AGRICULTURAL WATER WITHDRAWAL PERMITS: A GIS-BASED PERMIT MANAGEMENT SYSTEM AND PERMIT MAPPING IN DOUGHERTY PLAIN

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Abstract. When agriculture was first brought under the permitting provisions of the Ground Water Use Act and the Water Quality Control Act in 1988, thousands of preexisting agricultural water users were grandfathered. As the State moved into a period of restrictions on withdrawals and began planning for future water users, Georgia=s Environmental Protection Division (EPD) needed a new system for permit management and needed more information on existing users. UGA, NESPAL, J.W. Jones Ecological Research Center, EPD and farmers have worked together to produce a GIS-based permit management system and to map permitted withdrawal points and irrigation areas. The process began in the Dougherty Plain with the voluntary mapping effort of farmers and landowners. Over 80% of the 8692 Agricultural Withdrawal Permits in the 17 counties area have been identified and entered into the system. To date 768,000 irrigated acres have been identified there. The GIS permit mapping system has been incorporated into the Agricultural Permitting Unit of EPD.

INTRODUCTION

In 1998, EPD initiated the Regional Water Development and Conservation Planning for the Lower Flint River and Upper Floridan Aquifer. During the 5-year planning period, Georgia law allows EPD to suspend water withdrawal and other permitting activity. Effective December, 1999, EPD suspended permitting most new groundwater sources in the Dougherty Plain and surface sources in the Flint River and tributaries.

Hook et al. (2001) reviewed the rationale for freezing permitting in the region and discussed interim actions by EPD to accommodate existing water users while protecting flow in the Flint River during severe droughts. Among the five major goals set out for the Lower Flint plan that authorized the freeze, EPD indicated that it would create a process for determining exact numbers of irrigated acres. Conflicting acreage estimates were hindering negotiations on allocation formulas for the Tri-State Water Compact, preventing EPD from calculating withdrawals from ground and surface water, and placing flow in the Flint River in drought, should a drought become severe enough.

BACKGROUND AND RELATED WORK

Even before the freeze was in place EPD began to address the problem of calculating irrigation withdrawals. In 1997, EPD contracted with the University of Georgia to begin a random representative sampling of water use by farmers (Thomas et al., 1999). One facet of this effort was creation of a data base for managing the agricultural permit information. The MS Access database could readily handle data tracking, permit creation, and summary needs of a permit system that had grown to over 19,000 permits in its first 10 years. However, irrigation area and withdrawal point data are inherently spatial data, and mapping is needed to understand the impact of water withdrawal by basins, and other areas.

Mapping of irrigation in Georgia, begun as early as the 1970's, was accomplished by site visits by the U.S. Geologic Survey in cooperation with EPD=s Geologic Survey Branch (Pierce et al., 1984). Irrigated fields were hand drawn on overlays of orthoquad maps. Information was gathered on land owners, wells, pumps and irrigation equipment. These irrigation maps and information were gathered before any permitting process was in place, and no effort has been made to connect these 1980 maps with subsequent permit applications.

Blood et al. (1999) mapped irrigated fields in a GIS system in an effort to understand impacts of irrigated fields on watersheds and wetlands. On high resolution Digital Orthophoto Quarter Quadrangles (DOQQ) from U.S. Geologic Survey, center pivots, the predominant irrigation system in Southwest Georgia, are readily visible and data layers outlining these field shapes were drawn and area

calculated.

On contract with EPD, The University of Georgia Center for Remote Sensing, used this approach for the Dougherty Plain area of SW Georgia (Litts et al., 2001). The Center staff identified pivot circles and pie-shaped fields on 1993, and later 1999, DOQQs and created a GIS layer with pivot field areas. Almost 392,000 acres were visible as irrigated fields in the delimited area of the Dougherty Plain. Additionally, almost 84,000 acres were estimated to be irrigated with systems other than center pivots. The effort by Litts et al. (2001) provided EPD with the first real measure of irrigated area for the region.

During 1999, following discussions between EPD and farmers in the Dougherty Plain where EPD planned to suspend irrigation permitting, county permit days were held to allow farmers to get their irrigation permits in order and make applications for unpermitted or planned irrigation. To assist farmers and EPD in the process, GIS based irrigation maps previously drawn by Blood et al. (1999) were incorporated with a new base image from a 1998 SPOT satellite. The SPOT image did not have the resolution of the 1993 DOQQ but it did provide more up-to-date ground cover. Farmers who participated helped to identify previously mapped pivot irrigated fields by permit number and added newer and non-pivot irrigation areas to the GIS irrigation data layer. The success of those efforts in mapping demonstrated to EPD how a GIS system could assist management of agricultural withdrawal permits and determine accurate irrigated area within counties, basins and aquifer areas. This effort served as a prelude for creation of the GIS based permit management system reported here.

METHODOLOGY

Creation of a permit management system proceeded in three steps: 1) development of a survey approach; 2) creation of a GIS and associated imagery; and 3) creation of a system to track individual permits.

The importance of the first step cannot be over emphasized. Several open meetings were held in the area to be mapped with farmers and other permit holders, their elected officials, and state officials. Respect for the needs of the water users and empowering them to shape the permit management system enabled state and officials and University personnel to develop a procedure that would respect their personal and business privacy rights and provide them with copies of records collected and maps prepared for EPD. This would assured permittees the opportunity to review draft copies and make corrections if needed. The confidence gained in this process led to the high level of voluntary participation by farmers, even though several hours of their time was needed in many cases to complete the mapping effort.

All of the GIS permit mapping accomplished by the 1999 effort was captured, standardized in format and labeling, and rechecked for accuracy. Separate data layers were created for each county. While permit mapping was only required for the delimited Dougherty Plain area, announcements, communications, and meeting places were easier to arrange around county lines. Thus mapping was expanded to the full county area.

The ArcInfo/ArcView GIS system incorporated 1993 or 1999 DOQQ images plus published highway, stream, watershed, and county boundary layers. DOQQ images were merged into single county images and degraded about 1:4 to reduce the images to a manageable file size and quality. The mapped but unidentified shapes of irrigated fields became the working layer for irrigated field shapes. Initially, data layers for location of wells and surface water pumps were created from earlier EPD latitude and longitude information. However, in practice it took longer to locate incorrectly positioned points and move them to the correct locations than to draw the points in as farmers indicated their position. Blank working layers were thus created for well and pump mapping. Finally, data fields were added to the irrigation polygon shape files and well and pump point shape files to record information provided by farmers on field names, general crop types, active status, and permitted sources associated and main (direct) irrigation sources, refill sources, and backup sources.

Individual permit images were created in an ArcInfo macro that linked each permit source (point) with all associated irrigated fields (shapes), and a uniformly scaled portion of the DOQQ imagery as a base. Images included a scale, directional indicator, legend, and the permit number. These images were stored as individual image files (jpg format) in a standard directory. Updates, when needed, replaced earlier images. ArcView data tables associated with current well, pump, and field layers were exported as spreadsheet files after latitude and longitude were calculated and area of polygons calculated.

The third step of the permit management system was a system to track permitting and mapping progress. Farmers often waited months for acknowledgment that EPD had received and was processing their applications. Or they feared that no one would remind them of follow-up expected from them. Each communication step, each item mailed, returned, signed, etc. was tracked in a table within the permit data base. Descriptive steps needed for follow-up or dates of activities were recorded there. A quick query could provide status of an individual permit or summarize

Table 1. Summary of EPD official values for number and permitted area of agricultural permits issued by December 2002, number of permits mapped and area calculated on GIS maps for those permits, and area of other additional but unidentified irrigation systems visible on 1993 orthoquad photos

County	Total Permits	Permitted Area	Mapped Permits	Area of Mapped Permits	Additional area mapped
	no.	acres	no.	acres	acres
Baker	480	64,153	425	44,312	2,965
Calhoun	300	50,836	261	31,785	3,947
Colquitt	842	64,863	299	17,159	8,518
Crisp	404	45,084	362	29,768	1,308
Decatur	673	94,228	560	69,766	7,954
Dooly	437	60,860	340	35,559	2,138
Dougherty	195	24,953	193	21,266	32
Early	553	78,255	476	53,643	2,732
Grady	257	23,743	200	14,431	3,041
Lee	464	67,560	403	43,829	4,322
Miller	656	84,815	593	62,458	3,204
Mitchell	841	106,470	722	81,584	6,109
Seminole	569	72,548	517	56,150	1,645
Sumter	413	74,540	330	46,022	3,827
Terrell	334	42,109	304	28,890	2,410
Turner	683	58,901	549	29,481	2,583
Worth	591	63,208	507	42,353	3,037
Total Dougherty Plain	8,692	1,077,126	7,041	768,276	59,872

followup needed for groups of permits.

Within the database, a form was created that pulled spreadsheet information from the GIS mapping effort, permit map images, and official permit information from the permit data base. This image, map information, and official permit limits formed a ›permit map:, a side product of the permit management system.

With a permit management system in place, we began to map all agricultural withdrawal permits in 17 counties. Working with the county agent or other local officials, we arranged for convenient places to meet with farmers and scheduled times for individual permit holders to meet with mapping personnel. We prepared copies of the data that EPD had on record for each permit to assist farmers in linking permits to specific fields. Official permits documents have very few geographic clues.

For these county visits, we placed the current GIS data layers for that county onto a laptop computer. A projector displayed a large image to assist the farmer in locating individual wells, pumps, and fields. Usually one person sat with the farmer and drew in the field shapes, calculated the area of shapes drawn, and labeled the shape with the permit number and other information, as indicated by the farmer. Well position and permit numbers were drawn on the appropriate data layers and labeled by permit. Typically the process required 15 minutes per permit.

After the county visit permit maps were created for each mapped permit. A copy was sent to the owner for verification. After they agreed to the map image and other data on the permit map, they signed and returned it indicating their agreement. In the final step, EPD inspected each permit maps and indicated its concurrence. A signed copy was returned to the permit owner.

At any time during the mapping effort, GIS records, which are housed in EPD offices, were available for analysis by watershed, source, county, etc. Requests for new permits could be reviewed by examining location of nearby wells or upstream and downstream pump stations. Future actions involving site visits can be used to gather GPS position data to further improve accuracy of point data, and changes in irrigated land can be made readily.

RESULTS AND DISCUSSION

Since its beginning in mid-year 2000, over 80% of current permit holders have participated in the mapping of their withdrawal permits and areas irrigated from those sources (Table 1). The 17 counties contained 7053 permits at the start of this period, but ongoing permitting has added 1639 additional permits. Table 1 indicates the numbers of permits currently issued, by county, and indicates that a total of 6807 permits have been drawn onto data layers in the GIS Permit Management System. An additional 234 permits were identified as inactive or duplicate. Farmers brought permits that had been issued for withdrawals, but the source either no longer exists or the area is no longer involved in farming. They also identified permits that were erroneously issued as duplicates for the same source. Often these had been issued to a new owner who hadn=t learned that a previous owner or tenant had obtained the needed permits.

To date 4824 irrigation wells have been located, and 2539 surface pump locations mapped. On average, actual total irrigated area per permit is slightly smaller than that stated on the official permit B 127 acres mapped versus 136 acres permitted for those same permits. About 24% of permit holders irrigated more than 110% of their permitted acres, while 39% irrigated less than 90% of their permitted acres. Of the 7041 permits mapped to date, EDP official permitted acreage exceeds actual irrigated acreage by 178,614 acres in the 17 Dougherty Plain counties.

As a management tool, the combination of ArcInfo GIS and Access data base has been effective, but a high level of training and experience is required for each. Eventually, the two systems should be merged into a seamless system where permit information (well depth and diameter, for example) that is linked to spatial information B the location of the well B is placed in a comprehensive image and data layer. Other relational data that is not spatial in nature B permit owner, contact information, EPD action, tracking status B would be maintained in data-only tables. In the meantime, a workable GIS and associated database serve to provide both functions and allow a high degree of analysis and as well as management of individual permits.

CONCLUSIONS

By December, 2002, 81% of all permits issued in the 17 counties encompassing the Dougherty Plain had been mapped into the GIS permit management system. A total of 828,000 acres had been mapped. This compares with EPD=s total of 1, 077,000 acres permitted for irrigation in these counties. Direct comparison of mapped versus permitted acres shows that farmers are irrigating at least 178,000 acres less than EPD permits allow. It is expected that two-thirds of the 165,000 acres remaining on permits that have not been located will prove to be duplicates or unused permits.

The Flint River Drought Protection Act required expansion of mapping to surface water users throughout the Flint Basin. Currently efforts are underway in the Suwannee basin and the Coastal Zone counties to expand mapping and bring permit management into a statewide GIS.

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