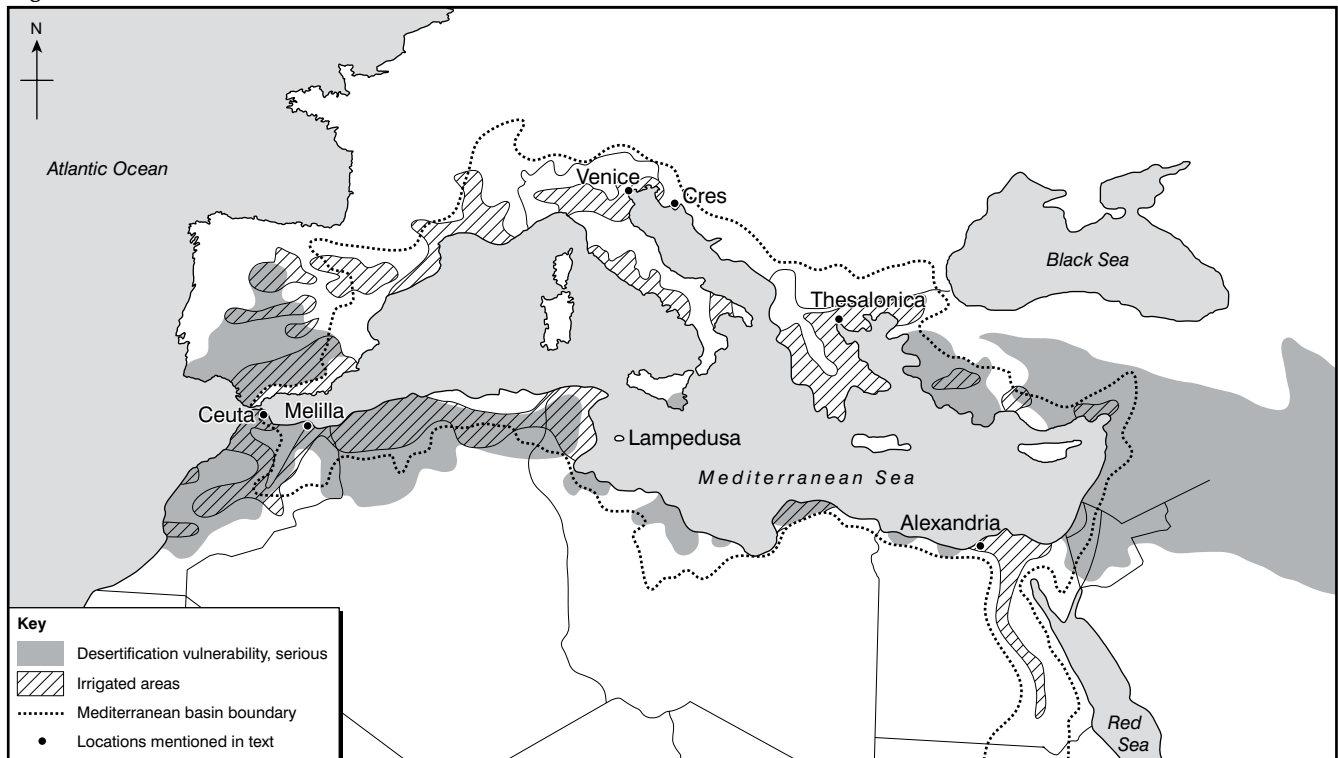


## GLOBAL WARMING – IMPACTS IN THE MEDITERRANEAN REGION

Figure 1: The Mediterranean Basin



Source: <http://maps.grida.no/go/graphic/water>; Emmanuelle Bournay and Matthias Beilstein, Zoë Environment Network

The Mediterranean region has many characteristics, both physical and human, which make it vulnerable to global warming. The climate is known for its hot, dry summers and warm, wet winters. Maximum summer temperatures can reach extremely high figures (eg Seville 47.2°C, 2003).

There is a high level of natural variability in the Mediterranean region, so climatic changes are difficult to detect and attribute to global warming. However, the Intergovernmental Panel on Climate Change (IPCC) has predicted that this region will experience a temperature rise of 2.0–5.5°C by 2100. Coupled with this, it is also projected that rainfall will decrease substantially, by 20%. Paradoxically, however, extreme rainfall events are increasing in size and frequency; for example, Italy will have 14% fewer days of rain, but more heavy rainstorms. There will also be significant seasonal changes, and though winter rainfall may increase, annual totals are expected to decline, due to increased evapotranspiration

and intensity of rainfall, meaning less will be stored underground.

Also of concern is the number of dangerously hot summer days. Research indicates that if today's rate of greenhouse gas emissions continues, countries around the Mediterranean will experience up to five times as many dangerously hot summer days by 2100 as currently occur. In 2003, an August heatwave in France and Italy was responsible for an extra 20,000 deaths, and models suggest that by 2100, the hottest summer days in the French Riviera could be 8°C hotter than those which occurred between 1960 and 1990. The entire coastal belt, both north and south of the Mediterranean, could see these extreme hot summer days rise to up to 40 per year. The sensitivity to climate change of the Mediterranean region is exacerbated by a surface moisture positive feedback mechanism. As temperatures rise, the landmass gets hotter and drier, meaning there is less evaporative cooling.

### Spatial variation of impacts within the Mediterranean basin

The more vulnerable Mediterranean areas will be those of North Africa adjacent to desert areas, the major deltas (those of the Nile, the Po and the Rhone, for instance), all coastal areas, and regions of high population growth and social vulnerability. Where local subsidence is a major issue, such as the Nile Delta, Venice and Thessalonica, it could magnify the relative sea level rise by 50%. Overall, the worst problems are expected to affect the southern and eastern Mediterranean countries (SEMCs). They are, on the one hand, more exposed to accelerated desertification, soil aridity and water scarcity and, on the other hand, have economic structures that are more strongly dependent on natural resources, as well as limited technical and financial capacities, which makes large-scale adaptation measures very difficult to achieve. There is also less potential for good governance, as political structures are not so well developed in these areas of the Mediterranean.

## Impacts of global warming

Climate change in the Mediterranean basin will create enormous pressures on people, their livelihoods and the environment. Although many of the following factors are interlinked, specific impacts will be felt in all sectors of life.

### 1. Loss of ecosystems

The current rate of climate change is such that species may not have sufficient time to adapt to higher temperatures by moving north or to higher altitude, or they may find their pathways blocked by human development, and so may die out. In central Spain, 16 butterfly species displayed an upward shift of 210m between 1970 and 2004. Coastal ecosystems are under threat from rising sea levels and drought – Greenpeace estimate that 85% of wetlands may be lost in southern Europe if temperatures increase by 3–4°. The tree line has shifted to higher altitudes, and exotic thermophilous (heat-loving) plants have spread into the native ecosystems. There is a risk of amphibian extinctions on mountains due to climate change-induced disease outbreaks.

### 2. Water supply

Supplies of water will reduce due to decreased annual rainfall, sun-baked ground due to increased evapotranspiration, and increasing human demand. Mountainous areas will be hardest hit, experiencing more frequent droughts and forest fires. Agriculture will change in terms of crop type and yields, and therefore so will people's livelihoods and migration patterns. Models of future warming predict that 20–38% of the Mediterranean population will experience increased 'water stress'. Particular examples include:

- Forests require minimum levels of water, below which ecosystems may revert to thorny scrub and grasses, so forest resources that have been exploited for centuries may be lost.
- Desertification will be even more severe, as the loss of forest will mean less storage underground and changes in local climates (drier and warmer). In turn, agriculture and public health may be affected, and consequently force human migration.

- In 2001, the average water availability for the Arab region was 977m<sup>3</sup> per capita, but by 2023 this will have almost halved, to 460m<sup>3</sup> (the UN's minimum requirement is 1000m<sup>3</sup> per person). It is expected that within 15 years, 165 million people in the Mediterranean region will be suffering some degree of water stress, and 40% will be living on less than half the minimum requirements.
- High global population growth (rising from 6,700 million in 2008 to 9,000 million in 2050) means that increased water stress is unavoidable. As the Mediterranean region is already very politically volatile, this could be an additional factor in creating instability and conflict.
- The poverty gap between the rich European states along the Mediterranean's northern shores, and their poorer Middle Eastern and North African neighbours, will result in uneven impacts, as some countries are better able to adapt to change. However, while developing countries have long-established ways of coping with low water availability, should water levels decrease even further, then their abilities to cope too must be questioned.
- Decreasing water supplies will increase pollution, because toxic substances become more concentrated as river flow decreases, causing health hazards in developing countries lacking water quality infrastructure.
- Hydroelectric power plants depending upon certain minimum river levels could be jeopardised, having an impact on industry and social usage.

Libya is one of several North African nations which, as long ago as 1990, were already classified as facing a severe water shortage. In 1984 it began a long-term project – 'The Great Man-Made River' – to utilise fossil groundwater supplies from the Sahara, but many people worry that it is unsustainable, as this reservoir cannot be replenished due to current low rainfall, compared with long ago.

Secondary impacts of global warming have occurred through attempts to secure water supplies. The Two Seas Canal, connecting the Red Sea and the Dead Sea, started in 2005, has been criticised for possibly

causing damage to the Red Sea corals at Aqaba and altering desert ecosystems.

### 3. Desertification

An increasing area of the Mediterranean is very vulnerable to the complex issue of desertification (Figure 1), with feedback mechanisms involving interrelated physical and human issues. These include changes in land use driven by population growth and migration, which in turn is linked to changing water availability, water demand and consumption. The North African Bedouin people have been discouraged from their nomadic lifestyle, which is very adaptive to low water availability, but a more settled existence leads to overgrazing by their livestock, which causes desertification. Reduced rainfall enforces land use change and, as agricultural plots are abandoned, and as the economy encourages more to leave the land for urban employment, so desertification will increase.

Desertification will increase as a result of less soil moisture, leading to more erosion, greater fire risk and salinisation, which will produce a positive feedback in terms of poor soil quality. The economic costs of global warming are massive – even today, annual costs are estimated for Tunisia and Spain to be \$100 million and \$200 million respectively.

### 4. Food production and agriculture

As grassland ecosystems come under stress, they will be unable to support current levels of livestock production. Crop yields are susceptible – cereal production in Spain is dependent on irrigation, and if this becomes untenable due to the high costs of maintaining such systems, maize production could halt. Most irrigation is in coastal locations, and water supplies may become salinised by seawater intrusion, as sea levels rise. Food security could become a major issue especially in the southern Mediterranean region.

Figure 1 shows how many of Spain's coastal irrigated areas – in particular in the western basin – are facing a serious threat of desertification. This, coupled with loss of land due to rising sea level, and salinisation of groundwater stores, means that food security will be an important issue as temperatures rise.

Figure 2: Projected climate events with an impact on human health

Global warming indicator	1961–90	2071–2100
Heat waves (biggest natural hazard killers)	1 every 3 years	Nearly 3 per year
No. of summer days with temps >40.6°C	1.6 per year	16 per year
Major drought frequency in Iberian Peninsula	1 in 100 yr event	< 1 in 10 yr event
Length of drought		Start earlier in the year and last longer

**5. Water wars**

Headlines in the media reflect some researchers’ and politicians’ views that decreasing water availability is a significant factor in a politically volatile area, and likely to cause unrest. Israel is a case in point, where water availability has been a critical factor in the siting of new settlements in Palestine’s Occupied Territories. Another continuing source of conflict is the Golan Heights – Israel is unwilling to cede possession, as the area provides one third of Israel’s water supply.

However, not all conflicts are transboundary. In Lebanon, along the course of the Oyoun Orgosh, to the east of Mount Lebanon, downstream villages have protested about fair access to water for irrigation and drinking, believing that villages upstream have extracted too much water.

**6. Migration**

On the richer European coastline of the Mediterranean, Spain has received most migrants, accepting over 650,000 immigrants in 2005. North African countries used to be transit countries for migrants hoping to reach the European shores, but all European countries have tightened their immigration controls in recent times. This means that sub-Saharan migrants have tended to stay particularly in the north of Tunisia and Morocco, adding to stresses on natural resources. In the last decade, Melilla and Ceuta, two Spanish enclaves in Morocco, have become immigration hubs. Also, many people have died trying to reach the Italian island of Lampedusa from the shores of Tunisia (Figure 1). In a UN study in 2004, it was suggested that up to 60 million people could move north from other African regions, imposing extra stress on water and arable resources along the African Mediterranean coast.

**7. Geopolitics**

Good governance and cooperation can reduce global warming impacts, especially as global warming is a transboundary problem. The northern, richer states already have an advantage in that their political structures are designed for collaboration, whereas Arab countries tend to be far more independent and less able to deal with global-scale issues affecting their region. The north and south Mediterranean regions need to collaborate at a time when political and economic differences are likely to make the impacts of global warming worse for poorer nations.

**8. Tourism**

The Mediterranean will become less popular as a tourist destination in the hottest months, although the tourist season may well split into two seasons, either side of the severe summer heat, thus maintaining revenue. Tourism, water supply and urbanisation are closely interlinked, and cannot be planned separately. Further north, the glaciers of the Pyrenees have lost 88% of their mass in the past 100 years and the majority of Spain’s ski resorts face closure. Heritage sites such as Venice may be inundated by a small rise in sea level – already, St Mark’s Square, Venice floods up to 60 times a year, compared with 10 in 1900.

**9. Risks to public health (Figure 2)**

Food insecurity and malnourishment weaken people’s ability to resist infection, and together with infectious diseases such as dengue fever, malaria and yellow fever, will require large increases in countries’ health budgets. Heat waves and high pollution levels cause respiratory problems among urban populations, whilst extreme weather events increase death and injury rates.

However, improved weather forecasting, education and more effective use of air conditioning mean that death totals need not be severe. Global warming will create greater humidity, making it harder for people to regulate their body temperature, and higher nighttime temperatures will make it more difficult to sleep.

**Case study – Egypt**

Egypt as being particularly vulnerable to the impacts of global warming. 96% of Egypt is desert, leaving only 4% of the land suitable for agriculture, of which about 60% lies in the Nile Delta. Not only is this Egypt’s ‘breadbasket’, it supports 30% (24 million) of the country’s population. Since nearly a third of the population rely on agriculture for their livelihood, land degradation through desertification (plus pollution), together with reduced water supplies, are destroying traditional livelihoods and in turn, leading to chaotic urbanisation of the only available arable land. In fact, the Egyptian environment minister believes that rapid and uncontrolled urbanisation is a greater threat to the Delta region than global warming (certainly a more immediate one).

The Delta, composed of river-borne silts, is necessarily a low-lying region and is particularly susceptible to sea level rise, as the Aswan Dam has caused the dwindling of sediment replenishment over recent decades which would otherwise help to sustain the coastline. Comparison of today’s coastline with older maps (Figure 3) reveals changes. Sea level has been rising here at 2cm/year for the last decade, causing flooding and erosion of beaches, as well as loss of archaeological treasures still to be excavated in ancient Alexandria, once the second-most important city in the Roman Empire.

The impacts of a sea level rise of 1.0m by 2100 will include:

1. Flooding of 25% of the delta, forcing about 8 million peoples from their homes, and this could be worse if the expected doubling of population occurs by 2050.
2. The nation’s food supply (and export potential) would be decimated, as nearly half of all crops, including wheat, bananas and rice, are grown here.



3. Seawater intrusion into the fresh groundwater would contaminate water supplies used for irrigation.
4. In Alexandria, over half a million people could be displaced, and 70,000 jobs could be lost.
5. Export items such as high-value added agricultural products could be damaged.

### Conclusion

Besides the impacts outlined in this article, global warming is a critical issue which may well undermine efforts towards sustainable development. It will exacerbate existing problems, and new and unforeseen threats to human health, ecosystems and national economies may emerge. Whilst single extreme events do not constitute evidence of climate change, there is increasing documentation to show that trends are developing which might be expected of warmer temperatures.

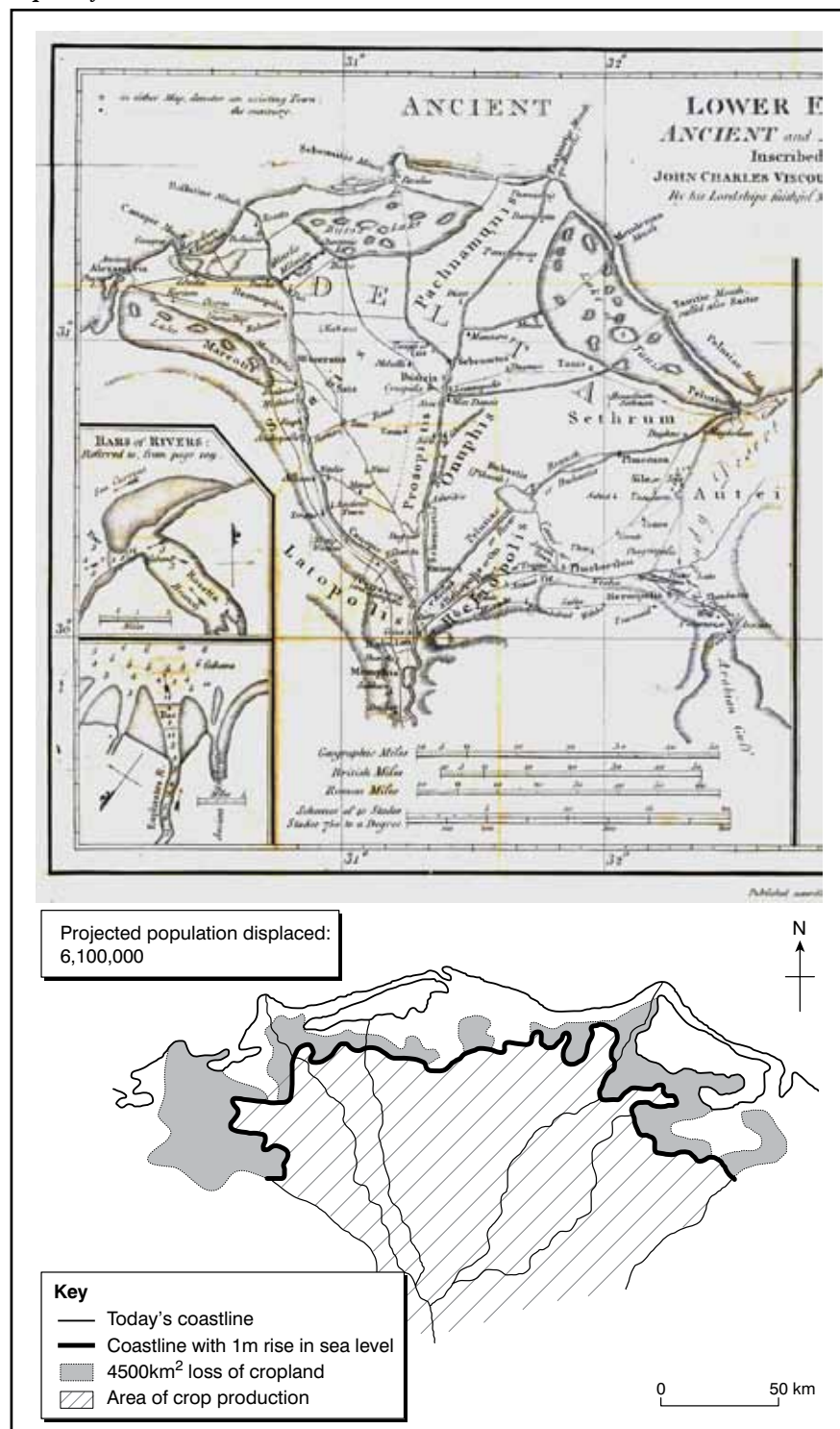
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Figure 3: A map of the Nile Delta published in 1800; below it is a map showing the impact of sea level rise on the Nile Delta



## FOCUS QUESTIONS

1. Why are impacts of global warming in the Mediterranean likely to show spatial variation? Which countries will suffer most, and why?
2. Explain why it is so difficult to determine the actual cause of desertification.
3. How might societies benefit from positive impacts of global warming?