State of the Living Planet

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Back in the 1940s a bedrock scientific study about sustainability was published by Ruth Patrick, then fairly newly arrived at the Academy of Natural Sciences of Philadelphia. In the academy's history, the study should loom larger than Jefferson's fossils or the botanical specimens of Lewis and Clark that were deposited there before the establishment of the Smithsonian Institution.

Ruth Patrick, today an amazing 105 years old, specialized in freshwater ecology (limnology) and in particular the group of algae, diatoms, that produce exquisite silica boxes. Undertaken at the behest of the Sun Oil Company, the study concluded that the number and kind of species in a stream or river reflected not only its natural conditions (physics, geology, and chemistry) but also the stresses created by human action in the watershed.[1]

Suddenly there was an objective way to assess human activity—and environmental impact—or, as we would frame it today, sustainability. In the close to seven subsequent decades, various forms of measuring human impact have built upon that beginning. I term it "The Patrick Principle": Namely that one can read in the biodiversity of an ecosystem—whether freshwater, terrestrial, or marine—the impact of human activity.

In a way it is profoundly simple: Biodiversity integrates the full variety of environmental impacts because by definition they affect living systems. At the global level, it is apparent in Johan Rockström et al.'s famous 2009 paper in *Nature* on planetary boundaries.[2] At the time it showed three boundaries transgressed. 1.) Nitrogen is quite prominent because today the world has double the natural amount of biologically active nitrogen, leading, among other things, to a doubling of aquatic dead zones in coastal waters (devoid of oxygen and fish) every decade for the last four decades. 2.) Climate change appears to have a lesser transgression and be of less concern, but I believe it is significantly underestimated because of the impacts on the biology of the planet. 3.) By far the greatest transgression of the three is in biological diversity, namely because, as noted, in addition to being affected directly by factors such as habitat destruction, it is also affected by all the other environmental factors.

Thomas Lovejoy (left), Marina Silva, and the late Stephen Schneider. Picture taken April 14, 2010.

The message in one sense is quite simple: the Living Planet is in serious trouble. And the pressures are mounting.

Today the planet has a human population literally double what it was when I was born. The projections suggest at least two billion more will be added with a huge proportion of that in Africa. The middle class is growing rapidly in most parts of the world beyond Europe and North America, and that means consumption per capita is on the rise. That has multiple dimensions (both resources consumed and waste produced) but obviously energy is central, and most of humanity is acting as if we have all the time in the world to adjust the global energy base.

Far from it. If the world is to not exceed a two degree Centigrade increase in average global temperature, global emissions have to peak around 2016. That target was largely arrived at

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as something negotiators thought was doable vs. something that made sense in itself. And many talk blithely about three, four, five, and even six degrees Centigrade. All of that is divorced from the reality of how the planet works.

Two degrees is actually too much for many if not all ecosystems. In particular, tropical coral reefs are extremely sensitive to an increase in water temperatures even for relatively short periods of time. The change induces what is known as coral bleaching, in which the coral animal ejects its basic partner (an alga) and the whole system crashes, along with all the benefits to local communities. Something like one-twelfth of the world's population depends on coral reefs. Reefs can recover from a bleaching event, but not when those events become chronic. In addition, coral reefs must cope with oceans that are now on average 30 percent more acidic than in preindustrial times because some of the CO_2 oceans absorb has become carbonic acid. The Royal Society in the United Kingdom has determined that for the world to have tropical coral reefs, CO_2 atmospheric concentrations must not exceed 350 ppm. The current atmospheric level is 400; pre-industrial was 280 ppm.

Already, the fingerprints of climate change on the biology of the planet are ubiquitous. Species are changing their annual cycles. Some species are changing where they live, trying to track their required conditions.

We are also seeing major tipping points in ecosystems. The balance of coniferous forests of western North America from Alaska to southern Colorado has been tipped in favor of the native pine bark beetles: Longer summers and milder winters mean more beetle survivors and another generation per year with the result that in many places 70 percent of the standing trees are dead.

In the Amazon, the combined effects of climate change, deforestation, and fire are perilously close to a tipping point that would lead to dieback of the forest in the southern and eastern Amazon. Already there have been two historic droughts—one in 2005 and an even stronger one in 2010.

All of this is happening with global temperature at close to a 0.9° C increase over average, so the prospect for ecosystems at two degrees higher—beyond what we can already foresee—has to be unacceptable.

In addition there is a simple fact rarely ever mentioned: namely that the last time the planet was two degrees warmer, the oceans were four to six meters higher. We can argue about how long that will take to happen, but the end point is not in question. If someone on the floor of the U.S. Congress, Japanese Diet, or some similar body had ever suggested raising the level of the oceans, they would have been removed and taken for mental treatment. Yet here it is happening and it is rarely remarked upon, let alone treated as anything unusual.

Fortunately, there is about half a degree of climate change currently in the pipeline from current atmospheric concentrations that we can avoid. Little appreciated is the presence of a significant amount of atmospheric carbon which stems from three centuries of ecosystem destruction and degradation. With a concerted effort at ecosystem restoration at sufficient scale, about 50 ppm can be drawn out of the atmosphere. That would be achieved through reforestation, restoration of degraded grasslands and pasturelands, and transformation of agricultural ecosystems so they accumulate carbon instead of leaking it. As scientists explore soil carbon and blue carbon (that in coastal systems), the potential exists to remove a greater amount.

Basically humanity needs to move from a hunter gatherer lifestyle, taking what we will whatever the consequences (whether overfishing, shopping online, or whatever), to proactively managing the planet as the combined biological and physical system that it is. At the rate humanity is burning fossil fuels it will be important to identify economically practical, nonbiological ways to remove CO_2 from the atmosphere. (Most so-called geo-engineering schemes only address the symptom—temperature—and not the cause—greenhouse gases—and consequently represent dangerous and ill-considered options.)

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If we gain control of ourselves so we can manage the biophysical system of the planet in a manner necessary for a salutary future, much of the sustainability challenge will still lie starkly before us. Consider sub-Saharan Africa, where only 30 percent of the savannah remains intact, where the human population is expected to increase by maybe as much as a billion, where already outside interests are moving in on the resources, especially the land that will be essential for agricultural productivity. Can we avoid, for example, the mistake made repeatedly in history of human settlements close to agricultural productivity, in which the town or city spread over the good farmland?

While it may be starkly obvious in Africa at the moment, it is equally true elsewhere that the situation cries out for integrated planning and integrated management. It is vital to move beyond situations where different parts of development

and aspiration operate as if the other parts don't exist and are not affected. That may seem like a hopeless dream, but we actually have the technology to achieve much more integration using Geographic Information Systems and Global Positioning Systems (GPS). Think of a huge modern tractor doing precision plowing with the help of GPS—and with the rapidly spreading use of cell phones worldwide, there is no reason such technology, or knowledge of market prices, cannot assist local communities. Today many an Amazonian indigenous group is mapping its own lands with GPS. An integrated approach to planning and management is needed everywhere, not just in developing nations.

In addition there is the necessity of recognition of the importance of ecosystems and biological resources. Each species represents a unique set of solutions to a set of biological challenges, any one of which can revolutionize our understanding of what biology can do for us in medicine, the factory, or the agricultural field. In other words, in biodiversity can be found a lot of the contributions and pathways to sustainability.

In writing this I am acutely aware that my own definition of sustainability is one that includes life on Earth in all its variety as an essential component. Yet, to be logical, no matter what level to which we impoverish the biology of the planet, there should be a way to sustain it and the human condition at that level and prevent further degradation. While I am seriously impressed with the extent to which people can survive (in some version of sustainability) under pretty miserable conditions (garbage dump dwellers come to mind), that is not what most people have in mind when using the term sustainability. As the Patrick Principle suggests, to ignore the glory and benefit of the Living Planet makes no sense, either practically, or morally, in terms of its implications for future generations, or ethically, in terms of our responsibilities to the rest of life on Earth—of which we are in so many ways a part.

References

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