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Assimilative Capacity Revisited

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Abstract : Assimilative capacity is the ability of natural systems to assimilate humankind's wastes. Wastes (output) of some species in natural systems are the resources (input) of other species. Before the Industrial Revolution, this concept of input and output held true for human activity, but industrialization created wastes that were qualitatively and quantitatively different from those of natural systems. The unique nature of some persistent wastes that accumulate in organisms over long periods of time makes estimates of safety problematic. An even larger problem is the devastating effects that global heating and other types of climate change are having on the integrity of ecosystems. An ecosystem in disequilibrium probably has no assimilative capacity. Since greenhouse gas emissions are increasing rapidly, the already bad situation will worsen. Another factor diminishing the probability of the effective use of the assimilative capacity concept is ecological overshoot (i.e., humankind's failing to live on ecological services and using ecological capital as a substitute), which is an unsustainable practice. Biotic impoverishment (i.e., loss of biodiversity) also increases the probability of ecological disequilibrium. Finally, exponential growth of the human population, about 1.5 million additional people weekly, means a steadily increasing loss of space for natural systems and more acquisition of natural resources for human use. In short, present waste disposal practices are no longer suitable.

Key words : Assimilative capacity, Toxics accumulation, Global heating, Ecological overshoot, Exponential population growth

Introduction

It is horrifying that we have to fight our own government to save the environment.

Ansel Adams

The nation behaves well if it treats natural resources as assets which it must turn over to the next generation increased, and not impaired in value.

Theodore Roosevelt

We abuse the land because we regard it as a community belonging to us. When we see land as a community to which we belong, we may begin to treat it with love and respect.

Aldo Leopold

Even in the early days of the Industrial Revolution, human population densities were far below those existing today. Industrial waste discharges were also less damaging than they are today. For the last half of the 20th century, I carried out laboratory toxicity tests with freshwater organisms, beginning with single species tests using fish (*e.g.*, Cairns and Scheier, 1957) and later including an alga, an invertebrate, and a fish (*e.g.*, Cairns *et al.*, 1964). I also moved from lethality to some functional tests (*e.g.*, Cairns and Scheier, 1966; Cairns and Loos, 1967). At the same time, I observed effects of pollutants upon organisms in entire drainage basins (*e.g.*, Cairns, 1949). When the

laboratory toxicity tests indicated no-observed harm to the stream biota, none was observed; when deleterious effects were predicted, they were observed. The methodology used in North American rivers was used in a major South American river and proved valid there (Patrick *et al*., 1966).

Overview books on biological methods (*e.g.*, Cairns and Dickson, 1973) estimating hazard (Cairns *et al*., 1978), and community toxicity testing (Cairns, 1986) are also available. I have cited personal publications to indicate that my support of the assimilative capacity concept is based on a wide variety of professional experiences. Of course, problems, such as bioaccumulation, synergistic interactions, and chemical transformation, required an entirely different approach; however, for most chemical substances, the concept of assimilative capacity remained useful. Then I co-edited a book on global warming (Cairns and Zweifel, 1989) and began to have doubts about the continuing applicability of the assimilative capacity concept when global ecosystems were being stressed by climate change.

Klimakatstrophe

Klimakatstrophe is the word of the year 2007 chosen by the Society for German Language. It seems preferable to the cozy term *global warming* and even James Lovelock's more threatening term *global heating*. Greenhouse gas emissions occur from a variety of sources - humans even exhale carbon dioxide. However, for most of human history, the carbon dioxide emissions from all sources did not exceed Earth's assimilative capacity. After 1980, a rapid rise began in global average temperature, which led to melting of ice (*e.g.*, glaciers and ice shelves). A global tipping point may have occurred at about 350 ppm atmospheric carbon dioxide since, at 385 ppm, disastrous climate changes (*e.g.*, unusual droughts and floods) have already occurred. The Intergovernmental Panel on Climate Change (IPCC) reports indicate that, if concentrations of atmospheric carbon dioxide continue to increase, other serious impacts on human society (*e.g.*, sea level rise) will probably occur. Undoubtedly, other tipping points or breakpoints are looming at higher concentrations, such as 535 ppm atmospheric carbon dioxide.

At present, American citizens appear to be unconcerned about significantly reducing driving, although a modest trend is occurring toward more fuel efficient cars. Tata Motors in India is ready to market a very low cost car that may get as many as 50 miles per gallon. Still, even with such commendable mileage, if millions of people purchase it, the atmospheric carbon dioxide will increase. The situation is similar in China where the number of automobiles has been increasing dramatically. Both India and China have a much lower per capita consumption of petroleum than the United States, but, since Earth's assimilative capacity for carbon dioxide has already been exceeded (hence the word *klimakatstrophe*) this development is ominous. The reports of the IPCC strongly indicate that greenhouse gas emissions should be dramatically reduced, but they are still increasing.

Coal

Abundant evidence shows that coal produces the greatest amount of carbon

dioxide per unit of energy, but coal appears to be the fossil fuel of choice now that peak oil has been reached or is so near. For years, reassuring statements have indicated that coal reserves are adequate for the next 200-250 years. However, the report published on 5 April 2007 by the Energy Watch Group, which reports to the German Parliament, found that global coal production could peak in as little as 15 years (Heinberg, 2007). The report's authors (Werner Zittel and J. Schindler) note that, with regard to global coal reserves, "the data quality is very unreliable." Heinberg (2007) concludes: "For China and the United States, the world's two most coal-dependent countries, the message could not be clearer: whether or not global climate concerns are taken seriously, it is time to fundamentally revise the current energy paradigm."

Political Tipping Points

Persuasive evidence indicates that Earth has passed a major ecological tipping point on climate change. Almost certainly, this threshold is the first of a series of ecological tipping points that will only become evident after they have been passed (i.e., exceeded). However, as the Sierra Magazine (2008) interviews with Matt Stoller, Michael Bocian, David Orr, and Newt Gingrich show, the US presidential candidates traditionally "blow off" the environment as an issue since it is still not a top priority for the United States as a nation. However, the spectacular success of former US Vice-President Al Gore, on explaining climate change to a broad international audience, plus sharing the Nobel Prize with the IPCC, has markedly increased public attention to this world-class issue. Even so, US Environmental Protection Agency (USEPA) Administrator Stephen L. Johnson denied the US state of California's request for a waiver to implement its own global warming laws (which 15 other states wished to use), which were more stringent than the federal laws (Simon, 2008). Simon (2008) quotes Senator Frank R. Lautenberg (New Jersey) as stating: "It's bad enough when the federal government fails to lead. But it's even worse when the federal government gets in the way of states that are tying to act in the interest of the public and in the absence of leadership from the EPA." On the same subject, the Coalition of EPA Labor Unions sent a letter to USEPA Administrator Johnson expressing deep dismay and concern over the damage to EPA's reputation following Johnson's decision to deny the California Waiver Request on vehicle greenhouse gas emissions (Shapiro *et al*., 2008). Senator Barbara Boxer made this statement on the waiver rejection:

> As our investigation of the EPA record continues, it is clear that EPA's own experts told Administrator Johnson that California's case for the waiver is solid. His decision was not supported by the facts, by the law, by the science, or by precedent. It will not stand. Tomorrow's hearing provides an important opportunity to closely question the Administrator on this unconscionable decision. I look forward to a reversal of this decision as soon as possible" (US Senate Committee on Environment and Public Works, 2008).

Senator Boxer's statement was supported by an earlier mass petition by a majority of the entire EPA workforce (Public Employees for Environmental Responsibility, 2006). The petition stresses that time is running out to prevent cataclysmic environmental changes induced by human-caused pollution and urges the US Congress to undertake prompt action. This tragic situation is summed up well in Senator Boxer's statement. A political appointee can block action to protect present and future generations from the catastrophic consequences of climate change by ignoring the scientific and legal advice of his staff, and the massive evidence produced by the IPCC over many years. California and the other states merely wanted to improve on federal standards. All this controversy is occurring in a time when the adverse effects of climate change are apparent to non-scientists who never heard of IPCC. For example, Javier Mestres (Columbia, South America) saw the results of a warming planet clearly in the premature flowering of his coffee plants (Cycon, 2008) - smaller weaker berries dotted the stems and Mestres wondered why the outside world wanted to harm these beautiful plants.

Nuclear Power Plants

As fossil fuel diminishes, advocates of nuclear power plants to generate electricity have become numerous. However, Jim Warren, executive director of North Carolina Waste Awareness and Reduction Network, states: "Water is the nuclear industry's Achilles heel. You need a lot of water to operate nuclear plants. This is becoming a crisis" (as quoted in Weiss, 2008). In this instance, the aquatic ecosystem's assimilative capacity for heated waste water discharges is diminished either because the water has become too warm or, most likely, because the water has been withdrawn from the lake or river for other uses (*e.g.*, irrigation, golf courses, transported [*e.g.*, canal] to other areas with water scarcity [*e.g.*, Las Vegas, Nevada]).

Designing for Nature

The most obvious solution is to redesign humankind's wastes so that they become beneficial inputs into natural systems. Another obvious solution is to use far less material goods per capita and thus reduce the volume of wastes from production. McKibben (2007, p. 11) believes that humankind is addicted to growth: ". . . despite a slavish devotion to growth economics, real per capita income is the same as a quarter century ago. Unrestrained economic growth is producing more inequality than prosperity, more insecurity than progress."

This approach is the challenge of our era: produce wastes that benefit natural systems (*e.g.*, are beneficial rather than just produce no-observable harm). Wastes that cannot be assimilated should not be produced (*e.g.*, high-level nuclear wastes). Humankind must not diminish assimilative capacity (*e.g.*, climate change) or alter natural systems so that their natural assimilative capacity is greatly reduced (*e.g.*, interbasin water transfers). A species that destroys its habitat is on the road to extinction. Humankind congratulates itself that it is an intelligent species, but is it merely delusional?

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