

Ecological Sustainability: A New Look at an Old Paradigm

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Introduction

This paper identifies the Resource Buffer Theory, which articulates the pattern of the asymmetric distribution of resources in our biophysical environment¹. The paper discusses the theory's development, connections, complications, utility, and potential for tackling the challenge of sustainability. I suggest how we might better manage our natural resources by making use of a 400-hundred-year-old paradigm² in the form of a quote from Sir Francis Bacon (1620) called to my attention 50 years ago: "Nature to be commanded must be obeyed." More recently, and prompted by Marsh (1874), a keynote address,³ and much reading, I became concerned about how *many* forested acres—and other resources—we as individuals use and need in direct- and indirect-use environments. In addition, examination of resources that support individuals and populations in light of the Resource Buffer Theory presents evidence of excessive human numbers, the importance of the inorganic carbon buffer, and the massive extent of the human impact on carbon dioxide. The challenge of the Resource Buffer Theory lies in understanding its importance in our many environments, what it is that we must do to successfully apply Bacon's paradigm, and how we might go about it in order to ensure human sustainability.

Commonality in Our Resources

Professionally aware of the lop-sided distribution of the planet's water resource (Black 1996:10),⁴ I noted that several resources follow that pattern. In fact, *all* our resources are asymmetrically distributed (Black 2004): the universe's dark matter and dark energy;⁵ Solar System mass;⁶ Solar System planetary mass;⁷ energy received on Earth;⁸ biological/reproductive processes; and of course, the nature of the basic building block of the universe, the atom.⁹ Even

time—and human relationship to it—seems to be similarly distributed (Diamond 1992:169).

Thus, from this atomic-to-cosmic blueprint a theory emerges that helps explain how we live and thrive as individuals and in our community environments. The Resource Buffer Theory (Black 1995) is that *for every resource where people rely on an infinitesimally small percentage of the resource for survival as individuals, the vast remaining percentage serves as a buffer that maintains environmental conditions that promote survival of the species.*

Connections

The Resource Buffer Theory is attested to by its descriptive truths and by its complementary connections to other theories advanced to explain the evolution and nature of our multiple environments.

The buffers¹⁰ are shock absorbers, absorbing impacts of disturbances. In addition to the many services of the oceans, for example, Earth's life is protected by Jupiter's (and the other giant planets') presence that attract most of the Earth-pummeling debris (comets, asteroids, and meteors). At the other end of the environmental spectrum the vast spaces in the tiny molecules of life provide protection as they permit the passage of radiation through the voids.

The Resource Buffer Theory supports John Lovelock's (1988) concept of *Gaia*, that as conditions eons ago promoted life on Earth, life in turn modified the very conditions that enabled it in a positive feedback loop.

The buffers are often the un-owned "commons" (Hardin 1968) such as the oceans, forest and grasslands, tundra, and what we often refer to as open space or barren or vacant land. Thus, they harbor bountiful reserves of natural resources, but are simultaneously looked upon as exploitable, often not a viable option for sustainability; they all require careful management.

Sustainability

I define “sustainability” as *being continuously maintained by its inherent characteristics and its interacting environment*. Many equate the general term ‘sustainability’ with ‘sustainable development,’ which replaces a human *value* on the definition. However, sustainability should be defined in terms of human *existence*. Generally, life as we know and define it on this planet is sustainable; it has managed to exist for nearly four billion years (Heintz 2004). However, the Resource Buffer Theory is better served by a definition of sustainability that includes both the human needs from, and interactions with, the biophysical environment, such as Canada’s 1915 Commission on Conservation: “Each generation is entitled to the interest on the natural capital, but the principal should be handed down unimpaired,” which emphasizes the status quo of the environment. This is in contrast to “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Commission 1987), which emphasizes human needs and development. The process-focused definition of sustainability by Allen et al. (2003:26) also emphasizes human needs, but gives a nod to the environment through “acceptable cost” and, more important for the Resource Buffer Theory, emphasizes the ability of systems to buffer change and be resilient:

...maintaining, or fostering the development of, the systematic contexts that produce the goods, services, and amenities that people need or value, at an acceptable cost, for as long as they are needed or valued.

Although life is sustainable, and human behavior sustainable according to many definitions, the asymmetric distribution of carbon—the fundamental resource by which life is defined—is experiencing a radical shift. Carbon distribution is more complex¹¹ than most other resources, exhibits an incredibly large buffer of inorganic carbon, and is a clear indicator of human excess. In the context of the Resource Buffer Theory, one would expect the percent of carbon in humans located atop Earth’s food chain to be infinitesimally small. However, of the terrestrial carbon in animals, eight percent is

in human beings¹². If the planet’s human population were to increase by 12 percent in the next fifty years—the “high” projection—that would mean that 16 percent of the animal carbon would be in humans, and it is difficult to comprehend even four or eight percent as being sustainable.

The carbon buffer most important to survival of any species is biodiversity, as attested to by Orr (2004), Pimental et al. (1999:30), and the National Commission on Science for Sustainable Forestry (2004:13). However, Allen et al. (2003:247) assert that “biodiversity can mean anything and is likely to take on many and confusing meanings,” and they question the general utility of biodiversity for measuring ecological conditions. Although they might not agree, I think that these authors’ argument underscores the importance of emphasizing patterns of distribution in the biological and physical environments. In the context of the Resource Buffer Theory, the maintenance of an asymmetrical pattern in the distribution of environmental biodiversity is essential for maintaining sustainability. Diamond (1992:314) points to the failure of many island and continental civilizations to maintain a resource base. He documents the massive extinctions of species and human support systems caused by forest destruction that upset the balance of local ecological communities. Management of natural resources demands a balance of exploitation and preservation necessary to practice conservation (Black and Fisher 2001)—and to achieve sustainability.

The principal impact to the carbon cycle is that humans also upset (and thereby inadvertently reduce) biodiversity by removing a small percentage of the huge inorganic carbon buffer¹³. In itself, this is probably not important, but in the form of fossil fuels and their conversion to water and carbon dioxide (both greenhouse gases)¹⁴, the impact is of great importance. More importantly, the ratio of the total mass of carbon in the Earth’s huge inorganic buffer to the atmospheric CO₂ is on the order of ninety thousand to one, thus the three-fold increase in atmospheric CO₂ since the end of the Industrial Revolution may not reasonably be considered to be sustainable since that is what drives Earth’s growing climate change (Karl and Trenberth 2003). In the context of the Resource

Buffer Theory, it is concluded that the Earth is overpopulated with human beings¹⁵ who are upsetting the delicate natural distribution of gaseous carbon, a double-whammy. The continued steady release of inorganic carbon to the atmosphere by burning fossil fuels is not conducive to sustainable populations or to the environments in which they developed and by which they are nurtured.

Practical Application of the Resource Buffer Theory

Other than accurately describing the carbon cycle, how specifically does the Resource Buffer Theory address the sustainability of the relationships between the life that we are trying to sustain and the ecological systems that support it? For example, above the magnificent alluvial stand of trees preserved by the creation of the Coast Redwoods National Park, most of the Redwood Creek watershed area was included to preserve conditions that led to the trees' development. The great height reached by these trees is possible because of the multiple layers of root systems that develop as the sediments lain down by periodic floods from the watershed above—a resource buffer—supplied new sources of both nutrients and physical support. The tall trees are dependent upon the maintenance of all the factors that affect their development, including meteorological events interacting with watershed characteristics. Utilizing the Resource Buffer Theory for that region requires consideration of the small percentage of the water in the watershed that the few individual trees use directly in transpiration and nutrient transport, but the entire alluvial stand depends upon the more extensive relationship between the upper portions of the watershed and the alluvium in which the trees grow. While that seems obvious for this simple situation, it demands that one ask the question “What role does this resource play in the environment?” or “What is the buffer of protection of these alluvial trees?” or “What is the environment of the resource that is of concern?” Any one of these questions will lead the resource manager to a productive action.

Another example involves the role of the forest in the midst of a widespread urban area, the New York-New Jersey Highlands Area. The combined

area of 1.1 million acres embraces watersheds that provide water and open space. In the late 1980s, extensive forest land in private ownership was proposed for sale, eventual subdivision and uncontrolled sprawl that could lead to a significant loss of urgently needed biodiversity in the midst of a highly urbanized environment. The potential loss of natural cover in an important urban supply watershed involved anticipated changes in the following: amount and distribution of open space, diversity of plant and animal life, water supply and attendant natural streamflow regulation, wildlife populations as part of the area's biodiversity along with a simultaneous loss through fragmentation (of biological communities as well as ownership and forest continuity), and amenities that forest land supplies in the form of recreation and climate amelioration. Here an interdisciplinary team initially investigated the benefits and potential losses if the tract were to be sold and eventually lost to suburban development, followed by political action that is backed by a broad partnership that involved local citizens and their government groups (Michaels et al. 1993:7-11).

These two cases suggest procedures for addressing the questions that arise concerning natural resource conservation: thus, buffer evaluation demands a resource research program that commences with an investigation requiring (1) use of an *interdisciplinary team*¹⁶ to evaluate the technical/scientific issues, and (2) establishment of a *partnership* that can identify appropriately interested (stakeholder) citizens along with government and non-government organizations. Such a program is obviously proactive and further demands that the interdisciplinary team evaluate (1) the extent of the resource buffer, (2) buffer destruction or pollutant assimilative capacity that would render the buffer ineffective, (3) proximity of the buffer to the resource that is to be sustained, and finally (4) how much of a buffer needs to be protected. More important than specifying the number of trees or acres of forest to be considered as a buffer is the *approach* to the fundamental question of “How much buffer do we need?”

This comprehensive approach is necessary for any natural resource for which a buffer is recognized, including perhaps all of Earth's biomes,

fresh and saline water bodies, and ice caps. It implies identification of buffers on which humans rely for sustainability, in addition to evaluation of a particular localized resource buffer.

The Human Dimension

A great irony of the Resource Buffer Theory is that it also models the distribution of knowledge within segments of the human population (Fagan 2004). In fact, the Resource Buffer Theory accurately describes the geographic distribution of humans from urban to rural environments, a condition that triggers consideration of how we can plan and preserve distribution of forestland buffers for purposes of supplying cities with oxygen, CO₂ assimilation, recreation facilities, open space, and biodiversity. The inability to manage or even consider these functions of the resource buffers on which we depend are really the cause for what Diamond and others refer to as the loss of a resource base (Diamond 1992:317-338). Another illustration of the Resource Buffer Theory within human culture is that there are fewer leaders than followers among the multitude of individuals that make up the human resource. Thus it is not surprising that only a small percentage of the populace that believes in the platform of a political party actually contributes time and/or money to the even smaller number of leaders. The same applies to public interest groups and government in general. Even within the human brain there seems to be a huge buffer—an excess—of developing and unused brain cells, further illustrating the existence of the Resource Buffer Theory in a bodily environment.

Summary

In sum, a universal pattern characterizes the distribution of the energy, water, air, soil, chemical, material, and even human resources in all our environments. The distribution of the resource that defines life—carbon—violates that pattern illuminating the Earth's excessive human numbers, the magnitude of the abuse of the inorganic carbon buffer, and the tremendous impact on atmospheric carbon dioxide that is currently affecting the planetary environment with potentially disastrous effect on climate change and the demise of human civilization. Consideration of the pattern articulated by the Resource Buffer

Theory must become a fundamental philosophy underlying all resource management decisions about human environments if we are to achieve sustainability. The challenge is daunting. Now, fifty years later, I am inspired by Bacon's quotation. If, indeed, the Resource Buffer Theory accurately and constructively describes our environment and provides a method of inquiry into questions regarding current normative interest in sustainability, then it is imperative that we find ways—strategies and the associated necessary tactics—to “obey nature.”

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Notes

- ¹ A longer and fully documented version of this paper may be downloaded without charge at <http://www.watershed-hydrology.com>.
- ² I heard the quote from School of Natural Resources Professor Stephen H. Spurr, my academic advisor and professor in my first course in silviculture, and wrote it on a three-by-five card that I stuck on my desk lamp as a fundamental guide to forest management. Dr. Spurr passionately believed that one must understand how the tree grows as an individual and as part of a community—what today we call its environment—in order to responsibly manage it.
- ³ Donald W. (“Don”) Moos, commenting on the immense numbers of salmon and buffalo that were not seriously impacted by seemingly decimating annual harvests by Native Americans, at an ASCE symposium on *Water management in the '90s: A time for innovation* in Seattle in May 1993. I am indebted to Mr. Moos for the fundamental concept of resource buffers.
- ⁴ Approximately 97 percent of the Earth's water is in the oceans—salty—leaving 3 percent fresh water. Of that, 2/3 is in ice, and nearly three quarters of the remainder is in deep and shallow ground water. Nearly all the remainder is in lakes (of which one-fifth is in one lake—Lake Baikal—and another fifth is in the Great Lakes), leaving about 0.006 percent of all Earth's water in circulation and readily accessible to humans (Black 1996:10).

- ⁵ The known quantities of dark matter and dark energy are tiny percentages of the estimated total amount (Rowan and Coontz 2003; Trefil 1993).
- ⁶ Our sun contains 99.9 percent of the mass of the Solar System (Hodgman 1951:2817).
- ⁷ For example, Jupiter contains 71 percent of the Solar System's planetary mass (Hodgman 1951:2817).
- ⁸ The Earth intercepts approximately 9.1×10^{-8} (about one-billionth of one) percent of the Sun's energy available at 93 million miles (calculation).
- ⁹ The mass of a proton is nearly 2,000 times that of an electron (Hodgman 1951:2817).
- ¹⁰ These buffers are not the same as the now-familiar *buffer zones* protecting stream corridors, but both types provide protection.
- ¹¹ Organic (living) carbon is 0.004 percent of the total on Earth; the rest (99.996 percent) is the vast inorganic buffer, including some in transition from inorganic to organic form or vice versa (Black 2004). Of the organic carbon, 99.88 percent is in plants; 0.12 percent is in animals. Probably half of the animal organic carbon is in viruses, fungi, and bacteria. Most of the remainder is in insects.
- ¹² The figure is actually calculated at about four percent of the animal organic carbon but, since animal carbon is nearly evenly divided between oceanic and terrestrial environments, and no humans live in the oceans, the fraction is eight percent of the Earth's terrestrial animal carbon (Black 1995). Even if some of them—indeed, if any of the above-listed resources—are “off” by several percentage points, the asymmetric pattern—the foundation of the Resource Buffer Theory—remains.
- ¹³ Neglect to include an inorganic carbon buffer was a nearly fatal omission in the 3.15-acre Biosphere 2 experiment resulting in a dangerous increase in atmospheric carbon dioxide (Severinghaus et al. 1994), as was including only a 0.16-acre ocean buffer. We may have learned more from Biosphere 2 than we think.
- ¹⁴ While the carbon removed is an infinitesimally small percentage of the inorganic buffer, it is discharged into a minuscule 0.033 percent of the atmosphere where it has a disproportionately large percentage impact on the small amount of the atmosphere's CO₂.
- ¹⁵ The world's population at 6.35 billion (and growing) exceeds by more than a factor of three the estimated carrying capacity set forth by Pimental et al. (1999:31).
- ¹⁶ The interdisciplinary team (IDT) is the only legal requirement for how to prepare environmental impact statements under the National Environmental Policy Act (42 USC 4321, 1970), demanding that the interdisciplinary team members be disinterested and that the expertise represented be appropriate to the resource under consideration. No number for the IDT is specified: the minimum number is two.

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