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Climatic changes: What if the global increase of CO_2 emissions cannot be kept under control?

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Abstract

Climatic changes threaten the planet. Most articles related to the subject present estimates of the disasters expected to occur, but few have proposed ways to deal with the impending menaces. One such threat is the global warming caused by the continuous increase in CO_2 emissions leading to rising ocean levels due to the increasing temperatures of the polar regions. This threat is assumed to eventually cause the death of hundreds of millions of people. We propose to desalinize ocean water as a means to reduce the rise of ocean levels and to use this water for populations that need good quality potable water, precisely in the poorest regions of the planet. Technology is available in many countries to provide desalinated water at a justifiable cost considering the lives threatened both in coastal and desertified areas.

Key words: Climatic changes; CO_2 emissions; Global warming; Desalination of ocean water

The whole world gathered in Copenhagen in December 2009 for the United Nations Climate Change Conference (COP15). On the agenda was how to cope with the rise in CO_2 emissions which, in addition to ocean acidification (1), will cause global warming and elevate the ocean level as much as 60 cm until the end of the century. This will jeopardize the life of populations living on islands and on ocean shores. It is estimated that the lives of 100 million people may be menaced. In fact, humans are pumping 7 Gt CO_2 in the atmosphere/year (2). Today the level of CO_2 in the atmosphere is approximately 370 ppm and, according to specialists, it should not go above 420 ppm by the end of this century to keep global warming below 2°C. Most solutions to reduce this trend are not short term. An integrated approach to carbon abatement in the automotive sector could reduce global passenger vehicle greenhouse emissions by 2.2 Gt by 2030 (3), much of it using proven technologies. Sugarcane-based ethanol produced in Brazil in 8 million ha can be substantially increased but that must be done without harming the environment. Ethanol produced from corn in the US can also be increased but that must be done without sacrificing the offer of corn as a commodity in the food chain (4). However, together both countries offer today only a fraction of what will be needed to replace automotive fossil fuel in years to come. Thus, abatement will not come from first-generation biofuels alone but from the combination of second-generation biofuel from cellulose, traffic flow shifts and a mix of several other technologies. Carbon capture and storage (5) moves at a pace of a few million metric tons of CO_2/year while 6 billion metric tons of coal alone are used each year producing 18 billion tons of CO_2. Brazil expects to reverse deforestation in the Amazon. During the last 20 years, deforestation in the region has claimed an average of 17,578 km^2 annually from the Brazilian tropical forest, and deforestation does not show consistent long-term signs of decline (Table 1). The total deforestation from 1988-2008 corresponds to 369,157 km^2, an area larger than Germany according to the National Institute for Space Research (INPE, Brazil). To revert this trend the National Plan of Climatic Changes in Brazil (6), as well the commitment of Brazil presented in Copenhagen, include voluntary efforts to be achieved by 2020 associated with reforestation of the degraded area as a means of CO_2 storage. Both are costly and long-term efforts but will be pursued under the National Policy of Climatic Changes. In addition, deforestation is not a problem of the tropical forest alone. The vegetation of other ecosystems has been also drastically reduced and only 7% of the original vegetation of the Mata Atlântica is left. The “Cerrado” is being destroyed at a rate of 0.5%/year. Figure 1 shows the main Brazilian

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ecosystems. Destruction of what is left of the Cerrado (17%) could result from inadequate use of this bioma for ethanol production from sugarcane and must be avoided.

The strategy to aggregate value to the products of the forest proposed in the nineties (7) has not been implemented to date for many reasons. Access to biodiversity is not a simple process. The present Brazilian legislation discourages and threatens scientists (8). New legislation to be analyzed shortly by the Congress in Brazil will try to reduce the lengthy process for scientists to obtain permission to collect samples of the biodiversity. Benefit sharing with those expecting a financial return from their knowledge of the products of biodiversity is undecided internationally. A biokeeper property right to benefit those conserving plant species of the biodiversity to be used by the pharmaceutical industry has been proposed (9). Cultivation of the plant species would assure non-exclusive rights to be under the control of the owner of the biokeeper property right. This strategy should be pursued since many drugs in the pipeline are derived from natural products (10,11) although, unfortunately, none from the Amazon.

What can be done if the level of CO_2 cannot be kept under control? Geoengineering proposes simulated volcanic eruptions to reduce the planet temperature and the level of ocean rise based upon observations made after the volcanic eruption of Mount Pinatubo, which occurred in June of 1991 (12). The eruption injected 10 Tg S in the stratosphere, which caused detectable short-term cooling of the planet. One simulated injection of SO_2 as an aerosol precursor equivalent to the Mount Pinatubo eruption every two years would cool the planet and consequently keep the sea level rise below 20 cm for centuries ahead, although ocean acidification due to CO_2 would persist.

The strategy proposed here is to desalinize sea water to use for irrigation or as a source of potable water where water is most needed, i.e., in the arid regions of developing countries. Since oceans occupy 360 x 10^6 km^2, if the ocean level rises at a rate of 6 mm/year the amount of water to be desalinized would be 2.16 x 10^{12} m^3. Since at least 10% of the regions of the planet are arid, this amount of water corresponds to only 140 mm of rain falling in 15 million km^2. Thus, the amount of desalinized water from ocean rise alone may be insufficient to irrigate adequately large areas. The advantage over the geoengineering strategy is that the water

Table 1. Deforestation in the Brazilian Amazon.

Year	[sq km]	Change [%]
1988	21,050	
1989	17,770	-16%
1990	13,730	-23%
1991	11,030	-20%
1992	13,786	25%
1993	14,896	8%
1994	14,896	0%
1995	29,059	95%
1996	18,161	-38%
1997	13,227	-27%
1998	17,383	31%
1999	17,259	-1%
2000	18,226	6%
2001	18,165	0%
2002	21,394	17%
2003	25,247	19%
2004	27,423	9%
2005	18,846	-31%
2006	14,109	-49%
2007	11,532	-47%
2008	11,968	-47%

Data from the National Institute of Space Research (INPE).

Figure 1. Main ecosystems of Brazil. The Cerrado (outlined in yellow) corresponds to approximately 2 million km^2. Reproduced, with permission, from the Plano Científico Rede de Cooperação em Ciência e Tecnologia para a Conservação e o Uso Sustentável do Cerrado (ComCerrado).

could be stored in reservoirs and underground aquifers to be used as potable water, very scarce in many regions of the world, particularly in the Sub Sahara. According to UNEP, lack of good quality potable water threatens today the lives of 1.1 billion people throughout the world due to infections resulting from the use of inadequate drinking water. Throughout most of the world, the most common contamination of raw water sources is from human sewage and in particular human fecal pathogens and parasites. In 2006, waterborne diseases were estimated to cause 1.8 million deaths each year while about 1.1 billion people lacked proper drinking water (13). It is clear that people in the developing world need to have access to good quality water in sufficient quantity, to water purification technology and availability, and to distribution systems for water. In many parts of the world, the only sources of water are from small streams often directly contaminated by sewage. Thus, desalinized ocean water would be an important alternative.

Desalination must use non-conventional energy sources such as wind-generated electricity and depends on a low-cost electricity supply. The experience of China reveals that wind is an important alternative for electricity generation at a competitive cost (7.6 US cents per kilowatt hour) and, equally important, 640 Gw of wind energy will be introduced in that country over a 20-year period (14). The composition cost for a typical reverse osmosis desalination system is shown in Figure 2. Forty-four percent of the cost is electrical energy. The reverse osmosis Unit shown in the figure can only desalinize 8.0 x 10^7 m^3 of water/year. Most desalination plants yield 10^7 m^3 of desalinated water/year (15). The world's largest desalination plant to date is the Jebel Ali desalination plant in the United Arab Emirates capable of producing 300 million cubic meters of desalinated water/year (16). Alternative technologies will be needed to permit desalination of 2.16 x 10^{12} m^3/year, the equivalent of 6 mm of ocean rise/year.

This proposal serves a dual purpose: first it contributes to reducing the risk of the populations threatened by the ocean rise process, second it immediately provides potable water to very poor populations, particularly in arid regions. If, after Copenhagen, countries engage in large engineering projects to desalinate ocean water as a mitigation policy, this effort may be the key to cope with the population growth that, according to the figures made public by Olivier de Schutter, Rapporteur for the United Nations Organization for Human Rights for Adequate Feeding, will require a 70% increase in crop production until 2050, a US$47 billion/year investment for developing countries alone. Today the world's hungry population is 1 billion but in 2050 the global populations will be 9.5 billion and the scarcity of water will require the desalination of ocean water as a last source of water for irrigation. Today the lack of potable water alone justifies these projects. Ted Levin, of the Natural Resources Defense Council, says that more than 12,000 desalination plants already supply fresh water in 120 nations, mostly in the Middle East and Caribbean. The market for desalination, according to analysts, will grow substantially over the next decades.

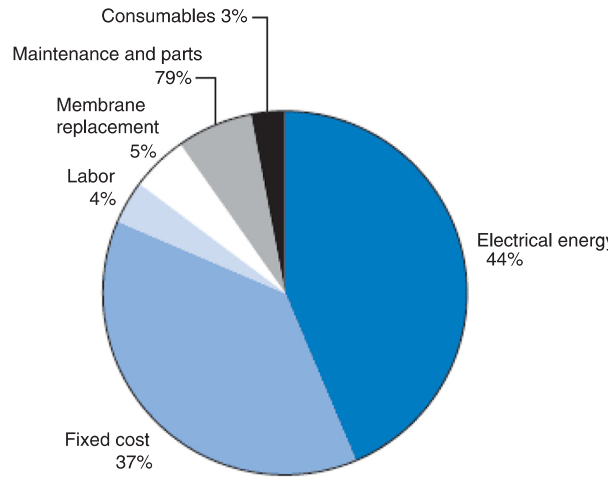

Figure 2. Typical costs of a reverse-osmosis desalination plant (18).

Note added in proof

The results of the United Nations Climate Change Conference 2009 (COP15) in Copenhagen unfortunately fell quite short of the expectations of most countries, Brazil included. Another COP meeting has been scheduled to take place from November 29 to December 10, 2010 in Mexico but advances regarding concrete strategies to deal with climatic changes will probably not be discussed in this upcoming event. Brazilian institutions have prepared a proposal to reduce deforestation in the Amazon (17). It is a costly but achievable project. Global funding to reverse the effects of climatic changes persists as an unresolved item.

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