

# Participatory Learning on the San Pedro: Designing the Crystal Ball Together

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The waters of the San Pedro River in southeastern Arizona support one of the most extensive cottonwood-willow forests in the Southwest, along with high-quality habitat for several endangered or protected species. The contribution of groundwater from the regional aquifer to both the alluvial aquifer and baseflows in the river is essential to sustain the lush habitats of the San Pedro ecosystem. However, increasing human water demands in the region, in combination with drought, have the potential to alter the hydrologic context that sustains this riparian vegetation and impact those species dependent upon it.

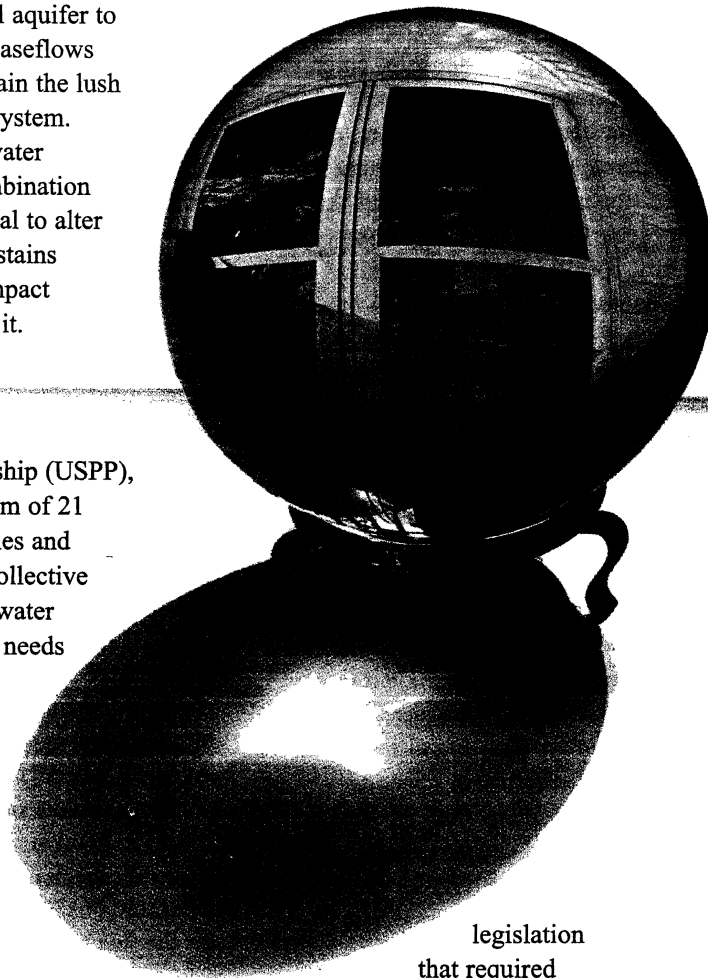
## **The Role of the Upper San Pedro Partnership**

The Upper San Pedro Partnership (USPP), formed in 1998, is a consortium of 21 local, state, and federal agencies and private organizations whose collective goal is to ensure an adequate water supply to meet the reasonable needs of Sierra Vista subwatershed residents and the San Pedro River. Members include elected officials, business representatives, non-profit conservation organizations, and resource agencies with expertise in various scientific and engineering fields.

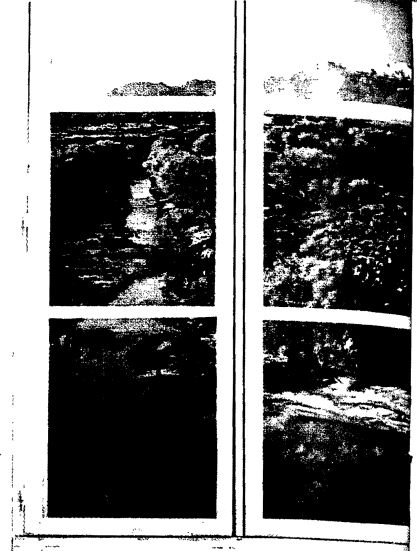
Initially, USPP focused solely upon updating a groundwater model and completing a feasibility cost/benefit analysis of potential management alternatives. As work progressed, members realized an adaptive management approach was needed to address the rapidly evolving challenges being faced. In 2002, USPP began developing a water budget-based decision support system (DSS)

model, working with SAHRA staff at the University of Arizona. A second phase shifted the focus to a spatially explicit model linked to a groundwater model.

Further changes in management goals were triggered in 2004 by passage of



legislation that required USPP to cooperate with the U.S. departments of interior, agriculture, and defense in preparing annual reports to Congress assessing progress toward sustainable yield of groundwater withdrawals from the regional aquifer. Managing for sustainable yield represented a significant paradigm shift from simply balancing an annual water budget; it required an improved understanding of the spatial and temporal



aspects of the system and its response to groundwater management options. A DSS became increasingly attractive as a decision-making tool that could incorporate spatial relationships.

## **Putting the Building Blocks Together**

The primary purpose of a DSS was to provide a basis for understanding the impacts and cost effectiveness of alternative water management options for decision makers within the Sierra Vista subwatershed. As DSS development got underway, a feasibility cost/benefit analysis commissioned by USPP (Fluid Solutions and BBC Research and Consulting, 2003) was being completed that summarized a comprehensive list of 74 water management alternatives identified by USPP members that could potentially be employed to meet their goals. These alternatives were grouped into general categories: public education, residential and commercial uses, recreational uses, irrigated agriculture, water importation and exportation, and reuse of wastewater. Each was described in terms of estimated annual yield in acre-feet and cost per acre-foot, among other factors. The report provided the DSS with a foundational set of alternatives. Furthermore, the categories defined by USPP directly influenced the eventual structure of the DSS model itself.

The cost/benefit study also required extensive discussion and deliberation by USPP members to reach consensus

on critical assumptions. An essential component of these long, detail-oriented discussions was the need for well-facilitated meetings, wherein all parties felt able to contribute to deliberations. The outcomes of these discussions also had to be transparent, well-documented, and directly reflected within the model in order for participants to trust model results. Considerable time was spent addressing pivotal key assumptions, such as population projections, that influenced the resultant water demands that spanned numerous alternatives.

### The Learning Process: A Journey, Not a Destination

The willingness of the modeling team from SAHRA to interactively develop the DSS with the diverse membership of USPP was a key and essential ingredient in model development. Group processes can be painstakingly slow and frustrating, even when well-facilitated, and few scientists have the luxury of providing the time needed to participate in such processes. Conversely, few elected officials have the ability to spend countless hours debating details such as the estimated percent of homes with evaporative coolers, what percentage of these coolers have bleeding systems, how much water is used during each cooler bleed-off event, and how many hours these coolers are used per year. All of these factors are assumptions that must be quantified in order to simply calculate the benefits of just one alternative: replacing evaporative coolers with air conditioners. However, for participatory learning to occur, these types of discussions must remain open to all interested parties, and be both transparent in processes and well-documented as to agreements reached.

The structure of the conceptual model developed for a DSS provides those engaged in its development with a useful roadmap from which they can more effectively understand the interaction of variables, functions, and dynamics of complex systems that would otherwise be impossible to conceptualize. For example, the water management alternatives for the San Pedro DSS are structured by different water use

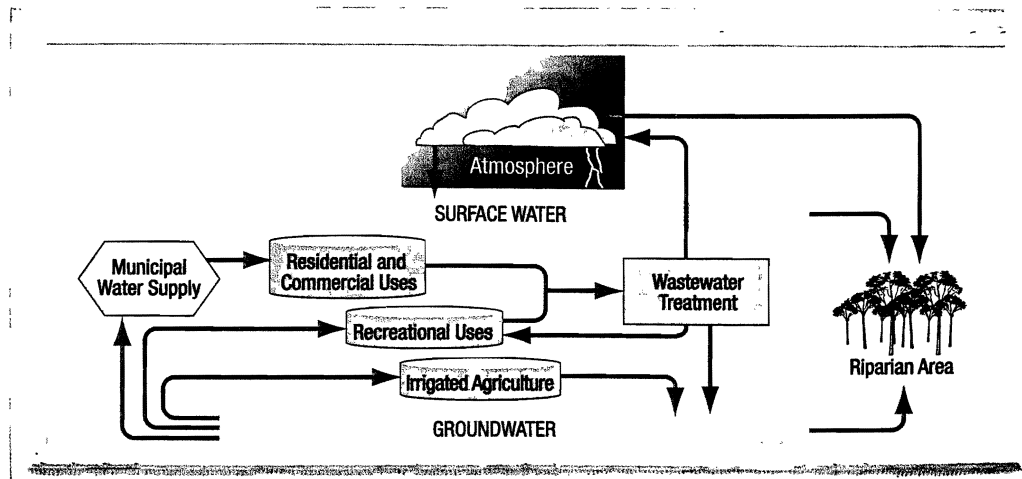


Diagram depicts the general relationships represented in the San Pedro DSS between water demand and supply. Within each of these demand and supply categories, the model can simulate the effects derived from implementation of various water conservation and management alternatives, such as the retirement of irrigated agriculture, recharge of treated effluent, use of pool covers, etc. Colored arrows represent individual flowpaths within the model. The model mass balance also includes groundwater inflows and natural recharge, not shown.

categories. Overall relationships among these use categories, and their relationship to groundwater, surface water, and the riparian area, provide a useful framework for decision makers to understand. At a finer scale, within each water use category, specific alternatives can be implemented in conjunction with others. Conceptualization of these relationships can also be very useful, and are illustrated through conceptual model diagrams of the system (see example above).

Due to variability in social and cultural preferences, economic factors, and other variables, not all of the communities or political jurisdictions within the Sierra Vista subwatershed will likely select the same alternatives. Therefore, another important aspect of the overall model structure is allowing different communities flexibility in selecting alternatives. The interaction between the modeling team and decision makers and local planners was essential for these aspects to be adequately considered in developing the model structure.

Perhaps the most helpful outcome of the DSS is the improved understanding of the interactions and potential overlap between water management alternatives. For example, the yield associated with an effluent recharge program decreases as additional water conservation strategies, such as residential indoor plumbing retrofits, are implemented. Determining yields from public water conservation

education programs was particularly problematic. After considerable discussion, education strategies were considered a fixed cost for regional water management, with no individual annual yield assigned, since many other water management measures would not be as effective without education programs in place.

In adaptive management applications, DSS tools require a long-term commitment by both modelers and users to continually refine and revise the model as new information becomes available, assumptions are revised, and new projects are implemented. The San Pedro DSS is now available online for internal decision-making by USPP members, but outreach applications of the model are yet to be implemented. One of the biggest challenges has been technical and logistical issues associated with launching the model on the Internet so it can provide access to many users simultaneously. Only a true crystal ball can tell us how the DSS will ultimately assist in decision-making for the San Pedro in the future, but it is fair to say that the development process alone has already greatly increased our understanding of several key issues.

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**Reference**.....  
 Fluid Solutions and BBC Research and Consulting. 2003. Preliminary Cost/Benefit Analysis for Water Conservation, Reclamation and Augmentation Alternatives for the Sierra Vista Subwatershed. Prepared for the Upper San