A "Natural" Proposal for Addressing Climate Change

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One of the fundamental challenges of climate change is that we contribute to it increment by increment, and experience it increment by increment after a considerable time lag. As a consequence, it is very difficult to see what we are doing to ourselves, to future generations, and to the living planet as a whole. There are monumental ethical issues involved, but they are obscured by the incremental nature of the process and the long time frame before reaching the concentration of greenhouse gases and the ensuing accumulation of radiant heat—and consequent climate change—that ensues.

In 1896, Svante Arrhenius published his landmark article establishing that greenhouse gases, especially carbon dioxide, trap sufficient radiant heat for the planet to be a habitable temperature for humans and other forms of life.[1] Yet he could not have been aware that the previous ten thousand years of planetary history had been a period of unusual stability in the planet's climate. This stability enabled the origins of agriculture and the establishment of human settlements, indeed the development of civilization. Essentially, the entire human enterprise is based on the assumption of a stable climate.

The possibility of maintaining the stable climate that was so favorable to the development of civilization would seem to be already lost: current atmospheric CO_2 concentrations have now reached 400 parts per million (ppm), as contrasted to preindustrial levels of 280 ppm. Indeed, the generally accepted goal of limiting climate change to no more than two degrees Celsius is slipping from us rapidly. Even this modest goal was arrived at on somewhat murky grounds, largely because it was seen to be achievable at the time and because it meant that some of the poorer nations could catch up economically before access to fossil fuel energy would end. (It is important to note that fossil fuel energy is perceived as cheap

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because most of the economic and social externalities involved in its production and use are ignored in the cost calculation.) Yet it is known that the last time the planet was two degrees warmer, during the last interglacial period, the oceans were at least four to six meters higher (and probably more).[2] And it is further known that should such a sea-level rise happen today, it would endanger the mass of human population and economic activity in coastal areas and essentially eliminate a number of island states. Now, with the West Antarctic Ice Sheets beginning to collapse, the impact of sea-level rise can no longer be easily dismissed. The Intergovernmental Panel on Climate Change has focused so much on the short-term rate of sea-level rise (which has itself been consistently underestimated) that the highly undesirable end point (a minimum increase of four to six meters) has been largely ignored.

In addition, it has become very clear that global ecosystems will be seriously affected even at two degrees of warming. To give just one example, with such a rise in temperature the world will lose all of its tropical coral reefs, which are vital to the economies and well-being of the significant portion of humanity living in their close proximity. Already, the fingerprint of climate change can be detected almost everywhere in the world. Species are changing their annual cycles; their geographical distributions are also changing as species seek to track their required environmental conditions. For example, Joshua trees can now be found beyond the borders of Joshua Tree National Park. In addition, "state shifts"—that is, abrupt threshold changes—are beginning to occur in ecosystems. For example, in the coniferous forests of western North America, longer summers and milder winters have tipped the balance in favor of native bark beetles, with a consequent tree mortality of up to 70 percent. Given that this is occurring at 0.8 degrees of climate change, one can only imagine the kinds of changes to biodiversity and ecosystems that will be brought about by two degrees of warming.

The good news is that the current levels of greenhouse gas concentrations, and the climate change they will generate, are not entirely irreversible or inevitable. Our planet actually works as a linked biological and physical system. Life on Earth is itself responsible in large degree for the composition of the atmosphere. Early in the history of life on this planet populations of algae produced the oxygen that made much subsequent life possible. And twice in the history of life on Earth there were extremely high CO_2 levels from physical processes that were subsequently brought down to preindustrial levels by biological activity. The first time was during the Carboniferous and Permian periods, which involved the advent of plants on land and the creation of deposits of fossil fuels (where the products of ancient photosynthesis were locked away). The second time was during the Cretaceous and subsequent periods. In that case, CO_2 levels were brought down by the advent of modern flowering plants operating even more efficiently than their predecessors. In addition to the sequestration of carbon from photosynthesis, the formation of soil (both the physical and biological aspects) led to further reduction in atmospheric CO_2. So the power of biology to help with this grave challenge is enormous. However, this time we cannot afford the tens of millions of years involved in those two cases.

Unknown to most of us is that not all of the current excess CO_2 in the atmosphere comes from the burning of fossil fuels. Indeed, a significant portion comes from three centuries of destruction and degradation of modern ecosystems (because all life is built on carbon). Deforestation in the tropics is a major current driver of rising atmospheric CO_2, but deforestation elsewhere has also been significant. Moreover, the destruction and degradation of grasslands has likewise contributed to the problem. In addition, most agricultural systems (agroecosystems) are managed in ways that leak carbon from the soil, through soil erosion and oxidation.

As a consequence, it is possible, indeed highly desirable, to engage in ecosystem restoration at a scale sufficient to pull back about 50 ppm of CO_2 from the atmosphere and avoid at least half a degree of climate change that would otherwise occur.[3] This would involve reforestation and the restoration of grasslands. Better management of agricultural systems (agroecosystems) can contribute as well. Examples include practices that use no tilling and that promote the accumulation of carbon in the soils, in contrast to much current agricultural practice, which leaks carbon. One interesting agricultural approach is "bio-char," in which organic waste is converted to a charcoal-like condition and added to the soil where it degrades very slowly, thus increasing soil fertility. A similar practice seems to have been practiced by pre-Columbian Amazon Indians, with the resulting "terra preta" (black soils) existing to this day.

In addition, recent work on what has come to be called "blue carbon"—which involves restoring coastal wetlands, mangrove forests, and sea grass beds—shows an additional promising approach with the potential to bring about another 10 ppm reduction.[4] At the same time, such actions will provide important benefits beyond reducing atmospheric carbon and stemming potential climate change. For example, restoring grasslands provides better grazing; any soils that accumulate carbon (not just terra preta) increase in fertility; and reforestation can provide economic benefits in terms of forest products and watershed management.

Until recently, restoration was a second-order priority for those seeking to address climate change, but as the pressures of climate change mount it has emerged as an important issue. It is, in fact, an area of concern where the three Rio treaties overlap: the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, and the United Nations Convention to Combat Desertification. Basically, this is a technique that uses the natural systems of the Earth to limit climate change with none of the downsides (known and unknown) that geoengineering schemes generally have. Most geo-engineering schemes address the symptom of temperature increase rather than the cause, namely, increased greenhouse gas concentrations. Consequently, if the intervention ever ceases, the global climate system will revert to where it would have been without it—hotter. In addition, any geoengineering approach that is global in scale has the possibility of negative consequences that would also be global in scale.

By lowering atmospheric CO_2 and keeping climate change to a lower level, the actual climate change impacts on the planet's biological systems could be limited to a range where they would be more manageable. It is likely that with greater climate change at some point the consequent biological change would not remain linear but would become exponential and thus harder to manage.

As we move into the future and toward billions of additional people, the pressure on the land to feed the world population will be great. Thus, the only way to achieve the climate benefits noted above will be through much more integrated planning and management of land, landscapes, and waterscapes. Among other things, it will be important to keep track of stocks and flows of carbon in natural systems. While biofuels obviously have an important role to play as humanity weans itself from fossil fuel use, if not done correctly this process can actually add to atmospheric CO_2. For example, the rush to produce corn ethanol in the United States actually led to land being withdrawn from the national Conservation Reserve. The natural ecosystems converted in the process had much greater CO_2 emissions than cornfields, so there was a net CO_2 *release* as well as loss of biodiversity.

To the extent that implementation of ecosystem restoration involves local people, whether rural, agrarian, or urban, every human being has the ability to make a difference—a wonderful antidote to the sense of helplessness that is so pervasive in climate discussions today. Indeed, such a program has the potential for individual participation (for example, through tree planting), much like the victory gardens of the Second World War. One could in fact see this as an opportunity for a new ethic, rather like Aldo Leopold's Land Ethic—an "ethic dealing with man's relation to land and to the animals and plants which grow upon it."

NOTES

[1] Svante Arrhenius, "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground," *Philosophical Magazine*, ser. 5, vol. 41, no. 251 (1896), pp. 237–75.

[2] Robert E. Kopp et al., "Probalistic Assessment of Sea Level during the Last Interglacial Stage," *Nature* 462 (2009), pp. 863–67.

[3] Rattan Lal et al., eds., *Recarbonization of the Biosphere* (Springer XXVIII, 2012), 560 pp.; Thomas E. Lovejoy, "The Need to Manage Global Change," in Richard A. Houghton and Allison B. White, eds., *Ecology and the Common Good* (Falmouth, Mass.: Woods Hole Research Center, 2014), pp. 35–42.

[4] Daniel C. Donato et al., "Mangroves among the Most Carbon-Rich Forests in the Tropics," *Nature Geoscience* 4 (2011), pp. 293–97; Elizabeth Mcleod et al., "A Blueprint for Blue Carbon: Toward an Improved Understanding of the Role of Vegetated Coastal Habitats in Sequestering CO_2," *Frontiers in Ecology and the Environment* 9, no. 10 (2011), pp. 552–60; Linwood Pendleton et al., "Estimating Global 'Blue Carbon' Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems," *PLoS ONE* 7, no. 9 (2012), pp. 1–7.