Generating meaningful and easy-to-interpret sustainability data to support decision making: a method and a case study

Matt Vanderkooy; Michaye McMaster; Gary Wealthall; John Vidumsky

RESUMO

Récemment, de nombreuses entreprises, organisations et agences gouvernementales mettent davantage l'accent sur l'évaluation de la durabilité des projets et des produits afin d'aider à orienter la production et l'implémentation. Cette etude présente une méthode pour générer et présenter les données d'analyse du cycle de vie (ACV) de facon claire, facile à interpréter et permettant de faciliter la prise de décision. Les éléments clés de cette méthode incluent (1) Un classement général des ACVs évalués qui peut facilement être intégré dans le cadre du processus décisionnel, (2) Une analyse robuste d'incertitudes des classements à l'aide de distributions de probabilité des résultats des ACVs, (3) Une analyse et une optimisation du processus de conception afin de diminuer les impacts environnementaux. Cet article illustre cette méthode en l'appliquant à l'évaluation des impacts environnementaux des options de dépollution d'un site pollué par du goudron de houille.

ABSTRACT

Recently many corporations, organizations, and governmental agencies are putting a greater emphasis on evaluating sustainability of projects and products to help guide implementation and production. This paper and presentation presents a method to generate and present sustainability data from Life Cycle Assessments (LCAs) that are meaningful, easy-to-interpret and simplify decision making. Three key outputs of the method include (1) a sustainability ranking table that can easily be incorporated into decision making frameworks, (2) a sustainability probability distribution to examine uncertainty, and (3) a contribution network to analyze and optimize sustainability. This paper and presentation showcases the method by applying it to evaluate the sustainability of remedial options for a coal tar contaminated site.

KEYWORDS: Sustainability, Life Cycle Assessments, Optimizing, Decisions, Probability

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1 – INTRODUCTION

Recently many corporations, organizations, and governmental agencies are putting a greater emphasis on evaluating the sustainability of projects and products to help guide production and implementation. This paper presents a method to generate and present sustainability data from Life Cycle Assessments (LCAs) that are meaningful, easy-to-interpret, and simplify decision making. LCAs attempt to capture all outputs to the environment (e.g. carbon footprints, particulate emissions, etc.,) to avoid environmental burdens being transferred from measured variables to unmeasured variables.

The method has three key outputs: (1) a sustainability ranking table that is easily be incorporated into decision making frameworks, (2) a sustainability probability distribution to examine uncertainty, and (3) a contribution network to analyze and optimize sustainability. These three key outputs are generated by a method comprising seven actions. The seven actions are consistent with ISO [1,2] and sustainable remediation forum (SURF) guidance documents [3]. The actions are listed in Figure 1.
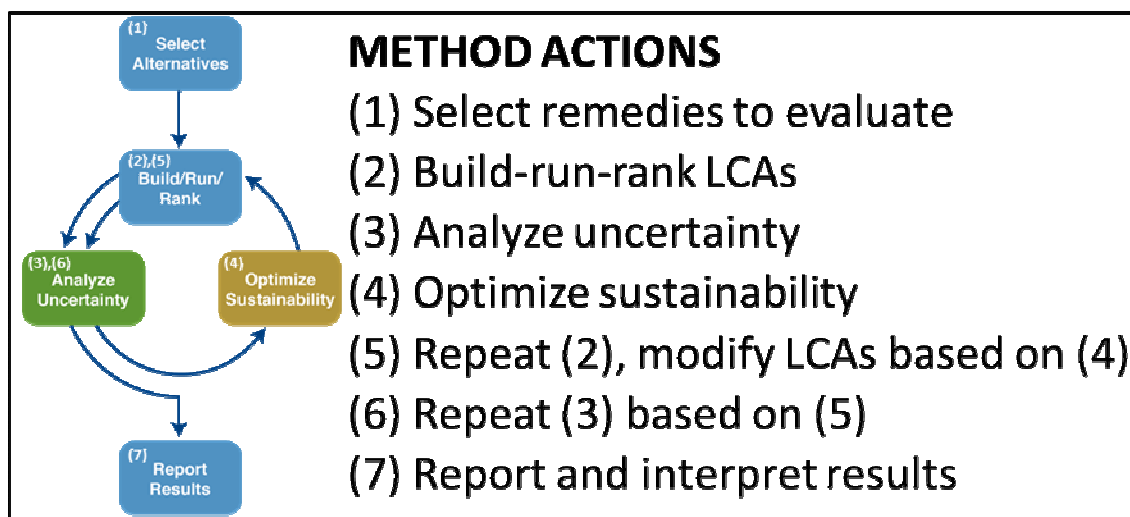

METHOD ACTIONS
(1) Select remedies to evaluate
(2) Build-run-rank LCAs
(3) Analyze uncertainty
(4) Optimize sustainability
(5) Repeat (2), modify LCAs based on (4)
(6) Repeat (3) based on (5)
(7) Report and interpret results

Figure 1. Method actions to evaluate sustainability and generate three key outputs.

2 – CASE STUDY SITE

The Site is a former road tar, cresols, phenols, and cresylic acid production facility. Approximately 860 tonnes of viscous, dense, coal tar is present in site soils and occupies approximately 43,000 cubic metres at depths of 1 to 10 metres below ground surface, across the site. Three remedies were considered to treat contamination in soils: STAR, Thermal Remediation, and Excavation and Off-Site Treatment.

STAR (Self-sustaining Treatment for Active Remediation) is an innovative new technology based on the principles of smoldering combustion where the coal tar or other combustible non-aqueous phase liquids (NAPLs) are destroyed as they combust in situ. A

short duration 'ignition event' starts the self-sustaining combustion. Oxygen is delivered to the combustion front by pumping in surface air. For the Site, initial remedy design included a bentonite-soil wall to protect off-site utilities from heat during STAR.

Thermal remediation is the process of removing hydrophobic contamination from the sub-surface by increasing temperatures causing the contamination to become volatilized (i.e. desorbed). The volatilized contamination is then captured through extraction wells and treated using granular activated carbon or a thermal oxidizing system.

Excavation and Off-Site Treatment is a combination method that involves the physical extraction of contaminated soil from its original location, and performance of Off-Site treatment to destroy the contamination before disposal or reuse of soils. For Off-Site treatment, an ex situ method, thermal treatment desorbs and combusts contamination.

2.1 – Output 1, Ranking Table

The ranking table effectively communicates the sustainability rankings. This ranking table is easily incorporated into decision making frameworks. Using an overall sustainability metric developed for the Site, STAR ranked most sustainable followed by Thermal, and then Excavation and Off-Site Treatment (see Table 1).

Table 1. Output 1 – Remedy Sustainability Ranking Table

Alternatives	STAR	Thermal	Excavation
Sustainability Rank	1	2	3

2.2 – Output 2a, Probability Distribution Plot

The probability distribution plot demonstrates uncertainty of the rankings from Output 1 by plotting the expected distribution of sustainability outcomes. The distribution curves were created using the Monte Carlo method in combination with uncertainty data about variables controlling sustainability. The data plotted in Figure 2 are from an overall sustainability metric developed for the Site. The plot indicates STAR is always the most sustainable remedy. STAR's curve never overlaps with Thermal or Excavation.
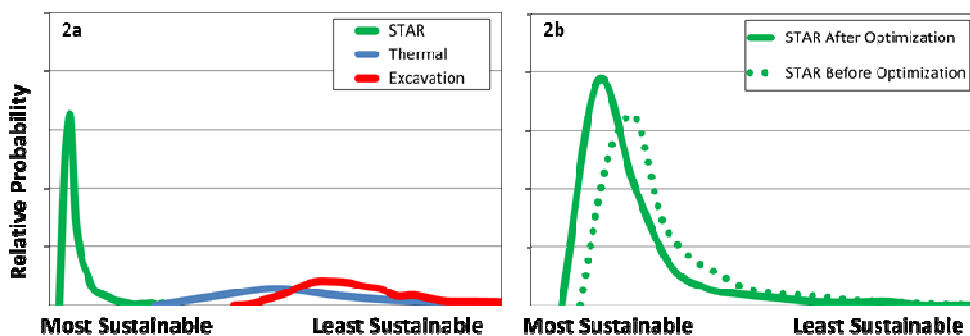

Figure 2a,b. Output 2a, remedy sustainability distributions; 2b, STAR after optimization.

3.3 – Output 3, Contribution Network

The contribution network identifies components of the remedies evaluated that contribute significantly to negative sustainability outcomes. STAR's contribution network (Figure 3) indicated that the Soil-Bentonite Wall, originally proposed as part of the remedy, causes significant climate change impacts (CO_2 eq, carbon dioxide equivalents). The wall is not necessary to implementing STAR and was removed from the remedy design.
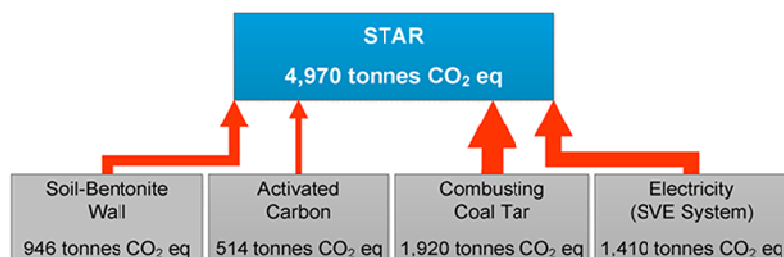

Figure 3. Output 3, Contribution Network of STAR climate change impacts.

3.3 – Output 2b, Re-generated Probability Distribution Plot

STAR's LCA was modified to remove the Soil-Bentonite Wall and the re-run. Figure 2b shows sustainability was improved by removing the bentonite-soil wall from the design.

4 - CONCLUSIONS

The method presented generates sustainability data that are easy-to-interpret, robust and simplify decision making. The method is flexible and can evaluate sustainability for any project, process, or product. The three key outputs (1) ranking table, (2) probability distribution, and (3) contribution network effectively communicate sustainability findings. The case study used the method and outputs to identify STAR as the most sustainable remedy to treat coal tar contamination, and optimize STAR's sustainability.

5 – REFERENCES

[1] Favara, P.J., Krieger, T.M., Boughton B., Fisher A.S., Bhargava M. Guidance for Performing Footprint Analyses and Life-Cycle Assessments for the Remediation Industry. US Sustainable Remediation Forum, *Remediation,* Summer 2011.

[2] International Organization for Standardization (ISO). 14040 international standard: Environmental management—Life cycle assessment—Life cycle impact assessment. Geneva, Switzerland. 2006a.

[3] International Organization for Standardization (ISO). 14044 international standard: Environmental management—Life cycle assessment—Requirements and guidelines. Geneva, Switzerland. 2006b.