MAPPING AGRICULTURAL WITHDRAWAL PERMITS AND IRRIGATED AREA IN THE LOWER FLINT BASIN

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Abstract. Beginning November 30, 1999, the Georgia Department of Natural Resources, Environmental Protection Division (EPD) suspended permitting of new agricultural withdrawals while conducting the Regional Water Development and Conservation Plan for the Lower Flint River and Upper Floridan Aquifer. The plan requires, among other things, an accurate determination of irrigated area in the region affected before permitting or other water management activities can resume. Determination of current irrigated area was initiated through identification of permanent irrigation structures visible on digital orthoquad images from the region. Subsequently, farmers and other permit holders identified which of their permits were associated with mapped fields and drew associated wells, surface pumps, and other irrigated fields directly to onscreen images. Each permittee was provided with documentation that contained an areal image of the permit site and official permit details. The Permit Maps eliminate confusion over which permit is associated with each parcel of land, document ownership during financial transactions, and help establish their water use. EPD was provided a GIS data base with irrigation shape and withdrawal point data layers labeled by permit numbers. The process illustrates how public agencies working cooperatively with water users can provide the action information the agency needs while protecting the rights of the established users.

INTRODUCTION

Georgia, Florida, and Alabama are continuing to negotiate an allocation formula for the Tri-State Compact of the Apalachicola-Chattahoochee-Flint (ACF) River Basin. If successful the Compact will manage river flow, allow adequate use to sustain economic activity and growth in each state, and protect natural resources in the basin. The US Department of Agriculture (USDA) reported that agricultural irrigation in the Flint River portion of the ACF Basin consumes the largest volume of water below the Fall Line in Georgia (USDA, 1994a). The rural economies of Southwest Georgia are particularly dependent upon that irrigation. When negotiators modeling various flow scenarios for the ACF Basin projected potential withdrawals for irrigation in severe drought years, they determined that the Flint River could stop flowing. One Compact objective is to maintain acceptable minimum flows; however, even with settlement terms very favorable to Georgia, the State might not be able to make its Compact commitments to minimum flows.

While the models and assumptions that predicted no flow can certainly be questioned, the prudent approach for EPD was to suspend permitting new agricultural withdrawal for irrigation, at least until questions could be resolved. EPD recognized that neither irrigated area nor irrigation amounts were well defined. The relationship between groundwater withdrawal for irrigation and base flow in the Flint River was poorly understood. Leakage around Lake Seminole at the confluence of the Flint and Chattahoochee Rivers made Georgia's contribution to net river flow into Florida questionable. To address all of these concerns, EPD initiated the Regional Water Development and Conservation Plan for the Lower Flint River and Upper Floridan Aquifer. During the planning period, Georgia law allows EPD to suspend agricultural withdrawal permitting.

In announcing this plan, a dilemma was created for EPD. First, by the time the plan was widely discussed in public, EPD had accumulated several hundred permit applications. For many of these, farmers had assumed that Letters of Concurrence (permission to proceed with well drilling) would come as usual and had begun investing in the irrigation equipment or with well drilling. Additionally, EPD learned that not all withdrawals that required permits had yet been permitted. In order to minimize economic harm to farm businesses that assumed

permits would be issued as usual, and yet bring all withdrawals into the permit system, EPD agreed to a compromise. A grace period would allow every farmer to bring their withdrawals into compliance with the law in exchange for a means to suspend at least part of the region's irrigation in years of severe drought. The grace period ended November 30, 1999, and all installed systems were permitted by the end of 2000. The irrigation suspension took the form of the Flint River Drought Protection Act of 2000 (FRDPA).

Both the permitting of new withdrawals and the Drought Protection Act emphasized the need for a more effective means for positively identifying withdrawal locations and calculating irrigated acreage precisely. EPD model calculations on the impact of irrigation on river flow had been based upon the sum of permitted acres as listed on its withdrawal permits. In turn, its estimate on the number of acres that must cease irrigation in a drought when FRDPA takes effect were also based on that permitted total.

However, farmers own admissions about the relevance of those permitted acres cast doubt on them. Many estimated the maximum acres they could irrigate from a source when they applied, but practical management or economic considerations led to fewer acres actually irrigated. In other cases, they cleared land or bought a neighbor's field to allow a pivot to complete a circle or otherwise increased the acres beyond their original application request. Many cases were noted where a new owner, lacking the permit for acquired land, simply reapplied and a new permit was issued, duplicating the permitted acres. The inability to tie a specific permit to a specific withdrawal point and irrigation system, particularly when a land owner had 5 to 10 or more permits, meant that transferring a permit when a title was transferred was an uncertain process.

As rules for the FRDPA were formulated during 2000 and finally adopted by the DNR Board December 6, 2000, the necessity to accurately locate permitted withdrawal points and to determine acreage became imperative. The rules stipulate that EPD must issue "auction certificates" to irrigators eligible to participate in the act. Auction certificates require that the entire irrigated area be bid when a drought-forced auction was held; farmers cannot subdivide their permitted area and offer bids for portions. To avoid paying for acreage that may be permitted but not irrigated, EPD needed a measure of the area of the irrigation system and evidence that it was used. Further, the rules stipulate that the only acreage that may be included are those irrigated from pumps directly withdrawing water from perennial flowing streams of the Flint River Basin. While mapping of permitted acreage was needed and initiated before the passage of the FRDPA, an urgency was added when this was signed into law.

At some time in the future EPD and Georgia farmers may come to agreement on volume based permitting, at least for some areas of the state. The system, used in many parts of the country and world, stipulates the maximum volume of water a farmer may withdraw in a given period, but does not stipulate how many acres may be irrigated or when the irrigation applied. Periods may be as short as a year, but in areas where the source is non-renewable, may allow carryover of water to future years to encourage conservation. To protect existing permit holders legitimately putting their water to beneficial use, accurate documentation of withdrawal location and irrigated acres would be essential in conversion from pump rate based to volume based permitting.

Tri-state allocations, drought year management, and improved protection of permit holders demanded a system of permit mapping for managing agricultural withdrawal permits. Our objectives were to map all existing irrigation in the Dougherty Plain, to provide image-based permit maps for permit holders, and create a geographic information system for EPD's management of agricultural permits.

BACKGROUND AND RELATED WORK

Surveys, water withdrawal permit information, and remote sensing (e.g. aerial photography) approaches have been used to quantify agricultural crop and irrigation acreage. The principal values for irrigated area used by EPD came from their agricultural water withdrawal permit data base. Individual land and permit owners, county, and surface source stream or pond name or ground water aquifer were known to some extent. Locations were designated by an 'X' on a small, low resolution county map at the time of the application. Irrigated area listed on these permits reflects farmers estimates of planned irrigated area at the time the application was made or estimates of existing irrigated area made when grand-fathered systems were first permitted. No source location or irrigated area verification was conducted by EPD during or subsequent to granting withdrawal permits. By December 2000, that data base indicated that total permitted irrigation covered 2,044,053 acres.

The National Agricultural Statistics Service (NASS)

conducts and reports annual crop surveys but its five-year surveys to detail crop production and irrigated area (USDA, 1998). That survey reported total irrigated area in Georgia was 748,520 acres, comparable to EPD's then permitted 1,899,430 acres. Since the former value directs Federal programming and the latter State programming, the more than 2-fold difference was bound to cause problems in negotiations involving agencies of each group, as was the case in Compact negotiations.

Since 1970, the University of Georgia Cooperative Extension Service has conducted approximately tri-annual county irrigation surveys estimating crop acreage, crop irrigated acreage, irrigation amounts, irrigation systems and irrigation water sources (Harrison, 2001). The estimates on the surveys are determined by a professional assessment by the county agricultural extension agents. In the current survey, irrigated area was estimated to be 1,492,980 acres, about twice USDA's 1997 estimate, but more than 500,000 acres less than EPD's current permitted area. The tri-annual county irrigated acres form the basis for other estimates including the five-year U.S. Geologic Survey water use report (Solley et al., 1998.)

The NRCS conducts five year natural resources inventories (NRI) that include soils, crops, conservation practices, and irrigation practices (USDA, 1994b). Additionally, the NRCS has developed spatial data associated with the resource inventories.

Finally, land use classification of satellite imagery and photo-interpretation of aerial photography provide quantitative "snap-shots" of agricultural landuse, crops, and irrigated acres (Houhoulis and Michener, 1998). This approach was demonstrated and compared with other area estimates for four counties in southwest Georgia (Blood et al., 1999.) The authors found good agreement of their mapped area with those with the Georgia Extension Survey.

RESULTS AND DISCUSSION

During 1998 and 1999, areal imagery consisting of the USGS 1993 Digital Orthoquads were obtained for the Lower Flint River Basin and incorporated as a data layer in ARCINFO. The high resolution images were carefully examined for visible signs of permanent irrigation systems (field patterns, center pivot mains, and wheels. Circular and pie-shaped images were drawn over these irrigated fields and area of visible systems computed.

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, we provided the GIS based irrigation maps previously drawn and added a new base image, a 1998 SPOT satellite image. The SPOT image did not have the resolution of the orthoquad photographs 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 greatly assist their management of agricultural withdrawal permits and determine accurate irrigated area within counties, basins and aquifer areas. Farmers asked for copies of their mapped system to assist in their record keeping for permits and documentation of irrigation water use.

Beginning in July 2000, we expanded our GIS base imagery of orthoquad photographs to cover the full county area of 17 EPD-designated Dougherty Plain counties. Three image layers were used to store geographic data about permits – 1) a well location point layer, 2) a surface pump location point layer, and 3) an irrigated field shape data layer. Data tables associated with these three permit data layers in the GIS were modified to include some additional data supplied by farmers. These included, for example, farmer names or codes for fields, pond names, and type of irrigation system. This enabled information they supplied to appear on their "Permit Maps" for more accurate descriptions. Permit Maps combined imagery and data from the GIS system and data from the official EPD Agricultural Withdrawal Permit Data base onto one sheet for each permit.

Permit Maps and all data for the permit management were managed in a Microsoft Access 2000 data base. The data base consisted of official EPD permit information obtained by frequently importing four data tables into the working data base. Working copies of these tables that contain 1) well source data, 2) surface pump data, 3) irrigated field data, and 4) owner and EPD action information, respectively, were created and updated with new permits as official files were updated. GIS tables that contained location information for well and pump data layers and area data for mapped field shape layer were imported into the Access data base, forming a parallel set of tables for wells, pumps, and fields. These tables provided an on-going assessment of the status of mapping, comparison of actual versus permitted area, and

comparisons for several other details. A standard size and scale image was created in ARCINFO, exported, and converted to jpeg image format. A data base report was created to pull data from EPD official tables, GIS map detail tables, and jpeg image to create a Permit Map.

The final effort of the mapping involved verification and certification. A completed map for each permit was returned to the owner. The permittee was asked to verify that the map image and text details were correct. An owner-signed copy was returned for filing with EPD. In turn, EPD signed a final copy indicating their authentication of the Permit Map, and that copy was sent to the permittee for safe keeping along with the deeds and other valuable records.

The current status of the permit mapping (Table 1) indicates that overall about 36% of permits have been identified on permit maps. This does not include about 850 that were mapped by EPD during the issuance of permits during 2000. When those are brought into the GIS system, the percentage mapped will approach 50%. During January and February, 2001, EPD redirected several personnel to assist in mapping surface water permits in the Flint Basin in anticipation of enactment of the FRDPA. These agents are determining field location of surface pumps and irrigation systems by GPS and mapping fields on paper in order to issue "Auction Certificates" to all surface permit holders prior to March 1, 2001, when a drought declaration may be required. Although mapped using a different approach, these field verified locations can readily be brought into the GIS system later this spring.

Closer examination of the area of mapped permits in comparison to the information on corresponding official permits reveals several trends. On average each permitted withdrawal is supplying water to 1.8, almost 2 irrigation systems or fields. Those working with the farmers in the mapping effort are learning how much effort farmers have used to supply water to their fields. Most who use ponds for irrigation have installed some sort of back-up system, either a well or a nearby stream or pond to refill it during drier seasons. Many use portable irrigation systems, including center pivots, moving them between fields within a crop season, or to a second field after an early season crop is mature. Some farmers have linked

Table 1. Summary of EPD official values for number of agricultural permits issued by December 2000 and area of those permitted for irrigation, number of permits mapped to date (January 2001), area on GIS maps of identified permits, and area of other unidentified irrigation systems visible on 1993 orthoquad photos.

County	Total Permits	Permitted Area	Mapped Permits	Area of Mapped Permits	Additional area mapped
	no.	ac	no.	ac	ac
Baker	472	62,146	200	24,993	12,406
Calhoun	287	45,671	236	29,925	5,415
Colquitt	812	59,908	283	16,032	10,127
Crisp	380	35,431	130	11,000	3,047
Decatur	659	89,427	375	49,185	18,342
Dooly	401	54,233	46	5,057	4,612
Dougherty	186	23,864	75	8,923	3,920
Early	532	72,855	399	43,794	4,285
Grady	240	23,015	183	13,578	2,865
Lee	444	59,786	191	20,335	17,584
Miller	646	82,448	278	42,873	11,719
Mitchell	812	100,049	517	62,471	8,047
Seminole	562	70,214	305	35,839	11,498
Sumter	379	68,154	240	36,807	9,074
Terrell	323	37,594	296	26,937	3,065
Turner	540	42,085	0	0	0
Worth	542	54,304	176	15,732	6,711
Total Dougherty Plain	8,217	981,184	4,030	443,481	132,718

ponds for irrigation have installed some sort of back-up system, either a well or a nearby stream or pond to refill it during drier seasons. Many use portable irrigation systems, including center pivots, moving them between fields within a crop season, or to a second field after an early season crop is mature. Some farmers have linked their well and pond sources in a network of water mains that provide enough water from several limited sources to one or more larger irrigation systems. While the mapping effort did not attempt to show these interconnection, the permit number was associated with all locations and fields where the water withdrawn by the permitted source could be used.

To date 2789 irrigation wells have been located, and 1652 surface pump locations mapped. On average, actual total irrigated area per permit is smaller than that stated on the official permit – 110 acres mapped versus 142 acres permitted for those same permits. About 19% of permit holders irrigated more than 110% of their permitted acres, while 52% irrigated less than 90% of their permitted acres. The remaining 29% irrigated within ± 10% of their official permitted acreage. Of the 4130 permits mapped to date, EDP official permitted acreage exceeds actual irrigated acreage by 127,400 acres in the 17 Dougherty Plain counties.

In the 10 counties where six or more days of mapping with the aid of irrigators has been completed, more than 75% of the visible irrigated land has been mapped. However in those counties, only about 60% of the permits have been mapped. As with many that we have mapped already, we expect that many of the remaining 40% will be duplicate permits and permits not directly connected to irrigation systems (wells refilling ponds, backup wells for emergencies, etc.) Given that, the smaller acreage per permits as irrigated, and the visible remaining irrigation, we estimate the final total for the 17 Dougherty plain counties will be between 700,000 and 750,000 acres.

CONCLUSIONS

At publication time permit mapping was still a work in progress. It is expected that in the 17 counties 95% of withdrawal permits will be mapped by December 2001. The majority of these will be mapped by spring of 2001, thanks in part to the urgency imposed by the Flint River Drought Protection Act.

Given the wide disparity among EPD, USDA , and UGA Cooperative Extension Service estimates, the GIS-based permitting system is providing substantial improvement in the management of withdrawal permitting and accurate estimating of irrigated area. With time the GIS system can be modified to include aquifer property and depth data layers, stream flow layers, and GIS functions can be created to allow future permitting decisions to be made on the basis of vicinity of existing wells, commitments to up-stream withdrawals, low flow records, and restricted access areas.

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