

Pima Regional Remote Sensing Program

Name of Tool: Orthophoto GIS Mapping and Analysis

Implementing Agency: Tucson (Arizona) MPO

Scale of Application: State/regional planning, corridor/subarea planning, transportation project development, local comprehensive planning

Description: Through its Regional Remote Sensing (RRS) program, the Pima Association of Governments (PAG) collects high-resolution digital imagery for state, regional, and local agencies and organizations. Since 1998, the region has invested \$5.2 million collecting the photos and applying them to land use planning, transportation planning, corridor studies, zoning code enforcement, preliminary roadway design, and other purposes in the public and private sectors. Data are maintained by PAG on a web-based Regional Data Center. In addition to providing higher quality data to a variety of users, the program supports development of partnerships among agencies at all levels of government.

Purpose and Need

A variety of government agencies in the Tucson, AZ region use Geographic Information Systems (GIS) for planning purposes. These include the Pima Association of Governments (PAG), the region's designated MPO; the Arizona Department of Transportation (ADOT); Pima County; and various municipalities including the City of Tucson. Mapping and terrain data are useful for hydrology and natural resources planning, transportation planning, preliminary roadway design, asset management, and land use planning. Unfortunately, in the past, agencies found procurement of maps and related geographic data difficult and costly. Furthermore, they expended considerable resources collecting redundant data—that is, data already collected by other agencies—and, because Pima County experiences high growth rates, land use base maps and photos could quickly become obsolete.

Today, the RRS program satisfies a need for more up-to-date, accurate, comprehensive, and shared GIS data. Orthophotography products provide numerous advantages to planners of all kinds in the Tucson region in the form of relatively quick and easy access to detailed maps. Users of the program include professional planners and engineers involved in land use projects, state and local transportation agencies, public utilities, journalists, real estate agents, lawyers, police, social services, private citizens, and various other organizations. In fact, a recent in-house PAG survey concluded that the project has become so widespread and is so valuable to its users that if it were to be discontinued, "there would be an uprising."

Description

Orthophotos are aerial photographs that, after computer rectification, represent ground features in their "true map positions" via a raster image. (Raster images are high resolution graphics composed of a rectangular array of picture elements or pixels, with each "dot," or pixel, carrying a specific color value.) Digital orthophotos serve as innovative base maps, offering a more complete and accurate foundation for GIS than other alternatives. Digital orthophotos have expanded in popularity to include applications in transportation planning, land use planning, natural resources planning, hydrology and storm water planning, parcel

locating, verification of grading, and inventorying and monitoring both infrastructure and natural resources.

In 1996, Ron Platt, GIS Coordinator for the city of Tucson Transportation Department, needed topography data for the entire city. Upon learning about the new electronic capabilities of orthophotos, Platt decided to procure a set. Funding, however, became an obstacle, and the first flight to obtain the photographs did not take place until PAG contributed its resources to the effort in 1998. Digital terrain models (a grid of points with the elevation specified for each point) and contour line files accompanied the first set of orthophotos. By sharing the cost, PAG and the city together made use of these tools that by themselves neither could afford. Pleased with the usefulness of the photos, the collaboration grew into the RRS program, a joint effort among the city, PAG, and numerous other jurisdictions in the Tucson region. Local agencies voluntarily contributing funds to the program and sharing the photos include the City of Tucson, Town of Marana, Town of Oro Valley, Tucson Airport Authority, San Xavier District of the Tohono O'odham Indian Nation, ADOT, and Pima County. The bulk of the \$5.2 million expended on the effort over the last eight years - about 75 percent - has been programmed by PAG from FHWA's Surface Transportation Program. Orthophotos of the Tucson region are managed by PAG and made available online and shared between agencies at no cost.

The imagery and elevation data set consist of the following:

- 1998 - 1-foot black and white resolution, 2-foot contours derived from digital terrain models
- 2000 - ½ foot black and white resolution, 2-foot contours derived from digital terrain models
- 2002 - 1-foot natural color resolution, 2-foot contours derived from digital terrain models
- 2005 - ½ foot, 1-foot natural color resolution, LiDAR (Light Detection and Ranging) of bare earth and vegetation/building canopy, 2-foot contours derived from digital terrain models

The RRS project has created numerous advantages for the Tucson region and the various agencies taking part in the program. For example, orthophotography technology allows for GIS applications to use and maintain accurate and up-to-date base maps. Additionally, consultants, agencies, and other users save valuable time and costs by accessing RRS for all of their mapping and aerial photography needs. Users cite the quality of the photos and the need for more recent data as the most pressing concerns, yet affirm that both the quality and timeliness of RRS data have improved markedly. Prior to the orthophoto program, ADOT and local agencies in need of photos contracted for corridor-specific flights, accessed archived hard copy photos, or simply relied on GIS data without base maps. Previous sources did not allow for nearly the degree of accuracy in defining parcels, determining topography, and identifying infrastructure as the new data does.

PAG coordinates the funding of RRS and provides some technical assistance for users. PAG makes no contribution requirements for participating agencies, but does ask them to contribute whenever possible. So far, the program has sustained and grown on this cooperative basis. Data are also available to private industry and the general public for

purchase, but PAG charges customers only for the direct cost of production. In addition to providing GIS technical training for local agencies, PAG hosts a one- or two-day workshop following the release of new orthophotos every few years in order to orient all the region's agency users as to the data's availability and contents.

Aside from its usage in a variety of tasks performed by agencies throughout the region, the RRS program adds considerable value to MPO long range planning and community involvement efforts. Models used in long range planning benefit from "better performance" due to the superior quality of input data, according to PAG Project Manager Manny Rosas. Furthermore, having the photos during community outreach activities as the backdrop for maps and displays "gives us a lot of credibility," according to Andy Gunning PAG Planning Director, who adds that the data serve as valuable educational tools: "You cannot overstate the true value of having real information."

Since 1998, when the first orthophoto flight occurred and the first set of orthophotos became available, PAG has coordinated three additional flights in 2000, 2002 and 2005. Plans for future flights include coverage of more territory and updates of existing coverage.

Application Examples

Because the orthophotos are made available online and through PAG, agencies, consultants, and other organizations have taken advantage of numerous application possibilities. This section describes a few of the more prominent uses, including land use applications.

Pima County uses orthophotos for transportation modeling, infrastructure planning, and hydrologic modeling. One particularly interesting application is for enforcement of a zoning law that protects peaks and ridges in the Tucson Mountains from development. In order to identify sensitive locations subject to the ordinance, county staff examines orthophotos. Once complete, they use GIS data and photos to create three-dimensional images as part of a presentation to a citizens' oversight panel. Then, based on GIS parcel data, they can contact residents whose property is affected. Pima County comprises over 9,000 square miles, a vast territory; consequently, county documentation of ridges, peaks, and other sensitive land use areas is an ongoing project that will be enhanced as new photos become available. In fact, much of this information is being documented to support the county's Sonoran Desert Conservation Plan.

The City of Tucson's Department of Transportation (TDOT) uses the photos as a base for infrastructure inventory projects and for maintenance and repair scheduling. Because TDOT must deal with right-of-way acquisitions, sales, easements, and demolitions, accurate data concerning property locations and infrastructure are essential. By using orthophotos for analysis and for help in the preparation of illustrations, staff save between one and three hours per project. In addition, photos and data replace the need to travel to remote areas of the city for analysis of projects and proposals.

TDOT also uses the data for infrastructure inventorying. The department has created databases from orthophotos defining the locations of small infrastructure such as street lights, street centerlines, speed humps, traffic signals, capital improvement projects, and others. Orthophotos replaced the need for staff to travel into the field and inventory the infrastructure directly. TDOT estimates that orthophotos saved "thousands of staff hours." The Town of Marana uses orthophotos in conjunction with satellite imagery to present zoning

proposals to the town council and zoning commission. Like Tucson, three-dimensional models enhance the power of the imagery, and Marana incorporates simulated "fly-throughs" of proposed sites. Such applications allow decision-makers to visualize proposed densities, evaluate environmental impact, and determine relationships with adjacent developments. According to town staff, "It has changed the way staff approaches project planning; imagery and the altered perspective it provides is now a common component of any town project."

Other examples of specific applications include development proposal reviews in the town of Oro Valley, in-house county preparation of roadway improvement plans, enforcement of compliance with state environmental laws, and use by consultants. Most of these examples share the dual benefit of saving time and money while also accessing better quality data more easily.

Successes and Lessons Learned

Rosas and PAG have promoted the RRS program as a useful model to other regions and to states. One benefit of the RRS in Tucson, beyond the data itself, has been the emergence of trans-governmental partnerships. Even where differences exist between technical and policy staff, the data provide a common ground for all the region's stakeholders.

Cooperation among the participants is not governed by any rules, procedures, or requirements. Agencies with funding to contribute do so whenever possible, and this arrangement has been sustainable so far. TDOT, for example, wants to have new digital terrain models from the next flight in 2005. Recognizing the importance of this particular product to their mission, Platt says his agency will make every effort to contribute this year.

Other regions or even states considering development of a program similar to RRS will face large up-front, startup costs. These costs represent a formidable barrier, but the self-assessment of RRS performed by PAG estimates a benefit-cost ratio of greater than 30:1. Although Gunning insists that the Tucson region "got lucky," in that they did not realize the value of the photos would be so tremendous when they set out to make them, it is clear that the region's leadership has capitalized on this asset by pooling resources for continued access to even better quality photos. The lesson for other regions is that the initial costs may seem formidable, but if the data are kept up-to-date and shared widely, the benefits will practically realize themselves. In Tucson, since savings to users outweigh the cost of the program, there is strong reason to believe similar efforts can succeed elsewhere. At least in the view of Tucson's program participants, RRS provides a far better quality product to a wide range of users at a far lower cost than they could previously expect.

For Further Information

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Web Sites and Publications:

- [Pima Association of Governments](#)

- [Pima County](#)