LCA of waste material in Tees Valley region for CO_2 sequestration with enhanced weathering

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1. Introduction

- Carbon dioxide removal (CDR) technologies are required to limit the increase in global average temperature to 2°C above pre-industrial levels [1].
- Enhanced weathering is defined as the "**process by which CO_2 is sequestered from the atmosphere through the dissolution of silicate minerals on the land surface**"[2] and has considerable potential as a CDR.
- However, CO_2 emission to execute the practice must not exceed its sequestration potential.

Objectives

✓ Evaluate the environmental impacts (CO_2 emission) of the practice in Northeast England through a Life Cycle Assessment (LCA) approach.

✓ Assess the potential net CO_2 removal of Northeast England agricultural land through enhanced weathering of waste clay material.

Sequestration potential per tonne of waste clay applied:

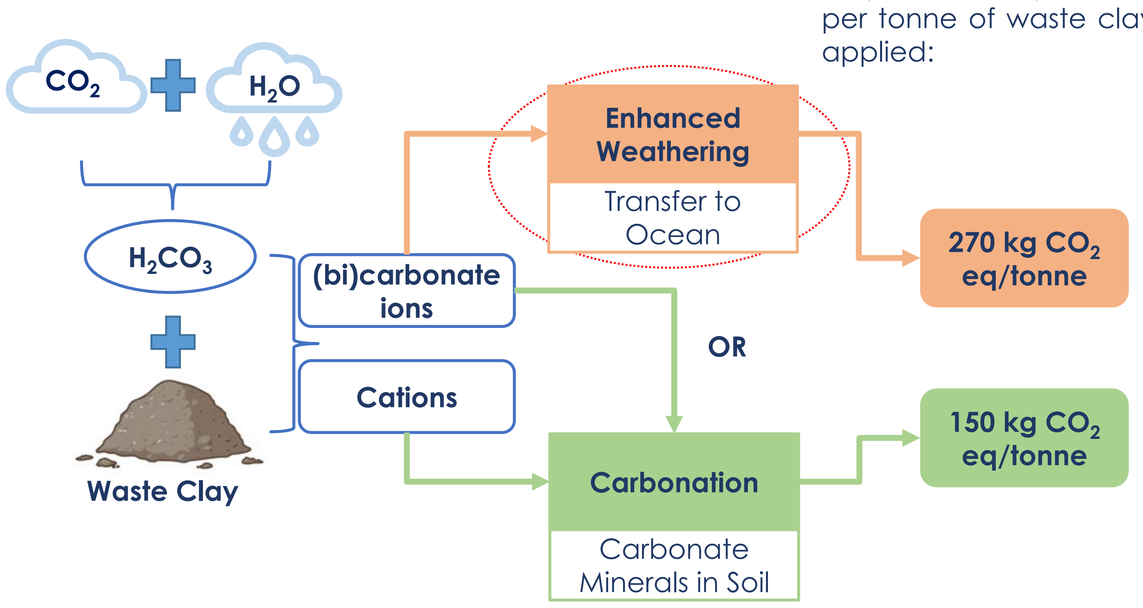

Figure **1**: Weathering Process and the two pathways (Enhanced weathering and carbonation)

2. Methodology

2.1 System Boundary

Processes within the boundaries are represented in Figure 2. This LCA did not consider any soil or crop response following the field application.

The functional units of this LCA are:

- Per hectare of Northeast agricultural land amended by <2mm waste clay particles.
- Per tonne of CO_2 eq removed

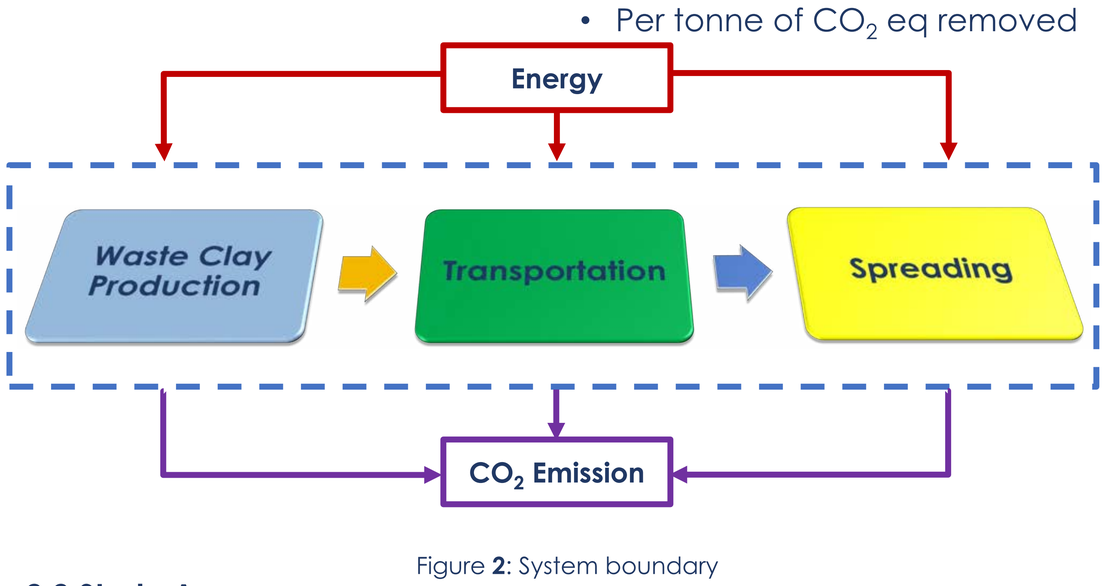

Figure **2**: System boundary

2.2 Study Area

Northeast was selected as a case study due to the following:

❖ Distance advantage: from a source of waste clay production to a field area [3].

❖ The soil conditions and climatic for enhanced weathering [4].

❖ Availability of appropriate waste clay in Tees Valley.

3. Result and Discussion

Carbonation and enhanced weathering produce around 162 and 90 kg CO_2 eq per tonne of CO_2 eq removed.

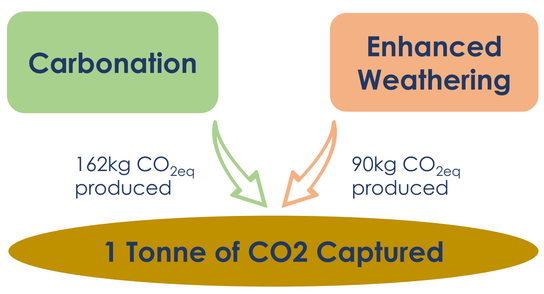

Figure **3**: CO_{2eq} produced for capturing 1 tonne of CO_{2eq}

Our CO_2 contribution analysis (Figure 4) indicates that transportation is the most impacting process (considering the average northeast quarry to field distance of 65km).

Figure **4**: CO_2 contribution analysis

- Based on (Defra, 2022) [5], the available agricultural land in the Northeast is 624,000 hectares.
- For spreading waste clay on agricultural land of the Northeast, a rate of 10.8 tonnes per hectare has been chosen to reach zero carbon emission in 2050.
- Spreading 6.7 million tonnes of filter cake on Northeast agricultural lands has the potential of 1.81 million tonnes to sequestrate carbon dioxide. Total CO_2 emission and net CO_2 sequestrated are shown in Figure 5.

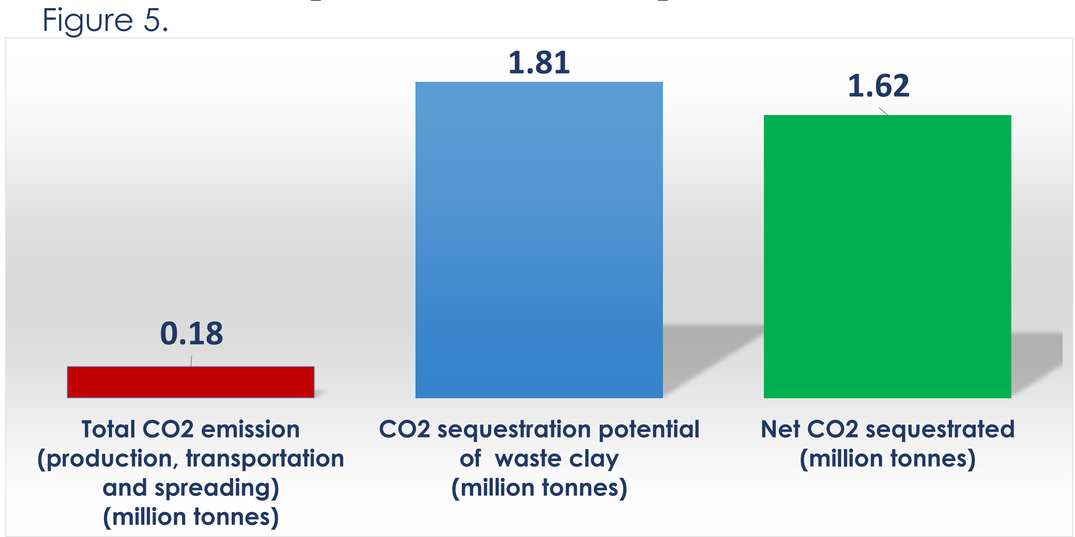

Figure **5**: Total emission and CO_2 sequestration potential for Northeast agricultural lands.

4. Conclusion

- An existing network of waste clay quarries has the potential to supply Northeast England with fine material suitable for enhanced weathering or carbonation.
- Using fine waste clay for agricultural lands of Northeast England, 6.7 million tonnes of waste clay will be needed, which eventually gives 1.62 million tonnes of net CO_2 sequestration by 2050.
- Transportation greatly affects the potential sequestration of the technique among the other sources of CO_2 emission

References

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3. DNPM. (2018).

4. Montserrat, F. et al. (2017). https://doi.org/10.1021/acs.est.6b05942.

5. Defra (2022) Defra statistics: Agricultural facts -Northeast.

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