

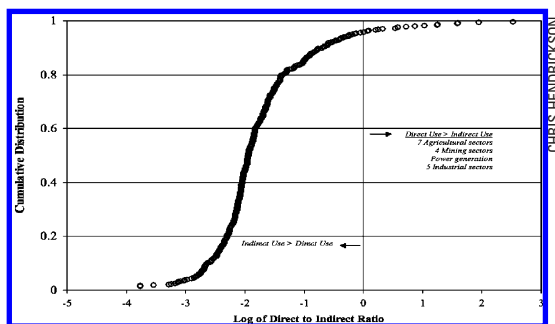
Water Uses by Industry Revealed

Water might be locally renewable, but it is also a globally finite resource with shifting availability. Industry accounts for most of the water used in the U.S., yet industry-specific estimates of that consumption—last tallied by the U.S. Census Bureau in 1982—are outdated. That is a problem because industrial sectors need to budget water uses correctly for effective planning.

In this issue of *ES&T*, Chris Hendrickson and colleagues address that shortage by estimating water withdrawals for more than 400 industry sectors (*Environ. Sci. Technol.* 2009, DOI 10.1021/es903147k). Their analysis accounts not just for direct uses—such as crop irrigation in agriculture—but also for indirect uses throughout a sector’s supply chain. For instance, irrigation water would be a direct use for agriculture but an indirect use for the grocery sector. “We’re trying to help industries track and make better management decisions about how they use water,” says Hendrickson, a professor of engineering at Carnegie Mellon University in Pittsburgh, PA. “If you’re trying to minimize environmental impacts, then you need to know about these upstream demands,” he adds.

Because reported consumption rates by sector are no longer available, Hendrickson and his colleagues had to estimate likely values and use them with a method called economic input–output life cycle analysis (EIO-LCA). By necessity, they had to combine disparate data sets for different sectors, gathered over varying time periods. Hendrickson acknowledges the results are subject to considerable uncertainty and variability. But Arpad Horvath, an associate professor

at the University of California, Berkeley, described the analysis as seminal. “It fills a very important gap,” he says. “The work comes nearly 30 years after the last reliable set of industrial water use data were made available. They used the best



As shown by this cumulative distribution function, supply chain (indirect) water use exceeds direct use for 96% of all 428 sectors evaluated.

available data and methods and provided a practical piece of research that will be useful for a long time.”

Hendrickson and colleagues started with total water uses for six industry sectors defined by the U.S. Geological Survey (USGS). These “umbrella sectors” are extremely broad. For instance, the irrigation sector consumes ~190 trillion liters (50 trillion gallons) a year, but USGS does not break that value out by crop. This is where Hendrickson’s analysis comes into the picture. He and his colleagues took each of 428 industrial “sub-sectors” defined by the Bureau of Economic Analysis (BEA), and assigned them to their corresponding USGS sectors. They then used other relevant data to determine how much of the USGS water totals were consumed by these more narrowly defined categories. Crop-specific irrigation values, for instance, were estimated using data from the U.S. Department of Agriculture. Likewise, “purchased” volumes consumed by sector were

estimated based on how much money industries spend on water in a given year.

Michael Blackhurst, the first author of the paper and a Ph.D. candidate working under Hendrickson, says he was surprised that most water uses—60% on average—are indirect. “That turned out to be a significant finding,” he said. “A lot of that water consumption is hidden because companies don’t pay for all of it.” Indeed, among 96% of sectors evaluated, indirect uses exceeded direct uses throughout product supply chains.

Hendrickson and Blackhurst emphasize that their data are national findings that do not apply regionally. Moreover, they could only track withdrawals, and were unable to determine how much water was returned to the system or recycled. That is a key limitation, Hendrickson says, because water that gets degraded during industrial processes might not be suitable for future uses. Yet Horvath says the LCA methods applied in the analysis reveal a comprehensive footprint of water use associated with products and services throughout the U.S. economy. “It gives a way to look at how we might use water more efficiently,” he says. “It allows us to hone in on the sectors that use the most water so we can start generating ideas and technologies for better management.”

—CHARLES SCHMIDT