Chapter XLIII
Methodology to Set Regulations for Safe Reuse of Wastewater and Sludge for Agriculture in Developing Countries Based on a Scientific Approach and Following the New WHO Guidelines

B. Jiménez
Universidad Nacional Autónoma de México, Mexico

I. Navarro
Universidad Nacional Autónoma de México, Mexico

ABSTRACT

This chapter describes, using the quantitative microbial risk assessment (QMRA) methodology proposed by WHO, how to set affordable standards for reuse of wastewater or sludge in agriculture using helminth eggs (Ascaris lumbricoides) as an example. The development of a risk-based model for Ascaris lumbricoides infection and its application to assess human risks associated with helminths egg exposure from crops irrigated with untreated wastewater, as well as crops grown in biosolid-enriched soil are explained. From QMRA results it becomes evident that WHO guidelines for wastewater reuse in agriculture seem more stringent than needed in developing countries, while for sludge reuse it will be the opposite. Even though more information is needed to confirm this conclusion from a single research, cautious approach when revalorizing sludge for agricultural purposes is recommended. Additionally, this work shows that intervention methods, other than wastewater and sludge treatment as suggested by WHO, can play an important role in controlling risks.

INTRODUCTION

In 1989, the World Health Organization (WHO) established that one of the main risks of reusing wastewater for agricultural irrigation was caused by helminth eggs. WHO set guidelines for safe reuse by considering epidemiological evidence. In 1992, the US EPA published its sludge regulations, defining helminth egg inactivation as a key parameter for safe reuse in agriculture. At the end of 2006, WHO published new guidelines, this time for the safe use of wastewater, faecal material and sludge in agriculture and aquaculture. But, instead of setting a universal criteria, WHO suggested the use of a methodology based on quantitative risk assessment (QRA) to determine limits that considered local situations. In the case of helminth ova, WHO established methodology for monitoring based on epidemiological evidence since there was not enough information to apply the QRA. The selected values, for both wastewater and faecal sludge, are low and imply the use of treatment methods that are unaffordable for developing countries. After the release of WHO guidelines the information needed to apply QRA to helminth eggs has been produced (Navarro *et al.,* 2009) and this chapter describes how to apply the WHO (2006) methodology to set affordable limits for safe reuse of wastewater and sludge in agriculture.

Importance of Wastewater Reuse in Developing Countries

Wastewater is an important source of water and nutrients for irrigation in developing countries. Wastewater is used to irrigate land because of high water demand (70% of the total use worldwide), the availability of wastewater, its fertilizing properties due to nutrients and organic matter content, its low or zero cost, and the possibility of sowing all year round (Jimenez & Garduño, 2001; Jimenez, 2006). There is no complete global inventory on the extent of non-treated wastewater used to irrigate crops. Nevertheless, the global figure commonly cited is at least 20 million hectares in 50 countries (nearly 10% of total irrigated land). Certainly the use of this wastewater varies considerably from one country to another and occurs almost exclusively in the developing world, where 75% of the world's irrigated land is located (UN, 2003). Figure 1 shows the 20 countries having the greatest number of hectares irrigated with untreated and treated wastewater, and it can be seen that the extent of untreated wastewater use is much greater than treated. It is of note that Figure 1 was constructed with relatively scarce amounts of information as data is often hidden due to the economic penalties a country might suffer when trading produce suspected to be irrigated with polluted water.

Agricultural use of wastewater has positive effects for farmers related mainly to improved income that directly helps health conditions by securing food and better nutrition in poor areas. Malnutrition plays a significant role in the death of 50 percent of all children in developing countries, amounting to 10.4 million deaths per year of children under the age of five (Rice *et al.*, 2000). The negative effects of wastewater reuse are due to its pathogens and toxic chemical compounds content. The most important and rapid effects on human health are caused by pathogens when municipal wastewater is involved. More detail on positive and negative impacts on the use of wastewater for irrigation can be found in WHO (2006) and Jimenez (2006).

Health Risks

Wastewater contains different types and concentrations of organisms depending upon the epidemiological conditions of the population discharging to the sewer. Once wastewater has been used directly or indirectly to irrigate, pathogens present can survive in soil or on crops for long enough to be transmitted to humans. The most environmentally resistant and persistent patho-