Environmental impacts of mugs produced at the Leach Pottery: a preliminary analysis

September 2023

Contents

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1. Introduction

This preliminary life cycle assessment (LCA) study was commissioned by the Leach Pottery to help understand the environmental impacts of one of of its main products – mugs. The results from this preliminary study are expected to inform interventions to reduce the environmental impacts as well as potential further research in the future.

2. Method and Data

The attributional life cycle assessment (LCA) methodology was used to provide a comprehensive coverage of all upstream and downstream processes related to the entire life cycle of the mugs. LCA is an internationally standardised method to quantify the environmental impacts over the entire life cycle of a product system or activity and has been widely applied in many sectors such as energy, water, food, raw materials and waste. The LCA software SimaPro and the Life Cycle Impact Assessment method ReCiPe 2016 were used to calculate the different environmental impacts.

The functional unit of the LCA is chosen as 1 kg of mugs produced. Material inputs and energy consumption in the production of the mugs and packaging (for delivery to customers) were included. The manufacture of machinery and tools used in the production process is also included. Detailed foreground input data and assumptions were supplied by Leach. The Ecoinvent life cycle inventory database was used for the background datasets in the LCA model to link the foreground inputs with the associated upstream processes such as material production, transport, energy production etc. To estimate the implications of different glazing recipes, three versions of the mug will be assessed.

3. Results

The 18 different environmental impacts for the mugs with three different glazing recipes are shown in Table 1. These results suggest that the differences between these three glazing recipes are relatively small. Therefore, results for the Ash Green mug will be used for further analysis. Figure 1 shows the contribution of different types of activities to the overall life cycle impacts of the Ash Green mug for different impact categories. It is obvious that energy use and packaging are the two key types of activities that contributed most to overall impacts for all impact categories.

Figure 2 shows the contribution of key life cycle processes in the upstream and downstream stages in the supply chain to the overall carbon footprint of the Ash Green mug. It suggests that natural gas use due to ghost firing using the gas kiln (37%) and heating demand in the studio (11%) is the largest contribution to carbon emissions. Electricity use due to lighting in the studio (11%) and bisque firing using the electric kiln (10%) is also a significant contributor. Packaging materials (19%) such as interleaf white paper (8%) and corn starch peanuts (6%) also have high embedded carbon emissions. The raw materials for the mug (6%), manufacturing of machinery (1%) and manufacturing of tools (<1%) are relatively small contributors.

Similar to Figure 2, Figure 3 shows the contribution of key life cycle processes of the Ash Green mug to Marine Eutrophication, an impact primarily caused by the packaging materials (see Figure 1). Tracking all the way back to the key upstream processes, it appears that the production of corn (due to run-off of the fertilisers used) is the single biggest contributing process (27%), followed by landfilling of the sludge from pulp and paper production (19%).

Overall, these results help better understand the magnitude of the environmental impacts of mugs produced at the Leach Pottery and identify key areas of focus to improve the accuracy of the results by collecting more data in the future. In addition, more detailed explanation of the method, input data and assumptions made as well as a more in-depth analysis of the results will be presented in an academic paper to be co-authored by Prof Xiaoyu Yan and Dr Giorgio Salani at the Tokyo Institute of Technology.

Table 1. Life cycle environmental impacts of the mugs with three different glazing recipes

Impact category	Unit	Ash green	Dolomite (white) WM 2B	Tenmoku (black) WM5
Global warming	kg CO2 eq	3.24	3.25	3.25
Stratospheric ozone depletion	kg CFC11 eq	0.00000141	0.00000141	0.00000141
Ionizing radiation	kBq Co-60 eq	0.90	0.90	0.90
Ozone formation, Human health	kg NOx eq	0.00457	0.00459	0.00459
Fine particulate matter formation	kg PM2.5 eq	0.00241	0.00242	0.00242
Ozone formation, Terrestrial ecosystems	kg NOx eq	0.00467	0.00469	0.00469
Terrestrial acidification	kg SO2 eq	0.00643	0.00645	0.00644
Freshwater eutrophication	kg P eq	0.00080	0.00080	0.00080
Marine eutrophication	kg N eq	0.00019	0.00019	0.00019
Terrestrial ecotoxicity	kg 1,4-DCB	7.27	7.29	7.31
Freshwater ecotoxicity	kg 1,4-DCB	0.1464	0.1466	0.1468
Marine ecotoxicity	kg 1,4-DCB	0.1944	0.1946	0.1949
Human carcinogenic toxicity	kg 1,4-DCB	0.1399	0.1402	0.1403
Human non-carcinogenic toxicity	kg 1,4-DCB	2.2264	2.2307	2.2332
Land use	m2a crop eq	0.3240	0.3252	0.3242
Mineral resource scarcity	kg Cu eq	0.0086	0.0116	0.0089
Fossil resource scarcity	kg oil eq	1.2578	1.2589	1.2593
Water consumption	m3	0.0296	0.0297	0.0296

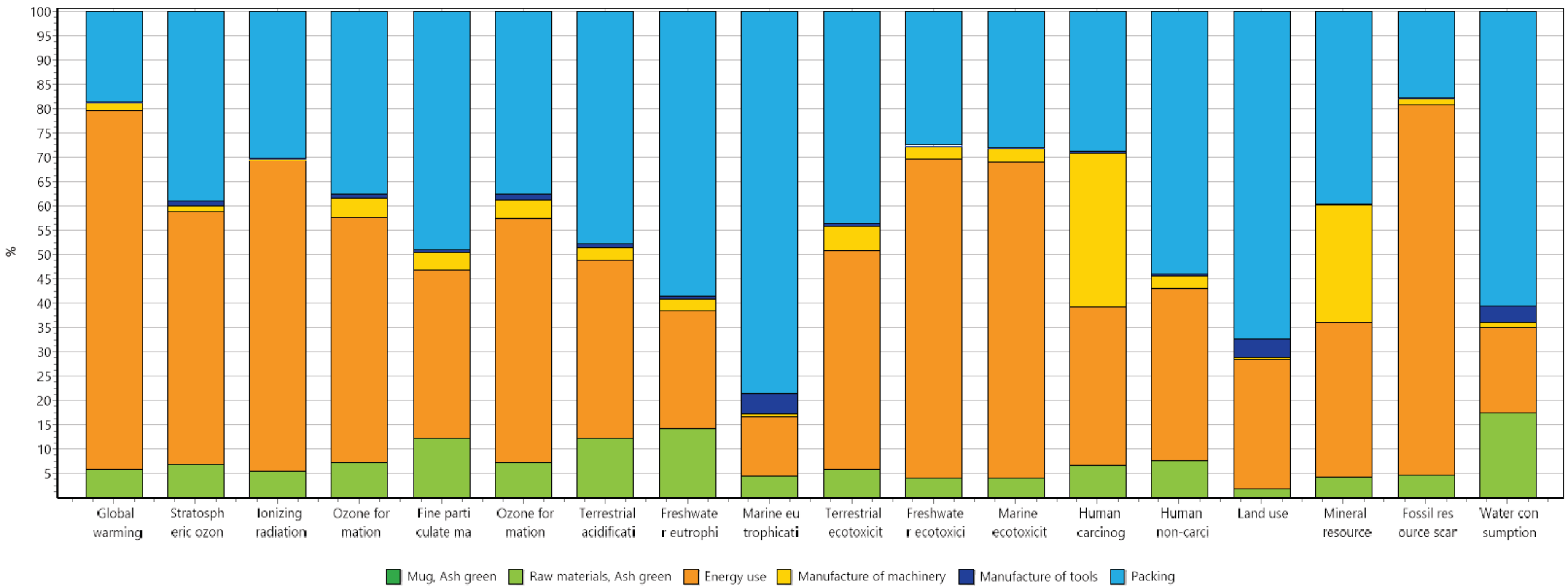

Figure 1. Contribution of different types of activities to the overall life cycle impacts of the Ash Green mug for different impact categories

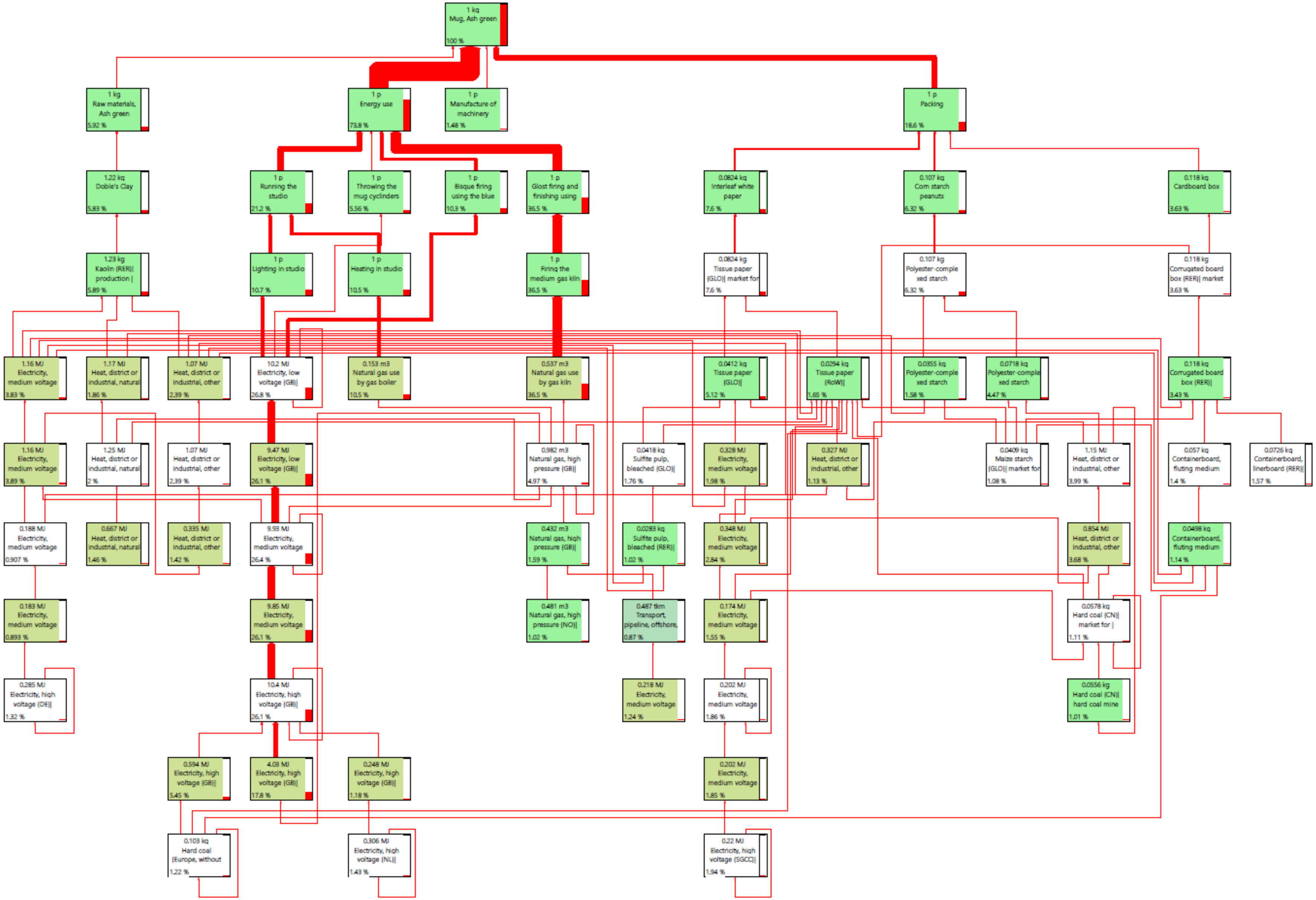

Figure 2. Network diagram showing the contribution of key life cycle processes to the total carbon footprint of the Ash Green mug

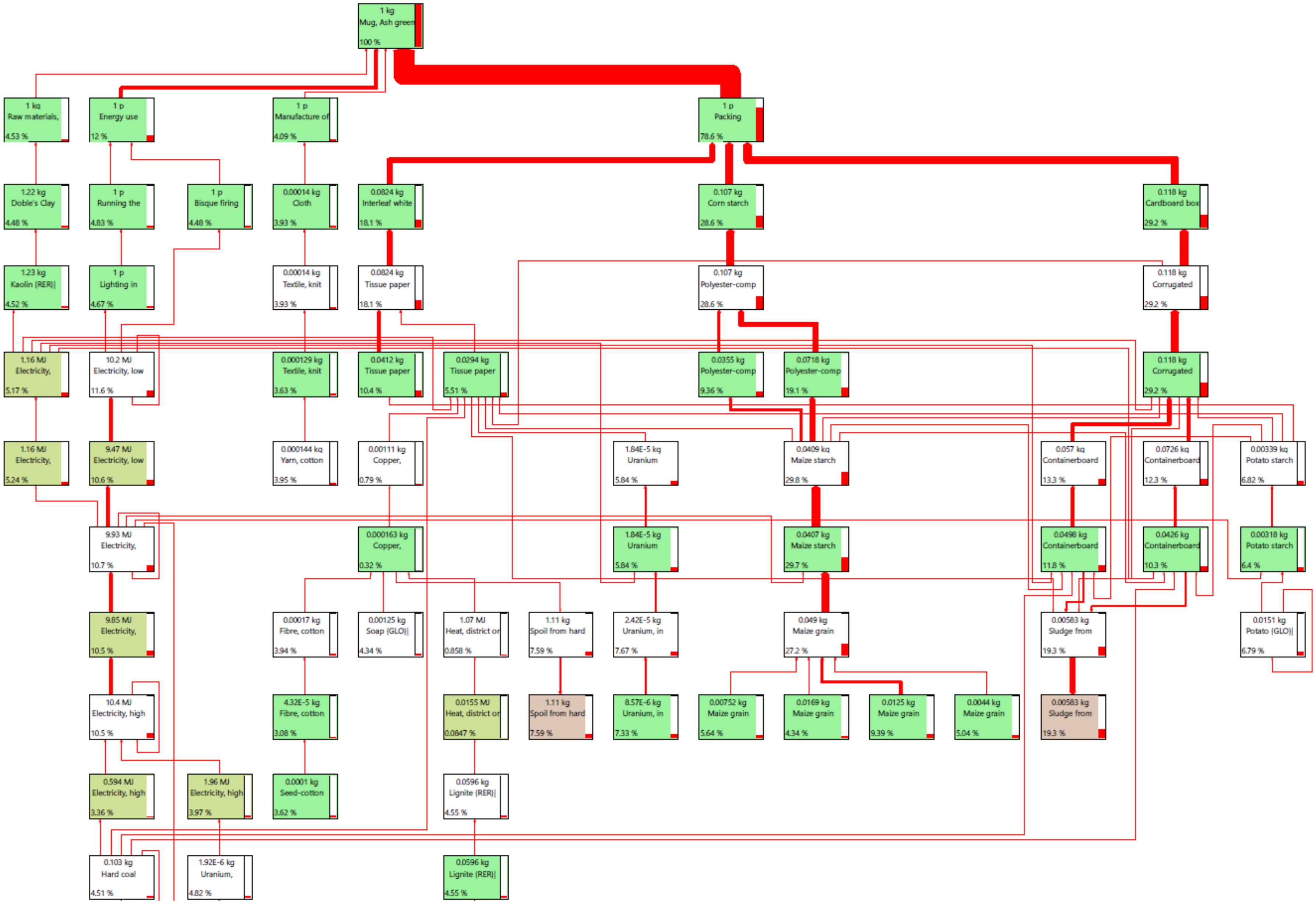

Figure 3. Network diagram showing the contribution of key life cycle processes of the Ash Green mug to the Marine Eutrophication impact