Development of Particulate Matter Footprint and Human Respiratory Impact Assessment

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Since the fine particulate matters (PMs) occurred from mainly combustion in industry and road transport effect to human respiratory health, the interest and importance are getting increased. PM, also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets that get into the air (US EPA, 2016). This complex mixture contains for instance dust, pollen, soot, smoke, and liquid droplets. Many scientific studies have linked PM10 and PM2.5 exposure to a variety of problems such as premature death in people with heart or lung disease and increased respiratory symptoms (coughing or difficulty breathing).

Life cycle assessment (LCA) is a structured, comprehensive, and internationally standardized method to assess potential environmental impacts and resources used throughout the life cycle of a good or service in a comparable way (ISO 2006). LCA thereby aims for best estimates in the modeling of all relevant impacts on the natural environment, human health, and resources in the life cycle impact assessment (LCIA) phase (EC 2010a, Finnveden et al. 2009). To help identify best LCA practice, Phase III (2012-2016) of the UNEP/SETAC Life Cycle Initiative1 has launched a flagship project aiming to provide global guidance and consensus on a limited number of LCIA indicators.

One of the challenges in LCA method is that impacts are linked to emissions via intake, whereas in epidemiology, impacts are related to concentrations. Generally, when assessing the health response of a population, the most accurate and efficient approach is to relate observed concentrations to population response. This also constitutes the basis for the LCA framework. However, this approach needs to be adapted for the emission-based LCA context for which the impact of an additional kg emitted by multiple sources in different, often unknown locations needs to be evaluated (Finnveden et al. 2009, Hauschild 2005). For such emission based assessments, the human intake fraction (iF) as the fraction of an emitted mass ultimately taken in by the total exposed population is well adapted, accounting directly for a temporally and spatially integrated concentration multiplied by nominal human intake rates. Intake fraction is a time- and space-integrated metric, easy to understand, to communicate and to combine with chemical emissions. Emission source types can be associated with specific iF, which is easier to interface and combine at the level of exposure than a field of concentrations over a certain distance around the source. Figure 1 shows a general assessment framework from Humbert et al. (2011) study.

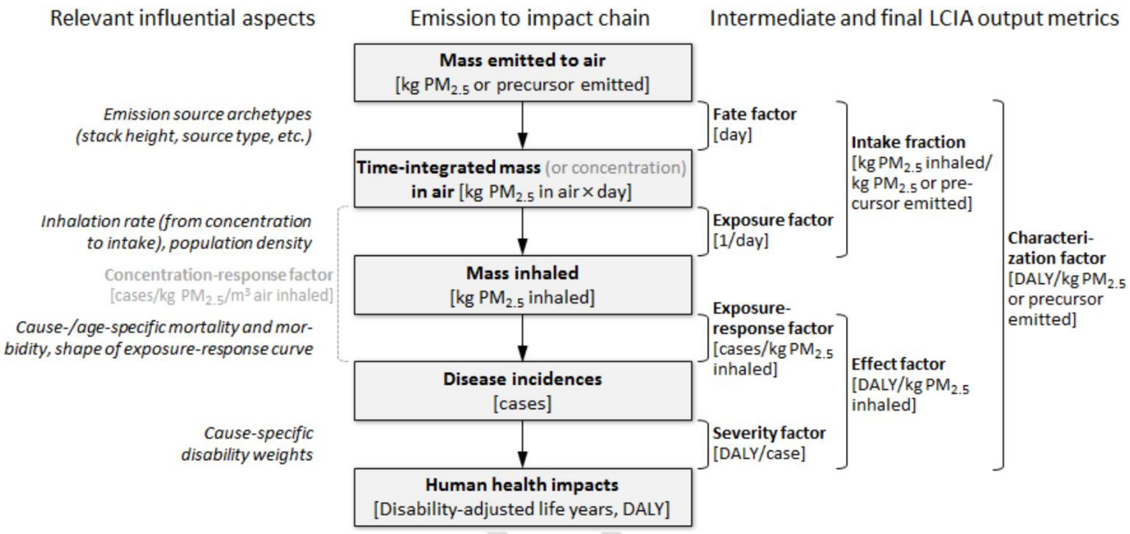

Figure 1. A framework for assessing human health effects from fine particulate matter 190 exposure in life cycle impact assessment; adapted from Humbert et al. (2011).

Based on these backgrounds, we will conduct our research following aspects:

- Data and information of the significant air emissions (e.g. CO, NOx, SOx) including PM10 and PM2.5 in each industry and region of China and France

  : 2007- 2017 data on air emissions in each industry (France and China) (see below table)

: 2007 - 2017data on air emissions in each region (France and China)

: Contribution and hotspot analysis

Industrial Sector (2007 – 2017)	NOx	SOx	PM10	PM2.5	NH3
Combustion in energy industries					
Non-industrial combustion plants					
Combustion in manufacturing industries					
Production processes					
Storage and distribution of fuels					
Solvent use					
Road transport					
Other mobile sources and machinery					
Waste treatment and disposal					
Agriculture					
Other sources & sinks					
Total					

- Development of new characterization factors of each emission in France and China
- Development and application of disability-adjusted life year (DALY) factors in France and China

Substance name	Unit	Midpoint (kg PM10 eq.)			Endpoint (DALY*(year))		
		Current	France	China	Current	France	China
NOx	kg	0.22			5.72E-05		
SOx	kg	0.2			5.20E-05		
PM2.5	kg	1			2.60E-04		
PM10	kg	1			2.60E-04		
NH3	kg	0.32			8.32E-05		

- PM long-range transboundary transport and simulation
- GIS mapping with PM footprint and human respiratory impact
- PM and health impact reduction scenarios with new future energy policy in China and France