Regulatory Science: Maximum Concentration Limits and Water Quality Standards (Newsletter)*

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Much has changed since the Clean Water Act (CWA) was passed in 1972, but not how water quality is regulated. Existing environmental data analyzed with advanced statistical models can bring CWA regulatory compliance into the 21st century. With global warming, and societal concerns about sustainability, modernizing regulatory compliance benefits everyone.

The use of maximum concentration limits (MCLs) on individual chemical ions or collections such as total dissolved solids (TDS) applied to all water bodies regardless of type or geographic location is similar to the way medicine was practiced centuries ago when we did not understand human physiology and variability.

MCLs have three critical shortcomings: geochemical constituents are predominantly compounds, not ions; there is no context to separate natural variability from anthropogenic effects; and there is no ecological cause-and-effect linkage between a specific concentration and the status of a beneficial use at a defined location and time.

Consider calcium. It is present as calcium carbonate, calcium sulfate, and other compounds. Calcium carbonate forms shells of fresh water mussels and snails as long as the pH is between 7.0 and 8.4. Below pH 6.8 calcium carbonate dissociates and the mollusks die. Knowing calcium ion concentrations without the context of pH, hardness (alkalinity), and other variables reveals nothing about the state of the aquatic ecosystem.

Virtually all environmental permitting decisions use baseline data. When correctly collected, these data provide measures of inherent natural variability. Compliance monitoring using the same methods allows separating natural from anthropogenic changes regardless of maximum concentrations. Time series analyses of relative proportions of geochemical constituents can detect meaningful trends; further analyses can determine whether the cause is natural or anthropogenic.

Insights of variability over time are strengthened by analyzing cause-and-effect relationships using appropriate regression models that are interpreted using established ecological theory. The response variable is a characteristic of a specific beneficial use while physical, chemical, and biological variables quantitatively explain the observed response.

In addition to point source discharge methods there are modern methods for nonpoint source discharges from broad land areas into larger reaches of receiving waters. One technically sound and legally defensible approach uses aquatic life: benthic macroinvertebrate communities. Taxonomic identification of these animals is unreliable as a measure of change. The ecological functions of energy processing and nutrient cycling/spiraling by these communities is independent of taxonomic structure and is represented by how the organisms feed: filtering organic particles from the water column; scraping them from solid surfaces; gathering them from loose surfaces; shredding leaves and other large organic materials; or predating other animals. The relative proportions of each group reflect available energy resources characteristic of that location and time and vary naturally and by anthropogenic activities.

There is neither scientific justification nor value in continuing to use MCLs for regulating water discharges under the CWA. Global warming and societal changes require environmental policies and regulations that are technically sound and legally defensible. Statistical models, correctly chosen and applied, meet these criteria and can assure everyone concerned that economic, environmental, and societal ecosystems can co-exist harmoniously in a changing world.

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