Framework for Multi-Pathway Cumulative Exposure for Comparative Assessments

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Abstract book

Tu-SY-G3: Advancing human exposure metrics in Life Cycle Assessment (LCA) and Chemical Alternatives Assessment (CAA) – I

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Framework for Multi-Pathway Cumulative Exposure for Comparative Assessments

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Efforts to assess human and ecosystem exposure to contaminants released to multiple environmental media have been evolving over the last decades. In this talk, we summarize the development and evolution of the multimedia mass-balance approach combined with multi-pathway exposure assessment as a framework for comparative assessment of chemicals, products, and services. We first review the development and evolution of the multimedia mass-balance approach to pollutant fate and exposure evaluation and illustrate some of the calculations used in multimedia, multi-pathway exposure assessments. The multimedia approach requires comprehensive assessments that locate all points of chemical release to the environment, characterize mass-balance relationships, and track contaminants through the entire environmental system to exposure of individuals or populations or specific ecosystems. For use in comparative risk assessment, life-cycle assessment (LCA), and chemical alternatives assessment (CAA), multimedia fate and exposure models synthesize information about partitioning, reaction, and intermedia-transport properties of chemicals in a representative (local to regional) or generic (continental to global) environment with information about larger scale populations rather than specific individuals or vulnerable subgroups. Although there can be large uncertainties in this approach, it provides insight on how chemical properties and use patterns map onto population-scale metrics of exposure, such as intake fraction for characterizing human intake per unit emission and aquatic or terrestrial ecosystem exposure concentrations per unit emission. We next discuss the reliability with which fate models at different levels of geographic scale--from near field indoor scales to urban, regional, continental and even global scale--can be used to determine cumulative human exposure and/or ecosystem exposure from multiple pollutants and emissions sources. The key question here is whether the results of cumulative assessments can provide sufficient insight for decision makers who are concerned with life-cycle impacts and chemical alternatives. We present a regional case study for pesticide alternatives in an agricultural valley of California to assess the opportunities and future prospects for the multi-pathway cumulative framework in LCA and CAA. This case reveals that the relative contributions to cumulative pollutant intake via different exposure pathways depend on (a) persistence of chemicals at different levels of integration (regional, urban-scale, food-web, indoors), (b) basic chemical properties, (c) the retention of chemicals in food webs, and (d) the retention of chemicals by indoor surfaces.