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Assimilative capacity — the key to sustainable use of the planet

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Page %P

Page 1

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Commentary

Assimilative capacity – the key to sustainable use of the planet

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Assimilative capacity has been defined as the ability of a natural system to absorb various materials, including anthropogenic wastes, at certain concentrations without itself being degraded (Cairns, 1977). The term was originally used by engineers to describe the use of streams to process simple organic wastes such as sewage. This process is very well understood. Oxygen declines that follow various levels of organic enrichment can be modelled, and the point downstream at which oxygen levels will recover to their original levels can be predicted. When concentrations of humans were small and wastes simple, there were few concerns about the appropriateness of the use of streams for treating anthropogenic organic wastes. These same streams processed organic wastes from the surrounding watershed, including formidable quantities of tree leaves and the occasional wildlife carcass. No new process was involved. However, large human populations made it obvious that the assimilative capacity of streams for organic wastes could be exceeded and that this overuse could have unpleasant consequences. Stream uses other than waste treatment, such as production of fish, safe drinking water, recre- than for simple organic materials, so any assimilative capacity would be lower.

In aquatic ecosystems, metals can be sequestered in a form that is no longer biologically available. In anaerobic sediments in wetlands, lakes, and depositional areas of rivers, metals can be bound as insoluble sulfides. In these sediment systems, if the metal concentration remains less than the concentration of acid volatile sulfide (AVS), no toxicity is observed (e.g., Ankley et al., 1993), and deleterious effects in contaminated systems are most pronounced where AVS concentrations are lowest (Pascoe et al., 1994).

Another example is nutrients that can be trapped in the soil and vegetation or moved to other systems where their effects are more desirable. Nitrification and denitrification remove ammonia, nitrate, and nitrite from aquatic systems and release nitrogen gas to the atmosphere. Aquatic plants that have trapped nutrients can be harvested and incorporated into agricultural soils. This type of assimilative capacity is the basis for modern management practices in which wetlands are used to protect riparian systems from agricultural run off (Schlosser & Karr, 1981), restore

ation, and aesthetic enjoyment, were precluded by the overuse of the stream as a waste treatment system.

The concept of assimilative capacity has been expanded to include the ability to absorb wastes other than simple organics without being degraded. In addition, natural systems can break down, render biologically unavailable, or disperse some other types of contaminants.

Even complex organic chemicals such as pesticides and hydrocarbons are broken down in the environment through both biotic and abiotic processes (e.g., Howard, 1991). Microbial mineralization, oxidation, hydrolysis, and photolysis all decrease the environmental concentrations of complex organic chemicals. However, the rates of degradation and losses to other media are typically much slower for complex organics

hypertrophic lakes (Lowe et al., 1994), or treat secondary sewage effluents (e.g., Hammer, 1989).

Assimilative capacity is often linked to toxicant concentration. However, altered hydrology usually leads to major changes in vegetation (e.g., Hackensack River Meadowlands in National Research Council, 1992) as well as other changes. Vegetational changes generally result in changes of assimilative capacity, particularly for organic materials. During any transitional period, it will almost certainly be reduced.

Socolow (1994) notes that to overwhelm natural systems implies a focus on a ratio, changing over time, that compares some human enterprise with some pre-existing characteristic of the natural environment. Except in cases of gross ecological damage, changes in assimilative capacity go unrecorded because there

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Page 2

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