The 5 Times of the Biosphere. Risks for the Mediterranean civilisation and sea biodiversity

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Abstract

Geology, Palaeontology and History can be brought together under the auspices of biogeography, the "frontier" disciplines, to guide us in the explanation of the orders and disorders of a World in perpetual movement through the theory of the "5 Times of the Biosphere". The subject of Fernand Braudel's geo-historical work, the Mediterranean sea and the Mediterranean region are like the cradle of a renewed reflection on Time and its rhythms in the light of climate change and rising salt water levels, which are accelerating at an alarming rate. This calls into question the biogeographical characteristics of the Grande Bleue or Big Blue and its shores. Global warming is thus likely to seriously weaken civilisations whose sustainability depends to a large extent, and even essentially, on the availability of water and an atmosphere that is simply breathable and physiologically bearable.

Keywords*: Climate Change, History, Adaptation, Mediterranean.*

Introduction

Life and Earth Sciences and Human and Social Sciences can be brought together under the umbrella of biogeography to guide us in explaining the order and disorder of a world in perpetual motion. We are currently experiencing accelerating climate change, which is calling into question the foundations of many civilisations. The subject of Fernand Braudel's pioneering geo-historical work, the Mediterranean sea and the Mediterranean region offer a concrete space for renewed reflection on Time and its rhythms. Extending the Braudelian concept of the "3 Times" of History, our reflection opens onto the "5 Times" of the Biosphere, a concept born of bio-geohistorical reflection committed to responding to the major challenges of climate disruption and the upheavals of the Earth, which overdetermine the life of living communities, of which humanity is a part.

Indeed, the acceleration of climate change calls for a fresh look at natural history and the rhythms of life on Earth. An effort to synthesise the visions of geologists, palaeontologists and historians would appear to be useful, confirming biogeography as a "bridge" between the natural sciences and the humanities. This approach also serves the purpose of futurists in their attempt to mark out the paths of the future by relying on a "science of temporalities" nourished by History but also by the ability to invent possible futures

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according to the oscillations of the "Clockwork of the Earth" (Degron, 2024 online[1]).

Understanding the cycles that over-determine the evolution of the biosphere requires an effort of abstraction in order to move away from a linear perception of Time and gain a better grasp of development cycles and their disruptions, as well as their implications in terms of public policy. The foresight approach helps us to do this (Degron, 2022). It is also a matter of better understanding the divisions between the components of a society whose components do not experience events according to the same rhythms: not being able to manage "one's end of the month", the socio-economic constraint, makes one less receptive to the "end of the World", the environmental constraint, as we pointed out at the time of the "yellow waistcoats" crisis, when working at *France Stratégie* (Degron, 2018). Even if the former can be considered "flexible", pushing living beings and singularly humans to adapt to the latter, perceived as hard, physically unsurpassable, we should not underestimate the strength of social movements hostile to an ecological transition deemed unjust, especially in a democracy where the opinion of the greatest number can take precedence over scientific rationality and where the political game has its own rationality, sometimes complex[2].

Analysing the timescale of the Biosphere requires the mobilisation of a variety of knowledges (geology, ecology, biology, history, economics, sociology, political science). We need to transcend the barriers between disciplines and encourage dialogue between them. By virtue of its in-between position, geography, which touches on the first world through biogeography and on the second through human or economic geography, can serve as a "bridge" for the construction of global knowledge. Alfred Wegener (1928) deals with time as much as Valérie Masson-Delmotte (2012), Claude Lévi-Strauss (1993) or Georges Duby (1996), but they do not understand it on the same "scale", or rather according to the same "time step": Wegener reasons about continental drift in terms of millions of years; using glaciology, Masson-Delmotte reconstructs climates from a few hundred thousand years ago; Lévi-Strauss's "sad tropics", the civilisations that have disappeared, will only have lived for a few thousand years; Duby deciphers medieval life from a secular perspective only.

To understand the phenomena affecting the Mediterranean world and appreciate the fragility of a thousand-year-old civilisation and its biodiversity, which are being permanently disrupted by global warming, we need to connect the many facets of the human and life sciences.

1. The theory of the three stages of history

Fernand Braudel, historian and geographer, developed the theory of the three stages of history without considering the evolution of geological substrata, or that of soils or climates, which he regarded as quasi-invariant (Braudel, 1949). Considered to be the founder of geohistory (Ribeiro, 2012), his pioneering thinking was anchored in his state thesis on the *Mediterranean and the Mediterranean world in the time of Philip II* (1949). In formal terms, the three phases he developed there correspond to the three parts of his work. In terms of content, these periods are characterised by a metric, ranging from a few thousand years to just a few years.

The first stage of history, that of civilisation, of the "long haul", is on a millennial scale. It brings with it religions, arts and mentalities, materialising in the architecture, painting, literature, music and art of living of the peoples of the Mediterranean basin. The second period perceived by Braudel is social. In line with the École des *Annales*, founded by Marc Bloch and Lucien Febvre, and the Marxist conception of history (Thuillier and Tulard, 1990), this time oscillates with the secular movements of the economy,

[1] https://www.futuribles.com/en/et-si-en-2050-lhorlogerie-de-la-biosphere-se-dereglait/.

[2] Robin Degron, 6 November 2023, Opinion column published in Acteurs Publics «*Finances publiques et Environnement : Acceptability, beware of the dangers*». https://acteurspublics.fr/articles/robin-degron-finances-publiques-et-environnement-acceptabilite-attention-dangers.

modes of production and trade: slavery, serfdom, wage-labour, the advent of industrial and then financial capitalism largely dictate the daily life of human communities and, more broadly, of all living communities. The historian's third and final phase is "the time of the individual", as Braudel puts it, the time of everyday life.

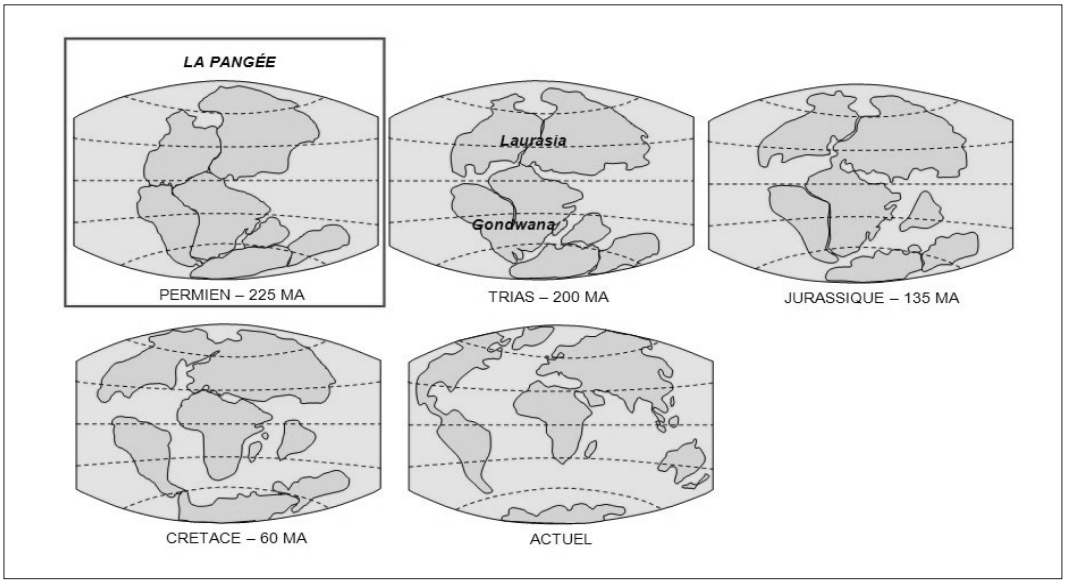
The Braudelian theory of the three times has enjoyed great success, but it has also been the subject of criticism, or at least debate. Other authors have attempted to analyse time through the prism of the human and social sciences, in particular the sociologist Georges Gurvitch, founder of the *Cahiers internationaux de sociologie*. In opposition to Braudel, whom he considered to be an "imperialist" theorist of history, Gurvitch acknowledged the importance of historical time, but relativised its explanatory value, considering it to be the result of social time (Maillard, 2005). He advocated a scale of *eight temporalities*: 1) time of long duration and slow motion, 2) "trompe l'œil" or "surprise time", 3) time of irregular beats between the appearance and disappearance of rhythms, 4) time lagging behind itself, 5) time alternating between delay and advance, 7) time in advance of itself, 8) the explosive time of creation. Fernand Braudel responded by noting the overly qualitative nature of the times proposed by Gurvitch. According to the historian, in this sociologist's division of time, time is difficult to measure: "*the time of sociologists cannot be ours* [...]. *Our time is measured, like that of economists. When a sociologist tells us that a structure constantly destroys itself in order to reconstitute itself, we readily accept the explanation, which historical observation confirms. But we would like, in line with our usual demands, to know the precise duration of these movements, whether positive or negative*" (Braudel, 1958).

With regard to Braudel's second "socio-economic" phase, we could introduce another criticism of a systemic nature, which this time resonates with the current situation of a World in which the Living is no longer limited to the Human in our awareness of it. In our view, it is worth highlighting the anthropocentrism of Braudel's original thinking, a logical prism for a post-war author who was confronted with the reality of a bipolar ideological opposition, but who was not yet at the height of environmental issues and the risks that the emerging consumer society would bring to bear on all living communities. It was not until the 1970s that the world turned the corner, notably with the first Earth Summit in Stockholm (1972). Industrial and then financial capitalism effectively dictated the lives not only of human communities but, more broadly, of all living communities. Biodiversity as a whole is being squeezed by the over-exploitation of resources, the artificialisation of land and the accumulating pollution (Lévêque and Mounolou, 2008; Degron, 2012; Lévêque, 2021).

By the same token, the third and final period of history, "the time of individuals" in Braudel's phrase, the time of our daily lives, has a major impact on living organisms as a whole and on their diversity. As a biogeographer, today we would prefer the term "the time of living organisms", "biological time" in short. With the exception of human beings, animal and plant biocenoses are caught up in the short time of their existence and appear fragile in relation to the time of the civilisations and societies that overhang and enslave them. If we were to associate this third time with a unit of measurement, we would obviously have to take a few precautions. A human life can be measured in decades, according to demographic data on life expectancy, which varies considerably from one region of the world to another, from one social class to another and, to some extent, from one gender to another. For other living organisms, the spectrum is wider: a butterfly lives only a few days; a flowering plant lasts only a few weeks; an oak, olive or sequoia tree can last several hundred years. All the same, for the sake of clarity, let's use the year or ten years as a yardstick for measuring our precarious lives. We will leave aside here the supra-individual reflection that encompasses the being in the *continuum* of a phylogenesis that is not a *priori* aware of itself. We are talking here about individuals, beings in their materiality and their sensitivity. We are taking an "augmented humanist" approach *to Homo sapiens sapiens*, part of a Biosphere in motion (Morin, 2021).

By adopting Braudel's ideas as our own, and

Map 1 - Evolution of the Earth's surface from the primary era to the present day (in Millions of years, MA)



Source: Banque de Schéma Supérieur, Académie de Dijon, Alain Gallien (2005)

building on his achievements to develop them further in the light of our "long emergency" climate, we are seeking to organise the times of the Earth and its living communities in a way that bridges the gap between History and the Life and Earth Sciences.

2. Geological time and natural weather patterns

When it comes to understanding the world, geography is not just about living communities, social pressures or human buildings. The history of the Biosphere must also include the temporality of biotopes and the environment. The Earth and the diversity of its landscapes are a dynamic geological and climatic construction, but this dynamic is slow enough for us not to perceive, in general, the driving forces at work over a very long time.

Geological time

Alfred Wegener's theory of continental drift (1928), extended by the theory of plate tectonics, provides an almost imperceptible image of the Earth's surface. Wegener, who trained as an astronomer, did not initially measure the dynamics of the Earth's crust. He began by observing the astonishing geometric interlocking of the African and American coasts and the proximity of plant communities on either side of the South Atlantic. From this he deduced how far apart they have become over millions of years. Occasionally, and often tragically, volcanism or earthquakes remind us of the power of tectonics: just think of the African plate gaining on the European plate, to the great displeasure of Italian Alpine communities[3] or, just recently, Moroccan populations in the Atlas mountains[4]; nor should we forget the French Overseas Territories where the work of the magma depths unexpectedly ris-

[3] Among the many earthquakes that have affected northern Italy, the most recent was the one that hit the town of Bonate Sotto in December 2021, and whose tremors shook Milan, fortunately without causing any casualties. In 2016, the Amatrice earthquake killed almost 300 people.

[4] The earthquake of 8 September 2023, which took a heavy toll on the Marrakech and High Atlas regions, recently reminded us that the African plate was also at play to the south of the Mediterranean along the subduction zone of the African plate beneath the European plate.

es to the surface and can engulf villages or entire towns[5]. If it is relatively discreet, so much the better, because when it is agitated, locally, it crushes everything.

In our analysis of time, geological time therefore holds a special place. Because of its power and slow pace, it could be considered virtually absent from the History of Mankind. And yet, with its spasms that are difficult to anticipate, it produces fearsome jolts that do not, in themselves, call into question civilisations that have extended far and wide, despite their punctual and territorial violence. At the limit of our reasoning on the Earth's timescale, we are also leaving aside, as a first approximation, non-geological phenomena of a planetary nature (e.g. meteorite impacts, solar eruptions) which can obviously eradicate all forms of life on the Blue Planet. Implicitly, we are isolating the Biosphere from its cosmic environment in order to better address the point of our fragility, as components of Living Things, from the effects alone of the geophysics of the Globe and the atmosphere induced by industrial activities.

So, alongside the cataclysmic events, the structural changes brought about over geological time become apparent as we look back over millions of years (see Map 1).

Natural weather patterns

Climate time is normally shorter in scale, but long enough to suggest the immutability of the biomes and soil and climate factors that structure our geography. Based on research by glaciologists in Antarctica, Valérie Masson-Delmotte (2012) points out that past climate variations over the last 800,000 years bear the imprint of the Earth's orbit around the Sun, with a cyclicity of around 100,000 years, to which is added a variability linked to the Earth's obliquity with a periodicity of around 40,000 years and another linked to the precession of the equinoxes with a time step of around 20,000 years. The glaciological analysis carried out at Vostok (Antarctica) of changes in carbon dioxide and methane concentrations and insolation over the last 420,000 years illustrates the natural climate cycle (see Figure 1 from Petit *et al.*, 1999).

This fundamental, long-term work is confirmed by the work of climate historians, in particular the remarkable work of the late Emmanuel Leroy-Ladurie (2007), who died last year. His work made it possible to detail the changes in climate over the course of medieval history, modern times and the contemporary period, without however calling into question the dynamics at work in global warming, which has been accelerating since the start of the 21st century: "*because of climate variability, we have experienced waves of hot, even scorching summers in the past, particularly in the 17th century. But from the point of view of the effect on humans, these episodes were quite different from those we "experienced" recently (notably in August 2003 and July 2006). In the twentieth century, there were heatwaves in 1911, 1921 (less severe), 1947, 1959, 1976 and 1995; as for 2003, it was the summer with the highest average temperature in the history of Western European weather for centuries*".

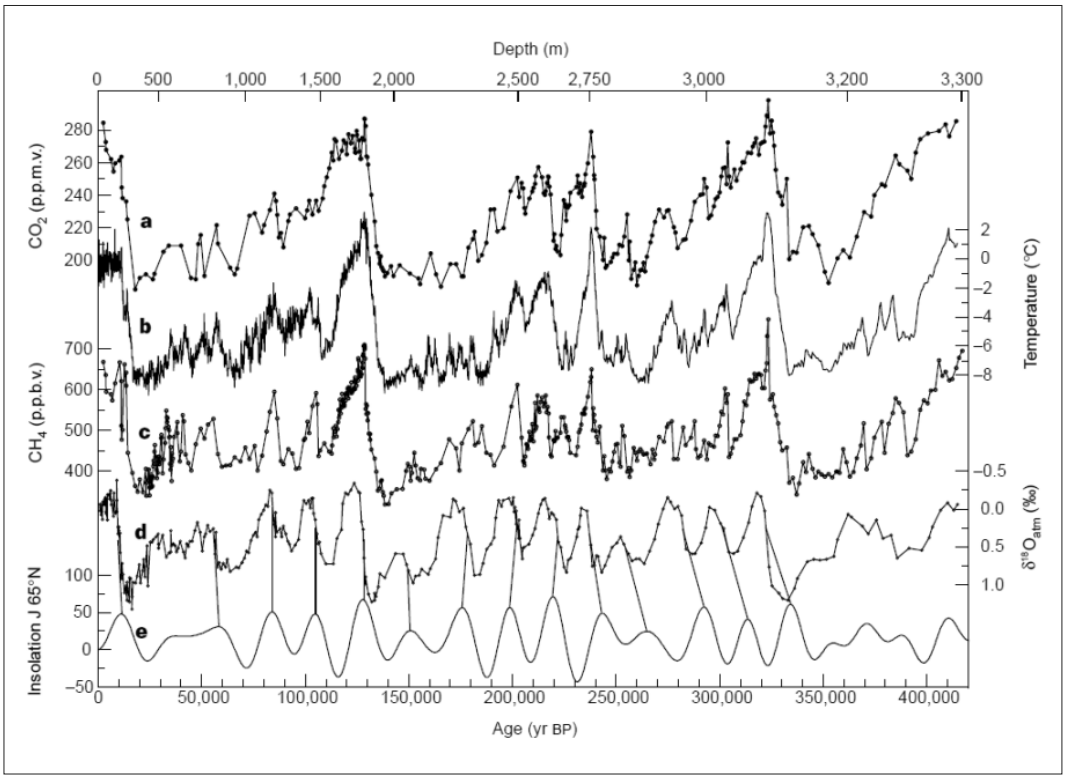
The IPCC's reports, in particular the 6ème report published in 2021, demonstrate the rapid warming caused by man-made emissions of greenhouse gases (carbon dioxide, but also methane and nitrous oxide), which have increased the Earth's average temperature by 1.1°C between 1850 and 2020. For 2023, in line with COP28 held in Dubai, it is worth highlighting the acceleration of the phenomenon: whereas in Paris, in 2015, COP21 of the Climate Convention (UNFCCC) aimed to limit the rise in average temperature to +1.5°C between 1850 and 2100, we have already reached +1.48°C in 2023. That's the bad news for early 2024. The international community's proactive approach seems to have been lost on a global scale.

At this rate, the IPCC experts consider that a rise of +3 to +4°C by the end of the century has become likely. To give an idea of the biogeographical consequences of such a temperature

[5] In 1976, the Soufrière volcano erupted, forcing the entire population of the town of Saint Claude in Guadeloupe to move.

Figure 1 - Changes in concentrations of carbon dioxide (CO2), methane (CH4) and insolation over the last 420,000 years, based on analysis of Vostok ice.

N.B.: The times closest to us are on the left of the graph. The scale at the top of the graph is expressed in terms of ice depth (in metres) and the scale at the bottom in terms of age (in years since present day).



Source: Petit et al., 1999

change, 100,000 years ago, the Earth's average temperature was around 5°C lower than it is today. Northern Europe was then covered by a glacier, France was covered by tundra and sea levels were 100 metres lower. Today, we are witnessing major climate disturbances that are disrupting the clockwork of the biosphere and its communities.

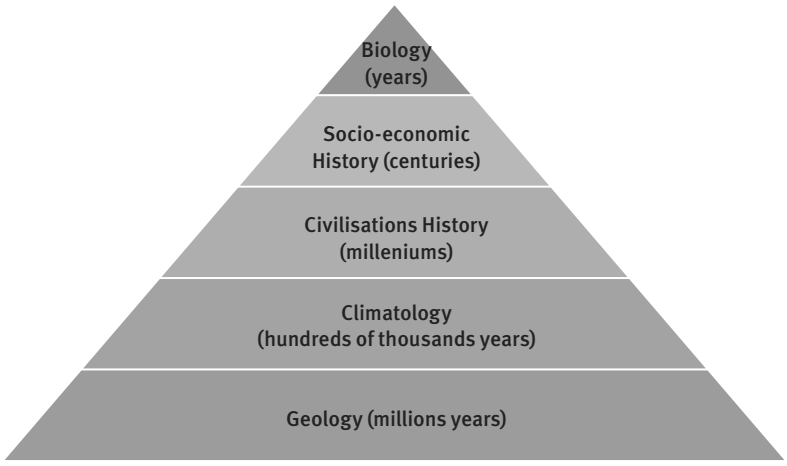
The very long time component of Biogeography is beginning to interact with the long time component of History, colliding with it and accelerating it. In fact, this "clash of temporalities" is forcing us to adopt a unified vision of the "5 Times of the Biosphere", in order to give a better account of the solidarity between living beings, and humanity in particular, and the planet that supports them.

3. Towards a unified and structured approach to Time

In the end, five timeframes are superimposed and articulated to give rhythm to the life of our planet and its living processions: geological time, pedoclimatic time, the time of civilisations, socio-economic time and biological time.

With atmospheric temperatures expected to rise by around 3 to 4°C by the end of the 21st century compared with the pre-industrial period (1850-1900), the soil and climate factors that characterise biomes are changing. Qualitatively, the main types of climate will remain broadly the same, but quantitatively, crossing record temperature thresholds will doom entire species, whose ecological amplitude is conditioned by a

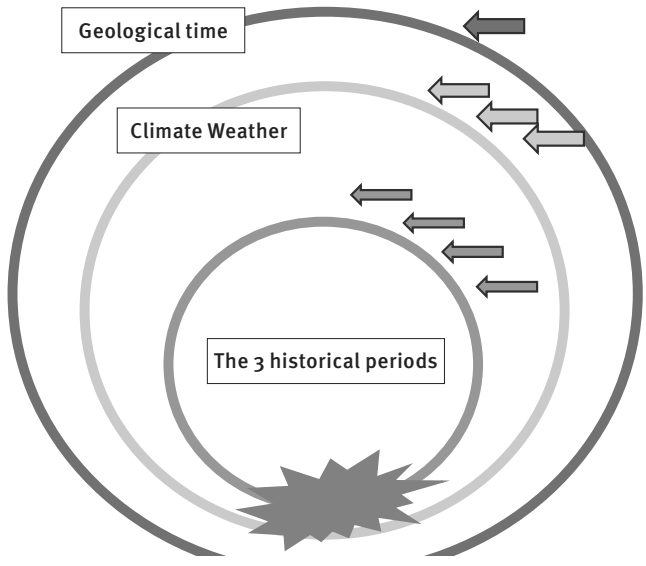
Figure 2 - The 5 times of the Earth and its living communities.



genetic capital that cannot mutate and adapt as quickly as the rise in temperatures. Climate disruption calls for an integrated vision of the Earth and its living communities (see Figure 2).

By speeding up natural climatic time (Figure 3), humankind, and in particular its unbridled industrial activity, which has been a corollary of the hyper-consumption society since around

Figure 3 - The 5-stage wheel of the accelerating Biosphere.



The acceleration of climate change, particularly in the Mediterranean, and the clash of timeframes in the Biosphere

1950, is disrupting the time clock of the biosphere and impacting on the times of History, starting with the times of our own times but going backwards to economic times and even, from now on, the times of civilisations.

The acceleration of climate change, particularly in the Mediterranean, and the clash of timeframes in the Biosphere.

4. The Mediterranean sea and the Mediterranean region at risk from climate change: leading indicators of the collapse of Mediterranean civilisations

a) The Mediterranean, a hotspot for global warming and plate tectonics

The Mediterranean region (see Map 2) has always been sensitive to the interactions between climate and mankind: Plato, in his last philosophical tale, Critias, noted that Attica had become a stony land due to alternating hot summers and abundant autumn rainfall, which washed out the soil, combined with overexploitation of forest resources that are difficult to regenerate in these soil and climate conditions (Degron, 2018). The Mediterranean area is a biogeographically degraded region, with low shrub formations of the scrubland or maquis type from which emerge a procession of pubescent or holm oak groves with pine plantations punctuated by relict climatic woodlands (e.g. culminating beech grove) like those depicted by Cézanne on the Sainte Beaume. Today's climate is therefore similar to that of yesteryear, but with the unprecedented intensity of worsening summer droughts and autumn rains caused by evaporation from an inland sea overheated in summer.

According to MedECC, the group of environmental and climate change experts specifically dedicated to the Mediterranean (UPM-UNEP/Plan Bleu, 2020), the average annual temperature on land and sea in the basin is already 1.5°C higher than in pre-industrial times. By 2100, it is set to rise by +0.5 to +2.0°C compared with the rest of the world, reaching 3.8 to 6.5°C depending on the scenario used to combat climate change (the optimistic RCP2.6 scenario, which aims to stabilise the average annual global temperature at +2°C by 2100, *compared with* the more pessimistic RCP8.5 scenario, which targets a global average of +4°C). Whatever scenario is adopted, the rise in atmospheric temperature in the Mediterranean is well above the global trend. This is particularly worrying given the sensitivity of southern environments.

Map 2 - The Mediterranean basin.

Source: Wikimedia Commons, sous licence d'utilisation libre, Idarvol (2005)

The Mediterranean region also has a remarkable geological feature that plays a role in the accelerated warming of sea water. Straddling the Eurasian and African tectonic plates, which form an East-West boundary, the Mediterranean Sea is subject to a subsidence phenomenon that makes its coastlines more sensitive to rising sea levels, in addition to the well-known factor of fluid dilatation caused by rising air temperatures.

Three researchers from the Italian National Institute of Geophysics and Volcanology in Bologna and Rome and the Dutch University of Radboud (Vecchio *et al.*, 2023) have established the facts about subsidence. Broadly speaking, the land sinks and the seabed rises, pushing up the water level on the coastline. In detail, the researchers demonstrate that the projections in the IPCC's 6ème report (2021) underestimate future sea levels along the Mediterranean coast because the effects of tectonics and certain other local factors have not been properly taken into account. Their revised projections of sea level in 2100, compared with those of the IPCC, show maximum and minimum differences of 1094 ± 103 mm and -773 ± 106 mm, respectively, with a mean value that is about 80 mm higher than that of the IPCC in its reference scenarios and at different levels of global warming.

The study even predicts that as a result of the global rise in the coastline (a rise of both climatic and geological origin), more than 38,500 square kilometres of coastline could be flooded by 2100-2150. According to this study and the projections made, France would be the third country most exposed to risk factors (3,681 km^2, mainly on the Rhône delta), after Egypt (12,879 km^2, on the Nile delta) and Italy (10,060 km^2, on the Po delta). Emblematic cities of Mediterranean civilisation such as Venice, Istanbul and Alexandria would be directly threatened. On the other hand, the Galilee coast in Israel and the Phlegrean Fields in Italy would experience a relatively slow rise in sea level thanks to the uplift of the land as a result of tectonics and volcanism, which are particularly prevalent in these regions: on the Galilee coast and the Phlegrean Fields, the variation in sea level in 2150 compared with 2020 would be around 0.5 and -0.7 m respectively.

The two primary processes of the Biosphere, that of Geology and that of Climatology, are therefore combining to harden living conditions in the Mediterranean basin. Natural history and history are working together on the Mediterranean. The concrete consequences are already palpable, and even threaten the fundamental equilibrium of terroirs and territories.

b) Worrying signs of the disappearance of Mediterranean civilisation

Agronomic issues

Over and above the fires that are perceived to be recurrent in the Mediterranean area (Clément, 2005), in order to measure the extent of the phenomenon of the disappearance of Mediterranean civilisation, we need to characterise the agronomic character of this civilisation and follow the evolution of a few key indicators that reflect, over time, the reality of a rapid decline. We have now reached a point that raises questions about the very survival of Mediterranean civilisations: their agriculture is dying out all over the Basin. To take a step back, let's return to Fernand Braudel (1949) and his attempt to characterise the singularities of the Mediterranean. According to Braudel, three emblematic products form the basis for the development of community life in this vast region: wheat, wine and olive oil. A number of indicators point to yield losses and the subsequent worsening of environmental conditions.

In the case of wheat, which is the staple food in the south of France (e.g. bread, pasta, semolina), it is clear that productivity is being eroded, despite the fact that Mediterranean soils are already not very fertile: in France, the yield differential between the country as a whole and the Provence-Alpes-Côte d'Azur region is around 50%. Even more worrying is the long-term trend in productivity in the region, once the effect of genetic seed improvement has been neutralised: since the end of the 1990s, durum wheat yields have fallen by around 10 quintals/ha, or almost 25% of average annual productivity, according to the PACA consular chambers. In the Eastern Mediterranean, there is a lack of solid statistical data, but the problem is illustrated by the inabil-

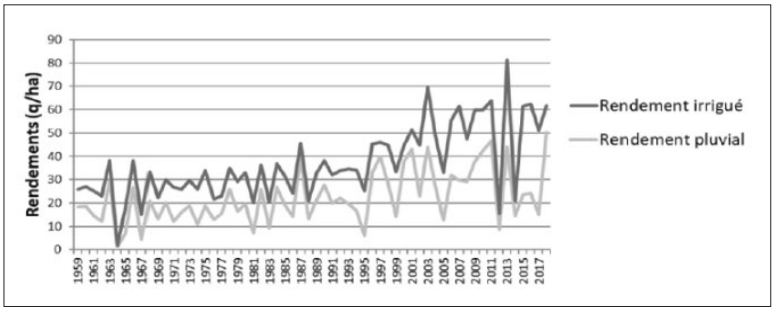


Figure 4 - Yield trends in olive groves in the province of Jaén (Andalusia, Spain) from 1959 to 2018.

Source: Arfaoui et al., 2021

ity of the Mashreq countries to feed their own populations. Current geopolitical events remind us that Egypt is obliged to ask Russia for help to ensure the security of its soft wheat imports and to produce the semolina that is the staple food in the Nile Valley[6].

Wine production is also struggling, despite the widespread use of drip irrigation systems, particularly in the Languedoc region, since the early 2000s. A study carried out by the Hérault Chamber of Agriculture, which is at the forefront of winegrowing issues, reveals and measures the impact of climate change on vines. Despite considerable inter-annual variability, a clear trend towards lower yields is emerging. Several trajectories, both linear and parabolic, can be used to explain the decline: with productivity of around 65 to 70 Hectolitres/ha in the 1990s, yields from Languedoc vines fell to around 55 Hl/ha in 2012. The latest figures for 2021 are 35 Hl/ha: the most rapid reduction curve seems to best reflect the downturn.

In Italy, the world's leading wine-producing country, the case of the vineyards of Umbria and the testimony of a traditional winegrower, Francesco Paolo Valentini, give a literary but very human and synthetic tone to the effects of climate change[7]: "*The climate is changing too fast. At this rate, we won't soon be able to make wine in Italy.* [...] *Agriculture is an outpost of changes in the natural cycle. Something very serious is happening.* [...] *Those who, like me, produce artisanal wines are the first to notice, but sooner or later everyone will see the effects. At this rate, prosecco will be made in Oslo while we grow bananas and pineapples.*"

The olive tree is the third characteristic cultural feature of Mediterranean agrarian civilisation, both to the north and south of the Basin. Thanks to its resistance to high summer temperatures, it is the "last line of defence" against global warming. It floods the Peloponnese from Corinth to Nafplio. It is becoming established in the south of Spain. The case of the province of Jaén in Andalusia – Spain's leading olive-growing region and world *leader* in the sector – has recently been the subject of a very detailed monograph showing the yield dynamics at work and the reactions of olive growers to drought (Arfaoui *et al.*, 2021). Since 1996, researchers have observed that yields have stopped increasing and are marked by high interannual variability (see Figure 4). On average, productivity is better under irrigation, with a difference of around 10 quintals/ha between rainfed and irrigated crops over the period 1959-2018, but in some cases with differences of almost 20 quintals/ha over the last fifteen years. In order to maintain their yields, farmers are having to resort to artificial irrigation on a crop that traditionally did without, putting additional pressure on all water users in a region of Spain that is already particularly arid.

[6] Egypt is the world's largest importer of soft wheat, with an average of 12 Mt/year over the period 2017-2022. According to the International Grains Council (IGC), it obtains 61% of its supplies from Russia and 23% from Ukraine.

[7] According to the Italian newspaper *L'Essenziale*, translated by Courrier International, «Quand le vin italien disparaîtra», 3 August 2022.

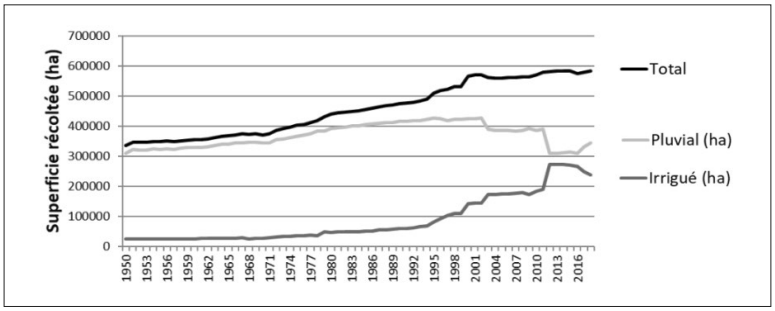


Figure 5 - Change in the area under olive trees in the province of Jaén (Spain) from 1959 to 2018.

Source: Arfaoui et al., 2021

In order to preserve their production, Andalusian farmers are planting more and more land, mechanically increasing the pressure on the water resources they can no longer do without (Figure 5): between 1950 and 2018, the area under olive groves in the province of Jaén practically doubled, rising from around 300,000 to 600,000 ha.

The maritime challenge

Then there's the sea to study: its biodiversity, shellfish, fish and fishing. Here, the seabed and aquatic populations are naturally more difficult to observe and measure. In fact, Braudel took fishing in the Mediterranean "out of the field" of his analysis, a sea that he saw primarily as a place of economic exchange, without paying too much attention to its strictly maritime production. In the light of climate change and advances in oceanography, we can now look at the sea and its products with a new, finer eye than in the past. The warming of the air is partly buffered by the water that absorbs the sun's energy. This affects the life of coral reefs, plankton and fish via the food chain. If fish populations collapse, fishing is threatened. The latest research findings are alarming. For the first time (Ben Lamine *et al*., 2023), French and Monegasque scientists have worked on the scale of the exclusive economic zones of EU countries, on nineteen species of major economic interest for Mediterranean countries. Their projections between now and 2100 compared with the reference period 1990-2017 show that, in the Mediterranean, the projected falls in tonnage (*Maximum Catch Potential*) range from -20 to -75% for catches using surface towed nets (pelagic trawls, seine fishing) to -50 to -75% for set nets or traps. They are over -75% for bottom trawls. We are indeed going to hit rock bottom.

Conclusions

Wheat, grapes, olive oil, fish: the agricultural and marine foundations of the Mediterranean are being inexorably eroded. The cradle of Judeo-Christian and Arab-Berber civilisations is withering away. Because the effects of the accelerating climate are not only affecting the roots of Western civilisation, from the Peloponnese to Catalonia, via Lazio and Provence. From Egypt to Tangiers, via Phoenicia and Carthage, the Arab-Muslim and Berber world is also suffering in the south of the Basin. Often opposed, antagonised since the Crusades, the fall of Constantinople, the battle of Lepanto and the wars of colonial independence, the two shores, the two souls of the Mediterranean are sisters in the face of the power of climate change. The environment unites us and calls for peace, especially in the Eastern Mediterranean (Degron, 2023).

Perhaps every cloud has a silver lining? Doesn't the pre-eminence of climate time put into perspective the permanent rivalries and resentments inherited from the history of simple civilisations? Positing the 5 Times of the Earth and its communities also means prioritising the issues so that we can better come together, identify the essentials and avoid the worst while awaiting the return of the best once we have reduced the stock of greenhouse gases. This is undoubtedly one of Geography's contributions to the edifice of a sacred union in the face of what appears more and more to be a climate collapse, which needs to be backed up as a matter of urgency. Red alert on the Big Blue.

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