

GIS Program Initiated at the U/AZ CPSU

By Tom Potter, Michael R. Kunzmann, and D. Phillip Guertin

Geographic Information Systems (GIS) have arrived at the National Park System in Arizona. In a joint effort at the University of Arizona at Tucson, the Cooperative Park Service Unit (CPSU/UA), Advanced Resource Technology Lab (ART) in the School of Renewable Natural Resources, and the Arizona State Museum have been working together to create GIS compatible databases for several Arizona NPS Units. So far, several themes of spatial data have been digitized for Tonto National Monument, Chiricahua National Monument, Organ Pipe National Monument, Montezuma's Castle National Monument, Wupatki National Monument, and Petrified Forest National Park. Work covering other Arizona Units is in the planning stage. Analysis and modeling of the data already captured also is in its beginning stages, but useful results have already emerged.

Initial data for each Arizona unit were digitized using a Calcomp 9500 digitizing tablet and AutoCAD (Autodesk, 1989) on a DOS-based 386 computer. The data were then loaded into IDRISI, a largely raster-, or grid-, based geographical analysis system that was originally developed as a GIS research and teaching tool for microcomputers. Since its introduction in 1987, IDRISI (Eastman, 1990) has grown to become one of the most popular raster-based GIS and image processing systems on the market. It is used in over 70 countries by a wide range of governmental and research institutions. It was chosen as the primary soft-

ware for this project for numerous reasons (Table 1).

One of the objectives of the CPSU/ART program was to provide Park Units with limited staff or technical expertise with the GIS software and data that could be used directly by the existing staff. IDRISI provides a low cost, user friendly program that fulfills this objective.

Examples of Current GIS Applications

Tonto National Monument

Tonto National Monument is located on the shores of Theodore Roosevelt Lake about 60 miles east of Phoenix, AZ. The monument is known primarily for its spectacular examples of Sinagua cliff dwellings. Due to its proximity to Phoenix and Roosevelt Lake, a major

concern at the unit is how increased development around the lake will affect the resources and prehistoric setting of the monument. The principal objective at Tonto is to evaluate the visual impacts of potential recreational camp sites and other development on the prehistoric viewshed.

Two basic themes, elevation data and features of interest, have been digitized for Tonto National Monument. The features of interest include entities such as the monument boundary, roads, trails, buildings and cliff dwellings. Several other themes, including a digital elevation model, slope and aspect, and a viewshed analysis were generated using appropriate IDRISI modules. Viewshed analysis consists of choosing one

Table 1. Advantages of IDRISI as a PC-based GIS

1. It is a low-cost (<\$300) vehicle for teaching and scholarly research.
2. It is easy to learn and use and runs on a DOS-based PC, which would facilitate teaching GIS principles in a familiar PC environment.
3. The program is small (<2.5 Megabytes) and runs on PPC DOS-based platforms that are ubiquitous throughout the National Park Service.
4. IDRISI offers the analytical capabilities common to most raster-based GIS systems.
5. The data format is compatible with GRASS, the recommended raster-based GIS.
6. Has excellent data-interfacing capabilities with commonly used software such as Lotus 123, Oracle, dBASE, Arc/Info, and AutoCAD.
7. The software is produced and actively supported by the Graduate School at Clark University as a non-profit project.

Tonto National Monument - Viewshed Analysis

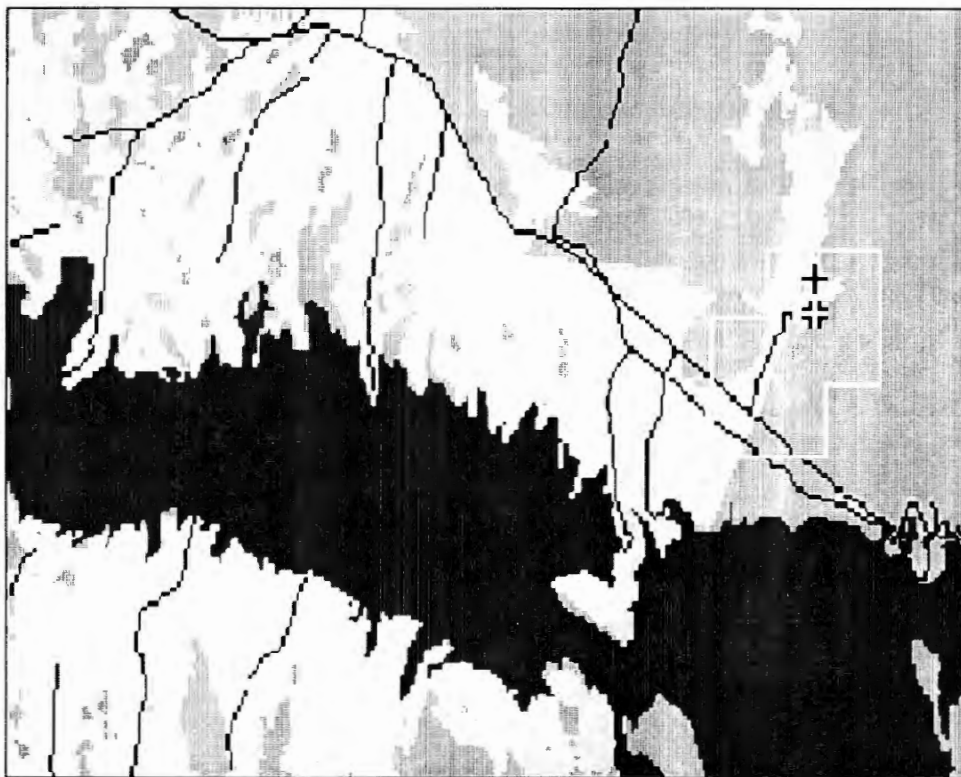


Figure 1. Viewshed analysis for Tonto National Monument and vicinity

or more viewpoints on a map and then generating another map that indicates areas that can be seen from the viewpoint(s). For the Tonto National Monument database, two viewsheds were generated, one from each of the two Sinagua cliff dwellings within the monument (Fig. 1). The monument staff now has an effective way of analyzing the impacts of proposed multi-use recreational sites on the prehistoric scene.

Chiricahua National Monument

Chiricahua National Monument is located in the Chiricahua Mountains in southeastern Arizona, about 125 miles east of Tucson. Four themes, including topography, vegetation, fire history, and physical/cultural features (Fig. 2), were digitized and loaded into IDRISI. Topography was used to create a digital elevation model along with slope and aspect. Fire data were coded by ignition cause, size, and date. With these data, and the addition of some lightning strike data, maps of fire probability and potential fire hazard can be generated. Work has also been initiated with the Laboratory of Tree Ring Research at the University of Arizona to digitize spatially-referenced tree ring data in order to map and analyze the paleo-fire history of the Chiricahua mountains.

Future GIS activities at Chiricahua will include the testing of GIS-compatible fire simulation software using data from the Chiricahua database (Ball and Guertin, 1991), and possibly the development of a model for the prediction of LD50 species mortality from fire intensity (Kunzmann et al., 1991).

Organ Pipe Cactus National Monument - Quitobaquito Springs

Organ Pipe Cactus National Monument is comprised of 300,000 acres in Southwestern Arizona and includes several distinct ecosystems. One of the unique environments in Organ Pipe National Monument is that surrounding Quitobaquito Springs, home of the endangered species, the desert pupfish (*Cyprinodon macularius* var. *eremus*). There are numerous management concerns related to the Quitobaquito Springs area, but of particular interest is how international border management will affect the springs. Of these concerns, the effect of topographic alterations on water levels in the main pond at Quitobaquito is of utmost importance.

For Quitobaquito Springs topography, vegetation, surface hydrology, and physical and cultural features were digitized and a digital elevation model and slope and aspect generated. These data are intended to help model the effects of alterations in topography on the local hydrology.

Montezuma's Castle National Monument

The data base for Montezuma's Castle is still under development. Topography and physical cultural features have been digitized and transferred to IDRISI, where a digital elevation model has been generated. As with Tonto National Monument, Montezuma's Castle is also facing increased development along its borders. Our intent is to use GIS-assisted analysis and modeling to help clarify some of the planning issues

related to the monument.

Two other issues at the unit are maintaining riparian corridors along Beaver Creek and monitoring and maintaining the sensitive aquatic habitats and rich archaeological resources at Montezuma's Well, a spring-fed pool bounded by the sheer walls of a limestone sinkhole.

Wupatki National Monument

Wupatki National Monument is located in north-central Arizona north of Flagstaff. The unit preserves a series of beautiful Sinagua pueblo dwellings. The entire unit is rich in archeological resources. Dr. Ken Kvamme at the Arizona State Museum has loaded the locations of known archeological sites, topographic data, and soils data into IDRISI. With these data, he has created archeological site-probability maps that can provide information for planning purposes and help direct future archeological field surveys.

Petrified Forest National Park

Petrified Forest NP is located in northeastern Arizona, about 120 miles east of Flagstaff. The park is known primarily for the rich fossil remnants of Mesozoic forest preserved within its boundaries. But the park also preserves other unique, though lesser known, archeological, ecological, and scenic resources.

GIS work at Petrified Forest NP began recently when a team from the Arizona State Museum started to compile and digitize data on the archeological, geo-

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Chiricahua National Monument - Vegetation (1939), Fire History and Current Monument Boundary

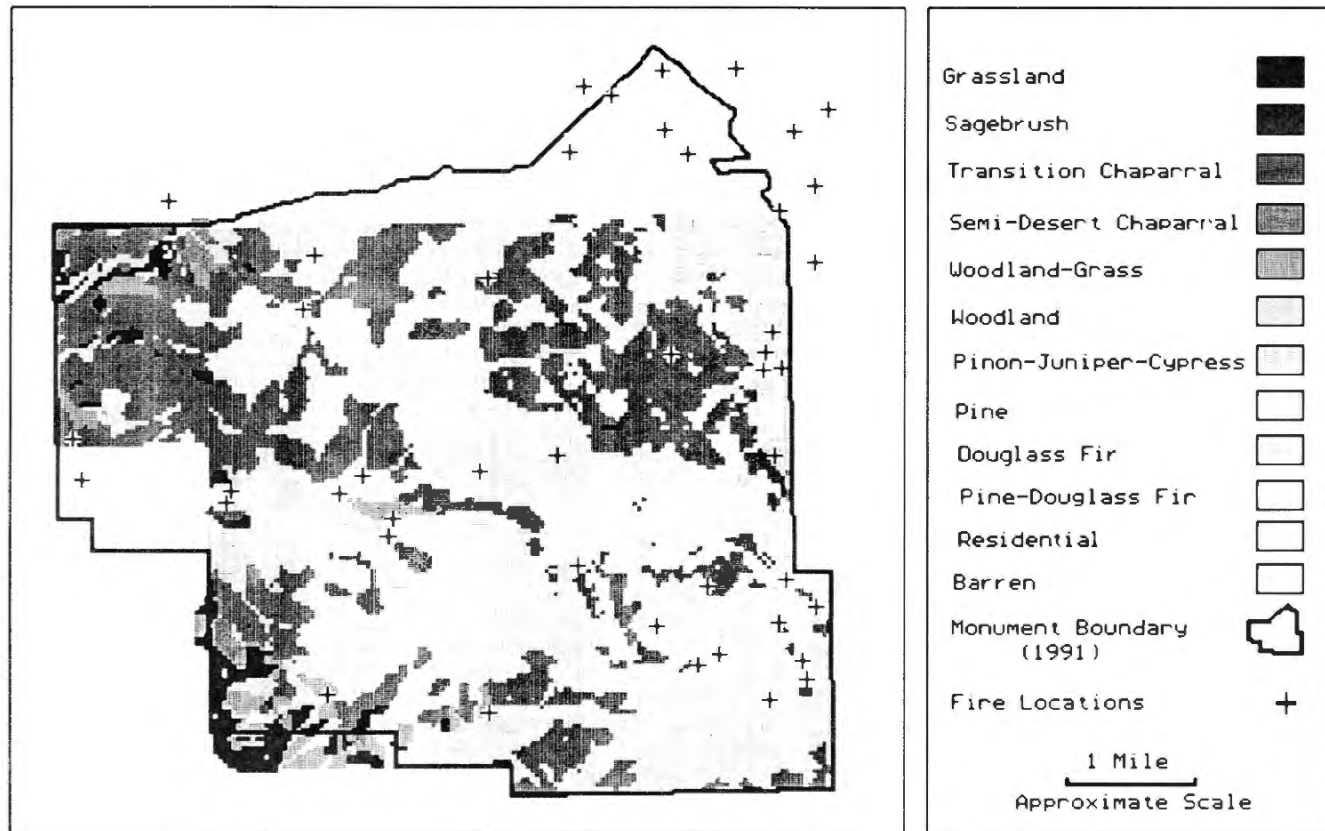


Figure 2. Vegetation (1939), fire history and current monument boundary for Chiricahua National Monument

logical, soils and vegetation resources in the unit. Future data acquisition efforts at Petrified Forest will likely include the collection and analysis of data from either satellite platforms or airborne video. In addition to basic research, these data will be used to predict the locations of archaeological and paleontological resources on land surrounding the unit.

Future Work

Many GIS projects are in the planning stages. Archeologist Trinkle Jones at the Western Archeological and Conservation Center (WACC) has extensive spatially-referenced archeological records in a dBASE format. Plans are in the works to develop a dBASE interface to permit directional transfer of these records into IDRISI. The Dbase/Idrisi map interface would allow park staff to easily transfer their own spatially-referenced dBASE records into IDRISI. In addition, IDRISI map files are easily transferred into GRASS, the primary GIS supported by the Service's Geographic Information Systems Division in Denver.

Efforts are under way to develop cooperative relationships with the state of Arizona and other federal agencies to collect and share spatially-referenced digital data. One example is the GAP project developed by the Fish and Wildlife Service. The GAP project will use various sources of digital data (Landsat, aerial video

and other GIS-compatible data) to comprehensively map critical wildlife habitat in the state of Arizona. In a cooperative effort, the data have the potential to provide much valuable information to the parks in Arizona.

Provision of GIS training for Arizona NPS personnel also is underway. A workshop covering a wide range of GIS-related issues took place at the University of Arizona's ART lab in June of 1991. The aim of the workshop was to familiarize Park Service personnel with GIS technology and provide them with some hands-on experience. Future workshops will be held according to interest.

Conclusion

The CPSU/ART GIS program is still in the initial stages of collecting and digitizing spatial data and developing techniques of modeling and analysis. The potential for useful GIS analysis is limitless, now that the effort has been started. Park managers in Arizona have responded positively to these initial efforts and see GIS as a promising tool that can enhance their abilities to accomplish many resource management tasks. For additional information about the CPSU/ART program call Mike Kunzmann (FTS) 762-5534 or Phil Guertin (602) 621-1723.

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The Spring issue of *Park Science* will carry an article by Kunzmann, George Ball, and Peter S. Bennett, describing Dynamic Fire Modeling Using GRASS 4.0, developed at the U/AZ NPS/CPSU.