PERSPECTIVE

A Precautionary Approach to the Regulation of Sewage Sludge

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Abstract

This article describes the ongoing debate as to the ability of the US Environmental Protection Agency's (USEPA's) sewage sludge regulations to protect public health and the environment. These regulations, known as the *EPA Part 503 Biosolids Rule*, or "biosolids rule" for short, are based on risk assessments that some consider inadequate in that they do not address all potential risks. This article provides information about why environmentalists, farmers, and scientists are encouraging the USEPA to adopt a more protective program. It has been suggested that the Precautionary Principle, an emerging general principle of international environmental law, should be used in determining the safety of such a widely used practice as applying waste to the land.

Background

Years of concern about the safety of applying sewage sludge to agricultural lands will potentially be resolved next year when the National Academy of Sciences concludes a new 18-month study of the USEPA's sludge program (National Academy of Sciences, 2001). Environmentalists, farmers, and scientists have complained that their concerns about the inadequacy of the USEPA's sewage sludge regulations were not being taken seriously. Congressional hearings in March 2000 reviewed these allegations to determine whether the USEPA or its employees have resorted to inappropriate tactics and destroyed public confidence in the science underlying the biosolids rulemaking process (House Committee on Science, 2000a). One scientist testified: "EPA attempted to discredit our science and to ignore the issues we have raised. Their responses have mischaracterized our research and have suggested that we used methods that are not appropriate to answering the scientific questions we seek to address." (House Committee on Science, 2000b).

Adding legitimacy to the concerns, the USEPA Office of Inspector General issued an audit report "Biosolids Management and Enforcement" that said: "The EPA does not have an effective program for ensuring compliance with the land application requirements of Part 503. Accordingly, while EPA promotes land application, EPA cannot assure the public that current land application practices are protective of human health and the environment." The report also criticized USEPA for lack of enforcement and for not maintaining data on cumulative sludge applications, a requirement of the 503 rules (USEPA Office of Inspector General, 2000).

As a consequence of the March 2000 hearings, the USEPA asked the National Academy of Sciences to review the science and methodology behind the USEPA's sludge program standards to determine whether these standards for land application of sewage sludge protect human health and the environment. An important task for this Committee on Toxicants and Pathogens in Biosolid Fertilizers will be an evaluation of how the relevant chemical pollutants were identified. It will revisit the National Research Council's 1996 review of the program and determine whether that report's recommendations have been appropriately addressed. This 1996 review concluded that sludge could be applied safely to land, but recommended early involvement of local officials and the public and additional study of the long-term impact of such application.

There are many reasons why the outcome of this new study may be far different from earlier ones. Very important new information is available about the persistent, bioaccumulative, and toxic chemicals found in sludge. Environmentalists and medical professionals now know more about the unanticipated low-level effects of such chemicals on endocrine systems and human development. And there is growing recognition of the role a more precautionary approach could have played in preventing the problems that have occurred due to poorly regulated sludge applications. It has been suggested that the Precautionary Principle, an emerging general principle of international environmental law, should be used in determining the safety of such a widely used practice. The Precautionary Principle, found in the Rio Declaration on Environment and Development, which the United States signed and ratified, states: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Rio Declaration on Environment and Development, 1992).

History of Biosolids Regulation

The biosolids rules were developed as part of an attempt to solve a serious environmental problem. In 1988, the Ocean Dumping Ban Act amended the 1972 Clean Water Act to prevent the ocean dumping of municipal sewage sludge. It prohibited all dumping of sewage sludge and industrial waste into the ocean after 1991, leaving three main options for the disposal of wastewater and sludge: *landfilling*, which is expensive and politically unpopular; *incineration*, which produces air pollution and toxic ash; and *land application*, which appeals to those who seek to restore depleted soils and reuse waste. The USEPA developed a regulatory program for land application of such sludge, and in 1993, the EPA Part 503 Biosolids Rule was published. The USEPA coined the term "biosolids" to encourage acceptance of this practice. It set standards for the use or disposal of sewage sludge, but regulated only nine metals: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

Many people do not realize that "When it comes to spreading sludge on agricultural land, the United States has the most relaxed standards for metals among developed nations. Standards for heavy metals are up to 100 times higher than any other country has ever proposed" (Renner, 2000). Critics assert that these rules are based on faulty assumptions of safety, as evidenced by problems that have occurred in their implementation in the states, and by new re-

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search findings about the many chemicals in sludge that the program did not regulate. Some concerned citizen groups believe that under existing programs, domestic sewage sludge is too contaminated for application anywhere. At the opposite end of the spectrum are those who want it further deregulated.

Applications of municipal sewage sludge to the land greatly increased after promulgation of USEPA's biosolids rule in 1993. Potential problems with the implementation of the program had been identified earlier by scientists in several states. Scientists at Cornell University concluded that "current US federal regulations governing the land application of sewage sludge do not appear adequately protective of human health, agricultural productivity, or ecological health." They document this in detail in their report, *The Case for Caution: Recommendations for Land Application of Sewage Sludges and an Appraisal of the USEPA's Part 503 Sludge Rules* (Harrison et al., 1999). This working paper was designed to make the technical literature more accessible to interested nonscientists. Cornell's scientists have been frustrated by USEPA's unwillingness to address the scientific issues raised by their work, and USEPA's attempts to discredit their science. They have pointed out the problems associated with self-enforcement of the regulations, lack of permitting processes, no requirements for labeling of products made from sludge, damage to organisms in soil (such as nitrogen-fixing bacteria), the need for stringent standards to prevent leaching of sludge-borne contaminants into groundwater, the need for environmental monitoring for all the possible contaminants (including the ones not yet regulated), and the disregard for the hazards posed by mercury in municipal waste. The USEPA had assumed that no mercury volatilized from land application. Cornell scientists reported that "worldwide sludge land application is estimated to emit to the air about one eighth of the amount of mercury discharged by power plants or by municipal waste incinerators." Regarding pathogens, they are concerned that no monitoring is required for viruses and that bacteria can actually increase in numbers during the sewage treatment processes.

Only a few states, such as New York, have enacted more stringent or site-specific regulations for sewage sludge management. A particularly interesting description of recent events was published in the online journal for solid waste professionals, *Your Solid Waste* (Arner, 2000). The article describes how in California, environmental, community and farmer groups, including the California Farm Bureau Federation (CFBF), criticized the State Water Resource Control Board for proposing inadequate regulations for biosolids applications because they were based entirely on the current USEPA regulations. "CFBF contends that land application of sewage sludge will increase the level of toxic chemicals and pollutants in the soils of land application sites. Since USEPA lacks sufficient data to develop regulatory standards to protect exposed individuals and the environment, a more complete understanding of pollutant chemistry, health hazards, pathways to exposure, and modeling techniques to develop maximum permissible loading limits is necessary."

Human Health and Environmental Concerns

Complaints from citizens who have experienced increased illness near sludge application sites have led to studies of the air emissions at those sites. Although human health impacts are difficult to document, research in one New Hampshire community suggests that irritant chemicals such as ammonia and dimethyl sulfide identified in air emissions may have enhanced susceptibility to infection and contributed to other serious problems (Lewis et al., 2000).

Workplace safety issues center on the acute effects of pathogens that remain in sewage sludge after treatment. Class B biosolids have undergone treatment by processes that significantly reduce concentrations of pathogens, including bacteria, viruses, protozoa, and helminths (parasitic worms), but may contain pathogens in sufficient quantity to warrant restricted public access and special precautions for exposed workers. Class A biosolids are those that have undergone treatment by processes that further reduce pathogen concentrations resulting in an end product that is virtually pathogen-free, although metals and organic pollutants remain. While there are restrictions on access for the public to treatment sites, workers have experienced problems.

The National Institute for Occupational Safety and Health evaluated worker complaints, interviewed workers, and tested air and waste samples. They concluded in their July 2000 report: "The detection of enteric bacteria in a limited number of air and bulk samples confirms the potential for workers to be exposed to organisms which have been associated with gastrointestinal symptoms and illness. Operations where employees are potentially exposed to Class B biosolids include transport, loading, unloading, and application activities. Other potentially exposed workers include compost workers, surface miners working around reclamation sites, and farmers" (National Institute for Occupational Safety and Health, 2000). Linda Rosenstock, Director of the National Institute for Occupational Safety and Health, has recommended additional practices to prevent the risk of disease among workers who are exposed on the job to biosolids used to fertilize agricultural lands or mine reclamation sites. "Workers are the individuals most likely to be exposed to biosolids, but practical steps can be taken to limit exposures and prevent the possible risk of disease transmission. In the absence of definitive information about the extent of risk to workers, our recommendations are based on good public health practice."

An important criticism of USEPA's sludge program is that it may be putting long-term soil productivity at risk. Studies in Europe have found that microbial functions in soils are affected at levels that are not toxic to crops (Harrison et al., 1999). Organic gardeners have voiced fears about repeated applications of biosolids. In addition to concerns that consumers might reject their produce, they suspect that contaminants will harm soil organisms that contribute to a healthy ecosystem. Heavy metals were found in earthworms from an old field after long-term nutrient enrichment with a sewage sludge product. Significant accumulations of cadmium, copper, lead, and zinc were found in rodents

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that were fed earthworms from the sewage sludge-amended soil. It was concluded that additional studies were needed to determine the degree of risk posed by these metals due to biomagnification in amphibians, reptiles, birds as well as mammals for whom worms are an important food source.

The more precautionary European approach to the risks posed by sewage sludge was described in a recent article in *Environmental Science and Technology* (Renner, 2000). "Evidence began to emerge about 10 years ago that sludge-borne metals could have adverse effects on total soil microbial biomass and on nitrogen fixation by cyanobacteria and by the nitrogen-fixing bacteria Rhizobium. The evidence, which was not conclusive at that time, came from long-term experiments at sites where sludge was repeatedly applied in large quantities." This evidence prompted the formation of a UK independent scientific review committee in 1993 that, despite what was then the inconclusive nature of the evidence, opted for caution and recommended that the standard for zinc be reduced in keeping with preliminary experimental results. Caution was appropriate for sewage sludge standards, "particularly because heavy metals, unlike many other pollutants, cannot degrade [and] are retained in soils virtually indefinitely," according to the committee's report. "As a result, there is little opportunity for natural recovery from the consequences of any error in judgment."

Some unregulated chemicals found in sewage sludge have recently been identified as endocrine disruptors, particularly nonylphenols and phthalates (Harrison et al., 1999). Nonylphenols are the degradation products of surfactants used in detergents, shampoos and other cleaning agents. They accumulate in sewage sludge and are released to surface waters, where their effects on fish and other aquatic life have been noted with concern. Nonylphenol based surfactants have been phased out in Europe, but they are still widely used in the United States in consumer products. Surfactants are quantitatively the most important synthetic organic compounds in municipal wastewater, but at present there is neither monitoring nor regulation of nonylphenol concentrations in sludges in the United States. Phthalates are chemicals often added to plastics to make them flexible. Because they are not chemically bonded to the plastic itself, they leach out of materials such as medical supplies and food packaging, and ultimately contaminate groundwater. Some phthalates have been identified as carcinogens, teratogens, and endocrine disruptors. Scientists in Puerto Rico recently found elevated levels of phthalates, but no other contaminants, in the blood of young girls with premature puberty and concluded: "The phthalates that we identified have been classified as endocrine disruptors. This study suggests a possible association between plasticizers with known estrogenic and antiandrogenic activity and the cause of premature breast development in a human female population" (Colon et al., 2000).

Dioxin is another contaminant of sewage sludge that was not considered when the USEPA's sludge rules were written. A national inventory of dioxin sources, the USEPA *Dioxin Exposure Initiative,* reported that a significant release of dioxin to the environment was from the "landspreading of wastewater treatment sludge" (USEPA National Center for Environmental Assessment, 2000). This is of great concern because some crops grown on sludge-treated land are fed to animals, cows and other herbivores ingest soil as they graze, and the greatest route of human exposure to dioxin, recently identified as a human carcinogen, is through consumption of meat and dairy products. In December 1999, USEPA proposed a standard for dioxin levels in biosolids: a limit of 300 parts per trillion toxic equivalents for dioxins in biosolids that are recycled and applied to the land as fertilizer. The environmental and public health community provided testimony calling that number far too high to be protective.

An Environmental Working Group analysis of the only available national data on sludge content, the 1988 National Sewage Sludge Survey of 208 treatment plants, *Dumping Sewage Sludge On Organic Farms? Why USDA Should Just Say No,* found a total of over 100 synthetic organic compounds (not including pesticides) in US sludge, including phthalates, toluene, and chlorobenzene. The average sample contained almost nine synthetic organic contaminants. Dioxins were found in sludge from 179 out of 208 systems (80%). In addition, 42 different pesticides were found—at least one in almost every sample, with an average of almost two pesticides per survey sample. None of these chemical contaminants are regulated in sludge. The nine heavy metals that are regulated in sludge were routinely detected, often at high concentrations. No comprehensive data are available to assess if USEPA regulations have reduced these toxic components of sludge since the late 1980s (Environmental Working Group, 1998).

Input Needed from Environmental Professionals

Sewage sludge has potential for restoring our nation's soils, but public health and the environment must be protected. The new National Academy of Sciences Committee on Toxicants and Pathogens in Biosolid Fertilizers has undertaken a challenging task. Some scientists have provided evidence of the need for caution, but more input from concerned environmental professionals would be helpful. There will be public access to the committee, chaired by Dr. Thomas Burke of Johns Hopkins University, as it can be contacted through their website (National Academy of Sciences, 2000) throughout the project.

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