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Marginal/peripheral populations of forest tree species and their conservation status: report for Mediterranean region

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Abstract - The Mediterranean region includes 13 countries among Europe, Near Orient, and Africa. This area is a huge "hot spot" of cultures, religions, socio-economical situations, and of habitats and biodiversity. The report illustrates the geographical and ecological features of the region. Forest ecosystems and vegetation traits, with particular focus on forest species growing at the edge of their distribution range, are here compiled. The accuracy of reports, shows the interest and attention that the Mediterranean countries have for the different and complex situations of marginality that characterizes the presence of many forest species in this region. In this area the occurrence of 166 marginal and peripheral (MaP) populations of different species has been detected. Most of populations are characterised by vulnerability and fragility. Many MaP survive in environmental refugia and /or in isolated stands. However, most of the MaP populations identified by FP1202 experts are located in protected areas and also sometimes registered as seed sources, although Mediterranean region appears heterogeneous with respect to protection measures.

Keywords - Forest genetic resources; forest tree marginal populations; MaPs; marginality; COST Action FP 1202 MaP FGR.

Geographical characteristics of the Region

Extension and borders and main characteristics

This compilation refers to the Mediterranean region and it is based on data and information supplied by the following Cost Action FP1202 countries: Croatia, Cyprus, France, Greece, Israel, Italy, Lebanon, Morocco, Portugal, Spain, Tunisia and Turkey.

Including part of Europe, Asia and Africa, with four extended peninsulas, many islands, several mountain ranges and active volcanoes, the Mediterranean area is considered as a huge "hot spot" where different biogeographic regions and many habitats coexist.

The Mediterranean bioclimate covers most of southern Europe and part of Middle Orient in Asia and the Maghreb region in northern Africa (Fig. 1). This area is strongly influenced by the sea's presence and several mountain ranges contribute to characterize the wind circulation as well as precipitation and temperature distribution and regime.

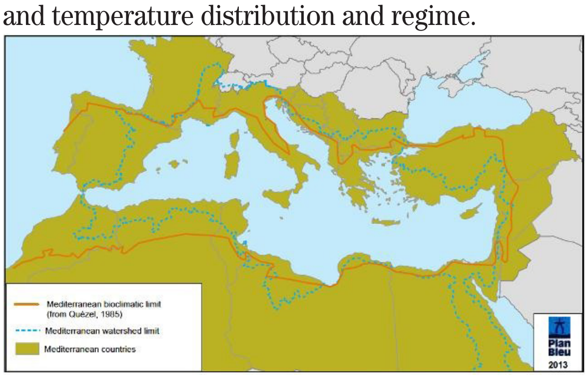

Figure 1 - The Mediterranean contour according to Quezel 1985 (FAO 2013).

Orography

The most important mountain chains in the region are high enough to influence climate at subregional level. They are mainly crossing the region in NW-SE direction as Pyrenees, Apennines, Dynaric and Albanian Alps and Balkan Mountains at the extreme eastern border. The mountain ranges of Atlas, Taurus and Caucasus are instead oriented in the direction of longitude.

Human presence

All the Mediterranean basin is densely populated. FAO (UNDEP 2011 in FAO 2017) estimates the human population in the area in 2020 to reach approx. 550 million inhabitants (Fig. 2). The human presence has been established in the area since very long time. Most of major and ancient civilizations were born in this area 5'000 years ago and pressure on habitats has been always very hard. They interacted with the Mediterranean ecosystem which the

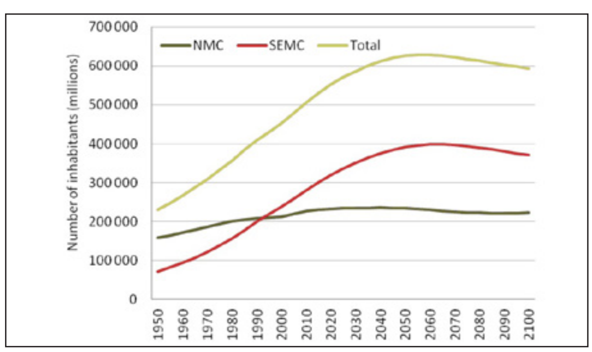

Figure 2 - Population growth in Mediterranean countries, 1950 -2010. Source: United Nations, Department of Economic and Social Affairs, Population Division, 2011.

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resilience is in general very low compared to other temperate systems.

This area has to be considered a hotspot of cultures, religions and socio-economical situations across all its history. Here the forest landscape has been severely reduced by wood utilizations, fires, grazing, agricultural and urban use since the Greek and Roman expansion. Many original forests became gradually converted into coppices in most temperate areas, in other cases native species were partially substituted or integrated by others as cypress, stone pine and chestnut in the ancient times following the human migrations.

Interesting historical examples of active forest management can be found everywhere around the Mediterranean. Beginning from the XI century religious orders started a regulated silvicultural management of forests including plantations. Ancient sea states and kingdoms established permanent and active management of local forest resources.

Most of the ancient Mediterranean forests were fragmented by the human activities and genetic characteristics are nowadays influenced by this situation.

Along with the above-mentioned processes, in some areas of the European side, two main waves of industrial activities occurred respectively in the 15th (Renaissance) and 19th (Industrialization) centuries with a consequent larger deforestation. In some areas intensive forms of silviculture were developed such as clonal poplar cultivation in Italy and exotics. The reforestation activities have expanded in the Mediterranean since the second half of 1800' and early 1900' according to the area (AA. VV. 1924 – 1935). Forests are currently expanding in several areas, in the last 70 years reforestation projects favored the expansion of forest tree farming activities.

Geographic barriers to gene flow

The geographic structure why five important genetic hotspots: the Iberian, the Italian, the Balkan, the Middle Orient and the North African one. These hotspots derive from refugia during the past glacial waves and served as re-colonization gene sources in the interglacial periods.

The region is nearly totally mountainous. In several cases, i.e. in Italy, the peculiar orientation of Apennines and in Alps the glacial valleys determined bottlenecks and northwards migration routes. The case of Oaks is typical, their migration towards northern regions along the eastern part is separate from the western one and Alps represent the main bottleneck. Everywhere, mountains plaid an important role in preserving mesophilic species meta-populations at higher elevation during the interglacial.

Other barriers

Gene flow may become reduced within Mediterranean area and on a local scale by additional factors like topography, local climate condition, altitudinal and edaphic characteristics that can originate isolation, bottleneck or in some cases asynchrony in flower phenology among populations of the same species and genetic incompatibilities. Furthermore, human activities (forest fires, overgrazing, over exploitation, illegal logging, atmospheric pollution, deforestation, habitat fragmentation, expansion of urban areas and other infrastructures) create barriers and hinder the natural gene flow.

Ecological aspects

Climatic characteristics of the Regions and availability of databases and maps at the regional level

An exact climate definition of this large and varied geographical area is difficult. In general, the Mediterranean climate shows a strong seasonal contrast between a hot and dry summer period, and a rainy autumn and spring season with relatively moderate frost episodes. Late frosts are in general frequent. In the region's north-western borders (Italy, France, Spain) climate is temperate with Atlantic or more continental influence.

In this region occurr winter clushes between cold-dry air masses from north-eastern and polar latitudes and hot-humid air of subtropical origin. Atlantic rainy perturbations passes at lower latitudes, involving also the Mediterranean area.

In summer, the Azores and the African subtropical anti-cyclones occurr at higher latitudes influencing the precipitation's distribution and the intensity and lenght of dry periods. Such a climatic complexity together with the geographic characteristics explain the climatic differences between the various parts of the area, from the alpine regions to the semi-desert or desert ones.

Altitude also plays an important role considering the gradients that develop from the sea to the high mountains. These gradients largely compensate the effect of low latitudes on the temperature, determining lower isotherm values in altitude. The average annual rainfall ranges between 2800 and in the northern side, but may drop to 350 - 400 mm (Cyprus) and even 20 mm in nearly desert areas, largely occurring in the Near-East and North Africa.

The dry period ranges from at least two months per year in the western Mediterranean, up to five or six months in the eastern Mediterranean. Even in the driest areas, sudden and intense rainfalls occur, causing considerable runoff phenomena and soil erosion. In July and August, mean temperatures varies between 29°C and 22°C, while in winter range between 10°C and 3°C. Snow is observed every year at higher elevation between December - April on average.

Winter winds from Balkans can be very cold and dry, are humid from the Atlantic regions and very hot and dry from Africa. In summer winds greatly increase evaporation and the drought effect (ANPA, 2001).

Besides these climate features, the high unpredictability of extreme events like late frosts, hot waves, storms and exceptional prolonged drought are typical of the Mediterranean region (Blondel and Aronson 1999, Grove and Rackham 2001 in ANPA 2001).

Table 1 - Datasets and maps on climatic data of Mediterranean countries.

Country	Available information
Croatia	http://prognoza.hr/karte.php?id=ecmwf; http://klima.hr/ocjene_arhiva.html.
Cyprus	Meteorological Service (MS) upon request.
France	https://www.umr-cnrm.fr/spip.php?article788 (SAFRAN).
Greece	Dig - Digital weather data of Greece at weather stations [on-line, real time point weather data and climatic statistics for temperature, precipitation, wind, cloud cover, humidity), source: Hellenic National Meteorological Service/104 georeferenced stations]; Surface wind, Rainfall, Snowfall, Cloudiness, Air temperature, Atmospheric pressure [on-line surfaces, 3-hour step, source: Hellenic Center for Marine Research POSEIDON system] http://poseidon.hcmr.gr/weather_forecast.php?area_id=gr.
Israel	http://www.ims.gov.il/IMSEng/CLIMATE (1981-2000 for temperature and humidity, and 1970/1971 - 1999/2000 for rainfall); http://www.ims.gov.il/IMSEng/CLIMATE/TopClimetIsrael/.
Italy	Observational 2000-2010 (ECAD project) and provisional 2020-2030 (Agroscenari project) data on hourly/daily basis for Italy/Europe (10 km): CNR IBIMET; Observational data 1950-today on hourly/daily/monthly basis for Italy (30 km): SIAN www.cra-cma.it; SCIA www.scia.sinanet.apat.it; Observational data 1975-today on daily basis for Europe (25 km): http://mars.jrc.ec.europa.eu/mars/About-us AGRI4CAST/Data-distribution/AGRI4CAST-Interpolated-Meteorological-Data; Precipitation observational data 1950-2012 on monthly basis for the Globe (0.25°, 0.5°, 1.0°): http://climatedataguide.ucar.edu/guidance/gpcc-global-precipitation-climatology-centre; Evapotranspiration and aridity data 1950-2000 on monthly basis for the Globe (1 km): http://csi.cgiar.org/Aridity/.
Turkey	http://www.ogm.gov.tr/Sayfalar/Ormanlarimiz/T%C3%BCrkiye-Orman-Varl%C4%B1%C4%9F%C4%B1-Haritas%C4%B1.aspx); http://www.ogm.gov.tr/Sayfalar/OrmanHaritasi.aspx.

The following table (Tab. 1) shows the available datasets and maps at regional/national coverage level.

Soil characteristics and availability of databases and maps at the regional level

The geology of the Mediterranean area is originated by the subduction of the African Plate underneath the Eurasian Plate, thus explaining the formation of the present orography.

Lime stones are predominant.

Paleo-soils are abundant, mainly produced by the disintegration of limestone rocks of ancient maritime origin. Red soils named terrarossa are present in all the region and characterize many areas of the Mediterranean landscape.

Karst formations are also frequent in Spain, Italy. Balkans and Anatolia with podzols, vertisoils, red Mediterranean soils, calcic-magnesic soils (dominant soils), brown and isohumic soils, saline and hydromorphic soils and also poorly evolved soils and arid soils are the main types.

Volcanic soils are also frequent in this area: they are pearly dark-coloured, derived from effusive rocks, often giving rise to very high fertility.

The most fertile areas are those of alluvial plains or deriving from siliceous matrix, which are, however, few in the region.

Table 2 shows the available datasets and maps at regional/national coverage level.

Possible future modifications due to climatic change

The global warming is affecting also this area, showing worrying future scenarios for both nature and humankind. Since mid-1980s, an increase in mean temperature was recorded together with a progressive increase in the frequency of extreme events as: heat waves, prolonged drought periods, floods and retreats of alpine glaciers. Italy is particularly at risk under the current climate change, owing to its position within the transition zone between North Africa and continental Europe. Indeed, experts warned about the desertification risk in southern regions and possible climate tropicalization in the rest of the country. Since 2010, an acceleration of the water cycle, the rise of alluvial phenomena and the tropicalization of the Mediterranean were observed. Warming and drought impacts on Mediterranean forests are already ongoing (Giorgi and Lionelli 2008).

Future scenarios assume significant temperature increases of 1°C in winter and more than 2°C in summer, relatively to both maximum and minimum temperatures (Fig. 3). Precipitation is projected to decrease by 2 to 8% and, in extreme cases, by 20%. These results will lead to the isotherm shift. Hot periods are expected to increase by more than 2 weeks/year. The annual number of consecutive dry days are expected to increase by 9 days on average (Giannakopoulos et al. 2010, Hadjinicolaou et al. 2011, AA. VV. 2013). As a result, the Mediterranean environment will probably suffer major changes, causing in some cases irreversible effects and affecting the most vulnerable forest ecosystems as the forest populations at the edge of the species distribution area (FAO 2013). Water scarcity will probably affect several Mediterranean countries in

Table 2 - Datasets and maps on soils data of Mediterranean countries.

Country	Available information
Croatia	http://prognoza.hr/karte.php?id=ecmwf. http://klima.hr/ocjene_arhiva.html.
Cyprus	Geological maps of Cyprus and Geochemical Atlas of Cyprus are being published by the Department of Geological Survey.
France	http://acklins.orleans.inra.fr/.
Greece	European Soil Data Base (ESDB) [polygon vector data of soil attributes, source: JRC_ESDAC, scale 1:1000000, also in raster and Google maps]; Land Use/Cover Area frame Statistical Survey (LUCAS) Soil dataset [vector data of 732 points in Greece/7819 panned, source: JRC_ESDAC]; Soil Threat Maps (Erosion risk/PESERA, Topsoil Organic Carbon Content, Natural susceptibility of soils to compaction, Saline and sodic soils) [raster data, source: JRC_ESDAC, scale 1:1,000,000]; Soil Map of Greece (Edafologikos Xartis Ellados) [image, source: Institute of Geology and Mineral Exploration (I.G.M.E), scale 1:1,000,000, year: 1967]; Physiographic map of Greece ('Nakos' map) [image,source: Forest Research Institute in Athens/Soil Science Laboratory, scale 1:50,000, year: 1982]; Soil Map of East Macedonia - Thrace Region (Soil Taxonomy Classification Map) [Aristotle University of Thessaloniki, School of Agriculture, Lab of Applied Soil Sciences, scale: 1:200,000, year:2010]; http://eusoils.jrc.ec.europa.eu/library/maps/country_maps/metadata.cfm?mycountry=GR; Slope and aspect derivatives from ASTER* satellite Digital Elevation Model (DEM) [grid raster, cell-size: 30 m, source: NASA/Jet Propulsion Laboratory, year: 2008-2009] *Advanced Spaceborne Thermal Emission and Reflection Radiometer: http://asterweb.jpl.nasa.gov/gdem.asp; Slope and aspect from Physiographic map of Greece ('Nakos' map) [image, source: Forest Research Institute in Athens/Soil Science Laboratory, scale 1:50,000,year:1982].
Israel	http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2389.1963.tb00926.x/pdf
Italy	Land use/land cover CORINE 1990-2000-2006 and changes for Europe (rst 100 m or vec1:100.000): http://www.eea.europa.eu/data-and-maps/data#c11=&c17=&c5=all&c0=5&b_start=0&c12=corine+land+cover; Digital elevation model for the Globe: 1km http://www.eea.europa.eu/data-and-maps/data/digital-elevation-model-of-europe; 90 m http://srtm.csi.cgiar.org/; 30 m http://asterweb.jpl.nasa.gov/gdem.asp; Soils of Europe (different resolutions) in terms of: soil threats data: http://eusoils.jrc.ec.europa.eu/library/themes/ThreatsData.html; soil profile data: http://eusoils.jrc.ec.europa.eu/projects/spade/; European soil database: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB/index.htm; Soil projects: http://eusoils.jrc.ec.europa.eu/projects/ProjectsData.html; Protected sites Natura 2000 of Europe: http://www.eea.europa.eu/data-and-maps/data/natura-2; Desertification map of Europe (1 km): http://www.eea.europa.eu/data-and-maps/data/sensitivity-to-desertification-and-drought-in-europe; Phytoclimatic map of Italy: prof. C. Blasi – University of Rome "La Sapienza" Naturalistic maps of Italy GIS NATURA: prof. M. Gatto – Italian Ministry of Environment Environmentally sensitive area of Italy (Climagri project) (1 km): CRA-CMA www.cra-cma.it; Soil quality, vegetation quality and climate quality maps of Italy (Climagri project) (1km): CRA-CMA www.cra-cma.it; Free satellite data for environmental applications: MODIS 250-500-1000 m https://lpdaac.usgs.gov; SPOT VGT 1 km http://free.vgt.vito.be.

the next years. This will have serious consequences on the social context and will increase pressures on the environment and cause land degradation. Moreover, it should be noted that overcrowded forest stands, due to the lack of forest management, may be more vulnerable to natural hazards such as pests, diseases and forest fires.

Vegetational aspects

Diffusion of forests

More than 25'000 plant species, about half of which are endemic.

According to FAO statistical definitions, wooded lands comprise "forests" and "other wooded lands". In the northern side of the Mediterranean, "other wooded lands" cover about a half of the total forest area; in North Africa, they cover about a third of the wooded lands. Northern Mediterranean countries are covered by both temperate and typically Mediterranean forests. In the southern side, the Mediterranean forest types are rapidly changing into deserts.

The total Mediterranean forest area (Fig. 4) is estimated over 85 million hectares, corresponding to 2% of the world's forest area, about 4'000 million ha (FAO 2015). 55% of the total Mediterranean forest area currently occurs in the northern part of the region.

Prevalent forest types

Most forest areas are usually exploited or over exploited. Many zones (semi-natural) show regressive secondary succession stages.

Concerning the two ecological extremes, natural forests (primary, undisturbed by man) are present only in very rare fragments whilst artificial forests have been widely planted along the 20th century to manage erosion, timber and non wood productions (Scarascia-Mugnozza et al. 2000).

Different types of forests were classified by Quézel (1985):

xerothermic-Mediterranean;
thermo-Mediterranean;
meso-Mediterranean;
supra-Mediterranean;
montane –Mediterranean;
oro-Mediterranean.

The various forest tree species form pure or mixed forests composed by evergreen broadleaved (about 60%), mixed mesic hardwoods and coniferous. However, the majority of Mediterranean forests is composed by oaks and pine stands.

In drier and compromised equilibria conditions, scrubs constitute typical ecosystems characterised by local variants: *maquis*, *garigue*, *macchia* and *phrygana*. In the Iberian peninsula, the *dehesa* is a characteristic agroforestry system with scattered trees embedded in pastures. In addition, the forests contain a wide range of aromatic, wild and medicinal plant species.

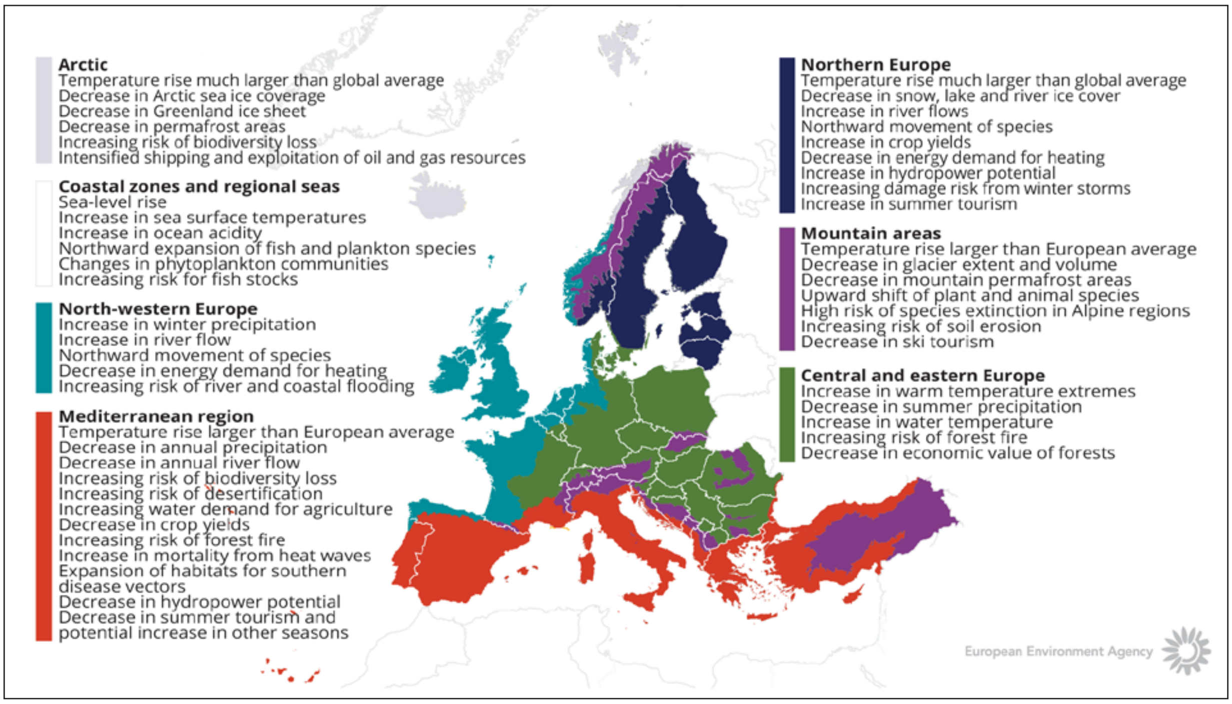

Figure 3 - Scenarios of future modification due to climatic change (EEA 2012).

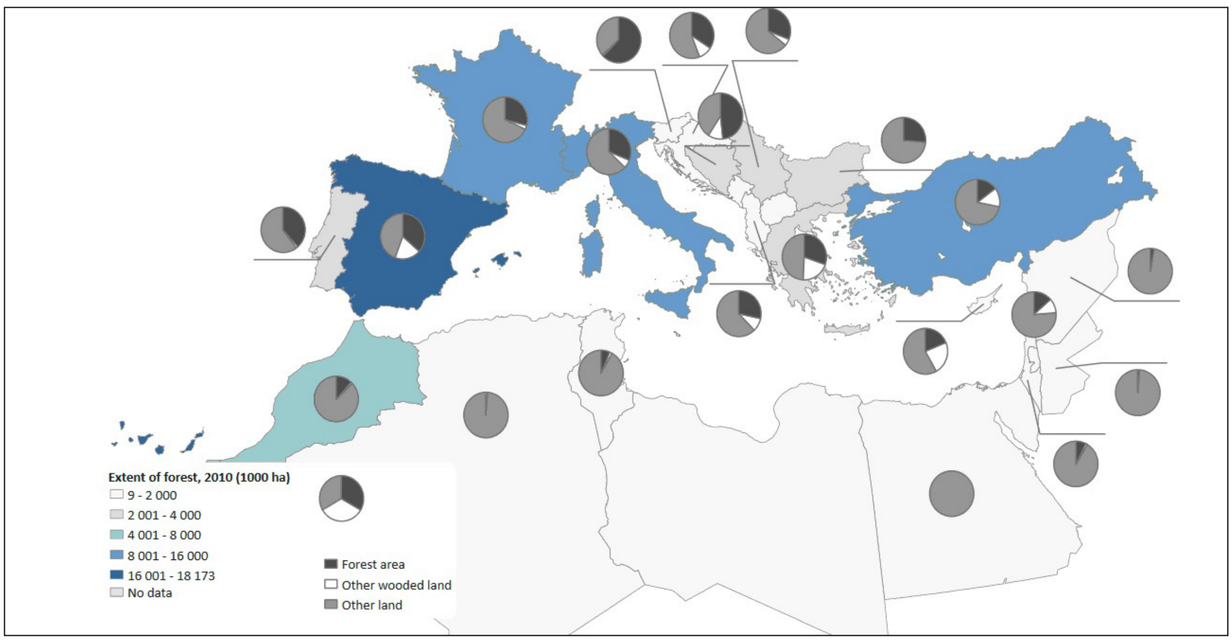

Figure 4 - Extent of forest in Mediterranean region. (FAO 2013).

Common and/or representative species

The distribution of species changes according to altitude and latitude.

Meso-, supra- and montane-Mediterranean forests are characterised by the following trees:: *Fagus sylvatica*, *Carpinus* spp. and *Ostrya* spp., *Prunus avium*, *Quercus robur* and *Q. petraea*, *Q. cerris* and *pubescences* and other oaks, *Acer* spp., *Alnus* spp., *Betula pendula*, *B. pubescens*, *Malus sylvestris*, *Sorbus* spp., *Tilia* spp., *Ulmus* spp., *Picea abies*, *Larix decidua*, *Abies* spp., *Pinus sylvestris*, *P. cembra*, *P. mugo* and *P. nigra*., *Cedrus* spp., *Taxus baccata*, *Juniperus* spp..

In the more xeric Mediterranean zone: *Quercus ilex*, *Q. pubescens*, *Q. suber*, *Q. trojana*, *Q. coccifera*, *Q. cerris*, *Q. calliprinos*, *Q. infectoria*, *P. nigra*, *P. halepensis*, *P. pinaster*, *P. brutia*, *Cupressus sempervirens*.

In lowland area and close to rivers are present: *Populus* spp. and *Salix* spp., *Alnus glutinosa*, *Fraxinus* spp. and *Q. robur*.

Some species diffusion was strongly influenced by humans management, like for *P. pinea*, *C. sempervirens*, *Castanea sativa* and *Juglans regia*.

Expected modifications due to climatic change

The impact of climatic change is likely to vary among the Mediterranean regions. In the Mediterranean region, Euro-Siberian or temperate and the Saharo-Sindic climatic regions overlap (Sánchez et al. 2004). Due to the isotherm shift, species climatic niches will probably be displaced by approximately 180 km northward and 150 m at higher elevations (Perini et al. 2007, Plan Bleu 2009 in FAO 2013). A similar shift is expected for pathogens and their vectors.

Studies have been conducted on the effects of climate change on spatial and temporal distribution of some ecosystems and species, monitoring networks were established in order to cover the various Mediterranean regions (Belgacem et al. 2013, Khouja et al. 2010, Ghandour et al. 2007, Marchi et al. 2016).

The increased frequency of prolonged dry seasons will affect survival even in more drought adapted tree species, as well as reproductive biology and natural regeneration will be affected.

Such changes could increase genetic erosion for a wide range of species, causing in some cases the extinction of local gene pools.

Global change effects, including forest fires, could lead to an accelerated desertification. As an example, in Lebanon by 2080, an expansion of arid zones is forecasted jointly to a contraction of cooler and more humid zones. On the opposite Tunisia, by 2030 natural forests are expected to increase in area.

Forest species at the edge of their distribution range

Species

In Middle East the Lebanese mountains are characterized by the presence of a considerable number of northern species, which may be regarded as relics of past mild and cooler periods and are still growing sporadically in spots such as *O. carpinifolia*, *A. tauricolum* (*Acer hyrcanum* subsp. *tauricolum* (Boiss. and Balansa) Yalt), *A. hermoneum*, *Rhododendron ponticum*, *F. ornus*.

P. halepensis has its easternmost and southernmost limits in Greece and in Israel, where *P. brutia* finds its westernmost limit. Still in Greece, *F. sylvatica*, *A. alba*, *P. abies*, *J. deltoides*, *J. phoenicea*, *J. drupacea* and *Q. ithaburensis*, *B. pendula*, *C. sativa* and *P. avium* meet their southern limit.

Pinus pinaster is distributed in western Mediterranean with limits between Italy and Portugal.

P. sylvestris, which is growing in high mountains, meets its southern limit in Italy, Spain and Greece.

Q. petraea and *Q. robur* reach their south-western limit in Italian and Iberian peninsula.

Israel is the northernmost limit for some tree species such as *Cyperus papyrus* and *Acacia albida*.

P. heldreichii and *A. cordata* are examples of species in fragmented populations which are marginal and isolated at the same time. Special cases are represented by unique isolated populations of several *Abies* species. They are remnants of ancient ancestral trees nowadays evolved into endemic species such as e.g. *A. pinsapo*, *A. numidica*, *A. nebrodensis*, *A. equitrojani*.

Kind of marginality occurring in the area

Many Mediterranean forest populations growing around the Mediterranean are potentially adapted to stressful environments because of their "marginality" status (Fady et al. 2016). Most of the marginal populations located at the rear edge of the species distribution areas can be considered marginal from both geographical and ecological points of view. Because of their possible adaptive potential, southern populations can be valid candidates as sources of better adapted reproductive materials.

Genetic information available on marginality

Genetic information is available for neutral markers and also for their growth, survival or adaptive traits surveyed in field, indicating populations harbouring significant genetic diversity. Information must be acknowledged to the implementation of EU funded projects like Walnuts, WBrains, Fairoak, Oakflow, Dynabeech, SeedSource, Evoltree, Noveltree, Treebreedex, Trees4future, international networks and cooperation projects coordinated by IUFRO WP 2.02.13 and FAO Silva Mediterranea and national funded projects. Forest genetic diversity in natural and naturalized populations have been studied on oaks, walnut, alder, wild cherry, beech, pines, firs, spruce and poplars. Most of the EU countries are members of the European Technology Platform (ETP) 'Plants for the Future', a forum for the plant sector, including plant genomics and biotechnology. Among EU-funded databases are presently actives FORGER and TreeBreedex, which are focused on the sustainable management of forest genetic resources in Europe, and ProCoGen promotes a functional and comparative understanding of the conifer genome implementing applied aspects for more productive and adapted forests.

Thanks to Evoltree genetic resources are available that are routinely used in tree genomics on *Pinaceae*, *Fagaceae* and *Salicaceae* (Greece, Italy, Spain, Turkey).

Genetic variation has been widely studied based on molecular markers for the following species: *Abies* spp., *Acer* spp., *A. cordata*, *A. glutinosa*, *B. pendula*, *B. pubescens*, *C. betulus*, *C. sativa*, *C. sempervirens*, *F. sylvatica*, *Fraxinus* spp., *J. regia*, *L. decidua*, *P. avium*, *P. abies*, *P. halepensis*, *P. brutia*, *P. nigra*, *P. pinaster*, *P. pinea*, *P. sylvestris*, *Quercus* spp.

Adaptive traits were studied for *Abies* spp., *P. halepensis*, *P. brutia*, *P. nigra*, *P. sylvestris*,*C. sativa*, *C. libani* and *Populus* spp.

Populations studied for all the above-mentioned studies include both core populations and marginal ones.

Most important marginal populations

The Mediterranean marginal populations represent reservoirs of genetic resources and cultural and landscape heritage. Many of them are characterised by vulnerability and fragility and in most cases are already protected within parks and reserves. A great number of species populations are starting to be affected by climate change effects.

Most of these populations survive in refugia on the mountains, in isolated stands. Very often they should be considered as marginal populations. The adaptive capability of these populations is usually important. The national priorities for protection purposes can change by country. Generally, gene resources conservation needs and nature conservation strategies are the common drivers for the priorities' choices. Table 3 lists the most relevant species recognised for their condition of marginality.

Forest ecosystems and protected areas

Measures of environmental protection

The Mediterranean region appears inhomogeneous as regards protection measures and common initiatives at national and international level. Despite the heavy human pressure on forests, natural forests have locally been conserved by protected area networks: these surfaces vary between 38.17% of the total country area in Croatia and 0.22% in Turkey, (Tab.4).

Increasing the protected area network supports also forest genetic resources (FGR) conservation.

Many forests are currently protected in the framework of European networks such as "Habitat" directive (since 1992), Natura 2000, and at the national level e.g. National Parks and Biogenetic reserves.

Furthermore, many forest species are included in *ex situ* conservation programmes or units, such as seed banks, gene banks, arboreta and provenance trials (Besacier et al. 2011).

Some countries (Cyprus, France, Greece and Italy) have endorsed numerous programmes, conventions and European directives relevant to nature conservation and mitigation actions with reference to climate change:

- National Strategy for Biodiversity
- Partnership REDDplus (Reducing Emissions from Deforestation and Degradation in Developing Countries).
- IPGRI/Bioversity - EUFORGEN Programme and framework of genetic conservation units (GCUs) within the EUFGIS Project (Tab. 5).
- Development of a national strategy for adaptation to climate change adverse impacts in Cyprus.

Measures for protection/exploitation/valorisation of already existing MaPs

The concept of marginality is relatively recent. At the beginning of the COST Action FPS 1202, MaP FGR was still an idea to be defined and developed. Most of the marginal populations belonging to mesophilic species are residuals of ancient glacial refugia and their small extension make them invisible to the present methods of forest inventorying, usually structured by forest types and aimed at timber production and/or carbon stocking evaluation. On the other hand, in the Mediterranean region the national registers of forest basic materials are important sources of information regarding MaPs. In fact, most of the registered seed stands can be considere as marginal at least from thr geographic point of view. Other sources of information can be found for some species in the EUFORGEN/ EUFGIS network of gene conservation units. Information also comes from programmes finalised to conservation and sustainable use of forest genetic resources, like GENFORED. These actions provide maps of species distribution, available to download in shape file format as well as .jpeg.

Protected areas such as national parks, nature protection areas, biosphere reserve areas, natural monuments, nature parks, have very often multiple functions. The gene conservation units represent one of the most relevant among the various functions. The gene conservation units actually provide an efficient coverage of the Mediterranean area and, in many cases, are properly monitored.

Obviously great differences exist by country and species. An international shared list of MaPs is still missing. In 1991 FAO published a list of Mediterranean forest basic materials (Topak 1991) which should be updated and extended to broadleaved tree species. Many interesting populations with marginality traits can be found there.

The French Commission on Forest Genetic Resources (CRGF) has set up a network of *in-situ* gene conservation units for the following species: *A. alba*, *F. sylvatica*, *P. abies*, *P. pinaster*, *P. sylvestris*, *Populus nigra*, *Q. petraea*, *U. laevis*.

Ex situ conservation activities are ongoing for

Table 3 - Overview of important marginal and peripheral species identified by the FP1202 experts for the Mediterranean area.

Species						Country						
	CY	**ES**	**FR**	**GR**	**HR**	**IL**	**IT**	**LB**	**MA**	**PL**	**TN**	**TR**
Abies alba			X		X		X					
Abies nebrodensis							X					
Abies cephalonica				X								
Abies cilicica								X				X
Abies borisii regis				X								
Abies bornmuelleriana												X
Abies equi-trojani												X
Acacia saligna	X											
Acacia tortilis											X	
Acer tauricolum								X				
Acer hermoneum								X				
Acer obtusifolium								X				
A.syriacum								X				
Acer monospessulanum										X		
Ailanthus altissima	X											
Alnus cordata							X					
Alnus orientalis	X											
Betula pendula			X									
Betula pubescens			X									
Castanea crenata x C. sativa		X										
Castanea sativa		X	X	X	X					X		
Cedrus atlantica									X			
Cedrus brevifolia	X											
Cedrus libani								X				X
Ceratonia siliqua								X			X	
Cercis siliquastrum								X				
Corylus colurna												X
Cupressus sempervirens	X			X								
Cupressus atlantica									X			
Eucalyptus spp.	X											
Fagus orientalis				X								X
Fagus sylvatica		X	X	X	X		X					
Fraxinus excelsior							X					
Fraxinus ornus								X				
Fraxinus spp.			X									
Juglans regia		X					X					
Juglans spp.		X										
Juniperus drupacea								X				
Juniperus excelsa	X							X			X	
Juniperus foetidissima	X											
Juniperus phoenicea	X											
Juniperus thurifera			X									
Juniperus turbinata										X		
Larix decidua			X				X					
Laurus nobilis								X				
Malus sylvestris			X									
Malus trilobata								X				
Ostrya carpinifolia								X				
Picea abies			X	X	X		X					
Pinus halepensis		X	X	X		X	X		X		X	
Pinus brutia				X			X	X				
Pinus canariensis		X										
Pinus cembra			X				X					
Pinus heldreichii,							X					
Pinus mugo							X					
Pinus mugo ssp. uncinata		X	X									
Pinus nigra		X		X			X					
Pinus nigra ssp. pallasiana	X											
Pinus nigra ssp. laricio			X									
Pinus nigra salzmannii			X									
Pinus pinaster		X	X				X			X		
Pinus pinaster ssp. iberia									X			
Pinus pinaster ssp. maghrebiana									X			
Pinus pinaster ssp. renoui											X	
Pinus pinea		X	X				X	X		X	X	
Pinus radiata		X										
Pinus sylvestris		X	X	X			X			X		
Pistacia lentiscus								X				
Pistacia terebinthus ssp. palaestina								X				
Pistacia spp.		X										
Platanus orientalis	X						X					
Populus alba		X										
Populus spp.			X	X								
Prunus avium			X	X			X					
Prunus mahaleb								X				
Prunus ursina								X				
Pyrus communis		X										
Quercus suber							X		X	X	X	
Quercus afares											X	
Quercus alnifolia	X											
Quercus brantii												
Quercus calliprinos								X				

Table 3 - Overview of important marginal and peripheral species identified by the FP1202 experts for the Mediterranean area.

Species	Country											
	CY	ES	FR	GR	HR	IL	IT	LB	MA	PL	TN	TR
Quercus canariensis											X	
Quercus cedrorum								X				
Quercus cerris					X		X	X				
Quercus cerris ssp. pseudocerris								X				
Quercus frainetto					X							
Quercus ilex							X					
Quercus infectoria								X				
Quercus infectoria ssp. veneris	X											
Quercus petraea			X	X	X		X					
Quercus pinnatifida								X				
Quercus pyrenaica										X		
Quercus pubescens					X		X					X
Quercus robur			X	X			X			X		
Quercus trojana							X					
Salix spp.			X									
Sorbus flabellifolia								X				
Sorbus torminalis								X				
Sorbus spp.			X					X				
Taxus baccata			X				X					
Tetraclinis articulata									X			
Tilia spp.			X									
Ulmus laevis			X									
TOTAL	**13**	**16**	**27**	**15**	**8**	**1**	**27**	**28**	**6**	**9**	**9**	**7**

Table 4 - Overview of numbers, surfaces and percentage coverage of protected areas within Mediterranean Region according dataset of IUCN, UNEP-WCMC (2017).

Country	Protected Areas Number (terrestrial and marine)	Land Area Protected (km²)	Total Land Area (km²)	Coverage (%)
Croatia	1'194	21'703	56'855	38,17
Cyprus	88	1'690'	9'063	18,65
France	4'611	141'362	548'954	25,75
Greece	1'260	46'509	133'012	34,97
Israel	273	4'180	20'958	19,94
Italy	3'878	64'791	301'335	21,5
Lebanon	34	268	10'329	2,59
Morocco	325	125'477	407'208	30,81
Portugal	440	21'101	92'141	22,9
Spain	4'038	142'140	507'013	28,03
Tunisia	148	12'283	155'230	7,91
Turkey	18	1'709	782'238	0,22

Pinus nigra salzmannii, *Populus nigra*, *P. avium*, *Sorbus domestica*, *U. glabra*, *U. laevis*, *U. minor*.

Some specific tests on assisted migration and active gene flow techniques are ongoing in Italy, on *A. nebrodensis*, an extreme case of marginal species within the *Abies complex*, and on *Q. robur* and *Q. petraea*. In this latter case, the marginality and isolation were generated by anthropic activities in northern Italy. These long-term experimental tests are aimed to monitor and verify the effects of the translocation actions on the gene pools. Aside the scientific purposes, the experimental sites satisfy also the urgent need to preserve a very endangered genetic material.

Table 5 - Overview of in situ genetic conservation units in the countries within the Mediterranean Area and the number of species registered in EUFGIS for each country (http://portal'eufgis'org/).

Country	Number GCU (*in situ*)	Number of tree species in EUFGIS
Croatia	19	8
France	95	8
Greece	15	5
Italy	209	35
Portugal	9	8
Spain	43	5
Turkey	271	36
Total	**661**	**105**

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