An Overview of Forest Cover and Management in Italy

Nicolò Di Marzio

Abstract – *Nacrtak*

Over the centuries, alongside multiple changes in socio-economical conditions, needs and technical possibilities, Italian forest and forest management have gone through a dynamic and complex evolution process. In the last decade, forest lands in Italy have been constantly growing and nowadays cover almost 11 million hectars, accounting for 36.4 % of the total national territory. Several quantitative and qualitative aspects of forest resources, regarding species composition, actual and available stock, ownership, volume of utilization, accessibility, terrain features and others, have been described through the analysis of the National Forest Inventory (INFC2005). The most represented forest typology is »coppice with standards«, while many forests are in a mature stage, waiting for conversion to transitional stands. Concerning forest logging, full length harvesting and winching-skidding extraction are the most widespread systems, but in many areas the low-openness conditions represent a limiting factor for logging distances, expecially in high slope classes, where sustainable and cost-effective operations are primary. The modern solutions allowed by technological progress, in addition to the growing environmental awareness and need of a sustainable management at multiple level, require an efficient forest communication management and professional training of operators, in a challenging scenario that Italy is called to approach.

Keywords: Italian forest resources, National Inventory, forest management, accessibility, sustainable management

1. Introduction – *Uvod*

The contemporary forest pattern in Italy is the result of a complex assemblage of different land covers and geo-morphological situations, as a result of a progressive natural and man-made modification process, following cultural, socio-economic and environmental changes through millennial history in the whole territory. An example of strong influence on the composition of forest since medieval times and until the IX century has been represented by naval construction, for civil and military purposes, until the switch to iron-hulled ships (Agnoletti 2018). Along with population growth, other major influences have been given by the relationship with agricultural practices, the creation of hunting forests, where the structure was shaped in order to create suitable conditions for particular animal species, by different grazing management techniques for forest pastures and grasslands on hillside and mountain areas, and by the production of fuelwood and charcoal from every kind of forest, according to the needs and local traditions (Agnoletti 2018). By the National Unity (1861), Italian forest has undergone big modifications and impacts connected to the expansion of big towns and agricultural lands, the strong need of raw material for railway sleepers to support the creation of new rail networks, and the first national forest law of 1877, which allowed the beginning of reforestation, although with many hardships, operated by new consortia and forest administration (Gabbrielli 2007). Such process was disrupted by the First World War events, because of the considerable wood demand for military logistic and the need to provide a valid alternative to fossil fuel and timber, which was no longer possible to import from Austria (Ermacora 2009). By the interwar the negative trend of forest cover was reversed (Agnoletti 2018), whilst it was affected when the Second World War brought a new arms race and self-man-

agement of manufacture, resulting once again in a growing demand for raw material and charcoal, especially for foundries. The management of forest in this tough time was therefore oriented to productive purposes in several areas, so the positive trend of forest cover started to be more consistent in the second half of the century, thanks to legislative measures adopted and deep socio-economical changes such as land abandonment as well as the arrival of petroleum products and reinforced concrete as new energetic and building resources, and it still continues to be positive to date.

The aim of this paper is to give an overview of the actual situation in Italy concerning forest cover, forest management, main logging and extraction methods, with a few final remarks about future prospects for forest management, in view of the current needs.

2. Material and methods
Materijal i metode

All data presented in this paper have been gathered from the National forest inventory, official documents and databases, as well as from the National Report on the status of forest resources and other cited articles available on Google Scholar. Microsoft Excel has been used to implement data in order to make tables and graphs. This paper provides information about the current status of forest resources, stressing some main aspects of forest management and utilization in order to better focus on future perspectives.

3. Forest resources and national forest inventory – *Šumski resursi i nacionalna inventura šuma*

The first Italian Forest Inventory (NFI) was carried out in 1985. According to the definition of forest adopted at that time, the national forest cover was about 8,675,000 ha with 80 % of broadleaves, 16 % of coniferous and 4 % of clear mixed situations (www.infc.it).

The second Forest and Carbon Pools Inventory was carried out in 2005, following the International FAO definition of forest and CORINE Land Cover classes at a general level. The third National Inventory (INFC2015) has been completed partially at present; therefore, it is only possible to make a comparison with the previous situation on the basis of data projection. For future considerations of this paper, the second one (INFC2005) will be considered.

Fig. 1 shows the amount of forest cover in the above-mentioned inventories. The figure only gives a general idea about the trend of forest cover (forests + other wooded lands) through the years, accounting for an increase from 27.8 % of total forest land in 1985 to 36.4 % in 2015. In this figure, timber/wood plantations have not been considered, as data were not provided in preliminary results of INFC2015.
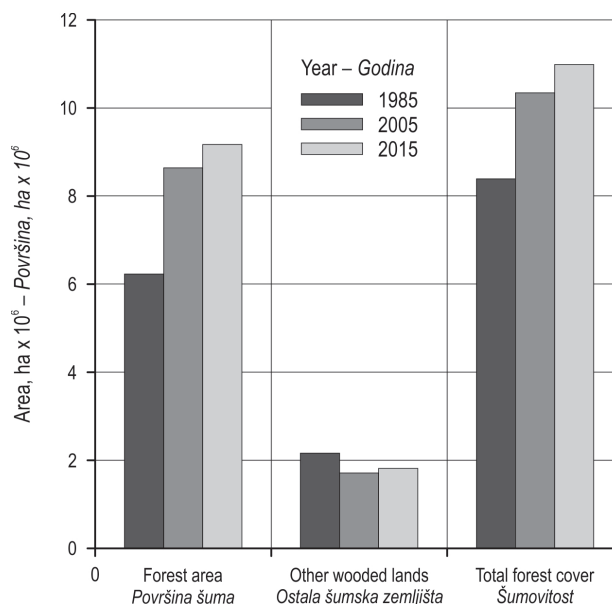

Fig. 1 Forest cover throughout national inventories
Slika 1. *Šumovitost prema nacionalnim inventurama*

According to the European standard and within FAO definition, *forest category* at the second level of classification is composed of tall tree forests (98 %), productive timber/wood plantations (0.4 %) and temporarily unstock areas (0.2 %), whether natural or artificial. Other forested areas, which do not completely meet the requirements of FAO definition of forest, are classified as other wooded lands. On balance, the completely forested national territory (forest + other wooded lands) accounts for 34.7 % in INFC2005, with the assumption to be 2 % more in INCF2015.

Tall tree forests are classified on the basis of 17 forest categories, according to the prevalent species in terms of crown cover, and three forest categories are considered for timber/wood plantations (Gasparini et al. 2016)

Table 1 shows the area, wood stock and annual increment of each forest category of INFC2005. The most forested regions are Liguria and Trentino (north part of the country), where forest cover is about 62.6 % and 60.5 %, respectively, of regional area.

Table 1 Area, volume and annual increment of forest categories (INFC2005)
Tablica 1. Površina, drvna zaliha i godišnji prirast visokih šuma (INFC2005)

Tall tree forest categories – *Kategorija visokih šuma*	Area – *Površina*, ha	Volume – *Drvna zaliha*, m³	Annual increment – *Godišnji prirast*, m³
Other coniferous forests – *Ostale sastojine četinjača*	63.407	12.496.202	404.893
Abies alba Mill.	68.460	29.244.196	565.119
Other evergreen broadleaved forests – *Ostale zimzelene sastojine listača*	84.712	4.476.479	226.448
Pinus sylvestris L. and *Pinus uncinata* Mill.	151.671	29.011.580	529.251
Quercus suber L.	168.602	8.444.671	220.298
Mediterranean pines – *Sastojine mediteranskih borova*	226.101	30.204.769	833.255
Hygrophilous forests – *Poplavne šume*	229.054	24.382.385	960.264
Black pines group – *Borove šume*	236.467	53.280.460	1.404.011
Larix decidua Mill. and *Pinus cembra* L.	382.372	76.930.988	1.282.925
Picea abies L.	586.082	218.166.422	4.567.710
Quercus ilex L.	620.318	45.598.302	1.453.949
Castanea sativa Mill.	788.408	139.697.903	4.941.237
Ostrya carpinifolia Scop. and *Carpinus betulus* L.	852.202	68.949.448	2.452.274
Other deciduous broadleaved forests – *Ostale listopadne sastojine*	994.777	94.003.164	4.006.403
Mediterranean oak spp. – *Sastojine mediteranskih hrastova*	1.010.986	103.797.336	3.233.075
Fagus sylvatica L.	1.035.103	240.009.507	5.597.810
Temperate oak spp. – *Sastojine kontinentalnih hrastova*	1.084.247	77.405.681	2.206.439
Total tall tree forests – *Ukupna površina visokih šuma*	8.582.969	1.256.099.493	34.885.361
Timber/wood plantation categories – *Kategorije plantaža*			
Poplar plantations – *Plantaže topole*	66.269	7.518.275	621.688
Other broadleaved plantations – *Plantaže ostalih listača*	40.985	1.976.387	196.488
Coniferous plantations – *Plantaže četinjača*	14.998	2.751.832	121.672
Total timber/wood plantations – *Plantaže, ukupno*	122.252	12.246.494	939.848
Temporarily unstocked areas – *Privremeno neproizvodne površine*	53.981	1.070.512	47.083
Total – *Ukupno*	8.759.202	1.269.416.499	35.872.292

Fig. 2 shows the proportions of the first 17 categories. Temperate and Mediterranean oak, beech, chestnut, hornbeam, holm oak and spruce are the most representative species in Italy. Because of the great variety of landscapes, resulting from socio-political changes and connected with the physical fea-
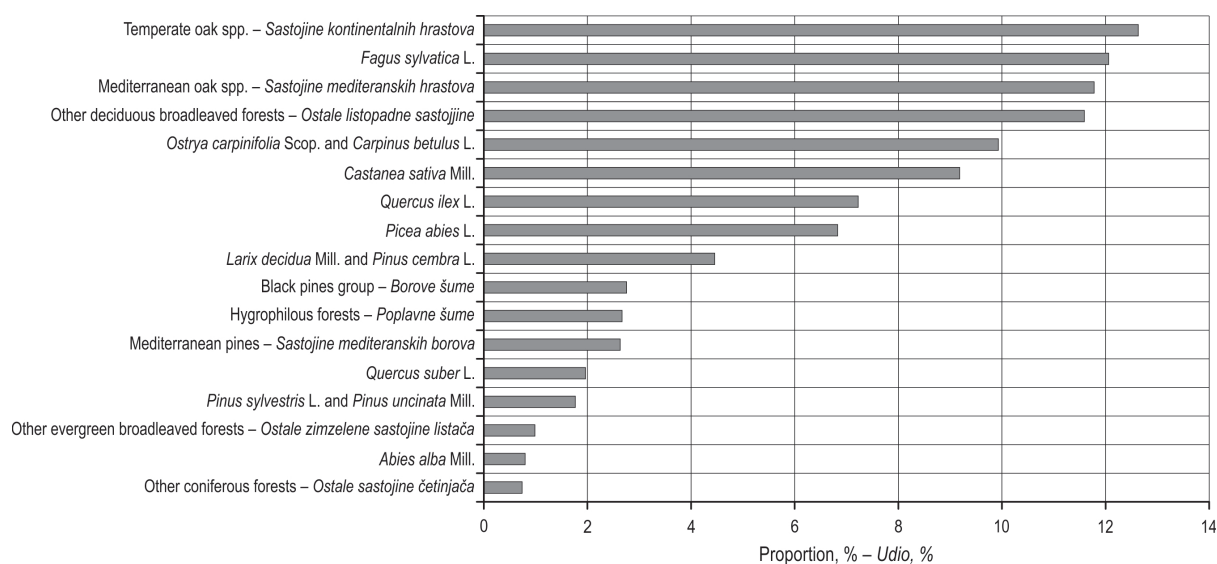
Fig. 2 Proportion of tall tree forest categories
Slika 2. Udio kategorija visokih šuma

tures and gradients of the environment (climate, lithology, morphology), forests are highly diversified at national scale, ranging from alpine forests comparable to central-north European situations, to Mediterranean and arid climates forests, more similar to North African typologies (Cesaro et al. 2009).

Tall tree forests are mainly composed of broadleaves, which are dominant in almost the all regions, with few exceptions in Alpine areas. Fig. 3 shows the distribution of pure and mixed forests. A similar situation can be found in timber/wood production, composed of 84 % of pure broadleaves.
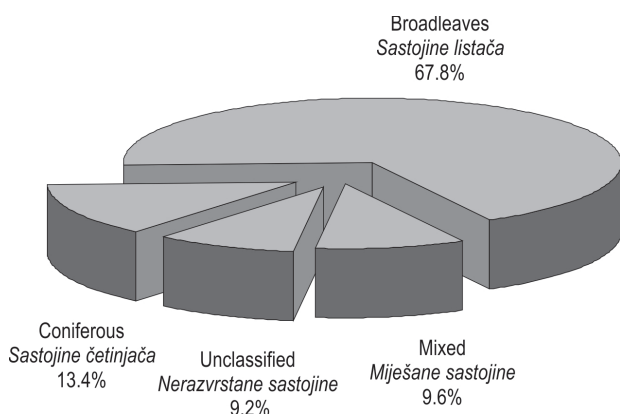

Fig. 3 Distribution of broadleaved and coniferous stands
***Slika 3.** Udio sastojina listača i četinjača*

Concerning the ownership, the majority of forests are private (66.2 % of forest category and 49.7 % of other wooded lands), mostly owned by individual owners, while public ownership is more represented within provincial and municipal administrations, as shown in Fig.4
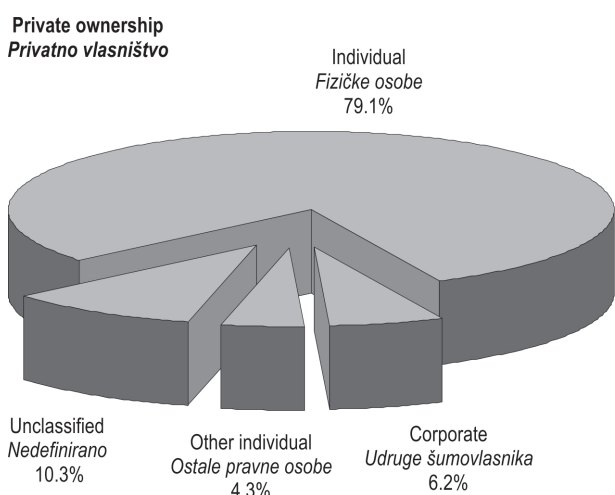
The predominance of private ownership is also typical of many surrounding Countries, *i.e.*, accounting for more than 75 % of the total forest area in Austria, France and Slovenia (Hirsch et al. 2007), while the balance is reversed in Switzerland and Croatia, accounting for over 68 % and 78 %, respectively, of public ownership.

The majority of forests in Italy are coppices (41.8 % of total forests), mostly represented by »coppice with standards« typology, where the utilization in a felling generally consists of about 80–85 % of the above-ground woody biomass (Venanzi et al. 2016) and, according to the regional law, the release of scattered standards between 20 and 120 per hectare, within one or two age classes. As a consequence of the massive abandonment of coppice management from the 1950s, due to changes in the economy and society such as the creation of major population centers and the drop in demand for fuelwood following fossil fuels entry, about 89 % of the coppices nowadays are in a mature status of »aged coppice«. According to Ciancio et al. (2002), coppice conversions to transitional stands and, subsequently, to high forests are expected to further increase.

High forests represent 36.1 % of total Italian woodlands. Within the category of tall tree forest (see Table 1), they include 15.8 % of even-aged and 13.5 % of uneven-aged stands. Most of the even-aged high forests are in the age classes 41 to 80 (Gasparini 2019).

The most represented typology of a logging company is the individual or family enterprise (Baldini et al. 2006), which sometimes relies on external seasonal workers or outsourcing to get some work

Fig. 4 Forest ownership distribution
***Slika 4.** Udio i raspodjela šumovlasništva*
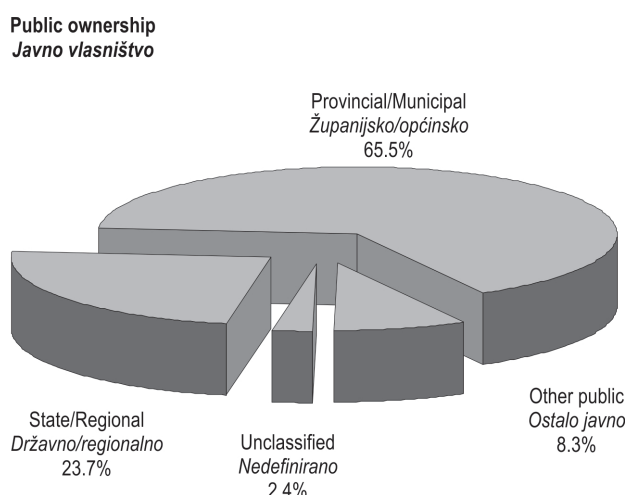
done. In some other cases, companies work both in forestry and agricultural industry, to round up the machines maintenance costs.

4. Forest logging and accessibility
Pridobivanje drva i otvorenost šuma

According to INFC 2005, 88.4 % of forest category results available to be harvested, which corresponds to an available volume of about 31.7 million of m³ (according to the average annual increment of 4.1 m³ha⁻¹). Unavailable areas, in line with FAO definition (2000), are considered on the basis of high legislative restrictions or policy decisions (including areas where forest harvesting is limited by nature conservation or other scientific, historical, cultural restrictions) as well as low productivity issues (for example access constraints and physical impediments affecting skidding distances and stumpage value).

The total volume of forest logging estimated in INFC2005 was about 13.8 million of m³. According to the Italian Institute for Statistics (ISTAT) a general decrease of forest utilization has been observed within the 1999 –2015 period, thereby confirming Italy as one of the countries with the lowest utilization rate, in comparison with the central-southern European standard, and strongly dependent on foreign imports for both fuelwood and raw timber (Mariano et al. 2019).
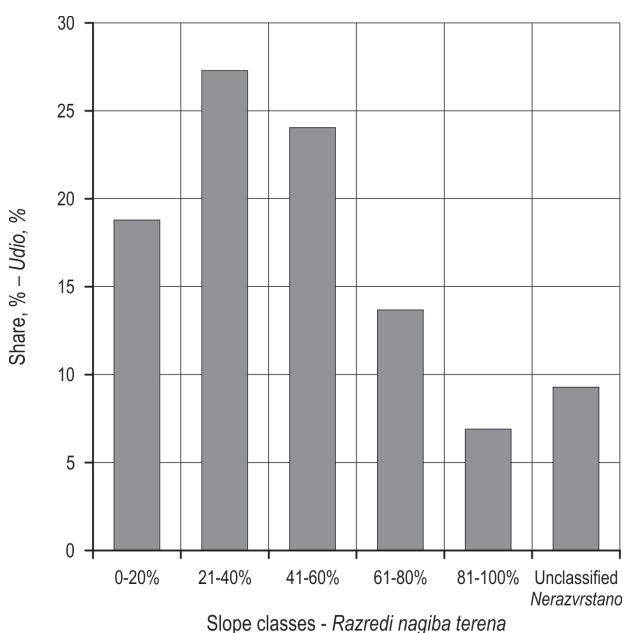

Fig. 5 Slope classes distribution
Slika 5. *Udio i raspodjela razreda nagiba terena*

Fig. 5 shows the distribution of slope classes according to INFC 2005. The most represented class is the second, while less than 20 % of forests are in lowland districts and more than 40 % of forests belong to classes with steep slopes. The high amount of unclassified slopes (9.3 % of the share) is specifically due to procedural constraints and technical difficulties occurred during the assesment, as well as the waiver to provide detailed information for areas not classified in any of the inventory categories.

The accessibility was estimated on the basis of the distance (Table 2) and gradient (difference in altitude) (Table 3) between the sampling point and the nearest forest infrastructure (INFC, 2007), without distinction between primary and secondary roads.

Table 2 Accessibility by linear distance classes
Tablica 2. *Udio pristupačnosti šuma prema razredima linearne udaljenosti*

Distance classes – *Razredi linearne udaljenosti*				
0–500 m	501–1000 m	1001–2000 m	Over 2000 m *Više od 2000 m*	Unclassified *Nerazvrstano*
54.7 %	9.8 %	4.8 %	1.40 %	29.30 %

Table 3 Accessibility by gradient classes
Tablica 3. *Udio pristupačnosti šuma prema razredima nagiba terena*

Gradient classes – *Razredi nagiba terena*			
0±100 m	101±400 m	Over±400 m *Više od ±400 m*	Unclassified *Nerazvrstano*
57.7 %	11.5 %	1.5 %	29.30 %

More than 50 % of the share is in the first class of both parameters, while the high amount of unclassified situations is mainly imputable to inaccessible areas. Other important paramenters, *i.e.*, soil bearing index, have influence on forest accessibility and may affect harvesting and extraction machineries choice, but they were not taken into account in INFC2005.

Forest opening, through a careful planning, designing and maintenance of road network is of primary importance in forest utilization and crucial for a sustainable management (Grigolato et al. 2019). Primary forest road system, including truck forest roads, is a key element to allow wood production in addition to many other social and environmental purposes, *i.e.*, research and monitoring activities, recreation, fire protection and extinguishing (Eastaugh et al. 2011, Stefanović et al. 2016, Laschi et al. 2016). Secondary forest communications, *i.e.*, skid

roads and skid trails, are determinant for basic vehicle-to-timber access during timber extraction (Đuka et al. 2017).

In a study performed by Baldini et al. (2009), based on field surveys in several regions of Italy, average values of 18 m/ha for primary classical openness and 17 m/ha for secondary classical openness have been found, considering both public and private roads. About the latter value, it is important to emphasize that secondary openness only includes skid roads, as skid trails are not registered in Italy. However, classical openness provides information about density of forest roads, but says little about qualitative aspects, such as their distribution (Pentek et al. 2011). According to the same authors of the above mentioned study, such values of road densities are scarce and not sufficient for a suitable forest management, considering the mechanization level, and may affect logging distances especially in slope classes above the second, highly represented in Fig. 5, limiting forest utilization in a 150–200 m buffer area around the existing roads to be cost-effective. In order to obtain a more rational accessibility, the optimal forest road density should be at the cost breaking point between skidding and road building and maintenance costs (Leonardi 1966, Leibundgut 1971).

Fig. 6 shows results about the main working systems for wood harvesting adopted by logging companies, according to a study by Picchio et al. (2010).
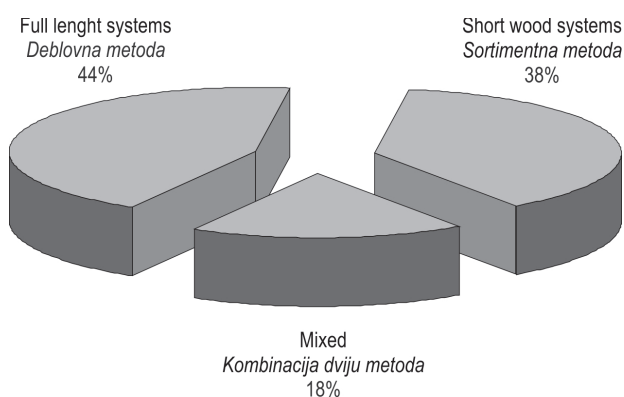

Full lenght systems
Deblovna metoda
44%

Short wood systems
Sortimentna metoda
38%

Mixed
Kombinacija dviju metoda
18%

Fig. 6 Main forestry utilization systems adopted
Slika 6. *Dominantne metode pridobivanja drva*

Full-length system accounts for 44 % of the total harvested wood, and includes tree-length method, where trees are felled, delimbed, and topped directly in the stump area and then transported to the landing, and whole-tree method, where trees are felled

and transported to the landing with the branches and top still intact. The waste material resulting from wood processing in full-length system can also be exploited through biomass energy production, which is recently having a growing attention in Italy (Pantaleo et al. 2009), and shows a potential in providing environmental and socio-economic benefits (Proto et al. 2014). Short wood system accounts for 38 % of the total harvested wood, consisting in felling and processing trees in the stump area into logs, later transported to the landing or roadside. Cut-to-length technology is the main short wood system adopted in the whole Southern Italy (Zimbalatti et al. 2008, Proto et al. 2014), generally operated through chainsaw and ground-based methods for wood extraction even in steep slope conditions (Zimbalatti et al. 2010). The most widespread extraction systems, mostly adopted by small-scale operators, are winching-skidding (Picchio et al. 2012), tractors with forwarding bins and pack mules and chutes, today made on PVC, which are getting increasingly popular among public forest operators (Picchio et al. 2009). In the Alpine area and other mountainous regions, wood extraction on steep slopes and rough terrain is also performed by cable logging systems, accounting for about 10 % to 20 % of the total harvested wood in Italy (Grulois 2007); in this regard, the most modern yarder developments originate in North Italian landscape (Lombardini et al. 2015). Cableways can also enhance forest logging in sites not suited to tractor traffic (because of terrain factors or lack of accessibility, as already pointed out) as well as in wet and sensitive sites, where soil preservation is primary (Erber et al. 2020). Harvesters have been introduced in Italy at the beginning of 2000 (Spinelli et al. 2011) with a subsequent growth of the Italian fleet, which counted over 200 units by 2013, including harvesters, processors and forwarders (Spinelli et al. 2013). However, the use of highly mechanized harvesting results limited in many areas because of orographic, technical and economic restraints (Picchio et al. 2010).

4. Final remarks – *Zaključna razmatranja*

According to the last projection of INFC2015 preliminary results, forest cover in Italy has been growing significantly in the last decade, enhancing forest resources in both qualitative and quantitative terms. In this scenario, given the limited internal supply of woody products and along with the growing demand for energy and quality timber, new perspectives can be achieved by forest sector. However, the growing environmental awareness, decreasing

the tolerance for soil disturbance (Abbas et al. 2018), in addition to the recent delicate socio-economical situation, make it unavoidable to provide such forest resources in a sustainable manner, through an accurate management which is able to guarantee economical, environmental and social benefits. For example, planning of forest road network is one of the most powerful instruments to connect those three pillars, by improving forest accessibility in order to allow forest enterprises to work in a safe and low impact way, as well as boosting their incomes and the stumpage value. New possibilities offered by technologically advanced machines and working methods, which can often be competitive with traditional methods in well-opened forests, should be considered along with their demand for forest accessibility and professional training of operators. In this perspective, an optimally planned and distributed network of primary and secondary communication infrastructures is therefore a founding principle to achieve a rational, high-quality and efficient management of forest ecosystems (Pičman et al. 2011).

Italian forest management is meant to – indeed it has to – make a qualitative leap if it is to be able to get the better of the challenges that lie ahead.

Acknowledgments – *Zahvala*

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--- Sažetak ---

Zastupljenost šuma i način gospodarenja šumama u Italiji

Tijekom stoljećâ, zbog višestrukih promjena u socioekonomskim uvjetima, potrebama i tehničkim mogućnostima, talijanske šume i način gospodarenja šumskim ekosustavima prošli su kroz dinamičan i složen proces evolucije. U posljednjem desetljeću površina šuma i šumskoga zemljišta u Italiji neprestano raste i danas pokriva gotovo 11 milijuna hektara, što čini 36,4 % ukupnoga nacionalnoga teritorija. Analizama nacionalne inventure šuma (INFC2005) obuhvaćeno je i opisano nekoliko kvantitativnih i kvalitativnih aspekata šumskih ekosustava, kao što su: sastav vrsta, podaci o stvarnim i dostupnim drvnim zalihama, strukturi vlasništva, stupnju iskoristivosti etata, stupnju otvorenosti šuma, značajkama i kategorijama terena te mnogih drugih. Najzastupljeniji je tip šumske sastojine u Italiji »panjača s pričuvcima«, dok su mnoge šumske sastojine u zreloj fazi koje čekaju konverziju u prijelazni oblik sastojina. Što se tiče dominantnih načina sječe i metoda pridobivanja drva, prevladava deblovna metoda pridobivanja drva te privlačenje/privitlavanje drva po tlu uz napomenu kako je na mnogim područjima nedovoljna otvorenost šuma u kombinaciji s velikom srednjom udaljenosti privlačenja, pogotovo na terenima gdje prevladavaju veliki nagibi terena, ograničavajući čimbenik za sječu i izradbu drva na održiv i troškovno prihvatljiv način. Moderna rješenja omogućena tehnološkim napretkom, uz rastuću ekološku svijest i potrebu za održivim upravljanjem na višestrukim razinama, zahtijevaju kvalitativni iskorak kako bi se poboljšalo učinkovito upravljanje šumskim ekosustavima, u ovim izazovnim vremenima u kojima se Italija nalazi, uz prijeko potrebno profesionalno udruživanje izvođača radova.

Ključne riječi: šumski resursi Italije, nacionalna inventura šuma, gospodarenje šumama, pristupačnost šumskoj površini, održivo gospodarenje

Author's address – *Adresa autora:*

Nicolò Di Marzio
e-mail: n.dimarzio@libero.it
University of Tuscia
Faculty of forestry
Department of Agricultural and Forest Sciences
Via San Camillo de Lellis, snc
01100 Viterbo
ITALY