MEETING SUMMARY

DATA NEEDS FOR LIFE-CYCLE ASSESSMENT

Science and Technology for Sustainability Program Roundtable Meeting - November 17-18, 2011

Dominic Brose, *Rapporteur*

Life-cycle assessment (LCA) is increasingly being used as a tool for system design, product procurement decisions, and policymaking. The LCA process, which examines the environmental, economic, and social impacts of a given product throughout its lifespan, makes intensive use of data. As more data have become available to a wide variety of users, gaps still exist in how to manage this data and how to best conduct life-cycle assessments. In November 2011, the National Academies' Roundtable on Science and Technology for Sustainability, in collaboration with the Board on Global Science and Technology and Board on Research Data and Information, convened in Washington, D.C. a panel of LCA practitioners, data managers and other experts to explore how LCAs are being used and to discuss related data and infrastructure issues.

Several overarching themes emerged from the speakers' presentations and discussion at the meeting:

- The quality of data available to LCA practitioners
- The need for open and transparent life-cycle assessment processes and modeling
- Requirements for standardizing data used in LCAs so that comparisons can be made across sectors and disciplines
- The importance of collaboration and communication between LCA practitioners and subject matter experts, modelers, information technology practitioners, decision makers, and funders
- Incentives for data stewardship and for maintaining a data repository

The U.S. National Agriculture Library (NAL) has taken important steps to address these data gaps and infrastructure issues by developing the Federal Life-Cycle Assessment Digital Commons Project as a virtual shop for life-cycle assessment information. Simon Liu, Director of the NAL, explained the steps involved in a full assessment and how the Digital Commons project could contribute to that process. He noted that life-cycle assessments begin with a life-cycle inventory (LCI) – a collection of data about unit processes and their associated inputs and outputs. This collection of inputs and outputs is very data intensive, and therefore this process is really about data management. Practitioners need to extract data, transform it, make calculations, and then perform quality control on data sets before a formal analysis can be conducted. The Digital Commons is collecting data from other agencies and industries to embody the whole of the life cycle inventory, so that practitioners would need to interact only with the Digital Commons.

The Digital Commons would allow data producers to upload data directly into the database as complete unit processes, incomplete unit processes, or LCI data sets. These data sets are reviewed by subject matter experts for quality control. Liu emphasized that the objective is to minimize subjectivity while at the same time maximizing the repeatability and usefulness of the data sets.

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences • National Academy of Engineering • Institute of Medicine • National Research Council

He noted that the reliability and reproducibility of data are essential, as are the calculations, which need to be transparent in order to ensure credibility. Data producers are able to go back into the Digital Commons to track progress of their data sets and to see reviewers' comments. Making the process open and transparent allows everyone in the LCA community to communicate with one another.

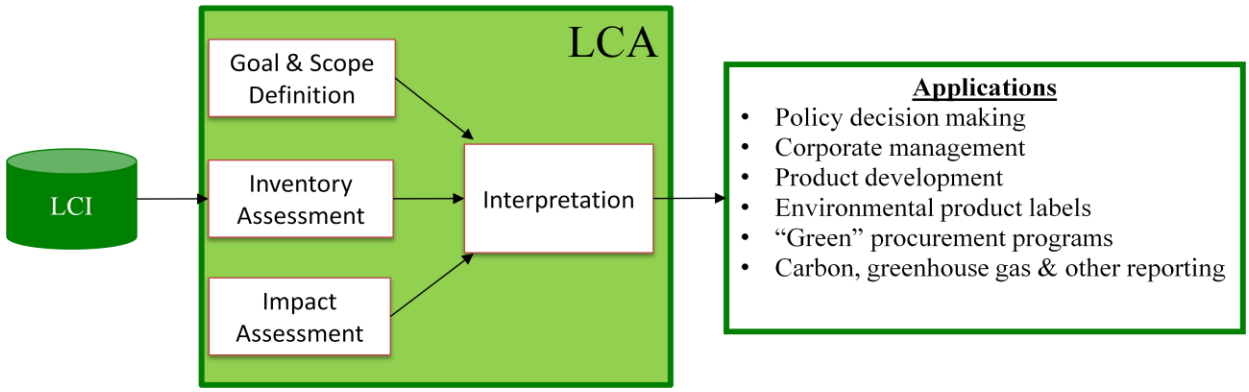

FIGURE 1 Life Cycle Assessment.
SOURCE: Simon Liu, Director, National Agricultural Library.

Liu stressed that the Digital Commons project will be successful only through a collective effort by the LCA community. To make participation in that effort more accessible, data producers can either create their database within the NAL framework or else be provided with software to create the database locally; however, these data sets will be kept to the same standards and level of quality as data directly uploaded to the Digital Commons, Liu noted. Among the next steps to be undertaken are the expansion of data sets to other commodities and sectors.

Ying Wang of the Innovation Center for U.S. Dairy provided an overview of the center's approach to life-cycle assessments. She noted that its assessments are holistic and use a systems approach to assess inputs into dairy production and expected outcomes. Wang stressed that dairy producers view LCAs as a way to promote more sustainable production methods and ultimately to improve economic returns.

Steps for Successful Life-Cycle Analysis:

- Clear definition of goals
- Careful selection of functional unit
- Close attention to data sources
- Work with the subject matter experts
- Assess impacts appropriately
- Peer review
- Documentation and transparency

Ying Wang, Innovation Center for U.S. Dairy, November 17, 2011

One important result of their LCA is understanding the potential value of reducing greenhouse gas emissions. The assessment showed that 72% of the greenhouse gas emission footprint occurs before the dairy products leave the farm. Therefore, improving management practices on the farm is the most significant way to reduce emissions. Wang said that it is best management practices – not size, region, or age of the operation – that matter the most. Examples of management practices likely to help reduce emissions and costs, she added, include increasing feed efficiency, reducing electricity use, reducing packaging materials and maintaining vehicles properly.

Peter Fox of Rensselaer Polytechnic Institute focused on the data life-cycle, noting that this term encompasses the entire process of data management, beginning with the study concept and data collection. Data is continually repurposed, creating new data products that may be processed, distributed, analyzed, and archived. He described three specific phases:

- Acquisition: the process of recording or generating a concrete artifact from the concept
- Curation: the activity of managing data from its point of creation to ensure it is available for discovery and re-use in the future
- Preservation: the process of retaining usability of data in some form for later use

Fox stressed the importance of data stewardship – the process of maintaining data integrity across all three phases. Echoing earlier speakers, he added that stewardship of data involves fiscal resources and intellectual responsibility. He emphasized the importance of equating sustainability to resources, social dynamics and organizational constructs – the human side of data. For example, he noted that there is a tendency for people to continue working the way they have in the past – the inertia of habit – which leads to slow growth in data submissions to archives.

Fox also discussed the need for a longer term view of data management, with incentives – such as wider data use, citations, contingent funding, and publications – used as potential motivators to change ingrained habits. Currently there is an emphasis on the preservation of data and not on the initial time for collection, but preservation becomes easier when there is more emphasis on the initial acquisition phase of data management, he added.

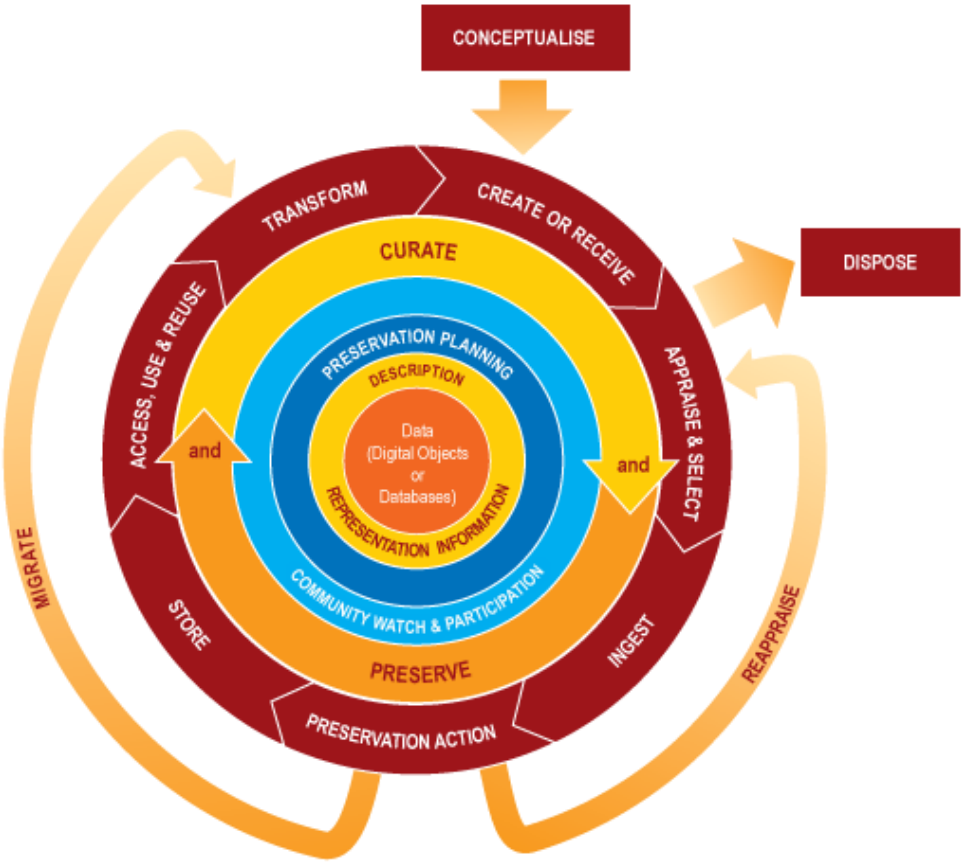

FIGURE 2 Key elements of the DCC Curation Lifecycle Model.
SOURCE: Digital Curation Center, http://www.dcc.ac.uk/resources/curation-lifecycle-model.

Mike Edgerton of Monsanto discussed the interoperability of data and ways to communicate more efficiently, focusing on the importance of agreeing on standards or norms for data. Given a set of standards, there should be a reasonable expectation that one data set could be used with another data set, Edgerton emphasized. He noted that the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model developed by Argonne National Laboratory provides a standard information structure, allowing comparisons between assessments of various energy sources.

One problem inherent in many LCAs is that often only one number is reported and much of the information contained in the full LCA is lost, Edgerton said. He gave the example of a survey asking for the weight of ranchers' cows. Although the data was normally distributed, there was as much as a 10% difference in averages, depending on if they were taken based on cow type or weight by herd. Additionally, when grazing intensity was assessed, the distribution became skewed, and if only the average value was reported in an LCA, the knowledge that this was a skewed distribution would be lost, he said.

"We as a community need to support efforts to centralize, standardize, and curate data so that there is a common means of communication across life-cycle analysts."

Mike Edgerton, Monsanto
November 17, 2011

Edgerton expressed his enthusiasm for the Digital Commons Project as a way to maintain this additional information and to make data sets more robust and usable. He noted that much data is time- and location-dependent, which needs to be considered so that the data is used properly. For example, data collected

from a 2008 survey might not be relevant to an LCA that is focused on 2012 or projected into the future for 30 years. It is important to be cognizant of this time dependence. Standardizing and curating LCA data will allow for better modeling and in turn for better policy and investment decisions.

Bill Berry, Director of the National Academies Board on Global Science and Technology (BGST), explained some of the issues discussed at a workshop held last year in Singapore on realizing value from "big data." He defined big data based on the following concepts:

- The complexity of the data, which is as important as size of a dataset
- The ability of the data to be integrated, analyzed, and reused
- The value derived from its ability to solve problems

He noted that researchers should think about big data in terms of the process through which one derives insight, rather than any specific characteristics of the datasets.

He noted that during the Singapore workshop, participants identified a number of challenges and opportunities. Two specific challenges highlighted were 1) finding, accessing and reusing relevant data, and 2) communicating and collaborating across scientific domains and cultures. Berry noted the importance of developing consistent standards for metadata associated with big data and for assuring that data repositories support scalable analytic tools and reduce the current network bottlenecks that hinder data migration.

Some participants also suggested that in order to realize the value inherent in big data, it will be important to identify promising ways to encourage people to collect, store, and put data in a format that can be shared with others. Berry noted that currently there is little credit given for storing data and allowing access to others. One of the workshop participants noted that "power no longer resides with those who own the data, but rather with those who can....make sense of the data deluge."

PLANNING COMMITTEE: Ann Bartuska, U.S. Department of Agriculture; Robert Stephens, Multi-State Working Group on Environmental Performance; Alan Hecht, U.S. Environmental Protection Agency.

About Science and Technology for Sustainability (STS) Program

The National Academies' Science and Technology for Sustainability Program (STS) in the division of Policy and Global Affairs was established to encourage the use of science and technology to achieve long-term sustainable development. The goal of the STS program is to contribute to sustainable improvements in human well-being by creating and strengthening the strategic connections between scientific research, technological development, and decision-making. The program concentrates on activities that are cross-cutting in nature and require expertise from multiple disciplines; important both in the United States and internationally; and effectively addressed via cooperation among multiples sectors, including academia, government, industry, and non-governmental organizations (NGOs).

For more information about STS visit our web site at http://sustainability.nationalacademies.org
500 Fifth Street, N.W., Washington, D.C. 20001
sustainability@nas.edu