Life Cycle Assessment of Ecosystem Services for Phoenix’s Building Stock

Researcher: Janet (Ferrell) Reyna, PhD Student, SSEBE
Advisor: Mikhail Chester, Assistant Professor, SSEBE, Affiliate Faculty, SOS

Introduction

Ecosystem services are crucial to sustaining human existence, yet are generally poorly accounted for in urban sustainability assessments. More comprehensive, transparent, and robust methods are necessary for holistic understanding of urban technoscapes and ecosystem services, including their interrelations. Ecosystem services are the human benefits derived from ecosystems which the Millennium Ecosystem Assessment defines as “dynamic complex(es) of plant, animal, and microorganism communities and the nonliving environment that together provide human societies with goods and services.” (Costanza et al., 2005). Ecosystem services are often indirectly gained from the natural environment, so the linkages between human activity and declining in ecosystem services are not always well understood. Including ecosystem services in life cycle assessment (LCA) is an important step to provide rigorous environmental impact accounting to decision makers.

Existing Literature

A comprehensive inventory of present inclusion of ecosystem services in LCA was performed by Zhang, Singh, & Bakshi, 2010. In a second paper, Zhang, Baral, & Bakshi, 2010 introduced a web tool called Ecologically Based LCA (Eco-LCA) that includes new impact categories to account for more ecosystem services. The Eco-LCA tool has included many new ecosystem service impact categories, such as deforestation, but has stopped short of providing a process-based approach of including ecosystem services in LCA. Instead, the impact categories have been linked to Economic Input-Output LCA, which models the entire 1997 US economy as 491 sectors. The advantage of this approach is that no section of the system boundary is “cut off,” which is consistent with systems-oriented thinking. The disadvantages of this method are the loss of detail in specific processes since impacts are aggregated by sector and the loss of regional specificity by presenting US average impacts. Studies have shown that spatial scale is especially important in developing new ecosystem service impact categories (Saad, Margni, Koelker, Wittstock, & Deschênes, 2011). A process-based LCA would be a more appropriate approach since it considers the exact processes and accompanying impacts.

Methodology

This project incorporates ecosystem service impacts within the current LCA framework to highlight the potential of further integrating ecosystem services in LCA. The goal of an LCA is to assess all relevant human and environment impact categories, including those which are ancillary. This is extremely important, as the majority of impacts could potentially exist in the outlying city regions as opposed to processes directly within a city (Chester, Pincetl, & Allenby, 2012). Current day buildings are inventoried by the Maricopa County Assessor’s Office, which provides information such as size, year of construction, and building type. Building material models were developed for 15 building classifications to capture the heterogeneity of materials between building types. Athena Impact Estimator software was then used to obtain an inventory model. Ecocent Database version 2.2 material processes were joined with the building material models to determine impacts. The impacts are then normalized based on the square footage of the category model buildings. The normalized factors were joined with the Maricopa County assessor data to determine regional impacts. This study is a cradle to gate assessment and includes extraction of primary materials through building material production at the factory gate. The transportation from the factory to the construction site and the equipment use in building construction are excluded in this assessment.

Results

Multiple Impact Methodologies were used from the ecocent database to give a range of impact categories. Samples from the EDIP Acidification and the Ecological Footprint mapping are presented here. These methodologies do not directly quantify reduced ecosystem service functioning, but rather quantify emissions which trigger ecosystem service damages.

References


