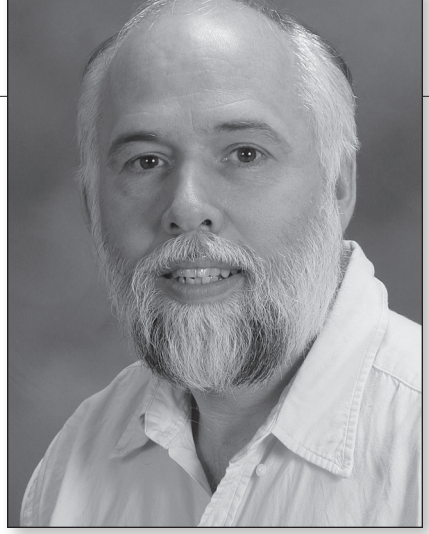

By Craig M. Pease

Land Use: You Can't Argue with the Data

Whereas attorneys look to legal authorities to tell them what the law is, scientists determine the truth not by looking not to human authority, but to data. The data are the authority, as illustrated by the scientific bromide "you can't argue with the data."

Aerial photography and satellite imagery data provide some of the most compelling demonstrations of the environmental impact of the 6.7 billion humans on Earth. See for example the *Atlas of Our Changing Environment* and *Earth Observations from Space: The First 50 Years of Scientific Achievement,* both freely available online, and both containing numerous beautiful and informative color maps and figures.

Quite often the raw remote sensing data must undergo considerable analysis to be useful, as in a July 2007 paper by Haberl and colleagues in the *Proceedings of the National Academy of Science,* also available for free online. Their color-coded global map shows that, across much of India, China, Europe, and the midwestern United States and Canada, humans exploit for their own uses over 60 percent of the potential net primary productivity (the sun's energy that plants capture). These maps are ultimately grounded on satellite imagery data, even if these data are buried deep under the several layers of computer models used in their analysis.

Aerial photography or satellite imagery data underlie all six papers in the December 2007 *Proceedings* special feature on land use change. These technically dense articles repay careful study, as they seek not just to describe patterns of land use change, but also to understand the social, economic, and behavioral forces driving this change.

In that issue, Manson and Evans's paper compares aerial photographs from south-central Indiana over the half-century ending in the late 1990s. Their analysis then combines this remote sensing data with on-the-ground household surveys, laboratory experiments that entail presenting human subjects with a hypothetical land use decision, and a computer model predicting landscape patterns from the land use preferences of the owners of individual parcels.

Unsurprisingly to students of behavioral economics, even though the subjects in the lab experiments (not owners of the actual parcels being studied) were given enough information to easily calculate the most economically productive use of each hypothetical parcel, many did not choose that use. More remarkably, this economically irrational behavior is reflected in the Indiana aerial photography data, which show a greater diversity of land uses than would be predicted if the landowners made decisions solely to maximize economic returns.

Ultimately, scientists know only what the data have told them. Data that do not exist cannot speak

Land use attorneys and policymakers will find much to contemplate in the growing body of scientific literature that seeks to explain patterns of land use based not only on household and biophysical characteristics (e.g., income, household size, soil types, land steepness), but also with reference to human decisionmaking. This scientific research is directly relevant to the environmental law goal of creating desirable spatial patterns of land use, for example through local zoning regulations or National Environmental Policy Act analyses of the environmental impacts of new highways.

Turning from the local to the planetary, over the last several decades satellites have played the central role in gathering global environmental data. Many of the roughly 50 remote sensing satellites currently orbiting Earth and gathering scientific research data operate on the same principle as the human eye or a camera. They sense and record light, albeit beyond the narrow range of colors humans can see, and with greater ability to distinguish nearly identical colors. Remote sensing data have documented deforestation in Amazonia, last summer's dramatic decrease in Arctic sea ice, atmospheric temperature, and even decimated villages in Darfur.

Yet the data responsible for these remarkable results are threatened, as demonstrated by the plight of the uniquely important Landsat satellites, which have provided a continuous remote sensing data set of the entire Earth across several decades. Landsat-5, launched in 1984, stopped working last October, though it is now again collecting data. Landsat-6 never achieved orbit after being launched in 1993, and burned on reentry. Landsat-7 malfunctioned in 2003, several years after its 1999 launch, though it still provides useful data. And the Landsat Data Continuity Mission is not scheduled for launch until 2011. More generally, the lengthy 2007 National Research Council report *Earth Science and Applications from Space* found systemic problems with the entire U.S. government remote sensing program.

Ultimately, scientists know only what the data have told them. To continue to gather data documenting the ongoing impact of humans on the Earth's landscape, scientists need political support, funding, and effective government institutions. Data that do not exist cannot speak.

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