GIS AS A TOOL IN IRRIGATION DISTRICTS AND PROJECTS

Guy Fipps[1]
Eric Leigh[2]

INTRODUCTION

This paper serves as an introduction to the Workshop on GIS in Irrigation Projected, conducted at the USCID Second International Conference on May 13, 2003. The workshop has four topics:

- GIS as a Mapping Tool
- GIS and Database Integration
- GIS as a Planning/Management Tool
- GIS and Modeling

The purpose of the workshop (and this paper) is to provide "how to" information and ideas for individuals and organizations beginning or expanding GIS programs. The workshop is also designed to foster communication with persons and organizations involved in GIS and to serve as a spring board for initiating active program of the USCID Working Committee on GIS in Irrigation Projects.

In this paper, we use specific project examples from Texas to provide a general overview and introduction to each topic of the workshop (note: complete reports on the Texas projects are posted on District Management System Team website, http://dms.tamu.edu). During the workshop, other papers are presented which provide detailed case studies on each topic.

GETTING STARTED - GIS RECOMMENDATIONS

Although a GIS software package can create useful, colorful maps, GIS is more than just a map. Before starting or expanding a GIS program, do your homework and think broadly about how how and what it can do for you. A GIS is people, machines, and information. Each component needs to be compatible, work together, and periodically be updated (or received additional training). The world is ever changing and so should your GIS.

First, define your goals and objectives. What do you want to use it for? Next, determine how much money, time and effort to put toward the GIS. Which persons will be working with the GIS? Do they have basic training and are tehy willing to learn? To have a successful GIS program you need the right

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[1]Professor and Extension Agricultural Engineer, Biological and Agricultural Engineering, 2117 Texas A&M University, College Station, TX 77843-2117; g-fipps@tamu.edu

[2]Extension Associate, Texas A&M Agricultural Research and Extension Center, Weslaco, TX.

person(s) to push it along.

Maps, Data Options and Costs

When choosing what data sources you will build your GIS with, consider cost, collection time and effort, and quality. The path to and speed of creating your GIS depends on how you balance data cost, usefulness, and availability.

Age of information:
Is the information/data the best source or is it the only source? Will the data be useful in creating a new map?

Cost:
What is the price of the information/data (including the time it may take to get it in a useable format)? How useful will the data be for the price? How much is outdated information worth (or is it the only information out there)?

Accuracy:
Determine the source and accuracy (or scale) of the data. Older blueline maps, most likely, were not drawn in any coordinate system, and usually are more useful as reference then as a premise for the base map. GPS surveying can produce the most accurate information, but at a cost.

Ease to work with:
GIS software packages are able to handle many file formats, but not all. Additional program extensions may be needed in order to import and export different sources of data. Paper maps will need to be scanned or digitized, and then geo-referenced (requiring equipment and expertise).

Sources:
Many federal and state agencies, private companies, universities, cities, consulting firms, etc. all now have done GIS work/research or have their own GIS department that can be a first good source for starting a GIS. In Texas, for example, state agencies use *ArcView* and related software for GIS and are producing data files, maps and layers that are compatible and readily available.

Data Sources and Considerations

Pros and Cons of data sources depend on your objectives.

Hard copies of maps:
Old blue sheet base maps, paper maps, etc. may provide good background data and usually are inexpensive or free. However, they are likely to have been affected by shrink/swell, were not mapped based a referencing system, and must be scanned and then overlaid within GIS, (which, to an inexperienced person, can be very difficult).

Aerial photographs:
Aerial photos are frequently used as a base to “draw” the GIS of a district. Aerial photography is usually produced by governmental agencies, and is available at a cost. In Texas, for example, the state and USGS has teamed up to produce geo-referenced aerial photos of the entire state in both 1 m and 3 m resolution. High resolution aerials provide great accuracy, but as the file size become larger, so does the need for faster computers to handle the vast amounts of data. Having up-to-date aerial photos made is expensive, but this may be needed to see changes in patterns from one year to the next.

Existing GIS data:
Existing GIS data can be found through governmental and state agencies, the internet, and most larger cities. However, some of the this data maybe outdated or costly.
AutoCAD:
Some AutoCAD drawings/projects, while drawn to scale, are not based on a real world coordinate system. Such projects make the overlay process difficult and the spatial data inaccurate. Trying to convert old AutoCAD maps into GIS is usually more trouble than its worth. Newer versions of AutoCAD have the ability to geo-reference (base the project on a standard coordinate system); making map integration between GIS software packages and AutoCAD easier and more accurate.
GPS:
With GPS equipment, mapping data can be obtain directly. This will require the purchase or lease of GPS equipment and training, or hiring outside consults/surveyors that can be very costly. The advantages to GPS is that the most current and accurate information is obtained on the locations and attribute data of the project.

TOPIC I: GIS AS A MAPPING TOOL

One basic function of GIS is the production of customized maps that can be updated and reformatted as needed. Most irrigation districts begin GIS program because of their need for continuing updating district maps and information, including distribution networks, canal sizes and lining, infrastructure locations, and other district facilities and their corresponding attribute information.

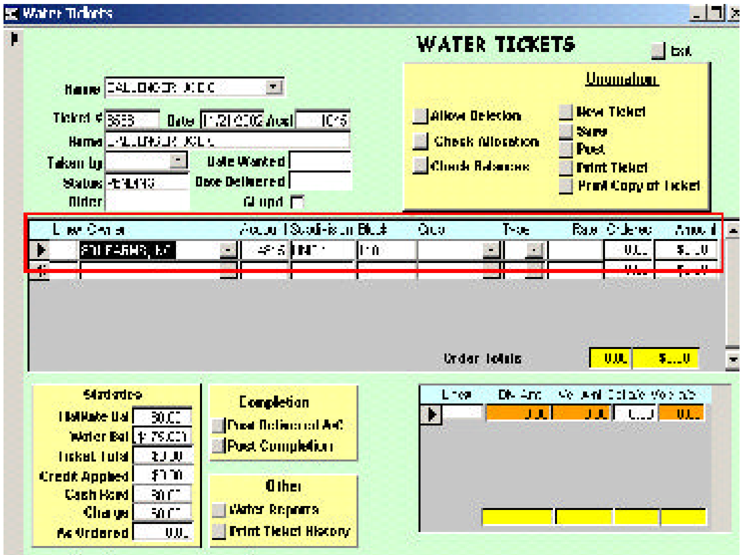
Examples of some wses of GIS maps include:

- allowing districts to have accurate and up-to-date maps as when changes occur
- defining conditions of the infrastructure to help identify segments needing increased maintenance or rehabilitation
- combining data based on spatially and find relationships
- solving location or property disputes
- to determining the size of a service area

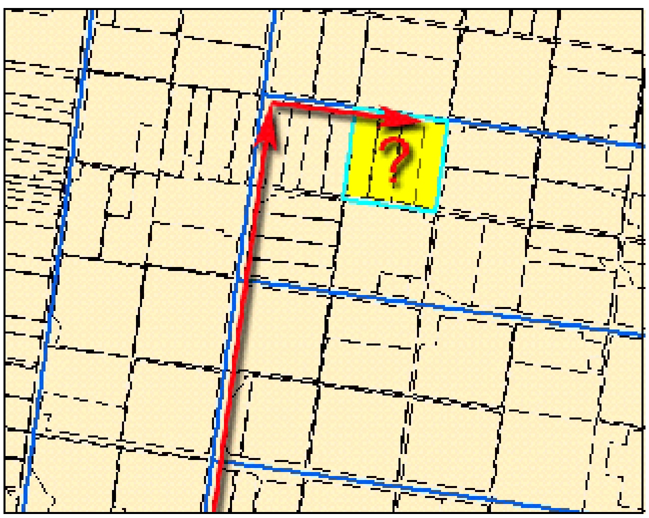
TOPIC II: GIS AND DATABASE INTEGRATION

Existing information in databases can be linked to the GIS and displayed to facilitate analysis and management. In *ArcView/ArcGIS*, dBase is the default file format. But *ArcGIS* can linked to the major commercial software packages. For custom, older, or non-mainstream databases, direct linkage will be a problem. These sources will have to be modified to produce an output file in the correct format.

In some cases, the structure of the database must be changed in order to provide the spatial or location data needed in GIS mapping. For example, some districts only keep records by account and not by field location. Adding another field in the database table that identifies the actual location is the solution. An example is the San Benito Irrigation District.

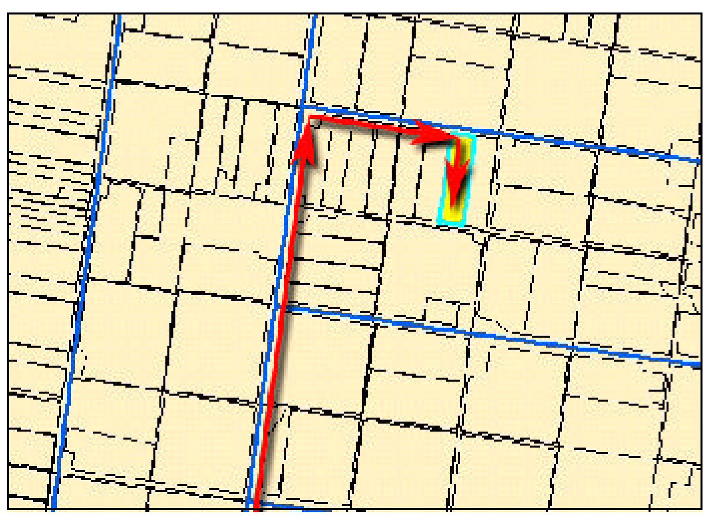


An example of the water order form for this district. It has places for the name, address, lot and block, but no field ID.



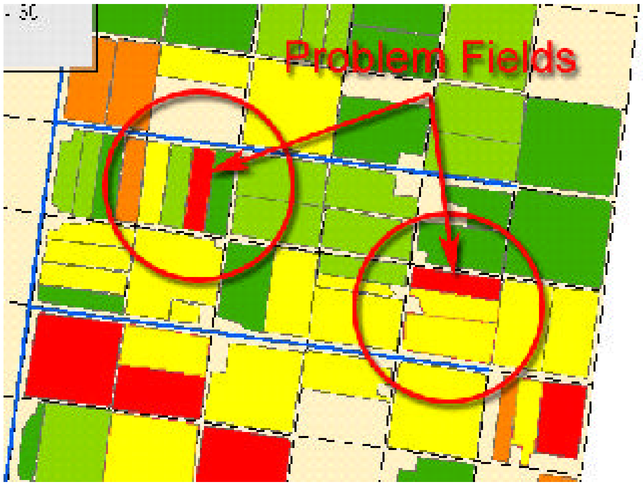
This image illiterates the problem of one district. The database had an ID for the account number and block, but no ID for individual fields within the block

The obvious solution is to add a new field in the database that would identify the specific field. One problem, tho, is that there could be no backward compatibility.



TOPIC III: GIS AS A PLANNING/MANAGEMENT TOOL

Once the GIS is build tricts and databases are linked, GIS can serve as a powerful resource for planning and management. The only limitations are the imagination and the availability of data.



One common use is to visually represent information for quick analysis. In the chart on the left, fields that have exceeded the normal amount of irrigation are highlighted in red.

The Harlingen Irrigation District Head Analysis Project is a good example of GIS as a planning tool, but it really combines all three categories:

mapping and collecting basic attribute data on the infrastructure

combining measured field information on flow rates with reported problems occurring in the system

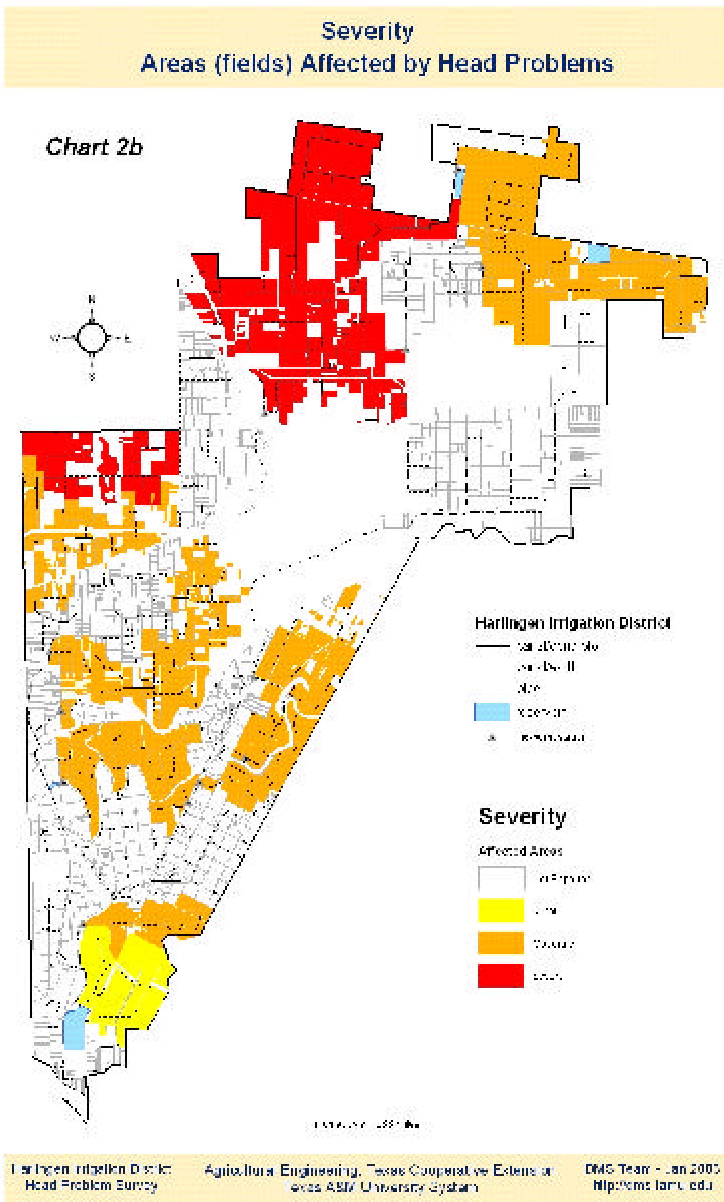
The Harlingen Project was implemented in order to demonstrate and evaluate the effectiveness of RAT (rapid assessment tool), a combination of GIS mapping, data collection, and field measurements designed to identify infrastructure problems in irrigation districts and the potential water saving benefits of specific rehabilitation projects.

The next step of this process is to use the information to:

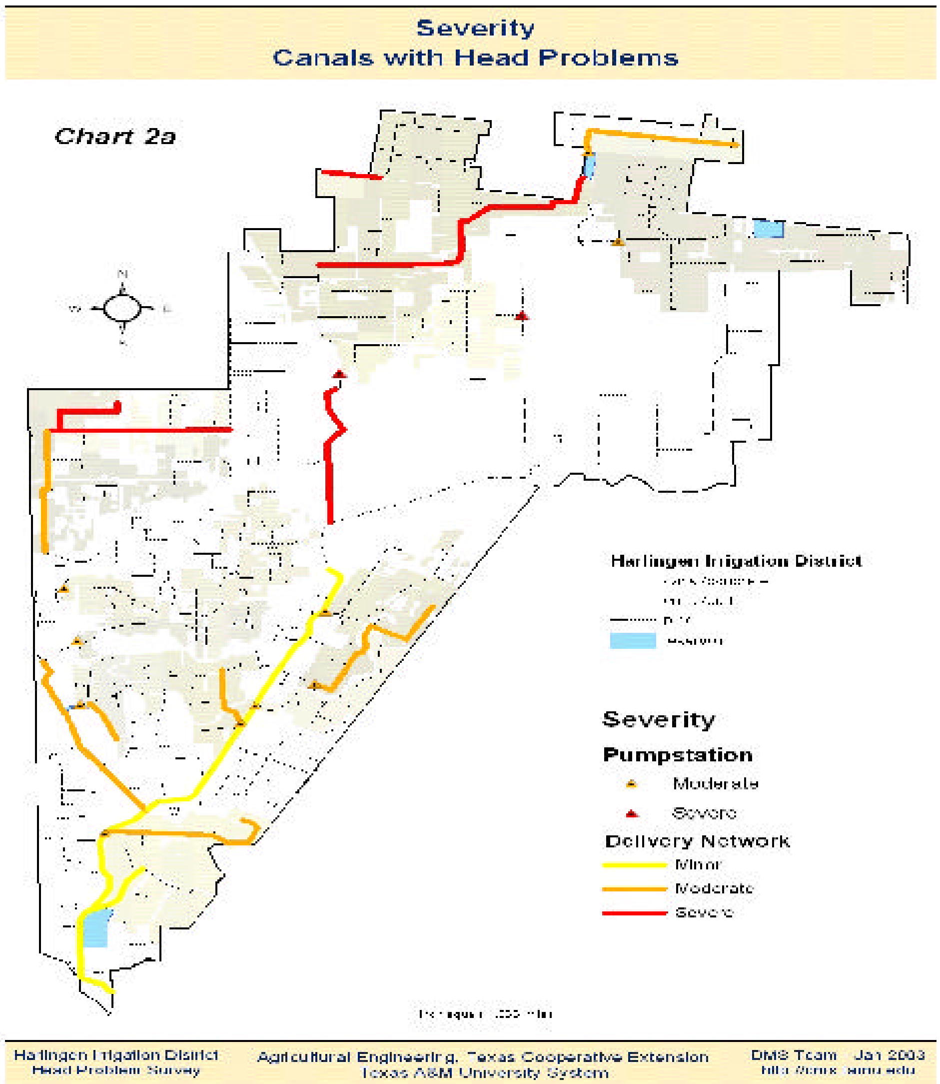
• plan rehabilitation projects and/or re-designing areas,

•or in the case of system problems that would not allow for a change in the infrastructure, change in the management of the system.

In the Harlingen RAT demonstration, areas of the district having head problems (inadequate flow or pressure at the farm turnout to allow for efficient on-farm irrigation) were identified, as well as specific canals, pipelines and pumping stations. The Chart below shows the areas of the districts having head problem and the severity of the problem.



This chart shows specific canals and pump stations with head problems.



Approaches to Integration of GIS with Hydraulic Models

1. Loosely coupling models

2. Closely coupled models that are linked to a GIS coverage data model such as ArcGis via a user interface.

3. Closely coupled models that are linked to a relational database such as a Geodatabase that stores geographic data

4. Modeling using tools within GIS

Issues and Challenges

GIS Integration with existing hydraulic models

Data availability and data quality

User considerations

Cost of data, hardware and software

Availability of skills

Integration with other spatial technologies