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DEVELOPMENT OF LIFE CYCLE IMPACT ASSESSMENT METHODS FOR SPACE RESOURCES

Abstract

Life Cycle Assessment (LCA) is a tool used to quantify the environmental sustainability of a product, process, or system. Mining resources from space may result in fewer environmental impacts on Earth, simply from the halt of Earth mining; LCA can quantify the differences in resources extraction. However, life cycle assessment methods and tools are not capable of addressing the unique aspects for exploration and extraction that will occur in space, as LCA methods were developed for terrestrial manufacturing. One of the major limitations to the use of LCA for design of space resources extraction is the lack of impact assessment methods. This paper proposes a set of life cycle impact assessment (LCIA) categories that can be applied to the most likely near-term space resource extraction activities: lunar mining, asteroid mining, and orbital debris collection and reprocessing. LCIA categories were identified via thorough literature review of space resources extraction. Standard LCIA methods were used to identify reference units and characterization methods. This paper describes proposed impact categories, reference units, and potential characterization models and methods; essentially the first and third steps of the LCIA. Twelve impact categories are proposed for space activities, which are grouped into four broad categories: atmospheric, surface resources, biological, and orbital.