salvage logging. Considering the diameter structure of harvested wood volume, the share of harvested trees dbh >50 cm amounts to 65 %, of trees dbh > 60 cm amounts to 50 % and trees >70 cm amounts to 35 %, while volume of harvested trees of dbh < 20 cm amounts to 2 %.

According to the Forest Act (2006) and Regulation for forest management planning (2006), harvesting operations must be prescribed. A deviation from the prescribed harvested volume of 10–20 % is allowed, depending on the type of harvest. For uneven-aged stands a 10-year harvest is limited to maximum 30 % of the standing volume. A new even-aged stand has to be established either by natural regeneration or planting latest at the end of the third year following the year of the final cutting. Clear cut areas larger than 0.2 ha (salvage logging) have to be re-established by seeding or planting in the same vegetation period or at beginning of the next vegetation period.

Institutions associated with forestry

- Faculty of Forestry, University of Zagreb (www.sumfak.unizg.hr)
- Croatian Forest Research Institute (www.sumins.hr)
- Croatian Union of Private Forest Owners' Associations (www.hsups.hr)
- Croatian Forests Ltd. (www.hrsume.hr)
- Croatian Chamber of Forestry and Wood Technology Engineers (www.hkisdt.hr)
- Croatian Forestry Society (www.sumari.hr)
- Ministry of Agriculture (www.mps.hr)
- Advisory Service (www.savjetodavna.hr)
- State Institute for Nature Protection (www.dzpz.hr)
- Ministry of Environmental and Nature Protection (www.mzoip.hr)

Forestry employment

Most of the wood (logs) from the State forests is sold to the domestic wood processing industry through the (annual and) perennial agreements based on fixed prices from the Croatian Forest Ltd. price list for wood products. Those prices had not been significantly changed for 10 years, and since 2012 the prices of all assortments have been corrected according to current market situation and new business policy of the company. Those market conditions lead to the fact that most of the industry is based on semi-processed wood for export instead on production of products with higher added value. Lately valuable wood assortments originated from state forests are advertised and sold on the international auctions (6.0 %, 3.6 % and 2.0 % of total amount of sold logs in 2011, 2012 and 2013 respectively) and are achieving better prices. There are no officially published data on wood assortments sold from private forests. Croatian Forests Ltd. sells more than 1 million m³ of energy wood annually to the local population for heating purposes, and up to 1,00,000 m³ to the Forest Biomass Ltd. for wood-chips production. Decreasing trend of the number of employees in companies operating in wood-processing sector, furniture production and forestry sector has started in Croatia even before beginning of last global economic crisis. In order to increase employment in these sectors and to balance and regulate mutual relationship, Wood Processing Industry Association of the Chamber of Commerce and Croatian Forests Ltd. made an agreement in 2012. Based on this agreement Croatian Forests Ltd. developed the new business model allowing annual and several year contracts (up to 10 years) with domestic wood-processing companies and Croatian Forests Ltd. for the purchase of raw wood material, based on defined terms, criteria and the rebate calculation system. According to the proposed model all the companies of wood-processing sector in Croatia have got ability and the right to access, under equal conditions, the signing and implementation of several year contract.

According to comprehensive analysis of forestry contractors and services provided to the company Croatian Forests Ltd. in the period 1998 to 2002, forestry contractors have carried out around 14% of all tree-felling activities and around 44% of all wood skidding (calculation based on extracted wood volume). Also they have carried out some 10% of reforestation and afforestation activities and around 70% of all wood transportation for the company Croatian Forests Ltd. The vast majority of forestry contractors' services were carried out in state forests. Service contracts have been contracted with forestry contractors each year for different implementation periods, from single day to annual contracts. The most common were short-term contracts with deadline for carrying out the services since 30 to 50 days. According the three Annual reports of Croatian Forests Ltd. (2011, 2012, 2013), the share of services provided by forestry contractors to the company has significantly increased. After the establishment of Forestry Extension Service in 2006, provision of forest management services by forestry contractors increased based on experts opinion. In Croatia, typical forest owners harvest their forest by themselves and then sell the round wood to contractors who resell it to sawmills, and forest owners and entrepreneurs are connected mainly through informal information channels (RoK-FOR report, 2012). It is possible also for forest owners to sell wood from their forest as standing trees. Then the contractors harvest and sell wood products. Classification of wood assortments is done according to the national standards for wood products (HRN). The complete process is based on the price list for wood products. The majority of the non-industrial private forest owners (NIPF) in Croatia use wood from their forests for household heating, and the average yearly consumption of wood for such purpose is 12 m³. Similarly, the majority of the NIPFs also reported that they purchased energy wood from market and around 7% of them sold energy wood from their forests, while the share of those who sell energy wood is 14%. Usually private forest owners are not aware enough on wood products standards (HRN) and then they accept some average assortment prices. The problem is that forest owners get lower prices for the wood, benefiting sawmills and dealers with extra profits. This is a result of the lack of wood market, making quite difficult to define market prices for different type of wood. The buyers are wood processing companies, and there is unknown number of intermediaries involved in the processes. The PFOAs are not involved in the selling process.

Source: Krajer Ostoić, S., Posavec, S., Paladinić, E., Županić, M., Beljan, K., Curman, M., Čaleta, M., Šimunović, N. (2015) *Forest Land Ownership Change in Croatia. COST Action FP1201 - FACESMAP Country Report, European Forest Institute Central-East and South-East European Regional Office, Vienna. 40 pages.*

Latest available data on forest employment is given in the following table.

Employment in Forestry	1990	2000	2005	2010	2014
	14,296	9,908	9,095	8,634	8,800

Table data source: *Global Forest Resources Assessment 2015, Country Report Croatia, FAO Rome, 2014.*

Forest ownership

The Croatian National Forest Inventory distinguishes forest ownership into two main categories: private forests regardless of property size (small-scale private forest property <1 ha is dominant), and state forests managed by the state enterprise Croatian Forests Ltd. These categories have been assessed in the field at plot level, and the area of each category is estimated using the proportion of field plots corresponding to the specified category and total forest area. The total area of state forests can be divided into the following categories using GIS: a) forests with public access, b) different forest categories of nature protection (nature parks, national parks, strict reserves), c) educational and military forests, out of management or under restricted management (nature parks) within the state enterprise Croatian Forests Ltd. Nearly one quarter (23 %) of the Croatian forest estate belongs to category of private forests. Forests of high ecological and social use (other state forests) comprise about 11 % of the Croatian forest area.

Ownership category		Area (ha)	Area (%)
Private forests (24 %)		661,721	24 %
State forests (76 %)	Enterprise Croatian Forests Ltd.	2,024,461	74 %
	Other state (public) forests	72,857	2 %
Total forest area		2,759,039	100 %

(Source: *Croatian national forest Inventory and Forest Management plan for the Republic of Croatia 2016-2025*)

Forestry policy

Forests are of extraordinary significance to the Croatian state. This is obvious from the fact that **forest as such is mentioned in the Croatian Constitution in the article 52 as a “resource of particular interest which enjoys a special state protection”**. Furthermore, the treatment of the entire forest is regulated by the Forest Act (2006). This Act regulates the silviculture, protection, use and management of forests and forest land as a natural resource, in order to maintain biodiversity and ensure management based on the principles of economic viability, social responsibility and environmental acceptability. Depending on the management objective, forests can be commercial forests, forests with protective functions and special purpose forests. Forests within protected areas or areas of natural value are protected by regulations on nature protection which are the basis of specific management plans for these areas. Forests of all categories may have certain restrictions for the wood supply. In commercial forests the dominant function is the production of wood, but in a way that production is balanced with other functions of forests. Within protective and protected forests, depending on their purpose, harvesting can be totally forbidden or limited. Harvesting is not allowed in strict forest reserves and national parks. In all other categories, the harvesting of wood is permitted in accordance with the characteristics and degree of protection afforded (historical sites, water protection areas, military training areas, research forests, nature parks, etc.). The silvicultural treatment applied to environmental and production characteristics of habitats also impose some restrictions for wood supply. For example, **clear-cutting is prohibited in Croatia** except within forest plantations. In mountainous areas due to the significance of soil protection from erosion, there are also some limitations and requirements for harvesting, management system and intensity of logging within commercial forests. A maximum of 30 % of the existing growing stock can be harvested every 10 years.

Source: Čavlović, J., Božić, M., Teslak, K., Vedriš, M., 2016: Chapter 15: Croatia (in Vidal, C., Alberdi, I., Hernandez, L., Redmond, J.: National forest inventories, Assessment of Wood Availability and Use, Springer, 845 pp.

Investigation and monitoring of forestry resources

There are several monitoring processes ongoing in relation to forest ecosystems in Croatia, one of which is the International Cooperative Program on Assessment and Monitoring of Air Pollution Effects on Forests which Croatia takes part in 1987, when first large-scale and permanent monitoring of forest ecosystems were established on 16×16 km grid network of plots (European network – Level 1) and intensive monitoring plots (7 plots in characteristic forest associations of Croatia – Level 2). The monitoring data are fulfilling the need of Republic of Croatia for domestic and international reporting. Nowadays monitoring is backed by forest law and regulations, and financed by the Ministry of Agriculture. Croatian Forest Research Institute is the National Focal Center of ICP-Forests. Detailed information along with annual reports on the condition of forests in Croatia can be found at www.icp.sumins.hr.

Other monitoring activities in relation to forests and forest land are conducted through surveys taken for the purpose of national forest Inventories, quarantine pests and diseases, NATURA 2000 and national nature protection network monitoring and alike. Most of these activities are either conducted and/or governed by the following institutions: Faculty of Forestry, Croatian Forest Research Institute, Croatian Forests Ltd., State Institute for Nature Protection and Advisory service.

Forestry Research and Education

Both forestry research and education in Croatia are concentrated in a small number of institutions. Undergraduate education of forestry is organized in several high schools located throughout the country with one dominant in the city of Karlovac (Forestry and Carpentry School in Karlovac). Higher education schooling of forestry is possible only at the Faculty of Forestry, part of the University of Zagreb, relatively large university by the European standards. Research in forestry has a broader list of public institutions and some enterprises-institutions, like Oikon Ltd. for example. However, the two by far dominant research institutions in Croatia are Faculty of Forestry (Zagreb) and Croatian Forest Research Institute (Jastrebarsko).

Forestry research

Research in the area of forestry and closely related research areas (nature conservation, landscape management etc.) is conducted mainly in the two research institutions:

- University of Zagreb, Faculty of Forestry (www.sumfak.unizg.hr)

The Faculty of Forestry of the University of Zagreb is the only faculty of its kind in Croatia. It was established in 1898 as the University's fourth faculty. At that time, it operated as the Forestry Academy within what was then the Faculty of Philosophy. With its long-standing tradition and high-quality programmes, it soon became the leader among higher education educational and scientific forestry institutions in this part of Europe, and one of the leading forestry faculties in Europe.

Today, the Faculty of Forestry consists of the Department of Forestry and the Department of Wood Technology. These include 11 institutes, 5 training and research forest centres and 2 hunting grounds.

To date, 6,600 students have completed undergraduate studies at the Faculty, 350 students have completed a post-graduate master's programme, and 200 students have completed the post-graduate doctoral programme. Through its scientific research work, the Faculty is associated with various corporate entities, ministries, agencies, etc. and with many European and other universities, faculties, institutions and agencies through various forms of international cooperation. Research at the Faculty of Forestry is conducted in two fundamental scientific areas: forestry and wood technology. Scientific research work, in the framework of both domestic and international scientific projects, is characterised by the high international standards of quality. Research is carried out in newly equipped laboratories, most of which are authorized, and at the training and research forest centres. Research results are published in international and domestic journals. The Faculty publishes 3 scientific journals and 1 scientific/professional journal.

- Croatian Forest Research Institute (www.sumins.hr)

Croatian Forest Research Institute (CFRI) is founded in 1974. It is a public research institute and leading national research institution in the scientific field of forestry. CFRI implements top-quality scientific research and together with other scientific institutions establishes a scientific infrastructure of the National Innovation System of Science and Higher Education. Three research pillars are Climate change and forest monitoring; Climate change adaptation and forest genetic resources; Social forest services, non-wood forest products and governance. CFRI has also important role in raising awareness on the role of forests, protection of forest resources, promotion of sustainable forest management (SFM) and natural resources as well as promoting cooperation and innovative approaches in SFM. CFRI's headquarters is in Jastrebarsko and the Institute is hierarchically organized in two departments, six research divisions, five laboratories and three Regional Research Centers (RRC). CFRI employs in total 88 staff whereas 42 R&D personnel, others are technical and other administrative staff. Institute's annual budget is 2.7mil €.

Forestry education

Future Forestry professionals in Croatia have a choice of applying to several study programs and curricula at the single one higher education institution – Faculty of Forestry in Zagreb, part of the larger University of Zagreb. The Faculty as a public institution is designed to operate as part of the Croatian higher education system. It is divided into several organizational units.

The Faculty of Forestry is the only institution of higher education in Croatia which trains experts in the fields of forestry and wood technology. It is a descendant of the Križevci School of Agriculture and Forestry, which was founded in 1860, and the Academy of Forestry. The Faculty of Forestry was founded on October 20th 1898 as the fourth constituent part in the history of the University in Zagreb. The first doctoral dissertation at the Faculty of Forestry was defended by Josip Balen on 4th June 1923, with a dissertation topic from the field of ecology and silviculture entitled "Bora and its Importance in the Afforestation of Karst". The title of doctor of science at the Faculty of Forestry has since been obtained by 274+ candidates.

Since the academic year 2014/2015, the Faculty of Forestry of the University of Zagreb has organized and conducted a postgraduate university doctoral study program of Forestry and Wood Technology, which

trains doctoral candidates in scientific-research work in the area of biotechnical sciences, the field of forestry (branches: genetics and forest tree breeding, forest technologies and management, urban forestry and nature protection, forest planning, ecology and silviculture, wildlife management and forest protection) and the field of wood technology (branches: wood materials, wood technology processes, construction and design of wood products and organization of production).

In the field of research and science, the Faculty is registered in the sector of biotechnological sciences, the fields of Forestry and Wood Technology. The teaching and research activities are performed at departments and institutes.

The Faculty has two departments – the Department of Forestry and the Department of Wood Technology – as well as 11 institutes, 15 laboratories and 3500 hectares of land with a total of 5 facilities for teaching and research in various forest ecosystems in Croatia.

Since the academic year 2005/2006, the study programs have been organized in accordance with the Bologna Declaration, and are divided into undergraduate, graduate, specialist and doctoral study programs. The Faculty offers three undergraduate study programs: 1. Forestry; 2. Urban Forestry, Nature Conservation and Environmental Protection; 3. Wood Technology.

Upon completion of the undergraduate study program in the duration of 6 semesters (180 ECTS credits), students can enroll in one of the four graduate study programs in the duration of 4 semesters (120 ECTS credits): 1. Forestry, 1.1. concentration Silviculture, Forest Management Planning and Wildlife Management, 1.2. concentration Techniques, Technologies and Management in Forestry; 2. Urban Forestry, Nature Conservation and Environmental Protection; 3. Wood Working Processes; 4. Design of Wood Products.

Upon completion of a graduate study program, students have the option of continuing training in postgraduate specialist study programs in the duration of 4 semesters (120 ECTS credits) or in postgraduate doctoral study programs in the duration of 6 semesters (180 ECTS credits).

Scientific, teaching and R&D activities are conducted in the departments of each section. The sections prepare, integrate and develop teaching, scientific and expert work in their scientific field or the fields for which they have been established. Sections are divided into departments that represent teaching, academic and professional organizational units. Within the departments, there are laboratories for the purposes of teaching, research and the practical work of students.

Departments at Forestry Section

- Department of Ecology and Silviculture
- Department of Forest Inventory and Management
- Department of Forest Genetics, Dendrology and Botany
- Department of Forest Engineering
- Department of Forest Protection and Wildlife Management
- Department of Training and Forest Research Centers

Laboratories at Forestry Section

- Laboratory of Ecology and Pedology
- Laboratory of Forest Seed and Nursery Production
- Laboratory of Measurement of Forest Resources
- Remote Sensing and GIS Laboratory
- Laboratory of Molecular Biology and Plant Physiology
- Laboratory of Technical and Technological Measurements in Forestry
- Laboratory of Forest Biomass
- Laboratory of Tree Pathology
- Laboratory of Forestry Zoology
- Forest Training and Research Centers: Lipovljani, Velika, Zalesina, Rab, Zagreb

Departments at Wood Technology Section

- Department for Wood Science

- Department of Materials Technology
- Department of Production Organization
- Department of Processes Engineering
- Department of Furniture and Wood Products

Laboratories at Wood Technology Section

- Laboratory of Anatomical Features and the Preservation of Wood
- Laboratory for Physical and Mechanical Properties of Wood
- Laboratory of Wood Panels
- Laboratory of Hydrothermal Treatment of Wood and Wood Materials
- Chemistry Laboratory
- Laboratory of Industrial Systems
- Laboratory of Mechanical Wood Processing
- Laboratory of Noise and Vibration Measurements
- Laboratory for Furniture and Furniture Parts Testing
- Laboratory for Wood in Construction

Forest economics

Gross added value of forestry to the country's GDP and the share of forestry's contribution varies between 3 and 3.5 % of Croatian GDP.

Forest products import and export trade

Import volume (tons), import value (millions of EUR) and export volume (tons), export value (millions of EUR) for wood products and furniture HS heading 44 + 94 (without 9405 and 9406), since 2012 are given in the following tables.

CT	PRODUCT	Import 2012		Import 2013		Import 2014		Import 2015		Import 2016	
		000 tons	mil. EUR	000 tons	mil. EUR	tons	mil. EUR	tons	mil. EUR	tons	mil. EUR
44 + 94 (without 9405 and 9406)	Total wood products and furniture	364	389	369	372	484	428	661	503	745	550
CT	PRODUCT	Export 2012		Export 2013		Export 2014		Export 2015		Export 2016	
		000 tons	mil. EUR	000 tons	mil. EUR	tons	mil. EUR	tons	mil. EUR	tons	mil. EUR
44 + 94 (without 9405 and 9406)	Total wood products and furniture	2,290	702	2,689	819	3,070	957	3,180	1,045	3,341	1,076

Source: Croatian Bureau of Statistics