Supplementary Material S1

Worked calculations for wastewater-process CH_4, sludge-storage CH_4, and wastewater-process N_2O emissions

Manuscript: Assessing net climate impacts and avoided impacts of sewage sludge management options: A case study of Ulaanbaatar, Mongolia

Functional unit (FU): 1 m^3 of treated wastewater. Methane and nitrous oxide impacts were characterized using IPCC AR4 GWP_{100} factors of 25 and 298 kg CO_2-eq/kg gas, respectively. The calculation inputs correspond to Tables 2 and 3 of the manuscript.

Displayed inputs and results are rounded for presentation. Full precision was retained in the calculation workbook.

S1.1 Wastewater-process methane

Eq. (1): $CH_4,WW = 10^{-3} \times 1 \times 679.7504 \times 0.44853 \times 0.50 \times [(0.30 \times 0.65)(1 - 0.45)] = 0.0163496$ kg CH_4/FU. Multiplying by 25 gives 0.4087 kg CO_2-eq/FU.

S1.2 Cumulative sludge-storage methane

Eq. (2): $CH_4,storage = 4.9078404 \times 0.05 \times 0.50 \times 0.40 \times 0.50 \times (16/12) \times [1 - \exp(-0.185 \times (4 - 0.5))] = 0.0155954$ kg CH_4/FU. Multiplying by 25 gives 0.3899 kg CO_2-eq/FU over the assumed storage period. The wet sludge input is 341,105 × 1,000 / 69,502,057 = 4.9078404 kg/FU. At 75% moisture, the corresponding dry matter is 1.2269601 kg DM/FU.

S1.3 Wastewater-process nitrous oxide

Eq. (3): $N_2O,WW = 1 \times 111.5 \times 0.0050 \times (44/28) \times 10^{-3} = 0.000876071$ kg N_2O/FU. Multiplying by 298 gives 0.2611 kg CO_2-eq/FU.

In Eqs. (1) and (3), 10^{-3} converts grams to kilograms. In Eq. (2), 16/12 converts carbon mass to methane mass. In Eq. (3), 44/28 converts N_2O-N to N_2O. Sludge-storage emissions are cumulative emissions attributable to sludge generated per FU over the assumed four-year storage period, including a 0.5-year decomposition delay; they are not a measured annual emission rate. For Eq. (3), the monitoring-summary TKN value of 111.46 g N/m^3 was rounded to 111.5 g N/m^3 in the calculation workbook; this model input gives 0.2611 kg CO_2-eq/FU.