**Biophysical Reality: The Primacy of Environmental Health and True Sustainability for Effective and Responsible Planning and Policy**

The topic of sustainability has great bearing on the goals of the Center for Global Responsibility (CGR), which include seeking a world without poverty and conflict, where respecting human rights and protecting the environment are the norm, and the earth’s natural resources are utilized in an equitable fashion. In the long-term, sustainable means possible, and unsustainable means not possible. There are many reasons, both utilitarian and not, for being good stewards of the earth. Whether one is an engineer or a financier, a farmer or a fisherman, the earth and its biosphere provide essentially everything we rely upon for our survival and sustenance, our spiritual well-being, and inputs and energy required by our economies. In recent decades, people have come to realize more fully the many “ecological services” that properly functioning natural ecosystems provide – from food to building materials, to flood control and pollutant removal, and a diversity of life, form and function on which to gaze in amazement.

 Use of the term “sustainability” has become nearly ubiquitous in public policy and development circles, and even in the public discourse. We hear about “sustainable development”, “sustainable growth”, and “sustainable resource use.” Sustainable has come to mean good, desirable. While this is welcome in one sense, I believe the term has become mis-used and misunderstood, from the standpoint of future development, and economic and environmental health. The recent popularity of the term sustainable can be traced to a 1987 report to the United Nations General Assembly by the World Commission on Environment and Development (“Brundtland Commission”) chaired by Ms.(Dr.) Gro Harlem Brundtland, then Prime Minister of Norway. The Brundtland Commission report defined sustainable development as that, “which meets the needs of current generations without compromising the ability of future generations to meet their own needs." It is a somewhat ambiguous definition, but also very conservative in light of more recent assumed meanings. The constraint about future generations makes the Bruntland Commission’s definition of sustainable consistent with mathematical and physical concepts of something being sustainable if it can be continued indefinitely into the future.

Policies based on erroneous assumptions of sustainability will ultimately fail when they run up against physical limits. The ecological concept of carrying capacity and of limiting factors – of habitat and essential nutrients - is equally applicable to the economic process. Indeed, whenever something new is purchased, a certain amount of energy and natural resources and labor were required to produce it. Pollution and damage to the environment have been historically associated with economic activity as well – soil erosion and degradation, greenhouse gas emissions and associated cascading effects, loss of biodiversity, and contamination of air and water. Taking this further, continued economic growth must be predicated on continued growth in the extraction of raw materials and energy needed to produce the goods and services demanded by the market, and of the associated pollution and environmental impacts. We now use more of most resources than ever before; this is not unexpected, given the continued expansion of economies and the population as a whole. In short, human endeavors take place within a system with boundaries and are reliant on biological and physical processes to provide for their needs. This is biophysical reality.

There are many who claim that natural resources are not as important for the economy as they once were, but I believe this is patently false. For instance, those operating in the increasingly important economy of “information” still require inputs of water, silicon, energy, etc., to produce and supply the office space and hardware they use and to keep their employees fed, clothed, and housed. We have become more efficient in use of some materials and inputs, but those aforementioned items are still required. Witness that while the world’s petroleum-consuming vehicles and machinery are more efficient than in the past, petroleum consumption has still increased – with that of 2015 being the highest ever. Also witness that while we have limits placed on the harvest of wild fisheries in the United States in attempts to avoid overfishing and collapse, we also see an increase in production of farm-raised fish and shrimp – indicating that the demand for seafood in general has still increased.

Many may ask, “Well, what is the problem?” The problem is that there are many signs that the cumulative magnitude of depletion of natural resources and damage to the biosphere are becoming limiting and costly - calling into question the kind of earth and quality of life that will be available to future generations. Such concerns about human impacts on environmental and human health are certainly not new; they became quite common in the 1960s. Meadows et al. from MIT published their first version of “The Limits to Growth” in 1972. Their work outlined results of numerous computer-generated scenarios in which resources and environmental health of the planet and human population and welfare were simulated through time. Computer models like the one the authors created are called systems models, because they involve definition of a system of interest – including boundaries, energy inputs, stocks of materials and resources, and various processes that take place within the system which interact with the stocks of resources and the materials produced by other processes. Meadows et al. concluded that by some time in the mid to later 21st Century, the accumulated damage to the environment, depletion of natural resources, and associated additional costs would overwhelm the functional capabilities of society and governments. Their conclusions caused quite a stir, eliciting vehement dismissal by many economists and pro-growth advocates. But the increases in environmental degradation, population, and consumption of resources continued through the authors’ 30-Year Update in 2004 and up until today. To compound matters, evidence is mounting that changes in climate and weather patterns induced by emissions of greenhouse gases may add perhaps one of the biggest system-stressors yet to the biosphere and its residents.

In past eras, governments and economies have been able to succeed with arguably little rigorous planning – by simply letting the invisible hand of the free market guide economic development. There was no application of whole-system models to simulate effects of this policy or technology or trend, or that - and everything seemed to work out – for those in charge anyway. This is not to say that this “method” was ideal, indeed our history of development has, by definition, brought us all of the environmental issues that we see today. Environmental impacts and related issues were dealt with, if necessary, in a reactionary fashion. Much of this history and “progress” was possible simply because we had both natural resources, and environmental degradation capacity to spare. Economies grew because natural resources could be supplied affordably at ever increasing rates – including especially the most important resource – cheap energy.

I am not so sure this laissez-faire planning method can be counted on very far into the future. Colleagues and I published a series of articles starting in 2003 focusing on the longevity of cheap conventional oil as a resource – perhaps the pre-eminent enabler of industrial economies since early in the 20th Century. We found that the availability of cheap conventional oil began to decline in 2005, and only the exploitation of lower-grade and or more expensive-to-produce oil from very deep waters, tar sands, and shale has allowed continued growth in the total production of oil. Growth in production of unconventional oil came at a cost – such growth requires higher oil prices, which erode the purchasing power of citizens, and has been accompanied by spills of oil (sometimes catastrophic) and production brines, and above-average emissions of greenhouse gases. This research and that of others has shown that the quality of many of the resources we exploit has been declining - with declines evident in the amount of energy returned on the energy invested in extraction, and the grades of mineral ores that remain (e.g. lower percentage of copper per mass of ore). So, resources do appear to have limits. Damage to the environment, and reduced affordability of resources, can exert real costs on both economies and people’s quality of life.

All of the aforementioned relates to the CGR because its ability to achieve its goals can be affected by the availability and expense of natural resources, a clean environment and healthy ecosystems. Scarce resources and environmental degradation can cause tensions, social unrest and mass migrations, and sometimes wars. Rising populations in various areas unavoidably factor into this arithmetic as well. The predominant policy and planning processes of today still center around economic models that are not sufficiently grounded in the biophysical realm. Not coincidentally, most economists generally do not see or even believe in limits. They also generally do not have extensive training in sciences such as physics, geology, or ecology. One of the most important assumptions underpinning almost all development and poverty reduction programs is continued economic growth – because it allows problems of poverty, joblessness, strife, and inequality to be more easily addressed. Economic growth is sought by essentially all governments and is espoused by all the major political candidates. But is this strategy and assumption as iron-clad as it once was given the trends previously mentioned? If economic growth stalls, many social welfare, poverty reduction, and conflict avoidance objectives become much more difficult to achieve.

We need to start making more realistic plans – and this is likely to require asking difficult questions and a sober, honest assessment of facts, trends, and possibilities. I believe the only way to do so is to root our decisions in biophysical reality. What kind of future do we want? The one brought to us by the kind of thinking that brought us the Great Recession because people couldn’t conceive that housing prices would soon go down? How difficult do we want it to be for children 50 years from now to find wilderness; clean water; food free of residues of industrial chemicals or pesticides; meaningful employment and decent quality of life?

In the interest of creating effective and resilient policies, all policies should be assessed through the lens of true sustainability. Can they be sustained indefinitely, or at least long enough for the purpose at hand? Does a plan or policy rely on ever increasing rates of extraction of a finite resource, or rates exceeding the rate of natural replenishment of a renewable resource? A resource could be anything –a supply of clean water; a fishery; an affordable source of energy or other essential input (e.g. copper, lithium, naptha); or a supply of people willing to finance debt (or able to pay it back). Biophysical and systems-oriented economic and planning models are useful because they keep track of the different interacting parts of systems and recognize the importance of, and constraints of, physical resources for economic activity. Planners should keep in mind realistic worst-case scenarios of availability for key sources of energy and resources. Additional questions may prove crucial. What effect might an increase in production of a certain type of energy or related technology have on the prices of the resources necessary to produce it, and how long would it take to make a significant global impact? What is the anticipated longevity of that alternative fuel or resource once a given policy is initiated? What are the potential environmental impacts or other cascading effects associated with it and will these require additional expenditure of money or energy? How might trends in human population impact on policy effectiveness over time? None of this is intended to throw a “wet blanket” on efforts related to good governance and social justice. It is simply a caution regarding realism and rigor of analysis, and against the reliance on optimism as a plan. There is a place for hope and optimism in this world - indeed, they are probably essential. However, these are things that should come into play after, or at least while, the hard questions are asked by the policy maker, not be substituted for them.

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