1.020 Ecology II: Engineering for Sustainability
Spring 2008

Lectures 08_21 & 08_22 Life Cycle Assessment -- Concrete Production

Motivation/Objective
Develop a Life Cycle Assessment (LCA) that identifies the resources consumed and waste produced in the manufacture of 1 m^3 of concrete.

Approach
1. Identify the product of interest (e.g. concrete), specify relevant processes, draw system boundaries to define scope of the LCA.
2. Define inputs and outputs for the processes included in the LCA. Distinguish economic and environmental variables. Define units for all variables.
3. Construct technology matrix (A) and environmental matrix (B). Estimate values for matrix elements from LCA data bases (available on-line for a fee).
4. Use MATLAB to solve LCA matrix equations for environmental vector (g).
5. Analyze environmental effects of production. Review analysis, refine boundaries, processes, data as required.

Concepts and Definitions Needed:
Construct process flow chart for specified product. Define system boundaries.
Economic variables: Describe products manufactured within system boundaries as well as energy and transportation required.
Environmental variables: Describe natural resources and wastes crossing system boundaries.
LCA Model:

$As = f$ Equation for evaluating scaling vector

A = Specified economic matrix (square)
Value in each element of A is amount of row variable (economic variable) required to produced 1 unit of column variable (economic variable).
All diagonal elements are +1, Other entries (inputs) are < 0.

f = Specified economic output vector (specifies that 1 m^3 concrete is to be produced)

s = Scale vector (specifies amount of each economic variable produced/consumed to obtain 1 m^3 of concrete).

$Bs = BA^{-1}f = g$ Equation for evaluating environmental vector

B = Specified environmental matrix
Value in each element of B is amount of row variable (environmental variable) produced/consumed to obtain 1 unit of column variable (economic variable).
Entries for resources consumed are < 0. Entries for wastes produced are > 0.

g = Environmental output vector (specifies amount of each environmental variable produced/consumed to obtain 1 m^3 of concrete)

Solve equations for s and g in MATLAB.

Results for Concrete Example
Examine A, B, s, and g arrays to determine impacts of different parts of the manufacturing process (see MATLAB code). Note 300 kg CO_2 generated to produce 1 m^3 concrete.