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Abstract book

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What are the elements required to improve exposure estimates in life cycle assessments?

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In this study we aim to identify and discuss priority elements required to improve exposure estimates in Life cycle assessment (LCA). LCA aims at guiding decision-support to minimize damages on resources, humans, and ecosystems which incur via providing society with products and services. Potential human toxicity and ecosystem toxicity of chemicals posed by different product life cycle stages are characterized in the life cycle impact assessment (LCIA) phase. Exposure and effect quantification as part of LCIA toxicity characterization faces numerous challenges related to inventory analysis (e.g. number and quantity of chemicals emitted), substance-specific modelling (e.g. organics, inorganics, nano-materials) in various environments and time horizons, human and ecosystem exposure quantification (e.g. exposed organisms and exposure pathways), and toxicity end-points (e.g. carcinogenicity). There are many relevant areas for improving exposure quantification in LCIA.

We explore prioritising future work based on investigating existing mitigation efforts, observed damages, and potential for (irreversible) harm to ensure LCIA covers at least the most relevant concerns faced by societies today regarding chemical exposure and harmful effects. Thereby, we structure this study of key elements identified as areas of elevated public, industrial, regulatory, and scientific concerns.

We found the majority of missing elements are directly related to the definition of exposed populations (both ecosystems and humans). For example, current LCIA human toxicity methods focus on exposure of the general population via chemical emissions. Occupational and consumer exposure to chemicals is of elevated concern for various stakeholders and leads to millions, if not billions, of dollars of damages yearly (e.g. through mesothelioma). Although consumer and occupational exposures often occur at magnitudes far greater than exposure mediated via environmental emissions, they are notably missing from current LCIA methods. As another example, recommended LCIA ecotoxicity methods focus on freshwater ecosystems. A significant amount of resources has been spent to mitigate damages on marine and terrestrial organisms such as fishes, bees, and birds. However, recommended methods are currently unavailable in LCIA to consider these organisms to evaluate the sensitivity of terrestrial and marine ecosystems. Microbes are another elevated concern due to the rise of antibiotic resistant organisms due to microbial exposure to disinfectants, antimicrobials and antibiotics etc. Yet, both the microbial exposure to chemicals and human exposure to microbes (and other disease vectors) are entirely missing from current LCIA exposure frameworks.

In all, defining exposure sub-populations and developing suitable methods can improve exposure methods in LCIA and capture major societal concerns.