Abstract

Paper Abstract: The Division of Water Resources collects and maintains agricultural and water-related land use data for the State of Utah. Each year one or two hydrologic basins are selected for an update resulting in a new statewide layer every five years. Since 2002 survey crews have been using a mobile geographic information system (GIS) to efficiently collect data from the field. The latest innovation for this agricultural/land use survey is a migration from older to more current software in order to take full advantage of a tablet platform's pen-based technology. The Division would like to demonstrate how a combination of satellite imagery, software, GPS, and handheld computers, have dramatically improved the speed and accuracy of their data-gathering efforts.

Background

In 1963 the Utah State Legislature charged the Division of Water Resources with the responsibility of developing a State Water Plan. This plan was to coordinate and direct the activities of state and federal agencies concerned with Utah's water resources. As a part of this objective, the Division of Water Resources continually assesses the water-related and agricultural land use of the state. This inventory includes the crop type and geographic extent of irrigated and non-irrigated crops, irrigation methods employed, and additional outlining of proximal urban and riparian areas. In order to organize the area surveyed, the state of Utah was divided into 11 hydrologic basins with the intent of surveying one basin per year (except for the relatively small Columbia River basin in Utah's northwest corner), resulting in a complete revision of the state's inventory every ten years (Figure 1). Each year approximately 200,000 to 300,000 acres of agriculture and associated urban and riparian areas would be surveyed. The entire statewide dataset covers approximately three million acres, representing 4.7% of the surface of Utah. Areas not inventoried are mainly desert, rangeland, and forested areas.

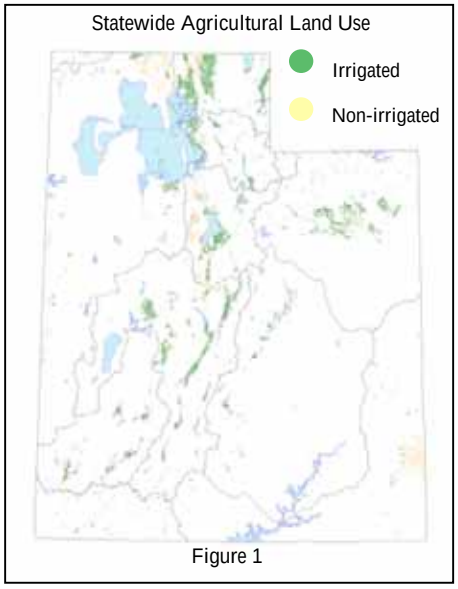

Figure 1

The data gathered in the inventory can be used in a wide variety of applications. Besides being made available to the public via the state's Automated Geographic Reference Center (AGRC), the Division uses the data to support planning activities, create water budgets, and estimate water usage for the state's localities. It also uses the data to assess agricultural trends and change of agricultural land to urban uses (Figure 2).


Figure 2

Methods

The methods used by the Division to gather this data have gradually evolved in the 30 years since its inception. The earliest inventories were prepared using large format aerial photographs supplemented with field surveys to assess the crop type. This data was then transferred to a base map and planimetered to determine acreage. The next major innovation for the inventory was the incorporation of GIS in the early 1980's. In 1984, a trip by staff members to the California Department of Water Resources to observe its methodology brought about dramatic changes. The Division revised its data-collection procedure to include the use of 35mm slides taken of the agricultural area, which were projected onto the back of topographic paper maps. The agricultural field boundaries were drawn onto the maps and surveyed in the field, then brought back to the office to be digitized. The resulting ArcInfo coverages were cleaned and built, and acreages summarized. This method increased the accuracy and efficiency of data gathering but was still laborious and slow, requiring most the off-season (October through May) to Q.C. the previous summer's survey and prepare for the coming year.

In the year 2000 the Division switched from aerial photographs to high-resolution, corrected satellite imagery to identify agricultural land and related field boundaries. Digitizing the boundaries outright as opposed to drawing them and digitizing after the field season eliminated an extremely time-consuming and redundant step (Figure 3).

Figure 3

Using ArcView 3.2 instead of a large digitizing table allowed more then one person to digitize different areas at the same time. The laborious process of edge matching along quad-edges was eliminated and at the same time the spatial accuracy of the field boundaries was greatly increased. Finally, in the summer of 2002, the entire step of printing and surveying with paper maps was done away with when the Division incorporated the use of a new prototype hardware: the tablet PC.

Mobile GIS

Implementing a mobile GIS data gathering method using a tablet PC, a GPS, and GIS software has dramatically increased the quantity and quality of the Division's water-related land use inventory. Two field crews sent to even the remotest corners of the state can gather more data in a week than one field crew could gather with paper maps in a month. The reason for this is three-fold: the ease of data-entry, ease of navigation, and elimination of redundant data transfer.

The tablet PC's pen-based data entry is simple, intuitive, easy to manipulate, and does not require any GIS training. The stylus of a tablet PC is the key to its functionality and makes it easy for a crewmember to pan, zoom in and out, and select multiple polygons with relative ease. Crop types and irrigation methods can then be attributed to

the polygons using a custom labeler created by Division staff. Even though laptops have the memory and processing power to accommodate large files of satellite imagery, these tasks would have been much more difficult given a laptop's bulkiness and sensitive mousepads (especially on some of Utah's back roads). Conversely, even though palm devices have become more sophisticated in recent years, they lack the memory and processing required for a full week's worth of inventorying. Surveying with a mobile GIS system in hand also allows the addition of background data, like topographic maps and DEMs for more contextual information. ESRI's addition of a toolbar created specifically for tablet PCs was an additional resource, allowing field crews to adjust field boundary lines with ease and make notes while onsite for later consideration back in the office (Figure 4 and 5).

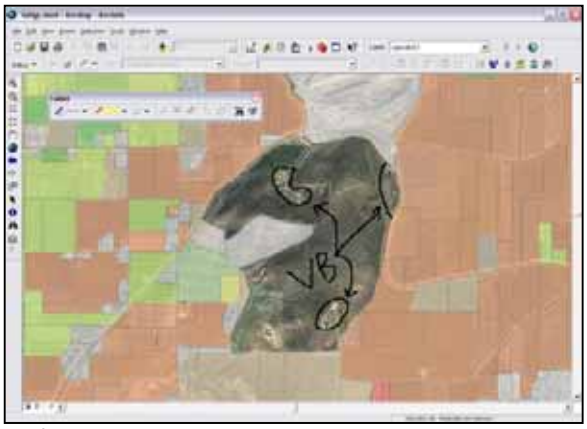

Figure 4

The addition of a real-time GPS tracking device to the GIS interface allows the crew to see its current location on the screen of the computer at all times. The field crew knows where it is, where it is going, and where it has already been. This was initially done using a program written by Division staff, which would take coordinate locations issued from the GPS and paint a dot in the right location, refreshing every few seconds. ESRI's GPS Toolbar has since been implemented to do the same thing.


Figure 5

There is one final major improvement made to the program by implementing a mobile GIS: once the field crew gets back to the office, the data is already in a digital format and doesn't need to be transferred from paper as before. This was a step that occupied a technician several months and was an additional process where error could be introduced. Office staffers no longer have to spend weeks either printing out maps of field boundaries for crews or entering the attributes once they return.

The tangible benefits of the new methodology were visible the first year that it was implemented. The Division is now capable of surveying at least double the acreage of previous years (Figure 6) and in much less time. It also has begun an ambitious new time schedule for revising the statewide dataset – renewal every five years instead of ten.

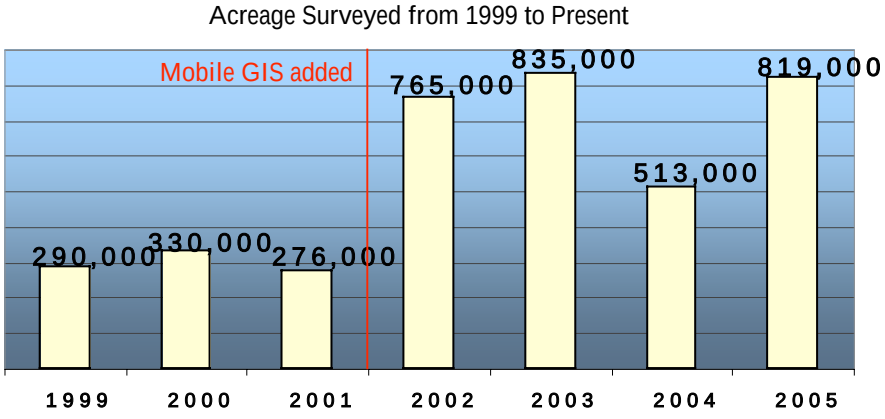

Figure 6

One of the most interesting benefits of the new method is that of GIS staffers having much more time during the off-season to devote to other GIS tasks and research. The GIS team at the Division has been able to broaden their skills to include other applications of GIS, including hydrology, urban growth modeling, programming, and 3D-modeling of water project construction, instead of working on water-related land use most of the year.

Conclusion

The challenge of gathering so much data for the state of Utah has been a daunting task for the Division in the past. Its early GIS integration helped the Division get a good start on achieving its goals of gathering and maintaining such a large amount of information, but having an open mind about trying new innovations in GIS has helped it become a really efficient and cost-effective program. Combining new hardware technology and ESRIs latest resources in software to create a customized mobile GIS system for data gathering has made significant improvement in both accuracy and quantity of its data. It has also made the most of the time of a small but dedicated group of GIS staffers and field crews.

Acknowledgements

Trimble – Picture of Trimble GPS
Compaq – Picture of Compaq Tablet PC
ESRI – ESRI Logo

References

Agricultural and water-related land use data are made available on the Division's website:
http://www.water.utah.gov/planning/landuse/index.htm

and Utah's Automated Geographic Reference Center (AGRC):
http://agrc.its.state.ut.us/

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