

PROPOSAL TO COCHISE COUNTY BOARD OF SUPERVISORS

Residence Time of Groundwater in the Middle San Pedro Basin

Executive Summary

The Problem

- Population in the Benson-St. David area is increasing, and the rate of increase is likely to accelerate greatly if planned real estate developments are brought to completion.
- Groundwater withdrawals are likely to increase to supply the growing population
- Water drawn from the deep aquifer over a long period may affect the amount of water available to support flow in the San Pedro River and for sustaining riparian vegetation along the River.
- The relationships between the flanking aquifers, the regional deep aquifer and the San Pedro River with its shallow riparian aquifer are not well understood.

Proposal

- We are requesting that the County support the collection of Carbon-14 data, which can help describe the relations between the deep aquifer and the shallow riparian aquifer.

Deliverables

- Within 9 months:
 1. Report describing groundwater ages and whether/where significant recent recharge to the regional aquifer is taking place.
 2. Presentation at a public forum
- Within 1-2 years:
 1. Masters thesis that uses the carbon-14 data and additional data that describes a water chemistry study of the aquifers.

Cost

- \$3000 for 12 Carbon-14 samples and analyses.

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Residence Time of Groundwater in the Middle San Pedro Basin

The Problem

Population in the Benson-St. David area is increasing, and the rate of increase is likely to accelerate greatly if planned real estate developments are brought to completion. The water supply for current residents is drawn from the regional deep aquifer that occurs in basin-fill sediment beneath clay beds along the central axis of the Middle San Pedro basin, and to a lesser extent from aquifers in basin-fill sediments along the basin flanks. Future residents will in all likelihood rely on the same water sources. Water drawn from the deep aquifer over a long period may affect the amount of water available to support flow in the San Pedro River and for sustaining riparian vegetation along the River.

The relationships between the flanking aquifers, the regional deep aquifer and the San Pedro River with its shallow riparian aquifer are not well understood. Relevant questions include:

1. Are the deep and shallow aquifers connected?
2. What is the source of water in the deep aquifer?
3. How long is groundwater resident in the deep aquifer?
4. What is the sustainable yield of the deep aquifer?

Studies of stable and natural radioactive isotopes in the groundwater can shed light on questions 1, 2 and 3, and can contribute to the development of groundwater flow models that will help to answer question 4.

Proposal

It would be a great advantage for the Masters study to have additional carbon-14 data for the deep aquifer along the basin axis. The individual analyses are expensive (\$250 each), and sufficient detail is beyond the scope of funding likely to be available through the USGS.

We are requesting that the County support expanding the current data set of carbon-14 measurements by funding an additional 12 analyses for a total of \$3000.

Collaborating Projects

The U.S. Geological Survey (USGS) is studying the Middle San Pedro Basin in detail, using a variety of hydrological and geophysical methods. As part of the study, the USGS is sponsoring a Masters thesis project in the Department of Hydrology and Water Resources at the University of Arizona. The graduate student, Candice Adkins, is working under the supervision of Dr. Jennifer McIntosh (Assistant Professor, HWR Dept.); Dr. Chris Eastoe (Staff Scientist, Geosciences Dept.) and Jesse Dickinson, (Hydrologist, USGS). The scope of Ms. Adkins' project includes the basin aquifer from the USGS streamgage at Tombstone to the Benson Narrows, and will use isotope and general geochemistry of groundwater to address the questions listed above. In addition, Dr. Chris Eastoe is beginning a preliminary isotope study of groundwater in the Cascabel area.

For the Masters study, one useful technique in constraining groundwater residence times will be the measurement of carbon-14 in bicarbonate dissolved in groundwater. In order to provide the most useful information, a comparison in a relative way of the groundwater carbon-14 measurements will be completed. Using an alternative approach of “precise calculations of the residence time or time elapsed between recharge of rainwater and the present is not usually possible (because of multiple sources of carbon in the groundwater) or entirely meaningful (because of mixing of water of different residence times).

A detailed set of carbon-14 data for the regional aquifer of the Middle San Pedro Basin is expected to show whether/where significant recent recharge has occurred. For instance, a carbon-14 map in the Tucson Basin shows clearly where recent recharge to the regional aquifer is focused, and where old groundwater from deep in the basin is upwelling along major faults (Eastoe et al., 2004).

Supporting Data

Three carbon-14 measurements, one from a flanking aquifer and two from the regional deep aquifer, are already available from earlier studies. They lie in the range 24 to 31 percent modern carbon.

One hundred percent modern carbon would correspond to rain that fell in 1950, while one to two percent modern carbon is typical of water thought to be more than 10000 years old in basins such as Safford Basin and the Hueco Bolson near El Paso. The three measurements within Cochise County are consistent with water that has been resident in the aquifers for thousands of years, probably in the range 1000-5000 years.

Deliverables

Within approximately nine months, the project directors will produce for the County a carbon-14 data set with detailed locations, and a preliminary report identifying whether/where significant recent recharge to the regional aquifer is taking place. This report will be presented at a public forum and the data set made available for future studies within the watershed.

In the longer term (1-2 years), there will be a Masters thesis in which the carbon-14 data will be interpreted in the context of the larger data set that is to be gathered for Ms. Adkins’ research, and in the 3-5 year range, the data will be included and further interpreted in the reports for the larger USGS project.

Benefits to Cochise County

As population in Cochise County grows, the need becomes more urgent for water management based on quantitative data on ground water and surface water. Large population growth in the Benson-St. David area seems inevitable in the coming decades.

Two considerations are of critical value to Cochise County:

1. A reliable (sustainable) water supply, drawing in large part on the regional aquifer; and

2. In at least some reaches of the San Pedro River, the maintenance of perennial flow sufficient to support bird migration.

The two considerations may or may not be mutually exclusive, depending on the degree of connection of the shallow and regional aquifers.

The most effective available way to gain a better understanding of groundwater and surface water in the study area is the construction of a detailed flow model. Such a model is the ultimate goal of the broader USGS study.

Candice Adkins' isotope and geochemical study will provide one set of information that is relevant to constructing the model. The carbon-14 sub-project proposed here will provide a crucial set of data for Ms. Adkins' isotope and geochemical study.

Relationship to CWA Objectives

The Community Watershed Alliance is a community-based regional organization that promotes collaboration and cooperation to advance research, education, and policies for the sustainability of our watershed. The Technical Advisory Committee of CWA defines key technical issues that need additional research and or monitoring to support informed decision-making on the Middle San Pedro portion of the San Pedro watershed. The CWA-TAC will provide a forum for sharing this technical information and interpret the research and monitoring results to the Community Watershed Alliance and broader community.

Cost-sharing

The proposed work represents a cost-sharing arrangement as follows. Only the cost of analyses is being requested from Cochise County. The following contributions will be (or already have been) made to the sub-project proposed here:

1. University of Arizona: Chris Eastoe's time, estimated \$700 (10 hours @ \$70/hour).
2. Pomerene Domestic WID: \$1000 for analyses on Pomerene wells.
3. US Geological Survey: Sampling time, transport and materials for the 12 wells involved in this sub-project, estimated \$300
4. Community Watershed Alliance: Assistance in identifying property owners, facilitating discussions for well access, assistance with documentation of results, sharing information thru community outreach, and posting report and data in technical web- library, estimated \$600.

Practical Matters

It is necessary for the University of Arizona to bill Cochise County directly for any work done within the scope of this proposal. The initial report will be authored by Ms. Adkins and Dr. Eastoe of the University of Arizona and personnel of the Community Watershed Alliance. The Masters thesis will formalize the results of this study. The USGS report will use the data in the initial report and the thesis when the information is beneficial for the USGS study..

Reference

Eastoe, C.J., A. Gu, and A. Long, 2004, The origins, ages and flow paths of groundwater in Tucson Basin: results of a study of multiple isotope systems, in *Groundwater Recharge in a Desert Environment: The Southwestern United States*, edited by J.F. Hogan, F.M. Phillips, and B.R. Scanlon, Water Science and Applications Series, vol. 9, American Geophysical Union, Washington, D.C., 217-234.