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Climate Holism vs. Climate Reductionism

Climate change may be the biggest threat facing humanity, but the way we're currently going about fighting it just ensures that, even if we prevail, another threat will follow, and another, and another.

To explain why, it's helpful to review a philosophical debate that's simmered throughout the past couple of centuries. With the advent of modern science came a general predisposition toward an attitude called "reductionism," the essential notion being that complex phenomena can best be understood by breaking them down into their component parts. Reductionism unquestionably works in many situations. For example, we can better understand the physical attributes of many materials if we study their molecular structures and their elemental atomic constituents. Chemistry is rooted in physics, and cell biology is rooted in chemistry.

On the other hand, however, some attributes of complex systems—especially living systems—are impossible to predict or understand on the basis of even the most thorough cataloging of their parts. For example, psychologists have spent decades trying to explain consciousness through a study of the molecular structure of brain tissue, but have gotten essentially nowhere. It appears that consciousness is an emergent property of the brain. An "emergent property" is something that "emerges" when component objects come together in a certain relationship so as to form a higher-level aggregate object, a property that cannot be predicted on the basis of a thorough knowledge of constituents. Even simple materials often have emergent properties: ordinary table salt is composed of atoms of sodium and chlorine, neither of which by itself has any hint of the taste of "saltiness."

The study of complex systems and emergent properties eventually led to the coining of the term *holism* to refer to the idea that systems (biological, social, economic, mental, linguistic, etc.) and their properties should be viewed as wholes, not as collections of parts. The science of ecology, which is the study of the relationships between organisms and their environments, is an inherently holistic enterprise: ecologists study whole ecosystems that emerge from, but cannot be reduced to, the sum of their living and non-living components. Other scientific disciplines (notably medicine and industrial agronomy) have historically tended to plow a much more reductionist furrow.

Both reductionism and holism can be useful pathways to learning and understanding, but problems arise if we insist on using one approach only, or if we misapply that approach. Ecologists tend to think that's what we in modern society do in searching for "silver bullet" solutions to problems in health care and environmental management rather than attempting to understand whole systems. The reasons for this reductionist bias have to do with the ways science developed from its philosophical foundations in the writings of Bacon and Descartes, and with the fact that commercial "silver bullet" products rooted in a reductionist approach to solving problems can be quite profitable for industries and investors (even when they don't work well), while holistic recommendations often require change in the behavior of individuals or society as a whole.

These two philosophical predispositions also shape our responses to climate change. The reductionist school of thought sees climate change as resulting simply from the technical problem of carbon emissions. If we reduce the crisis in this way to its simplest component cause, then we are drawn to certain kinds of solutions: why not continue burning fossil fuels, but capture and sequester the carbon? Why not produce more energy from nuclear reactors, since the nuclear cycle itself yields no carbon emissions? Why not build machines to suck carbon from the atmosphere? If we do these things, surely we can maintain our current economy and way of life with minimal disruption. Most policy makers and economists (i.e., most "serious people") see climate change this way, and even some solar and wind energy advocates are drawn along.

A holistic view of climate change starts by understanding its relationship to a complex of disorders that increasingly plagues the global ecosystem, including soil degradation, desertification, the decline of life in the oceans, species extinctions, deforestation, and water and air pollution. All proceed, in one way or another, from human population growth, economic expansion, and the ever-increasing use of fossil fuels. Once humans began burning coal, oil, and natural gas, these concentrated, then-abundant sources of energy supercharged the economic processes by which other natural resources are extracted and turned to waste. Further, as agriculture was industrialized and sanitation improved, population grew, thus increasing the scale of the problem. Climate change was just one of the predictable results. Therefore even if we deal with global warming through technical strategies that reduce carbon emissions, much of the rest of this complex of problems will continue to worsen until we deal with its systemic causes, or until it overwhelms the biosphere and human civilization.

This way of thinking may sound slippery and intuitive but it is also quantifiable and amenable to detailed analysis. It was the basis for the 1972 *Limits to Growth* computerized scenario studies, which investigated the likely future systemic interactions between population growth, pollution, and resource depletion. In nearly all the scenarios, the result included the collapse of the global economic system. Climate change is effectively an expression of the pollution component of the Limits to Growth model—which was the subject of a recent independent retrospective study (it turns out the most pessimistic scenario is the one the world is following most closely). The team who designed the original scenario study came up with

some recommendations: their scenarios suggested that the only way to avert collapse would be to deliberately reverse population growth, shrink the economy, and replace fossil fuels with other energy sources.

There are three drawbacks to the reductionist view of climate change. The first is that, even if its tactics succeed, it just leaves the door open to the next crisis in line, and the next, by maintaining overall growth in rates of extraction and consumption of resources. If we could somehow magically solve the climate crisis tomorrow, we might soon be faced with food shortages brought on by fresh water depletion or topsoil loss. By the end of the century we might be dealing with shortages of some critical minerals and metals, including phosphorus for agriculture, rare earths, antimony, zinc, copper, bismuth, chromium, cobalt, indium . . . the list goes on. The extinctions of species that perform essential ecosystem services (such as pollination or oxygen production) could provoke still more crises.

The second problem with reductionism is that it often leads to incomplete or misleading analysis. For example, many climate policy wonks think doggedly in terms of carbon dioxide: anything that results in increased CO2 emissions is to be discouraged, anything that reduces CO2 emissions is to be favored. This has led to the proposal that natural gas should be thought of as a "bridge fuel" to a renewable energy future, since it produces only half the carbon emissions of coal (at the point of combustion). But the case for natural gas as a climate-friendly fuel collapses if we take other greenhouse gases into account, notably methane. Natural gas consists mostly of methane, which is a far more potent greenhouse gas than CO2, and methane leaks are common enough and large enough to vitiate any climate advantage over coal.

Reductionism's third drawback is that it leads to responses that just won't work. One of the most popular proposed climate change responses (among policy elites, anyway) is the notion of building thousands of new nuclear power plants globally. But the nuclear industry is effectively moribund nearly everywhere except China because it is incapable of delivering new reactors on time and at budget, needs massive government subsidies, and produces wastes that nobody knows what to do with. Market prices of nuclear electricity are low, but external social costs (including liability insurance funded by taxpayers) are not reflected in this price; if they were, nuclear would be a much more expensive electricity source. Another favorite of reductionists is carbon capture and storage (CCS) technology, which catches and buries carbon dioxide from coal power plants. This technology works in principle, but cannot be scaled up significantly and makes no sense from an economic perspective (coal with CCS is more costly than many other electricity sources, including PV). Failure to think systemically leads us down rat holes.

Of course, holism has its limits too. The Achilles heel of holistic climate thinking is that it guides us toward strategies that might actually work to reduce climate change and other systemic threats but cannot currently be implemented because they are politically radioactive. Population reduction and a deliberate shrinking of the economy would almost certainly help not only to reduce greenhouse gas emissions but also our consumption of a host of resources,

leaving more for future generations. But what politician would advocate such policies? Only one who was determined not to be re-elected. In fact, the political blowback from such policies could exacerbate the problem.

Still, if we look at our whole complex of problems contextually, it is possible to find potentially politically viable climate solutions that address systemic causes. Sequestering atmospheric carbon not in depleted oilfields, but in soils and restored forests actually makes sense—it addresses several interconnected problems (climate change, habitat destruction, soil degradation, looming food crises) at once. Of course, small-scale organic farming doesn't make money for giant agribusinesses like Monsanto and Cargill, so this tactic runs headlong against powerful, entrenched interests. Similarly, meaningful forest restoration (especially in places like Brazil and southeast Asia) is likely to be opposed by both the agribusiness and the timber industries. Nevertheless, such opposition may be easier to overcome than the categorical unwillingness of policy makers in industrial nations to contemplate the controlled overall degrowth of their economies.

In general, then, reductionist thinking about climate change tends to lead to narrow, targeted strategies that will benefit centralized and powerful industries, whereas holistic thinking suggests systemic proposals for change that may not benefit any dominant group.

Renewable energy sometimes straddles the two: replacing coal, oil, and natural gas with solar and wind power is undoubtedly a major part of the solution to climate change. But when promoted as a "silver bullet" that will enable us to continue living essentially as we do now, renewable energy can become yet another reductionist technofix. Not only does renewable energy do little to address other systemic problems such as population growth and resource depletion, but the all-renewable-energy world is bound to operate very differently from our current fossil-fueled world: quantities of energy available are likely to be smaller and less controllable, transportation will be constrained (aviation and shipping will be very difficult to operate at current scale with renewable energy), and many high-heat industrial processes (required for making cement and semiconductor materials, for example) will have to be completely redesigned and may become significantly more expensive. The holistic answer to these renewable energy constraints is not to continue using fossil fuels, but to acknowledge that how we use energy will have to change, and to get started with reducing overall energy demand, downsizing motorized transportation (which effectively means re-localizing economies), and transforming agriculture and manufacturing so they'll work with intermittent sources of electricity.

The reductionist mindset is relentless: if one technofix leads to a problem, surely there will be a technofix for that too. Some habitual practitioners of reductionism do realize that their proposed tactics merely buy time before the next crisis hits, but they see no realistic alternative. Still, each new increment of time seems more expensive than the previous one.

It is discouraging to see the degree to which blinkered reductionist thinking permeates the recently hatched COP 21 climate agreement. In a letter to *The Independent* published on January 8, a group of

top climate scientists lament that the COP 21 document fails to call for immediate systemic reductions in carbon emissions on a scale that would actually achieve the goal set forth—i.e., the limiting of global warming to 1.5 to 2 degrees Celsius. Rather, the document's authors "require carbon to be sucked out the air [at a later date]. The favoured method is to out-compete the fossil fuel industry by providing biomass for power stations. This involves rapidly growing trees and grasses faster than nature has ever done on land we don't have, then burning it in power stations that will capture and compress the CO2 using an infrastructure we don't have and with technology that won't work on the scale we need and to finally store it in places we can't find."

The lure of the technofix is that we won't have to fundamentally change our behavior. We can go on extracting resources, using energy, and making money, all at an ever-accelerating pace. Wall Street is happy, government is happy, workers are happy. Here's the thing: this line of action cannot solve the cascading complex of crises that will hammer civilization to bits during the remainder of this century. Until we start thinking holistically and alter our systemic behavior, we are locked into a trajectory that leads inevitably to a chain of mutually reinforcing planetary breakdowns that start with droughts and superstorms and won't end until everything we hold dear is either destroyed or rendered meaningless.

Ecology, holism, and systems thinking are powerful tools for understanding ourselves and our world. If we start actually using those tools in earnest to address climate change and other related ecological and social dilemmas, we could save ourselves, our descendants, and a host of other living beings a great deal of unnecessary suffering.