Chapter 3

Executing CADRe: Integration of Models with Negotiation Processes

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Introduction

There is a long history of efforts to support water resource decision making with computer simulation/optimization models. Initial efforts often were called decision support systems (DSS) and while this label persists in the literature, a variety of other names for computer-aided decision support systems have emerged (Thiessen, Loucks, and Stedinger 1998). Advances in computational capabilities, user interfaces, and graphical displays have made it possible to rapidly analyze data and display the results for decision participants and decision makers.

Even as decision support system tools have grown in capability, the focus of the professional literature rarely considers how to integrate these technical advances into decision making processes (Loucks 1995). Decision support system software is often developed independent of any specific decision process. When there is an application, the analysis often presumes a generic and single well-defined "decision maker" (a single government agency) with authority to make choices among various alternatives, rather than the complexity of multiple decision participants and decision points. Furthermore, decision support models often produce a single set of model outputs and performance metrics selected by the model builders. The results are then offered to decision participants for possible use without consideration of the causes or degree of the dispute, the number or diversity of parties involved, the matters in dispute, or the specific institutional setting (Lund and Palmer 1997).

The distinguishing feature of CADRe processes is integration of decision support modeling into the processes of dispute resolution/negotiation. Technical models for CADRe are developed to serve a place-specific negotiation, rather than being developed independent of or parallel to decision processes. This creates the opportunity for an explicit discussion of the criteria for determining the "best" answer to the water management questions confronting decision participants, rather than relying on a model based on an implicit set of criteria (often the modelers') to define decision outcomes. This integration of decision support models with the decision-making process allows considerations about the values and interests of those affected to influence how the model is built and used as much as the model influences how the process evolves.

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Therefore, a first step in a CADRe process is not model building, but rather structuring the negotiation or decision-making process. There is an extensive literature on this topic (Schelling 1960; Deutsch 1973; Raiffa 1982; Fisher and Ury 1983; Lewicki 1985; O'Leary 2003; National Research Council 2008). For purposes of this chapter, two aspects of this step as being critical to CADRe are noted. First, there must be a decision on which agencies, organizations, and individuals will be asked to participate in the CADRe process and an agreement among them about the definition of the problem they are seeking to solve. The desire is to be comprehensive in reflecting the full range of values, interests, experts (scientific perspectives), and decision authorities that will be affected by the decision and/or are at the source of potential disputes. Second, there is a need to design a process that allows for different levels of participation. The use of the model, as will be described in this chapter, is to be a focal point for the communication between and among multiple groups and agencies. For this to happen there must be a trust in the model and that requires some decision participants to be engaged in the modeling. Because not every participant will be interested in or able to contribute to the modeling, the design challenge is how to assure that the decision participants trust those who are engaged in the model development process.

CADRe requires integrating technical simulation modeling into the collaborative negotiation processes in three dimensions:

- Collaborative development of the model outputs (Responsiveness)
- Collaborative development of the model mechanics (Credibility)
- Collaborative use of model (Usefulness)

This focus for integration ensures that the developers of analytical models and the models themselves are: 1) *responsive* to needs and concerns of decision participants, 2) *credible* to decision participants and decision makers (if different), and 3) *useful* to collective investigations and negotiation of alternatives. Each of the three dimensions is related to the others and attention to each requires the conscious attention of the model developer, in cooperation with the facilitator of the CADRe process. While these are not independent steps in executing a CADRe process, for purposes of exposition these dimensions are described in a sequence where discussion of each dimension builds on the discussion of the preceding one. Taken together, these dimensions of integration between technical model and collaborative negotiations represent the unique domain of CADRe processes.

Collaborative Development of the Model Outputs: Identifying What Decision Participants Want to Know

The purpose of integrating technical models with collaborative processes is to create useable knowledge *for decision participants*. Therefore, models must produce answers or outputs that are meaningful to multiple and perhaps non-technical decision participants. The challenge to the model developer is to assure that the modeling is responsive to interests of decision participants, and is not organized to answer questions solely of interest to the modelers or scientists and technical experts.

Therefore, the first effort is to identify the decision participants' interests and concerns, the resulting questions they see as relevant, the information desired, and then the performance metrics of the model. These performance metrics are the indicators of outcomes of interest and concern to decision participants. Performance metrics are what measures of outcomes that decision participants want to know. Responding to these needs makes model outputs decision-relevant. When performance metrics are explicitly linked to decision participants' interests and concerns, the information generated is more likely to be responsive and, thus, to be used in the decision-making process. Performance metrics also must be measurable and must be capable of being predicted by the model with some degree of certainty (Sheer, Baeck, and Wright 1989; Gregory and Failing 2004). Thus the CADRe process starts with a collaborative process involving modelers and decision participants, when decision participants are lead through a process to articulate their questions and concerns, identify the information they are seeking to answer those questions, and then, with assistance from modelers, to agree on those specific performance metrics that they will use. Generally, because they are linked to the parties' interests, these performance metrics can be used to evaluate outcomes of different management choices. The process of developing identifiable performance metrics is a learning process that requires stakeholders to sharpen their own thinking about what aspects of the problem are important and critical to their interests and values, and may well encompass a broader set of conditions than decision makers originally envisaged (Gregory and Failing 2004). Also, these performance metrics are place- and situation-specific, and are not given from outside the process. While the burgeoning literature on indicators produced for and by scientists can help inform this process (Turnhout, Misschoemoller, and Eijsackers 2007), in a CADRe process indicators must emerge from the collaborative process, cannot always be defined in advance or in isolation by experts, and, in the best case, will be continually refined as the process goes on.

However, there is a central role for technical expertise in the development of performance metrics. For instance, risk and uncertainty are expressed and understood very differently between risk experts and nontechnical people (National Research Council 1996). Thus facilitators and model experts may have to investigate ways to translate metrics of risk and model uncertainty into expressions that are meaningful to stakeholders. Subtle differences in the phrasing of indicators could also influence the acceptability of a performance metric. For example, expressing risk of flooding as "probability of flooding" was found to inhibit negotiation while expressing the same notion as "the reduction in the chance of flooding from the status quo condition" generated more productive discussions (Gregory and Failing 2004). The expression of probability focused stakeholder attention on how far an alternative was from what was considered an ideal (zero probability of flood risk), while flood risk reduction stressed the amount of improvement.

A second technical challenge is that some stakeholder objectives may not be readily translated into a measurable performance metric. Stakeholder objectives may be based on deeply felt but intangible or subjective values and beliefs (Sheer, Baeck, and Wright 1989). However, these cannot be dismissed or ignored. Developing performance metrics that resonate with all stakeholders is often one of the most creative and difficult challenges to developing CADRe models (Sheer 2007). While such values may be difficult to quantify, articulation and incorporation of such values are central to most problems and an essential requirement of any evaluation (Lord 1979; Sheer, Baeck, and Wright 1989).

Third, a multi-stakeholder and multi-agency process, responsive to these multiple concerns, can lead to many different performance metrics being developed. These metrics will, in all likelihood, be expressed in different units (dollars, flows, habitat, probabilities, etc). Multiple performance metrics may be more responsive to the dimensions of the problem important to stakeholders, but can increase the technical difficulty of presenting the comparison of alternatives. However, the number and content of the performance metrics can become more than a technical matter.

The more diverse the interests of the decision participants, the more diverse the performance metrics will be. For example, if federal funds are to be obligated there may be national objectives and metrics that are relevant to decision makers, but that may not be of interest to those who have more place-based objectives. Perhaps granting of a license or a permit for a proposed action by a federal agency may require meeting certain specified federal objectives. For example, the objective of a local water supply manager may be to secure storage in an existing reservoir to increase the safe yield of their water supply system. A local recreational group may have interest in the number and timing of whitewater boating days below the water supply reservoir. However, there may be a federal budget requirement to demonstrate that national economic development purposes are served by any proposed change to reservoir operations. For purpose of this chapter, we focus on the decision participants who have place-based objectives, because any alternative must always meet a test of local acceptability and earn support of the local population. However, we assume all required federal analyses would also be done.

Finally, development of performance metrics that are responsive to and reflective of decision participant needs serves a larger role than just facilitating negotiations or collaborative learning. Performance metrics can also serve the longer-term needs of implementing and monitoring outcomes. Performance metrics can be adapted and used as indicators that provide impacted parties a way to measure progress toward implementing the alternative selected. Performance metrics can facilitate learning and adaptation to the original agreement as people learn and refine their understanding of how the system responds to different conditions.

Collaborative Support and Development of the Model Mechanics: Developing a Model that Credibly Reflects the Effects of Alternatives on Performance Metrics

Technical simulation models predict the changes in performance metrics under the existing conditions and from different water management or investment alternatives, as well as for a future condition without action. These predictions must be trusted by the decision participants and so the model structure and modelers themselves must be credible to the decision participants.

Model construction for CADRe includes the same elements of any model-building process: conceptual model development, definition of technical relationships and response functions between model variables, identification and selection of data inputs, and meaningful and understandable presentation of results. What distinguishes a technical model in CADRe is that credibility comes from the openness of the modelers to engage stakeholders in constructing the model so that all the decision participants believe the model provides an acceptable and trusted representation of the water management system.

Collaborative negotiation professionals have developed procedures and research to integrate technical expertise into negotiation processes. This work is sometimes described as "joint-fact" finding. CADRE processes extend this dimension of integration by a deliberate, structured, and collaborative organization of scientific knowledge, data, and technical expertise into technical models. These models allow decision participants a platform for more systematic examination, exploration, and discussion of possible outcomes and alternatives.

Conventional modeling approaches envision the role of the scientist and technical modeler as providing analysis and results to the decision makers. The CADRe modeling process allows for joint learning and exploration of the water resource system, the problem, and more mutually satisfactory alternatives. Involvement of the modeling processes can deepen and broaden decision participants' understanding of the linkages and relationships within the water resources system. This understanding can also facilitate better mutual understanding of how different groups' interests and objectives relate to and impact each other. Yet, knowledge flow is not one directional: from technical experts to decision participants. CADRe allows for the possibility that system understanding (day-to-day working knowledge) and supporting data, in addition to the earlier step of framing performance metrics, can also be provided from decision participants to modelers. Therefore, the model construction process becomes the focal point and the forum for decision participants to share knowledge and achieve a common understanding of relationships within the system. Model development becomes a center for collaborative learning. CADRe model construction is the process by which to organize data, stakeholder knowledge, and scientific knowledge into a framework credible to all.

In most situations, not all decision participants will have technical expertise to actually construct a model or the data to inform different model runs. However, their participation often is necessary to build confidence in and a shared understanding of the model and its outputs. Recognizing this, some CADRe processes stress the direct collaborative construction of a model where a third-party modeler constructs basic elements of the model in the presence of decision participants (van den Belt 2004). This process might be simplified by a second approach in which decision participants communicate through a neutral and agreed-upon technical modeling expert. The expert would solicit direct input from stakeholders, but would work offline to develop the actual computer model (such as has been done, for example, by Hydrologics, a private firm). In yet a third approach, a subgroup of technical experts may be formed that direct or develop the technical models. This subgroup could include modelers sent by competing stakeholder groups to represent their specific interests. This subgroup would be directed and report back to the stakeholder (management or policy) group responsible for decision making (Werick and Whipple 1994; Call 2001).

CADRe technical models must be acceptable to decision participants if they are to be the basis for a common understanding of the alternatives being considered and their consequences for different performance metrics, and ultimately for assisting in the identification and discussion of alternatives. A range of model development requirements have been identified that would yield that result. All modelers undertake standard procedures for calibrating and verifying simulation models in order to increase their own confidence in the internal consistency of the model logic, in a model's ability to predict the outcomes of interest, and/or in order to have a sense of the magnitude and direction of error in model predictions. Knowing that these kinds of processes are employed will increase the acceptability and credibility of the models.

Equally important, if decision participants do not have confidence that the model adequately represents the system of concern, the CADRe models will be of limited value in negotiating agreements. Therefore, CADRe processes require a different process for verification by requiring the data, structure (technical relationships), logic, and predictions to "make sense" to the decision participants most familiar with the decision problem and to their trusted technical representatives. Toward that end, model architecture that is transparent to decision participants (or their technical representatives) can facilitate stakeholder confirmation and verification of data and technical relationships. This does not necessarily mean knowledge of the technical mechanics of the model, but rather the general ways the model elements are related to each other and how model output is produced. The inability of stakeholders to comprehend technical models has been cited as a major barrier to use of a model in negotiation processes (Sheer, Baeck, and Wright 1989; Dahinden et al. 2000). The use of object-oriented system software (STELLA®, WEAP, PowerSIM) is often used to construct such models because of the visually appealing and transparent way system elements relate to each other (van den Belt 2004; Werick and Whipple 1994).

Once initially constructed, CADRe models should be subject to revision and modification because nearly all—and certainly the most useful—negotiation processes are evolving, learning processes. Thus, the development of performance metrics and the technical model needs to be an iterative process. CADRe processes recognize that decision participants often enter with both vaguely formed notions of the scope and nature of the problem being confronted and their own specific interests and values (Simonovic and Bender 1996). Unstructured problems mean that model boundaries, objectives, and performance metrics may shift and be refined over the course of the negotiation. Models and modelers in CADRe processes must be in a position to both accommodate *and* facilitate the developing knowledge of the decision participants about their own preferences and interests. Because the model development process is on-going and must maintain credibility, most CADRe processes develop some process for decision participants to continuously contribute and discuss not only data inputs, but also relationships within the model. Joint fact finding efforts can be part of coordinated efforts for decision participants to develop the data foundation, technical relationships, and response functions within the model. Indeed, some suggest that the process of model development lends credibility to the model and to the decision process as much as the technical features of the model itself (Grayson, Doolan, and Blake 1994).

Admittedly, the CADRe expectation that technical computer models are developed in service of a negotiation process can present special challenges to modelers. One major challenge is making the trade-off between complexity and transparency. Technical models are all expected to be capable of "accurately" representing how the water resource system works. While modelers may wish to increase model complexity to better model system response functions, complex models will reduce transparency, understanding, and responsiveness of the model to the evolving needs of a negotiation process (Korfmacher 1998; Dahinden et al. 2000; Roach and Tidwell 2007). The modeler needs to maintain sight of the goal of a stable and supportable agreement, which is facilitated by the negotiation process as well as the model, and make complexity/transparency trade-off decisions accordingly. At the same time, decision participants will need to understand that the accuracy of the model predictions—defined as how closely the model approximates the "true" value of some predicted outcome—is always limited (Oreskes, Shrader-Frechette, and Belitz 1994).

A second model development challenge is to anticipate and address analytic dispute and uncertainty among scientific experts, and possibly between experts and nontechnical stakeholders. Technical models for CADRe are constructed on assumptions of how the relevant water resource system under consideration operates. Those technical assumptions are in turn based on scientific studies and analytical constructs from the physical, biological, chemical, and social sciences. The results from these studies may be in dispute and/or subject to significant uncertainty, and analytic dispute can reduce model credibility. For example, the returning adults of a migratory fish species may be of central concern to stakeholders. Yet, understanding the role of changing water quality or timing/duration/magnitude of flow levels on fish population is typically subject to considerable scientific uncertainty and perhaps professional disputes.

How and whether such disputed or uncertain response relationships are included in a technical model is important to building credibility for the model. Options to address scientific/technical uncertainty include conducting additional site-specific field studies, additional collaborative fact-finding, soliciting expert judgments to describe response functions, or developing acceptable, more identifiable surrogate response relationships (for example, estimating aquatic habitat rather than fish response). Gregory and Failing (2004) report stakeholder opposition to developing response functions based on expert judgment processes when data quality/scientific information is low.

The technical models themselves may help diffuse some scientific disputes by conducting sensitivity analysis around the system elements in dispute. In some cases, the range of scientific dispute over a particular modeled relationship may produce small differences in predicted performance metrics. Thus, a scientific dispute can effectively be set aside if it does not have immediate or significant impact on the policy decision under discussion.

A third challenge is maintaining the model focus on "if this … then that" relationships. Care must be taken to guard against embedding hidden value judgments in the model that are policy choices within the appropriate domain of the negotiations. The distinction is often difficult to separate and identify in practice. For example, the objective of one decision participant group might be to protect and enhance some biological measure of the status of a particular fish species. This interest might ask the question, "What timing, magnitude, and duration of water flow is needed to produce a healthy (or sustainable) fishery for species X?" Framing the question in such a way, however, requires the technical analysts and modelers to define "healthy" and "sustainable." Modeling becomes centered on trying to answer what is healthy or sustainable, but neither definition answers technical questions (Lackey 2007). The question the model should address is: "How will a population of fish species X respond to different water flows (magnitude, timing, and duration)?" This framing of the question focuses modeling attention on the stakeholder interest (fish species X), but will rely on the decision participants themselves to define what constitutes a "healthy" or "sustainable" fishery. The search for and identification of embedded model assumptions and model structures that circumvent or obscure policy choices also requires open and continuing communication between technical modelers and process facilitators (if different parties). Helen Ingram and Anne Schneider (1998, p. 27) state that "the most fundamental flaw in contemporary water policy is that many value questions in which ordinary citizens have a great interest are being framed as technical questions."

The process of developing a common technical model provides the opportunity to identify and manage technical and scientific disputes and to avoid an end state described as adversarial science (Ozawa 1991; Busenberg 1999). Collaboration at this level is a way to manage analytic dispute and overcome suspicion of centralized knowledge or perceptions of stakeholder information/knowledge bias. In many ways this level of integration forms the foundation for the CADRe process—if stakeholders cannot develop a credible technical foundation for the collaborative decisions and negotiation, a CADRe process cannot achieve agreement in the face of interest, value, and authority dispute.

Collaborative Use of Model: Assisting Decision Participants in the Formulation and Evaluation of Alternatives

In a CADRe process the accepted models and model outputs are the primary venue and vehicle for multiple and competing groups to communicate with each other. CADRE processes assume decision participants bear the joint responsibility for negotiating and deciding among alternatives. CADRe models are intended to support, not substitute for, the process of deciding. Communication through a single but shared technical computer model (or a system of connected computer models) allows decision participants to refine their own values, interests, and acceptable trade-offs while also learning the same about others. The model becomes useful only if it *facilitates* the development and discovery of more satisfactory alternatives through low-cost experimentation by playing "what if" exercises with the technical models (Sheer, Baeck, and Wright 1989; Werick and Whipple 1994; Reitsma et al. 1996).

CADRe technical simulation models are developed in support of collaborative negotiations. CADRe models predict how different alternatives affect the performance metrics of interest to decision participants. As useful decision-aids, models foster and focus development of and debate over alternatives. With transparent displays of performance metrics, decision participants can clearly link policy alternatives to changes in the interests of individual decision participant groups. The transparency and access to the model invite and encourage decision participants to modify and develop more broadly acceptable alternatives. Decision participants can modify alternatives to examine how incremental changes can help or harm the interests of particular groups. Clearly identified or unavoidable losses encourage decision participants to develop creative solutions to provide adequate and acceptable compensation. Decision participants are challenged by the models to create and negotiate alternatives that would bring the group closer to an acceptable agreement.

Because CADRe processes rely on computer simulation models as an integral part of how decision participants formulate and evaluate policy alternatives, a useful modeling platform is one that increases the likelihood of mutual learning and discovery of alternatives that lead to agreement on a preferred alternative. The usefulness of the model can be increased in several ways. One way is to test the sensitivity of the model solution to input data or other factors that might be in dispute. Given scientific uncertainties and room for different views, the ability to accomplish rapid "what if" simulations of different technical and data assumptions may help participants agree on performance metrics, on alternatives that might be formulated, and how different alternatives might affect the performance metrics. The model constructs a virtual reality for decision participants to explore consequences of different policy alternatives. Through the investigation of different possible future outcomes, collaborators collectively form (construct) their preferences for different possible future states of the world.

Making the model useful to negotiating parties creates technical challenges. First, given the complexity of water resource systems and management alternatives, simulations will typically produce multiple outputs and complex combinations of performance metrics. Such models are also capable of processing thousands of "what if" scenarios. Yet model output must be conveyed to decision participants in ways that highlight trade-offs and facilitate comparison of alternatives. CADRe modelers must devote attention and creativity to devising quantitative and visual display devises that can present output on performance metrics that is understandable and accessible to decision participants. Just as the development and identification of performance metrics must involve creativity, the presentation of model outcomes must also involve an element of creativity. Synthesizing complex and multi-dimensional information into forms that are accessible (tables, graphs, visual displays, etc.) and meaningful to decision participants will facilitate mutual learning and the negotiation process.

Second, as new alternatives are developed by stakeholders, modelers will be confronted with new requests for new model output or modeled relationships. CADRe model design must include effective ways to facilitate the search and sorting of potentially thousands of variations of alternatives that might be of interest to stakeholders without removing effective control of that evaluation from stakeholders. For example, with decision participants' concurrence, model algorithms might be designed to remove clearly "inferior" alternatives. Inferior alternatives are those that cannot improve (or actually decrease) the desired outcome of any performance metrics compared to a baseline alternative. Another approach is to bound the range of feasible alternatives; Werick describes the use of "fence post" alternatives for numerous single-interest models that both illustrate the consequences for other interests and establish the likely outer limits of any supportable solution (Werick 2007).

The model must be used for what-if analysis in the pursuit of alternatives that can achieve support by the decision participants. Therefore attention must be paid to how CADRe technical models can best be integrated into negotiations. Access to and use of the technical models involves deciding whether model runs and output are only produced in common joint meetings or whether individual stakeholder groups are expected to use the model independently and outside organized group meetings. Experimental research suggests that different levels of model accessibility do not produce substantive improvements in stakeholder understanding of the system or more satisfactory negotiated outcomes (Zigurs et al. 1999). However, accessibility and transparency may defuse suspicions of "black box" models, particularly for those not already intimately involved in the negotiation process.

Questions of who operates the technical models must also be addressed. In some processes, the operation of the technical models may be delegated to an agreed-upon individual or expert group. Requests for different model runs are provided to the model experts by stakeholder groups. Other processes may strive to increase model accessibility by allowing users to directly operate and run the technical model. In such cases, user-friendly software interfaces are designed to allow decision participants themselves to actively experiment and manipulate model inputs, assumptions, and parameters. The degree to which stakeholders may actively use the model can have implications for model design. For example, extremely complex and technical models may limit the degree of direct use nontechnical stakeholders may have with the model or whether technical models can be effectively used "on-line" during group negotiations (Dahinden et al. 2000; Roach and Tidwell 2007). CADRe process must also decide how decision participants socially interact with each other and the model.

Gaming or what-if exercises are one way to engage decision participants in real-time interaction in developing, experimenting, and evaluating alternatives. Because games are played in a group setting, the process may build social trust and personal relationships between competing and perhaps distrustful parties. Such games, however, require computer models capable of quick modification and real-time simulation. Models that require more data input or that have significant run-time requirements need to solved outside the group process and the results brought back to the group. This model support process may allow more use of more complex modeling structures, but limit the building of trust among the group members.

This discussion stresses the role of CADRe models to facilitate mutual learning and negotiation by simulating cause and effect of different alternatives and revealing trade-offs among performance metrics. Such an approach differs from many decision analysis tools proposed or advocated within the water resources literature. Analytical tools and models, such as comprehensive benefit/cost analysis or multi-attribute utility analysis, purport to construct response models of the water resource system and then measure or weigh the preferences or values decision participants place on all outcomes of alternatives. Such models weigh and aggregate stakeholder preferences either in dollars (benefit-cost analysis) or a system of subjective weights (multi-criteria analysis) into single quantitative rank alternatives that aims to identify the "best" or "optimal" alternative. Such approaches rely on analysts and analytical models, rather than collaborative negotiations, to identify the preferred alternative. In some applications, however, multi-criteria analysis might be used as a preference clarification tool to help focus stakeholder attention on their evaluation of trade-offs, and would not rely on the subjective weighting to select a preferred alternative (Rodrigo 2007; National Research Council 1996).

Thus, CADRe simulation models are *decision aids* rather than *decision optimizations*. CADRe models are designed in support of collaborative negotiations and are not intended as a substitute or replacement for them. CADRe processes avoid the presumption that models can decide for negotiating parties because behavioral assumptions implicit in the approach, including individual preferences, are being created and revised during negotiation, and because of analysts' inability to collect and know all values relevant to decision participants. As decision *aids*, CADRe models do not purport to solve the difficulties and challenges of deciding which outcomes are most important and what alternative is the best for all parties. CADRE processes are built on the premise that the responsibility for choosing rests squarely with the participants in the negotiation process.

Conclusion

This chapter has discussed ways to integrate technical models with a collaborative negotiation process. The three goals of integration are to make technical analysis more responsive the needs of the negotiating parties, make scientific and technical information more credible to multiple and disputing parties, and to provide a useful mechanism for collaborative negotiations to explore, create, and debate alternatives. The reason for achieving these aims is to increase the efficacy of scientific and technical analysis and to facilitate a more constructive dialogue between multiple parties with different knowledge bases, interests, and values.

This discussion, however, does not imply or dictate the specific processes used to achieve these broad ends. CADRe cannot be conducted by formula or by a pre-defined step-by-step process to make water resource modeling responsive, credible, and useful to decision participants. Most water resources decisions are made in unique and specific policy, economic, social, and physical settings. Consequently, each decision process will require different approaches to simulation model development and integration with the decision process. The chapters that follow illustrate the range of problems and problem settings, as well as a diversity of challenges and approaches needed to bring computer-based water resource modeling to the aid of collaborative decision process. It is the future challenge of CADRe to refine approaches to, and evaluate the effectiveness of, different approaches to the integration of technical models with collaborative decision-making processes.