Texas Water Resources Institute

Annual Technical Report

FY 1999

Introduction

The FY 99 research program was focused on statewide efforts in water supply and water quality (TMDL) planning. The project by Eaton, et al., investigates the impact of water supply uncertainty in market-based transfers, a strategy embraced by the state's water supply planning effort. The project by Lambert and Jennings also supports this planning effort through collection of data to improve groundwater models to predict safe yield from the Trinity Aquifer in Central Texas. The project by Matlock and Mukhtar builds on a much larger EPA-sponsored research project focused on water quality issues associated with TMDL development for fecal coliforms in urbanizing watershed in San Antonio. Data and tools developed through the Institue-sponsored project will allow the investigators to incorproate elements of risk in exceeding critical thresholds of coliforms to achieve the designated water quality.

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Value Assessment in Surface Water Transfers: Deterministic and Stochastic Issues for Buyer, Seller, and Third Parties
Project Number	1434-HQ-96-GR-02700-UTA-97-1
Start Date	10/01/1997
End Date	08/30/2001
Research Category	Not Applicable
Focus Category #1	Methods
Focus Category #2	Management and Planning
Focus Category #3	Drought
Lead Institution	The University of Texas

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
David Eaton	Professor	The University of Texas	01
Albert E. Utton	Professor	The University of New Mexico	02
Peter J. Wilcoxen	Assistant Professor	The University of Texas	03

Problem and Research Objectives

State water regulators are asked to consider externalities during administrative review of proposed water transfers. Few methods are available to accomplish this task. Methods of evaluating economic cost and benefit to third parties may not be "standard" and do not always satisfy the information needs of those making decisions about whether or not to allow a transfer. This project will develop "operational" water deliveries or measures of cost and benefit as an alternative to economic valuation where appropriate. Transfer decisions are further confounded by deterministic presentations of cost and benefit. In most empirical estimates of water value, there is no accounting for the risks faced by buyers, sellers, and third parties related to uncertainties of flows or future streamflows following the stochastic pattern of historical flows, even though benefits and costs change with altered patterns and characteristics of water supply. Stochastic variables that contribute to uncertainty in estimates of water values affect accessibility, reliability, timing, and benefits; in practice the failure to consider risks in empirical valuation of water may be an impediment to market activity. It is not enough to identify the sources of uncertainty. Water supply appraisals should also incorporate information about the levels of sensitivity and the degree of uncertainty in value estimates. This project addresses these issues with respect to specification of input variables and estimation of water values. The objectives of this research are to advance methods of appraising water supplies and to analyze the sources and effects of stochasticity and uncertainty in water values.

Methodology

This project started with a survey of operational valuation methods used in the Western states, continued with an assessment of the Texas study area, and included input from state and local water managers, water users, and environmental professionals. Investigators conducted interviews and focus groups in the Guadalupe-Blanco River Basin and the Rio Grande Basin to describe buyer, seller, and third party interests and identify and develop metrics for water valuation. Economic metrics are used to estimate values of the consequences of water trades, among other measures. This project addressed the element of uncertainty by developing probability distributions for the possible outcomes of change resulting from water transfers. Probability distributions and assumptions regarding some economic consequences are estimated empirically using existing data and through "expert elicitation." Optimization methods combined within simulation models were used to develop explicit methods for evaluating the impacts of water market decisions on buyers, sellers, and third parties.

Principal Findings and Significance

The project has developed ten reports of results. These are listed in Table 1. Staff at The University of Texas at Austin (UT/A) developed two river basin models based on the OASIS w/ OCL™ water supply operator modeling package, one focused on the Rio Grande River Basin and one on the Guadalupe-Blanco River Basin. Staff verified both multi-objective optimization and simulation based on the

historical record. The models enable researchers to compare various water reallocation (inter and intra-basin) scenarios in the study area. The model exercises were applied to evaluate the consequences for buyers, sellers, and third parties involved in a water trade using deterministic and stochastic metrics. During the 1998-99 academic year, the Principal Investigator led an intensive year long Policy Research Project (PRP) at the LBJ School of Public Affairs involving seventeen graduate students and five faculty members on the topic of "Water Planning in Texas." Implementation of the research methodology and completion of the activities discussed below have been a principal subset of the scope of work of the PRP. Students in the PRP assisted city, regional, and state water authorities by articulating issues for implementing the regulations of Senate Bill 1 (Texas Legislature.) These regulations redirect and guide water planning in Texas for the future. The policy directions of Senate Bill 1 include an emphasis on facilitating and promoting water reallocations. Government clients for the PRP included: the Guadalupe-Blanco River Authority (GBRA), which is a financial sponsor of the TWRI project, the Lower Colorado River Authority (LCRA), and the Texas Water Development Board (TWDB). The PRP is publishing four reports from the research during 2000 (see Reports #1 through #4 of Table 1). TABLE 1 REPORTS PRODUCED BY THE PROJECT (listed by proposed or actual title) Report # Citation 1 Eaton, D. (ed.), Evaluation of State and Regional Water Plans, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 2 Eaton, D. (ed.), An Assessment of Public Participation in Texas State Water Planning, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 3 Eaton, D. (ed.), Development of Methods for Evaluating the Consequences of Water Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 4 Eaton, D. (ed.), The Future of Rice Farming in the Lower Colorado River Basin, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 5 Hall, M. and S. Kim., Validation and Assessment of Methods for Evaluating Water Allocations and Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 6 Hall, M., How Possible Water Transfers in the Guadalupe/Blanco and San Antonio River Basins Could Affect Basin Municipalities and Industries, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 7 Valdez, P., Development and Testing of Methods for Evaluating Third Party Effects of Water Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 8 Kim, S., How Possible Water Transfers in the Guadalupe/Blanco and San Antonio River Basins Could Affect Basin Irrigation and Agriculture, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 9 Hurlbut, D., Evaluating Water Markets in the Rio Grande Basin, Ph.D. Dissertation, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 1999. 10 Hurlbut, D., Water Markets, Water Transfers, and Future Drought Risks for Municipalities in the Rio Grande Basin, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. B2.1 Activity 1: Develop Western states information. Researchers collected data on water market operations in Western States, focusing on efforts to evaluate and consider third party effects. Targeted research was conducted into water markets in California including the California drought, and the role of the water banks to value water and consider third party impacts. A review of the literature on methods used to evaluate buyer, seller, and third party effects is contained in three project reports listed in Table 1 (Reports #3, #7, and #9). B2.2 Activity 2: Identify the study area and stakeholders. Investigators used a proposed water transfer in Texas' Guadalupe-Blanco River Basin to the adjacent San Antonio Basin as a real case scenario for evaluating possible buyer, seller, and third party effects of water reallocations. The study area is the Guadalupe-Blanco River Basin and its neighboring San Antonio River Basin (Guadalupe-Blanco/San Antonio Case Study). UT/A researchers met numerous times with the principal agencies involved in the project; the GBRA, the TWDB, the Lower Colorado River Basin Authority (staff of whom were involved on a weekly basis in the PRP), and the Texas Natural Resources Conservation Commission (TNRCC). Together with GBRA, UT/A staff compiled a list of potential

stakeholders who participated in focus groups and interviews. Five UT/A staff developed a focus group protocol identifying stakeholder interests considering the participants, issues, and desired outcomes. The interviews were held in spring 1999 and results are included in two of the reports listed in Table 1 (Reports #1 and #2). One project member worked with the Rio Grande Watermaster's Office to use the border Rio Grande as a real case scenario for evaluating possible buyer, seller, and third-party effects of water reallocations. Potential stakeholders were identified and interviewed. Those results appear in two of the reports listed in Table 1 (Reports #9 and #10). B2.3 Activity 3: Identify stakeholder interests through focus groups. UT/A staff initiated efforts, supported by the TWDB and GBRA, for identifying stakeholder interest. The results of the research appear in two of the reports listed in Table 1 (Reports #1 and #2). UT/A staff have had discussions with LCRA and the North American Development Bank (NADBank) regarding their perspectives on water transfers in the two areas. Additional expert elicitation interviews were held in Spring 2000 and included in Report #6. B2.4 Activity 4: Identify, develop, and apply economic measures of cost and benefit. To investigate the value of water in transfers, UT/A staff modeled potential transfers in order to investigate the impacts of the transfers on the system and the relation of these impacts to the value of the water. Staff acquired the necessary basin data and prepared data sets for modeling various water reallocation scenarios with the OASIS w/OCL™-modeling package, a multi-objective optimization and simulation model. Models of two Western river basins were developed, one of the Rio Grande and one of the Guadalupe-Blanco/San Antonio. Both models are operational and UT/A staff used the models to evaluate the consequences of water markets on transfers. Results of this component of the research are contained in the nine project reports listed in Table 1 (Reports #1, #3, #4, #5, #6, #7, #8, #9 and #10). Economic results were compared with economic parameters through regional input-output models in Report #6. B2.5 Activity 5: Develop and formalize alternate operational measures and gather the necessary data. UT/A staff during 1999-2000 investigated alternate multi-objective metrics for water valuation and water operator management. Results on this topic are contained in eight of the reports listed in Table 1 (Reports #1, #4, #5, #6, #7, #8, #9, and #10). B2.6 Activity 6: Conduct a second iteration to focus group sessions to verify operational measures. UT/A staff during 1999-2000 implemented a second iteration of focus group sessions for verification of alternate metrics and revise alternate metrics if necessary. The deliverable included a description and rationale for revision of alternate measures of water values. These results are continued in four reports listed in Table 1 (Reports #6, #7, #8, and #10). B3.2 Activity 7: Conduct expert elicitation interviews to identify probability distributions for unobservable events. UT/A staff during 1999-2000 developed an expert elicitation protocol, identified experts for interviews, and implemented elicitation interviews. The deliverable was a description of elicitation protocol and preliminary results of elicitation interviews. The results are contained in two reports listed in Table 1 (Reports #6 and #10). B3.3 Activity 8: Analyze probability distributions. UT/A staff during 1999-2000 analyzed probability distributions, implemented verification interviews, and estimated operational values. The deliverable report included final results of elicitation interviews, description of operational water supply valuations and value estimates. The results are contained in seven reports listed in Table 1 (Reports #3 #5, #6, #7, #8, #9, and #10). B3.4 Activity 9: Incorporate economic and operational values in valuation of water market transfers. UT/A staff during 1999-2000 incorporated economic and operational value functions in valuation of water market transfers. The deliverable included documentation of methods and results. These results are included in seven reports listed in Table 1 (Reports #3 #5, #6, #7, #8, #9, and #10). B3.5 Deliverables from Activities 1-9: The reports listed in Table 1 included the items listed below: * methods used to evaluate buyer, seller, and third party effects of water transfers; * list of stakeholders and rationale; * description of focus group protocol; * description and analysis of focus group results including identification of interests, and potential costs, benefits and tradeoffs of recent or proposed water transfers; * rationale for selecting non-monetary measures of value, description of valuation methods, and rationale for selection of methods; * description and rationale for revision of alternate measures of water values; and * description of

elicitation protocol and results of elicitation interviews. The bulleted items listed above were all the deliverables proposed for the project. At this point in the project onward, staff will focus on publication and information transfer.

Descriptors

Water valuation Water transfers Policy analysis Water markets Sensitivity analysis Uncertainty analysis

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

Hurlbut, D., Evaluating Water Markets in the Rio Grande Basin, Ph.D. Dissertation, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 1999.

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

Report # Citation 1 Eaton, D. (ed.), Evaluation of State and Regional Water Plans, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 2 Eaton, D. (ed.), An Assessment of Public Participation in Texas State Water Planning, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 3 Eaton, D. (ed.), Development of Methods for Evaluating the Consequences of Water Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 4 Eaton, D. (ed.), The Future of Rice Farming in the Lower Colorado River Basin, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 5 Hall, M. and S. Kim., Validation and Assessment of Methods for Evaluating Water Allocations and Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 6 Hall, M., How Possible Water Transfers in the Guadalupe/Blanco and San Antonio River Basins Could Affect Basin Municipalities and Industries, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 7 Valdez, P., Development and Testing of Methods for Evaluating Third Party Effects of Water Transfers in the Guadalupe/Blanco and San Antonio River Basins, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 8 Kim, S., How Possible Water Transfers in the Guadalupe/Blanco and San Antonio River Basins Could Affect Basin Irrigation and Agriculture, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000. 9

Hurlbut, D., Evaluating Water Markets in the Rio Grande Basin, Ph.D. Dissertation, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 1999. 10 Hurlbut, D., Water Markets, Water Transfers, and Future Drought Risks for Municipalities in the Rio Grande Basin, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Austin, TX, 2000.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Spatial Determination of Recharge to the Trinity Aquifer (Lower Glen Rose). A Priority Ground-Water Region of Texas
Project Number	1434-HQ-9-GR-02700-WTSU-99-1
Start Date	03/01/1999
End Date	08/30/2001
Research Category	Not Applicable
Focus Category #1	Groundwater
Focus Category #2	Management and Planning
Focus Category #3	Water Quantity
Lead Institution	Southwest Texas State University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Lance Lee Lambert	Assistant Professor	Southwest Texas State University	01
Marshall E. Jennings	Professional Staff	Southwest Texas State University	02

Problem and Research Objectives

The Trinity Aquifer Group in Central Texas includes parts of 10 counties and has been declared a priority groundwater region of the State for more than 5 years. The reason for this designation is the rapid population increase in the region resulting in rapidly declining water levels, combined with relatively low aquifer yields and poorly defined recharge characteristics. Recharge to the Trinity Group, according to Groundwater Availibilty in Texas - Estiamtes and Projections throught 2030, Report 238, Texas Water Development Board, is estimated to be about 1.5% of average precipitation. This estimate--made in 1979--is based on analysis of available long-term base flow of streams in the region and springflows and has not been refined in later studies (e.g. Ashworth, 1983; Blunker, 1992). This estimate of recharge is being used in 1998-99 studies of the Trinity Group Aquifer for Senate Bill 1 planning by the TWDB staff who will use the recharge estimate in a MODFLOW computer model of the aquifer. The TWDB staff is aware of the liability of the recharge estimate and has plans to refine

recharge calculations for the Trinity Aquifer. Obviously, recharge and its spatial distribution throughout the region is highly important for any legitimate water planning ofr the Trinity Aquifer in Central Texas.

Methodology

The research described below, in collaboration with the TWDB, seeks to refine the recharge calculation for the Trinity Aquifer in central Texas using a data-based measurement technique. The data-based technique will rely on measruements of water levels in the lower Glen rose formation of the Trinity Group Aquifer. The lower Glen Rose is the most widely used Aquifer in the Trinity Group region and is also defined as the lower vertical layer of the two-layer regional MODFLOW model now being constructed by the TWDB. A group of about 20 wells, selected in consultation with TWDB, will be monitored for water-level changes; five of the wells will have water-level recorders with telemetry and five additional wells will have recorders but no telemetry. A network of rain guages will be used with National Weather Service Doppler radar to construct both storm, monthly, and annual rainfall isohyetal maps of the region. Pumps tests at several wells will be performed to determine regional aquifer storativity parameters which in turn will be used with water-level changes to determine storm, monthly, and annual recharge. Spatial recharge will be determined by correlating rainfall and water-level rises within the study region. Students will make the field measurements and service the recording and telemetry devices. A student has expressed interest in writing a MS thesis on aspects of the research. As director of the Southwest Texas State Unviersity Geology program, Dr. Lambert will work directly with the student on his thesis topic while Mr. Jennings will assist with field and office technical work related to the research, including supervising and assisting the student with field work. Mr. Petrini, TWDB, will collaborate to insure that the research has strong relevance to the water planning needs of the State of Texas.

Principal Findings and Significance

Non-recording water-level measurements at 22 ground water monitoring wells located in the ten-county priority ground water management area(PGMA) in Central Texas, were collected at 6-week intervals, from April, 1999 to mid-January, 2000. All data was from the Middle Trinity aquifer, the principal aquifer for water use in the region. Additional non-recording data has been collected at three of the 27 sites in Hays County only to May, 2000 (additional measurements planned). Daily recording records were also collected at five sites --- two sites using analog recorders supplied by the Texas Water Development Board (TWDB) and three sites (two of these established in mid-January, 2000) operated by Southwest Texas State University. An additional site was installed by TWDB but experienced failure of operation. All sites show general trends down--due to a general drought with high water use -- with some sites showing water level declines of over 30 feet in one year. Nevertheless, during sustained rainfall periods in some "zones", water level rises due to recharge have occurred. Because of a computer modeling activity of the TWDB now being finalized in a report, generalized aquifer properties e.g. storativity values are available for the ten county region. At present, water level changes and aquifer properties are being used to calculate periods of aquifer recharge in "zones" of the study region. These estimates will be organized into an annual recharge value for 1999 and for 2000 as records permit. These recharge estimates will be compared with various estimates of study area recharge obtained from several previous studies --- values range from 4 to 11 percent of annual rainfall over a multiyear period. At the study completion, comparisons of methods of recharge calculation with strengths and weaknesses of the various methods will be made. Suggestions will also be made of ways to increase the capability of recharge calculation by aquifer water-level based information which has certain advantages over streamflow recession methods.

Descriptors

Trinity Group Aquifer Recharge Karst aquifer Lower Glen Rose formation Doppler radar Precipitation Ground-water management Senate Bill 1 Texas Water Plan MODFLOW

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Developing a Risk-Based Approach to Watershed-Level, Non-Point-Source Modeling of Fecal Coliform Pollution for Total Maximum Daily Load
Project Number	1434-HQ-96-GR-02700-AGEN-99-1
Start Date	03/01/1999
End Date	07/30/2001
Research Category	Water Quality
Focus Category #1	Models
Focus Category #2	Non Point Pollution
Focus	

Focus Category #3	Water Quality
Lead Institution	The Texas AandM University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Marty Matlock	Assistant Professor	The Texas AandM University	01
Saqib Mukhtar	Assistant Professor	The Texas AandM University	02

Problem and Research Objectives

The primary sources of pollution to the water of the United States are urban and agricultural runoff (Environmental Protection Agency, 1994). The most common pollutants from these non-point sources are nutrients, bacteria, and silt (EPA, 1994). Agricultural land is most often used as the terminal receiver of animal waste. Thus, the persistence of potential microbial pathogens from wastes to soils and water is a constant concern. Bacteria pathogenic to humans such as salmonellae, campylobacter spp., Listeria monocytogenes, Eschericihia coli as well as others have been shown to survive in animal slurries for a considerable length of time (Jones, 1980; Kunte et al., 1998; Heinonen-Tanski et al., 1998). Consequently, the potential exists for the transmission of infectious diseases during land application of such slurries (Jones and Mathews, 1975; Ginnivan et al., 1980; Kudva et al., 1998; Kunte et al., 1998) as well from the runoff into streams and ground water (Kraft et al., 1969; Crane et al., 1983). Therefore, a risk analysis in the context of total maximum daily loads for indicator organisms such as fecal coliforms is important in protecting human health in watersheds with complex land use and multiple bacterial pollution sources. The Texas Natural Resource Conservation Commission (TNRCC) listed 148 stream segments in Texas as not meeting their designated use under the Clean Water Act, subsection 303.d (TNRCC, 1998). Bacterial contamination is listed as a pollutant of concern in 65 of these segments (TNRCC, 1988). Coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of animals. Fecal coliforms, a subgroup of these bacteria, can grow at elevated temperature, and include bacteria such as Eschrichia coli. The presence of fecal coliform bacteria in aquatic environments is used by the US Environmental Protection Agency (EPA) and TNRCC as an indicator that water bodies have been contaminated with fecal material. This contamination may result in exposure of humans and wildlife to harmful pathogens such as typhoid fever, or viruses such as hepatitis A, among others. While the methods used to measure fecal coliform bacteria are prone to interferences, they are the most cost-effective and practical methods available, and are not likely to change in the immediate future (APHA, 1990). The objective of this project is to develop a risk-based approach to watershed-level TMDLs for fecal coliform bacteria in the southwestern United States. This approach will provide a scientifically sound model for predicting point and non-point sources of fecal coliform bacteria within agricultural and urban watersheds. Our strategy is to quantify and reduce the uncertainty associated with watershed-level modeling of bacterial fate and transport. Reducing each source of uncertainty associated with bacterial TMDLs will result in their increased application for watershed-level pollution control, a concurrent reduction of bacterial contamination to our nation's waters, and reduction in the costs of achieving an acceptable level of environmental quality. The specific objectives of our research project are: 1. To develop a strategy for assessing risk associated with exceeding some critical contaminant level of fecal coliform bacteria under the TMDL approach developed by EPA; 2. To validate a risk-based model of fecal coliform deposition,

growth and persistence in aquatic ecosystems.

Methodology

We propose to develop a risk-based TMDL strategy for reducing fecal coliform pollution that will integrate in-stream processes with point and non-point source contamination. We will develop our risk-based approach to fecal coliform TMDLs in Leon and Salado Creeks in the San Antonio River Basin (Figure 1). The creeks transverse a variety of land uses in the urbanizing landscape around San Antonio, Texas. We will utilize a taxonomy of uncertainty that combines those defined by MacIntish et al. (1994), Suter et al. (1987) and Haan (1989). We will classify and characterize the uncertainties associated with each component of fecal coliform contamination, and identify potential mechanisms to reduce these uncertainties. We will evaluate alternative approaches and combinations of approaches to optimize our procedure. In addition, uncertainties will be propagated throughout each phase of the analysis utilizing a combination of first-order variance and Monte Carlo simulation methods (Rowe, 1977; Beck, 1987). We will calibrate a watershed model to simulate physical and biological processes within the Leon and Salado creek Watersheds. We will use the Hydrologic Simulation Program--FORTRAN (HSPF), developed by the United State Environmental Protection Agency, for this project. This model was developed for simulating water quality on agricultural watersheds, but has a high degree of versatility; EPA has recommended HSPF for assessment of complex watersheds (EPA, 1993). HSPF uses a geographic information systems interface for detailed watershed analysis and best management practices evaluation. This model has been incorporated into EPA's BASINS program for supporting TMDL assessments. We will use BASINS version 2.1 for this investigation. We will simulate the growth and persistence capacity of fecal coliform bacteria in Leon and Salado Creeks using the HSPF model (Barnwell, 1980; Kolomeychuk and Kalanda, 1983). The HSPF model has a deterministic model of bacterial growth; the model will be calibrated to Leon and Salado Creek watersheds in the first months of the project using detailed sampling data from the San Antonio River Authority (SARA) for the hydrologic years 1992-1994. We will validate the model using SARA data for 1995-98. Sara's database includes monthly or more frequent monitoring at 6 sites in the target streams over the years 1992-98. Point source fecal coliform contamination to the creeks will be estimated based on data from NPDES permit monitoring . Non-point source contamination will be simulated based on land use. Non-point sources of bacteria will be classified based on their profitability for contamination, and their potential for bacterial reduction. We will evaluate scenarios for fecal coliform reduction based on BASINS, with probabilistic output. The Department of Agricultural Engineering at Texas A&M University has the equipment and facilities necessary to perform this research, including aquatic ecosystem laboratories, UNIX-based Sun workstations for modeling, and field equipment for deploying and retrieving samples. The Department of Agricultural Engineering has a Spatial Analysis/Geographic Information Systems (GIS) laboratory equipped with six Sun SPARC stations (160 Mb RAM, 20" monitor, CD Rom, 14 Gb 8mm tape back-up, 10.5 Gb hard disk). Two GIS software packages (Arc/Info Version 7.1 and Arc View Version 3.1), image processing software, and geostatistical programs are resident on the workstations to allow for extensive spatial analysis. The lab has an Altek 48" by 60" (0.005" accuracy) backlit digitizer for data capture activities.

Principal Findings and Significance

We have calibrated HSPF in BASINS version 2.2 and Win-HSPF in BASINS version 3.0 (beta) for hydrology and temperature in Leon and Salado Creeks. We are validating the models based on field data collected by the San Antonio River Authority during wet-weather sampling events. We have developed a preliminary model of persistence based on literature and process theory. We will be integrating the persistence model into Win-HSPF at the conclusion of the study. We will calibrate and validate the

model's estimate of the probability that E. coli will persist or not, and the probability of exceeding a critical threshold (generally 200 cfu/100 ml) under a given scenario. The results from this project will provide a critical resource for managing water quality in subtropical waters. The model will provide probabilistic estimates of microbial contamination of waters in Florida, Texas, Puerto Rico, Guam, Hawaii, and other sub-tropical areas.

Descriptors

Non-point source Fecal coliform Water quality Total maximum daily load

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None

Information Transfer Program

Information Transfer Activities The Institute's technology transfer program attempts to communicate timely information about sponsored research projects and water resources issues to the people of Texas. To the maximum extent possible, TWRI stresses the involvement of professionals affiliated with universities throughout the State. The technology transfer program is delivered through a variety of media, including extensive use of high technology (e-mail Internet list servers and the World Wide Web) as well as traditional means (printed newsletters, brochures, and reports). It is hoped that the result of these technology transfer efforts will be an increased awareness of water issues, the latest advances in research, and rapid incorporation of research information and technology by all user groups. Activities during FY 99 include the following: 1. Continued publication of four quarterly newsletter series. Texas Water Resources discussed such issues as managing water demands, improving drought preparedness, the effect of electricity deregulation on water utilities, and the use and management of small watershed dams. Texas On-Site Insights provided valued information on advances in the development and management of on-site wastewater treatment systems (septic tanks and drainfields) as well as the effect of failing

systems on the environment. New Waves communicated the latest information about specific water research projects and encompassed news from a wide variety of academic disciplines and institutions. Texas Water Savers played a key role in communicating opportunities for increased water conservation, reuse and recycling, complementing the efforts of the American Water Works Association. 2. Expansion and improvement of the Institute's WWW sites. The Institute worked to continue to add content to and promote its main home page, Texas WaterNet (http://twri.tamu.edu), which contains a wealth of materials including the full text and graphics of newsletters and reports, archives of messages distributed over the list servers, and links to other sites. In addition, TWRI worked to increase the strength of websites directed to specific audiences such as on-site wastewater treatment (http://towtrc.tamu.edu) and water conservation (http://tx-water-ed.tamu.edu). Other activities during this period include improving the search engine for all sites to make customized searches easier and to better display results, and to improve the power and speed of the Institute's computers used as a web server. 3. The Institute works to build the capacity for water resources research within the Texas A&M University (TAMU) Agriculture Program and the Texas A&M University System (TAMUS). Examples of these efforts include playing a leadership role in the TAMUS Environmental and Natural Resources Program, bringing together teams from various colleges at TAMU to investigate policy issues associated with natural resources, and creating a program to provide start-up funds for interdisciplinary research teams. 4. The Institute's Director serves as a liaison with several State and Federal agencies, including the U.S. Geological Survey's NAWQA program, the Texas Natural Resource Conservation Commission's Agricultural Chemicals and Groundwater Protection Subcommittee, and Regional, basin-level TMDL Projects. The Director's efforts ensure that university researchers continue to have opportunities to participate in these important programs. 5. The Institute's Director actively participates in such national organizations as the National Institutes for Water Research, the Universities Council on Water Resources, the American Water Resources Association, and the American Water Works Association (AWWA). Additionally, other TWRI professional staff members actively take part with such groups as the Texas On-Site Wastewater Treatment Research Council, the Texas Academy of Sciences, and the Texas Section of the AWWA Water Conservation Subcommittee. The cumulative effect of these activities is to ensure that the Institute is represented at and supports the efforts of these groups, as well as to provide an opportunity to provide news from these organizations to colleagues at universities and to the general public. Citations Gerston, J. August, 1999. "Graywater Future Depends Upon Definition and Rulings," Irrigation Business & Technology. Vol. VII, No. 4. Boer, A., Harmel, D., Jensen, R., Kiesling, R., Matlock, M., McNitt, J., Rottler, C., Vargas, M., and Wilcznski, E. (Editors), Developing Total Maximum Daily Load Projects in Texas--A Guide for Lead Organizations (GI-250), Published by the Texas Natural Resource Conservation Commission, September 1999. Jensen, R., Increasing Awareness About On-Site Wastewater Issues in Texas -- Work of the Texas Water Resources Institute in Newsletters, World Wide Web Sites, and Internet List Servers, Proceedings of the 2000 Conference of the Texas On-Site Wastewater Treatment Research Council, Waco, TX. Jensen, R., Electric Industry Deregulation May Affect Water Utilities, Waterworld, March 2000. Jensen, R., Scientists Investigate Microbial Levels Near On-Site Wastewater Systems, Environmental Health, March 1999.

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	N/A	N/A	N/A	2
Masters	1	N/A	N/A	N/A	1
Ph.D.	1	1	N/A	N/A	2

Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	4	1	N/A	N/A	5

Awards & Achievements

1. Jan Gerston, the Institute's Science Writer, received two awards for recognition of her work and publications on water conservation: a. Conservation and Reuse Award, April 1999, Indirect Program for a Nonutility from Conservation & Reuse Division, Texas Section, American Water Works Association. b. Watermark Award for Communications Excellence, April 1999, jointly given by the Public Information Committee of Texas AWWA and Water Environment Association of Texas. 2. Models were developed for the Rio Grande and Guadalupe-Blanco River Basins to develop explicit methods for incorporating water supply uncertainty into water market decisions. The research underpinned a year-long Policy Research Project at the Lyndon B. Johnson School of Public Affairs, the Univeristy of Texas at Austin, in which 48 Master's-level students were trained in the role of water marketing in water supply planning. Methods were developed and tested to evaluate third party effects of interbasin transfers using focus groups and stakeholders. 3. Field measurements of aquifer water levels from 27 sites in a 10-county area in central Texas underlain by the Trinity aquifer were used to improve the state's ground water availibility model for the aquifer. Due to the prolonged drought, declines of over 30 feet were recorded, and estimates of transmissivity and storativity were improved for this urbanizing area. Results suggest best estimates of recharge are achieved by dividing the aquifer into spatially distributed zones because of large differences in physical properties. The results will be used to define sustainable water use rates for the Trinity Aquifer. 4. Urbanizing watersheds present a difficult challenge for water quality protection because of highly variable flows and multiple sources of contamination. The Leon and Saledo Creek watersheds in San Antonio are being studied to develop risk-based approaches to assessment of fecal coliform deposition, growth and persistence. Fecal coliform sample collection and modeling calibration (HSPF in BASINS) have been completed, and a model of coliform persistence is being tested. The methodology and approach are expected to yield tools for general use in sub-tropical areas in the southern U.S.

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Wurbs, R.A. and E.D. Sisson, 1999, Comparative Evaluation of Methods for Distributing Naturalized Streamflows from Gaged to Ungaged Sites. Texas Water Resources Institute, Texas A&M University, College Station, Texas. 177 pages. Wurbs, R.A., 1999, Reference and Users Manual for the Water Rights Analysis Package. Texas Water Resources Institute, Texas A&M University, College Station, Texas. 256 pages.

Conference Proceedings

Other Publications