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State of Mediterranean Forests 2018

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Foreword

The State of Mediterranean Forests 2018 analyzes the circum-Mediterranean region, a territory encompassing thirty-one countries and a wide range of political, economic, social and environmental contexts. The region has an extremely rich natural and cultural heritage. Here, human and economic development is largely dependent on at times scarce natural resources and a vulnerable environment. Today, human activity has placed substantial pressure on this environment, the impact of which is felt differently in the northern, southern and eastern sub-regions.

Based on a bioclimatic definition of Mediterranean forests, the Mediterranean region includes more than 25 million hectares of forests and about 50 million hectares of other wooded lands. These lands are strongly interconnected with urban and agricultural/rural areas. Mediterranean forests and other wooded lands in the region make vital contributions to rural development, poverty alleviation and food security, as well as to the agriculture, water, tourism, and energy sectors. Such contributions are, however, difficult to quantify. Moreover, changes in climate, societies and lifestyles in the Mediterranean could have serious negative consequences for forests, resulting in the potential loss or diminution of those contributions and to a wide range of economic, social and environmental problems.

In April 2010, at a meeting held in Antalya, Turkey, members of the Committee on Mediterranean Forestry Questions-*Silva Mediterranea* sought to address the lack of data on Mediterranean forests and provide a sound basis for their future management. They asked the Food and Agriculture Organization of the United Nations (FAO), in collaboration with other institutions, to prepare a report on the state of Mediterranean forests. The first edition of the State of Mediterranean Forests, coordinated by Plan Bleu and FAO and including contributions from 21 institutions, was published in 2013 and launched during the Third Mediterranean Forest Week in Tlemcen, Algeria (March 2013). The State of Mediterranean Forests 2013 successfully documented the main questions on Mediterranean forestry and has since become a reference textbook on Mediterranean forests. Its key findings formed the basis for the subsequent Strategic Framework on Mediterranean Forests endorsed by the high-level segment of the Third Mediterranean Forest Week (the Tlemcen Declaration).

In order to establish a regional overview, the 2013 edition of the State of Mediterranean Forests relied on systematic data covering all countries in the Mediterranean region. The second edition, while maintaining a regional interest, adopts a more focused geographic and thematic approach.

The State of Mediterranean Forests 2018 is the result of a collaborative process involving many different stakeholders from the Mediterranean region. In total, more than 160 individuals have contributed to this volume on a voluntary basis, whether as chapter coordinators, authors or reviewers. Of these, 41 percent are women. Sixty-one percent of the edition's contributors originate from the northwest Mediterranean, while 39 percent are from the southeast.

This new edition of the State of Mediterranean Forests aims to demonstrate the importance of Mediterranean forests to implementing solutions to tackle global issues such as climate change and population increase. The report is divided into five parts. After an introduction, the second part highlights the importance of Mediterranean forests and trees, examined with regard to various factors (area, biomass, roles in the landscape, etc.), with special attention paid to trees outside forests, which are particularly important in the Mediterranean context. Despite the important natural capital provided by Mediterranean forests, they are under jeopardy from climate change and population increase and other subsidiary drivers of forest degradation. The third part of the report outlines a number of forest-based solutions to tackle these threats. The goods and services provided by Mediterranean forests, for example, are a valuable asset on which to base sustainable development efforts. Forest and landscape restoration, adaptation of forests and adaptation using forests, climate change mitigation, and conserving biodiversity are complementary approaches that can be successfully implemented in the Mediterranean region to address the drivers of forest degradation to the benefit of populations and the environment. In its fourth part, the report outlines how to create the conditions necessary to scale up and replicate these forest-based solutions across the Mediterranean region. These include changing the way we see the role of forests in the economy, putting in place relevant policies, more widespread participatory approaches and improved governance, a recognition of the economic value of the goods and services provided by forests and, ultimately, creating appropriate financial incentives and tools.

Mediterranean forests also have a global role in helping countries to meet their international commitments on forests, particularly the Sustainable Development Goals (as part of the 2030 Agenda for Sustainable Development) and the objectives of the three Rio Conventions. We hope and expect the State of Mediterranean Forests 2018 will prove a useful tool in promoting and highlighting this role, while also supporting efforts specific to the Mediterranean region.

We wish you a pleasant read.

Hiroto Mitsugi
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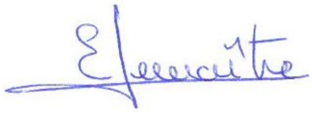

Elen Lemaître-Curri
Director of Plan Bleu
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Contents

Tables

Figures

Boxes

Acronyms and abbreviations

ABS	Access and Benefit Sharing
ACP	African, Caribbean and Pacific Group of States
AD	*Anno Domini*
AFD	Agence Française de Développement (France)
App	application
BC	Before Christ
CBD	Convention on Biological Diversity
CDC	Caisse des dépôts et consignations
CDM	Clean Development Mechanism
CEPF	Critical Ecosystem Partnership Fund
CESEFOR	Centro de Servicios y Promoción Forestal
CO_2	carbon dioxide
COP	Conference of the Parties
CORINE	CooRdination de l'Information sur l'Environnement
COST	European Copeeration in Science and Technology
CPMF	Collaborative Partnership on Mediterranean Forests
CRIC	Committee for the Review of the Implementation of the Convention
CSR	Corporate Social Responsibility
DNA	deoxyribonucleic acid
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EFFIS	European Forest Fire Information System
EFSOS	European Forest Sector Outlook Study
EIB	European Investment Bank
ERA-Net	European Research Area Net
ERDF	European Regional Development Fund
EUFGIS	European Information System on Forest Genetic Resources
EUFORGEN	European forest genetic resources programme
EUR	euro
EU	European Union
FAOLEX	FAO's Legal Service Database
FAO	Food and Agriculture Organization of the United Nations
FAPDA	Food and Agriculture Policy Decisions Analysis
FCPF	Forest Carbon Partnership Facility
FFEM	Fonds Français pour l'Environnement Mondial (France)
FGR	Forest Genetic Resources
FLR	Forest and Landscape Restoration
FORESTERRA	Enhancing FOrest RESearch in the MediTERRAnean
FRA	Global Forest Resources Assessment programme
FSC	Forest Stewardship Council
GCF	Green Climate Fund
GDA	Global Drylands Assessment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEZ	Global Ecological Zones
GFS	Global Forest Survey

GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	German Agency for International Cooperation
GPFLR	Global Partnership on Forest and Landscape Restoration
ha	hectare
HABEaS	Hotspot Areas for Biodiversity and Ecosystem services
HadCM3	Hadley Centre Coupled Model, version 3
HDI	Human Development Index
HFP	Human Footprint Index
IAF	International Arrangement on Forests
ICRAF	World Agroforestry Centre
INDC	Intended Nationally Determined Contribution
INFORMED	INtegrated research on FOrest Resilience and Management in the mEDiterranean
INS	Institut National de la Statistique (Tunisia)
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
LDN	Land Degradation Neutrality
LiDAR	Light Detection and Ranging
LIFE	L'Instrument Financier pour l'Environnement
LULUCF	Land Use, Land-Use Change and Forestry
MAD	Moroccan dirham
MBH	Mediterranean Basin Hotspot
MEDFORVAL	High ecological value Mediterranean forests network
MENA	Middle East and North Africa countries
MFW	Mediterranean Forest Week
MFWA	Ministry of Forestry and Water Affairs
MoA	Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
MSSD	Mediterranean Strategy for Sustainable Development
NAMA	Nationally Appropriate Mitigation Action
NAP	National Action Programme
NASA	National Aeronautics and Space Administration
n.a.	not available
NBSAP	National Biodiversity Strategies and Action Plan
NDC	Nationally Determined Contribution
NFI	National Forest Inventory
NGO	Non Governmental Organization
NLBI	Non–Legally Binding Instrument on All Types of Forests
NPV	Net Present Value
NRM	Natural Resources Management
NWFP	Non Wood Forest Product
ONF	National Forests Office
OWL	other wooded lands
PA	Protected Area
PEFC	Programme for the Endorsement of Forest Certification
PES	Payment for Ecosystem Service
PPP	Purchasing Power Parity
RAP	Regional Action Programmes

REDD+	Reducing Emissions from Deforestation and forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
RLTS	Red List of Threatened Species
RNA	ribonucleic acid
SCI	Sites of Community Importance
SDG	Sustainable Development Goal
SFM	Sustainable Forest Management
SFMF	Strategic Framework on Mediterranean Forests
SIDECM	Syndicat Intercommunal Distribution d'Eau Corniche des Maures (France)
SIVOM	Syndicat intercommunal à vocation multiple
SLU	Small Livestock Unit
SME	small and medium enterprise
SNFI	Spanish National Forest Inventory
SNP	single-nucleotide polymorphism
SoEF	State of Europe's Forests
SoMF	State of Mediterranean Forests
SPVB	Strategjia dhe Plani i Veprimit per Biodiversitetin (Albania)
TCM	travel cost method
tCO_2	metric tons of carbon dioxide
TEV	total economic value
TOF	tree outside forests
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNFI	United Nations Forest Instrument
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation
URFM	Unité de Recherche des Forêts Méditerranéennes (France)
USAID	United States Agency for International Development
USD	United States dollar
WRI	World Resources Institute
WWF	World Wide Fund for Nature
WWF-MedPO	World Wide Fund for Nature-Mediterranean Programme Office

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1

Introduction

1 The Mediterranean region's development and trends: framework aspects

Nelly Bourlion, *Plan Bleu*
Rémy Ferrer, *Plan Bleu*

With its ancient history and rich heritage, the Mediterranean region is a meeting point between three continents: Africa, Asia and Europe. Surrounded by 21 countries,[1] the Mediterranean is the largest semi-enclosed sea in the world. Countries in the Mediterranean region are usually divided into three sub-regions (FAO and Plan Bleu, 2013): the southern, eastern and northern Mediterranean (Figure 1.1).

The Mediterranean region is home to a great variety of ecosystems and species subject to significant pressures. Thirty percent of all international tourists descend on the Mediterranean coast (UNWTO, 2017). The development of large cities and megacities, leading to population growth and increased economic activity, places a strain on coastal areas. The Mediterranean diet and agricultural products are world-renowned, but depend for their sustainability on rural landscapes, resources and decent working conditions.

Box 1.1. The Mediterranean region in numbers

- 6.5 percent of global land area
- 7.3 percent of the global population in 2016 (World Bank, 2015a)
- 10.4 percent of the global GDP in 2016 (13.6 percent in 2000) (World Bank, 2015b)
- 29.1 percent of international tourist arrivals in 2015 (UNWTO, 2017)
- 6.0 percent of global carbon emission in 2014 (Global Footprint Network, 2016)
- 9.6 percent of global organic-production holdings in 2015 (Willer and Lernoud, 2017)

The significant differences in development between countries, as well as conflicts in the region, make it difficult to envisage a sustainable future for the Mediterranean basin. The region's fragility is exacerbated by its exposure and sensitivity to climate change: polar regions aside, Mediterranean ecosystems currently experience the greatest impact from the driving forces of global climate change and will continue to do so (Giorgi, 2006; UNEP/MAP, 2016). In order to better understand the issues specifically pertaining to Mediterranean forests, it is necessary to consider the environmental and socioeconomic characteristics of the Mediterranean region as a whole (Box 1.1).

Considerable natural and cultural resources

While the Mediterranean region is rich in natural and cultural resources, these remain fragile and under threat. There are also significant disparities between rural and forest areas on the one hand, and urban and coastal zones on the other.

[1] Unless otherwise stated, the report takes into account the 21 signatory countries to the Barcelona Convention (Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey), but also the six following countries and territories that are part of the Mediterranean bioclimatic basin: Bulgaria, Jordan, Palestine, Portugal, Serbia and the former Yugoslav Republic of Macedonia.

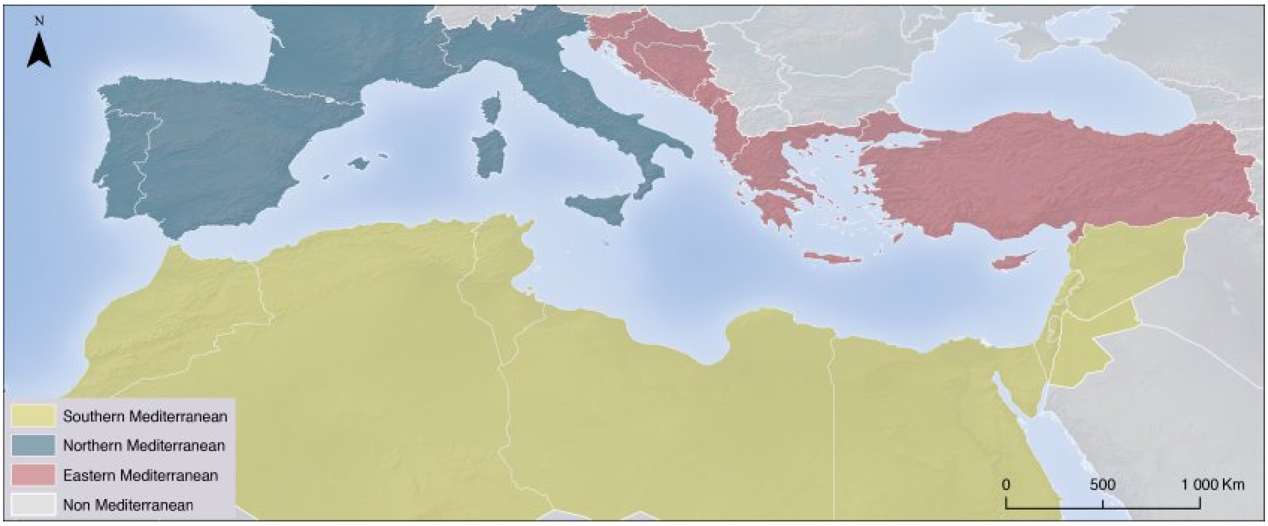

Figure 1.1. Northern (blue), southern (yellow) and eastern Mediterranean (red) countries

The Mediterranean region: a biodiversity hotspot

Its variety of marine and coastal ecosystems and wide diversity of fauna and flora make the Mediterranean one of the world's richest natural habitats. The region is characterized by extraordinary biodiversity, including a large number of endemic species. At the same time, it is threatened by critical levels of habitat loss (Derneği, 2010).

The Mediterranean basin, extending over more than 2 million square kilometres, is the largest of the world's five Mediterranean Climate regions and the world's second largest biodiversity hotspot (Myers *et al.*, 2000). The Mediterranean basin is rich in plant diversity (Mittermeier *et al.*, 2004), containing some 25 000 plant species (Myers *et al.*, 2000), 60 percent of which are endemic (Thompson, 2005). The region also contains a great wealth of endemism in trees and shrubs (290 indigenous woody species and subspecies, 201 of which are endemic; Fady-Welterlen, 2005). Quite a number of these are flagship species,[2] such as the cedar tree (Lebanese cedar, *Cedrus libani*), argan tree (*Argania spinosa*) and the date palm of Crete (*Phoenix theophrasti*). The Mediterranean basin is also home to more than 220 species of terrestrial mammals, 25 of which are endemic (11 percent) (Derneği, 2010).

Mediterranean forest ecosystems are very much tied to human activity: the current level of endemism and biodiversity is the result of this interaction. The impact of the increased pressure on these ecosystems will, however, be diffuse. Notably, the loss of biodiversity in these areas will inevitably affect their future economic potential.

Nowadays, protected areas (Figure 1.2) cover only 9 million hectares, representing 4.3 percent of the region's total surface area. The largest protected area lies in the north (UNEP-WCMC and IUCN, 2017). This number raises questions about the effectiveness of efforts to protect and conserve Mediterranean forests (see Chapter 9).

Scarce water resources

The Mediterranean region is characterized by heavy rainfall in winter and hot and dry summers. While the region's climate is diverse and spatially variable, a number of areas are classified as arid, semi-arid or desert. The region is a transition zone between a temperate European climate with relatively abundant and constant water resources, and the arid desert climates of Africa and the Middle East, whose water resources are very poor.

[2] A flagship specie is defined as a specie both popular and charismatic serving as a symbol and rallying point to stimulate conservation awareness and action (Heywood, 1995).

Figure 1.2. Protected areas (green) and limits of the Mediterranean biodiversity hotspot (blue)
Note: All sites that meet the standard definition of protected areas of the World Database on Protected Areas are shown in this map, contrary to the map in Figure 3.19.
Source: UNEP-WCMC and IUCN (2017).

A combination of factors have placed severe constraints on the Mediterranean's water resources. These include climate change, anthropic pressures arising from growing water demand for domestic and industrial uses, the development of irrigated zones and tourism (Figures 1.3 and 1.4). More than half of the world's "water poor" population is concentrated around the Mediterranean basin, which holds only 3 percent of the world freshwater resources (UNEP/MAP, 2017). These constraints are a major cause of Mediterranean forest degradation (see Chapter 5).

Governments have taken drastic measures to mitigate water scarcity, including large-scale water transfers both within and between countries, as well as the use of expensive non-conventional water resources (sea water desalination and waste water treatment). These necessitate the construction of containment structures to store as much water as possible to meet domestic, industrial and agricultural demands. However, these measures severely interfere with freshwater inputs and related sediments and nutrients in the Mediterranean Sea, endangering ecosystems (most notably coastal wetlands due to coastal erosion and salinization of aquifers).

Diversified rural areas

Due to their history, culture, natural conditions, population density, human settlements, economic structures and human resources, Mediterranean rural areas are relatively diverse. As such, each require different political interventions, but have a shared potential to establish new economic and social development bases. Rich and varied "know-how" exists in these areas, which is often under-exploited due to a lack of means and conditions for valorizing this knowledge.

Natural resources in rural areas are a source of both marketable and non-marketable goods and services. While these are underestimated and frequently go unrecorded, they are nevertheless essential to human development (see Chapter 6). These range from food and water through to aromatic and medicinal plants, fuels, wood and building materials. Maintaining the health of these fragile agrosilvopastoral ecosystems is therefore crucial to conserving both biodiversity and human well-being. Doing so requires a deeper knowledge of the forest resources that deliver these goods and services, which in turn requires large investments.

The sustainable use, management and conservation of natural resources, rural and local development, as well as food production and security are all interdependent aspects of ensuring the well-being of rural communities and provide significant input to downstream industries, from food processing to tourism.

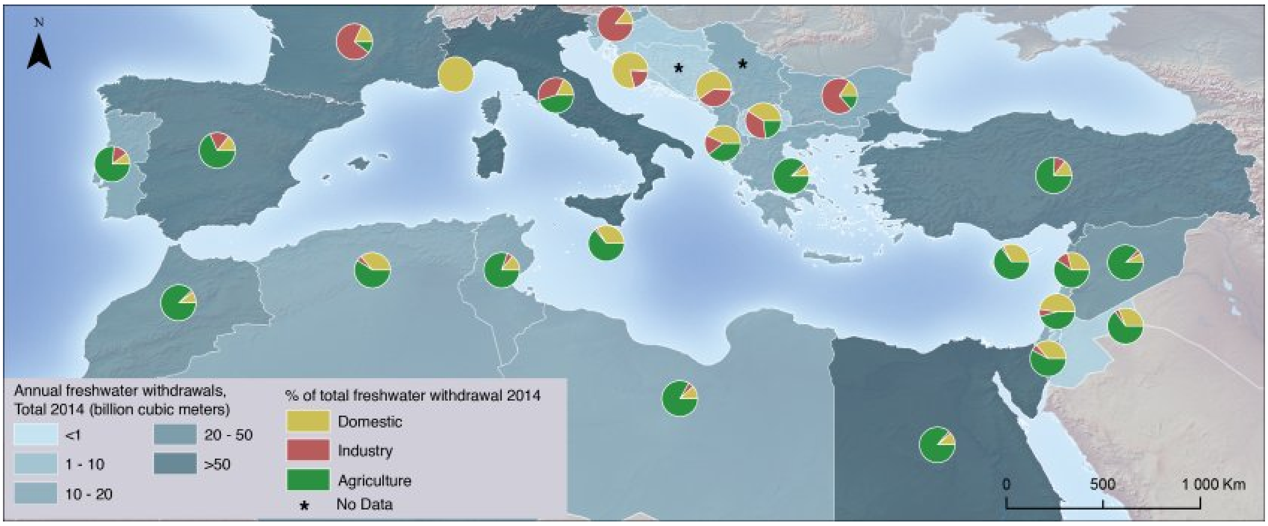

Figure 1.3. Water demand by sector in 2014

Note: Details of water use by sector are not available for Serbia and Bosnia and Herzegovina.

Source: FAO (2016a).

A unique cultural landscape

Home to some of the world's most ancient human settlements, the Mediterranean region has a unique heritage and culture. Over thousands of years, this has forged strong links between the region's inhabitants and rural communities. Despite its diversity, centuries of trade and communication have reinforced this regional identity, strengthening the so-called "Mediterranean character."

The number of UNESCO World Heritage sites in Mediterranean countries continues to grow, increasing from 36 in 1980 to 286 in 2016. Twenty-seven percent of all UNESCO World Heritage sites are located in Mediterranean countries (UNESCO, 2017) (Figure 1.5). There are, however, significant differences in number between countries. Italy (49 sites), Spain (42 sites) and France (39 sites) account for 45 percent of the region's total Word Heritage sites. Greece and Turkey are far behind this number, with 18 and 16 sites respectively, while a further five countries (Albania, Montenegro, Palestine and Slovenia) account for only two sites each. All of the sites recognized in the Syrian Arab Republic, Libya and Palestine are included in the List of World Heritage in Danger. Moreover, 26 percent of the 55 sites listed as in danger

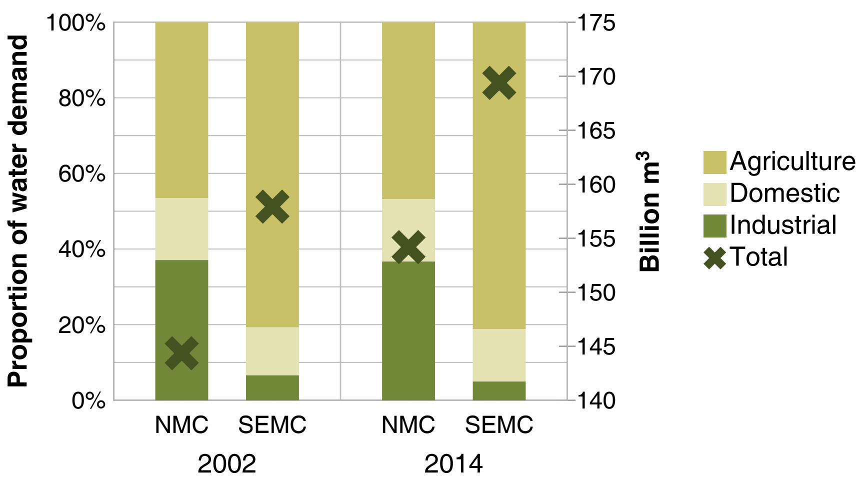

Figure 1.4. Development of water demand by sector in northern Mediterranean countries (NMC) and southern and eastern Mediterranean countries (SEMC) between 2002 and 2014

Note: 2002 data is not available for the following countries: Bosnia and Herzegovina, Croatia, Jordan, Montenegro and Serbia.

Source: FAO (2016a).

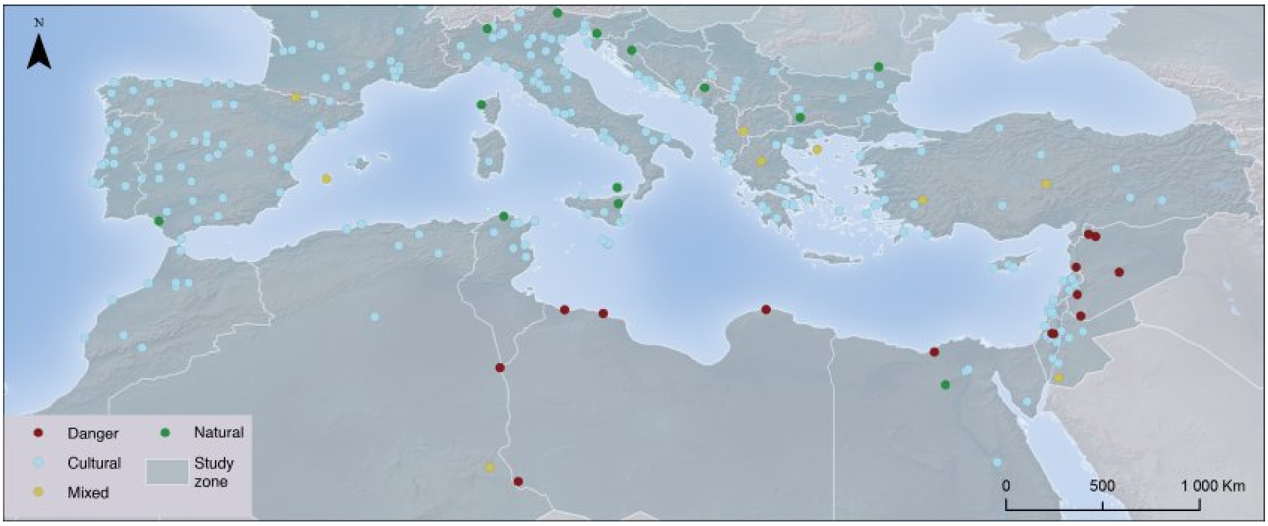

Figure 1.5. UNESCO World Heritage sites and World Heritage Sites in Danger, 2016
Note: To be included on the World Heritage list, sites must be of outstanding universal cultural and natural value. The list of World Heritage in Danger sites includes those cultural and natural heritage sites that are threatened by serious and specific dangers.
Source: UNESCO (2017).

globally are located in the Mediterranean. In addition, 434 Mediterranean sites are currently included on the World Heritage Tentative List (26 percent of the World's sites), an inventory of the sites State Parties intend to consider for nomination for inscription on the World Heritage list.

This cultural heritage can be seen as a "service" provided by Mediterranean ecosystems and a potential source of development.

Some socioeconomic disparities

The Mediterranean basin is characterized by large socioeconomic disparities, notably between countries in the region's north, south and east. These disparities have both direct and indirect impacts on Mediterranean forests.

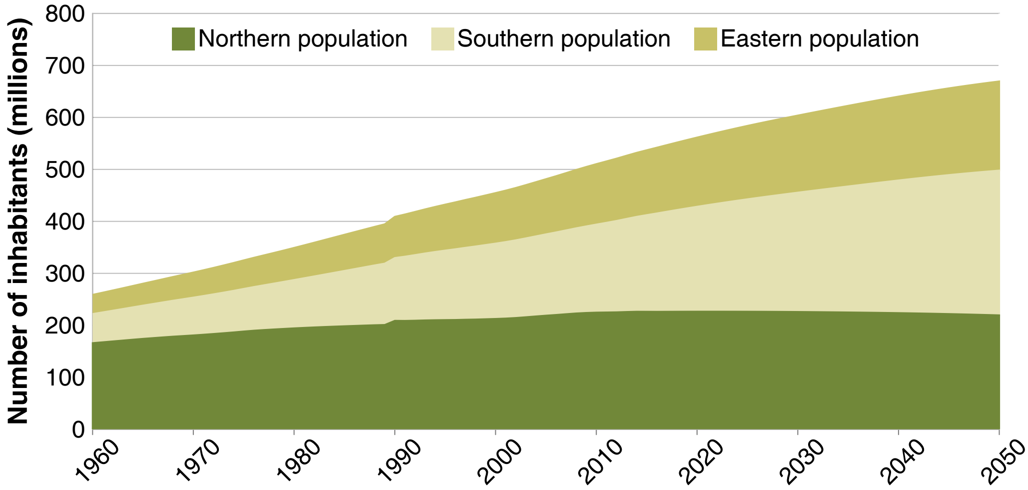

Figure 1.6. Population growth in northern, eastern and southern Mediterranean countries, 1960-2050
Source: World Bank (2015a).

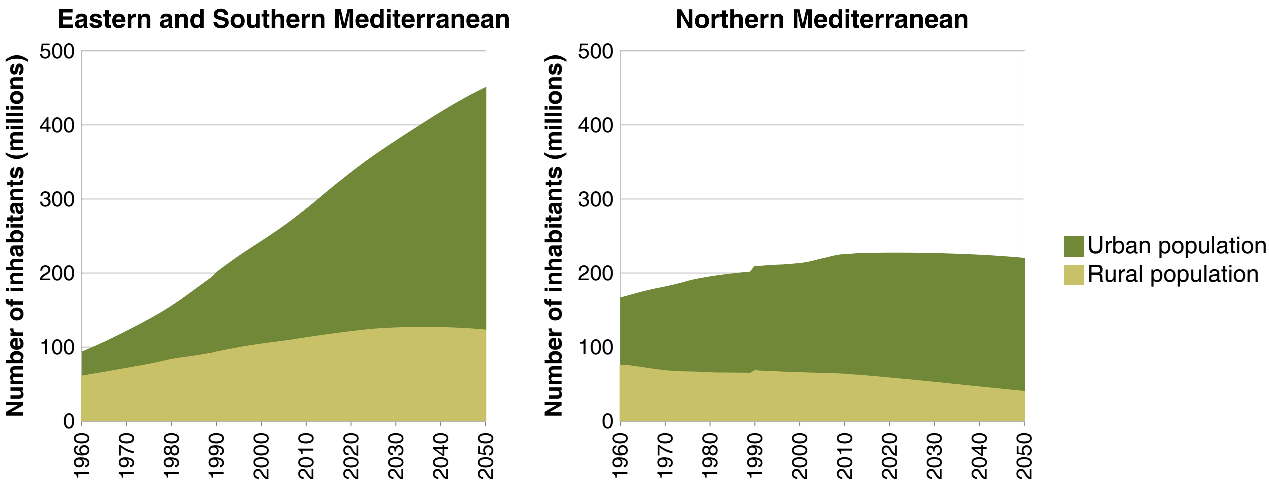

Figure 1.7. Urban and rural population growth in northern, eastern and southern Mediterranean countries
Source: World Bank (2015a).

An ever-increasing population

The population of riparian countries in the region increased from 259 million in 1960 to 537 million in 2015 and is projected to reach 670 million by 2050 (World Bank, 2015a). The population distribution in the northern, southern and eastern Mediterranean has also changed significantly during this time. In 1960, for example, southern and eastern countries represented 36 percent of the region's total population, whilst nowadays this figure stands at 58 percent (Figure 1.6). This increase is associated with significant urban population growth from 48 percent in 1960 to 68 percent in 2015 (Figure 1.7). This urbanization took place predominantly along the region's coastlines: cities such as Algiers and Tel-Aviv experienced a five to tenfold increase between 1950 and 2010 (World Bank, 2015a).

Approximately one third of the Mediterranean population was concentrated in coastal areas in 2015 (Figure 1.8). The total number of inhabitants in coastal areas was 150 million, while an estimated 250 million lived in hydrological basins, representing 33 and 55 percent of riparian countries' total population respectively. In southern countries, inhabitants in coastal areas accounted for 65 percent in 2015, with roughly 120 million inhabitants.

While there has been little demographic change in the region's north, strong demographic growth in the south and east has led to excessive exploitation of natural resources. This has included land

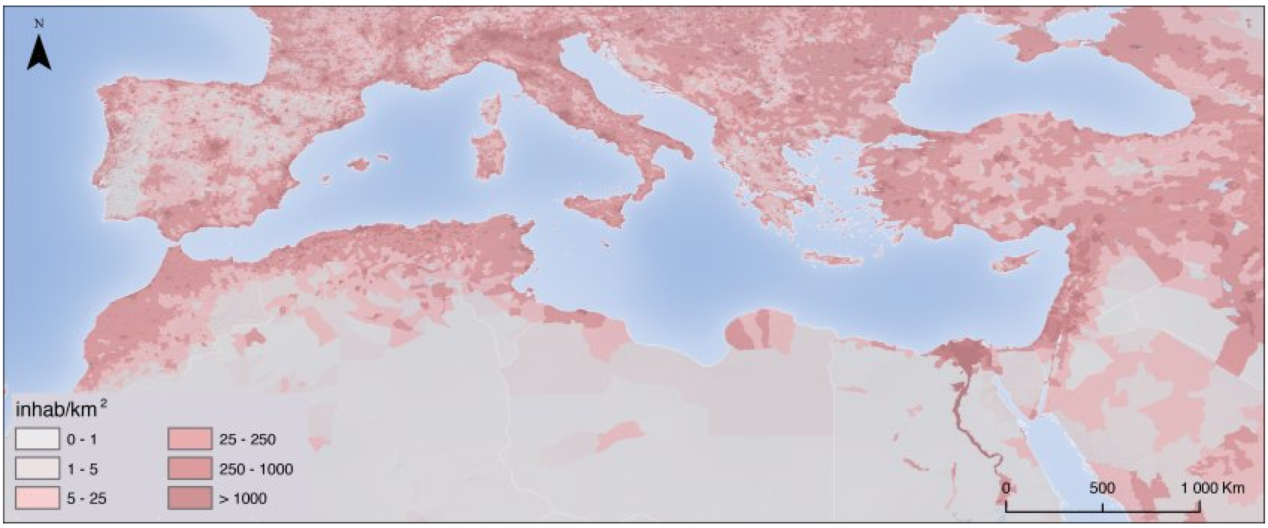

Figure 1.8. Adjusted demographic density, 2015
Source: CIESIN (2017).

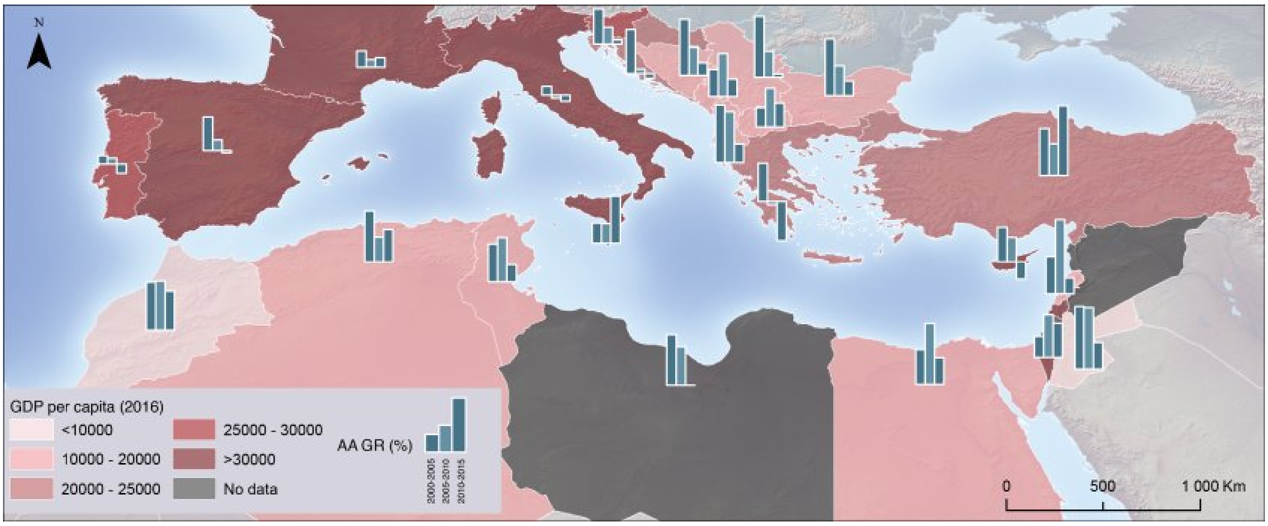

Figure 1.9. Gross Domestic Product (GDP) per capita in 2016 and average annual growth rates
Note: The GDP per capita is in USD purchasing power parity.
Source: World Bank (2015b).

clearing, marginal land cultivation, overgrazing and firewood collection. As a result, land productivity has decreased (see Chapter 5).

Table 1.1. Average annual GDP growth rate by percentage

Countries	GDP average growth rate (%/yr)		
	2000-2005	2005-2010	2010-2015
Albania	5.9	5.2	1.9
Algeria	5.2	2.5	3.3
Bosnia and Herzegovina	5.7	2.8	1.3
Bulgaria	5.8	3.1	1.5
Croatia	4.5	0.5	–0.5
Cyprus	3.6	2.5	–1.8
Egypt	3.5	6.2	2.7
France	1.7	0.8	1.0
Greece	3.9	–0.3	–4.0
Israel	2.1	4.3	3.5
Italy	0.9	–0.3	–0.6
Jordan	6.4	6.2	2.7
Lebanon	3.8	7.6	1.6
Libya	5.1	3.9	-
Malta	2.1	2.0	4.8
Montenegro	2.8	4.4	1.8
Morocco	4.9	5.0	4.0
Portugal	0.9	0.6	–0.9
Serbia	6.2	2.7	0.4
Slovenia	3.6	1.7	0.4
Spain	3.4	1.1	–0.2
The former Yugoslav Republic of Macedonia	2.0	4.0	2.4
Tunisia	3.9	4.5	1.8
Turkey	4.8	3.2	7.1

Note: Data is not available for Monaco, Palestine and the Syrian Arab Republic.
Source: World Bank (2015b).

By contrast, numerous rural areas in northern countries have reported the desertion of farmlands, which have subsequently been invaded by trees and bushes, resulting in revegetation. Southern and eastern Mediterranean countries are experiencing rapid urbanization, with primary demographic growth expected in cities, whilst urbanization rates in the north have remained stable.

Economic heterogeneity between two shores

In 2016, Mediterranean states represented 10.4 percent of the world's Gross Domestic Product (GDP), a decrease from 11.6 percent in 2010 and 13.6 percent in 2000. While its percentage of global GDP has declined, the Mediterranean population has remained constant at approximately 7 percent of the global population (World Bank, 2015b).

The GDP growth rate of countries in the southern and eastern Mediterranean is significantly higher than that of European Union (EU) member states in the region (Figures 1.9 and Table 1.1). Nevertheless, these rates are considered low when compared with demographic growth rates,

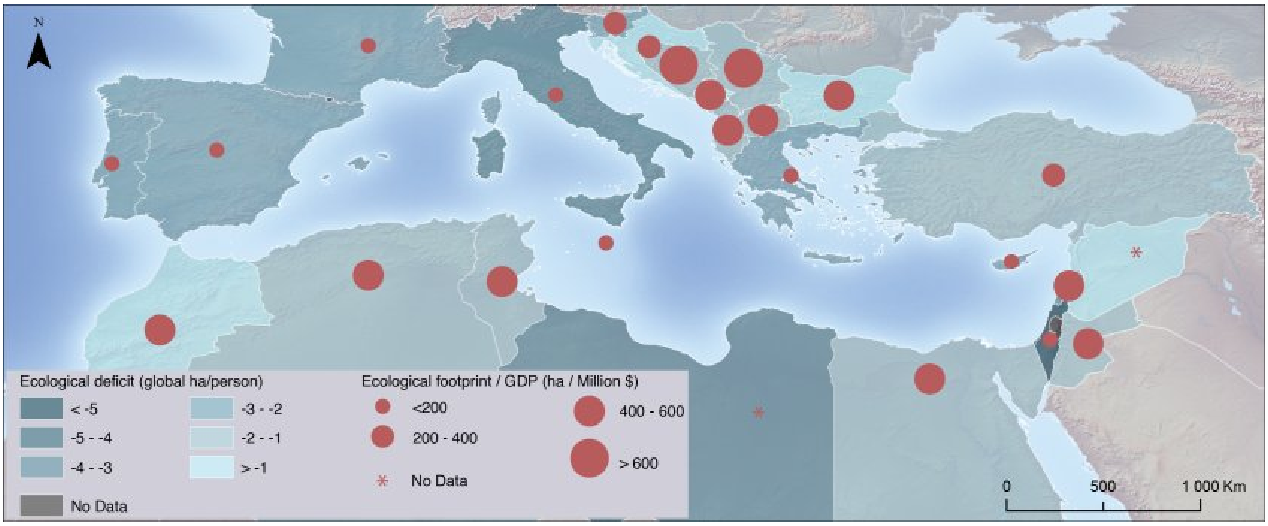

Figure 1.10. Ecological footprint, 2013

Note: Ecological Footprint measures the biologically productive area (on land or water) a country needs to produce all the resources it consumes and to absorb the carbon dioxide emissions it incurs (expressed in global hectares). Biocapacity: refers to the capacity of ecosystems to produce biological material used by the economy and to absorb man-made carbon dioxide (expressed in global hectares). Deficit/ecological reserve: refers to the difference between a region or country's biocapacity and ecological footprint (negative values correspond to a deficit).

Source: Global Footprint Network (2016).

particularly high growth rates in the southern Mediterranean.

While growth rates in southern and eastern countries are higher than those of EU member states in the region, significant demographic differences remain: in 2016, the average annual income per capita in southern and eastern countries (approximately USD 15 000) was 1.6 times lower than in the northern Mediterranean, and 1.9 times lower than that of EU member Mediterranean countries (in 2010, annual per capital income was 2.3 times lower at USD 13 000).

Poverty continues to affect many within the region. The Arab Forum for Environment and Development states that poverty affects 65 million people in the Middle East and North Africa (Saab, 2015). This economic insecurity is exacerbated by high unemployment rates, particularly among young people and women. Large income disparities within countries remain present and in some cases growth figures hide

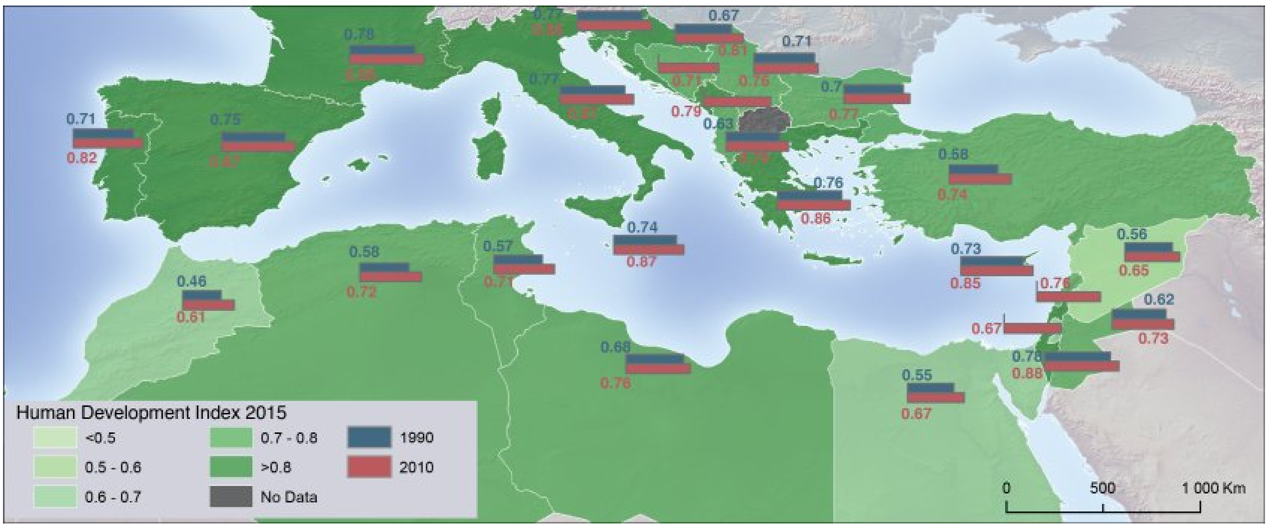

Figure 1.11. Human Development Index, 2015 and progress between 1990 and 2010

Source: UNDP (2016).

natural capital degradation (Figure 1.10).[3]

Economic insecurity in the Middle East and North Africa has an impact on the capacity of Mediterranean economies to reduce current unemployment rates while also creating the millions of jobs needed for new entrants into the job market. Poverty and unemployment also contribute to social marginalization which, exacerbated by income disparity, leads to social and political instability. Increasing economic, social and environmental tensions and their consequences on livelihood security have become unacceptable for many inhabitants. In the absence of sustainable and local development planning, civil and armed conflicts have increased in many countries. Regionally, the impact of current and emerging socioeconomic issues remains a major concern for sustainable and local development (Saab, 2015).

Table 1.2. Country ranking by HDI

Country	Global rank
Countries with high HDI (above 0.8)	
Israel	19
France	21
Slovenia	25
Italy	26
Spain	27
Greece	29
Cyprus	33
Malta	33 (tied)
Portugal	41
Croatia	45
Montenegro	48
Countries whose HDI is between 0.7 and 0.8	
Bulgaria	56
Serbia	66
Turkey	71
Albania	75
Lebanon	76
Bosnia and Herzegovina	81
Algeria	83
Jordan	86
Tunisia	97
Libya	102
Countries with HDI below 0.7	
Egypt	111
Palestine	114
Morocco	123
Syrian Arab Republic	149

Note: Data is not available for the former Yugoslav Republic of Macedonia and Monaco.
Source: UNDP (2016).

Improving social indicators

Economic growth in southern and eastern countries has been accompanied by significant improvements in social indicators on the Human Development Index (HDI)[4] (Table 1.2). With an average HDI of 0.787 in 2015, the Mediterranean region sits above the global average (0.7) (UNDP, 2016).

However, there remain large disparities between Mediterranean countries: 12 have a high HDI, ten have an HDI between 0.7 and 0.8, while four countries have an HDI below 0.7 (Figure 1.11).

There is more than a ten-year life expectancy gap at birth between Israel (83 years) and the Syrian Arab Republic (70 years). The average length of schooling in Mediterranean countries is nine years, but the range is considerable (from 4.4 years in Morocco to 12.9 years in Israel) (UNDP, 2016) (Figure 1.11). Education rates vary considerably between rural and urban areas, but there is little evidence on which to provide accurate data.

A region increasingly under pressure

While the Mediterranean environment is variable, the region as a whole is subject to

[3] Plan Bleu (2017) pointed out that between 2000 and 2009 only six Mediterranean countries reduced their environmental footprint.

[4] The Human Development Index (HDI) is a composite index measuring the evolution of a country according to three criteria: life expectancy at birth, average length of schooling and expected years of schooling, gross national income per capita in USD in terms of purchasing power parity (PPP). PPP is a conversion factor indicating the number of units of a country currency needed to buy on this country's market what one could buy with 1 dollar in the USA. The HDI is standardized and allows countries' classification according to values between 0 and 1.

Figure 1.12. Global Food Security Index (standardized, 2016)

Note: The World Food Conference of 1996 defined food security as a state in which "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." The Global Food Security Index takes into account three features: food accessibility, availability and quality. Accessibility measures "consumers' capacity to buy food." Availability measures "the adequacy of national food supply." Quality and security measure "nutritional diversity and quality of average diets, as well as food security."

Source: The Economist Intelligence Unit (2017).

many simultaneous, and in some cases protracted, pressures. The primary drivers of environmental degradation are urbanization, tourism, transport, business and industry (including mining and energy operations) and agricultural developments. These are propelled by demographic growth, pollution, overexploitation of natural resources (hunting, gathering and fishing), natural disasters and human disturbances. Changes in climate are already noticeable and will only aggravate this situation over coming decades. It is estimated, for example, that the cost to GDP of environmental degradation is 2.1 percent in Tunisia, 3.4 percent in Lebanon, 3.5 percent in Morocco, 3.7 percent in Algeria and 4.9 percent in Egypt (World Bank, 2015b; Hussein, 2008) (see Chapters 5 and 13).

Agriculture and livestock

As a result of desertion of farmlands and pastures, effective natural recovery and reforestation campaigns have occurred in northern Mediterranean countries. In the region's south and east, however, particularly in North African countries, pressures on agricultural and forest ecosystems remain significant. This is due to strong demographic pressures on land and water resources, urban sprawl, forest overexploitation and overgrazing.

Mediterranean agro-food industries consume a large portion of rural resources and, as result of processes such as desertification of unproductive soil and pollution from agriculture, are one of the main causes of environmental degradation in the region. At the same time, this sector is key to both the conservation of Mediterranean agricultural landscapes and the provision of subsistence and employment to the region's inhabitants (UNEP/MAP, 2016).

Food production and security are of paramount importance to the Mediterranean's rural areas (Figure 1.12). Due to the importance of small and medium-sized holdings in the rural areas of countries in the Mediterranean's south and east and the mobilization of the family workforce, family farms contribute to the food security of agricultural households and local communities, while guaranteeing supply to local markets.

Furthermore, the social cohesion and family and inter-generational solidarity prevailing in rural households

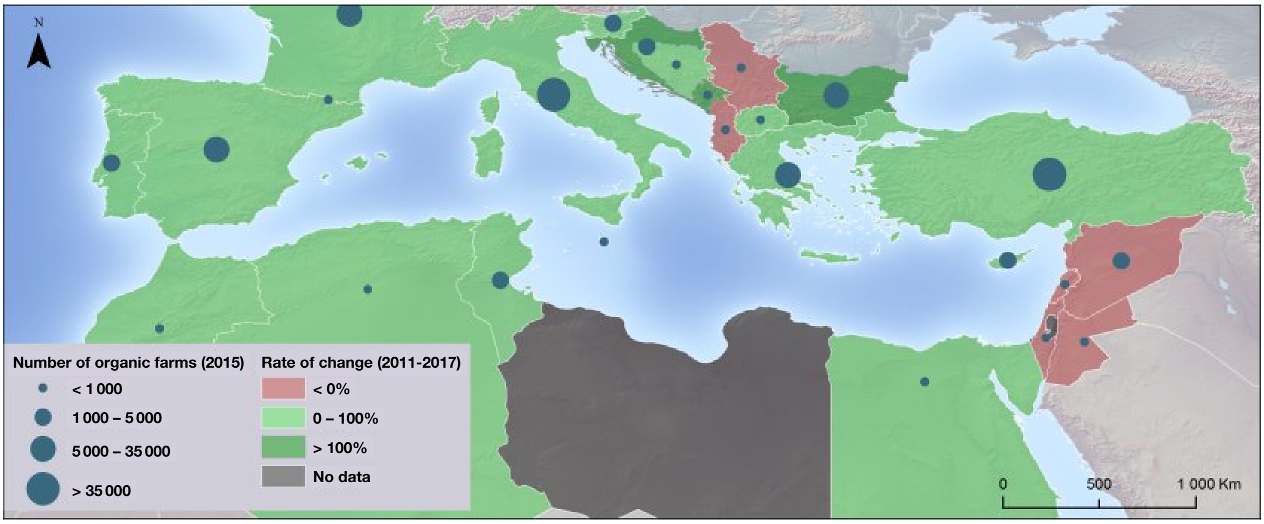

Figure 1.13. Number of organic farms

Note: Data is not available for Libya, Monaco and Palestine. The data source for Algeria is Pugliese *et al.* (2014): data includes all operators and not only producers; change rate for Algeria is calculated between 2012 and 2015.

Source: Willer and Lernoud (2017).

helps to counter food insecurity and the social vulnerability of rural populations at a local level. However, access to land and resources is increasingly open to foreign capital and investment without regard to their impact on agricultural and rural societies.

Southern and eastern Mediterranean countries are vulnerable to international price variation because of their dependence on cereal imports. This makes issues related to agriculture and food security quite sensitive in these areas.

In addition, since the impacts of climate change will result in the degradation of agricultural water resources and the loss of fertile soils, ensuring agricultural practices adapt to climate change is also necessary to protect food security and rural vitality. The effects of climate change will also present a risk to stability in these areas, as they will be felt directly by small farmers. Adaptation strategies and services for agricultural and rural areas, as well as public and private support for these adaptations, are therefore necessary. This includes the promotion of agro-environmental practices, alternative agricultural methods,

Box 1.2. Organic farming operations: rate of change 2011-2015

- Worldwide: 35 percent
- Africa: 35 percent
- Asia: 37 percent
- Europe: 21 percent
- Mediterranean: 32 percent
- The organic farming operations in Mediterranean countries studied represent 9.6 percent of the total number of organic farms operating globally

Source: Willer and Lernoud (2017).

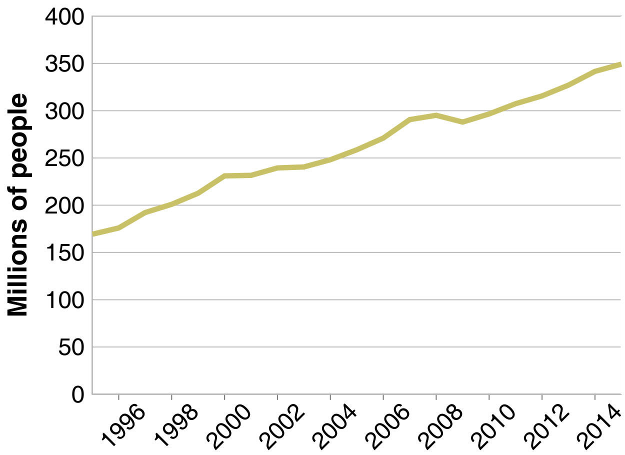

Figure 1.14. International tourist arrivals in the Mediterranean, 1995-2015

Source: UNWTO (2017).

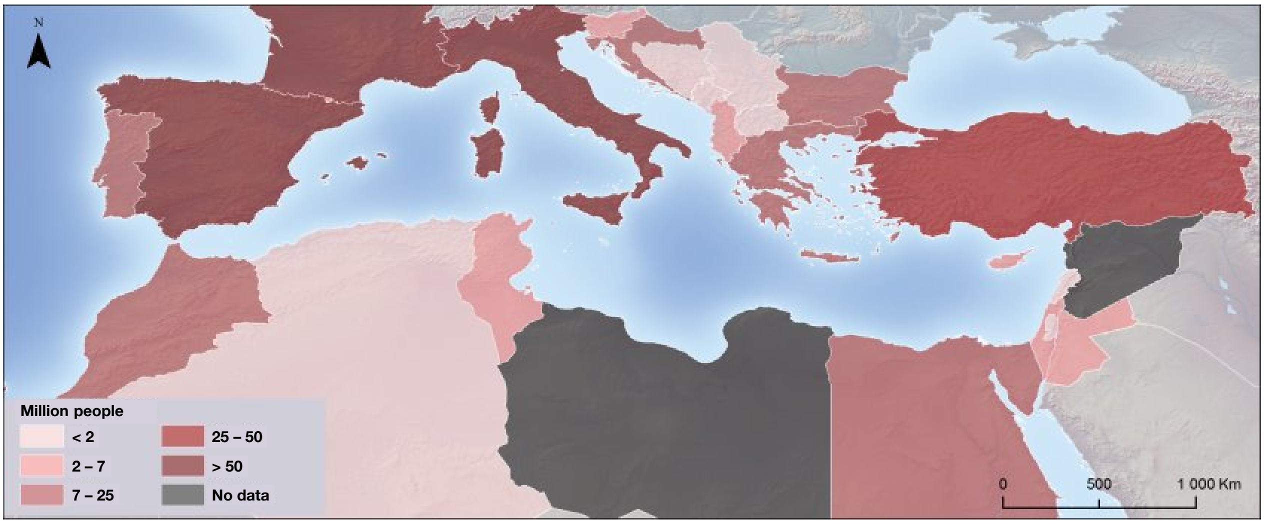

Figure 1.15. International tourist arrivals in Mediterranean countries in 2015
Note: Data not available for Libya and the Syrian Arab Republic.
Source: UNWTO (2017).

crop diversification and water and soil conservation, while limiting the consumption of natural resources (Figure 1.13 and Box 1.2).

Tourism

The Mediterranean is the world's leading tourist destination (including both national and international tourism), with more than 300 million international tourist arrivals in 2015 (representing 30 percent of all global tourist arrivals). International tourist arrivals grew from 58 million in 1970 to more than 349 million in 2015, with a forecasted 500 million by 2030 (UNWTO, 2017) (Figures 1.14 and 1.15).

In 2016, tourism helped generate USD 333 billion in Mediterranean countries (UNWTO, 2017). Over the last 20 years, the direct contribution of tourism to GDP in the Mediterranean region has increased by 53 percent. Tourism is a key pillar of Mediterranean economies, a constant source of employment (11.5 percent of the total number of jobs in 2014) and economic growth (11.3 percent of the region's GDP) (Figure 1.16). Tourism is vital for many countries in the region: for the economies of coastal regions, tourism represents more than 70 percent of the value of production and gross value added (UNEP/MAP, 2017).

Unfortunately, the prospect of deriving short-term financial benefits from tourism outweigh incentives to conserve biodiversity and ecosystem services (Derneği, 2010). Tourism, while currently a source of environmental degradation, can also be considered a service provided by ecosystems, particularly forest ecosystems. Tourism is, therefore, a potential source of income for local populations, under conditions of sustainable management (see Chapters 6 and 14).

Urbanization

Although affected by the economic crisis, urbanization of Mediterranean countries, particularly in the southern coast, has continued at a rapid pace. Two out of three people already live in urban areas, higher than the world average (Figure 1.17). By 2050, the United Nations Human Settlements Programme projects an urban population of about 162 million in the northern rim (145 million in 2010) and over 300 million in the south and east (165 million in 2010).

This population increase will result in serious difficulties. By 2030, for example, some 42 million additional homes will be required, mainly in cities (UN-Habitat, 2008a,b). In addition, most Mediterranean cities, particularly those located on the coast, are not managed sustainably, in the sense that their ecological

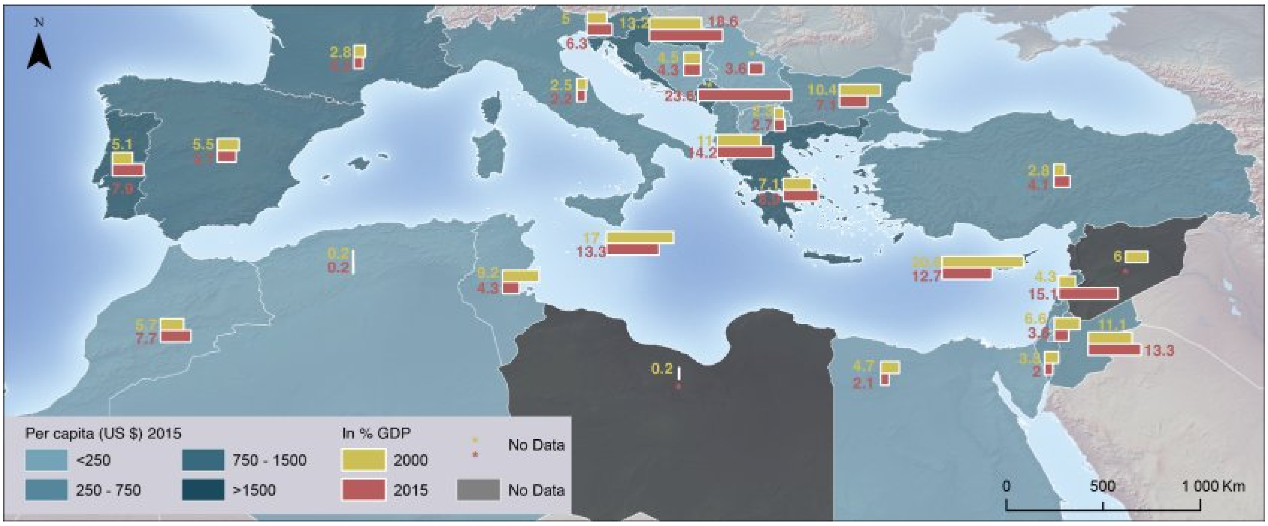

Figure 1.16. International tourism receipts in 2015 per capita and as a percentage of GDP in 2000 and 2015
Source: World Bank (2015b).

footprint remains too great, particularly with regard to their capacity. At the same time, the potential of cities as drivers of innovative and sustainable economic and social change is not sufficiently recognized (UNEP/MAP, 2016).

Mediterranean coastal cities are not sufficiently resilient to cope with risks and dangers of natural or human origin. In addition, they are highly energy-dependent; their productive capacity and use of renewable energy, as well as urban agriculture and recycling, remain under-exploited.

Waste production in the region has increased significantly over the last decade, largely due to population pressures and increased consumption. Significant improvements are required in this area: while three-quarters of waste is collected, most is deposited in open dumps, negatively impacting health and the environment. In 2014, less than 10 percent of the waste collected in the Mediterranean region was recycled (AEE, 2015).[5] In many municipalities, residents' participation in decisions on urban issues remains low, as does access to urban services.

Urban growth in Mediterranean cities has exacerbated current challenges. These include excessive land use, accelerated degradation of built cultural heritage, groundwater pollution and ineffective waste management. These factors have had a cumulative effect on the environment and population health. In this context, if corrective actions and initiatives targeting the territorial, environmental, economic and social imbalances caused by cities are not implemented, Mediterranean societies and ecosystems could suffer serious consequences, especially when combined with the expected negative impacts of climate change and variability. These changes are likely to affect urban coastal areas, where the majority of the population lives.

Sound policies for social and territorial cohesion in rural areas are also needed to ensure sustainable urban development. Urban sustainability is linked to food security and sustainable forms of rural development: poor conditions in rural areas have a profound social and political impact on cities, as they can lead to a rural exodus and attendant increase in urban populations.

Climate change

Climate change is emerging as the primary driver of environmental change in the region. The Mediterranean has been identified as one of the most reactive regions to climate change and defined as a major "hotspot" (Giorgi, 2006) based on the results of global climate change projections. The latest

[5]Data available for European countries and the ten South European Neighborhood Policy countries: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syrian Arab Republic and Tunisia.

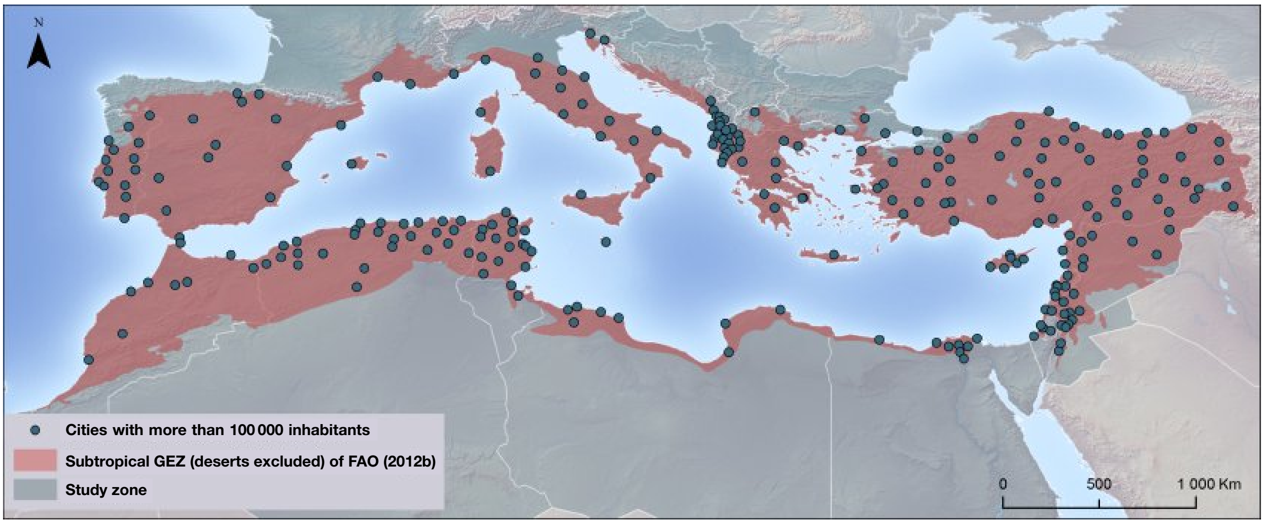

Figure 1.17. Large Mediterranean cities
Source: UN-Habitat (2008a,b).

report of the Intergovernmental Panel on Climate Change (IPCC, 2013) identifies the Mediterranean as one of the regions most vulnerable to the impacts of global warming. This reinforces the need to assess the potential impacts of climate change on the Mediterranean, a sensitive region that is likely to become warmer and drier (IPCC, 2007a, 2013) (Figure 1.18).

Environmental changes, both current and projected over coming years, are marked by the speed at which they will occur. Their anticipated impact is also greater, given rapid change does not allow for gradual acclimatization and adaptation by ecosystems and societies.

The primary projected impacts of climate change on the natural environment in the Mediterranean are: rapid change in the water cycle due to increased evaporation and lower precipitation (between 15 and 30 percent by 2030); a decrease in soil water storage capacity (due to changes in porosity resulting from a change in temperatures, making soil drier) and thus an acceleration of desertification already underway (overexploitation and depletion of soils); a northward shift in altitude of marine and terrestrial biodiversity (animals and plants); and extinction of the most climate-sensitive or least mobile species and colonization by new species (see Chapter 5).[6]

A governance system constantly evolving

New governance models

Today, the Mediterranean region has undoubtedly attracted significant international interest. The Arab Spring, the Syrian conflict, the economic crisis and questions regarding the future of Europe as a community, all have a clear international impact. Following the 2011 Arab uprisings in the Mediterranean's south and east, the region has reached an historical turning point, presenting as many opportunities as challenges. The European Union itself is facing serious financial and economic crises.

Significant differences in levels of development and living standards between countries, as well as conflicts in the region, affect investment and development and represent challenges for the Mediterranean basin's future sustainability. Sustainable development planning and new models of governance must be supported, geared towards high levels of cooperation, exchange and solidarity (IEMed, 2016).

[6] The impact of climate change on Mediterranean forests and possible responses to it are developed in specific chapters of this report (Chapters 5 and 8).

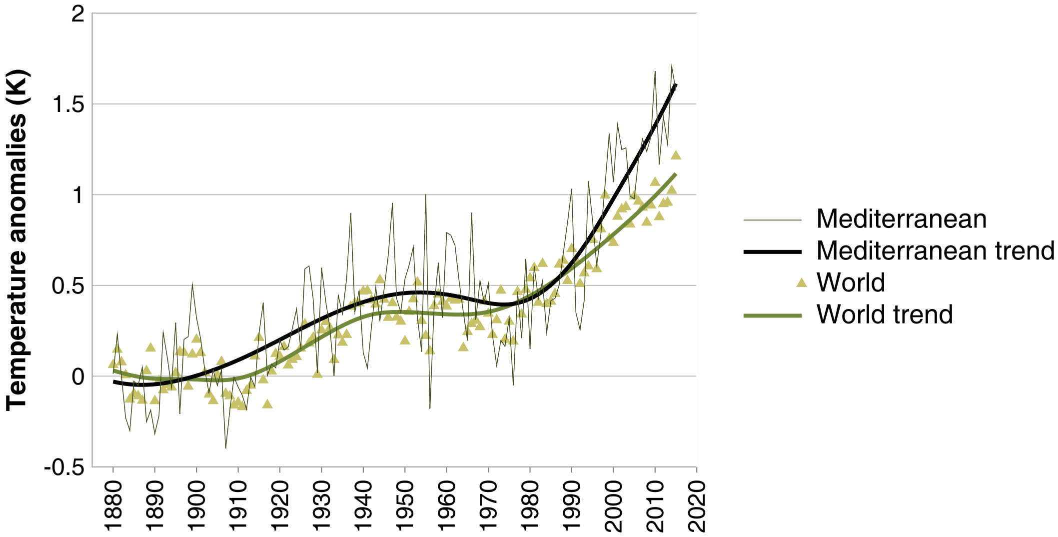

Figure 1.18. Comparison of climate change forecasts in the Mediterranean and around the world since 1880
Source: Berkeley Earth (2017).

One of the lessons to be learned from the Arab Spring is the transformation of countries in the Mediterranean south, propelled by a newly educated and mobilized generation, who is open to the world and refuses to be prevented from participating in their countries' governance. These young people recognize that economic and social rights are inseparable from political and civil rights and that these rights are universal (IEMed, 2016). As a result, governance has been increasingly characterized by the inclusion of non-state actors, such as civil society, the private sector and international organizations, in the decision-making process (see Chapter 12). This is likely to lead to new types of cooperation agreements at both the national and transnational levels. Vertical, multi-level governance has increased decentralization at all government levels. At the same time, a system of multi-polar, horizontal governance, including parallel systems for common rule making, has emerged.

Challenges to effective environmental governance include horizontal and vertical fragmentation of environmental responsibilities, planning and management, lack of enforcement and non-coordination, as well as a lack of human and financial resources in the public sector, particularly at the local level. Other governance challenges confronting Mediterranean countries include inadequate awareness, education, research and innovation and knowledge and information exchanges.

Effective and efficient governance in the Mediterranean requires increased participation in decision-making and cooperation at all levels (local, regional and national) to ensure social justice considerations are taken into account. In order to address inequalities, participation and cooperation must be strengthened and more opportunities for sustainable development must be found. Governance must be flexible, innovative and adaptable; open to new institutional forms based on discussion and participation, as well as innovative regulatory designs and constructive practices directly related to sustainability (UNEP/MAP, 2016).

Strengthening the institutional landscape

The need for cooperation and coordination across the Mediterranean region has long been recognized, resulting in nearly a century of international efforts to protect this fragile and vulnerable ecosystem. These have included: the Mediterranean Action Plan (MAP) created in 1975; the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean signed in 1976; the Euro-Mediterranean Partnership (EUROMED); and the Committee on Mediterranean Forestry Questions-*Silva Mediterranea*. The EUROMED partnership, also known as the "Barcelona Process," was re-launched in 2008 as the Union for the Mediterranean (UfM). In 2005, Euro-Mediterranean partners committed themselves to substantially reducing pollution in the Mediterranean region by 2020. This initiative was named the “Horizon 2020 Initiative” (H2020) and approved in Cairo in 2006 (AEE, 2015).

Silva Mediterranea established in 2011 is now a statutory body of the Food and Agriculture Organization of the United Nations (FAO), and works closely with partners in the Mediterranean region to implement international commitments and forestry initiatives. The objective of the Committee is to facilitate exchanges and cooperation on forestry questions between Mediterranean countries and institutions. Particular emphasis is placed on the importance of Mediterranean forests to the people who depend on them for their well-being, as well as their socioeconomic role, contribution to biodiversity, climate change and desertification and sustainable forest management and planning.

Other regional initiatives focus on specific issues to be addressed at the regional level, such as the most significant sources of environmental degradation in the Mediterranean region.

The Mediterranean Strategy for Sustainable Development (MSSD) is an integrative policy framework and strategic guidance document for all stakeholders and partners, translating the 2030 Agenda for Sustainable Development for application at the regional, sub-regional and national level. Contracting Parties to the Barcelona Convention adopted a first version of the MSSD (2005-2015) in 2005. The second version (2016-2025) was adopted in 2016.

The vision of the MSSD responds to the need to orient the sustainable development agenda towards a “prosperous and peaceful Mediterranean region in which people enjoy a high quality of life and where sustainable development takes place within the carrying capacity of healthy ecosystems” (UNEP/MAP, 2016). It addresses key sectors, including rural and agricultural systems in its second objective, “promoting resource management, food production and food security through sustainable forms of rural development.”

The MSSD calls for the conservation and use of indigenous or traditional plant varieties and domestic animal breeds, valuing traditional knowledge and practices in decisions relating to the management of rural areas. It promotes networks of ecologically protected areas, increasing stakeholder awareness of the value of ecosystem services and of the implications of biodiversity loss. It also recommends inclusive and sustainable rural development, poverty eradication, women’s empowerment, youth employment and equitable access by local producers to basic local services, distribution and market channels, including the tourism market.

The MSSD stresses the need to ensure that national regulatory measures to promote the sustainable use, management and conservation of natural resources and ecosystems are put in place in accordance with international and regional commitments. It provides for effective and participatory management of protected areas and exploitation of renewable natural resources for regulated development in rural areas, including through environmental impact assessments, strategic environmental assessments and licensing processes. The MSSD aims to improve the effectiveness of sustainable rural development and limit the unsustainable use of natural resources and ecosystem goods and services, particularly energy, food and water. It recommends institutional and legal reforms to foster water cooperation programmes in all sectors and across borders. One of its goals is to take urgent and significant measures to reduce the degradation and fragmentation of natural habitats, halt the loss of biodiversity and, by 2020, protect endangered species, prevent their extinction and promote adaptation to the effects of climate change.

2

The Mediterranean landscape: importance and threats

Trees are intimately linked to the Mediterranean landscape. A forest with Aleppo pines, a scrubland with holm oaks, an agroforestry system with olive trees, a forest with cork oaks or a city with stone pines are all immediately identifiable as distinctly Mediterranean. This distinctiveness is not coincidental but the result of long-term interactions with other components of the landscape that have shaped its identity. From an ecological point of view, Mediterranean tree species have evolved in a specific climate, resulting in specific features. Mediterranean flora has the distinction of being both diverse and having a high level of endemism. The Mediterranean region can thus be defined based on its bioclimate or almost equivalently based on the characteristics of its distinctive vegetation, with its typical plant and tree associations.

Since the establishment of civilizations in the Mediterranean thousands of years ago, the identifiability of the region's tree species has also developed based on the goods and services they provide. Olive groves or cork oak and grazing systems are typical examples. The use of forest ecosystems for the provision of goods and services raises another, more geopolitical, view of the region. Ultimately, one's definition of the Mediterranean region will depend on the weight given to geographical, biological or political considerations. Nevertheless, forests and vegetation certainly contribute to this definition.

The importance of Mediterranean forests and trees is not only a question of regional identity. It is first and foremost linked to the goods and services they provide. To fully capture the diversity of these goods and services, the notion of "forests" is to be taken as a blanket term including both forests in the strict sense and various other wooded lands and trees, including trees in agroforestry systems and urban and peri-urban forests.

Before considering these goods and services in detail in the second Part of this book, one can gain an idea of their regional importance by considering the extent of Mediterranean forests and trees outside forests. In order to conserve these valuable goods and services for the benefit of populations and the environment, it is important to be aware of their potential, while respecting the natural load these ecosystems can sustainably support. Moreover, in a context of a changing climate, Mediterranean forests have the advantage of foreshadowing the likely future of large forested areas to the north. Hence, the importance of Mediterranean forests derives both from their current value in terms of area and goods and services, and from the role they are likely to play in the future.

Unless action is taken, the future of Mediterranean forests may be undermined by several factors driven by climate change and demographic increase. Climate change will have a significant impact on Mediterranean ecosystems. By 2100, the Mediterranean climate is predicted to experience an average temperature rise of between 2°C and 4°C, rainfall is expected to decrease by between 4 and 30 percent and sea levels are projected to increases by between 18 and 59 cm (IPCC, 2007b). In addition to ecological changes, climate change risks include conversion of forests to fire prone shrub communities, outbreaks of pests and pathogens and wildfire and other large-scale disturbances (Resco de Dios *et al.*, 2007). Climate change will have a greater impact on the Mediterranean biome than others because of its exceptional biodiversity and the closeness of the distribution range of the species to the limits of their ecological niche. Due to the uniqueness of the Mediterranean biome, it is likely the impact of global changes will be experienced similarly across the region. It is therefore, advisable to adopt regional approaches to address the impact of climate change on Mediterranean forest ecosystems. Nevertheless, the interplay between climate change, other drivers of change and local particularities means that any regional approaches will require some adaptation to suit local conditions.

It is anticipated that demographic evolution will be another major driver of Mediterranean forest ecosystem change in the near future. The Mediterranean population has grown from 259 million in 1960 to 552 million today, and is expected to increase to 670 million by 2050 (World Bank, 2015a). This trend is not spatially homogeneous, with most of the population growth now occurring in southern and eastern countries, particularly in urban and coastal areas. This population increase and the spatial redistribution of populations within countries (e.g. between rural and urban areas) or across countries (e.g. migration) are already changing the way forest ecosystems are used and managed. Increased population numbers will intensify pressure on the resources provided by forests (fodder, fuelwood, non-wood forest products) with potential escalation of forest degradation. At the same time, rural exodus is already leading to an accumulation of unmanaged biomass and increased risks of large fires. Overall, increased population will highlight needs related to forest management such as access to water. As urban populations increase, recreational peri-urban forests and green urban infrastructure may become a priority.

To understand the challenges Mediterranean forests currently face and will face in the future, we must consider them in a global context. Climate change and population growth are global issues from which the Mediterranean region is not excluded. Under the three Rio Conventions and the United Nations 2030 Agenda for Sustainable Development, countries have made commitments pertaining to their forests. Mediterranean countries are aware of the important role their forests can play in the global climate change agenda. This can be seen from the role of the forest sector in Mediterranean countries' Nationally Determined Contributions (NDCs) to reductions in greenhouse gas emissions under the United Nations Framework Convention on Climate Change (UNFCCC), their National Biodiversity Strategies and Action Plans under the Convention on Biological Diversity (CBD) and in their National Action Programmes under the United Nations Convention to Combat Desertification (UNCCD).

This Part of the book will aim to demonstrate why and how Mediterranean forests and trees are important and identify the challenges Mediterranean forests currently face. Chapter 2 will establish the importance of Mediterranean forests in the global context, including countries' commitments under the global sustainable development agenda. Chapter 3 will outline the importance of Mediterranean forests in terms of area, growing stock and biomass. This Chapter will also address the place of forests with respect to other landscape components by assessing land use and land use change in the Mediterranean. Chapter 4 will focus on those trees outside forests making a significant contribution to the goods and services provided by tree-based ecosystems in the Mediterranean. Chapter 5 will demonstrate how the important role of Mediterranean forests and trees could be jeopardized in future if action is not taken to address drivers of degradation and other threats to the region's forests and trees.

2 Contribution of Mediterranean forests to the Global Agenda

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Introduction

The combined forest area of Mediterranean countries represents approximately 2 percent of the world's total forest area (FAO, 2015a), but the importance of Mediterranean forests with respect to global forest goals is far greater than this figure alone suggests. Because of the biodiversity in Mediterranean forests, because the region is one of the world's primary climate change hotspots (Giorgi, 2006) and because 7.3 percent of the world's human population lives in Mediterranean countries (World Bank, 2015a), the Mediterranean region is key to addressing global goals on forests.

The global conventions of primary importance related to forests are the three Rio Conventions, which date back from 1992. These are: the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD). These three Conventions, together with other multilateral agreements, contribute to sustainable forest management by regulating activities within their scope. Recent progress on important UN goals and conventions has put additional emphasis on the role of forests in the global sustainable development agenda:

- Several of the 17 Sustainable Development Goals (SDGs) established as part of the 2030 Agenda for Sustainable Development and adopted at the United Nations Summit on Sustainable Development in September 2015 are directly or indirectly related to forests. SDG 15, in particular, addresses sustainable forest management.
- The Paris Agreement, adopted on 12 December 2015 at the UNFCCC COP 21, emphasized the role of forests in strengthening the global response to the threat of climate change. Article 5 of the Paris Agreement specifically encourages Parties to "take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases (…) including forests."
- The UN Forest Instrument (UNFI), formerly Non-Legally Binding Instrument on All Types of Forests (NLBI), provides a framework for promoting sustainable forest management. The UNFI articulates a series of agreed policies and measures at the international and national levels to strengthen forest governance, technical and institutional capacity, policy and legal frameworks, forest sector investment and stakeholder participation. Key elements are: (i) to strengthen political commitment

and action at all levels to implement effective sustainable management of all types of forests and to achieve the shared global objectives on forests; (ii) to enhance the contribution of forests to the achievement of the internationally agreed development goals, including the Millennium Development Goals, in particular with respect to poverty eradication and environmental sustainability; and (iii) to provide a framework for national action and international cooperation.

- The first UN Strategic Plan for Forests 2017-2030, adopted at a special session of the United Nations Forum on Forests (UNFF) on 20 January 2017, defined six Global Forest Goals and 26 associated targets to be achieved by 2030, including the target to expand the world's forests by 3 percent, or about 120 million hectares, by 2030. These Global Forest Goals are closely connected to the SDGs, the Aichi Biodiversity Targets of the CBD and the Paris Agreement on climate change, among others.

This chapter aims to demonstrate the particular relevance of Mediterranean forests to the global agenda and how they can contribute, in view of their particularities, to fulfilling international commitments on the environment.

Mediterranean forests and the Sustainable Development Goals

Two SDGs directly address forests, with specific targets:

- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss;
    - 15.1. By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements;
    - 15.2. By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally;
    - 15.10. Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.
- Goal 6: Ensure availability and sustainable management of water and sanitation for all;
    - 6.6. By 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

Given their multifunctionality, forests also play a role also in the accomplishment of other SDGs and targets:

- Goal 1: End poverty in all its forms everywhere;
- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture;
- Goal 3: Ensure healthy lives and promote well-being for all at all ages;
- Goal 5: Achieve gender equality and empower all women and girls;
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all;
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive

employment and decent work for all;

- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable;
- Goal 13: Take urgent action to combat climate change and its impacts.

One of the many challenges facing the Mediterranean forestry sector is poverty (SDG 1). As a representative example of most countries in the southern Mediterranean, 15 percent of the Turkish population living in forests or forest-neighbouring villages subsist far below the average national poverty level (as stated by the World Bank in 2001 and 2017). In most cases, these people do not make their living from the forest. Instead, their incomes depend on alternative land uses that often compete with forestry, such as agriculture or grazing. Local villagers, however, depend on forests for firewood, animal fodder and grazing.

Initiatives and projects around the Mediterranean are already contributing to poverty alleviation and the achievement of SDG 1. In Tunisia, for example, community-based organizations and private owners are involved in co-management of forests and rangelands to grapple with poverty issues and reconcile the conservation of forests and rangelands with socioeconomic development by: (1) building capacity and adapting the sector's institutional and legal framework; (2) optimizing the sector's contribution to socioeconomic development; (3) maintaining and enhancing the sector's environmental functions and services; and (4) consolidating and improving the forest and rangelands' capital (World Bank, 2017).

Incomes from Mediterranean forests not only benefit local villagers but also contribute to national revenue and the population's overall well-being. Poverty, hunger and food security (SDG 1 and 2) are strictly interrelated. For this reason, national and regional strategies in the Mediterranean region must better reflect an emphasis on the role of forests and agroforestry (Box 2.1).

Box 2.1. SDG 2: forests and food security in Turkish national forestry legislation

The term "food security" is never directly mentioned in Turkey's national forestry legislation but is often referred to by different names.

For example, in the first article of Forest Law N.6831, "tree and woodland communities, which are grown by human efforts, are regarded as Forest, together with their lands." Based on this article, trees such as olive, walnut, chestnut and pistachio, which grow naturally in forests, were subject to private afforestation and supported by credit under special circumstances.

In 2011, a Non-wood Products and Services Department was established at the General Directorate of Forestry, which is responsible for: (i) products and services provided by forest ecosystems; (ii) support for the production of wood and non-wood forest products and their contribution to the development of value-chains; (iii) the protection and development of forest water resources; (iv) hunting and wildlife, grazing and beekeeping in forests.

In addition to the above-mentioned duties, several studies and action plans aimed at strengthening the role of forests in Turkey's food security were established, such as the Truffle Mushroom Forest Action Plan (OGM, 2014b), the Gum Tree (*Pistacia lentiscus*) Forest Action Plan (OGM, 2014a), the Chestnut Forest Action Plan (OGM, 2013), the Carob (*Ceratonia siliqua*) Forest Action Plan, the Almond (*Amygdolus communis*) Forest Action Plan, the Honey Forest Action Plan and the Walnut Forest Action Plan.

Moreover, grazing, which is fundamental to Turkey's forest sector, is regulated by Article 7 of Forest Law N.6831.

Mediterranean forests also make a strong contribution to SDG 3. Nowadays the role of forests and nature-based activities in promoting health, well-being and quality of life are well known (Cervinka *et al.*, 2014) and Mediterranean forests are valued and widely preferred over other forests for tourism and recreational activities (UNWTO, 2017).

One of the characteristics of this unique region is its rich biodiversity, reflected in its various habitats. This unique environment can only be maintained by the sustainable management, conservation and restoration of the Mediterranean's fragile and threatened forest resources (FAO and Plan Bleu, 2013). Various initiatives in this regard are and will continue to contribute to the achievement of SDG 15. Recent initiatives such as the Ankara Initiative, launched at the UNCCD COP 12 and aimed at strengthening implementation of the UNCCD, will support the global sustainable development agenda and leverage the lessons learned from Turkey's experience and approaches to land management. In 2017, at the Fifth Mediterranean Forest Week (Agadir, March 2017), nine Mediterranean countries – Algeria, France, Iran, Lebanon, Morocco, Portugal, Spain, Tunisia and Turkey – endorsed the Agadir Commitment to restore at least 8 million hectares of degraded forest ecosystems by 2030. This regional Mediterranean initiative will encourage political and administrative authorities at the national level, as well as stakeholders involved in the management of Mediterranean forest ecosystems and other wooded lands, to strengthen their respective forest and landscape restoration efforts. These efforts take place in the context of the United Nations Strategic Plan for Forests 2017-2030 of the United Nations Forum for Forests and in line with the global Forest and Landscape Restoration (FLR) objectives of the Rio Conventions and the 2030 Agenda for Sustainable Development.

Regional initiatives such as these are designed to integrate policies and investments at the country level in order to adapt forests to climate change (SDG 13). The Mediterranean region is extremely sensitive to climate change, facing longer and more frequent droughts and heat waves, increasing the risk of large-scale forest fires and severe water scarcity (SDG 6). These impacts will affect both rural and urban populations. Forested watersheds and wetlands supply 75 percent of portable water to these areas. As a result, the region is already subject to significant hydric stress (while the region is home to 7.3 percent of the global population, it can access only 1 percent of the world's renewable water resources). This exposure will be exacerbated by a predicted reduction in already scarce water resources: almost 290 million people in southeastern Mediterranean countries could face water shortages by 2050 (Birot *et al.*, 2011). It is, therefore, important to recognize the role forest ecosystems play in conserving and

Figure 2.1. *Tuber melanosporum* in Catalonia © Håvard Kauserud

regulating water resources.

Mediterranean forests are multifunctional forest resources, providing various non-wood forest products (NWFP). The region's exceptional species and genetic diversity enable the production and harvesting of a diverse range of products, such as mushrooms, honey, cork, chestnut, resins, truffles, aromatic and medicinal plants and pinecones (Figure 2.1). Although traditional forest management is not typically oriented towards the production of NWFPs (with the exception of cork), these products can be of high importance to local economies, generating income, employment and encouraging rural development (Slovenia Forest Service, 2012). Women often have a key role in the growth and extraction of these products (e.g. medicinal and aromatic plants, beekeeping and the production of argan oil in Morocco) for personal use or in furtherance of traditional non-farming enterprises.

Interest in and use of NWFPs has been increasing over the last decade. This has required regulations in order to prevent collected amounts from exceeding that required for personal use or causing permanent damage to forest resources. In recent years, contract mechanisms, licences or permits for the use of NWFPs, issued by forest owners, have been implemented in some Mediterranean countries (e.g. France, Italy and Turkey). These initiatives, coupled with supporting mechanisms such as loans, grants and technical assistance to enable women to take advantage of these emerging economic opportunities, may also significantly contribute to SDG 5.

The production of timber in Mediterranean forests is limited, particularly in southern Mediterranean countries (Slovenia Forest Service, 2012). More than 62 percent of regional wood production is concentrated in northwestern Mediterranean countries (France, Italy and Spain). These lead both the production of timber (64 percent of overall production in the region) and firewood (62 percent). The northwestern Mediterranean sub-region accounts for up to 81 percent of the total value of firewood. The primary forest product in the south Mediterranean sub-region is firewood (60-64 percent of the value of all wood products in this sub-region) (Masiero *et al.*, 2016).

These figures confirm the importance of forestry resources to local rural communities (especially in the south) and also highlight the need to regulate management of forest resources to maximize their ability to provide affordable and reliable energy to local populations. Governments, recognizing the comparative benefits of wood in terms of increased energy efficiency and reduced carbon footprint when compared to other materials, should promote initiatives that favour both wood and the transition to sustainable energy production in the region (SDG 7).

Box 2.2. Barcelona's green plan

Following the publication of the European Strategy to promote the use of green infrastructure in Europe in 2013, Barcelona developed its Green Infrastructure and Biodiversity Plan (Barcelona City Council, 2013). The plan envisages "a network of spaces with public or private agricultural or landscaped natural vegetation [and] a multi-purpose resource providing ecological, environmental, social and economic services. These services are enhanced further when connectivity of green infrastructure is achieved." By increasing connectivity between spaces using green corridors such as forests, parks and vegetable gardens in urban areas, the "multifunctionality" of the city is encouraged. The plan also aims to integrate green and other urban infrastructure.

Many of the benefits Mediterranean forests provide are intangible. Understanding the contribution of Mediterranean forests towards building a green economy (SDG 8), such as generating employment and providing ecosystem services, has been much discussed over recent years. It is now critical for forest managers and governments to account more effectively for forest stocks and flows (see Chapter 10).

Several good practice examples are already occurring in the region (Croitoru and Liagre, 2013) but further efforts are needed to improve governance and inter-sectoral cooperation.

In recent decades, the Mediterranean region has been characterized by increased migration from rural to urban areas. Today, 3.5 billion people, or half the world's population, live in cities across the globe. It is envisaged that 60 percent of the world's population will live in cities by 2030. It is also predicted that 90 percent of urban growth in coming years will be in developing countries. This will result in the depletion and degradation of natural ecosystems in and around urban areas, the drastic loss of vital ecosystem services and, potentially, a lack of resilience to disturbances such as those caused by climate change (Salbitano *et al.*, 2016). Evidence showing the unsustainability of urban growth is increasingly drawing attention to the need to develop sustainable urban models capable of responding to increasing demands for food and basic ecosystem services. Achieving SDG 11, which relates to cities, will depend on the sustainable management of urban and peri-urban Mediterranean forests. Well-designed and managed Mediterranean urban forests make significant contributions to the environmental sustainability, economic viability and habitability of cities (see Box 2.2). They help mitigate climate change and natural disasters, reduce energy costs, poverty and malnutrition and provide ecosystem services and public benefits.

Mediterranean forests and international commitments

United Nations Framework Convention on Climate Change

Forests will play a key role in helping parties to meet their climate targets under the UNFCCC (Grassi *et al.*, 2017). According to Article 4 of the Paris Agreement, each Party shall prepare, communicate and maintain successive Nationally Determined Contributions (NDCs) that it intends to achieve. Each NDC defines a country's emission reduction targets and the steps it will take to address and adapt to the impacts of climate change.

Countries published their Intended NDCs in the lead-up to the UNFCCC COP 21 in Paris. Upon ratification of the Paris Agreement, these INDCs became parties' first NDCs (except in cases where parties decided to submit a new NDC). The often complicated design of each country's NDC targets can make it difficult to assess and compare respective NDC ambitions (Hargita and Rüter, 2015). Nevertheless, forests often have a prominent role in Mediterranean countries' NDCs. Annex A lists the role of forests in the NDCs or INDCs of these countries.

Among the various mechanisms developed within the UNFCCC, it is worth mentioning the REDD+ (Reducing Emissions from Deforestation and forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks) mechanism acknowledged in Article 5 of the Paris Agreement. REDD+ was developed prior to the Paris Agreement to provide incentives to Non-Annex I countries to undertake mitigation activities in the forestry sector. Two Mediterranean countries have joined the UN-REDD Programme: Morocco in October 2012 and Tunisia in December 2013. Tunisia has conducted preliminary studies into implementing a national REDD+ strategy. Other Mediterranean countries have explored the option of NAMAs (Nationally Appropriate Mitigation Actions) to carry out mitigation or adaption activities in the forestry sector (Torres and Martinet, 2016). The relevance of REDD+ and NAMAs to Mediterranean forests is further addressed in Chapter 14.

Convention on Biological Diversity

The Forest Biodiversity Programme is one of the Convention on Biological Diversity's (CBD) seven programmes. The Programme is focused on three key elements: (i) reducing threats to forest biological diversity; (ii) the creation of an institutional and socioeconomic environment that will facilitate the conservation and sustainable use of forest biological diversity; and (iii) assessment and monitoring of forest biodiversity. The main instruments for implementing the CBD at a national level are the National Biodiversity Strategies and Action Plans (NBSAPs). Parties to the CBD are required to prepare a national biodiversity strategy (or equivalent instrument) and to ensure the strategy is mainstreamed into the planning and activities of all sectors whose activities could have an impact (positive or negative) on biodiversity. Because Mediterranean forests are the repository of significant biodiversity and because the region has a long history of human occupation, most Mediterranean ecosystems are semi-natural socio-ecosystems of high cultural, economic and biological value (e.g. cork oak forests). Most of the national targets defined in countries' NBSAPs will concern Mediterranean forests in some way. Annex A lists some of the Mediterranean NBSAP country targets relating specifically to forests.

The CBD implements the Forest Ecosystem Restoration Initiative (FERI) which supports country parties as they develop and operationalize national targets and plans for ecosystem conservation and restoration within the framework of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets.

The Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets, adopted at CBD COP 10 in 2010 in Nagoya, established biodiversity targets which are highly relevant to Mediterranean forests and aligned with the SDGs (CBD, 2017). Forests and degraded lands are explicitly addressed in three Aichi Targets:

- Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
- Target 7: By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
- Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 percent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

The Fifth National Report and Assessment of NBSAPs under the CBD reveals the following level of progress towards these Aichi Targets in the Mediterranean region (CBD, 2017):

- Percentage of Mediterranean countries that have submitted their Fifth National Report to the CBD: 92 percent
- Percentage of Mediterranean countries that have submitted their NBSAP: 48 percent
- Percentage of Mediterranean countries that have set a national target under Target 5: 65 percent
- Percentage of Mediterranean countries that have set a national target under Target 15: 57 percent.

United Nations Convention to Combat Desertification

Forests are among the UNCCD's six thematic priorities because of their critical role in eradicating poverty in the drylands and providing protection from desertification and drought. The UNCCD promotes both sustainable land and forest management to prevent land and forest degradation and the restoration of already degraded land and forests. Since the adoption of a ten-year Strategy at the UNCCD COP 8 in 2007, parties have been reporting on their implementation of the Convention at various levels. National Action Programmes (NAPs) to combat desertification are the key instruments to implement the UNCCD. Annex A lists forest-related objectives or measures included in the NAPs of Mediterranean countries.

In addition to NAPs, implementation of the UNCCD relies on Regional Action Programmes and Sub-Regional Action Programmes (SRAP) to harmonize, complement and increase the efficiency of NAPs. Regions are listed in the Annexes of the Convention and Mediterranean countries cover four regions: Annex I: Africa, Annex II: Asia, Annex IV: Northern Mediterranean, and Annex V: Central and Eastern Europe. The Union du Maghreb Arabe has detailed a SRAP for the Maghreb region.

The UNCCD has also established a global mechanism called the Land Degradation Neutrality Target Setting Programme (LDN TSP). LDN TSP is a voluntary target programme seeking to respond to the following challenge: how do we sustainably intensify the production of food, fuel and fibre to meet future demand without further degrading our finite land resource base? The LDN TSP supports interested countries in their LDN target-setting process, including defining national baselines, targets and associated measures to achieve LDN by 2030. As of September 2017, 110 countries have committed to setting LDN targets, including 12 Mediterranean countries (Algeria, Bosnia and Herzegovina, Croatia, Egypt, Italy, Jordan, Lebanon, Morocco, Serbia, Syrian Arab Republic, the former Yugoslav Republic of Macedonia and Turkey). Three Mediterranean countries (Algeria, Italy and Turkey) have engaged in LDN pilot projects to implement the LDN target-setting approach.

Putting into practice lessons learnt from their LDN Pilot Project, Turkey has initiated an LDN Transformative Project in Upper Sakarya Basin. The project will seek to integrate and implement best practice tools and methods learnt from previous projects. The Project will set out to develop a model for LDN target-setting, planning and implementation in the upper Sakarya basin with the aim of expanding the programme to a national level consistent with SDG target 15.3 and COP 12 on the LDN concept.

Algeria's LDN pilot project includes a National Reforestation Plan with the aim of rehabilitating 425 000 ha of forest by 2025 and protecting or sustainably managing 2 million ha of overgrazed lands by 2030 (MADRP, 2015). Italy's LDN targets comprise identifying the causes of forest decline and implementing appropriate rehabilitation measures on 1 325 000 ha of declining lands by 2030, divided as follows: 20 000 ha of dryland forests; 1 200 000 ha of non-dryland forests; 5 000 ha of shrubs, grasslands and sparsely vegetated drylands; and 100 000 ha of shrubs, grasslands and sparsely vegetated non-drylands (MATTM, 2015). Turkey's LDN targets include: a 5 percent increase in national forest area; afforestation of 15 000 km^2; rehabilitation of 15 000 km^2 of forest lands; a reduction in the average area per fire from 2.7 ha to 2.2 ha and a 3 percent reduction in the number of fires caused by human activity by 2030; rehabilitation of 58 km^2 of mine sites by 2019; a 1 416 decrease in the number of forest crimes; and a 2.7 percent increase in mechanical, biological and biotechnical pest control by 2017 (MFWA, 2016).

Regional Mediterranean forest initiatives which contribute to achieving the Sustainable Development Goals

Mediterranean forests contribute to the global agenda through various ongoing regional initiatives.

Silva Mediterranea was founded in 1911 to promote regional cooperation and sustainable management of Mediterranean forests. It later became the Committee on Mediterranean Forestry Questions-*Silva Mediterranea* of FAO. The Committee includes 28 members (27 countries and the European Union). Since its foundation, *Silva Mediterranea* has worked with the governments and institutes of member countries to examine regional trends in forest and land use, identify priorities for research and implement studies and surveys. Member countries exchange information and technology and share resources and expertise as they work together on selected topics of mutual interest. *Silva Mediterranea* currently comprises six working groups on forest fires, cork oak and non-timber forest products, forest management and sustainable development, forest genetic resources, urban and peri-urban forestry, and desertification and restoration in Mediterranean drylands.

The Collaborative Partnership on Mediterranean Forests (CPMF) is an international association bringing together various institutions interested in the future of Mediterranean forests and involved in regional cooperation actions aimed at improving forest management and enhancing their social benefits. The CPMF has a number of members: FAO, Plan Bleu, a regional activity centre of the UN Environment/Mediterranean Action Plan, the Global Mechanism of the United Nations Convention to Combat Desertification, the German Agency for International Cooperation (GIZ), the French Ministry of Agriculture, Food and Forests, the French Development Agency and French Global Environment Facility (AFD/FFEM), the International Association for Mediterranean Forests (AIFM), the Mediterranean Model Forest Network, the National Forestry Office-International (ONFi), the European Forest Institute's Mediterranean Office, the Forest Sciences Center of Catalonia (CTFC), the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM), the International Union for Conservation of Nature-Centre for Mediterranean Cooperation, the World Wide Fund for Nature's Mediterranean Programme, the Association of Forest Communities (COFOR International), the Turkish International Cooperation and Development Agency (TIKA) and the United Nations Development Programme Turkey.

Since 2010, several regional partners have committed to holding a Mediterranean Forest Week (MFW) every two years in a member country. The MFW was conceived as a common regional platform for cooperation on Mediterranean forests, aimed at improving dialogue between the Mediterranean forest research community, policy-makers and relevant stakeholders, as well as communicating the relevance and challenges faced by Mediterranean forests to the international community and society at large.

The Third MFW, held in Tlemcen, Algeria in 2013, adopted the "Strategic framework on Mediterranean Forests: Policy orientations for integrated management of forest ecosystems in Mediterranean landscapes" as a tool to provide a common policy direction for the integrated management of Mediterranean forest ecosystems. During the same event, the high level segment endorsed the Tlemcen Declaration, marking the political commitment of ministers and heads of delegation to consider the policy orientations proposed by Mediterranean experts during the event.

During the Fifth MFW held in Agadir, Morocco in 2017, the high level segment endorsed the Agadir Commitment to improve regional forest and landscape restoration, achieve Land Degradation Neutrality (LDN) and biodiversity conservation efforts. Under this Commitment, parties undertook to establish a new Regional Mediterranean Initiative on Forest and Landscape Restoration (FLR) to support the achievement of the Bonn Challenge and Sustainable Development Goal 15 (SDG15). This initiative also encourages national political and administrative authorities, as well as stakeholders involved in the management of Mediterranean forest ecosystems and other wooded lands, to strengthen their FLR efforts in furtherance of the United Nations Strategic Plan for Forests 2017-2030 of the United Nations Forum for Forests (UNFF) and in line with the global FLR objectives of the Rio Conventions and the 2030 Agenda for Sustainable Development. The Regional Mediterranean Initiative aims to restore at least 8 million hectares by 2030 and will join other regional initiatives such as the Great Green Wall Initiative for the Sahara and the Sahel and the 3 S Initiative ("Sustainability, Stability and Security in Africa"), which aims to strengthen synergies between the Rio Conventions and the SDGs.

During UNFCCC COP 22 in Marrakech in 2016, Morocco launched the AFMS Initiative entitled "Enhanced Action for Forests in the Med-Sahel Region in the Context of Climate Change," which aims to establish a regional cooperation and partnership framework. The initiative will reinforce regional FLR and LDN cooperation, particularly through enhancing coordination among organizations. It will also mobilize the *Silva Mediterranea* expert working group on desertification and restoration of Mediterranean drylands and develop targeted strategic collaborations with regions facing similar challenges in drylands, such as the Sahel.

At UNCCD COP 12 in 2016, the Ankara Initiative was launched to (i) strengthen implementation of the UNCCD; (ii) support implementation of COP decisions; (iii) achieve LDN; and (iv) support the implementation of SDG 15.3. Moreover, this regional initiative will contribute to the global agenda.

Conclusions

The role of Mediterranean forests in contributing to the achievement of the SDGs is already established. This role is attracting increased global attention thanks to several regional initiatives focused on the conservation and sustainable management of Mediterranean forest resources.

Recent international events such as the Twenty-Third Session of the Committee on Forestry (Rome, 2016) and the World Forestry Congress (South Africa, 2015) highlighted the role of Mediterranean forests in tackling climate change and promoting food security.

Action is still needed, however, to promote sustainable forest management to all relevant stakeholders, including local communities, forest owners and managers, farmers, herders, environmentalists, protected area managers and researchers.

Mediterranean forests support both agriculture and human well-being. It is therefore crucial to improve policies and practices to promote sustainable management of forest resources in a way that provides social and economic benefits while also increasing the resilience of ecosystems and societies.

3 Importance of Mediterranean forests

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This chapter aims to demonstrate the importance of Mediterranean forests with regard to forest resources. It will review different definitions of the "Mediterranean region," compiling forest statistics from Mediterranean countries (with regional aggregates) found in the Global Forest Resources Assessment of FAO. Many Mediterranean countries undertake national forest inventories (NFI) including regular monitoring. Theoretically, these country-level statistics could be extrapolated to the regional level. However, the lack of consistency between NFIs across countries makes it difficult to get a consistent regional picture, and using the results of regional studies such as the FAO's Global Dryland Assessment may still be a preferable means of establishing an overall regional picture of the extent of forest cover.

This chapter provides a snapshot of the state of Mediterranean forests in terms of area, growing stock, carbon stock and land use. It will predominantly base its analysis on the FAO definition of forests in Mediterranean countries, but other definitions will be included. The different figures obtained provide a complementary snapshot of Mediterranean forests captured from different angles.

The extent of the Mediterranean region

Even if a common definition of the core circum-Mediterranean Sea region existed, it is likely the precise extent of the region would differ depending on the emphasis placed on geographical, climatic, ecological or political factors.

All of these factors are relevant in the case of forests. A purely political (e.g. the number of countries containing a Mediterranean coastline) or geographical definition (e.g. the water catchment of the Mediterranean Sea) would exclude large areas with a Mediterranean bioclimate (e.g. Portugal, based on the two definitions given above). Conversely, such definitions could include large areas that do not have a Mediterranean bioclimate (e.g. most French territory, based on a political definition, or a large part of the Alps, based on a water catchment definition).

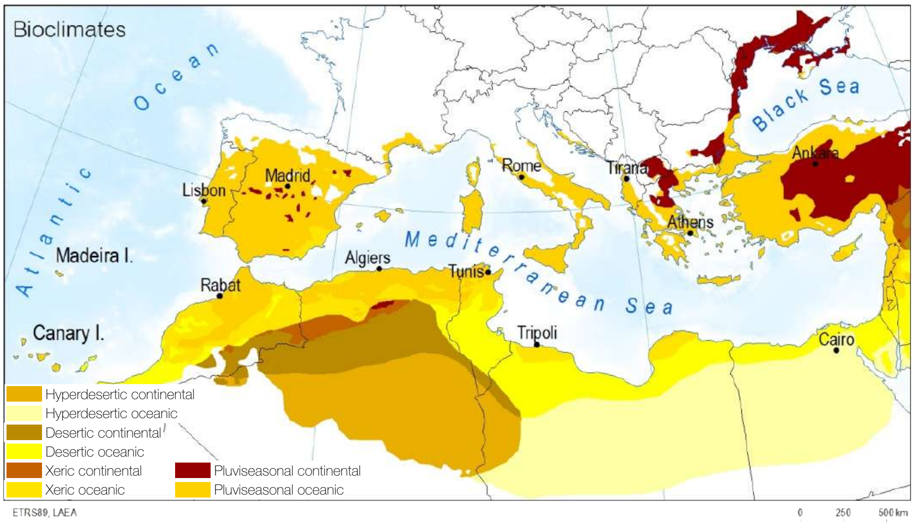

Figure 2.2. Mediterranean bioclimates in the area of study
Source: Rivas-Martínez *et al.* (2011).

Biogeography combines disciplines such as biology, climatology, ecology, edafology, evolution and geology to explain the distribution of animal and plant species. Biogeographic approaches to the definition of the Mediterranean region have mostly been based on factors such as vegetation, landform, soil and especially climate variables (i.e. bioclimatic) that influence vegetation growth and survival (FAO, 1999).

Two definitions of the Mediterranean region are based exclusively on bioclimatic variables. The region is characterized by a climate consisting of mild, rainy winters and hot, dry summers, and vegetation typified by forests, woodlands and scrubs. Again, the exact parameters of these definitions will depend on how climatic and biotic criteria are applied (Quézel, 1982). On the other hand, altitude and soil type have been less central to biogeographic approaches (Table 2.2). Among early attempts to delimit the Mediterranean bioclimate, Emberger's diagram using the mean minimum temperatures of the coldest month (m, in °C) in abscissa and the bioclimatic coefficient $Q = 2000P/(M^2 - m^2)$ (where P is the annual rainfall in mm, M the mean maximum temperatures of the hottest month in K, and m in K) has been a fruitful approach (Daget, 1977). Inspired by this approach, the UNESCO and FAO (1963) bioclimatic map of the Mediterranean region was based on a classification of ombrothermic diagrams and a xerothermic index (i.e. the index of hot weather drought).

Subsequent global applications of these bioclimatic approaches involved a larger set of bioclimatic variables and multivariate statistical analyses such as cluster analysis. Rivas-Martínez *et al.* (2011) designed a detailed bioclimatic classification system based on an extensive set of bioclimatic variables. This system classifies the world into five macrobioclimates, including a Mediterranean macrobioclimate divided into eight bioclimates.

The Mediterranean macrobioclimate is one of the largest typological units of the Rivas-Martínez *et al.* (2011) bioclimatic classification system. This macrobioclimate applies to all extra tropical regions of the Earth at any altitude and with any continentality value belonging to the subtropical and eutemperate zones (23° to 52°N & S), in which there are at least two consecutive arid months during the warmest part of the year, in which the value in millimetres of the average rainfall of the hottest two months of the summer quarter Ps_2 is less than twice the average temperature of the hottest two months of the summer quarter Ts_2 expressed in degrees centigrade ($Ps_2 < 2Ts_2$).

The Mediterranean macrobioclimate is composed of eight bioclimates: hyperdesertic-oceanic (26.8 percent), pluviseasonal-oceanic (24.9 percent), hyperdesertic-continental (12.9 percent), desertic-oceanic (11.8 percent), pluviseasonal-continental (8.12 percent), desertic-continental (6.96

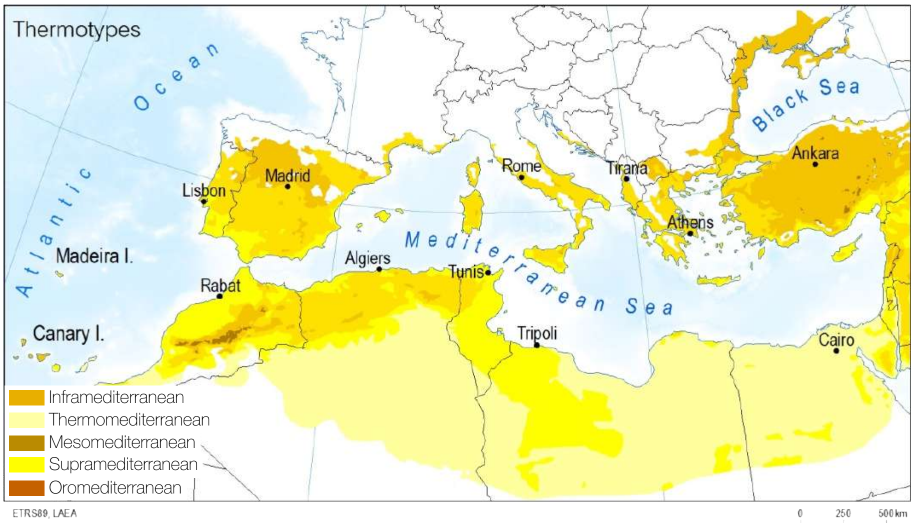

Figure 2.3. Thermotypes in the Mediterranean macrobioclimate in the study area
Source: Rivas-Martínez *et al.* (2011).

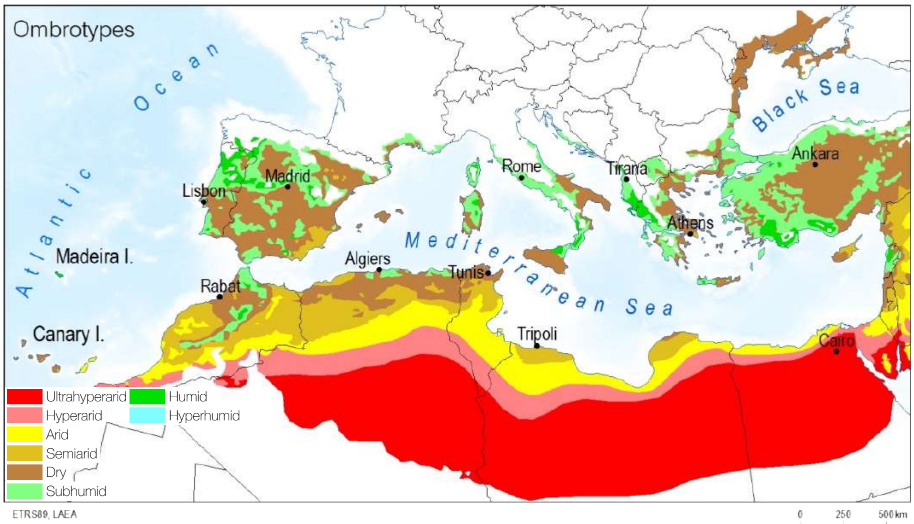

Figure 2.4. Ombrotypes in the Mediterranean macrobioclimate
Source: Rivas-Martínez *et al.* (2011).

percent) and xeric-continental (1.75 percent) (Figure 2.2). Forests cannot grow in desertic-oceanic, desertic-continental, hyperdesertic-oceanic or hyperdesertic-continental bioclimates.

A “thermotype” refers to a climate’s thermic category, taking into account various temperature parameters and indices such as the thermicity index (It), the compensated thermicity index (Itc) and the positive annual temperature (Tp). In order to account for regional climatic and vegetation differences, an altitudinal or latitudinal sequence of thermotypes (thermostages) is recognized in each of the macrobioclimates (including the Mediterranean bioclimate, see Figure 2.3).

Ombrotypes categorize precipitation rates. Because of their predictive value in the relationship between the climate and vegetation, the annual ombrothermic index (Io), monthly ombrothermic index (Iom) and summer ombrothermic indices (Ios) are the most widely used. The recognized ombric types are: ultrahyperarid, hyperarid, arid, semiarid, dry, subhumid, humid, hyperhumid and ultrahyperhumid (Figure 2.4).

Finally, bioclimatic stages refer to bioclimatic types conditioned by altitude or latitude. They are delimited according to thermoclimatic (thermotypes, It, Itc, Tp) and ombroclimatic factors (ombrotypes, Io). Each bioclimatic stage contains specific plant formations and communities, giving rise to the expression

Table 2.1. Bioclimatic stages representing combinations of thermotypes and ombrotypes where forest can exist

Thermotype	Ombrotype								
	Uha	Ha	A	Sa	D	Sh	H	Hh	Uhu
Inframediterranean	-	-	-	●	●	-	-	-	-
Thermomediterranean	-	-	-	-	●	●	-	-	-
Mesomediterraean	-	-	-	-	●	●	●	-	-
Supramediterraean	-	-	-	-	●	●	●	●	-
Oromediterraean	-	-	-	-	-	-	●	●	-
Crioromediterranean	-	-	-	-	-	-	-	-	-

Note: Uha = Ultrahyperarid; Ha = Hyperarid; A = Arid; Sa = Semiarid; D = Dry; Sh = Subhumid; H = Humid; Hh = Hyperhumid; Uhu = Ultrahyperhumid.

Source: Data sourced by authors.

"vegetation stages." Although the phenomenon of zoning is universally applicable, thermoclimatic thresholds (It, Itc, Tp) differ in the majority of macrobioclimates. Table 2.1 shows bioclimatic stages in the territory under study, including bioclimates where forests can grow.

Metzger *et al.* (2013) used 42 bioclimatic variables and hierarchical cluster analysis to classify the world into seven biomes, 18 global environmental zones and 125 global environmental strata.

The Global Ecological Zones (GEZ) of FAO (1999, 2012b) were based primarily on the Köppen-Trewartha climate map but also used vegetation maps to refine the global map and link it to vegetation types. These included the UNESCO and FAO Mediterranean vegetation map for the Middle East 1970. Although the GEZ did not identify a specific Mediterranean zone, instead classifying the world into five domains subdivided into 20 zones, the GEZ is the ecological classification adopted by the Intergovernmental Panel on Climate Change (IPCC) (Eggleston *et al.*, 2006) to define default values (Tier 1 value in IPCC tiered approach), and thus is important for UNFCCC greenhouse gas inventories. Sörensen (2007) is another worldwide classification system that relied on bioclimate variables (mean annual precipitation and mean annual potential evapotranspiration) to define levels of aridity within drylands. Like FAO's GEZ, this classification did not specifically identify the Mediterranean region but is relevant to the CBD and the UNCCD.

Other worldwide approaches have attempted to integrate more than bioclimactic information. Based on a worldwide compilation of biogeographic maps, Olson *et al.* (2001) identified the "Mediterranean forests, woodlands and scrub" biome, including 22 ecoregions around the Mediterranean Sea. Building on Metzger *et al.*'s map of bioclimates and adding information on landform, lithology and land cover, Sayre *et al.* (2014) identified 3 923 global ecological land units, several of which fall within the Mediterranean region.

All of the above classifications are consistent to some extent. Figure 2.5, for instance, compares the Palearctic component of the Mediterranean biome of Olson *et al.* (2001) with the drylands of Sörensen (2007) following removal of the hyperarid and arid zones (but including the presumed drylands). The two maps are largely consistent in their classification of the western Mediterranean. In the east, however, large areas of Turkey and Eastern Europe are classified as drylands by Sörensen, but excluded from the Mediterranean biome by Olson *et al.* The Mediterranean biome of Olson *et al.* (2001) is also similar in the western Mediterranean to the subtropical zones of the GEZ of FAO (2012b) when excluding subtropical deserts (Figure 2.6). In the east, large areas of Turkey and the Middle East are again classified as subtropical GEZ but excluded from the Mediterranean biome by Olson *et al.*.

The definition used for the Mediterranean region will ultimately determine its size and classification. With the growing availability of worldwide maps containing most bioclimatic, landform, geological, soil and land cover variables, it is likely that defining the Mediterranean region according to threshold values based on these variables will become less and less relevant. The current method used to predict the

Table 2.2. Maps of the Mediterranean region based on biogeographic and bioclimatic approaches. The column on the far right indicates whether a specific Mediterranean unit was identified among the different mapped units

Reference	Approach	Main variables	Scale	Units	Med. unit?
UNESCO and FAO (1963)	Bioclimate	Precipitation, temperature, humidity	Mediter-ranean	7 hot climates, 31 bioclimates	Yes
UNESCO and FAO (1970)	Biogeographic	Climate, vegetation physiognomy, soil and introduced vegetation	Mediter-ranean	105 vegetation types	Yes
Olson *et al.* (2001)	Biogeographic	Landform, vegetation and climate	Global	8 realms, 14 biomes, 867 ecoregions	Yes
Sörensen (2007)	Biogeographic	Precipitation, evapotranspiration, vegetation	Global	5 aridity zones	No
Rivas-Martínez *et al.* (2011)	Bioclimate	Precipitation, temperature, seasonality, evapotranspiration	Global	5 macrobiocli-mates, 28 bioclimates	Yes
FAO (1999, 2012b)	Bioclimate and vegetation Biogeographic	Climate, soil, landform, vegetation	Global	5 domains, 20 ecological zones	No
Metzger *et al.* (2013)	Bioclimate	Precipitation, temperature, seasonality and humidity	Global	7 biomes, 18 environmental zones, 125 environmental strata	No
Sayre *et al.* (2014)	Biogeographic	Bioclimate, landform, lithology and land cover	Global	3923 ecological land units	No

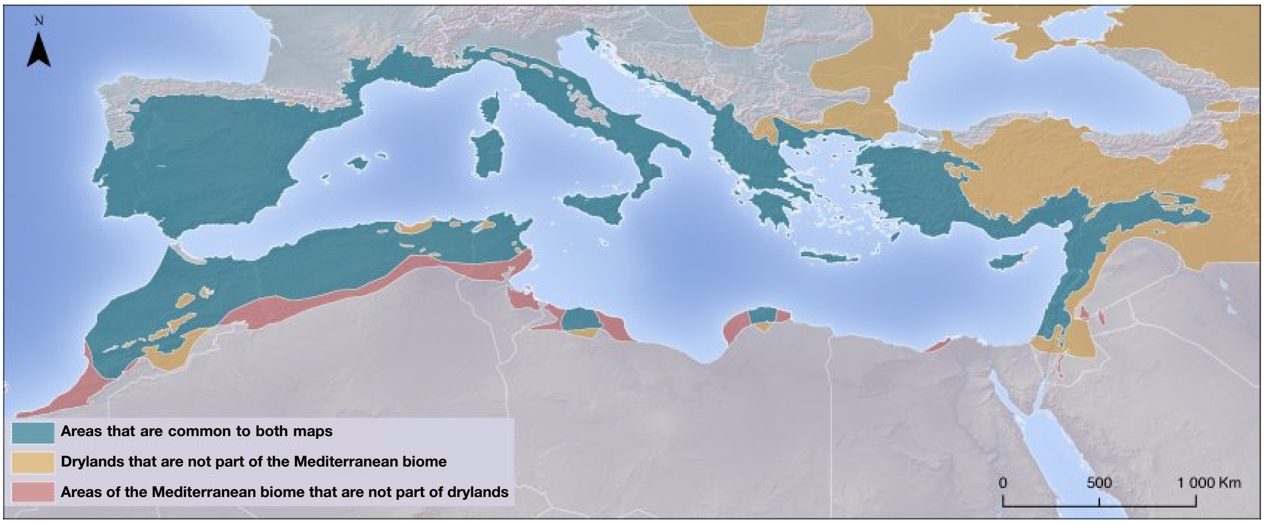

Figure 2.5. Comparison between the Palearctic component of the Mediterranean biome of Olson *et al.* (2001) and the drylands of Sörensen (2007) after removing the hyperarid and arid zones (but including the presumed drylands)

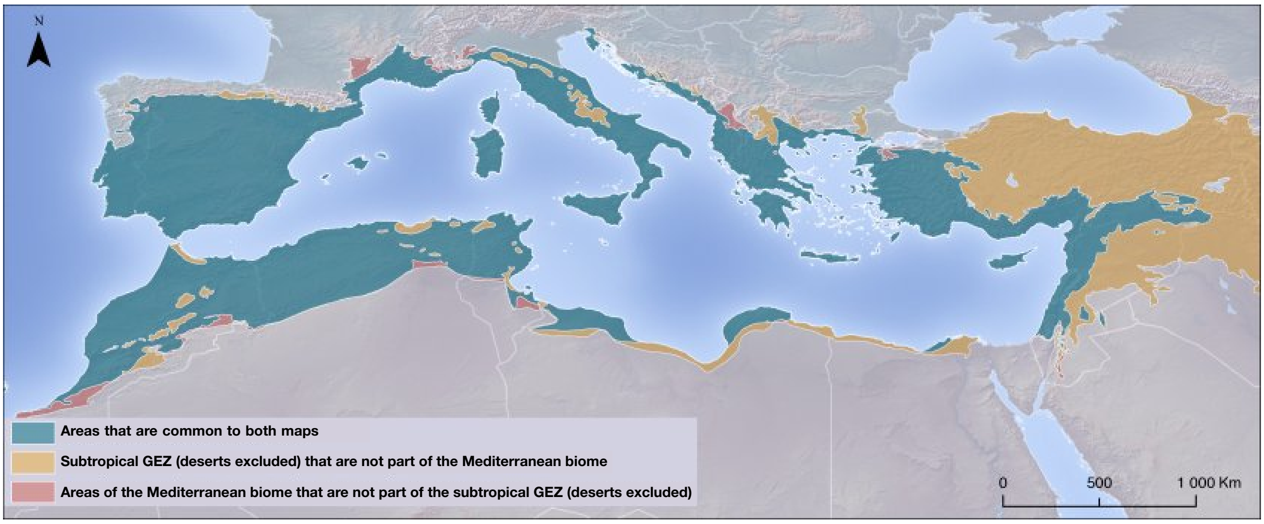

Figure 2.6. Comparison between the Palearctic component of the Mediterranean biome of Olson *et al.* (2001) and the Global Ecological Zones (GEZ) of FAO (2012b) when including all the subtropical zones except subtropical deserts

impact of climate change on the abundance and distribution of Mediterranean tree species, for instance, is to apply species distribution models using large sets of environmental variables but without reference to any specific definition of the Mediterranean basin (Benito Garzón *et al.*, 2008; Attorre *et al.*, 2011). Such definition-free approaches will become increasingly relevant, as it is expected tree species will respond in different ways to climate change rather than as part of a vegetation community. This means the vegetation communities typically associated with Mediterranean ecosystems will shift in composition in response to climate change, thus calling into question the previously accepted definition of "typical" Mediterranean vegetation.

Forest definitions and definition of the Mediterranean forest

In phytosociology, Mediterranean forests refer to typical assemblages of tree species specific to the Mediterranean region, resulting from the interaction between tree species' ecological requirements and abiotic factors. An alternative to this ecological approach would be to apply a general definition of forests within a region defined as "the Mediterranean." There are hundreds of country-specific definitions of forests, combining administrative, land use and land cover criteria (Lund, 1999). The FAO Global Forest Resource Assessment (FRA) (FAO, 2012a) provides a general definition of forests:

Forest: Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use.

Other wooded land: Land not defined as "forest," spanning more than 0.5 hectares; with trees higher than 5 metres and a canopy cover of 5-10 percent, or trees able to reach these thresholds; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.

Other land with tree cover: Land considered as "other land" that is predominantly agricultural or urban and has patches of tree cover spanning more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 metres at maturity. It includes both forest and non-forest

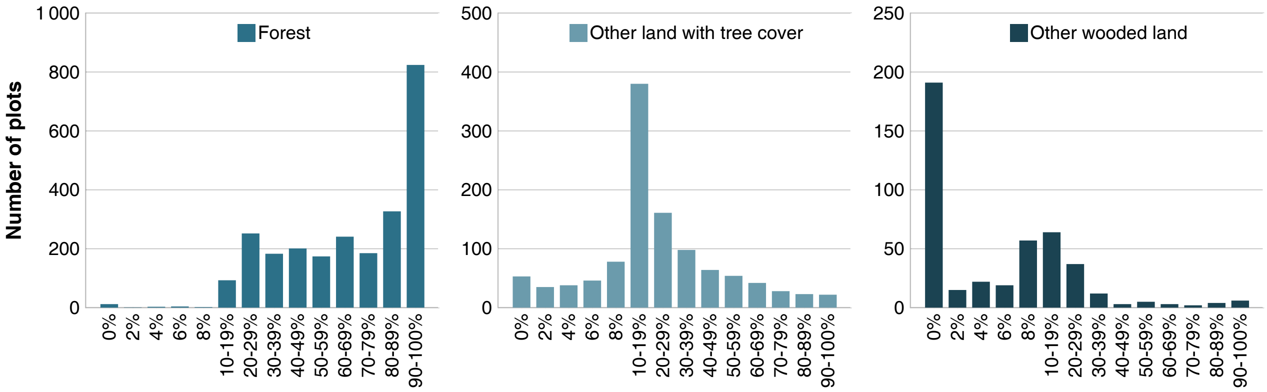

Figure 2.7. Classes of tree cover in percentage and frequency of plots for each class of each FRA definition
Source: Data sourced by authors.

tree species.

Applying a general definition of forests across the Mediterranean raises two additional questions, namely: (a) What is the definition of the Mediterranean region? (b) How to disaggregate country-level forest data to account for Mediterranean versus non-Mediterranean forests within countries?

In this section, we will try to answer these questions using FRA definitions. Because the Mediterranean region is characterized by ongoing human-induced impacts and marked climatic and ecological factors, our interest is not only in typical forests but all areas containing trees – i.e. any type of tree cover. Information on these FRA definitions was collected in 0.5 ha plots as part of the Global Drylands Assessment (GDA) (FAO, 2016d). Tree cover within the plot area was also measured. Using the Mediterranean region defined by the FAO Global Ecological Zones (GEZ) (FAO, 2012b), we found 12 933 plots available for analysis. Among the 31.4 percent of these plots (*n* = 4 064) that corresponded with FRA definitions, 61 percent (*n* = 2 502) corresponded to land defined as forest, followed by other land with tree cover at 28 percent (*n* = 1 122) and other wooded land at 11 percent (*n* = 440).

Within areas defined as forest, tree cover most frequently ranged from 90 to 100 percent. There was, however, great variability of tree cover ranging from 10 to 89 percent, which together represented most forest plots (66 percent) (Figure 2.7, left). Other land with tree cover frequently presented tree cover ranging from 10 to 29 percent, while other tree cover was minimal (Figure 2.7, middle). Finally, other wooded lands are frequently treeless, although some plots had between 8 and 30 percent tree cover (Figure 2.7, right).

Forest land has the highest percentage of tree cover. When compared against existing datasets such as Globcover 2009, these plots might correspond to intact patches of closed forests, but also to secondary forests and reforested areas. Here, we found the most open (15-40 percent tree cover) to closed (>40 percent tree cover) conifer evergreen forests and broadleaved deciduous forests as classified by Bontemps *et al.* (2011). Further comparisons demonstrate additional similarities: using maps developed by Bontemps *et al.* (2011), closed forests occupy 18 percent of the Mediterranean region, whereas our dataset indicates the presence of forest in 19.4 percent of all plots.

Other land with tree cover and other wooded land, which together represent 12 percent of all plots, were more difficult to classify. The abundance of other land with tree cover indicates the importance of trees in human environments, such as settlements or agricultural areas. They also represent most agroforestry open woodlands, olive groves or rain-fed tree crops which so characterize the Mediterranean landscape. Finally, other wooded land could correspond to Mediterranean shrublands or grasslands, both of which contain a sparse number of trees. Bontemps *et al.* (2011) found mosaics of forest, grassland and shrublands and sparse tree cover across 17.7 percent of the Mediterranean region, which could correspond to these definitions. However, these must include important vegetative formations such as open oak woodlands of *Quercus* species (known as "Dehesa" in Spain and "Montado" in Portugal).

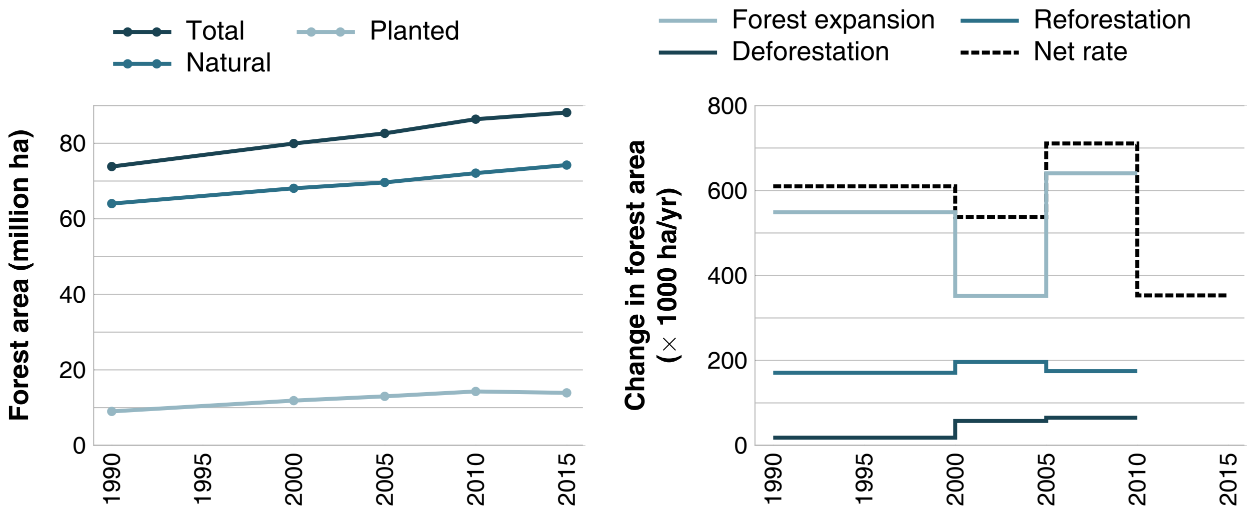

Figure 2.8. Total forest area growth for Mediterranean countries and average annual rate of change in forest area
Source: Adapted from FAO (2015a).

While these species might also have their place in these definitions, they could be included in lands classified as forests with medium to low tree cover.

Forest resources in the Mediterranean

Forest area

Based on the FAO definition of forests, there were an estimated 88 million ha of forest area in Mediterranean countries[1] in 2015 (Table 2.3), representing 2.20 percent of the world's total forest area (FAO, 2015a). Forest area in Mediterranean countries has been increasing since 1990 (Figure 2.8). The 0.85 percent/yr net increase in forest area between 1990 and 2010 has largely been the result of forest expansion (0.67 percent/yr), with reforestation contributing 0.23 percent/yr and deforestation remaining at a low level of 0.05 percent/yr (though it is trending upwards). In 2015, forests occupied 10.04 percent of the total area of Mediterranean countries, equivalent to the combined size of Spain and Morocco. Only four countries – Spain, France, Turkey and Italy – make up about 64 percent of the region's overall forest area. Between 2010 and 2015, total forest area increased by 2.04 percent, a new forest area (1.8 million ha) almost the size of Slovenia. Between 2000 and 2015, there has been a 8 million ha increase in forest area, equivalent to 0.93 percent of the total combined area of Mediterranean countries.

The increase in forest size is both the result of the European Common Agriculture Policy (as in the case of Spain) and forest regeneration in rural areas following abandonment, which can be seen in several Mediterranean countries (Fernández Nogueira and Corbelle Rico, 2017). Because statistics are provided at country level and not according to biogeographical region, a fraction of forest growth has taken place outside the Mediterranean region as defined above, thus accounting for vegetation growth in northern Atlantic regions such as northern Spain or France. In contrast with country-level forest statistics, remote sensing studies focusing on the Mediterranean region show that forest area in the Mediterranean region remains stable (see Section "Land use change" below). Moreover, a stable or increasing forest area according to the FAO definition of forests tells us nothing about forest degradation (see Chapter 5).

To complement the above snapshot using the FAO definition of forests, the Global Forest Watch definition, based on tree cover alone, indicates 85 million ha of land in Mediterranean countries has tree cover $\geq$ 10 percent and 81 million ha with tree cover $\geq$ 30 percent (rightmost columns of Table 2.3). Tree cover refers to the biophysical presence of trees, which may be a part of natural forests, plantations,

[1]Same list of 27 countries as in Chapter 1, cf. page 2.

Table 2.3. Forest area, percentage of forested area (with respect to land area or to total forest area), forest area growth and area of other wooded lands in Mediterranean countries

Country	Data extracted from FAO (2015a)					Data extracted from Global Forest Watch	
	Forest area 2015 (× 10^3 ha)	Land area with forest 2015 (%)	Share of regional forest area 2015 (%)	Change in forest area 2010-2015 (%)	Other wooded land area (× 10^3 ha)	Area with tree cover ≥ 10% (× 10^3 ha)	Area with tree cover ≥ 30% (× 10^3 ha)
Albania	772	28.16	0.88	−0.62	256	839	777
Algeria	1 956	0.82	2.22	1.98	2 569	1 690	1 472
Bosnia and Herzegovina	2 185	42.68	2.48	0.00	549	2 900	2 814
Bulgaria	3 823	35.19	4.34	2.30	22	4 461	4 377
Croatia	1 922	34.37	2.18	0.10	569	2 691	2 613
Cyprus	173	18.69	0.20	−0.17	213	154	132
Egypt	73	0.07	0.08	4.29	20	952	898
France	16 989	30.88	19.27	3.44	590	18 355	17 831
Greece	4 054	31.45	4.60	3.87	2 492	4 767	4 430
Israel	165	7.62	0.19	7.14	60	50	42
Italy	9 297	31.61	10.55	2.98	1 813	10 449	10 152
Jordan	98	1.10	0.11	−0.51	51	4	3
Lebanon	137	13.42	0.16	0.22	106	94	65
Libya	217	0.12	0.25	0.00	330	24	16
Malta	n.a.	1.10	n.a.	n.a.	0	0	0
Monaco	0	0.00	0.00	n.a.	0	0	0
Montenegro	827	61.49	0.94	0.00	137	692	667
Morocco	5 632	12.62	6.39	−0.71	580	1 113	892
Palestine	9	1.50	0.01	0.00	0	2	1
Portugal	3 182	35.25	3.61	−1.76	1 725	3 006	2 756
Serbia	2 720	31.10	3.09	0.26	508	3 026	2 943
Slovenia	1 248	61.97	1.42	0.08	23	1 342	1 324
Spain	18 418	36.90	20.90	0.94	9 209	14 326	13 061
Syrian Arab Republic	491	2.67	0.56	0.00	35	147	132
The former Yugoslav Republic of Macedonia	998	39.24	1.13	0.00	143	911	864
Tunisia	1 041	6.70	1.18	5.15	293	286	257
Turkey	11 715	15.22	13.29	4.57	10 130	12 909	11 968
All countries	88 141	10.04	100.00	2.04	32 423	85 192	80 507

Source: FAO (2015a) and Hansen *et al.* (2013).

agroforestry systems, or parks within cities. A definition based on tree cover may disregard burnt forests or clear-cut forests (which are included in the FAO definition) but may include agroforestry systems if their tree cover is large enough, even if the land is predominantly used for crops. Differences between the Global Forest Resources Assessment of FAO and Global Forest Watch estimates may also result from methodological limits in assessing tree cover, particularly the use of low-resolution satellite images in areas where tree cover is low (Bastin *et al.*, 2017) and where tree height is around the minimum height of 5 m used by the FAO definition.

Growing stock

The stem volume of living trees, known as "growing stock," is a basic variable in forest inventory. Its change over time provides basic information for the assessment of the sustainability of forest management. Growing stock information is also used as a basis for estimating the amount of carbon accumulated in living trees and allows forest managers to assess harvesting possibilities and risks of disturbance.

Figures for forest growing stock in almost all countries are available in the Global Forest Resources Assessment of FAO for the years 1990, 2000, 2005, 2010 and 2015. Most countries with data available provided figures on growing stock composition by coniferous and broadleaved tree species in forests. The total growing stock of Mediterranean forests is 10.3 billion m^3 (Table 2.4). Palestine, Portugal and the Syrian Arab Republic failed to provide growing stock data for 2015. The reported total growing stock

Table 2.4. Growing stock in forests and other wooded lands, Mediterranean countries, 2015 (million m^3)

Country	Coniferous	Broadleaved	Total Forest	Total OWL
Albania	19	57	76	8
Algeria	30	59	89	10
Bosnia and Herzegovina	135	223	358	n.a.
Bulgaria	315	384	699	n.a.
Croatia	54	361	415	6
Cyprus	11	0	11	n.a.
Egypt	n.a.	n.a.	9	0
France	1 043	1 892	2 935	n.a.
Greece	83	110	193	n.a.
Israel	3	3	6	n.a.
Italy	544	841	1 385	n.a.
Jordan	n.a.	n.a.	3	n.a.
Lebanon	4	2	5	1
Libya	n.a.	n.a.	8	4
Malta	0	0	0	0
Monaco	0	0	0	0
Montenegro	49	73	121	0
Morocco	52	102	154	1
Portugal	n.a.	n.a.	186	n.a.
Serbia	48	370	418	37
Slovenia	197	234	432	1
Spain	635	577	1 212	2
The former Yugoslav Republic of Macedonia	8	69	76	n.a.
Tunisia	17	11	27	1
Turkey	991	515	1 506	72
Total	4 238	5 881	10 325	143

Note: OWL = other wooded land. Data is not available for Palestine and the Syrian Arab Republic. Portugal did not report for 2015 so the figure for 2010 is included here.
Source: FAO (2015a).

of other wooded land amounted to 143 million m^3 in 2015, noting that only half of the Mediterranean countries provided data for this year. When interpreting the data for growing stock on other wooded land, it is important to keep in mind that it refers only to the volume of trees; the volume of shrubs is excluded. On the other hand, the definition of other wooded land includes various types of stock, including shrubs. Together with a relatively high percentage of unavailable growing stock data for the other wooded land category (due to high measurement costs and low demand for this information at national levels), there is lower reported growing stock in other wooded land than may actually be the case.

The average growing stock density in Mediterranean forests is 117 m^3/ha. But variability between countries is high. Slovenia has the highest density, with 346 m^3/ha, followed by Croatia with 216 m^3/ha. Bulgaria, France, Bosnia and Herzegovina and Serbia reported data in the range of 150-200 m^3/ha, while Morocco and Tunisia have the lowest reported stock density at 25 m^3/ha (Figure 2.9). High growing stock densities can be explained mainly by ecological conditions favouring tree growth, forest protection measures, management practices and local terrain conditions hindering the possibility of harvest.

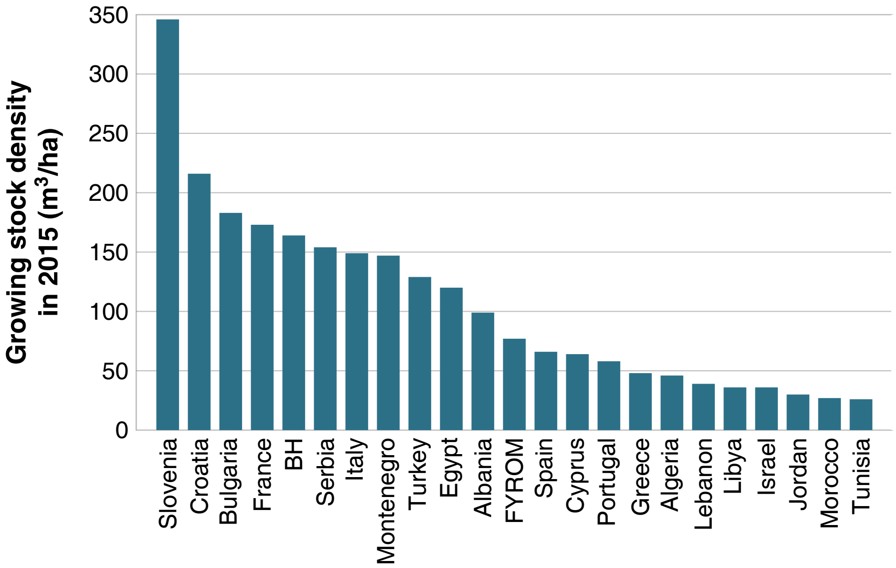

Figure 2.9. Growing stock density, Mediterranean countries, 2015

Note: BH = Bosnia and Herzegovina, FYROM = The former Yugoslav Republic of Macedonia. Data is not available for Malta, Monaco, Palestine and the Syrian Arab Republic.

Source: FAO (2015a).

Broadleaved tree species account for 58 percent, or 5.9 billion m^3, of Mediterranean growing stock in forests. The growing stock of coniferous tree species amounts to 4.2 billion m^3. The stem volume of living trees in Mediterranean forests is more or less evenly distributed between broadleaved and coniferous tree species in almost all countries.

Over the past 25 years, growing stock in Mediterranean forests has increased by 137 million m^3 per year. This corresponds to an annual rate of change of 2.0 percent (Table 2.5). The total growing stock in forests did not decrease in any Mediterranean country during the reporting period.[2] Some reported a constant growing stock between 1990 and 2015, which may be due to lack of data from more than one forest inventory. In absolute terms, the increase in total growing stock was highest in France, reaching an average of 34 million m^3 per year over the past 25 years, followed by Spain, with an average increase of 22 million m^3 per year and Italy with an increase of 21 million m^3 per year. Over the same period, the relative rate of growing stock accumulation in forests was highest in Spain, with an average yearly increase of 3.3 percent and Serbia, with an average yearly increase of 3.1 percent. The increase in growing stock may in part be due to the introduction of new sampling-based inventory systems, particularly in several countries in the east, but also to the expansion of forest area in most

[2]The decrease shown for Portugal is calculated over the period 1990-2010.

Table 2.5. Annual change in total growing stock in forests, Mediterranean countries, 1990-2015

Country	Total growing stock in forest (million m^3)					Annual change of growing stock 1990-2015		Annual change of growing stock 2005-2015	
	1990	2000	2005	2010	2015	million m^3/yr	%/yr	million m^3/yr	%/yr
Albania	75	76	74	75	76	0.04	0.06	0.19	0.26
Algeria	76	72	70	88	89	0.52	0.68	1.90	2.71
Bosnia and Herzegovina	291	358	358	358	358	2.68	0.92	0.00	0.00
Bulgaria	405	526	591	645	699	11.76	2.90	10.8	1.83
Croatia	310	360	385	406	415	4.18	1.35	2.99	0.78
Cyprus	7	8	8	10	11	0.15	2.01	0.27	3.27
Egypt	5	7	8	8	9	0.14	2.64	0.07	0.90
France	2 077	2 254	2 512	2 649	2 935	34.32	1.65	42.3	1.68
Greece	156	170	177	185	193	1.48	0.95	1.60	0.90
Israel	6	6	6	6	6	0.00	0.00	0.02	0.35
Italy	855	1 068	1 174	1 279	1 385	21.20	2.48	21.1	1.80
Jordan	3	3	3	3	3	0.00	0.00	0.00	0.00
Lebanon	-	-	5	5	5	-	-	0.05	1.00
Libya	8	8	8	8	8	0.00	0.00	0.00	0.00
Malta	0	0	0	0	0	0.00	0.00	0.00	0.00
Monaco	0	0	0	0	0	0.00	-	0.00	-
Montenegro	-	73	73	121	121	-	-	4.88	6.72
Morocco	128	143	152	150	154	1.04	0.81	0.20	0.13
Portugal	203	198	185	186	186	–0.68	–0.33	0.10	0.05
Serbia	235	250	298	415	418	7.32	3.11	12.00	4.03
Slovenia	273	333	374	406	432	6.33	2.32	5.75	1.54
Spain	664	906	1 027	1 120	1 212	21.93	3.30	18.47	1.80
The former Yugoslav Republic of Macedonia	76	79	76	76	76	0.00	0.01	0.00	0.00
Tunisia	17	22	24	26	27	0.40	2.35	0.30	1.25
Turkey	1 021	1 132	1 209	1 347	1 506	19.40	1.90	29.70	2.46
Total	6 892	8 051	8 798	9 573	10 325	137.29	1.99	152.70	1.74

Note: Data is not available for Palestine and the Syrian Arab Republic. Portugal did not report for 2015 so the figure of 2010 is reported for 2015.

Source: FAO (2015a).

regions. However, the relative increase in growing stock in forests (2.0 percent/year) was higher than the expansion of forest area during the period 1990 to 2015 (0.78 percent/year).

The reasons for growing stock accumulation in Mediterranean forests are many and complex, and of varying importance. The combined effects of CO_2 concentration and nitrogen deposition can lead to increased growth rates and low levels of harvesting activity (compared to growth) that could be the result of market conditions, increased societal awareness of the multi-functional role of forests, and more effective management of forests aimed at optimal and sustainable development of the goods and services provided by forest ecosystems.

Across the Mediterranean region, the rate of growing stock accumulation in forests was largely stable over the entire period 1990-2015 compared to the period 2005-2015.

Carbon stock

While growing, trees sequester carbon in their biomass. Forests, therefore, contain large stores of carbon in dead organic matter, soil and understorey. The total amount of forest carbon will change depending on forest management practices and climatic conditions. Forests can therefore mitigate or contribute to climate change by acting as a sink for or a source of atmospheric carbon.

On the other hand, changes in climate have had an impact on forest carbon stocks. According to the Working Group II contribution to the Fifth Assessment Report of the IPCC (2014a): "Recent indications are that temperate forests and trees are beginning to show signs of climate stress, including a reversal of tree growth enhancement in some regions (North America: Silva *et al.*, 2010; Silva and Anand, 2013, Europe: Charru *et al.*, 2010; Bontemps *et al.*, 2011; Kint *et al.*, 2012), increasing tree mortality (Allen *et al.*, 2010), and changes in fire regimes, insect outbreaks, and pathogen attacks (Adams *et al.*, 2012; Edburg *et al.*, 2012)."

Based on data in the Global Forest Resources Assessment of FAO, forests in the Mediterranean region stored 5 066 billion tonnes of carbon in 2015, equivalent to 1.7 percent of global forest carbon. Between them, France, Turkey, Italy and Spain stored 67.6 percent of total forest carbon stock in the Mediterranean region (Figure 2.10 and Table 2.6).

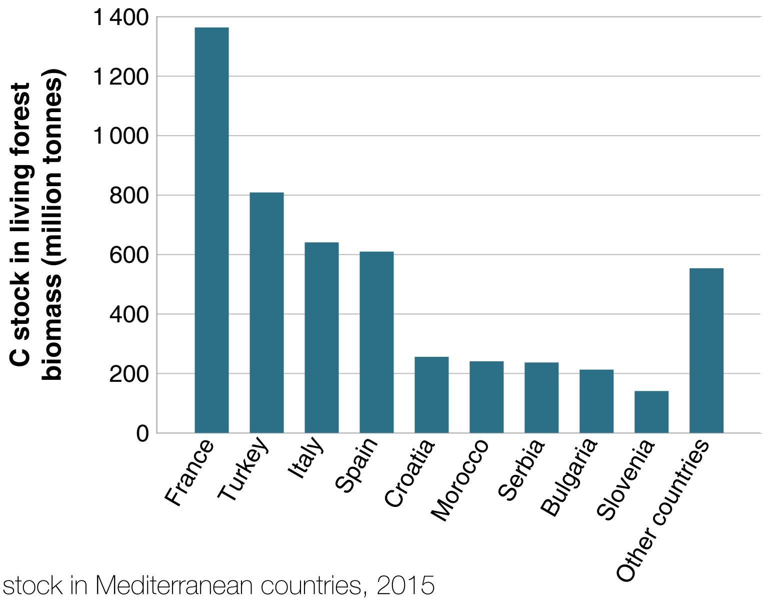

Figure 2.10. Carbon stock in Mediterranean countries, 2015

Note: Others = Albania, Algeria, Bosnia and Herzegovina, Cyprus, Egypt, Greece, Israel, Jordan, Lebanon, Libya, Monaco, Montenegro, Portugal, the former Yugoslav Republic of Macedonia and Tunisia. Data is not available for Malta, Palestine and the Syrian Arab republic.

Source: FAO (2015a).

Table 2.6. Carbon stocks in forests of Mediterranean countries in 1990, 2000, 2005, 2010 and 2015

Country	Forest carbon stock (× 10^6 Mg), 2015			Total biomass carbon in forests (× 10^6 Mg)				
	Above-ground biomass	Below-ground biomass	Dead wood	1990	2000	2005	2010	2015
Albania	38	12	14	49	49	48	49	50
Algeria	31	17	-	42	39	39	48	48
Bosnia and Herzegovina	95	23	-	96	118	118	118	118
Bulgaria	167	46	-	127	161	182	197	213
Croatia	196	60	-	190	221	237	250	256
Cyprus	3	1	-	3	3	3	3	4
Egypt	6	1	1	4	6	7	7	7
France	1 056	308	-	965	1 049	1 165	1 247	1 364
Greece	64	18	-	67	73	76	79	82
Israel	4	1	-	5	4	4	4	5
Italy	514	127	29	400	496	545	593	641
Jordan	2	1	-	2	2	2	2	3
Lebanon	1	0	-	-	-	2	2	1
Libya	5	1	1	6	6	6	6	6
Monaco	0	0	0	0	0	0	0	0
Montenegro	48	8	4	-	33	33	56	56
Morocco	184	57	1	203	227	240	239	241
Portugal	75	30	-	112	109	102	102	105
Serbia	185	52	33	122	138	147	235	237
Slovenia	115	26	6	88	107	121	132	141
Spain	458	151	-	325	454	518	564	610
The former Yugoslav Republic of Macedonia	48	13	-	60	62	60	60	60
Tunisia	7	2	-	6	8	8	9	9
Turkey	639	170	6	546	604	645	720	809
Total	3 941	1 125	95	3 418	3 969	4 308	4 722	5 066

Notes: 2015 carbon stock of Portugal is estimated with FAOSTAT data (FAO, 2017). Data is not available for Malta, Palestine and the Syrian Arab republic.
Source: FAO (2015a).

Forest carbon stock in the Mediterranean region increased by about 1.65 billion tonnes between 1990 and 2015, at a rate of 1.93 percent per year.

Land use change and pressure

Land use and land use change have a strong impact on the weather and may be as important as greenhouse gases in changing climate patterns (Pielke, 2005). Anthropogenic land use activities such as the management of croplands, forests, grasslands, and changes in land cover and land use create both CO_2 sources and sinks and are the driving factor in terrestrial carbon stock change (Schulp *et al.*, 2008; Smith *et al.*, 2014).

It is anticipated that ecosystem services will be particularly vulnerable to land use and land use change. The Mediterranean region in particular will be the most negatively affected by these changes in the medium term (Metzger *et al.*, 2006; Schröter *et al.*, 2005). Increased water stress and higher temperatures will have an impact on vegetation through stronger summer droughts and reduced availability of irrigation water. This will reduce the profitability and competitiveness of Mediterranean agriculture compared to other regions in central and northwestern Europe, which will in turn lead to the extensification and abandonment of agricultural lands (Holman *et al.*, 2017).

This section has a particular focus on Mediterranean forests and forestry. While it is known that annual mean temperatures are projected to increase in the order of 3-4°C and yearly rainfall is expected to drop by up to 20 percent in Mediterranean forests, less is known about how Mediterranean forests will adapt to these conditions. Schröter *et al.* (2005) found these changes would have negative effects on vegetation, especially as a result of increased drought, in projected scenarios. In most of these scenarios the burnt area resulting from forest fires would increase and the distribution of typical tree species such as holm oak (*Quercus ilex* L.) or Aleppo pine (*Pinus halepensis* Mill.) would likely be reduced or forced to shift northwards. Additionally, drought could be a major driver in replacing forest with shrubland or steppe vegetation (Hickler *et al.*, 2012).

Because socioeconomic factors affect land use and land use change, it is interesting to analyse trends in this regard, particularly since the adaptive capacity of forests and forestry is limited in the Mediterranean region, with large forest areas extensively managed or even unmanaged (Lindner *et al.*, 2010; Metzger *et al.*, 2006). Some authors predict that the abandonment of farmland and grazing lands will provide an opportunity for forest and shrub expansion in most Mediterranean mountain areas (e.g. García-Ruiz *et al.*, 2011).

In order to analyse these changes in land use, we examined current land use and land use change using data from two different datasets: (i) the Global Dryland Assessment (GDA) developed by FAO, spanning 2000 to 2015 (15 years), analysing and comparing data from a Global Forest Survey (GFS) of the Mediterranean, Euro-Siberian and other contiguous and/or comparable regions (such as some areas located in northern Europe, Russia, and North America); and (ii) the Human Footprint Index (HFP) by Venter *et al.* (2016) spanning 1993 to 2009 (16 years) in the Mediterranean.

- The GDA was developed by FAO. It systematically surveyed 213 783 square plots, each with an area of 0.5 ha, using Google Earth and Collect Earth Technologies (Bey *et al.*, 2016) in order to better understand the characteristics and health of forest ecosystems at a regional/biome level (i.e. independently of country borders). Besides variables related to forest characteristics, information about land use and land use change was also collected following the IPCC guidelines described in Bickel *et al.* (2006). The GDA analysis used the FAO GEZ (FAO, 2012b) definition of the Mediterranean region. The number of plots available for analysis using this approach totaled 12 933 in the Mediterranean region and 27 851 in the Euro-Siberian and other contiguous and/or comparable regions (García-Montero *et al.*, 2015, 2016).
- The HFP index is an attempt to quantify human pressure, which measures the impact of eight typical human activities, namely: (1) extent of built environments; (2) cropland; (3) pasture land; (4) human population density; (5) night-time lights; (6) railways; (7) roads; and (8) navigable waterways.

The HFP index by Venter *et al.* (2016) was used here. The cumulative human activities over a given area of 10^6 ha are weighted and added together, resulting in a standardized index ranging from 0 to 50, with 0 indicating very low or no human impact and 50 very high human impact. The HFP map was calculated for the years 1993 and 2009. When the difference between these two years is computed, the resulting map can be interpreted as a trend showing an increase or decrease in the HFP over a 16-year period. Our approach is to use the HFP index as a proxy to validate land use change by interpreting changes found in the GFS plots.

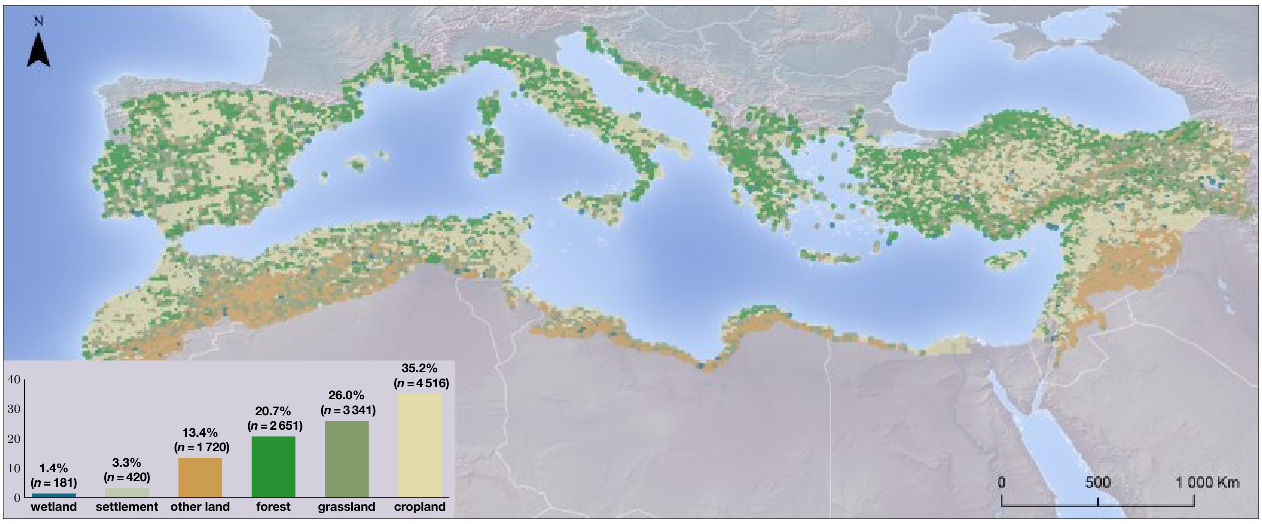

Figure 2.11. Map of GDA plots showing current land use (2015) as classified by the IPCC
Source: Data sourced by authors.

Current land use

In 2015 and referring to the IPCC land use categories, most of the plots surveyed across the Mediterranean region were classified as cropland (35.2 percent). Grassland was the second most common land use detected (26 percent of plots), followed by forest (20.7 percent) and other lands (13.4 percent). Settlement and wetlands accounted for the smallest number of plots, with 3.3 percent and 1.4 percent respectively (Figure 2.11).

Some of the maps used to build the HFP in 2009 showed similar results, reporting 31.2 percent of the region occupied by cropland, 21.5 percent by grassland and 7.3 percent by settlement. The differences found between datasets could be further explained with reference to spatial and temporal resolution. Nevertheless, these results seem to confirm the usefulness and accuracy of both datasets at a regional level.

Regarding the GFS inventory in the Euro-Siberian and other regions contiguous and/or comparable to the Mediterranean, García-Montero *et al.* (2015, 2016) reported the following patterns: (i) in the drylands of Europe and Russia, 33.83 percent of plots were classified as croplands, 17.71 percent as grasslands, 38.32 percent as forests, 3.42 percent as other lands, 2.56 percent as settlements and 4.15 percent as wetlands; (ii) In the European Euro Siberian region, 36.11 percent of plots were classified as croplands, 11.86 percent as grasslands, 41.37 percent as forests, 1.62 percent as other lands, 7.62 percent as settlements and 1.42 percent as wetlands; and (iii) in the North American region, 15.20 percent of plots were classified as croplands, 5.98 percent as grasslands, 66.91 percent as forests, 1.14 percent as other lands, 2.81 percent as settlements and 7.96 percent as wetlands.

Land use change

Overall land use in most of the plots surveyed (99.03 percent) did not change during the period 2000 to 2015. Only 0.97 percent of all 12 933 plots (n = 126) changed from one land use to another. While there were losses to grassland and other land (−0.23 percent and −0.10 percent respectively), there were net gains to croplands by an increment of 0.04 percent, followed by forest land and wetland which both increased by 0.02 percent (Figure 2.12a). The 0.02 increase in Mediterranean forest area between 2000 and 2015 contrasts with the reported increase of 0.93 percent for the same period according to the Global Forest Resources Assessment of FAO (see Section “Forest area”). This difference could either result from methodological differences, illustrating the difficulty in capturing small trends in forest changes; or it could mean that most of the increased forest area in Mediterranean countries actually

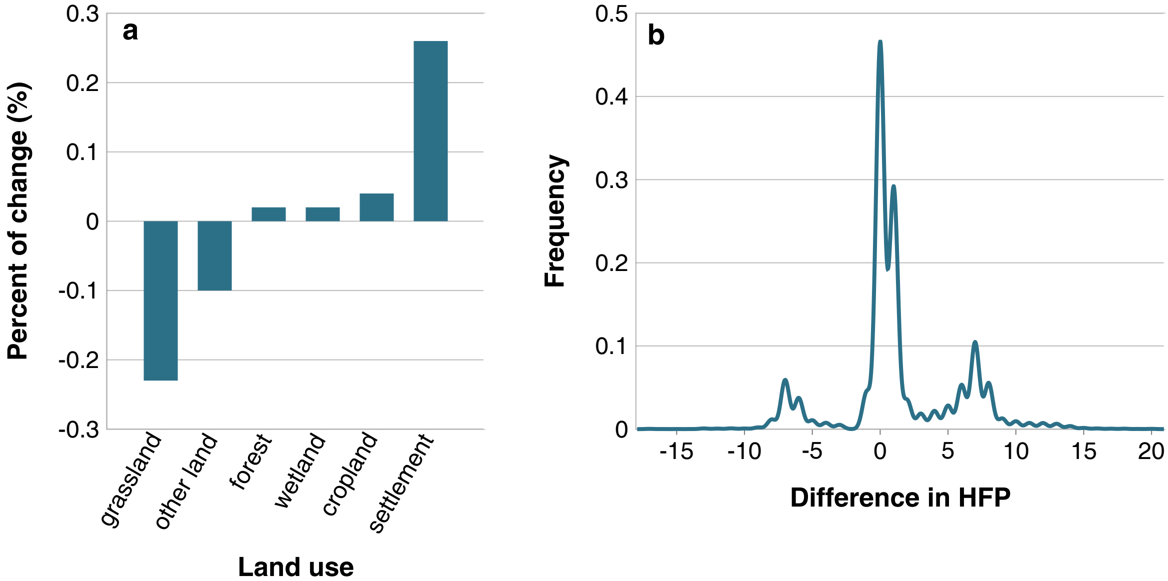

Figure 2.12. (a) Net change in the land use of plots inside the Mediterranean region surveyed between the years 2000-2015. (b) Density plot showing the frequency of the differences in the HFP index between the years 1993-2009. Negative values show a decrease in the HFP index, whereas positive values reflect an increase.

occurred outside the part of those countries defined as Mediterranean for the purposes of these studies. The single biggest increase in land use was in the settlement category, with an increase of 0.26 percent. Compared against the HFP index, most plots showed central values (61.4 percent of the values between −1 and 1) during the years 1993 and 2009, meaning that no important changes in the HFP index were detected on those plots. However, 28.2 percent showed an increased HFP index, while 10.4 percent showed a reduction (Figure 2.12b).

When comparing HFP maps, the data shows similar positive and negative trends in land use change: grassland decreased by 4.4 percent, settlement increased by 1.7 percent and cropland increased by about 8 percent.

Analysis of land use change in the Mediterranean against other contiguous and/or comparable regions between 2000 and 2015 showed similar results (García-Montero *et al.*, 2015, 2016):

- In countries located in the Euro-Siberian region, 2.10 percent of plots underwent changes of land use in the 15 years surveyed: 0.71 percent of plots transformed from various types of land use into forests, compared with a transformation of 0.35 percent of forest areas into different land uses;
- In plots located in the North American region, 1 percent of plots underwent changes of use in the 15 years surveyed, transforming 0.14 percent of area of various types of land use into forests, compared with a transformation of 0.64 percent of forests into various land uses and;
- In the drylands of Europe and Russia, 1.18 percent of the territory underwent change, transforming 0.28 percent of the plots subject to various types of land use into forests, compared with a transformation of 0.20 percent of forests into different land uses.

In summary, the Mediterranean region showed an increase in the number of new plots containing cropland which, contrary to Holman *et al.* (2017) and Schulp *et al.* (2008), shows a positive trend towards expansion. This expansion seems to be particularly evident in Spain, France, Turkey and North African countries. New plots containing settlements occurred concurrently with this regional expansion in cropland as a result of urbanization and tourism. Forest gains and losses were detected where forests were more abundant, mostly in Spain, France and Turkey (Figure 2.13).

Although we detected an increase in forest plots, mostly due to the colonization of abandoned settlements and croplands, the increase of human environments was greater still. Forests occupy 20.7

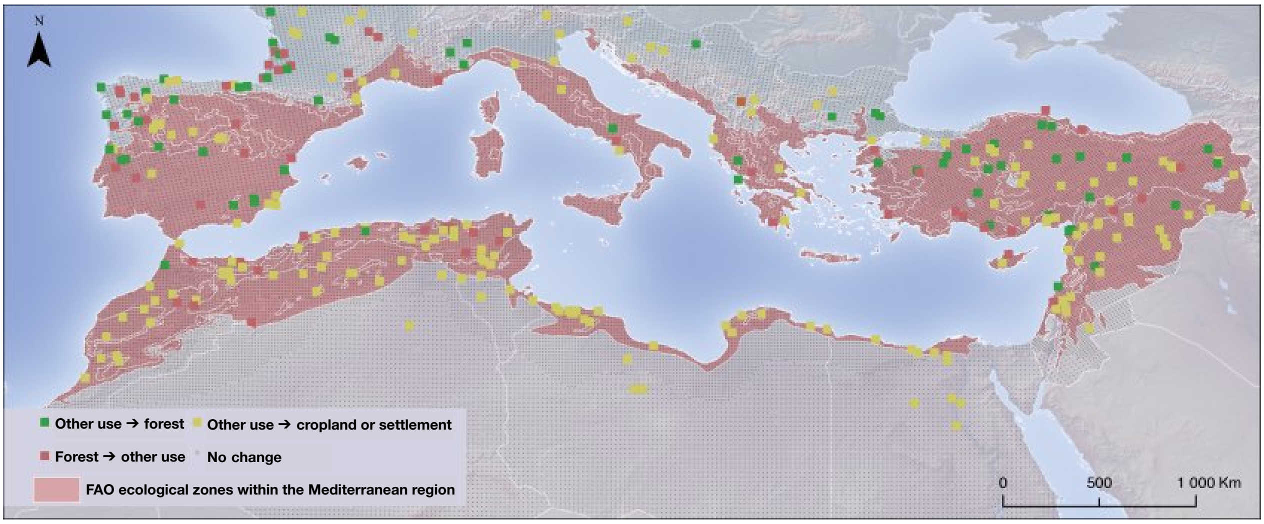

Figure 2.13. Map of GDA plots showing main changes in land use over the years 2000 to 2015. Non-forest land uses are shown in green. Land use shifting from forests to other uses are showed in red. Changes from other land use to cropland and settlement are shown in yellow. Plots that did not change are shown in black.

percent of the region and it is possible that abandoned grasslands in mountainous and rural areas could be colonized by forests in future. Although we detected movement in this direction, it was occurring at a very slow pace.

Overall, land use in the Mediterranean region is characterized by its stability. The reason small land use changes have been detected, as in other parts of the world, could be the result of temporal or spatial factors. The 15-16 year survey period may also be too small to detect important changes in our study area. Most climate change projections and scenarios are for the years 2040-2100. However, our analysis shows the importance of monitoring and classifying land use to validate longterm predictions or trends.

Conclusions

There is a moderate but stable trend towards increased forest area across the Mediterranean, with a corresponding increase in growing stock and carbon storage. The precise extent of this increase will depend on the definition used to define both forests and the Mediterranean region. To a large extent, it will also depend on the methodologies used to assess forest resources. Countries like Spain have shown an increase in forest area partly as a result of the European Union Common Agricultural Policy, but also resulting from the abandonment of rural areas. Forested areas are at great risk of forest fires and other natural disasters, as predicted in projected climate change scenarios. Moreover, the fragmentation of forested areas can lead to biodiversity loss. The Mediterranean region in particular is at risk of soil erosion and desertification.

Consideration of different approaches such as remote sensing and field-based inventories is a useful way to obtain complementary views on the state of Mediterranean forests. This calls for robust and transparent National Forest Inventories (NFI) that would allow for disaggregation of forest statistics from the country level to the sub-regional Mediterranean level. Some countries have already integrated the multidimensional scope of inventories and collect data on the various dimensions of the forests (see Box 2.3 on Spanish NFI). Harmonization of NFIs at the regional level would be a useful addition for the purposes of obtaining consistent regional data on Mediterranean forests.

Surveying forest area in the Mediterranean region over time has allowed us to conclude there has been a slight net increase in overall forest area at the regional level, even though deforestation may have occurred locally in some Mediterranean countries. This conclusion must be moderated by several questions that will be addressed in subsequent chapters: Will this slight increase in forest area continue in the future in the context of global changes? Is forest degradation occurring in the Mediterranean region? This latter question is trickier to address than assessing forest areas, as it requires a precise assessment of the state of tree populations and forest structures in areas classified as forests.

Box 2.3. The multi-objective Spanish national forest inventory

Over recent decades, the objectives of forestry and forest management in Europe have shifted from being primarily focused on wood production towards a focus on sustainable ecosystem management. The availability of appropriate forest information is essential to the decision-making process undertaken by forest managers and policy makers. In order to meet these increased information requirements, the scope of National Forest Inventories, which constitute the primary data source for national and large-area assessments, has been expanded to include new variables.

Following the Third Cycle of the Spanish National Forest Inventory (SNFI3, 1997-2007), a decision was taken to design an appropriate methodology to estimate forest biodiversity. The Fourth Cycle (SNFI4) therefore turned into a multiple objective inventory like many other European National Forest Inventories. The primary aims of the SNFI4 can be summarized as follows: estimating wood resources, biomass and carbon stocks, forest biodiversity, conservation status and the production of non-wood forest products. The methodology was developed by taking into account national forest characteristics, along with international requirements and new initiatives.

Assessment of these indicators is conducted according to the national features classification system (Alberdi *et al.*, 2014) applied to different forest types (Figure 2.14):

- Groundcover: Measuring the percentage of the sample units corresponding to different types of ground cover (bare soil, litter, rocks, etc.). Many indicators can be derived from field cover estimation such as average cover, number of plots containing more than 75 percent of one specific component and the Shannon-Weaver index (Shannon, 1948), among others.
- Presence of invasive species: A list of invasive species likely to be found in forested areas of each monitored province is devised. These invasive tree, shrub and herbaceous species are then recorded in 10 m, 5 m and 1 m radius subplots respectively. In addition, the presence of these species in the 25 m radius NFI plot is registered.
- Vegetation cover life forms: The total cover of herbaceous plants, ferns and three different shrub layers are recorded to define the vertical structure of the undergrowth.
- Complementary stand structure measurements: Due to the concentric circle plot design (which depends on tree diameters and distance to the plot centre), not all trees are measured. Additional tree location measurements and species identification of at least 20 trees are therefore recorded. This additional information allows for estimation of many horizontal, vertical and combined indicators together with neighbouring indices.
- Dead wood: SNFI records eight categories of dead wood as follows: dead standing trees (including snags, dbh > 7.5 cm, height > 1.3 m), dead downed trees (dbh > 7.5 cm), dead standing and downed saplings (2.5 < dbh < 7.5 cm), downed coarse wood pieces/downed branches (diameter at the thinner > 7.5 cm, length > 30 cm), stumps/snags (diameter at mid-height > 7.5 cm, total height < 1.3 m), coppice stumps

(representative diameter at mid-height > 7.5 cm, total height < 1.3 m) and accumulation (diameter > 7.5 cm of a representative branch at half length). The inventory considered the five classes of decay proposed by Hunter Jr (1990) and Guby and Dobbertin (1996) and defined two additional classes of dead wood: hollow dead wood (to avoid overestimation of volume) and recently cut (to deduce the probable amount of deadwood removed). Using this information, the volume and biomass of deadwood can be established.

- Micro-sites: Identifies and records elements indicating naturalness, such as nests, and others showing human activity, such as the presence of cattle, in each plot.
- Impact of browsing: SNFI records browsing impact data within a 10 m radius subplot for trees, saplings and shrub species and a 5 m radius for tree regeneration. Crown cover is used as a proxy to estimate browse availability for each species with 1 percent precision. Average browsing degree, indicating browse utilization, is also recorded by species according to the 6-rank classification method proposed by Fernández-Olalla *et al.* (2006).
- Stand age: In each plot, tree age and incremental diameter growth of the measured dominant tree are determined by means of core extraction at a height of 0.5 m above ground level. This information can be used to establish diameter-age models of dominant tree species and identify old growth trees (Alberdi *et al.*, 2013).

In addition, the SNFI has developed a new field protocol to estimate quantity and quality of cork based on SNFI measurements.

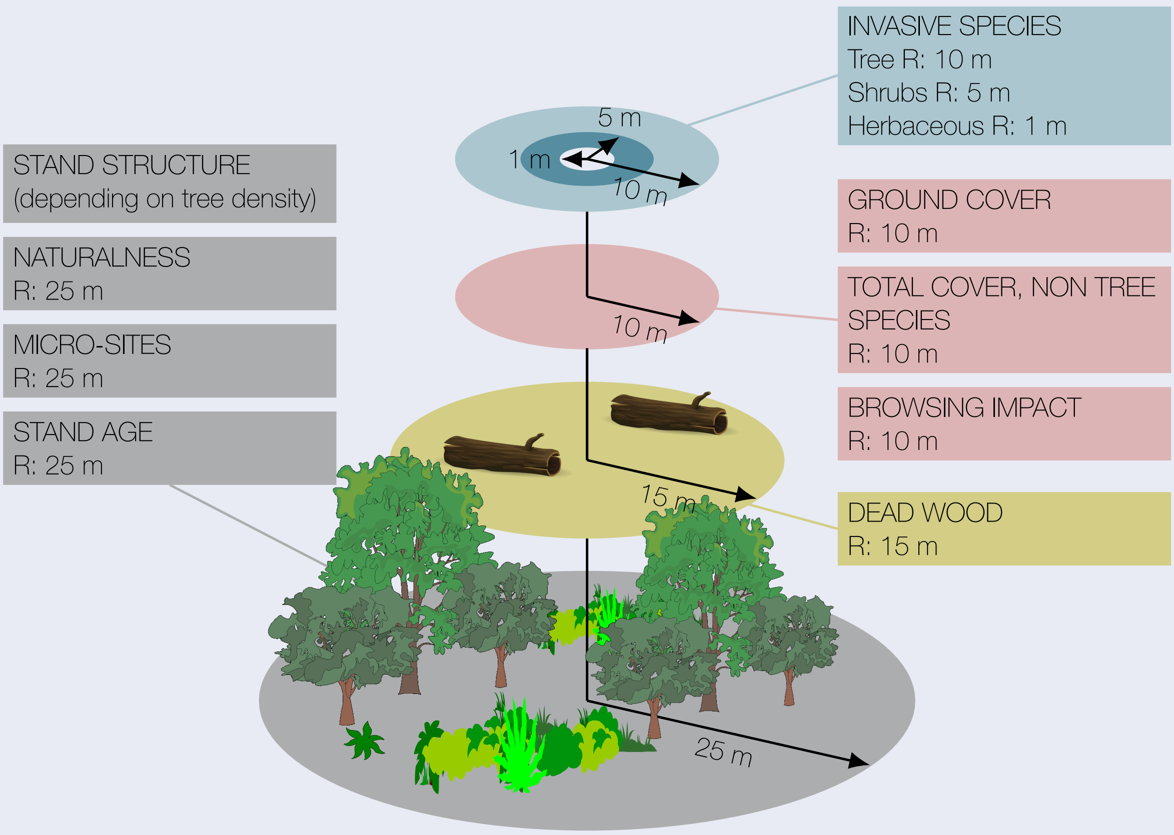

Figure 2.14. Spanish National Forest Inventory monitoring plots using new measurements

4 Trees outside forests in the Mediterranean region

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Introduction

Forests play a key role in sustaining the livelihoods of communities across the globe by providing people with ecosystem services, food and products for home consumption and income generation. Over the centuries, however, many forest and wooded areas have been cleared or depleted through unsustainable use or to make way for expanding urban and agricultural areas. As a result, trees scattered across the landscape – so-called *trees outside forests* (TOF) – play an increasingly relevant role in the provision of ecosystem services and products.

Any trees and shrubs that do not fit into the "forest" or "other wooded lands" category of a country's forest classification can be considered TOF. As a result, the exact definition of TOF will vary from country to country, depending on how the terms "forest," "land cover" and/or "land use" are defined. TOF can be found both in rural and urban landscapes. Their presence is either the result of the degradation or fragmentation of a previously forested area or of the purposeful planting of groups or individual trees on a given piece of land.

Due to the large variability and heterogeneity of TOF systems – sometimes characterized by sparse distribution, limited spatial footprint, complex ownership and institutional arrangements – the contribution of trees outside forests to the environment, people's livelihoods and national economies can be quite diverse. In this regard, several publications and reports have been produced in recent years with the aim of highlighting the economic and environmental importance of TOF in the context of international conventions such as UNFCCC, CBD and UNCCD (Rigueiro-Rodríguez *et al.*, 2009; Kumar and Nair, 2011; Metzler, 2013; van Noordwijk, 2013; Barbati *et al.*, 2014; Schnell *et al.*, 2014; Laestadius, 2015). This demonstrates that, in the global context of climate change, financial crises and food insecurity, the role of TOFs in local and national economies is likely to increase.

This chapter will provide an overview of the key role TOF have played in Mediterranean landscapes over centuries. In particular, it will focus on current distribution trends and dynamics, management challenges and risks in the near future, and policy and governance approaches to foster their sustainable management.

TOF systems in the Mediterranean region

Trees outside forests can be found in all climates, land types, land uses and regions, and include a wide range of tree and shrub systems. Spatially, they may be scattered sporadically, appear in small groups, or grow in lines. Their presence and distribution may be spontaneous (e.g. woodlands, peri-urban forests, riparian buffers) or intentional (e.g. agroforestry systems, woodlots, urban forests, food forests, trees in lines). They can be left in their wild state or managed to maximize productivity (e.g. orchards, agroforestry systems, food forests, home gardens). They can serve a protective purpose (e.g. windbreaks, greenbelts, street trees, riparian buffers), and/or ornamental/cultural role (e.g. parks, gardens, linear tree populations, street trees, isolated or grouped heritage trees). TOF are valued for their role in conserving the cultural heritage of landscapes, especially in rural areas, where they contribute to the functional and aesthetic conservation of traditional landscapes (Rackham, 1976; Gibbons *et al.*, 2008; Baffetta *et al.*, 2011; Rossi *et al.*, 2016).

In addition to being found and managed as individual trees within a landscape, TOF are a key component of many tree-based, non-forest systems. In such cases, their presence is intended to generate maximum socioeconomic and environmental benefit, both in rural and urban areas. TOF systems in rural settings include open parkland, home gardens, planted mixtures of a small number of species, intercropping in monoculture tree orchards and trees planted in hedges or on boundaries of fields and farms. Each of these will require different levels of human management. When integrated into agricultural landscapes in agroforestry systems[1] in particular, they contribute to more efficient use of water and nutrient resources, protect soil from erosion, and mitigate the local effects of climate change, thus increasing the sustainability and resilience of agricultural systems.

Generally speaking, three main types of agroforestry systems can be identified, based on the components associated with the trees in question: (i) agroforestry or silvicultural systems, where woody perennial trees are integrated with crops; (ii) agrosilvopastoral systems, where woody perennial trees are integrated with both crops and livestock production; and (iii) silvopastoral systems, where woody perennial trees are integrated with livestock production. When integrated into the urban environment, TOF form a key part of so-called urban and peri-urban forests. Urban forests can be defined as the network or system comprising all trees located in and around urban areas. These include small groups of trees, trees in parks and gardens, street trees and trees in alignment, and individual trees. Agroforestry and urban forestry refer to the practice of managing agroforestry systems and urban forests with the aim of optimizing the environmental and socioeconomic benefits provided by trees (and TOF in particular) in order to improve community livelihoods and well-being (Sheets and Manzer, 1991; Lovasi *et al.*, 2008; O'Brian, 2016; WHO, 2016).

Importance, uses and types of TOF

In the Mediterranean region, TOF have been a distinctive feature of both rural and urban landscapes for millennia. Regardless of the typological definition used, the role of TOF as a multifunctional resource remains evident (Paletto *et al.*, 2006). With regard to the productive role of TOF, it is useful to recall, for example, that this resource provides almost 9.5 percent of France's domestic fuelwood (Guillerme *et al.*, 2009). This figure would further increase if it included hedgerows harvested by private owners. In fact, while the contribution of TOF to the production of forage has been decreasing over recent decades – with TOF in rural areas being used more for aesthetic and landscaping purposes than their productive functions – they continue to play a prominent role in the food security of all Mediterranean countries, particularly those located in the southern part of the basin. TOF provide an affordable source of wood

[1]Wide range of land-use systems and technologies in which woody perennials (trees, shrubs, palms and bamboo, etc.) used deliberately on the same land-management units as agricultural crops and/or animals production in some form of spatial arrangement or temporal sequences (Lundgren and Raintree, 1983).

and non-wood forest products including food, medicine, fuel, fodder and timber for local communities, particularly in less developed countries. This is especially true in countries where forest cover is low or there is limited access to forests. In such cases, local communities can rely on TOF for a wide range of goods and ecosystem services. In these countries, trees are perceived and valued as a means of enhancing production systems and supporting community livelihoods, leading to the development of forest policies that give consideration to how farmers and rural people use trees (Bellefontaine *et al.*, 2002).

Across the region, TOF are valued and managed for their protective and regulating role. TOF grown in agricultural lands have a positive impact on soil fertility and play a role as a reservoir of biodiversity and ecological corridors, thus conserving the natural habitat for wildlife, especially birds (Boffa, 1999; Söderström *et al.*, 2001; Guillerme *et al.*, 2009; Sekercioglu, 2012). TOF also provide environmental protection by acting as windbreaks and fixing dunes, helping to combat drought and prevent the spread of deserts (Ben Salem, 1991). In addition, tree systems along hedgerows can provide a habitat for wild plants and animals, representing "islands of biodiversity" in rural landscapes (see Case study 1). By supporting pollinators and insectivore birds, TOF along agricultural plot edges also contribute to biological control of pests. By acting as windbreaks, TOF also have a positive impact on agriculture systems, as they help protect crops and produce better and earlier yields. TOF in rural settings are also recognized for their aesthetic and cultural value. This is the case, for example, for the rows of cypresses lining the rural landscapes of Tuscany (Italy) and Provence (France) (Figure 2.15).

Agroforestry practices, in particular, may be preferable to conventional agriculture as they aim to optimize synergies between tree and crop/animal components to increase and diversify overall land productivity. In the Mediterranean region, some of the most traditional agroforestry systems include fruit tree plantations in Morocco (see Case study 2) and the *dehesas/montados* systems practised in the Iberian Peninsula. Savannah-like ecosystems (Di Castri and Mooney, 1973) are distinctive landscapes found in many areas of the Mediterranean, of which TOF are key components. Although distributed across the region, these systems are characteristic of western areas of the Mediterranean basin and include the Spanish *Dehesa*, the Portuguese *Montado*, the Sardinian *Meriagos* and low density wooded pastures in general (see Case study 3). Other typical TOF systems characteristic of the regional landscape include isolated trees and trees in rows. These systems are usually managed through heavy pruning (such as pollarding, shredding and topping) in order to maximize the range of products they can produce. These include fodder and foliage (e.g. pollarded *Ostrya carpinifolia* and *Quercus pubescens* in Greece, Italy and Balkan countries), wood and fibre (e.g. *Quercus ilex* topping for firewood across the central/western Mediterranean basin) and material used for rural activities (e.g. willow twigs for baskets, vine ties, tutoring

Figure 2.15. Trees outside forests (cypress, willows, oaks, elms and flowering ash) are key elements in the conservation of cultural landscape in central Italy (Marche, Italy) while still providing shelter, firewood and foliage
© Fabio Salbitano

vegetable or flower species). In addition, the *Morus alba* was historically pollarded to breed Mulberry silkworms in Italy and Slovenia. One of the most notable traditional agricultural techniques developed in ancient times was the married grapevine, which involves attaching the woody-climbing grapevine to a living tree supporting its growth, to increase the overall productivity of the land (see Case study 4).

Discussion and interest in research, governance and uses of TOF in the Mediterranean are moving beyond rural to urban landscapes, reflecting a clear shift in understanding and evaluation of their role and uses. In urban areas, residents and decision-makers increasingly recognize TOF are a key component of a city's green infrastructure (see Case study 5). Ecosystem services provided by trees in urban areas are increasingly acknowledged, particularly for their contribution to urban communities' health, increasing air quality, removing pollutants, providing green spaces for open-air actives and recreational spaces in which people can socialize and relax. In some cases, TOF are remnants of the original rural landscape which existed prior to urbanization (see Case study 6). Their presence provides a bridge between urban and rural landscapes, as well as conserving local biodiversity and traditional socio-cultural features (see Case study 7). Such contributions are increasingly acknowledged in the southern part of the Mediterranean basin, where the design and management of urban and peri-urban forests is increasingly directed towards providing urban dwellers with multifunctional recreational spaces. In particular, the 'urban food forest'[2] (Clark and Nicholas, 2013), is an emerging, TOF-related management practice which seeks to meet food needs in urban areas, while also fostering social inclusion and environmental resilience in urban ecosystems. In the Mediterranean region, TOF are also grown in urban and peri-urban settings for ornamental purposes in gardens, public areas and along streets. These trees can include native, naturalized or recently introduced exotic species. As the international horticultural industry has developed and globalized over recent decades, the exotic component of this ornamental planting has increased.

Relevant case studies from the Mediterranean region

Case study 1: Fragmented forests: conserving remnants of Mediterranean forests. Over centuries, ancient Mediterranean forests have gradually been replaced with grasslands, fields, towns, cities and roads. This has contributed to the process of relegating forest remnants to areas with less favourable soil. In these areas, small remaining fragments of what used to be forest began to populate land in between extensive cultivated plots, forming so-called "tree islands." Tree islands constitute habitats of community interest under Council Directive 92/43/EEC of 21 May 1992 (Habitats Directive of the European Union). Regardless of their origin or degree of transformation, these tree systems play a prominent role in conserving local biodiversity and maintaining or restoring ecological connectivity, as well as providing important ecosystem services such as pollination, pest control and supplying wood and non-wood forest products. The criteria established for classifying a forest fragment as an "island forest" include:

- size between 1 and 1 000 ha
- remnants of vegetation surrounded by territorial matrix
- tree cover above 50 percent
- not including forest plantations with exotic species.

In Andalusia (Spain), tree islands and hedgerows account for less than 1 percent of the Andalusian forest area and consist mainly of pine forests, oak forests, mixed forests, cork oaks, abandoned tree crops and olive groves.

[2] Clark and Nicholas (2013): the intentional and strategic use of woody perennial food producing species in urban edible landscapes to improve the sustainability and resilience of urban communities.

Case study 2: Trees outside forests for fruit production in Morocco. In Morocco, where "forests" and "other wooded lands" cover less than 14 percent of the country, nearly 3 percent of the land is occupied by trees outside forests (FAO, 2015a). A significant percentage of these tree systems consist of fruit tree plantations, which are of great importance to the local and national economy. The cultivation of traditional olive plantations have been integrated with additional fruit tree species (including citrus, fig, walnut, date palms and almond trees) which, in addition to supplying products for local consumption, help respond to increasing demand from the domestic and export market. Some of these species, such as the carob tree (*Ceratonia siliqua*), olive tree (*Olea europaea*), palm tree (*Phoenix dactylifera*) and Argan tree (*Argania spinosa*) have a tradition of cultivation. In particular, *Ceratonia siliqua* is greatly appreciated by local farmers for the multiple products and services it can provide: it supplies fruit for consumption and sale on both the domestic and export markets and also provides fodder for livestock. In addition, many of these species also hold religious value for Muslims. In rural areas, some farmers plant these tree species to indicate identification with or connection to a specific group or place (Mhirit and Et-Tobi, 2002).

Case study 3: *Dehesas* and *Montados*: Iberian traditional agrosilvopastoral systems. Agroforestry can play a key role in raising livestock by providing fodder, shade and shelter for animals, particularly in arid and semi-arid areas. The *dehesas* and *montados* are traditional multifunctional agrosilvopastoral systems characterizing southern and central Spain (*dehesa*) and southern Portugal (*montado*) (Figure 2.16). They result from a intentionally induced simplification (both in terms of structure and species diversity) of the Mediterranean forest: anthropic intervention reduces tree density, removes shrub cover (*matorral*) and fosters the growth of the grass. Used primarily for grazing, these savannah-like ecosystems produce a variety of products, including non-timber forest products such as wild game, mushrooms, honey, cork and firewood. The tree component is oak, usually holm oak (*Quercus ilex*) and cork oak (*Quercus suber*), whose acorns provide food for both livestock and wildlife. Other oaks, including *melojo* (*Quercus pyrenaica*) and *quejigo* (*Quercus faginea*), may be present in *dehesa*, while in the central-eastern Mediterranean and the main islands of the basin deciduous oaks (*Quercus pubescens* and *Quercus cerris*), olive trees and carob-trees (*Ceratonia siliqua*) may be present. The latter, in particular, is of considerable social and economic significance in North Africa, Sicily, Greece, Crete and southern Croatia, as it grows in arid to semi-arid Mediterranean areas, adapts well to poor soils and represent a valuable source of food and fodder. At present, *dehesas/montados* occupy 2.3 million hectares in Spain and 0.7 million hectares in Portugal and represent one of the best conserved

Figure 2.16. Holm oak dehesa (*Quercus rotundifolia*) in Sierra Morena (Andújar, Andalusia) © Gabriel Blanca

low-intensity European farming systems. These systems are highly valued for their exemplary land use management, which integrates traditional land uses conservation, with biodiversity and landscape conservation and increased local production. In addition to supporting grazing by species like the Spanish fighting bull and the Iberian pig (known worldwide and sold for premium prices), these systems also provide farmers with a wide range of products including mushrooms, honey, cork and firewood. Furthermore, *dehesas/montados* are a suitable habitat for local wildlife species such as the Iberian lynx (*Lynx pardinus*) and the Spanish imperial eagle (*Aquila adalberti*), contributing to the conservation of these species classified as endangered and vulnerable respectively under the IUCN Red List. Like other agrosilvopastoral systems, however, *dehesas* and *montados* are under threat from agricultural intensification and land abandonment, which in turn threatens their diversity and capacity to provide the above-mentioned services and products. As a result, these systems are increasingly exposed to fire hazards, due to an excess of accumulated biomass, and consequent erosion.

Case study 4: The married grapevine. The married grapevine (English translation for the Italian expression "*vite maritata*") is a traditional agricultural technique developed by the Etruscans around the seventh century BC. It consists of associating ("marrying") the woody-climbing grapevine (*Vitis vinifera*) to a living tree (the "tutor") supporting its growth. Two related techniques were developed by the Etruscans: the *alberata* (in which the vine is tied to a single tree) and the *piantata* (in which the vine develops its branches along ropes tied to trees in a row). The married grapevine is an interesting example of traditional agroforestry practice used to maximize and diversify the production of a given plot of land. While the grapevine produces grapes for both wine production and direct consumption, the tutor tree provides farmers with an additional source of woodfuel, fodder, rough material for tools to be used in farming activities, as well as fruit (where the tutor is a fruit tree). The married grapevine was usually planted on the edges of fields used for the cultivation of cereals, legumes and other crops to mark the boundaries of properties and to separate the different cultivations. As such, it also acted as a windbreak, protecting crops from possible adverse climatic conditions. Tutor tree species were selected on the basis of limiting possible negative interactions with the grapevine (e.g. excessive shadow, pathogens) and in order to optimize the benefits of their presence (e.g. long tree life, additional source of income). The tree species most commonly used were field maple (*Acer campestre*), elm (*Ulmus minor*), poplars (*Populus* spp.) and willows (*Salix* spp.).

This local technique, extensively used by Latin populations, was progressively replaced by a practice of cultivating vineyards as small trees supported by wood poles (of Greek and oriental origin), more suitable for intensive monoculture production. In Italy, the use of this ancient technique remained common until the 1960s, especially in Tuscany (from where it originated). Interesting examples of married grapevine (both *alberata* and *piantata*) can still be found in some Italian regions. In the Campania region, for instance, examples of *alberata* married grapevine can be found in the Cilento area, while planted married grapevine cultivations remain in the Caserta countryside (Figure 2.17).

Case study 5: Valuing street trees: the "Right of Trees in the City" Barcelona Declaration. Trees in linear systems are the backbone of the green infrastructure of a city. They increase spatial and functional connectivity between urban and peri-urban green areas while also generating a large number of environmental (Gill *et al.*, 2007), ecological, social (Sullivan *et al.*, 2004) and economic (Wolf, 2004, 2005) services. The "Declaration of the Rights of Trees in the City" was conceived and signed in Barcelona during the first congress of the Spanish Association of Arboriculture (1995). The Declaration recognizes street trees as an essential element of the urban environment and calls for sound planning, design, management and monitoring of this resource, which "helps to establish culture at a local level and improve living conditions in the urban environment." The Declaration invites cities to commit to:

- Acknowledge the basic role of trees as one of the city's main heritage resources;
- Develop and promote, in a comprehensive and continuous manner, information, inventories, management techniques, practices, procedures, products, services and standards that promote

Figure 2.17. Married grapevine in Central Italy
© Fabio Salbitano

and support the establishment of trees in the city, under the best possible conditions;

- Raise awareness and educate the general public, various professional groups, the industrial and service sectors, schools, colleges and universities on the key role of trees in the life of the city;
- Establish policies, regulations, norms and practices in administration and governance that guarantee optimal conditions for the life of trees in the city;
- Reconsider all the elements that constitute "urban space" and in future conceive, plan, develop manage, use and reutilize all urban elements from the perspective of the requirements and potentialities of the Urban Trees System.

Since its proclamation, the Declaration has been signed by a large number of towns around Spain. Barcelona, in particular, is an example of a compact and densely populated Mediterranean city which has invested in a "green vision" to create a comprehensive green network. A study implemented with the Urban Forest Effects model estimated that in 2008 Barcelona's 200 000 trees and shrubs removed 305.6 tonnes of pollutants from the air, the monetary value of which amounts to over EUR 1 million (Chaparro and Terradas, 2009).

Case study 6: The Caffarella Valley: a remnant of ancient Roman countryside. By bridging urban and rural areas, trees and woodlands in peri-urban areas make a valuable contribution to the conservation of local biodiversity and historical landscapes, maintaining an area's local identity and providing inhabitants with a "piece of nature" close to their homes. Rome's Caffarella Park is a 250 ha alluvial valley located just outside the Aurelian Walls (the border of the ancient Roman city). This area is distinctive because it conserves the historical rural landscape of the Roman countryside in a highly populated and central part of modern Rome. Composed of a mosaic of croplands, vineyards and olive groves, individual trees and small woodlots, the Caffarella Park shows that trees have been a central element of the rural Mediterranean landscape since ancient times. Numerous paintings and illustrations of the valley reveal that trees and woodlands have characterized and shaped the landscape of this area over centuries. Over time, however, the originally dense forest area of the valley has progressively transformed into agricultural lands and pastures. Today, two residual woodlands comprising specimens of *Quercus dalechampii* (growing up to 14 m) and *Quercus pubescens* are still found in the area. Traces of a "sacred wood" also remain visible and testify to the cultural and religious value Mediterranean populations ascribed to trees and woodlands. In past centuries, the valley also housed Roman temples, mausoleums, villas and medieval towers whose ruins are still visible, making the area a fascinating mix of archaeological heritage and ecological features. After decades of neglect, Caffarella Park is now a protected area hosting ponds, woods, more than ten springs, pasture lands and meadows. It is also rich in biodiversity, making it an area of high naturalistic value. In the 1980s, the valley was reclaimed by citizens who (through the establishment of a committee) managed to save the area from urbanization and place it under the protection of the Appia Antica Regional Park. Since its establishment, the Park has been managed by a committee which, in cooperation with municipal councils, has initiated a series of campaigns to raise public awareness about the relevance of this natural heritage. Some farming activities (predominantly sheep farming) are still practised in the area. The park offers several educational and recreational activities (biking, naturalistic visits, etc.), attracting many residents who visit the area to play sports, enjoy picnics and visit its archaeological sites. An educational project, entitled *Kindergarten in the Wood*, aims to familiarize children aged between three and six with the natural environment of their city. With its significant socio-ecological importance, the Caffarella Park is highly valued and considered one of Rome's most important urban green areas.

Case study 7: The gardens of the *Galician Pazos*: where wilderness meets design.
Botanical gardens, arboretums or other outstanding tree formations with special botanical, social or historical value are significant examples of trees outside forests. The historic *Galician Pazos* are traditional noble country houses that typify the rural landscape of Galicia (northwestern Spain). *Galician Pazos* are famous for their fascinating architecture and beautiful gardens, characterized by a natural convergence of wilderness and design and utility and adornment, resulting in an outstanding mix of formal gardens, working farms and natural landscapes. These gardens are characterized by a variety of vegetation and large old tree specimens, attracting many visitors throughout the year. The *Pazo de Santa Cruz de Ribadulla* (in La Coruña), for instance, is characterized by a beautiful alignment of centuries-old olive trees. The gardens of the *Galician Pazos* host more than 8 000 varieties of camellias, including the oldest European specimens of this genus. In the *Pazo de Quiñones de León* (in Pontevedra), it is possible to encounter a huge camellia specimen whose crown measures over 15 metres in width. Attracting many visitors, this unique specimen is a great source of income for the local community. In light of its botanical, architectural and heritage value, *Pazo de Oca* (in Estrada) is acknowledged as the most significant representative example of Galician baroque gardening.

Classification of TOF

There are some commonalities in the classification of TOF across the Mediterranean. In most northern Mediterranean countries TOF systems are classified in forest and agriculture inventories (as well as in national statistics) according to their structure and physical features. In Spain, for instance, TOF were reported (and classified) as a separate category for the first time in the third National Forest Inventory (MAPAMA, 2008b). According to the baseline description (MAPAMA, 2008b), the types of TOF recognized in the Spanish NFI are:

- *Tree-lined river banks*: Ecosystems along the banks of streams and rivers, characterized by a predominance of trees, not ecologically connected to forest ecosystems, populated by autochthonous species, and presenting an irregular structure and high levels of biodiversity. This TOF typology usually consists of multiple patches, small in size and elongated in shape. These systems are usually valued for their environmental, protective and landscaping role.
- *Small woodlands*: Ecosystems consisting of small (< 0.25 ha) clusters of forest trees, shrubs and scrubland, of either natural or artificial origin, populated by either native or exotic species. These systems are usually valued for their environmental, protective and landscaping role.
- *Narrow tree alignments*: Ecosystems consisting of rows of forest trees narrower than 25 m in width but significant enough to be identified as a separate element from the surrounding land cover. These systems are usually valued for their environmental, protective and landscaping role.
- *Isolated trees*: Isolated tree specimens with a canopy cover large enough to create a habitat whose characteristics differ from those of the surrounding environment. These systems are usually valued for their environmental, protective and landscaping role.

In France, the two primary institutions responsible for monitoring TOF are the National Forest Inventory France (*Inventaire Forestier National France*), which has conducted TOF inventories since 1998 and the Central Bureau of Surveys and Studies (*Service Central des Études et des Enquêtes*), which has been implementing the Teruti land use survey since 1981. The main categories of TOF in these reports are:

- *Small woodlands* (i.e. *bosquet*): Groves covering a land area spanning between 0.05 and 0.5 ha and with a width of 20 m or more, populated by trees covering at least 40 percent of the total area and with at least four trees not growing in aligned systems;
- *Line-planting*: Large, even-sized trees planted in rows at regular intervals. This includes a dedicated category for poplars;
- *Hedgerows*: Compact linear formations of small trees, bushes and/or shrubs;
- *Scattered trees*: Tree formations smaller than 500 m^2, including single trees;
- *Fruit-tree meadows*: Fruit trees grown on permanent, productive grasslands;
- *Orchards*: Fruit trees cultivated for fruit production on an area spanning at least 500 m^2.

Italy's National Forest Inventory still does not include a dedicated TOF category. At present, the only non-forest systems reported in the national inventories are urban parks whose tree component meets the threshold (in terms of size, width and tree height) accorded to forests. The Italian National Forest Inventory framework adopted in 2015 includes the category of TOF (Ottaviano *et al.*, 2014). The proposed definition refers to all trees on lands not belonging to the category of "forest lands" and "other wooded lands," as well as all trees on lands having the characteristics of Forest and other Wooded Lands but falling within the following cases: (i) size less than 0.5 ha; (ii) trees reaching a mature height of at least 5 m but with a density of less than 5 percent; (iii) trees which do not reach a height of 5 m *in situ* but with a density of less than 10 percent; and (iv) linear formations and shields of widths spanning less than 20 m (FAO, 2001).

In other areas of the Mediterranean, the classification of TOF is based on their function, potential use and services and products. This is the case for most North African countries, in which the classification proposed for TOF (Mhirit and Et-Tobi, 2003) includes the following types:

- permanent wooded grazing lands
- highly dense fruit orchards
- sparse fruit trees (including particular species such as walnuts, figs and pomegranate) located in family backyards
- plantations for soil conservation, comprising stands of forest species, fruit trees or fodder crops
- green belt and road-alignment plantations
- urban and peri-urban parks
- poplar trees.

In urban areas, TOF classifications may differ from city to city and will be defined by local plans and norms. Also, each of the various sectors dealing with the urban landscape and its components (e.g. urban and ornamental arboriculture, urban forestry and agriculture, landscape architecture and urban planning) adopt different TOF classifications. In the case of Mediterranean cities, the types of TOF systems in urban areas are usually classified according to:

- *Setting*: squares, streets, public gardens, urban parks, historical parks and gardens, botanical gardens, pocket parks, playgrounds, schoolyards, cemeteries, parking lots, residential lots, home gardens or river banks;
- *Structure*: isolated trees, street trees, linear tree populations, groups of trees (< 5), or small woodlands (0.5 ha);

- *Functions* (i.e. the ecosystem services delivered): ornamental and amenity trees, trees for food production, trees filtering noise and/or air pollution, windbreaks, or trees in rain gardens;
- *Sociocultural value*: veteran or monumental trees (not necessarily isolated), historical and symbolic trees, trees in heritage sites, trees in service and recreational areas, or trees of value in residential areas.

None of the aforementioned classifications are applicable across the region. In fact, due to differences in tradition, history and legislation in the forest, agriculture and landscape sectors, the same tree system could be classified as domesticated woodland in some countries and as cropland in others. This is the case, for instance, with chestnut groves, classified as TOF in France but categorized as woodland in Italy. The same applies to olive groves, considered a full-scale woody agricultural crop in most northern Mediterranean countries, while associated with forest tree formations in several African Mediterranean countries.

Historical relevance of TOF in the region

Historical and archaeological evidence from Mediterranean countries demonstrates that TOF have been managed and valued as an important sociocultural, economic and environmental resource in both urban and rural environments since ancient times (Salbitano, 1988; Mazzoleni *et al.*, 2004; Gates, 2011; Walsh, 2013). Numerous agroforestry systems, urban forest components (e.g. historical parks, sacred woodlands, cemeteries and gardens) and tree systems remain intimately connected to urban and rural landscapes and have attained outstanding cultural value as important elements of historic rural landscapes (e.g. Italy, Agnoletti, 2013). They often attain iconic status in regional landscapes (e.g. the cypress tree lines of Tuscany or umbrella pines of Rome), are relics of ancient practices (i.e. vines trained upon trees), or have a prominent role in cultural heritage sites (i.e. isolated trees, olive trees, palms, trees in gardens or small woodlands in UNESCO sites, e.g. Alhambra, Generalife and Albayzín, Granada, Spain) (Figure 2.18).

Indeed, the initial use and cultivation of TOF as a human resource dates back to the Neolithic age (about 6000-8000 years ago) concurrent with the commencement of deforestation and land cultivation, when humans began clearing Mediterranean forests and systematizing farming activities (Salbitano, 1988; Mazzoleni *et al.*, 2004; Walsh, 2013). Where slash-and-burn systems were employed, it was common

Figure 2.18. Trees outside forests in urban areas place a major role in a variety of ecosystem services, most notably cultural services. This is the case in the Albaicín district in Granada, Spain, which was declared a World Heritage Site (together with Alhambra) thanks to the presence of an outstanding design which harmonized TOF and architectural elements
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to conserve specific trees with spiritual and/or symbolic value as well as living signs of family or clan farming boundaries.

The symbolism of trees is rooted in the Mediterranean's prehistoric and paleo-historic human societies (Salbitano, 1988). The umbrella pine (*Pinus pinea*), for example, was a sacred tree for the Etruscans and it remained a distinguishing symbolic and religious tree during the Roman age. Oak trees were considered sacred by the Celts, ancient Romans and Etruscans. Druids used to gather mistletoe (*Viscum album* L.) from oak trees, while other ancient Mediterranean populations paid homage to gods by planting trees such as oaks, which were sacred to Zeus, or laurel, sacred to Artemis. In the Balkans, lime trees were considered sacred. Village or city council meetings, wedding celebrations and official proclamations commonly took place beneath the canopy of these trees, which are still common in the centre of town squares in Mediterranean villages and cities.

Trees are an intrinsic part of Mediterranean mythology, history and society. But our Mediterranean ancestors also used trees for practical purposes. Trees left standing following slash-and-burn clearances provided shade, food, fodder and shelter for domestic animals and people, production of firewood, fencing materials and other non-timber forest products.

Pollarding and shredding of trees was widespread and common in the Mediterranean until the first half of the twentieth century. Trees were an important source of fodder and their branches were regularly lopped to allow sheep and cattle to eat their twigs and leaves. The branches were also used for firewood and other purposes. By the mid-nineteenth century, however, pollarding became increasingly rare and virtually died out by the mid-twentieth century. Nevertheless, pollarding remains common in several countries in the Balkans and southern Mediterranean.

Blondel and Aronson (1999) describe the Mediterranean region as follows: "apart from some remote mountain regions, it is very difficult to find a square metre that has not been repeatedly manipulated and redesigned by the man, by the presence of 300 generations of farmers." The domestication of fruit trees and their countless ways of planting and management are a fundamental trait of this relationship between Mediterranean communities and nature. All over the region, the importance of fruit trees is evident from paleo-botanical remains, archaeological and historical evidences, travel journals, literature and figurative arts. As example, excavations in Sicily, Campania (particularly in Pompeii),Tuscany, Puglia, Lombardy showed the practices of harvesting of wild plants, vines, figs, olive trees, cherry and apple trees dating back to the fourth millennium BC. This is a further evidence of the fundamental role of TOF along Mediterranean history.

Some northern Mediterranean landscapes, characterized by TOF, are linked to pig farming. From the fifteenth century AD, rural landscapes with low-density trees planted in an almost regular pattern became common (isolated oaks frequently dotted the landscape as far back as the middle ages). This agroforestry system, known as *plantade* in French and *plantada* in Occitan (from the Latin *plantadis*, or planted place) is a collective space used to breed pigs. The type of landscaping in which trees are planted more or less regularly at low density is know as *alberata* and reportedly occurred in central Italy from the fifteenth century AD. It soon became a very popular landscaping device, as can be seen in artworks from that time. These lands with scattered trees were used both for pasture and to produce multiple products. This continued until the first half of the twentieth century, when Mediterranean agriculture became mechanized and farming shifted to monospecific farming, dramatically modifying the landscape hitherto characterized by an agricultural mosaic (Sereni, 1997).

During this time, low density wood pastures (or wooded pastures) became increasingly important, from both an agricultural and ecological perspective. Savannah-like ecosystems (Rackham, 2008), probably one of the oldest landscapes in the Mediterranean (Di Pasquale, 2014), consist of open areas with multiple functions such as grazing, wood, cereal or other crop cultivations. An example of this landscape can be found in the Spanish *Dehesas* in the Iberian Peninsula (Gómez-Gutiérrez, 1992) and the Portuguese *Montados* (Pinto-Correia *et al.*, 2011), multifunctional silvopastoral systems together comprising an area of 3.5-4.5 million ha (Moreno and Pulido, 2009; Pinto-Correia *et al.*, 2011) (see Case study 3). Similar landscapes can be found in other Mediterranean countries such as Italy and Greece. In Sardinia (Italy), the local agrosilvopastoral systems "Meriagos" – classified as "Dehesa 84.6" according to the CORINE-Biotopes system – cover an area of approximately 112 668 ha, 96 percent of which is grazed (Pulina *et al.*, 2016).

In Italy's Umbria and Marche regions, "Querce camporili" or oak trees (generally *Quercus pubescens*), grew scattered in agricultural fields, or along main roads (Campetella *et al.*, 2002; Clement, 2008), providing shade for travellers, pilgrims, workers and livestock (e.g. bulls, cows and ploughing oxen). At the same time, these trees were used for "pannage," a practice common to the Middle Ages, but also used during the Roman Empire, in which pigs, sheep, goats and poultry flocks were released to eat acorns and other fallen fruits and leaves (Smith, 2010). This practice was particularly common during the frequent dry and hot Mediterranean summers, when fodder was not readily available (Cañellas *et al.*, 2007; Rigueiro-Rodríguez *et al.*, 2009). During arid periods, characterized by fodder shortages, branches of TOF such as *Quercus* spp., but also *Castanea sativa*, *Fraxinus* spp. and *Betula* spp. (Rigueiro-Rodríguez *et al.*, 2009), *Populus* spp., *Salix* spp., *Ulmus minor*, *Acer campestre* and probably other species, were pruned to feed animals and enhance fructification in subsequent years.

Other examples of typical landscapes in the circum-Mediterranean basin include landscapes formed by vineyards in which isolated trees are used as living stakes (but also have other uses). It is important to remember that vines were originally a wild rather than domesticated plant species (*Vitis vinifera* subsp. *sylvestris*). The most archaic "vineyards" were therefore shady woody plots in which vines climbed on live trees (see Case study 4). The integration of grapes with TOF represents one of the oldest known wine landscapes, and therefore has important cultural relevance. This form of cultivation was different from the Greek practice of growing vineyards as small trees supported by wood poles.

In Italy, the cultivation of grapevines was partially rationalized and disseminated by the Etruscans about 2 500 years ago, in a vast area from Veneto to central Italy, to the south of Campania (Di Pasquale *et al.*, 2012). The species used as living stakes for vineyards were poplars (*Populus* spp.), maples (*Acer* spp.), elms (*Ulmus* spp.) and fruit trees. This type of cultivation still continues in parts of the region, from the Caucasus to Italy (Di Pasquale *et al.*, 2010; Di Pasquale and Russo Ermolli, 2010) where it is typically used to produce well-known wine varities such as Chianti and Brunello, and Portugal where it characterizes the production area of Vinho Verde.

In recent times, TOF systems have been identified in archaeological areas. Their role and function must therefore be considered in a precise historical and cultural context. In some cases, the TOF systems discovered are fragments of an agricultural landscape that might be related, to some extent, with a previous archaeological landscape as evinced by the presence of agronomic or even ornamental species.

The various tree formations in urban spaces are well known. In historic gardens and parks in particular, tree lined avenues were used to create optical art effects or to re-qualify the city and improve urban liveability (Panzini, 1993). The use of TOF for landscaping is a recurrent theme of gardens in the southern Mediterranean from Lebanon to Morocco, Sicily to southern Spain. The structure and icon of the "secret garden," i.e. the fenced "*hortus conclusus*," was emblematic of the urban landscapes in southern Mediterranean cities until the end of the middle ages and contributed to shaping the renaissance and modern cities of the region (de Wit and Aben, 1999).

Tree-lined avenues are the oldest form of greenery in the Mediterranean. The Romans, with their large network of consular roads, laid the foundations of the most important Mediterranean road infrastructure. Trees lined all roads leading to Rome and were used to consolidate and make them permanent and recognizable: tree roots protected unpaved roads from erosion, mitigated the summer heat, offered protection from rain and snow in winter and (in the case of fruit trees) nourished travellers. Furthermore, they provided construction timber and firewood, glue, fodder, honey, etc. Many species of trees were used in this way, including pines, maples, oaks, planes and horse chestnut, but also walnut, hornbeams, mulberries, palms and cypress, as well as various species of fruit trees. Although during the Middle Ages roads and cities in the region went through a period of decline, trees lining roads kept their importance as a valuable multifunctional source for travellers (Peyer, 2009).

For a long time, prior to the arrival of the aggressive Dutch Elm disease (*Ophiostoma novo-ulmi*), elm trees dominated the roadsides of Mediterranean Europe. The branches, leaves and trunks of trees along avenues also serve an important environmental purpose, connecting ecosystems and providing a habitat suitable for many animal species, sometimes forming true ecological corridors. Visually, these formations were planted in such a way as to create distinguishing features in an otherwise homogeneous and uniform landscape dominated by flat areas where ploughed fields or pastures prevailed. For these reasons, tree-lining has become an almost indelible signifier of the Mediterranean landscape and an act of resistance against the process of landscape simplification taking place over recent decades.

Current trends and dynamics

Existing data on TOF cover

Data on trees outside forests (TOF) remains scarce and incomplete (Schnell *et al.*, 2014). Most institutional assessments only give a partial depiction of the state of TOF, the focus being primarily on a particular typology (e.g. urban forests, tree crops etc.). It is also difficult to reach a consistent and accurate assessment of TOF between countries, particularly as there is not yet a clear, agreed definition of the term.

In our exploration of TOF trends and dynamics in the Mediterranean, we will consider two different data sources: FAO's Global Forest Resources Assessment (FRA) 2015, based on national inventories, and ICRAF's Global Tree Cover and Biomass Carbon on Agricultural Land Database 2000-2010, based on satellite data. It is worth highlighting that their respective findings cannot be compared or integrated, based as they are on different TOF definitions (see below) and resulting from the application of different methodologies. They can, however, provide an overview of the worldwide distribution of TOF and help predict possible future trends and dynamics.

According to the FAO definition, TOF refer to all tree formations occurring in farmlands, fruit plantations, orchards, urban parks, settlements, along fields, roads or rivers, as isolated woodlots or low density savannas, etc. (TOF *sensu lato*). Minimum thresholds in terms of tree cover and patch size have, however, been established for assessment purposes under the FAO FRA (TOF *sensu stricto*). The FAO FRA methodology uses the term "other land with tree cover" for TOF *sensu stricto* within the category "other lands" (FAO, 2012a). This category includes all lands not fulfilling the criteria necessary for classification as "forests" or "other wooded lands."

The "other land with tree cover" sub-category includes all "lands predominantly agricultural or urban and whose patches of tree cover span more than 0.5 ha and have a canopy cover of more than 10 percent of trees able to reach 5 m height at maturity" (FAO, 2012a). TOF formations that do not meet these criteria are not included in the FAO FRA. Relying mostly on member countries' reports, the assessment provides global statistics for the years 1990, 2000, 2005, 2010 and 2015. However, of the 31 countries in the Mediterranean region, only 17 reported on "other land with tree cover" in the last FAO FRA report (FAO, 2015a).

The definition of TOF used in the ICRAF Global Tree Cover and Biomass Carbon on Agricultural Land Database 2000-2010 includes all trees located outside forests for agricultural land-use, including intensive cultivations and agroforestry systems, as well as degraded vegetation and forests interspersed with croplands (Zomer *et al.*, 2016). The assessment, conducted using MODIS (Moderate Resolution Imaging Spectroradiometer) imagery, provides estimates of worldwide canopy cover on agricultural lands

Table 2.7. Trees outside forest cover in the three Mediterranean sub-regions

Sub-region	Data from FAO FRA, 2015		Data from ICRAF, 2010	
	Area (× 10^3 ha)	Share of regional area (%)	Area (× 10^3 ha)	Share of regional area (%)
East	3 502	42.6	2 023	16.7
North	1 202	14.6	9 617	79.4
South	3 515	42.8	473	3.9
Total	8 219	100.0	12 113	100.0

Note: 31 countries or territories are included, namely the 27 countries listed in Chapter 1 (page 2) plus Andorra, Gibraltar, Holy See and San Marino.

Source: FAO (2015a) and ICRAF "Global Tree Cover and Biomass Carbon on Agricultural Land Database."

for the years 2000 and 2010 (Zomer *et al.*, 2016). Despite the coarse resolution (1 km^2), ICRAF's datasets have global coverage and can also provide a comprehensive insight into the state of TOF in Mediterranean agricultural landscapes.

Current distribution and differences between Mediterranean sub-regions

According to FRA data for 2015, at least 8.2 million ha of land in the region is covered by TOF *sensu stricto*, representing 0.9 percent of the 882.6 million ha of the total area of Mediterranean countries (this is a minimum as statistics are lacking for 14 countries). Values range from 0 ha in Gibraltar to 2.9 million ha in Turkey. Three countries, Morocco, Tunisia and Turkey, account for 78.5 percent of the total TOF (i.e. 6.4 million ha). Comparisons between sub-regions show that the largest (and almost equivalent) share of TOF is located in the southern (3.5 million ha, i.e. 42.8 percent) and eastern sub-regions (3.5 million ha, i.e. 42.6 percent), while the north accounts for only 14.6 percent of reported TOF (1.2 million ha) (Table 2.7).

According to the ICRAF Global Tree Cover and Biomass Carbon on Agricultural Land Database, 12.1 million ha of agricultural landscapes in the Mediterranean region were covered by TOF in 2010 (about 1.4 percent of the total area of Mediterranean countries). France had the largest area in this regard, with 3.4 million ha of agricultural lands covered by TOF. No farmland tree cover could be detected in Andorra, Gibraltar, Monaco or Vatican City. There was significant disparity at the sub-regional level between countries in the north, east and south. With the exception of Turkey (2.0 million ha, second only to France in area) and, to a lesser extent, Egypt and Morocco (0.2 million ha each), TOF in agricultural landscapes were more frequent in the region's north (with 9.6 million ha) than the east (with 2.0 ha, 97.3 percent of which was found in Turkey) and south (with 0.47 million ha, 79.4 percent of which was found in Egypt and Morocco combined. See Table 2.7). In terms of canopy cover per unit area, 78.1 percent of Mediterranean agricultural lands with high canopy cover (i.e. > 30 percent) and 83.6 percent of Mediterranean agricultural lands with moderate tree cover (i.e. 10-30 percent) were found in the region's north (i.e. southern European countries). In the Mediterranean's east and south, most agricultural lands (i.e. 83.2 percent and 88.1 percent of eastern and southern Mediterranean countries respectively), presented low levels of tree cover (i.e. < 10 percent). Exceptions to this pattern were found in Egypt, where 59.4 percent of farmlands (largely confined to the Nile delta) had moderate tree cover (i.e. 10-30 percent), and Spain, where 89.2 percent of agricultural lands had low cover (i.e. < 10 percent).

Trends and projections at the regional and sub-regional level

Given the incomplete data in FAO FRA 2015, it is not easy to project future regional and sub-regional trends with regard to TOF cover. That being said, a country-level analysis based on past trends for the period 1990-2015 suggests relatively stable TOF cover in nine countries (six in the north and three in eastern area of the basin), with a percentage of change lower than ±3 percent. The TOF area appears to have steadily increased in Morocco (+60.9 percent), Slovenia (+22.2 percent), Tunisia (+18.0 percent) and Turkey (+50.6 percent), while a clear decrease can be observed in Cyprus (−61.9 percent), Bulgaria (−25.3 percent), Serbia (−43.0 percent) and the Syrian Arab Republic (−11.8 percent) (Table 2.8).

With regard to TOF in agricultural landscapes, the comparison between the ICRAF Global Tree Cover and Biomass Carbon on Agricultural Land Database data in 2000 and 2010 shows a positive regional trend (+10.9 percent), with an annual increase of about 0.12 million ha of tree cover in regional farmlands.

Should this trend continue, agricultural canopy cover in the region's agricultural landscapes would reach 14.5 million ha by 2030. At the sub-regional level, there a clear difference between the three sub-regions in terms of percentage increase over this 10-year period. Eastern countries showed a 14.7 percent increase, followed by northern countries with a 10.7 percent increase, while the south experienced a negligible increase (0.3 percent), mainly due to the extensive decrease observed in Egypt (−53 774 ha) (Table 2.9).

Six countries in the Region showed an increase in TOF cover exceeding 50 percent, namely Palestine (+62.4 percent), Algeria (+56.7 percent), the former Yugoslav Republic of Macedonia (+55.8 percent), Malta (+53.2 percent), Tunisia (+53.2 percent) and Albania (+50.6 percent). Conversely, three countries experienced a substantial decline in TOF cover, namely Libya (−29.5 percent), Egypt (−19.9 percent) and Portugal (−15.1 percent). With regard to the level of canopy cover observed in the region's agricultural landscapes, areas with a high level of tree cover recorded a 27 percent increase, a 6.5 percent increase was recorded for areas with moderate tree cover, while a 4 percent decrease was observed for areas with low tree canopy cover. Ironically, this recorded decrease was probably due to increased tree cover in some areas, resulting in a re-classification from "low tree cover" in the 2000 assessment to the "moderate tree cover" class in 2010. Only Egypt and (to a lesser extent) Cyprus show patterns of change contrasting with the regional trend, with a clear decline in agricultural lands with high tree canopy cover (−86.1 percent and −40.0 percent respectively) and a significant increase in areas with low tree canopy cover (+16.8 percent and +1.0 percent respectively).

Drivers of change across the region

TOF presence is strongly associated with bioclimatic indicators, particularly aridity. This is reflected in the abundance of TOF in humid zones and their scarcity in hyper-arid drylands (Zomer *et al.*, 2014). In the context of climate change, rising temperatures, changes in precipitation patterns and longer drought periods are expected to significantly alter the distribution of TOF. Land clearing for agricultural use or urban development is one of the main causes of TOF cover decrease and can lead to dramatic changes in their regional distribution, especially if associated with the widespread desertification affecting Mediterranean drylands. An example of this is the Nile delta in Egypt, where farmland tree cover is shrinking at an alarming rate, due to a combination of land degradation, abandonment and conversion to urban settlements (Shalaby *et al.*, 2012). Other potential contributors to TOF reduction are forest fires and overgrazing, particularly in North Africa and the Middle East. On the other hand, drivers of TOF expansion include tree planting for agricultural production, natural tree regrowth on abandoned lands and

Table 2.8. TOF (*sensu stricto*) cover trends in the Mediterranean by sub-region from 1990 to 2015 and projected to 2030, as reported in the FAO FRA

Sub-region	TOF cover (× 1000 ha)					% of change between 1990 and 2015	Projection: TOF cover by 2030
	1990	2000	2005	2010	2015		
East	2 285	2 617	2 828	3 100	3 502	53.3	4 096
North	610	1 078	1 348	1 137	1 202	97.0	1 675
South	1 900	2 917	3 008	3 322	3 515	85.0	4 572
Total	4 795	6 612	7 184	7 559	8 219	71.4	10 343

Source: FAO (2015a).

Table 2.9. TOF cover trends in the Mediterranean by sub-region from 2000 to 2010 and projected to 2030, as reported in the ICRAF "Global Tree Cover and Biomass Carbon on Agricultural Land Database"

Sub-region	TOF cover (ha)		% of change between 2000 and 2010	Projection: TOF cover by 2030
	2000	2010		
East	1 763 978	2 022 744	14.7	2 540 276
North	8 686 132	9 617 130	10.7	11 479 126
South	471 867	473 395	0.3	476 451
Total	10 921 977	12 113 269	10.9	14 495 853

Source: ICRAF "Global Tree Cover and Biomass Carbon on Agricultural Land Database"

the implementation of policies promoting green infrastructure, rural landscaping, agroforestry and reforestation. Human activities and population density can also act as positive influencers, eventually overcoming the bioclimatic limitations, where demand for trees is high (Zomer *et al.*, 2014).

Innovative tools for TOF assessment

Significant progress in remote sensing technology and data collection and analysis has been made to facilitate land assessment at different levels (local, national, regional and global). Through the Open Foris initiative, FAO has developed a number of free and open source applications intended to overcome constraints related to cost, time and expertise in massive data processing and analysis. Among these, Collect Earth desktop is a software tool that allows users to combine pre-processed data from multiple publicly accessible sources to produce an augmented visual representation of the data collected (Bey *et al.*, 2016).

A thorough TOF assessment requires fine spatial resolution imagery to detect the presence of individual or small groups of trees. With this in mind, the tool allows users to visualize and interpret very high resolution images (from the Digital Globe archive in Google Earth and Bing Maps), in conjunction with a number of bio-geophysical indices and automatically generated time series data (e.g. derived from Landsat and MODIS data in the Google Earth Engine) (Bey *et al.*, 2016). The tool has already proved efficient in assessing the state of drylands, locating around 13.5 billion TOF in these ecosystems globally (FAO, 2016d).

A few other tools are dedicated to tree inventory in urban settings. These include the i-Tree suite (so far only adapted for application in the USA, UK, Canada and Australia; i-Tree, 2017), Greece's Urban Tree Management applications (within the programme URBAN; Tasoulas *et al.*, 2013) and the more recent web platform Curio, which relies on crowdsourcing to map trees in cities worldwide (Breadboard Labs and ESA, 2017).

Policies and governance

Rights over a natural resource are primarily determined by the status of the land on which the resource is located. TOF include trees growing on both private and public land in a wide range of possible land-uses. As a consequence, different policies and laws on forestry and/or agriculture (or neither) will govern access, use and management of this resource in any given country.

In Portugal, the management of TOF in rural areas can fall within the national jurisdiction (e.g. for trees along river banks) or local regulations (e.g. for the management of trees in national/natural parks). At present, tree planting is promoted through a national rural development framework, which provides financial support to those willing to increase the tree cover of their land up to a maximum of 80 hardwood trees or 250 non-hardwood trees per ha. Tree felling is only permitted following authorization by municipal/environmental authorities, and this also applies to trees located on private land. In particular, strict management applies to two species: the cork tree (*Quercus suber*) and holm oak (*Quercus ilex*), which can only be felled under exceptional circumstances involving new clearing plantations. In urban areas, tree management is often governed by local "green plans," which provide guidance on which species may be planted and their management. Due to their historical significance, there are strict regulations in place for the management of heritage trees.

In Turkey, unauthorized cutting of trees and shrubs in urban areas is considered a violation of property rights. Property owners may fell trees located outside forests that do not belong to forest species without obtaining authorization from forest administrators. This includes, among others, fruit trees. If a felling request relates to a forest species, however, specific permission must be granted by the forestry authority. For TOF in rural areas, ad hoc laws exist to protect tree species with high economic value, such as olives, pistachios, locust bean, and terebinth (e.g. Olive Trees Protection Law). A National Afforestation and Erosion Control Law (1995) encourages tree planting by public institutions and the private sector in order to increase forest cover and recover the ecological functionality of natural landscapes. Thus far, however, the law's promotion of afforestation activities has not proved very effective.

In Slovenia, the Forest Act of 1993 provides guidelines for the management of individual and small groups of forest tree species growing outside settlements. The main purpose of the guidelines is to provide indications on how to sustain and enhance the role of these trees towards the conservation and development of the landscape and wildlife. The Slovenia Forest Service records the location of these trees in the "spatial session" of its Forest Management Plan. Until 1973, a specific law existed to protect individual trees in urban areas (regardless of their ownership status) from felling and misuse. Since the abolition of that law, however, no national regulation or decree has existed to protect trees located on private lands in urban areas from being cut or mistreated. At present, each local community is responsible for issuing laws and decrees for the management of their urban trees. In the City of Ljubljana, for instance, the management of municipal street trees, trees in public spaces and urban forests owned by the city falls under the City Ordinance on the Maintenance of Municipal Roads and Public Green Spaces (Figure 2.19). Tree pruning (for which the City Department of Economic Activities and Transport is responsible) is carried out according to the European Arboricultural Council pruning guide, and certified arborists are employed for the management of urban trees as well as the forests in the city's Forests of Special Purpose (i.e. urban and peri-urban forests acknowledged by a city to play a key role for biodiversity conservation, environmental protection and social functions). Each of the city's 70 000 trees is annually assessed and assigned a code (which provides information on species, age, health status, height, etc.). A specific decree (based on the National Forest Act) governs the management of Ljubljana's forests of special purpose. A proposal for including the management of individual trees in the Environmental Protection Act has been advanced over the past few years. However, the government seems to be more inclined to allow cities to regulate the issue as they see fit.

In Morocco, the management of TOF falls primarily under the jurisdiction of the Ministry of Agriculture, Fisheries, Rural Development, Water and Forests and of the Ministry of National Planning, Urban Planning, Housing and Urban Policy. The Ministry of Energy, Mines and Sustainable Development also has jurisdiction when the implementation of environmental programmes includes tree planting. At a local level, the management of TOF in urban areas (e.g. urban parks, street trees, isolated trees) falls under the jurisdiction of urban municipalities, while the High Commission for Water, Forests and Combatting Desertification (HCEFLCD) has responsibility for the management of TOF in rural and peri-urban settings. Planning, planting and management of trees are predominantly ruled by national plans. Tree felling is formally banned by law and requires special authorization, but customary laws are also applicable in certain tenure systems. In rural lands owned by the state, usage rights may be granted to local communities, with some restrictions, to ensure the protection of natural resources. Permitted activities may include livestock grazing, firewood and gathering of small-sized wood products (e.g. fallen dead wood) and collection of non-timber products (e.g. fruits, nuts, seeds, fodder, etc.).

In Spain, no national legislation governing the management of TOF exists. The only national laws related

Figure 2.19. Residents and tourists in Ljubljana, Slovenia, enjoy outdoor leisure time in the shade of a large tree
© Simone Borelli

to the management of this resource are the Instrument of Ratification of European Landscape Convention and the Natural Heritage and Biodiversity Law (the latter acknowledging individual and monumental trees belonging to the Natural Monuments category). In rural areas, the management of TOF is partially ruled by policies aimed at the protection of agricultural lands. For urban areas, a National Strategy of Green Infrastructure and Landscape Connectivity and Ecological Restoration is currently under development, and will include the potential role of TOF in increasing green infrastructure connectivity. Similar to many other countries in the region, TOF management is largely governed at a municipal level. Although some municipal plans already make reference to tree protection and conservation, several cities are following Barcelona's example and drafting master plans for the management of urban trees or developing catalogues of Monumental trees.

TOF management is also governed at the provincial and autonomous community levels. The autonomous communities of Spain are obliged to develop their Ecological Connectivity and Green Infrastructure Strategy within three years from the date of the publication of the national strategy. Specific laws and decrees governing TOF management at community level include the Law on Protection and Promotion of Urban Trees of the Community of Madrid (8/2005, December 26), Decree 67/2007, regulating the Catalogue of Singular Trees of Galicia, the Catalogue of Singular Trees and Groves of Aragon (article 55 of Law 6/2014 and article 2 of Decree 27/2015), the Catalogue of Singular Trees and Groves and Protected Island Forests in the Community of Andalusia, and the Law on Monumental Arboreal Heritage in the Community of Murcia. Other autonomous communities such as Galicia, Cataluña, Valencia, Andalucía and Cantabria have their own laws on landscape protection which include TOF. An initiative for the development of legislation governing tree protection has been issued by the Barcelona Provincial Council.

In Italy, the governance of TOF in rural areas (including individual trees, trees in rows and small woodlands, i.e woods < 0.2 ha) falls under the local (region or province) policy framework, while in urban areas it is the responsibility of city councils. TOF in rural areas are governed by local rural development plans, issued by regions and autonomous provinces to put the directives of the European Common Agricultural Policy into practice and filtered by the National Rural Network, i.e. the ministerial programme on rural development. While local authorities govern the conservation and management of TOF, some specific issues refer to overarching protection or promotion directives such as the European Union high quality products schemes or the national landscape protection initiatives (e.g. wines, olives, cheese, berries, fruits, etc.). With regard to the governance of TOF in rural areas, Municipal Land Use Plans and their regional-specific technical norms and standards provide clear indications on the level of protection and conservation of different landscape elements (including tree systems). The Plans have a particular focus on the conservation of historical rural landscape features in which TOF often have significant importance. Regional initiatives promote the establishment of a register of heritage trees and define their characteristics. The Abruzzo Region's law on the Protection of Forests, Pastures and Tree Heritage (2014), as well as the Marche Region's law on the Protection of Monumental Vegetation Formations (2012) serve this purpose, protecting individual landscape elements including trees, shrubs, small groups of trees in rows and small woodlands. National Law 10/2013 on the development of urban green spaces and its implementing Decree of 23 October 2014, promote the presence and protection of trees in urban areas, based on the wide range of ecosystem services they provide towards improving the quality of urban environments. The Ministry of Agricultural, Food and Forestry's law on the Protection and Valorization of Environmental and Landscape Heritage (Decree 152/2006) and the Italian Cultural and Landscape Heritage Code (D.Lgs. 42/2004), protect monumental trees and tree systems in rural landscapes.

Trees found in linear formations on roads in Italy are managed by the Ministry of Transport and Communications, while Municipalities are responsible for the management of trees along urban streets. In both cases, however, rules for planting in new developments are governed by the new Italian Road Traffic Code (Decree-Law No 285/92), according to which the minimum distance between the tree and carriage way must not exceed the average maximum height reached by adult trees of that species. This clause may be waived in the case of renewal of existing trees by using the same species as before. Thus far, no references to TOF systems have been made in any of Italy's forestry policies. As a result of the increasing awareness of the important role played by these tree systems in the conservation of natural landscapes, a proposal to include TOF and small woodlands (< 0.2 ha) has been included in the upcoming national forest strategy.

It is clear that the management of TOF requires specific policies and laws in view of the variety of purposes and settings in which they can be found. It is nevertheless important to ensure these policies are integrated into a coherent policy framework.

With regard to TOF in urban settings, some cities in the Mediterranean region have begun developing green infrastructure strategies and plans. The Paris Greening Programme, for example, aims to reduce the urban heat island effect by planting more than 100 000 trees within Paris proper (excluding woodlands) and covering 23 percent of the Paris region with vegetation by 2020 (Mairie de Paris, 2014). The City of Barcelona has developed the Barcelona Green Infrastructure and Biodiversity Plan 2020 aimed at conserving urban biodiversity and providing residents with social and health benefits. Despite the relative abundance of green spaces, only 30 percent of urban green spaces in Barcelona are publicly accessible due to the nature of their distribution. One of the planned activities therefore includes incentives for private green space owners to open these areas to the public (Barcelona City Council, 2013). In Turkey, the establishment of urban forests began in 2003. Its General Directorate for Forests aims to establish urban forests in every province and large district in the country. By 2016, 133 urban forests had already been established. According to Atmiş (2016), however, some governance problems remain, such as unclear criteria for how urban forests are categorized, limited capacity of forest administrators to deal with urban forest management and transfer of management and maintenance responsibilities to municipalities and private companies. This has resulted in relatively limited usage of urban forests. More broadly, the new Common Agricultural Policy of the European Union promotes the presence and maintenance of TOF in rural settings across Europe. Under this policy, countries must provide incentives to farmers using climate and environmentally friendly farming practices. Among other things, this includes maintaining an ecologically focused area on arable land, consisting of field edges, hedges, trees, fallow land, landscape features, biotopes, buffer strips, afforested areas or nitrogen-fixing crops. The policy does not, however, explicitly promote agroforestry practices.

In addition to the implementation of specific policies and their integration into a comprehensive framework, sound management of TOF requires strategic and inclusive governance ensuring involvement by all local actors (i.e. local communities, urban planners, farmers associations etc.) and taking into account all relevant economic, social and environmental indicators. This also requires participation by all relevant disciplines and sectors (including urban planning, sociology, biology, forestry, agriculture, livestock and timber production), as well as close collaboration between municipalities and relevant institutions. Several countries are open to this type of participatory governance (Buijs *et al.*, 2016). In France, the Paris Municipal Government is devolving more responsibility to district authorities. This has resulted in the decentralization of green space management, enabling citizens to plant and maintain tree pits on sidewalks (Pellegrini and Baudry, 2014). In Ljubljana, an NGO initiative helped transform a degraded area characterized by illegal dumping of waste and non-indigenous vegetation into a recreational park with increased bio-cultural diversity, thus improving the quality of this urban ecosystem (Nastran and Regina, 2016). In 2008, the City of Lisbon (Portugal) introduced participatory budgeting at a municipal level. Over time, this had a significant impact on the city's green infrastructure and increased public involvement in decision-making (Buijs *et al.*, 2016).

Threats and challenges to the conservation of TOF

Climate change poses new challenges to the Mediterranean region, driving problems such as drought/heat-induced tree mortality, increased risk of wildfire, the spread of invasive species and pest and disease outbreaks. With regard to the latter, increased ornamental planting, tree translocation and the introduction of exotic species further exposes non-forest areas to insects and pathogens, and increases the risks of their spread into natural forests.

The detection of colonies of pine processionary moths in Paris and eastern France, beyond their historical distribution range in the south, illustrates this risk. Their presence in the area is presumably the result of transplanting adult pine trees with soil intact, and their successful establishment has been aided by changed climatic conditions, resulting from climate warming (Robinet *et al.*, 2012; Rossi *et al.*, 2016). Another notable example is the rapid spread of the bacteria *Xylella fastidiosa*, which originates from America, but now ravages olive plantations in southern Europe, particularly Italy (White *et al.*, 2017). Other major challenges facing the conservation of TOF in Mediterranean agricultural landscapes include overgrazing, which is severe in North Africa, leading to the degradation of cork oak-based systems in Morocco, and the abandonment of agrosilvopastoral practices and land clearing in favour of intensive monoculture farming, which is more prevalent in Europe (Laouina *et al.*, 2010; Kizos and Plieninger, 2008; Kigomo, 2003). In urban and peri-urban areas, patches of remnant forest, vacant wooded lots and other fragments of natural habitat are severely threatened by population growth and associated high demand for grey infrastructure, predominantly housing and transportation. This has led to uncontrolled urban sprawl, particularly in the southern and eastern Mediterranean (Houpin, 2011; CIDOB, 2015). Threats posed by illegal logging and vandalism are also worth noting here.

Despite their long history in the region, TOF are often found in isolated areas with low species diversity. In Spain, 56 percent of all trees planted in paved areas represent only six genera (García Martín and García Valdecanto, 2001). In the absence of natural selection, choosing and planting trees solely for their productive or aesthetic traits may lead to genetic erosion. This has a significant impact on small populations, compromising their adaptive capacities and reproductive success (although there are a few exceptions to this rule in the Mediterranean, such as the impoverished but geographically widespread *Pinus pinea* (Vendramin *et al.*, 2008) and the genetically diverse *Cedrus brevifolia* endemic to Cyprus (Eliades *et al.*, 2011). Planting trees in a new habitat, whether in urban, peri-urban or rural settings, may affect local environmental conditions and community interactions, such as competition for resources. To ensure the sound and efficient management of TOF, it is therefore important to adopt a multidisciplinary and holistic approach. Issues related to structural stability, toxicity, the risk of hosting parasites and pathogens, invasive behaviour, gene flows and cross-breeding should be given particular attention before introducing new species. As much as possible, TOF landscapes should be built with regard to projected challenges and conditions, without losing sight of sub-regional specificities and societal realities.

In the coming decades, new urban/peri-urban environmentally-oriented approaches might emerge from traditional agroforestry models. This will also necessitate a solid TOF framework linking diversity, performance, knowledge and management. At the same time, forestry-related education must be updated to integrate topics and skills relevant to the new global agenda, including adaptive management, traditional and local knowledge and equitable benefit-sharing. Promising advances in observational technologies, such as NASA's Global Ecosystem Dynamics Investigation LiDAR (GEDI), measuring the vertical structure of forests at a global level and the growing use of Unmanned Aerial Vehicles open up new possibilities for TOF assessment and monitoring with high spatio-temporal resolution and low costs.

Perspectives: expected role to be played by TOF in the Mediterranean region towards the fulfilment of the Global Agenda

Formerly overlooked, TOF are increasingly recognized for the environmental, socioeconomic and cultural services they provide. In the context of global change, their functions have shifted from simple food/wood productivity or ornamental uses to a multi-purpose role contributing to environmental protection, nature conservation, food security, poverty alleviation and improved liveability. The three Rio conventions (the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the UN Convention to Combat Desertification (UNCCD)) require member countries to take action for the conservation and sustainable management of all forests and trees, and call for regular monitoring to evaluate progress (United Nations, 1992a,b, 1994). The UNCCD, for example, urges affected countries to encourage farmers to grow more trees and adapt to and foster agroforestry systems in a way that conserves soil and water while capturing additional benefits, such as diversified crop products, fuelwood and forage/fodder for livestock (United Nations, 1994; Wunder *et al.*, 2013). Similarly, they encourage planting trees in urban and peri-urban areas as a means to protect cities from advancing desert, as illustrated by the pilot greenbelt project around Ouarzazate (Morocco) used to decrease soil erosion, halt encroaching dunes and provide a windbreak against sandstorms (UN Environment, 2015).

New perspectives for TOF development and expansion have also emerged through valuation initiatives, promoted by the Millennium Ecosystem Assessment approach (Millennium Ecosystem Assessment, 2005a,b,c). Certification schemes for cork and argan oil production, such as those supported by the WWF-MedPO and Rainforest Alliance, are examples of initiatives aimed at conserving Mediterranean silvopastoral systems' iconic tree species, while improving socioeconomic conditions for smallholders and local communities and conserving habitats for wildlife (Rainforest Alliance, 2008). Consistent with the Instrument on All Types of Forests (which is non-legally binding), strategies using TOF as a tool to promote sustainable livelihoods, rural development, access to fair trade markets, biodiversity conservation and carbon sequestration have increasingly been adopted in support of the 2030 Sustainable Development Goals (SDG) (United Nations, 2015). In keeping with this, the New Urban Agenda – adopted at the UN Conference on Housing and Sustainable Urban Development (HABITAT III) – calls for an increase in safe, inclusive and accessible green and public spaces providing opportunities for recreation, environmental education, pollution mitigation, climate regulation and even nutrition. The latter, in particular, is highly valued in the Mediterranean, where TOF have traditionally been linked to production (Fraser and Kenney, 2000; Habitat III Secretariat, 2016) even in cultural landscapes of particular value.

5 Drivers of degradation and other threats

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Introduction: Mediterranean forests at stake

Forests in the Mediterranean region have been subject to environmental changes since time immemorial. The region's geography and location has made it a conducive environment between biomes, resulting in significant biodiversity. Since the beginning of human history, forests have adapted to pressures caused by human development, resulting in a complex socio-ecological balance. These pressures, however, have never been more extreme than they are today.

Global change, understood as the wide range of global forces resulting from human activity, is affecting the entire Mediterranean basin (Doblas-Miranda *et al.*, 2017). The threats caused by global change pose particular risks to the principal characteristics of Mediterranean forests and forested habitats described in previous chapters:

1. Mediterranean forests and shrublands are highly sensitive to global atmospheric changes due to their proximity to arid regions;
2. a long history of land-use change may result in more frequent and intense fires, water scarcity and land degradation and;
3. a singular biota is linked to a higher vulnerability to global change-induced extinction.

Moreover, the wide range of socioeconomic conditions and government policies that characterize the Mediterranean basin affect the intensity and dynamics of these threats.

This chapter outlines the different threats to Mediterranean forest landscapes, structured according to indirect and direct causes of degradation. The anthropogenic origin of current global changes directly affecting Mediterranean forests is considered the underlying cause of degradation. Although in many cases these human forces have a global impact (such as greenhouse gas emissions caused by climate change), this chapter will consider their effect on the Mediterranean region in particular. This chapter will also consider the consequences of direct and indirect threats and the combination of both.

Underlying (indirect) causes of degradation

Local and regional policies

The Mediterranean region is located at the intersection of three continents. Mediterranean countries do not share a common forest strategy recognizing the many functions and values of Mediterranean forests, particularly in view of global changes. As a consequence, forest governance remains the responsibility of national authorities. In some cases, national forest laws and regulations help forest owners to promote sustainable forest management (Box 2.4). At a sub-national level, however, forest policies can easily lose their flexibility and in some cases may inadvertently promote (by not preventing) causes of degradation that are not only environmental but also economic and social (e.g. land abandonment and fuel accumulation, see Box 2.5).

Box 2.4. The Regional Center for Forest Ownership of the Provence-Alpes-Côte d'Azur Region, France

The Regional Center for Forest Ownership is a public establishment created under the supervision of the French Ministry of Agriculture to promote sustainable silvicultural management among private owners. Its forestry technicians meet private owners' needs, personalizing technical, legal, economic and financial support. The main aim of this Regional Center is to facilitate and promote the sustainable management of common causes of degradation through technical assistance and training.

Despite the fragmentation that characterizes regional governance in this area, several and ongoing regional efforts have been undertaken. A scientific Mediterranean Forest Research Agenda was developed for the period 2007-2020, based on a shared and common vision of Mediterranean challenges. It aims to protect the sustainability of Mediterranean forests by sharing and advancing knowledge about how forest ecosystems function and developing new tools for management and governance in the context of global change. Scientific advancement should form the backbone of more structured knowledge-based governance; it is a prerequisite for providing the scientific expertise with which to develop more efficient policies to establish a common Mediterranean vision.

At a policy level, the regional project "Adapting the framework for forestry policy to meet the needs of climate change in the MENA region" (with the support of the German Development Cooperation (GIZ) and under the Collaborative Partnership on Mediterranean Forests (CPMF)), has increased the capacity of national decision-makers to design forest conservation policy. It has also involved additional actors, motivating them to actively cooperate with other sectors. It will only be possible to overcome current challenges associated with global change through improved understanding and recognition of the economic (tourism, livestock farming, water, etc.) and social value of forests, including through better stakeholder coordination. Other initiatives go one step further, by also proposing participatory modes of governance (Box 2.6).

An additional regional tool promoting new policies and initiatives to mitigate Mediterranean forest degradation is the Strategic Framework on Mediterranean Forests (SFMF), adopted at the Third Mediterranean Forest Week (Tlemcen, Algeria, 2013). It calls for improved governance of policy development, implementation and monitoring, particularly by fostering the participation of all stakeholders at the landscape/territory level. The SFMF has rapidly been integrated in national initiatives. In Algeria, for example, it was considered during the formulation of the country's National Forest Plan. It nevertheless requires further translation and implementation in practice. The initiatives above are only few examples of several activities already undertaken in the Mediterranean region. Nevertheless, more work is still needed to develop a regional strategy supporting the development of revised and common Mediterranean forest policies. These are required to reduce degradation and maintain forest quality so that they can continue to provide various ecological and socioeconomic goods and services and contribute to socioeconomic development, based on integrated landscape planning.

Box 2.5. Wildfires and policies in the Mediterranean

The increased and extended risk of wildfires in the region requires new policies and approaches to fire management. Suppression policies that are not properly accompanied by vegetation management, silviculture and integrated landscape-level forest management may seriously increase forest degradation due to fuel accumulation, leading to an increased risk of forest fires. This situation requires new firefighting policies, together with efficient preventive strategies, such as integrated fire and forest management planning. The aim is to establish territorial policies that allow fires to remain a part of Mediterranean ecosystems at an 'acceptable' level. National and regional strategies and policies must be reconsidered, by tackling all dimensions of the problem, including clearly identifying civil protection and forest protection objectives. Finally, priority should be given to the shift from short-term fire control policies to longer-term policies of removing the structural causes of fires.

Micro and macroeconomy

Economy indirectly affects forest degradation. A key concept used to describe and design development policies in Mediterranean countries is the so-called "bioeconomy" (Bugge *et al.*, 2016). There is no consensus in the literature (Pülzl *et al.*, 2014) on whether bioeconomy represents a paradigm, a master narrative, or simply a general concept. However, analysing the implementation of this concept in the forestry sector, we find that there are two opposite views and different underlying perspectives on the role forest resources can play in rural development policies: a technological approach vs. a social approach to the concept of bio-based development. These two approaches have different consequences for Mediterranean forest ecosystems.

The technological approach to bio-based economies is based on the accepted wisdom of externality correction (i.e. "getting prices right" or applying a true value to resources, thus reducing the consumption of natural capital). This "old wine in new bottles" strategy gives technological change a central role, synergizing the food and raw materials produced by forests (e.g. biomass and cork) with agriculture and fisheries for use in new and expanding markets. Biotechnology innovations are the engine for growth in this regard. Bio-refineries are a reference model for this approach in the Mediterranean forest sector (Box 2.7). In seeking to increase the scale of production, companies have tended to focus on supply chain organization (often associated with quite large financial investments) and labour intensive production (raw material procurement is generally based on very large quantities of low quality commodities).

By comparison, a social approach to the bio-based economy (as defined both by OECD, 2011 and UNEP, 2011), emphasizes both the protection of natural capital and the importance of addressing equality and social inclusion to protect the sustainability of socio-ecological systems. This strategy focuses on the forest sector's social dimensions, in which the most critical innovations relate to land tenure organization and the provision of advisory and other supporting services in rural communities, such as micro-credit, e-marketing, job creation and social inclusiveness (Box 2.8).

Box 2.6. Practices to promote participatory approaches and the sustainable development of Mediterranean forest ecosystems in the Maâmora forest (Morocco)

Under the regional project "Maximize the production of goods and services of Mediterranean forest ecosystems in the context of global change" (funded by the French Global Environment Facility), two practical guides were created to facilitate the implementation of "win-win" partnerships in forested areas in Maghreb countries, especially in the Maâmora region. The Maâmora forest is the largest cork oak forest held by a single owner in the world. Despite this, its forest surface has decreased from 132 000 ha to 55 000 ha since the beginning of the nineteenth century. The main identified causes of this decrease are forest degradation and deforestation caused by strong anthropogenic pressure (grazing, pruning, resource withdrawal by local populations depending on those resources) and a failure of forest management to adapt to both this pressure and climate change. The initiatives in Figure 2.20 present options to encourage cork oak conversion and regeneration by involving local populations in responsible and sustainable resource management.

Before

- Illicit acorn collection, inadequate harvesting methods
- Degradation, regeneration of threatened cork oaks
- Necessity of importing seeds from outside

↓

Actions implemented with users

- Forming cooperatives and associations
- Raising awareness and education
- Win-win contracts between managers and populations: 60% of acorns to users/ 20% to plant nurseries/ 20% for natural regeneration

↓

After

- Partnership between managers and users for the benefit of the general public
- Improving revenues of local populations
- Value chain control
- Accountability of users adopting good management practices in a legal context
- Seed traceability (nurseries) and availability
- Reduced pressure on forest resources

Figure 2.20. Suggestions for the promotion of participatory approaches to reduce degradation in Maâmora Forest

The social approach more effectively supports job expansion and added value in rural areas than a purely technological focus (Table 2.10). Unfortunately, the social approach has limited political visibility. It is based on a constellation of niche markets in which products and services are promoted via investments in technical assistance, new contractual agreements and networking services. In many Mediterranean countries, these services are often the most vulnerable to public budget cuts.

Box 2.7. The technological approach to the bioeconomy: the thermic central of Gardanne Province (France)

The thermic central of Gardanne Province, located near Marseilles (France), is a wood-based power station converted from a former coal-burning station in 2016. The plant is managed by the German company E.ON, which claims it has reduced CO_2 emissions by 600 000 tonnes a year and created new jobs, ensuring a market for the low quality woodcuts sourced from forests in the surrounding region (even where importation of some portion may still be required). Annual demand for industrial wood (855 000 tonnes at the plant's full capacity) will, according to E.ON, have several indirect positive impacts. These include increasing active management of local forests, thus reducing the likelihood of abandonment and risk of forest fires. The environmental consequences of such enormous annual wood consumption, however, remain unexplored.

Moreover, the diversification of small-scale forest activities has led to increased integration with the farming, tourism and recreational sectors. This has created monitoring and evaluation problems, as limited statistical data is available. Finally, social innovations associated with increased social capital do not attract as much private sector attention as large-scale investments that require significant financial and technological capital. With a view to long-term sustainability, stronger private-public partnerships, focused on protecting and enhancing the non-market functions of the Mediterranean forestry sector, would result in greater balance between these social and technological approaches to managing forest resources in the region.

Box 2.8. The social approach to the bioeconomy: the Borgotaro Consortium in Parma Province (Italy)

The Borgotaro Consortium manages 13 000 ha of forest owned by local forest communities ("Comunalie"). The Consortium was created in 1957 to regulate and manage the rights of local residents to grazing, harvesting wood for fuel, tap water distribution and wild mushroom picking. Over time, wild mushrooms became the most important income source for local forest communities and in 1964 the first mushroom reserve was created, allowing communities to grant daily picking permits. In 1996 the local mushroom ("Porcino di Borgotaro") obtained EC Protected Geographical Indication status, leading to the creation of an economy based on wild mushrooms. The "Porcino" supports a variety of local activities: 100 000 pickers generate an annual revenue of EUR 5 million, which is in turn linked to the revenue of 15 agro-tourism farms, 12 small hotels, eight bed and breakfasts, nine cheese, sausage and grape growing and wine production factories, two didactic farms, three museums and private collections, 30 restaurants and 26 shops selling local traditional products. These activities are inter-connected by a "wild mushroom trial" ("La strada del fungo") and promoted by a web site (http://www.fungodiborgotaro.com/).

Cultural and technological factors

Mediterranean forest dynamics depend on interactions between environmental factors and anthropogenic activities, which form a complex feedback pattern and continuous landscape transformation. The modification of landscapes and, consequently, the structure of forests, began when humans first harnessed the use of fire, followed by the commencement of agricultural production and the domestication of livestock.

Pollen and charcoal evidence from the Bronze Age (around 4000 BC) suggests anthropogenic wildfires

Table 2.10. The technological vs. social approach to developing the bioeconomy: a broad comparison

	Technological approach to bio-based economy	Social approach to bio-based economy
Focus	Technological innovations, large scale investments	Social innovations, small scale, added-value products and services (→ low risk)
Vertical vs. horizontal relations	Value chain perspective; sectoral development; vertical integration	Network economy, inter-sectoral development; horizontal integration
Diversification of outputs and inputs	Wood as a unique raw material; diversification in outputs	Diversification in the use of inputs (industrial wood, biomass, non-wood forest products, ecosystem services)
Market power	Increased market power of industrial companies controlling advanced technologies (→ high risks connected to the company's consolidation trends)	Balanced market power among the various diversified operators (→ reduced risk due to diversification)
Examples	Innovation assessment approach by the EU Eco Innovation Observatory (http://www.eco-innovation.eu/)	Local Action Groups (Leader+ approach – http://enrd.ec.europa.eu/enrd-static/leader/en/leader_en.html)
Drivers	Patented (private) R&D initiatives, with public support	Public-private initiatives in education, training and non-patented innovations

in Italy led to the replacement of *Quercus ilex* forests with shrub-lands (Vannière *et al.*, 2008). Similarly, the interaction between climatic changes and human pastoral activities resulted in a transition from maquis forests to steppe vegetation in Mediterranean France (Henry *et al.*, 2010). It is believed that forest clearing was primarily driven by increasing demand for livestock pasture and crop land. Williams (2000) notes that as time progressed and technology evolved, deforestation increased as a result of timber requirements for ship construction, metal smelting and wood as an energy source. During the Middle Ages, a growing human population and subsequent increase in demand led to extensive land degradation and soil erosion.

Although traditional uses of forests persisted during the twentieth century (especially with regard to burning practices; Box 2.9), described trends were reversed in the Mediterranean basin. Accelerated urbanization led to a decreased rural population. During the 1950s the urban population of northern Mediterranean basin countries accounted for about 40 percent of the total, whereas in 2010 it rose to more than 60 percent (Antrop, 2004). In Maghreb countries, urban populations accounted for about 30 percent of the total in 1960, increasing to almost 70 percent in 2015 (World Bank, 2015b). Urbanization and declining rural populations are accompanied by abandonment of agricultural land and marked declines in free-ranging livestock numbers (Lasanta-Martínez *et al.*, 2005). These processes initiate secondary succession and a consequent increase in forest cover.

Urbanization commonly causes the young labour force to migrate to cities, meaning rural areas remain largely populated by the elderly. This demography is less likely to adopt new farming technologies or modern practices. Low income yields have made many small farms in remote, rural areas unprofitable, accelerating abandonment of agricultural practices (MacDonald *et al.*, 2000). In some regions, traditional local populations have been replaced by foreigners and residents from a high socioeconomic class who commute daily to large cities (Sluiter and de Jong, 2007). Rey Benayas *et al.* (2007) have shown that countries with lower population growth rates and higher Gross Domestic Product (GDP) are associated with higher land conversion rates.

In North Africa, forests have gradually declined at a rate of 126 thousand ha/yr over the last 50 years (Keenan *et al.*, 2015). This decline is driven by population growth but also by direct demand for

Box 2.9. Integral Forest Fire Prevention Teams in Cantabria (Spain)

Over the past few decades, wildfires have become one of the Iberian Peninsula's most critical environmental problems. However, in northwest Spain burning is still used as a traditional tool during the winter in order to create grasslands for extensive livestock farming. Despite bans on this process, rural populations take advantage of favourable weather conditions to eliminate bushland, spreading fires which cannot be controlled.

The Spanish Ministry of Agriculture and Fisheries, Food and Environment (MAPAMA) supports Autonomous Communities that experience high numbers of wildfires through its "Equipos de prevención integral de incendios forestales" (EPRIF)'s programme (Integral Forest Fire Prevention Teams). Prevention activitives developed by the EPRIF focus on making livestock farming practices compatible with the environment. The Cantabrian Autonomous Region team in the Pas and Cabuérniga Counties was one of the first to adopt these preventative measures. The EPRIF developed a programme of prescribed fires with different typologies and degrees of difficulty. Highly complex controlled fires were developed in collaboration with Cantabria's fire fighters and MAPAMA's Preventative Labour Brigades. The EPRIF's work consists of complementary environmental education programmes and activities to further improve these grasslands.

In some Cantabrian municipalities the EPRIF has been working continuously since 2013. Its programmes have led to a reduction in the number of wildfires related to the creation of agricultural pasture from an average of 50 wildfires burning 350-400 hectares per year in 2013, to less than 10 fires burning only 50 hectares in 2016. Over time, the EPRIF has been integrated into the standard practice of the region's rural population, evinced by an increased number of burning requests. Its awareness-raising efforts have also been met with approval by the Region's administrators and educational institutions.

fuelwood, food and fibre, which often leads to overgrazing, overexploitation and forest clearing (Palahi *et al.*, 2008). There is also considerable forest expansion in some areas of the south due to afforestation programmes (Hansen and DeFries, 2004), and most of the countries in the southern Mediterranean are reporting stable or slightly increasing forest areas (FAO, 2015a and Table 2.3). These complex socioeconomic interactions and transitions have, over time, resulted in the current Mediterranean landscape.

Demographic patterns and migration

Population increase in many Mediterranean countries is one of the principal factors affecting forest ecosystems throughout the region. While the southern European population is expected to increase slightly to 155 million people by 2050, the North African population is expected to increase by 50 percent to 328 million people over the same period (DESA, 2009). Although depicting population growth as the principal cause of erosion, desertification, deforestation, pest and diseases, pollution and decreased water resources may be a simplification of more complex processes (Auclair *et al.*, 2001), it is undeniably implicated in these environmental threats.

Apart from the migration of local populations from rural to urban areas (resulting in ageing populations) described above, regional migration across the Mediterranean also creates an imbalance between human populations and the environment. Migration is in part a consequence of environmental degradation in countries of origin, and causes a risk that the overexploitation of resources is passed through to countries of arrival (FAO, 2016b).

Morocco provides a good example of this issue. Annual forest loss in Morocco is the result of a

Table 2.11. Demographic changes in Morocco from the first and the latest general population census

Year	Total population	Rural population		Urban population	
		in thousands	% of total	in thousands	% of total
1961	11 897	8 350	70.2	3 547	29.8
2014	33 770	13 417	39.7	20 353	60.3

combination of different elements which either affect the quality of vegetation cover or lead to reduced prevalence of hardwood or natural species. Population increases in Morocco in the last few decades have placed pressure on the country's natural resources, especially forests. The annual total population growth rate changed from 2.25 percent in 1961 to 1.17 percent in 2014, showing an almost two-fold decrease in around 50 years (Table 2.11). However, in absolute terms, urban populations experienced a five-fold increase over the same period while rural populations "only" increased by 60 percent. On the one hand, the country's population increase has necessitated significant urban development, resulting in devitalization of large crop and forest areas and ongoing land demands for construction purposes. On the other hand, forest degradation is also the direct result of grazing, agricultural, building or artisanal activities carried out by rural populations. Excessive wood gathering, in places such as the Middle Atlas cedar forests, has resulted in the loss of vast forest areas (HCEFLCD, 2005). Overgrazing, evinced by the disappearance of pasture plains, prevents forest regeneration. Ecosystem simplification increases vulnerability and decreases vegetation cover, exposing soil surfaces to desiccation and ultimately rainfall erosion, which accelerates soil degradation. This, combined with reduced water reserves, leads to desertification to the south and east of the Atlas Mountains.

Direct causes of degradation and principal agents

Climate change: climate warming, drought and other extreme climatic events

Throughout the Earth's history, its climate has been characterized by frequent fluctuations between periods of relative warmth and relative cold. However, unusual increases in global temperatures have occurred over the last century and the Mediterranean basin shows no sign of escaping this unequivocal climatic change. Recent data indicates a temperature increase of about 0.85°C globally and 1.3°C in the Mediterranean area in the last century, compared to temperatures recorded over the period 1880-1920 (Solomou *et al.*, 2017). The Mediterranean climate is expected to become drier and warmer, with decreasing water available for plants and increasing evapotranspiration (IPCC, 2007b).

The Mediterranean's vegetative cover is the result of a long, slow evolutionary process influenced by the climatic factors characterizing the region (Valladares *et al.*, 2014). However, socioeconomic pressures have historically affected Mediterranean forests, leading to innumerable anthropogenic afflictions, unsustainable forest practices and neglect of forested lands. Climate change has exacerbated those pressures, adversely affecting forested lands in the region. The current rate of climatic change is much faster than previously and has an attendant higher risk of extreme weather events, such as prolonged periods of drought, frequent and severe storms, flooding and increased extreme heat events (Scarascia-Mugnozza *et al.*, 2000). While Mediterranean plant communities have adapted to survive long, hot summer droughts and prolonged wet winter periods, the current change poses risks to forests' adaptability and increases their susceptibility to pressures and risks in the absence of adaptive management (Box 2.10).

The combination of climate change, anthropogenic disturbances (overexploitation of forest resources, human-induced fires and deforestation) and other aspects of global change (particularly land use and pollution) will have an effect on Mediterranean forest vegetation (Peñuelas *et al.*, 2010). Impacts are expected to affect the structure and operation of Mediterranean forest ecosystems, as well as the services they currently provide (Table 2.12).

Alteration of wildfire patterns

As outlined above, Mediterranean ecosystems, having evolved in the context of environmental disturbances and centuries of human influences, are undergoing change as a result of extensive rural migrations and land abandonment.

The most productive lands are used intensively, while less productive areas are abandoned or subject to less intensive use and afforestation. Fire systems result from interactions between climate, topography, local micro-environments at smaller spatial and temporal scales, as well as land use and land cover changes. Demographic shifts from rural to urban areas may favour fuel build-up and, consequently, may result in large fires. Conversely, population decreases reduce the probability of human-induced fires (Moreira *et al.*, 2011). According to this hypothesis, less frequent but more intense and large fires are expected (Box 2.11). This alters the principal role of fires in the Mediterranean both as long-term landscape modifiers and as a mechanism to maintain land cover classes in fire-dependent ecosystems (Stamou *et al.*, 2016). Effects may vary from region to region due to differences in regeneration patterns among the main land cover types, topographic constraints and local fire histories (Viedma, 2008).

Box 2.10. Coping with climate change: adaptive management for Lebanon's forests

Given that Lebanon's forests and woodlands suffer from fragmentation, pest outbreaks, forest fires and unsuitable practices, adaptation measures have been established to increase their natural resilience, anticipate future changes and promote landscape management (Ministry of Environment, 2011). These measures have been mainstreamed towards the adaptive actions outlined below:

1. strengthening the legal and institutional framework to integrate climate change needs;
2. integrating landscape planning and development at local/regional levels;
3. strengthening awareness and education and supporting research; and
4. developing forest management plans for the most vulnerable ecosystems.

In tandem with these activities, the government has commenced initiatives with the ultimate objective of enabling Lebanon's forests to cope with the effects of climate change. A National Afforestation and Reforestation Programme, known as the "40 million forest trees initiative," was launched by the Ministry of Agriculture in partnership with FAO in December 2012. The initiative intends to plant 40 million forest trees to recover forest areas lost over the last decade.

The Ministry of Environment has also undertaken biodiversity conservation measures, developing and updating the National Biodiversity Strategy and Action Plan (NBSAP) for the period 2016-2030, as required under the Convention on Biological Diversity (CBD).

During the period 1985-2011, Turco *et al.* (2016) reported a broad decreasing trend in the total annual burned area in Mediterranean countries (with the exception of Portugal), due to improved fire management and prevention (or socioeconomic changes leading to more hazardous landscape configurations in the case of Portugal). Recent studies on forest fires in the Mediterranean basin, however, have recognized a shift in fire frequency and size, an extension of the fire season (Koutsias *et al.*, 2015), and indications of a relationship between increased fire activity and climate change (Moreira *et al.*, 2011; Pausas and Fernández-Muñoz, 2012; although see Bedia *et al.*, 2014 for consideration of various sources of uncertainty on this point).

Table 2.12. Effects of climate change on the Mediterranean forest vegetation

Observed effects	Cause	Consequences
Changes in forest plants' growth and health	Increased CO_2 concentrations	• Increased productivity of some species • Increased biomass production of some species: greater number of leaves, higher total leaf area per plant, larger diameter stems and branches • Reduction of growth and health of local vegetation
Changes in vegetation patterns and distribution	Drought, rainfall and extreme weather events	• Influences plant productivity and efficiency of water use • Influences seed production • Habitat and coverage losses • Loss of biodiversity • Forest distribution shifting northward and upward
Changes in plants' phenology	Decreased precipitation and increased average winter temperature	• Decrease in winter chilling requirements for flowering and seed germination • Advancement of flowering date • Increase in the length of growing season • Incomplete winter hardening • Reduction in winter cold/snow damages
Changes in wildfires	Increased dry and warm conditions	• Increased frequency of fire events • Increased forest fire intensity and length • Replacement of forest with fire-prone shrub communities • High risk for native species to fail seed regeneration • High risk of increased invasion by non-native species
Pest outbreaks	Increased winter temperatures and extreme temperature episodes	• Increased frequency and intensity of pest outbreaks • Pest location and range shifts poleward or to higher altitudes

Biological invasions

By comparing selected regions across the mainland (Chytrý *et al.*, 2008) and observing the presence of invasive plants in the Mediterranean (Vilà *et al.*, 2007) we can conclude that forests are among the least invaded habitats in Europe.

Classical forestry investigations (e.g. di Castri, 1990) suggested Mediterranean forests were particularly resistant to plant invasion due to their environmental resilience and changes over recent millennia. Other studies, however, indicate local human-induced disturbances encourage forest invasion by non-native plants (e.g. Martin *et al.*, 2009). Forest disturbances create an environment conducive to invasion by new and non-native species, yet this often takes place over a limited period while high resource availability is maintained (Pino *et al.*, 2013). Other studies have challenged this paradigm, showing that a significant subset of invasive forest species are neither dependent on disturbances nor restricted to early successional life strategies (Gilbert and Lechowicz, 2005). Thus, many foreign plant species have invaded shaded, relatively undisturbed forest undergrowth in both temperate and tropical regions around the world.

Peri-urban forests are particularly vulnerable to invasion by non-native plants due to their presence in landscapes characterized by high levels of human disturbance and propagule pressure[1] (Clotet *et al.*, 2016). The role human activity plays in encouraging foreign plant establishment in peri-urban habitats is

[1] Composite measure of the number of individuals released into a region to which they are not native (Carlton, 1996).

Box 2.11. The 2007 fires in the Peloponnese (Greece)

In 2007 catastrophic wildfires occurred in the Peloponnese, Greece. The most extreme natural disaster in the country's recent recorded history (Koutsias *et al.*, 2012), the fires led to 67 deaths. Part of those fires burned non-fire-prone ecosystems, indicating a departure from recent burning patterns. During the summer of 2007, Greece experienced three extreme heat waves from late June to the end of August and overall, the summer of 2007 was reportedly the warmest the National Observatory of Athens had ever recorded since Greek observations began. The extremely high temperatures, combined with a prolonged dry period, triggered the most extensive and destructive forest fires in Greece's modern history (Founda *et al.*, 2008).

According to the CORINE land-cover categories, areas most affected by fire are those with greater fuel accumulation through the encroachment of natural vegetation in abandoned fields, as well as changing land-use patterns (Koutsias *et al.*, 2012). Increasing levels of humid and sub-humid areas burned clearly relate to weather patterns. The relationship between fuel and weather helps explain unusually large wildfires. This change suggests established fire-systems are being altered by climate change, exacerbated by fuel accumulation. This could result in major ecological consequences, particularly given the lack of specific adaptations in place to cope with fires in non-fire-prone plant communities.

well understood (e.g. González-Moreno *et al.*, 2013). Recent studies in the Barcelona region show that species dispersed by vertebrates and introduced predominantly by horticulture are especially abundant in peri-urban forests (despite the fact that these species do not dominate the invasive species pool).

Previous studies have established that dispersal by vertebrates is an effective mechanism for invasive plant colonization and spread, but estimates of the importance of this dispersal process vary (Buckley *et al.*, 2006). Recent results point to the presence of ecological filters favouring the colonization, establishment and spread of these vertebrate dispersed species in forests (Basnou *et al.*, 2016); yet the composition of these filters is still largely unknown.

Consequences of underlying and direct causes of degradation

Alteration and pollution of water resources

Water scarcity is among the three most important long-term risks worldwide (WEF, 2015). The sustainability of freshwater resources is critical, not only for environmental reasons, but for social and economic sustainability. Several factors are related to the scarcity and quality of freshwater resources: population growth, irrational use of water resources, pollution and climatic and land-use change.

The global population, totalling 7.1 billion in 2012, is expected to grow to 8.3 billion by 2030. Urbanization is anticipated to increase alongside population growth. It is projected that about 60 percent of the world's population will live in urban areas by this time (DESA, 2009). Inequities between total water availability and its distribution throughout the population is a problem for the Mediterranean region, as is the planned use of water resources. Population growth and improved quality of life have increased demand for food, leading to an increase in water used for agricultural purposes. Excessive and uncontrolled use of groundwater is also a major problem. In some areas this has caused groundwater levels to fall between 30 and 60 metres, degrading forests that are in direct need of this resource.

The quality of water resources is rapidly deteriorating due to domestic and industrial wastewater, extreme fertilizers used in agriculture and leachate from pesticides and landfills, mining activities and geothermal activities (Box 2.12). This pollution will pass through hydrological cycles to water resources, soil, forests and vegetation, distorting ecological equilibrium. Mediterranean forests are generally located close to settlements; as a result, untreated solid waste landfills are often established in forest areas. Mining activities, when carried out without taking the necessary precautions, are a serious pollutant, as are the pesticides used to combat forest pests. In some countries, aircrafts use sea water to extinguish forest fires. This salt water, together with waste oil from machines used during forestry activities, can be harmful to forest ecosystems.

Box 2.12. Pollution of freshwater resources in Turkey

According to 2010 Turkish Statistical Institute data (www.turkstat.gov.tr/Start.do), 73 percent of Turkey's total population has access to sewer systems. In 1994, only 10 percent of the population was served by its wastewater treatment plant. By 2010, this number rose to 52 percent. More than 70 percent of Turkey's water resources are used for agriculture, while 20 and 10 percent are used for industrial and domestic purposes respectively. Nearly 90 percent of Turkey's irrigated areas are subject to surface irrigation or other means of release irrigation.

The causes of pollution to Turkey's freshwater resources are as follows (Ministry of Environment and Urbanisation, 2011): untreated or partially purified urban wastewater; leaks from sewage and solid waste piles; mixing of agricultural chemicals and chemical fertilizer residue from soil and irrigation channels with surface water and aquifers; and deforestation and inadequate agricultural practices that accelerate erosion, leading to sediment accumulation in lakes and reservoirs. Industrial wastewater amounts to about 1 percent of the total, but materials such as mercury, lead, chromium and zinc, whose composition have a high toxicity rate, constitute a great threat. The adverse effects of industrial activities are more harmful to the environment than others.

It is projected that Turkey's temperatures will increase between 3-7°C over the period 2090-2100. Warm-weather waves will also increase over the next 30 years. As a result, it is expected that snowfall areas will decrease in the winter months between 2015-2100. This reduced snow cover is expected to change the hydrological cycle of the Euphrates Dicle basin and the Eastern Anatolia Region and Eastern Taurus in particular. It is predicted that gross water potential of certain basins could be reduced by up to 60 percent between 2041 and 2070.

Over the last 25 years, precipitation has decreased in the Mediterranean basin by 20 percent. The future of water resources in catchments should, however, be assessed not only with regard to predicted temperature increases and decreased precipitation, but land-cover changes. Climatic shifts, increasing water consumption, but also encroachment of forest cover due to land abandonment, are drivers of decreasing annual trends and changes in flow regimes detected in the historical records of large catchments in southern Europe (e.g. Dahmani and Meddi, 2009; García-Ruiz *et al.*, 2011).

Land degradation and fragmentation

Land degradation is a generic term referring to a system's reduced productivity and complexity resulting from a combination of physical and anthropogenic factors. Forest fragmentation refers to the process by which forests are divided into smaller, more numerous, more distant or more isolated parts with patchy or uneven edges.

Despite the expansion of total forest area in the Mediterranean over recent decades, various factors and processes contributing to degradation pose a threat to the condition of forests in the region's northern countries. Mediterranean forests face many threats, particularly as a result of the interaction between land-use/land cover change and climate change, as well as changes to disturbance systems. Soil erosion is a major cause of forest degradation, affecting soil structure and related physical processes (e.g. runoff and flood control), organic matter content, carbon cycling, local diversity, local productivity and the resilience of the system. The degrading impact of soil erosion is more serious in Mediterranean forests where soils are thin and poor, particularly in mountain areas following disturbance events (fires, windstorms and pest outbreaks) (De Rigo *et al.*, 2016). Although precipitation in the Mediterranean is lower than in other regions, alternating drought and intense rainfall events increase the risk of severe hydric erosion in Mediterranean forests (De Rigo *et al.*, 2016). Similar processes are expected to take place in eastern and southern regions. Desertification is one possible result of large-scale land degradation in the Mediterranean basin. This is more likely to occur in the southern rim, which is subject to higher rates of current and projected environmental stress. Open cork and holm oak forests in southern Spain and Portugal are examples of Mediterranean forests vulnerable to desertification in the northern rim.

Forests in Europe are generally fragmented; woodland landscapes, which account for 70 percent of the subcontinent, are poorly connected (Estreguil *et al.*, 2013), making them more vulnerable to fragmentation. Fragmentation in Mediterranean forests is expected to follow the same trend as forest cover and forest degradation. Fragmentation statistics in Europe, however, depend on the particular methods and spatial resolution of the data used. Broadly speaking, forest fragmentation may have decreased slightly in recent years, but this trend is not spatially homogeneous across Europe (Saura *et al.*, 2011; Estreguil *et al.*, 2013). Although forest cover is expanding significantly in the Mediterranean's northern rim, there is no evidence defragmentation is following the same trend. Factors contributing to either increased or decreased fragmentation include fires (Box 2.13), agriculture, infrastructure expansion and urban sprawl. Fragmentation is likely to have increased in some countries in the southern Mediterranean due to the decrease in forest area and its relationship to habitat loss.

Box 2.13. Forest fires and soil degradation

Frequent and recurrent fires in Mediterranean forests lead to the destruction of vegetation cover and changes to soil properties, creating a "window of disturbance" during which there are enhanced conditions for surface runoff and soil erosion (Shakesby, 2011). In commercial tree plantations, this is often compounded by post-fire management operations for salvage logging and ground preparation for replanting, which create an even larger disturbance. While erosion rates in Mediterranean burnt forests are normally lower than in Australia or the United States, the underlying forest soils are generally poor (having experienced strong degradation before afforestation), and fires could lead to loss of organic matter and the support capacity for tree roots, furthering the degradation of forest soils. Repeated fires can therefore limit the soil capacity to support regeneration or replanting. Furthermore, this erosion also has an impact on water quality degradation, as ashes exported from burnt areas contain nutrients and toxic substances which can contaminate aquatic ecosystems and, eventually, pose a hazard for human health (Verkaik *et al.*, 2013).

Today, degradation in Mediterranean forests is lower than in areas used for other purposes, such as agriculture and in semi-natural areas. This is expected to remain the case into the future. Forests play a fundamental role in controlling degradation processes such as erosion and preventing desertification. Also, the expansion of forests, including plantations of exotic species in simplified forests, can reduce degradation in many areas where soil quality has been impoverished due to intensive farming or overexploitation. Forests of any kind help to conserve the presence of many species by helping to connect their habitats. The maintenance of forest cover is also essential to the supply of numerous ecosystem services on which populations depend. Maintenance of existing forest areas, in addition to expanding forest cover, is therefore a priority for conserving ecosystems and maintaining population well-being.

Forest dieback and regeneration decline

Even in the Mediterranean region, forest decline is taking place due to the combined effect of warming and drought (Allen *et al.*, 2010). Climate change is emerging as one of the most significant threats to the survival and function of Mediterranean forests (Martínez-Vilalta *et al.*, 2012). Tree species have adopted two primary mechanisms to mitigate the effects of drought: (i) drought avoidance, in which stomata close at a threshold water level to minimize further transpiration and (ii) drought tolerance, in which stomatal closure is less severe and transpiration continues at relatively high levels (McDowell *et al.*, 2008).

Trees adopting the drought tolerant approach can die through cavitation of water columns within the xylem (Gerosa *et al.*, 2009). Continuous stomatal responses through the drought avoidant approach can cause carbon starvation by shutting down photosynthesis while respiration costs continue to deplete carbon stores. Moreover, reduced cellular metabolism limits during drought may constrain the production and translocation of carbohydrates, resins and other secondary metabolites necessary for plant defence against insect attack and the colonization of fungi (McDowell *et al.*, 2008).

The combination of these factors has resulted in several instances of forest decline or dieback of oak, fir, spruce, beech and pine species in Spain, France, Italy and Greece (e.g. Peñuelas *et al.*, 2007; Landmann and Dreyer, 2006; Di Filippo *et al.*, 2010; Tsopelas *et al.*, 2004). Forest dieback has also occurred in the Mediterranean basin's southern rim, having an enormous impact on *Cedrus atlantica* in Algeria (but also other tree species including pine, oak and juniper), and especially in the drier mountains closest to the Sahara (Chenchouni *et al.*, 2008).

Dieback processes not only vary between co-occurring tree species, but will also depend on the genetic tolerance/resistance of individual specimens (Gitlin *et al.*, 2006). Dieback processes may also depend on a tree's age and stand density, characterized by delayed responses by some species. For these reasons, forest dieback is often a non-linear process. This, combined with a lack of quantitative knowledge on the mortality threshold from drought and heat stress for many species (McDowell *et al.*, 2008), significantly reduces the ability to predict rates of forest dieback at a regional and local level.

Figure 2.21. Grazing in a cork oak forest in Morocco © Nelly Bourlion

Deforestation and overgrazing

Changes in Mediterranean forest cover due to deforestation and afforestation are considered in Chapter 3, while their causes are explained in the "Cultural and technological factors" section of this Chapter. Overgrazing may also lead to forest degradation. These lands often present ageing tree populations due to a lack of natural regeneration, weakened and injured trees, decreased resilience to forest fires, shifts in the botanical composition of the undergrowth towards unpalatable species and, over the long term, loss of biodiversity (Ajbilou *et al.*, 2006) and even desertification (Le Houérou, 1990). On the other hand, Mediterranean vegetation is well adapted to grazing (Seligman and Perevolotsky, 1994). Sustainably managing forest areas for grazing can contribute to forests' economic value and control biomass accumulation, resulting in a decreased risk of major wildfires (Étienne, 2005).

Similar levels of overgrazing to those observed a few decades ago in many parts of Mediterranean Europe have now been observed in the Maghreb (Box 2.14). Even if overgrazing is still reported in some parts of Europe (e.g. Dano, 2005), the issue today is primarily related to disruptions to traditional agrosilvopastoral systems. In many Mediterranean dehesas, current breeding is characterized by a lack of synchronicity between periods of greater fodder supply provided by vegetation and periods of greater feed demand from animals, leading to the degradation of these systems (Enne *et al.*, 2004). Most often, however, the disruption of former systems has led to land abandonment and ungrazing, resulting in uncontrolled biomass accumulation and increased risks of major wildfires.

The big picture that emerges on grazing in the Mediterranean region is the duality between the region's south and north, both of which result in land degradation (Le Houérou, 1990). Provided that grazing systems are adjusted seasonally, since the availability of food and the demand from animals needs to be synchronized, grazing can be a sustainable management option for Mediterranean forests, with economic benefits and a positive impact on wildfire risk and biodiversity (Figure 2.21).

Box 2.14. Overgrazing diagnosis in Algeria, Lebanon, Morocco, Tunisia and Turkey

Local studies conducted in pilot sites under the auspices of the regional project "Maximize the production of goods and services of Mediterranean forest ecosystems in the context of global changes" identified overgrazing as a driver of forest degradation in all sites but found contrasting grazing dynamics in the Maghreb and Near East (Lefhaili, 2015). In the cork oak Maâmora forest in Morocco, grazing intensity was estimated to be three to four times higher than the load capacity of the ecosystem. This forage deficit (Table 2.13) led to an overexploitation of the fodder resources provided by forests, including tree lopping and the browsing of seedlings and saplings. Very similar deficits were observed in Algeria's Senalba forest, and Barbara district and the cork oak Tabarka Forest in northwestern Tunisia (Table 2.13; Nsibi *et al.*, 2006). By contrast, most of the forage resources in Tunisia's Siliana district were supplied by non-forest rangelands, reducing overall demand for forage in forest areas. In Turkey's Düzlerçamı Forest, grazing intensity largely exceeded the mean grazing capacity of southern Turkey's forest ecosystems (Tolunay *et al.*, 2014).

While overgrazing resulted in forest degradation in all pilot sites, it was not connected to deforestation that was driven by other factors (urbanization, land use change in agricultural lands, or transitory forest management activities). Increased forest cover was observed in Senalba and Siliana as a result of reforestation and land use change from agricultural lands respectively.

Interestingly, prospective overgrazing trends were quite different in the Maghreb and in Turkey. While overgrazing was identified as one of the primary drivers of forest vulnerability to the effects of climate change in Maâmora, Senalba, Siliana and Barbara, grazing pressure was expected to decrease in Düzlerçamı due to low market demand, migration and young people's lack of interest in rural work. Maintaining grazing activities in some areas was even seen as a positive way to prevent forest fires.

Table 2.13. Grazing pressure in different forest sites in Morocco (Maâmora Forest), Algeria (Senalba Forest), Tunisia (Siliana, Barbara and Tabarka forests) and Turkey (Düzlerçamı Forest)

Site	Forest area[a] (ha)	Forage capacity from forest area (× 10^3 FU)	Number of live-stock (SLU)[b]	Total forage demand (× 10^3 FU)	Forage supply by non-forest area[c] (× 10^3 FU)	Forage deficit (× 10^3 FU)	Deficit/ capacity ratio
Maâmora[1]	131 808	40 574[d]	789 330	236 799	51 401	144 825	3.6
Senalba[2]	68 000	24 684	335 700[e]	115 817	0[e]	91 133	3.7
Siliana[3]	65 753	16 438	241 345	87 418	78 368	0	0.0
Barbara[3]	13 526	3 382	76 385	23 605	10 101	13 504	4.0
Tabarka[4]	19 600[f]	6 860	97 635	39 054	0	32 194	4.7
Düzlerçamı[5]	2 472[f]		13 500				

Note: FU = Feed Unit = energy value (in kcal) provided by 1 kg of barley harvested at mature stage. SLU = Small Livestock Unit = number of livestock heads equivalent to the feed requirements of one sheep. [a]Including non-wooded lands within the zone classified as forest (such as fallows, etc.) [b]Considering that 1 head of cattle = 5 SLU. [c]Including external feed complement. [d]Computed using an annual forage productivity ranging between 250 and 350 FU/ha (308 FU/ha on average). [e]An equivalent number of livestock whose feeding depends entirely on grazing in forest areas (Gacemi, 2016). [f]Forest area where grazing is allowed (excluding forest protected areas or where grazing is not allowed).

Source: [1]Data from the 2013 report of the management plan of the Maâmora forest as reported by Lefhaili (2015). [2]Estimates based on 2010-2011 census data as reported by Gacemi (2016). [3]Data from the 2010 national forest and pastoral inventory of Tunisia as reported by Aloui and Tounsi (2015a,b). [4]Data from Nsibi *et al.* (2006). [5]Data from the District Directorate of Forestry of Düzlerçamı, as reported by Musaoğlu *et al.* (2014).

Pest and disease expansion

Even when scientific understanding about the nature of global climatic change was still developing, scientists were directing their attention to the possible effects of climatic change on pests and diseases. Then, as now, the scientific community agreed that climate change would favour forest pest species: while the survival of many arthropods depends on low temperature thresholds, fungi or pathogens benefit from dry conditions (e.g. Jactel *et al.*, 2012). How this general pattern will apply to specific cases is more uncertain. Increased temperatures could be very beneficial for pest populations at the upper altitudinal or latitudinal limits of their geographical distribution, since in this case low temperatures are limiting, but rear limits should also be taken into account, and in these cases could have the opposite effect. Apart from the direct effect of temperature, in Mediterranean systems, increased temperatures usually result in decreased water availability. The uncertain interaction between higher temperatures and reduced water supply makes predictions difficult. Finally, the impact of temperature and precipitation on the "humanized" landscapes of the Mediterranean will influence the manner in which disease could spread.

A good example of the insect pests common to the Mediterranean is the pine processionary moth (Box 2.15). Climatic change is expected to be conducive to the spread of other insect pests in coming years (Battisti, 2005). Many fungus pathogens are illustrative of the threats facing a large portion of Mediterranean forests due to the combination of increasing dry conditions and land use change (e.g. Bergot *et al.*, 2004; Desprez-Loustau *et al.*, 2006).

Box 2.15. The pine processionary moth *Thaumetopoea pityocampa*

As a result of its ecological, economical and medical importance, the pine processionary moth is a well-known species (Battisti, 2005). For this reason, it is frequently used as a case species for forecasting and modelling. The pine processionary moth has moved in altitude (Hódar and Zamora, 2004) and latitude (Robinet *et al.*, 2007) and is a paradigmatic case of sensitivity to global change for three reasons. First, the pine processionary moth larval development takes place during winter, rather than spring-summer, as is usually the case for Lepidoptera. As a consequence, the pine processionary moth is strongly dependent on minimum winter temperatures (Battisti *et al.*, 2015), making it highly responsive to climatic change. Second, the pine processionary moth demonstrate a high capacity for local adaptation, with some populations shifting to a summer cycle in cool areas and tolerating higher temperatures than expected in southern limits (Pimentel *et al.*, 2006). Lastly, the pine processionary moth has taken advantage of the massive afforestation of coniferous (*Pinus*) species in a significant part of its distribution area, creating extremely favourable conditions for the expansion of the species (Battisti *et al.*, 2015).

Biodiversity loss and genetic erosion

Biodiversity loss is one of the greatest environmental concerns facing mankind in the twenty-first century. Human pressure, wildfires and ecosystem fragmentation all have a detrimental effect on global biodiversity, and the Mediterranean region is no exception. Occupied since the Bronze Age, the Mediterranean has been home to many civilizations. This has had an impact on its landscape, forests and trees. In the Greco-Roman age, *Pinus pinea*, *Cupressus sempervivens* and *Castanea sativa* forests were planted throughout the Mediterranean region. These have become characteristic elements of the landscape (Scarascia-Mugnozza *et al.*, 2000).

Despite this significant human impact, the Mediterranean region is a biodiversity hotspot, with high conservation value (Myers *et al.*, 2000). Its many conifer and broadleaf species, widespread throughout central Europe, also present high genetic variability. The role of Mediterranean forests as biodiversity reservoirs has increased over recent decades as a consequence of European Union policies that have designated some forested habitats as a priority for diversity conservation in the Habitat Directive (Donoghue, 2008). Although the rate of biodiversity loss does not appear to be decreasing, it has stabilized in forests (Butchart *et al.*, 2010). Some economic improvements have also been made. Dramatic socioeconomic, environmental and land-use problems, however, remain present.

Conservation of genetic diversity – one form of biodiversity – is a fundamental concern in conservation biology. It provides the raw material for evolutionary change and thus the potential for adaptation to changing environments. The method used to regenerate forests is particularly important for forest genetic resources. The most simple and widespread system of forest regeneration following a clear cut is artificial regeneration (Ratnam *et al.*, 2014), which consists of planting seedlings raised in forest nurseries. By changing native gene pools through the use of introduced seed, this system of regeneration disrupts the continuous evolution of tree populations at a given site, disrupting natural breeding patterns, gene flow and genetic diversity. It can, however, improve site productivity through the selection of superior seed sources.

Artificial regeneration of forests, loss of forested areas and fragmentation all have a detrimental effect on their genetic pool. This can lead to genetic erosion – the loss of genetic diversity within a species caused by human activity. Population reduction and fragmentation result in a loss of gene flow (via pollen and seed) and genetic diversity, the basic element of evolution in a species. Smaller populations may experience genetic drift and inbreeding, which changes the allele frequency from one generation to the next, both creating differences between, and decreasing genetic variability within, populations.

Geographical and temporal degradation trends: facing the challenge

This chapter has sought to emphasize the geographic heterogeneity of the drivers and threats of forest degradation, influenced by differing processes in the Mediterranean's north (land abandonment, forest fires, etc.) and south/east (overgrazing, overexploitation of fuelwood, migration, etc.). These differences are the consequence of contrasting social and economic realities. Although climate change will affect both areas equally, its impact will depend on the particularities of a region's history of land use change. This leads to another important issue regarding the interaction between different causes of climatic change (Doblas-Miranda *et al.*, 2017). Population pressures, combined with fragmentation, climate change, etc., open the door to a series of new and complex reactions and consequences, which are very difficult to predict (Laczko and Aghazarm, 2009).

Increased environmental pressures are anticipated, especially in relation to climate change (temperature warming, drier conditions and, predominantly, extreme events) and derivative consequences in the form of wildfires and biological alterations (invasive species, extinctions and pest expansion), and energy, water and food requirements (IPCC, 2014b). The challenge for researchers is to understand and project new situations, interactions between threats and their effects on forest ecosystems (Doblas-Miranda *et al.*, 2015). At the same time, local and international efforts at the management and policy levels should explore smarter land use management, including regional policies which balance sustainability and development (e.g. Council of the European Union, 2006). Moreover, it is important to develop new value chains which consider and adapt to the known consequences of degradation. These must include not only those favoured by involved enterprises, but also the creation of new societal values with regard to consumption patterns (United Nations, 2015).

Maintaining Mediterranean forests and the services they provide poses an enormous challenge, but it is one we must face through the adoption of higher standards. Subsequent chapters offer potential strategies and solutions to combat the threats described above and help the Mediterranean socio-ecological system to evolve in support of a better and more sustainable future.

3

Mediterranean forest-based solutions

Mediterranean forests are an important regional asset but, as shown in Chapter 5, they are currently subject to threats driven by climate change and increasing demography. These threats jeopardize the goods and services provided by forest ecosystems. Secondary processes resulting from climate change and demographic increase, such as conversion from forests to shrublands, wildfires, pest and pathogen outbreaks, overgrazing and land abandonment, may lead to forest degradation and loss of forest benefits. A failure to take action to address these threats and drivers of degradation will eventually lead to a loss of the natural capital provided by forests and trees outside forests in the Mediterranean.

Yet forest-based solutions can be implemented to address this. A central tenet of these solutions is the value of the goods and services provided by forest ecosystems. While timber is the forest product that often comes to mind, Mediterranean forests provide a variety of non-wood forest products and environmental and cultural services. They play a key role in preventing soil erosion and maintaining water quality by protecting watersheds and providing high-quality water to local populations. They are also important for recreation and hunting. Mediterranean forests are rangelands that provide fodder for cattle. They provide fuelwood to many populations. They are also a source of cork, mushrooms, truffles, honey, aromatic and medicinal plants, resins, pine nuts, acorns and other non-wood forest products. The value of Mediterranean forests also lies in the carbon they sequestrate. At the beginning of this Part, Chapter 6 will review the goods and services provided by Mediterranean forests and demonstrate their cross-sectoral importance to food security, energy, water and population health. In order to address these different sectors, including the compromises and negotiations a resolution will require, we must enlarge the scope of the forest sector to include this great diversity of stakeholders.

An integrated approach to addressing the threats and drivers of Mediterranean forest degradations is Forest and Landscape Restoration (FLR). This is a process by which ecological functionality and human well-being are enhanced in deforested or degraded forest landscapes. This approach involves trade-offs between agricultural and forestry production and environmental conservation, ensuring the best possible integration at the landscape level.

FLR fully recognizes forests are a component of the landscape that interacts with other components. Forest restoration aims to restore a degraded forest to its original state – that is, to re-establish the presumed structure, productivity and species diversity of the original forest. In the context of climate change, FLR may be combined with adaptation techniques to anticipate changes the ecosystem would have undergone had it not been degraded. FLR complements forest restoration with participatory approaches involving stakeholders in all affected land-use sectors to manage the dynamic and often complex interactions between people, natural resources and land uses. Given the variety of goods and services provided by Mediterranean forests and the multiplicity of actors involved in their management, as well as the numerous opportunities for forest restoration in the Mediterranean, FLR is a particularly relevant forest-based solution for the region. Chapter 7 will be devoted to FLR.

Restoring degraded forests and reforestation are two forest-based options to mitigate climate change. Additional options include: reducing emissions from deforestation, reducing emissions from forest degradation, enhancing forest carbon sinks, product substitution (i.e. the use of woodfuel instead of fossil fuels for energy and the use of wood fibre in place of materials, such as cement, steel and aluminium, whose production emits larger quantities of greenhouse gases), adaptation of forests (i.e. make forests more resilient to climate change) and adaptation using forests (i.e. decreasing the vulnerability of forest-dependent people to climate change). These different options have varying degrees of relevance to Mediterranean forests. As a climate change hotspot and a pool of resources with potential to change forests outside the Mediterranean zone, Mediterranean forests will undoubtedly play a major role in climate change adaptation. The role of Mediterranean forests in addressing climate change is addressed in Chapter 8.

The biodiversity of Mediterranean forests is key to their resilience and adaptation to climate change, but its value extends far beyond this. Biodiversity regulates the services provided by forest ecosystems, including cultural services (e.g. recreation and tourism related to emblematic plants, animals and forest landscapes). Forest-based solutions using conservation actions and programmes, specifically addressing the biodiversity of Mediterranean forests, can be developed. These actions and programmes have actively protected species where the level of degradation was so high as to endanger their survival, reinforced and reintroduced populations and developed innovative models of sustainable forest management. Forest-based solutions targeting the biodiversity of Mediterranean forests will be addressed in Chapter 9.

6 Human needs and ecosystem services

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Mediterranean forest ecosystem services

Ecosystem services definition

Ecosystem services are the benefits people derive from natural and managed ecosystems. The concept of ecosystem services became prominent thanks to the Millennium Ecosystem Assessment (2003) and The Economics of Ecosystems and Biodiversity Synthesis Report (Sukhdev *et al.*, 2010), both of which emphasized the importance of natural capital for socioeconomic systems and warned of the potential socioeconomic drawbacks of ecosystem degradation.

The ecosystem service cascade applied to the social-ecological system of the Mediterranean forest (Figure 3.1) illustrates how ecosystem services link ecosystems and societies. Ecosystem biodiversity (e.g. tree species, herbs, game, mushrooms and insects) supports a range of internal ecosystem functions (e.g. biomass production, nutrient cycling or water retention) which have the potential to deliver ecosystem services to human populations. When people derive benefits from these potential services (i.e. when they are ascribed value as a result of their contribution to prosperity and well-being), they effectively become ecosystem services. There is a feedback loop from societies to ecosystems. This can either cause losses (e.g. as a result of climate change, deforestation, overharvesting or overgrazing) or gains (e.g. fire prevention, forest restoration, adaptive management) to ecosystem services.

According to the Common International Classification of Ecosystem Services (CICES) developed by the European Environment Agency, there are three categories of ecosystem services (Haines-Young and Potschin, 2012):

- Provisioning services, i.e. the material output from ecosystems including timber, biomass for energy, food and water;
- Regulating services, which relate to conserving the quality of our life environment, including maintenance of bio-physical conditions (e.g. climate regulation, pest control) or mediation of flows (erosion control, noise reduction); and
- Cultural services, including experiential, intellectual and spiritual interactions between humans and the ecosystem (e.g. recreation).

Some older frameworks (e.g. Millennium Ecosystem Assessment, 2003) also mention supporting services, but these refer to the underlying biodiversity and ecosystem functions beneath these other services.

Recent literature on forest ecosystem services shows that either synergistic or antagonistic relationships between them can occur, and that management practices can exacerbate this tendency. Pukkala (2016), for example, examines service provision using different forest management approaches and Vangansbeke *et al.* (2016) explores whether innovative forest management planning focused on biodiversity conservation can improve delivery of forest services such as wood production and recreation. Lichtenstein and Montgomery (2003) explore efficient land-use patterns established to maximize biodiversity richness while also maintaining a given level of wood production.

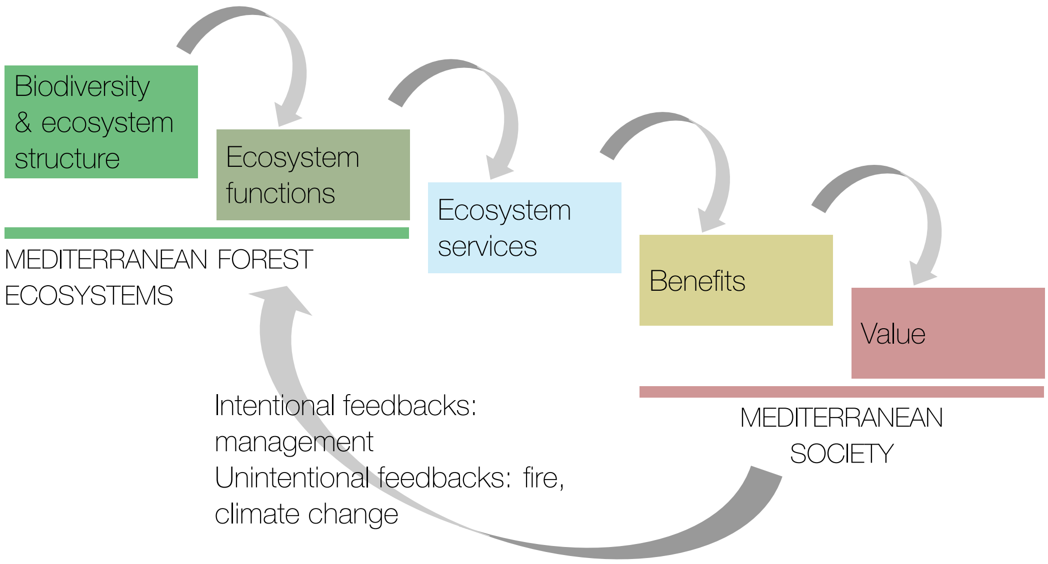

Figure 3.1. Ecosystem service cascade between Mediterranean forests and human society within the Mediterranean region
Source: modified after Haines-Young and Potschin (2010).

Links between Mediterranean biodiversity and ecosystem services

Ecosystem services are a hot topic in contemporary scientific literature, including in the context of Mediterranean forests. The first edition of the State of Mediterranean Forests (FAO and Plan Bleu, 2013) and Mavsar *et al.* (2014) provide an exhaustive list of ecosystem services delivered by Mediterranean forests. A search in Google Scholar (search string: Mediterranean forest “ecosystem services”) yields about 30 000 hits. The search term “Mediterranean forest” also yields a huge selection of earlier literature on forest resource use in the Mediterranean. Despite this, the role of biodiversity as an essential basis for ecosystem service provision in Mediterranean forests has been seriously neglected, only recently becoming an important subject of study. This chapter will focus on this most fundamental biological basis for ecosystem services in Mediterranean forests.

Mediterranean biodiversity as a source of wealth. The Mediterranean region is a global biodiversity hotspot. It is especially rich in plant species, with around 25 000 species, 60 percent of which are endemic to the region (Thompson, 2005). According to the IUCN, the Mediterranean is an outstanding centre of biodiversity, but is also one of the most threatened, largely as a result of human activity (Cuttelod *et al.*, 2009). The region is subjected to several anthropogenic threats. Some of these, such as climate change (see Section “Mediterranean forest ecosystem services under pressure”), agricultural intensification, urbanization, tourism and expansion of invasive species, are relevant to the whole region. Others are more geographically specific, such as deforestation and overgrazing, which predominantly concern the region’s south, or eutrophication and land abandonment, which are relevant to the north.

The Mediterranean’s exceptional diversity of trees, flowers, mammals, birds, amphibians and insects, together with the breathtaking landscapes which house them, represent a unique heritage that, besides providing a range of products and services for human use and consumption, also has intrinsic value. These include so-called bequest values (resulting from the satisfaction people feel when conserving natural or cultural heritage) and existence values (resulting from the simple knowledge that the resource is there). Similar to the large national and international efforts underway to conserve early Mediterranean archaeological sites, our society has a moral duty to protect the Mediterranean biodiversity by intensifying the network of natural parks and reserves, promoting sustainable land and forest management and taking measures to mitigate environmental degradation.

But failing to conserve biodiversity also poses a direct threat to economic prosperity and socio-political stability in the Mediterranean region (see Section "Ecosystem services in response to human needs"). In Box 3.1 we provide examples of typical Mediterranean species or species groups (including but not limited to trees), which have been key to regional economic prosperity and/or stability in the past, but also demonstrate characteristics likely to boost development of the sustainable bioeconomy into the twenty-first century.

Box 3.1. Examples of Mediterranean forest diversity serving past, present and future prosperity

Pines. Pine forests are emblematic of the Mediterranean, and the region is home to several species and varieties (mainly *Pinus brutia*, *P. halepensis*, *P. nigra*, *P. pinaster* and *P. pinea*). Thanks to their abundant seed, rapid young growth and drought resistance, pines are effective pioneer trees that make a large contribution to forest restoration. At the same time, their longevity and large size allows them to form old growth as well. Pines have always been a major timber resource across the Mediterranean. Today, they have potential to make a significant contribution to local cross-laminated timber production. Pine resin, a valuable base product for chemical applications for centuries, could not compete with petrol over the last 50 years, but has returned to favour in the twenty-first century bioeconomy as a basis for specialized chemical products. In addition, demand for pine nuts (mainly from *Pinus pinea*) remains very high.

Olive tree (*Olea europaea*). This long-living evergreen tree was one of the earliest trees to be domesticated in the world. A multipurpose tree, it produces fruits, oil, timber, etc. Its important cultural value is examined further in Box 3.3. Today, olive oil is considered a cornerstone of the healthy Mediterranean diet and global demand is booming.

Mastic tree (*Pistacia lentiscus*). The mastic is a common evergreen shrub found around the Mediterranean, but its optimum environment is on the island of Chios (Greece). There, large trees are traditionally tapped to extract mastic, a valuable resin with a wide variety of traditional and modern applications. These include food preparation in several Mediterranean cultures, cosmetics and medicine (mastic is antioxidant, antifungal and antibacterial).

Carob tree (*Ceratonia siliqua*). A widespread legume tree with edible beans, carob has been a valuable source of feed for livestock and an insurance against hunger for humans since ancient times. Dried beans have a rather constant weight and were once used as a standard to weigh gold and diamonds (the karat unit, from Arab and Greek). Recently rediscovered as an organic and vegan food trend, carob is a sustainable alternative to chocolate.

Edible mushrooms. Mushroom picking is a very popular activity in many Mediterranean countries and mushroom gastronomy is a cultural highlight. Some species collected from the wild, such as the saffron milk cap (*Lactarius deliciosus*) and porcino (*Boletus edulis*) are commercially traded, while the highly-valued black truffle (*Tuber melanosporum*) is increasingly artificially inoculated on purposefully cultivated oak trees. Other species are used as a basis for biotechnology, including products for medical therapies. But fungi are also crucial to forest growth and health: mycorrhizae form below-ground food and act as communications networks between trees.

Pollinator insects. Many Mediterranean crops need pollinator insects for successful fruit production, but agricultural intensification harms these pollinator insect species, including honeybees, native solitary bees and many others. The Mediterranean forest has become an important refuge for pollinators. In addition, it provides top quality honey for local consumption and export.

Goat (*Capra hircus*). This roaming animal native to the Middle East was one of the earliest animals domesticated in the region. Since that time, goats have become a key household asset, offering socioeconomic protection and insurance to subsistence farmers. Often considered a cause of deforestation and land degradation, the species is undergoing a revival as a source of organic dairy and meat, an agent in fire prevention and, together with other herbivores, a key conservation management tool to save many endemic plants from extinction due to land abandonment.

Role of tree species diversity for Mediterranean forest productivity and stability. The search for evidence demonstrating the positive effect of biodiversity on ecosystem services has recently become a popular topic in forest science. Important hypotheses include the biodiversity–productivity hypothesis, predicting better tree growth in mixed forests compared to monocultures, and the biodiversity–stability hypothesis, anticipating improved ecosystem health and stability in mixed forests. These hypotheses are currently being tested using forest inventory data, dedicated observational studies and, most recently, well-designed plantation experiments. Vilà *et al.* (2005) developed one of the first studies on the role of biodiversity for biomass production in Mediterranean forests. Using data from the Catalan forest inventory, the study found increased stemwood production in more mixed forests. This increase was only found in Mediterranean evergreen shrubland, not in conifer or deciduous broadleaved forest. This suggests that the advantages of mixture increase under more stressful conditions. Similar observations were also made using tree ring analysis on the sites of the Functional Significance of Forest Biodiversity in Europe project, where Mediterranean sites clearly showed higher productivity in mixtures than monocultures, but the stabilizing effect of mixtures on productivity over time was less pronounced than in cold temperate sites (Jucker *et al.*, 2014). In multiple ecosystem functions, including soil biological activity, resistance to pests and diseases, tree regeneration, etc., mixed forests performed better than monocultures. This was even more pronounced in water-stressed environments (Ratcliffe *et al.*, 2017).

The only tree diversity experiment in the Mediterranean thus far has been the IDENT Macomer site, coordinated by Sassari University and the CMCC foundation (Centro Euro-Mediterraneo sui Cambiamenti Climatici) in Sardinia (Italy) (Figure 3.2). Established in 2014, the experiment compares monocultures with between two and six species mixtures under irrigated and naturally dry conditions, using a total species pool of 12 native species: *Acer monspessulanum*, *Arbutus unedo*, *Fraxinus ornus*, *Olea europaea*, *Phillyrea latifolia*, *Pinus halepensis*, *P. pinaster*, *P. pinea*, *Pistacia lentiscus*, *Quercus ilex*, *Q. pubescens* and *Q. suber*. The experiment's earliest results indicate advantages for broadleaved sapling vitalities planted in mixtures with pines (Van de Peer *et al.*, 2018). Researchers found that the vitality of slow-growing, broadleaved seedlings was significantly higher in mixed forest restoration efforts. Due to their fast juvenile growth and sufficient crown light transmission, pines created suitable conditions for these broadleaved trees, supporting the idea that manipulation of tree species composition can overcome barriers of tree settlement in dry environments, and that pines serve well as nurse trees in this context.

It is anticipated that biodiversity function research in Mediterranean forests will further develop in the coming years, producing additional evidence and practical recommendations on how to build and maintain diverse forests to obtain increased and more stable levels of ecosystem service provision.

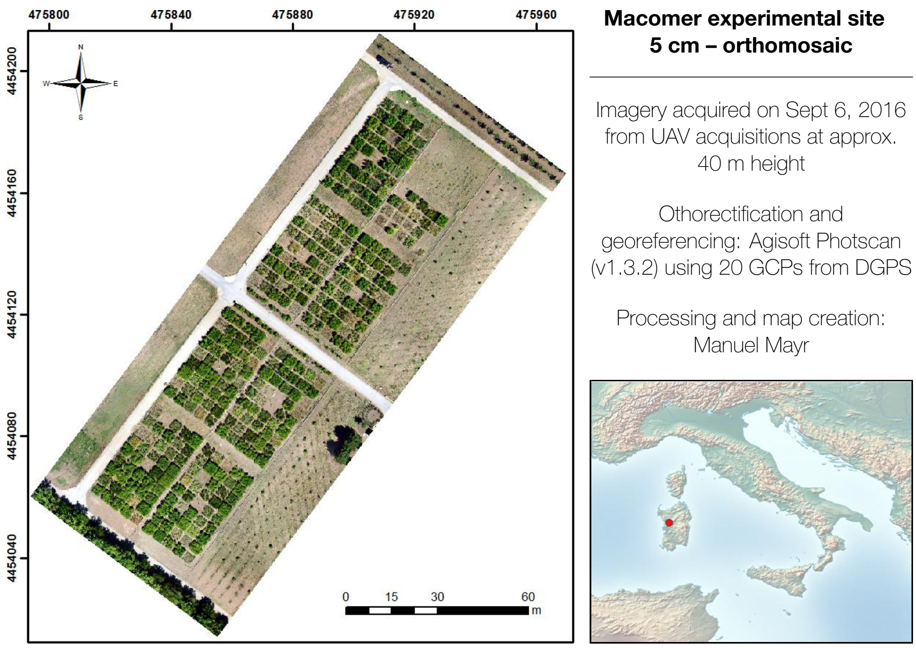

Figure 3.2. Aerial view of the first Mediterranean tree diversity experiment in Macomer, Sardinia

Ecosystem services in response to human needs

Benefits derived from Mediterranean forest ecosystem services

People derive various benefits at the local, regional and global level from the ecosystem goods and services provided by Mediterranean forests. Generally speaking, these benefits are rarely reported in the literature. Yet these goods and services contribute in many ways to population well-being and to national economies, even if these contributions are not traded on the market. They are key ingredients for agricultural, pharmaceutical and industrial enterprises, and also play a large role in human culture. These benefits can be direct or indirect and material or non-material. Benefits derived from Mediterranean forest services are summarized in Table 3.1.

Food, energy security and contribution to economies at the country level. Wood is generally the first forest product cited as a benefit provided by forests, given it serves as the basis for a vast range of products (e.g. industrial roundwood, sawnwood, wood-based panels, pulp and paper, particleboard, fibreboard and plywood, engineered lumber components, softwood lumber, flooring, pallets, veneer, etc). The production of fuelwood contributes to countries' energy security and constitutes the first source of renewable energy in Europe (European Commission, 2017). In 2010, the estimated potential wood production from the total forest growing stock in the Mediterranean was around 9 623 million m^3 (41 percent from conifers and 58 percent from broadleaved species) (FAO and Plan Bleu, 2013).[1] Non-Wood Forests Products (NWFPs) such as mushrooms, olive and carob also contribute to local economies by supplying raw materials to industry and in turn protecting jobs in the sector (see Box 3.2 for the Portuguese cork production example). Mediterranean NWFPs also contribute to local handicrafts such as Moroccan Tan bark (*Acacia mollissima*), traditionally used for tanning hides into leather, and alfa (*Stipa tenacissima*) in Algeria and Tunisia, used to produce high quality printing papers or, to a lesser extent, traditional carpets.

[1] These numbers also include other types of forest and cannot be attributed solely to Mediterranean forests.

Table 3.1. Benefits derived from Mediterranean forest ecosystem services

Ecosystem services	Provisioning services	Regulating services	Cultural services
Benefits	Products obtained from Mediterranean forests	Indirect benefits obtained from the regulation of Mediterranean forest processes	Non-material benefits people obtain from Mediterranean forests
Contributes to…	Food and energy security Maintenance of local economies (exportations, employment, etc.) Population health	Protection from risks Population health Food security	Good social relations and positive living environments Personal development Cultural identity Educational values Population Health
Examples	Industrial roundwood Cork production (Box 3.2) Medicinal plants (e.g. *Urginea*)	Erosion prevention, regulation of air quality	Olive tree – role in cultural identity (Box 3.3)

Box 3.2. Cork production and impact on the Portuguese economy

Cork oak (*Quercus suber* L.) production is a good example of the contribution of NWFPs to national economies. In addition to bottle stoppers, cork is used to make a wide range of products, including insulation panels, floors, wall tiles and sound-proofing in the car industry, as well as handicrafts and other artistic uses. A number of high-value, low-volume "niche" products are also made from cork, such as "cork paper," a thin slice of cork produced from corkboard. Cork is principally produced by northern (Portugal, Spain, France and Italy) and southern Mediterranean countries (Morocco, Algeria and Tunisia).

Approximately 650 cork companies currently operate in Portugal, the world leader in the cork sector, employing around 9 000 workers. This does not take into account the jobs created by subsidiary activities generated by cork production, such as tourism and other niche markets. Portuguese oak forests therefore have an undeniable economic and social value. Cork represents about 0.9 percent of the national industrial gross value added; 1.2 percent of domestic gross value added; 2.1 percent of industrial employment; 2.2 percent of domestic employment; 9.1 percent of forest industry exports in total national exports (Cork Information Bureau, 2015, 2016). Besides this, cork oak produces other environmental and non-marketed services, such as regulation services (e.g. carbon sequestration and storage, regulation of water quality and quantity) and cultural services.

Cork oak production is, however, threatened. This is largely the result of overgrazing, which results in a consequent lack of oak regeneration in localized areas, and generalized oak mortality, lack of management and abandonment more broadly. Cork oak is also prone to forest fires, which is exacerbated by the introduction of eucalyptus trees, which burn faster and hotter, making wildfires harder to control (Silva and Catry, 2006) (a very recent example includes a forest fire on Portuguese road N236 in 2017, which resulted in 64 deaths). The promotion of sustainable management of cork oak landscapes through multiple tools, including payments for ecosystem services, is a way to overcome inadequate forest management. The WWF project Green Heart of Cork (Bugalho and Silva, 2014), launched in November 2011, is a good example of how to maintain the services provided by cork oak by providing financial incentives to landowners. The project produced geographical and digital information on the production of ecosystem services by cork oak landscapes to identify potential hotspots and design payments to landowners for the purposes of biodiversity and watershed conservation. Coca-Cola® Portugal (an important consumer of the groundwater in the region) paid EUR 17/ha to forest landowners in the 600 ha identified and classified as hotspots.

For geographical and digital information on biodiversity, forest cover and services produced in south Portugal see: HABEaS: Hotspot Areas for Biodiversity and Ecosystem Services (www.habeasmed.org).

Food and energy security at the household level. Mediterranean forests produce many harvesting products, which can be essential to local populations (see sub-section "Spatial heterogeneity of populations' dependency on ecosystem services"). Game, biomass production, honey, mushrooms, chestnuts, berries, acorns, carob, myrtle, rosemary, pinecones and pine nuts, among others, are harvested, stored and consumed locally. Apart from NWFPs, firewood collected for subsistence plays a crucial role in many southern Mediterranean countries. For example, it accounts for about 81 percent of total forest removal in Tunisia, 94 percent in Morocco and 100 percent in Lebanon (Croitoru, 2007). In Mediterranean Europe, mushroom picking is a recreational experience and mushrooms are marketed according to origin (e.g. France, Italy and Spain) rather than used solely as a direct food source for local communities. Mediterranean forests also contribute indirectly to food security by maintaining good conditions for agricultural activities such as water regulation and pollination.

Protection from risks. Mediterranean forests also contribute indirectly to population well-being by mitigating several risks. Soil erosion control by vegetation, for instance, makes a significant contribution to the sustainability of Mediterranean agroforestry systems. Recently, Guerra *et al.* (2016) studied erosion prevention in the northern Mediterranean. Results showed a relative increase in the effectiveness of soil erosion prevention in Mediterranean Europe between 2001 and 2013 that was not replicated as a general trend across the Mediterranean region.

Population health. Forest ecosystems contribute to human health in various ways. One notable benefit is the regulation of global climate by carbon sequestration and storage. A recent study by Thurner *et al.* (2014) mapped total forest carbon density at the Pan-European level. Results show that Mediterranean forests greatly contribute to carbon storage even if the uncertainty related to the assessment in those countries is high. This indirect benefit (e.g. regulation of global climate) is not, however, assessed in a systematic way and often remains site-specific. Forests also contribute to air quality regulation, noise reduction, the provision of medicinal and aromatic plants and have a cooling effect (for peri-urban forests). Finally, exposure to natural environments can have a positive effect on mood (Johnsen and Rydstedt, 2013) and reduce the risk of cardiovascular diseases and obesity (BFW and ILEN, 2017).[2]

Socio-cultural benefits and cultural services. The importance of recreational benefits has increased tremendously over recent decades (Croitoru, 2007; García-Nieto *et al.*, 2013), both for regional and non-local populations (Figure 3.3). These recreational benefits also contribute to local economies and employment. Travel and tourism directly generated 7 795 000 jobs in 2014[3] (4 percent of total employment) and this is forecast to grow by 3.4 percent in 2015 to 8 060 000 (4.7 percent of total employment). This includes employment by hotels, travel agents, airlines and other passenger

[2]More information on https://www.youtube.com/watch?time_continue=39&v=h2VoGtA1ZiA

[3]Countries included are: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Montenegro, Morocco, Portugal, Serbia, Slovenia, Spain, Syrian Arab Republic, the former Yugoslav Republic of Macedonia, Tunisia and Turkey.

Figure 3.3. The Fenouillet trail, Cavalaire-sur-Mer, France
© Léa Tardieu

transportation services (excluding commuter services). It also includes, for example, those restaurant and leisure industries directly supported by tourists (WTTC, 2015). Beside recreation and eco-tourism, there is emerging recognition of socio-cultural values which recognize the direct or indirect contribution of ecosystem services to the user's cultural identity and heritage, spiritual values and the development of positive social relationships (Gómez-Baggethun *et al.*, 2014; Martín-López *et al.*, 2014). These include the benefits derived from spiritual landscapes, transmission of educational values and opportunities for ritual and spiritual practice. Several emblematic tree species are very important in the Mediterranean culture. In Morocco, for instance, the Argania (*Argania spinosa* L.) is a sacred tree that plays a key role in traditional rituals. From millennia, argan oil has been valued for its cosmetic, gastronomic and medicinal benefits. See also Box 3.3.

Box 3.3. The role of olive trees (*Olea europaea*) in Mediterranean culture and religion

Olive trees have had a special, even sacred, symbolic meaning in Mediterranean societies since the Egyptian and Greek-Roman periods. In addition to the central role both olives and olive oil play in Mediterranean gastronomy, the olive tree and its branches are used during many spiritual celebrations. The branch of the olive tree has been used as a symbol of peace and a sign of power and wisdom. It is also considered a sign of virginity and purity at Greek weddings. In the ancient Olympic Games, winners received a wild olive branch as their prize. This refers to the Greek myth in which Athena was established as goddess of Attica after presenting an olive branch as a gift to King Cecrops and the people of Attica. Following this, Attica's citizens adopted the name Athens in her honour.

Beside its symbolic value, the olive tree also has a place in the spiritual worship of several religious denominations in the Mediterranean (Christian, Jewish and Muslim religions). This is evident from its presence in sacred places such as the Garden of Gethsemane at the foot of the Mount of Olives in Jerusalem.

Spatial heterogeneity of populations' dependency on ecosystem services

Ecosystem services are an inherently territorial concept, intrinsically linked to the place where supply and demand for goods and services takes place. This truism holds for all forest services (see Burkhard and Maes, 2017). This dependency on services for subsistence will vary from country to country, according to demand and poverty levels. Most northern countries, for instance, generate significant income from timber production, while in most southern and eastern countries firewood collection is extremely high, leading in some cases to total wood removal (between 80-100 percent in Tunisia, Morocco and Lebanon) (Croitoru, 2007). In many southern and eastern countries, however, data on illegal harvesting is not available, resulting in underestimates about the benefits of firewood to these populations.

The prevalence of illegal harvesting and hunting is lower in the northern Mediterranean, due to stricter policy controls and lower population dependency on these resources. The extent of harvesting firewood will therefore depend on a country's political and economic stability. This, too, is influenced by the prices of alternative energy sources (as reported in the press in Greece or the Syrian Arab Republic).[4] There is high demand for NWFPs in the south, specifically those related to grazing. Despite the limited data available for several NWFPs (e.g. mushrooms), the average benefit derived from NWFPs in southern countries is higher than in the north, where data for many other NWFPs is more readily available (e.g. cork). In southern and eastern Mediterranean countries, most forests are publicly owned. Forest communities have some free usage rights (e.g. collection of firewood and grazing), but often have little incentive to conserve forests. A large share of the rural population is poor and thus depends on the benefits provided by forests as a major source of income (see Box 3.4, in the case of Tunisia). The value and classification of a forest "service" will depend on how it is used and by whom. For instance, forests are home to species of game that can be hunted by local populations. In the majority of cases, particularly in northern countries, this would be classified as a recreational activity. But for poor populations dependent on this service, game hunting could be classified as a provisioning service necessary for subsistence. This, in turn, influences which policies are (or can be) implemented for managing services.

Box 3.4. Tunisia case study

Tunisian Forests are publicly owned, with free access rights granted to local populations to fulfil their basic needs. Several studies have investigated forest use by local communities. These show that free access may have both positive and negatives effects on forests, leading in some cases to increased protection from threats (such as risk of fire) or resulting in critical levels of degradation due to overuse (from grazing, illegal harvest, etc.).

These studies have shown that local populations are economically dependent on forests. This was e.g. demonstrated by a study carried out in the locality of Iteimia/Ain-Snoussi in Tunisia (Khalfaoui and Daly-Hassen, 2017). Cork oak forests are Tunisia's second-largest forest ecosystem. Iteimia is a small village inside a forest of 634 ha, consisting largely of cork oak (39 percent), shrubland (27 percent) and cropland (21 percent). Iteimia's 85 households live on activities related directly or indirectly to the forest, namely livestock, agriculture, occasional employment and products gathered in the forest. The study investigated the economic dependence of local populations on forest resources, applying the gross margin as the income and using local market prices for all products except fodder, for which price-equivalent substitutes were used (barley in this case).

Results from the study showed that the average annual household income of USD 3 236 was

[4] http://www.yourmiddleeast.com/news/civilians-fell-rare-syrian-trees-for-firewood_12581

generated by: occasional forest employment (39 percent) and the sale of goods collected in the forest such as mushrooms, myrtle, firewood and acorns (15 percent). Crop production (20 percent), while decreasing, was still carried out by some households for the purposes of feeding livestock. Livestock production, which generated 26 percent of the average income, was the most profitable activity in the area, based mainly on free grazing (Figure 3.4). The study found that grazing became unprofitable for 65 percent of households in cases where they were required to buy supplementary feed to meet the basic needs of livestock (based on estimated grazing value using value-equivalent substitutes).

Income composition 20%	26%	54%
Crop production • Non-profitable activity • Practiced by 68% of the population for self-consumption and animal feeding, which also explains the crops choice (wheat, barley, oat, bean, etc.) **Additional income** • Households have additional income coming either from permanent employment (11%) and governmental financial support or family members (10%)	**Livestock production** • The most profitable activity • Practiced by 91% of the population • A household owns an average of 1.8 cattle, 6.3 sheep and 4.5 goats • Livestock expenditure is based on self production and grazing • The average grazing time is 5 h per day in the forest and 2 h in the shrubs	**Forest goods** • The collection of diverse goods in the forest such as mushrooms, myrtle, firewood and acorns is usually carried out by women and children. Selling products such as mushrooms, myrtle, firewood and acorns generates up to 15% of household income **Occasional employment** • Activities related to cork stripping and management activities generates 39% of the average income
—	**Forest dependence**	+

Figure 3.4. Rural household annual income composition

Local population income is derived predominantly from products extracted from the forest and occasional employment at the forest level, confirming their dependence on the forest's natural resources. The results also indicate that 50 percent of the local population lives below the poverty line, according to the average annual income per inhabitant established by the National Statistical Institute at USD 530 (INS, 2016). This is higher than the national average of 15.2 percent.

The so-called "rural exodus" can also explain this diverse demand for forest services. Populations in northern countries, for example, have undergone significant demographic migration from rural territories to cities or peri-urban areas. As a result, a new and diverse range of stakeholders, who place a different value on Mediterranean forests, has emerged. For a growing number of city dwellers, this includes seeing forests as a place for leisure and relaxation and an appreciation for homes in natural settings. Cultural services have thus become an increasingly large part of the benefits derived from forests by northern populations, while the heritage of the rural forest is maintained by a small number of local actors playing a key role.

Conversely, forests continue to provide indispensable resources to the most disadvantaged members of society in southern and eastern countries (which still occupy a relatively large fringe). In many parts of the region, the forest remains an integral part of the domestic heritage of families and villages, who still rely heavily on its resources to implement original and relatively autonomous management methods.

Table 3.2. The specifications of the four IPCC scenarios

Variables	Climatic model-HadCM3 (Scenarios by 2050)			
	Scenario A1 Fossil Intensive	Scenario A2	Scenario B1	Scenario B2
	Global economic	Regional economic	Global environmental	Regional environmental
Population (10^6)	376	419	376	398
CO_2 concentration (ppm)	779	709	518	567
Δ Temperature (°C)	4.4	2.8	3.1	2.1
Δ Precipitation Europe (%)	−0.5	0.5	4.8	2.7
Socioeconomic dimensions	High savings and high rate of investments and innovation	Uneven economic growth, high per capita income	High investment in resource efficiency	Human welfare, equality and environmental protection

Source: IPCC (2001); Schröter *et al.* (2005); Ding *et al.* (2010, 2016).

Mediterranean forest ecosystem services under pressure

Mediterranean forest ecosystem services and socio-climatic change scenarios

Climate change in the Mediterranean basin manifests in increased temperatures, reduced precipitation, an increase in the frequency of natural disasters or extreme events (storms, droughts, floods, etc.), and increased frequency of pathogens and forest fires. Moreover, it is expected that climate change will have an impact on forest dynamics (species occurrence or disappearance, forest growth, etc.), and on the functioning of ecosystems, including their biodiversity and ability to provide goods and services. The impacts of climate change on the future functioning and sustainability of Mediterranean forest ecosystems have already been described (see Mavsar *et al.*, 2014; Plan Bleu, 2016, and Chapter 5). Here, we focus on the impacts of climate change on ecosystem services supply and demand. These impacts are usually assessed using prospective scenarios, including socio-climate changes. Scenarios can differ in terms of population growth, precipitation rate, CO_2 concentration or temperature (e.g. temperature projections from +2.1°C to +4.4°C according to the IPCC, 2001). Scenarios referenced in this Chapter are reported in Table 3.2. The studies developed by Ding *et al.* (2010, 2016) provide a good overview of the impact of socio-climate change scenarios on the supply of three services in Mediterranean European countries:[5] wood provision, carbon sequestration and cultural services (Table 3.3).

Wood provision. Global simulations projected to 2050 show that wood productivity in northern Mediterranean countries is expected to decrease regardless of the scenario used. However, scenarios B1 and B2 (Table 3.2) indicate that the formulation and implementation of sustainable and environmental development policies to change and improve timber production can mitigate the impact of climate change on the industry.

[5]This study also includes Central Europe, Northern Europe and Scandinavian Europe in its analysis.

Table 3.3. Projected wood production, carbon sequestration and recreational values in Mediterranean European forests between 2005 and 2050

Ecosystem services	2005	2050			
		A1	A2	B1	B2
Wood pulp (Mt/yr)	4.82	3.68	3.92	4.97	5.27
Industrial roundwood (Mm^3/yr)	45.28	30.57	38.27	43.49	47.55
Recovered paper (Mt/yr)	11.85	7.18	7.61	9.62	10.6
Sawnwood (Mm^3/yr)	15.38	10.11	13.75	15.05	16.7
Wood-based panels (Mm^3/yr)	17.86	10.87	13.06	15.29	16.88
Paper and paperboard (Mt/yr)	19.6	11.58	12.3	15.45	16.98
Woodfuel (Mm^3/yr)	20.24	12.03	16.5	17.96	19.96
Carbon sequestration (Mt/yr)	4.601	3.334	4.106	5.97	5.704
Marginal recreational values (2005 USD/ha/yr)	[1.06-3.06]	[1.25-7.87]	[1.26-7.91]	[1.20-9.24]	[1.03-6.77]
Marginal passive use values (2005 USD/ha/yr)	[356–615]	[898–1552]	[902–1558]	[748–1292]	[678–1171]

Note: Mediterranean Europe includes Greece, Italy, Portugal, Spain, Albania, Bosnia and Herzegovina, Bulgaria, Serbia and Montenegro, Turkey, and the former Yugoslav Republic of Macedonia.
Source: Ding *et al.* (2016).

Carbon sequestration. Climate change can also impact potential CO_2 sequestration by Mediterranean forests. At a global level, carbon sequestration tends to decrease using the A-scenarios and increase using the B-scenarios (compared to 2005 levels). As for timber production, environmental development policies can compensate the negative impacts of climate change on forest ecosystems.

Cultural services. Using the regional scenario including the highest population increase (A2) as a benchmark and based on the total values obtained from the marginal values and the forest areas designated for recreation or conservation, the authors observed that only the extensive wood-forest production scenario (A1) had a worse impact on cultural values. Wood production impacts the availability of forests for recreational uses. Conversely, scenarios which include sustainable development and biodiversity protection (B1 and B2 respectively) have a better effect on recreational values than the benchmark.

Focusing on countries within the Mediterranean bioclimatic zone, welfare gains will increase with the application of an environmental scenario (an increase of 86 percent for cultural services, 45 percent for carbon sequestration and 24 percent for wood forest products).

Management practices for the maintenance of ecosystem services under climatic change

Adapting forest management practices to maintain ecosystem services supply in the context of climatic change is becoming one of the major challenges for decision-makers and forest managers. The adaptation of forest practices to face climate change effects will depend on forest type, structure, age, environmental factors, etc. (Mavsar *et al.*, 2014).

There is an increasing need for analysis of the response of forest ecosystem services provision to different management options in the context of climate change (e.g. monoculture/mixed forest species, rotation length, intensities of cutting, thinning). It has been proven, for example, that carbon storage can be enhanced by natural regeneration, mixed uneven forest stands, or the reduction of stand density using selective logging (FAO, 2014). Wood production and carbon sequestration are the most investigated forest services for the purposes of assessment. In the Molise region (Italy), Bottalico *et al.* (2016) assessed the effect of different forest management options on both services. Three scenarios were selected: the baseline and two alternatives, namely biodiversity conservation policies and intensification of timber production. Results showed that both scenarios and management options could strongly affect production of ecosystem services. The two alternative scenarios increased the total economic value of services from 82 percent to 85 percent respectively, compared with the baseline scenario. Yet Mediterranean forests provide many other services. Due to low data availability and a weakness of projection models, there are still too few studies on Mediterranean forests. Projects are, however, underway to fill this gap (Box 3.5).

Box 3.5. A research project on Mediterranean forest ecosystem services and their future under climate change

Integrated research on Forest Resilience and Management in the Mediterranean (INFORMED). Through the ERA-Net FORESTERRA, the collaborative project INFORMED (2015-2017) developed a multidisciplinary approach to the resilience of Mediterranean forests facing global change, based on the following conceptual scheme: global change modifies the overall context of a socio-ecological system, whereas management drives forest biodiversity and functions that determine the provision of ecosystem services. An assessment of their economic value can support governance systems to select the most appropriate future management options.

The project, coordinated by the Research Unit for Mediterranean Forests of the French National Institute for Agricultural Research (URFM), is conducted by a consortium of 15 partners from ten countries from both sides of the Mediterranean, combining well-balanced expertise in ecology, forest management, governance and economics. INFORMED has three main scientific objectives:

- to fill knowledge gaps on the basic mechanisms that determine the flexibility of the socio-ecological system in response to disturbances;
- to integrate knowledge by combining different process-based models at various spatial and temporal scales;
- to use integrated knowledge to develop management strategies, policy and governance guidelines to foster forest system resilience.

INFORMED aims to produce global change scenarios focused specifically on Mediterranean forests for several purposes. First, the goal is to develop process-based approaches to biodiversity conservation and functional responses of Mediterranean forests to disturbances. Further, the objective is to develop an integrated assessment of ecosystem services and their dynamics, based on ecosystem functions and their economic evaluation. Finally, it aims to evaluate adaptive management strategies, policies and governance for their projected impact on resilience. Specific tools are developed for data sharing within and across disciplines following an open data strategy. Methods in model coupling allow for the integration of multiple processes, operating at various spatial or temporal scales. Benefiting from existing knowledge (data and models) in various environmental and socioeconomic conditions, the scope of the research has been extended in order to address key issues about the impact of management options, supported by different governance tools at the local, national and international level.

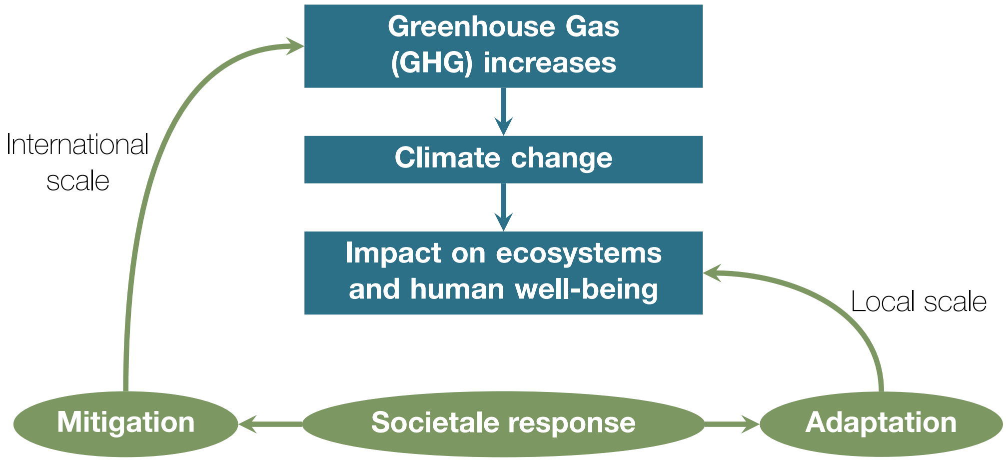

Figure 3.5. Distinction between adaptation and mitigation
Source: Locatelli (2013).

Using ecosystem services for climate change mitigation and adaptation

It is also important to highlight the contribution of forest ecosystem services to strategies for to climate change mitigation and adaptation. Mitigation relates to reduction of carbon emissions at the international level, while adaptation acts on ecosystems, with local benefits (Figure 3.5).

In the specific case of Mediterranean forests, mitigation relates to the promotion of carbon storage and sequestration in standing trees as well as long-lasting wood products, and the use of wood as a substitute for energy demand. Mitigation results in "well-managed forests which generally hold higher carbon stocks and show greater mitigation potential than disturbed, poorly managed, overexploited or burnt forests which can represent emission sources" (FAO, 2014).

Adaptation aims to reduce risks and improve the resilience of ecosystems and their goods and services. Ecosystem services can contribute in several different ways to Mediterranean forest adaptation (FAO, 2014; Locatelli, 2013):[6]

- Well-managed forest genetic resources constitute a living stockpile of adaptive traits that could be used for climate change adaptation;
- Forest products constitute goods for local communities facing climate shocks. Wood forest products (timber, charcoal, etc.) and NWFP (wild berries, mushrooms, fodder, etc.), have economic, social and cultural importance, promoting the diversification of income sources;
- Watershed purification provides high-quality water used by local populations. Forests regulate watershed hydrological regimes and protect against erosion. They contribute to the regulation of flow during dry seasons and flood flow during rain events. This allows populations to adapt to climate variability and change;
- Forests have an impact on the regional climate.

In this context, national and regional forest policies must adapt in order to integrate new challenges into the conservation of forest goods and services in response to climate change. In the European context, Box 3.6 presents the Second European Forest Sector Outlook Study, EFSOS II. Through national strategies for sustainable forest management, southern Mediterranean countries have defined their own challenges. Tunisia, for instance, has built its public policy objectives around four axes, including adapting the forest sector's institutional and legal framework, optimizing the sector's contribution to socioeconomic development and conserving the sustainability of environmental functions and services.

Finally, financial incentives to promote ecosystem services delivery may be necessary, especially when

[6] This chapter considers this issue from a global perspective and does not focus on differences at the local/international level.

the opportunity cost (i.e. the value of the best land use alternative) is high. In Mediterranean countries, many highly rentable alternatives are possible. These include villas for permanent residents (especially in northern countries); villas for secondary residents and tourist accommodation on the coastlines of all countries; and recreation or transportation infrastructure, etc. In general, these alternatives reduce ecosystem services provision as they require artificializing at least a part of the ecosystem. Without payment for ecosystem services, conversion is an alternative that may offer landowners the best opportunity to benefit from their property.

Box 3.6. European Forest Sector Outlook Study II (EFSOS II)

EFSOS II is a major component of the integrated work programme of the UNECE Timber Committee and FAO European Forestry Commission, dealing with public policies for the adaptation of forest management in response to global change (UNECE and FAO, 2011a).

Expectations surrounding the ability of the region's forests to meet increasing environmental, social and economic demands have never been higher. To meet these demands, European forest sector policy-makers must grapple with complex, imperfectly understood challenges when designing forest policies, which must address challenges such as climate change, protection of biodiversity, space for recreation and leisure and energy and raw material needs.

EFSOS II focuses on seven major challenges:

- mitigating climate change by increasing carbon sequestration in forests and harvested wood products, by creating substitutes for non-renewable raw materials and non-renewable energy;
- supplying renewable energy;
- adapting to climate change and protecting forests;
- protecting and enhancing biodiversity;
- supplying renewable and competitive forest products;
- achieving and demonstrating sustainability; and
- developing appropriate policies and institutions.

Four policy scenarios were developed: maximizing biomass carbon (with constant level of harvest, optimizing silvicultural methods for maximizing the carbon stored); promoting wood energy (focusing on wood for renewable energies targets); prioritizing the protection of biodiversity; and fostering innovation and competitiveness (innovation strategy leading to improved competitiveness).

Discussion and conclusions

Mediterranean forests deliver various ecosystem services that contribute directly or indirectly to human population well-being and supply different human needs. Ecosystem services improve quality of life for Mediterranean populations by contributing to food and energy security, protecting them from risks, energizing local and global economies, and contributing to cultural identity and personal development.

Dependence on the benefits provided by Mediterranean is, however, spatially variable across the Mediterranean basin. Population dependency on ecosystem services for vital subsistence will depend on the country in question, particularly population demand and poverty levels. Climatic change, which is likely to modify the level and spatial pattern of ecosystem services supply and demand, will therefore impact populations in different ways, with the most heavily dependent being the most vulnerable. Adapting forest management practices to maintain the provision and benefits of ecosystem services in the context of climatic change is a major challenge for decision-makers and forest managers.

Aside from geographic variability, ecosystem services may vary over time. One of the major limits of the ecosystem services valuation is that it does not fully account for the variability of benefits derived over time (i.e. the value ascribed to the same service will likely change over time based on changing priorities and demographics). It is therefore difficult to predict future uses of ecosystem services. References to bequest or existence value in the economic literature are a form of palliative to this uncertainty (Pascual *et al.*, 2010).

This point underpins the debate on weak and strong sustainability initiated by Dasgupta and Mäler (2000). The notion of weak sustainability is based on the fact that market growth is maintained by different capital stocks used to produce goods and services (natural, manufactured and human capital). It implicitly assumes that all capital stocks are mutually substitutable. The proposal of strong sustainability posits that human and natural capital cannot be substituted, considering that capital stocks are complementary. It thus calls for separate maintenance of both types of capital. In this analysis, if human societies degrade or deplete any element of an ecosystem faster than it can restore itself, they will eventually cross a threshold after which no net loss of environmental resources will be suffered.

The application of an economic value to ecosystem services implies either weak sustainability or a safe distance from ecological thresholds (Tardieu, 2016), because anything with a monetary value can be exchanged. This statement is obviously not ethically neutral. The point also raises the question of the evolution of environmental values that devalue ecosystem services. Several theoretical and empirical arguments, justifying either a time-declining approach to discounting or an evolution of relative prices for environmental goods over the long-term, have been provided over recent years (Pearce, 2006; Tardieu, 2016). Among these arguments, the issue of inter-generational equity is advanced in order to avoid the imposition of the values of one generation (present or future) over others (Chichilnisky, 1997).

Given that today's leaders seek to rely on economic or financial figures in making their decisions, ecosystem services valuation can be useful and should not automatically be discounted. Yet applying a value to ecosystem services is inherently uncertain, meaning the application of a fixed value could be unreliable. Valuing the flows of ecosystem services needs a clear objective, and the evaluator needs to clearly state the relativity of the information provided in order to be scientifically credible.

7 Forest and landscape restoration

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Introduction

Over millennia, Mediterranean landscapes have been shaped by the techniques employed by farmers and villagers to adapt to climatic conditions with extremely high variations in temperature and precipitation regimes, and the occurrence of unpredictable extreme events. The influence of intense, prolonged and extensive human activity, dating back at least 5 000 years, has had a major impact on these landscapes, the result of which is environmental variability and heterogeneity and an exceptional diversity of habitats. These include forests, woodlands and patches of grassland, intermingled to form patchwork-like landscapes where land use histories, species composition and intra-specific genetic variation is far greater than in most other areas of the world. This rich diversity and variability is threatened by increasing human pressure and accelerated climate change, leading to habitat fragmentation and biodiversity loss, forest and land degradation and desertification, putting human health and livelihoods at risk.

Restoration (including ecological restoration) has been at the core of interventions to combat increasing land degradation and habitat fragmentation. The Society of Ecological Restoration defines ecological restoration as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER, 2004). The term commonly refers to single ecosystems such as lakes, rivers, coral reefs and forests. In contrast, the term Forest and Landscape Restoration (FLR),[1] introduced more recently, refers to the restoration of several ecosystems at once, including production systems on well-defined landscape units and urbanized land use units. The objective of FLR is to achieve trade-offs by balancing social, cultural, economic and environmental benefits while minimizing losses to ecosystem health and biodiversity.

The Global Partnership on Forest and Landscape Restoration (GPFLR) defines FLR as an active process that brings people together to identify, negotiate and implement practices that restore an agreed optimal balance of the ecological, social and economic benefits of forests and trees within a broader pattern of land uses. Thus, FLR can be seen as an approach that involves stakeholders from a wide variety of land use sectors, applied through participatory decision-making processes (Sabogal *et al.*, 2015).

A related concept is that of Restoring Natural Capital (Aronson *et al.*, 2012). Similar terms tested recently include "a restoration continuum" (McDonald *et al.*, 2016b) and a "family of restorative activities" (Aronson *et al.*, 2017).

Whether restoration actions implemented in the Mediterranean are considered ecological restoration or FLR will depend on the definitions used. Historically, restoration interventions did not seek to recover "pristine" historical ecosystems; their targets were far more practical. Indeed pristine or near-pristine

[1] www.forestlandscaperestoration.org/

Box 3.7. Learning from the past: Algerian "Barrage Vert" towards the adoption of Forest and Landscape Restoration principles (Algeria)

The "Barrage Vert" is a government initiative that commenced in 1972 in a large degraded area (approx. 1 000 square km) in the pre-Saharan zone of southern Algeria. Annual rainfall in this region is just 100-400 mm per year. This supports highly adapted vegetation characterized by halfa (*Stipa tenacissima*) dominated steppes on the high plateaux, woodlands dominated by holm oak (*Quercus ilex*), Aleppo pine (*Pinus halepensis*) and Red juniper (*Juniperus phoenicea*) in the Saharan Atlas mountain chain. The objective of the programme was to stop and reverse land degradation caused by overgrazing and overharvesting of plant products, and to restore the ecosystem services supporting sustainable agrosilvopastoral production and the livelihoods of nomadic and semi-nomadic people. The initial interventions of the 1970s were reformulated after 1982 to include: (i) diversified tree planting using native species, together with fruit trees on approximately 300 000 ha whose potential vegetation is forest; (ii) improvement of 25 000 ha of rangeland through modified management; (iii) sand dune fixation on 5 000 ha; (iv) construction of water points and water erosion control infrastructure; and (v) improvement/construction of 5 000 km of forest dirt roads. Among the key factors of the successful transformation of the barrage vert to FLR were: (1) ten tree nurseries were locally established for the collection of local seeds and the production of high quality seedlings well-adapted to local bio-climatic conditions; (2) the choice of forest areas with clear land ownership for the implementation of diversified tree plantations helped correct the mistakes of the initial phase of the project, such as the destruction of well-conserved steppe vegetation, serious conflicts with local people due to undesirable tree plantations in community-owned rangeland/steppe areas with livestock routes, and the outbreak of tree diseases due to mono-specific plantations in areas unsuitable for Aleppo pine; (3) the use of augers for the opening and preparation of holes significantly increased seedling survival; (4) adapting the planting period to the most suitable climate conditions (early spring) and the use of supplemental watering increased the survival of seedlings; and (5) the professionalization of forest technicians – including university students – involved in the planting activities significantly improved the quality of their works. 120 000 ha were restored, with variable results, due to the limited capacity to control destructive actions in some areas, and the lack of a clearly defined strategy to address the need to improve livelihoods.

ecosystems can rarely be identified in the Mediterranean, almost all of which have been intensely used and partially transformed by human activity over a long period. Restoration and rehabilitation projects commonly focused on the establishment of single or a small number species and the recovery of specific ecosystem functions related to human welfare, which was probably a major driver of their success (Navarro and Cortina, 2011). Yet simplification is still the norm in ecological restoration projects.

Ecological restoration, reforestation, rehabilitation and afforestation efforts in the region increased dramatically during the late nineteenth and twentieth centuries (Birot *et al.*, 2011; Vallejo, 2005; Blondel *et al.*, 2010), with the objective of maintaining the ecological and socioeconomic functions of Mediterranean forests and agrosilvopastoral landscapes that benefit people in both rural and urban areas. Since the turn of the century (Andersen and Schmidt, 2002), the FLR concept has built upon these efforts and wealth of experience not only to counteract deforestation, fragmentation and degradation but also to contribute to the conservation of ecological and economic sustainability in rural areas.

The lack of understanding and/or uptake of substantive ecological restoration and FLR in the Mediterranean, together with vested political and economic interests, have favoured the overuse of these terms to justify interventions of scant quality. Coastal regression, which authorities repeatedly seek, in vain, to combat with sand dredging, and the simplification of quarry restoration by using green screens and hydro-seeding, are examples of these ineffectual and therefore undesirable practices (Josa *et al.*, 2012; Sardá *et al.*, 2000). Similarly, a narrow definition of ecological restoration has focused efforts on recreating a mythical or ill-defined pristine ecosystem. This has hampered the adoption of effective ecological restoration principles and tools in peri-urban and agricultural areas, which cover large tracts of the region. Fortunately, there has been significant progress towards understanding the limitations of ecological restoration as it is currently understood. Let us now focus on the Mediterranean basin in all its complexity and richness.

Restoration in the Mediterranean: from past to current efforts

A preliminary mapping of past and ongoing restoration initiatives was conducted by FAO in 2017 (Parfondry *et al.*, 2017), analysing data from 40 initiatives in 13 Mediterranean countries. The results indicate a shift away from large-scale monospecific afforestation, often using exotic species, throughout the twentieth century (e.g. "Green Dam or Barrage Vert" in Algeria, see Box 3.7), to a recent trend towards holistic approaches and initiatives with multiple objectives, combining several socioeconomic and environmental benefits (see Boxes 3.8 and 3.9 below). This mapping also indicates that restoration is currently practised through research pilot/small scale projects rather than large-scale programmes. One explanation for this is that research restoration projects are usually well-documented and can be traced through website research, while government projects or programmes are often documented internally and not made accessible.

Several countries including Algeria, Lebanon, Morocco, Spain and Turkey have developed national strategies to restore forests and landscapes. In 2003, Spain developed a National Plan of Priority Actions for Hydrological Forest Restoration. This framework was implemented by the Directorate-General for Rural Development and Forestry Policy and included in the National Action Plan to Combat Desertification, approved in 2008 (MAPAMA, 2008a). It calls for the following priority actions: (i) reforestation; (ii) reforestation in agricultural lands; (iii) silvicultural treatments; (iv) improvement of pasture and scrub lands; (v) soil conservation practices; and (vi) restoration of riverbanks. This plan identified 18.4 million ha in need of restoration. Over the last ten years, however, due to the economic crisis in Spain, efforts have been limited to the restoration of areas burnt after large fires, with an investment of nearly EUR 70 million for that period.

Figure 3.6. El Hondo Natural Park, Spain © Siim Vaikre

In Spain, important restoration initiatives in a variety of ecosystems are also being led by private landowners. Box 3.8 describes a restoration initiative in a wetland in southeast Spain that has generated biodiversity conservation and socioeconomic benefits for farmers and fishermen. Another Spanish example, presented in Box 3.9, illustrates the restoration of farmland in rural Granada and Almeria, which generated ecosystem goods and services, including non-timber forest products, to sustain the livelihoods of local communities while also benefiting biodiversity and combating erosion and desertification.

Box 3.8. A wetland reborn: El Hondo de Elche (Alicante, southeast Spain)

As a result of the colonization works of the Foundations of Cardinal Belluga (Canales Martínez and Vera Rebollo, 1985) in the early eighteenth century, the vast lagoon that once covered the northeast Vega Baja del Segura region (south of the town of Elche in southeast Spain), was drained. It had been covered by an extensive lagoon called Los Almarjales (The Marshes) connected to Elche's lagoon. Historic documents provide written evidence of the rich bird and fish fauna that had thrived in the area from medieval times. This large wetland was fed by ditches carrying surplus water from nearby orchards, in addition to occasional flooding from the Segura River and nearby ravines. During the first half of the twentieth century, the Royal Irrigation Company of Levante (Real Compañía de Riegos de Levante) elevated excess water from the Segura River to irrigate Elche's agricultural belt and adjoining areas. Two large reservoirs were excavated in a depression (Fondó or Hondo) located north of Los Almarjales. This area had not been cultivated previously due to high soil salinity and risk of flooding. The ground in the reservoirs was not paved and hygrophilous vegetation, mainly reeds (*Arundo donax*), rapidly colonized the area, together with abundant bird and fish populations. Farmers gradually engaged in complementary hunting and semi-natural aquaculture activities, eventually managing the area to favour these new resources by controlling reed expansion and occasionally feeding wild fauna. In the meantime, neighbouring small farms struggled for years to obtain agricultural benefits from salty lands, with little success. By the second half of the twentieth century, the El Hondo example encouraged farmers to build banks and channels and flood their land with excess water from the irrigation network and brackish water from local wells. These were later called "Pantanets" (small swamps). In this case, management was exclusively directed towards fauna for hunting (mainly Anatidae and Rallidae) and fishing for mullet and eel. Specific management actions included clearings, reed control and complementary feeding. Somehow, the old Almarjales were reborn, albeit in a new location benefiting from surplus irrigation water and the particularities of the Segura River irrigation system. These Pantanets, together with the large reservoirs of the Royal Irrigation Company of Levante, now constitute El Hondo Natural Park (Figure 3.6), a protected area since 1988, and one of the most important wetlands in the European Natura 2000 network due to its abundance and diversity of biota and its inclusion in the Ramsar Convention (www.parquesnaturales.gva.es/web/pn-el-fondo).

Lebanon has also developed a National Afforestation/Reforestation Programme aiming to increase forest cover from the current level of 13 percent to 20 percent of the country's surface area by 2030 (Regato and Asmar, 2011). This plan, which commenced reforesting areas of 60 ha ca. in regions across the country in 2002, is ongoing (Figure 3.7). It has taken into consideration the lessons learned from successful restoration projects to formulate its land management and policy frameworks and promote new private-public partnerships. The restoration of Al Shouf Biosphere Reserve is illustrative of this process (Box 3.10).

Turkey's Forestry Rehabilitation and National Afforestation Campaign, the basis for the preparation of its

National Determined Contributions (NDC), began in 2008. Through this campaign, Turkey has already rehabilitated 2.3 million ha (AGM, 2007) of forest and aims to increase its forest area to 30 percent (current 27 percent) by 2030 through afforestation, erosion control and rehabilitation activities (MFWA, 2016).

Other countries, such as Morocco, have also developed NDCs reflecting these commitments. It has committed to restoring 200 000 ha of forests by 2020 and 600 000 ha by 2030. Algeria has undertaken to restore 1 245 000 ha through its National Reforestation Plan, increasing the woodland/forest cover in northern Algeria from 11 percent to 13 percent of the land area, creating more than 500 000 jobs. Its so-called “Barrage Vert” or Green Dam initiative (Box 3.7) contributes to the national effort to achieve these commitments.

A new regional Mediterranean initiative on FLR has recently been initiated based on the Agadir Commitment, as part of which nine countries have pledged to restore a total of 8 million ha. It is hoped this will encourage countries along the basin to strengthen their national forest and landscape restoration efforts.

In addition to efforts at a national level, several sub-regional initiatives are jointly tackling common issues affecting countries. The Mediterranean region is experiencing a considerable increase in the duration and frequency of droughts and heat waves, resulting in increased water scarcity and risk of large-scale forest fires (Moritz *et al.*, 2012; Pausas and Fernández-Muñoz, 2012). Wildfires in the region constitute a serious environmental problem, with an immediate negative impact on its ecosystems, such as loss of vegetation cover, risk of erosion, effects on wildlife, alteration of the landscape and socioeconomic losses. The research community is leading some of these sub-regional initiatives, including the following COST Actions (EU funded research programmes) that have addressed the issue of restoration:

- The COST Action ES1104 “Arid Lands Restoration and Combat of Desertification: Setting Up a Drylands and Desert Restoration Hub” (2012-2016) (Kotzen, 2017) focused on “practical measures that can be used by practitioners, stakeholders and authorities to restore degraded drylands and manage their recovery.” This Action was largely confined to Europe, but also extended to countries in North Africa and the Near East. Among other achievements, it facilitated the development of fact sheets highlighting good practice in soil management, sustainable land management, revegetation and many other issues linked to restoration. It also made key recommendations to policy-makers and other stakeholders involved in combating desertification

Figure 3.7. Restoration activities in Lebanon © Valentina Garavaglia

and in drylands restoration.

- The COST Action FP0701 "Post-fire forest management in southern Europe" (2005-2012) was established to help respond to the overall question of how to manage 500 000 ha of forests burnt in Europe every year. Its primary objective was therefore to develop and disseminate scientifically-based decision criteria for post-fire management, applicable from stand-level to landscape-level planning. A total of around 170 researchers from 22 countries, including Tunisia and Morocco, were involved in activities divided into five working groups: (1) Fire hazard and resilience; (2) Fire effects and severity and global warming impacts; (3) Economic assessment of damage and current practices in post-fire management; (4) Forest conversion and post-fire management techniques; and (5) Knowledge transfer. The Action, which was closely linked to the European Forest Institute Project Center "Phoenix – Fire ecology and post-fire management" (Birot, 2009), also led to the publication of the book "Post-fire Management and Restoration of Southern European Forests" (Moreira *et al.*, 2012). Some key lessons learnt are presented in Box 3.11.

Challenges

How to better address the fragmentation and multiple uses of Mediterranean landscapes?

In rural landscapes throughout the Mediterranean region, the coexistence of landscape units dedicated to agriculture, forestry and pasture land use can be traced back to the ancient Roman land use categories of ager, saltus and silva (Blondel *et al.*, 2010; Barbera and Cullotta, 2016). The region's anthropic influence is heterogeneous, dating back thousands of years.

Box 3.9. The Almendrehesa case of Spain

AlVelAl is an association bringing together farmers, entrepreneurs, traders, and researchers from universities and other institutions, with the objective of improving the socioeconomic and environmental situation of less-developed rural areas – High Plateau Los Velez – in the provinces of Granada and Almería (South-East Spain). They have developed a FLR plan to restore a farmland landscape with degraded or eroded soils and create an integrated production system which combines almond and local trees with aromatic oil crops, beekeeping and sustainable grazing of the endemic sheep species (Figure 3.8). This productive ecosystem decreases erosion, restores water balance, enhances biodiversity and beautifies the landscape. Altogether, this enhances the local economy while promoting local pride and inspiration. In September 2016, AlVelAl created the company "Almendrehesa" to market the agricultural products of their intervention area. The Almendrehesa project is responsive to the need to add value to the agricultural products of the region, while improving and restoring its natural, agricultural, social and economic landscape. The main activity of the company is to market ecological products that regenerate high quality soils and landscapes, starting with the almond variety "Pepita de Oro" (Gold Nugget) and eventually expanding to a wide variety of products such as cereals, herbs, honey, wine, oil and lamb. An important purpose of La Almendrehesa is to support farmers by promoting the sharing of machinery and developing their capacity on issues of common interest, such as regenerative agriculture. The AlVelAl area covers about 600 000 ha of agroforestry ecosystem producing approx. 50 000 kg of high-quality almonds in the shell, including organic almonds of the highest quality produced through organic farming, and organic almonds from land under conversion, sold at a lower price. The produce is promoted mainly on the Spanish market, with the longer-term objective of increasing production and expanding to profitable European markets such as Germany and the Netherlands. In the near future, new products from the processing of almonds (e.g. flour, laminated almonds for pastry shops) will be added to the catalogue. The products are sold in "ecological" packaging based on a mixture of recycled paper and non-petroleum plastic that is compostable as organic waste or recyclable as paper. La Almendrehesa currently gathers 21 producers, who enjoy the technical support of AlVelAl and the Dutch Commonland Foundation.

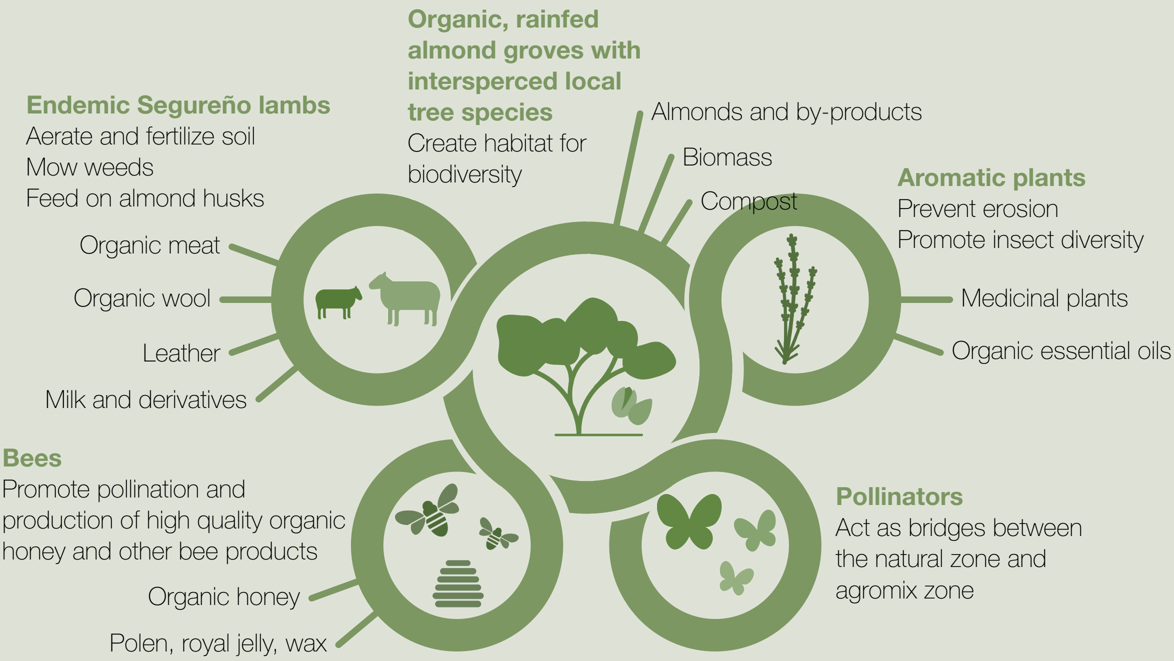

Figure 3.8. Integrated productive ecosystem for large-scale restoration based on business cases
Source: © Commonland Foundation.

It is easy to observe the variation of the bioclimatic forest life zones (étages, in French) from the Mediterranean scrub to the beech-dominated forests (*Fagus sylvatica*) in the mountains. The microclimatic variation is equally evident from one slope to the next; within a few metres one may observe evergreen oak forests, chestnut (*Castanea sativa*) and/or beech forest. This landscape is more complex in some areas as a result of the expansion of urban and peri-urban areas, industrial settlements and infrastructure and heavily mechanized agricultural areas where most traditional landscaping has been replaced. In the past, natural gene flows were to some extent assured by proximity or by the existence of natural corridors. Today, various factors obstruct, reduce or prevent migration and flow between populations.

Some authors have demonstrated how this species fragmentation can promote high landscape-scale biodiversity, inducing inter-population differentiation and genetic erosion (van der Werff and Consiglio, 2004; Piotti, 2009). This usually occurs when population areas are drastically reduced. Ortego *et al.* (2015) predicted that agricultural lands constitute barriers to gene flow and hypothesized that fragmentation has restricted inter-population dispersal and reduced local levels of genetic diversity. They confirmed that isolation and habitat fragmentation have reduced the genetic diversity of local populations. Landscape genetic analyses showed that agricultural land offers around 1 000 times more resistance to gene flow than semi-natural habitats, indicating that patterns of dispersal are constrained by the spatial configuration of remnant patches of suitable habitat (Ortego *et al.*, 2015). Nowadays, gene pools must also cope with climate change, exacerbating the Mediterranean's already harsh conditions.

Defending forest genetic resources is key to conserving a heritage that has survived natural changes and human pressure over millennia. Conserving forest trees' genetic resources means maintaining their

Box 3.10. FLR in the Shouf Biosphere Reserve (Lebanon)

The Shouf Biosphere Reserve is the largest protected area in the Mediterranean portion of the Middle East, with a size of 50 000 ha (Colomer *et al.*, 2014). It hosts a rich mosaic-like landscape of high mountain forests with cedar (*Cedrus libani*) and oak (*Quercus brantii* ssp. *look*), pastures and scrubland and a mid-mountain belt with oak (*Quercus calliprinos*, *Q. infectoria*) and pine (*Pinus pinea*, *P. brutia*) forest stands, interspersed with dry stonewall terrace systems with vineyards, olives and other fruit trees. The FLR initiative led by Al Shouf Cedar Society aims to increase the resilience of the socio-ecological landscapes of the Reserve to climate change impacts. The project followed the "Global guidelines for the restoration of degraded forests and landscapes in drylands" (FAO, 2015c) to formulate FLR goals addressing the needs of all concerned stakeholders, plan and choose cost-effective restoration interventions and monitor progress and impact. The project has established municipal forest committees to facilitate local participation in the development and implementation of the FLR plan.

Several restoration and management interventions were implemented in pilot sites, covering approximately 80 ha throughout the landscape over a period of three years: (i) sustainable forest thinning and pruning in coppiced oak and pine forests; (ii) ecological restoration through the production of high-quality plant material from 40 native species (10 percent of which are non-woody species) and the planting of seedlings and seeds in degraded forestland and abandoned quarries; (iii) recovery of agriculture terraces for the organic production of local crop varieties and medicinal/edible plants; and (iv) production of briquettes for bio-fuel by mixing agriculture with forest pruning waste. Key success factors in the FLR work were: 1) the production of high quality plant material and the adaptation of the planting density, soil preparation, mulching techniques and planting period to increase soil moisture conditions and minimize the need of water supply for the survival of the seedlings; 2) the use of agriculture and forest waste, helping reduce environmental risks while abating the energy bill of local communities and creating innovative business and employment opportunities; and 3) the restoration of agricultural terraces for the production of local crop varieties and native medicinal/edible plants with combined environmental and socioeconomic benefits (Hani *et al.*, 2017).

evolutionary adaptation potential, the forest community and the entire forest ecosystem *in situ*. *Ex situ* methods should be considered the last extreme pragmatic solution or should be used, as usual, for improvement purposes.

Restored forests and landscapes will not be self-sustainable if genetic variability is not taken into consideration at the planning level (Thomas *et al.*, 2014). In order to conserve a forest's genetic resources, its genetic variability must be protected, as well as its adaptability to natural evolutionary processes and environmental changes, and forest tree breeding. It is also necessary to increase our knowledge in order to identify individual trees which have developed a tolerance to certain diseases and pests (Orlović *et al.*, 2015). Research should be supplemented with data including species inventories, legislation, practical use and coordination at national and pan-Mediterranean levels, together with public awareness campaigns regarding the importance of conserving endangered species in forest ecosystems. Further scientific research to locate ecophysiology and adaptive traits, genetic variation and genomics is also required.

How to enhance restoration efforts and multiple benefits in Mediterranean landscapes?

The costs associated with FLR can be very high: between 1983 and 2013, 1.7 million ha of forest were planted in Spain at an estimated average cost of EUR 3 375/ha (Cuenca *et al.*, 2016). It has been

Box 3.11. Post-fire restoration: lessons learned in Southern Europe

Available scientific evidence (Moreira *et al.*, 2012; Birot, 2009) suggests these key messages for policy makers and stakeholders:

- Not all burnt areas require restoration;
- Forest planning should include the identification of fire-prone areas;
- It is not necessary to cut all burnt trees after fire;
- Emergency actions to decrease soil erosion and water runoff hazards should be implemented only in high risk areas;
- Reforestation is not necessarily the best post-fire response, and when undertaken careful selection of species and techniques is essential;
- Wildfires constitute opportunities for the planning and effective management of landscapes more resistant and resilient to wildfires.

estimated that achieving Aichi Biodiversity Target 15 in Europe will cost between EUR 506 million and 10.9 billion. Costs will depend on the strategic framework used and how the terms "degraded" and "restored" are defined (Tucker *et al.*, 2013; FAO, 2015d), making it important to quantify benefits and optimize investments in FLR. Tucker *et al.* (2013) and the more recent study carried out by FAO and the Global Mechanism of the UNCCD (FAO, 2015d) also provide a comprehensive discussion on funding opportunities for FLR activities.

Despite the essential goods and environmental services they provide (not to mention benefits to other sectors), trees and forests are often taken for granted. And, while immense efforts are often deployed to combat land degradation in Mediterranean countries, these activities often lack coordination (Cuenca *et al.*, 2016). In order to increase opportunities for complementary action and potential integration of ecological restoration into land planning (FAO, 2015c), communication and collaboration at different levels is required. This includes cooperation between regional and national administrations, as well as the different sectors linked to land management (agriculture, rural development, water, poverty reduction, infrastructure development, etc.).

The adoption of political, rather than ecological and social, timeframes has been the cause of substantial failures in ecological restoration in the Mediterranean. Prioritization of re-greening quarries and roadsides and deficient management of conifer plantations arrest succession and reduce ecosystem resilience against future disturbances (Maestre and Cortina, 2004). We must learn how to integrate short and long-term restoration solutions and ensure funding for adaptive management. This topic is related to the need to plan restoration actions in a timely manner. In some cases, strong initial momentum may be required in early or intermediate successional phases to direct the ecosystem towards desired goals (e.g. by modifying geomorphological features or watering in the months following plantation). In other cases, continuous intervention (such as repeated planting, removal of exotic species, etc.) may better contribute to assembling the plant community and recovering functions and services. Corroborating conceptual models of ecosystem restoration with cost-effectiveness data could help us understand and manipulate successional trajectories in order to achieve restoration goals in the most efficient way possible (Whisenant, 1999; Aronson *et al.*, 2017).

Over the course of the twentieth century, understanding of the need for participative approaches to environmental management and restoration increased. Participatory approaches must be designed and scaled-up so they can efficiently contribute to the success of ecological restoration projects (Derak and Cortina, 2014). Implementing protocols to engage and coordinate the contribution of stakeholders from the planning phase of restoration creates a sense of joint ownership about decisions and actions, increasing stakeholder commitment to an initiative's objectives and outcomes.

In some cases, ecological restoration may generate enhanced ecosystem goods and services, including the provision of forage, fruits, fuelwood and reliable supplies of clean water (La Notte *et al.*, 2017). Studies analysing the costs and benefits of ecological restoration projects are scarce, but available data suggests that the benefit-to-cost ratio may reach up to 35 in grasslands and 31 in woodlands (de Groot *et al.*, 2013; Wortley *et al.*, 2013). Market goods are complemented by a plethora of ecosystem services (Haines-Young and Potschin, 2012), but monetizing them is often complex and controversial (Rodríguez-Labajos and Martínez-Alier, 2013). The need for monetization can, however, be avoided if services are employed as criteria to identify social preferences in decision-making processes (Granata and Hillman, 1998). We must keep in mind that social preferences are frequently expressed as the result of formal or informal multi-criteria decision models based on subjective valuation and market prices do not always reflect preferred alternatives.

The cost-effectiveness of management interventions has been widely used as a criterion in health sciences where monetizing benefits is often difficult (Muennig and Bounthavong, 2016). Cost-effectiveness analysis in ecological restoration has received less attention, but existing studies have successfully integrated a variety of ecological and socioeconomic criteria (Birch *et al.*, 2010; Kimiti *et al.*, 2017).

Cost-effectiveness is related to other concepts, such as restorability (Lindig-Cisneros *et al.*, 2003; Cortina *et al.*, 2006). It is worth emphasizing the importance of the socioeconomic context and geographic scope for cost-benefit and cost-effective analysis of ecological restoration projects (FAO, 2015d). Thus, ecological restoration activities may be integrated into larger, regional development initiatives providing net benefits, including social and financial benefits (Wang *et al.*, 2011). This opens a significant window of opportunity to partner with the agriculture, rural development, building and tourism industries (among others), which environmental administrations should draw upon where possible.

Prioritizing target areas can increase the efficiency of forest and landscape restoration, while cost-effectiveness can be used to identify priority areas or hotspots for restoration. Most prioritization analyses are based on one or a few criteria – commonly identified by researchers – with few contributions from other stakeholders (European Environmental Agency, 2014). Yet some studies and management tools have succeeded in integrating a variety of criteria identified and weighed according to participative processes (e.g. Plan de Acción Territorial Forestal de la Comunidad Valenciana, PATFOR).[2] We must bear in mind that priority criteria may not be restricted to particular aspects of ecosystem structure, function and services, but may include other features, such as distance to the nearest populated area, accessibility, or the local unemployment rate. Priority maps, based on criteria identified by stakeholders (through participative processes and cost-effectiveness analysis), facilitate the identification of high priority areas that also provide the highest levels of biodiversity and services for a given investment (Cortina *et al.*, 2017). This can also be a step towards increasing the efficiency and support for restoration programmes.

More efficient monitoring of restoration efforts/initiatives in the Mediterranean at multiple stages

Comprehensive information (baseline and impacts) on restoration and rehabilitation initiatives is still difficult to access. Sharing knowledge and experience is crucial if restoration efforts are to succeed on a large scale (Parfondry *et al.*, 2017). Yet, restoration initiatives often lack efficient evaluation and monitoring mechanisms. They require operational protocols to both describe restoration works and evaluate and monitor their impacts using case-specific ecological and socioeconomic criteria. Further,

[2] www.agroambient.gva.es/web/medio-natural/patfor

data should be made easily accessible to the wide range of restoration practitioners, including ensuring this data is available in all regional languages (Fazey *et al.*, 2013).

FLR monitoring plays a key role in:

- providing information on FLR progress, achievements and impact;
- communicating results and outcomes to maintain momentum and inspire emulation;
- supporting the implementation of FLR activities;
- supporting reporting to FLR investors and fostering additional investments by demonstrating ability to oversee FLR investments; and
- supporting reporting on national, regional and international commitments.

The most critical FLR monitoring challenges include: improving stakeholder coordination and participation; meeting the needs of different audiences at different levels; implementing sustainable processes of assessment; including socioeconomic aspects; and linking monitoring across all levels (local, national and global).

Since 2013, in preparing its "Global guidelines for the restoration of degraded forests and landscapes in drylands: building resilience and benefitting livelihoods" (FAO, 2015c), FAO has developed a Monitoring and Reporting Tool for Forest and Landscape Restoration. The tool is used to analyse, report on, monitor and evaluate restoration initiatives and assist users to compile lessons learned and analyse and monitor performance, impacts and successes. Restoration project designers can also use the tool as a checklist to ensure the design includes the primary elements of a restoration. It will be made available online in three languages (English, French and Spanish) through the "Dryland Restoration Initiatives Platform." The tool has been field-tested and various experts and workshop participants have contributed to its development.

In this context, and building on the collaborative partnership launched in 2015, the so-called "Rome Promise for Monitoring and Assessment of Dryland for Sustainable Management and Restoration," participants at the FAO "Drylands & Forest and Landscape Restoration (FLR) Monitoring Week" (April 2016) jointly designed the collaborative roadmap for FLR monitoring.[3] The roadmap seeks to encourage and support countries, in-country actors and other relevant partners to monitor FLR at all levels. The primary objective of the roadmap is to share knowledge and develop monitoring guidance for implementation across different activity streams. The World Resources Institute (WRI) is working closely with FAO to develop a guidance document to help establish more efficient monitoring protocols and provide a set of necessary indicators to measure restoration success (WRI and FAO, in press). The Society of Ecological Restoration is also undertaking similar efforts to provide relevant standards and indicators for FLR monitoring (McDonald *et al.*, 2016a; Gatica-Saavedra *et al.*, 2017).

How to better share FLR technical knowledge and good practice between stakeholders of Mediterranean landscapes?

Improved FLR good practice and knowledge-sharing requires the establishment of common platforms for data and information-sharing across the Mediterranean. This includes encouraging use of global platforms, such as the Global Partnership on Forest and Landscape Restoration (GPFLR), and regional platforms, such as the MEDFORVAL project,[4] aimed at connecting stakeholders across the Mediterranean in order to share knowledge and experiences.

FAO initiatives have been especially designed to contribute to knowledge sharing on FLR issues. The

[3]The collaborative roadmap for FLR monitoring is being implemented by an open coalition of partners, with a core group composed of FAO, IUCN, WRI, CBD Secretariat and UN Environment.

[4]MEDFORVAL is a network of practitioners and decision-makers working on protecting, managing or restoring the ecological values of Mediterranean forests, see medforval.aifm.org/en.

Knowledge Base for FLR, built jointly with partners, provides access to a wide range of tools for potential use in the Mediterranean. The Community of Practice, providing peer-to-peer online exchanges and regular events (i.e. webinars) in which Mediterranean stakeholders are encouraged to participate, complements this FAO initiative. In addition, the Sustainable Forest Management (SFM) toolbox has a specific module focused on FLR, which includes tools, case studies and scientific publications on FLR. The Dryland Restoration Initiatives Platform can play a key role as a common platform to compile, share and disseminate data on FLR in the Mediterranean. This can support exchanges both with other Mediterranean regions and drylands worldwide.

There is also a clear need to improve, enhance and promote study tours for technology and experience transfers between countries experiencing similar issues (e.g. through regional network meetings and COST scientific missions, south-south and north-south cooperation).

Forest and landscape restoration opportunities in the Mediterranean

Assessing restoration opportunities in the Mediterranean: estimating land potential

In attempting to assess the Mediterranean's restoration opportunities, the authors have used and analysed data collected in the framework of FAO's Global Drylands Assessment (GDA) on trees, forests and land use in the Mediterranean region (see FAO, 2016d; Bastin *et al.*, 2017, and Chapter 3).

The GDA is an initiative launched in 2015 by FAO, in collaboration with many partners, as a follow-up to the Rome Promise on assessment and monitoring of drylands for sustainable management and restoration. The initiative interprets satellite imagery using Collect Earth (a tool in the Open Foris suite of free, open source software developed by FAO's Forestry Department in partnership with Google). The results of the GDA were disaggregated at the Mediterranean regional level, providing new and key data on forests, tree cover and land use in Mediterranean drylands.

Data collected by GDA, together with the Human Footprint Index (HFP) and land use data from the map GlobCover 2009 (Arino *et al.*, 2012), was used to map restoration opportunities in the Mediterranean (Martín-Ortega *et al.*, 2017). The methodology proposed a score-based classification system combining this data. Different scores were applied to different land uses depending on their suitability for forest restoration (i.e. high for abandoned croplands and low for forest with a cover > 40 percent). In regard to HFP, higher scores were given to decreasing HFP, whereas low scores were given in areas where HFP increased. Once established, these scores resulted in three restoration opportunity categories: 1) high priority restoration; 2) low priority restoration; and 3) no restoration. By combining priorities 1 and 2, up to 80 Mha had restoration potential regionally, accounting for 40.2 percent of the Mediterranean as defined by FAO GEZ (Figure 3.9).

The aim of this study is to draw attention to the need for restoration in the Mediterranean region and roughly estimate the magnitude of restoration opportunities. Due to the map's scale and resolution, it is not intended, nor should it be used, to identify restoration objectives, the type of restoration measures required, or specific areas where restoration should occur. This framework can instead be used as a basis for detailed assessments of restoration priority areas that integrate criteria at national and sub-national levels and engage local stakeholders and communities.

Figure 3.9. Map showing areas for potential restoration in the Mediterranean region
Source: Martín-Ortega *et al.* (2017).

Assessing restoration needs in the Mediterranean: managing and recognizing the potential of forest genetic resources

The great environmental variability and special location of the Mediterranean basin (between tropical and temperate latitudes), has resulted in diversity and fine-scale heterogeneity of habitats, species assemblages and genetic variation within species far exceeding that found in most other areas. Due to environmental changes, this diversity is at greater risk than ever before. It is therefore important to implement adaptive management techniques and, in some cases, rescue strategies. It is also important to understand how species react or will react in future. Indeed, the potential for forests to adapt to environmental changes fundamentally depends on genetic resources, but this potential is threatened by a diverse set of pressures including human population growth, forest fragmentation and neglect.

These pressures will gradually increase genetic erosion to the point where forests are at risk of extinction. Thanks to their genetic adaptation processes, however, existing species are the result of successful evolutionary adaptation over an extended period (Eriksson *et al.*, 1993). Large population sizes have facilitated a large number of genetic combinations and adaptive characteristics, which support the adaptive characteristics of populations/species (Eriksson, 1996, 1998; Hamrick, 2004).

The major mechanisms populations use for survival are: adaptation that allows the genetic heritage of a population to adjust to a given environment (Nanson, 2004) and phenotypic plasticity (Schlichting, 1986; Pigliucci, 2001), defined as a quantitative response to change by genotype (Eriksson, 1996; Eriksson *et al.*, 1993). Species, in addition to individual variability, still have the opportunity (apart from random mutations) to exploit adaptation and plasticity.

Micro-environmental variability can play an important role in the development and conservation process of genetic variability. Small, sheltered areas with characteristics suitable for the survival of populations have produced endemisms throughout the Mediterranean. It is clear, however, that if changes are too rapid and intense, these shelters will likely be swept away.

Most genetic resources of the Mediterranean forest tree population are unusual for their marginality. The State of the World's Forest Genetic Resources Report (FAO, 2014) recognizes that "Marginal and/or range-limit populations may be vital for tree species' adaptation to novel environmental extremes." Marginal and peripheral tree populations are unique and valuable sources of genetic information that enhance forest resilience. They may include specific adaptations that result from evolutionary processes operating over long periods of time in marginal environments. The FAO Global Plan of Action for the Conservation, Sustainable Use and Development of FGR defines its Strategic Priority 7 as "supporting assessment, management and conservation of marginal and/or range limits forest species populations."

Marginal populations are unique. They should, therefore, be accorded high priority in global and regional conservation and restoration strategies and programmes in order to conserve specific genetic variants and genetic resources that are not found elsewhere. These unique genetic resources could be used to help forests adapt to the challenges of the twenty-first century. Marginal and peripheral tree population FGR are thus a key priority of the Global Plan of Action for Forest Genetic Resources (Fady *et al.*, 2016).

Future restoration activities and management strategies must aim to conserve genetic variability, secure and enhance populations' adaptive potential and deploy forest reproductive material resistant to future environmental stresses. Genetic variation is a sign of functional and resilient ecosystems and, therefore, an indicator of successful long-term restoration (Thompson *et al.*, 2010).

FAO *Silva Mediterranea* and other international networks (Euforgen, EUFGIS, IUFRO 2.02.13, Treebreedex, Trees4Future, Cost FP102 MaP FGR, etc.) have demonstrated the need to establish and harmonize shared databases and maps of species distribution, experimental networks, climatic networks and future scenarios. Moreover, existing comparative trial networks are precious and should be carefully conserved, managed and monitored to collect valuable information on adaptation (Besacier *et al.*, 2011), and to integrate marker-assisted selection techniques. Marker-assisted selection is an indirect selection process whereby one or more traits of interest are selected based on a morphological, biochemical or DNA/RNA marker linked to other traits of interest such as growth, quality, pest/disease resistance, or abiotic stress tolerance (Collard and Mackill, 2008).

Managers and decision-makers should better understand these major genetic parameters in order to improve forest restoration and management plans. Understanding the significance of these parameters can improve silvicultural practices and the management of populations and breeding material in nurseries and plantations.

A more professional and biodiverse selection of nursery-grown plant material is required to improve restoration efforts. In addition, a wider range of species of known provenance should be produced and made available for large-scale use. The involvement of tree nursery managers in the success of plantations made with the materials they distribute is desirable. The annotation of the plots in which the reproductive material will be planted should be universally mandatory in order to monitor the success of plantations and to assess the adaptive capacity of the plant materials used across a spectrum of sites.

Several gene transfer techniques, known either as assisted gene flow or assisted migration, may prove useful in some cases, but cannot be used in every situation (Iverson and McKenzie, 2013). Moreover, as mentioned above, marker-assisted selection techniques made possible through the rapid development of genomics can improve the efficiency of adaptive genetic improvement (Mackill *et al.*, 1999; Slafer *et al.*, 2005).

Including genetics in FLR planning, from the point of forest establishment to growth, maturation and monitoring success (Le *et al.*, 2012), will increase the capacity of restored forest ecosystems to adapt to new threats. An ecosystem approach, which considers soil biota, pollinators and seed dispersal to help ensure long-term self-maintenance, is essential to comprehensive and lasting landscape recovery (Bou Dagher Kharrat, 2017).

Stronger links between research and practice should be established (Bozzano *et al.*, 2014), and restoration projects have untapped potential to generate scientific knowledge to improve future restoration. The need for improved knowledge and practical advice will become even more urgent in the future in view of the limited restoration experience of the many new actors likely to emerge in response to major international commitments to restoration goals.

FLR actors should collaborate to establish supportive national strategies that create demand for good quality forest reproductive material of native tree species. These frameworks should explicitly address the importance of adequate selection of sufficiently diverse genetics in ecosystem restoration (Bozzano, 2017).

In addition, the identification of appropriate incentives and financing mechanisms to encourage the evaluation of restoration success in a more holistic way, including the consideration of the FGR to be used in the restoration activities, is urgently required. Such evaluation should include assessments of how the restoration of a resilient ecosystem copes with changes and threats.

International commitments and initiatives related to Mediterranean forest and landscape restoration

UN multilateral conventions and the SDG Agenda

Countries in the Mediterranean region have made commitments to forest and landscape restoration under the Rio Conventions, the 2030 Agenda for Sustainable Development and the United Nations Forum on Forests (UNFF).

The CBD Aichi Biodiversity Targets aim to address five different strategic goals for the period 2001-2020. Of the 20 different targets, numbers 5, 14 and 15 are closely related to forest and landscape restoration. Specifically, target 15 aims to restore 15 percent of degraded ecosystems by 2020. Most Mediterranean countries[5] have prepared their national reports and National Biodiversity Strategies and Action Plans (NBSAPs) in the context of CBD Aichi Targets 5 and 15 (CBD, 2017), reporting on their efforts towards the achievement of these targets.

With regard to the sustainable development goals, target 15.3, which aims to achieve Land Degradation Neutrality (LDN), is closely linked to FLR. LDN focuses on maintaining and improving the quality of land resources necessary to support ecosystem functions and services and enhance food security by identifying drivers and measures designed to avoid, reduce and/or reverse land degradation. Mediterranean countries have already embarked on the process of establishing national LDN targets. These include North African countries, namely Algeria, Egypt, Morocco and Tunisia, East Mediterranean countries including Jordan, Lebanon, Syrian Arab Republic and Turkey, as well as European Mediterranean countries, including Bosnia and Herzegovina, Italy, Montenegro and Serbia.

As a result of the Paris Agreement adopted in 2016, several countries have included restoration in their Intended Nationally Determined Contributions (INDCs). UNFCCC parties are currently preparing their Nationally Determined Contributions (NDCs) to translate these intentions into action. In this context, EU member countries submitted a joint INDC, which considers afforestation and reforestation under the Land Use, Land-Use Change and Forestry sector, but without providing specific measures regarding emissions reductions. Other Mediterranean countries such as Algeria, Morocco and Turkey have reflected restoration and reforestation in their NDCs. These include either specific measures to increase forest cover and carbon stocks or reflect their commitments to implement the NDCs through existing national restoration efforts (e.g. Lebanon and Tunisia).

The Silva Mediterranea Working Group on “Desertification and Restoration of Mediterranean Drylands”

The FAO Committee on Mediterranean Forestry Questions-*Silva Mediterranea* took a decision to create a working group on “Desertification and Restoration of Mediterranean Drylands” during its twenty-first

[5] Albania, Algeria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Egypt, the former Yugoslav Republic of Macedonia, France, Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Montenegro, Morocco, State of Palestine, Portugal, Serbia, Slovenia, Spain, Syrian Arab Republic, Tunisia and Turkey.

session in February 2012 in Antalya, Turkey. This working group benefits from strong support (including financial support) from the Turkish Ministry of Forestry and Water Affairs (MFWA), particularly its General Directorate to Combat Desertification and Erosion, from the Scientific and Technological Research Council of Turkey (TÜBITAK) and from the Turkish International Cooperation Agency (TIKA). Technical support is provided by FAO's Forestry Department, drawing from its expertise on dryland forestry matters and dryland restoration-led initiatives.

The working group focuses on the implementation of Strategic Line 6 of the Strategic Framework on Mediterranean Forests (SFMF) to "Restore degraded Mediterranean forest landscapes" at national/regional levels by:

1. Promoting the dissemination and implementation of FAO's Global guidelines for the restoration of degraded forests and landscapes in drylands at the Mediterranean level (FAO, 2015c);
2. Compiling and analysing successful restoration efforts already implemented in the Mediterranean and sharing best practices and lessons learned at the regional level through projects, programmes and other initiatives to restore forests and landscapes in drylands with, in particular, support from FAO's two complementary initiatives: "Forest and Landscape Restoration Mechanism" and "Dryland Restoration Initiatives Platform;"
3. Contributing to the organization of Mediterranean Forest Weeks on restoration and the preparation of editions of State of Mediterranean Forests; and
4. Establishing partnerships with organizations supporting the development of innovative financing mechanisms for FLR and LDN.

The working group's achievements and contributions so far include:

- The 2015 publication of FAO's country-driven "Global guidelines for the restoration of degraded forests and landscapes in drylands – Building resilience and benefiting livelihoods," based on the results of two workshops organized with the support of Turkey (taking place in Konya, Turkey in 2012 and Dakar, Senegal in 2013). These guidelines have been promoted at the Mediterranean level and are available in five languages (English, French, Spanish, Turkish and Arabic). Turkey used these global guidelines as a basis for the preparation of its own national guidelines.
- A FLR monitoring tool was also developed to analyse restoration projects and programmes. The tool was revised and finalized in 2016 and is being published online (2018) in three languages: English, French and Spanish. It will be available on FAO's website, accessible as "Dryland Restoration Initiative Platform." This will promote ongoing exchanges about lessons learnt and good practice, both within the Mediterranean and with other dryland regions worldwide.
- Preliminary mapping and analysis of 40 restoration and rehabilitation projects, programmes and initiatives was carried out in the Mediterranean region (Parfondry *et al.*, 2017). The results of this work were presented during the Fifth Mediterranean Forest Week (Agadir, Morocco, March 2017) and published as part of its proceedings.

The Ankara Initiative and the Committee of Forestry Working Group on "Dryland Forests and Agrosilvopastoral Systems"

Turkey is working in partnership with the UNCCD Secretariat and its Global Mechanism and other organizations to support the development of innovative financing mechanisms for FLR and LDN through the Ankara Initiative. This will benefit UNCCD Annex 4 countries (Northern Mediterranean region). Turkey's Ministry of Forestry and Water Affairs (MFWA) is collaborating with FAO's dryland restoration programme in support of Africa's Great Green Wall initiative under the Turkey-FAO Forestry Partnership and with support from the Ankara Initiative. The "BRIDGES" (Boosting Restoration, Income, Development and Generating Ecosystem Services) project was developed by FAO with MFWA and three Great Green

Wall partner countries (Eritrea, Mauritania and Sudan). Bridging the Mediterranean drylands of Turkey with those in Africa, one of the objectives of the project is to stimulate south-south cooperation between Turkey and Africa's Great Green Wall countries, as well as across dryland regions globally.

During its Twenty-Third Session in July 2016, the FAO Committee on Forestry (COFO) agreed to establish an expert working group on "dryland forests and agrosilvopastoral systems." Its purpose was to: review and report to the COFO on the status, trends, issues and developments in dryland forests and agrosilvopastoral systems; contribute to developing a comprehensive understanding of dryland forests and agrosilvopastoral systems and the people who depend on them; and increase the adoption of good practices for the protection, sustainable management and restoration of drylands forests and agrosilvopastoral systems, enhancing environmental and socioeconomic resilience and sustainable livelihoods. The working group provides an opportunity to promote cooperation and share lessons learned between the Mediterranean basin region, other dryland regions and other regions sharing similar climate characteristics.

The Agadir Commitment of the Mediterranean Region

The Strategic Framework on Mediterranean Forests (SFMF) (FAO, 2013) provides policy orientations for integrated management of forest ecosystems in Mediterranean landscapes. Nine strategic lines form the key pillars of which strategic line six aims to "Restore degraded Mediterranean forest landscapes." This is expected to generate the following outcomes:

- Resilience to climate change is enhanced by restoring Mediterranean forest ecosystems with a global vision to cope with desertification issues;
- Forest ecosystem restoration is promoted as an opportunity to enhance food security and livelihoods in Mediterranean drylands;
- Environmental and cultural services (including habitats for native biodiversity) are regained in these restored forest ecosystems;
- Long-term forest restoration is considered using integrated approaches, restored forest ecosystems are managed, monitored and evaluated.

This strategic framework is very well aligned with Aichi Biodiversity Targets 5, 14 and 15, as well as SDG target 15.3.

During the most recent Mediterranean Forest Week in Morocco in 2017, nine countries[6] endorsed the Agadir Commitment, thereby agreeing to restore eight million hectares of degraded forest landscapes by 2030. This commitment is built on current national programmes. In support of this effort, countries agreed to establish a FLR Regional Mediterranean Initiative with the support of FAO and other partners.

These regional restoration undertakings are aligned with the UNFF (United Nations Forum on Forests), the UN Strategic Plan for Forests 2017-2030, the Rio Conventions and the 2030 Agenda for Sustainable Development. The endorsed Commitment includes four specific objectives:

- To assess ongoing national efforts on FLR;
- To reinforce regional cooperation on FLR and LDN;
- To strengthen cooperation among interested partners to develop a consensual and diversified strategy for FLR financing efforts and reinforce national capacities;
- To assess respective FLR and LDN efforts through the establishment of a voluntary monitoring and reporting system in the Mediterranean.

[6] Algeria, France, Iran, Lebanon, Morocco, Portugal, Spain, Tunisia and Turkey.

Conclusions and the way forward

As stated above, restoration (including ecological restoration and forest and landscape restoration) will play a key role in the Mediterranean Region in the context of the Rio Conventions and other international commitments, including the Paris Agreement and the Bonn Challenge. The implementation of the recently-signed Agadir Commitment will bolster country efforts to restore their degraded ecosystems and, at the same time, meet their 2030 targets. Recognizing the importance of the Bonn Challenge and the added value of collectively mobilizing the GPFLR, the Agadir Commitment will reinforce cooperation and existing regional restoration efforts to adapt Mediterranean forests, landscapes and populations to climate change (and mitigate its negative effects). It will also help to attract additional financial support to increase FLR investments with a view to meeting Paris Agreement targets.

The Agadir Commitment lies well within the regional restoration potential mapped using GDA data (more than 80 million ha across the Mediterranean basin). But additional and more detailed efforts to map and plan priority restoration areas are required at country and sub-national levels, using and analysing biophysical data, socioeconomic needs and opportunities. Country-led restoration and mapping exercises must be prioritized, conducted using a multi-stakeholder planning process built on existing or future LDN and NDC targeting processes. Prioritization and planning should also support the development of restoration objectives that balance the environmental, economic and societal needs of each landscape or landscape unit.

Mediterranean countries have committed to an ambitious restoration programme. In preparing to meet these commitments, efforts must be strengthened and directed towards addressing the mobilization of reproductive material that maximizes the use and propagation of forest genetic resources (diversity, variability of plant species, intra-species population and gene pools). This will help countries meet sustainable development challenges and build landscapes that are resilient to climatic changes. When selecting species for FLR, the use of more adaptive genetic materials should be emphasized, especially in relation to ecological sustainability and the effects of climate change. In view of this, legislation relating to certification and traceability should be more stringently applied, to ensure the propagation material pathway is traceable from source or provenance to the site of restoration.

Fires are a growing threat and challenge in the Mediterranean, particularly in the context of climate change. Restoration after wildfires must, therefore, be carefully designed according to the ecosystem's response to fire, fire severity and ecosystem type and management objectives, which can differ significantly depending on the geographical and socioeconomic context.

New approaches to socio-ecological restoration must be adopted to protect biodiversity, increase the provision of ecosystem services, reduce the inconvenience of ecological disservices and improve human welfare across the region. In this context, good practice sectoral standards are required to guide ecological restoration and FLR projects and increase restoration success. The FAO Global Guidelines for the restoration of degraded forests and landscapes, along with many other practices and lessons learned from research projects should be put into practice. Participatory approaches to designing, implementing and monitoring FLR activities, in close collaboration with all relevant groups, should be mainstreamed to ensure restoration efforts are owned and sustained by the appropriate stakeholders.

Initiatives to develop capacity are required to facilitate exchange and transfer of good practices. Tools and approaches such as the MEDFORVAL project, the collaborative roadmap for FLR monitoring and the Dryland Restoration Initiatives Platform will help achieve and assess the success of restoration projects and extend restoration knowledge in the region. Additional strengthening measures include: compiling and exchanging case studies on restoration in the Mediterranean and other dryland regions worldwide; baseline assessment and monitoring of the impact of restoration efforts using tools such as Collect Earth; and regional and international partnerships such as the GPFLR. These measures should be further increased and promoted.

Due to the often high costs of restoration, it is important to optimize these costs by applying cost-effective strategies. But this should involve more than a narrow cost-benefit analysis. In order to maximize the benefits of a given investment, analysis must consider the effectiveness of restoration activities based on broader environmental and socioeconomic factors. Public-private investments should be encouraged; the FAO FLR-Mechanism and other partners can help to identify and broker such win-win partnerships.

Last but not least, government institutions, NGOs and producers currently see FLR not as a choice but an imperative and an opportunity to address many other related SDGs. These including poverty eradication (SDG 1), Food Security and Sustainable Agriculture (SDG 2), Climate (SDG 13) and Life on Land (SDG 15). Addressing restoration at a landscape level, while complex, is the only way to bring sectors and stakeholders together to achieve sustainable development goals.

8 Adaptation and mitigation

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Introduction

Mediterranean forests in Europe, North Africa and the Near East are under pressure due to the combined effects of anthropogenic exploitation (fuelwood collection, overgrazing, agricultural conversion, etc.) and stress and disturbances related to climate change (drought, wildfires, pest and diseases) (see Chapter 5). At the same time, Mediterranean forest ecosystems play a key role in regional climate change mitigation, removing carbon dioxide from the atmosphere and storing carbon. Adjustments to forest management approaches are necessary, both to reduce the adverse effects of human and climate-induced pressures on Mediterranean forests and to enhance their role in climate change mitigation.

This chapter focuses on the linkages between climate change adaptation and mitigation. In particular, it will consider the role of global and regional policies, forest management strategies and social participation in rural governance in implementing mitigation and adaptation strategies. We will consider four overarching questions:

1. What threats are Mediterranean forests facing and what is their current mitigation capacity? (Section "The mitigation role of Mediterranean forests");
2. How can the current climate policy framework trigger mitigation and adaptation actions in Mediterranean countries? (Section "Climate policy actions in the Mediterranean region: Present and future roles");
3. How can forest management, including the management of forest genetic resources and fire regimes, be improved to enhance the resilience of Mediterranean forests to climate change-related stress and disturbances? (Sections "Fostering adaptability by silviculture"–"Progress in wildfire management");
4. How can the governance of Mediterranean rural landscapes interact with stakeholders to develop effective adaptation strategies? (Section "Adaptation strategies and stakeholder involvement in the Mediterranean rural landscape").

Mitigation

The mitigation role of Mediterranean forests

Forest ecosystems are important components of the global carbon cycle in at least two ways. First, they store nearly 3 billion tonnes of anthropogenic carbon each year through net primary production (Malhi, 2002). This corresponds to about 30 percent of all carbon dioxide released into the atmosphere from fossil fuel burning and deforestation. Second, they immobilize a large amount of carbon in their tissue, which roughly corresponds to more than double that present in the atmosphere (Canadell and Raupach, 2008).

Over centuries, Mediterranean forests have demonstrated an ability to cope with external change, particularly changes to climate conditions and anthropic activities. This explains their key role in mitigating the effects of climate change. As climate change is likely to affect the geographic location of the Mediterranean climate biome, with areas of expansion in either the northern or southern Mediterranean region (Figure 3.10), forest management and afforestation will play an important role in climate change mitigation and adaptation (see also Section "Climate policy actions in the Mediterranean region: Present and future roles").

Several studies have been conducted to determine carbon sequestration and greenhouse gas emissions by forest ecosystems in the Mediterranean region, based on data from forest carbon inventories, field measurements, remote sensing, laser scanning and growth simulation. Mediterranean forests represent a carbon sink (Pasalodos-Tato *et al.*, 2017) expected to increase over coming decades (Cañellas *et al.*, 2017). Table 3.4 details the amount of carbon sequestered annually in this aboveground biomass. Figures are devised applying biomass conversion and expansion factors provided by Eggleston *et al.* (2006) to data on net annual increments for the year 2015 in the Global Forest Resources Assessment 2015 (FAO, 2015a). However, as net annual increment is not available for all countries classified as Mediterranean in this report (see Chapter 3), information on aboveground carbon sequestration is limited to around a dozen countries. In these countries, annual aboveground carbon sequestration ranges from 0.2 to 2.4 tC/ha. On average, carbon annually sequestered in stems and branches amounts to 0.7 tC/ha. This falls within the range of estimates reported in the relevant literature (Croitoru and Merlo, 2005). Eddy flux measurements conducted in several Mediterranean forests in Italy indicate annual C absorption by all above and below-ground ecosystems compartments, including soil, ranges from 1 to 5 tC/ha, from Mediterranean macchia shrubs to Mediterranean oak and Montane-Mediterranean pine forests (Fares *et al.*, 2004).

Recent studies on *Quercus*, *Pinus* and *Eucalyptus*-dominated forests in the northern Mediterranean (Italy, Spain and Portugal) (Gratani *et al.*, 2017; Cañellas *et al.*, 2017), show that carbon is not only sequestered in above and below-ground biomass, but that significant quantities are also stored in litter

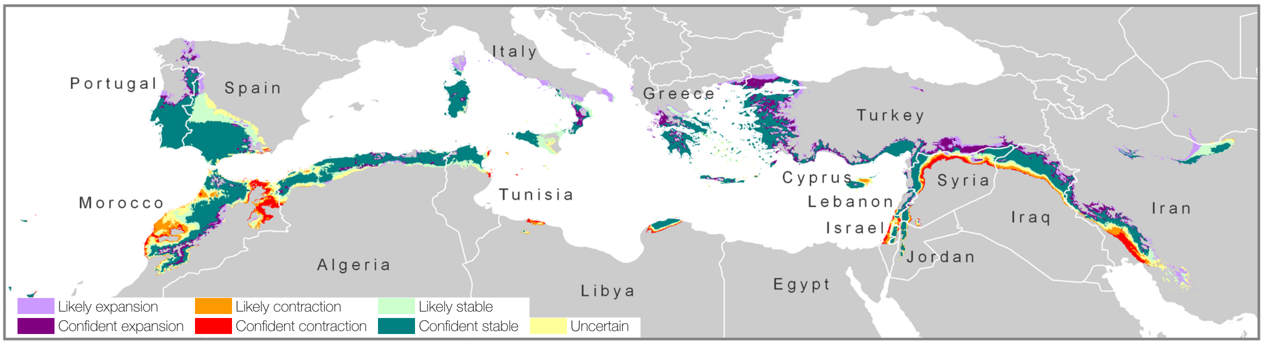

Figure 3.10. Projected status of the Mediterranean climate biome in 2070-2099, compared to 1960-1989 using a high (IPCC-A2) emissions scenario

Source: Klausmeyer and Shaw (2009) (modified).

and soil (40 percent of total forest carbon storage). Either way, interactions between climate change and disturbances will have different impacts on forest ecosystems (e.g. increased fire frequency and fire affected areas, reduced growth of drought-stressed trees and increased morbidity after fire), primarily reducing forest productivity and, by extension, climate mitigation capacity (Doblas-Miranda *et al.*, 2017; Reyer *et al.*, 2017).

Table 3.4. Estimates of aboveground biomass carbon removal from forests in some Mediterranean countries

Country	Annual aboveground biomass C-removal (year 2015, tC/ha)	
	Coniferous forest	Broadleaved forest
Bulgaria	1.17	0.60
Croatia	0.16	1.22
Cyprus	0.27	0.55
France	0.57	1.12
Italy	0.27	0.73
Morocco	0.08	0.15
Serbia	2.12	1.08
Slovenia*	2.43	
Spain	0.25	0.25
Tunisia*	0.18	
Turkey	0.57	0.36

Source: processed from FAO (2015a) data.

Note: *net annual increment breakdown by coniferous and broadleaved forest not available.

Wildfires represent the greatest disturbance in the Mediterranean basin by a considerable margin (Figure 3.11) (Seidl *et al.*, 2014; Nabuurs *et al.*, 2013). Exacerbated by climate extremes (Reichstein *et al.*, 2013) fires affect, on average, 450 000 ha in the region each year (Turco *et al.*, 2017). In recent decades (with the notable exception of 2017), total burned area and annual number of fires registered in the Mediterranean's north and northeast has tended to decrease, despite an increase in the of occurrence of large fires (> 500 ha) (Domingo *et al.*, 2017; Turco *et al.*, 2017). It is estimated that CO_2 emissions caused by fire total about 2 000 TgC globally each year (Fares *et al.*, 2017). Airborne Laser Scanning and simulation model data have been used to establish that a wildfire in a 40 year-old pine forest is estimated to produce an average emission of 60 tonnes of CO_2 equivalent per hectare (Montealegre *et al.*, 2017), compromising resilient species regeneration when the frequency of fire events is above average (Domingo *et al.*, 2017).

Deforestation and forest degradation are also sources of carbon emissions in the Mediterranean region. Deforestation is the result of both direct (agricultural expansion, urbanization, infrastructure development and mining) and indirect causes, related to demographic, economic, technological, social, cultural and political factors (FAO, 2016c) (see Chapter 3). Several studies conducted on forests located in the north and northeast Mediterranean basin locally show a decrease in forested, peri-urban and agriculture areas (Acácio *et al.*, 2016; Symeonakis *et al.*, 2017; Christopoulou, 2011), even if the overall forest area at Mediterranean level is reported to be stable or slightly increasing (Chapter 3). Forest degradation in the Mediterranean is directly caused by grazing and fires and is indirectly related to topographic constraints (Jucker Riva *et al.*, 2017).

Climate policy actions in the Mediterranean region: Present and future roles

The consequences of human pressure on Mediterranean forests are more evident where populations are strongly dependent on forest ecosystems, as is the case in North Africa and the Near East. In this region, forest administrators and managers also face significant technical and financial difficulties which impede the sustainable management of Mediterranean forest ecosystems, not least of which is the establishment of clear land property rights in forest areas.

Table 3.5 provides a list of rural and forest land management measures that could have a positive mitigation impact by either increasing carbon sequestration and/or reducing emissions. In general, there is a strong connection between adaptation and mitigation measures in the forestry sector. Adaptation of wildfire management to a changing climate, and the use of silvicultural measures to reduce vulnerability to water stress, pests and diseases have the capacity to both increase adaptability to climate change and lower GHG emissions in the atmosphere. Some of these measures will be specifically addressed in Section "Adaptation."

The international climate policy framework recognizes the role of forests in climate change mitigation. Policies and actions to enhance forest carbon stocks in the Mediterranean are already underway. On the other hand, there is currently a lack of active forest management in many parts of the Mediterranean due to the lack of well-developed forest value chains (Valente *et al.*, 2015). A larger effort is required in future to incentivize activities that reinforce mitigation in a changing climate. The transition towards a bioeconomy provides an opportunity to support long-term sustainable wood mobilization in Mediterranean countries (e.g. Lainez *et al.*, 2018) to replace fossil-based products (substitution effect) and to reduce the risk of wildfires associated with expanding and unmanaged forests, resulting in large CO_2 emissions (Verkerk *et al.*, 2018).

Forests in the current climate policy framework. The United Nations Framework Convention for Climate Change (UNFCCC) establishes country obligations with regard to climate change mitigation and adaptation, but also urges countries to cooperate in financing, technology transfer and capacity building in this sector.

The UNFCCC architecture consists of general Convention obligations, supplemented by other instruments that have evolved over time (Table 3.6): the Kyoto Protocol, the Cancun Agreements and the Paris Agreement.

The land sector, which includes forests, is widely recognized as one sector with high potential for

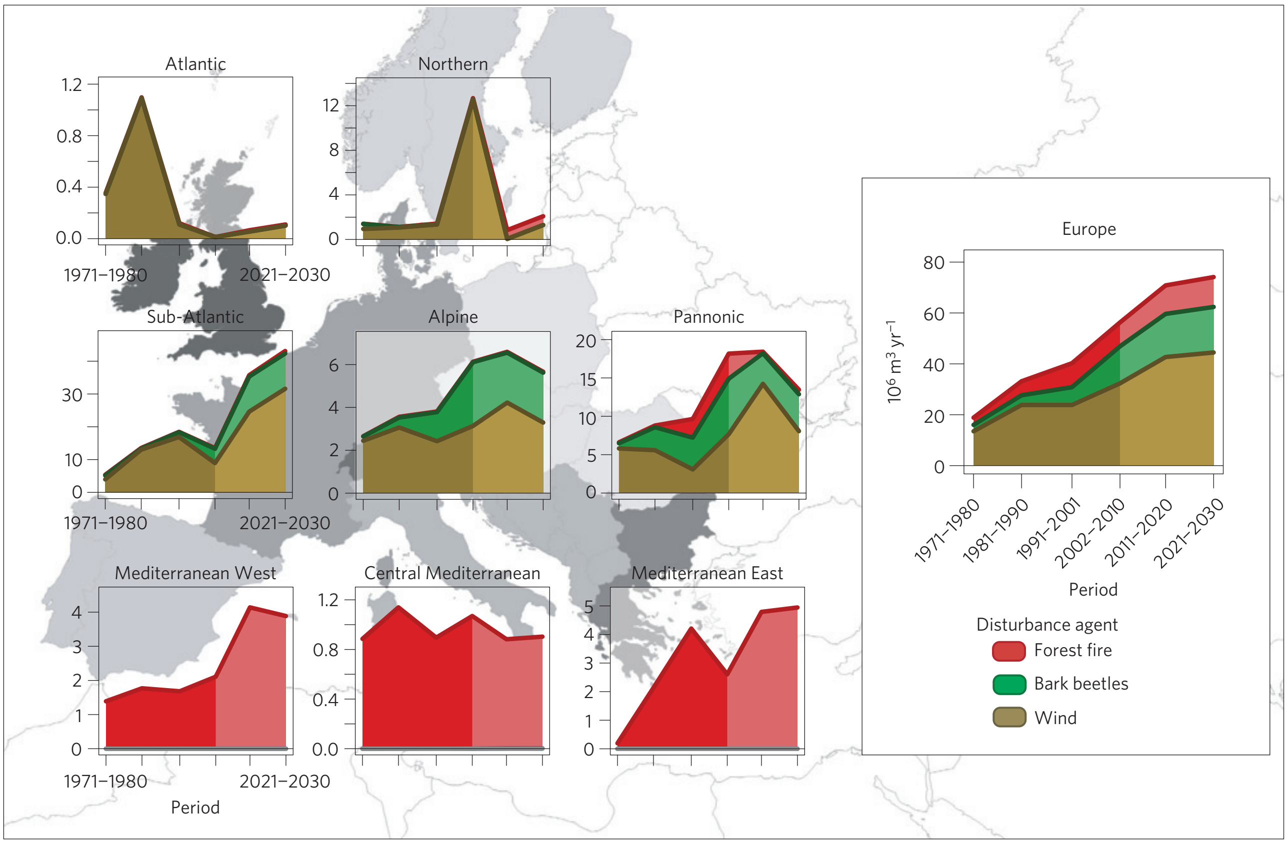

Figure 3.11. Damage from forest disturbances in Europe, 1971–2030. Values are disturbance damage in millions of cubic metres of timber per year. Lighter hues refer to predictions

Source: Seidl *et al.* (2014).

Table 3.5. Examples of measures to enhance the mitigation capacity of Mediterranean forests

Carbon pool	Mitigation measures
Living biomass	• Land reforms • Promote afforestation (bearing in mind future climate conditions) • Identify and combat causes of forest degradation and deforestation • Reinforce the role of fire prevention in wildfire management • Monitor pests and diseases • Promote forest regeneration and a balanced age/class distribution • Promote good practices in wood/cork/other product extraction to limit damage to trees and the proliferation of pests and diseases
Soil and Litter	• Avoid tillage wherever possible and/or reduce tillage intensity • Combat overgrazing by domestic and/or wild animals • Promote full and permanent soil coverage • Promote soil productivity and accumulation of organic soil matter

mitigation actions, both in terms of sequestration of carbon dioxide and reducing emissions of carbon dioxide, methane and nitrous oxide.

These instruments have resulted in two main frameworks applicable to forests: the current Kyoto Protocol land-use and forestry accounting rules, which details how to account for the contribution of forests to developed countries' targets under the Kyoto Protocol; and the REDD+ framework intended to support developing countries to reduce emissions from deforestation and forest degradation. In the forthcoming Paris Agreement framework this strict distinction will no longer be valid; forests will enter and be accounted for in the NDCs of all Parties. This is reflective of the Agreement's emphasis on moving towards economy-wide emissions reduction or limitation targets. REDD+, however, will continue to reward developing countries for their efforts to reduce emissions and enhance forest sequestration.

If the transition towards a true bioeconomy is taking place in Europe, the forest sector could also become instrumental in energy substitution (biomass and liquid biofuels), storing carbon in products (Harvested Wood Products) and substituting more energy intensive materials. Importantly, however, mitigation and adaptation policies in EU Mediterranean countries cannot be compared with those of non-EU Mediterranean countries, where the forest sector is under enormous pressure to meet the demands of food, fibre and energy to cater to an ever-growing population. Accordingly, the following section provides an overview of the variable role of the forest sector in the climate policies of EU and non-EU Mediterranean countries.

Forests in the climate policies of Mediterranean countries: EU countries. Under the Kyoto Protocol, EU countries (28 member states plus Iceland) agreed to jointly meet a 20 percent reduction target for the period 2013-2020 compared to 1990 levels. This has been "translated" into an EU law, known as the "2020 Climate & Energy Package," which sets binding targets and legal obligations to ensure the following is achieved by 2020: a 20 percent reduction in greenhouse gas emissions compared to 1990 levels; a 20 percent share of primary energy generated by renewables and; a 20 percent increase in energy efficiency (i.e. level of energy saving, expressed as proportion of the projected use of energy in 2020).

Although forestry sector targets are not included in the 2020 Climate & Energy Package, the sector is included in EU targets under the Kyoto Protocol. The role of the forestry sector in European climate policy is framed by Decision 529/2013/EU, which applies Kyoto Protocol accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry (LULUCF). It also establishes additional information requirements concerning actions related to those activities.

The "second pillar" of the Common Agricultural Policy is the EU's Rural Development Policy and

Table 3.6. Climate policy instruments influencing mitigation and adaptation actions in the forest sector

Instrument	Main characteristics	Legal status	Time frame(s)
Kyoto Protocol	Establishes emission reductions for *developed countries* only. Creates a number of market mechanisms, including CDM (projects in *developing countries*). Includes mitigation only.	Protocol under the UNFCCC. Legally binding.	2008-2012 2013-2020
Cancun Agreements	All countries. Includes mitigation only.	Voluntary commitments. Not-legally binding.	2013-2020
Paris Agreement	Establishes Nationally Determined Commitments for *all countries*. Includes mitigation, adaptation, finance, technology transfer and capacity building.	Agreement under the UNFCCC. Legally binding.	2021-2025 (or 2030) + provisions for future periods

it represents the main legal instrument for the implementation of policies in the agricultural and forestry sector in the European Union. In particular, the EU's Rural Development Policy for the period 2014-2020 has the following objectives: fostering agricultural competitiveness; ensuring the sustainable management of natural resources and climate action; and achieving balanced territorial development of rural economies and communities, including jobs creation and maintenance. Rural Development Programmes should contain measures on several topics, including: promotion of forest development and improvement of the viability of forests; promotion of afforestation; establishment of agroforestry systems; prevention and restoration of damage caused by forest fires, pests and diseases; improved forest resilience and environmental value; and forest conservation and promotion of the environmental and climate services they provide. Each Member State then develops its own Rural Development Programme according to its national/regional priorities, but in so doing is required to address the priorities and actions outlined above.

Other EU funds may also support action relevant to forests and climate change. The LIFE programme, for example, supports projects demonstrating climate action (mitigation and adaptation) and integrated projects linking climate action to other environmental issues (e.g. pollution, soils, biodiversity). The Horizon 2020 programme prioritizes climate change mitigation and adaptation research, while its structural funds may provide indirect support to the forest sector through, for example, investments in civil protection and fire fighting.

Under the Paris Agreement, the EU has committed to reducing emissions by at least 40 percent by 2030 compared with 1990 levels. Discussions on a "2030 Climate & Energy Package" legal framework that would comply with these 2030 commitments are ongoing. It has, however, been decided that forests and land-use will be included in fulfilment of the 2030 target (unlike the 2020 target), even if the details remain unresolved. A regulation on this topic was adopted in May 2018 (Regulation EU 2018/841). A modified version of the Kyoto Protocol rules was adopted to account for emissions and removals from LULUCF in the EU.

Forests in the climate policies of Mediterranean countries: Non-EU countries. Non-EU Mediterranean countries are not subject to emission reduction commitments under the Kyoto Protocol.[1] They are, however, encouraged to participate in the clean development mechanism (CDM), which allows emission reduction projects to gain credits for use by the Parties included in Annex I (Figure 3.12) to comply with their targets.

[1] Turkey has recently been re-classified as an Annex I country (list of developed countries).

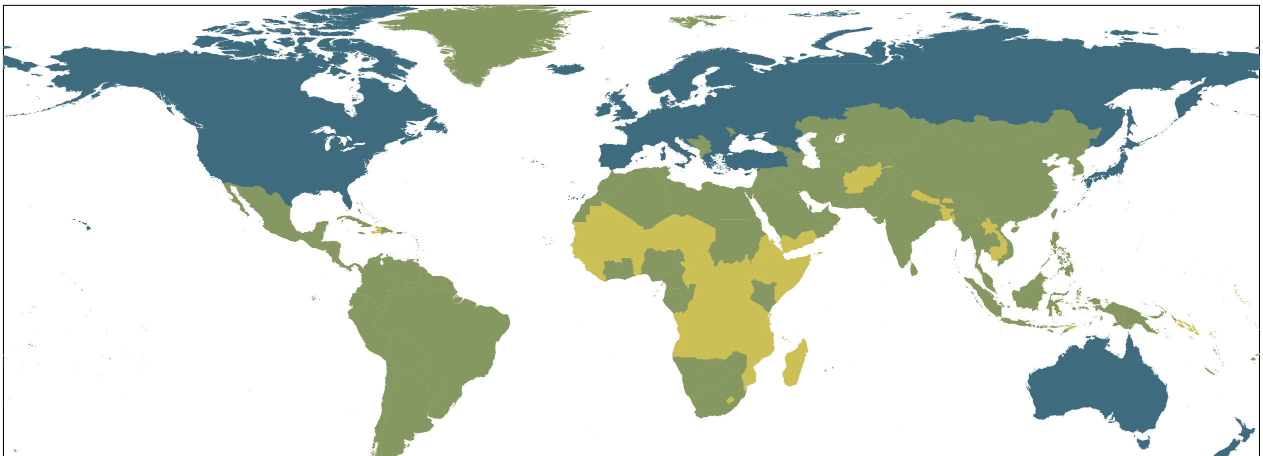

Figure 3.12. Annex I and Non-Annex I countries map

While CDM can occur in all sectors, CDM projects are limited to afforestation activities in the land-use sector. Albania is the only Mediterranean country that has an approved CDM in the forestry sector, with the implementation of a reforestation project promoting natural regeneration of degraded lands through grazing management and supplementary planting. Thus far, the project has absorbed 22 964 tCO_2 eq. from the atmosphere. Now that the Paris Agreement has entered into force, however, these kinds of projects are in stand-by mode, awaiting the conclusion of current discussions on the possible architecture of future market mechanisms.

The primary mitigation contributions from these countries – and their forests – will therefore come from other instruments, such as the Nationally Appropriate Mitigation Actions (NAMA), REDD+ and, more recently, the Paris Agreement Contributions.

The UN-REDD Programme supports nationally-led REDD+ processes and promotes stakeholder involvement in national and international REDD+ implementation. Through the stepwise architecture, REDD+ can assist countries in the readiness phase (i.e. support for development of national strategies or action plans, policies and measures and capacity-building), the pilot phase (implementation of national policies and measures and national strategies or action plans) and the results-based actions that should be fully measured, reported and verified. A country's starting phase will depend on its specific national circumstances, capacities and capabilities and the level of support received.

Participation in REDD+ by countries in the Mediterranean region remains very limited; only Morocco and Tunisia are enrolled in the UN-REDD Programme, and both are still at very early stages of engagement.[2]

Paris Agreement. The Paris Agreement brought together 197 countries to agree on new global goals to avoid dangerous climate change: to keep the increase in global average temperature to well below 2°C, to reach global peaking of GHG emissions as soon as possible, and to achieve a balance between anthropogenic emissions and removal from the atmosphere in the second half of this century. Achieving these goals will require a significant contribution from forests (Grassi *et al.*, 2017; Houghton *et al.*, 2015; IPCC, 2014c), not only through reduced deforestation, but also by maintaining and increasing the global sink capacity of forests through increased forest area, improved forest management, restoration of degraded forest lands and by better use of forest resources in energy production and bio-based products (construction materials, textiles, chemicals and plastics) capable of replacing fossil-based products.

The Nationally Determined Contribution (NDC) submitted by parties under the Paris Agreement

[2]http://www.unredd.net/documents/redd-papers-and-publications-90/un-redd-publications-1191/15996-key-achievements-of-the-un-redd-programme-2008-2016.html.

represents the country's commitments towards the Agreement's objectives. All Mediterranean countries, with the exception of the Syrian Arab Republic, are signatories to the Paris Agreement. Among the NDCs submitted, Algeria, Morocco and Tunisia have emphasized the important role of the forestry sector in meeting their targets, and have identified specific mitigation activities in the forestry sector such as reforestation, sustainable management of forest resources and fire control. Albania has not included the sector in its target, although it aims to do so at the next opportunity.

Adaptation

Rapid and intense changes in climate are expected to have significant impacts on Mediterranean forests. Rising temperatures and the projected decrease in rainfall will magnify drought risk. Even in drought-adapted ecosystems, drought is likely to lead to reduced plant growth and primary productivity and altered plant recruitment.

Under conditions of water stress, many Mediterranean broadleaved and coniferous trees are becoming increasingly vulnerable to fungal pathogens (e.g. *Phytophthora*), insect defoliators (*Lymantria*, *Processionaria*) and wildfires. Because the long lifespan of trees does not permit autonomous adaptation to a fast-changing climate, the implementation of adaptation measures at a management level is crucial to reducing the adverse effects of climate change-related stress and disturbances on Mediterranean forests.

The following sections provide an overview of adaptation options, based on stand level silvicultural measures and wildfire prevention strategies.

Fostering adaptability by silviculture

Because predictions about forest development under climate change are inherently uncertain, robust forest management strategies focused on adaptability are crucial. Accordingly, the focus on adaptive management should turn to the question of how to help current Mediterranean forests to develop and adapt, thereby sustaining the long-term provision of ecosystem services (see Chapter 6). A review of adaptive forest management in the Mediterranean (Vilà-Cabrera *et al.*, 2018) demonstrates that available empirical studies and experiments are biased towards short-term resilience (e.g. reducing vulnerability to drought and fire risk) rather than long-term adaptation.

One possible approach to fostering adaptability of managed forests in the long-term is to maintain and/or increase the complexity that already exists (Nocentini and Coll, 2013; Nocentini *et al.*, 2017). This does not mean uniformly maximizing forest carbon storage, which could induce larger risks (fuel accumulation, susceptibility to drought) and could preclude benefiting from the substitution effects (less fossil carbon released in the atmosphere). On the other hand, promoting forest diversification (including changes in forest composition towards drought and fire-tolerant species), while reducing short-term competition for resources between trees under drought conditions, is a complementary strategy to decrease vulnerability and increase resilience to climate change.

Management of stand density to reduce water use. Reduction of stand density through thinning operations has been shown to significantly reduce the impact of extreme drought on many forest ecosystems, including Mediterranean forests (Sohn *et al.*, 2016b). A lower stand density reduces water use at stand level, thereby decreasing competition between trees for above and below-ground resources, improving water availability and vigour of remaining trees. This improves the capacity of trees to resist and recover from extreme droughts and other biotic or abiotic hazards.

The thinning effect on growth response to drought has often been evaluated in terms of tree resistance and recovery to extreme drought events, which can also be expressed in terms of tree resilience. It is important to highlight that thinning generally increases both resistance and recovery in broadleaved species. For coniferous species, the most significant positive effect is on tree growth recovery after the event (Sohn *et al.*, 2016b). Nevertheless, tree growth under water stress can be affected by other factors such as differences in the growing season (e.g. evergreen broadleaves use water earlier, during spring, but also withstand periods of water shortage during summer), water-use efficiency (Brendel and Cochard, 2011), site, age and thinning regime (D'Amato *et al.*, 2013; Sohn *et al.*, 2016a). The higher resilience in thinned stands was explained in most studies by an increase in water available to trees, whereas the positive effect of thinning on intrinsic water use efficiency should be better elucidated (Martín-Benito *et al.*, 2010; Fernández-de-Uña *et al.*, 2016; Sohn *et al.*, 2016b; Di Matteo *et al.*, 2010, 2017).

Thinning studies on Mediterranean forests support these general trends (e.g. Martín-Benito *et al.*, 2010; Guillemot *et al.*, 2015; Fernandes *et al.*, 2016b), indicating that the regulation of stand density is one of the most important management options to mitigate the impact of extreme drought and high temperatures. Thinning is therefore crucial to adapt Mediterranean forests to climate change, particularly in very dense, high forest stands, such as some pine reforestations or post-fire regenerated Aleppo pine stands, where thinning is also essential to reducing fire risk and has other benefits such as promoting early cone production (Verkaik and Espelta, 2006; Ruano *et al.*, 2013).

Interactions between species mixing and thinning on growth. Promoting mixed-species stands is another management strategy to adapt forests to climate change (Figure 3.13). Besides the higher productivity and portfolio of ecosystem services found by increasing tree species diversity (e.g. Pretzsch *et al.*, 2015; Liang *et al.*, 2016; van der Plas *et al.*, 2016), more diverse forest stands frequently demonstrate greater stability. Mixing species can increase resistance and resilience to extreme droughts (Pretzsch *et al.*, 2013), temporal stability (Jucker *et al.*, 2014; del Río *et al.*, 2017), and reduce the risk of biotic and abiotic disturbances (Jactel and Brockerhoff, 2007; Castagneyrol *et al.*, 2014; Guyot *et al.*, 2016).

Studies focusing on the mixing effect on tree growth resilience to drought showed contradictory effects (Pretzsch *et al.*, 2013; Grossiord *et al.*, 2014; Merlin *et al.*, 2015), suggesting the lack of a general pattern but a dependence on species composition and site conditions (Forrester *et al.*, 2016), also for Mediterranean mixed forest stands (Grossiord *et al.*, 2014; de Dios-García *et al.*, 2015; Forrester *et al.*,

Figure 3.13. Mixed coniferous forest
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2016). There is considerable evidence that tree species interactions in terms of growth and productivity depend, among other factors, on stand density (Condés *et al.*, 2013; Forrester, 2014). However, how stand density and tree competition status influence the resilience of mixed-species stands to drought is poorly understood. There are a few studies focusing on growth response to drought in thinned and unthinned mixed-species stands in the Mediterranean region (Linares *et al.*, 2011; Aldea *et al.*, 2017), but unfortunately, they do not disentangle the role of species mixing on resilience to drought. Similarly, further study on the impact of species diversity on resilience to multiple stressors (e.g. drought and biotic disturbance interactions) in the Mediterranean is necessary.

Silvicultural actions to enhance regeneration. Forests are particularly vulnerable to climate change during the natural regeneration phase. Further attention in forest management to increasing adaptive capacity is therefore required. Moreover, natural regeneration treatments play a key role in promoting mixed species stands (Prévosto *et al.*, 2011), which could contribute to improving future forest resilience.

Most of the processes involved in natural regeneration are highly sensitive to climate, so a good knowledge of all climatic-driven mechanisms is the basis for adapting natural regeneration treatments in Mediterranean forests. By regulating light availability to forest floor, harvest intensity indirectly affects climatic conditions crucial for seed germination and survival of seedlings (temperature, humidity and radiation regimes). Under different harvesting intensities (e.g. between 25 and 100 percent of the basal area removed) and summer precipitation regimes, for example, *Pinus pinaster* germination and survival rates appeared to benefit more from the lowest harvest levels than from water availability (Ruano *et al.*, 2009).

Higher frequency of extreme droughts has also been found to reduce seed production and seedling survival (Mutke *et al.*, 2005; Gómez-Aparicio *et al.*, 2004; Calama *et al.*, 2016, e.g.), as well as seedling diversity (Lloret *et al.*, 2004). A recent review based on five Mediterranean pine species highlights the need to apply more gradual regeneration cuttings (shelterwood systems) and, as a general rule, to extend regeneration periods to meet the challenges posed by climate change (Calama *et al.*, 2017). Accordingly, shrubs can facilitate the initial establishment of some species in Mediterranean environments (Gómez-Aparicio *et al.*, 2004; Rodríguez-García *et al.*, 2011).

Silvicultural options to promote growth and resilience in coppice forests. The projected increase in drought risk is expected to magnify the already limited conditions for tree growth common to Mediterranean coppice forests (e.g. thin and eroded soils, poor soil carbon content). This widespread management system is characterized by densely-populated trees of small diameter. Tree species composition has long been simplified by coppicing, causing species with low stump sprouting ability to disappear from coppice forests (Fabbio, 2016). The structure of Mediterranean coppices explains their low growth rates under water-limited conditions, due to the lack of water availability and to higher respiration rates per unit of biomass, as compared to those of more mature forests (Gracia *et al.*, 2011) (Figure 3.14). In these conditions, reduced Leaf Area Index by means of thinning does not reduce the amount of water transpired, since the remaining trees use most of the water not used by harvested trees. This can result in less water stress and forest dieback during extreme drought, even by drought-tolerant species such as Holm oak (Gracia *et al.*, 2011).

Selective thinning is a useful technique to partially mitigate the negative effect of drought on the growth of deciduous oak coppices, although traditional thinning, characterized by low intensity and frequency, produces only transient results and needs to be modified to effectively mitigate the impact of increasing drought on Mediterranean oak coppices (Cotillas *et al.*, 2009).

Tree-oriented silviculture is a long-term management option to promote more complex and heterogeneous structure in Mediterranean coppices. Silvicultural treatments are directed towards early selection of target crop tree species, generally of sporadic occurrence in oak or chestnut-dominated coppice stands, whose crown growth is favoured by applying frequent thinning during the full rotation period (Manetti *et al.*, 2016).

Tree-oriented silviculture facilitates the diversification of timber assortments, e.g. producing valuable timber from sporadic trees (Giuliarelli *et al.*, 2016).

Advances in managing forest genetic resources

The Mediterranean region hosts a huge range of specific and genetic diversity. Its latitudinal position and geographic structure explains why important genetic hotspots (Myers, 1988, 1990; Myers *et al.*, 2000; Reid, 1998; Balletto *et al.*, 2010) are located in the Near East, North Africa and the Iberian and Italian peninsulas of southeast Europe. These biodiversity and genetic hotspots derive from refugia formed during past glacial waves that served as re-colonization gene sources during interglacial migrations. This is confirmed by the presence of considerable endemism of glacial or northern origin and of isolated populations of northern species belonging to mild and cooler regions. Most central European or northern and mesophilic species of colder, temperate regions find their rear margins here, mainly on mountain ranges at altitudes where suitable conditions can be found (e.g. *Fagus sylvatica*, *Abies alba*, *Pinus mugo*, *Picea abies*, *Pinus sylvestris*, *Quercus petraea*, *Quercus robur*). These so-called marginal/peripheral forest populations contain original genetic diversity (Hampe and Petit, 2005; Fady *et al.*, 2016).

The complex modern phenomenon of so-called "global change" tends to increase population fragmentation (Brook *et al.*, 2008). Climatic changes seem to be so rapid that tree populations are affected by severe and repeated stress periods, which are increasing in their intensity, frequency and duration. Populations growing at the rear edges will likely face genetic erosion or, in extreme conditions, extirpation risks (Aitken *et al.*, 2008; Aitken and Bemmels, 2016). On the other hand, more widespread species with larger populations are likely to persist and adapt, but will likely suffer adaptation lag for a few generations. Species with small populations and fragmented ranges will suffer decline and reduced fitness. In fragmented habitats, suitable sites are in fact separated by barriers that slow or completely disrupt gene flow. In these cases, inbreeding increases consistent with homozygosis levels, and the fitness of the population is globally reduced, instead favouring inbreeding depression (Hampe and Petit, 2005; Fady *et al.*, 2016).

Figure 3.14. Water limited plant growth
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Indeed, in a region like the Mediterranean it is unlikely that the migration of plant species and forest types will be fully capable of reducing the impacts of climate change on forests. Even where migration is possible, societies may be unwilling to accept massive forest dieback in some areas - and subsequent natural selection of more suitable genotypes - and may demand intervention. Initiatives which save time and resources should therefore be prioritized. An initial and useful approach to prioritization might be based on a list of tree species presently considered seriously endangered.

Màtyàs (2007) reported on a valuable comparison carried out among forest tree populations according to their main characteristics and population structure, and corresponding urgency for action. Initially, Mediterranean pines, evergreen oaks and other tree species may be less endangered than species in central-northern temperate habitats, as they are generally better adapted to drought. As the climate progressively dries, however, increased weather extremes and related events, such as forest fires and shifts in rural activities, will place increasing pressure on other habitats in this area.

***In situ* conservation.** Factors such as gene flow, genetic drift, selection, recombination and the reproductive system will determine a population's genetic structure, but the value of a stand's genetic resources is also strictly determined by the way they are managed. Therefore, conserving and managing the genetic variability of forest trees *in situ* is the basis for developing adaptive management strategies able to perpetuate ecosystem functions and services, as well as improving ecosystem resilience. *In situ* conservationists and reformers can work together to select adaptable basic materials within marginal populations, facilitating the production of adapted offspring. Indeed, the reaction of basic materials can be tested *in situ*, by exposing them to the temporal and spatial variation of micro-environmental conditions. It is evident that *in situ* selection should generally be carried out on highly heritable adaptive traits; predominantly eco-physiological (drought and frost resistance/tolerance) and phenological traits.

Knowledge of the spatial genetic structure of forests should be a common and shared approach to *in situ* silviculture and forest management of valuable populations. A first simple model of a stand structure is the subdivision of a population into sub-populations or demes. According to this model, the exchange of genes in a population is slower between groups of more distant trees and quicker and easier within them, regardless of the type of dispersal (Wakeley, 2000; Sagnard *et al.*, 2011). The entire population can also be accounted for by a number of demes. If demes structure remains stable for several generations, a certain degree of consanguinity between neighbouring trees within demes may occur. It is time to begin studies on the role of *in situ* conservation, including analyses on silviculture and tending effects on genetic structure. Konnert and Hosius (2010) and Ducci (2015) demonstrated the importance of genetics in developing a sustainable forest practice, either for silviculture implementing natural or artificial regeneration.

Special attention should be given to the silvicultural approaches, outlined in Section "Fostering adaptability by silviculture," aiming to increase species mixtures and control microclimates through canopy cover and crown density regulation to reduce drought susceptibility. Changes in tree density will also affect genetic diversity within species (Sagnard *et al.*, 2011). Applying silviculture principles to small management areas will produce patchy alternatives where natural selection can occur. It will, however, be crucial to monitor the impact of forest management on genetic diversity by using genetic and demographic indicators.

***Ex situ* conservation.** Integration with common garden networks is crucial to understanding and improving information on marginal populations and may be relevant to conservation and management in practice (Màtyàs, 2007). Without scientific experimental information on adaptive indicators, it is difficult to manage genetic resources and establish strategies for their conservation. For this purpose, it is important to make full use of several existing *ex situ* experimental networks and collections established in the Mediterranean.

In the past, IUFRO, FAO *Silva Mediterranea* and other important international networks established broad, international, multi-site tests, largely focused on conifers (four genera and some 20 species) and *Quercus suber*. This genetic stock, inventoried in the context of *Silva Mediterranea* (Pichot, 2011) and European projects such as TreeBreedex and Trees4Future, are a sound base upon which to develop future actions. Present trends in forest and tree-breeding research will influence the traits under consideration by future activities, as this approach to research has proved efficient (formerly *Silva Mediterranea* itself, IUFRO, EUFORGEN networks, EU TreeBreedex, Tree4Future etc.).

Studies should investigate adaptive characteristics and phenotypic plasticity and develop genomics as a basis for breeding, improvement and conservation (i.e. QTLs, QTNs, SNPs association techniques etc.). One must be aware, however, that identifying genes responsible for variation remains a slow and time-consuming process, especially in long-lived organisms such as forest trees (Vendramin and Morgante, 2006).

Reproductive materials. *Ex situ* conservation can be carried out at the national level and networked at the international level. Seriously endangered and valuable forest tree populations or species in the Mediterranean Region should be identified and conserved with the support of the international community. To this end, laws and regulations on management *in situ*, nursery systems and trade in forest reproductive materials should be modified. Namely, a revision of current concepts of seed zones and provenance region delineation should be considered. Almost universally, forest reproductive materials are used in forest plantation projects according to guidelines written under the assumption that local soil and climatic conditions will remain stable. According to most climate models, climatic conditions in the region will not remain stable over coming decades. There is, therefore, a need to revise rules regarding species provenance and the transfer of seeds and other reproductive materials (Konnert *et al.*, 2015).

The recent State of the World's Forest Genetic Resources (FAO, 2014), with a contribution from FAO *Silva Mediterranea* for Forest Genetic Resources in the Mediterranean region, should be considered under this framework. In the 1990s, Topak (FAO, 1997) inventoried forest reproductive materials used for reforestation in 17 *Silva Mediterranea* countries. Moreover, the FAO *Silva Mediterranea* database lists national and international forest tree common gardens[3] in the Mediterranean region. Such basic information is essential for rethinking seed zone delineation and provenance selection in the face of climate change. The Nagoya Protocol on Access to Genetic Resources and Sharing of Benefits should also be taken into consideration within the framework of the Convention on Biological Diversity.

Assisted migration. Where no other alternatives are available, assisted migration may help to formulate actions geared towards conserving endangered genetic resources. The main purpose of assisted migration is to conserve the genetic information contained in the original gene pool and revive evolutionary dynamics, as well as recreating an *ex situ* secondary ecosystem.

This concept necessitates some human interventions to assist forest populations to migrate. Seddon (2010) introduced the concept of migration of groups of species, defined as community construction. The current approach to assisted migration favours the use of a prudential "mimic." The relocation of the species within their existing range is also common.

There is, however, a need to develop informed policies on assisted migration, based on prioritizing species or other taxa for consideration as candidates for relocation/translocation, as well as on managing natural populations to minimize adverse ecological effects.

The present rules concerning forest reproductive materials do not include procedures related to future climate conditions and associated risks (Williams and Dumroese, 2013). Several techniques, such as Assisted Gene Flow between populations and assisted migration can help to mitigate maladaptation as a result of climate change (Aitken and Whitlock, 2013).

[3]Common garden: field test in which many individuals (clones, families, populations) of a given plant species sampled from an identified geographic area are grown in a common environment, making it possible to infer genetic information from the observation of phenotypic differences. These networks were previously known as "multisite comparative trials."

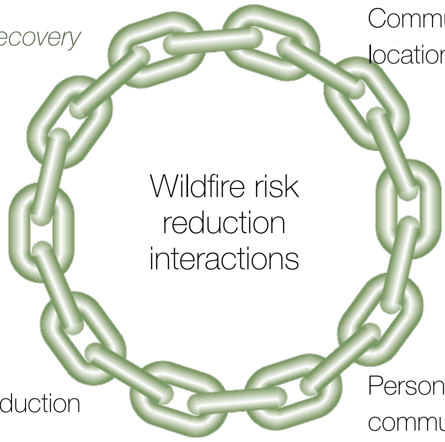

Figure 3.15. Fire-risk reduction interactions
Source: Corona *et al.* (2015) modified.

The primary challenge is the acceleration of climate change, which makes it difficult to prepare adaptation strategies. Current concept tools (including modelling, silviculture, nursery legislation and policies, etc.) and research networks are still based on a static or long-term environmental vision, even as major and rapid dynamism is currently underway (Kerr and Dobrowski, 2013). The low level and generally diffuse silvicultural management of our forests constitutes a real danger for the maintenance of these specific populations, which must be carefully managed *in situ* using suitable and well-focused adaptive cultivation techniques aimed at conserving their diversity and demographic structure.

Progress in wildfire management

Long-term forest fire data is available in most European Mediterranean countries. In addition, data from North African countries has also been included in the European Forest Fire Information System for the purpose of mapping burnt areas and assessing fire danger. Based on this data, it is possible to estimate that more than 400 000 ha of forest is still burned each year in the Mediterranean. Despite investments in fire prevention and fire-fighting, the occurrence, recurrence and magnitude of wildfires remains one of the largest environmental threats in the region (e.g. by causing significant emissions of greenhouse gases as a result of biomass burning) (Chiriacò *et al.*, 2013).

In the past, most wildfire protection programmes focused on fire suppression and related infrastructure, providing limited support for prevention and overlooking land management (Moreira *et al.*, 2011; Fernandes *et al.*, 2013). This policy has led to present-day wildfire problems: fire-fighting services, increased during periods of maximum fire frequency, are often not integrated with silvicultural and other management techniques.

Fire suppression policies should be integrated into a “360° view” fire management approach. An integrated fire management model combining science and fire management with socioeconomic needs at multiple organizational levels and not limited to fire suppression and provision of equipment, would be a more effective and proactive model of wildfire control (Corona *et al.*, 2015). The integrated approach includes activities such as prevention, awareness raising, preparedness and restoration. The actions required for fire-risk reduction are seen as a cyclic chain in which all actions are closely interlinked (Figure 3.15).

Adaptation of wildfire management to a changing climate. Increasing temperatures will lead to an increasing number of wildfires in the absence of improved fire management (Turco *et al.*, 2014). In particular, recent increases in the incidence of large and severe wildfires in parts of the Mediterranean region have been directly linked to a warming climate (Fernandes *et al.*, 2013; Prichard *et al.*, 2017) (see Chapter 5). These sort of fires have often overwhelmed the suppression capacity of any single nation in the last decade. In Mediterranean Europe, for instance, the Union Civil Protection Mechanism, which provides a coordinated response to extreme fire events, has been activated at least 69 times since 2007. There is also evidence that a shift to large, very extreme fires is contributing to the homogenization of post-fire landscapes; shrublands and open and dry vegetation types are increasingly prevalent in these landscapes, which may perpetuate the cycle of large fires (Moreira *et al.*, 2011; Fernandes *et al.*, 2016a). Decreases in biomass production as a result of climate changes may limit fire incidence over parts of the Mediterranean in the future but, on the other hand, new zones with high crown biomass accumulated in non-common drought areas will burn during severe wildfires (Lecina-Diaz *et al.*, 2014).

The adaptation of wildfire management to a changing climate requires integrated fire and forest management planning, including preventative silviculture and vegetation management techniques, as well as correct land use planning (Fernandes *et al.*, 2013). Distinct adaptation measures include: (i) modification of forest structure (e.g. tree spacing and density, regulation of age class structure); (ii) fuel management; (iii) creation of a landscape mosaic of forest types; (iv) infrastructure planning for direct fire attack with regard to the specific behaviour of each fuel model; and (v) implementation of policies to limit abandonment of burned areas and actions to prevent the spread of invasive species therein. Issues (ii) and (iii) are developed below, due to their particularities and relevance to an adaptation and mitigation framework.

Preventive silviculture and vegetation management techniques. Fuel management involves modifications to the three layers of live and dead fuels (surface fuels, ladder fuels and crown fuels) in the structure of a stand, namely: (i) removing or modifying surface dead fuels to reduce their flammability; (ii) selectively removing or modifying live/dead and ladder fuels to reduce their vertical arrangement and horizontal continuity, resulting in reduced crown fire probability (i.e. the passage of fire from neighbouring trees). The rationale behind fuel management is that three factors – weather, fuels (vegetal combustible materials of various size and type) and terrain (slope, exposure) – work in concert to give fires certain characteristics under the influence of a given casual factor. Of these factors, only fuel abundance can be directly influenced through treatments aimed at decreasing the amount of fuel in all three layers (Moreira *et al.*, 2011). To this end, even understanding the spatial distribution of vegetation dynamics based on the timing of fuel availability (an issue often undervalued by wildfire science), may be key to planning effective firefighting and prevention, since similar fuel management strategies should be applied to regions with similar fuel phenology patterns, and hence similar fire incidence (Fares *et al.*, 2017).

Table 3.7. The immediate effects of fuel treatments on factors that affect the ignition of a crown fire

Fuel treatment	Surface fuel load	Dead fuel moisture	Canopy base height	Wind speed	Canopy bulk density
Coppice conversion to high forest	–	–	+	+	–
Understorey removal	–	–	+	+	*
Thinning	*	–	+	+	–
Prescribed burning	–	–	+	+	–
Grazing	–	–	+	+	*
Pruning	–	–	+	+	–
Linear infrastructure	–	–	*	+	*

Note: + increase, – decrease, * no effect on crown fire ignition.
Source: Corona *et al.* (2015).

The load and arrangement of both live and dead fuels (i.e. reducing tree density and canopy cover, decreasing basal area, increasing the canopy base height) can be modified through: (i) horizontal, linear isolation of fuel (through firebreaks, fuel breaks and greenbelts); (ii) fuel reduction through physical removal, prescribed burning and intensive utilization; (iii) surface fuel reduction by prescribed grazing; (iv) changes to fuel bed density by lopping and scattering (manually or by tractor crushing) and chipping; (v) breaking vertical continuity through pruning; and (vi) changes to fuel moisture content through dead fuel removal and "introduction" of live understorey vegetation (Table 3.7).

The prescribed burning technique is popular in some countries primarily because it can attain multiple land management goals at the same time, including ecosystem restoration, increased livestock production and fire-fighter training, and can help to solve social conflicts related to traditional fire uses. Last, but not least, the financial costs of prescribed burning can be competitive compared to other fuel management techniques, although this will depend on the size of the area treated and on environmental (e.g. vegetation type, available weather windows) and operative (e.g. training of fire personnel) aspects (Rego *et al.*, 2010).

Integrating public interaction and landscape planning. An active human presence in forests, along with appropriate and planned silvicultural interventions, is important in Mediterranean environments, as it is one of the main guarantees against abandonment and consequent increased risk of fire. Public information and awareness about the importance of fuel management interventions should be promoted (Raftoyannis *et al.*, 2014), particularly with regard to social fire science, including enhanced understanding of the costs and benefits of wildland fires and organizational capacity. Research on public interactions is important to understanding socioeconomic issues such as how human attitudes, values and beliefs influence management options and how communities respond to risks in wildlands or rural or urban environments.

Forest protection measures should be integrated at the landscape level to balance forest stand level management goals and risk mitigation. From a management perspective, land cover (related to vegetation structure and fuel loads) is the only landscape variable influencing fire behaviour capable of manipulation. Wildfires start from a local epicentre (ignition point) and spread across landscapes as a function of the abundance and arrangement of areas susceptible to disturbance: thus, the spatial pattern of fire ignition and spread across landscapes is affected by the degree to which the landscape is fire prone (i.e. fire will behave differently depending on how fire prone various land cover types are) (Moreira *et al.*, 2011; Barbati *et al.*, 2015). On the other hand, high fire occurrence is mainly linked to the interface between wildland and agricultural areas and wildland and urban areas (Lafortezza *et al.*, 2015; Mancini *et al.*, 2017). Even linear infrastructure such as power lines, railroads and forestry tracks plays a major role in this regard (Rodrigues *et al.*, 2014).

Understanding the link between landscape pattern and fire spread should influence landscape-level management rules so that Mediterranean landscapes become less fire prone. The management implications of understanding the relationship between landscape and fire are not restricted to fuel break design; they should also influence land use management rules and the design and implementation of policies leading to specific landscape goals (in terms of overall fuel patterns), ranging from forests and agricultural and rural development to urban development policies (Moreira *et al.*, 2011). The territory-scale approach to integrated fire management is the "fire smart management of forest landscapes," which aims to control fire through vegetation (fuel) interventions to foster more fire-resistant (less flammable) and/or fire-resilient environments. "Fire smart" landscapes necessitate area-wide fuel modification and fuel conversion, rather than fuel isolation. Under moderate to severe fire weather conditions, fuel management should be focused on increasing fire suppression options and effectiveness by limiting fire ignition and fire spread in strategic locations (Fernandes *et al.*, 2013).

Adaptation strategies and stakeholder involvement in the Mediterranean rural landscape

In the Mediterranean area, rural landscapes are often characterized by fragile ecosystems vulnerable to climate change and at risk of environmental degradation. Sustainable management of natural resources is particularly important in rural areas in order to reduce the risk of natural catastrophes (e.g. flooding, avalanches and land-slides), deforestation and the impact of mass tourism. In these areas, the increasing pressure of climate change on natural resources endangers people's livelihoods, increases desertification and threatens biodiversity. Communities living in rural areas are sometimes socially and politically marginalized, making them more vulnerable to natural shocks than people living in urban areas.

Over time, rural communities have developed strategies to cope with these challenges. Some have achieved high living standards thanks to the development of green economies. These involve the sustainable use of natural resources for production and protection purposes and the rise of eco-tourism as a sustainable source of employment and income. Green economies can help increase the resilience of rural landscapes to climate change by reducing the impact of natural catastrophes, but good governance is crucial to achieving these outcomes.

Territorial governance is a complex formal and informal process of interactions, both vertical (between policy levels) and horizontal (between policy sectors and between public/private operators), that are permitted and conditioned by national spatial planning systems (Janin Rivolin, 2010). In the Lisbon Treaty adopted in 2009, the European Union (EU) considered territorial cohesion a primary objective, recognizing the highly diversified territories of which the EU is comprised. One of the primary objectives of territorial cohesion, (and therefore of territorial governance), is facilitating coordination between territorial and sectorial policies in order to generate more balanced development and greater solidarity between territories. This is achieved by pursuing fluidity between different territorial levels through forms of multi-level and non-hierarchical governance.

In this context, "adaptive governance" (a recently evolving framework for analysing the social, institutional, economic and ecological aspects of multilevel governance, aimed at dealing with adaptation to climate changes) (Dietz *et al.*, 2004; Folke *et al.*, 2005) is key to achieving greater climate change resilience in rural areas. Based on the concept of interactions at different levels, adaptive governance promotes communication between organizational levels (Adger *et al.*, 2011). Indeed, while mitigation to climate change is a global challenge, adaptation measures should be strictly linked to local context and needs.

Adaptation strategies are the changes that people, companies or governments make to moderate negative consequences and take advantage of the opportunities provided by climate change by adjusting natural or human systems (IPCC, 2001). Key to this concept is the notion that coping with the expected (future) effects of climate change requires a change in current individual behaviour, which should in turn be shared among the whole community.

Adaptive governance features are experimental, including: new policies for ecosystem management, new approaches to cooperation and relations between stakeholders, new ways to promote flexibility and new institutional and organizational arrangements. Governance can be defined as adaptive when it focuses on the behaviour of the individual, his/her actions and the results they are able to produce together.

Mountain regions are particularly interesting for field experiments in this area, as initiatives encouraging cooperation at a local level have already been established. Programmes targeting sustainable land management, valorization and protection of the mountain have been developed over time. These have been seen as key to enhancing the well-being of mountain communities. Internationally, the Mountain Partnership, promoted by FAO, has worked since 2002 to improve the lives of mountain people and protect mountain environments. The EU also promotes several programmes (Life+, Interreg Alpine Space Europe, European Social Fund and European Agricultural Fund for Rural Development) seeking to

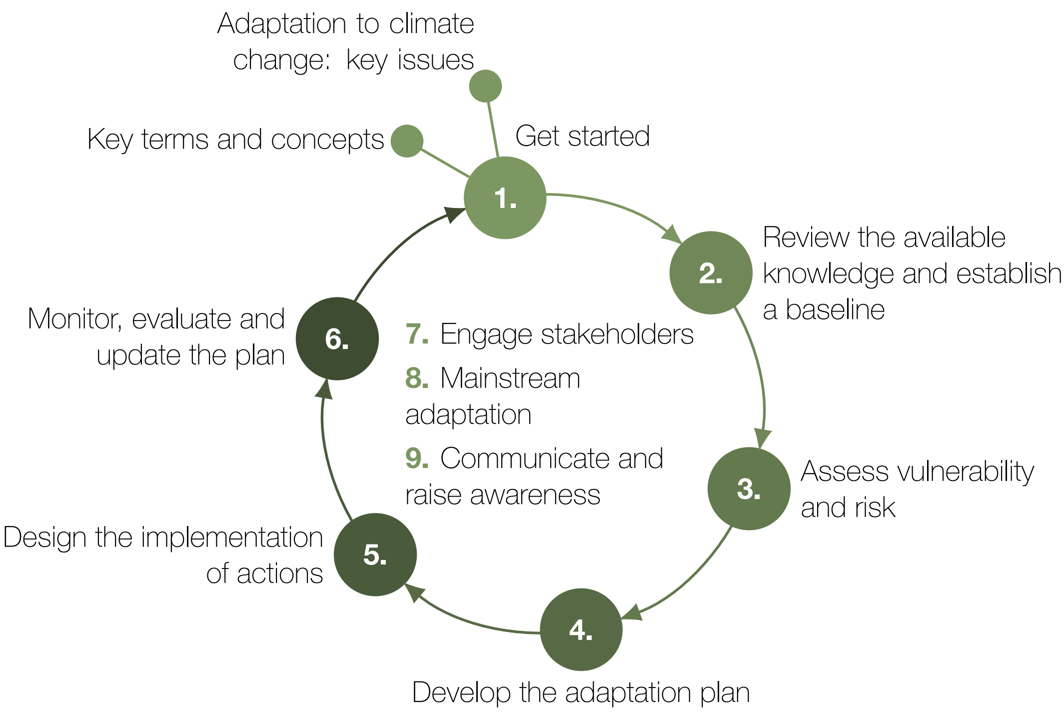

Figure 3.16. Process of co-definition of local adaptation strategies
Source: LIFE Adapting to Climate change in Time project LIFE08 ENV/IT/000436 (www.actlife.eu).

involve mountain regions in the development of innovative research or exchange good practices in the field of sustainable land management. This confirms that institutions are attuned to the issues raised by the impact of climate change on mountain regions, particularly alarming considering the depletion of social structures within mountain communities.

A field experiment into adaptive governance was attempted in 2016-2017 in four Mediterranean mountain regions through the project PALMO (Local Adaptation Plans in Mediterranean Mountain Areas), funded by the Italian National Research Council. The project studied how adaptive governance strategies could support the implementation of climate change adaptation policies. As part of the project, local communities were involved in a participative process intended to contribute to the definition of a Local Adaptation Plan. This plan is a tool that defines priorities, actions and solutions to cope with climate change challenges in a specific region. The process of defining such plans has been carried out in the four case study regions, following the guidelines provided by previous national and European experiences (Figure 3.16), and simulating adaptive governance with the involvement of local institutions. Local stakeholders have been involved in a two-step participatory process, including an online survey and a focus group session, to investigate their perception of climate change-related risks in their region, and to jointly discuss priorities and possible actions to cope with climate change challenges. Results were used to structure a tentative draft plan, based on scientific evidence of climate change observed in the area, and structured according to the risk perception and priorities of local stakeholders.

Based on the results of this experience, it seems that involving local stakeholders in the definition of adaptive strategies, despite being a great opportunity to increase the effectiveness of adaptation measures, is a hard task. When compared to other challenges affecting rural and mountain areas, such as depopulation, ageing population and poor job opportunities within the region, climate change is sometimes not perceived as a priority by local communities. However, most stakeholders agree that adaptation strategies should be shared at the community level, even though a common long-term vision of how the community should adapt to climate change impacts is still lacking.

It follows that local institutions have a key role in driving awareness of these challenges by establishing a positive policy context to support local adaptation solutions. Indeed, even local policies that are not directly related to climate change could lead to high quality adaptation responses (Allman *et al.*, 2004; Urwin and Jordan, 2008). It should be recognized, however, that top-down policies are unlikely to be effective if not supported by a science-policy interface based on citizen participation in local government decisions. Effective adaptation policies require strategic allocation of resources that acknowledge the local context and yet such policies are likely be politically difficult to implement. In this regard, academic and professional training is crucial to help forest managers incorporate climate change considerations into their own real-world management and to acquire skills that will lead to the implementation of action plans. When successful, shared, adaptive governance is capable of enhancing overall community resilience by encouraging flexibility, diversity, inclusion and innovation (Resilience Alliance, 2010) and placing socio-ecological systems at the centre of political decisions in marginal areas.

9 Biodiversity conservation and protected areas in the Mediterranean region

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Mediterranean forest biodiversity

Introduction

Mediterranean forests shelter high plant and animal biological diversity, exemplified by the large number of tree species present compared with Nordic forests. Evergreen oaks, coniferous and deciduous forests form the natural apex of large areas of the Mediterranean Basin Hotspot (MBH). However, much of this forest has disappeared or been altered as a result of thousands of years of human settlement and habitat modification (Tucker and Evans, 1997). Only 5 percent of natural vegetation in the MBH remains, the lowest of any hotspot (Sloan *et al.*, 2014). While human pressures have altered Mediterranean ecosystems throughout history, this long-lasting "co-evolution" between ecosystems and land-use practices across the hotspot has helped shape many semi-transformed habitats. Today these contain many rare and threatened taxa (Blondel *et al.*, 2010). This chapter provides an overview of current biodiversity knowledge in Mediterranean forest ecosystems across all levels (genetic diversity, species diversity, landscape diversity) and endemism, ecological peculiarities that make Mediterranean forest ecosystems different. It also outlines the importance of biodiversity for functional forest ecosystems and illustrates some examples of conservation efforts in the region.

Species diversity in Mediterranean forests

Biodiversity hotspots are terrestrial regions that contain at least 1 500 vascular plant species and which have lost at least 70 percent of their original natural habitat (Mittermeier *et al.*, 2004). The MBH is one of 36 areas in the world that meets these criteria. The MBH is the third-richest hotspot in the world in terms of plant biodiversity (Mittermeier *et al.*, 2004) and one of the greatest sources of endemic plants on Earth (Blondel *et al.*, 2010). At the moment, approximately 5 900 species, including all vertebrates and an important number of invertebrates and plants, have been recorded from the Mediterranean region into the IUCN Red List of Threatened Species (IUCN RLTS). About 2 089 of these species are considered native and occurring in forest habitats, while 770 are endemic to the Mediterranean region.

With more than 100 species recorded in Mediterranean forests, tree taxa are an important component of Mediterranean flora (Fady-Welterlen, 2005). There is no specific information about the number of plant species present in forest habitats, but current available information indicates that 511 of 1 540 higher plants assessed for the IUCN RLTS in the Mediterranean region occur in forest habitats (IUCN, 2017). Vertebrate diversity is also high but differs among groups. The number of mammal species, especially large animals, was reduced during climatic changes of the Pleistocene era, but later increased as a result of immigration. Much extinction subsequently occurred as a result of strong human pressure during the Neolithic age. At present, 194 of 253 Mediterranean terrestrial mammal species are found in forests, approximately 11 percent of which are endemic to the region. A larger number of Mediterranean vertebrate species (786 of 1 601) live in forest habitats. Although less well-known, 792 of 1 184 terrestrial insects assessed for the IUCN RLTS are recorded as living in forests, 364 of which are endemic to the Mediterranean region.

The above is only a small sample of Mediterranean forest biodiversity. Trees and plants diversity has already been addressed in the first edition of the State of Mediterranean Forests while other components of the forest biodiversity are often overlooked. As we will see in subsequent subsections, dead, decaying wood and its associated biota are known to play an important role in diverse ecological functions and processes. From nutrient cycling and moisture retention to habitat complexity (Stevens, 1997), it is increasingly recognized as a forest resource contributing to forest biodiversity.

Fungal diversity. Fungi, one of the largest and most diverse kingdoms of eukaryotes, are important biological components of forest ecosystems. The presence of fungi differs significantly between countries. The estimated number of mushrooms in Europe is about 75 000, of which 15 000 are macrofungi (Senn-Irlet *et al.*, 2007). Mediterranean forest ecosystems are among the richest in fungi (Angelini *et al.*, 2016; Zervakis, 2001) and constitute a unique natural heritage in terms of biological diversity (Scarascia-Mugnozza *et al.*, 2000). It is estimated that about 50 percent of forest fungi are wood decaying (Senn-Irlet *et al.*, 2007). The existence of these organisms is therefore dependent on a continuous supply of dead wood due to their close involvement in organic matter recycling. In Mediterranean forests, many fungi specialize in the colonization of plant twigs and small diameter wood pieces (Junninen *et al.*, 2006). More than 49 species of macromycetes from 23 families are target species (i.e. key or indicator species) of Mediterranean forests and Mediterranean maquis (Polemis *et al.*, 2013).

The main causes of progressively decreasing fungal diversity in Mediterranean forests are clear-cutting and timber harvesting, resulting in habitat shrinkage (e.g. old-growth forests) (Dahlberg *et al.*, 2010). The main cause of a lack of coarse dead wood in forests is related to silvicultural management. The removal of considerable quantities of timber from the understorey affects fungal growth, the establishment of mycorrhizal associations with plant seedlings and the maintenance of mycorrhizal fungi associations in seasonally dry forests (Huhndorf *et al.*, 2004). The overexploitation of edible mycorrhizal species belonging to the genera *Amanita* Pers., *Cantharellus* Adans. ex Fr., *Boletus* L., and *Tuber* ex F.H. Wigg is also an important threat in Mediterranean forests (Venturella *et al.*, 2016). The Baltic States, Poland and former Yugoslavia, for example, exported, respectively, 3 900 tonnes of fungi in 1998; 9 200 tonnes in 1984; and 7 800 tonnes in 1995, and Turkey exported about 800 tonnes in 1990 with an estimated value of USD 14.4 million in 1993 (Brainerd and Doornbos, 2013).

Changes to rainfall characteristics, a global reduction of total annual rainfall and particular annual weather conditions stimulate the growth of rare fungi in Mediterranean forests. Climatic changes caused the recent discovery of *Entoloma plebeioides* (Schulzer) Noordel, *Buchwaldoboletus lignicola* (Kallenb.) Pilát and *Capnobotrys dingleyae* S. Hughes outside of their known geographic range limit (Karadelev *et al.*, 2017; Venturella, 2017). In general, silvicultural practices should be mitigated in order to protect fungal diversity and loss of suitable habitats for threatened fungi species (Zotti *et al.*, 2013). In particular, there is a need to regulate the edible mushroom trade; laws to prevent overexploitation should be introduced in all European countries and action plans for the conservation and management of certain species in Mediterranean forests are urgently required.

Saproxylic beetles diversity. Saproxylic beetles, a group of insect species dependent upon dead wood or wood-decaying fungi for some portion of their life cycle (Speight, 1989), play an important role in decomposition processes and are therefore significant for forest nutrient cycles (Stokland *et al.*, 2012). Many saproxylic beetles also play a role in pollination. They contribute to insect biomass in forests available for higher trophic levels such as breeding birds. Longhorn beetles (Coleoptera: Cerambycidae) may be regarded as a representative group for saproxylic beetles due to a high species richness that correlates with most other saproxylic beetle families (Ohsawa, 2010).

The species richness of longhorn beetles is generally correlative to a temperature gradient leading to decreasing richness from southern to northern Europe (Baselga, 2008). Relatively high levels of species richness can be found in Mediterranean forests, particularly in areas that served as a refuge for both trees and associated insects during the last glacial maximum (Habel *et al.*, 2010; Médail and Diadema, 2009; Svenning *et al.*, 2008). Endemism centres are found in southwest and southeast Europe (Baselga, 2008), but also in Turkey (Özdikmen, 2012), the Near East (Sama *et al.*, 2010) and in topographically well-structured areas in North Africa (e.g. Atlas Mountains). Those areas have not, however, been studied in a systematic and standardized way. The large number of previously unknown species found by hand collecting in recent years indicates that more endemic species could, with a high sample effort, be found in the eastern Mediterranean and North Africa (Sama, 2008; Sama and Rapuzzi, 2011; Platia, 2010). According to Blondel and Aronson (1999), oak-dominated forests, the most important forest type for saproxylic beetles, might have covered large parts of the Mediterranean. For example, about 40 percent of saproxylic beetles living on oak trees in Israel were unique to the Levantine region (Buse *et al.*, 2013). On the other hand, plantations with conifers support only a limited number of saproxylic beetle species. These are usually widespread species that assemble in communities very much distinct from those found in semi-natural oak forests.

Major threats to saproxylic beetles in Mediterranean forests come from habitat loss due to tree felling, overgrazing and burning. In general, natural habitats are under significant pressure from a growing human population in the area. Dead wood enrichment is often recommended as a practical tool to support saproxylic organisms (Müller and Bütler, 2010). Guidelines developed for temperate broadleaved forests may not be applicable to Mediterranean forests for several reasons (e.g. climatic conditions, landscape and land-use history). Increasing temperature probably compensates for lower amounts of dead wood (Müller *et al.*, 2015). An important conservation measure to conserve existing semi-natural forests is to impose strict protection measures. Many Mediterranean forests, however, have been shaped by traditional management, a practice that should continue in a sustainable way.

Conservation status of Mediterranean forest biodiversity

Threatened species

At least 339 (16 percent) of the forest species assessed in the IUCN RLTS are threatened with extinction at a global or regional level (Table 3.8). Two hundred and sixty-six of these are endemic. More than half of the threatened species listed are animals (190 species), with saproxylic beetles (63) and reptiles (35) comprising the greatest number. Plants comprise 149 of the threatened species listed, 44 percent of the total number of threatened species in Mediterranean forest habitats.

Across the region, Spain, Italy, Greece, Turkey and Morocco have, in this order, the highest number of

Table 3.8. Estimated biodiversity in Mediterranean forest habitats based on the results of the extinction risk assessments by the IUCN Red List at global and Mediterranean regional level

Group	Estimated % of the group assessed for the IUCN Red List in the Mediterranean	IUCN Red List categories							Forest species endemic to the Mediterranean region	Total forest species assessed	% threatened forest species (Mediterranean or global level)
		EW/ RE	CR	EN	VU	NT	LC	DD			
Vertebrates total	-	3	16	32	45	74	591	19	141	786	12
Amphibians	98	0	4	10	10	17	50	1	46	92	26
Reptiles	93	0	8	13	14	23	125	7	67	190	18
Mammals	100	3	3	6	13	19	133	17	21	194	11
Birds	100	0	1	3	8	15	283	0	7	310	4
Invertebrates total	-	0	5	67	25	47	473	175	364	792	12
Saproxylic beetles	59	0	2	39	22	29	99	131	196	322	20
Dung beetles	35	0	1	19	2	11	63	29	94	125	18
Butterflies	100	0	2	9	1	7	293	14	73	326	4
Dragonflies and damselflies	100	0	0	0	0	0	18	1	1	19	0
Higher Plants total	7	1	57	44	48	49	253	59	265	511	29
Total		**4**	**78**	**143**	**118**	**170**	**1 317**	**259**	**770**	**2 089**	**16**

Note: IUCN Red List categories: EW = Extinct in the Wild, RE = Regionally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient. Categories CR, EN and VU correspond to species at risk of extinction.
Source: IUCN (2017).

threatened species living in their forests.

Most of the threatened forest vertebrate species (amphibians, birds and mammals) are found in Turkey, whereas a high number of threatened forest insects are found in Italy (Saproxylic beetles), Spain (dung beetles) and Turkey and Greece (butterflies). Spain has the highest number of threatened reptiles and plants (Table 3.9).

Threatened ecosystems

The newly-developed IUCN Red List of Ecosystems, which addresses ecosystems and their functioning, is part of a growing toolbox for assessing risks to biodiversity. The Red List of Ecosystems standard facilitates a systematic assessment of all ecosystem types in terms of their global risk of collapse. The Red List of Ecosystems standard thus has two primary applications: to produce and periodically update the global-level Red List of Ecosystems and to support others to develop sub-global assessments. (Rodríguez *et al.*, 2015).

A comprehensive regional assessment of threatened forest ecosystems occurring at the Mediterranean level, which would enable systematic analysis, does not yet exist. A growing number of national and subnational evaluations of forest ecosystems are, however, underway, including in Lebanon, Tunisia, Morocco and France (UICN France, 2014). Inspired by the methodology of the Red List of Ecosystems, the European Union (EU) conducted an evaluation of the Red List of habitats of Europe (Janssen *et al.*, 2016).

Table 3.9. Number of threatened forest species by country and territory

Country or territory	Vertebrates				Invertebrates			Plants	Total	% threat
	Amphibians	Reptiles	Birds	Mammals	Butterflies	Dung beetles	Saproxylics			
Spain	4	**9**	6	7		**14**	9	**38**	87	26
Italy	7	2	5	6	1	2	**23**	35	81	24
Greece	5	4	6	7	4		15	32	73	21
Turkey	**8**	2	**7**	**11**	**6**		14	9	57	17
Morocco	2	8	3	9	2	5	13	8	50	15
Algeria	1	5	5	9	1	2	13	5	41	12
Syrian Arab Republic		3	**7**	9	1		8	8	36	11
France			5	5		1	10	14	35	10
Israel		5	6	8	1		5	7	32	9
Cyprus		1	3	3			6	14	27	8
Lebanon		2	5	5	1		6	8	27	8
Portugal	1	3	3	2		2	3	11	25	7
Palestine		5	5	6			3	4	23	7
Tunisia		3	4	7		1	6		21	6
Jordan		3	5	7			1	4	20	6
The former Yugoslav Republic of Macedonia			5	6			5	2	18	5
Albania	1	1	4	5	1		2	3	17	5
Croatia	1	1	4	5			2	4	17	5
Bosnia and Herzegovina		1	4	5			2	2	14	4
Bulgaria			4	5			4	1	14	4
Slovenia	1		2	4			1	4	12	4
Egypt		4	5	2					11	3
Montenegro		1	4	3				2	10	3
Libya		2	3	3		1			9	3
Gibraltar		1	2	2			2	1	8	2
Iraq			6	2					8	2
Malta			2					3	5	1
Serbia			2	2			1		5	1
Holy See	1			1				1	3	1
Monaco				2				1	3	1
San Marino								2	2	1

Note: The highest number of threatened species by taxonomic group is in bold. % threat = percentage of threatened species in the region.

The absence of a common forest ecosystem typology used across the Mediterranean countries poses one of the biggest challenges to analysing the results of these studies. A preliminary overview of results suggests that relict Mediterranean forest types (i.e. cedars and fir forests, Box 3.12), still present in some mountain ranges, are among the most threatened Mediterranean forest types, together with Mediterranean riparian forests. For example, the European Red List of habitats includes 11 Mediterranean forest habitats, of which only Mediterranean *Cedrus* forest and Mediterranean riparian forest fall into the "vulnerable" category.

So far, most analysis is based on area trends. It is anticipated, however, that as knowledge on forest ecology advances and data becomes more widely available, the evaluation of the risk of collapse based on the Red List of Ecosystems standard will incorporate functional trends more broadly.

Threats to forest biodiversity

For this section, an analysis was carried out taking into account the 339 Mediterranean forest species at risk of extinction according to the latest IUCN Red List data (IUCN, 2017). The analysis shows that the main threats to these species are: overgrazing as consequence of livestock faming; urbanization; changes in fire regimens; effects of logging and wood harvesting; agriculture intensification and ecosystem modifications as consequence of land abandonment; and hunting (Figure 3.17). Hunting (52 species) and impacts resulting from agricultural activities such as annual and perennial non-timber crops (41) and livestock farming (34) were identified as important threats to vertebrate species. Of considerable significance were the 52 of 97 threatened invertebrate species affected by logging and wood harvesting.

Overgrazing, urbanization and changes in fire regimens were the most common threats to plants at risk of extinction. Today, the most widespread vegetation type in the Mediterranean region is sclerophyllous shrublands, maintained by grazing and sporadic fires. The balance between sustainable grazing levels and fire regimens is fundamental because many of the endemic and restricted-range plants depend on anthropogenic habitats maintained by grazing (Figure 3.18). As a result, several species are threatened by land-use change and rural abandonment (Sirami *et al.*, 2010).

Forest fires and plant diversity

While it is likely that fires contribute to structuring Mediterranean forest communities, increases in fire frequency and intensity pose various threats to many plant and animal species (Doherty *et al.*, 2015).

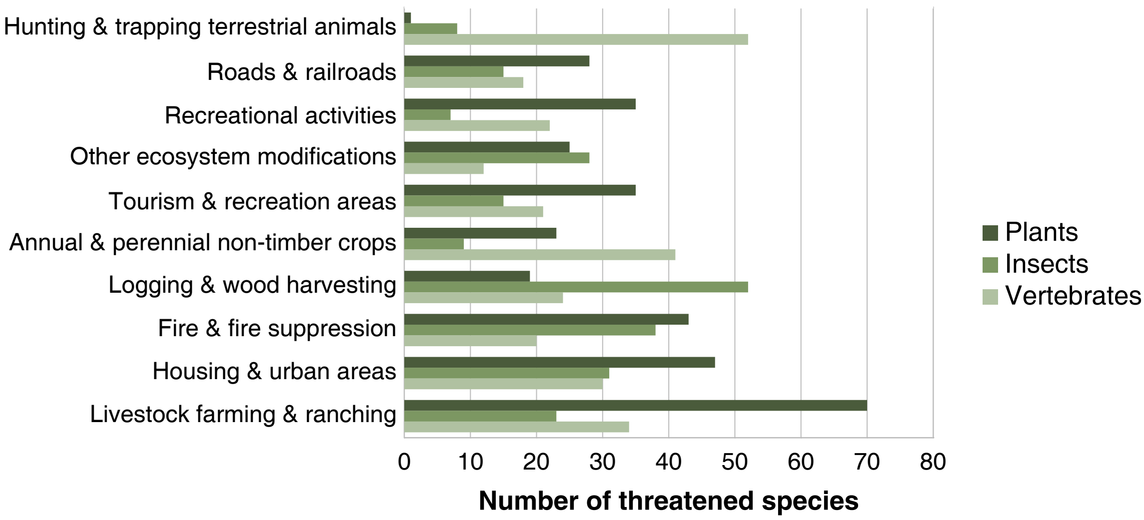

Figure 3.17. Primary threats to threatened forest species (IUCN Red List Categories CR, EN and VU) in the Mediterranean region

Figure 3.18. Argan (*Argania spinosa* L.) fruits, Morocco
© Valentina Garavaglia

The response of vegetation to fire is very complex (Gitas *et al.*, 2012) and plant vulnerability to fires can lead to permanent changes in vegetation composition (Pérez-Cabello *et al.*, 2009).

For example, vegetation-fire models applied to future climate and socioeconomic scenarios show that interaction between fire and climate change could prevent the cold-adapted fir from regeneration and, therefore, could cause changes to tree dominance and intensify fire systems (Thonicke *et al.*, 2014). Moreover, species with restricted distribution ranges seem to have more fire-sensitive germination than those which are widely distributed (Luna *et al.*, 2007).

Moreover, water stress has been found to decrease final germination for some hard-seeded species, as well as reduce germination speed (Luna *et al.*, 2014) and seed viability after germination (Chamorro *et al.*, 2017). Drought-reduced growth and the recovery of some plant species leads to increased abundance of herbs and, therefore, increased flammability during the first years after fire (Moreno *et al.*, 2014). Post-fire regeneration density of *Pinus brutia* in North Lebanon decreased by 93.8 percent five years post-fire, possibly due to the occurrence of long dry seasons (El Halabi *et al.*, 2014).

With regard to vegetation response to changes in fire systems, it was detected that increased fire recurrence altered post-fire vegetation. Furthermore, burning vegetation with little or no fire history resulted in growth failure among some dominant tree species (Arianoutsou *et al.*, 2014). In the case of black pine forests, the number of fires a site has experienced will have a negative effect on regeneration density, while the presence of recovering ferns seems to have a positive effect (Christopoulou *et al.*, 2014).

The effects of wildfire on floristic diversity will differ depending on vegetation type and fire frequency. A study made in a small islet in the eastern Aegean Sea (Abraham *et al.*, 2014) showed that woody species of all types decreased significantly in burned areas on one side of the islet, while annual grasses of *Sarcopoterium spinosum* phrygana and *Cistus creticus* decreased only in burned areas in abandoned terraces. On the other hand, annual forbs increased significantly on burned sites of *Cistus creticus* formations.

Attempts to diminish population declines for species in complex landscapes require an integrative approach to managing multiple threats, including fires and increased drought. Conservation plans designed to mitigate the impacts of a single threat will fail if additional threats are ignored (Bonebrake *et al.*, 2014).

In this context, the IUCN Red List of Ecosystems is a global standard for assessing the risk of ecosystem collapse. It could be an effective tool to identify critical habitats in the region, especially when information about species is limited. The Red List of Ecosystems has now been tested on more than 50 ecosystems, spanning six continents and three oceans. Several sub-national, national and larger regional ecosystem assessments have been undertaken worldwide (Rodríguez *et al.*, 2015).

Mediterranean forests coping with global change drivers

Mediterranean forests are exposed to a variety of threats that pose risks to the survival of tree populations in the medium and long-term. Among these threats, global-change components such as climate warming, drought intensification, land-use modifications and territorial movement of pests and pathogens have been broadly identified as major drivers of demographic changes in Mediterranean forests (e.g. Camarero *et al.*, 2004; McDowell *et al.*, 2008). The effect of these factors, either individually or in tandem, may have a significant impact on population dynamics and biodiversity by aggravating recruitment failures and/or accelerating mortality rates in adults.

One of the main groups of tree species that comprise Mediterranean forests, the *Quercus* species, are particularly vulnerable during their early life due to limitations imposed by several factors. First, Mediterranean tree species exhibit large variability, strongly driven by precipitation patterns, in seed production over their lifetimes (e.g. Espelta *et al.*, 2008; Pérez-Ramos *et al.*, 2010, 2015). Second, the seeds of most of these tree species are subject to intensive predation pressure, seed-seedling transition being considered one of the most important bottlenecks for regeneration (Pulido and Díaz, 2005; Pérez-Ramos *et al.*, 2012). This implies that seedling recruitment is commonly restricted to the sporadic wet years of large seed crops ("masting years"), where the abundance of seeds may satiate the animals that feed on them (Kelly and Sork, 2002). Third, seedlings are particularly sensitive to severe abiotic conditions, highlighted by high mortality rates registered during the dry season (Pulido and Díaz, 2005; Pérez-Ramos and Marañón, 2012). Finally, recent studies have shown that seedlings of some tree species are also under increasing attack by exotic soil-borne pathogens, such as those belonging to *Phytophthora* or *Phythium* genera (Gómez-Aparicio *et al.*, 2012; Ibáñez *et al.*, 2015), which appear to be involved in the extensive decline of some of these species (Pautasso *et al.*, 2010; Garbelotto and Pautasso, 2012).

Both the identity and the relative importance of factors affecting tree recruitment are likely to vary not only between species but also among ecosystem types. In natural forests, for instance, high numbers of seed consumers and high rates of seedling mortality during the dry season have been identified as the primary causes of recruitment limitation in *Quercus* species (Pulido, 2002; Pulido and Díaz, 2005; Pérez-Ramos *et al.*, 2012). In silvopastoral systems ("dehesas"), however, regeneration failures are mainly attributed to the limited presence of effective seed dispersers (such as jays) and scarcity of safe sites for seedling establishment (such as those located under nurse shrubs) (Pulido *et al.*, 2010).

The complex network of interactions that govern overall recruitment could be seriously altered in future by the expected decline in water availability as a result of climate change. Recent manipulative studies have suggested that ongoing, increasing aridity could exacerbate recruitment limitation in some tree species by aggravating the negative effects of water deficit on different demographic processes (Lloret *et al.*, 2004; Matías *et al.*, 2011; Pérez-Ramos *et al.*, 2013, e.g.).

Moreover, a growing number of studies have reported huge, worldwide forest decline and tree mortality events as a consequence of one or more global change drivers (climate warming, changes in biogeochemical cycles, land-use modifications and shifts in pathogen distribution) (Allen *et al.*, 2010; Carnicer *et al.*, 2011). The interactions between these potential drivers of decline at different spatio-temporal scales, however, remain poorly understood.

The invasion of exotic, soil-borne pathogens (particularly *Phythopthora cinnamomi*) is the other main factor leading to massive decline and tree mortality in many tree species. The *Quercus ilex* and *Q. suber*, which inhabit forests and savanna-like ecosystems in the Mediterranean basin, are examples of this (Sánchez *et al.*, 2006; de Sampaio e Paiva Camilo-Alves *et al.*, 2013). Recent studies have demonstrated that drought events might increase tree susceptibility to the disease (Roubtsova and

Bostock, 2009; Corcobado *et al.*, 2014).

Finally, land-use history and management may retard tree responses to drought. The managed structure of the savanna-like Iberian dehesas (locally called "seca"), for example, seems to predispose them to further decline (Mesón and Montoya, 1993). Thus, the combination of anthropogenic and ecological disturbances (such as drought) have been associated with lower tree resistance and increased vulnerability to pests and diseases (e.g. Pinto-Correia and Mascarenhas, 1999; Moreira and Martins, 2005; Branco and Ramos, 2009).

The potential impacts – and interactions – between each of these global change drivers could in turn trigger shifts in species abundance and composition of affected communities (Barbeta *et al.*, 2013). For instance, some observational studies have suggested a significant decrease in the relative abundance of oaks as a consequence of the expansion of other, co-occurring, shrub species better adapted to water deficit (Acácio *et al.*, 2007; Mendoza *et al.*, 2009; Pérez-Ramos and Marañón, 2012). By contrast, other manipulative studies suggest certain oak species (e.g. *Quercus ilex*) with a large ability to cope with drought will have a competitive advantage over others (Lloret *et al.*, 2009; Matías *et al.*, 2012). In the Iberian peninsula in particular, recent studies have envisaged a global change scenario dominated by the widespread expansion of *Q. ilex* and other broadleaved trees, which act as key inhibitors of pine recruitment and induce negative demographic trends in certain dominant pine species, such as *P. sylvestris* and *P. nigra* (Coll *et al.*, 2013; Carnicer *et al.*, 2013; Vayreda *et al.*, 2016).

Understanding how plant communities will respond to projected environmental changes is not merely base-level knowledge for tree population recruitment and behaviour. It is also a valuable ecosystem management tool which, when applied, can increase forest resilience and plant adaptation in response to ongoing climatic changes.

Conservation actions in the Mediterranean region

A representative analysis of forests in protected areas

Protected areas are one of the most useful conservation tools (Geldmann *et al.*, 2013). Assessing the state of Mediterranean forests and comparing their distribution to the network of protected areas raises some questions: how well protected are Mediterranean forests and Mediterranean forest systems? Is there sufficient representation of Mediterranean forests in the national protected areas network?

Designated protected areas now cover about 14 percent of the globe's terrestrial surface and are contributing significantly to reducing habitat loss and population decline (Geldmann *et al.*, 2013). We are witnessing an expansion in protected area networks globally, in concert with efforts to better manage protected areas.

Regional analysis of forest representation at the Mediterranean level poses some methodological challenges, most of which are derived from the use of heterogeneous national data. The fact that "forest" has been defined in many ways is a reflection of the diversity of forests and forest ecosystems in the world and of the diversity of human approaches to forests.[1] The FAO minimum threshold, namely a tree canopy cover of more than 10 percent, has been adopted for the purposes of this analysis. A regional analysis based on satellite imagery allows for comparison but it may produce a bias in cases where tree canopy dedicated to agricultural uses covers a significant portion of the territory (Figure 3.19).

An analysis of forest land (Hansen *et al.*, 2013) and the World Database on Protected Areas (UNEP-WCMC and IUCN, 2017) shows that 19 percent of the Mediterranean Basin Hotspot has a tree cover of more than 10 percent. When evaluating the network of protected areas, this figure doubles: more than 42 percent of protected area has a tree cover of more than 10 percent.

[1] https://www.cbd.int/forest/definitions.shtml

Figure 3.19. Representative analysis of forests in protected areas in the Mediterranean

Note: Protected areas are clipped to the Mediterranean Basin Hotspot. Only protected areas with a defined IUCN Management Category are considered.

Source: Hansen *et al.* (2013) (tree cover), UNEP-WCMC and IUCN (2017) (protected areas).

This tendency to protect forest areas more effectively than other systems is particularly marked in regions with small forest area such as North Africa, which only hosts 4 percent of the Mediterranean's forests, but where forest represents 22 percent (or five times) of the protected surface area. Even in the northern Mediterranean basin, one third of which is forested, forests make up 44 percent of protected areas (Table 3.10). This analysis reflects the importance ascribed to forested areas when establishing protected area networks as part of national conservation priorities. The analysis, however, reflects the "intention" to conserve forests rather that the results of conservation programmes themselves. The management effectiveness of protected areas is a competently different matter requiring more detailed analysis.

The MEDFORVAL Network of High Ecologic Value Forest Sites in the Mediterranean Region. The historical semi-domestication of Mediterranean forests and related agrosilvopastoral practices have contributed to their increased biological diversity. Conserving and enhancing forest landscapes of high ecological value is the best way to build resilience and secure the viability of these ecosystems and the communities that inhabit them.

The MEDFORVAL project aims to enhance the protection, sustainable management and ecological restoration of forest sites of high ecological value throughout the Mediterranean, by promoting networking and cooperation between relevant actors (e.g. natural resources managers, land users, scientists, academia, NGO, civil servants and the private sector). Over the longer term, the project aims to create a regional forum that can add value to its member sites with enhanced knowledge management and information sharing (research, development and innovation), capacity building (particularly through learning visits and training), collaboration on joint protection, management and restoration actions, and awareness raising and advocacy.

According to the MEDFORVAL definition, forests of high ecological value exhibit three main attributes: (i) well-conserved forest structure including all age classes – natural regeneration, young, mature, old-growth and deadwood; (ii) high diversity in terms of habitat types, flora, fauna and fungus; and (iii) well-maintained natural ecological processes – including natural disturbances – in forest blocks large enough to meet habitat requirements for viable species populations. Forest sites were grouped into four clusters – a simplified version of the schematic altitudinal arrangement of species and vegetation types corresponding essentially to thermal criteria, following the works of Gaussen (1926); Quézel (1974); Ozenda (1975), among others. These are:

- Cluster 1 – High Mountain Conifer Forests;
- Cluster 2 – Mid Mountain Mixed Deciduous Forests;
- Cluster 3 – Lowland Dry Evergreen Forests; and
- Cluster 4 – Freshwater Forests.

Table 3.10. Forested areas in protected areas in Mediterranean countries

Country	Forested area as % of	
	country's area in the Mediterranean Hotspot	country's area in protected areas
Algeria	6	49
Egypt	21	15
Libya	0	6
Morocco	4	16
Tunisia	4	31
Subtotal North Africa	**4**	**22**
Albania	29	33
Bosnia and Herzegovina	35	7
Bulgaria	56	70
Croatia	33	30
Cyprus	20	55
France	49	54
Greece	35	40
Italy	34	54
The former Yugoslav Republic of Macedonia	42	30
Malta	0	1
Montenegro	44	32
Portugal	29	34
Slovenia	67	70
Spain	23	41
Subtotal EU and Balkans	**30**	**44**
Israel	6	31
Jordan	0	2
Lebanon	9	6
Palestine	0	34
Syrian Arab Republic	3	70
Turkey	20	33
Subtotal East and Turkey	**17**	**35**
Total	19	42

Note: Forested area = area with a tree cover of more than 10 percent.

The project defined a set of criteria for each of the three attributes in order to assess potential candidate sites for the network. In its first phase, MEDFORVAL selected an initial list of 19 forest sites (about five sites per forest cluster). So far, network members and the secretariat have successfully: created a programme for small project grants addressing urgent needs and rapidly responding to emerging opportunities; established learning visits to share best practice and exchange knowledge; created a programme to support joint project development initiatives among MEDFORVAL member sites and partners; established annual workshops to share experiences and knowledge and develop common annual work plans; and a platform for communications and information sharing, as well as awareness raising and advocacy.

Mediterranean forest conservation and threatened species

The case of the Barbary macaque in the Maghreb region. The Barbary macaque (*Macaca sylvanus*) is the only primate in North Africa and the only macaque found outside Asia (Figure 3.20). It is known in the region as "ahaloum iddew," "ivki" or "kerd" in Berber and as "chadi" in Arabic. The species is unique among macaques due to its alloparenting behaviour, in which individuals other than the parent take on an infant caretaking role. The species occupies a variety of habitats, such as cedar, fir and oak forests and rocky escarpments. Macaques play an important role in forest ecosystems as they consume invertebrate plant pests and disperse plant seeds (Mehlman, 1988). Potential natural predators include large raptors and the African wolf (*Canis lupus lupaster*).

Figure 3.20. Barbary macaque (*Macaca sylvanus*), endemic to North Africa

Largely residing in cedar and oak forests, the species is threatened with extinction (Butynski *et al.*, 2008) due to illegal trade, overgrazing (leading to habitat degradation), human-macaque conflict, predation by domestic dogs, logging and unmanaged primate tourism (Fa *et al.*, 1984; Ménard *et al.*, 2014a; Waters, 2014; Waters *et al.*, 2017; Maréchal *et al.*, 2016). Forest logging to produce coal and timber and land clearing for agriculture and grazing are critical threats in Algeria. Barbary macaque populations in the Middle Atlas have declined rapidly over the last 20 years to approximately 5 000 individuals in fragmented populations (Camperio Ciani *et al.*, 2005; Ménard *et al.*, 2014c). In the High Atlas, the population is small and fragmented (El Alami *et al.*, 2013). However, long-term surveys have revealed the two populations in the Rif Mountains are much larger than previously supposed (Waters et al., unpublished data). Recent surveys in Algeria estimate the population at 2 500-3 500 individuals (Benrabah, upublished data).

Despite assertions that bark stripping behaviour in the Middle Atlas was the result of water scarcity (Camperio Ciani *et al.*, 2001), a study by Ménard and Qarro (1999) in the cedar forests of Morocco and Algeria found that cedar bark formed part of the macaques' diet only in heavily-grazed forest. In addition, energy costs for Barbary macaques were highest in Moroccan cedar-oak forest habitats degraded by overgrazing (Ménard *et al.*, 2013). The Barbary macaques' consumption of cedar bark may possibly be a reaction to a lack of nutrients in their diet as a result of degraded diversity in understorey plants due to overgrazing (Ménard and Qarro, 1999). In order to maintain sustainable Barbary macaque populations in the Middle Atlas Mountains, the number of sheep and goats grazing in the forest must be reduced to facilitate forest regeneration. Acorns are a crucial food resource, for both Barbary macaques and wildlife more generally, so allowing the holm oak (*Quercus ilex*) to develop fully without clear cutting would increase mast production (Ménard *et al.*, 2014b).

Unmanaged primate tourism in national parks such as Ifrane and Bejaia appears to increase health problems for macaques (Maréchal *et al.*, 2011, 2016). Habituation to people leaves some groups at risk of road traffic accidents in Ifrane National Park (Campbell *et al.*, 2016) and theft of infants for the pet trade (Ménard *et al.*, 2014c). Harassment and hunting of macaques by domesticated but free-ranging dogs occurs in Bouhachem forest (Waters *et al.*, 2017). In Algeria, human-macaque interactions are exacerbated during heavy snowfall when macaques enter villages searching for food (W. Boucekkine, personal communication).

Fortunately, conservation initiatives are underway at a national level. The Algerian Department of Water and Forests is publishing a national conservation action plan for the species. In Morocco, capture of infants for the illegal trade continues to be a problem in some areas and the Moroccan Association Barbary Macaque Conservation in the Rif has successfully encouraged Moroccans to report the illegal macaque trade using social media (Waters and El-Harrad, 2013). In Morocco, Barbary macaque conservation activities consist of awareness-raising and anti-poaching initiatives in Ifrane National Park.

Box 3.12. Conservation of *Abies numidica* in Algeria

The Numidian fir is a strict endemic species in the Babor Mountains belonging to the *Pinaceae* family and to the *Abiétées* subfamily described in 1886 by de Lannoy. This tree only exists in Djebel Babor, where it forms a mixture of cedar, zeen oak and maples, a mixed fir forest that occupies an area of about 300 ha. The fir forest occupies the altitudinal zone between 1 800 and 2 000 m a.s.l. on steep limestone slopes facing north and is in a wet and cold climate with annual rainfall of 2 500 mm, much of which falls in snow during the winter.

The Babor fir forest is not only an important habitat for many endemic plant species, but also for birds and animals with very narrow bioclimatic ranges, such as the Kabyle nuthatch (*Sitta ledanti*) and the maggot monkey (*Macaca sylvanus*).

The Numidian fir is listed on the IUCN Red List of Threatened Species as Critically Endangered. According to various authors, it seems that the number of fir trees has decreased since the 1950s, despite the regeneration that is currently documented as well as the difficulties of access to the site (especially in winter). The survival of the species is also now threatened by climate change. At the national level it is on the list of plant species protected by Executive Decrees Nos. 93-285 (of 23 November 1993) and 12-03 (of 4 January 2012). In 2014, the "Association de réflexion, d'échanges et d'actions pour l'environnement et le développement" (AREA-ED) in partnership and collaboration with the General Directorate of Forests, and with the financial support of the Fund Partnership for Critical Ecosystems, launched the project "Contribution to the participatory creation of a protected area in the Babor massif." This study covered an area of about 24 000 ha encompassing the two main peaks of the chain: Djebel Babor (2 004 m a.s.l.) and Jebel Tababort (1 969 m a.s.l.) which includes three wilayas (Setif, Bejaia and Jijel) and extends over five communes (Babor, Oued Bared, Darguina, Tamridjet and Erraguene). In light of the rich heritage of this site, a proposal to create a National Park was submitted.

These awareness-raising initiatives and community conservation activities have successfully changed perceptions and behaviour towards the macaque (Waters, 2014).

Conserving Mediterranean forest biodiversity: conservation of cork oak woodlands through sustainable use. Cork oak woodlands are multiple use systems whose main product is cork (oak tree bark), a non-wood forest product used for bottle stoppers worldwide (Berrahmouni *et al.*, 2009). Other uses of the system include livestock production, cereal crops and big and small game hunting (Bugalho *et al.*, 2009). The conservation value of these systems is partly dependent on their multiple uses. Cork oak woodlands usually consist of an open parkland structure of trees covering a diverse shrub understorey intermixed with grasslands. This shrub-grassland matrix constitutes a heterogeneous habitat providing a range of ecological niches for different species of wildlife and plants (Moreno *et al.*, 2016). Maintenance of such heterogeneity, however, depends on human use and adequate management.

First, traditional use typically involves shrub clearing in alternate areas every five to nine years, creating a moving mosaic of co-existing shrub and grasslands patches. These silvicultural practices were traditionally carried out manually and only around productive cork oaks. This saved money and energy and indirectly minimized damaged areas. Nowadays, due to both public subsidies and the development of motor-powered machinery, shrub clearing is producing a more homogeneous and intense perturbation in managed forests. From an ecological point of view, a manipulative study carried out in one of the largest cork oak forests in Europe ("Los Alcornocales" Natural Park, southern Spain) demonstrated that shrub clearing exerted a negative impact on herbaceous plant species diversity in the forest understorey (Pérez-Ramos *et al.*, 2008). Thus, shrub clearing favoured the expansion of ruderal herbaceous species and decreased spatial heterogeneity in understorey herbaceous composition (Pérez-Ramos *et al.*, 2008). The diversity of grassland species in the understorey of cork oak woodlands can reach over 135 species per 0.1 ha (Díaz-Villa *et al.*, 2003). However, for grassland diversity to be sustained it is necessary to maintain shrub-cleared areas (for example through cutting), otherwise shrub cover will rapidly dominate and outperform the herb community (Leiva *et al.*, 1997). In cork oak woodlands, therefore, maintenance of shrub-cleared areas interspersed with shrub-dominated areas increases habitat heterogeneity (Bugalho *et al.*, 2011a).

Box 3.13. The Forest Stewardship Council®

The Forest Stewardship Council (FSC) is a global, not-for-profit organization promoting standards for responsible forest management from an environmental, social and economic perspective. This is supported by a global forest certification system awarding forest management and chain of custody certificates. Responsible forest management as promoted by FSC confirms that the forest in question is being managed in a way that conserves its natural ecosystem and benefits the lives of local people and workers, all while ensuring it remains economically viable.

FSC® certification by numbers. As of January 2017, FSC certification achieved the following:

- 196.3 million hectares of FSC-certified forests in 82 countries, 8 million of which (4 percent) was in the Mediterranean basin (Bosnia and Herzegovina, Croatia, France, Italy, Slovenia, Spain and Turkey) (Figures 3.21 and 3.22);
- 1 462 forest-management certificates in 82 countries, 67 of which are in the Mediterranean basin (6 percent);
- 31 599 FSC Chain of Custody[a] certificates in 122 countries, 4 813 of which were in Mediterranean countries (15 percent);
- 163 380 smallholders and 39 certification bodies worldwide.

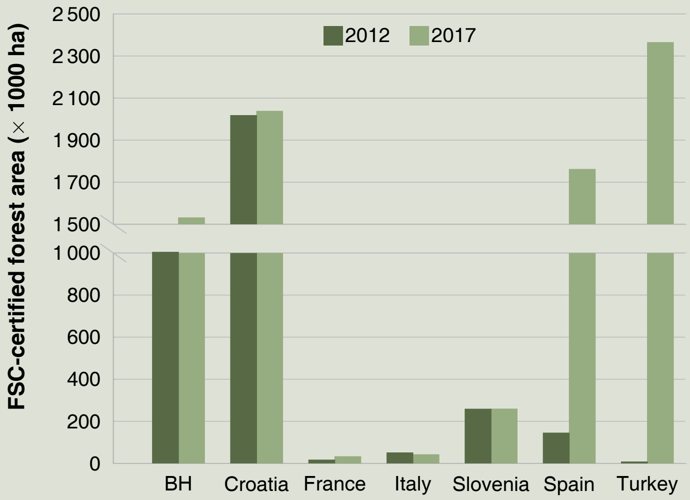

Figure 3.21. Hectares of FSC certification in the Mediterranean basin as of January 2017

Source: FSC® (2012, 2017).

FSC® forest management. Certification bodies award forest management certification to those forest managers or owners whose practices meet FSC Principles and Criteria.[b] Global forest management certification experienced a 35 percent increase over five years (2012-2017) and a 72 percent increase in the Mediterranean region.

In January 2017, more than 196 million hectares of forest in 82 countries were managed according to FSC standards, showing a 32 percent increase from 2012. In the Mediterranean region, this increase was particularly significant (130 percent) as a result of impressive increases in FSC certification in Spain and Turkey. FSC-certified forest areas have grown by 47 million hectares since 2012, roughly twice the size of Romania. European countries lead the way with regard to the percentage of their total forest area covered by FSC certification. In the Mediterranean, Turkey, Spain and France represent half of all FSC certification in the region.

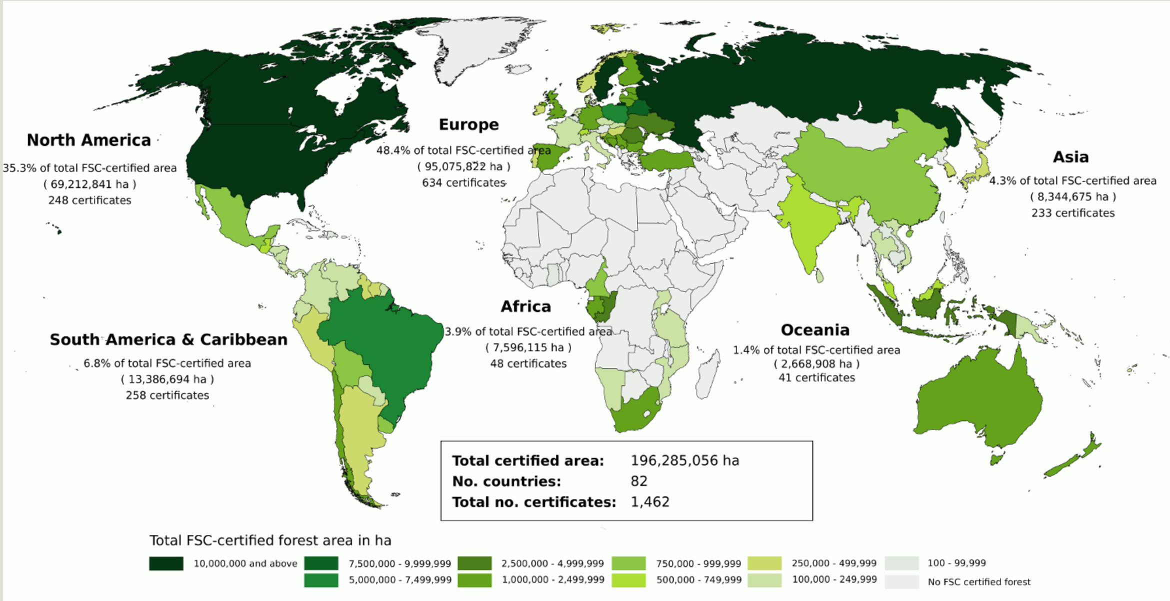

Figure 3.22. Global FSC certified area in 2017
Source: FSC® (2017).

[a]The channel through which products are distributed from their origin in the forest to their end use. Source: FSC-STD-01-001.

[b]https://ic.fsc.org/file-download.principles-and-criteria-v5-web.a-47.pdf

Second, grassland areas are used by domesticated animals (e.g. sheep, cattle) and wildlife species (e.g. deer, rabbits) for feeding, while shrubs also form good habitat cover for wildlife. Livestock grazing, at adequate stocking rates, can increase habitat heterogeneity and consequently local plant and invertebrate diversity (Bugalho *et al.*, 2011b; Moreno *et al.*, 2016). High grazing pressures, however, may endanger oak regeneration and damage oak saplings (Plieninger *et al.*, 2010). Existing cereal crops add another element of habitat heterogeneity to the system. Such habitat heterogeneity, dependent on human use and management, contributes to high species diversity, including threatened and endemic species, in cork oak woodlands (Diáz *et al.*, 1997).

Third, in some parts of Europe cork oak woodlands have been abandoned and management has ceased. This is partly the result of socioeconomic factors including insufficient income generation or ageing local populations. Lack of management leads in turn to shrub encroachment. This establishes continuous and homogeneous cover of often highly flammable species such as *Cistus* spp. This accumulation of vegetation fuel can burn easily, causing severe wildfires during the dry and hot Mediterranean summers, which hamper oak regeneration and establishment. In such cases, the system may fall into a stage of arrested succession, failing to progress from the shrubland to woodland stage (Acácio *et al.*, 2007). In other regions, however, overgrazing and frequent and extensive shrub clearing with heavy machinery, which damages oak roots and compresses the soil, may prevent oak regeneration. Such absence of vegetation cover protecting the soil against erosion will ultimately lead to the degradation of the system (Bugalho *et al.*, 2011b).

In order to maintain habitat heterogeneity and conservation value, cork oak woodlands require responsible, sustainable management. This involves applying management practices that ensure effective oak regeneration and establishment, shrub understorey clearing in long rotational periods and preferably only around productive cork oak trees, maintenance of uneven age classes of trees to assure tree replacement when tree mortality occurs, and adequate grazing stocking rates (Bugalho *et al.*, 2011a).

Forest certification, a voluntary mechanism under which forest owners and managers commit to socioeconomic and environmental management standards, is a sustainable forest management proxy (Auld *et al.*, 2008). By complying with independently audited, certified management practices, forest products, including non-timber forest products (e.g. cork, rubber, forest fruits, game species), are labelled so that consumers can recognize their sustainable origins. Globally, forest certification is progressing rapidly. The two dominant certification schemes, the Forest Stewardship Council (FSC) (see Box 3.13) and the Pan European Endorsement for Forest Certification (PEFC), cover 251 million ha (6.1 percent of the total area of productive forests) and 186 million ha (4.5 percent of the total area of productive forests), respectively.[2]

Forest certification is also expanding in cork oak woodlands. In Portugal, the country with the largest cork oak cover in the world (approximately 716 000 ha), over 100 000 ha of cork oak woodlands are now certified by the FSC scheme. FSC norms cover the management of non-timber forest products such as cork and wildlife hunting. Estates under FSC have higher oak regeneration and higher diversity of shrub understorey than other cork oak estates in Portugal (Dias *et al.*, 2016). The ecological condition of water streamlines crossing certified cork oak woodlands is also higher than that of streamlines occurring in non-certified woodlands (Dias *et al.*, 2015). These results suggest that certification is indeed contributing to the sustainable use and conservation of cork oak woodlands. Use and conservation of other Mediterranean Forests, and of the non-timber forest products they generate, may also benefit from forest certification.

Conserving Mediterranean forest biodiversity through tourism development: The Regional Natural Park of Luberon (France). The Regional Natural Park of Luberon implements three major activities contributing to: the conservation and enhancement of natural equilibrium, biological diversity, cultural heritage and landscapes; increasing tourist numbers and the development of sustainable tourism; and the quality of life of residents.

Event organizers are asked to fill out an application to obtain authorization with the appropriate state department. The state department seeks advice from the Luberon Park and the National Forests Office (ONF) for any portion of public forest that will be crossed. If an event takes place on or near a Natura 2000 site, and involves more than 75 pedestrians, 50 bikes, 25 horses, 100 motorized vehicles or 500 people, the Park requests an assessment of its possible impact on natural habitats and species included in the European Initiative Habitat (fauna, flora and/or birds). In this way, the Park can quickly identify possible impact on the area, propose alternative routes, establish adaptive measures and work with organizers to create a sustainable and eco-friendly event.

The network of hiking, biking and horseback riding trails, directed and managed by the departments of Vaucluse and the Alps of Haute-Provence, complete the leisure opportunities on offer in the territory. This network of marked and highlighted trails was designed to guarantee continuity between trails to serve residents, tourists and cross-country hikers, while conserving wildlife tranquillity (avifauna in particular) and fragile natural habitats (lawns, ponds, cliffs, etc.).

Specific regulations are established to prevent fires and protect visitors. These predominantly consist of access restrictions to forested areas depending on the fire risk (access is restricted if the risk is moderate to high). In addition, the Park hires, trains and manages about thirty young "Assistants in Prevention and Surveillance of Forest Fires" as part of the "Youth in Forest" initiative. They interact with visitors, explaining the rules and regulations that apply to the forest area (access restrictions, barbecues, cigarettes, garbage, etc.) and also provide information about the range of local activities and hikes.

[2]FSC: https://ic.fsc.org/; PEFC: https://www.pefc.org/.

4

Creating an enabling environment to scale up solutions

Mediterranean forests and trees are an important regional asset that could play an important role in the global forest agenda, but current threats, driven by climate change and increasing population, may jeopardize this natural capital if no action is taken (Part 2). The implementation of forest-based solutions can tackle these threats and promote the goods and services provided by Mediterranean forests to the benefit of populations and the environment. These include forest adaptation and climate change mitigation, biodiversity conservation programmes or Forest and Landscape Restoration (Part 3). Nevertheless, implementing these solutions and scaling them up from places where they have been successful to other areas necessitates certain enabling conditions. Part 4 will deal with these enabling environments.

The distinctive feature and advantage of Mediterranean forests and trees is the valuable goods and services that they provide. Implementing forest-based solutions will require policies at the national level and dialogue at the local level. Change will be facilitated by a paradigmatic shift in the way we perceive forest goods and services in the economy. The current economy, dominated by fossil fuels, occupies a linear production-use-waste line ("take, make, waste" paradigm). It often disregards the value of environmental services provided by forests with resulting negative externalities imposed on the people who benefit from these services. Promoting the goods and services provided by Mediterranean forests requires a move towards a more circular economy based on the "make, use, return" scenario. This new vision should acknowledge that resources are limited and worth recycling and that negative externalities impacting the environment should be internalized, to achieve a low carbon, resource efficient and more socially equitable economy. Chapter 10 will show how Mediterranean forests can contribute to and benefit from this new paradigm, known as the green economy.

Whether or not Mediterranean countries have already adopted this new economic vision, existing international commitments on forests – particularly in the framework of the three Rio Conventions – demonstrate an awareness of the role that forests can play. Implementing large-scale, forest-based solutions that have a country-level impact will require action planning at a national level, coordinated actions between stakeholders and collaboration between the two. This coordination at country level means national forest policies and programmes must be carefully prepared and effective, while also ensuring cross-sectoral complementarity. Forest-based climate change action, combating desertification, achieving land degradation neutrality and conservation of biodiversity all require national policies and programmes coordinated with local efforts. Most Mediterranean countries have already developed Nationally Determined Contributions under the UNFCCC, National Biodiversity Strategies and Action Plans under the CBD, and National Action Programmes under the UNCCD, which are closely connected to their national forest policies and programmes. Chapter 11 will review current policy frameworks in the Mediterranean region and reveal what is still needed to facilitate the implementation of forest-based solutions.

From the local to national level, successful implementation of forest policies and programmes will require involvement by many stakeholders. Robust approaches to stakeholder participation, sound governance and community engagement will be all the more critical to the success of forest-based solutions, as these solutions are cross-sectoral, reestablishing the forest as a component of the landscape. The precise difference between forest restoration and Forest Landscape Restoration lies in this broader approach to restoration, which encompasses all stakeholders to resolve the trade-offs between different natural resources and land uses at the landscape level. Modern, sustainable forest management has also integrated the role of all stakeholders into the planning and implementation of management actions. Innovative approaches to sustainable forest management in the Mediterranean, from participatory approaches to co-management and win-win contracts, are currently underway. Chapter 12 will review participatory approaches and show they are a key condition for the successful implementation of forest-based solutions in the Mediterranean.

Successful implementation of forest-based solutions will require a fair and accurate assessment of the value of the goods and services on which these solutions are based. As already mentioned, the goods and services provided by Mediterranean forests have too often been undervalued. Alternatively, their value has simply gone unrecognized and the cost of forest degradation disregarded as a negative externality. Recognition of the fair value of the goods and services provided by forest ecosystems to implement fair, forest-based solutions, requires an economic valuation of these goods and services. Chapter 13 will review the different approaches to valuing the services provided by forest ecosystem and discuss how these valuations can be integrated into the decision-making agenda.

Finally, implementing forest-based solutions in the Mediterranean region requires appropriate financing. Large-scale impacts of forest-based projects will be only obtained if specific financing mechanisms are established to support national forest policies and programmes over the long term. Public investment through national governments and incentives may have a leveraging effect if they also target private funding. Recognition that environmental services provided by forests are valuable in the context of the new, green economy may also lead to new financing mechanisms such as Payments for Environmental Services. In the context of climate change, climate finance that includes different funding mechanisms based on forests' mitigation and adaptation potential, such as REDD+ or NAMA, will also play an important role in supporting forest-based solutions in the region. The final Chapter of this Part will present different options to finance forest-based solutions, as a way to guide decision-makers in choosing the most relevant financing strategy.

10 Mediterranean forests in the green economy

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Introduction to the green economy

Global and Mediterranean drivers towards a green economy

The magnitude of global environmental change currently underway suggests that Earth has entered the Anthropocene, an epoch in which human activity is the dominant force shaping and conditioning key planetary processes (Lewis and Maslin, 2015), and whose main feature is an enormous expansion in the use of fossil fuels, triggering demographic and economic growth. During the twentieth century, the global population grew by a factor of four and global Gross Domestic Product (GDP) by a factor of 20 (Madison, 2001). Most of this expansion took place after World War II, with the commencement of ongoing great acceleration (McNeil and Engelke, 2016). Between 2000 and 2015, the global population has increased by an additional 5 percent to 7.3 billion inhabitants, while global GDP has doubled again to reach USD 75 trillion (World Bank, 2015b). An increased portion of this growth has taken place in developing countries. This extraordinary period has ushered in significant advances in human development (as measured by the Human Development Index (HDI) (UNDP, 2016) and reduced extreme poverty from 40 percent to 10 percent over the last 30 years (Roser and Oriz-Ospina, 2017). But it has also created deep income inequalities within and among countries (Ortiz and Cummins, 2011).

There is increasing evidence that Earth's capacity to provide a safe operating space for humanity has been jeopardized, especially with regards to four planetary boundaries: climate change, loss of biodiversity, land-system change and altered biogeochemical cycles for phosphorus and nitrogen. In addition, the potential impacts of current pollution and waste accumulation are still not well understood (Steffen *et al.*, 2015). It has been estimated that by 2030 the world will need to produce 50 percent more food, 50 percent more energy, and 30 percent more freshwater (UNESCO, 2012). This is due to continuing demographic growth and increased per capita consumption patterns of an expanding urban middle class (over 3 billion people) projected to reach 5 billion by 2030 (Kharas, 2017). Meeting growing demands within planetary boundaries is a great challenge. The Global Footprint Network estimates that humanity has already used the equivalent of 1.6 Earths in terms of bio-capacity, and that in two decades it will require two planets to sustain the current economic system (Global Footprint Network, 2016).

The Mediterranean region has followed this global trend (Figure 4.1). Population has nearly doubled over the last 15 years and is predicted to reach 584 million by 2025 (from 302 million in 1970). Most of this growth has taken place in southern and eastern Mediterranean countries whose total population share has increased from 36 percent in 1960 to 60 percent today (World Bank, 2015a). The region produces some 10 percent of global GDP (World Bank, 2015b). While GDP in southern and eastern Mediterranean countries has been growing at a faster rate in recent years, it has been insufficient to bridge one of the sharpest wealth divides in per capita GDP in the world. In 2014, the average GDP per capita in Mediterranean European Union (EU) countries (USD 36 200) was five times higher than countries in the Middle East and North Africa (USD 7 000) (World Bank, 2015b). Unemployment is one of the most pressing issues for Mediterranean economies. Youth unemployment (World Bank, 2015b) rates (i.e. the number of unemployed 15-24 year-olds expressed as a percentage of the youth labour

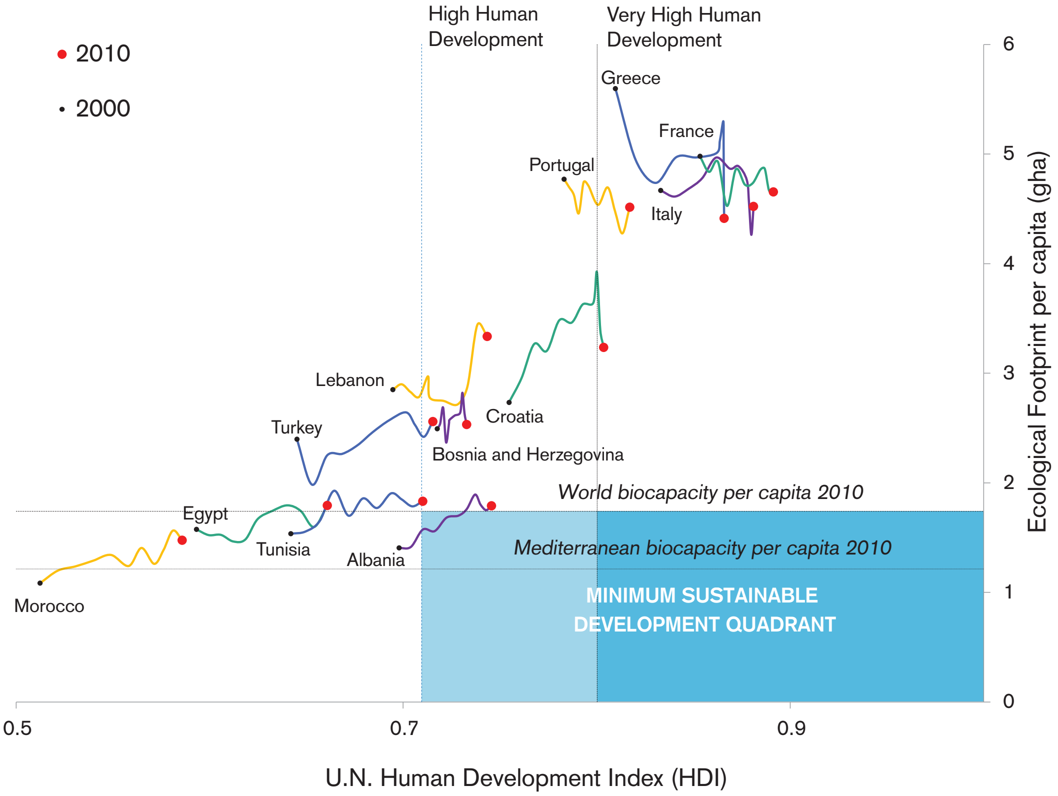

Figure 4.1. Trends in Human Development Index and ecological footprint in Mediterranean countries
Source: Global Footprint Network (2015).

force) are high in North Africa (Algeria 26 percent, Morocco 21 percent, Tunisia 36 percent) and the Middle East (Egypt 33 percent, Jordan 34 percent, Lebanon 21 percent, Syrian Arab Republic 31 percent) and can be very high even in northern Mediterranean countries, both within (e.g. Cyprus 25 percent, Greece 48 percent, Italy 38 percent, Spain 43 percent, Portugal 28 percent) and outside the EU (Albania 26 percent, Bosnia and Herzegovina 68 percent, Montenegro 38 percent). The gender gap is remarkably large; female youth unemployment is almost two times the male rate in some countries and is especially large in Egypt and Tunisia (World Bank, 2015b).

As a consequence of population growth and changes toward more resource-intensive consumption patterns, many countries in the region face scarcity of water, food and/or energy. The Global Footprint Network estimates that overall, the Mediterranean region is using approximately 2.5 times more renewable resources than its ecosystems can provide, while many countries still cannot provide satisfactory living conditions for their population (Global Footprint Network, 2015). This is partially due to the moderate-to-severe water scarcity that limits primary production. Water, food and energy supply and the management of natural resources constitute one of the most fundamental long-term challenges for the entire region (WEF, 2011). How it is able to address these challenges will have a significant impact on economic growth and well-being.

At the root of these problems lies a linear economic model of production, consumption and disposal, based on fossil fuels and non-renewable materials. This is supported by a gross misallocation of capital that has fueled the linear-fossil development path (UNEP, 2011). The dominant linear, fossil fuel-based economic paradigm is reaching its limits and must be replaced by an increasingly circular, bio-based and low carbon economy: a green economy.

A definition of green economy

The idea of reconciling economic growth with environmental protection and social equity has been on the international policy agenda since at least the Brundtland Report (WCED, 1987) and the first

United Nations Conference on Sustainable Development held in Rio de Janeiro in 1992. In the context of increasing environmental awareness and generalized economic concerns, the green economy has gained momentum as a response to increasing global economic and environmental crises, operationalizing sustainable development (Megwai *et al.*, 2016). The concept has been developed and highlighted by the United Nations Environmental Programme, placing a strong focus on redirecting investments to sustainable activities. The definition is as follows: "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, 2011).

It has been argued the green economy is no more than a buzzword, not very different in this sense from sustainable development, as both can assume different meanings at quite different levels of ambition. Bina (2013) proposes three main definitions within a continuum, i.e. green economy can be referred to as:

1. a general green stimulus within a mainstream economic model close to a business as usual paradigm;
2. a comprehensive effort to greening the economy, as proposed by UN Environment and the Organization for Economic Co-operation and Development (OECD), with a major emphasis on resource efficiency and low carbon growth, mainstreaming environmental economic approaches; or
3. an all-change approach championed by a diverse array of non-state actors that departs from the notion of planetary limits to advocate degrowth and the satisfaction of human needs as opposed to economic growth, and change in values as opposed to change in economic incentives.

Buzzwords can be useful when facing the nuances of a system as complex as the economy (Brand, 2012). In this sense, green economy can be understood as an umbrella concept encompassing different degrees of greening the current economic system, ranging from environmental improvements to business as usual up to a more radical discourse of societal change, focusing on consumption and production partners, equity and social justice to the abandonment of anthropocentrism (Bina, 2013). For the purposes of this chapter it is generally assumed that green economy refers to transforming the main economic sectors towards sustainability while securing human livelihoods. Taking UN Environment's approach as a reference, key priority sectors for greening are:

- Natural Capital: including ecosystems, agro-ecosystems and water habitats, as well as the sectors directly dependent on them for the production of biological resources, such as agriculture, forestry and fisheries. Internalizing and securing the supply of all relevant ecosystem services is a critical, long term challenge, as is the necessity of departing from a current bias towards extracting provisioning services (i.e. food, feed, feedstock and materials) that frequently erode natural capital and public goods through non-sustainable practices.
- Key economic sectors with larger environmental footprints, notably: energy, manufacturing, waste, construction, transport, tourism and the way people construct and live in cities. Their relevance and primary challenges are summarized in Table 4.1.

Green economy and bioeconomy

In tandem with the concept of green economy, the bioeconomy has also been gaining visibility. Its focus is on the use of biological resources to replace non-renewable materials and energy carriers, and can be understood as the bio-based component of green economy. In a narrow sense, the bioeconomy refers to all parts of the economy related to the management and processing of biological resources from agriculture, forestry and fisheries (OECD, 2009). More ambitiously, the bioeconomy envisages a society

Table 4.1. Main sectors and pathways towards the green economy

Sector	Relevance	Main options
Natural Capital (ecosystems and agro-ecosystems)	• Natural and agro-ecosystems provide the underpinnings of life and feed humanity • 4 billion people work directly in agriculture, forestry and fishery sectors	• Reversing critical negative externalities in agriculture, aquaculture and forestry • Food security and sourcing a bioeconomy through improved management and circularity • Bridging policy and market failures
Energy	• 80% of final energy consumption is based on fossil fuels • Global energy demand growing at 1.5%/year • 60% of renewable energy based on low efficient traditional biomass • 2.5% of world diseases caused by fuel burning	• Renewables (solar, wind, marine, geothermal, biomass, etc.) • Energy Efficiency • Universal access to electricity as a condition to access green energy, but also improved use of biomass in developing countries
Manufacturing	Is globally responsible for: • 20% of greenhouse emissions • 25% of resource use • 17% of pollution related health problems It provides: 23% of jobs globally	• Increase water energy and material efficiency • Substitution of non-renewable and high-energy footprint materials for low-footprint biomaterials • Circular economy, eco-design, biomimetics
Waste	• 11.2 billion tonnes/year of solid waste • Organic decay equals 5% of total emissions • Marine litter • Soil and water pollution	• Circular economy (reduce, re-use, recycle, bio-degradable) • Degradable biomaterials • Waste to energy conversions
Construction	• 10% of global GDP • 33% of GHG emissions • 33% of all material use • 40% of waste • 12% of freshwater	• Revert to timber and bio-materials • Passive house standards • Water efficiency, collective renewable heating • Retrofitting buildings
Transport	• 50% of liquid fuel consumption • 25% of energy related GHG emissions • 80% of atmospheric pollution in cities • 1.3 Million fatal accidents per year • Fleet to grow 300% by 2050	• Landscape and urban planning • Enhanced public transport • Digital economy (i.e. virtual meetings) • Sharing economy, shared transport • Renewable electric and lighter and more efficient vehicles (i.e. bio-based carbon fibre cars) • Aviation advance biofuels
Tourism	• 5% of global GDP & 8% of global jobs • 6% of total exports, first export sector for 150 countries • 5% of global greenhouse gas emissions, relevant local pressures on water and waste and nature	• Greening transport • Greening construction • Nature-based and heritage-based tourism • Increase benefit sharing for local populations
Cities	• 50% of global population, increasing rapidly • Up to 80% of energy consumption and GHG emissions • Consumption and waste generation centres	• Leveraging high density population to increase energy, water efficiency reducing waste • Improved urban-rural linkages • Nature-based solutions for human health, risk mitigation and urban farming

Source: UNEP (2011).

that is less dependent on fossil fuels and more reliant on biological resources to meet its needs in terms of energy and raw materials and is a key part of the solution to global environmental and social challenges (Bugge *et al.*, 2016). Arising from two very different arenas, these two concepts converge when considering the role played by forests and forestry in a more sustainable future. Accordingly, in the next section the role of forests in the bioeconomy is considered equivalent to their role in the green economy.

Box 4.1. On the current global contribution of forests to the green economy

Globally. The total value of the ecosystem services provided by forests has been estimated in the trillions of dollars – a magnitude of two or more orders above global GDP (UNEP, 2011). Despite this, 14 hectares of forest are deforested every minute, degrading vital natural capital (FAO, 2015b). This is partially due to the fact that only a fraction of this value is captured in current economic valuations (the economic value of forests is mainly derived though wood markets). Some 3.5 billion m^3 of wood is harvested every year, a remarkable amount if used wisely. At the EU level, domestic wood supply could satisfy 100 percent of the building or textile sectors, with very significant emissions reductions and job creation impacts (Hurmekoski, 2017). At present, however, some 50 percent of total wood harvested is used for energy purposes in largely inefficient traditional combustion and for energy uses of industrial side streams. In fact, woody biomass provides some 10 percent of the world's primary energy and is also more relevant locally; it satisfies 80 percent of sub-Saharan Africa's energy demands. According to FAO, forestry and downstream wood-based sectors represent 1 percent of global GDP, or some USD 470 billion per year, providing 10 million jobs, equivalent to 0.4 percent of the global workforce.

In the Mediterranean region. Merlo and Croitoru (2005) estimated the Total Economic Value of Mediterranean Forests at EUR 133 per forest hectare (in 2001 prices) – or almost EUR 50 per capita/year. On average, only 35 percent of this value can be attributed to wood forest products, 10 percent to grazing and 9 percent to Non-Wood Forest Products (NWFPs). The biggest contribution (46 percent) related to other ecosystem services. Under-reporting of forests' non-wood value is generally very significant. Mediterranean wood harvest yields are relatively low compared to other regions. Maximizing its contribution to the green economy requires smart and sustainable use of available resources. Increasing efficiency, developing higher added-value wood uses and leveraging the potential of NWFPs and other ecosystem services could have significant impacts on sustainability and economic development.

The role of forests in the green economy within the Mediterranean Region

The role of forests in the green economy has received attention at a global and regional level, with a particular focus on tropical and temperate regions with large per-capita forest resources, both in developed and developing countries (Box 4.1). The dual nature of forests is generally recognized. On the one hand, forests are one component of natural capital, as providers of public goods. On the other hand, forests are a source of raw materials at the base of more or less relevant value chains (both formal and informal), employment and livelihoods (UNEP, 2011, for example). Within this framework, the specific challenges and opportunities for Mediterranean forests have received far less attention, the work of Croitoru and Liagre (2013) being a notable exception. This section analyses the role of forests in the green economy/bioeconomy using regional green economy policy documents from Europe and Africa that include Mediterranean countries (even if not specifically targeted).

The EU Bioeconomy Strategy

Adopted in 2012, the EU Bioeconomy Strategy defines the bioeconomy as "using biological resources from the land and sea, as well as waste, as inputs to food and feed, industrial and energy production. It also covers the use of bio-based processes for sustainable industries" (European Commission, 2012). The bioeconomy can therefore be understood as the bio-based component of a green economy. It identifies forests and forestry as a key component for their contribution to its main strategic goals, namely: (1) Ensuring food security; (2) Managing natural resources sustainably; (3) Reducing dependence on non-renewable resources; (4) Mitigating and adapting to climate change; and (5) Creating jobs and maintaining European competitiveness. It also identifies three main areas for action: (a) Investment in knowledge, innovation and skills; (b) Participatory governance and informed dialogue with society; and (c) Enhancement of markets and competitiveness in the bioeconomy, communicating the benefits of bio-based products and supporting the expansion of markets through standards and standardized methodologies for sustainability assessment (European Commission, 2012).

Within sustainable and multifunctional management, the EU Bioeconomy Strategy and associated Action Plan focus on the increased production and transformation of forest biomass for multiple purposes. Several key areas of the bioeconomy are not dealt with, or it assumed they are tackled by other policies. This includes, for instance, resource competition, resource efficiency and, more generally, sustainability and social issues, beyond an emphasis on consumer engagement (Kleinschmit *et al.*, 2017).

The Rovaniemi Action Plan

The United Nations Economic Commission for Europe (UNECE), with the participation of regional forest stakeholders, has taken a close look at opportunities to increase the role of forests in the green economy. This resulted in a non-binding document adopted in 2013, known as the Rovaniemi Action Plan for the Forest Sector in a Green Economy (Box 4.2). Although the document formally encompasses all European countries (including Mediterranean ones), its primary focus is on temperate and boreal regions hosting large forest resources and wood-based industries. A close examination reveals a clear focus on wood, carbon and climate change mitigation, with an emphasis on the substitution effects of forest-based products. It advocates for correcting markets and prices for negative and positive externalities through valuation and Payment for Ecosystem Service (PES)-type mechanisms. It overlooks key Mediterranean challenges (e.g. water management and climate change adaptation) and opportunities (e.g. NWFPs, green tourism, forest restoration, plantations). While it provides an interesting and important framework, as a non-binding document its focus is on orientations rather than strict commitments and targets.

The role of forests in an African green economy

UN Environment and the International Institute for the Environment and Development (IIED) have analysed the role of forests in the green economy in Africa (Grieg-Gran *et al.*, 2015). The report has a focus on resource-rich, tropical countries, but includes interesting elements on the green economy relevant to the Mediterranean region. It describes the contribution of forests to the green economy in terms of:

- Despite incomplete and largely empirical evidence of their importance to local economies, NWFPs remain under-investigated and huge data gaps exist. It is estimated that the informal sector contributes significantly more to local economies than formally traded products. Sustainable consumption, creating demand for sustainable products through organic and fair trade labelling for NWFPs is a key action area.
- Ecosystem services are recognized as extremely relevant but they are not quantified or reported in

Box 4.2. Rovaniemi Action Plan in a nutshell

The Rovaniemi Action Plan for the Forest Sector in a Green Economy is a non-binding document adopted in 2013 and focused on how "the forest sector in the UNECE region could lead the way towards the emerging green, bio-based economy at the global level" (UNECE and FAO, 2014). Its vision includes areas of activity with specific objectives and actions, and potential actors who might contribute to achieving the stated objectives. It addresses the United Nations Economic Commission for Europe (UNECE) region, including all European countries (including Russia, Belorussia and Ukraine), North America (Canada and the United States), Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and Israel.

Key content is summarized below.

Vision

- The forest sector makes a profound contribution to human well-being through the supply of marketed and un-marketed forest goods and services and the creation of revenue and livelihoods, while conserving biodiversity and ecosystem services in the context of a changing climate.
- The forest sector protects the welfare of all stakeholders, including forest-dependent indigenous peoples, forest owners, forest industry and the forestry workforce, uses all resources wisely and economically, and contributes to the mitigation of climate change through both sequestration and substitution, while providing tools for societal climate change adaptation.
- Forest sector governance systems take into full account all of the ecosystem services provided by forests, compensating suppliers whenever appropriate.

Goals

1. Patterns of production, consumption and trade of forest products are truly sustainable.
2. The forest sector makes the best possible contribution to climate change mitigation (sequestration, storage and substitution) and adaptation.
3. The workforce is able to implement sustainable forest management and the forest sector provides decent jobs.
4. Forest functions are identified and valued and payments for ecosystem services (PES) are established, encouraging sustainable production and consumption patterns.
5. Policies and institutions relevant to the forest sector promote sustainable forest management; policy-making is evidence-based, policy instruments are effective, efficient and equitable and monitoring is adequate in order to mainstream the green economy in forest sector policies.

Actions. The plan proposes 118 potential actions to fulfil the five above-mentioned goals. They are not reported here in detail; nonetheless an overview of the frequency of hits (in brackets) of forestry-related keywords included/mentioned within the plan provides a general idea of its primary orientation. Provisioning services: wood (44), green building (16), energy (15), industry (12), trade (12), efficiency (5), non-wood (1). Non-provisioning ecosystem services: climate (24), carbon (24), Payment for Ecosystem Services (7), biodiversity (7), tourism (2). Crosscutting: research (20), jobs (9), consumer (8), innovation (4) and rural (2). Some topics that are relevant to the Mediterranean context are barely mentioned (e.g. soil (1)), or missing entirely (e.g. water, deforestation, plantations, restoration).

any detail in the report. Great emphasis is placed on biodiversity, water services and carbon sequestration. Green tourism and carbon payments are identified as potentially relevant ways to capture value and generate economic activity. The same situation is prevalent across the Mediterranean basin.

The contribution of forests to a green economy in North Africa and the Middle East

In 2013 the FAO Committee on Mediterranean Forestry Questions-*Silva Mediterranea* and the German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ) published a report exploring the role of forests in the green economy in North Africa and the Middle East, in order to fill the existing gap in global forest policy discussions (Croitoru and Liagre, 2013). The key elements of the report can be summarized as follows:

1. Low forest cover and a relatively weak formal forest-based sector;
2. Urgency for climate change adaptation;
3. High relevance of ecosystem services, particularly those linked to biodiversity and the forest-water nexus;
4. High relevance of NWFPs (timber is estimated to represent only one third of the Total Economic Value of regional forest resources);
5. The relatively high importance of informal sectors in wood and NWFPs value chains.

The report focuses on maximizing existing opportunities and best practice to capture the total contribution of Mediterranean forests as a means to correct policy and market failures, improve natural capital and create jobs and livelihoods. Some notable topics include:

- Green accounting, including satellite accounts for ecosystem services, as a potential contribution to better forest policies;
- Payment for Ecosystem Services focusing on water and biodiversity, acknowledging that currently PES implementation is scarce in the Mediterranean region;
- Placing value on Protected Areas by imposing access fees, improving local benefits through

Figure 4.2. *Ruscus aculeatus* L., a medicinal plant traded in Turkey © Elena Górriz

concessions and developing eco-tourism and PES schemes;

- Enhancing value chains for NWFPs through comprehensive approaches covering process (increasing production efficiency), product (qualitative improvements), functional (intermediaries) and channel upgrading (product diversification), as well as addressing demand for organic and fair trade labelling (Figure 4.2);
- Carbon finance: although financing forest carbon is possible, the opportunity to finance the development of renewable energies (wind, solar, geothermal and biogas) reduces pressure on forests fuelwood, thereby having a greater potential impact and;
- Financing forest-based adaptation. Better environmental governance and cross-sectoral cooperation is required to mainstream forest-based adaptation policies and initiates.

Mediterranean forests in the national green economy and related strategies

At a regional level, the Strategic Framework on Mediterranean Forests (FAO, 2013) places strong emphasis on the contribution of forests to rural and urban populations and economies and advocates for better coordination between the forest sector and broader socioeconomic development strategies. It concludes that, in general terms, the region has strong policies and commitments in areas that are very relevant to the green economy, such as: (i) sustainable forest management and wildfire prevention; (ii) forest and landscape restoration; and (iii) biodiversity conservation, while it has incipient inclusion in forest policies relating to (iv) climate change adaptation and mitigation and a sparse development of (v) market-based instruments for ecosystem services.

This Section presents a preliminary assessment of the role attributed to forests in the green economy, bioeconomy and other relevant policy orientation papers from Mediterranean countries. It is based on a literature review in English, French and Spanish. It does not pretend to be exhaustive, but instead aims to provide a broad overview. In total, 18 documents relative to 11 countries have been reviewed (see Annex B for a detailed list). They correspond to national strategies, governmental commitments or reports produced by international organizations. Single sectorial documents related to the green economy that may be relevant and have implications for forests and forestry (e.g. strategies and action plans for renewable energy, climate change, nature conservation, green tourism, rural development or research and innovation) are not analysed.

Table 4.2 summarizes the main outcomes of this analysis, reflecting the dual role of forests within the green economy: forests as natural capital providing public goods and forests as the basis for material value chains.

Although forests do not play the most prominent role in most of these documents, Table 4.2 shows that forests are broadly considered part of the green economy/bioeconomy. Generally speaking, all countries recognize that forests provide relevant private and public goods. While primary emphasis is placed on biodiversity and carbon sequestration, other services such as soil conservation (Spain and Turkey), protective functions (Croatia and Serbia) and water management (Turkey and Portugal) are mentioned. Despite this, the forest-water nexus seems to be underestimated in relation to the relevance ascribed to carbon sequestration. It is tempting to interpret this bias towards carbon sequestration as strongly influenced by the global agenda and the lack of a more detailed Mediterranean approach. Remarkably, there is an emphasis in most of the documents on forest-related problems, not opportunities. Forest fires (Algeria, Greece, Portugal), unsustainable management (Albania, Croatia, Montenegro) and pests (Portugal), along with previous deforestation, are seen as key threats. Middle Eastern and North African countries propose restoration and afforestation actions to maintain or increase the natural capital (Tunisia,

Table 4.2. The role of Mediterranean forests in selected green economy or related strategies and policy orientation papers

Country	Forests as natural capital providing public goods	Forest-based value chains
Albania	• Unsustainable forestry and forest degradation is a key environmental challenge (Republic of Albania, 2014) • Agency of Environment and Forests to monitor environmental situation and further protect forests (Republic of Albania, 2012) • Government committed to efforts to increase protected forest area (Republic of Albania, 2012)	• Ensuring efficient management of forests to expand their total area and productivity is a challenge (Republic of Albania, 2012) • Communal forests may be used as a tool for the eradication of poverty (Republic of Albania, 2012)
Algeria	• Forests, as carbon sinks, are recognized as playing a significant role in combating climate change (Algeria, 2015) • The National Climate Plan proposes massive reforestation (UNECA, 2014a) • Wildfire prevention and reforestation seen as major opportunities (PNUE and SwitchMed, 2016)	
Croatia	• Promote restoration in degraded forests (MEPPPC, 2011)	• Use of forest and forest land products in accordance with the principles of Sustainable Forest Management (MEPPPC, 2011) • Increase ecologic forest production (MEPPPC, 2011)
Cyprus	• Challenges include wildfire management and effective implementation of "Natura2000" • Objectives include increasing forest area and improving their ecological quality (MANRE, 2007)	
Egypt		• New policies in place to use sewage water in forest plantations • Investments in producing wood from waste (UNEP, 2014b)
France	• New methods to capture carbon (agroforestry) (MEDDE, 2015) • Maintain capacity to sustain ecosystem services (MESDE, 2015) • Woodlands produce environmental and social services (MAAF, 2016)	• Forestry as a pillar of bioeconomy (MEDDE, 2015) • Support research to improve the sustainability of productive systems and adapt biomass (MAAF, 2016) • Woodlands produce economic services (primary and secondary processing products) (MAAF, 2016)
Greece	• Environmental awareness has increased since 2007 wildfires (Pagoulatos, 2010)	• Research and Development policy seeks to improve efficiency in forestry
Israel	No mention of forests	
Italy	• Multipurpose forest management to maintain/improve forest biodiversity (Agenzia per la Coesione Territoriale, 2016)	• limited or absent contribution to the national wood industry due to heavy reliance on imported materials (Agenzia per la Coesione Territoriale, 2016)

Country	Forests as natural capital providing public goods	Forest-based value chains
Italy		• Forests are a source of biomass for multiple purposes (Agenzia per la Coesione Territoriale, 2016)
Jordan	• Afforestation plans to protect ecosystem services (Ministry of Environment, 2017) • Plans to maximize forests and biodiversity (Ministry of Environment, 2017)	
Lebanon	No mention of forests	
Malta	• Deforestation and forest degradation is a relevant challenge threatening biodiversity (National Commission for Sustainable Development, 2006)	
Montenegro	• Forests are described as extremely important for the conservation of natural balance • Unsustainable forest management and lack of protected areas are considered relevant challenges for the green economy (MTEP, 2007)	• Economic underdevelopment is linked to unsustainable use of forests (MTEP, 2007) • Absence of integral forest management is a problem (hunting, tourism, NWFP etc.) (MTEP, 2007)
Morocco	• Fragile forested areas are an issue of concern (UNECA, 2014b) • Ambitious afforestation programme	• Forest value chains will generate jobs • Timber harvesting exceeds triple the capacity of forest (UNECA, 2014b) • Morocco produces 4% of the world's cork supplies (UNECA, 2014b)
Portugal	• Biodiversity and ecosystem services are a key issue. Social perception on forests is multifaceted and different views are considered legitimate • Commitments include restoring nature, protecting and valuing biodiversity and addressing Land Use Land-Use Change and forestry emissions in national goals • Urban forests and green infrastructure • Critical challenges include forest fires and increased pest incidence due to global change	• Forest industry represents 2.1% of the GDP and 10% of export value, creating some 100 000 jobs. New investments are needed • Environmental activities and services are estimated to contribute around EUR 1.3 billion to the economy each year • Role of agroforestry and NWFPs in the economy is recognized • Forests contribute to renewable energy, green mobility (biofuels), rural development (local products) • Improved use of current industrial waste is needed
Romania	• Romania's forests have an important role in climate action (World Bank, 2016)	• Sustainable management of production forests (World Bank, 2016) • Forest land can sustain economic growth (World Bank, 2016)

Country	Forests as natural capital providing public goods	Forest-based value chains
Serbia	• Recognition of the role of forests in conserving biological diversity (UNEP, 2013) • Protective functions of forests should be maintained (MESP, 2012)	• Insufficient wood production is a problem (UNEP, 2013) • Forests provide significant products such as wood and wood products (UNEP, 2013) • A potentially large biomass is available but underused in wood waste and forest residues (MESP, 2012)
Slovenia		• Forests provide the country with advantages to switch to green services and jobs (MESP, 2016) • Timber value chains are among the greatest assets in the green economy for Slovenia (MESP, 2016) • Timber extraction is one indicator to measure green growth (Žitnik *et al.*, 2014)
Spain	• Natural resources to be protected in order to maintain the potential of productive systems (MEC, 2016)	• Forestry to be a cornerstone of the bioeconomy (MEC, 2016) • Productive processes based on forests have great potential for employment (MEC, 2016)
Tunisia	• Reforestation is a measure to reduce environmental impacts (UNECA, 2015) • The state has agreed to protect forest natural resources (UNECA, 2015)	• Forestry is a sector suffering from low productivity (UNECA, 2014c)
Turkey	• Low forest cover has a range of impacts, such as soil erosion (World Bank, 2013) • Forests produce a range of ecosystem services (regulation of soil, water, carbon sequestration) (World Bank, 2013)	• Natural capital includes timber and non-timber forest resources (World Bank, 2013) • Agricultural production is closely linked to the protection of forest ecosystem services (World Bank, 2013)

Morocco, Jordan, Algeria) while European countries focus on sustainable forest management (Spain, Portugal) or multipurpose forest management (Italy), but also on increasing protected areas (Albania) and restoring degraded forests (Croatia).

There is no direct acknowledgment in the review documents of the fact that some of the main contributions by forests to the green economy are externalities not captured in markets. Returns on investments in forest protection and restoration, while estimated to be very high, occur mainly through public goods and indirect benefits, rendering them unattractive (UNEP, 2011). Green accounting is therefore required in order to better reflect the contribution by forests to national wealth, either directly or indirectly (i.e. through other sectors such as water and tourism). The importance of implementing PES is also well-recognized in regional policy documents (see Section "The EU Bioeconomy Strategy" of this Chapter) but occupies a less prominent place in national strategies and action plans. The Portuguese Green Growth Commitment (MAOTE, 2015) is one remarkable exception to this trend. It specifically proposes to "implement the TEEB (The Economics of Ecosystems and Biodiversity) initiative in Portugal based on mapping and evaluation of the condition of ecosystems and ecosystem services and on their economic and social value."

With the exception of countries with very low forest cover (Cyprus, Egypt, Israel, Jordan and Malta), the role of forests as a source for material value chains is widely recognized. This is especially evident in the case of European bioeconomy strategies (France, Italy and Spain). Overall, emphasis is placed on wood, with a strong focus on its (increased) production (France, Italy, Romania, Serbia, Slovenia, Spain) or increased efficiency in the forestry sector (Greece). NWFPs are acknowledged to a lesser extent (Morocco, Portugal and Turkey) and in more generic terms. Rangeland grazing and agroforestry systems, extremely relevant to the Mediterranean context, receive limited attention. The role of forests and forestry in contributing to greening energy, water, construction, textile, medical and other sectors is only marginally addressed in some of the documents (e.g. the Portuguese Green Growth Commitment and French Bioeconomy Strategy). In European bioeconomy strategies, forestry and forest industries are seen as a green sector and their positive contribution to sustainability is generally assumed, even if there is increasing scientific evidence that this may not always be the case, for example when considering the role of forest-based bioenergy in carbon emissions (Berndes *et al.*, 2016).

Improvements in biomass processing and technological developments are seen as major opportunities, while territorial approaches and social innovation receive relatively little attention. The lack of a holistic approach on how to better use and maximize social and environmental positive impacts with the rich, diverse but also limited Mediterranean forest resources is perhaps the biggest gap identified in this analysis.

Conclusions

The Mediterranean region faces extraordinary challenges, such as climate change, environmental degradation, overexploitation of bio-capacity, globalization and unemployment. Although very diverse in both their extent and socio-ecological functioning, Mediterranean forests share common characteristics including relatively limited productivity, high fire risk, urgent need to address climate change adaptation, the absence of strong formal value chains and a comparably higher relevance of NWFPs and ecosystem services. This chapter has evaluated policy orientation documents related to how to include forests and forestry in the green economy at the global, regional and national levels. Regional documents tend to ignore Mediterranean specificities, while at national levels the role of Mediterranean forests in the green economy is only partially acknowledged.

The reviewed national documents emphasize improving forest management and strengthening the forest sector itself as opposed to maximizing the contribution by forests to greening the economy at large. This more ambitious approach, implicit in the concept of the green economy, requires careful consideration in terms of resource efficiency, hierarchy of use (e.g. managing for water vs managing for timber) and resource competition (i.e. energy vs industrial wood use). Similarly, sustainability concerns are limited to securing sustainable and multifunctional forest management. The positive environmental impacts of forest-based value chains are taken for granted even if there is contradictory scientific evidence regarding, for example, the carbon neutrality of biomass.

Finally, enhancing the role of Mediterranean forests in the green economy requires more systematic action in the following areas:

1. Overcoming market and policy failures for the provision of public goods through environmental accounting and the development of PES-type mechanisms. This is necessary to solve the contradiction between the extraordinary economic value of forests and their degradation due to unsustainable use, abandonment and, in more general terms, inadequate forest management approaches, making forest resources more prone to extreme events such as catastrophic fires. In addition, value can be captured through ecotourism and other territorial approaches built on local environmental and cultural values and securing adequate benefit-sharing at local, national and international levels.

2. Strengthening forest value chains based on wood and NWFPs. Currently, emphasis is placed on sustainable forest management, reversing deforestation and forest degradation and increasing the resource base through plantations and agroforestry developments. In addition, material and economic efficiency must be addressed to maximize the social and environmental benefits derived from wood and NWFPs (Figure 4.3). Greater efficiency (i.e. improved stoves and firing technology), increased added value (i.e. material uses vs energy), improved value chains (i.e. timber construction vs auxiliary wood), increased circularity (reusing, recycling, eco-design, waste as a resource, cascade use), advanced materials (high value extracts, engineered wood products), improved market access (through eco-labelling, green public procurement) are critical. PES-type mechanisms will be required in this regard to internalize ecosystem services, paying special attention to biodiversity and water-related services.
3. The social dimension of the green economy should be addressed more systematically, building on existing best practices and including, among other things, public dialogue, participatory approaches, public-private partnerships, etc. In addition, bioeconomy strategies should place greater emphasis on social innovation and place-based development, complementing technological innovation and advanced biomass processing.

Figure 4.3. Kavala, Greece
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11 Policy frameworks as an enabling environment for achieving international commitments on forests

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Introduction

Background

Forest sector policies are developed and implemented in the context of deep socioeconomic changes and need to address sector-specific challenges balancing economic, ecological and social issues. They must incorporate biodiversity conservation, ecological values and services alongside increasing demand for forest resources. They must also support traditional uses and local values while increasing the forestry share of total GDP, as well as contributing to national development and climate change mitigation. Despite the impressive amount of goods and services forests provide, the forestry sector is not a priority development sector for national economies in the Mediterranean region. Hence, special efforts to communicate and coordinate with other sectors are required to ensure that forestry priorities are represented in national policy planning and budgeting.

The relationship between national forest policies and laws has become more evident in recent decades. Policies define overall objectives for sectoral development, while laws serve as instruments to achieve policy priorities in a legal and coherent way. Still, efforts are required to strengthen this linkage.

Multi-sectoral challenges such as climate change, energy, sustainable development and food security will require and facilitate the development of new forms of inter-sectoral and inter-departmental coordination and coordinated policy development.

Innovative financial mechanisms and investment strategies must be defined and refined to counteract the inevitable and continuous reductions in public budgets and increasing needs for funding in response to socioeconomic challenges such as population growth, degradation of natural resources and food security. To achieve this goal, continuous involvement by various stakeholders and promotion of partnerships and coordination across sectors are key.

Approach to the analysis

Data presented in this chapter is derived from official and publicly-available national forest policies and related forest policy instruments published after 2000. Analysis focuses specifically on national policies. In order to maintain a balance between documents collected from countries in the northern, southern and eastern Mediterranean region, sub-national and regional policies have not been included. Forest policies are, in fact, typically decentralized in northern countries (Spain has 17 administrative and autonomous regions, Italy and France have 20 and 18 regions respectively), with specific forest policies derived from national directives.

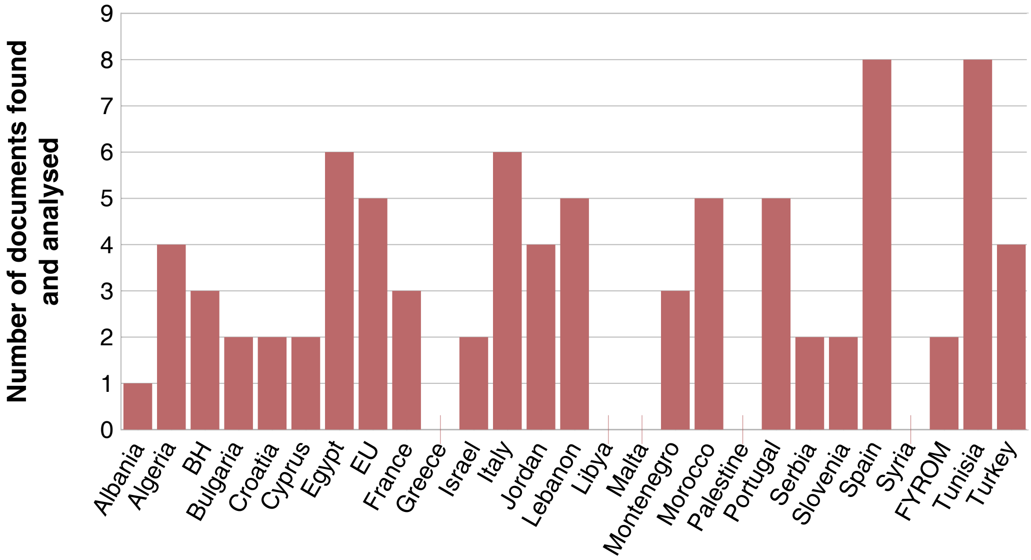

Figure 4.4. Number of documents found and analysed (per country)

Note: BH = Bosnia and Herzegovina. EU = European Union. FYROM = the former Yugoslav Republic of Macedonia. Syria = Syrian Arab Republic.

Documents were analysed using a qualitative discourse analysis: keywords relevant to priority topics selected for this publication were defined and used for document analysis to examine whether the key topics were addressed by the formal policy documents. The results were grouped into the following categories: Ecosystem Services and Wood Forest Products/Non-Wood Forest Products; Forest Restoration and the contrast between forest degradation and deforestation and Sustainable Forest Management and Forest and Landscape Restoration; Biodiversity Conservation; Climate Change Mitigation and Adaptation; Wildfire Prevention; and Communication, Coordination, Cooperation and Capacity Building.

Relevant documents (Annex C) were obtained from FAO's Legal Service Database (FAOLEX), Food and Agriculture Policy Decisions Analysis (FAPDA),[1] country reports for the FAO Global Forest Resources Assessment 2015, UNCCD and CBD databases, forest policy databases, other relevant literature and web searches. Additional information was obtained from FAO's Legal Service and regional and sub-regional FAO offices, national focal points in the Mediterranean network and co-authors of this Chapter.

Each document related to forest policy was analysed and relevant text matching the keyword search was selected and compiled into a one or two-sentence summary statement in a country-specific results table (Annex F).

Data availability and access

The qualitative analysis was based on policy documents in English, French, Spanish, Portuguese and Italian, which were publicly available online. The number of documents analysed per country varied from zero to eight (see Figure 4.4 and Annex C for more details). These numbers correspond only to the documents that were easy to find and access via an internet search and do not necessarily reflect all available documents. This can, however, be an indicator of communication and transparency.

[1] http://www.fao.org/in-action/fapda/forestry-tool/policies/es/

Findings

International initiatives and their impact on national forest-related policies in the Mediterranean region

Forest policy statements in the region are affected by a number of legally binding or non-legally binding international and regional agreements and conventions (see also Chapter 2). The United Nations Forest Instrument (UNFI – formerly "Non-Legally Binding Instrument on All Types of Forests") adopted by the UN General Assembly in 2007 is considered a global forest policy milestone, being the first time Member States agreed to an international instrument for sustainable forest management. The UNFI defines 25 voluntary and non-binding "national policies and measures" that countries should undertake to achieve the purpose of the instrument. The four global objectives on forests are especially relevant to the Mediterranean region as they address forest protection, restoration, afforestation and reforestation, forest degradation and forest-based economic, social and environmental benefits.

The 2015/33 resolution adopted by the Economic and Social Council of the UN in July 2015 reaffirmed the UNFI's global objectives on forests, extended the International Arrangement on Forests (IAF) to 2030 with five objectives, and asked the United Nations Forum on Forests (UNFF) to develop a strategic plan for the period 2017-2030. The United Nations Strategic Plan for Forests defined voluntary Global Forest Goals. It also incorporates the UNFI global objectives on forests, which in turn support the objectives of the IAF and are built on and contribute to the SDGs, the Aichi Biodiversity Targets and the Paris Agreement.

Legally binding conventions (such as the CBD, UNFCCC and UNCCD) do not specifically cover forests but are critical to establishing the legal and political framework in which regional and national forest policies are formed and subsequently enforced through national laws.

With the exception of the Syrian Arab Republic, the Paris Agreement has been adopted by all Mediterranean countries. Forests and forest policy will play a pivotal role in reaching the Nationally Determined Contributions (NDCs) established under the Agreement. Article 5 of the Agreement emphasizes "policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries; and alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable management of forests."

The Twelfth UNCCD COP was held in Ankara in October 2015. There, Parties endorsed the vision of SDG Target 15.3[2] as a driver for UNCCD implementation, while also contributing to other SDGs, including those related to: climate change mitigation and adaptation; biodiversity conservation; ecosystem restoration; food and water security; and disaster risk reduction. The Global Mechanism of the UNCCD has fully endorsed the objective of Land Degradation Neutrality. On this occasion, the "Ankara Initiative" was launched by the UNCCD Secretariat and the Government of Turkey and is expected to soon become national law in Turkey.

The Thirteenth CBD COP in Cancun, December 2016, led to an endorsement by Parties of the SDGs as drivers for CBD implementation. It also strengthened implementation of the Global Soil Partnership and Global Mountain Partnership and promoted the International Arrangement on Forests and the implementation of the UNFI.

Mediterranean countries have ratified all the main international conventions and agreements (see Annex D-E and Figure 4.5).

[2] "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world."

Regional forest policy frameworks

The European Common Agricultural Policy and the European Union (EU) Forestry Strategy define the main aspects of forest policy for EU member countries in the Mediterranean region, although the Treaties of the EU make no provision for a common European forest policy.

"A new EU Forest Strategy: for forests and the forest-based sector" responds to new challenges facing forests and the forest sector. Forests are multifunctional, serving economic, social and environmental purposes. The new EU Strategy seeks to "go beyond the forest" to address aspects of the value chain related to the use of forest resources to generate goods and services. The EU Strategy emphasizes that forests provide a large range of products other than timber, including cork, resins, mushrooms, nuts, game and berries. The EU strategy highlights the impacts of other policies on forests, as well as developments taking place beyond forest boundaries that should be taken into account:

- "Member States should make use of rural development funds to improve competitiveness, promote the diversification of economic activity and quality-of-life;"
- "Assess and improve the effect of forestry measures under rural development policy;"
- "With the help of rural development funding, Member States are encouraged to support: Forest Advisory Systems for awareness-raising; training; and communication between local forest holders and authorities;"
- "The Commission and the Member States should improve their valuing of the benefits that forests give to society and, through sustainable forest management, should find the right balance between delivering the various goods and services."

Forestry measures are an integral part of rural development programmes in EU Member states, supporting the implementation of sustainable forest management. Socioeconomic benefits derived from forests receiving EU funding contribute to improved quality of life in rural areas and encourage diversification of economic activities. This strategic approach places EU countries in a different situation to non-EU Mediterranean countries.

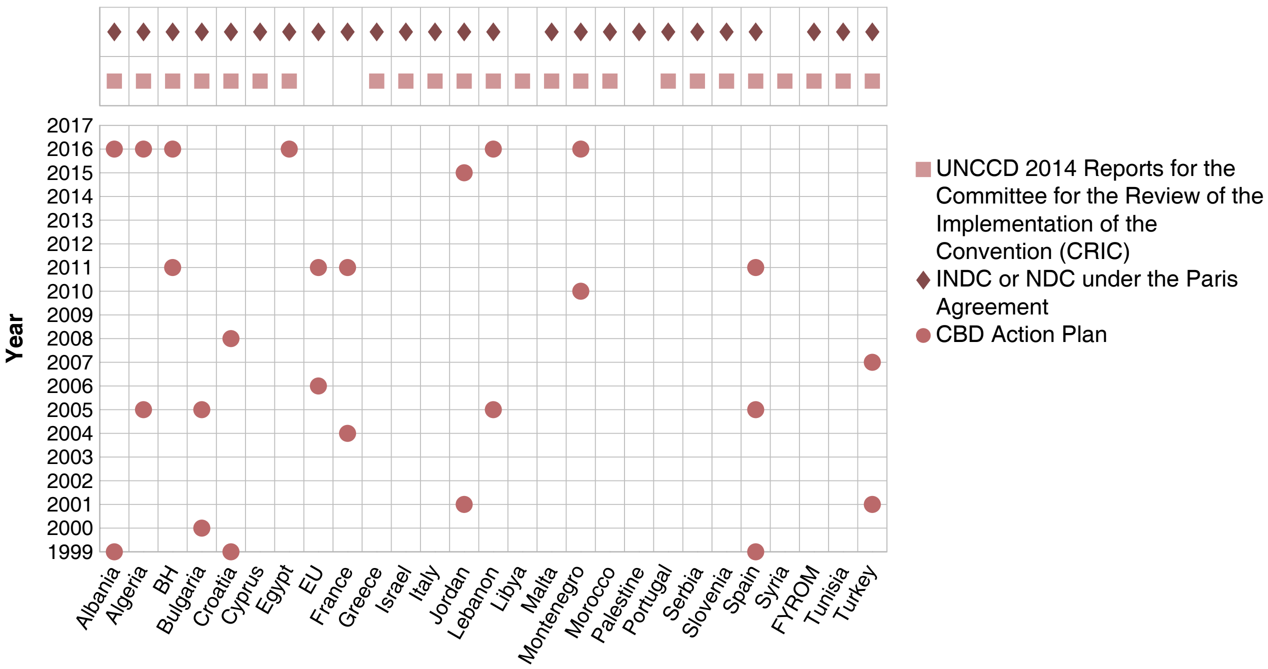

Figure 4.5. Mediterranean countries that have ratified all the main international conventions and agreements and dates (when available)

Note: BH = Bosnia and Herzegovina. EU = European Union. FYROM = the former Yugoslav Republic of Macedonia. Syria = Syrian Arab Republic.

During the Third Mediterranean Forest Week (Algeria, March 2013), Mediterranean countries adopted the Tlemcen Declaration and the Strategic Framework on Mediterranean Forests (SFMF). The Tlemcen Declaration represents an endogenous regional policy aiming to provide a common policy direction to support integrated management of Mediterranean forest ecosystems, focusing on the need to develop goods and services, promote resilience, and strengthen both capacity and resources. It calls on regional, national and local political and administrative authorities and stakeholders in the region to develop and adapt their strategies and policies (including governance) to support the sustainable development of forests. The Declaration also encourages the voluntary adoption of the SFMF.

The SFMF is a voluntary tool that identifies priorities for the forest sector in the Mediterranean and aims to be a source of inspiration for policymakers. It is also used to monitor progress through projects, initiatives and policies in key topics related to Mediterranean forests. Between 2013 and 2015, several strategic country-level documents have implicitly or explicitly referred to the SFMF. These include Algeria's National Programme for Rural Renewal (2014-2019), Tunisia's Strategy for Sustainable Development of Forests and Ranges (2015-2024), Portugal's new forest strategy, the 2015-2025 ten-year plan of the High Commission for Water, Forests and Fight Against Desertification in Morocco and France's 2015-2025 National Forest and Wood Programme.

The Agadir Commitment (ratified during the Fifth Mediterranean Forest Week held in Agadir, Morocco, in March 2017) addresses new challenges in international environmental and development policy, namely the Paris Agreement and the SDGs, and applies them to the Mediterranean context in order to:

- strengthen exchanges and synergies between global stakeholders in the restoration of Mediterranean forests and landscapes;
- help achieve SDG 15, especially target 15.3, by supporting efforts on the restoration of degraded lands in the Mediterranean;
- facilitate the mitigation and adaptation of Mediterranean forest landscapes to climate change, as well as the achievement of non-carbon benefits in order to support the implementation of Intended Nationally Determined Contributions (INDC) as part of the Paris Agreement (Article 5);
- actively promote forest restoration to reach the land degradation neutrality goals established by the United Nations Convention to Combat Desertification (UNCCD) and;
- contribute to Aichi target 15[3] of the Convention on Biological Diversity (CBD) by facilitating the conservation and restoration of biodiversity in Mediterranean forest ecosystems. Aichi Target 15 (to restore 15 percent of degraded ecosystems by 2020) echoes SDG Target 15.3 and has been addressed in strategic line 6 of the SFMF.

Additionally, FAO's "Global guidelines for the restoration of degraded forests and landscapes in drylands" have partially stemmed from *Silva Mediterranea*'s Working group on Desertification and Restoration of Mediterranean drylands.

National forest policies

Based on the data from the FRA 2010 (FAO, 2010), the State of Mediterranean Forests 2013 (FAO and Plan Bleu, 2013) reported that 14 countries in the region have general policy statements on forests, most of which are aligned with international commitments for Sustainable Forest Management (SFM).

The present study, based on data derived from the FAO national forest programme/forest policy database, country reports to global bodies (UNFF 8, 9 and 10), country reports to regional bodies (Forest Europe, Montreal Process), FAOLEX (forest-related legislation), project data bases of key international

[3] "By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks have been enhanced, through conservation and restoration, including restoration of at least 15 percent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification."

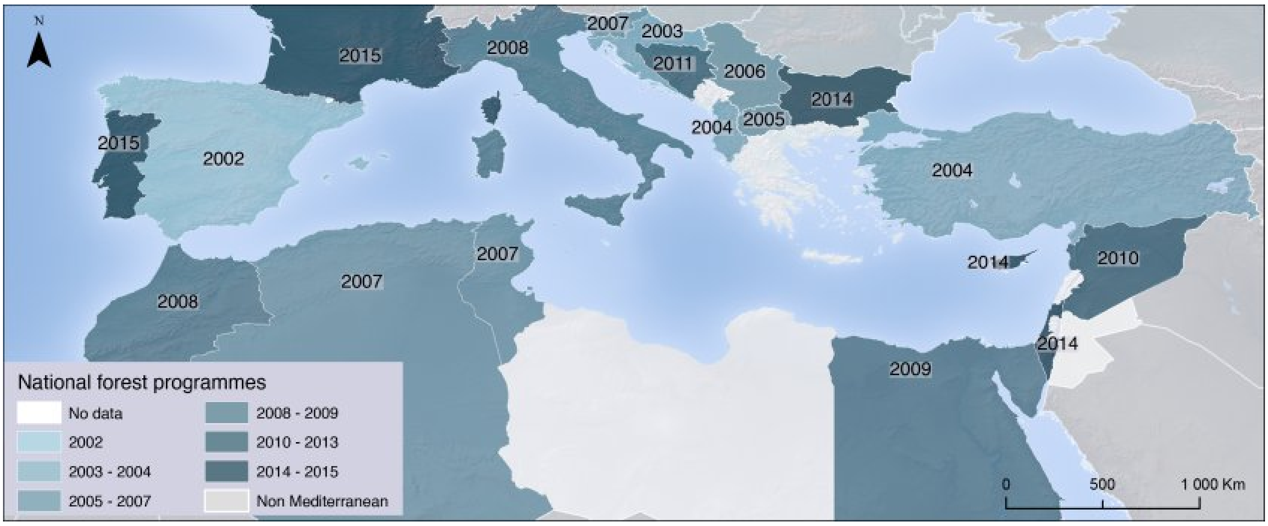

Figure 4.6. National forest programmes in the Mediterranean region
Note: The National Forest Plans of Cyprus and the Syrian Arab Republic have been defined but not approved.

organizations such as World Bank, FAO and bilateral development partners and others through a simple internet search, found forest-related policy documents from 27 countries in the Mediterranean region, as well as a number of policy documents at the EU level. National forest policy/programme documents were detected in 19 countries (Figure 4.6). The National Forest Plans of Cyprus and the Syrian Arab Republic have been defined but not approved. A National Forest Policy is being formulated in Jordan (expected 2018). It is assumed that following the adoption of Agenda 2030, countries will begin revising forest policy priorities and measures to align them to the achievement of SDGs and INDCs, but official information on this is not yet available.

National forest policy programmes/statements vary, and range from extensive documents (Box 4.3) to declarative, long-term sectoral visions. Sustainable forest management, however, is consistently prioritized. Ecosystem services and wood and non-wood forest products; forest restoration; forest degradation and deforestation; biodiversity conservation; climate change mitigation and adaptation; wildfire prevention; and communication, coordination, cooperation and capacity building are not systematically present in all policy documents and the level of detail varies. Results are presented in the sub-chapters below.

Box 4.3. National Forest Programme (Turkey)

The National Forest Programme of Turkey includes 30 policies, 56 strategies and 147 action proposals. A general framework for action includes short, five-year goals (2004-2008) and a longer 20-year term (2004-2023). The National Forest Programmes addresses “sustainable management of forest resources of our country and optimal contribution to people’s welfare and sustainable development of the country.”

Ecosystem services, wood products and non-wood forest products

Non-Wood Forest Products (NWFPs) and ecosystem services are the main outputs of Mediterranean forests, representing 65 percent of their total economic value (Prokofieva *et al.*, 2012). Priorities for forest products, NWFP and wood products alike, are homogenously expressed in policy documents throughout the region, while priorities for ecosystem services remain fragmented and intermittently implemented.

Payments for Ecosystem Services (PES) are a very effective mechanism for implementing policies promoting forests' total economic value. PES are part of the larger group of incentives for ecosystem services, which also comprise forest certification and a wide range of other measures. PES may also help to bridge the gap between conservation and development objectives in forest livelihoods. Article 5 of the Paris Agreement considers PES the main financing mechanism for sustainably-managed forests in the context of climate change.

Most Mediterranean forest policies include provisions for PES, but are implemented only sporadically. Implementation is highly problematic where land tenure and grazing permit rights are not clear or are based on informal use/tradition.

In order to facilitate PES implementation, countries throughout the region have developed cooperatives, associations, consortia and value chains comprised of small and medium enterprises (SMEs) to reduce negotiation costs, enable marketing of forest products, and thus contribute to rural livelihoods. As part of its National Forest Programme objectives, for example, Morocco undertook measures to establish and support forest cooperatives as a way to promote sustainable forestry and NWFPs (Box 4.4).

Box 4.4. Example of promotion of NWFP value chains through PES

In Morocco, the "Circular Economy Approach to Agro-Biodiversity Conservation in the Souss-Massa Region of Morocco" project, launched under the Middle East and North Africa Regional Programme for Integrated Sustainable Development (MENARID), aims to conserve agro-biodiversity and promote NWFP value chains through payments for ecosystem services. Products identified to be of local and global importance are argan (*Argania spinosa*), dates, figs, saffron, rose and honey. The development of this NWFP value chain is widely considered a mutually beneficial interaction between rural livelihood development and forest restoration and biodiversity conservation (Lybbert *et al.*, 2010; Taleb, 2014). The project implements Morocco's obligations under the Rio conventions, namely the UNCCD and the CBD, through the conservation of ecosystems such as the *Argania spinosa* and by integrating development objectives and biodiversity conservation. The project establishes direct linkages with the strategic priorities of Morocco's National Biodiversity Strategies and Action Plans (NBSAP) (October 2002), namely Objective 32 (Develop programmes for conservation, development and valorization of the argan tree) and Strategic Axis 3 (Contribute to the improvement of the living conditions of the populations thanks to the effective implementation of the NBSAP).

Agri-Environmental Measures (AEM) under the EU Common Agricultural Policy are an example of Result-Based AEMs (RB-AEMs), the most recent innovation in AEM payments. RB-AEMs are of particular interest due to their potentially higher conditionality, linking payments to the provision of a desired environmental outcome rather than to prescribed management activities. They can also help to deliver more targeted conservation outcomes for a range of species. Twenty RB-AEMs have been launched in the EU since 2017 and, consequently, will need to be implemented by the EU countries of the Mediterranean.

Market-based instruments aim to stimulate consumer and supplier behaviour through the creation of financial motivations to properly manage forest resources and conserve the ecosystems in which forest products, especially NWFPs in the case of the Mediterranean region, are produced. Many

NWFP species have a wide, genetically determined variation in product yield and quality; indeed, some industries exist only because of this variation (FAO, 2014). Marketing of NWFPs has been widely promoted as a conservation measure based on the assumption that an increase in resource value is a general incentive for local populations and forest users to manage forests and woodlands more sustainably FAO (2010).

Sustainable forest management and forest and landscape restoration

Sustainable forest management has been introduced into regional policies following the inclusion of the concept as part of the Forest Principles of Agenda 21, adopted at the 1992 United Nations Conference on Environment and Development in Rio.

The EU adopted its new Forestry Strategy in 2013, using as its guiding principle SFM and the multifunctional role of forests. France, Portugal and Bulgaria have reviewed their forest policies and promoted new laws on forests and forest management based on SFM with a view to socioeconomic development. Lebanon launched its first national forest programme in 2011 to strengthen SFM and address deforestation. Jordan is reviewing its forest policy and action plan to ensure alignment with the SDGs, INDC and national development strategies: the "Jordan Way to Sustainable Development."

While all the analysed policy documents referred to the concept of sustainable forest management, its actual implementation is hard to assess from these documents alone.

Forest inventories are carried out throughout the region. Country Reports for FAO's Global Forest Resource Assessment are submitted regularly, although there were some exceptions for FRA 2015 (Libya, Palestine and Syrian Arab Republic).

All Mediterranean countries have ratified the UNCCD and most have implemented the required National Action Plans. In 2013 for example, Turkey, in collaboration with FAO and the Global Environment Facility (GEF), implemented a project to strengthen national capacities in line with its National Action Plan to Combat Desertification, the UNCCD 10-Year Strategy and to comply with the UNCCD reporting and review process. A number of countries have included pledges and afforestation plans into their policy documents (Box 4.5).

Four countries in the region are part of the Great Green Wall initiative (Algeria, Egypt, Libya and Tunisia). In addition, a cooperation agreement was signed in 2016 between the Ministry of Forestry and Water Affairs of Turkey and the Pan African Agency on Great Green Wall.

Box 4.5. Pledges and afforestation plans reflected in the policy documents

Pledges and plans for afforestation are present in the forest polices of: Algeria (increasing the woodland/forest cover in northern Algeria from 11 to 13 percent of the land area by 2020 (National Reforestation Plan)), Lebanon (6 000 hectares to be afforested by 2019 under the 40 million tree initiative), Portugal (reforestation rate of 80-100 percent of burned areas) and Turkey (achieving 23 million hectares of forest cover/30 percent of total land by 2023 (National Forestry Programme)). Pledges vary greatly depending on GDP, country size and international financing through cooperation. Yet the main drivers of Forest and Landscape Restoration and SFM are political commitment and policy-based incentives.

Biodiversity is deeply rooted in forest policies throughout the region

Recognizing the Mediterranean basin as a biodiversity hotspot, all countries in the Mediterranean region are signatories to the Convention on Biological Diversity. The EU Forest Policy explicitly pledges to reach its Aichi Targets in the framework of the CBD.

According to Aichi Target 17, "By 2015, each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan." Fifteen countries in the region and the EU have an action plan or a strategy as required by the CBD (Article 6). Nine countries in the region have mapped national targets against the Aichi Biodiversity Targets, showing that, when present, National Biodiversity Strategies and Action Plans (NBSAPs) cover all Aichi Targets. In paragraph five of decision X/2 (Strategic Plan for Biodiversity 2011-2020), the Conference of the Parties "urges regional organizations to consider the development or updating of regional biodiversity strategies, as appropriate, including agreeing on regional targets, as a means of complementing and supporting national actions and of contributing to the implementation of the Strategic Plan for Biodiversity 2011-2020." Despite this strong emphasis and the existence of nine Regional Biodiversity Strategies and Action Plans, such as the Southern African Development Community (SADC) Regional Biodiversity Strategy and the MERCOSUR Biodiversity Declaration, no such strategy exists in the Mediterranean region. Only France has different strategies in place at the sub-national level (six for mainland France and one for its overseas territories).

Recognition of biodiversity is deeply rooted in forest policies, demonstrated by its prevalence in forest policy documents across the region, the main focus being the biodiversity-climate change nexus. Ongoing conservation and expansion of protected areas, including explicit mention of Ramsar sites (Morocco) and EU Natura 2000 sites (the Mediterranean Region contains 2 928 Sites of Community Importance (SCIs) under the Habitats Directive and a further 999 Special Protection Areas (SPAs) under the Birds Directive. There is considerable overlap between several SCIs and SPAs, meaning that figures are not cumulative. It is estimated that together they cover around 20 percent of the total land area in the region). Biodiversity conservation through rural development, fiscal measures and PES is proposed in EU, Moroccan and French forest policy. A new Italian law on the economic development of protected areas is under discussion at time of writing.

Forest policies envisage biodiversity conservation through *in situ* and *ex situ* conservation. Target 7 of

Figure 4.7. Reforestation, Maâmora Forest, Morocco
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the Global Strategy for Plant Conservation 2011-2020 (CBD 2010) recommends the inclusion of 75 percent of threatened species in accessible *ex situ* collections by 2020. A number of forest agencies or ministries in the region have published and regularly update official guidelines and supporting instruments (Box 4.6). In Italy, for example, the Italian Institute for Environmental Protection and Research (ISPRA) has recently published "Procedure per il campionamento *in situ* e la conservazione *ex situ* del germoplasma" (Guidelines for *in situ* sampling and *ex situ* conservation of germplasm) for the purposes of obtaining quality reproductive material for Forest and Landscape Restoration (FLR) initiatives.

Policies and instruments on climate change mitigation and adaptation are in their initial phase/stage in the region

Article 5 of The Paris Agreement highlights the major role played by forests in climate change adaptation and mitigation, particularly in the context of NDCs (Nationally Determined Contributions). The Paris Agreement sees PES mechanisms for carbon fixation as the main mechanism for financing this contribution.

In the region, seven countries and the EU (comprising all Member Countries, with France publishing an additional NDC for its overseas territories) had published NDCs at the time of analysis (Annex E). While all NDCs refer to forestry as a key sector, only Algeria, Jordan and Morocco link climate change policies and related commitments with quantifiable SFM or FLR measures (Table 4.3, Figure 4.7). In the case of Lebanon, the country has committed to implementing its Intended NDC through its already existing national restoration plan (i.e. the 40 Million Tree Programme).

As the average year for the publication of National Forest Programmes in the Mediterranean region was 2009, NDCs and the Paris Agreement are not mentioned in most forest policies. Since the average validity of NFPs is 20-25 years, revisions of forest policy are expected to take place in order to foster the role of forests in NDCs.

The primary focus of forest policy in the Mediterranean region is on researching the ecophysiological response of forests to climate change. Policies are therefore oriented towards an adaptive approach to climate change.

Policies on biofuels from forest resources exist throughout the region. The scope of these policies varies greatly, from regulation and monitoring of firewood consumption in rural areas to the use of wood products as an alternative for coal and other non-sustainable energy resources.

Table 4.3. Linkages between climate change policies and SFM or FLR measures

Country	SFM or FLR measure
Algeria	"The country aims to accelerate and intensify its National Reforestation Plan with a global objective of reforestation of 1 245 000 ha"
Jordan	Afforesting 25% of barren forest areas in the rain belt areas on which the rate of precipitation exceeds 300 mm
Morocco	"For 2020: The replenishment of 200 000 hectares of forests. For 2030: Protecting 1 500 000 hectares against erosion, which will include the prioritization of 22 basins, for USD 260 million" "Afforesting 600 000 hectares for USD 46 million" "Between 2020 and 2030, Morocco estimates that the cost of implementation of adaptation projects for the water, forestry and agriculture sectors, the sectors most vulnerable to climate change, will at a minimum reach USD 35 billion"

Green procurement of timber for construction is considered by a number of countries, often combined with policies regarding forest certification. In France, a Governmental Action Plan (MEFI, 2006) on public procurement and sustainable development (April 2004) included a project to prepare a Prime Minister's advice note ("circulaire") for public buyers (Premier Ministre, 2005). It established a target of ensuring 50 percent of timber and wood products bought by public buyers were sourced from legal and sustainably managed forests by 2007 and 100 percent by 2010.

Box 4.6. Policy instruments to support private sector investments in biodiversity conservation

One of the primary barriers to private sector investment in projects that have a positive impact on biodiversity in EU Member Countries is a lack of experience with biodiversity conservation through financial investments. To bridge this gap the EU, together with the European Investment Bank (EIB), has launched the Natural Capital Financing Facility, a financial instrument blending EIB funding with grant funding from the European Commission (Ezzine-de Blas *et al.*, 2016). EUR 150 million were allocated to the fund over the 2015-2017 period.

Wildfire prevention is among major declared policy priorities

As stated at the outset of the Agadir Declaration, forest wildfires are a specific regional threat to Mediterranean forest ecosystems, requiring specific regional responses, such as common monitoring initiatives supported by statements of regional cooperation in forest policy. The European Forest Fire Information System (EFFIS) network comprises EU Member States and other Mediterranean countries such as Algeria, Lebanon, Morocco, Tunisia and Turkey and could benefit from new partnerships in the region (Box 4.7). The Regional Southeast European/Caucasus Wildland Fire Network (covering Turkey, the Balkans, the southern Caucasus countries and adjoining Romania and Ukraine) is an active regional network acting as a forum for mutual consultation and a basis for cross-boundary cooperation and training in fire management.

Box 4.7. ˝Firewise-Lebanon˝

"Firewise–Lebanon" is a collaborative initiative under the Lebanon Reforestation Initiative, inspired by the "Firewise–US" programme. It strives to empower local communities to collaborate to prevent and reduce wildfire risks, which have an adverse economic, social and environmental impact on local communities. In partnership with the University of Balamand, the programme was piloted in 2014 in Kaftoun and was extended to five municipalities by 2016. Sites were chosen based on a set of criteria including high fire risk and socioeconomic and environmental value. Stakeholders in municipalities worked to develop an action plan that featured social and technical activities equally.

At least six countries in the Mediterranean region (Lebanon, Morocco, Portugal, Spain,[4] Tunisia and

[4] Spanish forest policy includes forest fires, http://www.mapama.gob.es/es/desarrollo-rural/temas/politica-forestal/incendios-forestales/

Turkey[5]) have specific strategies relating to forest fires. In Turkey, forest fire control is included in its Constitution (Box 4.8). Portugal created a special Permanent Forest Fund by earmarking part of its petrol tax after the country experienced severe wildfires in 2003. Andalusia (Spain) has a specific financial mechanism to support grazing practices as part of fire prevention (Box 4.9). In the majority of cases, policies and instruments in the region persistently lack integration between SFM practices, biodiversity conservation, climate change and wildfire prevention.

In policy documents, forest wildfires are often treated as an emergency rather than part of a continuous interaction between society and the environment in the context of climate change. In addition, at the national level, extinction generally receives much greater attention (and funding) than prevention, which can lead to over-expenditure (as more investment in prevention would reduce overall expenditure). Prevention and awareness-raising are key factors in the Mediterranean region, as more than 90 percent of fires are human-induced.

Box 4.8. Forest fire control in Turkey

All forests in Turkey are under State control. The fight against forest fires has been sufficiently addressed in both the Constitution and national laws. Four of the 177 articles in Turkey's Constitution relate to forestry. Article 169, for example, refers to the protection and development of forests: "The State shall enact the necessary legislation and take the necessary measures for the protection of forests and the extension of their areas. Forest areas destroyed by fire shall be reforested; other agricultural and stockbreeding activities shall not be allowed in such areas. All forests shall be under the care and supervision of the State… Offenses committed with the intention of burning or destroying forests or reducing forest areas shall not be included within the scope of amnesties or pardons on other occasions." Turkey has established the organizational structure necessary to support this and all expenditure is covered by the State. In addition to public officials, the citizens living near fire zones also play assigned roles in fire prevention. Related costs are also covered by the government. The State also pays compensation for loss of life during the fight against fire. Fire-affected areas are reforested in the fastest possible way.

Research, communication, coordination, cooperation and capacity building

Advancing scientific knowledge and fostering innovation is essential for sustainable forest management and to guide policymakers in the Mediterranean region. Countries of the Mediterranean basin, as well as other regions with a Mediterranean climate (e.g. the California chaparral and woodlands eco-region of California and Baja California, southern and southwestern Australia, the Cape province of South Africa and the Matorral eco-region of central Chile), face similar challenges regarding forest ecosystems and the provision of crucial goods and services in the context of climate change. It is critically important to reinforce scientific cooperation on Mediterranean forests and international cooperation between other regions with Mediterranean climates, in order to reduce fragmentation and maximize the impact of research, education and capacity building activities at all levels.

The overall Mediterranean region research budget totals EUR 295.5 million per year. A survey (Nardi *et al.*, 2016) conducted in 13 Mediterranean countries between 2010 and 2011 shows that France (EUR 87.4 million), Spain (EUR 54.1 million) and Italy (EUR 50.8 million), alone account for 80 percent of

[5]Forest fires policy of Turkey, http://www.carfu.org/?p=1393

the total budget allocated for forest research. These countries also make the greatest contribution to Mediterranean forest research. Basic research on Mediterranean forest ecosystems is primarily conducted on ecophysiology, while applied research mainly relates to land-use and degradation, biodiversity and conservation and forest fire research topics. Research cooperation could mitigate the polarization of resources and broaden the topics covered.

Eighty-eight countries published at least one document related to Mediterranean forest research between 1980 and 2014 (Nardi *et al.*, 2016). Spain published 44 percent of total publications, followed by Italy and France. Other Mediterranean countries, such as Portugal, Greece, Israel and Turkey were among the top 20 publishers.

Key to fulfilling the objective of the SDGs in a fragmented region such as the Mediterranean is improving engagement between researchers, public and private stakeholders, communities and decision-makers through cross-sectorial communication and cooperation, ultimately making research more relevant to the policy-making process. The sector could regularly review its standing, including its institutional design, in order to achieve the critical mass needed to influence and impact policy and society more broadly. This could be achieved through long-term research partnerships to align cooperation mechanisms and networks in the region.

Next steps and future challenges and opportunities in Mediterranean forest policies

Current forest-related policy documents in the Mediterranean region require improvement. These include:

Improved access to and availability of formal policy documents. Making policy documents available to the general public in at least two languages (a national and international language) is an integral and cost effective way to establish an open and collaborative environment with public and private stakeholders and enhance communication and transparency of decisions at the national and international levels.

Legally-binding conventions can mandate public availability of policy documents, decisions and data on the environment in different Mediterranean countries, i.e. the Aarhus Convention, which requires Parties (EU Member Countries and other signatory countries) to make policy decisions and data easily available to the general public in the framework of a continuous participative interaction.

FAO provides a number of relevant databases to facilitate this process, namely the forest policy database under the FAPDA[6] and legal forestry documents under the FAOLEX. While different in scope, the overall objective of these databases is to correct informational asymmetries between law and policy in order to facilitate international and regional cooperation. Through its Agriculture Information Management Systems (AIMS) platform, FAO has also recognized the importance of open data and information as part of the capacity building process. These tools could serve as a platform to share information on policies relevant to forests and legal documents for policymakers in Mediterranean countries.

Concrete measures to achieve obligations under international agreements must be included in forest programmes and action plans. Practically all of the analysed countries have ratified basic international conventions and agreements (see Annex D). In general, countries continue to amend their long-term policies and laws to be more consistent with the concept of sustainable forest management. Yet while many countries (mainly outside the EU) have established sustainable forest management as an overall goal, they have yet to define specific objectives, measures and financial mechanisms.

[6] http://www.fao.org/in-action/fapda/forestry-tool/policies/es/

Box 4.9. PES schemes for wildfire prevention

The Red de Áreas Pasto-Cortafuegos de Andalucía (RAPCA) (Spain) is a scheme that rewards grazers for managing firebreaks (technically known as "fuelbreaks") through intensive seasonal grazing to reduce vegetation biomass. It comprises around 6 112 ha involving 206 farmers.

The scheme began in 2005 and payments to grazers commenced in 2007. It targets publicly-owned forestland in Andalucía subject to high wildfire hazards. Preventing wildfires and actively maintaining extensive grazing systems are key elements in regional conservation strategies.

Payments are calculated with regard to grazing difficulties (steepness, distance from the farm and vegetation type) and adjusted according to annual results. Farmers will receive payment by achieving one of three possible results (expressing the success as percentage of objectives that have been reached): 100 percent, 75 percent or 50 percent. Payments of between EUR 42 and 90 per hectare are calculated in relation to these percentages. These amounts can be reduced or cancelled if the removal of vegetation is deemed insufficient by inspectors (i.e. where less than 50 percent of vegetation has been removed).

National forest policies must be reviewed to respond to new global priorities (SDGs, Agenda 2030) and supported by implementation mechanisms. The analysis of available policy documents and relevant policy instruments showed that although some forest-related national policies in the Mediterranean region date from 1993 (Slovenian Forest Act), the majority of documents were adopted after the year 2000. It is still desirable to review these polities to align them with the Global Forest Goals, SFM elements and corresponding criteria and indicators. This will also facilitate the measurement of achievements and international reporting.

Countries continue to develop longer-term policies to be more consistent with the concept of sustainable forest management, aiming to balance economic, social and environmental factors.

Many countries promote rural community development through policy measures enabling them to use and sustain forest goods such as non-wood forest products and ecosystem services.

Local stakeholder involvement and coordination with the policies of other sectors should be an integral part of all policy development or review processes.

Concrete strategies and action plans supporting the implementation of policy objectives will give a more concrete character to the SFM in policy documents. The forest-water nexus is not often addressed in forest policies in the region (with the exception of Spain and Turkey), despite the classification of the southeast Mediterranean as physically water scarce. In Turkey, for example, management of forest watersheds, the fight against drought and desertification and the implementation of relevant policies fall within the authority of the Ministry of Forest and Water Affairs, where a Department of Soil Conservation and watershed rehabilitation under the General Directorate of Forestry is entitled to soil conservation and watershed rehabilitation to "obtain high quality and maximum amount of water in water basins."[7]

Only Morocco has a specific policy for peri-urban and urban forests, which is deeply connected to efforts to combine the combat of desertification with the provision of ecosystem services.

A clear policy framework is needed to promote ecosystem services and Non-Wood Forest Products. In order to be implemented successfully, PES schemes require a clear and stable land tenure framework. Forest management plans should be designed or updated to include all factors

[7] https://www.ogm.gov.tr/Baskanliklar/ToprakMuhafazaveHavzaIslahi/Sayfalar/Toprak-Muhafaza-ve-Havza-Islahi.aspx

relative to the promotion of non-wood forest products and ecosystem services, possible impacts of climate change and adaptation measures. A system of extension, capacity development and education of young specialists, from technicians to forestry engineers, must also be designed and supported.

Broad and flexible institutional research is needed, since PES schemes established by State Agencies generally involve a contract with the individual provider of ecosystem services based on ecological conditions. All other measures (eg. AEM/RB-AEM) should be considered and applied if possible.

Concrete strategies and measures are required for effective wildfire prevention. Establishing conditional grants and incentives to encourage wildfire-resistant species selection for reforestation and restoration could be considered by extension services and has already been included in forest policy documents in one country in the region ("Monitoring application of subsidies for Reforestation of Agricultural Land, in order to carry out the appropriate preventive silviculture tasks, as well as to consider fire hazard in the choice of species," MMA, 1999).

Bottom up and community approaches to wildfire prevention, as well as communication and campaigns aimed at the general public, are encouraged in policies throughout the region, even though no regional study on the implementation of these approaches has been made.

Since challenges posed by climate change, energy and biodiversity issues are exceptionally complex and occur over the long-term, overcoming them necessitates profound change, benefiting some actors and harming others. Mobilizing enough wood for energy to establish the right balance between carbon sequestration and substitution and conserve biodiversity without sacrificing wood supply, demands highly sophisticated policy-making, sharply-focused policy instruments and strong political will. The policy environment will be increasingly difficult, as government budgets are cut and international commitments and negotiations increasingly influence domestic policies.

Will today's policies and institutions rise to the challenge? Doing so will require improved monitoring systems, the ability to reach consensus on complex issues (inside and outside the sector), as well as creating and implementing highly-targeted policy instruments to make the best possible use of limited government funds. High level political will is also necessary, to ensure that forest management is not only sustainable, but makes the best possible contribution to the sustainable development of society as a whole UNECE and FAO (2011b).

The results of the analysis undertaken here indicate that:

- The European Common Agricultural Policy and the EU Forestry Strategy, as well as regional initiatives and declarations, form a solid framework to guide national forest policy development;
- Countries continue to develop longer-term policies and laws to be more consistent with the concept of SFM, but further revision is required to align policy priorities with the objectives of Agenda 2030;
- The role of Forests for SDGs and national development of forest policy and measures must be better articulated;
- Reflection, precision and evidence-based data, augmenting the role of forests in NDCs in the framework of the Paris Agreement, should be enhanced and broadly used at national and regional levels;
- PES schemes require additional assistance and, possibly, regional solutions;
- Communication, Coordination, Cooperation and Capacity Building in Mediterranean forest policy requires further support and facilitation; and
- Harmonization between Mediterranean forest policies, concrete regional initiatives and policy frameworks must be enhanced.

12 Participation: a pillar of sustainable forest management in the Mediterranean

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What are participatory approaches and the conditions for their implementation?

What are participatory approaches?

Overall concept. Participation is one of the founding principles of good governance and democracy (UN-ESCAP, 2009). It raises local community awareness and empowers its members by sustaining rights and responsibilities. This improves the quality, acceptance, stability and sustainability of management decisions, resulting in the more efficient use of available public resources (FAO *et al.*, 2000; Stringer *et al.*, 2006; Kuper *et al.*, 2009). Participatory approaches strive to embrace the diversity and complementarity of stakeholder views, balancing their multiple and sometimes conflicting interests and establishing coherent and accountable rights and obligations to manage forests according to a shared vision and shared objectives, for the common good (Borrini-Feyerabend, 1997a,b).

Participation can be promoted at all levels and stages of the forest planning, management and decision-making process. It can work towards various goals, from defining and prioritizing forest management objectives, implementing, monitoring and evaluating local forest management activities, to the design of national, regional and international forest strategies and policies (see Chapter 11).

Participation by stakeholders (public/private, including local populations) in the sustainable management of natural resources in general, and in the management of forests in particular, is at the heart of many issues such as food security, poverty alleviation, rural development and environmental protection.

Participatory management can be defined as joint actions by local people and management staff with the objective of formulating management objectives and selecting the best available alternatives for their implementation. It relies on practices, discussion spaces and institutions that allow local actors/stakeholders, including those outside the formal politico-administrative circle (citizens, communities, associations, administrations, businesses, etc.), to take a more active role in local affairs. This includes influencing decisions affecting their territory and participating in formal and informal meetings, consultations and exchanges (FAO, 2005).

Participation begins from the observation that projects which are conceived and implemented without participation by the social groups for which they are intended, generally yield poor or unintended results. Moreover, controversies surrounding sustainable development are gradually changing the way development is conceived. Indeed, the existence of a formal, local organization supporting participation by rural communities has almost become a prerequisite for donor assistance. Participation aims to solve serious problems by redefining access to resources and reorganizing relationships between local communities and the state. Flexible, dynamic, proactive, long-term decision-making processes are therefore required to overcome factors such as: uncertainty; large and diverse spatial and temporal scales; complex intersections between multiple levels; and the ambiguous nature of responsibilities and impacts. These factors require an approach that facilitates management of conflicts sometimes anchored in an irreducible plurality of values and facilitating the progressive integration of qualitatively different information.

Participation has been increasingly promoted over recent decades in the Mediterranean region. This has already had significant impacts on the design and implementation of projects targeting vulnerable populations more likely to be involved in biodiversity conservation and development activities. With the advent of climate change, participation occupies an even more prominent place in current debate and action.

Concertation: a preliminary step. According to Beuret (2006), "concertation is based on a horizontal dialogue between the participants, whose objective is the collective construction of visions, objectives and joint projects, in order to act or decide together. Sharing the decision-making power between the participants is not a requirement and the decision is not the primary objective of the consultation, the interest of which lies above all in building common objects together."

For a project to be sustainable, actors must have ownership of it, and actors must therefore be consulted during its design and implementation. Concerted environmental management, which also refers to notions of understanding and collective action that go beyond consultation, would be a subset of participation, which is a broader and inclusive concept. Indeed, for Beuret, participation means to "take part in something," whereas "concertation" implies that parties project something in common.

Concerted management is a process in which actors collaborate to manage one or more shared/common good, space or territory or influence actions and decisions that determine the future of these common assets. Concerted management could include simple information-sharing and dialogue

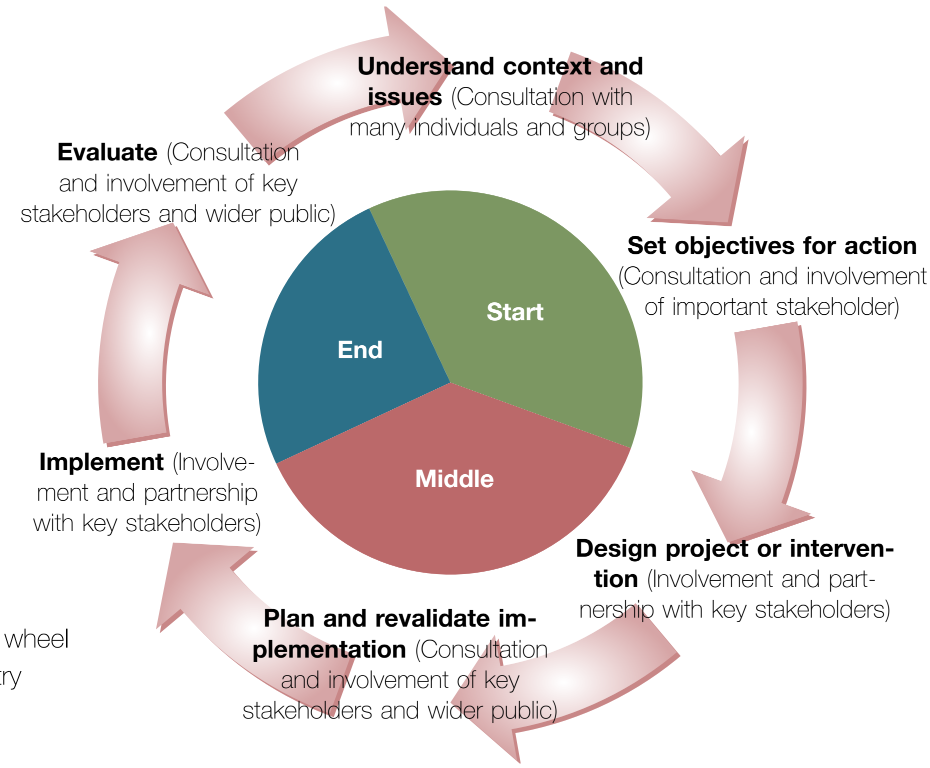

Figure 4.8. The engagement wheel
Source: Adapted from Forestry Commission (2011).

with participants, consultation with certain social groups, negotiation, etc.

Concertation is a preliminary step prior to the negotiation process and involves looking for compromises and consensus on the sustainable and participatory management of natural resources. Negotiation outcomes should result in stakeholder engagement and the conclusion of win-win contracts.

Rural grassroots communities: a focal point of participatory development policies. Natural resources – land, water, forest, pastures – often form the foundation of rural economies and are located in territories in which community members have individual, familial or collective rights inherited over a long period. A community's territory forms not only the physical foundation of its economy but also the basis for its members' cultural and social identification and the geographically-defined support of the local political system.

The rhetoric of sustainable development thus places an emphasis on the participation of rural populations and communities. Local or traditional knowledge is increasingly valued within the framework of grassroots participatory approaches, which should allow local actors to take responsibility for their own development (self-reliance). Emphasis is placed on the need to empower and strengthen communities' capacity to self-govern. As social bodies, they must therefore attain legal status and competence to authorize the conclusion of contracts and budgets, in recognition of their ownership (either individually or collectively) over the natural resources falling within their territory (Lazarev, 1993). Although theoretically straightforward, this framework is not widely developed or uncontested.

From the "participation injunction" to the negotiated management of natural resources. Despite the repeated "injunctions" to participation, it is now recognized that the approaches adopted by many development projects do not consider the complex changes affecting societies and the need to genuinely negotiate the terms and conditions for the implementation of other forms of multi-actor governance. Participatory approaches have been widely used in the field of natural resource management, in which they are presented as a solution to environmental problems analysed through the lens of "the tragedy of the commons" (Hardin, 1968). Several authors argue that participation encourages consideration of stakeholder interests, promotes transparency in decision-making and hold public services accountable, even making it possible to avert the above-mentioned tragedy (e.g. Ostrom *et al.*, 1999). By applying participatory programming techniques, the management of natural resources can play an educational role by changing the communication style of bureaucrats and populations. In short, it would be a school of local democracy. This implies reaching explicit and negotiated compromises between multiple actors involved in structures that become the locus of power and decision-making.

Levels and forms of participation

Participation at different levels. Participation follows and iterative process, taking place at different levels/stages of forest management and including different goals (Figure 4.8), including:

- Design of national/regional forest strategy and policy within the international context and in concert with different sectors;
- Diagnosis of a territory's assets, strengths/weaknesses and opportunities;
- Definition and prioritization of the objectives of local forest management within a national/international policy framework; and
- Implementation, monitoring and evaluation of forest management activities.

Different stakeholders generally participate at different stages in a given project and process, with various degrees of decision-making power.

Participatory approaches can take different forms depending on the people/institutions implementing them, their objectives, available means and local contexts. They can include stakeholder information and

Box 4.10. Model Forest

What is it? A Model Forest is simultaneously a place, a partnership and a process. The place is a large landscape or ecosystem that typically contains a forest. The partnership is voluntary and inclusive, with partners ranging from local farmers to national policy-makers. The process is a journey towards sustainability through dialogue, experimentation and innovation.

A Model Forest is a voluntary association of people living in a particular territory, interested in discovering, defining, enhancing and guaranteeing its sustainability and sharing their experiences and knowledge to contribute to global environmental goals. The three pillars of the Model Forest are Landscape, Partnership and Sustainability.

Key figures: Instituted in 1992 in Canada, the initiative is now international, involving 71 sites in more than 30 countries (2016). Model Forests cover more than 30 million ha of forest landscapes.

Actors involved: All actors with an interest in forests, including: users, owners and managers of natural resources; forestry and other industries; NGOs; local authorities; local communities; universities and research centres. The structure of Model Forests is a partnership involving all stakeholders, which can take a legal form (organization, legal agreement or other) depending on the country's legal system.

Funding: Member fees, local, national and European public subsidies, and private contributions (gifts and sponsorship).

Governance: Lead structure and partners (i.e. people or organizations with an interest in forest use/management such as foresters, hunters, farmers, mushroom pickers, visitors, students, environmentalists, local elected representatives), steering committee, technical committee, working groups.

Actions: Improving forest exploitation (timber, biomass and non-wood forest products extraction, transformation and certification), afforestation/reforestation, organization of actors in the forest value chain, infrastructure development, forest fire prevention, developing value of recreational amenities (environmental education, eco-tourism, etc.), soil, water and biodiversity conservation and monitoring, pests and disease control, awareness-raising, etc.

consultation, shared management, co-management, collaborative management or joint management, co-innovation, etc. (Figure 4.11).

The roles of institutional and other actors will differ according to the type of land involved and its legal status. Some legal texts governing rangelands and forests have been ratified independently, without any reference to or links between the uses of the elements supporting the rural population's primary economic activity (e.g. livestock husbandry).

The implementation of so-called participatory projects aimed at sustainably managing natural resources and improving the living conditions of rural populations have often failed due to a lack of coordination between the numerous stakeholders.

The complexity of participatory resource management lies mainly at two levels:

- numerous stakeholders interact with rural areas: several departments/authorities have responsibility for managing specific areas but their actions are not coordinated on the ground. Stakeholders include institutions, organized groups or individuals who interact with and benefit from the management of a rural area. Moreover, they are located both inside and outside the managed area, so identifying (and justifying) boundary judgments (de Loë and Patterson, 2018) is key;

- stakeholder roles, objectives and strategies: each department/authority adopts strategies relating to the domain or sector it manages without any common strategic vision. Stakeholders have various expectations and their compatibility or contradictions are not necessarily known.

Therefore, it is critically important to:

- encourage mutual understanding and consensus between stakeholders on the objectives and management of natural resources;

Box 4.11. Forest Territory Charter (FTC)

What is it? The FTC is a context-specific, local development project typically involving a diagnosis, the identification of orientations, the development of scenarios and the implementation of an action programme. It results in an orientation document signed by local stakeholders, which encourages concerted, inclusive and sustainable forest management that reconciles their environmental, economic, social and cultural functions (i.e. their multi-functionality). It frames contracts and/or conventions between forest territory owners, managers and users to facilitate the effective implementation of agreed conservation and valorization activities.

Key figures: The FTC was established in France in 2001 following the ratification of its Forest Orientation Law. In 2016, 143 FTCs were implemented in more than 6 000 municipalities and covering about 5 million forest hectares (i.e. 32 percent of all forest area in mainland France, Figure 4.9), including 72 percent of private forests (Data from FNCOFOR, 2016).

Actors involved: National and local administrations, regional nature parks, forest owners and managers, forest value chain actors, farmers and their organizations, chambers of agriculture, NGOs, forest users, etc.

Funding: Public subsidies at the European, national, regional and local levels, and partial funding from lead organizations.

Governance: Consisting of a lead (e.g. local administration/municipalities, regional nature parks, agricultural chamber) and partners (people or organizations with an interest in forest use/management such as foresters, hunters, farmers, mushroom pickers, visitors, students, environmentalists, locally-elected representatives); a steering committee, technical committee and working groups.

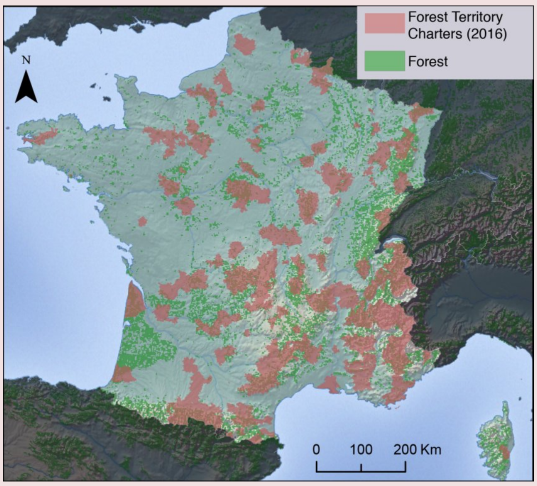

Figure 4.9. French national network of FTCs
Source: FNCOFOR (2016).

Actions: Improved forest exploitation (timber, biomass and non-wood forest product extraction, transformation and certification), afforestation/reforestation, organization of forest value chain actors, infrastructure development, forest fire prevention, recreation and amenity value development (environmental education, eco-tourism, etc.), soil, water and biodiversity conservation and monitoring, pest and disease control, awareness-raising, etc.

- identify external or broad linkages between interests, such as power and political relationships, and monitor them over long periods as societal expectations evolve.

Box 4.12. Participatory forestry in Lebanon: improving forest governance through participatory approaches

Lebanon's Ministry of Agriculture (MoA) monitors the management of forest resources through its Directorate of Rural Development and Natural Resources, the lead national authority responsible for developing the strategy for the protection and management of forests and rangelands.

Lebanon's decision to manage its forest resources using participatory approaches through its 2015 National Forest Programme has put the MoA ahead of neighbouring countries in terms of the adoption of participatory initiatives to manage forest resources.

A participatory governance model would support adoption of protection measures and regulations, enforced by the responsible public entity. The approval of neighbouring communities would increase acceptance of these decisions, leading to the implementation of successful management practices.

A process for engaging local communities in the management of resources is designed and tested in pilot forest areas to improve governance practices (Figure 4.10).

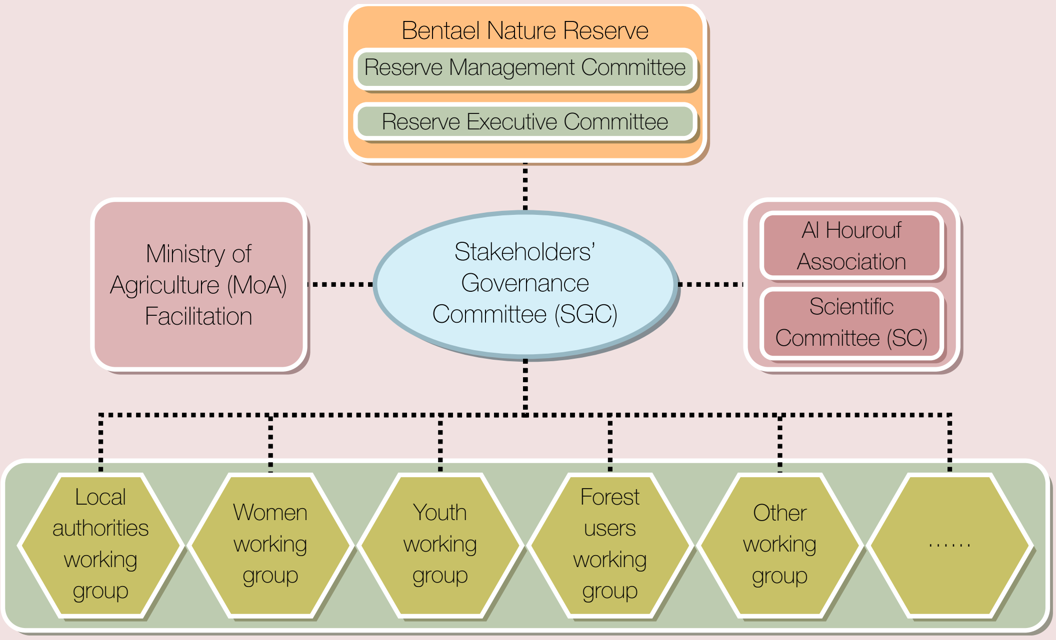

Figure 4.10. Process for engaging local communities in the management of forest resources in Lebanon

The current structure and methodology is an important tool for improving forest resource management. It is anticipated this process will be replicated, which will further consolidate improved management practices. It is therefore important to test this methodology at different sites and in different management contexts to encourage continued improvement.

The diversity of participatory approaches in the Mediterranean region. Mediterranean forests have been shaped over centuries by human activities and biotic and abiotic factors, giving rise to very diverse and often resilient ecosystems. Today, however, anthropogenic activities, coupled with global warming, are exerting significant pressure on forests. These are contributing to forest decline and reduced resilience, and to the degradation of their capacity to provide the goods and services that are at the foundation of Mediterranean societies' socioeconomic development and well-being (Potschin and Haines-Young, 2016). Participation by local stakeholders (especially forest users) in the decisions and activities affecting forest development is thus critical to reconcile socioeconomic activities and resource conservation.

The implementation of participatory forest management is relatively recent and not yet widespread in Mediterranean countries, although the concept itself is not new. Participatory initiatives are, however, spreading and increasingly recognized at the institutional level. Most of these initiatives, which consist of establishing participation processes and implementing concerted actions in given territories (whether protected or otherwise), do not have dedicated names. Nevertheless, among other well-known and institutionalized participatory approaches are the Model Forests (e.g. Provence in France, Ifrane in Morocco and Yalova in Turkey) (Box 4.10), the Forest Territory Charters (FTC) (e.g. Albères and Aspres Cork Oak Forest in France; Bouhachem Regional Nature Park in Morocco) (Box 4.11), Mountain Forest Planning Plan (MFPP), Mountain Forest Strategic Plan (e.g. in the Alps); Concerted Operations for the Planning and Management of the Rural Space (OCAGER; Languedoc-Roussillon), Réserves de Biosphère (e.g. Jabal Moussa in Lebanon) and Participatory Management Plans in Tunisia (Box 4.12).

The mechanisms established for participation and collaboration will depend on the relationships between various actors, particularly those encouraged by the instigators of these mechanisms. The effectiveness and success of such mechanisms will often depend on the quality of human relationships established locally at the first instance (Box 4.13).

Planning and designing a participatory project. Planning stakeholder engagement throughout the project cycle and beyond is crucial (Figure 4.12).

A common general approach is presented by the logical framework. Proposed by USAID in the 1960s, the logical framework is the basis of most methodological tools. This technique allows stakeholders to identify and analyse problems, define their objectives and the activities they wish to undertake (Figure 4.13).

What are the enabling conditions for participatory approaches?

As mentioned above, the rationale behind applying a participatory approach lies in the distinct expectations of forest managers and beneficiaries of ecosystem services. Because of diverse socioeconomic factors, including historical and cultural heritage, there are no strict rules for effective implementation of participatory approaches. However, experience shows that successful management requires the establishment of appropriate governance conditions. These concern both administrative settings (including political commitments and supporting regulations) and societal preparedness

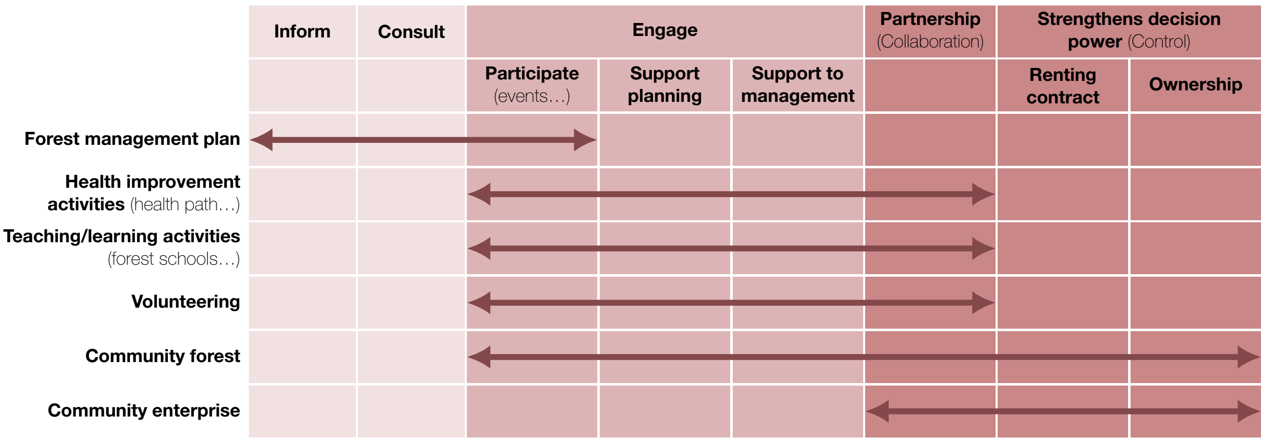

Figure 4.11. Opportunities for public engagement in forest management
Source: Adapted from Forestry Commission (2011) © Crown Copyright 2011.

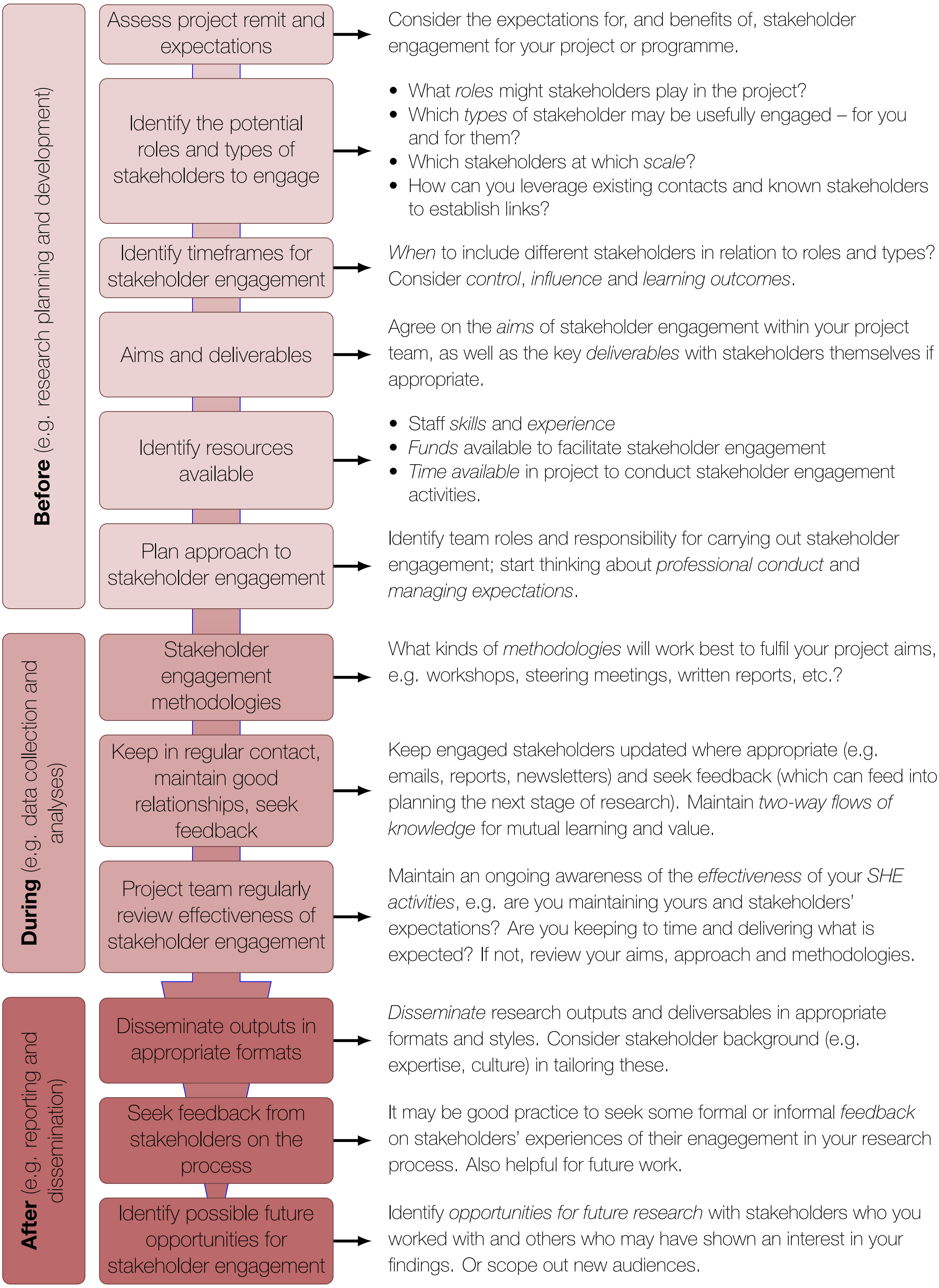

Figure 4.12. Engagement planner
Source: Nicholson-Cole and Whitmarsh (2008).

(relevant to the degree of knowledge and empowerment of the various stakeholders). Some essential considerations are worth emphasizing:

- Without a certain degree of *ex ante* political will, participation will not produce results or impact.
- A certain equivalence of cognition and power must exist between actors. If this is not present, external support must be provided to under-represented actor/s.
- It is futile to propose a participation exercise among actors that are not mutually dependent to some degree. To the extent possible, these inter-dependencies should be identified, analysed and acknowledged.
- Whether at the starting point or as a result of the process, a common vision should guide participation.

Box 4.13. Forty forest resource management projects in Morocco

By analysing about 40 forest resource management projects carried out in Morocco over the last ten years (2002-2014), a typology of the adopted approaches was established by distinguishing between four main approaches:

1. Ethno-spatial approach for the management and development of silvopastoral resources: this approach is based on ethno-spatial units (fraction or sub-fraction) as the basis for concerted implementation of silvopastoral and socioeconomic development actions;
2. Socio-territorial unit approach for integrated development: this approach involves local populations with projects on the scale of land exploited by the inhabitants of one or more territory unit (e.g. douar). As an example, the Douar Development Plan brings together actions implemented in all areas, including silvopastoralism;
3. Community approach focusing on the management of forest periphery: this also involves organizing community groups based on territory (e.g. douars in Maghreb), but the interventions focus on agriculture, infrastructure and socioeconomic development;
4. Contract-programme approach with local organizations: this approach has been developed by GIZ within the framework of the "Protected Areas" project, which consists of delegating the execution of annual programmes to local associations. These programmes are based on the DPDs established above.

Policy support towards increased stakeholder participation: What international and national strategies say. As highlighted in many international processes, participation by local communities in decision-making is a promising way to improve global well-being. As a general rule, the sustainable development goals (SDGs) (United Nations, 2015) see stakeholder participation as a major step towards peaceful and inclusive societies for sustainable development (SDG 16). The forestry sector recognizes that increased stakeholder involvement – particularly by local communities – is a requirement for sustainable forest management. The FAO Global Forest Resources Assessment provides an overview of countries that have established a national platform to promote stakeholder participation in forest policy development, as well as countries in which stakeholders are consulted or contribute to the management of public forests. These two elements show a willingness to implement participatory approaches at the highest level. Although it is not a prerequisite, this commitment can facilitate the establishment of appropriate administrative and regulatory conditions to develop local initiatives.

All countries in the Mediterranean basin are involved in at least one international sustainable forest

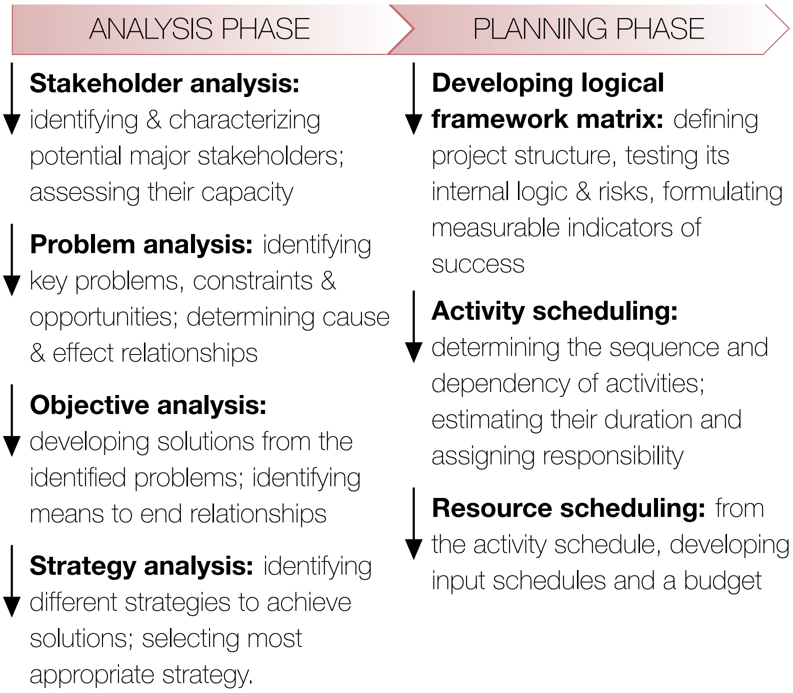

Figure 4.13. The Logical Framework approach
Source: European Commission (2004).

management process. Northern Mediterranean countries from Portugal to Turkey are part of Forest Europe (Oslo, 1993), while countries from the southern and eastern rims (including Cyprus, Malta and Turkey) are involved in the Near East process (Cairo 1996, extended to North Africa). In both processes, the participation of stakeholders is one indicator and is therefore encouraged.

Consistent with international processes, certification schemes such as the Programme for the Endorsement of Forest Certification (PEFC) and Forest Stewardship Council (FSC) acknowledge the importance of considering local communities when defining a management plan. The production of certified wood products is still limited in the Mediterranean. However, increased demand for labelled products will favour improved integration of social needs in forest management.

What the law says. Acknowledging historical practices, most national forest laws provide local communities with the right to collect dead wood, hunt or graze cattle in public forests. On the one hand, forest degradation occurs when these rights are misused. For example, overgrazing reduces a forest's regeneration capacity. Some countries have added temporary protection regimes to their legislation in order to reduce these risks of forest degradation (e.g. deferred grazing in Morocco and Tunisia). However, these measures are not always well understood and respected by local beneficiaries. On the other hand, forest degradation is also more likely to occur when these rights are not used at all. The absence of grazing and deadwood removal leads to an increase of the biomass that, in the Mediterranean, can increase the risk of forest fires. In order to participate more effectively in management of forest ecosystems, local communities should seek to better understand the impact of their behaviour. This need for awareness-raising is now reflected in forest policies.

Participatory approaches in the Mediterranean context. In the context of global change, the Mediterranean's highly diverse forest ecosystems face numerous environmental and socioeconomic threats. Increases in temperature, reduction in precipitation, higher frequency of extreme events and fires are a challenge for the maintenance of the ecosystems and the services they provide. A large portion of Mediterranean forests, particularly those in the south, are public and managed by administrators. Forest management by a public administration responds to political, economic and environmental objectives that are not necessarily shared by local communities.

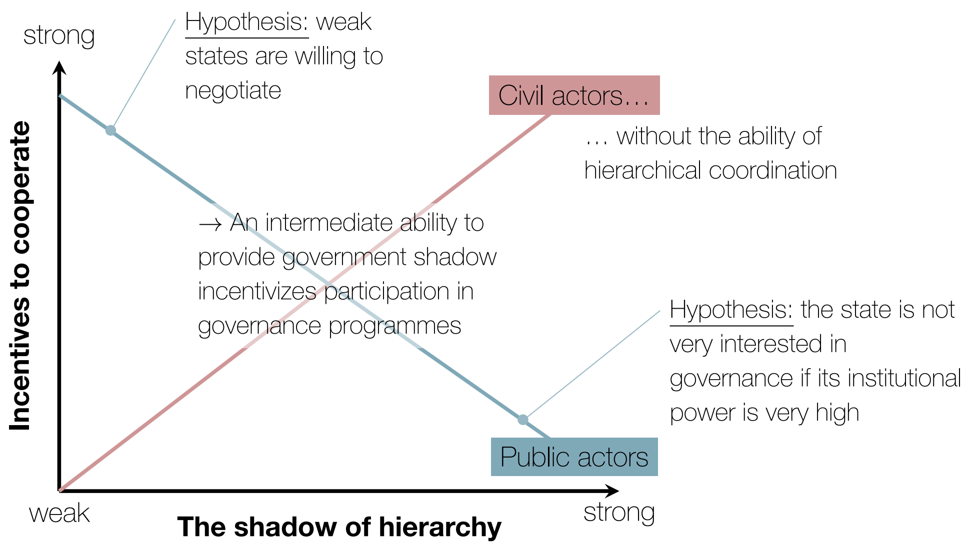

Figure 4.14. The shadow of the state

At the same time, population increases lead to higher pressure on lands and natural resources, as well as higher demand for forest ecosystem services such as erosion control and water regulation. Moreover, rapid urbanization has changed and redistributed stakeholder needs. In the northern Mediterranean, the demand for ecosystem services in cities, such as recreation and water filtration, has increased, while demand for firewood and grazing by local populations has decreased. A similar change can be observed in the southern rim. However, the pressure from local populations remains high and desertification has become a serious threat. Changes to demand for ecosystem services and the geographic distribution of stakeholders has increased the complexity of forest management. This calls for an inclusive and adaptive form of planning and management, which can be facilitated by a participatory approach.

Stakeholders are not necessarily aware of their impacts on forests and the all the benefits they derive from forest ecosystems. In particular, people living in cities enjoy recreational opportunities, but also climate regulation, erosion control protecting infrastructure, water purification, etc. Most of them do not understand the impact of high frequentation, intensive mushroom picking or seed collection. Rural populations also lack information on the sustainable use of forests. The participatory approach facilitates awareness-raising and mutual learning between stakeholders.

The structures of southern Mediterranean communities have changed over recent decades. The hierarchical management of the community, in which the head makes decisions for all, has been replaced by higher individualism in many places. If each individual competes for access to public resources, the resultant pressure on that resource increases beyond what the ecosystem can withstand. This is an illustration of the tragedy of the commons. Stakeholder involvement in the decision-making process can provide the basis for an alternative way to regulate harvesting of wood and non-timber forest products. Forest managers may encounter difficulties in establishing restriction measures (e.g. a ban on grazing or on nut harvesting) and controlling their application. The participatory approach helps define measures that beneficiaries can accept and even control themselves, increasing their chances of success, while also being more cost-efficient.

The need for coordination comes from: (a) the pursuit of greater efficiency and reduced transaction costs and (b) the need, exceptionally acute in forest management, to work in stable, adequate temporal-spatial scales for the activity. These two main factors demonstrate need to recognize and utilize interdependencies (Jessop, 1998). On the other hand, competition (e.g. in markets) can make these interdependencies challenging. The shadow of the state (Héritier and Lehmkuhl, 2008), remarkably big in Mediterranean forest environments, can be an additional obstacle (Figure 4.14). The provision of sufficient and fair information, knowledge and skills (including financial) (Table 4.4), recommended by expert reviews (Sayer *et al.*, 2008; CBD SBSTTA, 2011), is also frequently lacking.

How can these approaches be put in place for effective and efficient participatory management?

Initial conditions

Prior to the establishment of a participatory management process, the situation must be diagnosed and the territory in question must be established. This includes the land, its resources, its owners (public, private or collective), its managers and the various stakeholders living on or deriving benefits from it. Second, the relationship between stakeholders, the objectives of management and possible conflicts must be identified. If the diagnosis confirms interest in a participatory approach, regulatory, administrative and social contacts must be analysed.

Stakeholders must be empowered to put forward and discuss proposals. In other words, participating bodies should understand their role in the process and know which decisions and responsibilities are theirs. In most cases, participating stakeholders represent larger groups such as residents or shepherds. These representatives should be trained to prepare for the meetings and commit at the appropriate level.

Stakeholders should trust the institutions responsible for running the participatory process and implementing the resultant plan. In particular, when public forests are at stake, local or national authorities must be committed to ensuring an equitable relationship between actors. In places where the state is weak, some stakeholders may refuse to participate because they feel powerless or are apprehensive about potential manipulation by other stakeholders. The process is facilitated when official documents such as forest laws, strategies or policies clarify the relationship between actors, including their respective responsibilities and duties. The authorities should also be prepared to devolve power to local actors. The project facilitator is key to the successful preparation and conduct of the process. The organization responsible for the facilitator must have sufficient funding capacity to allocate resources and time to the process. Generally, for limited territories, at least one full time equivalent is needed.

Making participation happen: steps, methodologies and tools

A participatory approach is:

- a pluralistic approach to the management of natural resources involving diverse partners assuming a variety of roles and generally aiming towards environmental protection, sustainable exploitation of natural resources and equitable sharing of benefits and responsibilities;
- a political and cultural process par excellence: the search for a form of "democracy" and social justice in the management of natural resources;
- a process that must be built upon certain basic conditions (full access to information about relevant issues and solutions, freedom and ability to get organized, etc.).

The main steps to follow when implementing the participatory process are summarized below:

Table 4.4. Enabling conditions for participatory approaches

Pre-requisites			
Normative framework		Knowledge	
Regulation	Economic disincentives	Competency	Awareness
Stimuli			
Social licence		Risk awareness	
Seed capital		Market incentives	
Coordination mechanisms			

1. Choice of territory and shared diagnosis.

   The territory or natural resource (forest, grazing track, etc.) must be characterized by traditional users (users, right holders, etc.) identifying themselves according to this territory or resource. This involves working to merge these traditional uses by ethnic groups with the corresponding space. The territory or natural resource should not involve two different ethnic groups; doing so would give rise to potential conflict regarding traditional usage.

   A shared diagnosis of the territory must be carried out with the population to analyse and quantify its environmental and socioeconomic resources, identify actors (stakeholder mapping), understand their visions and expectations, build on existing local dynamics and jointly design a desirable future (prospective analysis).

2. Governance structure and mechanisms of the participatory approach.

   Participatory approaches may rely on different structures at various administrative/territorial levels, which could include:

   - Lead Entity ("coordinator," e.g. a nature park, an association, etc.). The lead entity mobilizes stakeholders, drives the work forward, carries out the monitoring and evaluation and ensures the cohesion and efficiency of the different structures and processes;
   - Steering/management committee (elected officials, representatives of government services and

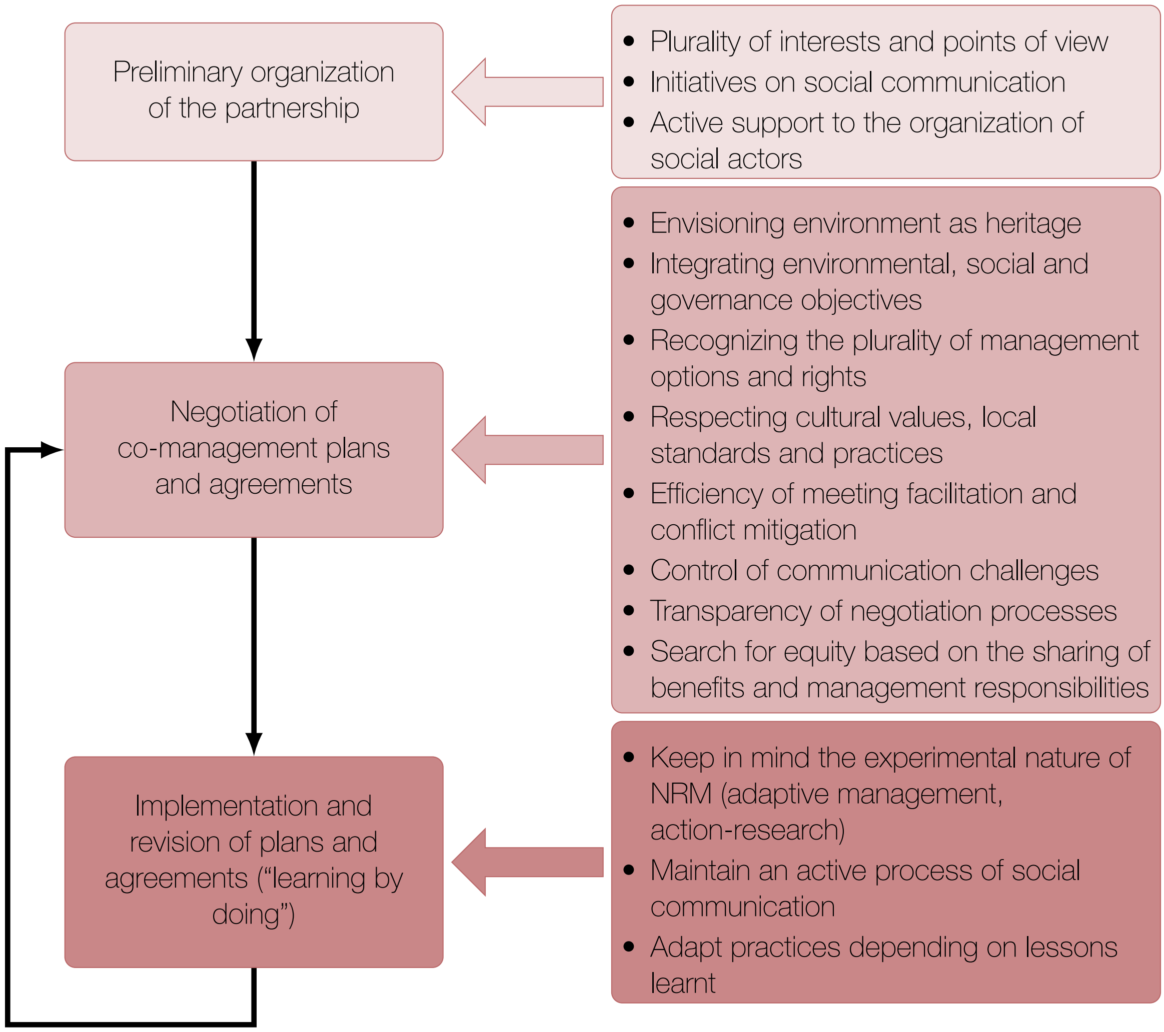

Figure 4.15. Schematic representation of the concepts, approaches and values in the participatory management process

stakeholders). It manages the process, drives the project forward, helps reach a consensus and has the greatest decision-making power (e.g. Provincial Coordinating Committee (Wilaya in Morocco) whose role is to oversee the participatory process and help remove constraints);

- Stakeholder committee (stakeholder representatives). This influences decisions and agrees on the activities of the working groups;
- Working group or implementation committee (anyone interested in working on the project at the local level). This works on the technical aspects of sector-specific or cross-sectoral themes;
- Consultative technical and/or scientific committee (renowned experts and scientist from the academic and research/innovation sector). This provides an opinion on management, decisions and activities.

3. General mapping and objectives/interests and relationships between actors.

   Two modes of representation can facilitate a formulation of the actors identified a priori, including their potential role in the participatory process:

   - actors with a direct interest in the natural resources of the area concerned, i.e. directly extracting ecosystem goods and services;
   - actors with indirect interests, i.e. indirectly extracting ecosystem goods and services;
   - surface or groundwater users, i.e. exploiting ecosystem-related water resources;
   - actors with professional interests, i.e. having professional duties and interests in the sustainable management of natural resources in the area.

4. Implementation of the communication, collaboration and negotiation process with stakeholders.

Main tools of the participatory approach. The concepts and approaches contributing towards understanding and practicing the participatory approach are:

1. Adaptive management is a management approach that recognizes, on the one hand, the lack of definitive knowledge about the behaviour of ecosystems and, on the other hand, the uncertainty that governs our interaction with them.

   The main stages of adaptive management throughout the participatory process are:

   - Assessment of the situation and problems of Natural Resources Management (NRM) (usually in workshops, with several stakeholders);
   - Identification of NRM activities (usually in workshops) on the basis of a comparison between several possible options;
   - Implementation of NRM activities in accordance with the chosen plan (which may include land zoning and experimenting with different activities in different areas – referred to as “active management”);
   - Monitoring the results obtained on the basis of indicators chosen to reflect expected changes;
   - Evaluation of results to test the effectiveness of the actions undertaken;
   - Adjustment of activities based on lessons learned (this may include problem re-wording, NRM objectives, activities, indicators, etc.).

2. Plurality.

   Participation by several categories of social actors (e.g. governmental and non-governmental bodies, groups and individuals, local and external communities with rights to local resources), is key to successful natural resource management. Communities are, per se, actors and constitute the most natural and convincing unity of identity, integration and defence for many disadvantaged groups and individuals. Communities are not homogeneous entities and their internal differences must be taken into account. Allowing space for this multiplicity of views and voices is a fundamental condition of fairness and justice during the negotiation process, including negotiations towards participatory management plans and agreements.

Table 4.5. Tools and methods to promote participatory forest management

Tools and methods for participation and communication	Planning	Implementation	Monitoring & evaluation	Finalization
Conferences		••		••
Consensus building	•••	••		
Courses and study programmes		•		
Events		••		
Experimental plots		•••	••	••
Focus groups	••	••	••	
Imagine	•••			
Internal and external audits			•	•
Interviews	•		•••	
Logical frameworks	•••			••
Meetings (annual, extraordinary, strategic)	••		••	
Method sheets		••	••	
Multi-part monitoring programmes			••	••
Newsletter	•	•••		••
Online social networks (e.g. Twitter, Facebook)		••		••
Open days		••	••	••
Participatory budget	•••	•••		
Participatory mapping and GIS	•••	••		
Participatory platform for monitoring and evaluation			••	••
Postal surveys and questionnaires	•		•••	
Press	•	•••		•••
Radio	•			•••
Scenarios method	•••	•	•	
Seminars	•••	•••		
Sheets with indicators of performance, results, impact, etc.			•••	••
Site visits	••	•••		••
Stands		••	••	••
Surveys and face-to-face questionnaires	••		••	
Telephone surveys and questionnaires	••		••	
Website	•	•	••	•
Working groups	•••	•••		
Workshops	•••	•••		

Note: GIS = Geographical Information Systems.

Source: Forestry Commission (2011).

3. Governance.

   The effective exercise of authority depends on the legitimacy of a political system and the population's respect for its institutions. It also depends on its capacity to respond to problems and reach a social consensus through agreements and compromise. Governance is neither a system of rules nor an activity but a process. It is based not on domination but compromise and involves both private and public actors. Governance is not necessarily formalized and is usually reliant on ongoing interaction.

4. Heritage.

   Heritage refers to the set of material and immaterial elements contributing to the identity and autonomy of an owner by adapting to a changing environment. The patrimonial representation of a territory, a zone or a set of resources allows for:

   - linkages between past, present and future generations of land managers;
   - greater emphasis on owners' obligations than their rights;
   - a common vision of sustainability bringing together the needs and opinions of various actors.

5. Social communication seeks to establish an identity of views within a community. It involves exchanging messages (communication) to give meaning to actions and enrich common knowledge, often as a way of coping with change. Effective communication generally has remarkable individual effects such as improved well-being, strengthened sense of personal worth, dignity and self-esteem, and strengthened social solidarity and cooperation. Communication can be personal (face-to-face), interpersonal (between a few individuals) and social (when it involves social groups like a local community) (Table 4.5). In the context of participatory approaches, communication aims to provide favourable conditions for conscious decision-making in society, encouraging information exchanges and discussions about problems, opportunities and action. It is generally a complex phenomenon, encompassing a variety of situations, one-on-one dialogue and group meetings (aspects of personal and interpersonal communication) for use in media such as radio, television or online.

6. Conflict management/resolution.

   Conflict management is a process of dialogue and negotiation with constructive rather than destructive results. It consists of:

   - resolving disagreements before they escalate;
   - helping stakeholders to consider various options for agreement before choosing one that is acceptable to all;
   - identifying and eradicating the root causes of conflicts to avoid their recurrence.

7. The three main phases of the participatory management process (Figure 4.15) are:

   (a) partnership preparation and stakeholder involvement/participation;

   (b) negotiating participatory management plans and agreements;

   (c) implementing and revising the plans and agreements (learning by doing).

How can these approaches last over time? What affects their sustainability?

What matters for the sustainability of these approaches?

To ensure an enduring process, trust between stakeholders should be developed and maintained. The moderator has a key role. She must ensure that all stakeholders have an interest in participating, anticipate conflicts and prevent non-collaborative behaviour. Meetings must be organized regularly to maintain connections and facilitate exchanges.

Stakeholders must stay motivated. At the outset, they often hope to derive some benefit from the process. Connecting stakeholders with different perspectives will stimulate creativity. The meeting should lead to decisions and effective implementation. Repetitive discussion should be avoided to prevent stakeholders from becoming bored. The outcomes of participatory management should be monitored and presented to stakeholders to facilitate continuous improvement. The decision-making process, use of resources and outcomes should be transparent at all stages to maintain trust in the process. Finally, as in any project, sufficient allocation of human and financial resources is important.

Over a ten-year period (2006-2015), the Mediterranean Model Forest Network tracked a total of 30 Model Forest initiatives (attempts to develop a Model Forest) in the Mediterranean region (Table 4.6). Of these, 33 percent were still active after four years and 29 percent had reached full Model Forest status by the end of the study period. The question of permanence is not, therefore, an inconsequential one for participatory approaches in Mediterranean forests.

Some elements of the above-mentioned best practice stand out when dealing with permanence over time: Sayer *et al.* (2013)'s Principles 1, 8 and 10 and Lally Principles (Sayer *et al.*, 2008) 2, 3, 6, 8, 16 and 19. The first case focuses on how a participatory process should incorporate mechanisms for (a) monitoring (i.e. devolving meaningful data to participants on the efficiency, effectiveness and impact of activities), (b) adapting (changing course when the situation changes) and (c) learning at all levels (to enhance participants' capacities over time) to maximize longevity. The Lally Principles assert the need for (d) (lasting) skilled facilitation, (e) shared ownership and (f) careful expectation management.

Beyond these structural and process features, it has been observed during real processes occurring in the Mediterranean that participatory processes tend to persist by carrying out (g) step-by-step, innovation-driven, small activities with a bold problem focus, only to (h) expand when sufficient trust has been established. This iterative practice has the important consequence of providing opportunities for enhanced cooperation in matters of interest to specific stakeholders (while at the same time not seeking their participation in activities that do not fit their skills).

Monitoring and evaluation

A good framework regarding what to monitor is provided by CBD SBSTTA (2011). Only implementation monitoring, effectiveness monitoring and project monitoring, however, are of special relevance for participatory processes in the Mediterranean.

As mentioned above, effective and creative monitoring is key to the sustainability of participatory processes, since it provides actors with motivational information that keeps them engaged. This happens even when monitoring results show no major progress.

Evaluation is made on dissimilar criteria and on diverse temporal-spatial scales by different actors, and can easily be based on incorrect assumptions. For example, one participant in the Urbión Model Forest (Segur *et al.*, 2014) established a seven-year timeframe for evaluating participation in the local Model Forest process. By the time that evaluation became due, the Model Forest had already failed.

If participatory processes are evaluated based on whether they have solved the problem they were established to address (impact evaluation), they will most probably be deemed a failure unless: an apolitical temporal scale is used, or the whole context (and not just the participatory process itself), is evaluated. On the other hand, process evaluation should focus on "continued commitment to dialogue… locking… partners into a range of interdependent decisions… and encouraging solidarity among those involved" (Jessop, 1998).

In 2012, FSC Spain began a participatory process to review and transfer Spain's FSC forest

Table 4.6. Model Forest attempts 2006-2015

	Initiative	Region	Country	Date	2015 status
1	Urbión	Castilla y León	Spain	2016	Model Forest
2	Tlemcen	Wilaya of Tlemence	Algeria	2009	Model Forest
3	Forêt Modèle de Provence	Provence-Alpes-Côte d'Azur	France	2009	Model Forest
4	Corsia MF initiative	Corse	France	2009	Dismissed
5	Volos MF initiative	Magnesia	Greece	2009	Dismissed
6	Kozani Model Forest	Western Macedonia	Greece	2009	Initiative
7	Arci-Grighine	Sardinia	Italy	2009	Dismissed
8	Ifrane	Province of Ifrane	Morocco	2009	Model Forest
9	Dehesa Charra	Castilla y León	Spain	2009	Dismissed
10	Sierra Espuña	Murcia	Spain	2009	Dismissed
11	Kroumirie et Mogods	Kroumirie et Mogods	Tunisia	2009	Dismissed
12	Yalova	Yalova	Turkey	2009	Model Forest
13	Montagne Fiorentine	Tuscany	Italy	2010	Model Forest
14	Serranía de Cuenca	Castilla La Mancha	Spain	2010	Dismissed
15	Pinares del Duero	Castilla y León	Spain	2010	Dismissed
16	Cansiglio MF initiative	Veneto	Italy	2011	Dismissed
17	Lebanon MF initiative	n.c.	Lebanon	2011	Unknown
18	Mirna Watershed	Istria	Croatia	2012	Model Forest
19	Dalmatian Model Forest	Dalmatia	Croatia	2012	Initiative
20	Delta del Po MF	Emilia-Romagna	Italy	2012	Initiative
21	Voskopoja Model Forest	District of Korca	Albania	2012	Initiative
22	Tesanj Model Forest	Sarajevo	Bosnia and Herzegovina	2012	Initiative
23	Pećini	Vojvodina	Serbia	2012	Initiative
24	Igoumenítsa	Epirus	Greece	2012	Dismissed
25	Golija-Kopaonik initiative	Golija and Kopaonik Natural Parks	Serbia	2012	Initiative
26	Montenegrin Coastal MF	all Montenegro coast	Montenegro	2012	Initiative
27	Buçak	Anatolya	Turkey	2013	Model Forest
28	Massa MF initiative	Tuscany	Italy	2014	Dismissed
29	Páramos Palentinos	Castilla y León	Spain	2014	Initiative
30	Etna initiative	Sicily	Italy	2015	Initiative

Note: MF = Model Forest. Date is commencement date.

management standards to Version 5 of FSC's international Principles and Criteria. The process, which was due to be finalized in December 2017, has led to continuous monitoring and evaluation, resulting in substantial improvements in the future field application of the new FSC forest management standard for Spain, largely due to active stakeholder participation (Martínez Martínez *et al.*, 2017) (Box 4.14).

Case study: Win-win contracts for oak forest management in Morocco – The Maâmora Forest

In the Maâmora forest, the objectives of the participatory approach were:

1. To build an appropriate and effective participatory approach to contribute to the development and successful implementation of the revised Maâmora Forest Management Plan.
2. To ensure collaboration/negotiation with relevant stakeholders, including the local population, to

promote their involvement in the rational management of natural resources (monitoring, conservation and valorization) and the conservation of sensitive sites.

3. To design and promote participatory eco-socioeconomic models (for the organization of value chains and valorization of non-wood forest products).

Box 4.14. The process of adapting the Spanish FSC standard of sustainable forest management to the new FSC principles and criteria (Spain)

What is it? The process follows the international system established by FSC International to transfer the current Spanish FSC forest management standard to the new structure and requirements of the FSC International Principles and Criteria version 5-1. To this end, a participatory and transparent process has been carried out, balancing environmental, social and economic interests in order to guarantee a reliable standard adapted to the Spanish context. In addition, this adaptation has been used to extend the scope of the national standard, including the possible certification of ecosystem services, all timber and non-timber production, as well as to promote adaptive forest management to cope with global change.

Key figures: from September 2012 to October 2017 more than 45 meetings were held throughout the transfer process (mostly online and some in person), which were later transferred and developed. One hundred and eighty-eight indicators were analysed and responses were provided to more than 1 350 comments received during three public consultations. In addition, 11 face-to-face workshops and two Iberian meetings were held (FSC national offices and stakeholders from Spain and Portugal), as well as multiple meetings with stakeholders. The FSC standard for forest management will apply to those holding FSC certificates in forest management in Spain. In October 2017, 26 certificate holders managed more than 260 000 ha and more than 14 000 forest management units.

Stakeholders: FSC-certified forest management certificate holders, certification bodies accredited by Accreditation Services International, forest owners and managers, consulting forestry firms, homeowners' associations, industry associations, industries, forest products, environmental NGOs and social unions, local administrations, autonomous communities and the national government, FSC Spain (Standards Committee, expert group, advisory forum and national partners), as well as FSC International.

Funding: funds provided by FSC Spain and FSC International.

Governance: Standards Development Group or FSC Spain Standards Committee comprised of a coordinator and two members for each of the FSC Spain partners (environmental, social and economic). The decisions of the standards committee were ratified by the Board of Directors and FSC Spain's members assembly.

Actions: More than 45 FSC Spain Standards Committee meetings, 11 face-to-face workshops in different cities in north, central and southern Spain and multiple meetings with stakeholders have been held. Progress has been reported to FSC International, the Board of Directors and FSC Spain partners. In addition, news has been published in FSC Spain's social networks and the web, as well as in sectoral media.

Seven types of eco-socioeconomic development models were proposed using the strategic axes and variables identified by stakeholders based on the "integrated and concerted development of the territories." The primary goal was to establish effective conditions for the success of the technical actions identified in the Maâmora management plan. The "Agroforestry management of trees and stands of cork oak" Model case study below is a good example of a win-win contract relating to the collection of acorns.

Since state-imposed sanctions proved ineffective in combating wood, foliage and acorn collection, a new negotiation and partnership approach was proposed to reconcile the interests of the two stakeholders, i.e. the land manager and user. It aims to ensure the rational management of cork oak stands while allowing users to take advantage of resources, namely acorns and foliage, without damaging the trees. This approach is based on three essential actions:

1. organization of users by territory (socio-territorial unit): existing silvopastoral associations can be empowered and made responsible for the oak stands (acorns and foliage). If needed, specific silvopastoral associations can be established;
2. establishment of partnership contracts establishing rights and duties for the rational exploitation of cork oak stands, while providing specific training and permanent supervision of users;
3. support for the autonomy of local organizations through their involvement in forestry activities.

Expected results / outcomes. Harvesting of acorns by users organized in associations or cooperatives has several advantages, mainly:

- creating an atmosphere of collaboration and partnership between users and forest authorities based on a common interest in forest resource conservation: the imposition of fines has not represented a threat for users, who consider fruits and local products a gift from God and the environment;
- enhancing user participation and empowerment: bringing users together and providing support and the conviction that their well-being will be improved, will greatly facilitate involvement by local populations in the conservation and management of forest resources;
- improved user revenues by increasing both the value-added component of the product and interest in organizing the value chain/sector: organizing this sector will provide significant added value to users, increasing their feelings of responsibility for the conservation of oak trees as fruit trees;
- improved traceability and availability of forest tree seeds, some of which will be destined for forest regeneration and development under the terms of the contract. The reserved product is thus characterized by its exact origin (organization, plots, zone, etc.), thus maintaining the performance and origins of the oak stands;
- changing social consensus on forest harvesting: organizing users to participate in fruit harvesting and marketing facilitates the transition from an uncontrolled and competitive harvest to a respectful (mature) harvest using techniques that are not detrimental to trees. The community will change its perception of the oak tree from a purely forest tree to a multi-purpose tree (fruits and others).

The win-win contract for the harvest of acorns encourages:

1. Engagement by local organizations. They undertake to:
    - Ensure the successful execution of commitments under contract (e.g. respecting the acorn harvest commencement date and techniques (ground pick-up, tree climbing, other techniques, etc.) and reserving a portion of the overall harvest (negotiated and adapted to agreements and territories; e.g. 20 percent for the supply of nurseries and 20 percent for the supply of forest seedlings);
    - Ensure compliance with the measures taken, technical supervision and population awareness;

- Manage conflicts and disputes that may arise between managers and users.

2. Commitment of the Water and Forest Administration. It undertakes to:
    - Provide technical guidance and training on harvest techniques to local organizations;
    - Organize awareness-raising and information workshops for users to encourage them to join the process of participatory, sustainable natural resource management;
    - Study and promote the valorization and marketing of the acorn sector. Comparison between the current situation and expected results following implementation of the proposed measures/activities (Table 4.7).

Table 4.7. Comparison of the current situation and expected results following the implementation of the proposed measures/activities for the collection of acorns in the Maâmora Forest

Current situation	Measures and activities	Future desirable situation
Chaotic harvesting: • Users • Non-users • Inappropriate harvesting methods	Organization of users in an association or cooperative (it will also deal with delimbing). On the ground demonstration of the techniques of rational acorn harvesting for the benefit of users	Creation of an atmosphere of collaboration and partnership between the Forest Authority and a common interest in the conservation of forest resources
Social consensus based on competition and mining	User training and awareness on acorn harvesting techniques and sustainable tree management	Encourage constructive and empowering involvement by user populations
Unorganized marketing: • Intermediaries: non-users and derive more added value • Uncontrolled marketing channel	Organization of the acorn marketing circuit at national and international level	
Difficulties in supplying cork oak seeds: • Strong demand for human consumption • Existence of uncontrolled circuits for acorn exports to Spain • Difficulties in ensuring the traceability of acorns locally Local products and forest goods and services: • Not very profitable for users: about 30 percent of the selling price in city markets • Local sellers: about 50 percent of the selling price in city markets	Establishment of a win-win contract between the Forest Authority and the user organization (association/cooperative), setting out the following rights and duties: • Fixing and respecting the harvest period • User share (e.g. 60%) • Share to be transferred to the Forest Authority (e.g. 20%) • Share to be transferred to nurseries (e.g. 20%)	Traceability and availability of mature cork oak seeds. Changed social consensus on the irrational exploitation of acorns. Increased user incomes by increasing the value added to the acorn product and interest in the organization of the sector/value chain

13 Valuing ecosystem services as part of the decision-making agenda

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The importance of forest ecosystems to human well-being cannot be overstated. But forest management strategies do not necessarily seek to enhance the value of all forest goods and services, whether locally, nationally or internationally. In most cases, management considers a limited portfolio of ecosystem services, mainly limited to those goods and services that are marketable. This is because there is not a market for some goods and services and our knowledge about how changes in ecosystems affect the level of services the system provides is often incomplete. This chapter presents a methodology to estimate the economic value of forest goods and services (Box 4.15) applied to the Mediterranean region and shows how economic value can be used as a concrete tool in the decision-making process.

Box 4.15. Environmental services vs. Ecosystem services: the need for clarification

It is important to clarify the definition of the terms "environmental services," "ecosystem services" and "ecological services." Ecosystem and ecological services, often considered synonymous, are the outputs from ecosystems that directly or indirectly benefit humans and contribute to their well-being (Millennium Ecosystem Assessment, 2005b). FAO (2007) defines environmental services as a subcategory of ecosystem services, corresponding to externalities between economic actors based on payments for environmental services (PES). Environmental services have the characteristics of local or global public goods. This excludes "provisioning services" that can be treated as private goods traded on markets. That said, definitions are not always hermetic; some authors, for example, use the term "payments for ecosystem services" (Kosoy and Corbera, 2010).

Forest ecosystem services in space and time

Ecosystem services are often underestimated

Only a few of the many benefits that Mediterranean forests provide enter formal markets, usually wood products and some non-wood forest products (NWFPs) (Daly-Hassen *et al.*, 2010). When goods and services are traded in formal markets, their prices usually provide an estimate of their financial value and scarcity. When benefits are traded only in informal markets (e.g. firewood for self-consumption), an estimate of their financial value can be obtained through the price of substitute products.

Other goods and services do not enter any markets (Merlo and Croitoru, 2005). Despite providing benefits to societies or forest owners, they do not have a price that would serve as an indicator of their scarcity or predict their demand (Sills and Abt, 2003). Managers predominantly consider marketed goods and services, omitting consideration of non-marketed components. Management decisions impacting those goods and services tend to be suboptimal, as their focus is on the production of commodities eventually subject to environmental or social constraints (Holmes, 2003).

While the concept of economic value is based on peoples' preferences, economists often estimate value in monetary terms even for non-marketed ecosystem goods and services, since money is an exchange value that reveals preferences on a comparable scale.

The value of ecosystem services depends on location and beneficiaries

The value of an ecosystem service depends on supply capacity (associated with the forest type and environmental conditions), and on demand for that service. Forests in the mountainous regions of Italy, Greece and North Africa, for example, offer higher protection against erosion than inland open forests in the plains, which are subject to higher erosion risks.

Demand varies considerably in space, influencing the value of ecosystem services provided by a forest. The provision of carbon sequestration to mitigate climate change, for example, is provided locally but with global benefits. The regulation of water flows benefits people using water in the watershed. Benefits are local, even though they are not obtained in the forest itself. Recreation is a service provided to people visiting the forest. Both supply and use of this service occurs in the same place.

Some regional differences in the valuation of certain ecosystem services can be explained by heterogeneous social needs. For example, in the southern Mediterranean, fodder plays an important role in the well-being of local populations who, among other activities, graze cattle. The value of forest fodder in this region ranges from EUR 31 to 85/ha. In most northern Mediterranean countries, however, grazing is now a limited practice and its value ranges from EUR 5 to 20/ha, except in Portugal (EUR 37/ha) and Greece (EUR 38/ha) where traditional agroforestry practices persist (2005 prices from Croitoru, 2007). In the eastern Mediterranean, fodder value per hectare is relatively low (EUR 8 to 24/ha). This is the result of reduced fodder productivity rather than absence of demand.

Finally, the economic value of non-marketed services, particularly social services, is estimated according to the population's willingness to pay. It is therefore highly variable. The economic value of non-marketed services will depend on beneficiaries' priorities, revenues and the cost of alternative goods and services (which vary around the Mediterranean). Thus, it is not surprising to find, for example, lower recreation values in the MENA countries than in southern Europe. Care should be taken when comparing the monetary value of ecosystem services in different countries, since a comparable monetary amount does not provide the same well-being in all countries.

Changes to environmental and socioeconomic conditions alter the value of ecosystem services. In a more urban, economically developed society, dependence on forest resources decreases, while demand for recreation increases. In northern Mediterranean countries, forest fires are larger today than half a century ago due to land abandonment while, in southern countries and despite a decrease in local population, considerable degradation exists due to intensive fuelwood extraction and grazing.

Social perceptions regarding forests have also changed. In addition to former local users, new stakeholders are concerned with forest regulation and cultural services. Potential conflicts and/or cooperation between these stakeholders (rural vs. urban, public vs. private, individual vs. community), facilitates the development of different economic and policy instruments. Rural households are more interested in forest uses while urban inhabitants are more concerned by regulation and social services, such as recreation, water quality, etc. (Daly-Hassen *et al.*, 2017). Similarly, individual households/private forest owners undertake different activities to increase their incomes (overgrazing, illegal logging,

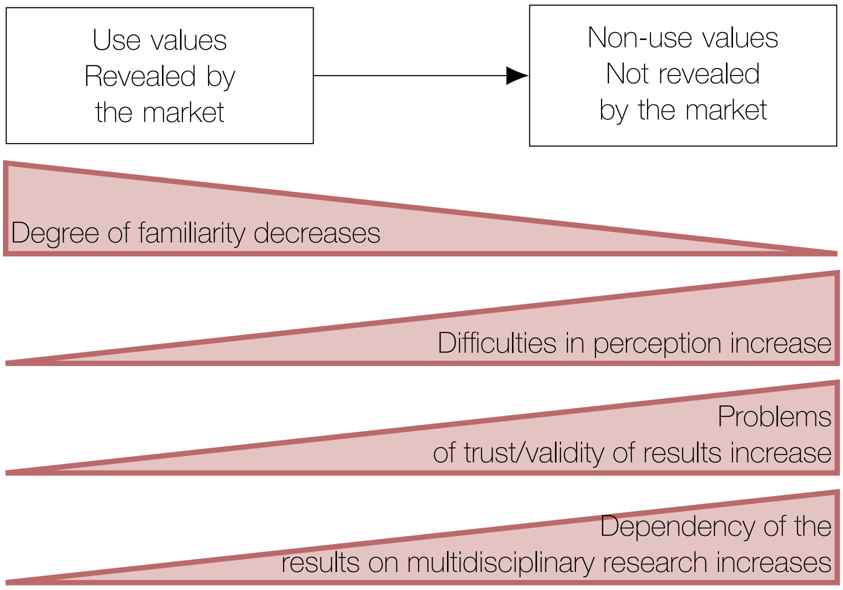

Figure 4.16. Moving from use to non-use values in environmental valuation
Source: Bateman and Turner (1993).

deforestation), leading to the reduction of social and regulation services that benefit local inhabitants, society and the global community (Daly-Hassen *et al.*, 2010).

According to the INFORMED project that commenced in 2015 and remains ongoing, both the frequency and intensity of disturbances are expected to increase and modify the value of forest ecosystem services. This research project encompasses different Mediterranean countries, developing knowledge on the topic.[1]

The value of Mediterranean forest ecosystem services

Concept and methods of economic valuation

Economists developed a set of methods to estimate the economic value of goods and services, including those that are not marketed. There are two main methodological groups: *revealed preference methods* and *stated preference methods* (Riera and Signorello, 2012). The revealed preference methods express the value of the direct or indirect use or consumption of a good, while the stated preference methods can also account for non-use values, mostly using surveys based on hypothetical markets. The aggregation of use and non-use values (Figure 4.16) is often referred to as "total economic value" (TEV).[2]

The choice of method depends on the objectives of the study and the researcher's familiarity with the different methods. Final selection will depend on: (i) the type and number of services to be valued; (ii) relevant population (e.g. users or non-users, geographical scope); (iii) data availability; (iv) availability of time and financial resources; and (v) team capacities.

When high levels of uncertainty and sensitivity surround the final result (not uncommon in the TEV technique), alternative methods to evaluate specific components of the TEV are recommended.

[1] http://www6.inra.fr/informed-foresterra_eng/
[2] These methods and their application are detailed in factsheets developed by Plan Bleu (2015).

Table 4.8. Values of forest ecosystem services in the three Mediterranean sub-regions, in EUR/ha/year – 2016 prices

Ecosystem services	South Mediterranean	East Mediterranean	North Mediterranean
Wood	16	28	87
Grazing	41	13	13
NWFP	5	6	21
Hunting	–3	1	4
Watershed protection	28	–5	23
Carbon sequestration	–3	10	10
Recreation	0	1	41

Note: Negative values mean that estimated social costs due to poor forest management are higher than estimated forest benefits.
Source: Merlo and Croitoru (2005).

Some values of forest goods and services

The first attempt at valuing forest goods and services in 18 Mediterranean countries can be traced back to 2005 (Merlo and Croitoru, 2005). This was followed by a study financed by the French Global Environment Facility (FFEM) in selected sites in Morocco, Algeria, Lebanon, and Turkey, focused on selected goods and services (Plan Bleu, 2015) (Box 4.16). A third and more recent study (Masiero *et al.*, 2016), focused on the economic valuation of a selected set of services at a national level. Other national studies were also run in several countries to update the results of the first economic valuation and/or to investigate the impact of natural hazards and major changes such as climate change.

In southern and eastern Mediterranean countries, the main results of Merlo and Croitoru's 2005 study shows that the estimated value of grazing and NWFP is higher than that of wood products. Watershed protection has the second highest value after grazing. The value of carbon sequestration is small due to low wood increment (Table 4.8). In certain cases, economic values are negative. This means that estimated social costs of poor forest management are higher than estimated forest benefits (e.g. forest fires) (Campos *et al.*, 2007). Masiero *et al.* (2016) show similar results for NWFP and carbon, but place a much higher value on wood, especially in eastern Mediterranean countries. This higher value occurred because the study considered average export and import wood prices rather than local market prices.

Wood has the highest value in most northern Mediterranean countries, with some exceptions: Portugal (cork), southeast France (recreational uses) and Greece and Albania (fodder) (Merlo and Croitoru, 2005). Here, animal production is much less dependent on forest areas than in southern Mediterranean countries. As a result, less importance is attached to forage production (Daly-Hassen *et al.*, 2010). The value of watershed protection and carbon sequestration were incomplete and probably underestimated in the Daly-Hassen *et al.* (2010) study. The Masiero *et al.* (2016) study, which considered the market

Table 4.9. Values of a set of forest ecosystem services in southern and eastern Mediterranean countries

Country	Site	Value of ecosystem services (EUR/ha 2014)				
		Wood	Grazing	NWFP	Recreation	Hydrological services
Morocco	Maâmora forest	83	142	76	90	
Algeria	Chrea National park			0.7	11	74
Tunisia	Barbara Watershed	10	73	82		20
Lebanon	Jabal Moussa Biosphere Reserve	18	77	44	8	
Turkey	Düzlerçamı forest	16			19	

Source: Daly-Hassen (2016).

Table 4.10. Comparison of willingness to pay results between Spain and Tunisia

Attribute	Willingness to pay*		Units
	Spain	Tunisia	
Biodiversity	-	7	Increasing the number of species by 1%
Carbon	$42 \cdot 10^{-5}$	$3 \cdot 10^{-5}$	Sequestration of 1 tonne of CO_2
Erosion	4	2	Negative impacts of erosion reduced by 1%
Forest fires	−9	−6	Increased burned forest area by 1%
Recreation	7	5	Allowing recreation activities in planted forests
Access	13	4	Access for forest uses (mostly grazing in Tunisia and mushroom picking in Spain)

Note: *Annual values per individual in EUR over a five-year period from 2008, taking into account purchase power parity for GDP of the two countries.
Source: Daly-Hassen *et al.* (2017).

price of four goods and services (timber, firewood, NWFP and carbon sequestration), found that timber and firewood prevailed over other services with 64 and 24 percent of estimated total value respectively (while NWFP attained 9 percent and carbon sequestration only 2 percent of total value). Care should be taken when considering this data, however, as NWFP data is often insufficient and assumptions about its value must be made. Figures related to NWFP could therefore be underestimated.

The second study on southern and eastern Mediterranean countries (Daly-Hassen, 2016) shows that the value of ecosystem services will vary as a function of the forest type, location and local demand (Table 4.9). This study also demonstrates that the development of recreational activities and production of NWFP improves the contribution of forest ecosystems to the well-being of local and national populations. This justifies investments to improve the status of forest ecosystems in order to maintain their capacity to supply goods and services.

A choice experiment[3] was performed in both Spain and Tunisia in 2007-2008 (Daly-Hassen *et al.*, 2017; Mavsar and Riera, 2007). The Spanish and Tunisian studies use almost identical attributes (with the exception of biodiversity) to express attribute units and annual payment formats, making them suitable for comparison. The estimated values of all services are higher in Spain, which may reflect different environmental priorities, as well as socioeconomic differences between the two populations (Table 4.10). Estimates regarding erosion, forest fires and recreation are similar, but values attached to access for forest uses differ more significantly. Nevertheless, they reflect different types of uses: in Tunisia, neighbouring communities are predominantly interested in grazing, while mushroom picking is an important recreational use in Spain. The largest difference is in the value of sequestering CO_2, which differs in one order of magnitude.

The number of studies into ecosystem service values and their vulnerability to global changes in the Mediterranean basin is growing. This is enhancing awareness and interest by decision-makers in economic valuation as a tool to justify and guide forest investments and ecosystems development. These assessments can inform the decision-making process, enabling policy-makers to better understand the impacts of their policies and to adjust them if necessary. These mechanisms can highlight the distributive effects of different policy options for different stakeholders.

Negative impacts on human well-being: disservices

The concept of ecosystem services as the benefits provided by ecosystems to human well-being is well studied. But ecosystems may also produce negative effects. Vaz *et al.* (2017) presents a typology

[3] The choice experiment method is a questionnaire-based technique that seeks to discover individual preferences for simultaneous changes in the attributes that comprise an environmental good or service. The basic premise of the choice experiment is that a forest good or service can be disaggregated to a bundle of attributes or features and that individuals are sensitive to changes in these attributes.

of ecosystem disservices, defined as negative impacts affecting: human health (allergic reactions or intoxications, transmission of zoonotic diseases), infrastructure (damaged by roots), security and safety (fire-prone vegetation due to dense biomass stands), culture (unpopular species) and recreation (presence of weeds, pests or mosquitoes).

There are few studies about these potential negative impacts in Mediterranean forests (von Döhren and Haase, 2015). A study was conducted in Tunisia in 2012 on damage caused by wild boars on agricultural land adjoining forests. The cost of damage was estimated using the costs of protection (fencing) at EUR 178 200/year in 2012.

Lack of management can cause loss and degradation of ecosystem services, and/or induce a disservice. In the case of Mediterranean forests, Merlo and Croitoru (2005) assessed costs of forest degradation due to lack of management in different Mediterranean countries. These costs were estimated at 15 percent of TEV in Morocco, 7 percent in Algeria, 17 percent in the Syrian Arab Republic, 13 percent in Turkey, 51 percent in Greece and 20 percent in Italy. The costs of degradation were estimated to reach EUR 17 million in Tunisia in 2012, representing about 13 percent of the TEV of forest services (Daly-Hassen *et al.*, 2012).

Limitations of economic valuation

The valuation of ecosystem services should support decision-making, particularly when decisions involve trade-offs between different services and service beneficiaries.

Methods used to value intangible services necessitate numerous assumptions and stakeholder participation. Because each study has a different context and stakeholder sample, results contrast significantly. It is therefore essential that studies clearly state and justify their hypotheses and involve as many stakeholder groups as possible to describe the variety of values associated with a specific forest ecosystem. Moreover, contrasting results against other studies and providing the rationale for their differences is important to facilitate effective use of the results. If differences are barely acknowledged or understood, stakeholders may use the results in a way that supports their point of view, leading to misunderstandings rather than facilitating dialogue.

Socioeconomic valuation techniques are flexible enough to respond to specific contexts. However, stakeholders should not seek to misuse this flexibility to support their opinion/position or to affect value. For example, the travel cost method – commonly used to estimate recreation values – can take into account the opportunity cost of time in contexts where individuals could instead have engaged in a remunerated activity. However, people rarely make a choice between leisure and paid work and the value may therefore be overestimated. Inappropriate use of this method creates confusion and leads to mistrust in the results.

Clear communication about results, including their explanation, meaning and possible use, is required.

Economic valuation to change forest management scenarios

Despite its methodological limitations, economic valuation can support the decision-making process, the design of management techniques and provide information.

Evaluation of management scenarios: cost-benefit and multi-criteria analyses

This use of cost-benefit analysis is a common decision-making technique used to evaluate diverse forest management options. This technique was used in two watersheds in Tunisia to analyse technical management treatments affecting forest cover. Watershed forests are expected to reduce water erosion through run-off, increase water availability and carbon sequestration. The costs and benefits of improved management were estimated both ecologically and monetarily, using market prices and economic valuation for non-market assets. The traditional financial cost-benefit analysis of management improvements in the BouHertma watershed provided a positive Net Present Value[4] (NPV) and a 13 percent internal rate of return.[5] The Marguellil watershed management improvements, however, presented a negative NPV and a lower IRR (9 percent). When including non-market effects such as erosion prevention, water availability and flooding occurrence, the indicators in the cost-benefit analysis changed substantially: NPV for Marguelil interventions became positive and its IRR increased to 18 percent, while in BouHertma the IRR reached 23 percent. In conclusion, accounting for off-site, non-market and social costs and benefits highlighted the additional welfare gain of the watershed projects, demonstrating high overall profitability (Cesaro *et al.*, 1998).

Box 4.16. Algeria's experience assessing environmental goods and services

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In a study carried out as part of a cooperation project financed by the French Global Environment Facility (FFEM) under the management of Plan Bleu and the FAO Secretariat of *Silva Mediterranea*, Algeria's General Directorate of Forests estimated the economic and social value of services rendered by Mediterranean forest ecosystems. This research was used to guide its national environment policy.

The study was developed in the Chréa National Park, evaluating three types of services:

- Regulatory services by estimating the value of water purification provided by vegetation cover. This involved calculating the difference in purification efforts between a forest-covered catchment and another with no forest cover, resulting in the avoidance of an economic cost. The forest covers 19 600 ha, making it possible to save EUR 1.4 million per year (i.e. an economic value of the forest estimated at EUR 74/ha/year).
- Supply services by estimating the economic value of a NWFP (*Arbutus unedo*'s fruits). The income for harvesters in 200 ha forest area was estimated at EUR 13 700/year (i.e. a forest value estimated at EUR 68/ha/year).
- Cultural services by estimating the recreational value of a busy site in the pilot area (Chiffa Gorge). The social benefit was estimated to reach EUR 223 500/year in the magot monkey habitat, a forest area of 1 300 ha. This profit represents the equivalent of EUR 172/ha/year.

Studies such as this make it possible to support forest administrations using tangible arguments about the value of managing natural ecosystems sustainably. It therefore deserves to be duplicated in other sites.

When beneficiaries will not consider an exchange value for some ecosystem services (i.e. will not accept any decrease in the supply of one ecosystem service, even in exchange for compensation), the ecosystem service value may not be well reflected in typical valuation exercises. The multi-criteria analysis solves this limitation by evaluating preferences between different characteristics and outcomes of alternative forest management scenarios without requiring the use of monetary units. A study in the Valencia region (Spain) was conducted on several ecosystem services in preparation for a regional action plan on forests (Maroto Álvarez *et al.*, 2013). Stakeholders attached greatest weight (an average

[4]The net present value (NPV) corresponds to the additional net benefits for the duration of the management scenario.
[5]The internal rate of return (IRR) corresponds to the discount rate for which the NPV is null.

of 40 percent) to environmental criteria (hydrological regulation and erosion, climate change mitigation and biodiversity). Social criteria (employment, recreational activities and landscape) were weighted at 38 percent and economic criteria (wood, hunting and fishing, livestock, renewable energies, rural tourism and mining) at 22 percent. A comparison of stakeholder preferences against the public budget revealed that while most public funds were assigned to fire prevention and extinction (with an emphasis on extinction), stakeholders attached less weight to these criteria. The budget ratio directed towards forest infrastructure also exceeded stakeholder preferences. Conversely, investment in forest research remained under-resourced.

Mapping the value of ecosystem services

Mapping the value of ecosystem services using spatially explicit models, in conjunction with valuation methods and considering climate change impacts, helps decision-makers to identify management options that optimize the overall value of forest goods and services (Bateman *et al.*, 2013). In Europe, mapping ecosystem services remains peripheral, generally used to obtain better land allocation and justify the protection of specific ecosystems. Many countries contributed to the Mapping and Assessment of Ecosystems and their Services atlas (Maes *et al.*, 2011). Italy, Greece and Cyprus prepared biophysical maps showing erosion risk, landscapes with recreational potential, etc. Spain conducted a national evaluation and France, in the process of completing its evaluation, will include a component on forest ecosystems. However, as far as most regulation and social services are concerned, economic valuation is still in its infancy (Forest Europe, 2014).

Economic valuation for setting up economic instruments

Ecosystem service preferences are generally studied individually using surveys. Alternative approaches, which include greater participation by civil society, have attracted attention in recent years. The FFEM project tested different participatory governance techniques, leading to shared diagnoses and prioritized forest ecosystem services (Gouriveau, 2016).

Both individual and participatory valuation methodologies equip decision-makers with sound information on social demand for intangible goods and on the complex biophysical consequences of diverse forest management options. These results can be used as a technical tool to design (or justify existing) economic instruments to guide decisions by forest managers and users.

Possible options for enhancing the value of forest goods and services

Even if they are not marketed, ecosystem services have economic value. This value can be used to communicate and increase public awareness about the importance of ecosystem services for human life. These services can also be marketed, thus providing an opportunity to motivate potential suppliers and increase consumer awareness about the value of the ecosystem services. To realize this option in practice, the economic value of an individual ecosystem service and value chain must be calculated or estimated. At the same time, value chains must also be activated (see Section "The value of Mediterranean forest ecosystem services" and Chapter 6).

An overview of instruments used to capture forest benefits, including examples from the Mediterranean region, are available in Croitoru and Liagre (2013). This section focuses on value chains and their potential to enhance the value of forest ecosystem services within the Mediterranean basin.

Value chains in the forestry sector

Value chains link ecosystem services suppliers and users in a specific market, often involving different actors (aggregators, processors, traders, etc.) along the commercialization process (Boxes 4.17 and 4.18). In the forestry sector, products such as industrial timber and woody biomass[6] have structured and (quite) well-understood value chains (Shabani *et al.*, 2013). This is also the case for certain domesticated, non-timber forest products based on agroforestry (e.g. cork; de Fátima Ferreiro and Sousa, 2005). The value-chains of wild forest products (e.g. truffles, mushrooms, berries, nuts, medicinal plants) are often less structured and poorly understood, with limited official information available about their size, added value, stakeholders and inter-linkages (Vidale *et al.*, 2015). Non-material ecosystem services – such as water protection, biodiversity, recreation and cultural services – will be more or less advanced depending on the maturity and structure of the market and the degree to which quality information is available (Landell-Mills and Porras, 2002). This is also the case for carbon sequestration and cultural services.

Box 4.17. Integrated forest management and biomass supply chain for the development of the local economy: Borgo Val di Taro (northern Italy)

In 2011 the Local Health Authority of Parma (Italy) decided to install a modern boiler using locally produced woody biomass at the Hospital Santa Maria in the municipality of Borgo Val di Taro. Biomass was supplied by a local consortium, a public-private body managing 7 000 ha of forest owned by 29 traditional collective forest domains and another 8 000 ha of private forests belonging to six private forest consortia. All biomass (about 800 tonnes/year) was sourced within a radius of 15 km from the boiler, while seasoning and chipping were performed through a local biomass trade centre, using infrastructure that permitted raw material concentration and selection based on quality standards. Forest management for biomass extraction from local coppice forests is integrated with myco-silviculture activities. The area is internationally known for the Borgotaro mushroom (EU Protected Geographic Indication), the only wild product to attain a label under this system. Through the introduction of picking permits (1993), local forest owners covered the additional management costs, while local commercial pickers had greater access to wild mushrooms. The Borgotaro Mushroom Consortium and forest owners managed an annual revenue of between EUR 0.5 and 1.2 million while the wild mushroom supply chain generated additional annual revenue of around EUR 0.5 million of added value from the 5-10 tonnes of wild mushrooms sold. Networking between different stakeholders and activities in the area strengthened its marketing strategy. Hotels, B&Bs, restaurants, tourist agencies, local shops and public transportation were some of the stakeholders involved in the recreational wild mushroom picking network, which attracts up to 100 000 local and non-local pickers per year. Revenues are used to cover the administrative costs of the picking permit commercialization (5 percent), while a proportion is transferred to forest owners to reinvest in socioeconomic activities and another is reinvested in the forest to enhance wild mushroom productivity (Ecostar, 2017).

Options for value chain development in Mediterranean countries

Wood products. In Mediterranean countries, wood value chains have been analysed with a special focus on value chains for pulp and paper (eucalyptus and pine plantations) and, more recently, biomass for energy (Ketikidis *et al.*, 2016; Shabani *et al.*, 2013; Scarlat *et al.*, 2015).

[6] Valorization of value chains for woody biomass are key elements of several bioeconomy policies and strategies in Europe at both regional and national levels (Scarlat *et al.*, 2015).

There are several reasons for promoting shorter value chains in Mediterranean countries: reconnecting domestic production with local consumption would reactivate management of abandoned forests, reducing fire risks; provide employment opportunities in rural areas; and help to maintain hydro-geological stability and landscapes, etc. The development of a short, local supply chain would also be consistent with EU policies calling for the promotion of wood mobilization, i.e. increased forest removals and the adoption of a cascade use of wood. The latter involves "prioritizing the forest outputs that have higher added-value, create more jobs and contribute to a better carbon balance" (European Commission, 2013). According to this approach, wood should be utilized to the highest level technically possible based on an order of priorities, from wood-based products with a long service life (building material, furniture, etc.) to bioenergy. After primary use is established, the cascade approach should be followed according to an order of priorities. For example, wood-based products with long service life should be reused or recycled (e.g. to produce panels) before being burnt for bio-energy and, if needed, disposed.[7]

Short value chains can be activated by introducing tools such as: long-term management agreements and contracts with service providers and consultants (e.g. Italy's "network contracts;" Abatangelo *et al.*, 2016); biomass concentration and trade centres that facilitate the selection and grading of wood assortments produced within a certain area and the provision of additional services (de-barking, chipping, drying, sale management, etc.); and land banking, as occurs in the farming sector, to reduce fragmentation of private ownership, land abandonment and the tragedy of the anti-commons (Heller, 1998).

Non-wood forest products (NWFP). In Mediterranean countries, NWFPs include a large variety of products: those intended for mass markets (cork, chestnut); specialties (truffles) and various niche markets (*P. pinea* seeds, argan nuts); new, emerging products (resin, "tree water," products for foraging); and old, sometimes declining products (spontaneous medicinal plants). Short value chains for many of these products may increase income generation in rural areas by linking local producers to local and external buyers. These can be promoted as emblematic products ("genius loci") in territorial marketing initiatives that brand a geographic area and facilitate stakeholder networking (the "blueberry valley," the "chestnut trial," the "Boletus roads"). These types of value chains have been successfully developed in Mediterranean countries, including through new channels such as e-marketing using social media and online sales. Some critical issues must, however, be carefully considered. First, failing to reach minimum and stable product volumes is a potential problem (wild production volumes are influenced by climate variability and seasonality). Private pickers frequently collect and sell wild products in informal markets. They may have limited capacity and/or willingness to collaborate in consortia, cooperatives or similar associations. Sometimes, their property rights are not compatible with or easily promoted via commercial value chains (e.g. in Greece all NWFPs are owned by the State; mushrooms can be collected for free in most forest areas in Spain). The possibility of developing value chains for food and medicinal and aromatic plants is affected by legislation relating to origin and tracking (i.e. rules linked with transparency, an issue associated with clear definitions and implementation of property rights and fiscal regulations).[8] In Moroccan cork oak forests, acorns are collected for animal and human consumption. Over the last few years, an informal market has developed. Although forbidden by law, acorn value is such that illegal trade continues to occur. While these informal markets provide a revenue source for local populations, the intense collection of acorns endangers the ecosystems and, consequently, other ecosystem services. This situation requires a more integrated valuation model that takes into account both rural community interests and the importance of preventing illegal and unsustainable harvesting. When NWFP markets develop, measures may need to be taken to ensure sustainable harvesting through community-based management or regulation and enforcement. Monitoring is often one of the first steps to be implemented, eventually with community and science combining information.

[7]Care should be taken when using these last options; burning treated wood can cause damage the environment and human health. These trade-offs should therefore be taken into account in the value chain (Zelikoff *et al.*, 2002; Rogaume, 2009).

[8]Refers to the transfer of the tax burden from landowner and collector to the middle man, maintaining traceability.

Services. In Mediterranean countries, recreation, landscape and water protection are all key ecosystem services, but many others may be relevant to local contexts (e.g. biodiversity, carbon sequestration, soil erosion control, etc.; Blondel, 2006). Payments for Environmental Services (PES) mechanisms (Wunder, 2007) are tested or implemented as instruments for assigning a financial value and commercializing ecosystem services (Engel *et al.*, 2008). They are particularly successful if applied locally (Gatto *et al.*, 2014). What matters is that the basis of any PES should include a possible value chain. A well-defined ecosystem service is delivered by at least one supplier to at least one buyer on the basis of a (voluntary) contractual agreement and a commercial transaction between the two parties. The mechanism requires that the provider secure ecosystem service provision (Wunder, 2005) and often includes intervention by an intermediary.[9] While PES appears easy in theory, its practical implementation is often very complex. To design and implement value chains is a challenging task for both policy makers and innovative entrepreneurs or NGOs. Initial issues often relate to property rights to the ecosystem services (Mauerhofer *et al.*, 2013). The owner of the land is not necessarily the owner of the ecosystem services, for example in the case of carbon credits (Hepburn, 2009). A second issue relates to the technical difficulties in finding evidence of a causal relationship between management practices and changes to the ecosystem services (Pettenella *et al.*, 2012). This creates problems in identifying added value and its correct distribution amongst suppliers (if there are many), thus raising problems of equity. New contractual agreements and legal frameworks must be formulated and updated to replace existing models that are too complex, rigid and obsolete (Pettenella *et al.*, 2012).

Bottlenecks and future directions for developing value chains

Value chains can usefully enhance the value of goods and services derived from Mediterranean forests. Value chains should be legally feasible, economically viable, socially acceptable and environmentally friendly. Depending on the specific product or service, establishing a value chain can be complex, requiring multifaceted case-by-case solutions. However, a couple of general remarks are worth mentioning here.

New and innovative agreements and policy reforms should be designed to regulate property rights, relationships between suppliers (typically landowners and forest managers), buyers and end users of a product or service. Institutional and organizational innovations are needed here (Weiss *et al.*, 2001). These are particularly important in the case of ecosystem service value chains in which forest owners

[9] The intermediary, for example, facilitates the negotiation process, implements the administrative procedures for payment or monitors the ecosystem services level.

Box 4.18. Economic valuation of forest ecosystems, Turkey

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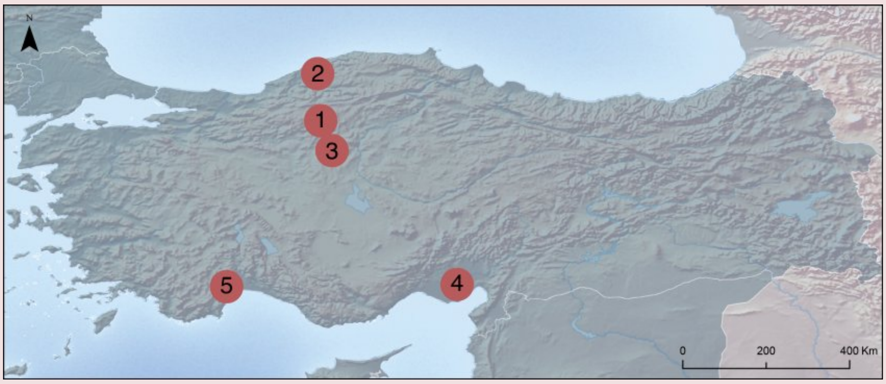

Figure 4.17. Sites in Turkey with an economic valuation of forest ecosystems

What	Where[a]	How	Results	Year	Ref.	Implication for decision making
Recreation services	① Soguksu National Park	TCM and CVM	USD 3-5/visitor Total value of USD 380-619 million/year	1999	Kaya *et al.* (2000)	The conservation statute should be maintained
Wildlife conservation	② Bartin	CVM	USD 53-72/year/hh for residents	2008	Kaya *et al.* (2009)	Allocating the forest site for wildlife conservation is a priority
Scenic beauty	③ Middle East Technical University Forest	HPM	USD 8 300-12 500 per dwelling USD 4.3-6.5 million/year Total of USD 54-81 million targeting housing market, and USD 3 800-5 700/ha for the forest area	2013	Kaya and Özyürek (2015)	Financing forest management with municipality tax revenues is recommended
Watershed conservation	④ Çakıt Stream Basin Erosion Control Project in Adana and Niğde provinces	CE	USD 0.6/hh for one year postpone of flood occurrence USD 2.5/hh for one percent prevention of soil erosion USD 0.1/hh for one year increase for dam life USD 1.2 for one percent increase for access to spring water	2012	Deniz and Ok (2016)	Confirms the contribution of forests to watershed conservation
Four services	⑤ Düzlercamı Forest	MP, CB and BT	Wood production: USD 16/ha/year Biodiversity protection: USD 4/ha/year Recreation and tourism: USD 18/ha/year Carbon sequestration: USD 57/ha/year	2015	Balkız (2016)	A need for action to adapt to climate change
Variety of goods and services (except timber)	Turkey	TEV	USD 1.1 Billion	1999	Bann and Clemens (2001)	Importance of ecosystem services for sustainable forest management in the context of social welfare

Note: BT = benefit transfer, CB = cost-based, CE = choice experiments, CVM = contingent valuation method, TCM = travel cost method, hh = household, HPM = hedonic pricing method, MP = market price, TEV = total economic value.

[a]See Figure 4.17 for the location of the sites.

must learn how to interact and make contractual commitments with new, non-forest stakeholders (e.g. tourism and travel agencies, water sector companies, health care services), build novel (and thus far unknown) inter-sectoral networks and speak "new languages" (see Chapter 12). To a large extent, the development of these value chains depends on the promotion of public-private partnerships, especially in state forests. A relationship of shared benefits will guarantee sustainable management, resource conservation and improved well-being for forest users.

Main conclusions and recommendations

Economic valuation is a useful tool to educate decision-makers and society about the value of ecosystem services. In the Mediterranean, valuing products and services is highly relevant because a large portion of the benefits derived from forests are not marketed. In this context, economic valuation becomes a tool to support decision-making directed towards forest ecosystem conservation and development. Various studies show that developing recreational activities and producing NWFP can increase contributions by forest ecosystems to the well-being of local and national populations and reduce damage to ecosystems, if this development is accompanied by sustainability measures. This increased well-being justifies investments to conserve, develop and exploit forest ecosystems sustainably. It is also a tool to support the design and implementation of incentives, compensation and PES mechanisms.

Assessments of goods and services also serve as a basis for negotiating and reaching compromises between stakeholders. The link between an economic valuation of goods and services and participatory governance initiatives emerges through the identification of win-win situations (see Chapter 12) that compromise to resolve conflicts and even co-manage agreements.

Weaknesses are largely related to the methods used and the availability of data, the absence of which is a major weakness making it difficult to accurately assess the value of goods and services.

Three overall recommendations are:

- Improve knowledge and build capacity. There is a need to teach economic valuation tools and to train forest administrations and forest managers (capacity building). Local communities and stakeholders should be educated about the value of different ecosystem services from which they benefit. They should be invited to participate in the valuation process in order to witness its practical implementation, provide information and understand the results.
- Integrate economic valuation as a tool to support forest management decisions. Cost-benefit analysis and multi-criteria analysis are used to compare different management options (as opposed to business as usual) and to identify the most advantageous option for the owner or society. This assessment helps target those operations with the greatest social impact and determine the economic consequences (i.e. gains and losses) for all stakeholders.
- Develop economic instruments to encourage multipurpose forest management/reduce degradation.

This involves identifying and developing economic instruments and funding mechanisms to attain a compromise between the forest owner/forest manager, local users and off-site beneficiaries of ecosystem services. The switch to a more sustainable management type may require an initial investment. In such situations, the instruments should provide for compensation over a limited period to those stakeholders who suffer initial losses. Traditional incentive systems and market-based economic tools (such as compensation mechanisms and Payments for Environmental Services) should be considered. Contractual measures (contracts, co-management agreements, collective management) between the manager and users and/or beneficiaries of the service should also be explored to ensure the sustainability of the service.

14 Financial incentives and tools for Mediterranean forests

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Public sector expenditure in the forest sector: state of the art

Forestry interventions generally constitute medium to long-term investments. Anticipated cash returns and associated risks along with consequent externalities, often justify the requirements for public funding to cover some costs. These revenues are assigned from the general Treasury, often complemented by earmarked taxes, concessions or public service fees or private or international funds (discussed further in subsequent sections). Budget distribution will depend on forest ownership, taking the form of allotments for the Forest Service and related agencies (including public forest enterprises), or subsidies to municipalities and private forest managers.

From a fundraising stability perspective, budgetary allotments largely depend on fluctuations in economic policy. Public fees charge for a service offered by the Forest Service, such as tree marking. Concession fees reflect the costs that concession-holders incur in exchange for obtaining exclusive management rights over a piece of public forest during a prescribed period (e.g. eco-tourism in Tunisia). Earmarked taxes penalize selected activities and their derived funds are consigned to certain actions, leaving a low margin for political fluctuations. A few municipalities in Catalonia (Spain), for example, have introduced a tax on homes situated at the wildland-urban interface to cover the costs of installing fire prevention strips (e.g. Matarò, Vallirana, Argentona). Yet the volatility of tax-derived budget depends on the demand elasticity of the taxed asset.

From a budget allocation perspective, subsidies and grants reflect policy preferences. Non-state beneficiaries (e.g. municipalities, industrial or private landowners) receive incentives to (or not to) implement or address selected forestry measures or apply certain requirements. Subsidies often target the provision of forest externalities (e.g. biodiversity, fire prevention). The European Union Common Agricultural Policy constitutes the largest subsidy scheme for forest management in Mediterranean Europe (Box 4.19). The Policy's Rural Development Programme is funded through the European Agricultural Fund for Rural Development (EAFRD) and Members co-finance its measures with additional national public funds. Non-EU Mediterranean forests are mainly owned by the state. Therefore, instead of addressing private managers, subsidy schemes are directed to local communities of forest users (see Box 4.20).

Public expenditure is the backbone of forest management finance. Table 4.11 reflects public expenditure per hectare. The wide variations are partly explained by the different items under consideration: forest management and surveillance, administration staff, forest-related research and education, wildfire suppression corps, or protected areas.

Since 2007,[1] the Cross-Border Cooperation (CBC) programme, under the European Neighbourhood

[1] In 2007-2014 the programme ran within the European Neighbourhood Partnership Instrument (ENPI); it runs within the ENI

Box 4.19. EU Rural Development Programme of the Common Agricultural Policy

Among a set of measures suggested at the EU-level to bolster rural development, each Member (or region) adopted and co-financed certain strategic forestry measures. During the programme period 2007-2013, these core measures were: afforestation (measures 221 and 223), agroforestry establishment (measure 222), restoration of forestry potential following disasters (measure 226), non-productive forestry treatments (measure 227), support for productive investments and added value in forests (measures 122 and 123) and forest environmental payments (measure 225). In the current financial period 2014-2020, Members are required to reserve a minimum of 30 percent of their EAFRD contribution for investments for forest area development, forest viability improvement, climate/environment and forest payments, or Natura 2000 forests (Article 59 (6) of EC Regulation 1305/2013). Most measures are maintained (measures 8.1 and 15.1) or reshaped. For example, damage prevention (measure 8.3) and restoration (measure 8.4) are disaggregated, agroforestry now includes maintenance (measure 8.2) and forestry treatments now focus on resilience (measure 8.5). A new measure promotes the conservation of forest genetic resources (measure 15.2). In addition to forestry-specific measures, substantial amounts of funding can be used in forestry through horizontal measures which target either agricultural and forestry activities or biodiversity maintenance.

Instrument (ENI), has supported projects between EU Members and partner (e.g. MENA) countries. It includes a component on the Mediterranean Sea Basin (ENI-CBC-MED),[2] whose priority lines include climate change action (e.g. water-efficient forestry), boosting small businesses (e.g. NWFP value-chain networks, innovative eco-tourism) and civil-society engagement (e.g. social innovation projects in rural areas). These projects last between 24 and 36 months and are 90 percent funded. At least half of their allocated budget should be spent in non-EU countries. The first call for projects was launched in November 2017.

In addition to the EAFRD, EU Members can benefit from the European Regional Development Fund (ERDF) and European Social Fund. The ERDF co-finances projects potentially related to forests within a territorial development measure, e.g. by supporting small and medium enterprises. The ERDF also co-finances transnational and interregional cooperation programmes (INTERREG), which can support forestry projects with activities such as monitoring systems, networks linked to forest fires, information sharing on climate change adaptation, sustainable use of bio-energy, etc.

Natura 2000 is the largest coordinated global network of protected areas, covering a substantial forest surface area. Forests falling within Natura 2000 areas count as part of the EU LIFE Instrument, which specifically dedicates about 50 percent of its budget to nature and biodiversity. LIFE has financed a vast range of projects for the management of forests in Natura 2000 areas. This tool is especially relevant in Mediterranean countries, which host comparably larger portions of land under Natura 2000 (ranging from 17 percent in France to 39 percent in Slovenia). Funds from LIFE instruments are applied through measures such as the fight against invasive alien species, implementation of sustainable management plans, habitat restoration and forest monitoring. Moreover, they contribute to Prioritized Action Frameworks supporting the management and restoration of Natura 2000 sites across a broad geographical area, such as a region or country (European Union, 2015). Financial efforts in the Mediterranean region are largely devoted to reducing the main pressures and threats to forest habitats and species: fire, unsustainable grazing, invasive alien species, pests and diseases, deforestation for land use change and natural system modifications (European Union, 2015).

over the period 2015-2020.

[2]http://www.enpicbcmed.eu/enicbcmed-2014-2020

Table 4.11. Public expenditure on forest management in 2010

Countries	Forest and OWL cover (1 000 ha)	Public expenditure in the forest sector		Forest public revenue (1 000 EUR)
		Total (1 000 EUR)	EUR/ha	
Cyprus	386	38 210	99	496
Spain	27 627	1 552 080	56	n.a.
Syrian Arab Republic[a]	526	28 918	55	631
Israel[a]	225	10 658	47	n.a.
France	17 579	487 000	28	n.a.
Italy	11 110	295 000	27	n.a.
Lebanon[a]	243	6 005	25	842
Jordan	149	3 603	24	n.a.
Slovenia	1 271	29 910	24	35 466
Morocco	6 212	139 590	22	69 042
Algeria	4 525	84 411	19	3 668
Turkey	21 863	381 790	17	727 729
Greece	6 539	106 714	16	n.a.
Tunisia	1 334	20 959	16	6 047
Montenegro	964	6 480	7	5 643
Croatia	2 491	13 760	6	1 427
Portugal	4 907	25 981	5	n.a.
Albania	1 237	5 170	4	735

Source: FAO and EFI (2015) and FAO (2015a).

Note: No data available for Malta, Egypt or Palestine. OWL = other wooded lands. [a]Data from 2005.

Other possibilities exist under the Horizon 2020 programme, which supports activities related to research and innovation, including the public-private partnership on bio-based industries.

Diversity of financing approaches and mechanisms: current practices and perspectives

Forest management expenditure can be derived from other funding sources in both the public and private sector. Subsection "National Forest Funds" deals with Forest/Green Funds, which have precedence in some countries. Subsequent subsections deal mainly with innovative financial mechanisms applied in different settings across the Mediterranean.

National Forest Funds

The forest-related activities of some Mediterranean governments are delivered (at least in part) through institutional mechanisms known as "National Forest Funds" or "National Green Funds" (Figure 4.18). Some countries complement their general budget with specific funds derived from earmarked taxes or fees. The Croatian Green Fund, for example, directs 0.0265 percent of professional turnover for use in forestry treatments carried out by public enterprises, such as wildfire prevention, forest research, or the delivery of forest management plans in private forests (Krajter Ostoić *et al.*, 2015). This fund was established in 1980 to support the management of forests in karst areas (which have high ecosystem services value, but a low wood value), but has been implemented continuously since 1990 through an initial 0.07 percent tax (equivalent to 0.12-0.13 percent of the Croatian GDP) (Coello, 2011).

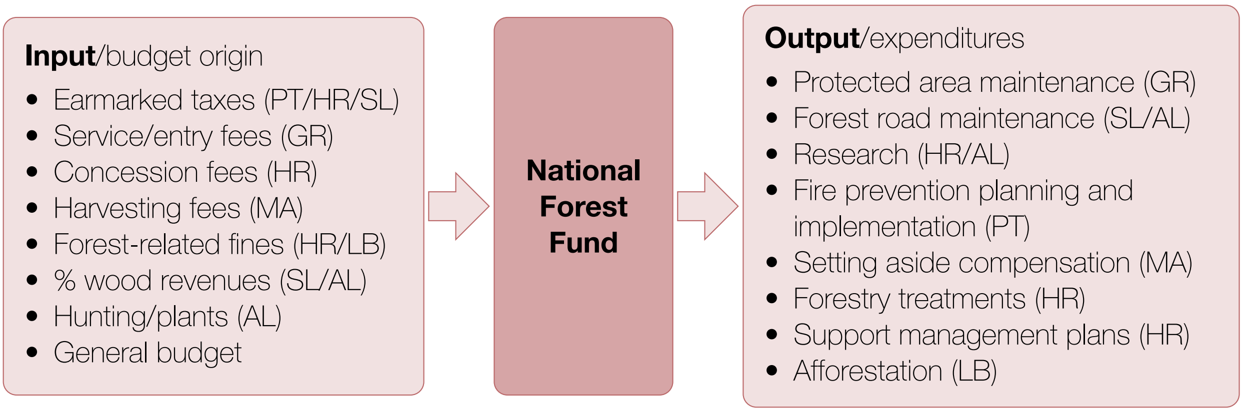

Figure 4.18. Financing and expenditure structure of analysed National Forest/Green Funds
Note: AL: Albania, GR: Greece, HR: Croatia, LB: Lebanon, MA: Morocco, PT: Portugal, SL: Slovenia.

The Portuguese Permanent Forest Fund[3] is fed by an eco-tax on oil products (0.05 EUR/litre for gasoline and 0.25 EUR/litre for diesel in 2003). The consolidated funds are predominantly used for wildfire prevention, with additional support from EAFRD funds (i.e. cost-sharing grants). The fund aims to tackle three challenges simultaneously: wildfires, land fragmentation and abandonment of forestry practices. It therefore incentivizes joint forest management focused on Forest Intervention Zones (ZIF). The ZIF is a group of private forest owners (at least 50) whose land covers more than 750 ha and has a minimum of 100 individual land parcels (Valente *et al.*, 2013). In addition, a conglomerate of forest owners totaling 5 percent of a continuous area is sufficient to constitute a ZIF. Usually driven by an intermediary association, ZIF provides opportunities to broaden forestry planning and facilitate landscape-level strategies for wildfire prevention and wood mobilization. Each year, the Permanent Forest Fund finances projects to develop a five-year forest management plan and a 25-year fire prevention strategy. From 2005 to 2012, 162 ZIF were endorsed, representing more than 845 000 ha of land and corresponding to 24 percent of the national forest area (Valente *et al.*, 2013).

The Greek Green Fund is funded by fines imposed for breaching building regulations and environmental legislation, as well as entry fees (chiefly the Samaria Gorge National Park). Its income was intended to fund environmental protection, improvement and restoration programmes, including forest and national parks management. However, Greek commitments shifted following its economic crisis, and 97.5 percent of the Green Fund is now allocated for general state expenses, the remaining 2.5 percent directed towards environmental projects (Murray, 2015).

In the southern rim, the Moroccan National Forest Fund budget is derived from forest harvesting fees paid by forestry firms. It is used for promoting afforestation and reforestation, forest research and to indemnify local users for the loss of forest usage rights (Box 4.20).

The Slovenian National Farm Land and Forest Fund,[4] established by the Forest Act (2010), is fed by state forest concession fees. The Fund manages state forests and acts as state landowner representative. The Forest Act provides that all forest owners contribute a part of their cadastral income from forests (fee) to the maintenance of forest roads, while the state contributes 35 percent of total funds. Fees from forest owners are collected in a single account and later divided between municipalities. Municipalities, in the cooperation with the Slovenia Forest Institute, provide for the implementation of forest road maintenance works.

Since 2009, the region of Lombardy (Italy) has had a Green Fund to compensate for impacts caused by development projects (Bennett *et al.*, 2017a) by charging a levy of between 1.5-5 percent against development projects. The department of Finance of Lombardy Region manages this fund, which is

[3]http://www.icnf.pt/portal/fundos/fundo-florestal-permanente
[4]http://www.s-kzg.si/en/fund-management/

Box 4.20. The Moroccan Forest Fund

Since the passage of decree 1855-01 in 2002, shepherds in degraded areas have been compensated for setting aside areas for forest regeneration (a minimum of 300 ha or 100 ha for argan ecosystems). The compensation amounts to 350 MAD/ha, which was initially calculated based on the national average forage yield (250 FU/ha) and the 2002 price of barley (1 MAD/kg) (Croitoru and Liagre, 2013). This amount was subsequently updated, as it did not completely cover foregone costs or increased barley prices. The compensation is not given directly to the shepherds but instead provided in the form of local community projects (Matta, 2015). Most families in these communities are highly dependent on grazing animals for their subsistence (Figure 4.19). By 2011, 134 shepherd associations participated in the programme, comprising 15 000 members and covering 278 000 ha (Aouni, 2012).

used to make permanent environmental improvements within the affected municipality. It assigns funds to municipalities to carry out eligible projects in accordance with priority areas or ecosystem aspects outlined in *i.a.* the Italian Forest Plan and regional Ecological Network Plans. In 2017, about 18 percent of the total funds collected since 2009 (nearly EUR 1 million) were used for 63 projects covering 16 ha of forest, 5 ha of hedgerows and 38 ha of silvicultural improvements.

In contrast with the above, the annual budget of some funds is politically determined, drawn from the central budget. The Spanish Natural Patrimony and Biodiversity Fund, for example, is not operational, but does have the potential to channel aid to municipal and private landowners. Moreover, the government-dependant Foundation (*Fundación Biodiversidad*) channels subsidies and grants towards improving natural areas, often serving a co-financing instrument for EU LIFE projects.

The Lebanese "Reforestation Fund" (so-called *Sandouk al Tahrij*) was established under its 1949 Forest Law, but is not operational. In theory, it should receive funding for public afforestation activities derived from forestry infraction fines (Ministry of Environment *et al.*, 2015). Rosenbaum and Lindsay (2001) report on other funds in Mediterranean countries. The Albanian earmarked income from state forests (Law 8302, 1998) receives 70 percent of funds generated by grazing fees, wood sales or hunting permits and is used to tend forests, support forest nurseries and afforestation, fauna protection, forest road maintenance and fire prevention, among other activities. The Tunisian silvopastoral development fund incentivizes participation in wood and forage production to improve the socioeconomic conditions of forest populations.

Payments for ecosystem services

Payments for Ecosystem Services (PES) consist of transactions in which ecosystem services beneficiaries reward ecosystem services providers for either executing an action that boosts the quality or quantity of an ecosystem service beyond the status quo, or for giving up a planned action that would result in ecosystem services depletion. Forest ecosystem services providers voluntarily engage in PES and public or private actors can manage PES systems. Several local-scale PES initiatives affect Mediterranean forests.

Watershed investments. Forest management activities are among the most important actions undertaken in the context of watershed investments that are transactions for activities related to the maintenance and enhancement of watershed services (Bennett and Ruef, 2016). In Italy, several water boards or regional parks make agreements with landowners for management activities to improve flood controls. In a mountain basin in Tuscany, for example, the "Land Stewards" project makes payments to farmers and forest owners for their contribution to flood control and involvement in forest hydrology operations (Bennett *et al.*, 2017a). In Romagna, a public water company directs a part of its revenue towards payments for forest management to improve water quality (Box 4.21). Similarly, a water supplier in the Gulf of Saint-Tropez (southern France) pays a consortium to manage upstream forests to avoid sedimentation in La Verne reservoir (Box 4.21). In France, several private and public contractual agreements between stakeholders involved in water management support the general delivery of water quality (e.g. the company Danone was able to improve the management of 7 300 ha of land for bottled water purposes) (Bennett *et al.*, 2017b). In Catalonia (Spain), the water bottling company Aguas Font Vella y Lanjarón S.A. provides payments to landowners for reducing the environmental impact of their activities on the land (Russi, 2010).

Box 4.21. Watershed payments for fire and soil erosion prevention

Romagna Acque S.p.A. is a publicly-owned company that manages the drinkable water resources of Romagna (Italy), whose most important water source is a dam basin in the Apennines. When the basin was undermined by high levels of sedimentation, the company invested in research to improve catchment management. The research found that clear-cut forests and conversion from coppice to high stand led to erosion, while close-to-nature forest practices prevented erosion, reduced nitrogen levels and increased pH stability. Romagna Acque Spa therefore invested part of its annual revenue (4 percent or EUR 5 000-6 000 per year), derived from the water bills of consumers, to create an environmental fund to compensate landowners for changing their management practices. This PES has reduced sedimentation from 42 600 m^3 in 1982 to $< 30\,000$ m^3 today, and led to nitrogen reduction and pH stabilization (Gatto *et al.*, 2009; Pettenella *et al.*, 2012).

The Gulf of Saint-Tropez is an important tourist area home to several water-consuming towns. Its water supply comes from La Verne reservoir, located upstream in the Maures massif, an area very vulnerable to fires. It is surrounded by state, municipal and private forests, whose land cover prevents erosion during infrequent but torrential rainfall. Following hydrogeological and forestry analyses, the dam managing entity and the association of municipalities engaged in a co-funded plan for wildfire prevention. The water company contributed EUR 50 000 in the period 2006-2010 and EUR 72 000 for 2011-2014, covering 20 percent of the initial investment and 40 percent of maintenance costs (Gorriz and Prokofieva, 2014).

Habitat banking. Offset mechanisms compensate for inevitable impacts by improving environmental assets either in the location where the loss is incurred or elsewhere. Habitat reduction is often the result of infrastructure and urban development, affecting a number of plants and animals. In order to uphold the "zero-biodiversity loss" principle (adopted in the EU through the 2020 Biodiversity Strategy), habitat banks provide a brokerage service through flora and fauna indicators (i.e. credits) in the execution of forest improvement actions elsewhere. In the EU, three regulatory frameworks include these compensatory mitigation elements: the Birds and Habitats Directives, the Environmental Liability Directive and Environmental Impact Assessment frameworks. Each one is transposed into national law by EU Members. In addition, some countries have their own national or subnational policies. A French regulation, for example, obliges development companies to offset their biodiversity impacts. To facilitate such compensation the Caisse des Dépôts Bank created the CDC Biodiversité (Biodiversity Offset Supply), which provides offset credits for habitat, species and ecosystem functions. In Lombardy (Italy), the "Green Fund" mentioned above collects the financial compensation provided to all municipalities for the loss of agricultural land as a result of development projects. These funds are then used for environmental improvements (management of wildlife corridors, urban forests, hedgerows) within these areas (Bennett *et al.*, 2017a).

Forest access fees. The increasing use of forests for recreational purposes can conflict with other forest functions, but also provides opportunities to finance recreational infrastructure or forest management. A range of usage fees are charged, such as:

- fee for road use: e.g. car access to Malniu lake, Spain;
- parking fee: e.g. Parrissal de Beceite or Montrebei gorge, Spain;
- hiking Fee: e.g. Al-Shaouf Cedar reserve, Lebanon; Cinque Terre or Gorropu Canyon, Italy; Samaria Gorge, Greece; all protected areas in Israel and Jordan;
- camping fee: e.g. use of the municipal forest of Pinar Grande in Soria, Spain, for summer camps;
- fee for other outdoor activities, such as cycling or horse riding (e.g. Puig de Massanella, Spain), or adventure parks and geocaching (e.g. Casaboli Ecocampus, Italy).

Fees generally range between EUR 2-10 per person. The amount is based on visitors' willingness to pay rather than the actual costs of ecosystem services provision. As a result of the expansion of orienteering and trail running competitions in recent years, some institutions have rewarded owners who grant access to their land for such activities. By using new technologies, the Landscare[5] initiative (Spain) provides an online platform for eco-tourists to "e-meet" landowners whose forest they are visiting and gives them an opportunity to make a donation.

Harvest fees for non-wood forest products. Some landowners (municipalities, private owners or their associations) have sought a fee for mushroom or truffle picking on their property (Italy, France, Spain). The amounts vary depending on the origin and objective of those seeking to pick this produce: commercial pickers often pay larger fees than recreational pickers and there is generally positive discrimination towards local inhabitants (Prokofieva *et al.* (2017)). If permit revenues are invested into ecosystem restoration and enhancement (especially those activities aimed at ensuring the provision of non-wood forest products, e.g. mycosilviculture), the result is a PES-type mechanism.

Biodiversity payments. The global Critical Ecosystem Partnership Fund (CEPF)[6] provides finance to NGOs and private sector organizations for executing projects focused on biodiversity hotspots in developing and transitional countries. CEPF donors are: the French Development Agency, Conservation International, the European Union, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. Examples of Mediterranean projects under the CEPF are: the integrated management of Drini River basin (Albania) through reforestation, bioengineering and improvement of pasturelands; and the community management of medicinal plants in Morocco's Atlas Mountains.

Other initiatives channel private funds in European countries. In 2011, WWF catalysed financial support from Coca-Cola Portugal for sustainable forest management practices in private cork woodlands (Box 4.22). In Spain, the Selvans Initiative channels private and public donations to purchase 25-year harvesting rights to old-growth forests for the purposes of biodiversity conservation (2008-present). Average compensation depends on the timber market value of the species and ranges between EUR 500-900/ha, provided as a one-time payment (Górriz Mifsud, 2013). An underused option for EU Mediterranean countries is the Natural Capital Financing Facility,[7] part of the European Investment Bank and LIFE programme. This financial tool finances projects between EUR 1-3 million in Natura 2000 zones. These include PES-type mechanisms, biodiversity offsets and green infrastructure. Both public and private entities are eligible for funding.

[5] https://www.landscare.org/
[6] http://www.cepf.net/grants/project_database/Pages/default.aspx
[7] http://www.eib.org/products/blending/ncff/index.htm

Box 4.22. The WWF Green Heart of Cork project in Portugal

In 2012, the WWF Mediterranean Programme in Portugal catalysed a PES scheme between a corporate water user (Coca-Cola Portugal) and the association of private forest owners APFCertifica. The firm has a beverage factory located over the Tagus aquifer, which consumes 500 000 m^3 of groundwater per year. Forty percent of its forest cover is composed of cork oak (*Quercus suber*) trees. Forest management practices applied to cork oak woodlands thus affect the quality and quantity of water received by the aquifer.

The project aims to promote sustainable management practices in these cork oak woodlands. Such practices benefit biodiversity and water conservation. WWF mediated an agreement under which Coca-Cola pays a fee (amounting to EUR 17 per ha) to APFCertifica associates located in "sensitive areas for biodiversity and water conservation" who commit to sustainable forest management practices by engaging with forest certification. FSC certification focuses strongly on biodiversity conservation and watershed protection. Studies have shown that certified practices favour cork oak regeneration, understorey plant diversity and the conservation of water streamlines. The commitment is annual and is dependent on landowner performance.

The EU-funded QualiGOUV project facilitated the establishment of this scheme by providing the necessary background information: the development of a web GIS tool Hotspot Areas for Biodiversity and Ecosystem services (HABEaS): www.Habeas-med.org, which gathers public information on biodiversity and ecosystem services in Portugal. HABEaS helps to target PES areas, important for the conservation of water and biodiversity (600 hectares). Other potential financier companies are currently being identified (Bugalho and Silva, 2014).

Climate finance

Several international mechanisms focus their funding on carbon sequestration with a view to tackling climate change. These provide opportunities for Mediterranean countries, mainly in the south and east.

Reducing Emissions from Deforestation and forest Degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+). This is a multilateral fund established by the Durban climate negotiations at the Seventeenth Conference of the Parties of the United Nations Framework Convention on Climate Change. REDD+ compensates sustainable land management that reduces CO_2 emissions by avoiding deforestation and degradation. Conceived as an improvement on the Kyoto Clean Development Mechanism, REDD+ involves funding commitments from 2013-2020 by the most polluting countries. Its conceptualization is equivalent to a carbon PES. Yet the official REDD+ design is yet to be finalized. In the meantime, several international initiatives are financing its preparatory phases, including emissions reductions (UN-REDD, Forest Carbon Partnership Facility (FCPF), EU-REDD). Due to ecological constraints for CO_2 sequestration in MENA countries compared to tropical wood growth rates, REDD+ strategies have not prioritized the Mediterranean basin. The effort countries employ in the verification of CO_2 sequestration may not always exceed the foreseen revenues. Some forestation projects could, however, be of local significance. Morocco and Tunisia are UN-REDD member countries and Tunisia has received preparatory support from FCPF. As part of the AFD/FFEM project,[8] Algeria, Lebanon, Morocco, Tunisia and Turkey have developed the Cost-Benefit Analysis component on REDD+ readiness.[9]

[8] http://planbleu.org/en/activites/foret/optimizing-production-goods-and-services-mediterranean-forests-context-global

[9] See presentations at the Regional Workshop towards a common position of CPMF partners on REDD+, 2014: http://www.fao.org/forestry/82870/fr/.

Nationally Appropriate Mitigation Actions (NAMA). NAMA facilitates carbon emissions reductions by developing countries with developed country support. The main difference with REDD+ is that NAMA addresses all sectors, not only forestry. Of the MENA countries, only Lebanon has joined NAMA thus far through its Afforestation and Reforestation Programme to plant 40 million trees in 70 000 ha. This programme is expected to sequester nearly 933 000 tonnes of CO_2, in addition to co-benefits (Ministry of Environment *et al.*, 2015).

The Green Climate Fund. This fund was established by the UNFCCC in 2010 and began mobilizing resources in 2014. Its aims to help developing countries to reduce emissions and adapt to climate change. Investments can be in the form of grants, loans, equity or guarantees. In the MENA region, only Morocco has participated so far, through its project to develop Argan orchards in degraded environments.[10]

The Global Climate Change Alliance, Germany's International Climate Initiative, Climate Investment Funds and Adaptation Fund provide further options for climate financing for Mediterranean countries.

Private investments in value chains (with direct financial returns)

Finance strategies usually include one or more of the following: equity financing (shares), debt financing (loans, bonds), venture capital (risk shares), or public capital market (stock trade). Venture capital and capital markets are compatible with enterprises relating to marketed forest products such as timber, bioenergy and cork.

Impact investments. More adapted than REDD+ to the Mediterranean context, the Land Degradation Neutrality (LDN) Fund is a public-private fund managed by a private company (Mirova) and initiated by UNCCD to accompany the LDN target by 2030. Algeria, Morocco, Turkey, Syrian Arab Republic, Israel, Egypt, Lebanon, Croatia and Italy are some of the participating countries. The LDN Fund intends to make land degradation neutrality profitable by supporting rehabilitation projects suggested by land managers and generating revenue streams from sustainable production in upgraded lands. LDN financing therefore expects both social and biodiversity impacts, but also financial returns for fund shareholders.

The Access and Benefit Sharing (ABS) mechanism is part of the multi-donor Nagoya Protocol Implementation Fund established by the Global Environment Facility (GEF), in which the World Bank serves as the trustee. ABS, which became operational in 2011, aims to fund activities under the Nagoya Protocol. It supports projects that encourage engagement with the private sector to explore the economic potential of genetic resources and facilitate the transfer of appropriate technologies. Through these projects, countries should generate additional information to increase understanding about their ABS capacities and needs, with a focus on existing policies, laws and regulations affecting genetic resources (GIZ, 2012). Proposals should be endorsed by the national GEF Focal Point and submitted to the GEF Secretariat through one of its eighteen GEF agencies. The bilateral "Adaptation to climate change – Implementing the Nagoya Protocol" project, as implemented by GIZ on behalf of the German Federal Ministry for Economic Cooperation and Development, is a Mediterranean example.[11] That project involved the development of a legal and institutional framework as well as ABS compliant value chains in two pilot regions, Souss Massa Drâa and Tadla-Azilal (Morocco).

Private financial instruments. Examples of *equity financing* (i.e. by shareholders) are found in Spain's Bosques Naturales and Maderas Nobles del Segura. Unfortunately, both initiatives went bankrupt due to improper management and inaccurate financial analyses. For example, their studies anticipated overly optimistic growth rates and low biotic and abiotic risk assessment. Moreover, market

[10] http://www.greenclimate.fund/-/development-of-argan-orchards-in-degraded-environment-dared
[11] http://www.abs-initiative.info/countries-and-regions/africa/

Figure 4.19. Grazing in the Maâmora Forest, Morocco, impacts fodder price © Nelly Bourlion

prices may adjust differently over the long-term in ways that are not foreseen. Lessons can be learned from these examples for future equity financing initiatives. In Portugal, Floresta Atlântica S.A. is a recent public-private shareholding. The State participates via the Institute of Financing for Agriculture and Fishing and holds 40.5 percent of the share capital. The private investors are five Portuguese banks that each own a 11.9 percent share. The investment strategy includes the acquisition of rustic and/or mixed agricultural land holdings to develop forestry and nature tourism projects. Wood production occurs mainly through replanting and managing existing stands, especially *Pinus pinaster*. For wood production, the fund emphasizes risk reduction through a specific strategy for wildfire prevention. They also re-parcel land in order to achieve economically sustainable productive units from highly fragmented properties. Non-wood forest products are also being promoted (e.g. hunting, fungi and external rental for compatible activities).

Within *debt finance*, entrepreneurs engage in credit liabilities through commercial bank loans. In order to implement the Green Plan of Morocco, a financial alternative was established for those farmers who were excluded from traditional bank financing due to insufficient collateral. In 2007, Crédit Agricole du Maroc, in partnership with the state, created the finance company Tamwil El Fellah[12] to reach these farmers. This firm includes a guarantee fund that partly covers its risk. Tamwil El Fellah provides financing to small-scale forestry cooperatives producing NWFP (FAO and CTFC, 2016). These ethical banks are gaining traction, as they offer bank loans with lower interest rates than traditional counterparts. For example, Triodos bank has financed the activities of the Ambientea Co-op forest place nursery in Castilla-La Mancha (Spain).

Lastly, new and decentralized online private investment opportunities include crowd funding and venture philanthropies. Commercial (and especially ethical) banks and social stock markets/brokers are increasingly considering *venture philanthropies* among their business portfolios. While little has been done in this field so far, these channels will likely open doors for future financial developments. Moreover, different training and sponsorship opportunities for new nature-based entrepreneurs are available (e.g. ECOSTAR for global entrepreneurs, SwitchMed for Mediterranean-based ventures).

A recent study emphasizes the success of crowd funding in financing small-scale charity projects. About 70 percent of environmental, social and development projects proposed on crowd funding platforms reach the required funding target. This is a great opportunity for Mediterranean forest and landscape restoration initiatives. Examples of crowd funding for landscape restoration (with varied success) include

[12] http://www.abs-initiative.info/countries-and-regions/africa/

Mirlo Positive Nature (Spain),[13] Adopt a Cedar Tree in the Shouf Biosphere Reserve and Zoomaal (both in Lebanon). Crowd funding was one of the funding options considered for the 40 Million Trees Initiative launched by the Ministry of Agriculture of Lebanon. The main challenge is the creation of a critical mass to fund the proposed initiative.

Corporate Social Responsibility

Firms are moving towards including environmental aspects in their business models beyond legal requirements as part of so-called Corporate Social Responsibility (CSR) obligations. These companies allocate a budget that can fluctuate according to certain turnover variables. Budgets linked to production variables (e.g. emitted pollution) will be more stable. Legally, these transfers to forestry projects are donations or sponsorships, which some countries incentivize through tax levies. Moreover, these contributions help build a green image of the donating companies.

The variety of environmental CSR initiatives available often motivates companies to fund beneficiaries for green marketing purposes; in these cases CSR takes the form of regular, targeted payments. Examples of this include donations for the establishment of a new protected area along the Brenta River Forest (Veneto, Italy) and the Laisas Foundation's donations to WWF Greece to strengthen local forest fire volunteer groups after the catastrophic wildfires of 2009. Through the Moroccan Crédit Agricole "green card," companies can donate a percentage of their finances to forest management through the "Partnership for Moroccan Forests" programme. Similarly, a "green card" is issued by the Tunisian UBCI bank, contributing to forest management and the living conditions of related communities through the "Pact for a Green Tunisia" programme. While the above-mentioned European examples involve transactions between private agents, the Moroccan and Tunisian cases are examples of public-private partnerships based on coalitions with the public administration.

Some companies and individuals also invest in offsetting their carbon footprint through voluntary forestry projects within their countries or elsewhere. The Carbon Monitoring Group has been collecting data on voluntary forest carbon market initiatives in Italy since 2009 (such as LifeGate, AzzeroCO2,[14] Carbon Sink). So far, it has reported on more than 70 forest carbon projects, located both in Italy and abroad, for a transacted value of approximately EUR 5 million (Hamrick and Brotto, 2017). The LIFE-project CarboMark also attempted to create a structured institutional market in northern Italy. In Spain, HuellaCero[15] (CESEFOR-AGRESTA) offers other silvicultural works that increase Carbon sinks in Spanish forests. Moreover, Spain has established a national registry of voluntary emissions compensations, which acts as broker between polluting companies and a pool of carbon sink projects[16] in the form of afforestation of post-fire reforestations. An attempt for a structured market started in northern Italy through the LIFE-project CarboMark.[17]

From rural development donors to impact investors in ecosystem services

The previous sections demonstrate an increasing trend towards financing that goes beyond traditional wood production linked to measurable environmental and social impacts. Financing is progressively shifting from philanthropic donations towards risky investments in improving ecosystem services and assisting their dependant populations.

[13]http://mirlo.co/
[14]https://www.azzeroco2.it/compensation-through-afforestation
[15]http://www.huellacero.com
[16]http://www.mapama.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/proyectos-absorcion-co2.aspx
[17]http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3269

Most Mediterranean countries are considered emerging or frontier markets. Emerging countries can more easily attract financing from traditional investors (e.g. commercial banks), who seek high, medium-term return rates. By contrast, frontier market investors search for diversification and high returns that are often delivered over the long-term. Returns on forest-related investments will only be delivered over the long-term. Projects should therefore target forest investors who are not speculators with short-term liquidity needs. Instead, they should assess risk capacity in terms of time ("patience investments"). Ethical factors and social and environmental impacts will also reduce the risk aversion of investors in this field.

Business models will vary according to the type of initiative. Because public initiatives are funded by the taxpayer, governments can pursue relatively large, long-term projects. When the general budget is not sufficient for this purpose, governments can use specific tools, such as an earmarked fee (which is sometimes channelled through a specific fund). If the earmarked fee cannot be raised (as a result of the citizenry's reduced purchasing power or the government's inability to enforce it) external funding may be required. States may search for those large donors or investors who base their investment decisions on indicators such as project quality, country reputation and potential impact.

On the other hand, small initiatives, be they private (e.g. local companies, NGOs) or public (e.g. municipality-led) require more modest financing. These modest initiatives are common in northern Mediterranean countries. Investments in the provision of timber, bioenergy or NWFP (e.g. cork, resin) can rely on traditional financing mechanisms (shareholders, bank loans). New finance possibilities for biodiversity projects include PES schemes (which can be local), recreational projects funded by forest access fees, climate projects using carbon payments, or water projects funded by bottler companies or water suppliers. Other finance options include crowd funding and impact investments. Local governments that own forestland can also impose concession fees for harvest (wood, NWFP), or recreational infrastructure. They can also opt to apply a local tax, for example, to implement wildfire prevention plans in the wildland-urban interface.

Conclusions and prospects for Mediterranean forest financing

Financial instruments in the forestry sector are those tools required to fund the costs of forestry projects. A variety of financing options are available to Mediterranean countries (as highlighted in Table 4.12). Forestry financing stems primarily from taxpayers, but private instruments are an increasingly widespread option. In Mediterranean countries, public administrations have primary responsibility for forest-related decision-making and, as a result, its financing. As a subset of public financing, new principles of "polluter-pays" or "user-pays" have led to new and complementary funding streams in this sector. This is not only related to the Mediterranean's current land ownership structure, but also its tradition of civic and business engagement. There is evidence of emerging PES-like systems in the northern Mediterranean, while the growing mobilization of civil society organizations in MENA countries means these systems are likely to be found there in time. Alliances between companies and forest administrations are likely to increase in Mediterranean countries, to take advantage of the opportunities offered by public-private partnerships.

Ultimately, private forest owners are entrepreneurs who must cope with market and environmental risks. Private financing instruments have a number of benefits: they offer advantages to forest managers (by diversifying their income portfolio, decreasing their dependency on bank loans and on political volatilities); introduce societal preferences into management decisions (by incentivizing multifunctional forestry alternatives and/or poverty reduction); and strengthen links between forest managers and users/beneficiaries (through earmarked fees or direct payments).

Tools to redistribute EU public funds are largely applicable to northern Mediterranean countries, as southern and eastern countries are more likely to seek international funding. However, they often lag behind tropical countries, as carbon sequestration efficiency criteria are prioritized above desertification risk. A tool is needed to target the specific aridity and degradation challenges these countries face. The LDN fund can play a relevant role in this regard in coming years.

Table 4.12. Summary of identified financial instruments per Mediterranean country, excluding the EU tools

Country	National Forest Fund	Climate finance	Private investments	PES(-like)	Other mechanisms
Albania	Forest and Pasture Fund		GCF-adhered		
Algeria			LDN participant; ABS strategy; GCF-adhered		
Croatia	Green Fund		LDN participant		
France				La Verne dam (PACA)	CDC Biodiversité; Mushroom picking fees
Greece	Green Fund				Fire volunteers donation
Israel			LDN participant		
Italy	Lombardy's Green Fund		LDN participant	Watershed investments; 63 biodiversity projects; 70 carbon projects; Access fees; Mushroom picking fees	Brenta river crowd funding
Jordan			GCF-adhered		
Lebanon	*National Restoration Fund*	40M trees	LDN participant; GCF-adhered	Al-Shaouf entry fee	40M trees; ZooMaal crowd funding
Morocco	Green Fund	Joined REDD+	LDN project on Argan; ABS capacity assess-ment; GCF-adhered	Carte Verte Crédit Agricole du Maroc	
Palestine			GCF-adhered		
Portugal	Fundo Florestal Permanente		Floresta Atlantica Fund		High Nature Value donation
Slovenia	National Farm Land and Forest Fund				
Spain	*Fund Biodiversity Heritage*	Compensation registry		Selvans (Catalonia); LandsCare (App); Mushroom picking fees; Access fees	Crowd funding against land degradation (Canary)
Syrian Arab Republic			LDN participant; GCF-adhered		
Tunisia		Joined REDD+	GCF-adhered	Carte Vert UBCI	
Turkey			LDN participant		

Note: Lacking information from: Malta, Cyprus and Montenegro. Not functional mechanisms in Italics.

5

Conclusions

The importance of forest ecosystems to the Mediterranean region is intrinsically linked to the impressive amount of goods and services they provide to a population expected to reach over 670 million by 2050. Since the region was colonized by the first Mediterranean civilizations, its forest landscapes have actively contributed to poverty alleviation and food security. Current changes and challenges, including climate change, natural resource degradation, demographic development and migration and energy transition are undermining this role, threatening the future of Mediterranean forests and their natural capital.

The impacts of climate change, exacerbated by anthropogenic pressures, are already evident in the region. These effects will only increase unless action is taken to prevent the degradation of natural resources that jeopardizes the goods and services Mediterranean forests provide.

Further action at local, national, regional and international levels is needed to recognize the role Mediterranean forest ecosystems can play in addressing the challenges the region is currently facing. An active role includes recognizing Mediterranean forests are renewable resources conditional on ongoing, sustainable management. The forest sector can provide jobs in rural areas in a green or circular economy and contribute to renewable energies and ecosystem services. Forest-based solutions can tackle threats driven by climate change and human intervention. Forest adaptation and climate change mitigation, biodiversity conservation programmes and forest and landscape restoration are among the actions that can be promoted. Implementing such forest-based solutions requires an adequate economic valuation of Mediterranean goods and services, fundamental to building dialogue and promoting forest policies and programmes. An enabling environment also requires recognition and integration of all stakeholders in the planning and implementation stages of management actions.

Finally, appropriate financing – and choosing the most relevant financing strategy – is the engine behind the design, implementation, management and policies that integrate these goods and services in a multi-functional way towards a new, green economy. Forests must have an active role in this new economy. Mediterranean forests and trees will only be able to play a role in tacking global threats if they are viewed from a cross-sectoral perspective that connects the forest sector with others. The landscape approach is particularly relevant to practical implementation of forest-based solutions in the field. The management of Mediterranean forests is no longer the sole preserve of forest managers, but also involves users benefiting from the ecosystem services forests provide, populations who derive their livelihoods from forests and young entrepreneurs developing businesses based on forests in the green economy.

Given that Mediterranean forests are an important regional asset, demonstrated by several regional initiatives (e.g. the Tlemcen declaration, the Strategic Framework on Mediterranean Forests, the Barcelona Declaration and the Agadir Commitment for the restoration of 8 million ha of Mediterranean forests by 2030), their role in the global agenda should be further enhanced. Through the three Rio Conventions – on biodiversity, climate change and desertification – countries committed to combating forest ecosystem degradation. The forest sector is part of their Nationally Determined Contributions to reductions in greenhouse gas emissions under the UNFCCC, their National Biodiversity Strategies and Action Plans under the CBD and their National Action Programmes under the UNCCD. Mediterranean forests contribute to several Sustainable Development Goals, also playing a role in the 2030 Agenda for Sustainable Development.

Ensuring an active role for Mediterranean forests requires the integration of goods and services in a multifunctional way. This can be achieved using management and policy tools that solve the paradox of Mediterranean forests – valuable green infrastructure whose value is unrecognized by society – and by establishing enabling conditions to meet future threats and uncertainties.

Promoting integrated and sustainable management of Mediterranean forests, and their strategic role from local to global levels, requires strong and active regional cooperation. Current international commitments and the global agenda call for a coordinated regional strategy. This should promote active involvement by Mediterranean countries toward enhanced regional actions based on recognition of forests' environmental, social and economic value. Mediterranean countries are already responding to this call with revitalized engagement in regional and international activities. But further cooperation and harmonization is required to establish a collective effort toward an enhanced regional agenda.

Annexes

A Contribution of forests in NDCs, NBSAPs and NAPs

Contribution of forests in the NDCs (or INDCs when the Paris Agreement has not yet been ratified), in national targets as defined in the NBSAPs, and in the NAPs of the Mediterranean countries.

Country	Role of forests in NDC	Role of forests in NBSAP (national targets)	Role of forests in NAP
Albania	No accounting from forestry (to be included in a later NDC)	Restore at least 15 percent of degraded areas through conservation and restoration activities in line with Aichi targets. This action will be achieved through the implementation of management plans for Protected Areas and through the implementation of single species action plans for species and habitats. More sustainable agriculture and forestry activities in line with biodiversity objectives	No NAP found but member of Annex IV-Northern Mediterranean RAP
Algeria	Accelerate and intensify the National Reforestation Plan with a global objective of reforestation of 1 245 000 ha by 2030. Main actions: afforestation, reforestation and prevention of forest fires as well as improving means to fight them. Fight against erosion and rehabilitate degraded lands as part of the efforts to combat desertification in the national plan of adaptation to the impacts of climate change	Objective 12: Protect, conserve, and restore ecosystems in order to maintain their balance, ensure their longevity and to ensure sustainable production of ecosystem services; with a view to protect at least 20 percent of terrestrial zones, 5 percent of marine and coastal zones, and to restore natural ecosystems on at least 5 million hectares of land. Objective 17: Integration of adaptation to climate change (ecosystem resilience, restoration of degraded ecosystems, combat against desertification) into ecosystem management approaches and prevention of natural hazards and risks	Erosion control: Implementing an exploitation regulation for various wood and product opportunities of forests indicating duration of usage and the amount of products to be collected during a certain period of time; identifies exploited areas that need to be protected for a sufficient recovery period; identifies areas that could be included in grazing routes and determines the maximum number of animals to be admitted therein; specifies necessary measures to restore and enhance forest stands and pastures; and creates pasture stocks in case of periods of scarcity. Combating deforestation: Development, extension, management and usage of forests,

Country	NDC	NBSAP	NAP
Algeria			areas used by forestry sector and for other forestry activities. Combating deforestation by combating forest-clearing, implementing measures against wildfires and diseases and regulating grazing and constructions in forestlands. Protection and conservation of lands: integration of human element into the economic cycle of forestlands by taking into account the concerns of forest users in forest development projects and by encouraging the formation of common forestry and/or pasturelands interest groups
Bosnia and Herze-govina	Keep a sequestration capacity of the forestry sector of app. 6 470 $GgCO_2$	Target 7: By 2020, certify all state-owned forests. Target 15: By 2020, map and evaluate the benefits from forest, agricultural and water ecosystems and strengthen the environmental permit mechanism and supervisory inspection within protected areas, areas of special interest and areas from the Natura 2000 ecological network plan. Target 16: By 2020, restore 30 strip-mine lakes into wetland habitats, increase the productivity of all categories of forests, preserve the existing area of flood alder and willow forests and increase the regulated urban green areas by 20 percent	No NAP found but member of Annex V-Central and Eastern Europe RAP
Bulgaria	Cf. EU	n.a. or not found	No NAP found but member of Annex V-Central and Eastern Europe RAP
Croatia	Cf. EU	n.a. or not found	No NAP found but member of Annex IV-Northern Mediterranean RAP
Cyprus	Cf. EU	n.a. or not found	No NAP found but member of Annex IV-Northern Mediterranean RAP

Country	NDC	NBSAP	NAP
Egypt	Wood forests should use treated wastewater for irrigation	Target 13: By 2030, Research and implement measures and strategies to strengthen local-level biodiversity resilience to desertification. Target 14: By 2025, investigate and monitor all the effects of climate change on biodiversity and ecosystem services	Stabilization of sand dunes through afforestation and conservation of the planted dune areas. Safe use of treated sewage water for afforestation: reduce pollution loads; reduce CO_2 concentration in the atmosphere; insure long-term sustainability of the afforestation project through the use of the income generated from the forest's timber wood
European Union	Land Use, Land-Use Change and Forestry set out in Decision 529/2013/EU: Afforestation, Reforestation; Deforestation; Forest management	Target 3B Forests: By 2020, Forest Management Plans or equivalent instruments, in line with Sustainable Forest Management (SFM), are in place for all forests that are publicly owned and for forest holdings above a certain size (to be defined by the Member States or regions and communicated in their Rural Development Programmes) that receive funding under the EU Rural Development Policy so as to bring about a measurable improvement in the conservation status of species and habitats that depend on or are affected by forestry and in the provision of related ecosystem services as compared to the EU 2010 Baseline	n.a. or not found
France	Cf. EU	Target 6: Preserve and restore ecosystems and their functioning	n.a. or not found
Greece	Cf. EU	Target 2: Conservation of national natural capital and ecosystem restoration. Target 3: Organization and operation of a National System of Protected Areas and enhancement of the benefits from their management. Target 5: Enhancing synergies among the main sectoral policies for the conservation of biodiversity. Establishing incentives. Target	Forest protection: recovery of vegetation in disturbed ecosystems; restraint of soil erosion and restoration of soil productivity. Protection against illegal land use changes in forests. Forest fire control: measures to prevent forest fires and discourage prospective arsonists; measures for restraining fire consequences. Protection from damaging grazing. Forest management: ensure sustainable forest yield

Country	NDC	NBSAP	NAP
Greece		5.5: Ensure the compatibility of agricultural, fisheries and forestry activities with biodiversity conservation. Target 7: Prevention and minimization of the impacts of climate change on biodiversity. Target 7.4: Enhance the role of forests in mitigating the effects of climate change	
Israel	n.a. or not found	n.a. or not found (but the Fifth National Report under the CBD stated: by 2025 restoration of wetlands in critical state, including streams and winter ponds, will be accomplished, and restoration of underrepresented ecosystems and extinct species will take place as a management routine)	No NAP found but member of Annex IV-Northern Mediterranean RAP
Italy	Cf. EU	Forests constitute a target of the Italian NBSAP with a series of 14 specific objectives (NBSAP p.55-56)	Sustainable management and increased forest assets. Updating forestry inventories and reference regulations in order to bring Italian forestry policy into line with the Italian national commitments taken within Europe and internationally. Implementation of measures aimed at the adoption of agricultural, animal-husbandry and forestry production systems capable of preventing physical, chemical and biological damage to soil. Land restoration: recovery of soils damaged by erosion, salinization, etc.; reclamation and re-naturalization of contaminated disposal sites in abandoned mining areas
Jordan	Afforesting 25 percent of barren forest areas in the rain belt areas on which the rate of precipitation exceeds 300 mm. Highest vulnerable ecosystems are forests (especially in the north) and freshwater	Target 10: By 2020, a national strategy for forest conservation and sustainable use is developed and effective	Clean Development Mechanism (CDM) afforestation projects. Sustainable land management in climate change funding: UN-REDD Programme, Forest Investment Programme, Forest Carbon Partnership Facility, etc.

Country	NDC	NBSAP	NAP
Jordan	ecosystems (especially in Jordan Rift Valley), that highlights the priority to perform adaptation interventions within these two ecosystems. Urgent need for restoration of the degraded forest ecosystem, protection of forest and reforestation to increase the green land area		
Lebanon	Towards sustainably managed forest resources, safeguarded ecological integrity, and economic and social development for the benefit of present and future generations. This will be achieved through the implementation of the National Forest Programme including, among others: Raising tree nurseries productivity; Planting of trees; Implementing the forest fire fighting strategy; Rehabilitating irrigation canals; Promoting good agricultural practices through the support of organic farming and obtaining quality certificates; Applying forest integrated	Target 6: By 2030, 50 percent of all natural ecosystems are sustainably managed and properly considered in land-use planning implementation. Target 8: By 2030, the private sector has taken steps to implement plans for sustainable production and consumption to mitigate or prevent negative impacts on ecosystem carrying capacity through the use of natural resources. Target 9: By 2030, rehabilitation plans are implemented in at least 20 percent of degraded sites that will safeguard the sustained delivery of ecosystem services	Adopt and harmonize forest-related definitions; Adopt a participatory approach fostering negotiation with different stakeholders to ensure that local needs are considered in forest management; Update, revise and enforce the laws related to forest management; Empower and build the capacity of the forest management administration including the forest guards; Empower and build the capacity of municipalities and local authorities to engage in forest protection and management; Promote and enforce the protection and sustainable management of forests; Promote public awareness; Develop and implement a long-term reforestation plan in order to achieve a 20 percent forest cover within a period of 30-40 years; Ensure the protection of forests from overgrazing; Support pilot projects on forest management; Support forest fire management programmes; Forbid and penalize wood cutting except according to previously agreed management plans; Promote the conservation of seeds of local species; Support efforts aimed at collecting information and knowledge gained and synthesizing the national experience on forest management; Prepare

Country	NDC	NBSAP	NAP
Lebanon	pest management; Developing an early warning system for agricultural pests and climatic conditions.		management plans for the protected forests; Promote forest research; Support Non-Wood forest products; Prepare a Forest Action Programme including a forest inventory and mapping Implement a unit in the MoA to be in charge of forest organization and management.
Libya	No submission found	n.a. or not found	No NAP found but member of Annex I-Africa RAP
Malta	Cf. EU	Target 5: By 2020, the rate of loss of natural and semi-natural habitats of conservation value is at least halved, and degradation and fragmentation is significantly reduced. The percentage cover of "forests and semi-natural areas" has not decreased below the CORINE land cover data of 2006. Target 13: By 2020, vulnerable ecosystems that provide essential services are safeguarded, with at least 15 percent of degraded ecosystems restored, while 20 percent of the habitats of European Community Importance in the Maltese territory have a favourable or improved conservation status.	No NAP found but member of Annex IV-Northern Mediterranean RAP
Montenegr	No accounting from forestry (to be included in a later NDC)	n.a. or not found	No NAP found but member of Annex V-Central and Eastern Europe RAP
Morocco[a]	Develop forestry and surrounding areas; Finalize land demarcation and registry of forested areas; Complete the suckering, renewal or afforestation of approximately 50 000 ha per year, with a primary focus on natural species and support for high-quality	Objective A4: Strengthen or establish appropriate programmes for the *in situ* and *ex situ* conservation of genetic diversity of cultivated plants, domestic and wild animal breeds, microorganisms, as well as for the conservation of forest and other species spontaneous flora that have a socioeconomic value. Objective C2: Take necessary steps to increase ecosystem resilience and the	Integrated development of forest areas and pilot peri-forest areas: implementation of integrated development pilot projects in 10 forest and peri-forest areas, as part of the Plan for Reforestation. Energy and sustainable development: rationalizing demand through the improvement of energy technologies and the substitution of fuelwood with other fuels.

Country	NDC	NBSAP	NAP
Morocco[a]	forest research when rehabilitating territory; Protect water basins against erosion and siltation of dams; Rehabilitate ecosystems and protect and promote natural areas as well as endangered species as resources. Replenishment of 200 000 ha of forests by 2020. Protecting 1 500 000 ha against erosion, which will include the prioritization of 22 basins for USD 260 million, and afforesting 600 000 ha for USD 46 million by 2030. Forests will represent 11.6 percent of Morocco's mitigation effort between 2020 and 2030, and 12.1 percent in 2030.	contribution of biodiversity to carbon stocks, including through conservation and restoration, mitigation and adaptation to climate change, and synergy with actions taken under the other Rio Conventions (Climate change and combating desertification).	
Portugal	Cf. EU	n.a. or not found	Expansion and improvement of forests and their management in order to reinforce the role of forestry in conserving soil and water. Identification of the areas most affected and allocation of the resources necessary to recover degraded areas.
Serbia	n.a. or not found	Target 1.1: Enable the Republic of Serbia's extinction threatened species and ecological communities to survive and thrive in their natural habitats and retain their genetic diversity and potential for evolutionary development.	No NAP found but member of Annex V-Central and Eastern Europe RAP.

Country	NDC	NBSAP	NAP
Serbia		Restore biological diversity in degraded areas. Complement *in situ* conservation measures by maintaining *ex situ* facilities and conducting *ex situ* conservation measures.	
Slovenia	Cf. EU	n.a. or not found	No NAP found but member of Annex IV-Northern Mediterranean RAP.
Spain	Cf. EU	Target 2.3: To contribute to the conservation and restoration of natural habitats and wild species. Target 3.2: Promote sustainable forest management. Target 3.3: Contribute to the monitoring and improvement of the health status of forests and assess their contribution to climate change mitigation and adaptation.	Silvicultural activities: Sustainable management of forest masses, both public and private, from the perspective of the characteristics of Mediterranean forests (heterogeneity, instability, low profitability, importance of externalities); Reforestation, with special attention to the establishment of a protective vegetal cover and soil fixer, tolerant to conditions of extreme aridity; Suitable silvicultural treatments to improve the quality and biological diversity of the protective forest masses, to guarantee their stability and to ensure their resistance and functionality in extreme conditions; Protection and improvement of non-tree plant groups with protective functions; Forest defence measures: prevention and control of agents that destroy soil and/or vegetation (fires, pests and diseases); Study and design and/or promotion of sustainable agrosilvopastoral systems in arid and semi-arid conditions, including the evaluation and adaptation of traditional systems; Genetic selection of forest plants resistant to extreme ecological conditions; Promotion of research and experimentation on vegetation restoration techniques in arid zones; Application of bio-engineering techniques for erosion control. Soil conservation: reforestation of marginal and/or abandoned agricultural land subject to degradation processes. Protection against forest fires: preventive silviculture,

Country	NDC	NBSAP	NAP
Spain			both in public and private forests; Improvement of preventive infrastructure in the mountains; Improvement of surveillance networks; Promote the formation of groups of volunteers for fire prevention and monitoring; Continuous improvement of means of extinction; Promotion of the elimination of the agricultural remains without the use of fire in the cultivation areas close to forest lands. Strict control of agricultural burns; Promotion of exploitation, rational and compatible with the fight against desertification, residual agricultural and forestry biomass.
Syrian Arab Republic	No submission found	n.a. or not found	Deepen forest role to achieve food security besides environmental protection by agricultural afforestation integration, grazing afforestation, and cultivation-grazing afforestation. Make objective studies aiming at multiplication of forest plant species in a way that is allowed by economical goals such as forests investment to maintain soil fertility and increase forest's stability. Support systems and measures of forest protection from all aggressive means on it which were and still the reason of its deterioration. Organize grazing in forests so that to achieve a typical investment of forest, providing protection against over-grazing. Increase afforestation areas by supporting artificial forestry plans. Implement more studies on forest plant species, especially those which are drought resistant. Protect and renew river forests.
The former Yugoslav Republic of Mace-donia	Forest sector not analysed since it has a relatively small share in total GHG emissions	n.a. or not found (but the Fifth National Report under the CBD defined preliminary Target 8: To integrate measures for adaptation and mitigation of climate change and combating desertification)	No NAP found but member of Annex V-Central and Eastern Europe RAP

Country	NDC	NBSAP	NAP
Tunisia	The mitigation plan aims to intensify the CO_2 absorption capacities of forestry and arboriculture by stepping up reforestation and by consolidating and increasing carbon reserves in forest and pastoral environments. Adaptation measures: Rehabilitation of forest nurseries and the expansion of indigenous and multi-use species; Holistic management of cork oak forests in zones at high risk of fire in the north-west of the country; Management of the degraded rough grazing and esparto areas in the central and southern regions; Biological consolidation of work to combat silting in the south of Tunisia and support the implementation of regional action plans to counter desertification.	n.a. or not found	Forest regeneration and reforestation of bare land: implementation of forest management plans, developed through a participatory approach which mainly includes work on the natural and artificial regeneration of forest stands. Agricultural and pastoral development: conserving the production and protection potential of rangelands and forests. Rationalize fuelwood consumption in rural areas.
Turkey	Increasing sink areas and preventing land degradation. Implementing Action Plan on Forestry Rehabilitation and National Afforestation Campaign.	The NBSAP includes goals and actions that will directly or indirectly affect all sectors that play a role in the conservation, management and utilization of biological diversity. It also defines the priorities and commitments of the country at the international level with regard to	Sustainably manage forest resources and areas to sustain social, economical, cultural and psychological needs of the next generations. Eliminate all kinds of external impacts, such as fire, varmint, diseases and misuse, and provide a sustainable protective-use balance. Complete forest cadastre for safety of forest

Country	NDC	NBSAP	NAP
Turkey	Ministry of Forestry and Water Affairs of Turkey published "National Report of Land Degradation Neutrality 2016-2030" with the cooperation of different institutions and organization.	the conservation and sustainable use of biological diversity. NBSAP mentioned "Threats to Forest and Mountain Biological Diversity and their Causes" and "Forest Biyodiversity." Some of the goals and strategic actions related to forestry in NBSAP are: Goal 7: To establish an effective monitoring, management and coordination system for the conservation and sustainable use of mountain biological diversity, together with its different ecosystems, pursuing a holistic approach. Strategic actions: 7.2.1. The identification of the adverse impacts of the key threats to mountain biological diversity like climate change and the determination of measures either to prevent or to mitigate such impacts.	areas in the future and sustainability of forestry activities. Review forestry law and make new arrangements to mitigate the current degradation of the forest areas. Solve conflicts with local people afforestation or soil conservation. Create national awareness and sensitivity to protect forests through training and campaigns. Encourage local communities, industry and labour force, non-governmental organizations, forest villagers and women to participate in planning, implementation and development of national forestry policies. Reforest blasted forests by using suitable technologies immediately. Prevent the transformation of forest areas into agricultural areas by improving conditions of forest villagers through several rural development projects, along with income rising initiatives by trade of forest products in addition to employment, providing additional incomes to villagers through protection of afforestation areas by village legal entities, breeding harmless goat species, controlled grazing in forest lands. Set legal amendments on keeping forest areas as forests and limiting settling areas within the forest boundaries.

Note: [a]the first NDC is a submission separate to the INDC.

B List of documents related to the green economy and forestry

Country/ region	Document	Author
Albania	A new path for the sustainable development: a green economy for Albania	Republic of Albania (2012)
Algeria	Intended nationally determined contribution – INDC Algeria	Algeria (2015)
	The green economy in Algeria	UNECA (2014a)
	Plan d'action national sur les modes de consommation et de production durables 2016-2030	PNUE and SwitchMed (2016)
Croatia	Strategy for sustainable development of the Republic of Croatia	MEPPPC (2011)
Cyprus	Sustainable development strategy 2007	MANRE (2007)
Egypt	Green economy: Egypt fact sheet	UNEP (2014a)
	Green economy scoping study: Egypt	UNEP (2014b)
	Green economy: Egypt success stories	CEDARE (2013)
EU	Innovating for sustainable growth	European Commission (2012)
France	Une stratégie bioéconomie pour la France. Enjeux et vision	MAAF (2016)
Greece	The Greek economy and the potential for green development	Pagoulatos (2010)
Israel	Green growth: connecting the economy and the environment in Israel	MEP (2014)
Italy	Bioeconomy in Italy, consultation draft	Agenzia per la Coesione Territoriale (2016)
Jordan	A national green growth plan for Jordan	Ministry of Environment (2017)
Lebanon	Sustainable consumption and production action plan for the industrial sector in Lebanon 2015	UNEP and SwitchMed (2015)
Malta	A sustainable development strategy for the Maltese islands 2007-2016	National Commission for Sustainable Development (2006)
Montenegro	National strategy of sustainable development of Montenegro	MTEP (2007)
Morocco	The green economy in Morocco	UNECA (2014b)
	Morocco intended nationally determined contribution (INDC) under the UNFCCC	Morocco (2015)
	Morocco's youth employment strategy green	Morocco and UNDP (2012)
Portugal	Green growth commitment	MAOTE (2015)
Romania	Romania green growth country assessment	World Bank (2016)
Serbia	Green economy scoping study: Serbia	UNEP (2013)
	Study on achievements and perspectives towards a green economy and sustainable growth in Serbia	MESP (2012)
Slovenia	Connected for growth: Transition to a green economy in Slovenia	MESP (2016)

Country/ region	Document	Author
Slovenia	Green growth indicators for Slovenia	Žitnik *et al.* (2014)
Spain	Estrategia española de bioeconomía	MEC (2016)
Tunisia	The green economy in Tunisia	UNECA (2014c)
	Politiques d'économie verte inclusive et transformation structurelle en Tunisie	UNECA (2015)
Turkey	Turkey green growth policy paper: Towards a greener economy	World Bank (2013)

C Documents available and analysed per country

Country	Name of the document	Type (strategy/plan, act, policy, action plan)
Albania	Strategy for the development of the forestry and pastures sector in Albania	National Strategy
Algeria	Programme d'Action National sur la Lutte contre la Desertification	UNCCD National Action Plan
Algeria	Politique forestière nationale et stratégie d'aménagement et de développement durable des ressources forestières et alfatières	National Forest Programme
Algeria	Plan d'action du goivernement pour la mise en oeuvre du programme du Président de la République	National Action Plan
Algeria	Stratégie et Plan d'Actions Nationaux pour la Biodiversité 2016-2030	CBD National Action Plan
Bosnia and Herzegovina	Forest Development Strategy	Forest Policy
Bosnia and Herzegovina	Strategy and Action Plan for Protection of Biological Diversity in Bosnia and Herzegovina (2015-2020)	CBD National Action Plan
Bosnia and Herzegovina	Action Programme To Combat Land Degradation and Mitigate the Effects of Drought in Bosnia and Herzegovina	UNCCD National Action Plan
Bosnia and Herzegovina	Climate Change Adaptation and Low-Emission Development Strategy for Bosnia And Herzegovina	Climate Change Strategy
Bulgaria	National Strategy for Sustainable Development of the Forest Sector in Bulgaria, 2014-2023	National Strategy
Bulgaria	Програма от мерки за адаптиране на горите в Република България и намаляване на негативното влияние на климатичните промени върху тях (A programme of measures to adapt forests in the Republic of Bulgaria and reduce the negative impact of climate change on them)	Programme
Croatia	National Forest Policy and Strategy	National Forest Programme
Croatia	National Biodiversity Strategy and Action Plan	CBD National Action Plan
Cyprus	National Forest Programme	Forest Programme
Cyprus	Ministry of Agriculture's Strategic Planning	Plan
Egypt	Sustainable Agricultural Development Strategy towards 2030	National Strategy
Egypt	Egypt Vision 2030 – Sustainable Development Strategy	National Strategy

Country	Name of the document	Type
Egypt	Egypt's Five Year Macroeconomic Framework and Strategy	National Strategy
Egypt	Egypt's Sixth Five-Year Plan	Plan
Egypt	Egyptian National Action Programme To Combat Desertification	UNCCD National Action Plan
Egypt	Egyptian Biodiversity Strategy and Action Plan 2015-2030	Action Plan
Egypt	Forest Policy and Strategy	National Policy
European Union	EU Forest Strategy	Forest Policy
European Union	Multi-annual Implementation Plan of the new EU Forest Strategy	Implementation Plan
European Union	EU Forest Communication Strategy	Communication Strategy
European Union	Seventh Environment Action Plan	Environmental Policy
European Union	The EU Biodiversity Strategy to 2020	Biodiversity Policy
France	Contrat d'objectifs et de performance 2016-2020 de l'ONF	Strategic Plan
France	Orientations nationales d'aménagement et de gestion	Forest Management Guidelines
France	Programme forestier national	Programme
Greece		
Israel	Forest Management Policy of Israel - Guidelines for Planning and Management	Forest Management Guidelines
Israel	The National Master Plan for Forests and Afforestation	Plan
Italy	The National Strategy on Adaptation to Climate Change-Strategia Nazionale di Adattamento ai Cambiamenti Climatici	National Strategy
Italy	Programma Quadro per il Settore Forestale	Programme
Italy	Piano per la filiera legno 2012-2014	Industry plan
Italy	Agroforestry-Indirizzo per la programmazione 2014-2020	Guidelines
Italy	Quadro delle misure forestali nello sviluppo rurale (Fondo Europeo Agricolo per lo Sviluppo Rurale) 2014-2020	Guidelines/Measures
Italy	La Formazione professionale per gli operatori del settore forestale Guidelines Jordan Jordan 2025 (A National Vision and Strategy)	Sustainable Development Strategy
Jordan	The National Biodiversity Strategy and Action Plan	CBD National Action Plan
Jordan	Jordan updated Rangeland Strategy 2013/2014	Strategy
Jordan	The Aligned National Action Plan to Combat Desertification	UNCCD National Action Plan
Lebanon	National Forest Programme 2015-2025	Forest Policy
Lebanon	Lebanon Ministry of Agriculture Strategy 2015-2019	Strategy
Lebanon	National Action Plan (UNCCD)	National Plan
Lebanon	Lebanon's National Blueprint for a Sustainable Forest Biomass: promoting renewable energy and forest stewardship	Strategy

Country	Name of the document	Type
Lebanon	Firewise-Lebanon: Best Practice Guidelines for Wildfire Risk Management at the Local Level	Guidelines
Lebanon	National Forest Fire Management Strategy	Strategy
Libya		
Malta		
Montenegro	Montenegro Development Directions 2013-2016	Policy
Montenegro	National Forest Policy of Montenegro	National policy
Montenegro	Nacionalna Strategija Biodiverziteta sa Akcionim Planom za period 2016-2020 Godina (National Biodiversity Strategy and Action Plan)	CBD National Action Plan
Morocco	Programme de conservation et de développement des écosystèmes forestiers	Programme
Morocco	Ordre d'opérations pour la prévention et la lutta contre les incendies de forêts	
Morocco	Stratégie nationale de développement du secteur des plantes aromatiques et médicinales au Maroc	National Strategy
Morocco	Plan d'action du Haut Commissariat Aux Eaux et Forêts et à La Lutte Contre la Désertification	
Palestine		
Portugal	Multifunctional Management for Forest Stands	Forest Management Guidelines
Portugal	Programa de Desenvolvimento Rural do Continente para 2014-2020	Rural Development Programme
Portugal	Programa de Ação Nacional de Combate à Desertificação	UNCCD National Action Plan
Portugal	Estratégia Nacional para as Florestas (National Forest Strategy)	Forest Strategy
Portugal	Plano Nacional de Defesa da Floresta contra Incêndios	Forest Fire Action Plan
Serbia	National Agriculture and Rural Development Strategy	Strategy
Serbia	Forestry Development Strategy for the Republic of Serbia	Strategy
Slovenia	Forest Act	Act
Slovenia	National Forest Programme	National Forest Programme
Spain	Plan Nacional de Actuaciones Prioritarias en materia de restauración hidrológico-forestal, control de la erosión y defensa contra la desertificación	Action Plan against Erosion and Desertification
Spain	Estrategia Forestal Española	National Forest Programme
Spain	Estrategias de Conservación de los Recursos Genéticos Forestales	Strategy on Natural and Genetic Resources
Spain	Plan de activación socioeconómica del sector forestal	Forestry Sector Action Plan
Spain	Plan estratégico del patrimonio natural y de la biodiversidad 2011-2017	CBD National Action Plan
Spain	Programa Nacional de Desarrollo Rural 2014-2020	Rural Development Programme
Spain	Programa de Acción Nacional contra la Desertificación (UNCCD)	UNCCD National Action Plan

Country	Name of the document	Type
Spain	Programa español para la evaluación y conservación de los recursos genéticos de los olmos y la obtención de individuos resistentes a la grafiosis	Genetic Resources Action Plan
Syrian Arab Republic		
The former Yugoslav Republic of Macedonia	Strategy for sustainable development of forestry in the Republic of Macedonia (2006-2025)	Forest Strategy
The former Yugoslav Republic of Macedonia	Action Plan for Implementing the Programme of Work on Protected Areas of the Convention on Biological Diversity	CBD National Action Plan
Tunisia	Programme Forestier National	National Forest Programme
Tunisia	Programme d'action National de Lutte Contre la Désertification	UNCCD National Action Plan
Tunisia	Stratégie Nationale de Developpement Durable	
Tunisia	Stratégie nationale de développement forestier et pastoral 2002-2011 Strategy	
Tunisia	Stratégie de Développement de la Tunisie Nouvelle	
Tunisia	Stratégie Nationale sur le Changement Climatique	
Tunisia	Stratégie nationale d'adaptation de l'agriculture tunisienne et des écosystèmes aux changements climatiques	
Tunisia	Guide Forêts Durables	
Turkey	Turkey's National Action Programme on Combating Desertification	UNCCD National Action Plan
Turkey	Inventory, planning, production and marketing principles for NWFP, rescript (working guidelines/by-laws) No: 297	NWFP Guidelines
Turkey	Climate Change Strategy	Strategy
Turkey	Turkish National Forestry Programme 2004-2023	National Forest Programme

D Mediterranean countries and international agreements

Country	CBD	UNFCCC	Kyoto Protocol	Paris Agreement	UNCCD	CITES	Ramsar	World Heritage Convention	NLBI
Albania	•	•	•	•	•	•	•	•	•
Algeria	•	•	•	•	•	•	•	•	•
Bosnia and Herzegovina	•	•	•	•	•	•	•	•	•
Bulgaria	•	•	•	•	•	•	•	•	•
Croatia	•	•	•	•	•	•	•	•	•
Cyprus	•	•	•	•	•	•	•	•	•
Egypt	•	•	•	•	•	•	•	•	•
EU	•	•	•	•	•	•		•	•
France	•	•	•	•	•	•	•	•	•
Greece	•	•	•	•	•	•	•	•	•
Israel	•	•	•	•	•	•	•	•	•
Italy	•	•	•	•	•	•	•	•	•
Jordan	•	•	•	•	•	•	•	•	•
Lebanon	•	•	•	•	•	•	•	•	•
Libya	•	•	•	•	•	•	•	•	•
Malta	•	•	•	•	•	•	•	•	•
Montenegro	•	•	•	•	•	•	•	•	•
Morocco	•	•	•	•	•	•	•	•	•
Palestine	•	•	•	•	•	•		•	•
Portugal	•	•	•	•	•	•	•	•	•
Serbia	•	•	•	•	•	•	•	•	•
Slovenia	•	•	•	•	•	•	•	•	•
Spain	•	•	•	•	•	•	•	•	•
Syrian Arab Republic	•	•	•		•	•	•	•	•
The former Yugoslav Republic of Macedonia	•	•	•	•	•	•	•	•	•
Tunisia	•	•	•	•	•	•	•	•	•
Turkey	•	•	•	•	•	•	•	•	•

Note: EU = European Union. NLBI = Non-Legally Binding Instrument on All Types of Forests. For the Paris Agreement, the table refers to the signature of the Agreement, not to its ratification, acceptance, approval or accession.

E Status of the main instruments in Mediterranean countries

	CBD Action Plan	UNCCD 2014 Reports for the CRIC	NDC under the Paris Agreement
Adopted and/or revised	Albania (1999, 2016) Algeria (2005, 2016) Bosnia and Herzegovina (2011, 2016) Bulgaria (2000, 2005) Croatia (1999, 2008) Egypt (1998, 2016) EU (1998, 2006, 2011) France (2004, 2011)[a] Jordan (2001, 2015) Lebanon (1998, 2005, 2016) Montenegro (2010, 2016) Spain (1999[b], 2005[b], 2011[c]) Turkey (2001, 2007)	Albania Algeria Bosnia and Herzegovina Bulgaria Croatia Cyprus Egypt Greece Israel Italy Jordan Lebanon Libya Malta Montenegro Morocco Portugal Serbia Slovenia Spain Syrian Arab Republic The former Yugoslav Republic of Macedonia Tunisia Turkey	Albania Algeria Bosnia and Herzegovina EU[d] France[e] Israel Jordan Morocco Tunisia
Under revision	Tunisia (1998)	–	–
Completed but not adopted	Greece (2014) Israel (January 2010) Italy (2010) Portugal (2001) Slovenia (2001)[f]	–	–
Under Development	Cyprus Libya	–	–
No Information at time of analysis	Palestine[g]	–	Egypt Lebanon The former Yugoslav Republic of Macedonia Palestine Serbia Turkey

Notes: EU = European Union. CRIC = Committee for the Review of the Implementation of the Convention. [a]Strategy adopted in 2004; Sectoral Action Plans adopted between 2006-2008 and revised in 2009; Strategy revised in 2011. [b]Strategy. [c]Action Plan. [d]All relevant member countries. [e]Complementary document to the EU NDC. [f]Strategy only. [g]Became a Party on 2 April 2015.

F Country specific results: Albania

Similar tables exist for all analysed countries.

Focus Areas	Themes and Keywords	Albania	
Ecosystem Services and WFP/NWFP	Value Chains; Livelihoods; Pluriactivity; Eco-tourism; Forest Management Plans; SMEs; Short Supply Chains; PES Compensations; Territorial Marketing; Private/Public Sector Collaboration	"Strategic line. Nature protection and eco-tourism promotion. Objective 1. National plan preparation for the tourism development in forest and pastures and in some PAs categories and its implementation." "Develop a model for a concession arrangement with private sector entrepreneurs interested in providing nature-based recreation and tourism services." "Encourage the bank sector to assist through soft loans the development of family tourism in the remote rural areas that are near the protected areas and have got potential for the development of mountainous tourism." "Organization of state high forest stands into productive units aiming at the security of the process continuity in forestry production at regional level"	"Objective 2. Promotion of the productive potential for non-wood productions." "Study of carrying possibilities of forest and pasture fund for the encouragement and development of bee keeping sector." "Promotion of productive potentials of forests and pastures in medical plants and tanifers." "Lending of soft loans as well as other promotion measures in the support of activities and services in forests and pastures"
Contrast Degradation/ Deforestation through Forest and Landscape Restoration (FLR)	Combat against Desertification; UNCCD National Action Plans; Natural Regeneration; Assessment and Monitoring of Forest Restoration	"Objective 1. Conservation of forests through prohibition of commercial logging (which have a profit aim) and illegal cutting, allowing only the cultural cutting of all kinds." "Objective 2. Restoration and rehabilitation of forestry and pastoral ecosystems which are damaged and in degradation"	"Promotion/Incentive of individual or collective initiatives for the re-forestation of abandoned land, especially for those which are de-forested or ploughed pastures in the past." "Promotion/Incentive of individual or collective initiatives which aim at decreasing erosion level which widely threatens the future of mountainous communities and it causes a great harm to the water quality of water points and irrigation infrastructure, as well."

Focus Areas	Themes and Keywords	Albania	
Biodiversity Conservation	Genetic Diversity; Native Genotypes; Adaptive Silvicultural Practices; Reproductive Material; Endangered Species and Habitats; *ex situ* Conservation; Tree Seed Centres and Nurseries	"Extension of a representative network in PAs in order to cover 25% of the Albanian territory. The second step, after the establishment of the above-mentioned network, is the establishment of bio-corridors in order to connect PAs with one another. Such a process would demand that within 2020, the PAs network would cover about 25% of the territory which is a remote objective of SPVB"	
Climate Change Mitigation and Adaptation	Forest Carbon Stocks; Carbon Benefits; REDD+; UNFCCC; Woofuel; Forest Biomass		
Wildfire Prevention	Wildfire Management Plans; Fire Management Voluntary Guidelines; Wildfire Prevention; Integrated Fire Management Approaches; EFFIS; Awareness Campaigns		
Communication, Coordination, Cooperation and Capacity Building	Forest Sector Stakeholder Training; Coordination of Forest Research; Stakeholder Involvement; North-South and South-South Cooperation; Mediterranean Forest Research Agenda 2010-2020; EU-MENA dialogue; FAO; UNCCD; UNFCCC; CBD; Committee on Mediterranean Forestry Questions-*Silva Mediterranea*	"Enlist the NGO support which are interested in PA and define appropriate working relations with them in the area of public awareness raising, environmental education, non-technical voluntary service (anti-litter campaigns and ecological studies)"	"Planning of an amount of funds (200 000-500 000 Leke/year) for the qualification/training of the employees of Forestry Service, especially for the staff that has got managerial and extension duties"

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