A Comparison of CADRe Processes: Perspectives from the Gila, Rio Grande and Willamette

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Introduction

The value of collaboration, whereby various stakeholders work with policy-makers to address a particular issue has been well documented (Spash 2001; Claussen 2001; Susskind et al. 2001). These stakeholder groups increasingly include collaborative model building as an effective way to inform the decision process. Examples of collaborative modeling include assessing the effects of sheep grazing on sage grouse populations (van den Belt 2004), energy use in iron and steel production (Costanza and Ruth 1998), air quality issues (Stave 2002); sustainability of Arctic communities (Nicolson et al. 2002); park management (Videira et al. 2003); and water management (Moxey and White 1998; Tidwell et al. 2004).

Although growing in popularity, the practice of Computer-Aided Dispute Resolution (CADRe) is still in its infancy and evolving rapidly. As a result, there is limited consensus on the exact meaning of CADRe, which is clearly seen by the different monikers by which it is known (e.g., mediated modeling (van den Belt 2004), cooperative modeling (Tidwell et al. 2004), shared vision planning (Palmer et al. 2007), computer-mediated collaborative decision making (Kreamer and King 1988). This proliferation is in part driven by the fact that each management and planning exercise is unique, requiring careful tailoring of the process.

In this paper we present three applications of CADRe to water related planning problems, each with their unique demands. Our objective is to identify key forcings in the planning process and how they influence the structure of CADRe. In so doing we hope to demonstrate that while the details of each project differ the general approach remains the same; that is, a process for involving stakeholders in the conceptualization, specification and synthesis of knowledge and experience into useable information (i.e., model) for the express purpose of addressing a complex problem. While not a comprehensive list, for the purposes of this paper we will focus our attention on three key forcings: the physical setting of the project, the available modeling toolset, and the decision landscape.

We begin by reviewing the basic features characterizing each of the three CADRe case studies. Geographically, these case studies are associated with the Upper Gila River and Upper Rio Grande in New Mexico and the Willamette River in Oregon (Figure 1). A brief description of the implementation of CADRe within the differing settings is then given. Finally, a discussion of the key forcings and their influence on the CADRe process is considered. It should be noted that each of these projects are in relatively early stages

of the planning process. Specifically, efforts to date have focused on the model development aspects prior to any application in formal decision making. Thus, perspectives shared in this paper are conditioned on this timing.

Background

Below we provide a general description of the setting for each of the three CADRe projects. In particular, we characterize each with respect to the three key forcings: physical setting, available modeling toolset, and decision landscape.

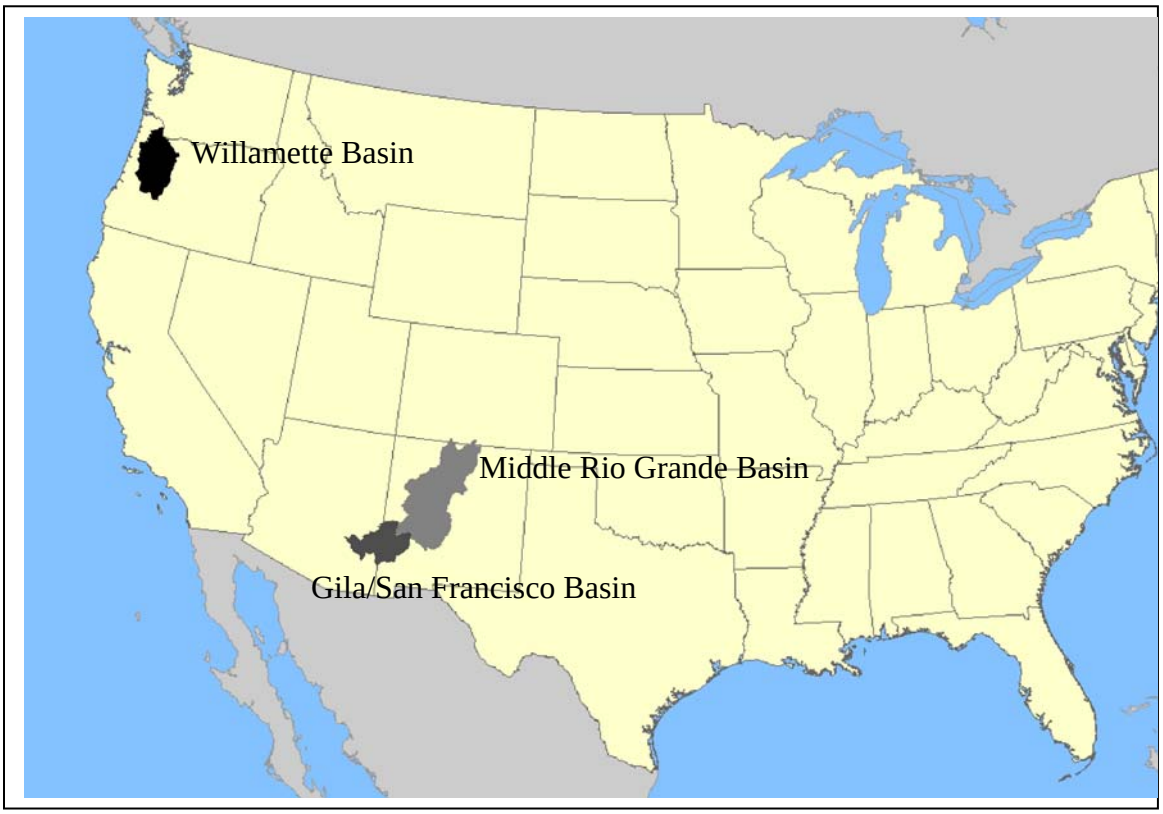

Figure 1. Case study test sites.

Gila: The Upper Gila and associated San Francisco Rivers in southwestern New Mexico provide the setting for our first case study. This region encompasses four large and sparsely populated counties, much of which is protected wilderness. Key water demands for this region include traditional flood irrigation and copper mining, which are being challenged by growing municipal demand and instream flow requirements to address endangered aquatic and riparian species. The driver for this project is the 2004 Arizona Water Settlements Act, which provides New Mexico an additional 140,000 acre feet of water from the Gila Basin in any ten year period. In addition, the State of New Mexico will receive $66-128M for paying costs of water utilization alternatives to meet water supply demands in the Southwest Water Planning Region of New Mexico. Implementation of these articles is the responsibility of the New Mexico Interstate Stream Commission (NMISC) in consultation with the Southwest Water Planning Group

(SWPG). To help capitalize on this opportunity, a CADRe approach is being used to develop decision tools to support implementation of the articles of the 2004 Arizona Water Settlements Act. Application is occurring early in the planning process in a basin where no water resource management or planning models exist.

Rio Grande: Our second case study also focuses on New Mexico; specifically, the Upper Rio Grande which we define as the river reach from the Colorado border to Elephant Butte Reservoir in south central New Mexico. Along this reach the Rio Grande drains the Sangre de Cristo and Jemez Mountains along with extensive high desert regions. River water is heavily used for traditional flood irrigation throughout the basin while Albuquerque, Santa Fe, and other small communities pump municipal water from groundwater aquifers that are in direct communication with the river. Beyond the uses by irrigators and growing municipalities are riparian evapotranspiration, instream flows to support the endangered silvery minnow, and evaporative losses. Currently there is no immediate water planning driver for this project; however, impending demands include support for water rights adjudication and changing instream flow requirements. Toward this need, a CADRe approach is being implemented to develop decision tools to assist with stakeholder engagement and rapid screening analysis to support future planning projects. These exercises are being conducted in a basin where numerous trusted water management tools exist.

Willamette: Our third case study involves the Willamette River in western Oregon. The Willamette is the 13th largest river in the continental United States in terms of stream flow and produces more runoff per unit of land area than any other river. The U.S. Army Corps of Engineers (USACE) operates 11 major water storage reservoirs on tributaries to the Willamette River for irrigation, inexpensive power generation, and flood control. Water managers on the Willamette face a number of difficult and closely interrelated challenges associated with the Endangered Species Act, Clean Water Act, and growing demands and stresses on the resource. Considerable public planning has already been accomplished in the basin with much of the assessment and planning phases for solving some of the basin's problems codified in evolving regulations. CADRe has been implemented to facilitate discussions on water resource management in the basin, with decision tools built to link multiple factors such as water quality (including temperature), aquatic and terrestrial biological communities, and other concerns at different locations throughout the basin. Again, this basin benefits from the availability of several detailed and trusted water resource management models; however, these tools are not currently coupled.

Methods

As the characteristics for each of the case studies differ in terms of their physical setting, availability of water management models, and the decision landscape, so to do the details of the CADRe application. Here we compare and contrast stakeholder involvement in the development and application of decision tools as experienced in each case study.

Gila: In the Gila Basin the NMISC in cooperation with the SWPG, the U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife and the Governor's Office

established a science, planning, and public outreach program aimed at addressing opportunities associated with the Arizona Water Settlements Act. In this case, the CADRe exercise represents one key facet of a broader planning program. The objective of this effort is to develop a decision support tool that has broad acceptance across the science, decision-maker and stakeholder community.

In an effort to establish an open and transparent modeling process a "cooperative modeling team" was created. The team consists of representatives from each of the planning agencies noted above plus municipalities, irrigated agriculture, ranching and the environment. In addition, a professional facilitator and meeting note taker have been responsible for managing the flow of each meeting. This team has been meeting on a bi-monthly basis since it was formed in September of 2005. Because of the wide geographic dispersion of the team members meetings are held via web/voice conferencing. In addition, quarterly face to face meetings coinciding with the monthly SWPG meetings are held to help build a sense of team among the members while giving the general public an opportunity to stay informed and provide feedback.

Because of the lack of other planning tools in the Gila, the CADRe process has been responsible for building decision tools from the ground up. In this way the cooperative modeling team has assisted with system conceptualization, data gathering, defining causal relations and quantifying key physical processes. Actual coding of the model has been performed outside the meetings by the authors of this paper. The resulting model is developed in a system dynamics framework to address the principle water supply and water demand sectors within southwestern New Mexico; specifically, surface water, groundwater, land surface processes, institutional controls, environmental, water use, and future water utilization options. Model simulations are conducted on a daily time step over a variable planning horizon. Spatially, the model is disaggregated according to eight river reaches as defined by active gauging stations.

Rio Grande: The CADRe process as applied to the Upper Rio Grande has a very different character than the Gila. Much of the difference is due to the fact that the CADRe effort is not focused on an immediate planning issue; rather, the effort is supporting tool development for future exercises. While there are other trusted water planning models for this basin, the purpose of the CADRe effort is to develop decision support tools for rapid scenario screening and to provide a vehicle for stakeholder engagement in future water planning. In this way the model sacrifices some spatial and temporal resolution for rapid simulation and an expanded decision space.

Again, a cooperative modeling team was formed; however, it is populated only by technical representatives from state and federal water agencies; specifically, scientists and modelers from the United States Geological Survey (USGS), the USACE, Reclamation, and the NMISC. Collaboration occurred primarily through monthly to bi-monthly meetings over the last year. These meetings focused on the abstraction of the physical relations and data contained in the higher resolution models for use in the decision support tools, specifically reviewing the general framework, assumptions, and methods employed. In this way the resulting decision support model reflects the science

and data of the higher resolution models, while the necessary upscaling is accomplished according to the knowledge and experience of the cooperative modeling team.

The resulting model focuses on the Rio Grande surface water and groundwater system in northern and central New Mexico. This river basin scale model integrates three existing MODFLOW groundwater models (at reduced spatial resolution) and one RIVERWARE surface water model (at reduced temporal resolution) in a system dynamics framework. To this physical model, a simple human behavioral model and user interface was added. The resulting tool runs 40-year simulations on a laptop computer in tens of seconds, with inputs that are easily changed by non-expert users via a graphic, user-friendly interface.

Willamette: The Willamette provides yet another variant on the CADRe process. The key driver in this case study is a recently issued biological opinion and associated regulatory Total Maximum Daily Load (TMDL) for water temperature. These new regulations require the USACE to undertake significant actions with regards to their current reservoir operations. Local municipalities and pulp/paper industries that discharge waste water to the river are also subject to these new regulations. In an effort to help meet the TMDL faster and to reduce the cost and conflict of compliance with multiple regulations while delivering broader environmental benefits, a coalition of stakeholders formed the Willamette Partnership (WP). The WP recently received a grant from the Environmental Protection Agency to develop an ecosystem marketplace where water quality and conservation credits can be traded.

The USACE in cooperation with the WP (and the broad stakeholder group that they represent) are spearheading the planning process. CADRe has been implemented to assist with the development of decision support tools for the evaluation of alternative reservoir operations and conservation credit systems that might be used to meet the new TMDL. Specifically, these tools need to couple river/reservoir routing with temperature dynamics (which does not currently exist). In this case, the stakeholders represented by the WP requested to have a limited role in the model development phase, focused on defining the overarching model scope and decision metrics. Technical aspects were left to the review of a group of local experts who had experience in modeling temperature dynamics on the Willamette. This team consists of representatives from the USGS, USACE, Portland State University, and Oregon Department of Environmental Quality. The team functions in much the same model development capacity as that of the cooperative modeling team for the Middle Rio Grande. Additionally, this advisory role is intended to build a level of confidence with the stakeholders that the models can be trusted for their intended use. Meetings with this advisory team occur quarterly, given the demands of the project and the physical separation of the advisory and core modeling team.

The resulting model is once again developed in a system dynamics framework. Because of the importance of temperature dynamics, the model operates on a 6 hour timestep. The model disaggregates each tributary and the mainstem into multiple interacting reaches and addresses each reservoir individually (with associated operations rules). The model tracks river discharge and temperature as a function of changing reservoir operations, climate conditions, and loads to the river. Also considered are economic costs,

recreational values and power generation. Model outputs are ultimately assessed in terms of TMDL compliance. Throughout this process considerable effort has been made to demonstrate the degree to which this lower resolution systems model compares to results of the higher fidelity (yet uncoupled) HEC ResSim and CE-QUAL-W2 models.

Discussion

In this section we compare and contrast application of the CADRe process across the three case studies. First, we consider similarities shared across all three projects. We then turn our attention to differences in application and the relation of these differences to the key forcings characterizing the three projects.

Indeed, all three case studies share important similarities in their application of CADRe. In fact, the similarities represent some of the key characteristics distinguishing CADRe processes. First, each case study was faced with a challenging suite of decisions involving the interplay of complex physical, institutional and legal systems subject to a growing and diverse set of demands and values placed on the water resource. Second, stakeholders in all three projects recognized a need for computer-based tools to support the decision process. Even in situations where detailed and trusted water management models existed there was a need to make the science and subsequent scenario analysis accessible to the stakeholder. Third, the stakeholders required that the model development or abstraction process be transparent; that is, they wanted some level of involvement in modeling. In each case the stakeholders took an active role in defining the scope of the model, decision metrics, and oversight of the technical content.

Likewise, there were significant differences in the details characterizing the CADRe process in each of the case studies. Although all three CADRe models were developed in a system dynamics context, each differed in terms of the scope, spatial/temporal resolution, and the physical/social attributes modeled. These differences were at the direction of the cooperative modeling team and are a result of the variability in project setting and the decision landscape. The availability of existing water management models had the effect of improving the quality and confidence in the CADRe model.

Another important difference was in the composition of the cooperative modeling teams. The Gila Cooperative Modeling Team had the broadest stakeholder involvement and the most active participation. The momentum generated by the early stages of the Arizona Water Settlements Act planning certainly had a strong influence on this level of participation. Other contributing factors included the lack of trusted water management models and thus the desire for careful oversight by the team, and that the Gila is the last free flowing river in New Mexico which provided a rallying issue for both local, state, and national environmental interests. The Willamette also enjoyed broad stakeholder participation; however, participants requested that the technical issues be handled by a smaller sub-committee. The stakeholder team was willing to relinquish some of its control and involvement because of the trust and confidence developed with the technical experts and models through interactions on past planning efforts. These past efforts also created a sense of “planning fatigue” and thus the desire to limit time spent in meetings. Stakeholder participation in the Middle Rio Grande was limited to state and federal water

managers. This was driven by the decision landscape in which there was a desire to take proactive steps toward preparing for future planning efforts. Because of the lack of a specific planning driver and limited resources involvement by a broad stakeholder team was impractical.

The mode and frequency of stakeholder meetings also differed across the three case studies. The highest frequency meetings (bi-weekly) occurred in the Gila, largely because the model development process was starting from scratch—no models existed prior to this effort. The monthly to quarterly meetings of the Middle Rio Grande and Willamette teams reflect the fact that model development was largely an abstraction exercise from existing models. The mode of the participation in all three case studies included face-to-face meetings. However, in the Gila, where participants were geographically dispersed yet there was a need for high meeting frequency, web/voice conferencing was used

Finally, the role of CADRe within the broader planning context differed across the three case studies. In the Gila project, the CADRe process worked in parallel with other science and public outreach efforts. CADRe was simply one piece in a broader effort. However, the Arizona Water Settlements Act planning project was recently stalled by a Governor's veto because of a lack of balance across key interest groups. This resulted in a request by the NMISC and Governor's Office for the Cooperative Modeling Team to facilitate efforts to re-structure the broader planning process. While the effort on the Willamette also involved a distinct planning driver (new temperature TMDL), there was no coordinated state or federal response. Also, over the course of the CADRe project the compliance time was shifted from 18 months to ten years. This change in compliance timing has made it much more difficult to maintain stakeholder focus in the effort. The Middle Rio Grande represents a very different case in which a "preemptive CADRe" planning effort was established in efforts to avoid future conflict. While there are significant advantages to developing planning tools and creating an environment of cooperation among water managers prior to conflict, there is the distinct danger of not having broader stakeholder involvement in the model formulation stage. We will take this experiment to the next stage as we engage a broader group of stakeholders in tailoring and applying the model to look at alternative conservation storage options in upstream reservoirs.

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