Terraprima

Cork Oak Landscapes, Their Products and Climate Change Policies

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Disclaimer

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Table of Contents

Table of Figures

Table of Tables

Executive Summary

Cork oak landscapes exist in a relatively small portion of our planet, but they are extremely important for the products they produce, the most iconic of which is cork, but also for the social and environmental services they provide.

Climate change will affect all ecosystems and this report makes the link between climate change, climate change policy and cork oak forests. It looks at how cork oak forests contribute to emissions and to carbon sequestration (chapter 2), how cork oak forests will be affected by climate change (chapter 3) and how cork products contribute to mitigation of climate change (chapter 4). It then provides a summary of the main existing international climate change policies and instruments (chapter 5), in particular those related to carbon markets (chapter 6). It concludes with a section suggesting measures to tackle address climate change (mitigation and adaptation) in cork oak forests and to how to take better advantage of existing climate related finance (chapter 7).

Cork oak landscapes are unique in their ecological characteristics, their management system and they are the origin of an iconic and singular product: cork.

These forests are managed using a set of practices which affect their contribution to mitigate climate change. On the negative side, deforestation, over grazing and over harvesting, land abandonment and forest fires are contributing to emissions and forest degradation. On the positive side, afforestation and changes in soil management practices are increasing carbon sequestration and forest resilience. However, the actual balance of emissions and removals in any particular forest plot will depend on the effect of a set of management practices on different carbon pools. Unfortunately, **the availability of public data did not allow the quantification of the emissions and removals in cork oak forests for the whole region** and further information needs to be compiled for this assessment to be made with the right level of detail. **There is therefore a need to go deeper into the understanding and data collection for a complete and accurate estimation of emissions and removals in cork oak forests**.

Cork oak forests are located in a region which already is and will increasingly be severely affected by climate change. That reinforces “old” climate related risks and places new challenges on existing cork oak forests. Amongst these challenges the most significant are the likely exposure to **more frequent droughts and water stress**, **increased fire risk leading** to more frequent and more intense fires and possibly, **increased exposure to pests and diseases**.

Under Mediterranean conditions the management actions to promote climate change mitigation and climate change adaptation are often overlapping, as they contribute both to increase resistance and resilience to climate change and to reduce emissions or to increase sequestration. This is clearly the case of management actions that promote soil protection against erosion and soil organic matter, which lead to soil carbon sequestration and to increased capacity to cope with droughts, or improvements in fire prevention measures, which reduce fire emissions and maintain the health and vitality of cork oak forests.

Many of the recommendations for climate friendly mitigation and adaptation practices make sense on their own. However climate finance may have a pivotal role to foster large scale management changes, as it can be used to:

- **provide financial viability to alternative practices**, e.g. replacing “bad” (but profitable) practices with climate friendly ones;
- **cover losses associated with temporary restrictions to current practices**, e.g. excluding grazing until soils or forest densities recover
- **overcome non-financial barriers**, e.g. training and capacity building to cover knowledge and information gaps;
- **overcome resistance to innovation**, e.g. provide an incentive to change practices that have been common in a certain region for extensive periods of time;
- **finance external and specialized input** into designing better and locally adapted practices;
- **finance the information and monitoring system** to measure the costs and the climate benefits introduced by the measures

Climate finance is available in multiple formats and can be mobilised for different purposes, but ultimately they may all converge to promote better forest management:

- **REDD+ finance** can be used to finance capacity building and “reward” emission reductions in forest landscapes (non-A1 countries)
- **NAMA finance** can be used to finance climate mitigation resulting from activities that reduce emissions or increase sequestration in the forest, agriculture and grazing sectors (non-A1 countries)
- **Adaptation finance** can be used to promote forest resilience and resistance to climate change (non-A1 countries)
- **Common Agriculture Policy finance** can be used for both mitigation and adaptation (EU countries)
- **Life Programme finance** can be used to promote best practices and demonstration projects in both mitigation and adaptation (EU countries)
- **Voluntary carbon market finance** can so far be used only for a limited number of practices (all countries)

In the case of cork-oak forests most of the practices that contribute t climate change mitigation also foster their adaptation. **It is therefore important to understand, for each set of intended practices or actions, which is the best format for finance**.

1 The Cork Oak Landscapes

Cork oak forests are found only in the warmer parts of the humid and sub-humid western Mediterranean[1]. They occur predominantly in the Iberian Peninsula and Morocco, but also on the western coast of Italy, in southern France and the coastal plains and hills of Algeria and Tunisia (Figure 1). Cork oak forests cover approximately 2.33 million ha, 1.57 million ha in Europe and 757 thousand ha in North Africa (Figure 2).

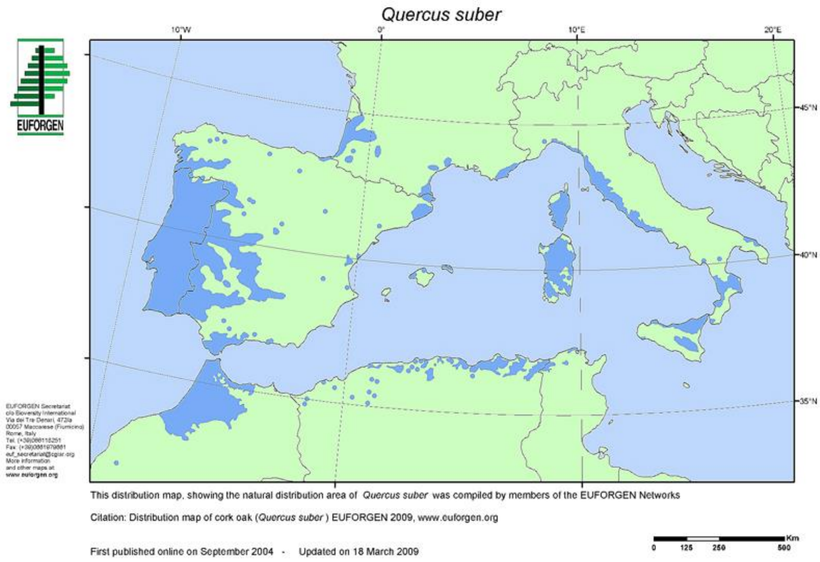


Figure 1: Cork Oak Forests - Natural Distribution

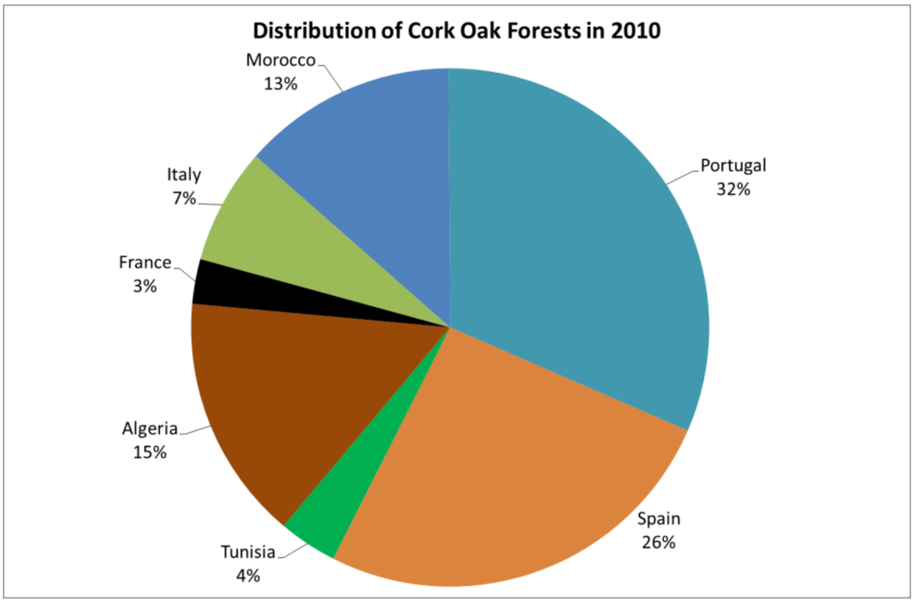


Figure 2: Distribution of Cork Oak Forests in 2010 [2]

[1] http://www.fao.org/docrep/017/i3226e/i3226e.pdf
[2] Based on the data presented in Figure 5

Climatically, cork oak forests occur in regions with average annual precipitation above 600 millimetres and average temperature near 15^{o}C. In Europe, it is low temperatures that appear to set the geographic limits and most cork oak stands are located in areas below 800 meters in altitude and usually grow in acidic soils on granite, schist, or sandy substrates or, more rarely, in limestone-derived soils or in neutral soils overlying dolomitic bedrocks (Aronson, J., Pereira, J., and Pausas, J..2009).

Cork is the bark of cork oak trees and has evolved as an evolutionary response to protect the tree from fires and drought, both common features in its natural distribution area. Cork is an extremely insulating material and protects the tree from the extreme temperatures during fires. Epicormic buds are also protected by the cork and guarantee a quick recovery of the affected trees after fire. Its characteristics also reduce the losses of water by evaporation, another useful feature in times of extreme drought. Cork is composed mostly of suberin (39%), lignin (22%) and polysaccharides (18%) (Pereira, H. (1988).). The high levels of suberin present in cork (compared to other specie's bark) make it a material which is impermeable, buoyant, fire resistant, compressible, elastic, long lasting and resistant to abrasion.

An additional and distinctive characteristic is that, unlike most other trees, the cork oak bark renews itself after harvesting and there is usually no mortality associated with the bark extraction. As bark production depends on tree size, there is no incentive for harvesting the trees, and cork oak forests tend to have older and larger trees than other forests types used for wood production, and frequently reach over 200 years of age.

Recognising the unique characteristics of cork, humans started harvesting and using this material for numerous purposes, and currently cork is the most valued product of cork oak forests. Cork became iconic for its use for bottle stoppers in the wine industry. More recently, building on the chemical characteristics of cork, cork industrial uses have expanded tremendously and it is now used in the automobile, military and space industries, for footwear and clothing, in building and architecture, as tiles in floors, in furniture etc. Certain materials obtained from corks as derivatives are used for such purposes like black agglomerate, white agglomerate and rubbercork[3].

Cork oak forests are often explored in agro-forestry systems, combining the presence and use of cork oak trees with the use of its understory for direct grazing by pigs, cattle, sheep or goats or for extensive cereal production. These systems are known as "montado" in Portugal or "dehesa" in Spain.

The products of cork oak landscapes are, therefore, more diverse than just cork, including meat, cereals, but also natural products such as mushrooms, asparagus, bee honey, medicinal herbs. Cork oak landscapes are also use for hunting, both small game (rabbits, partridges, etc) and large game (red deer, fallow deer, wild boar). Beside the provisioning ecosystem services referred, cork oak woodlands also provide the ecosystem services of regulating (soil conservation, water retention, watershed protection, erosion control, amongst others examples), supporting (soil formation, nutrient cycling, primary production, etc.) and cultural heritage (landscape amenity, recreation and tourism) (MA (Millennium Ecosystem Assessment). 2005.). Finally, the unique biodiversity of the Mediterranean region, of which the cork oak landscapes are an essential part of, has made it one of the 34 global biodiversity hotspots identified by Conservation

[3] http://www.cork.pt/other-applications-of-cork.html

International[4]. WWF further states that "cork oak forests support one of the highest levels of biodiversity among forest habitats, as well as the highest diversity of plants found anywhere in the world"[5].

WWF has elected cork oak one of its 36 priority species programmes[6] at global level and identifies the following threats to cork oak forests:

- increasing human pressure on resources, through overgrazing, over-harvesting and forest clearance;
- forest conversion for fast growing tree plantations;
- poor forest management practices;
- land abandonment;
- urban development in coastal areas;
- forest fires;
- perverse subsidies in the north;
- poverty and lack of economic opportunities for rural populations in the south;
- lack of forest management capacity and investment to integrate environmental and social issues into management practices and land use planning;
- cork market fluctuations.

These threats, will become exacerbated by climate change and will affect cork oak landscapes health and increase their vulnerability to diseases, pests, and large-scale fires.

[4] http://www.conservation.org/where/priority_areas/hotspots/europe_central_asia/Mediterranean-Basin/Pages/default.aspx
[5] http://mediterranean.panda.org/about/forests/cork/about_cork/biodiversity/
[6] http://wwf.panda.org/what_we_do/endangered_species/cork_oak/

2 Current Trends in Emissions and Sequestration in Cork Oak Landscapes

2.1 Emissions and Removals in forest ecosystems

The IPCC structures the carbon cycle of forest ecosystems in Carbon Pools and for each pool both Gains and Losses of Carbon should be estimated. Carbon Pools include living biomass (above and below ground); Dead Wood and Litter; Soil Organic Matter; and Harvested Products. “Gains” are all processes that increase the Carbon content of a pool, while “Losses” are those processes that reduce the Carbon content of pool. The “losses” refer to emissions of various GHGs to the atmosphere (carbon dioxide CO_2, methane CH_4 and nitrous oxide N_2O) or simply to transfers of Carbon between different Carbon pools, while “gains” refer to sequestration of CO_2 from the atmosphere or transfers of carbon (organic matter) or increases of carbon due to transfers of Carbon between different pools (Figure 3). Some processes and management activities may also add emissions of other greenhouse gases, most notably methane and nitrous oxide (Figure 4).

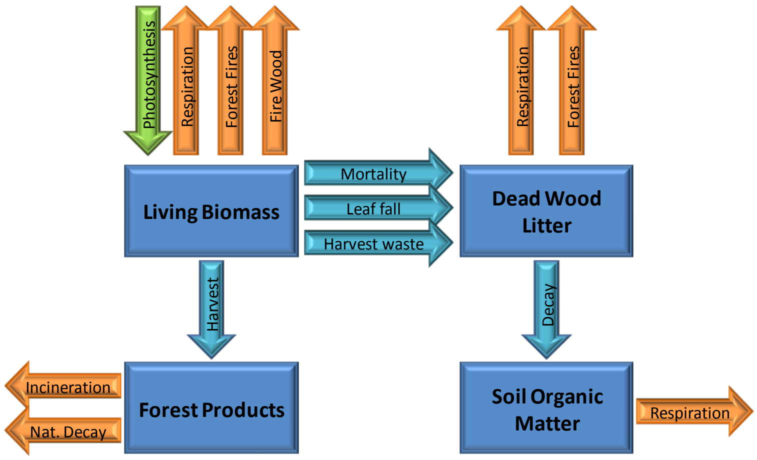


Figure 3: Simplified representation of the main Carbon Flows (in blue), Emissions (in orange) and Removals (in green)

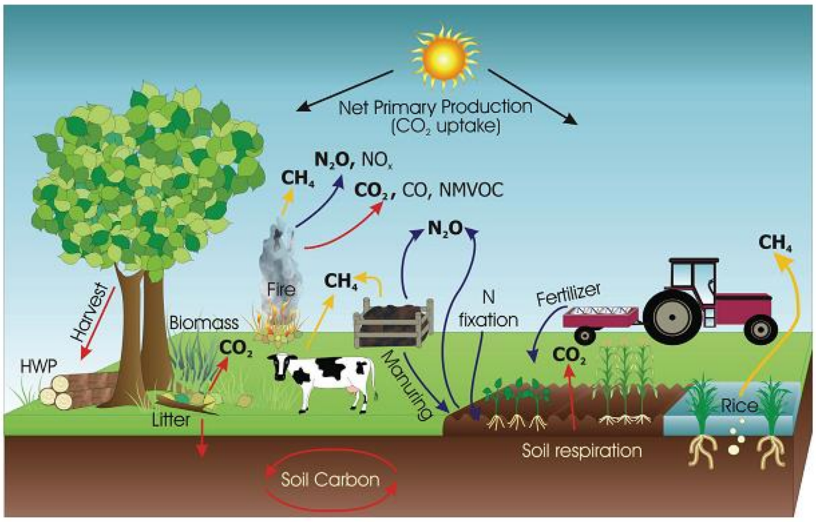


Figure 4: Main Greenhouse Gas Emissions and Removals in the Land Sector

Understanding and quantifying all these processes is not a simple task and requires the combination of many different information sources and an understanding of these flows in both space and time, as some of these flows are relatively slow to materialize (e.g. sequestration or emissions from natural decay of wood) while others can be of high magnitude over short periods (e.g., emissions from forest fires).

The National Inventory Reports[7] presented to the UNFCCC by the countries in the cork-oak distribution area present their results in aggregated manner and do not allow singling out emissions and removals associated with this specific forest species, so it is not possible to present aggregated data from official sources.

Nevertheless, it is possible to identify a series of management activities that will contribute as a source of emissions. These may come from deforestation, from mortality, from legal and illegal harvesting or pruning, from degradation of soils and desertification, grazing, etc.

Other activities and characteristics of cork oak landscapes contribute in the opposite, more positive, direction. The expansion of cork oak areas, the efforts to increase regeneration, soil restoration and measures to fight desertification usually have a positive contribution in fighting climate change by removing CO_2 from the atmosphere.

In the absence of concrete detailed data for the countries concerned, this report will focus on *proxy* information, i.e., variables that have a known contribution to emissions and removals, even if no quantification is possible at this point in time.

2.2 Land-use change in Cork Oak Forests (Afforestation and Deforestation)

Land-use changes usually involve removing the vegetation of a particular land-use and replacing it with a new type of use. They are also often associated with changes in soils (e.g., tillage). Therefore, land-use changes are usually associated with the most dramatic emissions and removals on land and, therefore, receive a lot of attention when estimating emissions and removals.

[7] NIR from PRT, SPA, ITA, FRA https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php

The balance of carbon involved in land use changes depends very strongly on the original and future land use being considered. In general, transitions from low carbon stock land-uses (e.g. annual rain-fed crops) to high carbon stock land-uses (e.g. forests) result in net-sequestration of carbon, whereas the reverse results in net-emissions.

Therefore, to correctly quantify emissions and removals associated with land-use transitions to and from cork oak forests one would need to know in detail where these transitions are taking place and which land-uses are being replaced. Information of this type is usually collected in countries or regions where maps in different points in time exist, or where the National Forest Inventories are based on permanent plots, resampled at each inventory.

Overall, and as shown in Figure 5, areas covered in Cork-oak forests have increased from 1975 to 1990 at a rate of about 14,102ha/year. From 1990 to 2000 the total area continued to grow, although at a slower rate of about 10,507ha/year. However, this trend has been reversed from 2000 to 2011 with a recorded decrease in total area of about 2,083ha/year.

Data also shows that these trends have not been uniform across the region (Table 1), with some countries showing a consistent increase over time (Spain, Italy), a stabilization of total area (Portugal) and decreases in area (Morocco, Algeria).

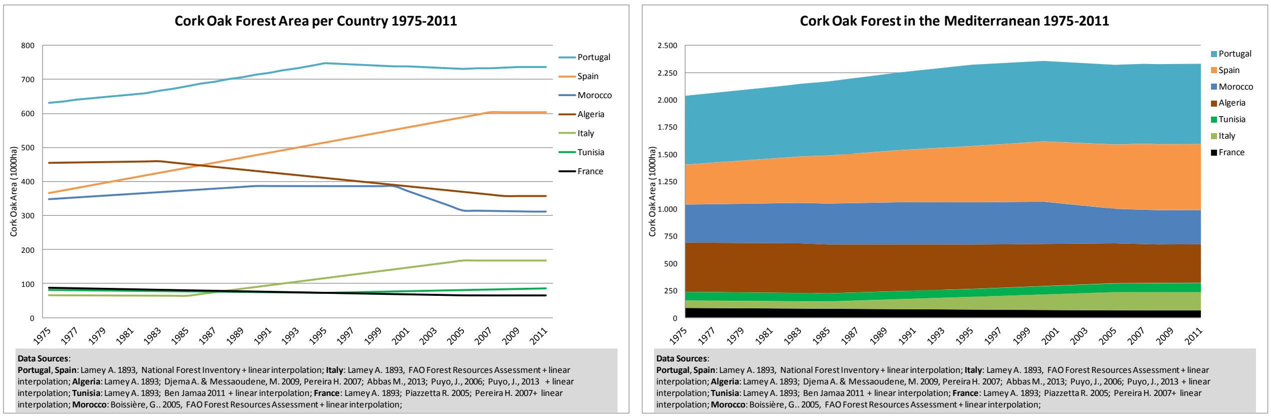


Figure 5: Changes in Total Area of Cork Oak Forests

Table 1: Annual Trends in Cork Oak Forest Area per Country

	1975-1990	1990-2000	2000-2011
Algeria	-1.534	-4.097	-3.266
France	-743	-743	-353
Italy	1.292	5.190	2.268
Marocco	2.562	-45	-6.548
Portugal	5.490	2.558	-92
Spain	7.457	7.457	5.110
Tunisia	-422	188	798
Total Cork Oak Area	**14.102**	**10.507**	**-2.083**

unit: ha/year

Although relevant, it should be noted that changes in total area are *per se* is a poor indicator for the carbon dynamics associated with afforestation and deforestation in any particular territory. National Forest Inventories usually provide total area estimates and thus, comparing one inventory with the previous one only allows the calculation of net-afforestation (if total area increased) or net-deforestation (if it decreased). However, as annual emissions per hectare from deforestation are usually much larger than annual sequestration per hectare from afforestation, it is very important to know the dynamics of each of these activities separately.

For example, in Portugal, preliminary NFI6 data suggests that a net-total of 10,052 ha were lost between 1995 and 2010 (approx. -670ha/year). However, a closer look shows that this net-number actually results from a gross deforestation of 86,379 ha and a gross afforestation of 76,168 ha (Figure 6).

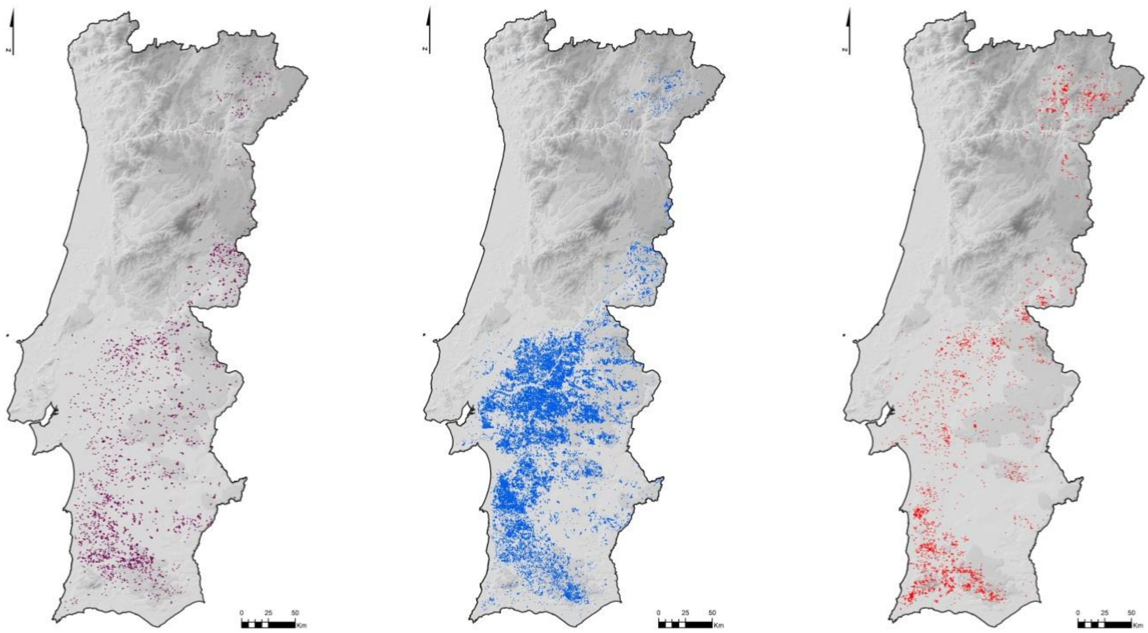


Figure 6: Cork Oak Forest Dynamics in Portugal
Afforestation 1995-2010 (left); Distribution in 2010 (center) and Deforestation 1995-2010 (right)

Using the net or the gross afforestation and deforestation figures will result in very different annual emissions and sequestration estimates. Table 2 illustrates, for the case of Portugal, the emission estimates that result from using the net-deforestation or the gross-afforestation and gross-deforestation.

Table 2: Estimating Emissions and Removals based on NET or GROSS Afforestation and Deforestation

	Net-Deforestation		Gross-Afforestation and Gross-Deforestation	
	Total Area (1995-2010)	Estimated Annual Emissions(-) or sequestration(+)[8]	Total Area (1995-2010)	Estimated Annual Emissions(-) or sequestration(+)
Afforestation	NA	NA	76,168 ha	+94,927 tonCO_2
Deforestation	NA	NA	-86,379 ha	-433,941 tonCO_2
Net-change	**-10,052 ha**	**-50,488 tonCO_2**	**-10,052 ha**	**-339,014 tonCO_2**

In the estimation of emissions and removals associated with afforestation, it is also of paramount importance to know what the land use was present before the afforestation took place. As carbon stocks associated with each land use can be very different, the emissions associated with each transition can also be quite different as illustrated in Table 3 for the case of Portugal.

Table 3: Emissions Associated with Afforestation with Cork Oak, depending on previous Land-Use

Land Use before afforestation with cork oak	Emission associated with afforestation tCO2/ha	Years before new cork oak forest offsets initial emission
Pinus pinaster	110	47
Eucalyptus spp.	81	35
Quercus rotundifolia	49	21
Quercus spp.	75	32
Other broadleaves	162	69
Pinus pinea	74	32
Other coniferous	60	26
Non-irrigated annual crops	2	1
Irrigated annual crops	2	1
Rice paddies	2	1
Vineyards	23	10
Olive groves	33	14
Other permanent crops	36	16
Grassland	5	2
Shrubland	50	22

As the table shows, afforestation with cork oak is a much better mitigation option when the previous land use was agriculture or grassland, and a relatively poor option when replacing other types of forest.

2.3 Emissions and Removals in existing forests of Cork Oak

Even when no land-use change is involved forests will still sequester carbon or emit carbon, particularly when they are managed. The processes driving these changes are photosynthesis (tree and cork growth) or carbon accumulation (increases in soil organic matter or litter and dead wood) and, simply speaking, all processes that remove biomass and organic matter from forests (e.g. respiration, harvesting, cork extraction and forest fires). Both natural processes and management play a vital role in the carbon balance by altering the rate at which emissions and removals are taking place at any given point in space and time.

[8] Considering only the carbon present in cork oak trees, and using the emission factors as presented in the National Inventory Report 2013 for Portugal.

Table 4 makes a summary of the impact of the main natural processes and management actions in cork oak forests and relates them to their consequences in terms of emissions and removals.

Table 4: Main Natural Processes and Management Actions in Cork Oak Forests and their Impact in Mitigation to Climate Change

Natural process / Management action	Consequence in emissions and removals
• Tree planting / assisting natural regeneration	• Increases tree density and average standing volume **– contributes to removals**
• Cork extraction / cork growth	• Increases emissions in the year of harvesting; likely compensated by removals in the following years **– probably neutral over a full cork extraction cycle** • May degrade tree health and vitality condition (if not implemented correctly, if done in excess, too frequently or over a too large surface) **– contributes to emissions**
• Cork oak harvesting and thinning	• Decreases tree density and average standing volume **– contributes to emissions**
• Cork oak pruning	• Increases emissions in the year of pruning **– contributes to emissions** • May improve tree health and vitality condition (e.g. when used to control pests or diseases) **– contributes to removals (or avoids future emissions)** • May degrade tree health and vitality condition (e.g. illegal collection of fire wood or accorns) **– contributes to emissions**
• Cork oak natural mortality • Cork oak pests and diseases	• Decreases tree density and average standing volume **– contributes to emissions**
• Tillage	• Decreases soil organic matter content **– contributes to emissions** • May degrade tree root system and tree health and vitality condition **– contributes to emissions**
• Shrub control	• Increases emissions in the year of control; likely compensated by removals in the following years **– probably neutral over a full shrub control cycle** • Decreases fire probability and reduces damage and tree mortality in case of fire – **avoids future emissions** • May improve soil organic matter (if shrub mowers are used to reduce shrub biomass and biomass is left on the ground to decay) **– contributes to removals** • May degrade soil organic matter (if tillage is used to destroy shrubs) **– contributes to emissions**
• Grazing by cows, sheep, goats, pigs • Grazing by large herbivores (deer, wild boar)	• May limit tree regeneration (especially in over-grazing situations) **– limits future removals** • Decreases fire probability and reduces damage and tree mortality in case of fire – **avoids future emissions** • May degrade soil condition (especially in over-grazing situations) **– contributes to emissions** • May improve soil organic matter (e.g. due to organic input; if improved pastures are sown, etc.) **– contributes to removals**
• Agriculture under tree cover	• Decreases fire probability and reduces damage and tree mortality in case of fire – **avoids future emissions** • May improve soil organic matter (if no till is used)

Natural process / Management action	Consequence in emissions and removals
	– contributes to removals • May degrade soil organic matter (if tillage is used) **– contributes to emissions**
• Liming & fertilization	• Increases system productivity, growth and may improve tree health and vitality condition **– contributes to removals** • Increases losses of nitrogen **– contributes to emissions (of N_2O)** • May improve soil organic matter (if no till is used) **– contributes to removals** • May degrade soil organic matter (if tillage is used) **– contributes to emissions**
• Forest fires	• Causes direct fire emissions of several greenhouse gases (CO2, CH4 and N2O) **– contributes to removals** • Consumes / degrades the layers of litter and dead wood **– contributes to emissions** • Exposes surviving trees to increased post-fire mortality and to pests and diseases **– contributes to emissions** • Increases soil loss and decreases soil organic matter content **– contributes to emissions**
• Drought & flooding	• May increase natural mortality or attacks by pests and diseases **– contributes to emissions**
• Soil erosion • Soil degradation • Desertification	• Increases soil loss and decreases soil organic matter content **– contributes to emissions**
• Soil restoration	• Decreases soil loss and increases soil organic matter content **– contributes to removals**

Estimating gains and losses for all these processes can be technically complicated and requires a lot of data. One alternative is to estimate whether the net-effect of all these management activities and natural processes is leading to a net-sequestration or a net-emission of GHG emissions is to compare how the average standing volume of cork oak trees (and other carbon pools) is evolving over time. An increase will mean that forests are accumulation carbon, i.e. sequestration is on average bigger that emissions, while a reduction will mean the opposite, emissions are greater than the removals or sequestration. Although data is limited, we can see that existing cork oak forests are increasing their average carbon stocks in most countries, while Portugal shows a stabilised carbon stock, suggesting that cork oak forests are, on average, acting as a carbon sink.

Table 5: Evolution of mean volume per hectare in Cork Oak Forests

	1975	1985	1990	1995	1996	2000	2005	2007
Algeria								
France								
Italy		50						
Morocco			28			30	39	
Portugal				31			31	
Spain	22				22			29
Tunisia				74		92	94	

unit: m^3/ha

As with afforestation and deforestation, the trends in average carbon stocks may be hiding different trends in different parts of the same country. Net-changes in carbon stocks are already a combination of areas that are gaining carbon with areas that are losing carbon. Quantifying these different trends and identifying where they are taking place is important for understanding the processes that are improving or degrading carbon stocks in order to better design proper mitigation policies. E.g. Figure 7 shows, for the case of Portugal, that some areas are increasing tree crown cover, while others decreasing tree crown cover. Understanding the processes that lead to the latter is important in order to stop those (likely) emissions from continuing.

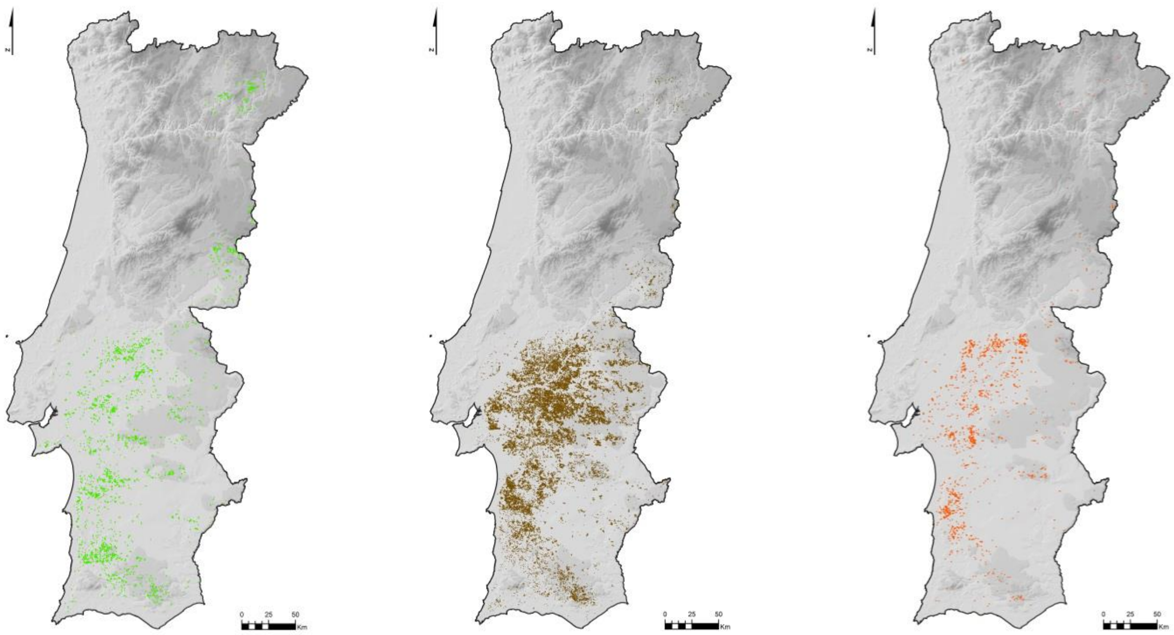


Figure 7: Changes in Tree Crown Cover in Cork Oak Forests in Portugal 1995-2010
Increase (left), No-change (center) and Decrease (right)

BOX 1: CASE STUDY: Financing Soil Carbon through Sown Biodiverse Pastures and Improved Shrub Control

In 2009-2014, 3 projects were financed by the Portuguese Carbon Fund (PCF) to promote climate friendly changes in pasture management in the South and Centre of Portugal. All projects impact the soil organic matter (SOM) by changing common management practices in degraded soils. Increases in SOM induced by these changes were accounted as Carbon Sequestration, and this environmental service was paid for by the PCF, as part of a Domestic Offset Programme. Increases in SOM also have important adaptation benefits.

The overall impact is summarised in 3 indicators: 130000ha intervened; >1000 farmers involved; 1.5 MtCO2 of additional sequestration.

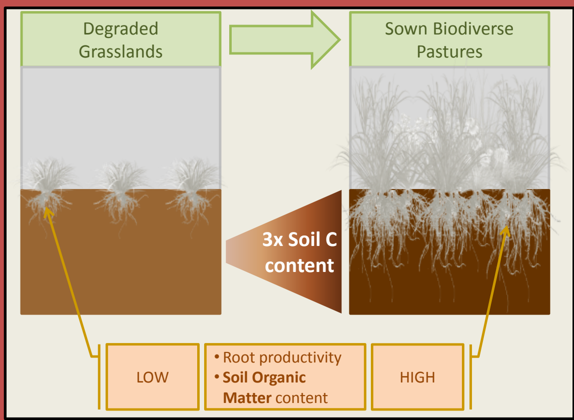
The baseline situation for all projects was similar: degraded grasslands of "natural" herbaceous vegetation, which in time is colonised by woody vegetation (shrubs) to which farmers react by resorting to tillage, further degrading the soil. This cycle repeats itself every 4-8 years and the corresponding average levels of SOM are very low. The process also exposes soils to erosion, reduces water storage capacity and may damage tree roots.

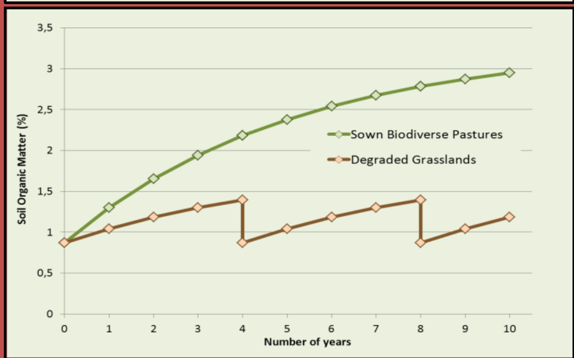
The projects offered two alternatives for farmers: Sown Biodiverse Pastures (SBP), for the cases where the degraded grasslands were used for extensive grazing; Improved Shrub Control (ISC), for the cases where shrub control takes place mostly to reduce fire risk and/or to allow for cork extraction.

SBP use a combination of up to 20 species and varieties of grasses and legumes, which increase productivity, do not require tillage for maintenance, and thus result in increases of SOM at 10 cm depth of ~6.5tCO2/y for 10 years (//youtu.be/WR4tINbSXp4)

ISC replaces the conventional tillage by a biomass shredder that leaves the soil untouched, which results in increases of SOM at 30 cm of ~6 tCO2/y for 10 years.

All farmers received technical support to guarantee the proper implementation of the proposed management practices. Their adhesion to the project was voluntary and regulated by individual contracts.





To know more please visit: https://www.youtube.com/watch?v=WR4tINbSXp4 ; http://terraprima.pt/en/projecto/2 ; http://terraprima.pt/en/projecto/1

3 Challenges for Cork Oak Landscapes in Adapting to Climate Change

Impacts of climate change have the potential to affect global terrestrial carbon sink and to further increase atmosphere CO_2 concentration. Recent research confirms that carbon storage in soil organic matter is often increased under elevated CO_2 in the short-term (Allard et al. 2004 cited at IPCC 2007), yet the total soil carbon sink may saturate at elevated CO_2 concentrations, especially when nutrient input are low (Gill et al. 2002 and van Groeningen et al. 2006 cited at IPCC 2007).

Carbon stored in the terrestrial biosphere is vulnerable to be lost back to the atmosphere as a result of the direct and indirect effects of climate change and forest degradation. The net transfer of carbon dioxide from the atmosphere to the land is projected to weaken during the 21st century. The direct effects of climate change on stored terrestrial carbon include high temperatures, drought and windstorms, indirect effects include increased risk of fires, pest and disease outbreaks.

Cork oak landscapes are located in the Mediterranean Basin, a region that is very sensitive to climate change. Climate change modelling suggests that the Mediterranean region will experience change in terms of:

- precipitation patterns: reduction of total precipitation; redistribution of annual patterns; more inter-annual variation; more frequent and longer droughts; etc.;
- temperature patterns: increases in mean temperature; more frequent heat waves; etc.;
- frequency and intensity of extreme events: storms, wild fires, etc.

These future trends are only reinforcing what is already being felt across the region. In fact, increases in mean annual temperature in the cork oak area have been higher than in most of Europe (Figure 8) and there is significant trend for reduction of both warm days and cool nights (Figure 9). Although less significant, the changes in precipitation have also shown a decrease in annual rainfall (Figure 10)[9].

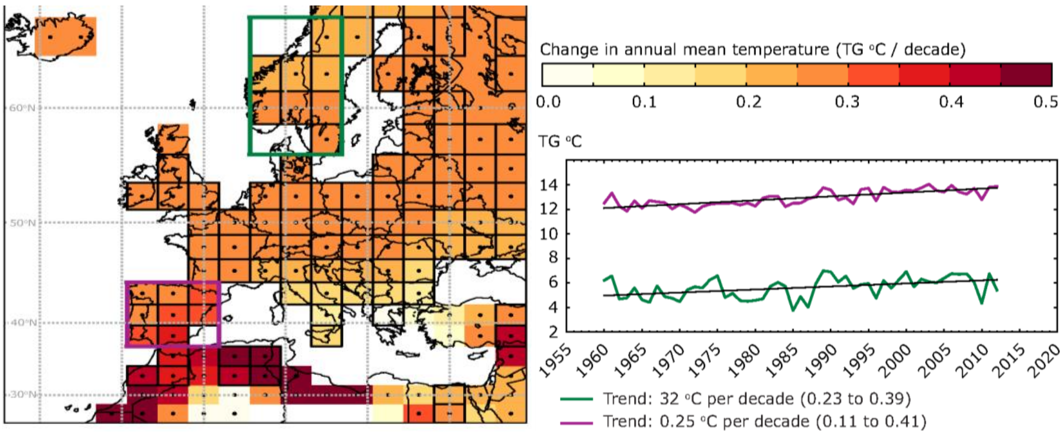


Figure 8: Observed Trends in Mean Annual Temperatures 1960-2012

[9] Figure 7 to Figure 10 retrieved from the European Climate Adaptation Platform http://climate-adapt.eea.europa.eu/data-and-downloads?searchtext=&searchelements=OBSERVATIONS&searchtypes=MAPGRAPHDATASET

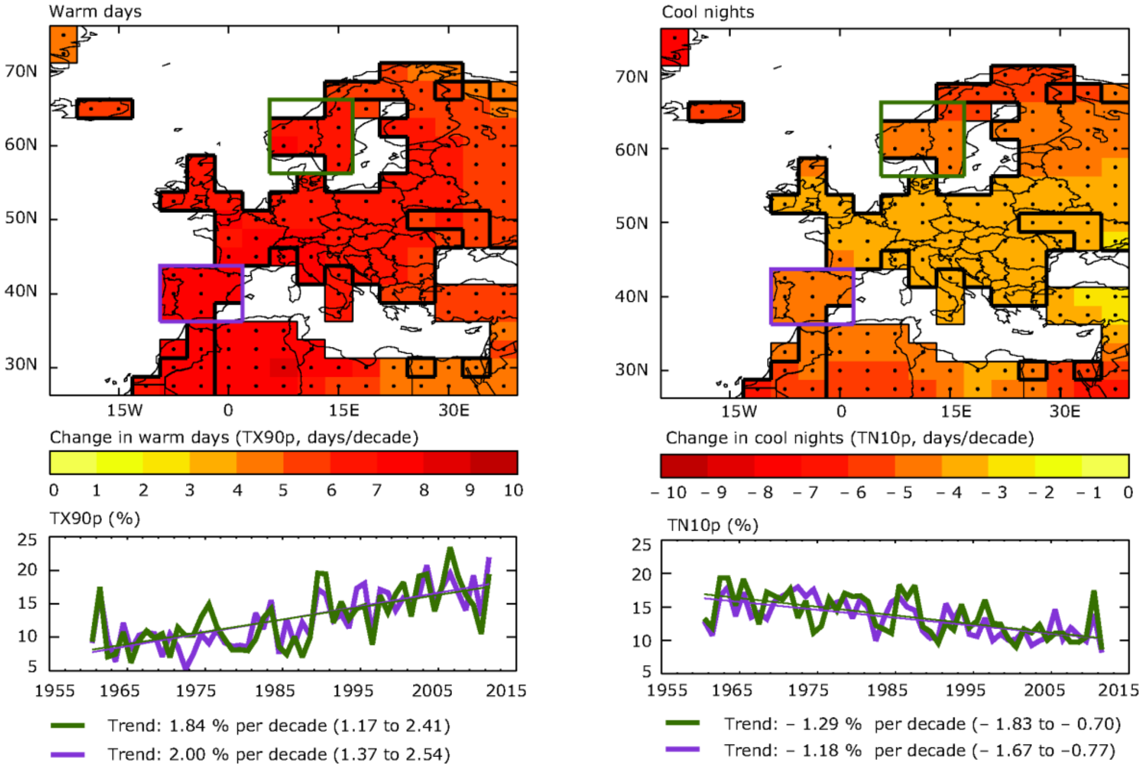


Figure 9: Observed Trends in Number of Consecutive Warm Days and Cool Nights 1960-2012[10]

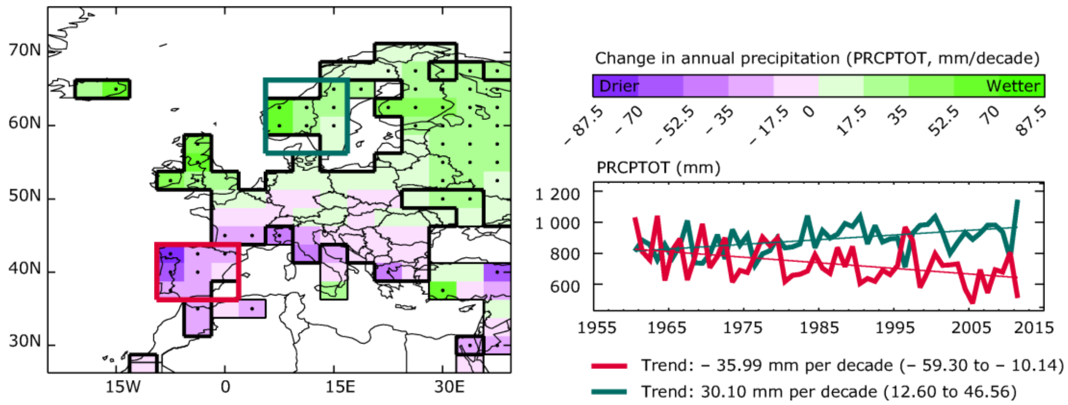


Figure 10: Observed Trends in Annual Precipitation 1960-2012

By the end of the twenty-first century, mean air temperature in the cork oak region is expected to rise by 2 to more than 4,5°C, an increase that will be felt most intensively in the summer than in the winter (Figure 11). Total precipitation may decrease by as much as 30 percent (Figure 12). Furthermore, the Mediterranean basin appears to be one of the primary climate change hotspots, which means that the climate change will be felt more intensively in this region than in other places (Aronson et al. 2009).

[10] Warm days are defined as being above the 90th percentile of the daily maximum temperature and cool nights as below the 10th percentile of the daily minimum temperature (Alexander et al., 2006). Grid boxes outlined in solid black contain at least three stations and so are likely to be more representative of the grid-box. High confidence in the long-term trend is shown by a black dot. Area averaged annual time series of percentage changes and trend lines are shown below each map for one area in northern Europe (green line, 5.6 ° to 16.9 °E and 56.2 ° to 66.2 °N) and one in south-western Europe (purple line, 350.6 ° to 1.9 °E and 36.2 ° to 43.7 °N).

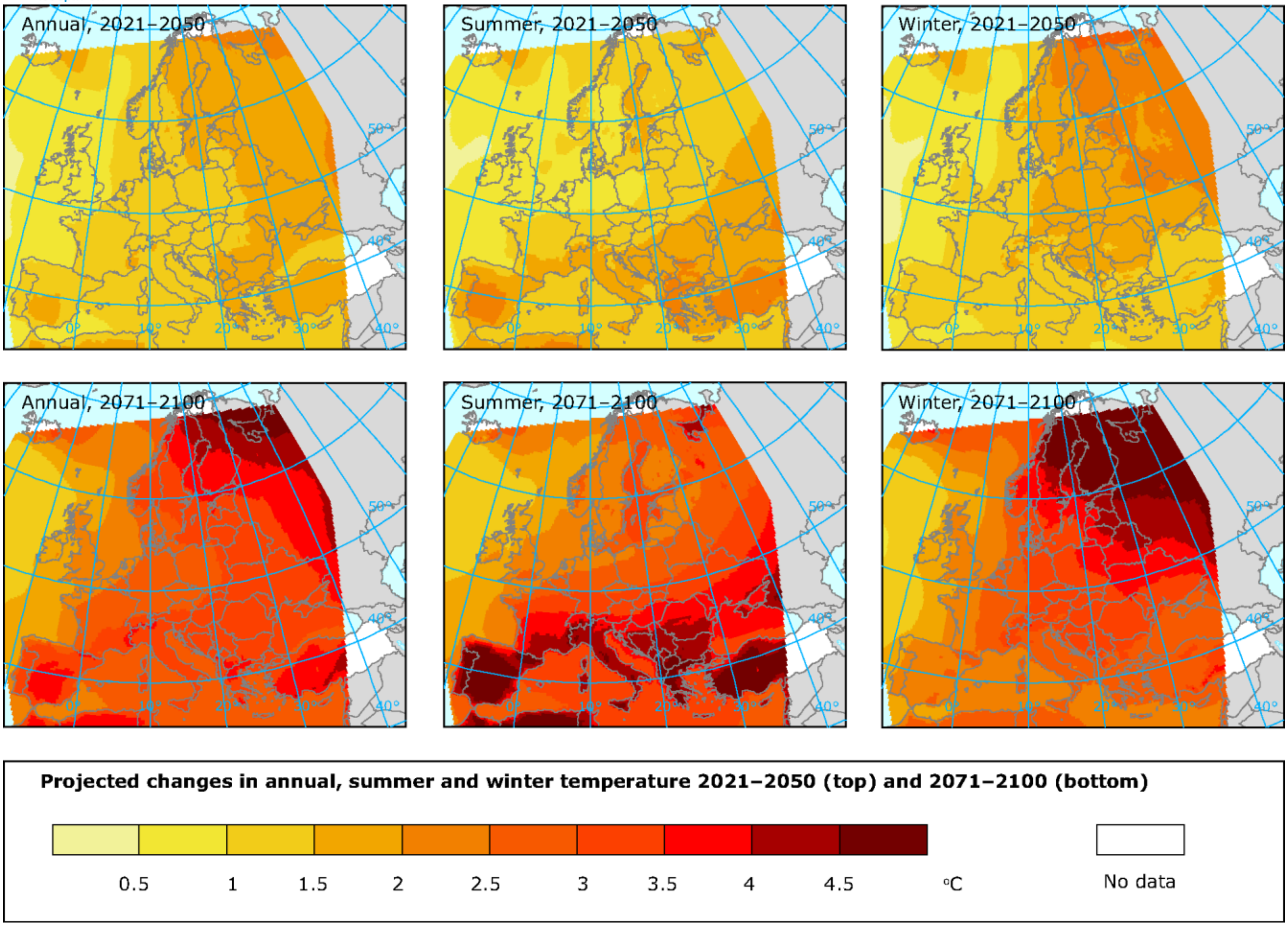


Figure 11: Projected Changes in Mean Annual Temperature (left), Mean Summer Temperature (center) and Mean Winter Temperature (left). Values for 2021-2050 (up) and 2071-2100 (down) as simulated by ENSEMBLES Regional Climate Models for the IPCC SRES A1B emission scenario

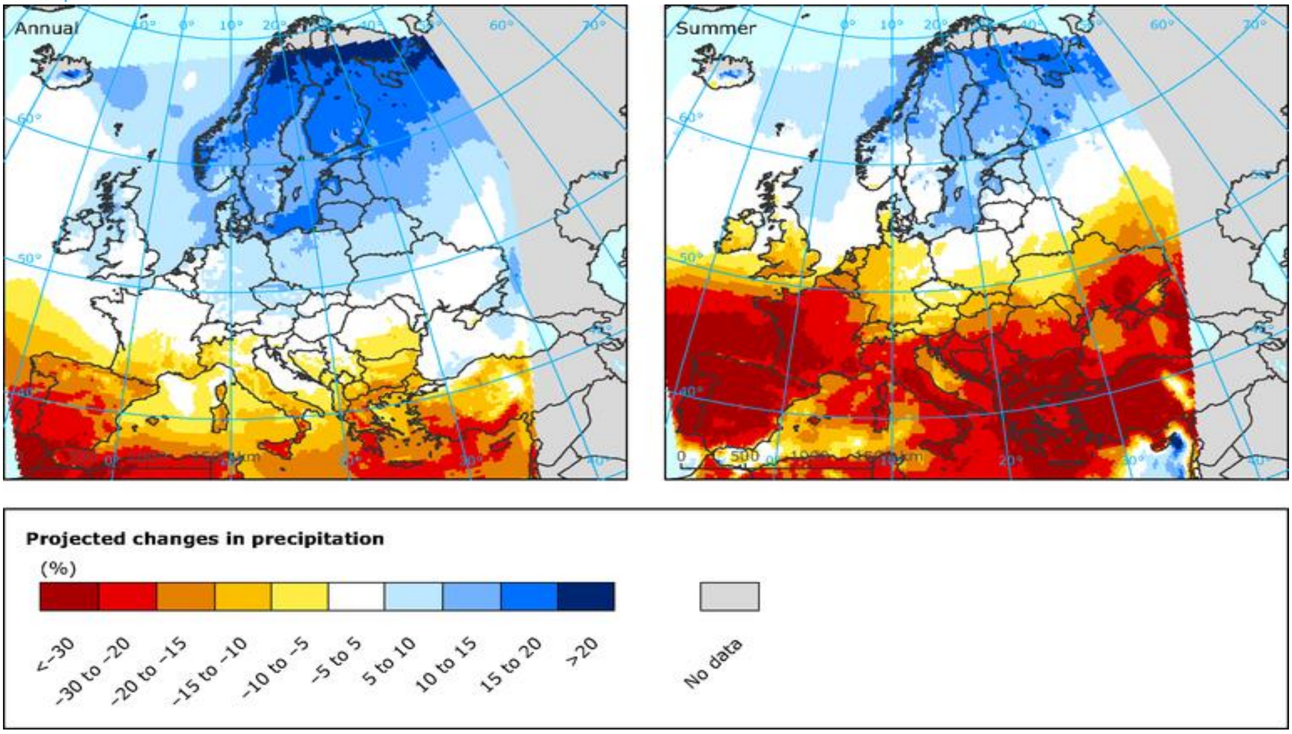


Figure 12: Projected Changes in Annual Precipitation (left) and Summer Precipitation (right). Precipitation (%) between 1961-1990 and 2071-2100 as simulated by ENSEMBLES Regional Climate Models for the IPCC SRES A1B emission scenario

These past and future trends will affect cork oak landscapes in different ways, quite often placing new or increasing environmental pressures on the maintenance of cork oaks forests.

Cork oak forests are naturally adapted to a particularly variable climate and are biologically equipped to deal with a highly variable weather patterns, both between and within years. However, the adaptation to climate change will be more difficult for species with low dispersal capacity and that occur in extensive landscapes, because they must disperse over longer distances climate change will occur too quickly to allow natural migration or adaptation (SIAM and IPCC AR5), which places cork oak as a vulnerable species to climate change.

3.1 Elevated CO_2 Concentration and CO_2 Fertilization

Plants initial response to elevated CO_2 is to increase its carbon assimilation rate and decrease transpiration, or loss of water, due to partial stomatal closure, which would suggest more productivity and better water efficiency. However, research seems to indicate that the combined changes in temperature and precipitation in future decades will modify, and often limit, this direct effect of CO_2 on plants. Some experiments with trees grown under elevated CO_2 concentration (e.g. Medlyn et al. (1999) and Maroco et al. (2002)) show that biomass increase is not sustained over time and that the potential for CO_2 fertilization is not fully realized after long-term acclimation to elevated CO_2 (Figure 13). Furthermore the impacts on soil fertility and drought may overcome the potential benefits of CO_2 fertilization.

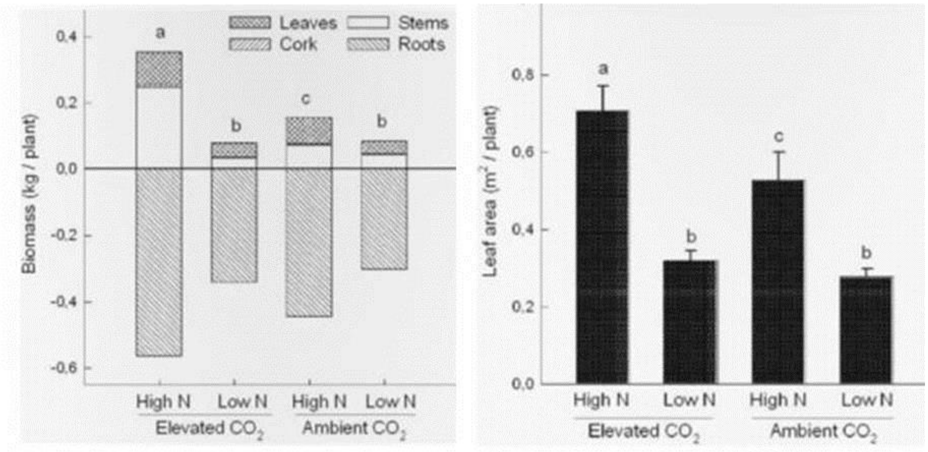


Figure 13: Effect of long term (4 year) exposure to elevated CO2 (700 ppm) and ambient CO2 (350 ppm) on (a) biomass accumulation and (b) leaf area cork under diferent nitrogen fertilization regime: higth N (8 mM) and low N (1 mM) in nutrient solution (source: original data in Maroco et al 2002)

These experiments show that the effect of increase CO_2 concentration, per se, may not be significant. In fact the net primary productivity (NPP) simulations, based on an "optimal" distribution of forest vegetation, suggested the opposite; i.e. a decrease in NPP in most countries due to the increasing water deficits (SIAM).

The irregular rainfall patterns that characterise the Mediterranean will become exacerbated by climate change which will increase not only the severity of plant water stress, cause overheating and damage in leaves, but also increase the rate of nutrient losses from soil (Aronson et al. 2009). All these factors combined seem to suggest a higher mortality of cork oak or at least a loss of primary productivity.

The effects of rising temperature on carbon balance on the cork oak may be negative, in summer, due to an increase in plant respiration relative to carbon uptake and assimilation and positive in autumn and winter, by reducing the limitations on photosynthesis related to low temperatures. A secondary flush of shoot growth in autumn may be stimulated (Aronson et al. 2009).

Additionally, climate change will also affect many limiting factors such as pests, weeds, competition for resources, soil, water and air quality, etc., which are neither well understood at large scale, nor well implemented in leading models. Plant physiologists and modellers alike recognise that the effects of elevated CO_2 measured in experimental settings and implemented in models may overestimate actual field and farm level responses (Tubiello and Ewert, 2002; Fuhrer, 2003; Karnosky, 2003; Gifford, 2004; Peng et al., 2004; Ziska and George, 2004; Ainsworth and Long, 2005; Tubiello et al., 2007a, 2007b).

Nadal-Sala et al. (2013) defends that some Spanish forests may start performing as a net carbon sources during the second half of this century, due to an increase in aridity, depending on the magnitude of the climate change projections considered. Furthermore, for the same reason, the relative amount of evapotranspiration will be also increased due to a rising atmospheric evaporative demand.

3.2 Increased frequency of forest fires and other extreme events

The frequency of extreme weather events such as windstorms, severe droughts or long hot spells will likely increase in the future (Grau et al. 2012). These extreme events, together with an increased meteorological risk of fire will enhance the risk of losses of productivity through tree mortality and subsequent land degradation (IPCC 2007).

Cork oak trees are notorious for their fire resistance. However, and despite that resistance, there is always some mortality associated with fire. Mortality rates may vary according to pre-fire tree density and tree health condition, fuel density and weather conditions at the time of fire (which to a large extent determine the energy released during the fire). I.e., increased fire frequency and/or intensity will inevitably lead to increased mortality.

In this scenario, and even if the recovery conditions are assured (by natural regeneration or artificial plantation), this increased mortality will probably result in a shift towards younger age classes. While not necessarily compromising the existence of cork oak forests *per se*, the death of older and larger trees and their replacement for seedlings may result in significant impacts in cork production.

Figure 14: Tree mortality in a burnt cork oak forest in Catalonia.
When fires are particularly intense, tree mortality can be very significant

Another relevant aspect to consider in relation to fires in Mediterranean forests is their role and impact in the dissemination of fire prone invasive species, like Acacia and Ailanthus. A more frequent fire regime will assist the dissemination of those species and the replacement of native ecosystems with simpler systems dominated by those species (Figure 15).

Figure 15: Acacia dealbata regeneration in a burnt cork oak forest in Catalonia

3.3 Effects on Communities and Ecosystems

Cork oak trees represent a key role in the ecological communities where they occur. Although not studied in depth, if they change their behaviour, they can cause a sequence of several effects at the community and ecosystem levels. For example, the ectomycorrhizal fungi communities, responsible for enhancing the acquisition of resources by cork oak trees, may change in response to drought and soil warming, modifying their function role in nutrient uptake (Aronson et al. 2009).

Change in temperature may also induce uncoordinated shifts in the phenology of interaction organisms. For example, the infection by pathogen fungi, as *Phytophthora cinnamon* (a major root disease agent that affects cork oak (Brasier 1996)) and *Armillaria mellea*, is favoured by warm and wet conditions (SIAM), this means that in Mediterranean area the risk of invasive pathogens may increase affecting the resilience of cork oak.

Figure 16: Decay of a Cork Oak Tree in Doñana National Park [11]

Climate change may also affect soil processes, so if in one hand the increase of temperature will increase microorganism's activity in winter, which promotes mineralization and increases nutrients available for the plants (Aronson et al. 2009), but, on the other hand, it also increases microorganism respiration and, as a consequence, accelerates rate of loss of soil organic carbon, i.e., induces a degradation of the soil due to loss of structure properties.

Climate change scenarios suggest an aggravation of environmental conditions for cork oak, namely increasing aridity with greater unpredictability of rainfall. Furthermore, the mid and high-range rates of projected climate change will cause limitations on the adaptation capacity of cork oak. Future climate scenarios seem to favour cork oak migration to higher latitudes and altitudes where it is not abundant today, so the key for the survival of cork oak is the adjustment of the broad geographic distribution. This can be engaged by new management practices and paradigms, such as suggested by Aronson et al. (2009) and Grau et al. (2012):

- Promote natural regeneration to allow genetic variability and the possible selection of drought-tolerant genotypes, as well as future evolution toward equilibrium with a new environment;
- Careful planning of plantation and selection of appropriate genotypes combined with natural regeneration to stimulate a stress avoidance migration;
- Provide corridors to prevent habitat fragmentation;
- Promote the health and vitality of cork oak;
- Forest management adapted to land use;
- Reduce fire risks;
- Diversify forest employment opportunities;
- Public support for cork oak woodlands.

Is also important to remember that adaptive forest management to climate change would help to increase water use efficiency by forests, as well as to maintain positives its carbon balances (Nadal-Sala, et al. 2013), reduction the impact of climate change.

[11] "Nowadays, two species of pathogenic oomycetes negatively affect the cork oaks in the Doñana National Park: *Phytophthora cinnamomi* and *Pythium spiculum*. The former species experienced a large expansion in the area in 2010, when the winter and the spring seasons were exceptionally humid. In this cork oak forest, there is a direct relationship between P. cinnamomi infection and tree decay and death." From http://www.irnase.csic.es/users/pajarera/home.html

4 Emissions and removals and Cork Oak Forest Products

From a climate change mitigation perspective, there are two characteristics of forest products (cork products included) that are relevant: (1) carbon in products; (2) substitution effect.

Carbon in products: Forest products are made from raw materials harvested from forests that contain carbon. This carbon was initially sequestered from the atmosphere. From that perspective, harvesting is not, in many cases, the end of life (emission) of that carbon. Cork products will effectively store their carbon for as long as they are in use, i.e., from a forest carbon storage perspective, our homes and offices act as an extension of forests themselves. In fact, that emission will still occur, but not at the time of harvest, but when the products end their life cycle and are either burned, e.g. for energy recovery from waste, or naturally decay, e.g. in landfills (Figure 17).

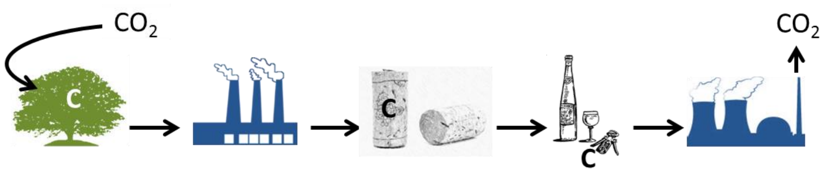


Figure 17: Illustration of Carbon Cycle in Forest Products
(in this example: cork stopper for use in wine bottle, with energy recovery of used cork)

Substitution effect: While some products can only be made from wood or other raw materials harvested from forests, many forest products compete with alternative materials that fulfil the same function, but originate in other raw materials, often of non-renewable origin. In this case, the mitigation advantage of using raw materials of forest origin exists only to the extension that the emissions associated with their production are lower than the emissions that result from the production of their competitor non-renewable materials (Figure 18).

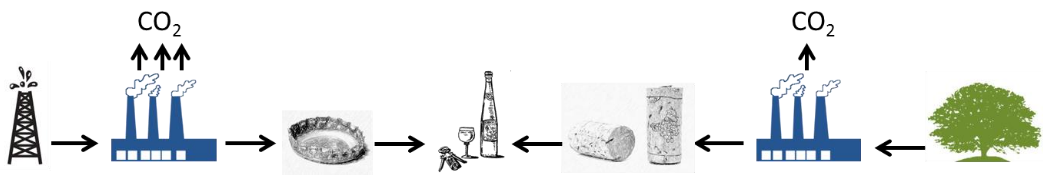


Figure 18: Illustration of the Substitution Effect in Forest Products
(in this example: aluminium cap and cork for the same function – sealing a bottle)

The role of Harvested Wood Products as carbon stocks has been recently recognised in the Kyoto Protocol LULUCF Accounting of emissions and removals, but so far no references to cork products have been made. In the context of REDD+, wood products are not – to date – considered explicitly. Section 4.1 attempts to quantify the carbon stored in products and estimate the implicit emissions and removals associated with it.

The substitution effect is harder to estimate and is not reported as such in the emissions inventories. However, some life cycle studies do compare the advantages of alternative products, including comparative estimations of greenhouse gas emissions. Section 4.2 highlights some of these studies addressing cork.

4.1 Carbon in Cork Products

Estimating how much carbon is contained in products in use is not easy, as there are no inventories of how much of each forest product is in our homes, offices, buildings, etc. However, it is usually possible to know the annual production of each product type.

To address these challenges, the IPCC has adopted an approach that estimates of how long a product will remain in use, after which the emission will take place. The concept is borrowed from other sciences and builds on half-life and simple decay functions to describe how much of the products produce in a given year are still in use in the years that follow. For example, if the half-life of a product is 20 years that means that 50% of all products produced in one year will still be in use after 20 years later. Longer half-lives mean that the products will emit their carbon later, while short lived products tend to release their carbon much sooner. Products with very limited half-lives (e.g. those used for bioenergy) are usually ignored in this type of analysis.

So far the IPCC has focused on wood products and thus it does not provide values of half-lives for cork products. However, all the rationale used to justify the inclusion of “Harvested Wood Products” in accounting is equally valid for cork products and so, it should be possible to expand the same methodologies to cork products.

Annual cork production has shown an upward trend from 1986 to 1999 (about 2,720 ton/year) followed by a downward trend since 1999 (about -5.362 ton/year), as shown in Figure 19.

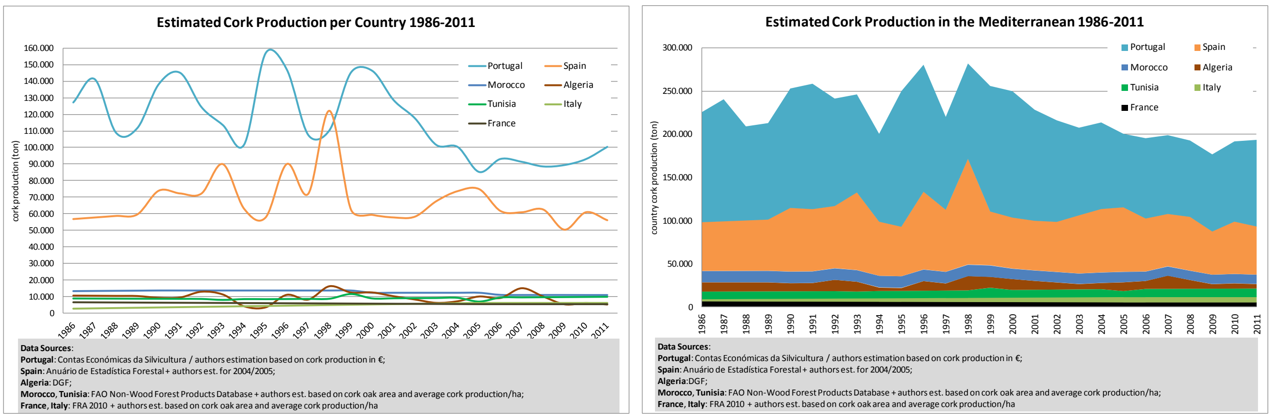


Figure 19: Estimated Cork Production in the Mediterranean

Although this gives an idea of the amount of material available for the production of cork products, these quantities are not usable directly to estimate the carbon sequestered in products. This is because cork is a raw material and only part of it ends incorporated in products. The remaining is used for energy production or is transformed into waste and should not be considered as carbon stored in products.

The available data from national statistics (through the industrial production statistics) is grouped in two categories: cork stoppers (Figure 20) and other cork products (Figure 21).

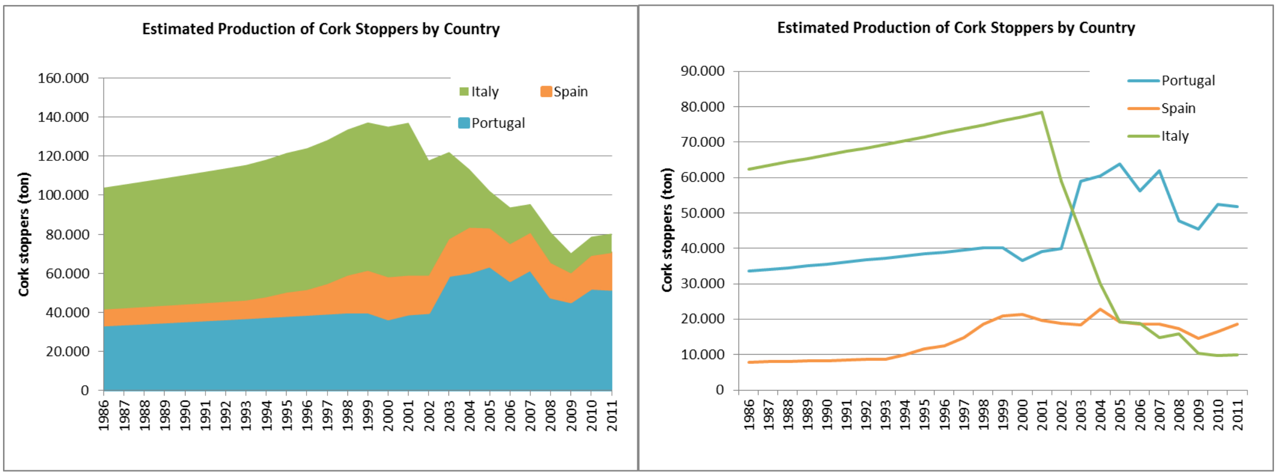


Figure 20: Estimated Production of Cork Stoppers by Country

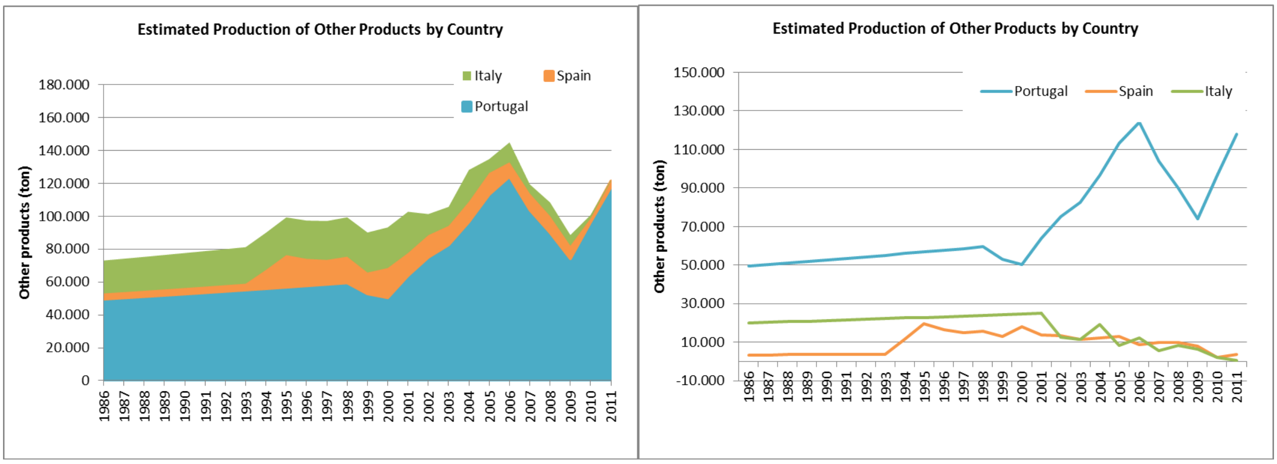


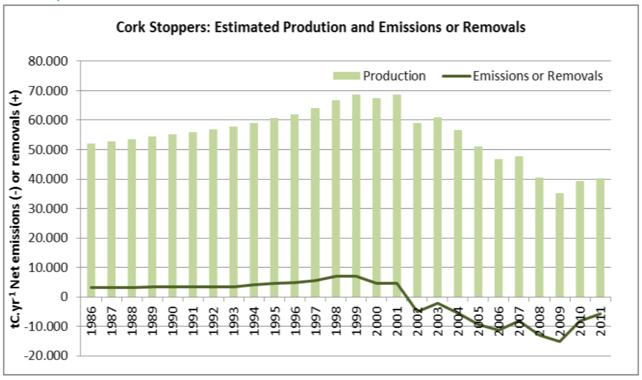
Figure 21: Estimated Production of Other Cork Products by Country

For the first category, since stoppers are expected to have a short live (comparable to paper), a half-life of 3 years is assumed. For the second category, we assume that products are used in buildings and construction, and, therefore, a half-life of 20 years is considered. The carbon stock of products is estimated accordingly to the IPCC guidelines.

Table 6: Available data on cork products

Country	Source	Year / Period
Italy	www.istat.it	2001 – 2011
Portugal	www.ine.pt	1998 – 2012
Spain	www.ine.es	1993 – 2012

The results obtained are presented in Figure 22 and Figure 23. According to these results cork products are, on average, sinks of carbon. Carbon emissions only take place for the year of 2009. This result is due to the drop in production that takes place since 2007. Although the drop affects both products, due to the much lower half-life time of stoppers, this product plays a more relevant role on results.



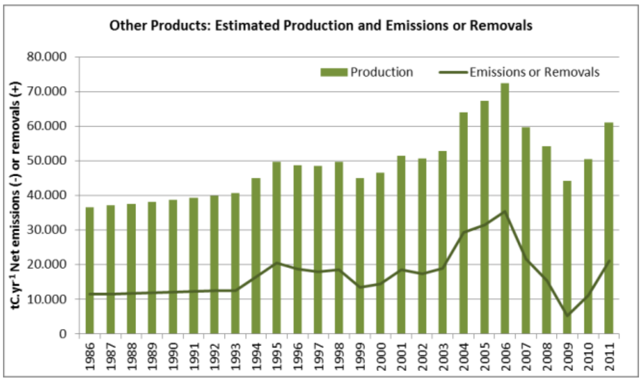


Figure 22: Annual Production of Cork Stoppers (left) and Other Cork Products (right) and Changes (emissions and removals) in the Corresponding Cork Products Pool

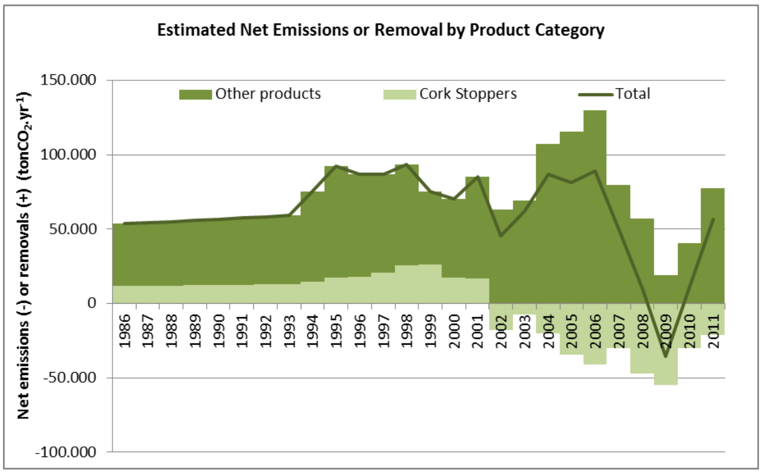


Figure 23: Emissions and Removals of CO2 Associated with Cork Products

4.2 Substitution Effect in Cork Products

As mentioned in the introduction to this chapter, the substitution effect is not reported as such in National GHG Inventories, nor does the IPCC provide methodologies for estimating it. However, if policies are introduced for substituting and using less emitting raw materials, the emissions inventory would implicitly capture the effect of those policies by reporting lower energy consumption. Therefore, one can argue that the impact of substitution is accounted for, even if it cannot be singled-out and quantified separately.

An alternative way of estimating the potential advantages of using forest based raw materials can be found in Life Cycle Assessment (LCA) studies, a methodology that allows for alternative materials with a similar function to be compared in relation to many environmental parameters, GHG emissions included. In this section we present the comparative analysis of cork products versus their non-cork substitutes, in terms of their impact on climate change.

As presented by the ISO 14040, Life Cycle Assessment (LCA) allows the analysis of environmental impacts of products (goods or services), from raw material acquisition to final disposal. This is done in a systematic way in accordance with the stated goal and scope, and including direct and indirect impacts.

As previously stated, the most emblematic product of cork is a cork stopper. However, cork stoppers can be substituted by both aluminium and plastic closures. Figure 24 a summary of LCA results presented in literature. For the interpretation of these results, it must be noticed that it is only accounted for the emissions of CO_{2eq} associated with the system, while potential CO_2 fixed as a consequence of cork oak forest is not considered in these results. The substitution of products occurs by wine stopper, and, therefore, the results are presented considering 1,000 wine stoppers as the functional unit.

From Figure 24 it is possible to conclude that aluminium stoppers are the ones with the higher burden, followed by the plastic and finally by the cork stoppers. The use of cork stoppers, instead of aluminium ones allows the saving of 23,576 gCO_{2eq} for each 1,000 stoppers (considering the most conservative difference). The use of cork stoppers, instead of plastic ones allows the saving of 1,237 gCO_{2eq} for each 1,000 stoppers.

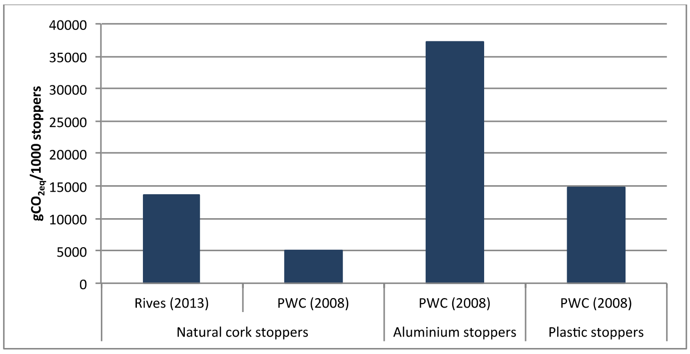


Figure 24: LCA literature review of cork stoppers versus plastic or aluminium alternatives

Combining the production data of cork stoppers with the carbon emission savings of PWC (2008) it is possible to conclude that the avoided emissions over the last 10 years associated with the use of natural cork stoppers are in the range of 254 thousand tons of CO_2 per year (if instead plastic stoppers had been used) and 830 thousand tons of CO_2 per year (if instead aluminium stoppers had been used).

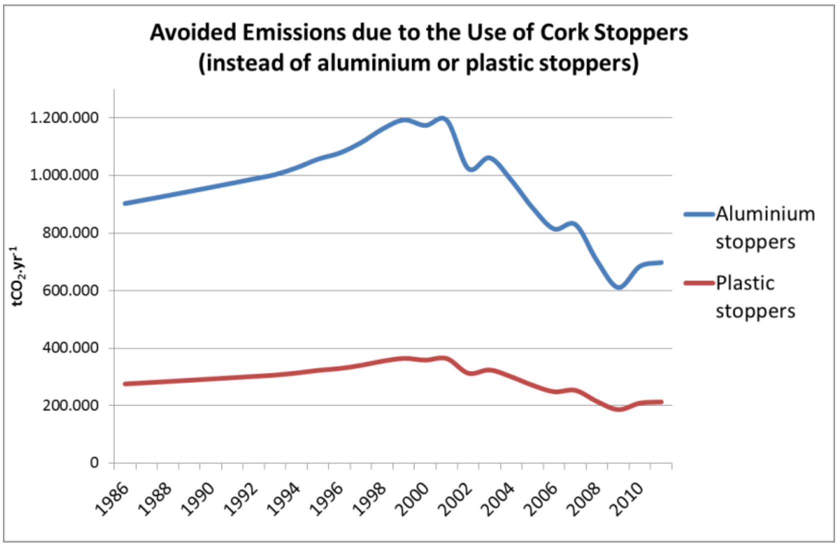


Figure 25: Avoided Emissions due to the Use of Cork Stoppers (instead of aluminium or plastic stoppers)

Regarding the use of cork as a building material, the use of cork as an insulation material, its use on wall and as a flooring material is analysed on the literature.

Bribián et al. (2011) presented a study regarding the impact of construction materials, namely for insulation materials. According to the obtained results (see Figure 26), the impact of conventional insulation with a high level of industrial processing – such as Expanded polystyrene (EPS) – is clearly higher than the impact of natural materials, such as cork, wood fibre and sheep's wool, or recycled ones such as cellulose fibre.

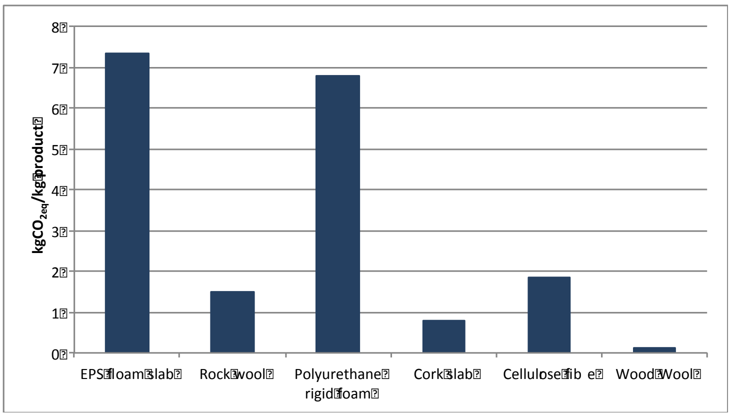


Figure 26: LCA literature review for the use of cork slab as an insulating material, versus its substitutes (Bribián et al., 2011)

La Rosa et al. (2014) performed an analysis aiming to find material solutions for building applications with low thermal conductivity and low environmental impacts. The four different systems presented on Figure 27 were considered.

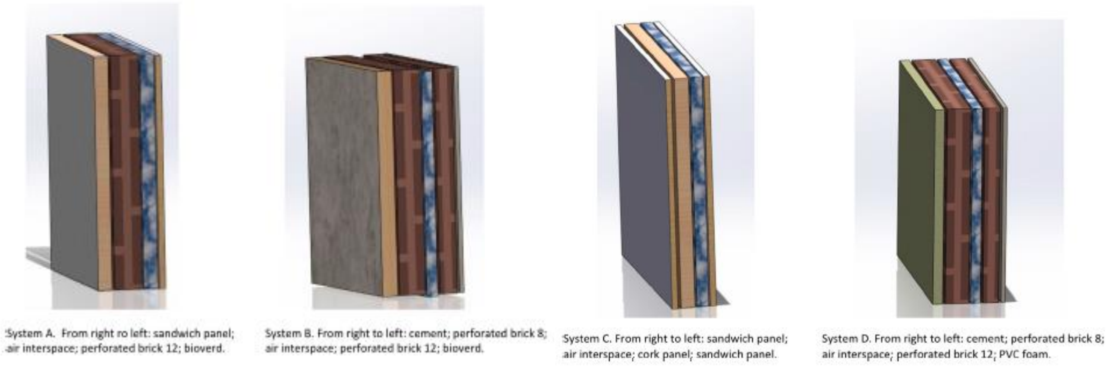


Figure 27: Graphical representation of the systems under analysis (from La Rosa et al., 2014)

The sandwich panel is composed of a Syfar cork core and Biotex; entropy resin as skin. The functional unit assumed was the mass of each sample, which can provide the same thermal resistance (System A: 115 kg; System B: 208 kg; System C: 38.8 kg; System D: 197 kg). The results presented by La Rosa et al. (2014) were limited to the product manufacture phase. According to the authors, if the transport to the building place would be considered, results might change. We added the simulation of 1,500 km transportation, with the final results presented on Figure 28.

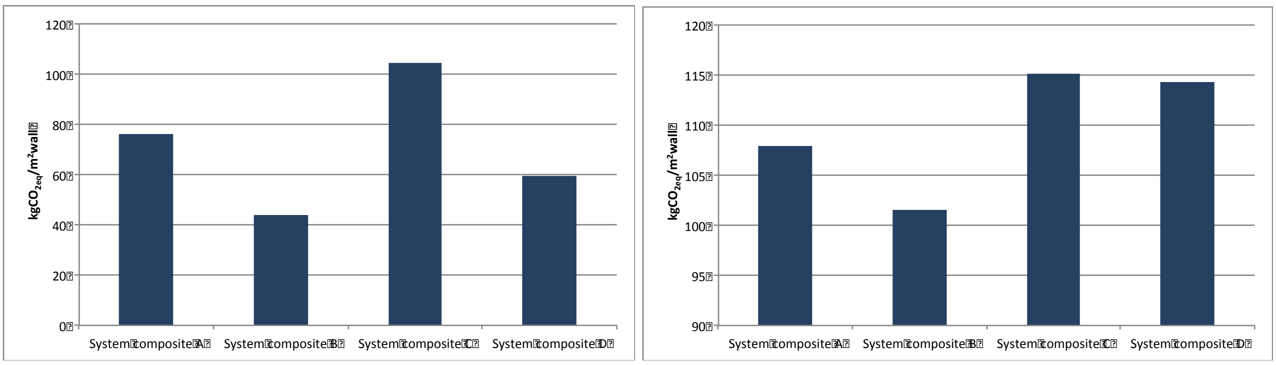


Figure 28: Graphical representation of the systems under analysis, without transportation (left) and including transport to the building site (right) (adapted from La Rosa et al., 2014)

The use of cork on linoleum floor covers was analysed by Gorrée et al. (2002). Linoleum is a floor covering consisting mainly of linseed oil, other vegetable oil, wood flour and limestone on a carrier of jute. According to Gorrée (2002), the substitution of wood by cork allows a decrease on the climate change impact by about 5%.

Quinones (2011) studied two floor covering alternatives, namely generic vinyl composition tile and natural cork floating floor plank. In this case study, the vinyl flooring was perceived as the conventional product, and the cork flooring as the alternative product. The functional unit for flooring products is 0.99 m^2, or 1 ft^2, for 50 years. The obtained results are presented in Figure 29.

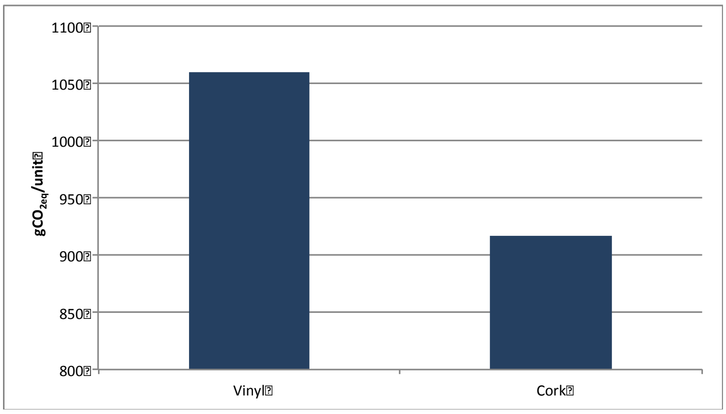


Figure 29: Vinyl versus cork flooring (Quinones, 2011)

5 The UNFCCC (Political) Landscape and Cork Oak Landscapes

The most recent IPCCC report on working group 1 (IPCC, 2013) confirmed two facts: (1) that climate change is already happening; and (2) that climate change is caused by man-made emissions.

These conclusions reinforce the importance and urgency to address emissions and removals in all human activities (mitigation of climate change) and the need to adapt to a change where and how human activities are carried out given the predictable changes in the climate (adaptation to climate change).

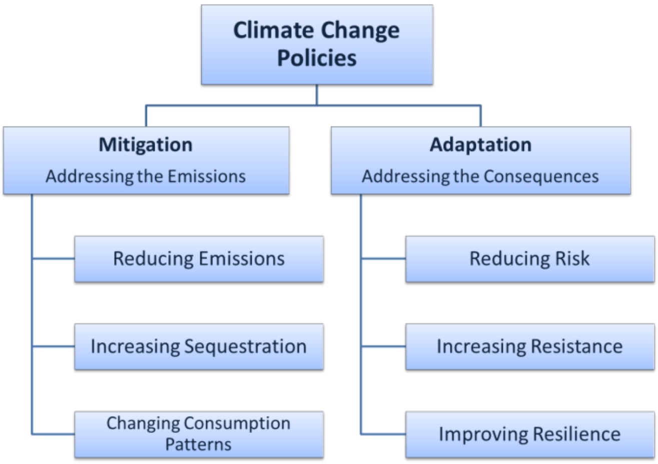


Figure 30: Strategies to Address Climate Change

Natural ecosystems, agriculture and forestry are considered key in both of these strategies. On the one hand, they can contribute to mitigation of climate change by:

- Adding carbon to the atmosphere (e.g. deforestation, forest degradation and illegal logging, fertilization, grazing, fires, etc.);
- Removing carbon from the atmosphere (e.g. carbon sequestration, afforestation, land restoration, etc.);
- Producing goods that compete and replace other products with different carbon intensities (e.g. product and energy substitution).

On the other hand, they are in the frontline of the systems that will be impacted by climate change itself and, therefore, require action to promote adaptation to climate change (e.g. impacts of droughts and irregular precipitation patterns, changes in frequency and intensity of forest fires, heat waves, etc.).

The United Nations Framework Convention for Climate Change (UNFCCC) establishes obligations of countries and opportunities for intervention in all these domains. The land sector is widely recognised as one sector where there is high potential for mitigation action, both in terms of sequestration of carbon dioxide and in terms of reducing emissions of carbon dioxide, methane and nitrous oxide. The sector may also be instrumental in energy substitution (biomass and liquid biofuels), in storing carbon in products (Harvested Wood Products) and in substituting more energy intensive materials. It is also a sector that is vulnerable to climate change and it is a sector under enormous pressure for meeting the demands of food, fibre and energy to cater to an ever growing global population. Finally, it is now widely recognised that deforestation and forest degradation are globally a very important source of emissions that need to be reduced if we are to be successful in dealing with climate change.

In this context, the UNFCCC has been calling on its Parties to reduce emissions and increase removals and has developed instruments and incentives to monitor emissions over time and to account for reductions in emissions. The architecture that evolved from this process has led to three main processes: the Kyoto Protocol; the Commitments for the period Pre-2020 (Cancun Agreements); the process to develop commitments for the period post-2020 (Paris 2015).

Following the principle of "common but differentiated responsibilities" (enshrined in the UNFCCC text), the instruments and agreements that were developed so far under the UNFCCC have always made a distinction between Annex 1 (containing the countries considered "developed countries" at that time) and non-Annex 1 countries. A group of non-Annex 1 countries is further specified as "Least Developed Countries" (LDC). In this context, Annex 1 countries are supposed to take the lead in reducing emissions and to provide support for non-Annex 1 countries, in particular to LDCs, to reduce emissions and/or to enhance adaptation.

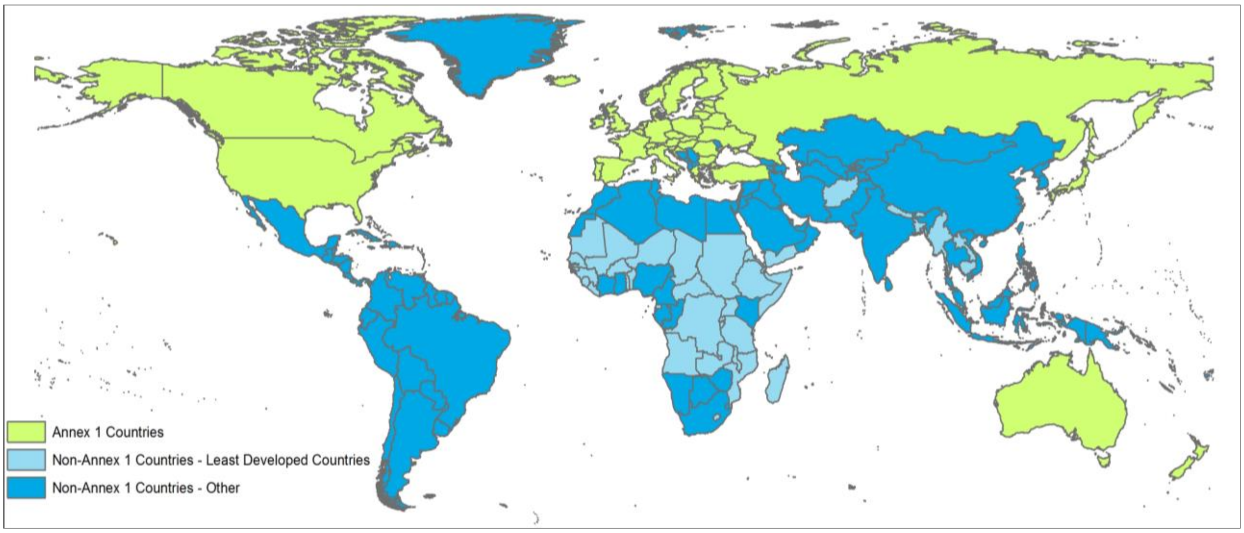


Figure 31: Map of UNFCCC Annex 1 and Non-Annex 1 Countries

When looking at the natural area of distribution of cork-oak forests and the listing of countries considered as Annex 1 and non-Annex 1, there is a clear divide between the northern (Annex 1 countries) and southern (non-Annex 1 countries) banks of the Mediterranean (see also Figure 31). Therefore the Commitments and Incentives for each of these groups of countries are different, as outlined in the sections below. Given the broad scope of application and complexities of each of those topics we will focus only on the topics and instruments that are relevant most for forests in general and cork-oak landscapes in particular.

5.1 The Kyoto Protocol

The climate change convention allows in its article 17 the establishment of additional protocols to further advance the implementation of the convention. So far, the Kyoto Protocol is the only Protocol that was agreed in this context. It establishes different obligations and commitments for Annex 1 and non-Annex 1 countries.

5.1.1 Annex 1 Countries (France, Italy, Portugal, Spain)

Under the Kyoto Protocol, only Annex 1 countries have quantified emission reduction commitments or targets. For the large majority of sectors, these commitments cover all emissions and removals that take place in the country during a “commitment period”[12]. The targets are expressed as percentage reductions in relation to the emissions in a base year (1990 for most countries). However, only part of the emissions and removals from the land sector are accounted for, using what is known as the Land-Use, Land-Use Change and Forestry (LULUCF) accounting rules.

The Kyoto Protocol rules for LULUCF were designed around the concept of “activities”. The KP and decisions 16/CMP.1 and 2/CMP.7 define two types of activities: mandatory activities (that all KP A1 Parties need to account for); and voluntary activities (that each Party may decide – or not – to elect for compliance). The list of voluntary activities for possible election is also pre-defined. The list and status of all mandatory and voluntary activities in use in each of the Commitment Periods is summarised in Table 7.

Table 7: Mandatory and Voluntary KP LULUCF Activities in the 1st and 2nd Commitment Periods

<table>
<tr><th>KP LULUCF Activities</th><th>KP</th><th>1st Commitment Period Status (2008-2012)</th><th>2nd Commitment Period Status (2013-2020)</th></tr>
<tr><td>Afforestation</td><td>Art. 3.3</td><td rowspan="3">Mandatory</td><td rowspan="4">Mandatory</td></tr>
<tr><td>Reforestation</td><td>Art. 3.3</td></tr>
<tr><td>Deforestation</td><td>Art. 3.3</td></tr>
<tr><td>Forest Management</td><td>Art. 3.4</td><td rowspan="4">Voluntary</td></tr>
<tr><td>Cropland Management</td><td>Art. 3.4</td><td rowspan="4">Voluntary
(Mandatory if elected in CP1)</td></tr>
<tr><td>Grazing land Management</td><td>Art. 3.4</td></tr>
<tr><td>Revegetation</td><td>Art. 3.4</td></tr>
<tr><td>Wetland Drainage & Rewetting</td><td>Art. 3.4</td><td>[non-existent]</td></tr>
</table>

The activities that are most relevant for cork oak forests are:

1. Afforestation and Reforestation;
2. Deforestation;
3. Forest Management.

[12] So far, only 2 commitment periods have been negotiated: 2008-2012 and 2013-2020

For ***afforestation, reforestation and deforestation*** all emissions and removals during the Commitment Period that occur on lands subject to the activity since 1990 are accounted (this rule is known as “gross-net”). Figure 32 illustrates the application of this rule for the case of afforestation and reforestation.

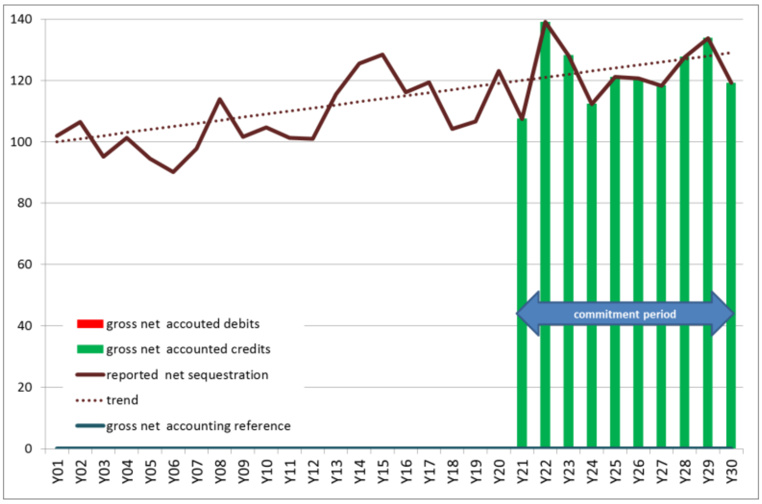


Figure 32: Illustration of the Application of Gross-Net: the accounting rule for afforestation and reforestation

For ***forest management*** only the difference between the emissions and removals that occur on lands subject to the activity in each year of the commitment period and an agreed reference level are accounted for. In addition to this basic accounting rule, other rules apply (in conjunction with the reference level) to forest management: limitation to the amount of credits that can be generated from this activity (the so called “cap”) to a level equal to 3.5% of Base Year emissions; requirement to include in accounting emissions and removals from harvested wood products (includes bark); and possibility to exclude emissions from natural disturbances under certain conditions.

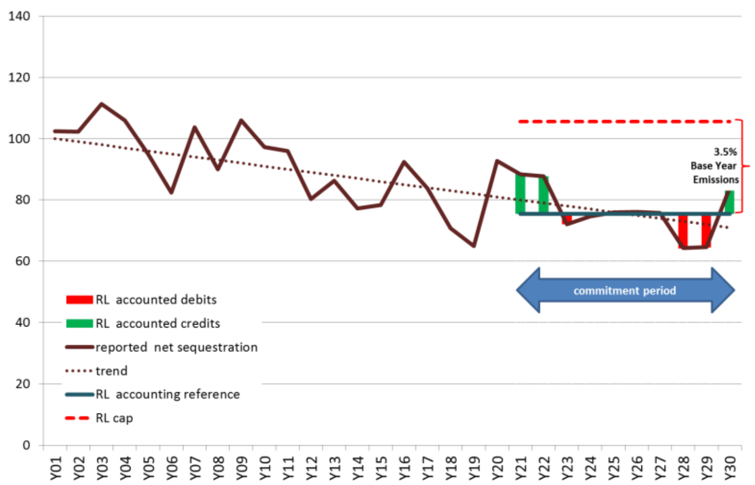


Figure 33: Illustration of the Application of Reference Level: the accounting rule for forest management

These accounting rules try to capture the emissions and removals that are “additional” to those considered in their reference level. For most countries (including France, Italy, Portugal and Spain), the reference level represents a BAU scenario of expected level of emissions and removals during the second Commitment Period. However, the number presented as “reference level” and inscribed in Decision 2/CMP.7, is an aggregated number for the whole forest area in these countries and it is not possible isolate the exact contribution of cork oak forests to that number (although they are implicitly included in the total).

Even so, the accounted emissions and removals in cork oak forests will result from a comparison between the expected emissions and removals in those areas and their actual emissions and removals during the commitment period (2013-2020).

5.1.2 Non-Annex 1 countries (Algeria, Tunisia, Morocco)

As mentioned already above, non-Annex 1 countries don’t have quantified emission limitation commitments under the Kyoto Protocol. However, the KP has enabled these countries to participate in the carbon market that was created together with the Protocol, through a mechanism called the “Clean Development Mechanism”.

The Clean Development Mechanism is a flexible mechanism established by the Kyoto Protocol which allows an annex 1 Party to partly meet its emission reduction target by investing in emission reductions in a project implemented in a developing country Party, while contributing to the host Party’s sustainable development objectives.

CDM projects can be carried out on all sectors, but so far the only LULUCF activities eligible under the clean development mechanism are projects of afforestation and reforestation (AR CDM). A negotiation process is ongoing trying to identify other activities that might (if accepted by all Parties) become available for application during the second commitment period (2013-2020). A project is generally eligible under the CDM if the implemented activity results in an emission reduction additional to what would happen in the absence of the project.

Therefore, the only activity relevant for cork oak forests is:

1. Afforestation and Reforestation CDM;

For ***afforestation, reforestation CDM*** only the difference between the emissions and removals that occur on lands subject to the activity in each year of the commitment period and a pre-defined baseline are accounted for. This accounting rule tries to capture the emissions and removals that are “additional” to those considered in their baseline. Baselines are defined as “emissions that would have occurred in the absence of the project activity”.

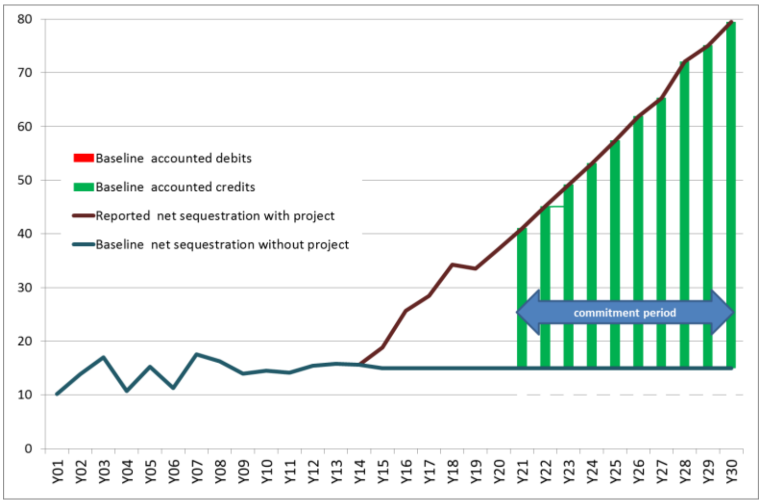


Figure 34 Illustration of the Application of Baseline: the accounting rule for afforestation and reforestation clean development mechanism projects

So far, 55 Afforestation and Reforestation CDM projects have been registered in the world[13], but none of them is being implemented in Algeria, Tunisia or Morocco, i.e., there are no CDM Afforestation projects targeting cork oak forests.

5.2 The Cancun Agreements

In 2007, a negotiation process to develop emission reduction commitments for the period 2013 to 2020 was launched (Bali Roadmap). As some Parties to the Convention were not signatories of the Kyoto Protocol, a need was felt to design a more flexible instrument to allow the integration of all countries in a mitigation framework of some sort. This process was therefore conducted in 2 tracks: the Kyoto Protocol Track; the LCA (Long Term Cooperative Action) track. The LCA further discussed and agreed mitigation actions by both developed and developing countries.

The results of these negotiations were eventually captured as the Cancun Agreements that set out commitments for these two tracks. The consequences for the countries in the cork oak distribution area are outlined in the sections below.

5.2.1 Annex 1 Countries that ARE also Parties to the Kyoto Protocol (France, Italy, Portugal, Spain)

For this group of countries, the emission reduction commitments and activities that are relevant for the cork oak forests are the same as those outlined above in section 5.1.1.

5.2.2 Annex 1 Countries that ARE NOT Parties to the Kyoto Protocol

As there are no countries of this group in the cork oak distribution area, this section is not elaborated further.

[13] http://cdm.unfccc.int/Projects/projsearch.html

5.2.3 Non-Annex 1 countries (Algeria, Tunisia, Morocco)

For non-Annex 1 countries there are two instruments that were created with the Cancun Agreements and that are relevant for cork oak forests, known by their acronyms: NAMA and REDD+.

5.2.3.1 NAMA

NAMA is acronym used for "Nationally Appropriate Mitigation Actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner".

The UNFCCC has provided some guidance on how to define and implement NAMAs, but in much less stringent terms than those used for LULUCF or REDD+. The general objective is to enhance national action by non-Annex 1 Parties in mitigating climate change by achieving a deviation in emissions relative to a "business as usual" emissions scenario in 2020.

In the official decisions related to NAMA, there are no specific references to forests or to LULUCF, but the sector is implicitly included in the spectrum of possible activities to be carried out by non-Annex 1 Parties. Given the similarities between the architecture of both REDD+ and NAMA, some countries even consider REDD+ as a special type of NAMA.

Moreover, the list of all proposed NAMA has been growing over time, although, due to the variable level of detail provided, it is not easy to perform one-on-one comparisons between the individual proposals or even, in some cases, fully understand the activities that are being proposed. An attempt to standardise the information submitted by Developing Country Parties is contained in the NAMA Registry that has been recently created, but so far only 52 NAMAs have been registered using this tool[14].

For the countries in the cork oak area, the NAMAs which may apply to cork oak forests (depending on the specificities of the design of the measures that are not available) include[15]:

- Algeria has made no reference to the land or forest sector,
- Morocco proposed the following NAMAs which may apply to cork oak forests:
    - Reforestation according to the National Reforestation Plan adopted in 1994, which carries out reforestation of 50,000 ha/year until 2013, and which will reforest 1 million ha by around 2030
    - Protection of forest from fire by implementing a permanent Fire Prevention and Fire-fighting Plan, adopted in 2003
- Tunisia proposed the following NAMAs which may apply to cork oak forests:
    - Energy production from biomass
    - Increasing the forest cover rate from 12.8% in 2009 to 16% in 2020 by ensuring 250,000 ha of forest and pastoral tree planting at a rate of 27,000 ha annually, starting from 2012
    - Increasing the percentage of natural reserves from the total forest area from 17% in 2009 to 20% in 2014, by creating and rehabilitating 20 new natural reserves in forest areas

[14] According to the NAMA Registry http://www4.unfccc.int/sites/nama/SitePages/Home.aspx. Retrieved 20th August 2014. The 52 NAMAs were recorded in the following categories: 14 NAMAs seeking support for preparation; 32 NAMAs seeking support for implementation; 4 "other" NAMAs (for recognition); 2 Supported NAMAs. There are no records from Algeria, Morocco or Tunisia in the database.

[15] According to FCCC/SBI/2013/INF.12/Rev.2

The implementation of NAMAs will be reported as part of the Biennial Update Reports, the first of which is due in December 2014, as so it not possible at this point in time to evaluate progress in implementing those NAMAs.

5.2.3.2 REDD+

REDD+ is the acronym used for "Reducing Emissions from Deforestation and Forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".

Like LULUCF under the Kyoto Protocol, REDD+ is organised around the concept of "activities" that contribute to reducing emissions and/or increasing removals in the forest sector. Five activities[16] have been identified that contribute to this objective:

1. Reducing emissions from deforestation;
2. Reducing emissions from forest degradation;
3. Conservation of forest carbon stocks;
4. Sustainable management of forests;
5. Enhancement of forest carbon stocks.

REDD+ is supposed to be "results-driven", meaning a country implementing REDD+ should be able to demonstrate by how much it has reduced its emissions, compared to an expected path of emissions. Due to the complexity of measuring these "results", it was further determined that these activities are to be implemented in 3 phases: (1) development of national strategies or action plans, policies and measures, and capacity-building; (2) implementation of national policies and measures and national strategies or action plans and results-based demonstration activities; (3) results-based actions that should be fully measured, reported and verified.

Any non-Annex 1 country may choose to engage in any subset of the five REDD+ activities, at any point in time and at the phase that best corresponds to the level of knowledge of the sector. "Results" are measured by comparing reported emissions and removals with a reference level, an "accounting" approach similar to the one used for Forest management under the KP (Figure 35).

[16] The Cancun Agreements (UNFCCC Decision 1/CP.16)

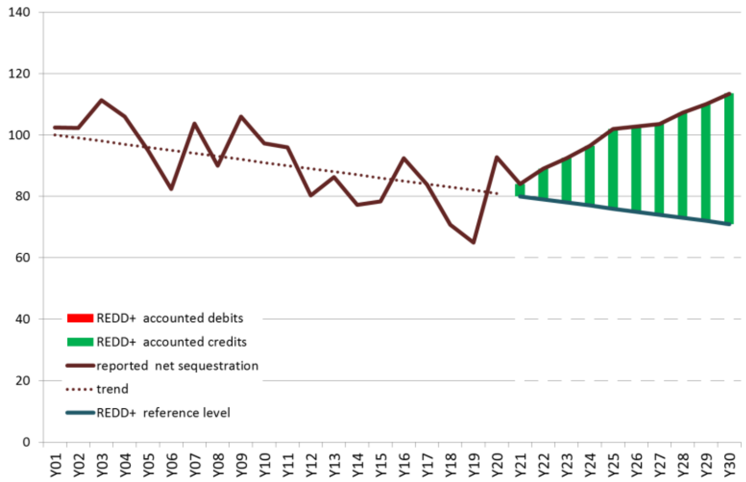


Figure 35 Illustration of the Application of REDD+ Reference Level: the "accounting" rule for reducing emissions from deforestation and forest degradation

The UNFCCC also elaborated on the information requirements of REDD+, which can be summarised as follows:

1. A national strategy or action plan (addressing, i.a., drivers of deforestation and forest degradation, land tenure, forest governance, gender and safeguards)
2. A national (or subnational) forest reference emission level or forest reference level.
3. A robust and transparent national (or subnational) forest monitoring system that should:
    a. Build upon existing systems
    b. Enable the assessment of different forest types, including natural forest
    c. Be flexible and allow for improvement
4. A system to provide information related to environmental and social safeguards

The UN-REDD Programme is the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally-led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in national and international REDD+ implementation.

To-date, the UN-REDD Programme's Policy Board has approved a total of US$67.8 million for National Programmes in 21 countries. These funds support the development and implementation of National REDD+ Strategies. In addition to this group of countries, "other partner countries" are also engaged in the process. "Other partner countries" can benefit from unique knowledge sharing opportunities, facilitated through UN-REDD Programme events and the Programme's online collaborative workspace. Partner countries can also receive targeted support from the UN-REDD Programme, in particular for readiness processes. These countries also have observer status at UN-REDD Programme Policy Board meetings, and may be invited to submit a request to receive funding for a National Programme in the future, if selected through a set of criteria to prioritize funding for new countries approved by the Policy Board.

For the countries in the cork oak area, involvement in the REDD+ process is relatively recent and Morocco and Tunisia currently have the status of "other partner countries" in the UN-REDD Programme. Algeria is not yet formally involved in the programme.

Figure 36: Map of Countries Participating in UN REDD Programme17

5.3 The ADP Process and the Paris Agreement

More recently, a new body under the UNFCCC was established: the "Ad Hoc Working Group on the Durban Platform for Enhanced Action" (ADP). Its mandate is to negotiate a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties. The ADP needs to be completed no later than 2015 (COP 21 in Paris), for it to come into effect in 2020.

What is perhaps the biggest "novelty" of the ADP (compared with its predecessor, the Kyoto Protocol) is that it has to develop its work under different premises than those that were in effect when its predecessor, the Kyoto Protocol, was adopted. While the Kyoto Protocol was fundamentally targeting action by Developed Countries (listed in Annex 1), the preamble of decision 1/CP.17 emphasizes the need for action by all Parties:

> ***"Recognizing that climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires to be urgently addressed by all Parties, and acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions"***

Therefore, in an "ADP World" all Parties (developed and developing) are expected to contribute to the emission reductions that are required to keep climate change under manageable levels, reflecting the different contributions to climate change and the different capacities to undertake emission reductions.

The ADP is also expected to take into account the results of the decisions that took place since Copenhagen, inter alia, the issues now have more prominence (in comparison to when the Kyoto Protocol was first negotiated). These "new issues" include adaptation, REDD+, technology transfer, capacity building and financing. In conclusion, everything points to a situation where the ADP negotiations will be, both technically and politically, more complex than the KP negotiations.

[17] http://www.un-redd.org/Partner_Countries/tabid/102663/Default.aspx consulted 21/08/2014

So far the negotiations on how the Land Sector is to be integrated in the "targets" of the new agreement haven't yet begun, and so it is not possible to assess the implications for cork oak forests.

5.4 Adaptation under the UNFCCC

5.4.1 National Adaptation Programmes of Action

In 2001 a Least Developed Countries work programme, that included National Adaptation Programmes of Action (NAPA), was created to support Least Developed Countries to address the challenge of climate change given their particular vulnerability. A Least Developed Countries Fund (LDCF) was also established to fund the preparation and implementation of NAPAs and an LDC Expert Group to provide technical support and advice to the least developed countries (LDCs).

There are no Least Developed Countries in the cork-oak distribution area (see Figure 31) and so this topic is not explored further in this report.

5.4.2 Nairobi work programme on impacts, vulnerability and adaptation to climate change

The Nairobi work programme (NWP) was established in 2005 as a mechanism to facilitate and catalyse the development and dissemination of information and knowledge that would ultimately inform and support the development of adaptation policies and practices.

Its objective is to assist all Parties, in particular developing countries to improve their understanding and assessment of impacts, vulnerability and adaptation, and to make informed decisions on practical adaptation actions and measures to respond to climate change on a sound, scientific, technical and socioeconomic basis, taking into account current and future climate change and variability. The implementation of the programme may include:

a) Organisation of workshops and meetings;

b) The drawing on the knowledge, expertise and input from experts, practitioners and relevant organizations;

c) The building on and/or updating of relevant existing information resources;

d) Targeted submissions, including those based on questionnaires, from Parties and organizations;

e) Reports and technical papers, assessments prepared by the secretariat, Convention expert groups or experts from other organizations;

f) Other modalities, such as a group or groups of experts, upon agreement by the SBSTA.

5.4.3 Cancun Adaptation Framework

Parties adopted the Cancun Adaptation Framework (CAF) as part of the Cancun Agreements in 2010. These agreements affirmed for the first time that adaptation must be addressed with the same level of priority as mitigation.

The objective of the Cancun Adaptation Framework is to enhance action on adaptation, including through international cooperation and coherent consideration of matters relating to adaptation under the Convention. Ultimately enhanced action on adaptation seeks to reduce vulnerability and build resilience in developing country Parties, taking into account the urgent and immediate needs of those developing countries that are particularly vulnerable.

According to the Decisions adopted to date, the CAF includes:

- An obligation for all Parties to plan, prioritize and implement adaptation actions and to use existing channels to provide information on support provided and received for adaptation actions and on activities undertaken;
- A process for developing countries – building upon the experience of Least Developed Countries with the NAPAs – to formulate and implement national adaptation plans;
- A mechanism to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change[18].

5.4.3.1 National Adaptation Plans

The national adaptation plan (NAP) process is a means for Developing Countries to identify medium and long-term adaptation needs and to develop and implement strategies and programmes to address those needs. In general terms, the objectives of the NAP process[19] are:

1. To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience;
2. To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels.

The NAP process for Least Developed Countries (LDC) will be supported through various modalities. Developing countries which are not LDCs are invited to employ the same modalities in the elaboration of their own planning efforts.

The following modalities to support the NAP process were agreed:

- Technical guidelines for the national adaptation plans;
- Workshops and expert meetings;
- Training activities;
- Regional exchanges;
- Syntheses of experiences, best practices and lessons learned;
- Technical papers;

[18] This mechanism – the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts – was only adopted in 2013, following a negotiation process decided in Cancun.
[19] See Decision 5/CP.17
https://unfccc.int/files/adaptation/cancun_adaptation_framework/national_adaptation_plans/application/pdf/decision_5_cp_17.pdf

- Technical advice.

5.4.3.2 Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (Loss & Damage Mechanism)

The Loss & Damage (L&D) Mechanism was agreed in 2013 and aims to address losses and damages associated with impacts of climate change, including extreme events (such as hurricanes, heat waves, etc.) and slow onset events (such as desertification, sea level rise, ocean acidification, etc.) in developing countries that are particularly vulnerable to the adverse effects of climate change.

The L&D Mechanism will promote the implementation of approaches to addresses loss and damage in three ways:

1. Enhancing knowledge and understanding of comprehensive risk management approaches;
2. Strengthening dialogue, coordination, coherence and synergies among relevant stakeholders;
3. Enhancing action and support, including finance, technology and capacity–building.

An initial 2-year work plan for the implementation of the L&D Mechanism will be developed during the course of 2014.

6 Climate and Carbon Finance

6.1 Carbon Markets

6.1.1 Compliance Markets

The **Clean Development Mechanism (CDM)**, allows projects in developing countries to generate credits that can be used for compliance by Annex 1 Parties that have targets under the Kyoto Protocol.

The **European Union's Emission Trading Scheme (EU-ETS)**, is the largest compliance market in the world. However it is restricted to large energy and industrial companies and, therefore, does not allow the participation of forest or land based projects. It allows the use of a limited amount of CDM credits for companies to comply with their targets, but excludes credits of the forest sector for this purpose.

6.1.2 Voluntary Markets

In the much smaller, voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use, and other sources. For example, an individual might purchase carbon offsets to compensate for the greenhouse gas emissions caused by personal air travel. Many companies offer carbon offsets as an up-sell during the sales process so that customers can mitigate the emissions related with their product or service purchase (such as offsetting emissions related to a vacation flight, car rental, hotel stay, consumer good, etc.).

A wide range of participants are involved in the voluntary market, including providers of different types of offsets, developers of quality assurance mechanisms, third party verifiers, and consumers who purchase offsets from domestic or international providers. Suppliers include for-profit companies, governments, charitable non-governmental organizations, colleges and universities, and other groups. By 2012 forestry and land-use related projects amounted to 32% of the volume of voluntary credits sold worldwide.[20]

The **Verified Carbon Standard (VCS)**, is the biggest voluntary carbon market operator. Projects from around the world are eligible. Projects in the forest and land sector may fall under one of the following categories: Afforestation, Reforestation and Revegetation (ARR); Agricultural Land Management (ALM); Improved Forest Management (IFM); Reduced Emissions from Deforestation and Degradation (REDD); Avoided Conversion of Grasslands and Shrublands (ACoGS); Wetlands Restoration and Conservation (WRC); Jurisdictional and Nested REDD+ (JNR).[21]

Under the **Gold Standard**, projects in the forest and land sector may fall under one of the following categories: Afforestation/Reforestation; Improved Forest Management; Climate Smart Agriculture.[22]

[20] http://www.forest-trends.org/documents/files/doc_3846.pdf
[21] http://www.v-c-s.org/
[22] http://www.goldstandard.org/luf

The **Climate, Community and Biodiversity (CCB)** standards try to identify projects that deliver net positive benefits for climate change mitigation, for local communities and for biodiversity. This certification works in combination with other standards (for carbon only), like the VCS.

The **American Carbon Registry (ACR)** operates both in the voluntary carbon market and in California cap-and-trade programme. Projects from around the world are eligible. Projects in the forest and land sector may fall under one of the following categories: improved forest management (US Forest only); afforestation and reforestation of degraded lands; REDD avoiding planned deforestation; afforestation and reforestation (CDM).

The **Climate Action Reserve (CAR)** is a voluntary carbon market registry that operates in the USA and Mexico only. In the forest and land sector projects may fall under one of the following categories: reforestation, improved forest management, and avoided conversion projects.

The **Carbon Farming Initiative (CFI)** allows farmers and land managers in Australia to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land. In the forest and land sector projects may fall under one of the following categories: reforestation and afforestation; regeneration of a permanent even-aged native forest; native forest from managed regrowth; native forest protection (avoided deforestation); permanent environmental plantings of native species; permanent plantings of native mallee eucalypt species; reduction of greenhouse gas emissions through early dry season savanna burning.

6.2 Other (non-market) climate funding

6.2.1 General

The **Green Climate Fund** was recently created by the UNFCCC with a view to "promote the paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change, taking into account the needs of those developing countries particularly vulnerable to the adverse effects of climate change". The fund is still being designed, but it will probably have a mitigation and adaptation window. Under mitigation, action on NAMAs and REDD+ will likely be eligible. The World Bank will serve as interim trustee for the Fund. Around 37M USD have already been deposited in the GCF.[23]

6.2.2 REDD+

The **UN-REDD Programme** is a collaborative initiative that builds on the technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). Launched in 2008, its mission is "to support countries' efforts to reduce emissions from deforestation and forest degradation through national REDD+ strategies that transform their forest sectors so as to contribute to human well-being and meet climate

[23] http://www.gcfund.org/home.html

change mitigation and adaptation aspirations". Around 248M USD have been committed by different countries to this programme, and 98M USD have already been used by the participating organisations[24].

The **Forest Carbon Partnership Facility** is a global partnership of governments, businesses, civil society, and Indigenous Peoples focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries (activities commonly referred to as REDD+). The World Bank assumes the functions of trustee and secretariat. The World Bank, the Inter-American Development Bank and United Nations Development Programme are Delivery Partners under the Readiness Fund and responsible for providing REDD+ readiness support services to distinct countries. It runs a "readiness fund" to support tropical and sub-tropical developing countries in preparing themselves to participate in a future, large-scale, system of positive incentives for REDD+ and a "carbon fund" that will pilot incentive payments for REDD+ policies and measures in approximately five developing countries. Around 355M USD have been committed to this facility, and 101M USD have already been used by the participating organisations [25].

The **Global Environment Facility** finances projects addressing forest conservation and management in developing countries. Forest projects and initiatives have received from GEF over 1.6 billion USD since 1991. The GEF has further strengthened its commitment to REDD+ financing for the period 2010-2014, where under the objective 5 of the **Global Environment Facility Climate Change Mitigation Strategy**, 50M USD (plus $100 million contributed to SFM) have been allocated to "promote conservation and enhancement of carbon stocks through sustainable management of land use, land-use change, and forestry"[26]

The **REDD+ Partnership** serves as an interim platform for its partner countries to scale up actions and finance for initiatives to reduce emissions from deforestation and forest degradation (REDD+) in developing countries.

6.2.3 Adaptation

The **Special Climate Change Fund** was established by the UNFCCC to support adaptation and technology transfer in all developing country parties to the UNFCCC. The Global Environment Facility is the trustee of the Fund. Around 202M USD have already been spent on adaptation projects.[27]

The **Adaptation Fund** was established by the UNFCCC to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change. The fund is financed from the share of proceeds on the clean development mechanism (CDM) project activities and other sources of funding. The share of proceeds amounts to 2% of certified emission reductions (CERs) issued for a CDM project activity. Up to December 2012, around 340M USD had been allocated to this fund, from which 198M USD have already been assigned to specific adaptation projects.

[24] http://mptf.undp.org/factsheet/fund/CCF00?fund_status_month_to=&fund_status_year_to=2014
[25] https://www.forestcarbonpartnership.org/
[26] http://www.thegef.org/gef/CC_mitigation_strategy
[27] http://www.thegef.org/gef/SCCF

The **Global Environment Facility Strategy to Combat Land Degradation**, specifically desertification and deforestation, takes into account emerging issues for SLM in rural production landscapes, such as: management of competing land uses and resulting changes to secure ecosystem services; managing the exploitation of natural resources to balance short-term economic gains with the need for ecological and social sustainability; adaptation to climate change and potential for mitigation through reduced emissions and carbon sequestration.

7 Measures to Improve the Climate Performance of Cork Oak Landscapes

Ultimately, either to mitigate climate change or to adapt to changes in climate, there will have to be changes in the way we manage cork oak landscapes and how we promote and use its products.

In this section we will list some possible actions to improve the current and future performance of cork oak forests in relation to climate change. The actual measure to implement will vary with forest site conditions and the drivers of emissions and potential for sequestration that are most relevant for each site.

7.1 Adaptation Measures

A list of possible adaptation measures is contained in Table 8.

Table 8: List of adaptation measures in cork oak forests

Climate Impact	Adaptation measures
More water stress, longer periods of drought	• Improve soil protection • Promote soil organic matter (e.g. less tillage, cover crops) • Identify and promote drought resistant genotypes (genetic improvement?) • Irrigate young plantations • Allow natural migration (e.g. ecological corridors) to on higher altitudes (active planting?) • Monitor cork production and adjust cork extraction cycles to actual cork production rates
Increased fire risk and fire frequency and intensity	• Improve and increase frequency of preventive silviculture measures • Improve fire detection and combat capacity • Control invasive species (e.g. acacia)
More intense rainfall	• Improve soil protection
Changes in pest & diseases behaviour	• Study pest behaviour • Improve capacity to detect and combat pests and diseases

7.2 Mitigation Measures

A list of possible adaptation measures is contained in Table 9.

Table 9: List of mitigation measures in cork oak forests

Carbon Pool	Mitigation measures
Living biomass	• Promote afforestation (bearing in mind future climate conditions) • Identify and combat causes of forest degradation and deforestation • Increase frequency of fire prevention management actions • Monitor and, when necessary, act on pests and diseases • Promote forest regeneration and a balanced age class distribution • Promote good practices in cork extraction to limit damages to trees and the proliferation of pests and diseases
Soil and Litter	• Avoid tillage to the extent possible and/or reduce tillage intensity • Combat overgrazing by domestic and/or wild animals • Promote full and permanent coverage of the soil • Promote soil productivity and accumulation of soil organic matter

7.3 Promote the use of cork as a climate-friendly material

Cork products can usually be used as a more climate friendly material than other materials that may fulfil the same function. This “substitution effect” should be communicated to the public, so that their choices as final consumers may reflect that fact.

Increased consumption of these products would also maintain or increase the economic interest in cork production and, implicitly, have an impact in the conservation and expansion of cork oak forests.

7.4 Knowledge is important for decision making

Produce a (at least 20 years) consistent time series of area covered in Cork Oak Forests, including identification of gross-afforestation and gross-deforestation. Develop the basic knowledge to be able to estimate emissions and removals in all carbon pools, sources and sinks, using IPCC methodologies.

Identify areas of cork oak forests were the carbon density is decreasing and areas where it is increasing. Identify also the drivers for those carbon dynamics, as these will be relevant to identify possible needs to introduce regulatory or management changes. It may also allow the identification of good practices to be further promoted and disseminated.

Try to identify the pressures and drivers of deforestation and the needs and constraints to promote further afforestation.

Promote research: to further develop management practices to improve the efficiency of fire prevention and combat; to cost-effectively monitor and combat pests and diseases; to promote natural regeneration in forests that are extensively grazed; to cost-effectively monitor and combat invasive species; to maintain or increase cork quality.

7.5 Make an efficient use of climate related finance

Many of the recommendations for climate friendly mitigation and adaptation practices make sense on their own. However climate finance may have a pivotal role to foster large scale management changes, as it can be used to:

- provide financial viability to alternative practices, e.g. replacing “bad” (but profitable) practices with climate friendly ones;
- cover losses associated with temporary restrictions to current practices, e.g. excluding grazing until soils or forest densities recover
- overcome non-financial barriers, e.g. training and capacity building to cover knowledge and information gaps;
- overcome resistance to innovation, e.g. provide an incentive to change practices that have been common in a certain region for extensive periods of time;
- finance external and specialized input into designing better and locally adapted practices;
- finance the information and monitoring system to measure the costs and the climate benefits introduced by the measures

As elaborated in chapter 6 above a number of funds and financial instruments are available both for mitigation and for adaptation.

Climate finance is available in multiple formats and can be mobilised for different purposes, but ultimately they may all converge to promote better forest management:

- REDD+ finance can be used to finance capacity building and “reward” emission reductions in forest landscapes (non-A1 countries)
- NAMA finance can be used to finance climate mitigation resulting from activities that reduce emissions or increase sequestration in the forest, agriculture and grazing sectors (non-A1 countries)
- Adaptation finance can be used to promote forest resilience and resistance to climate change (non-A1 countries)
- Common Agriculture Policy finance can be used for both mitigation and adaptation (EU countries)
- Life Programme finance can be used to promote best practices and demonstration projects in both mitigation and adaptation (EU countries)
- Voluntary carbon market finance can be used for a limited number of practices (all countries)

Although much focus is usually placed on mitigation finance, it should be noted that cork oak forests are located on an extremely sensitive regions that will undergo significant changes due to climate change and, all other things equal, this region should be “attractive” for adaptation investments from international adaptation funds.

Finally, finance of mitigation and adaptation will be an important block of the ongoing discussions for the post-2020 climate regime (see chapter 5.3) and countries within the cork oak region still have time to try to influence those decisions so that the existing instruments are maintained or improved, or that new ones are created.

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