Using Life Cycle Analysis model to quantify the environmental impact of a developed device in order to measure greenhouse gas emission in agriculture

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Life cycle assessment (LCA) is considered one of the most effective tools to calculate the impact on the environment. Specifically, LCA is a holistic method for assessing the 'cradle-to grave' environmental impacts of products and processes by quantifying environmental flows at each stage of a product's life cycle (James et al., 2021; McAvoy et al., 2021; Sutar and Jadhav; 2022). LCA is used not only in agriculture but also across industries and organizations for quantifying the carbon footprint of different type of products and the results are adopted by business and policy makers to evaluate impacts of value chains (Amadei et al., 2021; Lei et al, 2021). According to the International Organization for Standardization (ISO, 2006), LCA is defined "*as the compilation and evaluation of the inputs, outputs, and potential environmental impact of a product system throughout its life cycle*".

Under the European program ClimaMed LIFE17 CCM-GR-000087, the objective of the study is to conduct Life Cycle Analysis to quantify the environmental impact of the developed arrays of devices and services that will be developed in order to measure Greenhouses Gas Emission GHGs fluxes and Soil Organic Carbon (SOC) stock changes, which are: i) LIDAR devices, ii) arrays of devices and technical procedures to measure SOC stock changes, iii) the telemetric system and iv) IT services (web app, CMM). Specifically, LIFE ClimaMED aims at developing and delivering innovative, reliable, rapid and cost-effective technologies of Tier 3 level for the on-site measurement of CO_2, CH_4 and N_2O emissions and SOC stock changes from agricultural fields at real time, in order to assist scientists, public authorities and policy makers in collecting, quantifying, evaluating, mapping and reporting spatial data for GHGs emissions and SOC stock changes from the Mediterranean agricultural and livestock sector.

In order to implement LCA in this study ISO 14040:2006 standard was used. Consequently, considering ISO 14040, the LCA consist of four distinctive stages. Firstly, goal and scope definition are set in order to explain the study purpose, introduce the functional unit for analysis, set up system boundaries, outline the impact categories chosen for analysis, justify the assessment method used and explain the assumptions applied to perform the appraisal. Secondly, a Life cycle inventory that involves data collection and systematisation will be done. In this stage all environmental inputs and outputs into the system, associated with the devices and the services produced by ClimaMed, throughout their life cycle will be established and then assembled and presented in the form of an inventory. After that, stage three includes the Impact assessment, to evaluate the magnitude of environmental burdens attributed to the devices and services. The general framework of impact assessment will consist of four structural elements: classification, characterisation, normalisation and weighting. The classification and characterisation steps convert the impact assessment outcome into an easy-to-understand, quantitative indicator for specific impact categories (i.e. kg of CO2 -eq produced). Finally, interpretation of results to draw conclusions and provide recommendations for environmental improvements will take place. Considering ISO 14040, a number of checks will be performed at this stage of LCA to ensure the conclusions drawn upon the assessment outcome are feasible. To this end, uncertainty and sensitivity analyses will be carried out with a view to test how changes in appraisal parameters may affect the study results. LCA will be combined with the results of the Cost Benefit Analysis, the business plan and the SWOT analysis of order to optimize also the profitability of the products without imposing significant environmental impact.

References

Amadei, A.M., De Laurentiis, V., Sala, S. (2021). A review of monetary valuation in life cycle assessment: State of the art and future needs. Journal of Cleaner Production, 329,129668.

ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework

James, A., Sánchez, A., Prens, J., Yuan, W. (2022). Biochar from agricultural residues for soil conditioning: Technological status and life cycle assessment. Environmental Science & Health, 25,100314.

Lei, H., Li, L., Yang, W., Bian, Y., Li, C-Q. (2021). An analytical review on application of life cycle assessment in circular economy for built environment. Journal of Building Engineering, 44, 103374.

McAvoy, S., Grant, T., Smith, C., Bontinck, P. (2021). Combining Life Cycle Assessment and System Dynamics to improve impact assessment: A systematic review. Journal of Cleaner Production, 315, 128060.

Sutar, D.D., Jadhav, S.V. (2022). Life cycle assessment of methanol production by natural gas route. Materials Today: Proceedings. In Press.