ABSTRACT
Triclosan (TCS, 3-<i>chlorophenoxy</i> phenol) is an antimicrobial agent found in a variety of pharmaceuticals and personal care products. Numerous studies have examined the occurrence and environmental fate of TCS in wastewater, biosolids, biosolid-amended soils, and plants and organisms exposed to biosolid-amended soils. TCS has a propensity to adhere to organic carbon in biosolids and biosolid-amended soils. Land application of biosolids containing TCS has the potential to contribute to multiple direct and indirect human health exposure pathways. To estimate exposures and human health risks from biosolid-borne TCS, we conducted a risk assessment in general accordance with the methodology incorporated into US EPA’s Part 503 Biosolids Rule. Human health exposures to biosolid-borne TCS were estimated for 10 direct and indirect exposure pathways using upper-end environmental partitioning estimates. Similarly, margins of safety (MoSs) were estimated for 10 direct and indirect exposure pathways using US EPA’s Part 503 Biosolids Rule.

METHODOLOGY

• Evaluated 10 direct and indirect human exposure pathways using US EPA’s Part 503 Biosolids Rule methodology (Figure 1), with the following exceptions:
  ▪ Dermal exposure parameters
  ▪ Eliminated inhalation exposure pathway since TCS is not volatile (based on US EPA criteria)
  ▪ Median (50th percentile) and upper bound (95th percentile) TCS concentrations in biosolid-amended soils were based on lunches (2010)
  ▪ TCS concentrations in groundwater, surface water, and plant and animal products were calculated using US EPA environmental partitioning equations and compared to measured concentrations found in the literature
  ▪ Calculated MoSs for children and adults using upper and lower bound (95th percentile) TCS concentrations in biosolid-amended soils in the literature (2010) and lower (1.2 mg/kg/day) bound non-cancer toxicity benchmarks
  ▪ Evaluated the impact of using a range of soil-water partition coefficients (<i>Kd</i>) on predicted TCS concentrations in groundwater and surface water

RESULTS

• Cumulative biosolid-borne TCS exposure ranged from 0.00047-0.0117 mg/kg-day for children and 0.00038–0.00811 mg/kg-day for adults
• The MoSs for cumulative exposure to biosolid-borne TCS for children and adults were all above 100, a value generally considered to be protective (US EPA, 1998) (Figure 3).
• MoS for individual exposure pathways using the lower bound toxicity benchmark (12 mg/kg-day) (EC, 2011):
  ▪ Children: 1,000-5,711,000,000,000
  ▪ Adults: 2,720-7,633,000,000,000
• MoS for individual exposure pathways using the upper bound toxicity benchmark (47 mg/kg-day, Rodricks, 2010):
  ▪ Children: 7,700-2,240,000,000,000
  ▪ Adults: 15,000-2,910,000,000,000
• Using the lower bound log<sub>Kd</sub> of 1.4 and the upper bound (95th percentile) biosolid amended soil concentrations, groundwater ingestion was the largest contributor to overall exposure (72%) of the total intake in adults and 51% in children, followed by juvenile consumption (20% in adults and 10% in children)
• Dermal exposure to biosolid-borne TCS in surface water was the lowest contributor to overall exposure and risk
• Modeled biosolid-borne TCS concentrations in surface water and fish were below literature-based measured concentrations

STUDY OBJECTIVES

• Quantify human biosolid-borne TCS exposure using measured and modeled exposure estimates
• Conduct a multi-pathway human health risk assessment for biosolid-borne TCS, following US EPA’s Part 503 Biosolids Rule methodology

CONCLUSION
Although TCS is extensively removed during waste water treatment, it is frequently detected in biosolids. Measured concentrations of TCS in biosolids and modeled concentrations of biosolid-borne TCS in groundwater, surface water, and produce were used in a multi-pathway risk assessment consistent with US EPA’s Part 503 Biosolids Rule. Estimated exposures from biosolid-borne TCS resulted in large MoSs, even when using upper bound exposure estimates and lower bound toxicity benchmarks. This analysis clearly demonstrates that biosolid-borne TCS is not likely to be a significant contributor to human health exposures and risk.