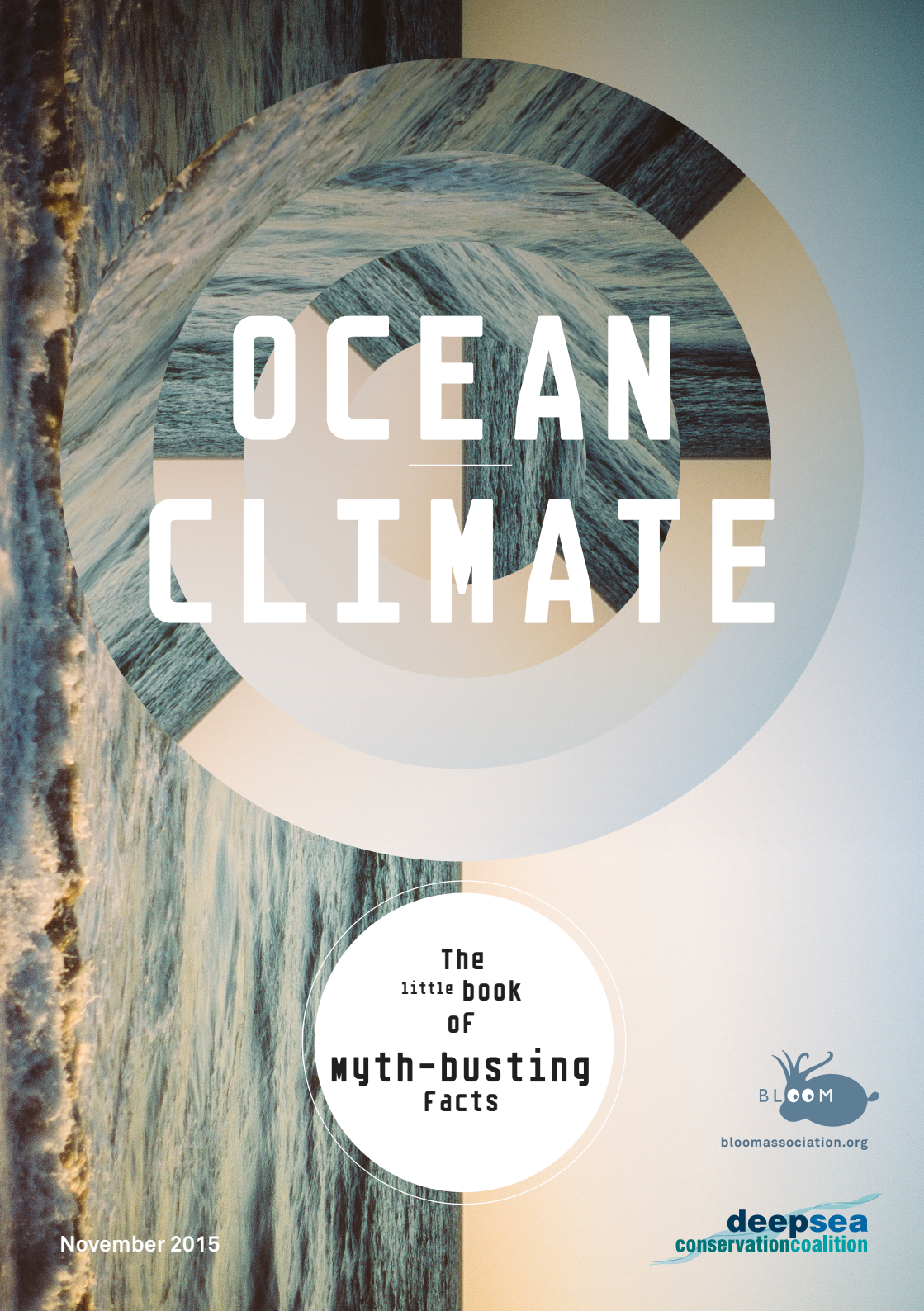

OCEAN CLIMATE

The little book of myth-busting facts

BLOOM

bloomassociation.org

deepsea conservationcoalition

November 2015

Everyone knows that the ocean regulates our climate. But how? And to what extent? Being able to answer these questions is a whole different story...

This little guide full of scientific references will allow you to develop a cast-iron knowledge of the relationship between the ocean and the climate in record time. Ready, steady, go!

THE OCEAN: THE PLANET'S LUNGS

The ocean covers 71% of the planet's surface and almost 98% of its habitable space. It contains 96.5% of the water present on Earth [1] and produces half of the oxygen we breathe. [2] Its good health is therefore fundamental to our wellbeing, especially as hundreds of millions of people depend upon it directly for their work or nutrition. [3, 4]

WARNING! UNPRECEDENTED STAKES

Our civilization is now at a tipping point. We have understood that our activities deeply affect the natural balance of our planet and that renewable energy alone is insufficient to counter climate change. Reforming our production and consumption methods has become necessary, along with a change in our thought patterns to learn to value and protect nature, both on land and at sea, since these ecosystems perform vital economic and climatic functions without which we will be unable to reverse current sombre trends.

DECARBONIZE OR PERISH?

If nothing is done to massively decarbonize our economies, scientists from the Intergovernmental Panel on Climate Change (IPCC) predict temperature rise of 2 to 6 degrees by 2100. [5] How will these changes affect the planetary balance? The ocean lies at the heart of the issue.

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1 Shiklomanov (1993) World fresh water resources. pp. 13-24 In Gleick PH (ed.) Water in Crisis. Oxford University Press, New York, NY (USA).

2 Maribus (2010) World ocean review - Living with the ocean. Hamburg (Germany). 232 p.

3 Teh and Sumaila (2013) Contribution of marine fisheries to worldwide employment. Fish and Fisheries 14(1): 77-88.

4 FAO (2014) The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations (FAO), Rome (Italy). xvi + 223 p.

5 IPCC (2014) Climate change 2014: mitigation of climate change. Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge (UK) and New York, NY (USA). xv + 1435 p.

1

Is sea level really rising?

YES Since 1900, sea level has risen by almost 20cm, at an average speed of 1.7mm per year. [6] This average has almost doubled throughout the last two decades, and the pace is quickening! [7]

WHY IS SEA LEVEL RISING?

Contrary to popular belief, melting sea ice does not contribute to rising sea level. In fact, these ice floes are made up of frozen sea water, forming a giant ice cube whose melting adds no extra water to the ocean. Only the melting of continental glaciers and polar ice caps – made up of fresh water and located on dry land – adds extra water, contributing to rising sea level.

The expansion of the ocean's water as its temperature rises also causes the sea level to rise.

AN 80CM RISE OVER 80 YEARS, IS IT REALLY SO BAD?

Unfortunately, yes. While the rise of 80cm between now and 2100 predicted in some scientific scenarios [8] may not seem excessive, it could wipe low-lying islands such as the Maldives in the Indian Ocean or Kiribati in the Pacific Ocean off the map entirely.

Sea level rise could also have a devastating effect on our coastline. [9] Combined with extreme weather events (hurricanes, cyclones, typhoons) or large tidal ranges, sea level rise could cause huge flooding more frequently, as we saw after Hurricane Katrina or Cyclone Xynthia.

6 IPCC (2013) Climate change 2013 - The physical science basis. Working Group I contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge (UK) and New York, NY (USA). 1535 p.

7 Watson et al. (2015) Unabated global mean sea-level rise over the satellite altimeter era. Nature Climate Change 5(6): 565-568.

8 IPCC (2000) Emissions scenarios. A special report of Working Group III of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge (UK). ix + 599 p.

9 Sea level rise can be simulated with an online tool: www.floodmap.net.

2

Ocean currents as climate regulators

Ocean currents are powerful thermal regulators. They absorb the excess of heat in one place and move it to another, colder site. One example is the Gulf Stream, which gathers heat at its source in the Gulf of Mexico and redistributes it to European coasts. The Gulf Stream is responsible for far milder winters in Europe than at the same latitudes on the other side of the Atlantic Ocean.

These ocean currents flow around the world at varying depths. The depth of a body of water is determined by its density and therefore by its temperature. By changing the temperature of the atmosphere and water, we risk disrupting ocean currents and our climate.

Salinity also dictates water density. Concentrations of salt in the ocean are also at risk of being modified by climate imbalances (heavier rains, flows of fresh water from melting glaciers).

ABOUT

BLOOM is a non-profit organization founded in 2005 that works to promote marine conservation and ecologically sustainable, humane fishing, through awareness-raising and scientific mediation of environmental issues, production of independent studies, and participation in public consultations and institutional processes. Its activities are aimed at the public, as well as at political decision-makers and economic actors.

www.bloomassociation.org

The Deep Sea Conservation Coalition is an organization that groups together more than 70 non-governmental environmental protection organizations, fishing groups, legal institutes and discussion forums committed to protecting the deep sea.

www.savethehighseas.org

3

Will extreme weather events increase in number and intensity?

YES, The IPCC predicts an increase in extreme weather events such as heatwaves, hurricanes, El Niño-type phenomena or torrential rains. [10, 11]

IS 'EL NIÑO' A RESULT OF CLIMATE CHANGE?

No. 'El Niño*' refers to the warm phase of the El Niño Southern Oscillation (ENSO), which is an irregular climate cycle in the Pacific Ocean. El Niño is a natural climate phenomenon characterized by its devastating impacts (drought or flooding, coral bleaching, etc.) and its most visible feature is a strip of abnormally warm water which develops along the Pacific coastline of South America. After drawing media attention in 1997, a large El Niño event is again gaining strength and is likely to last until the first quarter of 2016. [12]

Given its atmospheric origin, scientists predict an increase in the frequency of El Niño events as a result of climate change. [13] A concrete example of the negative effects of El Niño can be found along the Peruvian coastline, which is normally fed by the continuous rise of deep, cold waters rich in nutrients. This 'upwelling' is at the root of the most productive fishing region in the world: every year, millions of tonnes of anchovies [14] are fished there! During El Niño years, the strip of warm water prevents cold waters from rising to the surface. As a result, the productivity of this fishing area falls dramatically, with a calamitous impact on the region's economy.

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(*) The phenomenon is nicknamed 'El Niño', the Spanish term for 'the child' Jesus, as it appears around Christmas.

10 IPCC (2012) Managing the risks of extreme events and disasters to advance climate. A special report of working groups I and II of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge (UK) and New York, NY (USA). x + 582 p.

11 IPCC (2014) Climate change 2014: mitigation of climate change. Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge (UK) and New York, NY (USA). xv + 1435 p.

12 https://lejournal.cnrs.fr/articles/el-nino-lenfant-terrible-du-climat-est-de-retour

13 Cai et al. (2014) Increasing frequency of extreme El Nino events due to greenhouse warming. Nature Climate Change 4(2): 111-116.

14 FAO (2014) The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations (FAO), Rome (Italy). xvi + 223 p.

4

The acidification of the ocean

THE EFFICIENCY OF THE 'CARBON SINK' DAMAGES ECOSYSTEMS

The ocean absorbs huge quantities of carbon dioxide (CO_2) through mere contact between the air, which is rich in CO_2, and the water, which contains less. It therefore plays a major role in slowing climate change by trapping around half of the CO_2 that we emit each year. However, the excess of CO_2 in the atmosphere and its absorption by the ocean provoke chemical reactions that lead to an acidification of the water, disrupting marine ecosystems.

WHAT IS THE IMPACT OF AN ACID MARINE ENVIRONMENT?

The acidification of the ocean impacts all living beings. The most affected are animals with a calcium carbonate shell or skeleton. To simulate the effect, pour an acidic product such as vinegar over chalk (that is, calcium carbonate) and observe the reaction: it will dissolve before your eyes! In this way, some species of microscopic algae contained in phytoplankton are severely affected, along with coral reefs which could have disappeared entirely by 2050 due to the combination of rising water temperatures and acidification. [15]

PLANKTON: THE PLANET'S 'CARBON PUMP'

By using the carbon trapped by the ocean during photosynthesis, vegetable plankton (phytoplankton) produces 50% of the oxygen that we breathe, accounting for every other breath! [16]

Plankton also serves as the planet's lung (the other lung being forests on land). Phytoplankton occupies the base of the aquatic food chain, and it is therefore essential to limit the impacts of climate change upon these tiny algae that our lives depend on.

15 Burke et al. (2011) Reefs at risk revisited. World Resources Institute, The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network, Washington, DC. 114 p.

16 Guidi et al. (2015) A new look at ocean carbon remineralization for estimating deepwater sequestration. Global Biogeochemical Cycles 29: 1044–1059.

17 The surface coral that we can see below the tropics feed primarily from the photosynthesis of their hosts. On the contrary, deeper coral, such as that destroyed by Intermarché's fishing nets, feed only by hunting using their tentacles (like jellyfish) and do not have algae living in symbiosis in their layers.

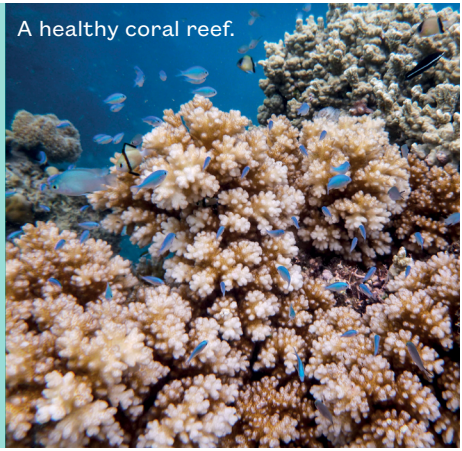
18 Cheung et al. (2013) Signature of ocean warming in global fisheries catch. Nature 497(7449): 365-368.

19 Allison et al. (2009) Vulnerability of national economies to the impacts of climate change on fisheries. Fish and Fisheries: 24.

20 Cheung et al. (2010) Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology 16(1): 24-35.

CORAL BLEACHING

The microscopic algae that live in symbiosis with the coral (the 'zooxanthellae') leave their hosts when water temperatures rise. [17] These algae allow the coral to nourish itself, and their departure therefore signs the coral's death warrant.
Coral reefs serve as a nursery, shelter and pantry for a huge number of species. In this way, they create prime fishing grounds for coastal populations living in equatorial regions.
The disappearance of coral reefs would thus cause serious problems for food security.



A healthy coral reef.

Rainbow reef, Fidji ©F. Le Manach

FOOD SECURITY UNDER THREAT

Temperature rises are already giving rise to important changes in the distribution of marine species, with consequences for the populations that depend upon them. Like humans, other living beings have an optimal temperature for their physiology. Mobile species already migrate towards the poles in search of cooler temperatures. Wildlife living at the poles will disappear (as it cannot migrate) because the waters will no longer be cool enough. [18]
As a result of these migrations, scientists predict a 40% reduction in fishing catches around the Equator. Their impact will therefore be most significant in poor countries whose economy revolves largely around fishing. [19] Ironically, catches will increase by 30 to 70% in higher latitudes, that is, where the richest countries are located! [20]

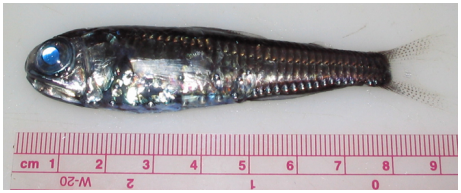
5

The deep sea: a carbon trap

Vegetable plankton plays a crucial role in the sequestration of the CO_2 that we emit into the atmosphere. However, the role of animal species in this process is still largely unknown and researchers are only just beginning to understand its extent.

Recently, the number of small fish known as 'mesopelagic', living at a depth of between 200 and 1,000 meters, has been revised upwards: they are at least 10 times more numerous than previously thought, making them the largest group of vertebrates on the planet! [21] These 'myctophidae' fish are vertical migrants that spend the day in deep waters and move towards surface waters at night to feed. Since they serve as food for demersal fish which live close to the sea bed, at depths between 500 and 1,800 meters, they allow huge quantities of carbon to be sequestered in the ocean depths. [22]

A group of researchers has shown that deep sea demersal fish living in British and Irish waters stored between 1 and 2.5 million tonnes of CO_2 a year, [23] the equivalent of the quantity of carbon that a capture plant proposed by the British government at a cost of 1.4 billion euros over 10 years would have been able to extract from the atmosphere. [24, 25] By comparing the income generated by deep sea fishing to the value of the ecosystem service they provide by sequestering carbon, we can see that they are far more useful to us alive than on our plates!



Small 'myctophidae', several centimeters long, form the most important biomass of vertebrates in the world. They actively contribute to transporting CO_2 towards the depths of the ocean.

21 Irigoien et al. (2013) Large mesopelagic fishes biomass and trophic efficiency in the open ocean. Nature Communications 5: 1-10

22 All the carbon that passes below the ocean mixed layer, beyond 500 metres in depth, is trapped for thousands of years. Davison et al. (2013) Carbon export mediated by mesopelagic fishes in the northeast Pacific Ocean. Progress in Oceanography 116: 14–30

23 Trueman et al. (2014) Trophic interactions of fish communities at midwater depths enhance long-term carbon storage and benthic production on continental slopes. Proceedings of the Royal Society B: Biological Sciences 281(1787).

24 www.ccsassociation.org/why-ccs/ccs-projects/current-projects

25 The proposal to fund a capture plant has since been abandoned by the British government: www.telegraph.co.uk/finance/newsbysector/energy/12016882/autumn-statement-2015-UK-scraps-1bn-carbon-capture-and-storage-competition.html

6

Social and economic consequences

FOR MANY COUNTRIES, SEA LEVEL RISE IS ALREADY A REALITY

Island states in the Pacific, the Indian Ocean, and the Caribbean are seriously concerned about sea level rise in their countries. In Kiribati, for example, an archipelago located in the center of the Pacific Ocean, sea walls have been constructed to protect one of the islands from rising sea level, but this will be insufficient to rehouse its 102,000 inhabitants. The Kiribati government has also established evacuation centers and purchased a section of land in the neighboring Fiji islands to provide shelter in the event of rapid sea level rise or extreme weather events. [26, 27]

Small island states are not the only countries affected: between 147 and 216 million people currently live in areas which will be submerged by 2100. [28] In the Netherlands, the country most vulnerable to rising waters, almost half of the population will be displaced. [29] Asia (especially China and Bangladesh) will be the continent most severely affected by rising sea level.

CLIMATE REFUGEES IN PERSPECTIVE

Three out of four countries in the world have at least one ocean border and the 48 land-locked countries will not be able to take in all the climate refugees, estimated at 250 million by 2050 by the UN. [30] Climate change, its consequences on food security, rising sea level, and the massive population displacements these will provoke are global issues that urgently require large-scale cooperation.

In 2015, the United Nations adopted 17 sustainable development goals (SDGs) to be achieved by 2030. The thirteenth goal is "*Take urgent action to combat climate change and its impacts*". Natural, economic and human balances depend upon the decisions which are taken today. The political stability of our world is at stake.

26 http://time.com/4058851/kiribati-cliamte-change

27 www.scientificamerican.com/slideshow/the-kiribati-people-battle-sea-level-rise-slide-show

28 www.climatecentral.org/news/new-analysis-global-exposure-to-sea-level-rise-flooding-18066

29 See NY Times infographic: http://nyti.ms/1lEdn8f

30 www.euractiv.fr/sections/aide-au-developpement/le-changement-climatique-risque-daugmenter-lafflux-de-migrants-268488