EFFECTS OF USE OF GIS AS A REAL TIME DECISION SUPPORT SYSTEM FOR IRRIGATION DISTRICTS IN TEXAS
Gabriele Bonaiti  
Extension Associate

Guy Fipps  
Professor and Extension Agricultural Engineer  
Director, Irrigation Technology Center

Irrigation Technology Center  
Texas AgriLife Extension Service  
Department of Biological and Agricultural Engineering  
Texas A&M University, College Station

This work is supported in part by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Agreement No. 2005-45048-03208. For program information, see http://riogrande.tamu.edu
Caballo and Elephant Butte reservoirs

Rio Grande Region

A El Paso County
B Maverick County
C Hidalgo, Willacy, and Cameron Counties
INTRODUCTION

• Irrigation districts in Texas are aware that more is to be done in terms of efficiency and data management, and that GIS can be a useful tool
• SCADA systems and online information are more being used and linked to GIS
• The integration of these tools, though, is hardly achieved
• Security is an issue when sensitive data are to be displayed online
INTRODUCTION

• We selected irrigation districts with detailed information on water accounts and flows in the canals, with the general objective to improve the efficiency of daily water management

• Two districts that begun in 2009 and 2010. GIS was linked to daily water accounting information and to real time water flow monitoring, and posted in the district website

• Objective of identifying problems and recommendations, proposing changes, and evaluating the effects of adopted changes
FEATURES
Improved and simplified management of databases
<table>
<thead>
<tr>
<th>Problems</th>
<th>Recommended changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data are in standalone machines</td>
<td>Connect machines to the network</td>
</tr>
<tr>
<td><strong>Water account</strong></td>
<td></td>
</tr>
<tr>
<td>Format is encrypted</td>
<td>Use standard format</td>
</tr>
<tr>
<td>Infrequent update</td>
<td>Update daily</td>
</tr>
<tr>
<td>Irrigated fields ID are missing</td>
<td>Add irrigated fields ID</td>
</tr>
<tr>
<td>Crop information is missing</td>
<td>Add crop information</td>
</tr>
<tr>
<td><strong>SCADA</strong></td>
<td></td>
</tr>
<tr>
<td>Data are hidden</td>
<td>Use standard format</td>
</tr>
<tr>
<td><strong>GIS</strong></td>
<td></td>
</tr>
<tr>
<td>Is not properly drawn</td>
<td>Correct data</td>
</tr>
<tr>
<td>Is not up to date</td>
<td>Update at least yearly</td>
</tr>
<tr>
<td>Irrigated fields are missing</td>
<td>Add irrigated fields</td>
</tr>
</tbody>
</table>
BEFORE:

BID Example

AFTER:
Establishing Data Transfer to TAMU server
1. Automatic extraction of data from existing District database
   • SCADA (polled every 15 minutes)
   • Water accounts (polled once a day)

2. Transfer of data to TAMU server via the Internet

3. Partition of data into a SQL Server database
Example of data to be included:

- **SCADA**
  - Pumps status
  - Water levels
  - Gate position
  - Current and cumulative flow
  - Alarms based on water levels

- **Water account**
  - Water sales

- **GIS**
  - Water accounts shape
Web-based tools for use of data through the Internet
Example 1

• Query and download real time and historical SCADA data as spreadsheet and charts
Query for historical data and charts

Previous Day Summary

Specify Dates (enter data below)

Start Date

Stop Date

Query Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Canal</th>
<th>Data Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>03/15/2011 10:03:49 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.861000</td>
</tr>
<tr>
<td>03/15/2011 9:52:49 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.085000</td>
</tr>
<tr>
<td>03/15/2011 9:19:08 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.846000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.088000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.090000</td>
</tr>
<tr>
<td>03/14/2011 6:55:50 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.885000</td>
</tr>
<tr>
<td>03/14/2011 6:35:55 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.303000</td>
</tr>
<tr>
<td>03/14/2011 5:43:06 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.863000</td>
</tr>
<tr>
<td>03/14/2011 5:28:34 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.085000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.846000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.088000</td>
</tr>
<tr>
<td>03/14/2011 12:49:00 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.090000</td>
</tr>
<tr>
<td>03/14/2011 10:45:17 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.885000</td>
</tr>
<tr>
<td>03/14/2011 9:52:57 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.303000</td>
</tr>
<tr>
<td>03/14/2011 9:34:22 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.863000</td>
</tr>
<tr>
<td>03/14/2011 9:13:04 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.085000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.846000</td>
</tr>
<tr>
<td>03/14/2011 8:31:28 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.088000</td>
</tr>
<tr>
<td>03/14/2011 6:30:26 AM</td>
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<td>FLOW Val</td>
<td>3.090000</td>
</tr>
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<td>FLOW Val</td>
<td>2.885000</td>
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<td>03/14/2011 12:52:22 AM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.303000</td>
</tr>
<tr>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.863000</td>
</tr>
<tr>
<td>03/13/2011 11:32:57 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.085000</td>
</tr>
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<td>3.088000</td>
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<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.090000</td>
</tr>
<tr>
<td>03/13/2011 3:43:35 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>2.885000</td>
</tr>
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<td>FLOW Val</td>
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<td>FLOW Val</td>
<td>2.863000</td>
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<tr>
<td>03/13/2011 2:22:53 PM</td>
<td>C CANAL</td>
<td>FLOW Val</td>
<td>3.085000</td>
</tr>
</tbody>
</table>
Example 2

• Current flows are shown, critical water levels are highlighted in yellow and red
Example 3

- Display water account information such as field ID, owner, grower, pending orders
Maps for display and use of data - Examples
Example 1

- Status map set up to show the most relevant information in real time, such as water flow, water levels, alarms
Real-Time Flows (GPM) & Water Levels (In)

Map showing various locations with water levels in inches and gallons per minute (GPM). The map includes locations labeled 1 to 12, with water levels ranging from 35.897000 to 72.000000 inches. The Farm Meter Area is highlighted on the map.
Example 2

• District personnel can access data by means of a password protected interactive map, on which real time and historical data can be queried and displayed.
Enabling access to specific data for water account holders
Example 1

- The grower/landowner can locate their fields, and find and print information
<table>
<thead>
<tr>
<th>ACCOUNTS</th>
<th>BLOCK</th>
<th>LOT</th>
<th>SUBDIVISION</th>
<th>GROWER</th>
<th>OWNER</th>
<th>NET_ACRES</th>
<th>NET_ACRES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1465</td>
<td>161</td>
<td>1</td>
<td>Texas Acres</td>
<td>Joe Jones</td>
<td>John SMITH</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>1-1466</td>
<td>162</td>
<td>1</td>
<td>Texas Acres</td>
<td>Sue Smith</td>
<td>John SMITH</td>
<td>16</td>
<td>5</td>
</tr>
</tbody>
</table>
Example 2

• Detailed information can be viewed for each field
<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJECTID</td>
<td>1506</td>
</tr>
<tr>
<td>Grower</td>
<td>JOE JONES</td>
</tr>
<tr>
<td>Owner</td>
<td>JOHN SMITH</td>
</tr>
<tr>
<td>Block</td>
<td>162</td>
</tr>
<tr>
<td>Lot</td>
<td>Null</td>
</tr>
<tr>
<td>Acres</td>
<td>16.15</td>
</tr>
<tr>
<td>Purch_Date</td>
<td>6/16/2011</td>
</tr>
<tr>
<td>Wat_Date</td>
<td>6/22/2011</td>
</tr>
<tr>
<td>Crop</td>
<td>Null</td>
</tr>
<tr>
<td>Crop_Des</td>
<td>PASTURE</td>
</tr>
<tr>
<td>Account</td>
<td>1466</td>
</tr>
<tr>
<td>Inches</td>
<td>4</td>
</tr>
</tbody>
</table>

Add to Results
Example 3

- Farmer can access his own meter readings
Management tools to improve conveyance efficiency and water deliveries
Example

• Use of soil-water balance models to create maps showing water status of crops

• Red and orange fields need irrigation
PROBLEMS AND SOLUTIONS

Data management

• SCADA and water account databases proprietary format → contractor set-up of a routine creating text output data

• Automatic transfer of data to our server → Specific code to bypass the firewall protecting the TAMU server

• Data storage and management → SQL server database

• Connection to spatial data: geodatabases and “join” operation within the ArcGIS software
Collaboration with contractors and consultants

- Only contractors could manipulate the data and knew what data were available
- Contractors sometime saw us as competitors
- District encouraged us to be involved with the contractors
- Beneficial interaction in terms of knowledge and future collaboration, but also in terms of minimizing any impediment to the current organization of the system
PROBLEMS AND SOLUTIONS

Identification of district needs and best solutions
• As the district was not familiar with the proposed technology we had to design the project based on our knowledge of the district, rather than on a specific request
• Among other activities, we organized some GIS classes, and demonstration workshops

Security
• Passwords were set to access farmers meters data and other sensitive data
• District ARCGIS web applications were protected by password

Data validation
• District typically used SCADA data only as real time source of information
• We set up some simple automatic strategies to overcome most of the common errors (e.g. routines to delete data when outside a minimum or maximum threshold)
EFFECTS ON DISTRICT ACTIVITY

• Perception that the changes introduced could save water and time

• Districts actively responded to make the changes required

• Compliance to our recommendations for improvement (e.g. change water account database software)

• Availability of flow meters readings to account holders reduces need of talk to the districts personnel
  – Total volumes used
  – Current flow → more efficient field distribution

• Daily update of water account information

• GIS brought up to date
BID Information Management System project - USER EVALUATION FORM

Name: [Name] Date: 3/31/1

1. Did you use one of the new web pages at least once:
   - [ ] No
   - [ ] Yes
   - Pump and Meters Daily Weekly Monthly
   - Water orders Daily Weekly Monthly
   - Interactive map Daily Weekly Monthly
   - Pump Flow
   - Default displayed data (on/off, flow volume, resaca level)
   - Unit Chart links
   - Other information related to units
   - Water account
   - Default displayed data (current purchased ticket)
   - Account/Owner/Grower/Ticket 2010 queries
   - Print
   - Historical data Daily Weekly Monthly

2. General comments:
   - [ ] Useful
   - [ ] Sped my work
   - [ ] I will you use again
   - [ ] Too difficult to use
   - [ ] Too slow
   - [ ] There are no useful information
   - [ ] Other: 

3. Water management improvements (also if based only on perception):
   - [ ] Time saving Major Minor None
   - [ ] Money saving Major Minor None
   - [ ] Water saving Major Minor None
   - [ ] Energy saving Major Minor None
   - [ ] Interaction with account holders Major Minor None
   - [ ] Other: 

4. What other information would you like us to add to the web site?
   [ ] Have already added all we need at this time.

5. What changes/improvements would you like us to make?

6. Any other comment?

..........................

..........................
CONCLUSIONS

• Designed for districts that had specific interest in:
  – Make best use of the large amount of available data
  – Adopt web applications
  – Enable customers to access their data through the internet.

• Changes required a long time to be fully implemented:
  – Identifying district needs and accurately designing the project
  – Integrating the non optimal existing data
  – Securing sensitive data
  – Involving contractors and consultants to deal with software that were in a proprietary format
  – Collaboration with contractors resulted beneficial for the sound implementation of the project
CONCLUSIONS

• The activity looked promising:
  – Adopted most of the new proposed strategies
  – Promptly complied with many recommendations
  – Started suggesting further steps

• Overall feeling from the districts that the adopted changes would help save water and time:
  – Periodical qualitative evaluations
  – Water balances and reliable historical data might help to make these assessments in the future
  – Need to quantitatively estimate such benefits
  – An initial understanding of such benefits might be obtained with a description of improved services provided to growers (e.g. availability of flow meter readings on line reduces the number of calls to the canal rider, and improves irrigation efficiency)