Challenges and choices in environmental sustainability

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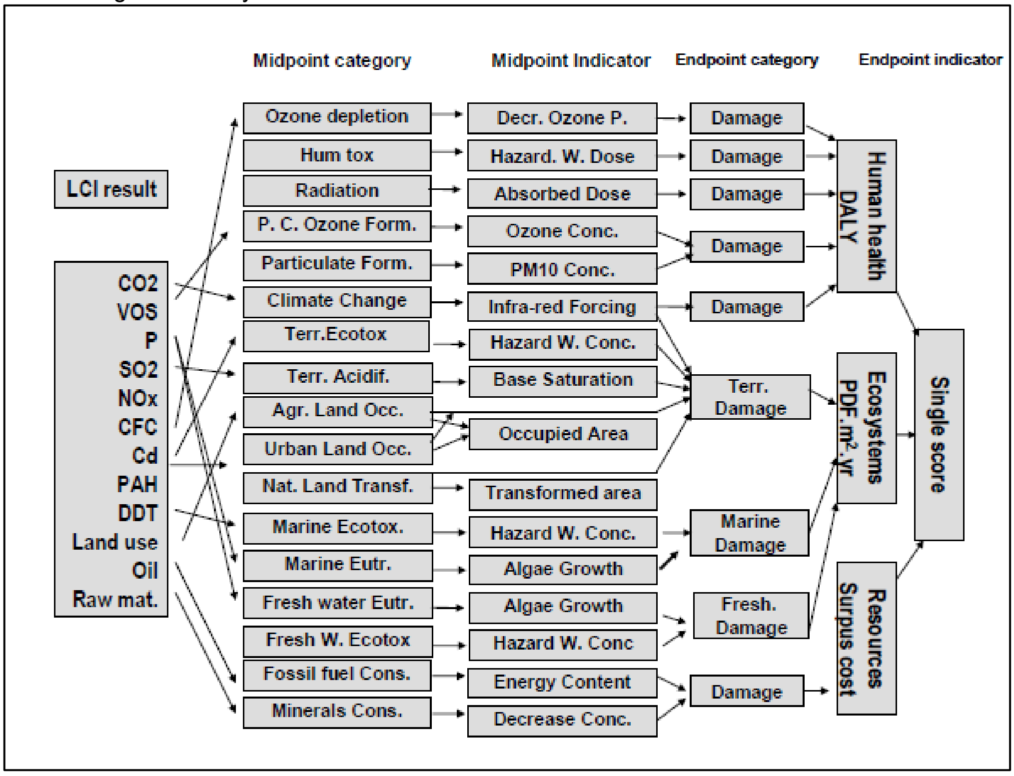
As veterinarians, we are accustomed to making decisions and recommendations based on a preponderance of scientific evidence. The multitude of studies available to support specific actions generally are performed to answer a binary question: is treatment A better than treatment B? Within this, there are often uncertainties and dependent variables, with different patients and owners requiring different treatment plans. However, in general there is a 'gold standard' treatment which is the most likely to give us the best outcome.

Sustainability decision making is far more complex. There are always trade-offs, competing interests and qualitative choices to be made when deciding on a path forward. It is rare to have a clear and definitive best option. Even when the environmental priorities are set, there is the consideration of economic and environmental justice – which societal groups will benefit from or pay the cost (environmental, social, or economic) of the decision?

The methodology by which we measure environmental impacts is Life Cycle Assessment (LCA). LCA studies are performed to international standards (ISO 14040/44) and measure environmental impacts across a range of impact categories, from Global Warming Potential to Human Toxicity impacts. An example of the impact categories measured in one of the common LCA methodologies is below.

Figure 1. Impact categories and pathways covered by the ReCiPe methodology. Source: ILCD Handbook LCIA Background Analysis 2010.



Prioritization of impact categories can be difficult and is identified in the initial scoping of the LCA. If the goal of the project is to identify climate change impacts, then occasionally that will be the only impact category included – a carbon foot-printing study. However, as LCA and sustainability goals have developed, there has been a move away from carbon foot-printing only studies to inclusion of more impact categories. This has increased the complexity of interpretation because most comparative studies will find variable outcomes for different impact categories.

The dilemma facing decision makers is amply demonstrated by the paper vs plastic bag conundrum. In 2019, New Zealand banned single use plastic carrier bags, as have many other jurisdictions globally. However, one key aspect of LCA studies is to include the environmental impacts across the product's life cycle – from raw materials extraction to recycling or landfilling. When comparing bags, the study design should include a functional unit and a temporal aspect – how many of product A will be needed to perform the equivalent service to product B? For example, the UK government Environment Agency compared a single use high density polyethylene (HDPE) plastic bag, a HDPE bag with a degradant, a starch blend bag, and four 'reusable' bags: paper, low density polyethylene (LDPE), polypropylene, and cotton, and included the re-useability of some bags in the evaluation (Table 1.)

Table 1. Sample comparison of carrier bags (rounded figures). Shaded columns indicate the impacts from the reusable bags if they were to be reused the number of times required to meet the HDPE GWP. (Edwards and Meyhoff Fry 2011).

	HDPE bag	**HDPE bag with degradant**	**Starch blend bag**	**Paper bag**		**LDPE bag**		**Polypropylene bag**		**Cotton bag**	
GWP (kg CO^{2}eq)	1.6	1.8	4.2	5.5		7		22		272	
Reuses needed to meet HDPE GWP (rounded)	1	1	3 (but this is unlikely)	4		5		14		173	
Abiotic depletion (g Sb eq)	16	19	16	27	**6.7**	83	17	275	20	1520	9
Acidification (g SO^{2} eq)	11	12	18	37	9.4	29	**6**	101	7	2788	16
Eutrophication (g PO^{4} eq)	0.76	0.84	7	5	1.3	2.6	**0.5**	15	1	304	2
Human Toxicity (kg 1,4 DB eq)	0.21	0.23	1.2	3.2	0.81	0.7	**0.1**	3	0.2	66	0.4
Freshwater ecotoxicity (g 1,4 DB eq)	67	72	200	150	38	187	37	468	**33**	23477	136

The results indicate that the HDPE bag has the lowest impact for climate change, which is consistent with multiple other studies and reviews (Ahamed *et al.* 2021, Gómez and Escobar 2022). However, when the additional impact categories are considered, the picture is less clear. If the goal of the work is to reduce acidification and eutrophication impacts, the 'reusable' LDPE bag might be the better choice – assuming that it is reused the requisite five times. When human behaviour is considered, the need to reuse bags adds an additional element of uncertainty into this data.

The data also does not include impacts such as damage to sea life or microplastics from plastic bags – there are not currently impact categories which measure this. Is this more important than climate change? than damage to freshwater ecosystems? than damage to human health? That is a philosophical, moral, and ethical question.

All of which is why the answer to: is product A or B better for the environment, is often, *it depends.*

To learn more about LCA, check out the Life Cycle Association of New Zealand www.lcanz.org.nz or high quality LCA journals such as the *International Journal of Life Cycle Assessment* or the *Journal of Cleaner Production.* To learn about the actions the global pharmaceutical industry is taking, check out the Pharmaceutical Supply Chain Initiative PSCI (pscinitiative.org), and the American Chemistry Society Green Chemistry Institute Pharmaceutical Roundtable ACS GCI Pharmaceutical Roundtable Portal » ACS GCI Pharmaceutical Roundtable Portal (acsgcipr.org).

References

Ahamed A, Vallam P, Iyer NS, Veksha A, Bobacka J, Lisak G. Life cycle assessment of plastic grocery bags and their alternatives in cities with confined waste management structure: A Singapore case study. *Journal of Cleaner Production* 278: 123956, 2021

Edwards C, Meyhoff Fry J. *Life Cycle Assessment of supermarket carrier bags: a review of bags available in 2006*. Environment Agency, UK, SC030148, Bristol, United Kingdom, 2011

Gómez IDL, Escobar AS. The dilemma of plastic bags and their substitutes: A review on LCA studies. *Sustainable Production and Consumption* 30: 107-16, 2022