

1st Report 2013-2014 of the Working Group “Mountain Forests” of the Alpine Convention

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1. Introduction to the objectives of the mandate 2013-2014 of the Working Group “Mountain Forests”

Pursuant to the decision B7/2 taken by the Ministers at the XII Alpine Conference on 7th September 2012 in Poschiavo, the Parties to the Alpine Convention established a Working Group (WG) on “Mountain Forests. According to the mandate approved by the 52nd Permanent Committee of the Alpine Convention (Bolzano, 8th – 9th March, 2013) the Working Group was tasked to prepare two background documents

- 1) *“from an active monitoring to the development of sustainable forest management strategies”;*
- 2) *“the value of Alpine forests”;*

The Working Group focused its activity on three main topics, which have been discussed in the workshops organized with the meetings to provide information and data

- I. the state of Alpine Mountain Forests, trends, threats, opportunities and challenges;
- II. the valorization of Alpine forests’ functions and the ecosystem services they provide;
- III. the role of sustainable forests management within an Alpine Green Economy;

As a synthesis of the outcomes a number of specific recommendations for future common initiatives is addressed in the fifth chapter of this Report, with a view to propose to the governing bodies of the Alpine Convention the contents for a declaration on the importance of Alpine forests to be submitted to the attention of the XIII Alpine Conference (November 2014).

2. State of the Alpine forests: an overview

The Background Document consists in a survey of the available data for the forests within the area of the Alpine Convention, addressing their current conditions, trends, major threats and challenges. Most data have been provided by Member States.

2.1 Data availability and comparability

The European Forest Monitoring is based on the National Forest Inventories and monitoring; an harmonizing process is on course; at present NFIs are not always built on the same parameters, and many data, particularly on the management of the forests, including most of the Pan-European Indicators for Sustainable Forest Management defined by the Ministerial Conference on the Protection of Forests in Europe (MCPFE), are only available at national level. In addition regional units do not cover the Alpine area of the Convention.

This document considers the forests within the area of the Alpine Convention. As said, since Member States often collect data in different ways, comparability is difficult for some parameters. In addition some assessments and indicators are only available at national level. Nevertheless, the WG considers the quality of attained data as sufficient and the approximations as reasonable for enabling a first analysis and evaluation, as far as expected from the WG.

It appears clear that more precise information on Alpine forests, to be collected through a broader project of statistical analysis in all national existing datasets and databases, will be very useful. Such an initiative would enhance data quality, allow better comparison, as well as the exchange of experiences and good practices.

2.2 Forest area

Within the Working Group, National delegations from the Contracting Parties sent information on the state of the forest derived from National Inventories, which not always use the same parameters.

Most Countries consider areas as forested if the tree canopies cover more than 10% of the area and if the trees are higher than 5 m (however, for example, these parameters are calculated in Switzerland at, respectively, 20% (and 3 m). In fact, yet in a methodological perspective, it is important to remember that an even precise assembling of data for the Alpine Convention's area requires two possible operations, either: 1) use of regional data in addition to national datasets; 2) or applying national average. This might produce uncertainty in some cases, for instance because original data may refer, for example, to even slightly different areas.

Table 1: forest cover in the Alpine Convention area (data from national delegations)

Forest area	Unit	CH	I	D	F	A	FL	Slo	Tot
Alpine Convention territory	km ²	24,862.0	52,033.8	11,054.8	40,788.4	54,702.2	160.0	6,671.0	190,272.2
national inventory	100 ha	8,000.00	28,000.00	4,756.00	14,469.00	25,826.00	51.72	4,853.53	88,277.5
shrub forest	100 ha	660.00	2,866.40	587.00	834.50	1,340.0	14.63	175.04	6,004.68

In addition to the forest area, National Forest Inventories also define a **shrub forest area**, that in the Alpine Convention is calculated for vegetation with a height at maturity of less than 5 metres (3 m for Switzerland). The shrub forest area covers an additional area in the Alpine Convention' Countries ranging between 3,5% (Austria) and 28% (Liechtenstein), though is generally not exceeding 10%.

Furthermore, in the framework of the Working Group, another source of information was finally considered as an important useful proxy calculation for deriving the total forest area for the Alpine Convention perimeter. The source of information derived from satellite images based on CORINE land cover (CLC) dated 2006, which are available at the European Environment Agency[EEA, 2013 a]. The original data are of raster pixels that have a resolution of 100x100 meters. Due to this low resolution, these data in some cases differ significantly from those of the national inventories. Nevertheless, the Working Group believes that they are an important reference because they cover exactly the Convention area and are homogenous for all countries.

Table 1 shows the results of the analysis of the Working Group "Mountain Forests" for the calculation of the forest cover in the area of the Alpine Convention.

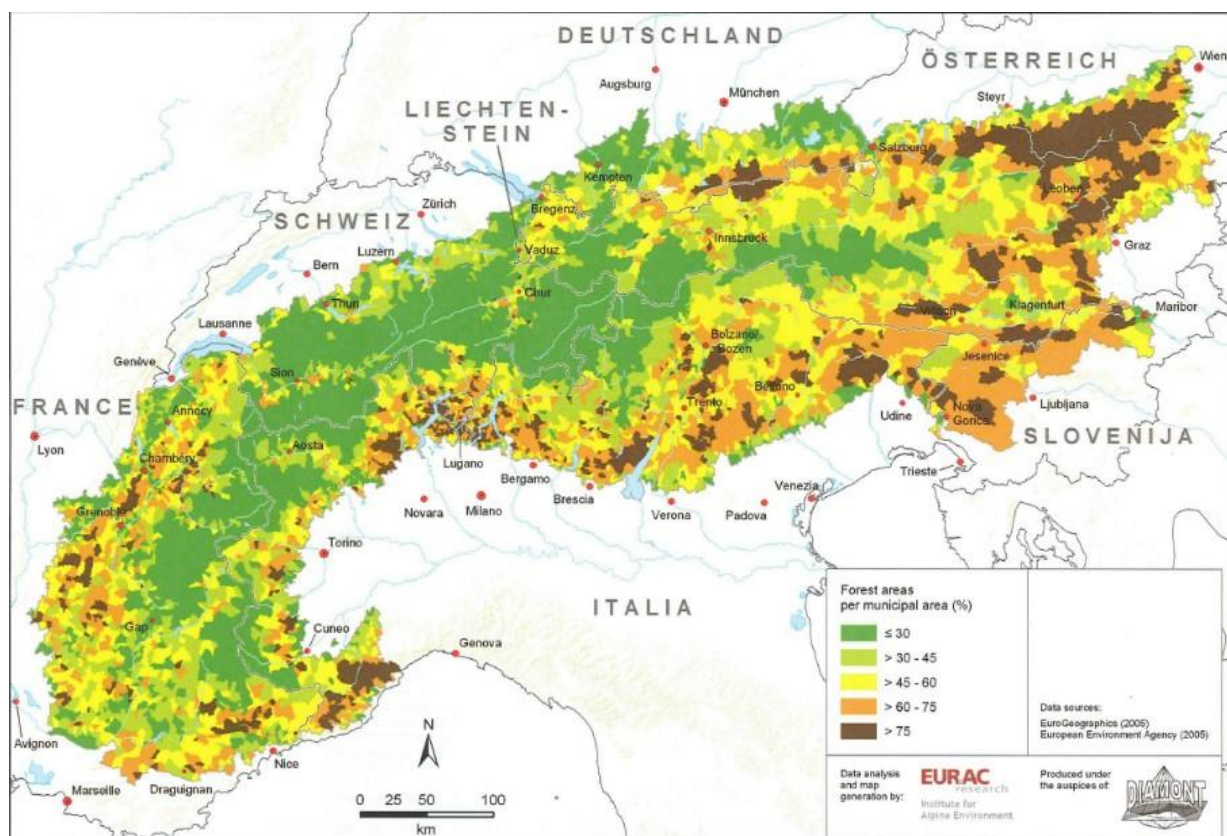


Figure 1. In the map operated by EURAC the forest area as a percentage of the municipality is shown. The map clearly shows evidence of the lower forest area in the central part of the Alps due to the higher elevation.

	Unit	CH	I	D	F	A	FL	Slo	Tot
Forest area (CLC, 2006)	km ²	7,506.8	25,072.0	4,468.2	16,526.0	28,813.7	73.7	4,539.3	86,999.8
Alpine Convention territory	km ²	24,862.0	52,033.8	11,054.8	40,788.4	54,702.2	160.0	6,671.0	190,272.2
% Forest	%	30.2%	48.2%	40.4%	40.5%	52.7%	46.1%	68.0%	45.7%
national inventory	100 ha	8,000.0	28,000.0	4,756.0	14,690.0	25,826.0	51.72	4,853.5	88,277.5
Difference	100 ha	593.2	2,928.0	287.8	-1836.0	-2,987.7	-22.0	314.2	1,277.5
difference %		7.9%	11.7%	6.4%	-11.0%	-10.4%	29.8%	6.9%	1.5%

Table 2. Comparison of forest cover data from satellite images Corine Land Cover 2006 (EEA,2013) and from national inventories.

The forested area in the perimeter of the Alpine Convention results amounting to roughly 87,000 km² and covers around 46% of the total area of the Alpine Convention, compared to a total forest area for the EU 27 that encompasses 1,59 M km² and covers 37.4% of the total EU territory [European Commission 2013a].

Significant differences between Alpine countries become hereby evident. In general, forest cover is lower in the western and central Alps. Differences are due to average elevation, climate as well as soil conditions. Moreover, at current trends, ongoing changes in the capacity of the mountain agriculture to resist abandonment is relevant.

The WG tried a synthesis of the available information on the forest area of the Alpine Convention. In order to carry out this task, the WG accepted the data from the CLC information [EEA, 2006] computed by EURAC (2013). Data show, with the exception of Liechtenstein, where the difference of the national datum is significant (-30%) in all other countries differences between +11.7%, in Italy) to -10.4% in Austria. In the assessment of the WG, this comparison confirms the plausibility of using data taken from National Inventories for a first assessment of the land cover of Alpine forests. More precise data shall be available through statistical extraction of the sample plots from the national inventories that the WG recommends.

2.3 Ownership

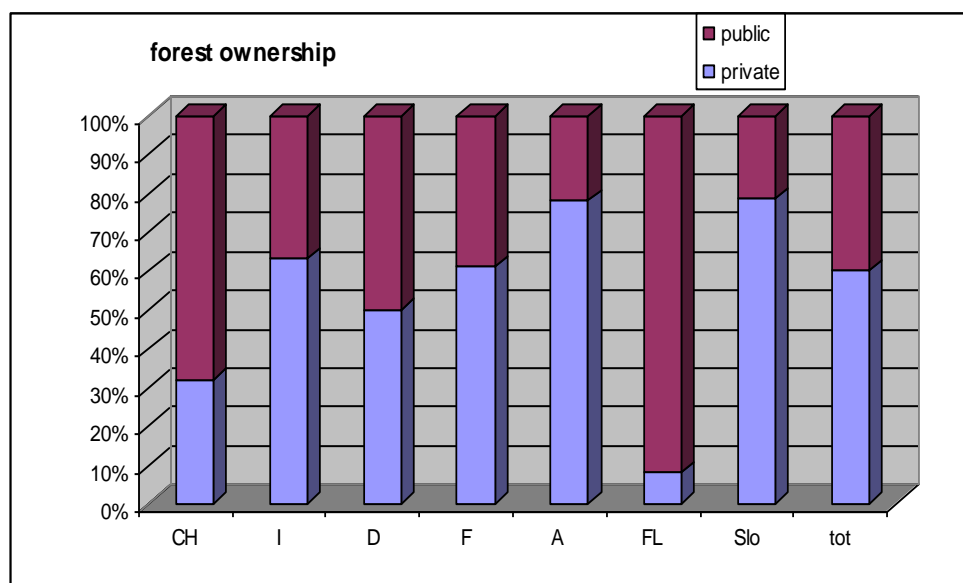


Figure 2. Alpine forest ownership (data from national delegations of the Working Group “Mountain Forests” of the Alpine Convention)

Figure 2 shows how, on average, forest ownership in the Member States of the Alpine Convention is 64% private. In Switzerland and Liechtenstein, public ownership is instead predominant. It is important to recall that collective ownership of pastures and forests has been important in the past in many parts of the Alps.

2.4 Annual change in forest area

forest area	Unit	CH	I	D	F	A	FL	Slo	tot
annual change	100 ha	48,2	253,9		117,4	27,8	0,01	7,5	454,8
(period)		(2005-10)	(1985-05)		(1986-00)		(2002-08)	5 years	
%/year	%	0,6%	0,9%		0,78%	0,11%	0,02%	0,16%	0,52%

Table 3. Forest area change (data from national delegations)

The forest area in the Alpine Convention area has expanded in recent years. The process seems to be stronger in the southern slope (Italy 0,9%, CH 0,6% annual increase) than in Austria (0,11%) and Liechtenstein (0,02%), although the different time scales considered could have an influence here. In Germany (Bavaria) there are in practice only few shifts between forests and open land.

There is a general tendency of forest to re-occupy [MacDonald et al. 2000; Tasser et al. 2007] marginal agricultural land, on which management is abandoned due to the following three categories of reasons:

- economic → competition of products from plains with lower costs;
- technical → tendency toward larger and more productive animals, whose productivity is reduced by grazing over longer or steep paths;
- social → aging of rural population, abandonment of farms, fragmentation of landownership.

Furthermore, as some studies show, the effects of climate change could possibly accelerating the process in the higher elevations [Estaugh 2008].

In such a context, within some regions (i.e. southern and western Alps) the traditional Alpine landscape is therefore impacted by the expansion of forested areas, that overgrows the typical interchange of open and wooded land. For example, an analysis of the forest area at different elevations shows percentages of 75% and more between 600 and 1500 m above the sea level, with peaks of over 85% in Friuli Venezia Giulia.

In light of these insights, the WG could evaluate that such a significant growth in forest area has happened predominantly (where often, exclusively) in the mountain area as regards the Convention's Countries. This growth, it can be claimed, cannot however generally compensate the scarcity of forests in the lower areas, where agriculture, infrastructure projects and the settlements expansion are steadily demanding for new land.

As a potential consequence, it can be claimed that this "shrinking process" of mountain agriculture in certain regions might have a negative influence on biodiversity in the Alpine areas [Tasser et al. 2005], that would hence have an impact also on the quality of the landscape itself. Currently, in many Alpine regions rural development and landscape policies aim to maintain existing extensive agricultural land (mainly meadows and pastures) and open landscapes. However, it can be claimed that the increase of forested land can also trigger positive effects, for example by enhancing the protection against natural hazards, as well as biodiversity and wildlife [Navarro & Pereira 2012].

2.5 Wood production, increment, growing stock, biomass, fellings

Alpine forests did not only expand their area significantly over the last decades, but they have also been increasing their biomass. In fact, according to the data referring to the Alpine Convention's area that have been provided by the National delegations in the WG on the basis of National Inventories, the total above ground volume (stems and large branches) is estimated to some 2.000 million m³, with an average of almost 240 m³/ha.

Just as a comparison, the EU27 has a total above ground volume of 22.000 million m³, with an average of almost 146 m³/ha [European Commission 2013a].

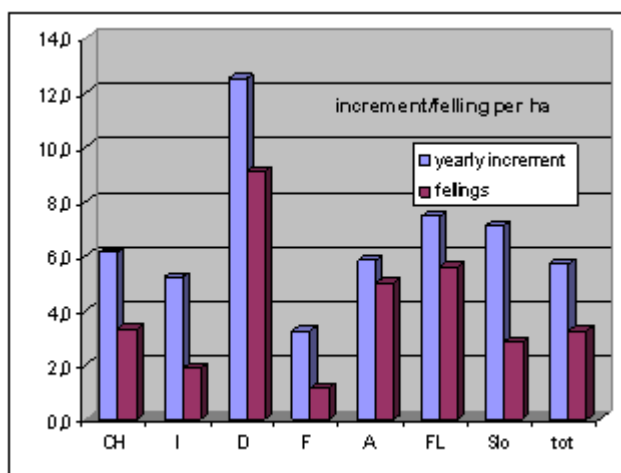


Figure 3. Annual growth and felling in the Alpine forests (data from national delegations).

The annual increment is approximately calculated by the WG to 50 million m³ equal to 5.7 m³/ha, higher than the EU 28 average of 4.8 m³/ha [European Commission 2013]. The significant increase in the annual increment observed in last decades is likely due to the multiple combination of several factors such as a larger growing stock, a reduction of grazing for the fertilization effect caused by atmospheric nitrogen deposition, by the increase in atmospheric higher CO₂ content concentration and temperatures [Bellassen et al. 2011]. Under an historical perspective, in most of the Alps and particularly in the western and southern areas, the period of intense exploitation of the Alpine forests lasted until 40-50 years ago and was followed by reduced felling, linked with an action of active saving and reduced pressure resulting from declining wood prices and the shift from a mainly local towards a global market. These processes, arguably, brought about a trend of abandonment of the territorial management of marginal areas (fragmented properties, insufficient infrastructure, small quantities).

On the other hand, in some Alpine areas, such as in Austria), upswing of wood mobilisation started in the 1980s and increased substantially annual felling bringing them to an all-time high (see Figure 4, showing felling dynamic for the period from 1974 – 2012 for Tyrol).

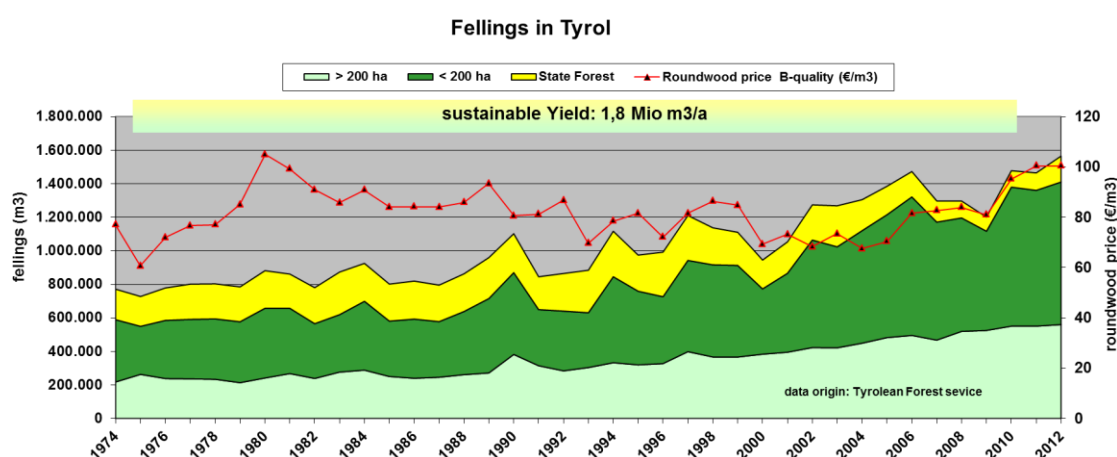


Figure 4. Fellings in Tyrol: smaller and larger than 200 ha properties and state forests (Data from the Austrian delegation)

This dual process is reflected in the Figure 3. in the south – west Alps felling achieve a quote of 35% of the forest-increment, while in the north-eastern area they are 75%.

Over the last 10-15 years a growing interest for wood biomass has risen as a further wood product [UNECE-FAO 2011]. According to the WG's assessment, this situation can represent an opportunity for forest management and for the local wood industry in the Alpine area.

2.6 Species composition, naturalness, structure of Alpine forests

Due to the geological history and the glaciations, the Alps concentrate on a relative small area a very high number of different habitats and species, for instance 100 out of the 198 habitats listed in Annex I of the Habitats Directive (92/43/EEC) are found in the Alpine area and two of them are present only in the Alps.

Indeed, the altitudinal succession and size of the Alps creates the basis for the development of a highly diverse flora. The region hosts some 5.000 native vascular plants, i.e. about 40 % of the European flora.

The Alpine area is one of the most diverse regions of Europe, despite the relatively low number of tree species. The Mediterranean Alps particularly contribute to this regional biodiversity in harbouring up to 2.800 species. The area hosts some 350 endemics, most of them found in the south. Strictly endemic species represent 7–8 % of the Alpine flora. [EEA2002].

Additionally, the Alpine region is not only the largest wild area in Europe, but also the most anciently occupied as well as the most visited mountain region in the world, with human beings leaving imprints in the region for more than 7.000 years. Agricultural activities have traditionally been present in the area and gave rise to numerous semi-natural habitats that are living spaces for a number of species.

The crisis incurred by rural societies at the end of the 19th century disrupted the way of living which had not been changed for hundreds of years. Overpopulation led to deforestation and overgrazing which in turn has led to increased erosion.

Thereafter, with the change in agricultural practice occurred in the 20th century, forests started to increase in the whole area through a process of natural re-growth and afforestation. Such increase in forested areas in the Alps play an important role in preventing soil erosion, avalanches and landslides [EEA,2002].

Currently, half of the Alpine Convention's territory is covered by forests, these being composed by a relatively low number of tree species as shown in Figure 5 below. Conifers are the prevailing trees in Alpine forests. The main species that can be found include silver fir (*Abies alba*), Norway spruce (*Picea abies*), larch (*Larix decidua*), Scots pine (*Pinus sylvestris*), Alpine pine (*P. cembra*, *P. uncinata*, *P. mugo* and *P. nigra*).

In addition the region hosts some 40 species of deciduous trees, among them beech (*Fagus sylvatica*), hazel (*Corylus avellana*), ash (*Fraxinus excelsior*), sycamore maple (*Acer pseudoplatanus*), alder (*Alnus incana* and *A. viridis*) [EEA, 2002].

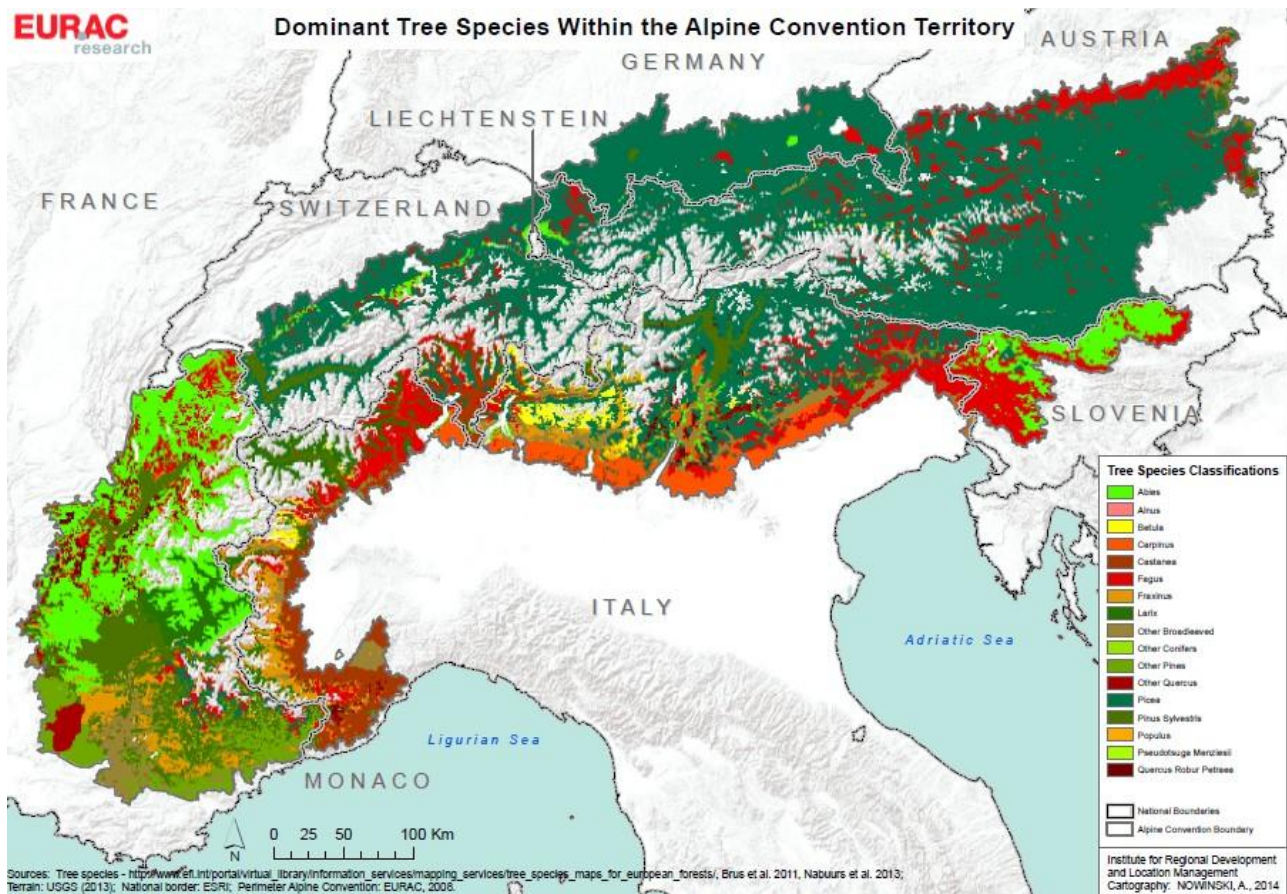


Figure 5. Dominant tree species in the Alps. This figure also shows also as, in relatively small areas such as particularly in the southern slope, many different types of tree species can occur,

As the WG could corroborate, Alpine forests display a good degree of naturalness: they are mostly mixed, with an increasing diversity of species.

Broadleaved forests had a remarkable “come back” after the forest policy shifted from an economically driven strategy on coniferous species and artificial regeneration towards a more functionally and ecologically driven approach that also maintains and respects

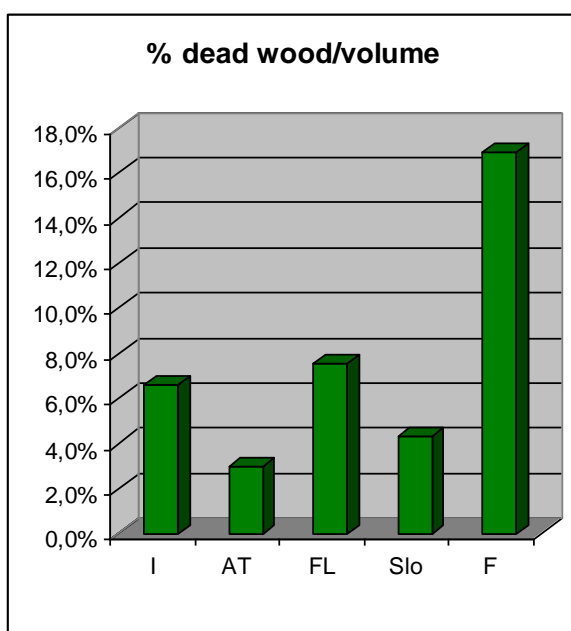


Figure 6. Deadwood as % of growing stock volume. Definition of dead wood is however different according to the respective National Forest Inventories

‘minor’ and rare species. The strong reduction of grazing in the forests also contributed to the growing presence of these broadleaved species. Nowadays, Alpine forests mainly resemble the natural vegetation associations with predominantly native tree species; on the other hand, the presence of exotic species is very low.

This structure affects the profitability of Alpine forests in comparison with flatland forests and plantations. In the Alps, the regeneration is predominantly natural and the stand-structures are moving away from strictly even-aged and artificial. The predominant management model mimics natural processes, i.e. clear-cuts on large areas are replaced by more structured cuttings and selection procedures.

In the northern slope, the WG could investigate that regeneration is less diverse, due to a selective action through game and cattle browsing (notwithstanding the latter displays reducing trends over the last decades). In some regions, especially the North-Eastern part of the Alps, there is a prevalence of older age classes associated with lack of regeneration, that threatens the protective function of forests for the future.¹

The structure of almost all Alpine forests is thus generally defined as “semi-natural” according to the indicator used by Forest Europe, showcasing a significant presence of large and old trees.

The amount of dead biomass, which is directly connected with biodiversity (insects, fungi, birds) and naturalness, is higher in mountain areas than in lower forest areas with a better accessibility.

As shown in Figure 7 although there are almost no truly virgin forests in the Alps, there is an increasing number of old stands, with large trees, that have developed naturally for many decades and are now good examples of re-naturalisation.

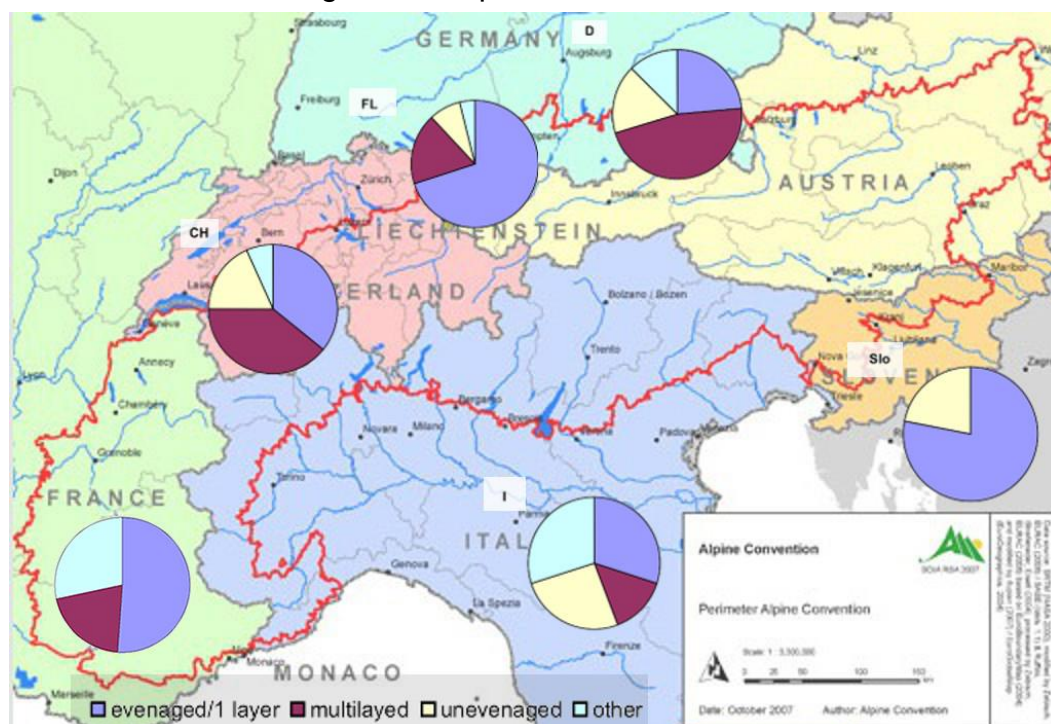


Figure 7. Structure of Alpine forests: single-layered, multi-layered, unevenaged, other (data from national delegations).

Even aged structures predominate in Slovenia and Liechtenstein, while in the other Alpine Convention's countries providing available data, they are approximately rounding one third of the overall forest structure.

A survey [EURAC, 2006] conducted on the naturalness of the Alpine region hemeroby, indicates the degree of anthropogenous influence on the environment.

In this study, each cover type was assigned a value within a 1 (unaffected) to 7 (artificial system) range. Unaffected cover types characterised by no anthropogenous influence include glaciers and virgin rocky areas.

¹ As shown by some relevant examples and literature provided by the national delegations, several management projects in the protective forests are in place in the Alpine Convention's Countries.

Forests were assigned values around 2-3 points, while values between 3 (pastures) and 5 (permanent cultivation, arable areas) were assigned to agricultural areas. The map in Figure 8 below shows the mean values calculated at the level municipality.

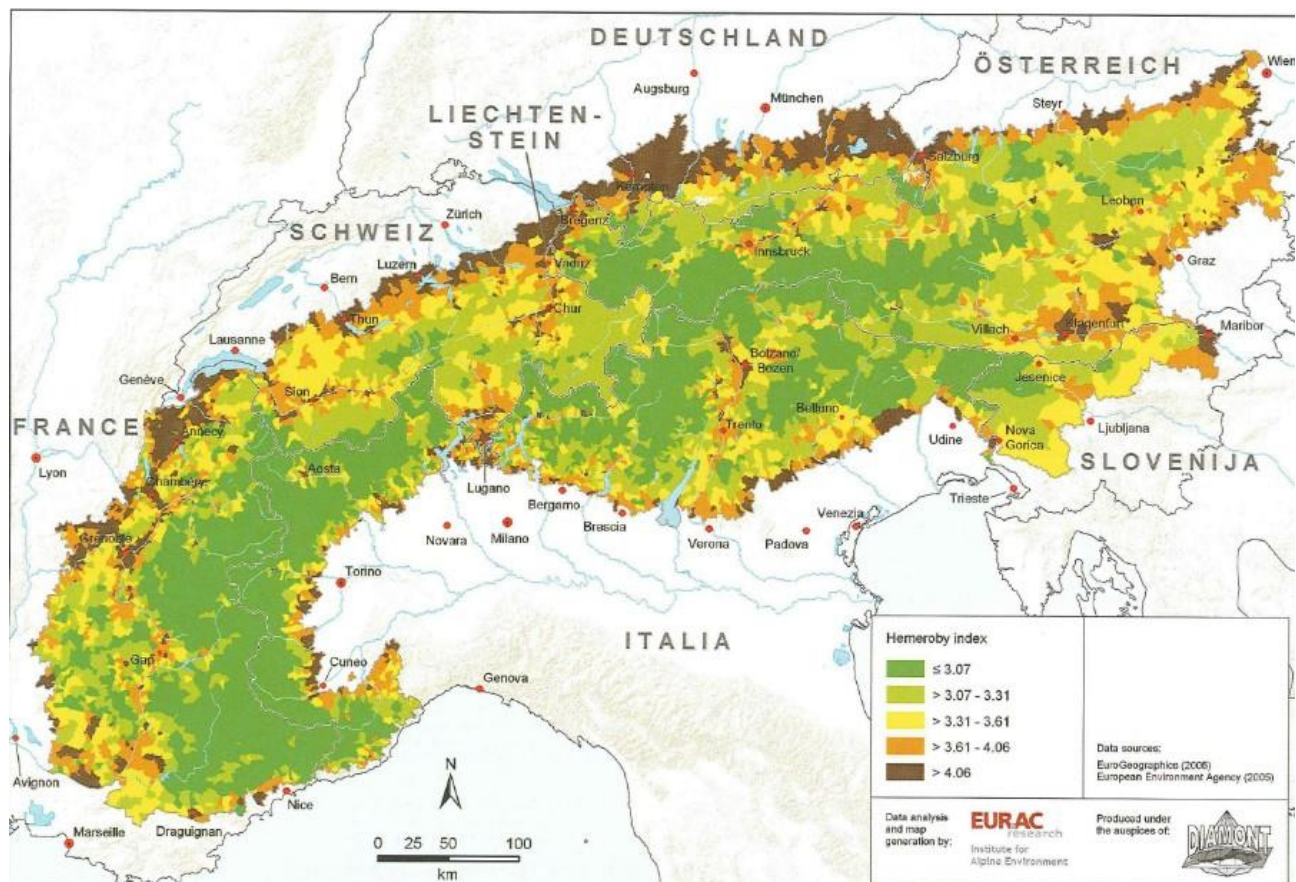


Figure 8. Hemeroby of the Alpine area: hemeroby index is assigned for values ranging from 1 (natural) to 7 (artificial) [EURAC, 2006].

2.7 Biodiversity and nature conservation

Biological "naturalness" and diversity of European forests have been influenced by human activities for a long-lasting span of time. The so-called "undisturbed" forests, the largest of which can be mainly found today in Russia, Eastern and Northern Europe, represent today a 27 % of European forests., (whereas "semi-natural" forests account for a 70 % of the total European forest area (MCPFE, 2003).

Nature-oriented silviculture is currently the main trend in European forestry, and its importance is recalled also under the Protocol on "Mountain Forests" of the Alpine Convention. Nature-oriented silviculture is based on less intensive management methods favouring retention trees and decaying wood, the establishment of natural tree species and species mixtures, and the protection of small key biotopes (EEA technical report 9/2006 Forest types).

EU Member States are abiding by the compliance with the "Natura 2000" Directive [EEC 1992] concerning the Natura 2000 areas dedicated to biodiversity protection known as. The 20% of the Alpine Convention area is considered as Natura 2000 areas, with respective national quota varying from a minimum 15% (France) to a maximum of 47% (Slovenia).

Switzerland and Liechtenstein as no-EU Member States are not bound to the Directives 92/43/EEC and 79/409/EEC, and therefore do not join Natura 2000 network. However, Switzerland participates in the Emerald network using the same criteria applied for the Natura 2000 network.

	Unit	CH ²	I	D	F	A	Slo	tot
Land area in AC	100 ha	25.251	52.034	11.055	40.788	54.702	6.671	190.502
Area Natura 2000/Emerald	100 ha	366	12340	2118	5975	9290	3153	33.242
	%	1.5%	23,7%	19,2%	14,6%	17,0%	47,3%	17,4%
Forest area in Natura 2000/Emerald	100 ha	138	3.760	884.5	1.557	4534.9	2408.6	13.284
	%	38%	30.5%	41.8%	26.1%	48.8%	76.4%	40.0%
% of total forest selected in Natura 2000/Emerald	%	1.7% *2	13,4%	18,6%	9,3%	17,6%	49,6%	15,1%

Table 4. Natura 2000/Emerald areas in the perimeter of the Alpine Convention (data are referred to the biogeographic Alpine region, that does not coincide with the Alpine Convention perimeter)

Protected areas, such as national parks, regional parks, biosphere reserves or natural reserves, cover about 15% of the Alps.

Worthwhile to say, within these protected areas, any form of human intervention is to be considered as forbidden on 1% of the area. Moreover, in the Alpine Convention perimeter, the territories of the 13 national parks existing in the various Countries cover up to 4.2% of the total area.

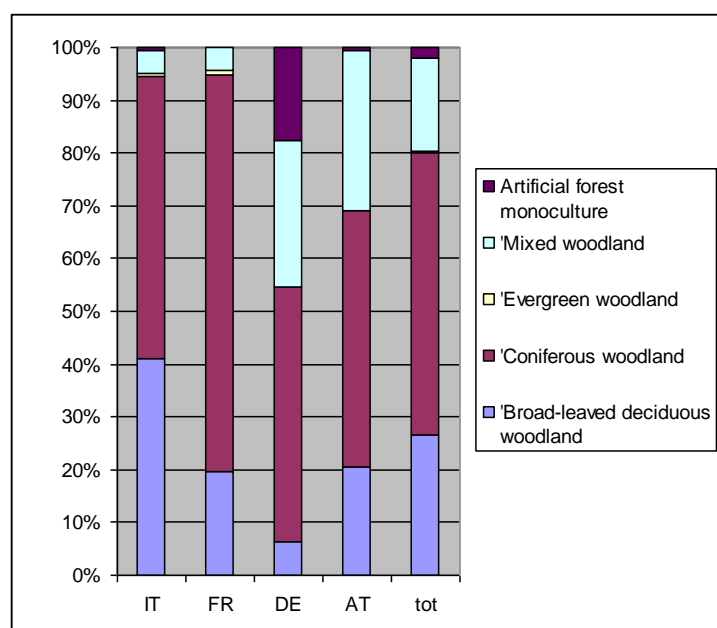


Figure 9. Classification of Alpine forests in Natura 2000 (EEA, 2002)

Most of the large protected areas are actually to be found at high or very high altitudes. In general little protection is given to areas below the sub-alpine zone, no protection at all in the valleys [EEA, 2002].

² Switzerland is not part of the “Natura2000” network but of the “Emerald” network, which is based on equal criteria. The explanation for low percentage for Switzerland is that presently the Emerald Network area covers only national habitat/biotope inventory. Additional sub national inventories are in preparation.

Natura 2000 forest habitats are divided in five major categories: a) Broad-leaved deciduous; b) Coniferous; c) Evergreen; d) Mixed; e) Artificial monoculture. The percentage of each category is shown in Figure 9 at the previous page.³

By downscaling the available data for the total forest area calculated by the Working Group on “Mountain Forests”, the WG has measured that 15% of the Alpine Convention’s total forest area has been declared as a Natura 2000 area, though peak reach almost 50% in Slovenia.

In the Alpine Convention’s “Natura2000” areas, 40% is covered by forests, with a west-east gradient that can be tracked which is due to elevation of the selected sites. National percentages ranges vary from 26% in France to 76% (in Slovenia).

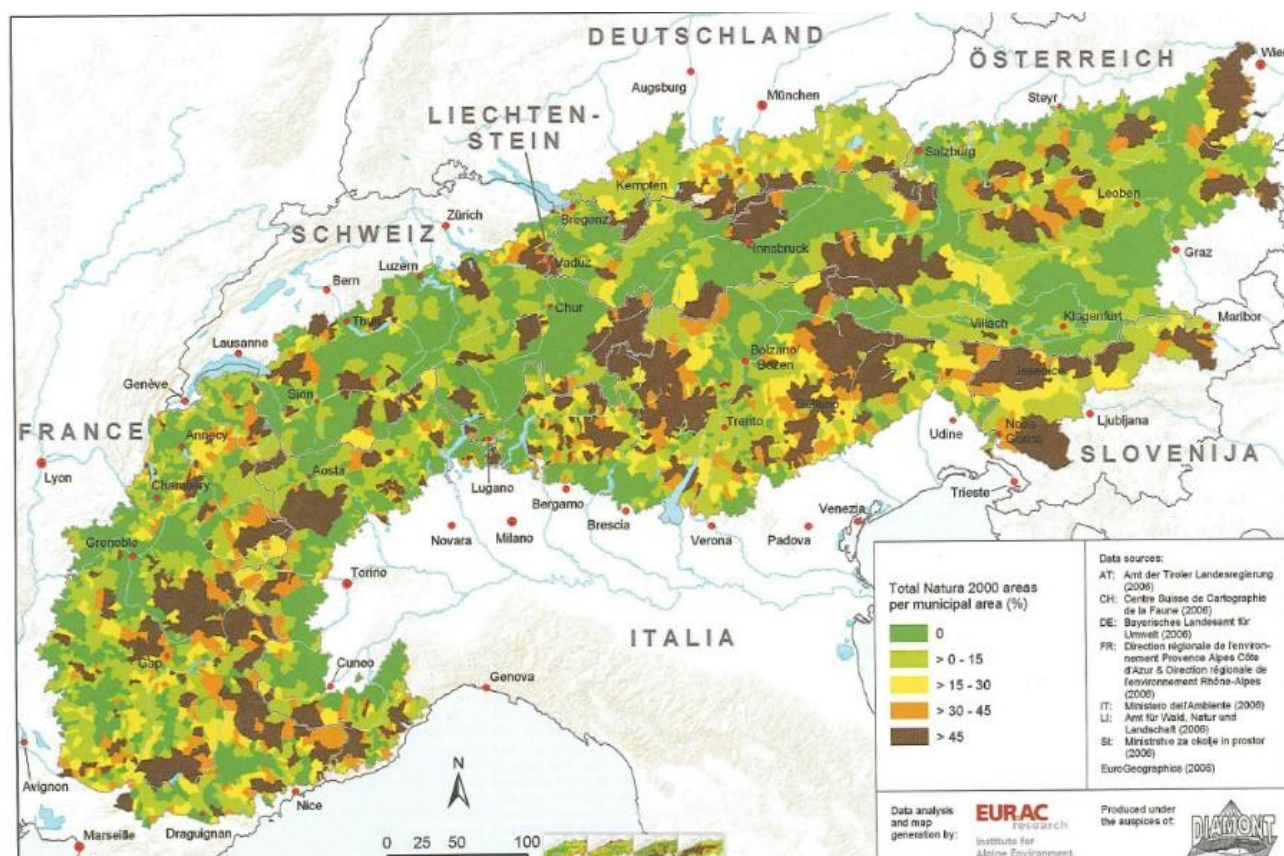


Figure 10. Percentage of municipality land in Natura 2000 (DIAMONT).

2.8 Connecting disjointed habitats

The Natura 2000 Directive, in parallel with the so called “Emerald” process applied in Switzerland, has defined at the EU level the basic net with the most relevant areas of interest for biodiversity and naturalistic values. In addition to that, other protected areas contribute to the conservation of the Alpine landscape and semi-natural conditions.

In general, a large part of the Alpine region is managed on the basis of sustainable criteria, with a multifunctional approach and with schemes derived from natural processes. Conservation of rare species, presence of deadwood and biodiversity are preserved not only in the protected areas.

³ No official data for this indicator was available for Slovenia.

Due to the sustainable management approach that can be generally found as well as to their significant extension in the region, forests represent the land use typology that connects the hot spots of the biodiversity network, together with water courses for linear and functional links. In general, forests are permeable for most species and offer protection and nesting possibilities.

Alpine forests are of unique importance in providing this function: they are in fact less fragmented and therefore less exposed to invasive species than in other regions, hosting an important share of those interior core habitats that are then connected with semi-natural open habitats, such as meadows, pastures and heath lands. [Estreguil et al., 2012].

This important connectivity function must be recognised, supported and valorised, avoiding the creation of barriers through infrastructures, land use changes or management measures: specific measures should be designed to improve the connecting function, creating micro- and fringe-habitats.

Another important aspect is the communication of the Alpine biodiversity and nature net: owners, managers, residents, responsible authorities for ensuring forest services should increase stakeholders' awareness of the values of the net and make them feel to be part of an Alpine network, preserving forests as one of the most important European natural landscape. Awareness is an added value for local conservation policies and measures and needs to be taken into account within resource enhancement and communication policies.

2.9 Carbon storage and CO₂ sequestration

CO₂ is removed from the atmosphere via photosynthesis and stocked in organic, carbon – based compounds. Wood and biomass are essentially made of carbon. As a rule of thumb, 1 m³ of wood stocks 1 t CO₂.

By transforming the estimated biomass in the inventories in carbon on the base of 0,5 t carbon/t biomass⁴, the total amount of carbon stocked in the above ground biomass of the alpine forest reaches 600 million t, which is the equivalent of 2.200 million t CO₂.

At present, Alpine forests act as carbon sink, as a result of the forest-increment both in area and in biomass: when forests stop growing and reach a state of equilibrium, they can no more act as carbon sinks.

In sustainably managed forests trees are harvested before they reach their physiological age limit and the ecosystem remains in the more productive phases of the succession cycle. Furthermore, wood used in construction, furniture and other products continues to stock the carbon for decades. Carbon will be released at the product life-cycle end, when it will be disposed of, i.e. often burnt producing energy and possibly replacing fossil fuels).

A 'cascade' use of wood (primarily as a raw material, using only rest-products as fuel) extends the carbon sequestration service [UBA, 2014].

Alpine Forests absorbs every year 55 million t CO₂: part of it is stocked in the growth of forest stock (accountable sequestration), part is felled as structural wood (non accountable sequestration) and part as firewood (returned to atmosphere).⁵

⁴ As also explained by the Working Group to the 56th meeting of the Permanent Committee (Brescia, 24-25 June 2014, decision PC56/B5/6) the reference-base parameter of 0,5 t Carbon/ t Biomass was calculated on the basis of the related parameter derived in the Italian inventory of carbon sinks,

⁵ this, amount is approximately 50% of the total CO₂ emission of the alpine area, as estimated by CIPRA (Info 85, 2007).

2.10 Water and soil protection, prevention of natural hazards

Forests play an essential role in providing soil cover and protection against natural hazards like avalanches, rockfalls, erosion and floods. The recognition of this function is at the basis of many existing regulations to protect forests in mountain areas and particularly in the Alps, characterised by steep slopes, dense population and infrastructure. Generally forests cannot be easily changed into other land use: also private owners need permits to enforce certain management measures. Often laws and regulations refer to all forests located in mountain areas and allow to undertake only defined management measures, that maintain forest soil protection.

Some countries designate special areas for specific functions, so e.g. Switzerland implements a concept of “*Integrated Risk Management*”, including hazard mapping and measures to be enforced in protection forest (www.planat.ch). This tool seeks a comparable safety level against all natural hazards, that is ecologically justifiable, economically proportional and socially viable. It involves all responsible actors and it is based on all the available information on risks. Measures include prevention, accomplishment and regeneration.

Austria (Wasserrechtsgesetz 1959 idgF, BGBl 1959/215), Germany and Liechtenstein (Water Protection Act; LGBl 2003, Nr. 159) have specific water protection areas, designed to maintain and/or improve quantity and quality of water. As a result of this national policies, currently 8% of the Alpine forest area is designated as water protection areas. In these areas, forest management has to be close-to-nature, implying that clear cut is not permitted and, on the other hand, natural regeneration, broadleaved species and natural composition are promoted.

In other countries, namely Switzerland and Italy, these requirements are instead generally applied to all forest areas. Furthermore, Switzerland and Liechtenstein have additional restrictions for water protection zones, concerning use of chemicals (ChemRRV).

Bavaria has defined in its Forest Function Plans “Water Protection Forests” to protect the quality of water, both surface and groundwater and to ensure water provision (quantity).

Special areas are defined for subject-to-flood-areas and flood producing areas, with some restriction to the forest management. Austria has designated “soil and water-cycle protection forests” (36%), while Liechtenstein “protection forests” (54%).

3. Threats to Alpine Forests

Alpine Forests are subject to many threats and suffer serious damages, that are expected to further increase as a consequence of the ongoing climate change: a sustainable forest management should try primarily to assure stability and resilience of forest ecosystems to cope with existing pressures and threats.

All National Forest Inventories collect data on damages to forests. Nevertheless, an actual comparison and summary of the available data is difficult, due to different methods and accuracy criteria of the types of surveys conducted. Typically, for instance, trees damaged by extreme events (or dead after a pathogen attack) are quickly removed by forest managers also in order to prevent further pest damages. As a consequence, these damages are not reported..

As a result, data on forest damages from the National Forest Inventories are largely insufficient to give a clear summary state in different Countries.

A further integrative source of data and analysis for forest hazards in Alpine forests can be however represented by specific projects. In particular, some significant data on extreme events and pest damages have been collected and analysed for most of the Alpine region whose assessment was under the scope of this WG in the framework of the EU Project “Management Strategies to adapt Alpine Space forests to climate change – MANFRED”⁶, co-financed of the “Alpine Space Programme 2007-2013”, by also taking into account climate change adaptation scenarios and perspectives.

The MANFRED mainly presents and discusses some ‘case studies’ on trends, risks and management strategies concerning main significant biotic and abiotic stressors for Alpine forest. However, also within the MANFRED Project, lack of homogeneity and comparability of the multiple existing datasets, results are not yet enough to draw a general trans-national picture of the current state and future trends of main hazard factors to Alpine forests. For this reason, the WG recommends the Contracting Parties to systematically exchange information, data and monitoring methods on these events, which probably will increase in future

3.1 Game browsing

Concerning damages from browsing, data are scarcely collected in most Alpine Countries, in particular, no systematic datasets are in fact available for Italy, France and Slovenia.

Moreover, different methodologies for data collection are applied in the other Alpine Convention’s Countries, hence the collected information is not comparable.

Arguably, the heterogeneity of these approaches and the interest for these data well reflect either the different perceptions and dimensions of the item across the Countries.

In fact, in the northern Alpine regions, the pressure of browsing on forest regeneration constitutes a relevant problem. Winter-feeding that allows higher populations of game can make the situation worse. On the other hand, forests located in the Southern slope of the Alps have a lower forest cover, are younger and often enjoy better regeneration conditions.

As a consequence, in the northern part there are more damages to forest regeneration capacity, which is mainly a problem in old and protective stands, threatening the future existence of the forests. In this case, very costly regeneration projects are needed to maintain cover and the vital protection function performed by mountain forests.

The clear difference between the two sides of the Alps is dwindling: browsing damages to forest regeneration are increasingly found also in the southern Alps, particularly in the proximity of protected areas (where hunting is usually not permitted), especially when free migration of wild population is made difficult by man-made barriers. In this situation sharing of information and experience, also on measures to reduce the pressure of intensive game browsing and to regenerate old stands, will be a sizable task for all Alpine countries in the future.

⁶ All results from the MANFRED Project are available on the project website: <http://www.manfredproject.eu/download.php>.

3.2 Forest fires

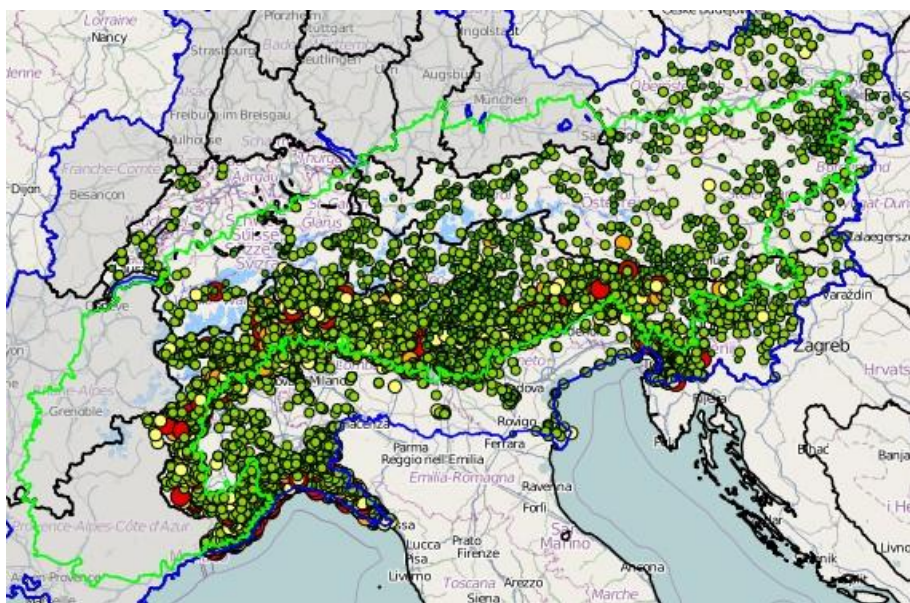


Figure 11. forest fires in the Alps, 1990-2000 (MANFRED Project, 2012)

Forest fires still represent one of the main threats impacting Alpine forests of the southern slope of the Alps.

Recent studies dedicated to forests fires statistics in a long-term management perspective have been conducted at the Alpine scale in the framework of the “Alpine Space Programme 2007-2013” projects, namely the already mentioned “Management Strategies to adapt Alpine Space forests to climate change – MANFRED” and the project “Alpine Forest Fires Warning System - ALPFFIRS”, aimed to control and reduce the role of the forest fires as natural hazard for the Alpine environment considerably through prevention and mitigation actions.⁷

However, it is worth noticing that data for the statistical period 2000-2009 (with a total of 26.017 forest fires in the Alpine arc) show a general decrease both in the overall frequency of forest fires and in the mean extension of burnt area per single fire occurrence.

Forest fires (as well as extreme events) can generally occur all over the year. It is relevant that 75% of the fires started among one of the 3/4 categories of most thermophilus kinds, i.e. those which are likely to expand as a consequence of climate change.

During the observation timespan, there were no significant changes in fire ignition patterns. At the Alpine level, in fact, the same four vegetation units are associated with a number of fires that is higher than average.

Over the next future, on-going climate change trends could play a relevant role in influencing both the frequency, geographical patterns and regimes of fires in the Alpine

⁷ In particular, the ALPFFIRS project aimed to develop a multi-referential service that supports forest fire management, above all in prevention activities and in the mitigation of the impact due to flaming front on the Alpine forests. All outcomes and results of the ALPFFIRS project are available on the project website: <http://www.alpffirs.eu/>.

It is worth highlighting that data on forest fires assessed by the project MANFRED and ALPFFIRS have been mutually shared by the projects' partnerships and the work resulted in a common geo-referenced census and a pan-alpine database and on forest fires run on the MANFRED Web-Gis at <http://servizi.terraria.com/manfred/index.html>. Results from the projects MANFRED and ALPFFIRS have been shared and made available in the framework of the first Workshop organized in the framework of the Working Group on “Mountain Forests of the Alpine Convention”, titled “The future of Alpine forests in light of the potential impacts of climate change: threats and opportunities” (Udine, 17th May 2013).

area, because they could induce the occurrence of big or extreme fires (the threshold was set at 105 ha with 255 events, 1%, in the category).

By investigating the geographical and frequency distribution of “extreme” fires in the Alps, researchers within the MANFRED Project tried to trace trends that can be linked to climate change. Results show that the relative frequency of fires with ignition points at lower altitudes (0 – 500 m and 500 – 1.000 m) is significantly increasing. The number of natural fires (lighting) is also increasing, while the frequency of extreme fires is decreasing [MANFRED, 2012].

Fires are likely to increasingly and represent a threat to Alpine forests, particularly but not only in the southern range. Cooperation, experience and data exchange will be important tasks in fighting forest fires effectively.

3.3 Extreme climatic events

Comparable and reliable data on damages in Alpine forests caused by extreme climatic events such as storm and heavy snow could not be found for the Alpine areas by the assessment carried out by national delegation of the Working Group “Mountain Forests” of the Alpine Convention.

In Central Europe, for example, storm damages have a long history, with secondary spruce stands being particularly prone. Changes in the last decades have brought to higher and denser forest cover, which increased the risk of storm damages.⁸ At the same time, the evolution towards mixed forests and irregular structures contributes to reduce the risk, at least to the extent of enabling the restoration of the forest after one event as easier.

The Atlantic European Regional Office of the European Forest Institute - EFI-ATLANTIC states that storms are responsible for more than 50% of the primary abiotic and biotic damages to European forests and has identified 130 wind storms in the last 60 years, described in the database of the regional office (<http://www.efiatlantic.efi.int/portal/>).

Amongst the Alpine countries, on the basis of the data available at the national level, Switzerland had 27 storms, France and Germany 25, Austria 8, Italy 4 and Slovenia 2. Even considering that the database is still not complete neither homogeneous, a North/South (and a minor West/East) divide is clearly evident, with damages happening predominantly in the North and Western part of the Alps. As a general remarks, it should be remembered that the Alps represent a barrier against the most extreme storms.

Further to the damages directly caused by the storm, a secondary range of damages usually follow up due to the actions of biotic agents (predominantly bark beetles), on the weakened stands. It is not to be overseen, that these damages have an important impact on the wood market in light of the effects on the quality of the wood supply and therefore cause an additional negative externality to be accounted by forest economics. Moreover, some available current estimates suggest that storm damages to European forests results out in an annual reduction of 2% in the carbon sequestration by forests [MANFRED, 2012]. The amount of damages is therefore a complex interaction between meteorological conditions, especially gust wind peak speed, and stand characteristics. Statistics suggests

⁸ See, R. JANDL, *Management strategies to adapt Alpine forests to climate change: results and guidelines from the MANFRED project*, presentation at the Workshop of the Working Group “Mountain Forests” of the Alpine Convention “The future of Alpine forests in light of the potential impacts of climate change: threats and opportunities” (Udine, 17th May 2013).

that spruce and poplar are the most vulnerable species, while silver fir, larch and oak least as well as coniferous species in general appears as more than deciduous. Soil conditions, water logging and freezing are important influencing root anchorage. Recent thinning, particularly in older stands, increases vulnerability while regular/irregular structure has little influence.

The increase of growing stock and age of the European forests over the last 60 years has contributed to the observed increase of the damages. According to the WG, there is some evidence that storm intensity is increasing and that storm tracks are penetrating further into mainland Europe (i.e. towards the Alps). An active integrated management of all risks to forests - abiotic and biotic - has consequently become part of the standard forest practice.

There is no consistent recording and reporting system for wind damage across Europe or for reporting damage from different abiotic and biotic hazards. The information on how to deal with them in the aftermath, entailing integrated considerations on subsidies for collecting wood, special risks in logging, dealing with the unplanned large amount of work and wood and forest regeneration, is significant but dispersed. The European Forest Institute suggests an European response to large scale storms [Gardiner et al., 2013]. Alpine logging companies, having machineries, training and experience to work in difficult conditions (cablecrane logging) can play an important role both in preparation and reaction to the storm.

3.4 Pests

Insects and pathogens usually become aggressive when plants are suffering as a consequence of stress due to climatic conditions, or following population explosions after extreme events caused large amounts of dead trees in the area. The most important pests are bark beetles.

An Alpine monitoring network for pests, diseases and their management providing for an information platform for institutions, experts and forest owners was an expected outcome of the MANFRED project. The resulting database hosts information on all relevant pests, diseases and quarantine pathogens. For eleven relevant pathogens the platform contains extensive data for the years 2007-2011. Austria, Slovenia, Switzerland and the German Landers of Baden-Württemberg and Bavaria use the same types of traps and pheromones to monitor the flight patterns of *Ips typographus* and *Pityogenes chalcographus* and exchange information.

It is feared that most pathogens species will extend their range due to more favourable climatic conditions: some scientists, in fact, predict a northwards movement of these species as : simulations to 2080 show an enlargement of the potentially area affected with a higher probability of occurrence over the Western borders of the Alps. In the Southern Alps, instead, the suitable range of occurrence shifts from the South-West to the North-East.

In addition to the acknowledged problem of pests, invasive species are also to be considered a global problem overpassing the borders of the Alps and this could become very relevant, with the consequence of threatening the Alpine biodiversity with relevant impacts on the important function of conservation supplied by the Alpine forests.

4. Opportunities for and from Alpine forests

Mountain forests are likely to be playing a role in a green economy framework, as proposed by major international and EU bodies. There are specific opportunities to be considered for the further development of the forest sector, in the field of local supply chains and products, renewable resources, wood and biomass energy, CO₂ sequestration and storage, tourism and contribution to a better quality of life. Products and services from sustainable forest management can find larger approval and market success.

4.1 Sustainable forest management

Sustainable forest management⁹, as practised in many Alpine forests, aligns to the paradigm of multi-functionality: forests provide wood-production that is an essential renewable resource for a green economy, and ecosystem services such as protection from natural hazards, biodiversity and wildlife conservation, protection of water supply, landscape and recreation.

In order to keep forests able to deliver their multiple functions, adequate infrastructure, machineries and training of owners, contractors and foresters is needed. Mountain forests have to bear higher costs because of the steep and often difficult terrain, which makes forest management economically difficult. At the same time, mountain forests provide services to local and national communities in large part without any compensation.

For the future, the design of compensation/payment schemes or other market-based instruments (MBI) linked to the services provided could help ensure a long-term provision of these vital services. Communication to stakeholders and the society on the functions of mountain forests is an essential step to create acceptance and awareness.

All Alpine Convention's Countries have private certification systems in place, either the Programme for the Endorsement of Forest Certification schemes (PEFC) or the Forest Stewardship Council (FSC), and some forests have both in parallel. More than 40% of Alpine forests appear to be certified, mostly according to PEFC standards. Liechtenstein and Switzerland use mainly FSC certification (Li 98%, CH 49%). Austria and Germany have the highest share of certified forests (over 60%, predominantly by PEFC).

In the Alpine Countries, as well as in the Alpine Convention perimeter, many companies of the wood sector apply the so called "chain of custody" forest certification system, that gives the final user the assurance that the wood produced comes from sustainably managed forests.

Site surveys, performed at different scale and with different topics in Alpine countries and regions, provide valuable information about soil properties, natural tree species composition, yield class, risks induced by climate change and many other basic information which are needed to manage a forest sustainably.

⁹ According to the H1 Resolution of the Second Ministerial Conference on the Protection of Forests in Europe (16-17 June 1993, Helsinki, Finland), sustainable forest management is defined as "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems". See http://www.foresteurope.org/docs/MC/MC_helsinki_resolutionH1.pdf.

As outlined on the WG's mandate 2013-2014, forests represent a particularly suitable sector to define and test methods for the economic valorisation of the ecological functions of mountain ecosystems, considering their environmental, social and economic multi-functional functionality, that are potential drivers of economic development and can contribute to the promotion of a green economy and the creation of green jobs in the Alps. The theoretical background underlying the economic valorisation of the ecosystems, and of the broadly defined natural capital in general is still in under evolution, with a proliferation of different approaches and implementation perspectives. Concrete policies and experiences oriented to the valorisation of the potential economic values of forest assets are therefore applied at various, not integrated scales, in single projects.

The Working Group has therefore worked on a qualitative level, by collecting some relevant information concerning the main existing approaches, methodologies and policy frameworks at national, EU and international level. Moreover, the Working Group focuses on some specific national case-studies the valorisation of specific forest goods and services, which appear of particular significance for the aims of this report and their potential for the Alpine context.

4.2 Ecosystem services

The Millennium Ecosystem Assessment (www.maweb.org) defines Ecosystem Services as *“the benefits people derive from ecosystems”*.

These benefits include both material goods like food, wood as well and other raw materials, plants, animals, fungi or micro-organisms. Moreover forest perform other ecosystem services playing essential regulation functions, likewise prevention of soil erosion, water purification and pollination of crops. Last but not least, forests also encompass a vast range of socio-cultural values which are relevant for the livelihood of local communities and of other people, including shaping of habits and traditions, recreational functions and the contribution to the quality and enhancement of the landscape.

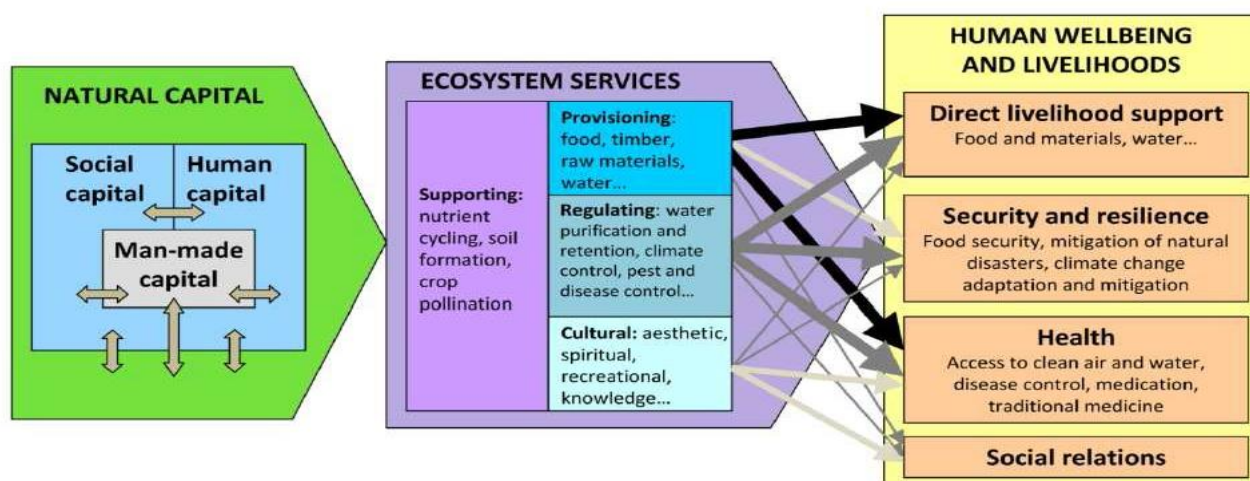


Figure 12. Schematic impacts of ecosystem services on human wellbeing and livelihoods (TEEB, 2013).

In spite of such a wide range of “positive externalities” – usually delivered for free - the importance of ecosystems and their services to human welfare is still underestimated and not fully considered in planning and decision-making.

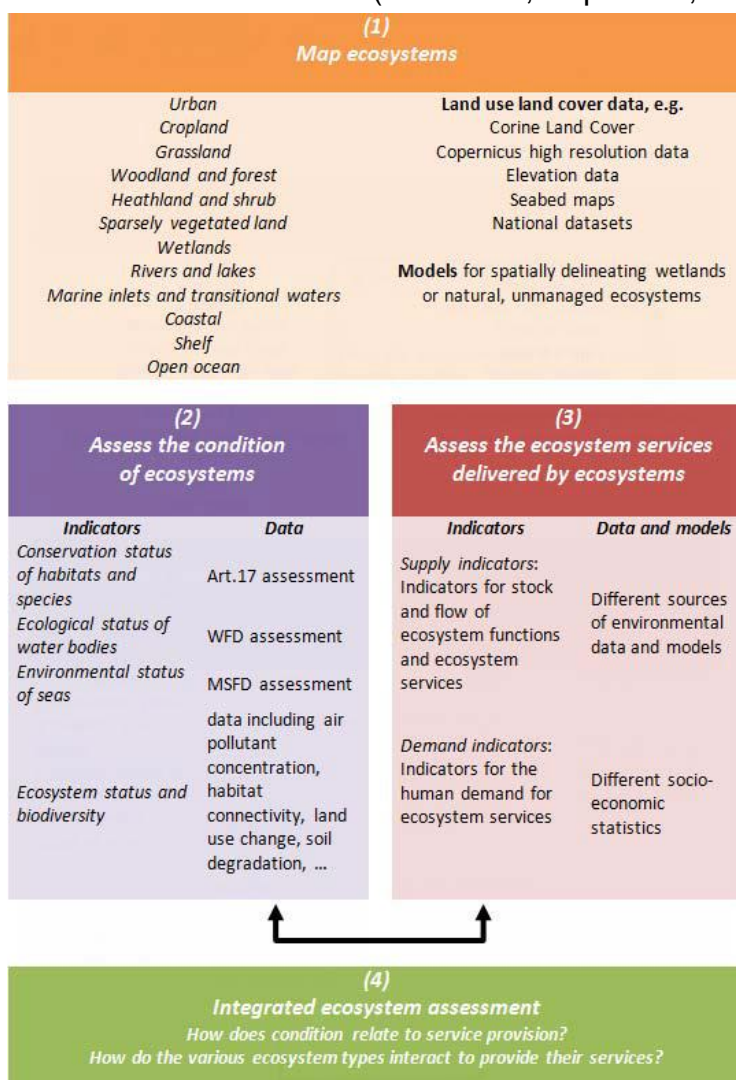
For this reason, notwithstanding the awareness of the benefits deriving from those services, they are hardly traded on markets.

In particular, the costs for sustaining and maintaining these services over time are often

scarcely linked to the *benefits* (to be at least calculated as avoided potential damages) that these services actually provide to human beings. As a consequence, almost no exchange takes place in markets for these services: usually they are regulated by forest conservation and management laws at national and regional level. These are quite different from region to region and, in general, more restrictive in mountain (and Alpine) areas. Therefore a general reference to ‘commitments beyond existing legal requirements’ can be discriminatory, because based on very different restrictions to landuse.

According to the “Common International Classification of Ecosystem Services” (CICES), ecosystem services can be divided into the following categories:

- provision services (goods: wood, non wood)
- regulation services (water, air, element cycles, habitat)
- cultural services (recreation, inspiration, landscape, heritage)



On the international level, “*The Economics of Ecosystems and Biodiversity*” (TEEB)¹⁰ is a global initiative focused on drawing attention to the economic benefits of biodiversity including the growing costs of biodiversity loss and ecosystem degradation. TEEB presents an approach that can help decision-makers to recognize, disclose and evaluate the values of ecosystem services and biodiversity).

The European Commission also started to consider ecosystem services within its strategy for biodiversity with the explicit goal to assess and improve the state of European ecosystems and their services.

The European Commission listed 10 ecosystem types (Urban, Cropland, Grassland, Woodland and Forests, Heathland, Sparsely vegetated land, Inland wetland, Freshwater, Coastal, Marine) to be identified and assessed, and supports projects to propose methods and indicators.¹¹

Figure 13. The procedure for mapping and assessing ecosystems and their services [European Commission, 2013b]

¹⁰ www.teebweb.org.

¹¹ EUROPEAN COMMISSION, Mapping and Assessing Ecosystems and their Services, MAES, Technical Report, 2013.

The objective of the EU strategy is to monitor the state of the ecosystems and the pressures they are subject to, due to human impact in the following categories:

- *habitat change*
- *climate change*
- *land use management*
- *invasive species*
- *nutrient enrichment*

Forests in mountain areas, due to their extension, their protection function and management conditions, that are characterized for being based on close-to-nature management principles, play an important role in the provision of specific ecosystem services to local and downstream communities.

Coherently with this background, the European Forest Strategy [European Commission, 2013b] highlights the importance of ecosystem services, especially emphasize the role of forests in its priorities for the domains number 2) forests and climate change and number 4) forests and environment: *"Protection efforts should aim to maintain, enhance and restore forest ecosystems' resilience and multi-functionality as a core part of the EU's green infrastructure, providing key environmental services as well as raw materials."* [European Commission, 2013].

In order to guarantee the maintenance of forest ecosystem services, the European Forest Strategy establishes a strong link to forest-oriented measures in the Rural Development Programmes (RD), that has to ensure the application of sustainable forest management principles in EU forests.¹²

3.1.1 Provisioning services

As shown at Figure 16 in the following page, wood and timber, both as raw material and energy supply, still represents by far the most important and often only income source

for forest owners. This truth, at present, also holds for the Alps.

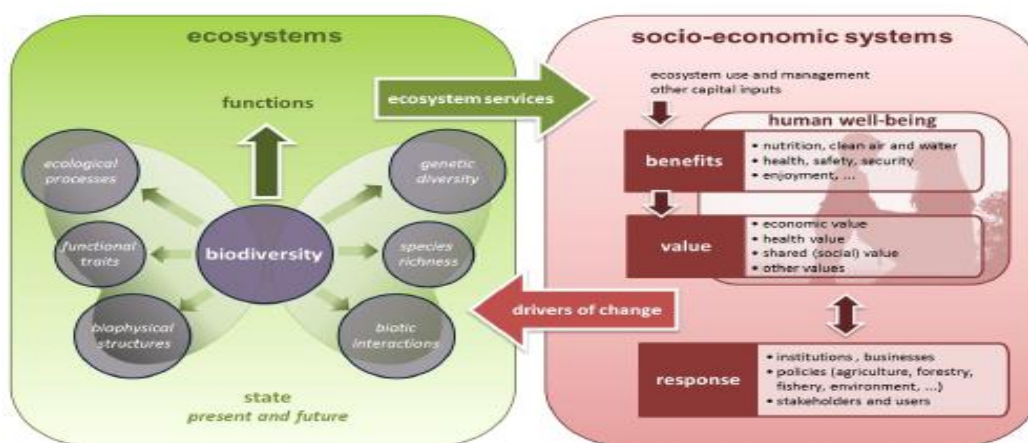


Figure 14. The relation between ecosystem and society [European Commission, 2013].

¹² The European Commission presented these inputs from European Forest Strategy at the Workshop organized by the Working Group "Mountain Forests" of the Alpine Convention "The ecosystem services of Alpine forests: identification, evaluation and potential instruments for their valorization" (Trento, 4th December 2013). See, for more information, T. Szedlak, *Forests, rural development, green infrastructure and ecosystem services*, <http://www.alpconv.org/en/organization/groups/WGForest/WSTRENTO/Documents/Szedlak%20Forests%20RD%20green%20infrastructure%20ES.pdf>.

Further to wood products, forests provide also Non-Wood Forest Products (NWFPs), that are commonly defined as “goods of biological origin other than wood derived from forests, other wooded land and trees outside forests” [FAO, 1999].

At local level, NWFPs also provide raw materials for large scale industrial processing. Some NWFPs are in fact also important export commodities. At present, at least 150 NWFPs are significant in terms of international trade, among which: honey, arabic gum, rattan, bamboo, cork, nuts, mushrooms, resins, essential oils, plant and animal biological components for pharmaceutical products.¹³

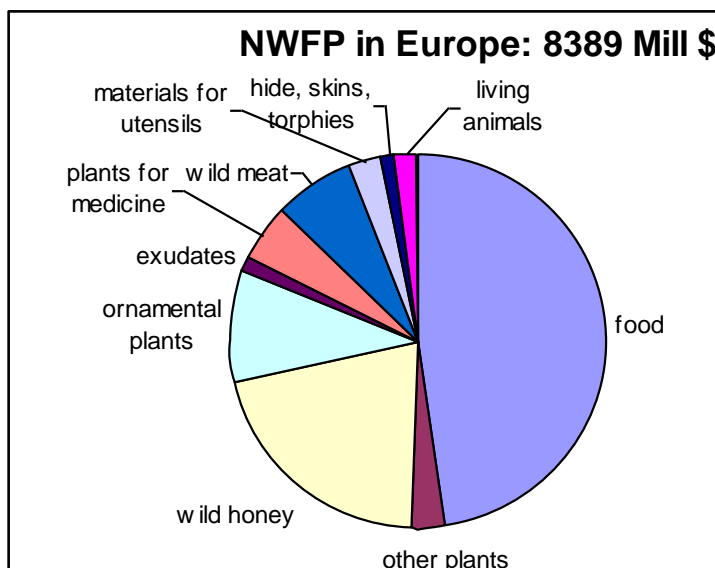


Figure 15. Non Wood Forest Products (NWFPs) in Europe [FAO, 2010]

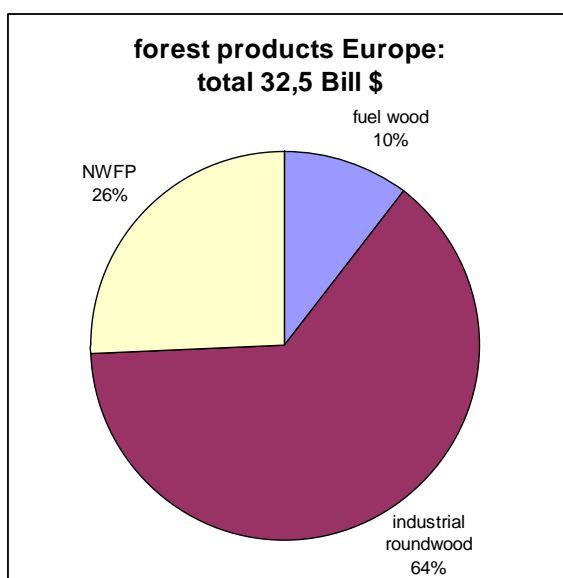


Figure 16. Forest products in Europe [FAO, 2010]

¹³ An analysis on the role of Non Wood Forest Products was presented by F. Brun at the WS “The ecosystem services of Alpine forests: identification, evaluation and potential instruments for their valorization” (Trento, 4th December 2013). See, for more information, F. Brun, *the Economics of Alpine non-wood forest products: the multifunctional role of forests in a green economy*, <http://www.alpconv.org/en/organization/groups/WGForest/WSTRENTO/Documents/Brun%20Presentazione%20NWFP.pdf>.

Real figures on economics of NWFPs and are however scarce and often unreliable. Usually, in fact, Countries only report figures in national statistics if they are included in an industrial production process. Other uses tend to remain unknown. As a consequence, data are quite poor in significant statistical surveys and often rely on rough estimates [Brun, 2013].

In the Figure 15, data from the FAO on the total value of Non Wood Forest Products in Europe are presented. The figure shows that half of the value of NWFPs in Europe derives from the “food” category (mushrooms, truffles, berries, plants, etc.). It is worth to underline that the total estimated value of NWFPs in the EU shows a significant market value, with estimates for Europe of 8.4 billion US Dollars, compared with a total value deriving from wood products amounting to 24.1 billion US Dollars [FAO, 2010] .

However, most of this relevant value comes from informal markets and it is often hard for forest owners to receive direct monetary revenues for these products.

In such a context revenue schemes and market regulatory policies have been developing through tailored practices. Some interesting examples in the field can be pointed out for Alpine Countries, such as the disposal of tolls, fees or other payment schemes for mushroom picking permits and licenses, which constitutes a relevant income for mountain municipalities in Italy, even though in most cases the revenues are usually transferred to public bodies and do not go to forest owners.

Worthwhile to say, a large social interest is developing for the collection and valorization of these products, that can be easily integrated in a regional marketing in various Alpine areas.

Figures suggest there are in fact significant opportunities for growth of the NWFPs sector, which can be supported through integrated tailored policies aimed at favouring transparency of markets (i.e. by means of certification), better integrating local typical products from forest in the overall high quality food and tourism, and involving forest owners in the business.

Ecosystem type	Habitat change	Climate change	Invasive species	Over-exploitation	Pollution and Nutrient Enrichment
Woodland and forest	↘	↑	→	→	↗
Grassland	↗	↑	↗	↗	↑
Heathland and shrub	→	↑	↗	→	↗
Agro-ecosystems (cropland)	↗	↑	↗	↗	↑
Rivers and lakes	→	↑	↗	→	↘
Wetlands	→	↑	↗	→	↘
Marine	↗	↑	↗	↗	↗

Driver's actual trends			
↘	→	↗	↑
Decreasing	Continuing	Increasing	Very rapid increase
Driver's impact on biodiversity (past evolution)			
Low	Moderate	High	Very High

Table 3 shows the impact of the major drivers and their trends impacting biodiversity in Europe in the last decades (ETC-SIA, 2013).

Figure 17. The Drivers' impact and trend on the major ecosystem types is shown: semi-natural types (forests, heathland and grassland are key for the European biodiversity.

4.1.2 Regulation services

According to a useful classification provided by the European Environment Agency [EEA 2013b], forests ecosystems perform a range of different regulation services that can be divided in the following categories:

a) *Natural hazard regulation (protective functions against erosion, flood, debris flows, avalanches, landslides and rock falls):*

Particularly relevant in mountain areas, also Alpine forest ecosystems play a significant role in the prevention of soil erosion, specifically by cutting surface run-off and storing water with a decreasing effect of extreme weather events and natural hazards like floods, storms, avalanches and landslides.

Moreover, Alpine forests also create buffers against rock-falls, thereby contributing to prevention and damage's reduction .

b) *Water cycle regulation (water flows, run-off, groundwater, water filtering and quality)*

Alpine forest ecosystems also have a specific contribution in the maintenance and regulation of the water cycle, by storing and filtering large amounts of water.

Concretely, trees act in fact like sponges and pumps: the forest soil stores water and tree roots bring it back to the atmosphere through transpiration; on the other hand, during dry periods, trees reduce evaporation.

In addition, the soil beneath the forests acts as a massive filter that purifies water.

At the macro-regional scale, the Alpine forests have therefore an important role in providing clean water for the surrounding territories, including highly developed urban and metropolitan areas such as for example Vienna, Munich, Milan, making the Alps the so called "water tower" of Europe [Colonna, 2009; Imhof, 2009].

c) *Atmosphere components regulation (air quality, micro- and macro-climate):*

Trees also play an important role in regulating air quality by removing pollutants (such as, among others, the ozone) from the atmosphere. The CO₂ sequestration function is especially to be recognized as a very important one, due to its capacity of counteracting greenhouse gases emissions and reducing the GHG accumulation rate and in the atmosphere, hence providing a support to climate change mitigation policies.

	<i>division</i>	<i>group</i>	<i>class</i>	<i>indicators</i>
provisioning	<i>nutrition</i>	biomass	wild plants, output	heathlands, other plants, honey production
				wild berries, mushrooms
				distribution (modelling)
			wild animals	harvest, production
				hunting, breeding
		water	surface drinking water	value
				total supply (modelling)
				water conservation forest area
				surface water supply
				river discharge
	<i>materials</i>	biomass	fibres, other materials	reservoir water
				water consumption
				forest stock
				forest increment
				timber, pulp wood, energywood
				resins, tannins
regulation	<i>mediation of waste, toxics</i>	mediation by ecosystems	filtration, sequestration, storage	consumption
				forage
	<i>Mediation of flows</i>	mass flows	mass stabilisation of erosion	for biochemical/pharmaceutical use
				forest area
		liquid flows	attenuation of mass flows	O ₃ , S, N retention/removal
				erosion protection
	<i>Maintenance of physical, chemical, biological conditions</i>	lifecycle, habitat and gene pools protection	pollination and seed dispersal	area designated for risk mitigation
				water protection area
			nursery populations and habitats	special protection area
				pollinators
		pest and disease control		honey production
				tree species distribution
		soil formation and composition	weathering	protected areas
				host species
		water condition	decomposition/fixing	pest and disease
				forest soil condition
		atmospheric composition, climate regulation	chemical condition of freshwater	soil organic matter
				deadwood
cultural services	Physical and intellectual interaction	physical, experiential interactions	experiential use of species, landscapes	water quality
				water quality protection areas
		intellectual interactions	scientific, education, heritage, cultural use	C storage
				C sequestration
	Spiritual, symbolic, other interactions	spiritual, emblematic	symbolic, sacred, religious	forest growth
				albedo maps
		other cultural output	existence and bequest	foliar surface index
				emblematic wildlife species
				important bird areas
				visitors, hunters
				research, educational projects
				publications, historical citations
				emblematic plants, sites with spiritual value
				forest biodiversity and conservation
				priority species/habitat
				designation for cultural value

Table 5. Relevant ecosystem services for Alpine forests [European Commission, 2014]

d) *Habitat supporting services*

Alpine forests are close to nature and extensively managed ecosystems, with methods derived from natural processes and biological automation, i.e. trees selection and regeneration are based on natural dynamics. Forest cultivation is practiced over long intervals, and periods occurring in-between cultivation are generally left with no man-intervention in forests.

All these specific features of Alpine forest make them particularly suitable to offer the following range of those ecosystem services falling under the umbrella of the so-called "habitat supporting" functions, which for the Alpine context can be distinguished in :

- *Habitat for species*: each ecosystem provides different habitats that can be essential for some species' lifecycle (breeding, dispersal etc.)
- *Maintenance of genetic diversity*: the genetic diversity is based on the existence of different breeds or races within the species, as well as on individual differences. Genetic diversity is strongly influenced by cultivation and breeding. Natural and semi-natural ecosystems, based on natural regeneration, are essential gene-pools and provide the basis for locally well-adapted cultivars and for further developing of plants and livestock.
- *Pollination* is another service supplied by semi natural and agricultural ecosystems, which is essential for ensuring the seasonal production of fruits, vegetables and seeds.

Ecological connectivity and interrelation of forest with other Alpine ecosystems is another important service that contributes to nature and biodiversity conservation

4.2.3 Cultural services

the Working Group distinguished between:

- *Opportunities for tourism and sports (tourism, scenic beauty, sports)*

Alpine forests are part of the typical Alpine landscape attracting every year millions of tourists, making the Alps the first tourist destination in Europe [Siegrist, 2001; Dettling, 2005].

The individual demand for outdoor activities in "untouched", pristine nature is steadily rising over the last decades and the outdoor industry segment is facing growing trends.

In this sector, innovation in new disciplines and events that may benefit from the settings offered by the Alpine mountain forests (such as hiking and mountaineering, nordic walking, mountain biking, horse riding, paragliding, canyoning, etc.) can represent an important driver for complementing territorial attractiveness and thus to open opportunities of local economic development and location specialization in the Alps. This holds not just with reference to the diversification of tourist offers as part of the promotion of tourism policies, but also concerns welfare and the overall quality of life of residents in the Alpine locations.

- *Opportunities for leisure-time activities (mushroom and berry harvesting, spending leisure time in forests for relaxing) – recreation and welfare.*

At the same time, Alpine forests perform recreational services as close-to-nature leisure locations which in light of growing demand are increasingly considered in the territorial strategies for the promotion of tourism in the Alps. Alpine forests recreational services,

often combining multiple opportunities linked with their local specificities (i.e., mushroom, wild berries or herbs picking, etc.) can therefore be considered as a specific set of cultural services offered by the various Alpine locations,.

4.3 Tourism and recreation

Alpine forests' cultural services have an increasingly recognized economic and societal value, whose economic potential could represent a significant asset in a green economy.

Some national case studies in the Alps can provide first insights and hints concerning challenges and opportunities linked with issues potentially arising as regards supply, consumption, ownership and regulation of the so-called forest-based cultural services.

Alpine forests are generally open to pedestrian visitors for recreational purposes and they are crossed by forest roads and paths. Consequently, the presence of tourists can exert impacts on forest management.

In order to tackle potential conflicts, Austria introduced the designation of some "special recreation forests" (0,9% of the total national forest area) where the management targets priorities are to maintain and enhance this function, treating other functions as production as secondary goal.

Switzerland also adopted the same forest management approach for a share of 2.4% of the total national forest area, by means of tailored spatial planning instruments to be enforced at the sub-national and municipal levels, or even by promoting direct involvement of forest owners.

As commonly acknowledged, mountainous forests are an essential component of the Alpine landscape and generally accessible for recreational uses, implying cost and standards for the realization and maintenance of the networks of pathways and infrastructures that are required to guarantee for tourists' accessibility and is relevant for the tourist development.

In this regard, the growing importance of new sport activities such as mountain-biking, free-skiing and ski-touring, climbing and other forms of recreation can have a significant impact for the tourism valorisation of forests.

As a general consideration, the balanced management of this newly arising market demand and the traditional functions will be an important task for the forest services' stakeholders in the Alps. Communication, involvement and sharing of the costs will have then to be carefully discussed with stakeholders at multiple levels, in particular with the tourist sector.

In fact, although Alpine forests are usually managed according to multi-functional criteria, demand for and provision of the forest-based different products and services can cause conflicts due to interests and priorities of different actors. In such a context, the WG recommends to foster dialogue between all involved stakeholders to design careful planning policies, taking into account that tailored, context-fit burden sharing mechanisms and special measures (such as accessibility regulation, guidance system, permits and licences) can be used to coordinate and balance demands and rights, including property rights.

Specific contracts to regulate the use of forest roads by cycling-tourists in Austria are a good practice working in this direction: forest owners are paid by the district tourist offices

to allow, regulate and fee the access of bikers in forest roads., indications, maps, parking possibilities are agreed on in the process of designing of itineraries. The measure is oriented to the promotion of responsible recreational use of the forest, and is based on the direct involvement and reward of forest owners .

The development of these kinds of practices may borrows from similar approaches already applied at various Alpine local contexts for other services such as parking and access roads for hiking, mountaineering or other sports.

Alpine forest ecosystem services spill over their benefits over a broader territory.

Thanks to cultural traditions and habits, Alpine populations have developed awareness of the role of forest multi-functionality, and had been consequently paying a constant, specific attention to the preservation of the forest protection function over centuries.

Historically, Alpine communities run in a condition of subsistence, relying primarily on wood and animal breeding as basic resources for their living-hood, developed an "Alpine silviculture", with high standards on protection, conservation and accessibility. In many alpine areas attention to protection functions brought to several forms of collective ownership and rights.

This Alpine approach to silviculture is reflected throughout the Alpine States in a broad range of local and regional regulations which, however sometimes posing demanding burdens on forest owners, are generally accepted by the affected Alpine communities, due to the long tradition and sharing of common values.

Nevertheless, local regulations formalizing such a long-lasting tradition may constitute a constraint for environmental payments to land and forest owners as currently envisaged by the disposal of the European Rural Development Regulation framework, which foresees to compensate only those commitments going beyond existing rules.

In the southern side of the Alps figures (see chapter 2) suggest that the share of forests which is not subject to any form of management is increasing: here there is room for sustainable forest management strategies with infrastructural investments oriented to improve both wood mobilization and to ensure an effective management of the priority functions of forests ecosystems.

4.4 Diversification

BOX 1. Income from services: the case of Austria

Type of activity	Documenting enterprises	Costs related to TP	Earnings related to TP
Hunting	97.5	9.9	6.8
Agriculture	79.1	1.6	2.0
Fishing	76.9	1.5	2.6
Provision of services	47.4	4.1	3.1
Renting of buildings	39.1	6.3	3.9
Renting of landed estate	33.9	0.3	1.1
Water	33.2	0.0	0.2
Gravel and sand	24.4	1.0	2.4
Recreation and tourism	13.8	4.7	3.6
Christmas trees	11.7	1.2	0.9
Forest nursery	6.5	3.4	2.9

Table 6. Income from different services in Austrian forests [Sekot, 2014]

A comparative study by [2014] on the economic performance for forest enterprises larger than 500 hectares in Austria) shows some very interesting data on auxiliary activities, where costs and earnings have been compared to those of timber production [Sekot, 2014]¹⁴. Traditional activities are reported, including hunting, agriculture, fishing; quite important too is the role played by services. At present only estate renting, water, gravel and sand, fishing and agriculture are more profitable than wood production in terms of earnings - costs.

However, data from the public corporation Austrian Federal Forests highlights that there has been a larger growing trends for activities in the non-wood forest-based sectors (25% of the total turnover), whose main drivers can particularly be found in the real estate market (tourism-, quarrying, water-related revenues amounts to a16,2% of the turnover) and in the service sector (consulting and forest services, 8,0%).

According to this study, lack of economies of scale to days can constitute a problem for the enhancement of non-wood forest-related activities, where for smaller properties cooperation constitutes an opportunity that might also play an important twinning role in wood marketing as a response to the strong concentration of the wood demand.

Diversification can be an opportunity for forest management: multi-functionality and ecosystem services, that are gradually becoming taken under growing consideration in

¹⁴ W. Sekot, Challenges for Sustainable Forest Management in an Alpine country - the case of Austria, presentation at the Workshop of the Working Group "Mountain Forests" of the Alpine Convention "A green infrastructure for growth: the potential role of the Alpine forests in a European Green Economy" (Galbiate, Italy, 7th March 2014), http://www.alpconv.org/en/organization/groups/WGForest/wslecco/Documents/SEKOT_WS_7%20March_Galbiate.pdf

recent international and national forest policies, can in fact also disclose economic viability. The long-term policy objective for Alpine forests is thus the (uneasy) task of transforming the growing interest for forest ecosystem services in actual monetary revenue for forest managers, either public or private.

Levying taxes, charges and subsidies can be used as compensation or incentive measures, notwithstanding their limits related to societal.

Other measures (voluntary-based mechanisms), have the advantage to be more socially acceptable, but face the challenge of effectiveness, since this implies shifting people's behaviour, within the framework of existing rules, from a generally favourable disposition to pay (the so-called "willingness to pay" concept used in economics) to the concrete action of paying for services that have been so far actually free of charge. Some examples quoted in this document are worth of attention: contracts for the use of forest roads by mountain bikers; consortia for issuing permits for mushroom collection; use of forest roads and parking as access for recreation and agritourism; cooperation for wood marketing, service acquisitions and offer.

5. Sustainable forestry in an Alpine green economy

Green economy can be defined as an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive [UNEP, 2012]. At the 2012 Rio+20 Conference, green economy was recognized as a tool for achieving social, economic and environmental sustainable development.¹⁵

In the "Europe 2020" strategy for growth endorsed by the Member States within the Lisbon Agenda (2009)¹⁶, the European Union has pledged to be a forerunner in a global economy scenario which would be moving towards a "green economy" framework.

As recalled by the XII Alpine Conference, the territories under the scope of the Alpine Convention have a potential to become a laboratory to promote an "ad hoc" regional approach to green economy in the Alpine Region, as stated in the multi-Annual Programme 2011-2016 of the Alpine Convention and in the "Action Plan on Climate Change in the Alps (X Alpine Conference, Alpbach, 2009).

<i>green economy</i>	<i>Specific for forest sector</i>
low carbon	Climate mitigation
resource efficiency	Sustainable goods and services
social inclusiveness	Education and decent jobs

Table 7. Characteristics of a green economy, with specific features for the forest sector.

¹⁵ UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT, *RIO+20 The Future We Want*, Rio de Janeiro, June 2012, <http://www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf>

¹⁶ See also, fur further information: http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/priorities/sustainable-growth/index_en.htm

In this framework the Alpine forest sector appears to offer a significant potential to actively and strongly contributing towards the promotion of the objectives of a regional green economy.

Forests, in fact, cover 47% of the Alpine area and are mostly managed according to the principles of multi-functionality, as it is typically true for the Alpine forestry, and according to sustainability criteria. In an historical perspective the very idea of sustainable management is at the base of modern forestry and was actually born in the XVIII century but roots back to previous traditional practices of local communities.

In the opinion of the Working Group, the Alpine forest sector possesses a set of structural fundamentals which offer a potential to contribute to the development of a green economy in the region. Sustainable wood production, that is considered as a key resource in “green economy” models due to its characteristics of being renewable, low-energy intensive and no-waste producing, can represent a significant driver for the development of a green economy based on innovative low-carbon consumption paths for the regional economy. Opportunities may also be linked with the provision of raw materials for renewable energy production by means of firewood and biomass as well as on the consolidation and specialization of sustainable functional forest management practices to guarantee for an efficient performance and supply ecosystem services to the local and regional communities.

The Alpine forest sector can contribute to a stronger regional labour market, with creation of green, decent jobs, supplying a green, future oriented sector (forest industries), with sustainable wood and energy.

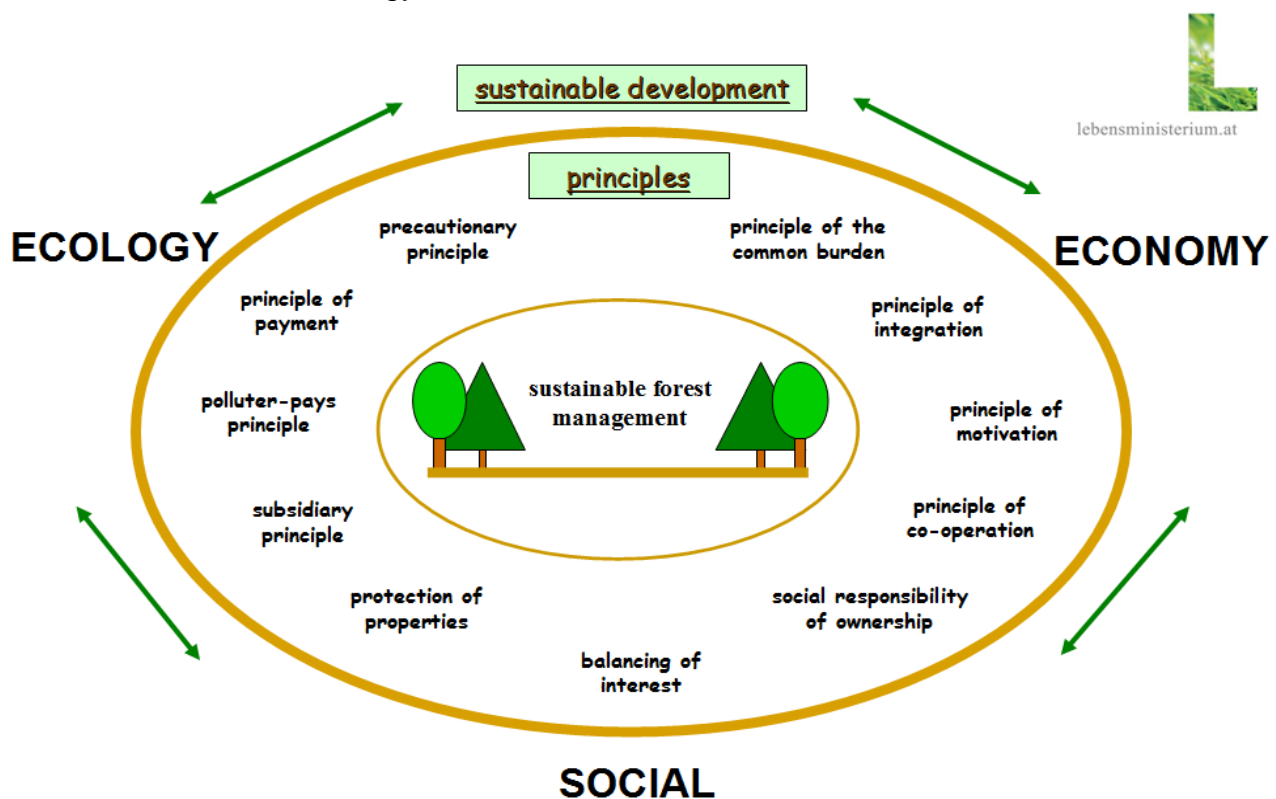


Figure 18. Sustainable development and sustainable forest management principles (Schima, 2014)

Recent developments in the international forest policies are establishing principles that can act as reference frameworks in this direction. In first stance at the EU level, the new European Forest Strategy [European Commission 2013c]¹⁷, released on September 2013, stresses the following topics as central for EU forests: sustainable management, multi-functionality, forest protection, sustainable provision of goods and services, with a particular attention to wood, as the core-issues. Moreover, communication and cooperation are regarded as key factors in order to effectively carry out the strategy. It is worth mentioning that the document of the European Commission also underlines the role of forests in supporting rural communities and indicates the Rural Developments Regulation as the financial instrument at EU level to be used for the implementation of the strategy.

At the international level the process launched by the United Nations Economic Commission for Europe (UNECE) and the FAO towards the adoption on December 2013 of the “*Rovaniemi Action Plan for the Forest Sector in a Green Economy*”¹⁸, a voluntary-based international instrument for promoting cooperation in policy-making to address the potential contribution of the forest sector in a green economy in the UNECE region.

To this aim, the Action Plan identifies an overall vision, strategies and a number of areas of activity, proposing specific actions for each of these areas of activity and identifying potential actors who might contribute to achieving the following stated objectives:

- a) sustainable production and consumption of forest products: certification and labelling, procurement practices, wood mobilisation, innovation, trade, green building;
- b) forest and wood for a low carbon sector: substitution of non-renewable materials and fuels, reducing waste, adapting forests to climate change, carbon sequestration and storage;
- c) providing decent jobs: safety and health, innovation in the forest operations, creating jobs in the supply chain;
- d) enhancing long term provision of ecosystem services: identification and valuation of services, recognition of public goods, experimenting payments, relation between forest and human health;
- d) policy development and monitoring: checking effectiveness of policies, implementation of criteria and indicators of sustainable forest management, including its assessment on regional level, ensuring adequate information and communication.

5.1 Alpine forests: management and market position

Mountain forests, in general are less productive and more expensive to manage compared to the ones located on flatland and hills. Therefore, as it is usually the case with low productive forest lands, management is more extensive.

¹⁷EUROPEAN COMMISSION, A new EU Forest Strategy: for forests and the forest-based sector, (COM(2013) 659 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0659>).

¹⁸ See, for more information, <http://www.unece.org/forests/greeneconomy.html>.

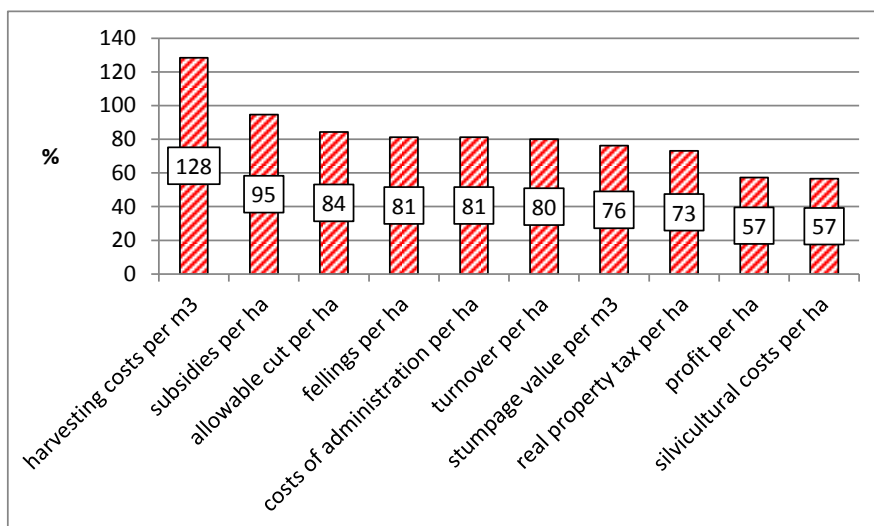


Figure 19. Management costs in Austrian forests [Sekot, 2014]

In a recent study [Sekot, 2014] costs and income for alpine and non-alpine Austrian forests¹⁹ have been compared [Sekot, 2014]. As expected in the Alpine area costs are higher (+28%); fellings and income are lower (-20%); and forest management is more extensive (silvicultural costs are -43%). Somewhat surprisingly, instead, subsidies are slightly lower (-5%). The economic result is significantly lower for mountain forests (stumpage value per m³ -24%, profit per ha - 43%). In light of these figures, the study shows that the dimension of the property influences the intensity of the applied management: over the same period (2000-2009) enterprises smaller than 200 ha cut 30% less than those larger than 200 ha.

Owners have started cooperative initiatives for wood marketing: 13% of the wood in the period 2006-12) has been sold by cooperatives.

An important factor in the forest management is therefore the change in the ownership structure. Nowadays, traditional owners, linked to agricultural activities and actively involved in the direct management of the forests, represent only 40% of the total, while “new” owners, often with jobs in other sectors and generally possessing little experience and knowledge about forestry as well as no direct economic interests, make up to 1/3 of the total [Hogl et al. 2003]. This novel identity for forest owners deeply affects and changes the general conditions for forest management and consequently the typology of incentives needed, the relative importance of owners’ labour and the relationship with forests’ property, the need for cooperation in the sector and the overall supply structure of forest services.

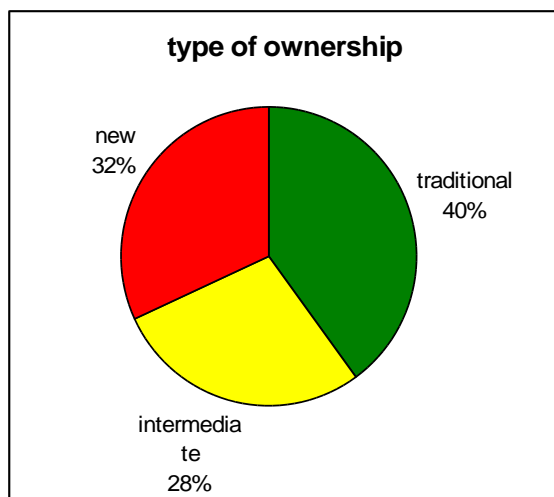


Figure 20. Changing ownership in Austrian forests [Sekot, 2014]

¹⁹ W. Sekot, Challenges for Sustainable Forest Management in an Alpine country - the case of Austria, presentation at the Workshop of the Working Group “Mountain Forests” of the Alpine Convention “A green infrastructure for growth: the potential role of the Alpine forests in a European Green Economy” (Galbiate, Italy, 7th March 2014), http://www.alpconv.org/en/organization/groups/WGForest/wslecco/Documents/SEKOT_WS_7%20March_Galbiate.pdf. Data refer to Austrian forest enterprises larger than 500 hectares over the period 2003-2012).

At the end it must be noted that, despite the growing attention to the importance of multifunctional management of mountain forests, wood still remains, by far the most important source of income in the forest sector.

5.2 Wood and energy market for Alpine forests

Often only managed forests can ensure an effective performance and delivery of their multiple functions to optimality, including the protection against natural hazards and other ecosystem services, as well as obviously raw materials. Earning a sufficient income is thus crucial for implementing a sustainable forestry also in a green economy framework.

Figure 21 [Sekot, 2014] shows that in Austria non-wood income averages some 13% of the total income from forest management, and this share is not showing significant changes over the last 25 years.

The performances of economic revenues from forest management therefore appear to be still largely dependent, in a similar context, on the output connected with wood (and firewood) market: the final income depends on the sales of wood products, which have increased in Austria over the last 20 years, and on the level of prices, which instead reduced as a result of deflating value dynamics.

In such a situation, forest management economic performances are faced with steady income dynamics that was coupled by decreasing trends in the value of forest properties. On the other hand, it is important to consider that the productivity of forest work has actually shown a significant growth over the last 50 years. Harvesting costs have been reduced, also as a result of increasing use of forest contractors and high process mechanisation.

However, in the medium run, productivity gains, have not been sufficient so far to fully offset the effects of the reducing trends of wood prices, which is the consequence why the real net income result from forest management appears as facing lowering profitability trends.

The decreasing profitability of forest management over the last decades has arguably contributed, together with other factors, to bring about to a significant reduction in the forest workforce which was linked to a process of extensive organization of the forest activities aimed at maintaining profitability.

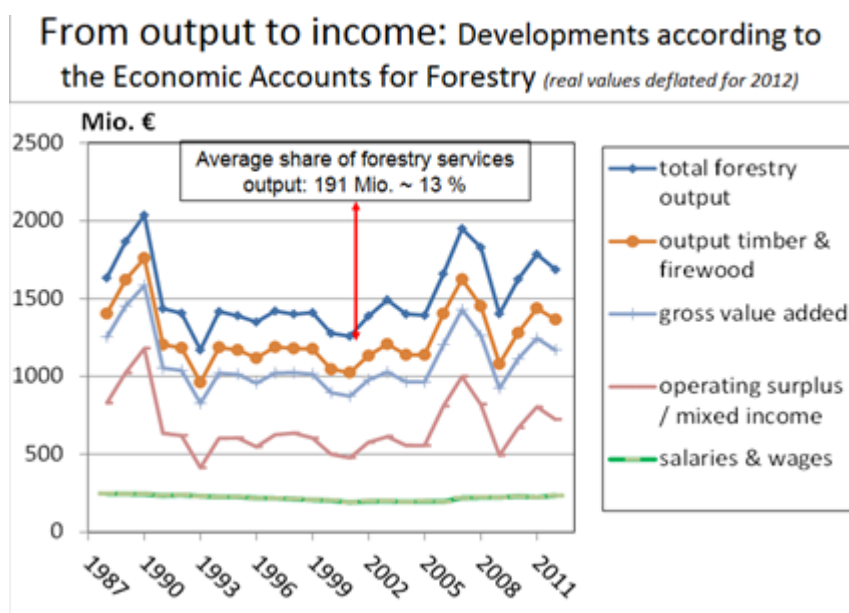


Figure 21. Costs and income in Austrian forestry (Sekot, 2014)

In this situation, even if the introduction and wider use of new products cannot change the dependency of income from forestry from wood, it is worth trying strategies for the creation new products and services, and there are examples at the local scale (e.g. revenues from the permits for mushrooms-picking in Italy) where the overall share of income generated from non-wood forest products (NWFP) is higher than that from wood.

As assessed by the experts of the national delegations of the WG, several successful measures have been undertaken over times in the Alpine Countries to reduce costs and improve profitability of the forest sector in specific contexts, such as increasing fellings, rationalising procedures, reducing the intensiveness of management, avoiding to impact sustainability of major assets for forestry. It is essential that society understands that forests need a certain level of management to maintain forest ecosystem services, with, on the other hand, the need to enable forest owners and managers to avoid negative impacts on them.

Finally, it is worthwhile to briefly describe some figures that could have been made available in the assessment carried out by the WG under the mandate 2013-2014 concerning the current situation of the energy market related to wood. In fact, over the last 10 years, and notwithstanding the production of firewood remained steady, the production of wood biomass has grown substantially, with wood chips and pellets that almost tripled its production their output and currently make up to 2/3 of the total wood energy market in the Alpine region. The share of the total income deriving from the energy market for Alpine wood that directly revenue forest owners is not very high, but the contribution to the promotion of a local green economy can be important, and could mainly take place in the forms of district heating, co-generation, dissemination of local *know-how* and green jobs creation, climate change awareness and action.

On the other hand, it is important to highlight the removal of biomass can also have negative effects on the nutrient pool on poor stands and on biodiversity. A balanced management is therefore necessary to guarantee sustainability paths.

5.3 Communication and Cooperation

One important conclusion of the Working Group is that the forest sector shall involve stakeholders and the civil society to discuss and communicate the role that sustainable and multifunctional forest management can have for a green economy. . The goal is to raise awareness, discuss conflicts of interests and create partnerships.

Messages should be focusing on some key-factors for the future of forestry in Europe, according to the EU forest strategy (priority area 7), that include the recognition of some of the distinctive characteristics of Alpine forests and forestry presented above, in particular:

1. a reduced wood-based forest value, with small potential for introducing further rationalisation measures
2. the potential role of ecosystem services, and in some case of non-wood forest products (NWFP), as well as the connected difficulties to shift from public interests and demands to income generation for forest owners
3. the ongoing changes in the relationship between society and forests, the understanding of forest value by the civil society and the citizens, and the change happening in the social structure of forest owners.

A good practice in communication and stakeholders cooperation on the role of the forest sector is represented by the “Austrian Forest Dialogue” started in 2003 (www.walddialog.at). The “Austrian Forest Dialogue” aims at ensuring the active participation of all relevant groups, an inter-sectoral and interdisciplinary approach, a long-term and iterative process, and the application of the principles of openness and transparency. So far, the process has involved political parties, environmental NGO’s, governmental bodies, church, youth, science, forestry and forest industry and other relevant interest groups (business, labour, social welfare, communities).

The process main objectives are :

- highlighting the importance of forests and forestry for society;
- identifying needs and wishes of interest groups;
- developing strategies for long-term economic, environmental and societal sustainability;
- coordinating with other sectors.

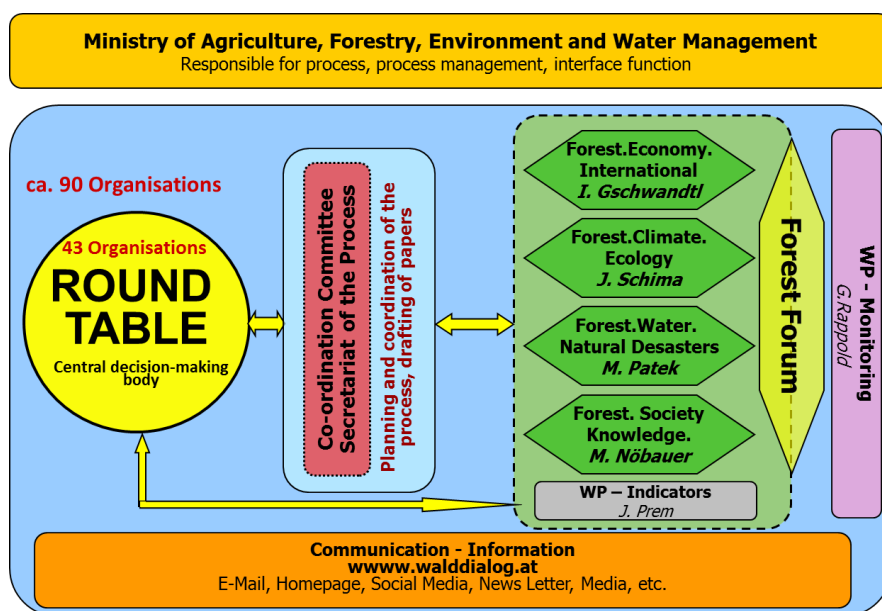


Figure 22. Structure of the forest dialogue in Austria.

6. Future challenges

6.1 Climate change

It is a challenging task to project how the climate may look like over the next 50-100 years, that represents a time period relevant to forest management planning cycles. For this reason, planning has to be based on the projected trends and uncertainty must be considered.

For forest management and decision-making, no exact forecast is possible. Rather, forestry must base its planning on the projected trends including their uncertainty. An assessment of possible future climate scenarios which may provide inputs relevant to develop forest management strategies for the Alpine area was undertaken in the framework of the MANFRED project [MANFRED, 2012].²⁰

In light of the MAFRED Project's results, the following considerations regarding temperature and precipitation, as key factors for designing long-term forest management strategies, can be formulated deriving from the combination of these scenarios:

1. *Temperature*: a general warming trend in the range of 1.8 to 3.8 °C, with least warming in the winter half. The Alps generally face higher warming trends than the surrounding mainland. The warming is more pronounced in the Western and over the Southern Alps.
2. *Precipitation*: the annual trend is not very strong, however the seasonal differences are large. The summer semester of the year is projected to experience significantly less precipitation, with some regions in the Central Alps experiencing only 70% of current summer rainfall rate. The winter semester the year is projected to be wetter for most regions, especially the South-western Alps.

²⁰ For the MANFRED project, five different regional climate models (RCMs) driven by four different global climate models (GCMs) have been used, resulting in six GCM/RCM combinations in order to study the impact of likely climate changes on forest species and ecosystems.

As a result, the models predict a “Mediterranization” of the climate in the Alps,

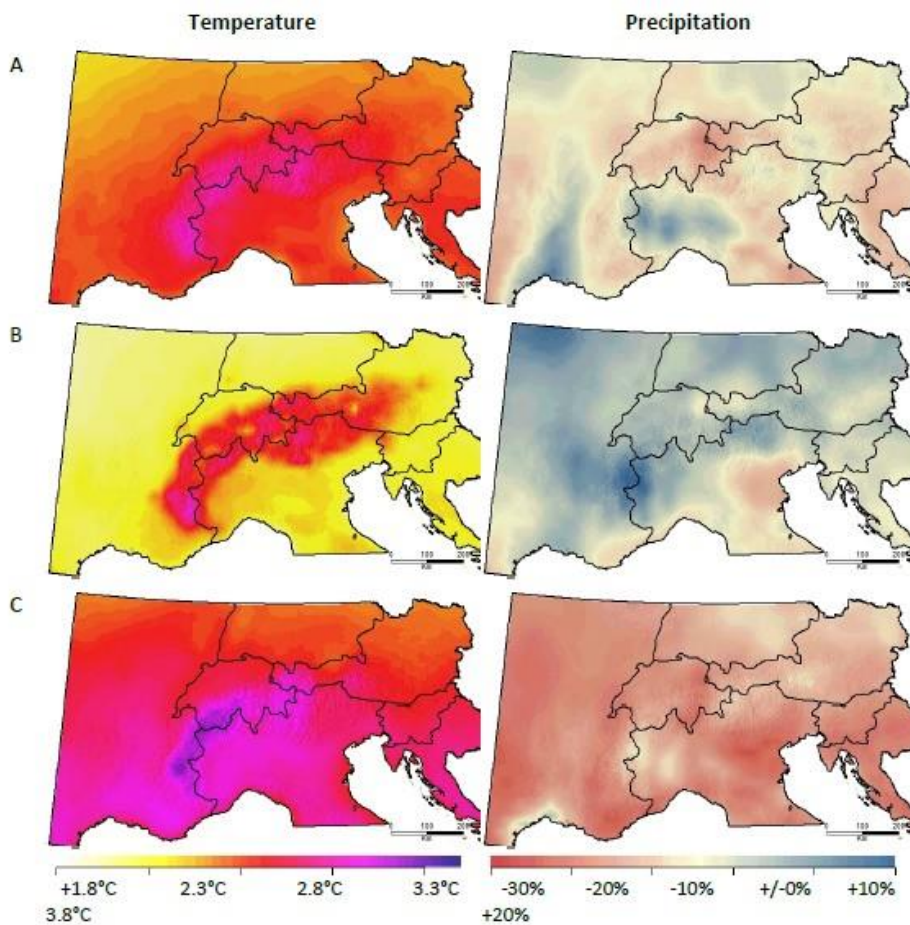


Figure 23. Climate anomalies scenarios elaborated by the MANFRED Project (2012): A) annual; B) winter months (October - March); C) summer months (April - September)

by projecting significantly lower levels of summer precipitation than today and increased spring (especially on March and April) and autumn (especially on November) rainfalls. For forest management, this scenario implies taking into account warmer and drier summers, which will have significant effects on some tree species, notably those with lower drought tolerance. This trend is projected as particularly strong throughout the Southern Alps. Furthermore, the models also consider extreme events which are relevant for forestry, where, in particular, torrent activity and droughts represent

decisive factors.

Climate change impacts on forest biodiversity and ecosystems can therefore be expected as particularly relevant, as trees take many decades to reach maturity and fecundity. In a nutshell, Alpine forests results to be highly vulnerable to rapid changes in climatic conditions.

The MANFRED project studied the possible future distribution of forest species as a consequence of climate change applying distribution models for 50 tree species with projections until the year 2080 divided by three different time-steps, specifically 2020, 2050, and 2080.

According to these projections, for spruce and beech, that are the main tree species present in the Alpine forests, the climatic risk will rise in the future in larger areas at lower altitudes, while an expansion is expected at higher altitudes, particularly for spruce.

Species from the (Sub-) Mediterranean regions such as the *Quercus ilex*, the *Ostrya carpinifolia* and the *Quercus pubescens* are expected to expand their ranges northwards, though these species will not reach the areas formerly suitable for beech by the end of the 21st century.

Several pine species are expected to extend their ranges quite considerably, but they could face indirect threats through insects and other pests. It has to be stressed, however, that the models are not currently capable of projecting the effective fate of the different tree populations, that may survive for quite a while at locations considered unsuitable. Pine species will eventually face physiological stress from a climate that they cannot tolerate, and stronger competition from other more suitable species and/or threats from other kinds of antagonists such as pests, that may reversely profit from a changing climate consequently spreading to trees weakened by changed conditions.

Other studies [MANFRED, 2012] show that drought plays a negative impact on ecosystem productivity and increases mortality. In this regard, species adapted to cold and wet conditions with low reproductive rates and limited mobility seem to be the most affected. The drought occurred in 2003 was, especially in Germany and France, the strongest drought over the last 50 years. The analysis showed that some time lag effect occurs, i.e. for beech the reduction in growth was stronger in 2004.

Experts assume that a change in the frequency of hot and dry years could affect tree species composition and diversity more than one single event.

In conclusion, there is general consensus within the scientific community that climate changes will impact forest vegetation in three major ways:

1. An upward altitudinal and elevation shift of the forest timberline and a shift in the distribution of tree species, that can be already observed within Europe;
2. An increase in forest growth (already observed within Europe);
3. An increase in the development and impacts of pests and diseases.

All stakeholders involved in the Alpine forestry should therefore consider that:

- climate change is happening and in the Alpine area it is more intense than on average;
- uncertainty in forestry planning and management plays a major role when dealing with trees living for 1-2 centuries or even more;
- it is necessary to focus on adaptation measures: climate change mitigation does not work on regional scale because the problem is global and does not stop at borders. Mitigation measures are still necessary to reduce climate change, but adaptation measures must be introduced as a priority;
- in designing forest adaptation strategies, social changes have to be considered as regards, among others, the following phenomena: a pressure to reduce forest management costs; a high and increasing demand for wood for utilization as raw materials, for energy and for bio-based industries; a new balance between protection and wood mobilisation; measures to increase stability and resilience; a growing attention to ecosystem services; migration to urban agglomerates and demographic transition;
- highly productive spruce mountain forests will be more affected than less productive forests located at higher elevation.

7. Recommendations

On the basis of the results achieved over 2013-2014 in the context of its first mandate, the Working Group “Mountain Forest” of the Alpine Convention can formulate the following recommendations to the Contracting Parties of the Alpine Convention for promoting further coordinated action toward an effective implementation of the objectives and aims endorsed within the Protocol “Mountain Forests” of the Alpine Convention:

- Initiate a joint project to scrutinize and compare data from national forest inventories, using data and information already existing in Alpine Forests and present in all national data set. . The initiative would allow better and deeper comparisons, enhancing information exchange, cooperation and monitoring.
- Improve reliable monitoring of biotic damages to forests. At the moment the available information is incomplete: it would be useful that Member states agree to systematically exchange information and data on these events, which probably will increase in future.
- Share information and mapping of areas exposed to increased risk. Management models for the exposed areas can help to reduce the impact of larger storms in the future; basic infrastructure, knowledge and cooperation will help to improve the response.
- Encourage research to identify whether and where, which kind of additional measures are useful to maintain or restore biodiversity, particularly in areas of existing old stands, old trees and dead wood and areas with a longer period of natural undisturbed evolution or microhabitats of high value;
- Exchange information and data on forest threats, management and marketing of forest products in order to help owners and policy makers to develop strategies and approaches, helping to strengthen the forest sector;
- Analyse the direct and indirect protective function of Alpine forests towards settlements, infrastructures and other goods, methods to define and manage forests to maintain and improve the protection function, promote best practices and experience exchange;
- Within the framework of EU forest research encourage efforts to quantify and valorise ecosystem services offered by alpine forests to the whole society and on how to transform the benefits to society into income for the owners through financial tools and mechanisms . Good policies, strategies practices must be analysed, communicated and replicated.
- Communicate with relevant stakeholders, create awareness of the ecosystem services and protection granted by Alpine forest (mostly for free), improve public knowledge on the contribution provided by Alpine forestry to the Alpine economy (wood, energy, other products, ecosystem services, jobs) and involve all relevant stakeholders and forest owners in the discussion on ecosponsoring, nature protection, ecosystem services and payment/compensation.

- Raise awareness of forest owners and managers, producers and traders of forest products, concerning the threats to forests by giving priority to the following measures (not exclusive list):
 - improve resilience of forests, promote the development of forest types adapted to the site and integrate risk management in forest management objectives and practice;
 - encourage mixed forests and natural regeneration to provide for large genetic pools that are essential in uncertain conditions;
 - improve game regulation in order to ensure natural regeneration of native species and to avoid high costs on protection from game browsing;
 - consider and integrate ecosystem services in all forest-related strategies and in their implementation: be careful to reduce the potential impact of forest measures on ecosystem services (land and water protection, landscape, recreation).

- Recognize that Alpine forests provide many ecosystem services to local and European societies and communities, with little or no reward; at the same time, steep terrain and high elevation cause higher costs for harvesting Alpine wood. People, inside and outside the Alps, should recognize the importance and quality of Alpine forests: it is worth verifying the possibility to create products that may increase the value of Alpine wood. The extent of forest certification schemes creates the technical possibility to guarantee the Alpine/local origin of the wood.

- Make use of the wood potential: in the Southern and Western Alps there are significant possibilities to produce more wood within a sustainable management framework, preserving the multifunctionality of the forests and under cautious criteria: for this objective adequate investments in infrastructure (accessibility), equipment and training of companies, workers and owners and equipment are needed.

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