The Resource Buffer Theory: Connecting the Dots from Conservation to Sustainability

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Abstract—*Review of conservation history and scientific developments helps us understand relationships between humans, environment, and sustainability. Applying "conservation" to natural resources and practical resource management occurred early in the Twentieth Century; practical economic definitions of conservation and natural resource followed. Resource surpluses underpin the luxury of conservation in which we currently bask. We are not paying attention to the fact that accumulated natural science discoveries about wide-ranging resource distribution – so specialized that many scientists are unaware of each others' works – are remarkably alike. The pattern – the Resource Buffer Theory – demands recognition, understanding, and emulation to ensure humankind's survival. Buffers are vast amounts of resources that are as essential to species survival as are the few units of the resource utilized by individuals; despite their vastness, they often display delicate limits. The terrestrial resource buffers to which we have access and on which we depend are Hardin's global commons. Maintaining a large biodiversity buffer is paramount. The distribution of carbon – the stuff of life and a critical linkage between the hydro- and biospheres – contradicts the pattern, indicative of Planet Earth's overpopulation. Consequent global change events are signaling us that humankind's oblivious violation of the ubiquitous environmental pattern provides an unparalleled challenge to our survival. Faced with the imperative of sustainability, we need to connect the dots, to control the Earth's human population and activities including resource use and waste, and to under-stand and thereby proactively emulate the Resource Buffer Theory in our natural re-sources management policies and practices.*

A Century of Conservation

It has taken a century following the Industrial Revolution to define and refine what we call conservation. Three individuals among many scientists, activists, and writers played particularly significant roles and serve as examples. Gifford Pinchot first applied the term "conservation" to natural resources in the early 1900s. Hugh Hammond Bennett applied conservation concepts to soil productivity management and urged the creation of the Soil Conservation Service (now Natural Resources Conservation Service) in the mid 1930s. At mid-century, S. V. Ciriacy-Wantrup defined conservation as "shifting rates of resource use toward the future" (Wantrup 1951). Resources, he said, are things that have utility and scar-city and are simply classified: renewable or flow resources are characterized by having different amounts become available in different time periods; nonrenewable or stock resources are limited in total quantity. Wantrup's linkage of resource utility (value) and scarcity (in time or space) provide background for understanding the range of resource management: exploitation is all use and no time, whereas preservation is all time and no use. There have been many battles over resources conservation, with champions of exploitation and preservation squaring off over legislation-defining public policy, and creating innumerable non-government organizations, government agencies, and regulations. Recognition that conservation is a social-political-economic meeting (or battle) ground suggests that a good definition of the word "conservation" is a mix of exploitive and preservationist policies and practices that varies over time as dictated by the resource-using public. Simultaneously, shortages in developing countries that do not even have "conservation" in their lexicon preclude that luxury when scarce resources are needed for day-to-day food, clothing, and shelter, often for a rapidly-expanding population.

These Twentieth Century thoughts and milestones—and later air, water, and environmental quality, and endangered species protection laws—characterized changing attitudes toward environmental management by an always changing mix of exploitation and preservation.

Fundamental philosophical and site-specific issues persist, hopefully in light of better scientific understanding of our natural resources.

The Atomic-to-Cosmic Blueprint

Reviewing the wide range and long history of basic and applied research illuminates a ubiquitous pattern to the distribution of our terrestrial and extraterrestrial resources. Thus, energy, space, and matter (and time?) are distributed so that (1) only a very small proportion of the total quantity of the resource is directly "used" by humans and, (2) the vast remaining—seemingly "unused" proportion—is an essential buffer. Buffers absorb environmental excesses that establish and maintain those conditions under which a species survives. For example, the oceans absorb biological wastes, gasses, eroded elements and compounds from the land masses, and energy from the sun and atmosphere. Covering two thirds of the planet, they also shield us from catastrophic impacts of comets and meteorites that do get past our Solar System's outer planets' gravitational pull. The theory complements Lovelock's (1988) assertion that Earth's combined physical, chemical, and biological systems—Gaia—exhibit homeostasis, that life favorably modifies a species' environment, thus promoting sustainability; if it doesn't, the species dies.

The pattern suggests a generalization, the Resource Buffer Theory: "For every resource where a small proportion is essential to life processes of individuals, the greater proportion maintains environmental conditions necessary to the survival of the species" (Black 1995). The significance of the pattern is in the lopsided distribution of vital resources, the wonders and aesthetic patterns of which describe order in the universe as aesthetically articulated in Music of the Spheres (Murchie 1967). The concept is, indeed, just a theory; it may not demand or even be capable of identification as a law or principle. Nevertheless, it is.

Research provides some of the more dramatic examples of the resources so distributed, including:

- Only 1 to 4 percent of the "dark matter" of the universe is "known" to us (Trefil 1993, Rowan and Coontz 2003), and recently-articulated "dark energy" is similarly distributed.
- Closer to home, the Sun contains 99.9 percent of our Solar System's mass, while 71 percent of the Solar System's planetary mass is in one planet, Jupiter (a very disproportionate 99.6 percent is in the outer three planets).
- The Earth intercepts approximately one billionth (9.1x10-8 percent) of the sun's energy available at the surface of a sphere at a distance of 93 million miles.
- Summarizing the distribution of Earth's life-giving water: 97 percent is salty; 2 percent is ice (or was prior to what currently appears to be accelerated global warming); three fourths of the remaining one percent is in deep and shallow ground water, and one-fifth of the rest is in lakes. The remaining approximately 0.006 percent of Earth's circulating fresh water is the renewable resource on which we directly depend.
- The lopsided pattern was probably first observed in biology where reproduction exhibits its excesses and seeming waste of vast numbers of unused resources of sperm, eggs, seeds, and seedlings, and where for agriculture and forestry it is managed as in thinning dense plantations.
- The most complex of the essential resources that exhibit this pattern is carbon, the very stuff of life. A mere 0.004 percent of the total carbon on the planet is organic; only 0.12 percent of that is in animals, the rest in plants. And, of this tiny percentage of all animal carbon, 4.0 percent is currently in one species, human beings. Actually, it is more than that. Since to my knowledge, no humans live in the oceans and the animal carbon is nearly equally distributed between oceanic and terrestrial environments, 8.0 percent of all the terrestrial animal carbon is in the 6.3 billion human beings that inhabit the Earth.

The Population Dimension and Global Change

The carbon data do not mimic the universal pattern; not for a species that is at the top of the food web. The numbers constitute evidence that humans overpopulate the Earth: according to the Resource Buffer Theory, one would expect "higher" life forms to have sequentially lower percentages of carbon. And, were the population to double by 2050 (the high growth rate estimate), 16 percent of the terrestrial animal carbon would be in one species: us. That number is probably not sustainable. Even the present 8.0 percent is probably not sustainable, primarily because it is at the expense of biodiversity and partially underlies accelerated global change. Perhaps of greater importance is the observation that in addition to the actual amount of carbon in human beings, there is the impact that human activities have on the carbon cycle and, therefore, the vital carbon buffer, a major portion of which makes up the biodiversity buffer.

The distribution of humans is equally serious. At present, one half of the world's population lives in cities of more than one million; 400 urban areas have populations of one million or more. Sustainable? Questionable. The financial resources to provide closely packed urban and sparse suburban and rural communities with water, food, sanitary facilities, and energy at western rates of excess resource consumption are not sustainable without energy subsidization (Odum 1989): and maintaining an affable climate in an atmosphere overloaded with anthropogenic-increased carbon dioxide and methane is unlikely. Even—maybe especially—in the resource-wealthy United States the fast-growing, uniform landscapes of the Sunbelt areas are particularly vulnerable to fire, drought, flood, climatic change, and, perhaps, disease. These harbingers of pre-glacial-period warming are already exerting relentless impacts to budgets currently challenging governments at all levels. They will get worse. The familiar situation in developing countries is critical, as evidenced by the well-publicized death rates due to inadequate and/or contaminated water, drought, famine, and disease.

Further, when stressed, delicate ecosystems—the biodiversity buffer—display amplified fragility. There is little doubt that humankind's industrialization has stressed ecosystems in a variety of ways. Re-source exploitation, population growth, urban sprawl, and reliance on the personal automobile are principal contributors to this stress. Widespread deforestation and agricultural- and tree-farm-induced mono-culture that support this life style characteristic of western civilization have replaced the natural ecology of the Earth's surface on a significant scale (Marsh 1874). Currently, extensive pavement and regulated storm water runoff management schemes to decrease local flooding also decrease ground water recharge that consequently diminishes on-site water for cooler climate, water supplies, and environmental variability. Increased impervious area results in subsidence as well as more downstream flooding such as in central Europe in 2002.

On a broader scale, wetlands, rainforests, and coral reefs are disappearing dramatically. This is a global problem and must not be considered independent of the Resource Buffer Theory. The classic understatement by Karl and Trenberth (2003) is "We're entering into the unknown with climate, and its associated impacts could be quite disruptive." Watson (2004) presents a stronger case:

> Human-induced climate change is one of the most important environmental issues facing society worldwide. The overwhelming majority of scientific experts and governments acknowledge that there is strong scientific evidence demonstrating that human activities are changing the Earth's climate and that further human-induced climate change is inevitable.

Clearly, ramifications of excess unsustainable human activity are already here. Local and global climate change includes greater extremes of precipitation and temperature associated with and/or caused by El Niño and La Niña, glacial retreat, rising ocean levels, more and greater droughts, and floods, and increased wildfires in Australia, Indonesia, and the United States. Biodiversity has decreased coincident with new diseases and reoccurrences of old pathogens. Southward movement of the winter storm track has brought record low winter temperatures and snow to the northwest and southern states, tornados in October of 2003, snow to the Middle East and Las Vegas, and the first-ever hurricane in the South Atlantic Ocean as I write. We can expect—and in all likelihood cannot prevent—ocean current reversals that are associated with alternating glacial and interglacial periods (Taylor, and others 1999). The North Atlantic Ocean Current did in fact reverse in the summer of 2003, apparently due to the reduction in the thickness of the arctic ice and subsequent movement of cold water through the formerly blocked Northwest Passage, with a probable assist from the Coriolis force. There were fifteen million square miles of cool waters pooled in the North Atlantic Ocean. The Nova Scotia lobster industry crashed and in Paris hundreds of deaths caused by unprecedented heat were recorded.

Connecting the Dots

The repetitive pattern of our resource distribution inspires the opportunity for action, but not without potential confusion. Modern sciences are quite specialized and research results are not often read by individuals in other disciplines. And, without statistics and "sound science" behind them, few authors scream "the sky is falling." Disagreement among reputable scientists, experts, and politicians with vested interests leaves us confused and adrift in a sea of often conflicting opinions that befuddle the public. Linkage between global change patterns and many of the above-listed afflictions of and affronts to human civilization are probably not provable by any standards of sound science, nor is sound science sufficient for governance of the commons (Dietz and others, 2004). We are too close to some of the changes to see them; others are not fully understood, and there may be unexpected and unpredictable outcomes. On the other hand, logic is speaking to all of us. Scan the current journals: articles on these changes are rampant. It may already be too late to stop the drastic changes anyway; but we are going to have to live with—or die by—these changes. It is time to put things together, to consider the evidence and logic that is before us.

The need to connect the dots begins with recognition of the fundamental, universal ecological pattern rooted in the theory and function of the resource buffers: they are essential for the maintenance of conditions that will ensure—or at least make more likely—the continued survival of the species. For example, the cause of the excess build-up of carbon dioxide and near lethal low values of oxygen in the Arizona research facility Biosphere 2 (Severinghaus and others 1994) was probably the failure to provide an adequate inorganic buffer that properly mimicked Biosphere 1, Planet Earth. Earth's buffer of inorganic carbon contains 99.978 percent of the planet's carbon in the sediments. Our current direct alteration of the fragile level of atmospheric carbon dioxide (along with methane and ozone) similarly endangers the conditions that could ensure our survival. For three hundred years climate was relatively stable and affable demanding only small, acceptable, and challenging fluctuations in human activity, ready to explode as it recognized the value of its natural resources and exploited them to support the Industrial Revolution. The interactions between climatic change and stability, subtle shifts of storm tracks, and the development of an agricultural base associated with growing population and industrialization are often complex as well as unpredictable (Fagan 2000). There is little doubt that humans are dramatically changing the conditions under which we live.

In fact, the buffers that sustain us—and myriads of other species—include the global commons referred to by Hardin (1968). To ignore them is to invite disaster. It is therefore quite appropriate that it is the commons from which we infer a focal pattern and to which we may address an innovative environmental management scheme. Surely, the most threatening change over which we have some control is the reduction in biodiversity, a critical buffer. Caused by the shift of carbon to human beings and human activities, biodiversity is in need of definition in theory, and evaluation in terms of quality and quantity so as to be fully understood in its commons role and thus capable of being nurtured in this light. In addition to direct inroads on the diversity of life on the planet, human—and to some degree geologic time changes—are severely impacting this all-important buffer. We are not only observing the onset of major climate change, but there is a resurgence of diseases (Levins and others 1994) that may be associated with the widespread uniformity of agricultural and forestry practices including West Nile Virus, avian flu, mad cow disease, Ebola virus, cryptosporidium, and giardia, to mention a few. Perhaps even AIDS and SARS are reactions of natural systems to overpopulation and biodiversity reduction. There remains the question of the source of the increased carbon for greater human numbers: if from the vast inorganic buffer in the sediments, the resultant increase in release of carbon dioxide to the atmosphere from increased human activities will promote temporary global warming and long-term climate change, ultimately a new glacial period. If from the organic pool of wetlands, rain forests or coral reefs the biodiversity buffer is directly diminished at our peril.

The luxury of conservation extends from the end of the Industrial Revolution, when segments of humanity were large enough to significantly affect global conditions, to the recent past where frequent and major consequences of our actions are beginning to strike back. And, as more and more comforts of civilization are developed, technology is called upon to protect against or reimburse losses from environmental disasters that wreak unprecedented personal, societal, and financial damage (Tenner 1997). The imperative of sustainability demands attention. Humankind faces serious threats to its otherwise promising current civilization because of our own growth, actions, and excessive demands on natural resources: resources on which we depend and that exhibit the lopsided distribution patterns characteristic of natural buffers. The "good life" that is the fruit of the Industrial Revolution and western civilization's excessive and often mindless exploitation of natural resources is, in the long run, not "good."

The bottom line: we're in trouble. Vitousek and others (1997) state unequivocally "humanity's dominance of Earth means that we cannot escape responsibility for managing the planet. Our activities are causing rapid, novel, and substantial changes to Earth's ecosystems." Assuming that we wish to resolve the problem and be the masters of our future on Earth, there is much to do research, education, and effective implementation of policies and practices to achieve population control. The challenge will be a critical and timely test of the awesome potential of globalization.

A Time for Action

First, an international and truly interdisciplinary team must be convened to formulate and evaluate fundamental questions about environmental assimilative capacities. Then, joined by social scientists, effective policy and management solutions with high success potential must be created. This is not a situation in which to pursue and achieve pet goals: this is a matter of survival of the human race, not of any one individual, community, hemisphere, or nation. This cooperative world-wide agenda may not even be feasible: Fagan (2004) points out that "if we've become a supertanker among human societies, it's an oddly inattentive one. Only a tiny fraction of the people on board is engaged with tending the engines. …." Yes, ironically, the Resource Buffer Theory applies to us, too. Those that know, however, need to show the way. Western civilization's excess resource users must reduce excess use and waste of natural resources, especially excessive pollution of the vital resource buffers. It is time—and hopefully not too late—to make timely and informed choices. To whatever extent we put off action by unproductive pondering of the enormity of the task and procrastinate on any action, we invite increasing potential disaster.

Second, the information from this assemblage—assuming it succeeds in its mission—must be disseminated in an unprecedented global education program. A challenging part of this effort will be convincing all—especially those in developing countries—to listen and understand so as to play meaningful and effective roles in the decision-making process to secure the future of humans on the planet; and those that know and understand the severity and enormity of the problem are equally challenged to effectively convey the message. The challenge to the resource-guzzling western civilization will be most difficult: how to limit resource use while allowing others to increase theirs, with an overall net reduction in technological development and resource use. Nothing short of this will work, although it is possible that partial steps might buy time, which might simultaneously delude us into thinking that we are safe. An unlikely alternative may be to entrust solutions to that "tiny fraction of the people … engaged with tending the engines." And, interim conditions, whoever implements them and for whatever reason, may not be any more pleasant than non-human-controlled solutions. A first order of business will be to convince all that failure would have disastrous consequences—soon, and sooner than we care to think about.

Third, we must design, adopt, and implement workable and acceptable strategies that will provide a schedule to enhance our ability to deal with the fundamental problem: unsustainable human activity. At the current rate of agricultural land degradation, and with current technology, "in just 42 years there will be sufficient arable land for a population of only 2 billion" say Pimental and others (1999), who have revised an earlier estimate of the Earth's carrying capacity down from 2.5 billion to 2.0 billion, less than one third the present number. Such an unprecedented challenge must be accomplished humanely to protect our humanity; it cannot be achieved by an elite leadership. And it won't win popularity contests in any case. However, if we wish to have control over the future, we must be proactive. Whatever is done must be achieved by global communication, cooperation, and action. An international Earth Summit on Environmental Sustainability might succeed, but not if its focus is the oxymoronic "sustainable development" as in the past: development is the historic cause of the challenge that now confronts us. It is thus important that we are aware of lurking pitfalls: efforts to bring resource use and waste under control are threatened by long- and widely-held religious beliefs along with ignorance, stupidity, waste, and greed. If the latter is a natural characteristic of humans (of life?), success might be discouragingly be-yond our grasp. We may not obtain the necessary understanding anyway, much less support from those who spread terror, reflecting their legitimate but derogatory view of how western civilization wastes its resources and disproportionately pollutes its buffers.

In view of widespread terrorism driven in part by unequal utilization of resources (as well as persecution, poverty, lack of feelings of personal worth or sense of community, and lack of hope) there is an ironically disturbing thought: we are already applying the Resource Buffer Theory in western civilization. But we're doing it in ways that may ensure western civilization's collapse: through disproportionate abuse of resources and environmental buffers. Developing countries will not be convinced of any urgency of action without substantive sacrifice by those that have an abundance of resources. The best way to convince the world's underprivileged of the seriousness of our mission—the importance of workable sustainability measures—is to acknowledge and act to reduce waste of resources and associated pollution of environmental buffers. Were we to make serious changes in those habits, we might gain essential support in the all-important sustainability agenda. One approach with high-success potential is Brown's (2003) suggestions of tax- and subsidy-shifts that in-corporate the "honest" cost of environmental degradation into supply costs of human needs. It provides alternatives that may be adapted to meet local and national needs, resources, populations, and times; and numerous nations have already applied the shift-based approach as a strategy with high degrees of success. For example, Iceland has converted from a carbon based energy economy to a hydrogen base; Japan has invested heavily in solar energy, and Ontario is "phasing out coal." Tax shifts and setting reasonable prices on water and energy are the only sure way in which to reduce consumption. This approach may be the best way to reduce or eliminate the inexcusable and wasteful use of fossil fuels for high-consumption personal transport and for vehicles such as racing cars, SUVs, and ATVs. The immediacy of the challenge is well expressed by McMichael and others (2004):

> Addressing sustainability is more than an academic exercise. It is a vital response to a rapidly evolving crisis and should be at the top of our research agenda. The forces that opposed social change for sustainability, whether from indifference, incomprehension, or self-interest, are powerful, and neither individual scientists nor isolated scientific disciplines will suffice to change understanding policy. Science itself needs to be fully engaged in this challenge.

And by Brown (2003), who points out that "we must be quick. Our demands on the earth exceed its regenerative capacity by a wider margin each day."

Finally, assuming that all agree about the significance of the pervasive pattern in the universe, humans must find ways to incorporate the environmental patterns that sustain us. Proper homage to Sir Francis Bacon implies that it would be a good idea to base our resources management practices on a strategy he elucidated in 1620: "Nature to be commanded must be obeyed." Finding ways to obey the fundamental pattern that we observe throughout the Universe in our everyday and long range resource management plans is a challenge to which all can find creative responses. It represents a major paradigm shift of the greatest importance. By adopting shift-based strategies to the natural environment and other innovative measures, we might really attain human sustainability. It certainly is worth a try.

Conclusions

There are three conclusions. First, the Resource Buffer Theory emerges from reflective consideration and observation of the characteristics of the abundant resources that surround us. Second, among the many resource buffers (global commons) available to us, biodiversity—represented by the out-of-line large percentage of organic carbon in humans that simultaneously marks our runaway numbers—is perhaps the most critical. Finally, to assure continued existence of humanoids on Earth, we must adopt a paradigm shift from resource and buffer abuse to one that attends to the fundamental and universal environmental pattern.

In sum, we need to recognize, embrace, and celebrate the Resource Buffer Theory that protects and sustains us by making it the focal point of our resource management policies and practices. A red flag demanding attention ought to appear whenever humans impact a resource buffer. Noting the limits of existing resources and the need to maintain buffers that protect the conditions that enable our species to survive should be the new goal of conservation. Conservation must address the question: How might we emulate the universal environmental pattern in our management strategies and practices? Based on sound science, conservation is the cornerstone to sustainability, to survivability. In this fundamental context the future of resource-using humans on planet Earth must be considered. We must pay attention; and act.

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