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LCA SENSITIVITY ANALYSIS OF AN ENERGY-BIOCHAR CHAIN FROM AN ITALIAN GASIFICATION PLANT: ENVIRONMENTAL TRADE-OFFS ASSESSMENT

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Abstract – Due to its potential applications in bioenergy production, coproducts (bio-oil and syngas), mitigation of global warming, sustainable agriculture, pollutant removal, and other uses, biochar has drawn interest from all over the world. Producing and using soil-based biochar as a method of carbon sequestration could help reduce emissions while benefiting the soil and opening up possibilities for bioenergy production. However, to characterize the production cycle's environmental and energy loads and confirm all of the advantages of biochar, Life Cycle Assessment (LCA) represents a reliable tool for evaluation. This work is based on continuing the study of Marzeddu and Cappelli (Marzeddu, Cappelli, et al., 2021) to understand the environmental impact of an energy-biochar chain involving a gasification plant in Italy. In the LCA carried out in the previous paper for the characterization of biochar, which is used as a soil conditioner, soil carbon sequestration, nitrous oxide emissions, fertilizer use, and water use for irrigation were considered. The results showed that the use of gasification for energy and biochar is an attractive strategy for mitigating the environmental impact analysis, especially climate change, with a net decrease of about $-8.3 \cdot 10^3$ kg $CO_{2,\,eq}$. The previous study was lacking a sensitivity analysis. For this reason, a sensitivity analysis is proposed in this study to consistently assess the environmental trade-offs of the biochar and the amended soil. In specific for the upstream processes the sensitivity is addressed to the selection of a different type of woodchips, for the core process in terms of selection of different packing material, and to the entire cradle-to-grave perspective by improving the logistics of the transportation, the distances within the supply chain and the choice of BAT technology for the transportation vehicles. This study highlights strategic research developments that combine to find potential environmental trade-offs and thresholds towards using biochar and its final use as a soil conditioner.

Keywords – Agricultural land detection; biochar; environmental impacts; environmental trade-offs; gasification; natural resources management; pyrolysis; sensitivity analysis