The acidification of the Oceans

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The wonder of the oceans

The oceans have a very special place in the story of the Universe. To many of us, they are just there and seem ordinary and common place. But we can truly appreciate their significance when we view them as a special aspect of the unfolding of the universe itself. As far as we know, liquid water is found nowhere else in the Universe. Water vapor and ice has been found on other planets, but only on planet Earth have the oceans been created and maintained in their liquid form for four billion years. Oceans were probably on the Red planet (Mars), but they have long since vanished.

Furthermore, the oceans are the womb of life. For almost 2 billion years, bacteria were the only forms of life on earth. During the first billion years, the blue-green algae learned how to take hydrogen from the oceans and to release oxygen into Earth's carbon-dominated atmosphere. This was the beginning of photosynthesis.

More serious disruption than sea-level rising

Many people are now aware that the increased levels of CO_2 in the atmosphere, since the beginning of the industrial revolution, is contributing to the rise in the ocean levels through thermal expansion and through melting glaciers in the Antarctic and Greenland.

But something else is also happening about which few people are aware. About one quarter to one third of the CO_2 ends up in the oceans, where it dissolves to form carbonic acid, and then dissociates into bicarbonate and hydrogen ions. The more hydrogen ions there are in the water, the lower its pH is. In other words, it is more acidic. Furthermore, the excess of hydrogen ions react with, and eliminate carbonate ions, which are necessary for the formation of calcium carbonate skeletons and shell production in many species of marine organisms. Scientists have found that there are less carbonate ions in the ocean now than at any other time in the past 800,000 years.

Normally the surface waters of the oceans are slightly alkaline with a pH greater than 7. However, because they are absorbing more CO_2, the oceans are about 30% less alkaline today than they were before the industrial revolution. The consequences of this are very significant and worrying on a number of fronts. Less alkaline water reduces the availability in seawater of

carbonate minerals such as calcite and aragonite. These minerals are important in the formation of corals, shellfish, marine plankton and fish skeletons. The physiology, development and even survival of these creatures are thereby threatened.

During my years in the Philippines, I enjoyed regularly snorkeling in coral reefs. I also became aware of the importance of corals for marine life and the people who fished the reefs. Over the years, I began to learn something about the extraordinary biological diversity in coral reefs. Studies have shown that that at least one quarter of the biodiversity of the oceans are found in coral reefs. Because of their wealth in species, coral reefs they are often referred to as the rainforests of the ocean.

They are very important for humans also. It is estimated that world-wide, 500 million people depend on corals reefs for coastal protection, food, tourism and other forms of income. Economists estimate that reefs and their products are worth between US$30 and $172 billion per annum. In Hawaii alone, for example, the tourism generated by the coral reefs brings in US $364 million per annum.

This is all under threat from ocean acidification. Since 1990, skeletal growth on the Great Barrier Reef off the east coast of Australia was down by 14%. This is the largest stunted growth level in the past 400 years. In an increasingly acidic ocean, coral reefs will decline and may even become extinct.[1] It is estimated that 4,000 species of fish depend on coral reefs. Reefs are marine nurseries, providing food, shelter and a safe haven from predators. The dwindling corals are already impacting on a number of species of fish, leading to the extinction of some species.

Pteropods

Pteropods are tiny swimming sea snails which are abundant in the oceans. There are often thousands of individual snails per cubic metre.[2] They are an important element in the marine food chain as they form the diet of zooplankton, salmon, herring, and baleen whales. The question is: will they thrive in increasingly acidic oceans, because their calcium carbonate shells may not develop properly? Some predict that as early as 2050, pteropods

[1] Hoegh-Gudberg, O …et all (2007) Coral reefs under rapid climate change and ocean acidification. Science, 318 (5857); 1737-1742.
[2] Doney, S., Fabry, V. Feely, R., Kleypas, J. (2009) Ocean Acidification: The Other CO2 Problem, Annual Review of Marine Science, 1:169-92.

may be unable to form shells which would threaten their own survival and the species which depend on them. [3]

Other species will benefit from higher levels of carbon dioxide in the oceans. The problem is that these species are currently seen as nuisance or weedy species. Top of the list are jellyfish. Scientists are not clear yet whether the increased prevalence of jellyfish is as a direct result of ocean acidification. Jellyfish blooms could have a disastrous impact on other species and on the oceans in general. They also will impact on tourism, as no one likes to be stung by a jellyfish while swimming in the ocean.

If the oceans become more acidic there will be a serious decline in biodiversity, and thereby affecting a whole raft of species, including humankind as the oceans are less able to supply us with food. Reducing GHG gas emissions, especially CO_2 is not just important in tackling climate change, it is also necessary if we want to protect the fruitfulness of our oceans on which we all depend.5

[3] Orr, J.C., et al. (2005) Anthropogenic ocean acidification over the twenty-first century and the impact on calcifying organisms, Nature, 437-:681-686.