SEWAGE SLUDGE: RESOURCE OR POLLUTANT

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Summary Disposal of sewage sludge on agricultural land poses potential threats to ecological sustainability, including the possibility of long term contamination of agricultural soils and increased violative levels of cadmium in agricultural commodities and food. Under increasing pressure to find sustainable solutions, governments are faced with the dilemma of devising robust policies for the disposal of sewage sludge on rural lands that can adequately balance the potential pollution problem with the benefits of additional nutrients and organic matter.

INTRODUCTION

Sewage sludge is a solid waste or by-product of sewage treatment works. As the volume of human and industrial waste increases, so does the need for municipal and government agencies around the world to find environmentally sound and sustainable methods for disposal. Many developed countries have ceased or curtailed the practice of dumping solid waste at sea and now seek alternative means of disposal, including landfill, composts for use in the horticultural industries and as a source of organic matter and nutrients on agricultural land. Until recently, sewage sludge has not been applied in appreciable amounts to rural land in Australia, but this is likely to change as governments move away from the disposal of sewage through ocean outfalls or by incineration. Australian governments have commenced the task of addressing issues of concern through the National Water Quality Management Strategy (1), and the development of other guidelines and codes of practice relating to the use of sludge (e.g. 2). This paper briefly outlines the regulatory environment applying to the disposal of sewage sludge on agricultural lands overseas and raises issues concerning the adequacy of guidelines being developed for Australia. Credible policies will need to be based on the results of local research.

SEWAGE SLUDGE AS A POTENTIAL RESOURCE

There is increasing interest in recycling sewage sludge as a source of nutrients and organic matter for use on the land (3). Capitalising on the potential requires finding ways to use the valuable components of sewage sludge without adversely affecting the ecological sustainability or cropping capacity of the land through contamination. Several states are researching options for the use of sewage effluent and sludge on forestry land or plantations. The National Landcare Program is funding several research, monitoring and demonstration projects investigating the impact of using sewage wastes to improve the organic content of soil (4). Other options for the use of sewage sludge under investigation include soil injection, spray application to forests, anaerobic digestion for methane and as a nutrient supplement for the compost recycling of wood fibre (5).

SEWAGE SLUDGE AS A POTENTIAL POLLUTANT

Sewage sludge may contain a range of contaminants, including metals such as cadmium, arsenic, copper, lead, mercury and zinc and pesticide residues such as organo-chlorines aldrin, dieldrin, heptachlor, DDT and lindane. The quality and contaminant status of sewage sludge will depend upon both the source of sludge and the method of treatment, with sludges derived predominantly from residential areas containing fewer contaminants than those from industrial areas. The pollution potential of sewage sludge depends upon the area of land used for disposal, the volume and frequency of application and the level of contamination of the material in question. Claims about the value of sewage sludge as a source of nutrients and organic matter need to be placed in the context of international efforts (6) to minimise the accumulation of heavy metals, particularly cadmium, in crops and in the environment.

CADMIUM AS AN ISSUE FOR GOVERNMENTS

Governments are becoming increasingly concerned about cadmium because of its potential to adversely impact on human health, international trade and the environment. Cadmium poses a concern to health authorities because it accumulates in human kidneys where elevated levels are associated with a condition in which low molecular weight proteins are excreted in the urine. Violative levels in food disrupt international trade and pose a particular concern for Australia with its heavy dependence on rural exports. Environmental concerns, including issues of sustainability, arise because cadmium additions to agricultural land exceed transport out of the system in rural commodities and by leaching. The resulting contamination appears to be virtually permanent.

Australian soils are naturally low in cadmium and for the most part have not been polluted from industrial sources. Cadmium accumulation primarily arises through the application of phosphatic fertilisers containing small amounts of cadmium and from industrial wastes used as a source of trace element supplements. An assessment of the impact of adding sewage sludge to the system needs to take account of the unique nature of Australian soils, many of which are highly weathered, with poor nutrient status, low organic matter content and low cation exchange capacity. Many are susceptible to increasing problems of acidity and salinity. This combination of characteristics reduces the capacity of soils to bind cadmium. As a consequence Australian soils, in contrast to soils in many parts of the world, are more likely to act as sources rather than sinks for cadmium. This points to the need to develop guidelines for sewage disposal adapted to Australian soils and climatic conditions.

GOVERNMENT RESPONSES

International Regulations

In Europe and North America large amounts of sewage sludge are disposed on agricultural land where it is valued as a source of nutrients and as a soil conditioner, with cadmium being the principal factor limiting its use. Governments in many countries explicitly recognise the threats posed to soil, air and water quality by heavy metals and other contaminants in sewage sludge. Many seek to contain the risks by regulating sludge disposal in a number of ways, such as by:

• imposing limits on the content of contaminants in sludge, taking into account the proposed use

• limiting the volume that may be used in any particular application

• regulating the frequency of application to agricultural soils

• establishing cumulative limits on the application of contaminants to soils and

• setting limits on the maximum soil load of contaminants.

EEC Directive 86/278 sets limits for the maximum concentration of cadmium at 20-40 mgCd/kg dry matter for sludge destined for use on agricultural land in the European Union and specifies that member countries should prohibit the use of sludge on soils where cadmium concentrations exceed 3 mgCd/kg dry weight. Finnish regulations are more stringent, specifying that the concentration of cadmium in sewage sludge may not exceed 3 mg/kg dry weight and that this sludge may only be used on soils which contain less that 0.5 mgCd/kg dry weight. Regulations limiting industrial discharge of waste into public sewers have led to a decrease in the level of cadmium in Finnish sludges.

The Netherlands has devised policies on the premise that soil is the crucial environmental sector when considering cadmium and adopted three basic principles (7):

• input of cadmium from air should not exceed removal from soil through combined run-off and leaching

• input of cadmium to arable land (as fertilizer and sludge) should be brought into equilibrium with removal via harvesting

• the level of cadmium in newly formed sediments should not exceed the same limits that are set as target values for soil.

Most Canadian provinces have guidelines limiting the cadmium content of sludges applied to agricultural soils. Extensive research in the United States, where considerable monitoring of cadmium in soil is carried out, shows that sewage sludge application may increase the organic matter content of soils and consequently improve the potential to sequester cadmium (8). Under the US EPA guidelines (9), if sewage sludge is pasteurised and stabilized and has cadmium concentrations below 39 mgCd/kg, it may be marketed for general use on land.

Australian Regulations

There are no uniform national standards relating to the disposal of sewage sludge on agricultural lands in Australia, but existing State regulations mirror the regulatory controls in place overseas. The input of contaminants from trade wastes into sewerage systems is regulated by guidelines developed under the National Water Quality Management Strategy (1). National guidelines for the management of sludge or biosolids products are also under development and due for publication next year as part of the same process, while several states have or are in the process of developing draft guidelines (2, 10).

New South Wales Code of Practice

The Environment Protection Agency in New South Wales has developed an Interim Code of Practice for Use and Disposal of Biosolids Products (2). One of the primary objectives of this code is to adequately protect the environment, human and animal health and agricultural products while seeking to provide realistic and practical avenues for utilisation and disposal of biosolids products, the latter being another term for sewage sludge.

Under the NSW Code, guidelines for the use of sewage sludge on agricultural land set limits for both the concentration of contaminants in sludge products and the rates of sludge application to soil. Sewage sludge is classified into three categories: *unrestricted, restricted* and *unsuitable*. Sludges classified for *unrestricted* use may be applied in an unrestricted manner to all lands excluding sensitive sites, while those deemed *unsuitable* cannot be used outside the boundaries of the source sewage treatment plant. Sludges in the *restricted* class are further subdivided into four grades (A, B, C, and D) on the basis of contamination load (metals and pesticide residues) and stabilisation characteristics related to the processes used to reduce pathogens, odours and vector attractants such as flies. Sludges not making any of these grades are disposed of in dedicated landfills. Disposal options and limits for cadmium content for these restricted sludges are set out below.

Grade A	Grade B	Grade C	Grade D
unrestricted use on home gardens	sporting ovals and other recreational sites	can be used on agricultural land	limited to use on forest plantations
3 mgCd/kg	11 mgCd/kg	20 mgCd/kg	32 mgCd/kg

Sludges graded as *restricted* may be used on agricultural land provided application rates comply with stipulated management practices: a requirement to incorporate the sludge to a depth of 75 mm; containment of cadmium levels in topsoil to 3 mgCd/kg soil following application and limiting the frequency of application to once every five years unless the soil is stabilized to pH 5.5 (measured in calcium chloride) or above with lime and maintained at this level for at least two years. The NSW Code of Practice also sets out requirements for monitoring the environment in which sludge is placed to determine and verify its compliance with environmental criteria.

DISCUSSION

At a public forum held in 1995 under the aegis of the Standing Committee on Agriculture and Resource Management, participants recommended that Australian governments develop a National Cadmium Minimisation Strategy to contain the threats to health, trade and the environment. This recommendation is now under consideration by governments. Elements of the proposed strategy will have implications for the disposal of sewage sludge on agricultural lands.

Cadmium levels in food and agricultural commodities produced in Australia are not dissimilar to those in other countries and in some cases levels have exceeded maximum permitted concentrations even in situations where no sludge has been applied, but following a history of superphosphate use. Any decisions made about the use of sewage sludge as a soil amendment or nutrient source in Australia will have to take account of the unique nature of Australian soils and the cycling of cadmium within our environment. There is a need for extensive research to underpin credible policies for the disposal of sewage sludge and to avoid untested extrapolation of results from other countries to set guidelines for Australia. Constructive input from agronomists will help to ensure that actions taken today do not jeopardise future land use options.

REFERENCES

1. ARMCANZ/ANZECC 1994. National Water Quality Management Strategy: Guidelines for sewerage systems. Nov. 1994, AGPS, 53 pp.

2. NSW EPA 1994. Interim Codes of Practice for Use and Disposal of Biosolids Products - Draft June 1994. Environment Protection Agency, New South Wales, 30 pp.

3. Ross, A.D., Lawrie, R.A., Whatmuff, M.S., Keneally, J.P. and Awad, A.S. 1991. Guidelines for the use of sewage sludge on agricultural land. New South Wales Agriculture, 17 pp.

4. Department of Primary Industries and Energy 1995. Economic measures and the reduction of nutrients from agricultural run-off in waterways. AGPS, Canberra, 60 pp.

5. Line, M.A. 1995. Compost recycling of wood fibre waste produced by paper manufacture. Compost Science and Utilization Vol. 3, pp 39-45.

6. OECD 1995. Risk Reduction Monograph No. 5: Cadmium. Environment Directorate, Organisation for Economic Cooperation and Development, Paris, 187 pp.

7. Directoraat-Generaal Milieubeheer 1991. Policy on Cadmium. Ministerie van Volkhuisvesting, Ruimtelijk Ordening en Milieubeheer, Netherlands, 29 pp.

8. Chaney, R.L. 1993. Risks associated with the use of sewage sludge in agriculture. Aust. Water and Waste Assoc., 15th Fed. Convention Vol. 1, Gold Coast, Qld, 18-23 April 1993, pp 7-31.

9. US EPA 1992. US Sewage Sludge Regulations, Standards for the Disposal of Sewage Sludge.

10. Beavers, P.D. 1993. Guidelines for use of biosolids - the Queensland scene. J. Aust. Water and Wastewater Assoc., December 1993, pp 23-26.