

Climatic Change in the Mediterranean Basin: Territorial Impact and Search for a Common Strategy

EUGENIA FERRAGINA*, DÉsirÉE QUAGLIAROTTI*

Jel classification: Q540, Q160, Q130

Introduction

The cause and the effects in time and space of climate change constitute an extremely complex topic. From a scientific point of view, perplexities particularly concern the factors that caused the phenomenon and the impact on a local and global scale. Although numerous studies confirm the influence of greenhouse gases on the thermal balance of the Earth and they therefore ascribe to climate change an anthropic reason, nevertheless many experts consider the current increase in the planet temperature as a natural phase of the climatic evolution that has already occurred in other eras.

The lack of agreement on the causes of climate change affects the opportunity to adopt a common strategy to reduce greenhouse gas emissions. In the industrial countries, these measures entail intense changes in the energy policy, investments for the development of alternative energy and the introduction of constraints and charges for firms. For the developing countries, forced between environmental and economic emergencies, a change in the energetic balance and the associated economic system reconversion have to face strong resistances since they bring about an additional cost delaying the industrial develop-

Abstract

Climate change assumes special importance in the Mediterranean basin, a region characterized by the presence of large desert areas whose fragile ecosystem is deeply exposed to environmental degradation. The lack of agreement on the causes of climate change affects the opportunity to adopt a common strategy to reduce greenhouse gas emissions. In the European countries, these measures entail changes in the energy policy, investments for the development of alternative energy and the introduction of constraints and charges for firms. For the Arab countries, the economic system reconversion has to face great resistance since it represents an additional cost delaying the industrial development and the short-term goals of the development policy. In this context, the role of the Northern countries is particularly important in supporting Southern and Eastern Mediterranean countries that are particularly vulnerable to the adverse effects of climate change, in order to build their adaptive capacity through scientific and technological cooperation and financial assistance.

Keywords: climate change, ecological economics, R&D.

Résumé

Le changement climatique joue un rôle primordial dans le pourtour méditerranéen, qui est une région caractérisée par la présence de grandes zones désertiques dont l'écosystème est fortement exposé à la dégradation de l'environnement. Le manque d'un point de vue commun sur les causes du changement climatique entrave l'adoption d'une stratégie commune visant la réduction de l'émission des gaz à effet de serre. Dans les pays européens, ces mesures comportent des changements dans la politique énergétique, dans les investissements pour le développement d'énergies alternatives et dans l'introduction de contraintes et taxes au détriment des firmes. Pour les pays arabes, la reconversion du système économique est confrontée à une forte résistance comme elle comporte des coûts additionnels qui retardent le développement industriel et la réalisation des buts à bref terme de la politique de développement. Dans ce contexte, les pays du Nord jouent un rôle fondamental car ils doivent supporter les pays du Sud et de l'Est de la Méditerranée qui sont particulièrement vulnérables aux effets négatifs du changement climatique, afin d'augmenter leur capacité d'adaptation par le biais d'une coopération scientifique et technique et d'une bonne assistance financière.

Mots-clés: changement climatique, économie de l'écologie, R&D.

ment and the achievement of short-term objectives of the development policy.

Given that climate change is one of the factors that contribute to feed the desertification process, it becomes particularly important in the Mediterranean basin, which is already characterized by the presence of large desert areas where the precarious balance is deeply exposed to environmental degradation.

This work aims at giving some cues of reflection and presenting some data on the climate change. This phenomenon will deeply affect the territorial features and the Mediterranean societies' standard of living in the future. The paper proposes an analysis of the relations between climate change and greenhouse gas emissions in the Mediterranean countries recognizing the potential impacts on the European side as well as on the African and Asiatic side. In the

last part, we consider the national and international strategies aimed to reduce global emissions of carbon dioxide and stop the evolution of climate change.

1. Climate change in the Mediterranean region

The average global surface temperature is the most fundamental measure of climate change. In the last 10,000 years, human history has been characterised by a considerable increase in temperature and by a marked reduction in

* Istituto di Studi sulle Società del Mediterraneo (ISSM), Consiglio Nazionale delle Ricerche (CNR) Napoli, Italy.

the extension of the glaciers. Climatic variations have altered the borders of the inhabited world and natural space has been transformed in the course of centuries by the settlement of new lands, the conversion of forests into arable lands, the reclamation of marshes, and the settlement of desert areas. However, over the last half a century, temperatures have probably been the highest of any 50-years period for the past 1,300 years and there is strong evidence that the process is growing faster and faster. Eleven of the twelve warmest years since 1850 have occurred between 1995 and 2006, and over the last 100 years the Earth has warmed by 0.7°C.

There is an overwhelming body of scientific evidence linking rising temperature to increased atmospheric concentration of CO₂ and other greenhouse gases. The effect of these gases in the atmosphere is to retain part of the outgoing solar radiation, thereby raising the temperature of the planet Earth. This natural greenhouse effect is what keeps our planet habitable: without it the planet would be 30°C colder. Throughout the Earth's four previous glacial and warming cycles, there has been a high correlation between atmospheric concentration of CO₂ and temperature. What is different about the current warming cycle is the rapid rate at which CO₂ concentrations are increasing.

The Fourth Intergovernmental Panel on Climatic Change Report (IPPC, 2007) concludes that there is high evidence that the observed changes in the global climate systems are influenced by human activities. Global atmospheric concentration of carbon dioxide, methane and nitrous oxide have markedly increased as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years¹. In support of the conclusions of the IPCC Third assessment report (IPCC, 2001), the Fourth assessment stresses how human-induced climate change will not only affect global temperature, but will also lead to changes in the entire climate system, including precipitation patterns and intensity, wind patterns, sea level rise, frequency and intensity of extreme weather. It also points out that the impacts of these changes will be differently felt in different regions of the world.

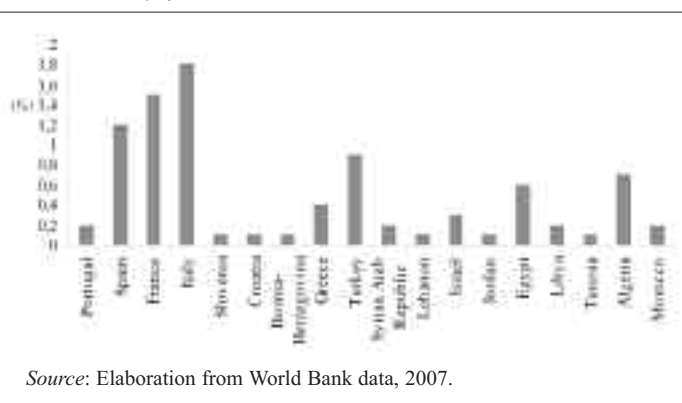
The scenarios of global climate change that appear from these studies do not supply detailed data about changes on a regional scale. The Mediterranean area is certainly one of the most vulnerable regions in the world, for its population intensity, concentration of economic activities in coastal zones, and for its climatic borderline balance. During the 20th century, air temperature in the Mediterranean basin was observed to have risen by 1.5-4°C depending on the sub-region. Over the same period and with clear acceleration since 1970, temperatures in south-western Europe (Iberian Peninsula, south of France) rose by almost 2°C.

¹ The global increases in carbon dioxide concentration are primarily due to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.

The same warming effect can also be seen in North Africa, though more difficult to quantify given the more patchy nature of the observation system. According to recent simulation models, in the 2^{1st} century, the Mediterranean will experience an increase in average temperature, a significant increase in heat waves, and a strong decrease in precipitations. In fact, even if the European Union's objective of not exceeding the global average temperature increase of 2° C is met, temperature increases in the Mediterranean are likely to be above 2°C and the impact will be more marked than in many other regions of the world, because of the ecological and socio-economic characteristics of the areas. The nature of the closed basin of the Mediterranean Sea characterized by weak external changes makes us suppose an amplification of the effects driven by the increase of global warming with serious consequences on marine and terrestrial ecosystems. Mediterranean waters will be more and more exposed to higher temperatures with a double effect: the tropicalization of sea water with a change in the marine flora and fauna, and an alteration of the terrestrial vegetation and of the crop patterns with a higher fire risk (Vallega, 2005).

By 2004, the Mediterranean countries jointly produced about 8% of the aggregate world emissions of carbon dioxide. The aggregate emissions of Southern and Eastern Mediterranean countries (SEMCs) account for 3% of the aggregate global emissions, and those of the Northern Mediterranean countries (NMCs) account for 4.5% of the aggregate global emissions. Thus, in the Mediterranean basin, the major share of aggregate CO₂ emissions comes from the European side (58%), particularly from Italy, followed by France and Spain. Emissions coming from the African and Asian side are still relatively scarce, with the exception of Turkey, Algeria and Israel (Fig. 1).

Figure 1 – Carbon dioxide: emissions by country. Share of world total emissions (%).



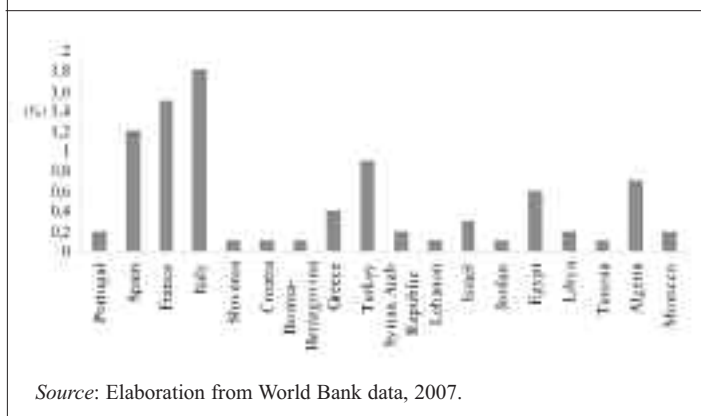
Source: Elaboration from World Bank data, 2007.

Per capita CO₂ emissions range from an average of 4.4 t in SEMCs to 5.6 t in the Balkans area, to 7.2 t in NMCs.

If we analyze the emission variations between 1990 and 2004, we find an increase in all European countries, particularly in Spain. In the Balkans, the increase is more limit-

ed, except for Croatia that has been characterized by a rapid economic growth in the last years with a subsequent development of polluting activities. Increase in CO₂ emissions is much faster in SEMCs than in NMCs, particularly in Israel (+110%), Algeria (+100%), Egypt (+90%), and Morocco (+85%) (Fig. 2).

Figure 2 – Total emissions of CO₂ (Mt CO₂).



Emissions due to electricity and heating constitute the main quantity of total CO₂ emissions due to energy use in the Mediterranean. Especially in SEMCs, this sector has been the first contributor to the rise of emissions since 1990. Emissions of the transport sector are closely connected with the level of wealth and they are thus high in NMCs where they account for 29% of the total emissions and where they constitute the main component in emission increase. The industry and construction sector account for 20% of the CO₂ emissions due to energy in SEMCs. Growth has been lower than in the two preceding sectors: +11% in NMCs and +46% in SEMCs between 1990 and 2003. CO₂ emissions due to «other fuel combustions» mainly derive from direct combustion of fossil energy in the residential and commercial sector. The sector that discharges more CO₂ in the Mediterranean area is the electric power supply, with the exception of France and Spain that chose nuclear energy and of Croatia where the transport sector is the main responsible for emissions.

As we deduce from these data, in the next few decades, those Mediterranean countries that are in the economic transitional phase could increase their production of greenhouse gases.

This course could be amplified by the objectives of economic integration that the Euro-Mediterranean Partnership has adopted in the Barcelona Declaration of 1995. In the short term, the establishment of the Euro-Mediterranean Free Trade Area (EMFTA) will not provide a change in the production patterns of SEMCs but the strengthening of the

already existing sectors, such as the textile, tanning, chemical and petrochemical sectors, which have a deep environmental impact. It is expected that a further growth of CO₂ emissions could follow the increase of the demand for primary products necessary to boost the industrialization process (cement, steel and paper).

The dimension and direction of foreign direct investments are other factors capable of generating an environmental impact. The willingness of small enterprises to elude the environmental laws and the mainly coastal localization of the industrial activities could increase together with the amount of the emissions and their concentration in those areas that have already been subject to a strong human-induced pressure. Above all, there is a risk of environmental dumping in North Africa and Middle East where European firms that are environmentally-unfriendly get established to keep away from increasingly strict European environmental laws. The existence of a market still poorly controlled by regulations could be utilized by SEMCS as a comparative advantage against the emerging countries in Eastern Europe and Southern-Eastern Asia.

2. The territorial impact of climate change

The impact of climate change on the environment is already noticeable in the Mediterranean and it is already producing observable effects on human activities.

According to IPCC's scenarios, an increase of 1°C of the average global temperature could lead to an increase of air temperature between 0.7°C and 1.6°C in the Mediterranean basin.

The same projections assume a rainfall decrease between 4 and 27% in Southern Europe and in the Mediterranean region, while Northern Europe will record an increase between 0 and 16%. Extreme events such as heat waves, drought and floods could be more frequent and stronger.

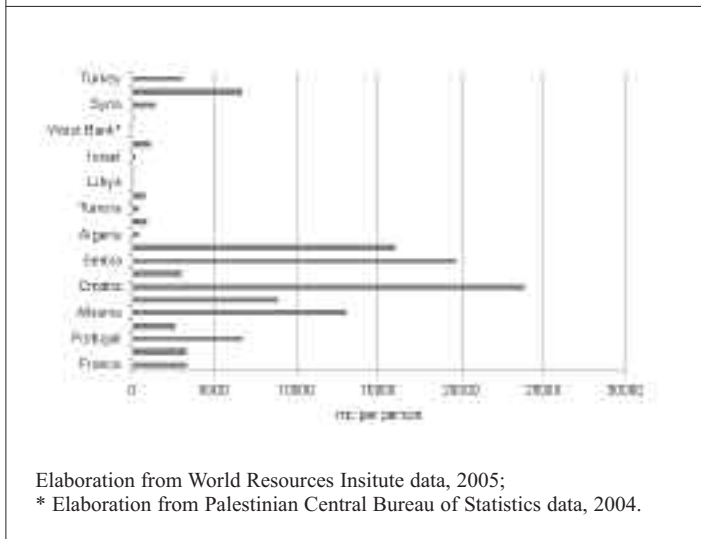
The most vulnerable natural resource to climate change is water. In European countries, the water issue is more a qualitative issue than a quantitative one. Despite the numerous investments for the treatment of wastewaters, water resources continue to be polluted by nitrates and phosphates. The European Union, through the Water Framework Directive adopted in 2000, introduced a new water policy with the purpose of establishing a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. It will ensure that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands meet *good status* by 2015².

Along the southern and eastern shores, the water issue is quantitative as well as qualitative. There is, in fact, a constant increase in water demand resulting from demographic pressure and from the development of activities, such as tourism and some manufacturing sectors (food, textile, and tanning) that are water intensive. Indeed, water supply remains fixed because of the lack of new exploiting sources

² The Directive entered into force in December 2000 and member-states are required to transpose it into national legislation by December 2003. The Directive has a series of implementation deadlines which stretch to December 2015, the date by which environmental objectives must be met.

and, in some countries, it reveals a decreasing trend. The unbalance between supply and demand could be perceived by the reduced water resources availability per-capita (Fig. 3).

Figure 3 – Renewable water resources per-capita (m^3 per person).

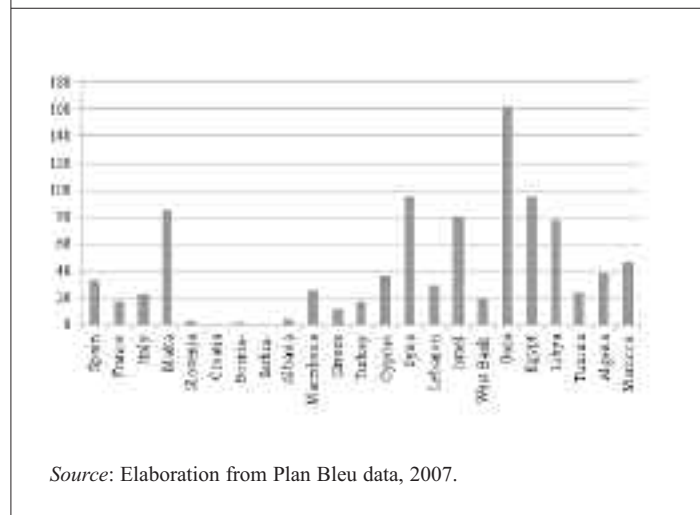


In the African and Asian side of the Mediterranean, surface waters are polluted by wastewater urban and industrial discharges, while pollution from agriculture (fertilizers, pesticides) threatens the quality of groundwater sources.

Water scarcity can be defined by the Water Exploitation Index (WEI). The WEI in a country is defined as the ratio of withdrawals from renewable natural resources to average renewable natural water resources expressed as a percentage. It points out the countries that have a high water demand compared with their resources. The warning threshold for WEI which distinguished a non-stressed from a stressed country is around 20%. Severe water stress can occur where the index exceeds 40% indicating unsustainable water use. Calculation of this index for the Mediterranean countries highlights a variety of situations. European countries present a low percentage, except for

Malta (84%) and Spain (33%). An exploitation index equal to or higher than 100% indicates that all renewable water resources are already being utilized and countries have to meet the growing part of their water demand by using non-renewable sources. The countries that already heavily depend on non-renewable groundwater and that show a high exploitation index are Gaza (161%), Egypt, and Syria (95%) (Fig. 4).

Figure 4 – Exploitation Index of renewable water resources (%).



In order to overcome water scarcity, all countries of the Region have heavily invested in technology and facilities to store and divert water resources and deliver water services to households, industries, and farmers. Today, the increase of water supply meets impediments of financial, social and environmental nature³. New prospects are offered by non-conventional water supply such as desalination and reuse of treated domestic wastewater (Ferragina and Quagliarotti, 2005) (Tab. 1)⁴.

Global warming is expected to make water resources even scarcer in SEMCs because of a decrease in the average annual precipitation, the increased variability in the frequency and intensity of precipitation events, the increased average temperatures and higher evaporation from dams and reservoirs, and increased urban and irrigation water demands⁵.

In NMCs, climate change is expected to produce opposite effects, such as an increase in the average annual precipitation with the risks of floods and landslides in the most vulnerable areas from a hydro-geological point of view. In European countries, the impact of climate change appears to be less devastating, but the effects could be amplified by the lack of an efficient soil management policy. Particularly, in the last few decades, hilly regions have experienced a gradual depopulation process that caused the unfulfilled maintenance of slopes, variations in vegetative covering on versants, quarrying of building materials from the mountains.

³ There are many factors that reduce the exploitable portion of water resources: increasing distance between the sources of supply and the point of use; increasing environmental considerations in developing new infrastructures; growing pollution of resources. All these factors increase the cost of exploitation of new water sources.

⁴ Desalination is heavily susceptible to energy price so it is still more expensive than most conventional sources for non oil-producing countries. In fact, major producers of desalinated water are oil-producing countries such as Saudi Arabia, Arab Emirates, Kuwait, Qatar, Bahrain, and Oman. The Region as a whole has helped to reduce the cost of water desalination. As experience and technology have developed, also through major investments by Israel and other countries, production costs for desalination have fallen. New technologies, such as reverse osmosis, electro dialysis, and hybrids, can deal with different types of input water or are more energy efficient, or both. Unit sizes have increased, bringing economies of scale. These advances have pushed prices down from an average of US\$ 1.0/ m^3 in 1999 to US\$ 0.50/ m^3 - 0.80/ m^3 in 2004 (World Bank, 2007).

⁵ High evapotranspiration rates could increase the concentration of pollutants in rivers and salinity rates in lakes and reservoirs.

Table 1 – The production of non-conventional water sources in some southern and eastern Mediterranean Countries.

Countries	Desalination	Recycling of wastewater
Israel	In Israel the development of desalination techniques began in 1960. The average production in 1990 was 25 million m ³ /year. Current capacity is 400 million m ³ /year, with plans whose capacity is supposed to increase to 750 million m ³ /year by 2020.	Israel plans to provide half of all irrigation water from this source by 2010.
Jordan	In 2002, in Jordan, there were 10 plants with a total capacity of 4 million m ³ /year. The country plans to have desalination capacity of 17 million m ³ /year by 2010.	In Jordan, treated wastewater blended with freshwater irrigates food crops over 10,600 hectares, and accounts for nearly 12 percent of the country's irrigation water.
Egypt	Egypt has several desalination plants that provide water for seaside resorts and hotels on the coasts of the Red Sea and the Mediterranean. The average production during 1998-2002 was 100 million m ³ /year.	In the country, a good share of treated wastewater is reused in agriculture.
Libya	The country has the largest desalination plant in the world and produces a total of 18 million m ³ /year from its 17 plants. A number of new large plants are under construction.	In Libya, 40 million m ³ /year of wastewater generated annually are treated and reused on fodder crops, ornamental trees, and lawns.
Tunisia	Tunisia has desalination plants to remove salt from brackish groundwater. 48 plants have a total capacity of 47 million m ³ /year. A large seawater desalination plant with a capacity of 9 million m ³ /year should be built in Djerba to cope with the increasing water demand, mainly from tourism.	In Tunisia, around 30 percent of treated wastewater is reused in agriculture and other sectors.
Algeria	Algeria began investing in desalination plants in the 1960s, primarily to support the oil and steel industry, and more recently to increase the water supply in coastal towns. The country has 42 units with a total capacity in 2004 of 59 million m ³ /year. The Ministry of Water Resources plans to greatly increase the capacity by constructing 28 new large-scale desalination plants, with a combined capacity of about 712 million m ³ /year.	

Source: World Bank, *Making the Most of Scarcity*, 2007.

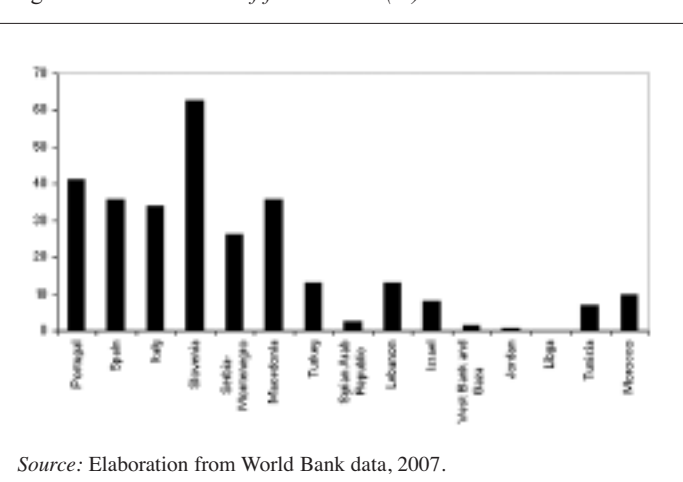
All these factors contribute to the increase of floods and landslides during intensive precipitations. The stronger risk of floods and landslides as a consequence of changes in the climate systems is expected to cause injuries and casualties. Infrastructures may be lost and damaged, economic activities may be destroyed, as well as crops and agricultural land. Per-

⁶ Economic losses resulting from weather and climate related events have significantly increased in the last 20 years, from an annual average of less than USD 5 billion to about USD 11 billion. The average number of disastrous weather and climate-related events in Europe doubled over the 1990s with respect to the previous decade, while non-climatic events such as earthquakes remained stable (European Environment Agency, 2004, p. 70).

⁷ On the other hand, forests can play a key role in accelerating or mitigating climate change. Forest areas affect climate evolution because they play a major role in the Earth's carbon cycle. Trees convert atmospheric carbon from CO₂ into organic woody biomass as part of a respiratory process called photosynthesis. Trees then store carbon until the woody biomass is destroyed. This carbon storage is called sequestration. When forests are cut down for timber commercial uses or to convert forestlands into other uses such as agriculture, carbon absorption ceases and so future carbon sequestration is lost. If forests and forest products are burned, carbon dioxide is released into the atmosphere adding greenhouse effect. According to IPCC, 1.6 billion tons of carbon dioxide a year are released to the atmosphere due to deforestation. Until the early 1990s, deforestation was the dominant source of increased CO₂ in the atmosphere. Since that time, the burning of fossil fuels has surpassed deforestation, but deforestation alone is estimated to be responsible for up to 35% of the greenhouse effect.

⁸ Responsibility for forest management has been transferred to the environment ministry in many countries, reflecting a growing recognition of the potential role of forests in meeting environmental objectives and perhaps a declining role for their productive functions.

Figure 5 – Distribution of forest areas (%).



Source: Elaboration from World Bank data, 2007.

haps more significantly, irreversible damage may occur to unique cultural heritage, art masterpieces and buildings. Natural ecosystems and biodiversity may be lost or displaced⁶.

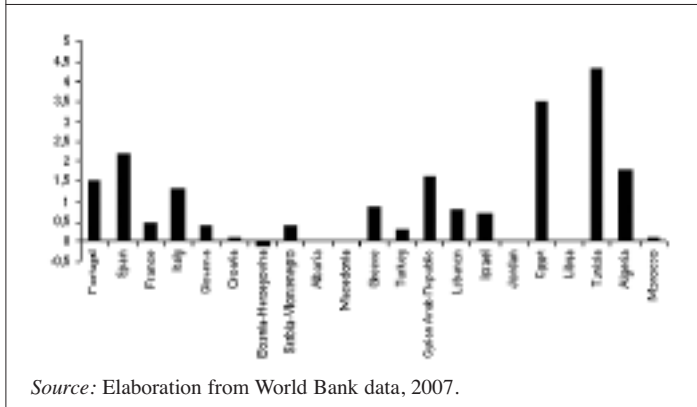
There is increasing evidence that forests will be profoundly affected by climate change in the Mediterranean region. Climate change plays a central role in shaping fire regimes and generating weather conditions that favour fire events⁷. Forests are unequally distributed on the two shores of the Mediterranean basin. 42% of forest areas are concentrated in European countries and only 4.7% in Arab countries. Countries that present greater forest coverage on the total surface are Portugal (40%) and Italy (34%), whereas a minor percentage is present in Egypt (0.1%) and Libya (0.2%) (Fig. 5).

In European countries, forest degradation is mainly the result of urbanisation and tourism development in coastal areas and high mountains. In SEMCs, forests are under pressure for competition for agricultural land, firewood collection, overgrazing, wildlife hunting and unsustainable plant harvesting. Apart from this, between 600,000 and 800,000 ha of Mediterranean forests burn every year and 95% of these fires are caused by arson or negligence. Data on forest areas show that, with the exception of Lebanon, the forested area becoming steadier in Morocco and increasing in Tunisia, Egypt, Algeria, Syria and Turkey. However, this interpretation requires caution. Stabilization or increases in many countries mostly result from reforestation activities. For natural forests, in contrast, the picture is much less encouraging. In fact, the naturally wooded area is decreasing, while the composition of the wooded land is degrading. Many forest areas with tall trees are changing into shrub lands such as *macchia* or *garrigue*. A few countries have demonstrated political commitment to forest protection over the last 15 years. Among those that have enacted new forest policies or laws, there are Morocco, Syria, Tunisia, and Turkey⁸.

In NMCs, recent changes have provoked a strong increase in the forest cover: 0.9% per year in Greece, 2.2% per year in Spain, 1.5% in Portugal per year between 1990

and 2005. This rapid increase in forest cover has partly been the result of continuous reforestation policies, very often carried out or subsidized by the state to re-occupy abandoned private land with marketable woody vegetation. However, a large part of the re-vegetation has spontaneously occurred, when dense shrubs and *macchia* with little commercial value encroach on abandoned agricultural land (Fig. 6).

Figure 6 – Target markets for flowers production in the sample surveyed (value expressed in %) - 2006.



Changes in the Mediterranean Sea are strongly associated to climate change. Climate change may have a negative impact on Mediterranean marine biodiversity, through several direct and indirect mechanisms that still need to be investigated. The sea surface temperature and its impact on deep water, changes in salinity, and chlorophyll and nutrient concentration may induce significant local changes. Some environmental effects could occur under the sea level rise effect that threatens coasts, wetlands, and deltas (Brown, 2003). Submersion of sensitive deltas can be reinforced by the subsidence of these regions under the sediment load, which is no longer balanced by the alluvial deposit blocked by dams and embankments. Offshore bars could be broken or flooded, causing salted water areas to extend in these regions, or salinity to increase, bringing severe stress to natural ecosystems. Some of these areas have a major environmental or economic interest and should be protected. Erosion of fragile coastlines should also increase since the swell could more easily reach the shore. In addition to sea level rise, deficit in sediments carried on by rivers and streams, as explained above, explains a sensible retreat of sandy or shingle beaches. Another effect of increase in sea level is to induce seawater intrusion into the coastal aquifers. As a consequence of salted water entering irrigation sources, soil salinity increases by causing severe loss to agriculture. Camargue in France, the Venice lagoon in Italy,

⁹ Egypt is the most sensitive Mediterranean country to the rise in sea level. A 30 cm sea level rise would endanger the Alexandria harbour and cause a flooding of large agricultural, densely populated surfaces in the Nile delta, the only large fertile area of the country (Plan Bleu, 2001).

Nile delta and lagoons along this delta and Sinai coasts in Egypt are examples of such environmental threats on Mediterranean rims⁹. The city of Alexandria, but also the cities of Rosetta and Port Said, is particularly vulnerable: a rise in sea level by 50 cm is likely to entail the loss of 200,000 jobs and incur the loss of 30 billion dollars in farmland and housing infrastructures (Plan Bleu, 2008).

The Mediterranean basin can thus be seen as a laboratory for assessing vulnerability and impact of climate change and for introducing adaptation and emission-reducing measures at different scales enfolding global and local agents, cities and territories (Box 1).

Economic Impact of Climate Change in the Southern and Eastern Mediterranean Countries

The vulnerability of SEMCs to climate changes varies according to the share of their economy being sensitive to climate (agriculture, tourism, infrastructures, energy, and ecosystems). Estimates indicate that the costs of non-action are likely to be more significant for agricultural countries (Syria, Egypt, Morocco, and Tunisia): between 2 and 9% of the countries' agricultural GDP by 2050.

Studies focusing on specific regions reveal that for a 2.5°C increase in temperature, loss will be around 7% of GDP per capita on average for North Africa and around 4% for East Europe up to 2100. The environmental and socio-economic characteristics of the Mediterranean and these forecasts make us think that the Southern Mediterranean will be among the areas of the world that are the most affected, and most rapidly affected, by adverse impacts of climate change. The main problem factor by which climate change will be affecting all sectors of the economy is related with the scarcity of water resources. The economic analysis of adaptation in the Mediterranean countries has been fairly limited to date. The few sector elements being available (agriculture in particular) lead to believe that appropriate measures to adapt and reduce vulnerability are likely to have a cost lower than the benefits that they might yield. However, the capacity of adaptation of SEMCs is limited. A public-private partnership and international cooperation are important in helping the region to adapt to the new climate context. The issue of financing the actions remains a key question that is currently under discussion (Source: Benoit and Comeau, 2005).

3. How to manage climate change: global and regional strategies

Estimates of the increase in the average global temperature and its potential impact on the Mediterranean area, described in the previous section, are related to hypothetical scenarios in a context without climate change mitigation strategies. In the last few years, there has been an increased awareness in climate change as a global issue that can be managed only through an efficient international cooperation. A global strategy on climate change has been agreed upon the 1992 United Nations Climate Change Convention. The Convention became effective on 21 March 1994 and

represents the first important political initiative that aims at achieving the stabilization of greenhouse gas concentrations in the atmosphere at a low level to prevent dangerous anthropogenic interference with the climate system. As originally framed, the treaty set no mandatory limits on greenhouse gas emissions for individual nations and contained no enforcement provisions; it is therefore considered as non-binding from a legal point of view. Rather, it included provisions for updates (called «protocols») that would set mandatory emission limits. Since then, the parties have been meeting every year in Conferences of the Parties (COP) to assess progress in dealing with climate change and in the mid-1990s started to negotiate the Kyoto Protocol to establish legally binding obligations for developed countries to reduce their greenhouse gas emissions¹⁰. Most industrialized nations and some central European economies in transition (all defined as Annex B countries) agreed on legally binding reductions in greenhouse gas emissions of nearly 6 to 8% below the 1990 levels between the years 2008-2012, defined as the first emission budget period. The Kyoto Protocol allows developed countries to reach their targets in different ways. They have to implement domestic Policies And Measures (PAMs) and they are allowed to implement these PAMs with projects abroad and market instruments called «flexibility mechanisms». Practically, short-term objectives aim at reducing emissions by improving energy use and efficiency; medium and long-term objectives include the development of renewable energies such as biofuels, biomass, geothermal, solar and wind energies¹¹. In general, the use of renewable energies would benefit from bilateral and regional cooperation. A regional cooperation in the field of renewable energy in the Mediterranean region is necessary and can significantly improve the sustainable development of the region while playing an important role in reaching the Kyoto targets of NMCs.

Most Mediterranean countries, particularly the Southern and Eastern ones, consider the Kyoto Protocol as a constraint to national development policies. Israel has established an Inter-ministerial Committee on climate change that is charged of formulating a national policy on the reduction of greenhouse gases and of preparing reports on national greenhouse gas inventories, policies, measures and future forecasts. Morocco has agreed on the international initiative but has fears for the constraints on the country's economic growth process that could increase the develop-

ment of polluting economic activities. The most important oil-producing countries – Libya and Algeria – are afraid of being doubly penalized by the objectives of the Protocol: directly by diminishing greenhouse gas emissions, indirectly by developing renewable energy sources that reduce the demand for fossil fuels and consequently decrease oil exports. The two countries thus demand the introduction of gears to compensate the reduced utilization of fossil fuels.

The inexistence of a shared project to reduce greenhouse gas emissions is mainly caused by the lack of environmental governance at Euro-Mediterranean level. At international and regional level, the 1980s were characterized by a veritable outburst of environmental laws with nearly 300 documents, treaties and conventions (Comeau and Benoit, 2005). The Euro-Mediterranean Partnership, created as result of the Barcelona Declaration in 1995, has a priority programme for the environment, the *Short and Medium Term Action Programme* (SMAP) that defined around five priorities in 1997: integrated water management, waste management, host spots (pollution and biodiversity), integrated coastal area management, and fight against desertification. But resources remain weak in the challenger's point of view and more of them support projects in water and sanitation sectors. The Euro-Mediterranean partnership is not succeeding in truly influencing policies on the environment in the Mediterranean Countries because of the lack of common objectives and of environmental monitoring systems. Besides that, the analysis of the contents of bilateral association agreements shows few references to the environmental protection issues. A change in the European policy happened in 2001 with the European Union Strategy for Sustainable Development by affirming that the European Union should support efforts made by non-member countries to achieve sustainable development. The Conference of Euro-Mediterranean Ministers of Foreign Affairs held in Valencia in 2002 represented a progress in support of environmental protection due to studies and research performed on the impact of the Euro-Mediterranean Free Trade Area in terms of sustainable development.

In MPCs, the environmental aspect of development is often eclipsed by economic aspects, institutional weakness, and by the lack of an administrative decentralization capable of removing environmental protection from the exclusive public authority. The priority of supporting the *mise au niveau* of the economic system in a context of trade liberalization makes environmental protection the very last governments' objective, whereas the few interventions are dictated by emergency therefore they do not pursue an environmental risk management strategy in the long term.

Conclusions

In the last few decades, a greater knowledge of climate change has been the result of the damage it has produced. The consequences of an increase in the Earth's temperature

¹⁰ The Kyoto Protocol of the United Nations Framework Convention on Climate Change was adopted by COP-3, in December 1997 in Kyoto, Japan, after intensive negotiations.

¹¹ The Mediterranean region is endowed with high potential for renewable energy resources. However, the full potential and advantages of renewable energies are currently hindered in the region due to the existence of many barriers, amongst which the institutional barriers and the price of fossil fuels that do not always reflect their full cost. Prices for conventional energy source are often subsidized in Southern and Eastern Mediterranean countries and the externalities associated with the use of these resources, such as additional health and environmental costs, are not considered. Removing subsidies from fossil fuels would make renewable energy relatively more competitive (Observatoire Méditerranéen de l'Énergie, 2007).

involve natural phenomena as well as landscape transformation, and present a definite effect on economic development and on the quality of life of the world population.

The most significant impacts from an environmental point of view are: the loss of marine and terrestrial ecosystems such as river deltas, coastal wetlands, sandy beaches and coral reef systems; the flooding of coastal areas for the sea level rise due to the melting of glaciers; the loss of biodiversity. From an economic point of view, the predicted pattern of higher temperature, reduced precipitations, and changes in the frequency and intensity of storms, floods and droughts, will decrease agricultural yield - creating the risk of further depressing the sector's economic performance, especially in arid countries - and they will cause a rise of costs resulting from extreme weather and climate events. The negative consequences of climate change are uneven across countries, with more profound negative impacts for areas being more vulnerable from a socioeconomic and environmental point of view. Deeper impacts of global warming will afflict those countries that contribute least to the global emissions of greenhouse gases and will contribute to produce important issues such as the rise of flows of the environmental refugees¹². The transfer of entire populations because of environmental deterioration will particularly affect the areas near deserts that associate to the negative characteristics of the soil a negative water balance for a long year period because of scarce and irregular precipitations and high evapotranspiration rates. The increase of temperature in the Mediterranean will be caused by the interaction of global and local effect. At a regional scale, the pursuit of the Kyoto commitment of reducing greenhouse gas emissions by the Mediterranean Northern Countries will be decisive. Likewise important it will be the objective of making the new *European Neighbourhood Policy*, introduced in 2003, the means for a more intensive cooperation on the environment. In the South rim, the change will be due not just to a formal and generic ratification of the Kyoto Protocol by MPCs, but also to the capacity of the European countries to support SEMCs that are particularly vulnerable to the adverse effects of climate change, in order to build their adaptive capacity through scientific and technological cooperation and providing financial assistance. The local scale is fundamental in order to link environmental protection to economic growth and establish the requisites required for a development model based on the participative approach. It enables, in fact, to exploit the cultural, environmental, and landscape specificities that the cultural homology derived from the globalisation

process and from territorial transformations due to climate change is able to remove.

References

- Adornato F., *Quale ruolo per l'agricoltura nella lotta alla desertificazione*, Seminario di studio «Desertificazione: ruolo dell'agricoltura e politiche di settore», INEA, Potenza, 30 November 2005.
- Bacci L., *Popolazione e clima: le incerte relazioni*, in «Il clima dell'energia», Limes, Rivista italiana di geopolitica, n. 6, Roma, Gruppo Editoriale l'Espresso, 2007.
- Barbieri G., Canigiani F. and Cassi L., *Geografia e cambiamento globale*, Torino, Utet, 2003.
- Brown L., *Bilancio Terra. Gli effetti ambientali dell'economia globalizzata*, Milano, WWF, Edizioni Ambiente, 2003.
- Comeau A. and Benoit G., *A Sustainable Future for the Mediterranean*, Sophia Antipolis, Plan Bleu, 2005.
- Commissione Europea, *Verso una strategia tematica per la protezione del suolo*, Bruxelles, 2002.
- European Environment Agency, *Impacts of Europe's Changing Climate. An Indicator-Based Assessment*, EEEA Report n° 2/2004, Copenhagen, EEA, 2004.
- Faggi P., «Il ruolo dei quadri ambientali nella comprensione del sottosviluppo» in Boggio F., Dematteis G., *Geografia dello sviluppo*, Torino, Utet, 2002.
- Faggi P., *Desertificazione: geografia di una crisi ambientale*, Milano, Etas, 1991.
- Ferragina E. and Quagliarotti D., *L'ambiente*, in (a cura di) Paolo Malanima, «Rapporto sulle Economie del Mediterraneo», Bologna, Il Mulino, 2005.
- Ferragina E. and Quagliarotti D., *Cambiamenti climatici e processi di desertificazione nel Mediterraneo*, in Paolo Malanima (a cura di), «Rapporto sulle Economie del Mediterraneo», Bologna, Il Mulino, 2006.
- Fierotti G., Dazzi C. and Tusa D., *Riflessi sull'irrigazione con acque saline sulla qualità dei suoli*, «OTRIS» – Progetto di ricerca e divulgazione – «Ottimizzazione dell'uso delle risorse idriche, convenzionali e non, in sistemi colturali sostenibili», INEA, www.inea.it.
- Food and Agricultural Organization (FAO), *Land Resource Potential and Constraints at Regional and Country Levels*, World Soil Resources Reports, Roma, 2000.
- Henke R., *Verso il riconoscimento di un'agricoltura multifunzionale*, INEA, Napoli, Edizioni Scientifiche Italiane, 2004.
- IPCC, *Climate Change 2007*, Contribution of Working Groups to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, Cambridge University Press, 2007.
- ISMEA-IAM, *Lo sviluppo rurale nelle politiche di integrazione del Bacino Mediterraneo*, Bari, Osservatorio permanente sul sistema agroalimentare dei Paesi del Mediterraneo, 2004.
- Leone U., *Nuove politiche per l'ambiente*, Roma, Carocci, 2002.

¹² The term “environmental refugee” is attributed to Lester Brown of the World Watch Institute in the late 1970s. More recently, Norman Myers has defined environmental refugees as “people who can no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification, deforestation and other environmental problems, together with associated problems of population pressures and profound poverty” (Myers, 2005).

Laureano P., *Atlante d'acqua. Conoscenze tradizionali per la lotta alla desertificazione*, Torino, Bollati Boringhieri, 2001.

Myers N., *Environmental Refugees: An Emergent Security Issue*, 13th Economic Forum, Prague, 2005.

Ministero dell'Ambiente, *Comunicazione Nazionale per la Lotta alla Siccità e alla Desertificazione*, Roma, 1999.

Observatoire Méditerranéen de l'Energie, *Renewable Energy in the Southern and Eastern Mediterranean Countries. Current situation*, OME, Sophia Antipolis, 2007.

Pagetti F., *Il riscaldamento del pianeta*, Milano, Angeli, 2005.

Plan Bleu, *The Present Status of Knowledge on Global Climate Change; its Regional Aspects and Impacts in the Mediterranean Region*, Plan Bleu, Sophia Antipolis, 2001.

Plan Bleu, *Indicateurs pour le Développement Durable dans le régions côtières méditerranéennes*, Plan Bleu, Sophia Antipolis, 2002.

Plan Bleu, *Threats to Soils in Mediterranean Countries*, Plan Bleu, Sophia Antipolis, 2003.

Plan Bleu, *Climate Change and Energy in the Mediterranean*, Plan Bleu, Sophia Antipolis, 2008.

Puigdefabregas J. and Mendizabal T., «Perspectives on Desertification: Western Mediterranean», in *Journal of Arid Environments*, 39:209-224, 1998.

Spinelli G., «La prospettiva antropica del cambiamento climatico», in *Bollettino della Società Geografica italiana*, 2003.

Statistical Abstract, Palestinian Central Bureau of Statistics, 2004.

Studi e Ricerche per il Mezzogiorno, *Il sistema idrico dell'Italia Meridionale: regioni a confronto*, Rassegna Economica, n. 1/aprile, Napoli, 2004.

United Nations Development Programme (UNDP), *Human Development Report 2006*.

United Nations Environmental Programme (UNEP), *Guidelines for Erosion and Desertification Control Management*, 2000.

Vallega A., «Mediterraneo: i giochi della natura», in AA.VV., *L'Italia nel Mediterraneo*, Rapporto Società Geografica Italiana, 2005.

World Bank, *Making the Most of Scarcity: Accountability for Better Water Management Results in the Middle East and North Africa*, Washington DC, World bank, 2007.

World Bank, *World Development Indicators 2007*.

World Resource Institute, *World Resources 2005*.