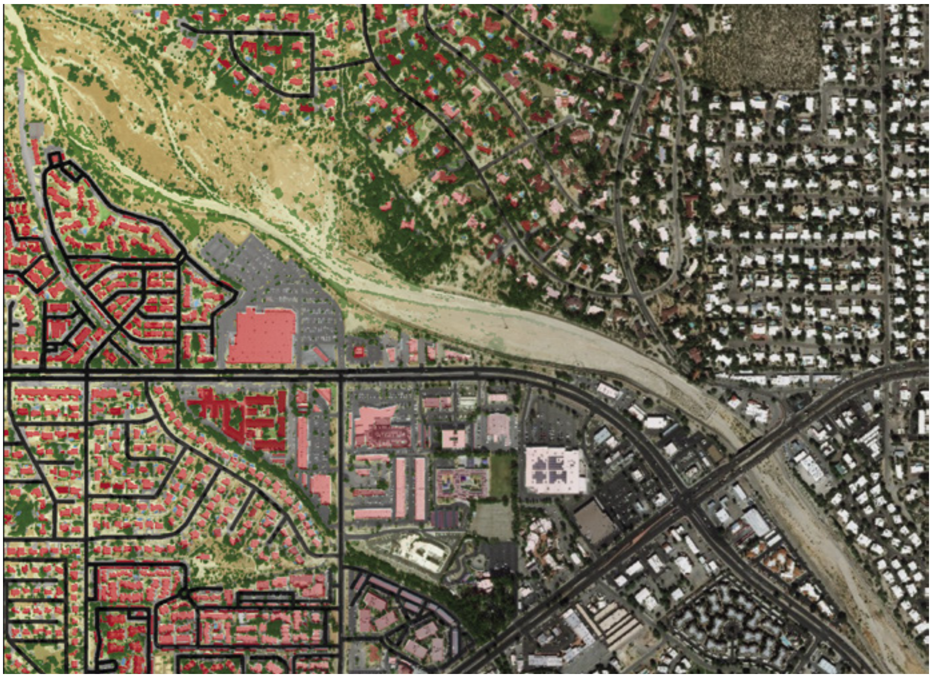
Precision-Mapping for Water in the Desert



Chesapeake Conservancy's high-resolution land cover data—shown here beside the source imagery used to produce it—accurately depicts small features across the landscape. This level of detail is critical for planning projects that work with individual properties and landowners. Credit: Conservation Innovation Center

THE DESERT CITY OF TUCSON, ARIZONA, has an average annual rainfall of just 12 inches. But when the rain comes, it often comes in the form of torrential downpours, causing damaging floods across the city. This is a perhaps ironic challenge for Tucson and the broader Pima County area in which it is situated, given that it's part of a much larger region working to ensure that there is—and will continue to be—enough water to go around in a time of unrelenting drought.

Both of these distinct water-management challenges—too dry and too wet—can be addressed by thoughtful land use and infrastructure decisions. Of course, when making such decisions, it helps to have precise mapping data on hand. That's why Pima County officials are working with the Lincoln Institute's Babbitt Center for Land and Water Policy and other key partners to pilot the use of some of the most cutting-edge mapping and data analysis tools on the market.

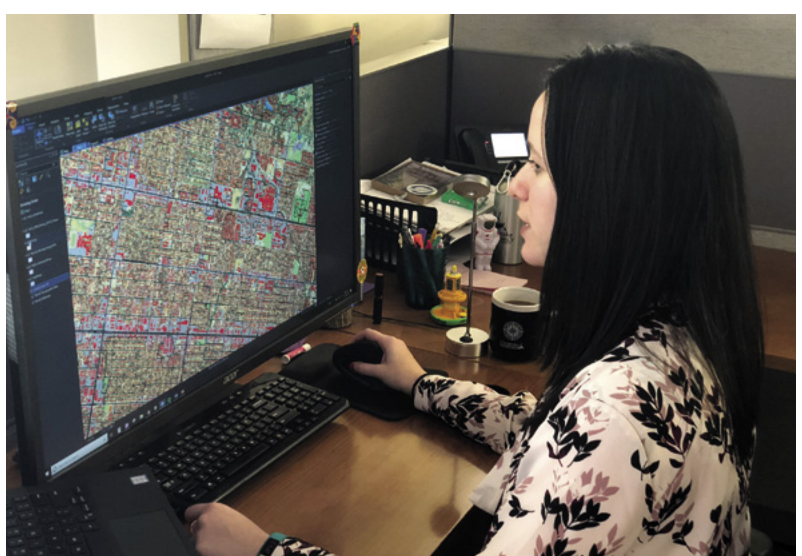
For the Babbitt Center—founded in 2017 with the mission of providing land use research, education, and innovation to communities throughout the Colorado River Basin—the partnership represents one early step in exploring how such technology can be used to help integrate water and land use management across the region.

The technology itself originated across the country, at the Conservation Innovation Center (CIC) of Maryland's Chesapeake Conservancy, a key player in cleaning up the notoriously pollution-addled Chesapeake Bay. To oversimplify a bit: CIC has designed image analysis algorithms that provide distinctly more granular image data of the earth's surface. The technology has enabled a shift from a resolution that made it possible to observe and classify land in 30-meter-square chunks to a resolution that makes that possible at one square meter.

The details are of course a little more complicated, explains Jeffrey Allenby, the Conservancy's director of conservation technology. Allenby says the new technology addresses a historic challenge: the compromise between resolution and cost of image collection. Until relatively recently, you could get 30-meter data collected via satellite every couple of weeks or even days. Or you could get more granular data collected via airplane—but at such a high cost that it was only worth doing every few years at most, which meant it was less timely.

What's changing, says Allenby, is both the camera technology and the nature of the satellites used to deploy it. Instead of launching a super-expensive satellite built to last for decades, newer companies the CIC works with—Allenby mentions Planet Labs and DigitalGlobe—are using different approaches. "Smaller, replaceable" satellites, meant to last just a couple of years before they burn off in the atmosphere, can be equipped with the latest camera technology. Deployed in a kind of network, they offer coverage of most of the planet, producing new image data almost constantly.

Technology companies developed this model to respond to commercial and investor demand for the most recent information available; tracking the number of cars in big-box store parking lots can, in theory, be a valuable economic indicator. Land use planners don't need images quite that close to real time. But Allenby says the CIC began asking the tech companies, "What are you doing with the imagery that's two weeks old?" It's less expensive to acquire, but far better than what was previously available. The resulting images are interpreted by computers that classify them by type: irrigated land, bedrock, grassland, and so on. Doing that at a 30-square-meter level required a lot of compromise and imprecision; the one-meter-level is a different story.



Rachel Soobitsky, geospatial project manager at the Chesapeake Conservancy, reviews detailed land cover data from Tucson. Credit: CIC

The goal is to "model how water moves across a landscape," as Allenby puts it, by combining the data with other resources, most notably LIDAR (Light Detection and Ranging) elevation data. Those are the "flour and eggs" of land use data projects, supplemented with other ingredients like reduction efficiencies or load rates from different land cover, depending on the project, Allenby says: "We're building new recipes." For the Chesapeake Bay, those recipes are meant to help manage water quality. If you can determine where water is concentrating and, say, taking on nitrogen, you can deduce the most cost-effective spot to plant trees or place a riparian buffer to reduce that nitrogen load. (See "Precision Conservation," October 2016 *Land Lines*.)

In the Colorado River Basin, the most urgent current water-management challenges are about quantity. Since water policy is largely hashed out at the local level despite the underlying land use issues having implications across multiple states, the Babbitt Center serves as a resource across a broad region. There's currently a "heightened awareness" of water management among municipal and county policy makers, says Paula Randolph, the Babbitt Center's associate director. "People are wanting to think about these issues and realizing they don't have enough information."

That brings us back to Pima County. Although it lies outside the basin, it boasts two features that make it a good place to evaluate how the uses of precision mapping data might be applied in the West: Basin-like geography and proactive municipal leaders. When the manager of technology for the Pima Association of Governments saw Allenby speak about the benefits of his work in the East, he contacted the CIC to discuss possibilities for the West. A year into the resulting project, several partners are on board, the group is mapping a 3,800-square-mile area, and the open-source data lives on the Pima Regional Flood Control District website, where others throughout the county are able to access and use it.

Broadly, this process has taken some effort, Randolph notes. Satellite data gathered in the West has different contours than the East Coast imagery that Chesapeake's sophisticated software was used to, and that has required some adjustment—"teaching" the software the difference between a Southwestern rock roof and a front yard that both look (to the machine) like dirt. "We need human partners to fix that," she says. "We strive for management-quality decision-making data."

Even as such refinements continue, there are already some early results in Pima County. Clearer and more precise data about land cover is helping to identify areas that need flood mitigation. It has also been useful to identify "hot spots" where dangerous heat-island effects can occur, offering guidance for mitigation actions like adding shade trees. These maps provide a visual showcase about water flow and land use more efficiently than a field worker could.

Both Allenby and Randolph stress that this partnership is still in the early phases of exploring the potential uses and impacts of high-resolution map data. Randolph points out that while the Babbitt Center is working on this and another pilot project in the Denver area, the hope is that the results will contribute to a global conversation around water-management experimentation.

And Allenby suggests that the "recipes" being devised by technologists, policy makers, and planners will ideally lead to a shift in more accurately evaluating the efficiency and impact of various land use projects. This, he hopes, will lead to the most important outcome of all: "Making better decisions."

The Lincoln Institute has provided occasional financial support to the CIC for map- and data-related projects.

Rob Walker (d) is a journalist covering design, technology, and other subjects. His book *The Art of Noticing* will be published in May 2019.