Strategic Sectors | **Economy and Territory**

The Economic Costs of Climate Change

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With the release of the April 2014 contribution of Working Group III (WGIII), the Intergovernmental Panel on Climate Change (IPCC), the international organisation responsible for collecting and synthesising the latest peer-reviewed scientific knowledge in the field of climate change, concluded its Fifth Assessment Report (AR5).[1] The report periodically improves on past reports – the last was released in 2007 – describing new advances and findings in climate research. It is organised according to three main areas: the physical science basis for climate change, impacts and adaptation, and mitigation. The AR5 is the most important and comprehensive document to date to analyse the negative repercussions of climate change and offer insightful and evidence-based suggestions for policy-making.

Compared to earlier editions, one new feature of the contribution of Working Group II (WGII), that on impacts and adaptation, is a much more detailed regional analysis. Confirming and strengthening past evidence, variations in climatic conditions emerge as one of the most challenging of the many change drivers affecting the Mediterranean region. This article will briefly summarise these current and future trends.

[1] www.ipcc.ch/report/ar5.

Climate Change: The Problem

Climate change refers to a set of variations in climatic and environmental conditions, such as changes in maximum, minimum and average temperatures, the intensity and frequency of precipitations (rainfall and snowfall), wind speed, ice melting, and ecosystems, that will eventually affect human wellbeing.

Climate change has both natural and anthropogenic causes; nonetheless, the AR5 concludes that "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" (WGIII 2014). This human influence mainly takes the form of greenhouse gas (GHG) emissions due to the combustion of fossil fuels for production and consumption activities and to changes in land use.

Once in the atmosphere, GHGs alter the energy balance, cause warming and lead to climatic changes. These, in turn, are already affecting, and will increasingly affect, through environmental changes (impacts), many human activities around the world, albeit with important regional differences. These differences will depend on the varying levels of vulnerability of different regions of the world, which are driven by changes in local climate drivers, the intrinsic nature of the environmental services affected (land and water availability, land productivity, extent of flood-prone areas, and so on) and society's capacity to react to these changes with appropriate mitigation and adaptation measures.

Ultimately, climate change affects key aspects of our life: food and energy production, health, the degree of society's exposure to extreme events, mobility, and the inter- and intra-generational distribution of wealth.

Climate Change Impact Assessment: Methodological Issues

Assessing the current impacts of climate change, in physical and, then, economic terms, is extremely difficult. The main problem is that the available historical observations do not go back far enough to enable the proper attribution of a given phenomenon, including those with a clear weather-related component such as droughts, floods or heat waves, to climate change rather than natural climate variability. Moreover, these phenomena are often exacerbated by resource mismanagement. The IPCC's AR5 has made some progress on this issue, gathering better evidence that at least some of the episodes of water scarcity and yield decline experienced today can be imputed to climate change. There is then the difficulty of linking these phenomena to the right set of social and economic consequences (e.g. loss of land, labour and capital stock, or productivity) and, finally, of providing an economic assessment. Accordingly, estimates of the costs associated with current climate change are rare and basically consist of analyses of the direct economic losses entailed by a given well-defined extreme weather event. However, the main purpose of these exercises is more to offer an indication of what could reasonably be expected in a future characterised by greater changes in temperature than to determine current climate change costs.

The problem of attribution is somewhat less severe in long-term economic assessments of climate change impacts. However, in this case, uncertainty regarding future impacts, the structure of future societies and long-term aggregations of costs and benefits, including "intangibles," poses other daunting challenges. The dominant approach in these exercises is the use of a suite of coupled models. This makes it possible both to manage the huge complexity associated with the task and, by integrating knowledge from different disciplines (climate science, environmental concerns, socio-economic factors), to address all relevant aspects of the issue. Against this background, many different methodologies are used to conduct economic assessments. There are partial-equilibrium or bottom-up models providing detailed descriptions of impacts in a given market or sector with a focus on direct costs and there are top-down models emphasising long-term transitions, rebound effects and indirect costs.

Climate Change: Current Evidence and Future Trends in the Mediterranean

In the WGII's contribution to the IPCC's AR5 (2014), the Mediterranean picture can be derived by compounding the "regional" reports for Europe and Africa. Overall, the Mediterranean emerges as a climate hotspot[2] in terms of both natural conditions and society's attitude. Specifically, it is one of the regions of the world most subjected to phenomena such as soil degradation, desertification and water scarcity, especially on the southern shore. Moreover, the whole region may suffer from rising sea levels and droughts, the frequency and intensity of which have likely increased since 1950, as well as forest fires and heat waves. Extreme events such as coastal and river floods will be more frequent in the north. In Mediterranean Europe, for instance, there is already evidence of biodiversity reduction in plant and animal species, especially in mountain regions, which face a potential future loss of important ecosystem services. Wildfires have also generally consistently increased in recent decades, notwithstanding a decrease in the number of events and in total burnt area in the very last years.[3] In the longer term, the region is expected to experience a significant decline in yields, especially for cereals, given the sharp reduction in groundwater resources induced by significant changes in total runoff and evapotranspiration.[4] Health will likewise be strongly negatively impacted, due to more frequent and intense heat waves, with the associated reduction in labour productivity. The energy and recreational sectors will be also affected. Increased electricity demand due to increased cooling needs will raise generation costs,[5] while outdoor tourism activities are expected to decline as a result of the deteriorating climatic conditions, including unpleasantly high temperatures and

[2] IPCC AR5 defines "hotspot" as "A geographical area characterised by high vulnerability and exposure to climate change."
[3] Marques et al. (2011) in IPCC (2014).
[4] Olesen et al. (2011) in IPCC (2014).
[5] Giannakopoulos et al. (2009) in IPCC (2014).

increasingly heavy precipitations in summer. Unlike Mediterranean Europe, where negative climate change impacts will prevail, northern Europe may benefit from climate change, at least in moderate warming scenarios.[6] Therefore, climate change could be an additional factor contributing to widening the existing gap between northern and southern European countries.

The main climate change vulnerability of the southern Mediterranean region (i.e., North African countries) is expected in the agricultural sector. The observed changes in precipitation patterns in recent decades, with increases in autumn, but decreases in winter and spring, are expected to be further consolidated in the future.[7] This will exacerbate water scarcity and accelerate the negative change in yields.[8] Given the still high contribution of agriculture to the production of value added in the region, this effect is particularly worrisome. Another important stress factor is rising sea levels. In particular, the vulnerability of the Nile mega-delta will continue to increase due to higher population and infrastructure exposure on the already over-crowded and sea-flood-prone coastal system caused by migration/urbanisation phenomena[9] and to a sea-level rise that seems to be worse than anticipated in the IPCC AR4 (2007). Underlying all of this, health statuses may also worsen, due to both water-borne and vector-borne diseases, challenging regional healthcare systems.

Economic Estimates of Current Climate Change and a Glimpse into the Future

With all the caveats of the previous sections, to give an idea of the possible costs associated with climate change, we will first refer to the EMDAT International Disaster Database,[10] which reports extreme events occurring since 1900 by country and type, including, in some cases, the associated economic damage, although there is a particularly notable lack of data for North Africa and the Middle East.

The only two events somewhat related to weather conditions reported with the associated economic damage for the Mediterranean region in 2013 were a flash flood occurring in the French Pyrenees in June, killing two people and affecting 2,000 more, with an estimated cost of around $655 million, and a general flood occurring in Sardinia (Italy) in November, which killed 18 people and affected 2,700 more, causing $780 million in economic damage. In 2012, three flood events were recorded in Spain, Slovenia and Italy with estimated costs of $395, $265 and $15 million, respectively. Italy was also affected by a drought episode lasting from June to October, causing damage equal to $1,190 million. In Mediterranean Europe, the largest losses since 2005 were experienced by France, due to two storms, in 2010 and 2009, causing an estimated total damage of $4.23 and $3.2 billion, respectively. Wildfires have also been quite remarkable in the last decade, with two events in France (2005) and Greece (2007) causing economic losses of $2.05 and $1.75 billion, respectively. Overall, EEA (2012) estimates that costs linked to extreme events in Europe have increased from €9 billion/year in the 1980s to more than €13 billion/year in the 2000s (with a cumulative total of €445 billion over the 1980-2011 period) and that they could possibly increase to €15 billion/year by 2070.

The most recent economic assessment of a climate-related event for North Africa refers to a flood in the El-Bayadh region of Algeria occurring in October 2011, which killed 10 people and resulted in $779 million of economic damage. The EMDAT database reports other floods of minor intensity for Algeria in previous years, while other countries are very poorly covered. Only two floods are recorded for the eastern Mediterranean, both occurring in Turkey, in 2009 and 2006, entailing estimated losses of $550 and $317 million respectively; likewise, there is record of a wildfire in Israel in 2010, causing $270 million in damage.

Overall, since 2005 the average annual economic damage in the Mediterranean region due to weather-related events recorded by EMDAT amounted to $1.408 billion for floods, $2.816 billion for storms, $1.190 billion for droughts, and $971 million for wildfires.

[6] EEA (2012).
[7] Barkhordarian et al. (2012 and 2013) in IPCC (2014).
[8] Gao and Giorgi (2008) in IPCC (2014).
[9] Seto (2011) and Smith et al. (2013) in IPCC (2014).
[10] www.emdat.be/database.

Looking back slightly further, the heat wave that swept Europe in the summer of 2003, in addition to causing a heavy death toll, led to a remarkable 20% reduction in grain yields in Mediterranean and eastern Europe. The net primary productivity of France and Italy fell 17% and 12%, respectively,[11] with estimated economic losses of €4 billion each.

It is important to stress that we are not claiming that these losses were caused by climate change. Nonetheless, it can be correctly claimed that episodes such as heat waves, droughts, wildfires and extreme precipitation will increase in frequency and/or intensity in future due to climate change. Accordingly, the highlighted economic losses are also likely to increase in the absence of appropriate mitigation and adaptation strategies.

To conclude this section, we will just mention the results of the CIRCE[12] FP6 project. Among many other findings on future climate change and impacts in the Mediterranean, it reports the associated expected costs in terms of changes in gross domestic product (GDP). An initial survey of the existing literature found GDP losses ranging from 0.25% (or even slight gains) for moderate temperature increases (less than +2°C with regard to preindustrial levels) to 1.4% for quite extreme 5°C temperature increases for southern Europe and of around 2% for North Africa and the eastern Mediterranean by mid-century. Of major concern for Euro-Mediterranean countries are the impacts originated by rising sea levels and changes in tourism attractiveness, while in North Africa impacts on agricultural productivity are of greater concern, accounting for 77% of total losses. CIRCE also developed its own impact estimates, restricting the analysis to sea-level rise, energy demand and tourism. In terms of aggregate impact, by 2050, for a temperature increase of roughly 2°C with regard to 2000, GDP for the entire Mediterranean region would fall 1.2%, with the northern Mediterranean countries clearly less vulnerable than southern Mediterranean ones. Among the former, the average loss by 2050 would be 0.5% GDP, while among the latter it would be more than double that (Bosello and Shechter, 2013).

Conclusions

The Mediterranean region is particularly exposed to climate change. Some of the effects of climate change can already be detected today. Nonetheless, attributing economic losses to current climate change is very difficult. What can be said is that current economic losses associated with weather-related events such as floods, droughts, heat waves, wildfires and sea-level rise will increase in future because of the additional pressures posed by climate change. Also, in a scenario of moderate climate change with a limited number of impacts, the Mediterranean region as a whole could experience GDP losses of 1.2% by the mid-century. Furthermore, these costs will not be evenly borne. Northern Mediterranean countries are clearly less vulnerable than southern Mediterranean ones. The potential scale of impacts and their distribution thus calls for appropriate mitigation and adaptation measures.

References

Bosello and Shechter. "Integrated Socio-Economic Assessment (The Economic Point of View)." In: Navarra, A., and Tubiana, L. (Eds.). *Regional Assessment of Climate Change in the Mediterranean – Volume 2: Agriculture, Forests and Ecosystem Services and People*, 2013.

European Environment Agency (EEA). *Climate Change, Impacts and Vulnerability in Europe*. 2012. Available at: www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012.

Intergovernmental Panel on Climate Change (IPCC). "Climate Change 2007 – Impacts, Adaptation, and Vulnerability," WG II contribution to the *IPCC Fourth Assessment Report*. 2007. Available at: www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html.

Intergovernmental Panel on Climate Change (IPCC). "Climate Change 2014 – Impacts, Adaptation, and Vulnerability," WG II contribution to the *IPCC Fifth Assessment Report*. 2014. Available at: www.ipcc.ch/report/ar5/wg2/.

[11] Ciais et al. (2005) in IPCC (2014).

[12] CIRCE: Climate Change Impact Research: The Mediterranean Environment. Available at: www.circeproject.eu.