Denise Kan, Ecology

An Acidifying Problem

Looming with a vast expanse of underwater species and serving as a key complex ecosystem, the Great Barrier Reefs in Australia is considered one the seven natural wonders of the world. The Great Barrier Reef is the largest coral reef in existence, harboring three thousand individual reef systems over six hundred continental islands from the coastal town of Bundaberg to the tip of York. This reef supports four hundred types of coral, fifth teen hundred species of tropical fish, two hundred types of birds and twenty species of reptiles. The Great Barrier Reef and other coral reefs only account for one percent of area on the ocean floor, but supports over twenty five percent of marine life. As an epicenter of marine biodiversity, the Great Barrier Reef is a regular breeding ground for six species of turtle and the humpback whale, as well as a habitat for the endangered dugong (sea cow) and large sea turtle. In Australia, the reef is also one of the world's greatest tourist attractions generating four to five billion Australian dollars into the economy annually while aiding the tourist, commercial and local fish industries. As one of the largest tourist industries the reef supports fifty thousand jobs. In science and medical fields, the Great Barrier Reef has also allotted the creation of many important medical breakthroughs that have treated cancer and AIDS. The natural ecological service the reef provides is also estimated to be worth three hundred and seventy five billion dollars a year. It is evident that the reef is irreplaceable, however it is slowly being destroyed by the rising problem of ocean acidification.

The rising threat of ocean acidification has been slowly deteriorating the health of the Great Barrier Reef leaving irreversible damage. "Acidification can be defined as the slight lowering of the pH (the measure of hydrogen ion concentration that determines the alkalinity of a solution) of ocean water. Atmospheric gases act in equilibrium with oceanic waters and create "dissociation reactions" where an exchange occurs between the air and water surface [1]." Carbon from the atmosphere reacts with the seawater to become a part of the carbonate system (see Appendix A). Accelerated amounts of carbon then bonds with water to form carbonic acid releasing bicarbonate and hydrogen ions. This process prevents coral fertilization, larvae settlement and survival of the Elkhorn coral within the Great Barrier Reef. The extra carbon that is stored makes the ocean water more acidic causing the corals to erode. Due to accelerated bicarbonate reactions corals are left with little to none of carbonate ions to form skeletons. Without shells and skeletons, coral polyps and organisms cannot defend themselves and die, affecting the entire food chain and species the coral reefs support. The acidification not only suffocates the reefs, but also ensures that there is no recovery. "Studies have shown that since 1990, there has been a fourteen percent decrease in coral growth at the Great Barrier Reef signifying the most significant decrease recorded within the last four hundred years [2]."The root cause of this threat and halt to the health of corals is attributed to pH levels being lowered. "The pH level of the world's oceans has already dropped by 0.1 and it is estimated to drop by 0.4 by the turn of the century, halting the growth of coral reefs by the year 2050 [3]." The poor and acidic water quality around Australia's Great Barrier Reefs also deteriorates surrounding ecosystems like mangroves, and the life of beaches demonstrating that ocean acidification affects multiple ecosystems. Without the vast size of the reef there is also no protection for the coastal cities and beaches of Australia. The root cause of this ecological problem of acidification is also attributed to accelerate carbon emissions from human production, fossil fuel use, and lifestyle.

Currently, the largest source of carbon emissions is the combustion of fossil fuels like coal, oil and gas from power plants, automobiles and industrial and manufacturing facilities. "Since the Industrial Revolution in the early 1800s, the amount of carbon emissions induced from human facilities is phenomenal**.** Seventy two percent of emitted greenhouse gases are attributed to carbon dioxide, and within the last fifty years there has been a three percent rise annually in carbon emission releases [4]." Naturally, as carbon emissions have increased more bicarbonate reactions occur, lowering the oceans pH levels therefore making the water more acidic. Such a dramatic increase would most likely halt the growth of coral reefs altogether and destroy what remains of the Great Barrier Reef. The impacts of such a loss would be widespread and affect many species within the oceanic food chain and alter the economy. Researchers and scientists have conducted experiments to understand the ocean's acidity and the acidification process by modeling changes in the ocean's pH before the Industrial Era and into the year 3000(see Appendix B). By studying the calculated carbonate saturation state they can draw conclusions on the effects of fluctuating alkalinity levels on organisms, especially that of coral reefs. Furthermore, researchers have referenced paleoceanographic evidence by studying sediment cores and carbonate rock below the Earth's surface to evaluate how carbon levels in current society have varied from the past (see Appendix C).

From large scale to smaller scale changes, actions must be taken in order to reduce human inducted carbon emissions. The health of the Great Barrier Reef is reliant on the participation of more than just Australia in order to truly reform elevated pollution that is turning our ocean waters acidic. A feasible option to make this outcome realistic is to use government enforcement in controlling the output of carbon from all nations in industry and in individual households. The output of carbon should be taxed in order to make companies and individuals aware of the economic cause-and-effect relationship pollution has on our natural ecological services like the Great Barrier Reef. "Acts like the Regional Greenhouse Gas Initiative which charges a tax for every ton of carbon emitted while also allowing carbon trade allowances could be a crucial step to reducing emissions [5]."If carbon budgets and taxes were enforced industries and manufacturing companies would be forced to reevaluate their energy sources, which could also promote the use of renewable energy versus the use of fossil fuels. The government could also provide financial grants from these taxes to promote alternative energy resources, like solar panels or windmills. Nations should also model their societies like that of the United Kingdom.

“In the United Kingdom, forty percent of electricity has to come from low carbon sources [6].”If the same rules were to apply to American and Australian households the impact would be substantial. For example, another possible solution to reducing carbon footprints would be for countries to begin to implement code and appliance standards and efficiency requirements for each house hold. Government enforcement is necessary to create environmental change and awareness through the taxation and the passing of new laws that restrict pollution in households and in industries. The only risk factor to implementing new laws and taxes would be the political and public uproar it might cause, however drastic options are necessary to address this ecological threat in order to produce change.

Another way to deter the impacts of carbon emissions is to strive for the long-term solutions in life style changes of the individual and the household. Although this would be a gradual process if large populations altered living standards, pollution could be significantly reduced. By evaluating the modes of transportation used in homes whether it be carpooling, using public transportation or finding transportation with alternative energy sources, the burning of fossil fuels from cars is trivial to carbon emissions. Families should switch to fuel-efficient cars and remain cautious of their mileage per gallon. Secondly, families should also be wary of their use of electricity and appliances. Appliances should be unplugged when not in use, and light bulbs should be changed to compact fluorescent lamps. These light bulbs require two thirds of the energy that a regular light source would need. Recycling, and leading a vegetarian lifestyle can also significantly reduce one’s carbon footprint. “Eating less meat could save three thousand pounds of carbon a year [7].” There are endless ways to reduce the carbon footprint and live an ecologically conscious lifestyle, the key to successfully reducing one’s own carbon footprint is to remain aware of how much energy in one consumes in his or her lifestyle. Energy can be equated to carbon emissions because of the cost of fuel that it might cost to manufacture a product, generate electricity, fuel transportation, or generate heat and so on. By taking these simple steps and thinking twice about energy outtakes, we can slowly begin to save the oceans and the coral reefs from the damage of ocean acidification that has a product of too much carbon excretion.

Bibliography

1. European Project on OCean Acidification. "What Is Ocean Acidification?" *Http://epoca-project.eu*. Observatoire Oceanologique De Villafranche Sur Mer. Web. 01 Mar. 2012. <http://epoca-project.eu/index.php/what-is-ocean-acidification.html>.

2. Biello, David. "Ocean Acidification Hits Great Barrier Reef." *Www.scientificamerican.com*. Scientific American, A Division of Nature America, Inc, 01 Jan. 2009. Web. 01 Mar. 2012. <http://www.scientificamerican.com/article.cfm?id=ocean-acidification-hits-great-barrier-reef>.

3.Burns, Dr. William C.G. "Ocean Acidification: A Greater Threat than Climate Change or Overfishing?" *Www.terrain.org*. Terrain Publishing, 1997. Web. 29 Feb. 2012. <http://www.terrain.org/articles/21/burns.htm>.

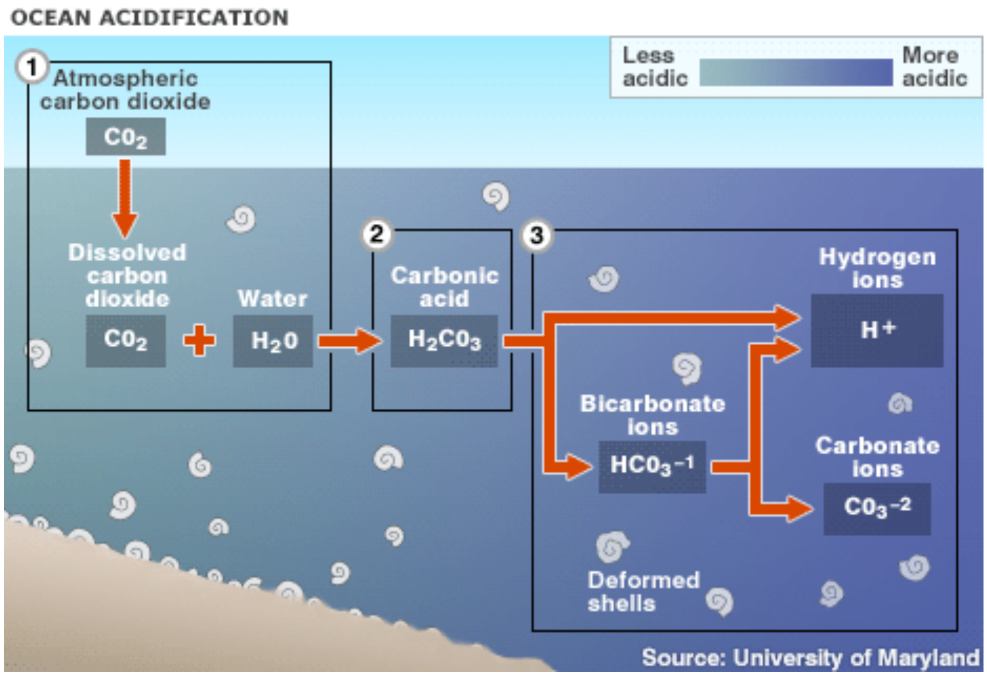
4.Rohrer, Juerg. "CO2 The Major Cause of Global Warming." *Timeforachange.org*. July 2007. Web. 01 Mar. 2012. <http://timeforchange.org/CO2-cause-of-global-warming>.

5.Lacey, Stephen. "Regional Greenhouse Gas Initiative Adds 16,000 Jobs and $1.6 Billion in Value to Northeast Economies, Study Finds." *Http://thinkprogress.org*. Center for American Progress Action Fund, 15 Nov. 2011. Web. 2 Mar. 2012. <http://thinkprogress.org/romm/2011/11/15/368500/regional-greenhouse-gas-initiative-jobs-northeast-study/?mobile=nc>.

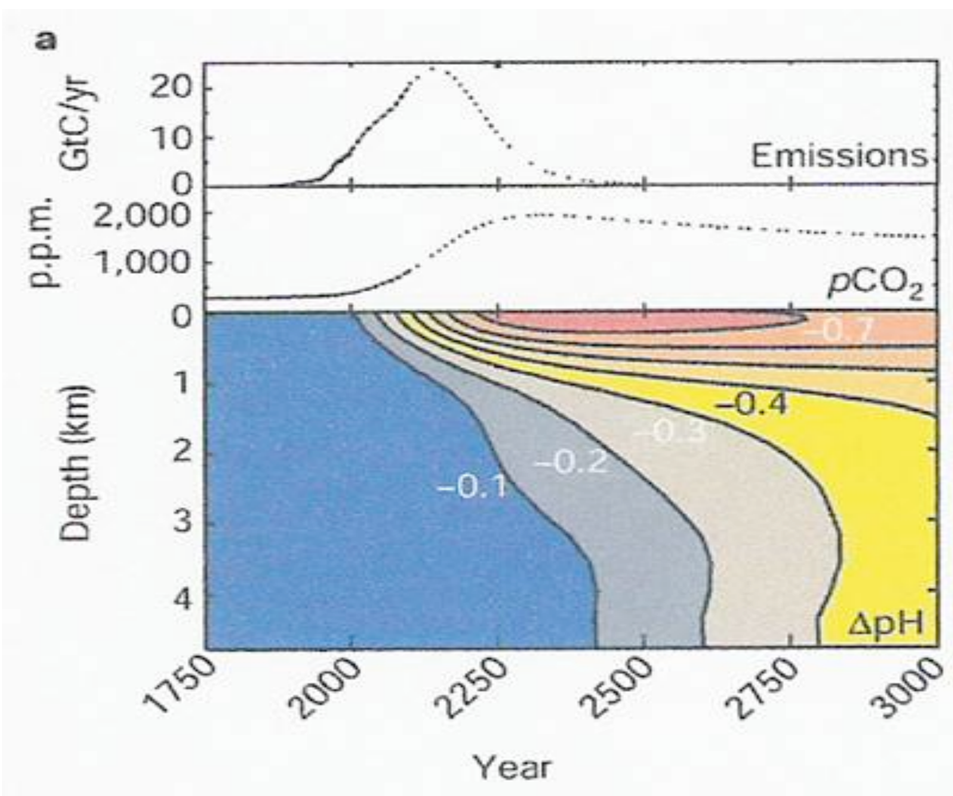
6."British Government Unveils Low Carbon Roadmap to 2020." *Www.ens-newswire.com*. Environment News Service, 2009. Web. 02 Mar. 2012. <http://www.ens-newswire.com/ens/jul2009/2009-07-15-01.asp>.

7."Reduce What You Can." *Http://carbonfund.org*. Web. 1 Mar. 2012. <http://carbonfund.org/reduce>.

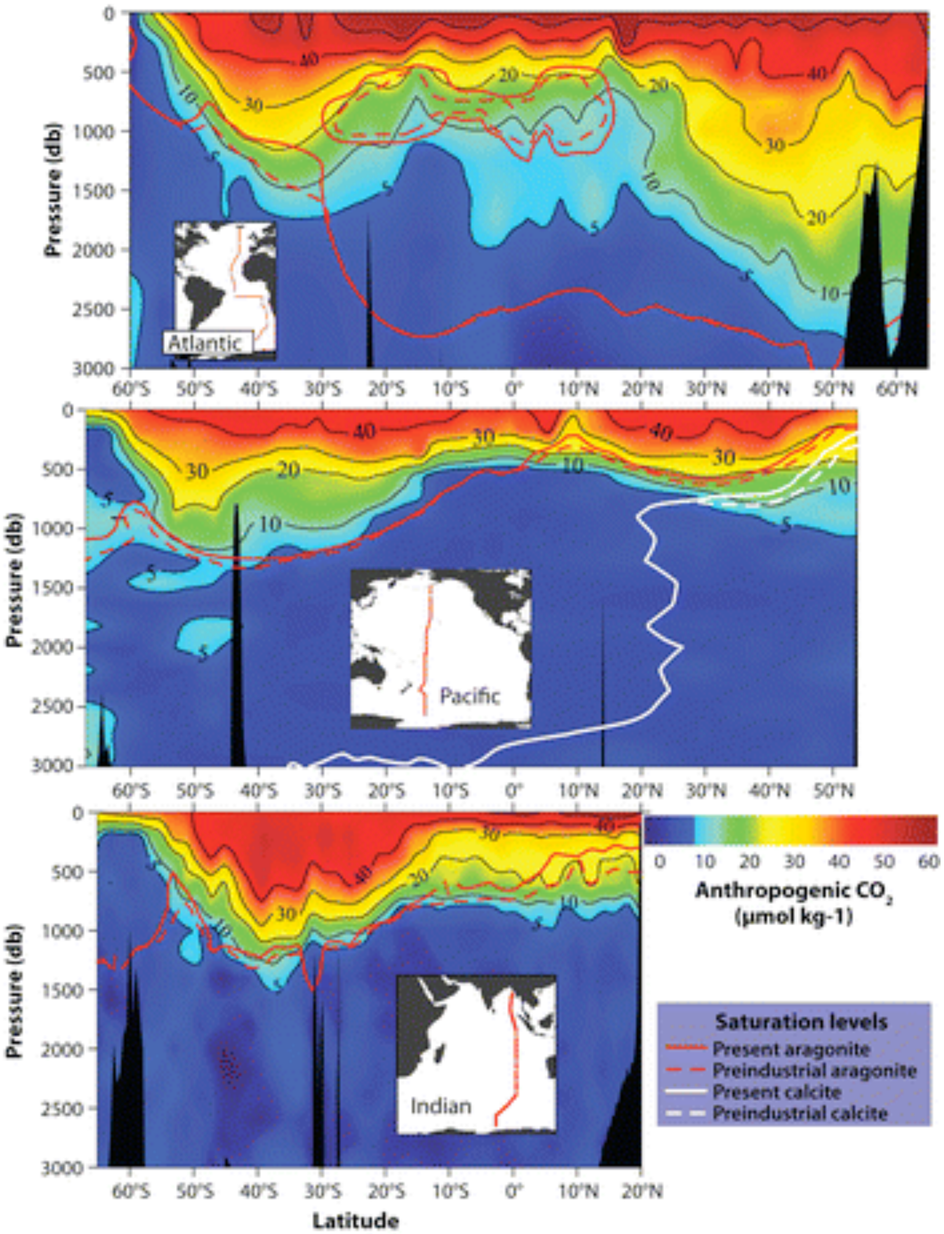
Appendix



"Appendix A" from University of Maryland,
http://news.bbc.co.uk/2/hi/science/nature/7933589.stm



“Appendix B” *from Caldeira, K., and Wickett, M.E. 2003. Anthropogenic carbon and ocean pH. Nature, 425: 365-368.*



Doney SC, et al. 2009.
Annu. Rev. Mar. Sci. 1:169–92

“Appendix C” from A. Mucci, Am. J. Sci 238,780(1983)