

<https://doi.org/10.7250/CONNECT.2025.023>

ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACT: SYNTHETIC AND NATURAL BINDERS

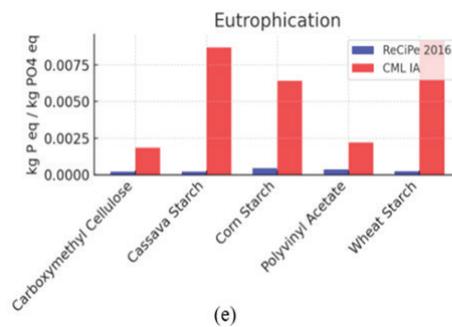
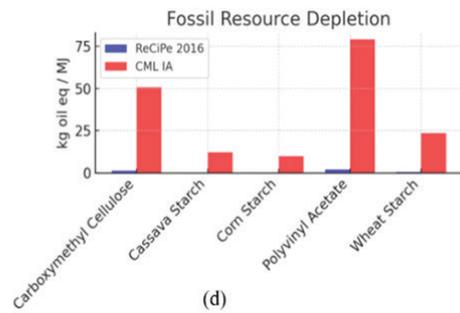
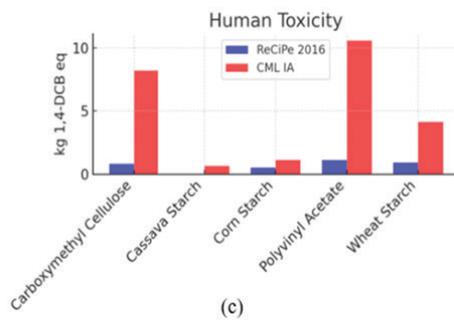
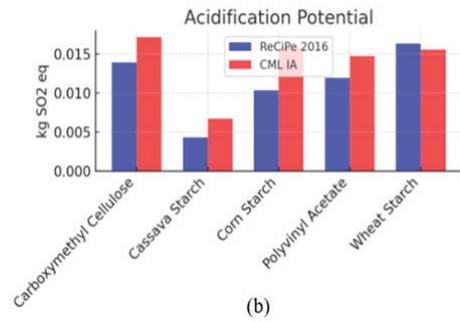
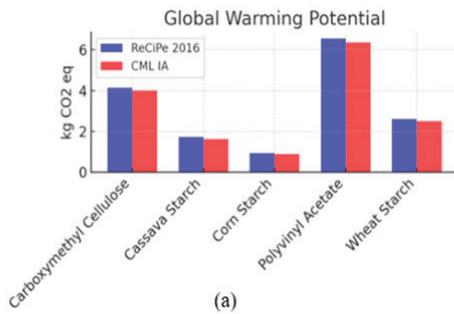
Nuushuun Archie GBOE^{1*}, Mantas GARNEVIČIUS², Raimondas GRUBLIAUSKAS³

¹⁻³ *Department of Environmental Protection and Water Engineering, Vilnius Gediminas Technical University, Sauletekio al. 11, Vilnius Lithuania*

* **Corresponding author.** Email address: nuushuun-archie.gboe@vilniustech.lt

Abstract – Binders play a critical role in the construction industry, especially when combined with plant-based granulates and fibers. The binder is selected based on its physical and chemical characteristics for compatibility with certain construction requirements. New market trends highlight the use of green binders that meet global sustainability targets, demonstrating a move toward greener building and environmental sustainability. This study presents a cradle-to-gate comparative life cycle assessment (LCA) of synthetic binders – namely Polyvinyl Acetate (PVA) and Carboxymethyl Cellulose (CMC) and agriculture starch-based binders made from cassava, wheat, and corn. The Life Cycle Assessment was conducted using SimaPro software based on ISO 14040/14044 standards using the ReCiPe Midpoint and CML IA Baseline. The assessment is cradle-to-gate with a function unit of 1 kg for binder production. Key environmental sustainability metrics such as Global Warming Potential (GWP) and Acidification Potential (AP) are assessed to rank the binder sustainability relative to each other. The results show that synthetic binder PVA has the highest environmental impact in almost all impact categories, especially GWP (6.55 kg CO₂ eq in ReCiPe and 6.37 kg CO₂ eq in CML) and AP (0.012 kg SO₂ eq in ReCiPe and 0.015 kg SO₂ eq in CML). Among natural binders, Corn Starch shows the lowest environmental impact with GWP values of 0.930 kg CO₂ eq (ReCiPe) and 0.896 kg CO₂ eq (CML) and AP values of 0.010 kg SO₂ eq (ReCiPe) and 0.016 kg SO₂ eq (CML). The agricultural binders (Cassava Starch, Wheat Starch, and Corn Starch) are environmentally friendlier than the synthetic binders (PVA and CMC). Although agricultural binders carry environmental costs associated with farming operations, they have lower environmental impacts than synthetic alternatives, demonstrating their sustainability potential in binder applications.

Keywords – *Environmental impacts; Life Cycle Assessment (LCA); sustainable binders; synthetic binders; starch-based binders*



Comparative evaluation of impact categories ReCiPe vs CML (a) Global Warming Potential (GWP) (b) Acidification Potential (c) Human Toxicity (d) Fossil Resource Depletion (e) Eutrophication