

Pima Regional Remote Sensing Program

Activity

Orthophoto GIS Mapping and Analysis

Implementing Agency

Pima Association of Governments (Tucson, Arizona area Metropolitan Planning Organization)

Summary

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 collected photos and applied 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.

Link to Livability

This tool helps planners to work more efficiently by providing accurate, comprehensive data about specific areas of interest. Accurate photos support public participation and visioning tools, allowing members of the public to better understand the reach of the project area and potential community impacts. Aerial photographs and contours illustrate the connections between land forms, transportation networks and the built environment. Historic aerial imagery can also show changes in land use over time, which reinforces the need for comprehensive planning that considers land use and transportation.

Background and Context

State, regional, and local governments in the Tucson, AZ region all use Geographic Information Systems (GIS) to support planning activities, including: hydrology and natural resources, transportation, preliminary roadway design, asset management, and land use. Procuring maps and related geographic data can be difficult and costly and agencies often spend valuable resources collecting data already procured by other agencies. Additionally, in recent years Pima County has experienced rapid growth, making some land use base maps and photos quickly become obsolete.

The Regional Remote Sensing (RRS) program managed by the Pima Association of Governments (PAC) satisfies a need for more up-to-date, accurate, comprehensive, and shared GIS data. Orthophotography products provide planners in the region with relatively quick and easy access to detailed maps. Users of the program include land use planners, engineers, state and local transportation agencies, public utilities, journalists, real estate agents, lawyers, police, social services, and private citizens.

Detailed Description

Orthophotos are rectified aerial photographs that represent ground features in their "true map positions" via a raster image. 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, the city of Tucson Transportation Department needed topographic data for the entire city and was interested in the new electronic capabilities of orthophotos. The city partnered with PAG in 1998 to develop the first set of orthophotographs, with included digital terrain models (a grid of points with the elevation specified for each point) and contour line files for over 600 square miles in the Tucson urbanized area (includes Marana, Oro Valley, Sahuarita and Green Valley). Interested in continuing these activities, PAG, with the city of Tucson and other government and tribal agencies, developed the RRS program. 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 funding expended on the effort has been programmed by PAG from the FHWA 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 is also available to the general public for a small fee.

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
- 2008 - 4-inch, 1-foot natural color resolution, Bare Earth LiDAR 2-foot digital elevation models (point file)
- 2011 (planned flight) - 6-inch, 1-foot natural color resolution, Bare Earth LiDAR 2-foot digital elevation models (point file)

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 base maps reflecting recent changes in land use and infrastructure. Additionally, consultants, agencies, and other users save time and money by accessing RRS for all of their mapping and aerial photography needs. 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 itself and grown through this cooperative arrangement. 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.

In addition to its usage 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 superior quality input data. Furthermore, using the photos during community outreach activities improves PAG credibility with the public and improves communication between planning staff and their stakeholders. Since 1998, when the first orthophoto flight occurred and the first set of orthophotos became available, PAG has coordinated five additional flights in 2000, 2002, 2005, 2008, and 2011. Plans for future flights include coverage of more territory and updates of existing coverage.

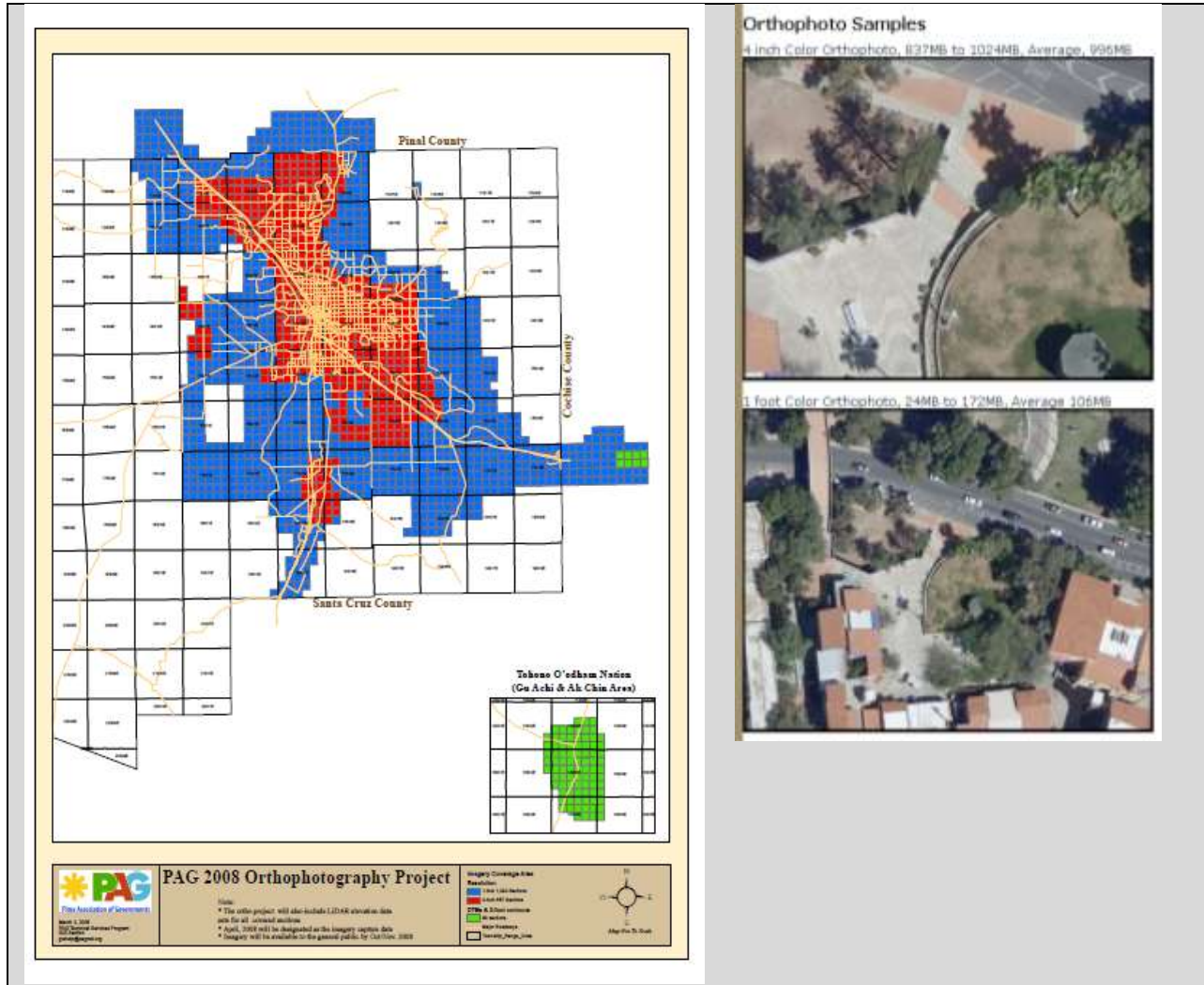


Figure 1 Orthophoto imagery | PAG website, 2010

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. The orthophotos were particularly useful when Marana GIS specialists discovered a hazardous waste site near a proposed housing development that was missed in the development's environmental assessment because it site was not listed in municipal records. 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.

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.

Orthophotos are also a beneficial set of historical data, especially concerning properties, structures or land forms that have not been recorded elsewhere. Most of these examples share the dual benefit of saving time and money while also accessing better quality data more easily.

Lessons Learned

Access to high quality, current orthophotography is of great benefit to local planners.

The orthophotography program has proved to be an important tool for PAG planners. The orthophotos provide a snapshot that incorporates diverse information that can otherwise be difficult to collect and synthesize. Planners can quickly see an overview of an area and can make connections between natural areas, transportation assets, land use types, barriers, challenges and opportunities to develop context-sensitive solutions.

Participation in the RRS program has facilitated intergovernmental partnerships on a variety of topics.

PAG has 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 intergovernmental partnerships. Even

where differences exist between technical and policy staff, the data provide a common ground for all the region's stakeholders. Each year, additional counties and agencies have asked to participate in the project, enhancing the data collection and contributing to additional partnership opportunities.

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.

Coordination on expensive orthophotography is cost-effective.

The initial costs for the orthophotography program were \$2.3 million, however, the assessment of RRS (performed by PAG) estimates a benefit-cost ratio of 35:1, which becomes even more valuable when more agencies contribute funding and share data. 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 significantly. Members of the RRS program continue to work to develop better quality photos.

For Further Information

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Websites and Publications

[Pima Association of Governments](http://www.pagnet.org/RDC) www.pagnet.org/RDC

[Pima County](http://www.dot.co.pima.az.us/gis) www.dot.co.pima.az.us/gis