ALTERFOR

Deliverable 1.1 – FMM descriptions (in report form)

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I. Forest Management Models (FMMs) description

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4. Italy

4.1. Background and forest history

Italy has a total forest area of about 10.9 million hectares (Table 14) -i.e. 9.3 million ha forests and 1.6 million ha other wooded lands (CFS, 2015a)-, mostly located in mountainous or hilly areas (95%). Lowland forests mostly consist of industrial poplar plantations and arboriculture systems. According to the 2005 edition of the National Forest Inventory (INFC, 2005) about 66% of Italian forests are privately owned, mostly consisting of small forests owned by individuals (79%): the final result is strong forest ownership fragmentation that affects forest management practices and profitability. The remaining 34% forests are public, with a prevalent role played by local municipalities (65.5%).

Forest resources quality differs depending on their geographical position, in the Alps (North) or Apennines (Centre or South and Islands). About 42% of forests are managed as coppices (mostly as coppice with standards), whereas high forests represent 36%, and the remaining proportion is not classified or consists of very specific management types (e.g. cork oak or chestnut forests). Coppices predominate in Central-Southern Italy, whereas most of the productive high forests (mainly coniferous ones) are in the North-Eastern part of the Country.

High forest management follows different models, mostly consisting of uniform (even-aged forests) or non-uniform (uneven-aged forests) shelterwood systems. Clearcutting systems are not very common due to strong limitations in clearcut areas imposed by Law.

Forests with a higher quality (i.e. higher production potential) are more frequently covered by forest management plans (e.g. up to 94% in Autonomous Province of Bolzano, in the Alps).

As a consequence of a decentralization process started in the 70s, agriculture and forest matters are under ruling responsibilities of local governments (i.e. 19 Regions and 2 Autonomous Provinces), with poor horizontal coordination and no single/updated National Forest Programme (NFP) nor a comprehensive sectorial policy.

Despite the relatively large amount of forest cover (33% of total land), for various reasons Italian forests have been systematically underutilized over the years. Today, only 23.8% of the net annual increment is harvested, i.e. less than half of the average figure at EU level (55.6%). Over about 50 years (1950-2007) the forest cover has doubled, wood consumption tripled, while the economic value of domestic timber production has halved. The expansion of forest area is one of the most relevant land use changes currently underway in the country (+6.2% in the last 10 years, from 2005 to 2015; +0.6% in the last year), mainly associated with farmland abandonment and natural forest expansion.

The forestry and logging sector share on the national GDP has reduced considerably in the last decades (remaining negligible, i.e. accounting for about 0.05% of national GDP). The whole forest

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sec-tor share (i.e. including the contributions of wood industry and pulp and paper industry) has had similar trends. Also the employment (formal sector) and the number of enterprises in forest sector have reduced significantly. Notwithstanding a general decrease in overall wood imports in recent years, Italy remains one of the major European wood importers, accounting for 15% of the EU sawnwood imports in 2013. As for the industrial wood, the self-sufficiency rate is only 17% (with 4.7 million of cubic meters of production of raw material and sawnwood and 14.2 millions of cubic meters of consumption) (UNECE FAO, 2015). These data show the structural disconnection be-tween the use of domestic forests and the national wooden-based industrial activities (Ciccarese et al. 2014), which is associated to a lack of wood mobilization, land abandonment and very limited active management. Despite the fact that about 65% of domestic removals consist of wood for energy, Italy became the largest worldwide importer of firewood and the fourth largest importer of wood residues, particles and chips, and the first European importer of pellets for residential use.

Table 14. Total land area and forest area divided in different land uses, the Italian CSA, Veneto region and Italy.

		AFP (case study)	**Veneto**	**Italy**
Total area (ha)		315.41[a]	1 840 742	30 207 284
Forest area (ha)*		291.05	2015: 465 624 2005: 444 766	2015: 10 982 013 2005: 10 345 282
Forest cover (%)*		92.3%	2015: 25.3% 2005: 24.2%	2015: 36.3% 2005: 34.2%
Forest area per altitude classes (m asl) (%)*	0-500 501-1000 1001-1500 1501-2000 >2000	100.0% - - - -	2005: 21.2% 27.1% 28.8% 16.9% 1.4%	2005: 35.4% 34.7% 17.4% 7.3% 1.2%
Forest area potentially suitable for harvesting (ha)[b]		291.05	2005: 369 715	2005: 8 511 098
Forest area potentially suitable for harvesting (%)[b]*		100%	2005: 83.1%	2005: 81.3%
Average volume (m^3/ha)		50.7	2005: 204.1	2005: 144.9
Natura2000 areas (%)		24%	37.4%	21.5%
Forest area under hydrogeological constraints (according to Law 326, 1923)		25%	91.2%	80.9%

Notes: Inclunding other wooded lands; [a] Referred to the total area within the scope of the forest management plan and not to the total area of municipalities hosting forests included within the case study. In this case the total area would be 68,931.97ha; [b] Taking into account legal/normative and physical factors/constraints.*

Sources:

The 2015 edition of the National Inventory has not been completed and no data are available apart from preliminary area estimations. As a consequence hereinafter reference will be made to the 2005 edition.

CFS (2015). Stime preliminari basate sui risultati della sola fotointerpretazione di INFC2015 e sui risultati di INFC2005. Corpo Forestale dello Stato. Available online, URL: www.corpoforestale.it [accessed 03.011.2016]

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Ciccarese, L., Pettenella, D., Pellegrino, P. (2014). A new principle of the European Union forest policy: the cascading use of wood products. L'Italia Forestale e Montana-Italian Journal of Forest and Mountain Environments, 69 (5), 285-290, DOI: 10.4129/ifm.2014.5.01

INFC (2005). Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. Ministero delle Politiche Agricole, Alimentari e Forestali/Corpo Forestale dello Stato/Consiglio per la Ricerca e la Sperimentazione in Agricoltura. Available online, URL: www.sian.it/inventarioforestale [accessed 03.011.2016]

UNECE/FAO (2015). Forest Products Statistics. UNECE/FAO Forestry and Timber Section. Available online, URL: www.unece.org/forests/forestsfpmonlinedata/forest-products-statistics/production-and-trade-tables-2010-2014.html [accessed 03.11.2016].

The disconnection between national forests and wood&paper industry also reflects on forest certification data: while Italy ranks in the first 3 to 5 positions globally in terms of number of FSC and PEFC chain of custody certificates, certified forest areas remain limited (about 820,000 ha PEFC certified and 45,000 ha FSC certified) (FSC, 2016; PEFC, 2016).

Domestic industrial wood production (i.e. removals) is mostly concentrated in two clusters: (i) more than 70% of softwood industrial production is provided by the three North-Eastern regions (Trentino Alto-Adige, Veneto and Friuli Venezia Giulia); and (ii) about 50% of hardwood industrial production is provided by poplar plantations in the Po Valley (North).

Domestic forest removal trends have been mostly influenced by the market for wood for energy rather than by the demand for industrial timber. Industrial timber removals remained more or less stable until the end of the last Century, when a downturn started. On the other hand the absolute and relative incidence of wood for energy among total removals increased, especially in areas where coppices prevail. This has been interpreted as a general de-specialization trend within the Italian forest sector favoured by several factors, including (among others) lower complexity of firewood production (e.g. lower mechanization level), viability for smallholders, large firewood demand at local scale (especially in mountainous areas), the existence of a more informal market.

Apart from wood and wood-based products Italian forests deliver multiple services that are not (or not fully) reflected into national accounts. A major role is played by non-wood forest products (or forest wild products), such as mushrooms, truffles, resin, fruits, etc. While in many cases economic activities related to these products remain largely informal, there is an increasing number of situations where wild product production became structured and more important than wood production in terms of direct and indirect income opportunities, job creation, visibility etc.

Moreover, in the last years the number of forest management experiences aimed to the provision of cultural-recreational services increased (adventure parks, art exhibitions and concerts within forests, environmental education etc.).

4.2. Ownership

All forest land in the CSA has public owner, the province of Venetio. In Veneto 35% of forest land is owned by the province and for Italy 34%. Information about the CSA and ownership, Table 15.

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Table 15. Forest area ownership in CSA, Veneto province and in Italy, figures refer to 2005.

	AFP (case study)	Veneto	Italy
Total. Public	100%	34,6%	33,8%
State/Region	-	7,7%	7,9
Municipalities/Province	100.0%	25,9%	22,2%
Other public	-	1,1%	2,7%
Public not classified	-	-	1,0%
Tot. Private	-	65,4%	66,2%
Individuals	-	53,5%	51,9%
Companies	-	1,2%	4,1%
Other private	-	8,7%	2,8%
Private not classified	-	2,0%	7,4%

4.3. The case study area

Table 16. The forest area in the Italian CSA divided in productivity and moisture classes, %.

Productivity/ moisture	**Productivity, ($m3ha^{-1}y^{-1}$)**	**Dry %**	**Mesic %**	**Moist %**	**Wet %**
High	>1.5	0.0%	6.9%	6.9%	0.0%
Medium	0.75-1.5	0.0%	0.0%	16.5%	1.0%
Low	<0-0.75	0.0%	3.3%	65.4%	0.0%

4.3.1. Tree species

There is a large number of tree species in the CSA. Most common is *Pinus pinea* and *Quercus robur*, 13, 2 and 12, 6 % of standing volume respectively. Broadleaves dominate, the coniferous, *Pinus pinea*, *Pinus alepensis* and *Pinus nigra*, are together less than 20% of the standing volume, Table 20.

Table 17. Tree species, proportion of total volume in the Italian CSA, Veneto region and in Italy.

Specie	**CSA** (% total volume)	**Region Veneto** (% total volume)	**Italy** (% total volume)
Pinus pinea	13.2%	0.1%	0.7%
Quercus robur	12.6%	0.3%	0.6%
Ulmus campestris	11.4%	0.1%	0.3%
Quercus ilex	8.9%	0.3%	2.8%
Acer campestre	8.7%	0.4%	0.5%
Carpinus betulus	8.3%	[a]NA	[a]NA
Fraxinus excelsior	7.5%	1.6%	1.1%
Pinus nigra	6.6%	0.9%	2.4%

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Specie	**CSA** (% total volume)	**Region Veneto** (% total volume)	**Italy** (% total volume)
Fraxinus angustifolia	5.8%	[a]NA	[a]NA
Fraxinus ornus	5.5%	1.4%	1.4%
Alnus glutinosa	2.5%	0.1%	0.7%
Populus nigra	2.4%	0.5%	0.5%
Pinus alepensis	1.8%	0.0%	0.7%
Populus alba	1.5%	[a]NA	[a]NA
Populus nigra hybrids	1.1%	0.2%	0.6%
Robinia pseudoacacia	0.5%	1.3%	1.6%
Salix alba	0.5%	aNA	aNA
Acer platanoides and Acer spp.	0.2%	[b]1.1%	[b]0.7%
Ostrya carpinifolia	0.1%	6.3%	
Other broadleaves (incl. cherry, walnut, black walnut, linden, etc.)	0.8%		

[a] Not available; [b] Just referred to Acer platanoides;

Sources:

Rasera, R. (2016). Piano Sommario dei beni dell'Associazione Forestale di Pianura. Periodo di validità 2016-2025/Forest Management Plan of the Lowland Forest Association. Regione del Veneto. Available online, URL: http://static.forestedipianura.it/media/uploads/Piano_sommario_dellAssociazione_Forestale_di_Pianura_PDF.pd [accessed 03.011.2016]

INFC (2005). Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. Tabella 1.9.1.6 - Valori totali e per unità di superficie, distinti per spe-cie, del numero di alberi, dell'area basimetrica, del volume del fusto e dei rami grossi, dell'incremento corrente di volume e della fitomassa arborea epigea, per la macrocategoria inventariale Bosco in Veneto/ National Forest and Carbon Sink Inventory. Table 1.9.1.6 – Number of trees, basal area, volume, annual increment and aboveground mass for "Forest" category, total and unit (i.e. per ha) values per species in Veneto. Ministero delle Politiche Agri-cole, Alimentari e Forestali/Corpo Forestale dello Stato/Consiglio per la Ricerca e la Sperimentazione in Agricoltu-ra. Available online, URL: www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp [accessed 03.011.2016]

INFC (2005). Inventario Nazionale delle Foreste e dei Serbatoi Forestali di Carbonio. Tabella 1.9.1.22 - Valori totali e per unità di superficie, distinti per specie, del numero di alberi, dell'area basimetrica, del volume del fusto e dei rami grossi, dell'incremento corrente di volume e della fitomassa arborea epigea, per la macrocategoria inven-tariale Bosco in Italia/National Forest and Carbon Sink Inventory. Table 1.9.1.22 – Number of trees, basal area, volume, annual increment and aboveground mass for "Forest" category, total and unit (i.e. per ha) values per species in Italy. Ministero delle Politiche Agricole, Alimentari e Forestali/Corpo Forestale dello Stato/Consiglio per la Ricerca e la Sperimentazione in Agricoltura. Available online, URL: www.sian.it/inventarioforestale/jsp/dati_carquant_tab.jsp [accessed 03.011.2016].

4.4. FMMs in the Italian CSA

A number of FMMs are used in Italy while in the CSA only one model, selective cuttings, is used on almost all forest area, Table 21. A marginal part of the case study – one stand consisting of a walnut and black walnut forest plantation and corresponding to less than 0.5% of the overall case study area- is to be first removed through uniform shelterwood system and then replanted to be managed through selective systems.

Since there are no national-wide data available on FMMs, the figures in Table 18 have been estimated building assumptions based on available data from the National Inventory of Forest and

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Carbon Sinks (INFC, 2005) (see notes below). Experts' opinion has also been sought, by interviewing Prof. Dr. Emanuele Lingua (Associate Professor in Forest Ecology and Silviculture at TESAF Dept., University of Padova) who however confirmed the lack of specific statistics and the difficulties in providing fully reliable data and estimations especially for high forests.

Data only refer to Forests and do not take into account Other Wooded Lands. While the Inventory clearly distinguishes between coppice systems and high forests, it does not include detailed information regarding FMM applied within the latter. In addition to this there are no official data regarding the proportion of managed and unmanaged (i.e. abandoned) forests, nonetheless there is empirical evidence that in many cases –especially in marginal areas- forests are not managed and they are left to natural evolution. This however can hardly qualify as a real management choice, rather de-pends on several factors, including, lack of awareness/interest/skills by owners as well as low profit-ability due to fragmentation, slope, poor assortments, etc. According to some sources, unmanaged forests would account up to 50% (Fedagri, 2011): this would lower all figures.

Finally it has to be considered that FMM implemented in the field are not always black or white, i.e. clearly identifiable and classifiable within strict and highly standardized silvicultural models. While this might possible for productive forests, it remains very difficult for newly formed forests growing on marginal lands and for forests having not wood production as the main management objective. Finally, even when wood production remains the main objective, close to nature silviculture and even single-tree silviculture are becoming more common and popular.

Table 18. The major FMMs used in the Italy and in the CSA. The total sum for Italy is larger than 100% depending on the uncertainness in the estimation.

FMMs	Coverage **CSA** (% forestland)	Coverage **Italy** (% forestland)
Clearcuting	0.0%	(1.4%[a])
Uniform shelterwood systems	0.0%	(17.2%[b])
Non-uniform shelterwood systems	0.0%	(13.2%[c])
Selective cutting	**100%**	**(5.6%[d])**
Coppice	0.0%	10.0%[e]
Compound coppice	0.0%	4.4%[e]
Coppice with standards	0.0%	27.5%[e]
Natural evolution	0.0%	?
Other specific FMM (e.g. cork oak forests, chestnut forests for chestnut production…)	0.0%	1.2%[e]
Not defined	0.0%	10.1%[e]
Not classified		10.7%[e]

a Forest plantations are managed through clearcutting systems at the end of the rotation period (clearcut in natural and semi-natural forests is limited by Law)

b Even-aged high forests and high forests originated from coppice forests are managed through uniform shelter-wood systems

c Uneven-aged forests are managed through non-uniform shelterwood systems

d Irregular high forests are managed through selective systems (or not managed at all)

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e Data for coppices are provided by the National Inventory of Forest and Carbon Sinks (INFC, 2005).

There is a large difference between the CSA and Italy in the use of FMMs. This is mostly due to the fact that the case study area consists of lowland forests, including newly/recently planted forests (afforestation and reforestation areas, max 20 years old), 60-70 years old planted forests (mostly planted pine forests) and semi-natural lowland forest remnants.

As reported by the newly developed and approved forest management plan for the case study area, sivilcultural models for these forest types are not yet consolidated. Planned forest management operations are not primarily aimed to wood production, rather to improve forest areas according to their features and purposes (environmental protection and/or tourism), trying to support their development towards more close-to-nature conditions. More in detail management objectives include:

1. Improvement of ecologic and environmental functions/features;

2. Improvement of tourism, recreational and social/cultural functions;

3. Valuing ecosystem services provided by the forest area.

While the area has limited wood production capacity (low-value assortments, mostly firewood, chip-wood and very limited wood for packaging) it plays a relevant role with reference to:

- tourism and recreation activities, and

- wild product production (mostly truffles and pine nuts).

Moreover about 24% of the forest area is part of the regional Natura 2000 network (with a lower percentage being also part of the Sile River Regional Park). Although the belonging to such a network per se does not exclude active forest management it affects the intensity of management regimes.

Last but not least the area is under preparation for forest certification according to FSC standards. It will likely be the first FSC forest management certification in Veneto and - consistently with both forest features and FSC Principles & Criteria (version 5-0) - management operation will aim to ensure an adequate ecosystem service flow while dealing with some limiting factors like forest fragmentation and discontinuity, as well as human pressure by both locals and tourists.

4.5. Ecosystem services

The most important ecosystem services in the Italian CSA is Biodiversity and nature conservation. Also a number or forest products are also important, such as pine nuts and truffles are of interest, while wood products are ranked as number five, The proportion of the total volume refers to all tree species in the compartment (forest stand), however the proportion of area refers to the main tree species in the compartment (the last option is important in defining the FMM). Only compartments covered by forest stands in forestland are included. Non-forestland being grown with the forest was not included. The country level statistics were obtained from Forestry statistical yearbook 2015, published by State Forest Service.

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The proportion of Norway spruce is larger in the CSA than in the country, contrary, the Scots pine seems to be under-represented in the CSA, which is primarily due to relatively rich forest soils, prevalent on the CSA. Also we can note relatively larger shares of Grey alder and Pedunculated oak and a smaller share of Black alder in the CSA than in the country.

Table 22.

Table 19. Ecosystem services in the Italian CSA. Ranking of important ES

Ecosystem services connected to the FMM/CSA
Biodiversity and nature conservation
Cultural services, in particular tourism and recreation
Wild forest products (non-wood forest products, in particular truffles and pine nuts)
Protection against marine aerosol and hydrogeological protection
Wood (mostly firewood)
Landscape and scenic beauty

4.6. The selection system used in the Italian CSA

The FMM used all over the CSA is classified as Selective system. Given the specificity of forests within the case study area and the lack of consolidated FMM and silvicultural approaches for them, the forest management plan defines specific management directions and objectives, but at the same time remains flexible, leaving to the manager the possibility to choose the best solution case-by-case. In line with this approach, criteria for selecting trees to be harvested are not only based on age distribution, but again take into account multiple issues, including health status, present and future potential forest structure, presence of deadwood, presence and status of natural regeneration, accessibility and risk for visitors, etc.

The selection system/model aims to protect and enhance biodiversity and nature conservation in lowland and coastal forest areas, thus favouring progress towards more natural conditions. It also aims to create appropriate conditions for tourism and recreation activities within (part of) the area, and (to some extent) to support wild product production (pine nuts and truffles). In addition to the point above, in some areas the FMM is also aimed to ensure appropriate protection against wind, marine aerosol and against hydrogeological risks (e.g. floods). The management model is not primarily intended to produce wood assortments, nonetheless forest operations can also generate marketable wood products (firewood, chip-wood).

Based on previous considerations, the FMM consists of selective cutting inspired by close-to-nature silviculture principles and to be largely defined case-by case (intensity, target trees, etc.). As a consequence, within a common framework in terms of orientation, management practices and goals defined by the forest management plan and existing regulations, the FMM gives the manager(s) room and flexibility to make and implement management choices. This is also due to additional

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issues including the fact that lowland forests mostly consist of forest patches (rather than large, continuous forest areas) and that silvicultural practices for lowland forests are not well consolidated as they are in traditional productive forests in mountainous (e.g. alpine) areas.

In general terms forest management practices can be broadly distinguished according to the three main forest types that can be identified in the case-study area:

- coastal forests (pine and mixed pine-holm oak stands)

- lowland oak-hornbeam forests

- riparian forests (dominant role of poplar and willow).

Besides environmental issues connected with the FMM and the management/conservation of relevant and rare forest remnants and/or newly established forests, the social dimension should not be forgot: the case study area is highly populated (about 140,000 inhabitants just in the municipalities within the case study area) and it directly/indirectly attracts a huge number of tourists and visitors.

In relation to this it worthwhile remembering that the case study represents a unique case in Italy, being an association of public owners (mostly Municipalities) active in managing lowland forests and working in strict connection with private actors (forest technicians, forest enterprises, farmers, not-for profit organizations, a university spin-off etc.).

Edaphic conditions

The FMM should be (and actually is) adopted under different edaphic conditions. From high production to low production, from dry to wet sites. However specific measures and management intensity/frequency vary depending on specific situations. Management on very dry (e.g. close to sand dunes and arid meadows) and wet areas should normally be performed at lower intensity compared to the intensity level that is normally defined under mesic and moist conditions.

Tree species used

A number of tree species are growing and then managed with selection systems, see Table 17.

Tree species composition

The case study areas is characterized by the presence of multiple species or in other words; mixed stands. While some of them tend to prevail, none is supposed to have a dominant position within the whole area. This is due to several issues, including the coexistence of multiple forest types - each characterized by different species and species-blends- variability of site conditions, the fact that some stands are still at early development stages, the dynamicity of forest development and the forest management activities that do not aim to maximize wood production, favouring the most productive species, rather to support evolution towards more natural forest ecosystems and multiple functions/services.

Nonetheless, percentage shares of prevalent species might increase (up to 25-49% or even more) if the main forest types are considered separately:

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- coastal forests: today prevalence of holm-oak and pines. It is recommended that forest management orientation should tend to favour the combination with holm-oak whenever possible, maintaining pure (or almost pure) pine forest areas in those areas where they play a relevant role as windbreaks and/or aerosol interceptors, and where they support recreation and tourism activities (camping, shadow for visitors, etc.). Native pine species (i.e. black pine in the Tagliamento river area) should also be favoured when they occur.

- oak-hornbeam forests: today prevalence of oak and European hornbeam (the former to be supported through appropriate forest management choices aiming to facilitate natural regeneration and growth). It is recommended to keep the prevalence of oak and European hornbeam (in a wide range: 20 to 100%). The later normally tends to prevail and oak regeneration shall normally be supported through appropriate forest management (e.g. clearings to support regeneration, thinning, etc.). Oak tends to prevail (or even dominate) in areas that are periodically submersed by water. Depending on water availability and, more in general, on edaphic conditions additional broadleaf species include elm, ash, maple, alder, linden, cherry, etc.

- riparian forests: prevalence of poplar and willow. Poplar and willow with presence of huge single trees. In terms of stand volume poplar and willow represent 50% or more of the total volume.

Only one stand makes exception because at the moment the stand is dominated by walnut and black walnut trees.

Although there are no specific data available, it can be observed that forest resources within the case study area are undergoing development processes (both natural and driven by forest management operations) towards conditions described above.

Rotation periods

There are no regulations about rotation period. The definition of rotation period in selection cutting systems/models are not as clear as for other forest models. Selecting trees to be harvested are not only based on age distribution, but take into account multiple issues, including health status, present and future potential forest structure, presence of deadwood, presence and status of natural regeneration, accessibility and risk for visitors, etc.

Size of clearcuts and gaps

In the case selective cutting consists in creating forest gaps or clearings (e.g. in the case of pine forests planted on/just behind coastal sandy dunes) the recommended minimum size of clearings in order to maximize naturalization effects should be 1,000 to 1,500 m2. If trees have some control function over marine aerosol then smaller (300 to 400 m2 or even less) but more frequent (i.e. higher number per ha) clearings are allowed. Mean size of openings are around 1000m2. Maximum size depends on each situation and are deicide from case to casa.

Forest management and goals for forestry

The selection of appropriate forest management operations and the identification of target trees/groups of trees for harvesting operations depend on multiple issues (see also question 12 above) including desired output in terms of ES delivery:

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Biodiversity and nature conservation

Planted Oak-hornbeam forests: harvesting operations should remove wilting trees and facilitate natural oak regeneration.

Riparian forests: harvesting operations should remove trees and residues that might obstruct water flow and increase hydrogeological risks (thus also maintaining regulatory services), while favouring the development of the forest structure and composition. Isolated big trees should be released to favour saproxylic invertebrates (e.g. *Osmoderma eremita*, *Lucanus cervus*, *Cerambyx cerdo* and *Morimus funereus*).

Coastal forests: harvesting operations should remove wilting/unstable (pine) trees and facilitate natural holm-oak regeneration. In the case of pine forests on xeric soils and pine forests planted on/just behind sandy dunes this can be achieved through the creation of small-medium clearings.

Tourism and recreation

Forest management operations (harvesting, pruning) shall focus on ensuring safe conditions for visitors and/or infrastructures (e.g. access roads, parking areas, etc.) and create appropriate access conditions (e.g. by allowing/not allowing access to certain areas, or by "forcing" the staying on paths). Target trees shall be identified accordingly.

Wild forest products

Truffles (*Tuber borchii* Vittadini or *Tuber albidum* Pico): low forest density favours higher yields, therefore forest management operations in areas where favourable conditions from truffle-growing exist (coastal pine forests, holm-oak forests and oak-hornbeam forests) should be oriented to keep density appropriately low (according to some studies basal area should be around 18-25 m2/ha and canopy cover around 45-60%) as long as this is compatible with other forest features and management objectives.

Pine nuts: existing pine (*Pinus pinea*) forests are normally too dense for achieving optimal pine nut yields. Density reduction through thinning and the creation of clearings can improve nut production in the short-medium term (5-8 years) and, at the same time, favour progress towards more natural forest conditions (by supporting the spreading of holm-oak trees). Where compatible with naturalization aims, inoculated-pine trees can be planted to support nut production while creating favourable conditions for truffle growing. Low forest density conditions can also favour the growth of other wild products, in particular wild asparagus (*Asparagus officinalis*).

Forest regeneration

Site preparation. Site preparation is normally not done unless totally new areas are planted. This is unlikely to occur in the short run -next 7 years- because no funds for reforestation/afforestation in lowland areas are made available through the current Regional Rural Development Program).

New seedlings. About 60% of existing stands have been originally established through artificial re-generation but are currently managed through natural regeneration (Brotto, 2011). Artificial re-

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generation (planting) mostly regards shrubs to be established within artificial/natural clearings established in coastal pine forests, however tree seedlings can be planted as well.

Also in the future it is suggest that between 90 and 100% of the new seedlings are natural regenerated. Artificial regeneration (planting) should just be performed to support natural regeneration within existing forests in cases where this is not enough or it is not possible. This is for example the case of forest parcels with a prevalent tourism-recreational aim that are subject to regular mowing operations: artificial regeneration is then needed to replace trees when this is needed.

Artificial regeneration should also be performed in the case new forest areas are established, for example through compensation mechanisms (green-funds) or sponsorship initiatives (e.g. local retailers).

Fences are not used.

Introduced species

No non-European species are used because the rationale behind forest management in the case-study area is to facilitate re-naturalization of local forest areas: the use of non-native tree species would be in contrast with this idea as well as with current normative requirements at least in the case of Natura 2000 and other protected sites. Moreover since the area is approaching FSC certification the use of native species is very much encouraged and to be preferred. Forest management plan requires that seedlings consist of ecologically coherent species and are locally sourced so they can better adapt to local conditions. Hybridization however can occur naturally, for example in the case of poplars.

There is no need to use genetically improved trees or hybrids as long as local species are used.

Use of GM trees is not allowed by Law (with exceptions for authorized experimental trials). Moreover the area is undergoing preparation for FSC certification that does not allow the use of GM trees in certified forests.

Herbicides and chemicals used

Mechanical control of invasive species is done instead of chemical one (cutting, weed control fabric in the case of newly established plantations/planted forests,

Fertilization

Fertilization is normally not done. Fertilizers might be used in the early stages of newly established plantations. At present no new plantation/planted forest are forecasted within the CSA.

Harvest

Harvest is normally done manually with chain-saw. Wood extraction is normally performed with tractors and trailers and about 10% with forwarder. Loading operations can be either manual or mechanized, depending on the size and nature of different assortments.

After logging is normally 80 to 100% of logging residues as braches and tops (>5cm in diameter). According to the forest management plan, logging residues shall be completely removed or, as an

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alternative, partly left in ad-hoc identified areas within the forest. If residues are left, attention shall be paid to the prevention of phytosanitary (pests) and fire risks. The management of residues, however, is to be defined case-by-case through specific harvesting plans/projects.

Stand management

Pre-commercial and commercial thinning

About 15-20% of the area is today pre-commercial or commercial thinned during a rotation period. Very often this is removal of invasive and not wanted species. It is recommended that this is doubled, another 15-20% managed with thinnings or pre-commercial thinnings, invasive shrubs not accounted. It shall be considered that the real performing of thinning operations is sometimes influenced by availability of rural development funds (e.g. young forest stands).

The FMM adopted within the case study area has not the primary aim to produce wood, therefore the distinction between pre-commercial and commercial thinning might not be always appropriate. Even when wood is extracted, assortments consist of firewood and chip-wood that allow taking advantage also of small trees and, sometimes, even shrubs.

Pruning

Based on the existing forest management plan it is estimated that trees on 5% of the area is pruned during a rotation period.

Pruning is a costly operation and so far it is performed just to ensure safety for users/visitors, while in the next future, once forest stands will be more mature, their structure better defined and potentialities more evident, it could become relevant to use pruning for producing valuable assortments from the best broadleaf trees (single tree-silviculture). Suggested that pruning increase to 8-10%

Nature protection/consideration

Nature protection is one of the main objectives of the forest management implemented in the case study-area. Silvicultural operations planned and put in practice are intended to facilitate (whenever possible) the development of forest stands towards more natural conditions (species composition, structure etc.) rather than maximize wood extraction.

In particular the forest management plan defines best practices to minimize negative impacts on natural resources during harvesting operations, as well as those deriving by the use of the areas by visitors. Among measures defined by the plan, the release of deadwood (on average 5m3/ha) is included.

High Conservation Values have been identified according to requirements laid down by FSC Principle 9 (including stakeholder consultation) and specific measures have been defined for their conservation and, whenever possible, enhancement. These include, among other, areas belonging to the regional Natura 2000 network and the Sile River Regional Park.

It is also worthwhile remembering that nature protection measures are laid down within FSC Principle 6, including, for example, the identification and protection of representative sample areas of native ecosystems, the protection of rare and threatened species as well as their habitats, etc.

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ALTERFOR

II. Ranking of Ecosystem Services (ES)

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2.3. Italy

2.3.1. Assessment of biodiversity by the stand level FMMs in the Italian case study

The ranking of FMMs in the Italian case study has been developed based on biodiversity proxies and indicators (determinants) defined by guidelines for biodiversity Table 12; tree species composition, forest structures, and spatial-temporal disturbance patterns. Following the same approach adopted for the Swedish case study, each of the three determinants has been qualitatively ranked 0-7 (0=very bad, 7=very good) based on expert judgment i.e. no DSS or quantitative data has been used in the assessment. A summary rank has then been defined based on the average of the three scores.

Data have been sourced from the forest management plan for the case study area, including High Conservation Value (HCV) identification -namely HCV 1, HCV 2 and HCV 3- for the aims of forest certification according to FSC standards.

Table 12 Qualitative assessment of biodiversity values associated with FMMs in the Italian case study

FMM/Concept*		Tree species composition (Native trees, broadleaf trees, tree species diversity)	Forest structures (older / larger trees coarse woody debris)	Disturbance regime (emulate natural disturbance regimes spatially and temporally)	Average
Selective cutting					
Coastal forests (pine and holm-oak forests)	Mixed stands	5.0	3.0	6.0	**4.7**
	Pine stands	3.0	3.0	6.0	**4.0**
Oak-hornbeam forests		6.0	4.0	6.0	**5.3**
Riparian forests		6.0	6.0	6.0	**6.0**

As a general remark all FMMs have been scored 6 with reference to the disturbance regime because –as indicated by the forest management plan- management operations are clearly oriented to favor a shift towards more natural forest conditions, simulating natural evolution processes. Nonetheless in some cases management operations might be forced/made more intense to boost the process or different solutions (e.g. planting) might be adopted. Due to this, it was decided not to give a score equal to 7.

Coastal forests

Coastal forests have an average score ranging between 4,3 and 5, i.e. lower than oak-hornbeam and riparian forests. However, it should be noted that coastal forests spatially occur at the end of

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the natural plant succession that from the sea goes to the inland. The succession includes in the first part the vegetation communities of *Cakiletum* and *Agropiretum,* that have the strategic ecologic role of steady the soil with roots. Because of these plants, the sand can behind accumulate in dunes and allow the settlement of *Ammophilia arenaria,* which creates effective barriers for sand and wind. After the dunes, in a protected microenvironment, both occur xeric species such as *Thymus longicaulis* and *Stachys recta,* and, in sites with more water, the vegetation community of *Schoenetum,* with species such as *Erianthus ravennae* and *Juncus littoralis.*

Even if the coastal forests score a relatively low value of biodiversity with respect to other lowland forests, by considering the whole natural succession of plants, which play a strong ecological role, the score would be higher.

In the coastal forests *sensu stricto,* higher biodiversity value has been attributed to mixed (i.e. holm-oak and pine) stands. The general orientation, indeed, is to favor pine and mix-pine stands evolution towards "native" holm-oak coastal forests by removing pine trees progressively. Harvesting operations should remove wilting/unstable (pine) trees and facilitate natural holm-oak regeneration. In the case of pine forests on xeric soils and pine forests planted on/just behind sandy dunes this can be achieved through the creation of small-medium clearings (3-400 m^2). Since holm-oak natural regeneration results a bit problematic, planting (artificial regeneration) is needed. It shall be noticed, however, that holm-oak is less effective in contrasting invasive species, including alien ones, therefore in some cases planting pine might slow a bit the naturalization process but, at the same time, reduce the risk of invasive species spreading.

Moreover in some cases full pine stand conversion is not possible due the role played by pine trees in terms of protection and recreational services. In particular, with their thick and broad canopies, pines provide shadows during the hot summer season. Pines stands play a relevant role as windbreaks and/or aerosol interceptors, and where they support recreation and tourism activities (camping, shadow for visitors, etc.). Native pine species (i.e. black pine in the Tagliamento river area) should also be favored when they occur.

Oak-hornbeam forests

Oak-hornbeam forests represent the most common lowland forest typology within the case study area. Forest management operations try to facilitate natural regeneration, removal of invasive species (where present) and ensure adequate species diversity (including species in the understory). Especially in early stages hornbeam normally tends to prevail and oak regeneration shall normally be supported through appropriate operations (e.g. clearings to support regeneration, thinning, etc.). Harvesting and thinning operations should remove wilting trees and facilitate natural oak regeneration. Oak tends to prevail (or even dominate) in areas that are periodically submersed by water. Depending on water availability and, more in general, on edaphic conditions additional broadleaf species include elm, ash, maple, alder, linden, cherry, etc. and forest management operations try to preserve this species diversity. Biodiversity conservation should also be seen in terms of fauna protection, as selective cutting aims also to maintain favorable conditions for animal species such as amphibians (e.g. *Rana dalmatina*, *Tritus* spp etc.) including rare and endemics ones (e.g. *Rana latastei*, that is included within the IUCN national red list), reptiles (e.g. *Natix natix, Lacerta bilineata* etc.*),* micromammal such as *Sorex arunchi* and several birds (e.g. *Carduelis carduelis* , *Turdus iliacus* etc.).

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Some of these forests are located close to urban areas and used for recreational purposes by local population and visitors in general. As a consequence management operations sometimes are oriented towards ensuring safe conditions for users and this might have marginal trade-offs with biodiversity conservation at a very punctual scale (e.g. removal of dead trees or trees that might be dangerous because of their instability).

Riparian forests

Forest management operations on riparian forests within the case study area tend to be minimal and basically consist of limited clearing of the understory, thinning and partial removal of dead trees. Management operations aim to eliminate invasive/exotic species and favor recovery towards better functionality and more stable and natural conditions in terms of both composition and structure. Thinning operations might imply some diversification of the forest structure, with a slight differentiation into layers and support to larger trees (mostly willow and poplar).

Harvesting operations should also remove trees and residues that might obstruct water flow and increase hydrogeological risks (thus also maintaining regulatory services), while favoring the development of the forest structure and composition. Isolated big trees should be released (not in a detached position exposed to strong water streams) to favor saproxylic invertebrates (e.g. *Osmoderma eremita*, *Lucanus cervus*, *Cerambyx cerdo* and *Morimus funereus*).

It shall be considered that, as for the case study area, these forests constitute relic riparian forests included within a broader protected area (Regional Park) and as such subject to stricter management conditions and regime.

2.3.2. Assessment of carbon sequestration capacity by the stand level FMMs in the Italian case study

The carbon sequestration capacity has been assessed based on a ranking ranging from 0 (low) to 5 (high) of different forest stand indicators indicated by *ad hoc* developed guidelines developed by ALTERFOR ES experts and including:

1) stand productivity

2) disturbances

3) cultivation and site preparation

4) silvicultural systems

5) harvesting operations and

7) wood utilisation properties.

Table 13 Qualitative assessment of carbon sequestration capacity associated with FMMs in the Italian case study.

FMM/Concept	P	S	C	H	D	HWP	Sb	Average

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Coastal forests (pine and holm-oak forests)	Mixed stands	0.0	2.9	5.0	0.0	4.0	0.0	0.0	1.7
	Pine stands	0.0	2.9	5.0	1.5	4.0	0.0	0.0	1.9
Oak-hornbeam forests		0.0	2.9	5.0	2.5	4.5	0.0	0.0	1.9
Riparian forests		0.0	2.9	5.0	2.0	4.5	0.0	0.0	1.9

P = productivity; S = silviculture; C = cultivation; H = harvest; D = disturbance; HWP = harvested wood products; Sb = substitution

Table 13 summarizes the findings. For each indicator, average values have been computed based on range values defined by the guidelines and stand data reported within the forest management plan. Values shall be treated carefully and as very preliminary and need to be further elaborated. Moreover indicators regarding rotation period were not taken into account due to the fact that management operations within the forest area do not make reference to a rotation period.

The models considered for the assessment present similar partial and average values. This is mainly due to the fact that:

- in all cases is adopted a selective cutting system

- wood production is not the main function/aim of forest management operations

- management operations and in particular thinning are not very intense

- wood assortments only include firewood

2.3.3. Assessment of the provision of cultural services by the stand level FMMs in the Italian case study

The ranking of FMMs in the Italian case study has been developed based on criteria defined by guidelines for cultural services (Table 14). Following the same approach adopted for the Swedish case study, attributes have been qualitatively ranked 0-1 (0=very bad, 1=very good) based on expert judgment i.e. no DSS or quantitative data has been used in the assessment.

Table 14 Concepts, dimensions, attributes used to rank the aesthetic/recreational

Concepts	Dimension	Attribute	Indicator	Effect
Stewardship (S)	Sense of care	Amount of logging residue	Frequency of thinning/final felling. Very high (0) – No intervention (1).	-
Naturalness/ disturbances (N)	Alternation/ impact	Frequency of final felling	Frequency of final felling. Very high (0) – No intervention (1).	-
Complexity (C)	Diversity	Tree species diversity within stands	Monoculture (0)- Highly Mixed (1)	+

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Concepts	Dimension	Attribute	Indicator	Effect
Complexity (C)	Variety	Variation in tree size within stands	Even aged (0)- Uneven aged (1)	+
Visual scale (V)	Openness	Visual penetration	Extremely dense (0)- Open (1)	+
Historicity/ imageability (H)	Historical richness	Age of trees in stands	Relative age/size* at final-felling. Very low (0) - Similar to "natural" conditions (1)	+
Ephemera (E)	Seasonal change	Presence of broadleaves	Totally absent (0)- 100 % broadleaves (1)	+

**Relative to the species lifespan and growth pattern, because a fast growing species will reach the size associated with higher aesthetical/recreational values faster.*

In general terms cultural services are very much important for the case study area due to closeness to periurban areas, thus making these areas very much appreciated by local communities as green areas for recreation opportunities, and tourism sites/infrastructures.

Table 15 Qualitative assessment of the recreational/ aesthetical values associated with FMMs in the Italian case study.

FMM/Concept*		S	N	C	V	H	E	Average
Selective cutting								
Coastal forests (pine and holm-oak forests)	Mixed stands	0.90	0.90	0.63	0.60	0.80	0.70	**0.75**
	Pine stands	0.80	0.80	0.33	0.35	0.80	0.45	**0.59**
Oak-hornbeam forests		0.75	0.75	0.60	0.45	0.60	1.00	**0.69**
Riparian forests		0.95	0.95	0.50	0.30	0.60	1.00	**0.72**

**s= Stewardship, N= Naturalness/disturbances, c= Complexity, v= Visual scale, h= Historicity/imageability, e= Ephemera*

Coastal forests

Overall coastal forests show the higher average score among the three models taken into account. The range in terms of average scores reflects different compositions in terms of broadleaf/conifer mixtures which also affects visual penetration and complexity (both in terms of tree species diversity and structure). It shall be considered, however, that as a matter of fact some pure (or almost pure) pine stands have high relevance in terms of cultural services when focusing in particular on tourism (e.g. parcel 11 -*Pineta Santa Margherita*- that hosts a camping size and parcel 9 -*Pineta di Eraclea*).

Oak-hornbeam forests

The average score corresponds to 0,69, however the situation is a bit nuanced when comparing different examples within the case study area. In some cases (e.g. forest sub-parcel 4.2, *Bosco di Via Carrer*) the forest area presents a string recreational function, while in some other cases forest

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stands are still quite young and their cultural value is still not fully expressed, although, based on empirical evidence, it can be assumed that proximity to urban areas increases quite a lot the relevance of cultural services for locals.

Riparian forests

The average score for riparian forests is 0,72, being mostly influenced by the high presence of broadleaves and very limited (almost absent) management operations. These forests are marginally represented within the case study (sub-parcel 3.1) and despite their environmental relevance as a wet area and a relic riparian forest included within a broader protected area (Regional Park) they are almost abandoned and partly degraded.

2.3.4. Assessment of regulatory services by the stand level FMMs in the Italian case study

As regards regulatory services with regard to the Italian case study area, reference is made in particular to prevention of/protection against forest fires.

Additional regulatory services for the case study area include protection against:

- marine aerosol, in particular by coastal forests and more specifically by pine stands;
- pests; and
- spreading of alien invasive species.

For the aims of this assessment the focus is on prevention of/protection against forest fires. Although no significant fire events occurred within the case study area during the last fifteen years, fire risk is taken into account by the forest management plan as one of the main risks in particular for costal forests and for afforested/reforested areas especially when left unmanaged. This is even more relevant considering the importance of many of the forests within the case study area for tourism/recreational activities. Being located close to Venice and other touristic places along the northern Adriatic Sea, the area is visited every summer by about 3 millions of tourists. Another 0.5 million live within the municipalities hosting the forest area and neighboring ones.

Marine aerosol is a relevant issue when considering that the area just behind coastal forests hosts some of the most fertile and productive agriculture lands in Italy and Europe.

Alien invasive species, such as *Ailanthus altissima* may conflict with strict biodiversity goals but also with all other silvicultural goals, as these species can outcompete native tree species. The European Union Regulation on invasive alien species (Regulation (EU) 1143/2014), entered into force on 1 January 2015, underlines the importance of prevention, early warning, and control measures. These measures encompass silvicultural practices such as shelterwood or selection systems of management which are applied in a close-to-nature silviculture, while on the contrary the spread of alien species may be connected with abandonment and wrong forest practices.

Attributes that have been taken into account with reference to regulation of fire risk include species composition and forest types (based on Ciancio *et al.*, 2007), intensity of thinning/harvesting, density (presence of gaps), and structure (number of layers) of the stand. These attributes might partly be informative also for other regulatory services (protection against marine aerosol, pests and invasive alien species), however they have not been explicitly addressed here. Data have been retrieved from the forest management plan for the case study area, while the ranking of the forest management models is based on expert judgment. Each of the four

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determinants has been qualitatively ranked 1-5 (1=lower risk, 5=higher risk). A summary rank has then been defined based on the average of the scores.

The assessment does not take into consideration relevant variables influencing ignition risk, such as climatic conditions, and socio-economic factors (Ganteaume *et al.*, 2013).

Results are summarised in Table 16 and briefly commented for each model taken into consideration.

Coastal forests

Coastal forests are the most exposed to forest fire risks and require specific management measures. This includes, in particular, clearings and reduction of the understory to reduce ignition risk. For similar reasons harvesting residues should normally be removed or released in limited amounts. Deadwood is also limited to normally 5 m^3/ha. Mixed stands tend to present lower risks due to the presence of gaps, while high density can be a critical factor for pure or close-to pure pine stands.

Oak-hornbeam forests

Oak-hornbeam forests are not very much exposed to fire risks unless left abandoned. Thinning operations that are normally implemented for favoring oak regeneration and the removal of less valuable trees contribute also to the reduction of fire risks. Release of deadwood to support microfauna might increase fire risk and should normally be limited to 5 m^3/ha.

Since many of this forests are used for recreational purposes, the presence of trails and other infrastructures for users might contribute to gaps in tree coverage, thus reducing the overall fire risk.

Riparian forests

These forests are less subject to fire risk due to the fact that they grow in sites rich in water and where conditions are normally less favorable to ignition. Thinning and clearing operations reduce stand density and create gaps that help reducing the risk while at the same time favoring some diversification of the forest structure, with a slight differentiation into layers and support to larger trees (mostly willow and poplar). Removal of deadwood and other materials that might obstruct water flow and increase hydrogeological risks is also functional to the reduction of fire risk.

Table 16 Qualitative assessment of regulatory service (fire risk) associated with FMMs in the Italian case study (1-5)

FMM/Concept*	Tree species composition (forest type)[a]	Intensity of thinning/ harvesting operations	Density of the stand and presence of gaps	Structure (number of layers)	Average
Selective cutting					

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FMM/Concept*		Tree species composition (forest type)[a]	Intensity of thinning/ harvesting operations	Density of the stand and presence of gaps	Structure (number of layers)	Average
Coastal forests (pine and holm-oak forests)	Mixed stands	3.0	4.0	3.0		**3.3**
	Pine stands	4.0	3.0	4.5		**3.8**
Oak-hornbeam forests		1.0	3.5	3.5		**2.7**
Riparian forests		0.5	3.5	4.0		**2.7**

A reported in Ciancio et al., 2007

2.3.5. Assessment of effects on the chemical and ecological status of water resources by the stand level FMMs in the Italian case study

ALTERFOR guidelines for water-related ecosystem services potentially provided by forests address five different aspects:

- Provision of surface water for drinking\non-drinking purposes
- Mass stabilization and control of erosion rate; Buffering and attenuation of mass flow
- Hydrological cycle and water flow maintenance
- Flood protection, and
- Chemical condition of freshwaters.

Building on data sourced from the forest management plan for the case study area, this assessment focuses on the provision of surface water for drinking\non-drinking purposes and flood protection.

Provision of surface water is mostly affected by evapotranspiration that, besides climatic parameters, is influenced by tree species composition (and forest density). In general terms evapotranspiration for broadleaf forests is less than that for coniferous forests and evergreen forests could have higher evapotranspiration than deciduous ones (McPeel *et al*., 2010).

As for flood protection (and, more broadly, management and control of the hydrogeological regime) evapotranspiration and canopy interception were taken into consideration, as per forest species composition and density resulting from the harvesting regime.

Different forest management models have been assessed in qualitative terms by attributing a score (1 to 5 range) to the two attributes taken into account (species composition and harvest intensity): average figures have then been computed for each model. Results of the assessment are reported in Table 17.

As for water-related ecosystem services in general, it shall be noticed that, as reported by the forest management plan for the case study area, no harvesting operation shall be performed close to streams and other water bodies.

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Table 17 Assessment of relative suitability (1-5) of different FMMs for provision of surface water and flood protection (1= very bad, 5=very good).

FMM/Concept*		Tree species composition	Harvest intensity	Average
Selective cutting				
Coastal forests (pine and holm-oak forests)	Mixed stands	3	4	**3.5**
	Pine stands	2	3	**2.5**
Oak-hornbeam forests		4	3.5	**3.8**
Riparian forests		4	4.5	**4.3**

Coastal forests

Coastal forests present the lower score among the three different models taken into account for the aims of this assessment. Pure (or close-to pure) pine stands show worse performance due to both three composition and possible higher harvesting intensity. Indeed, in the case selective cutting consists in creating forest clearings (e.g. in the case of pine forests planted on/just behind coastal sandy dunes) the recommended minimum size of clearings in order to maximize naturalization effects should be 1,000 to 1,500 m^2.

Oak-hornbeam forests

Planted oak-hornbeam forests within the case study area tend to present medium to low density when they are intended mostly for recreational purposes, being characterized by a combination/patchwork of areas covered by trees and uncovered areas. Species only include deciduous broadleaves, with very limited exceptions. The intensity of harvesting operations is limited and affects small portions of forest areas. While these forests tend to poorly contribute to runoff generation, their position close to urban/peri-urban areas effects on run-off propagation might be influenced by density of road trails or, for forests located within/close to agricultural areas density of ditches.

Riparian forests

These forests only include deciduous broadleaves and harvesting operations are quite limited. Operations should remove dead trees and residues that might obstruct water flow and increase hydrogeological risks (thus also maintaining regulatory services), while favoring the development of the forest structure and composition. Due to their position along rivers/streams riparian forests also play a relevant role as buffers influencing quality of water resources through filtration and purification.

The consumption of land in the plain, following a widespread type of settlement, has dramatically increased the hydrologic risk. One solution is to create space for water by developing controlled floodable zones. In these zones, unlike agricultural crops, forests would not suffer for damages created by water. These areas with forests and a maze of hedges and ditches help in limiting the

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intensity of floods and in maintaining a regular water flow, providing more time for water to deeply infiltrate.

The species suitable for these areas are broadleaves such as willow, alder, ash, poplar, white hornbeam and oak. Forest planning should avoid to expose big detached trees to strong water streams and should also include bushy vegetation.

2.3.6. References

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