

Incorporating life cycle screening into Alternatives Analysis Jordan Chamberlain | Kristen Magnuson | Carolin Meier | Yu Yu Faculty Advisor: Dr. Arturo Keller | Client: Department of Toxic Substances Control

Background

In 2013, the Safer Consumer Products Regulations went into effect in California to reduce the use of chemicals with negative human health and/or environmental impacts.

These Regulations require manufacturers to perform an Alternatives Analysis to identify and evaluate alternatives to Priority Products—products that pose high risk to human health and the environment.

This Analysis consists of two stages. The First Stage focuses on screening alternatives and identifying factors that are relevant to consider in a thorough investigation of alternatives during the Second Stage. The Alternatives Analysis requires the incorporation of life cycle thinking to account for impacts throughout the production, use, and disposal of a product.

Life cycle assessments are time-consuming and data-intensive. Furthermore, many companies, particularly small ones, lack the technical expertise to conduct such assessments. Thus, there is a need for a framework to incorporate life cycle thinking into the First Stage of an Alternatives Analysis in a constrained time frame.



Generic life cycle phases of a product. Note, not all phases are shown.

Objectives

- To develop a life cycle alternatives screening framework and test the framework with a case study of methylene chloride in paint strippers and alternatives.
- 2. To design a document explaining the steps needed to implement the life cycle screening framework for a particular product and a visual presentation to communicate the results to public and corporate audiences.

Approach

Relevant literature was reviewed to provide a background on Alternatives Assessment, Life Cycle Assessment, and hotspotting analysis. The developed framework made use of valuable aspects of each of these separate methodologies.

To inform and test the framework, a case study was performed. Methylene chloride in paint stripper was chosen as an appropriate Priority Product because of the availability of both chemical substitutes (e.g. benzyl alcohol-based paint stripper) and full process substitutes (e.g. sanding). The combination of these alternatives ensured that the developed framework was applicable to both formulated and composite products.

Data sources for the case study included government (e.g. US EPA) and non-government agencies (e.g. Material Safety Data Sheets). These sources provided both qualitative and quantitative data on human health, environmental, and waste/end-of-life impacts.





Examples of paint stripper products

Results 1. Framework Our framework outlines an approach for incorporating life cycle thinking into a First Stage Alternatives Analysis, as set forth in the Safer Consumer Products Regulations. The framework consists of six primary steps. 2. Identify 3. Define the 1. Determine functional unit product and possible alternatives Chemical of consider Concern function Recommended Exist on the Impact by suppliers Categories market **Public Health** Environmental Impacts Impacts Water Air Quality Soil Quality Quality 2. Visualization

The data gathered by following the framework requires a user-friendly visualization to achieve two of the goals of a First Stage Alternatives Analysis: (1) screen alternatives; and (2) identify factors that are relevant for consideration in a Second Stage Alternatives Analysis. Evaluation criteria were used to assess the severity of impacts. Each impact level—minimal to no, low, medium, and high—was assigned a color for visualization.

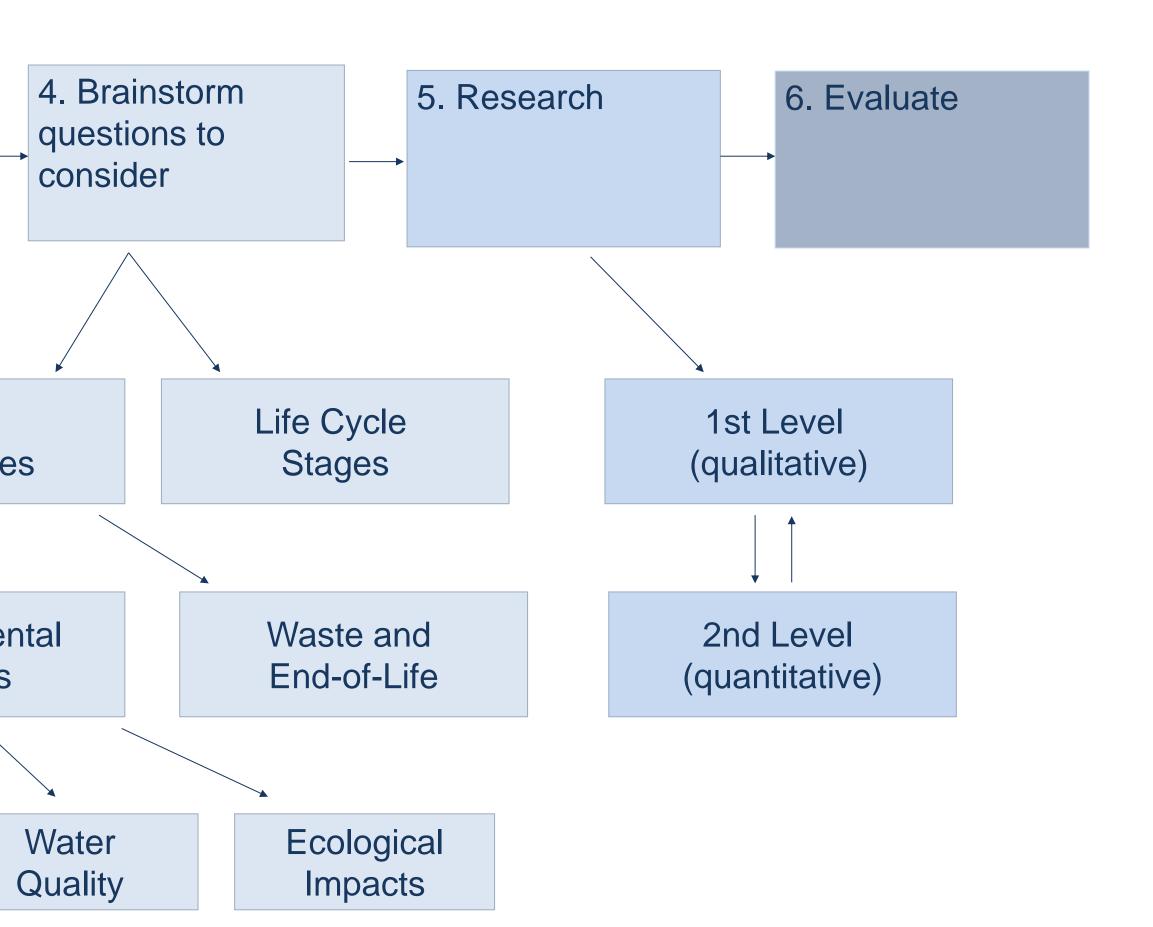
A series of heat maps was used to present the results of the case study on paint strippers and to illustrate how this visualization tool can be useful to decisionmakers.

Screening Alternatives

To identify alternatives that can be screened out from further consideration, To help identify factors relevant for consideration, the evaluation was presented as a series of impact-specific heat maps. This format allows for an easier evaluations were presented as product-specific heat maps. This presentation of the evaluation allows for the identification of alternatives that have an overall comparison of alternatives for specific impacts to determine whether a more insimilar or worse level of impact than the Priority Product. depth investigation of a particular impact is warranted.

	Raw Material Extraction	Intermediate Material Processes	Manufacture	Use	Reuse and Recycle	EOL and Disposal	Raw Material Extraction	Intermediate Material Processes	Manufacture	Use	Reuse and Recycle	EOL and Disposal
Public Health	н	М	L	L		L	М	М	М	L		
Air Quality	н	М	М	L		L	L	Н	L	L		М
Soil Quality	н		Н	Н		н	L		М			L
Water Quality	м	Н	Н	Н		н		L	М	L	М	L
EcologicalImpact	н	L	L	L		L	М			L		
Waste/End-of-Life		L	М	М		М		М		М	М	L
		Me	thylen	e Chlor	ide				Benzyl	Alcohol		
Public Health	н	н	н	Μ		н	М	М	н	Н		н
Air Quality		М	М	L		L	M	М				М
	V						141	141		М		171
Soil Quality	М		М	н		н	M	M		M M		M
Soil Quality Water Quality	M M		M	H H	Н	н н						
					H H		M	М		М		М
Water Quality	M		М	н			M	M		M		M
Water Quality Ecological Impact	M		М	H H H	H H	Н	M M M	M M M	San	M M M		M M M

High Uncertainty					Minimal	
Medium Uncertainty		High Impact	Medium Impact	Low Impact	to No	No Data
Low Uncertainty	,	mpact	mpact	mpact	Impact	



Identifying Relevant Factors

		•			-	
	Raw Material Extraction	Intermediate Material Processes	Manufacture	Use	Reuse and Recycle	EOL and Disposal
Methylene Chloride	н	М	L	L		L
Benzyl Alcohol	М	М	М	L		
Dimethyl Adipate	н	Н	Н	М		н
Sanding	М	М	Н	Н		н
			Public	Health		
Methylene Chloride	н		Н	н		н
Benzyl Alcohol	L		М			L
Dimethyl Adipate	М		М	н		н
Sanding	М	М		М		М
			Soil Q	uality		
Methylene Chloride	н	L	L	L		L
Benzyl Alcohol	М			L		
Dimethyl Adipate	М		Н	н	н	
Sanding	М	М		М		М
		E	cologica	al Impac	t	

	S			e	
Raw Material Extraction	Intermediate Material Processes	Manufacture	Use	Reuse and Recycle	EOL and Disposal
н	М	М	L		L
L	н	L	L		М
	Μ	М	L		L
М	Μ		М		М
		Air Q	uality		

М	Н	Н	н		Н
	L	М	L	Μ	L
М		М	н	Н	н
М	Μ		М		Μ
		Water	Quality		

	L	М	М		М
	Μ		М	Μ	L
М			н	Н	н
М	М		L		М
	V	/aste/Er	nd-of-Li	fe	



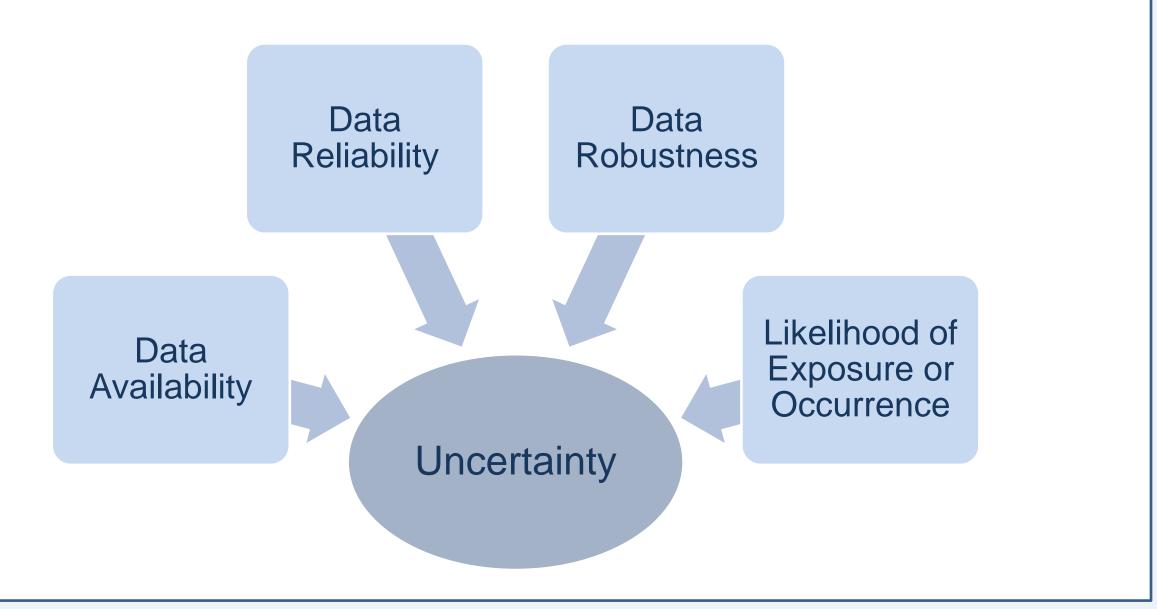


Data Uncertainty

The paint stripper case study demonstrated that there are multiple elements to assessing data uncertainty in a life cycle screening.

Data quality is a result of the availability, reliability, and robustness of data. An additional consideration that is important to the screening process is the likelihood of a particular exposure scenario or a particular impact occurring.

The developed framework does not currently include quantitative methods for assessing uncertainty.



Conclusions

A new framework was developed and tested using a case study of methylene chloride-based paint strippers and three alternatives. It incorporates critical aspects from Alternatives Assessment, LCA methods, and hotspot analysis, and is applicable to both formulated and composite products.

The framework introduces life cycle concepts to a non-expert audience as a way to achieve the objectives of a First Stage Alternatives Analysis to: (1) identify alternatives; (2) screen alternatives; and (3) identify relevant factors to consider in a Second Stage Alternatives Analysis. This framework successfully addresses these three objectives. The second step of the framework presents a process for identifying alternatives, and the final step introduces a visualization tool to screen alternatives and aid in identifying relevant factors.

Framework for Initial Life Cycle Screening in		orating life
Alternatives Analysis		duct to
		'k was
	4 4	into so within
	5	blished
The following document outlines an approach for	5	ies on n-making.
incorporating life cycle thinking into a First Stage	5	evant
Alternatives Analysis, as set forth in the California	5	s. A
Safer Consumer Products Regulations.	17 18	ant factors h of the
	20	
	22	explored
PREMIUM PROMAM	34	
REMOVER Stripper Stripper Stripper	34 34	
		6. Evaluate
	ripper Case	
	35	
	37 37	
Prepared by:		s Nethylene
Jordan Chamberlain Kristen Magnuson Carolin Meier Yu Yu		g for easier this
		und la
Advisor Dr. Arturo Keller		sidered for
DI. Arturo Kener		
*		
California Department of Estimation Control California Department of Ca		ern nt to first
		the
	2	

Sample pages from the framework document

This framework was tailored to the Safer Consumer Products Regulations. It focuses on introducing the concepts of life cycle thinking and suggests an approach to incorporate these considerations quickly. This framework is malleable, and additional impacts, such as economic or social impacts, could be incorporated into this model.

Next Steps

- Further develop quantitative methods for life cycle screening using the paint stripper case study.
- 2. Develop framework for Second Stage Alternatives Analysis.

Acknowledgements

Special thanks to the individuals and organizations that advised and supported this project: Arturo Keller; Bob Boughton; Sangwon Suh; Anastasiya Lazareva; Allison Horst; Adeyemi Adeleve; Jessica Perkins; Patricia Holden; Jay Means; Sage Davis; the Bren School of Environmental Science & Management; the Department of Toxic Substances Control; and W.M. Barr & Company.