Assessing Public Perceptions of Computer-Based Models

Authors
Kristan Cockerill, Vincent Tidwell, and Howard Passell

Abstract
Although there is a solid body of research on both collaborative decision-making and on processes using models, there is little research on general public attitudes about models and their use in making policy decisions. This project assessed opinions about computer models in general and attitudes about a specific model being used in water planning in the Middle Rio Grande Region of New Mexico, United States. More than 1000 individuals were surveyed about their perceptions of computer-based models in general. Additionally, more than 150 attendees at public meetings related to the Middle Rio Grande planning effort were surveyed about their perceptions of the specific Rio Grande-based model. The results reveal that the majority of respondents are confident in their ability to understand models and most believe that models are appropriate tools for education and for making policy decisions. Responses also reveal that trust in who develops a model is a key issue related to public support. Regarding the specific model highlighted in this project, the public revealed tremendous support for its usefulness as a public engagement tool as well as a tool to assist decision-makers in regional water planning. Although indicating broad support for models, the results do raise questions about the role of trust in using models in contentious decisions.

Cockerill, K., V. Tidwell and H. Passell. (2004). Assessing Public Perceptions of Computer-Based Models. Environmental Management 34(5): 609-619. Published by Springer Verlag (ISSN: 0364-152X). DOI: 10.1007/s00267-003-0259-z

Cockerill, K., V. Tidwell and H. Passell. (2004). Assessing Public Perceptions of Computer-Based Models. **Environmental Management** 34(5): 609-619. Published by Springer Verlag (ISSN: 0364-152X). DOI: 10.1007/s00267-003-0259-z

Assessing Public Perceptions of Computer-Based Models

Kristan Cockerill, Vincent Tidwell, and Howard Passell

ABSTRACT

Although there is a solid body of research on both collaborative decision-making and on processes using models, there is little research on general public attitudes about models and their use in making policy decisions. This project assessed opinions about computer models in general and attitudes about a specific model being used in water planning in the Middle Rio Grande Region of New Mexico, United States. More than 1000 individuals were surveyed about their perceptions of computer-based models in general. Additionally, more than 150 attendees at public meetings related to the Middle Rio Grande planning effort were surveyed about their perceptions of the specific Rio Grande-based model. The results reveal that the majority of respondents are confident in their ability to understand models and most believe that models are appropriate tools for education and for making policy decisions. Responses also reveal that trust in who develops a model is a key issue related to public support. Regarding the specific model highlighted in this project, the public revealed tremendous support for its usefulness as a public engagement tool as well as a tool to assist decision-makers in regional water planning. Although indicating broad support for models, the results do raise questions about the role of trust in using models in contentious decisions.

The confluence of water and computers epitomizes our modern era. The first is quite literally essential to life; the second has become so ubiquitous as to be perceived as essential. From the large quantities of water required to manufacture computer chips to using these same chips to help identify better ways to protect and manage this resource, water and computers are integrally linked. In fact, the evolution of computer technology has made it increasingly possible to use computers and computer models to help us better understand water and the impacts of our demands upon it. Computers also provide a powerful means for engaging diverse stakeholders in resource planning processes.

Increasing demands for public involvement in decision-making has contributed to a focus on collaborative approaches whereby diverse and often competing stakeholders work with technical experts and with decision-makers to frame an issue and develop possible solutions. In this milieu, system dynamics modeling has become a popular tool because it allows everyone involved in the collaborative process to utilize diverse sets of data to visualize possible impacts from various decisions (van den Belt 2004; Ford 1999; Vennix 1996).

It is probable that the reliance on computers and the calls for collaborative decision-making are not coincidental, but correlative. The literature provides abundant examples of models being used in public decision-making about contested water issues. There are at least three ways in which models have historically been or are being used in water-relevant decisions. First, they were originally the domain of technical experts who used them to generate data/information used for purely academic purposes or to deliver that information to decision-makers. Second, expert-generated models have been used to engage the public in dialogue by helping to explain complex issues and/or to demonstrate the outcome of some potential decision (cf. Stave 2003; Punnett and Stiles 1993; Randall and others 1988). Finally, there are examples of models being developed (at least partially) collaboratively among technical experts, decision-makers, and stakeholders to reach some decision (Tidwell and others 2004; Costanza and Ruth 1998; van den Belt 1998; Palmer 1993; Johnson 1990; Wallace and Sancar 1988; Jordao and others 1997; CRDSS undated).

Although computer models have become a seemingly indispensable tool, Saunders-Newton and Scott (2001) thoroughly discussed potential pitfalls in relying on computers in public decision-making. In particular, a long-standing issue for public policy-making is dealing with scientific uncertainty (cf. Helstrom and Jacob 1996; Sublet, and others 1996; Costanza and Cornwell 1992). At one level, computers are reducing uncertainty because they are capable of processing waves of information quickly and are increasingly capable of ''thinking.'' Yet, the level of sophistication in computer models means that few people fully understand how they work and hence, the level of uncertainty about how models function might affect public perceptions about credibility and appropriate roles in public decision-making.

In the studies cited here in which a model was used in an actual decision-making process, authors report that the models were instrumental in helping participants see the complexity in the issues and that the models helped improve communication in the process. Whereas the existing literature often emphasizes the importance of using sound data, well-defined parameters, and well-considered processes, the papers largely ignore a potentially key issue: a model's credibility with the public and public attitudes about appropriate roles for models in decision-making. This is critical because understanding public attitudes about a model, especially in controversial decisions, could be a crucial factor in whether a process and, subsequently, a decision succeeds or fails. This has ramifications related to ensuring public involvement in decision-making as well as ensuring that models do not ''tempt public sector decision-makers to abdicate personal responsibility for poor choices'' (Saunders-Newton and Scott 2001). If the public does not like or is intimidated by a model, they might be discouraged from participating. Conversely, if the public (or decision-maker) places too much faith in a model for making decisions, this could have serious and potentially negative consequences for the policy process. In a collaborative endeavor, explicitly addressing public attitudes about a model is important so that no one can be tempted to abdicate responsibility for decisions.

This project builds on existing information about using models in community-based water planning and adds a public assessment component. Although the primary focus of the project was to develop a sound model to be used in a planning process, it also presented an excellent opportunity to assess public attitudes. To that end, two surveys were conducted to gather data on public perceptions about models in general and about a specific model being used in New Mexico regional water planning.

MODELING-MEDIATED WATER PLANNING

The Middle Rio Grande (MRG) planning region (Figure 1) encompasses three counties in semiarid north-central New Mexico, United States. The region encompasses a roughly 100-mile reach of the Rio Grande and includes Albuquerque, the principal urban center in New Mexico. The challenge within the area involves balancing temporally variable supplies with the demands of irrigated agriculture, urban development, open-water evaporation, and in stream/riparian uses.

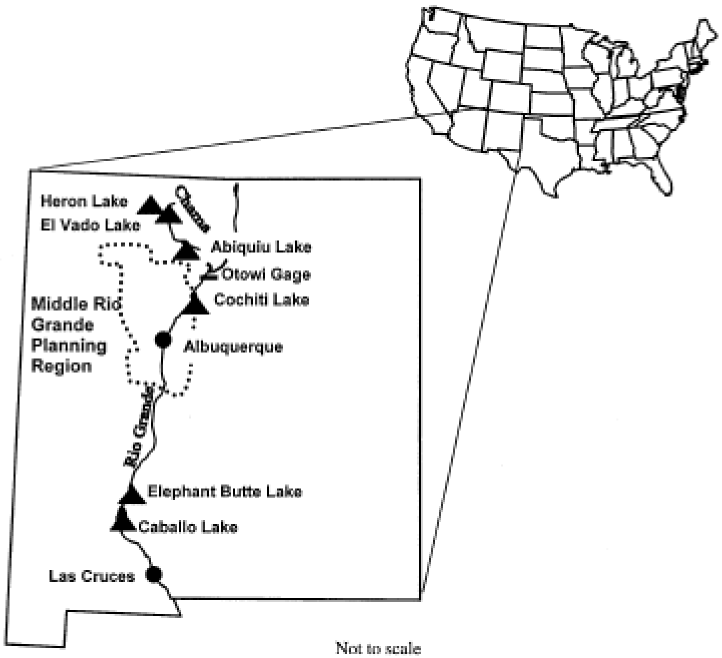

Figure 1. The Middle Rio Grande region of north-central New Mexico, United States.

In 2002, Sandia National Laboratories (SNL), in collaboration with the volunteer-based MRG Water Assembly, the Mid Region Council of Governments (MRCOG), and the Utton Transboundary Resources Center at the University of New Mexico, began developing a model of the MRG region. Model objectives included developing a framework for the following:

- Quantitatively evaluating tradeoffs, in terms of water savings and costs, between alternative water conservation strategies
- Engaging the public in the decision process
- Explaining the complexity in the regional water system

Appropriate architecture for the planning model was selected based on two criteria. First, a model was needed that provided an ‘‘integrated’’ view of the watershed— one that coupled the complex physics governing water supply with the diverse social and environmental issues driving water demand. Second, a model was needed that could be taken directly to the public for involvement in the decision process and for educational outreach. For these reasons, we adopted an approach based on the principles of system dynamics (cf. Sterman 2000).

The basic structure of the model is that of a dynamic water budget. Specifically, each supply and demand component is treated as a spatially aggregated, temporally dynamic variable (Figure 2). The MRG model addresses environmental issues, legal compact delivery requirements, and interests from residential, industrial, and agricultural water users. Built into the model were 24 different water-conservation strategies (e.g., graywater reuse, irrigation efficiency) suggested by the public. The model allows the user to explore the consequences in terms of water savings and cost associated with alternative water-conservation strategies relative to the ‘‘no action’’ alternative. Model results are expressed in terms of the Rio Grande Compact balance (key legal institution for the basin), groundwater depletions, water savings, and costs (construction, operation, and maintenance). A user-friendly interface guides the user through the model and assists him or her in selecting alternatives and interpreting results.

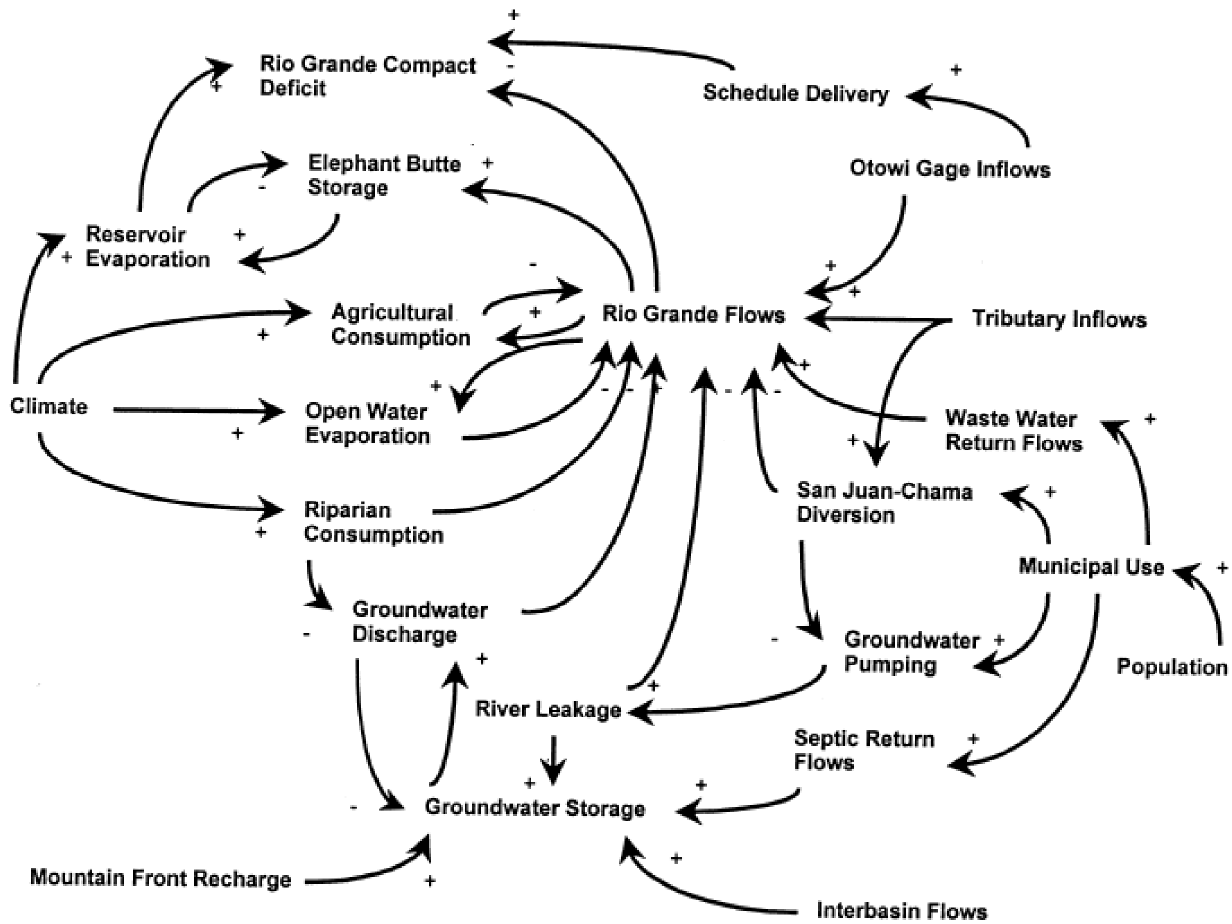

Figure 2. Causal loop diagram depicting the key elements influencing water supply and demand in the Middle Rio Grande Planning Region. The arrows denote interaction between elements and the sign designates whether the feedback is reinforcing (positive sign means as element at base of arrow increases the element at the head of the arrow increases) or balancing (negative sign meaning opposite that for positive sign). To facilitate presentation, only elements with first-order effects are presented.

The model was developed in a very public venue. A core team of about a dozen people drawn from the volunteers in the MRG Water Assembly and MRCOG directed the modeling process, which spanned almost 2 years. At semimonthly meetings, this diverse team discussed model structure, data sources, and interface issues. Between meetings, the SNL modelers coded this structure and data within a system dynamics framework, which was then reviewed at subsequent meetings. In addition to the core team, anyone from the region was welcome to enter the process at any point and to contribute ideas for adapting the model. Members of the public could attend the focused planning sessions or could attend broader public meetings where the model was demonstrated. The SNL modelers noted all public comments from these open meetings and, to the extent possible, incorporated suggestions into the model. Additional details on the model and planning process can be found in Tidwell and others (2004) and Passell and others (2003).

Within this framework, the researchers documented public attitudes about models in general and about the MRG model in particular. Although there is a growing body of literature related to assessing attitudes of individuals who actually participated in developing a model, there are few references in the literature to projects assessing attitudes about models among the broader public. Rouwette and others (2001) provided an excellent overview of projects that assessed group model-building effectiveness. Yearley (1999) provided information from a series of focus groups, with members of the broader public discussing their attitudes about and perceptions of an air-quality model used in England. His work comes closest to matching the objectives in the study reported here and the two projects reveal some similar results. There is, however, no evidence that there has been any attempt to quantify broader public attitudes on a larger scale. Because this was a strongly collaborative and highly contentious planning effort, it was deemed important for the modeling team to better understand public attitudes about and perceptions of models in general, as well as responses to the specific model being employed. The researchers therefore implemented a public attitude portion of the project.

PUBLIC SURVEY STRUCTURE

The project assessed perceptions and attitudes on two levels. First, the project identified attitudes toward models in general. Second, the researchers assessed attitudes about the MRG planning model specifically. The research team created a ‘‘general’’ and a ‘‘specific’’ survey to address these two levels of attitudes. These surveys then targeted three different ‘‘publics’’: the general public, the interested public, and the academic public. Data gathered from both surveys and from all three ‘‘publics’’ were entered into Statview for statistical analysis. Table 1 shows the number of respondents for each type of public for each survey.

Table 1. Total number of respondents from each public for the general and specific surveys

	Survey type	
Public type	General	Specific
General	1068	0
Interested	117	93
Academic	97	74
Total	1282	167

General Public

The ‘‘general public’’ included people who live in New Mexico but who might not have any strong interest in water policy or be actively involved in any water planning effort. To gather data from this group, the Institute for Public Policy (IPP) at the University of New Mexico was contracted to ‘‘piggyback’’ questions about models onto their regular quarterly survey of New Mexicans. IPP uses random digit dialing and a Computer Assisted Telephone Interview system to contact residents and conduct a 20-min survey on various policy issues. Approximately 54% of those contacted completed the survey, which is a typical response rate. IPP interviewers read respondents the following statement:

> Turning to another subject, researchers and educators increasingly use models that run on computers to accomplish a variety of tasks, including predicting the weather, assessing groundwater levels, analyzing economic trends, and designing computer games. Please tell me whether you strongly agree, agree, disagree, or strongly disagree with the following statements about computer- based models.

Respondents were then read the statements in the ‘‘general survey’’ shown in Table 2. These four statements were designed to test different perceptions about models in general. The first statement assessed the general public’s confidence in their own ability to use models.

Table 2. Total responses to the general survey statements

General survey statement	Agree	Disagree	Don’t know
Most computer-based models are **too complex** for people like me to use them to get information. (n = 1206)	35%	61%	4%
My level of **trust** in the results from a model would depend upon who designed the model.	84%	12%	4%
Computer-based models are best suited to serve as **education** tools to help people like me learn about complex issues. (n = 1206)	77%	18%	5%
Computer-based models are powerful tools that decision-makers could use to obtain **solutions** to policy problems. (n = 1206)	80%	15%	5%

In public participation practice, it is widely accepted that trust among participants is a key determinant for whether an effort succeeds or fails. Likewise, there is some evidence available that trust in models is important when they enter the public decision-making realm (Saunders-Newton and Scott 2001; Yearley 1999). The ‘‘trust’’ statement was written to provide more quantitative support for this idea.

The other two statements ascertained the public’s ideas about appropriate roles for models in decision-making. Although models are pervasive, there is not substantial information about how the public believes models should be used in the public policy arena. The ‘‘solutions’’ and ‘‘education’’ statements addressed this.

Interested Public

The second ''public'' identified in this project included those people who have been active in the Middle Rio Grande region's efforts to develop a water management plan—the ''interested public.'' As an initial data-gathering effort, in September 2002, the lead author conducted a group interview with several individuals who were intimately involved with developing the MRG model. Additionally, researchers observed public reaction to an early version of the model presented at two public meetings. Information gathered in these activities was used to write both the general survey and the specific survey. Both surveys were distributed at six public meetings held throughout the region in 2003 to reach the interested public. The majority of individuals at these meetings had not been actively involved in developing the model, although they potentially had attended previous sessions where the model was demonstrated.

Meeting attendees were given the four statements in the general survey at the beginning of each meeting. Authors Tidwell or Passell then demonstrated the MRG model, and at meetings where time allowed, attendees had the opportunity to ''play'' with the model themselves. At the end of each meeting, attendees were asked to respond to the statements in the ''specific survey'' (Table 3).

Table 3. Total responses to specific survey statements about the Middle Rio Grande Regional Water Planning Model

Specific survey statement	Agree	Disagree	Mixed Response
Using the model to create and submit ideal scenarios for water management is an effective way to get people like me to participate in the decision-making process. ($n = 162$)	89%	10%	1%
I believe the model is an appropriate tool for decision-makers to use to identify ''**preferred scenarios**'' for making water policy decisions. ($n = 165$)	83%	14%	3%
If you disagreed with the above statement, what is your primary reason for disagreeing? ($n = 40$)*			
Too many errors in the data used in the model. ($n = 9$)			
The model does not specifically include my interests in the water issue. ($n = 6$)			
The model is biased toward a particular political viewpoint. ($n = 4$)			
The model is too simplistic. It does not fully capture the complexity in the region's water situation. ($n = 21$)			
I have a concern with a specific decision-maker or group using this model. ($n = 14$)			

*Note: Respondents selected more than one reason.

In the planning process, the model was used to create ''scenarios'' that included combinations of publicly derived conservation alternatives that would enable the region to better balance water supply with demand. Therefore, members of the ''interested public'' were asked about the value and validity of using the MRG model in creating these scenarios, which would become the framework for the regional water plan. Also of concern was reaction to the MRG model as a means for engaging the public in the decision-making process. Finally, the respondents could register potential concerns with the MRG model and/or how that model might be used.

Academic Public

The third group identified in this project was the ''academic public,'' which included people who are largely removed from the planning process but who likely have high familiarity with models and might use them. To gather data from this group, researchers tapped a University of New Mexico Civil Engineering Department Seminar in March 2003 and a graduate level watershed management class at New Mexico State University in May 2003. Additionally, attendees at the Aquatic Resources in Arid Lands conference held at New Mexico State University in April 2003 participated.

Like the interested public data-gathering process, respondents from the academic public were asked to respond to the four ''general'' survey statements, were then shown the model, and asked to respond to the ''specific'' survey statements.

RESULTS AND DISCUSSION

The one-line result is that all publics have positive perceptions of models as tools and the interested and the academic publics in this project are pleased with the specific model being used to support the Middle Rio Grande Regional Water Plan. There are, however, differences among the publics that are relevant to any decision-making process using a model.

General Survey

As Table 2 shows, a strong majority of respondents (61%) said that they do not believe that models are too complex for them to use to obtain information. This supports the idea that models have become accepted tools in our modern society. It is also in agreement with Yearley's (1999) results showing that participants in his focus groups had confidence in their level of knowledge about the model. Of course, this raises the question of whether the respondents actually understand how models work and what results from a model mean. There is evidence that the public does not understand information from models used in air-quality management (McDonald and others 2002). This could definitively affect decision-making efforts; the question of actual knowledge, however, is outside the scope of this article.

Trust is an issue for using models in public decision-making. As Table 2 reveals, 84% of all respondents said that whether they trusted a model's results would depend on who designed the model. Yearley (1999) concluded that one factor determining participant perceptions about the model in his research was the level of trust they had in the government agency using the model. For agencies that do not have the public's trust, designing and/or using models in a decision-making process might not be as successful as in situations where there is high trust. Additionally, this suggests that using a model as a tool to gain trust might not be effective. This is especially salient in public decision-making because government entities typically have the lead role in these processes, yet there is (and historically has been) a general sense of distrust of the government among the US populace (Wills 1999). It is also possible that issues of trust reflect a general concern about models dominating a decision-making process, as Sanders-Newton and Scott (2001) discussed. More detailed analyses to assess specific concerns related to various model designers and model users are warranted.

Survey responses also suggest considerable support for using models in educating the public on complex issues and to assist in public policy-making. Specifically, 77% of the respondents felt that models represent an effective educational tool, whereas 80% supported using models to help obtain solutions to public policy issues.

Although the overall responses are positive toward models, there are differences among the three publics regarding attitudes about models in general. Table 4 shows the mean differences that were statistically significant ($P < 0.05$) using a standard t-test comparison hypothesizing a mean difference of zero between any two groups. The P-value reflects the likelihood that the reported difference in mean values could occur by chance.

Table 4. Significant differences in responses to general survey statements among the three publics

	Mean values for statements for each public			
Statements	General	Interested	Academic	*P*-Value
Too complex	2.704	2.883		0.0446
	2.704		2.947	0.0056
Trust	1.855	1.718		0.0403
Education		1.990	2.211	0.0314
	2.031		2.211	0.0139

Note: Responses were scored from strongly agree (1) to strongly disagree (4).

Although the general survey assessed the public's attitudes about models in general, both the interested and academic publics might have been exposed to the specific MRG model via the media or public meetings and this might have influenced their responses about models in general. As might be expected, the general public was more likely than either the interested or the academic publics to believe that models are too complex for them to use. By definition, the academic public are people who are probably familiar and comfortable with models, so they should be comfortable with their ability to understand models. The interested public, by virtue of being involved in the MRG planning process, might have had exposure to the specific MRG model and this could have given them confidence in their ability to understand all models and their output.

The interested public was less likely to say that who designed a model would affect their level of trust in the results. This might be a function of the specific MRG project. Based on data collected between 1993 and 1996, New Mexicans generally have a positive opinion of Sandia National Laboratories (Cockerill 1996). Members of the interested public might have equated models in general with Sandia’s efforts in the MRG planning process when responding to the general survey.

The academic public was least supportive of using models as educational tools. This could reflect an assumption among ‘‘academics’’ that the general public does not understand models or their output and, hence, would not benefit from a model as a tool or could possibly use a model (or results) in inappropriate ways. The interested public was most supportive of models as educational tools, perhaps indicating that their exposure to the MRG model had been educational, and, hence, they knew that models could serve that function.

There were no significant differences among the groups pertaining to the statement about using models to obtain solutions to policy problems, although the academic public was again least supportive, followed closely by the interested public.

The results show that, in general, people think that models are appropriate tools for decision-making processes. They also reveal that understanding who the public is in any given process might be important in terms of level of support for a specific model and that knowing whether the public trusts the agency or organization creating and/or using that model is important.

Specific Survey

There were 167 responses to the specific survey. Because attendees in the public meetings or the academic venues were not static, there is not a one-to-one correlation among individuals who completed the general survey and then the specific survey. As Table 3 shows, the interested public and the academic public who completed questionnaires after seeing the MRG model strongly supported using this specific model as a tool for public participation and for building the scenarios to be used in the MRG plan. Specifically, 89% saw the MRG model as an effective tool for public participation, whereas 83% viewed the MRG model as a good means for evaluating alternative water conservation scenarios within the context of regional water planning.

The strong positive response to the MRG model came as a bit of a surprise to the authors. In public meetings early in the model development process, many of the comments posed to the modeling team emphasized that the model did NOT include ‘‘pet interests’’ or raised questions about whether the data being used were the most accurate, or most appropriate. Many individuals expressed tremendous concern about whether their specific interests (e.g., agriculture, conservation, development) were fully captured in the MRG model. Water in New Mexico is a very contentious issue and there was a distinct sense in the meetings that people were worried about being on the ‘‘losing’’ side of water management decisions. Based on public meetings prior to beginning the survey project, the research team anticipated more critical comments about the MRG model. The discrepancy between the impression from those meetings and the results of the survey suggests that there is a small but vocal group of individuals who have concerns, but that even they generally believe that the MRG model provides value to the planning process. Additionally, because the process was fully open and individuals had multiple opportunities to ask questions and to provide recommendations for adjusting the MRG model, they might have become comfortable with the MRG model and, therefore, granted it a high level of confidence by the time they were asked to respond to the specific survey.

About 24% of the respondents did note that they had a concern with the MRG model, even if they thought it was a positive tool. Figure 3 shows the results from the question about the MRG model structure and use. Most comments revealed concerns with the model's sophistication and whether it adequately covers the complexity in the situation. Based on questions posed at the public meetings and reactions to the MRG model, this might be correlated with the fact that many model results are incongruous with commonly held beliefs. For example, many residents are concerned with leakage losses from the agricultural conveyance system (i.e., canals, laterals, and ditches). However, the MRG model shows little advantage to lining the conveyance system, as most of the leakage is captured by the shallow groundwater system and returned to the river. When the MRG model results contradict an individual's beliefs, that might lead them to question the model's validity rather than their own beliefs and assumptions.

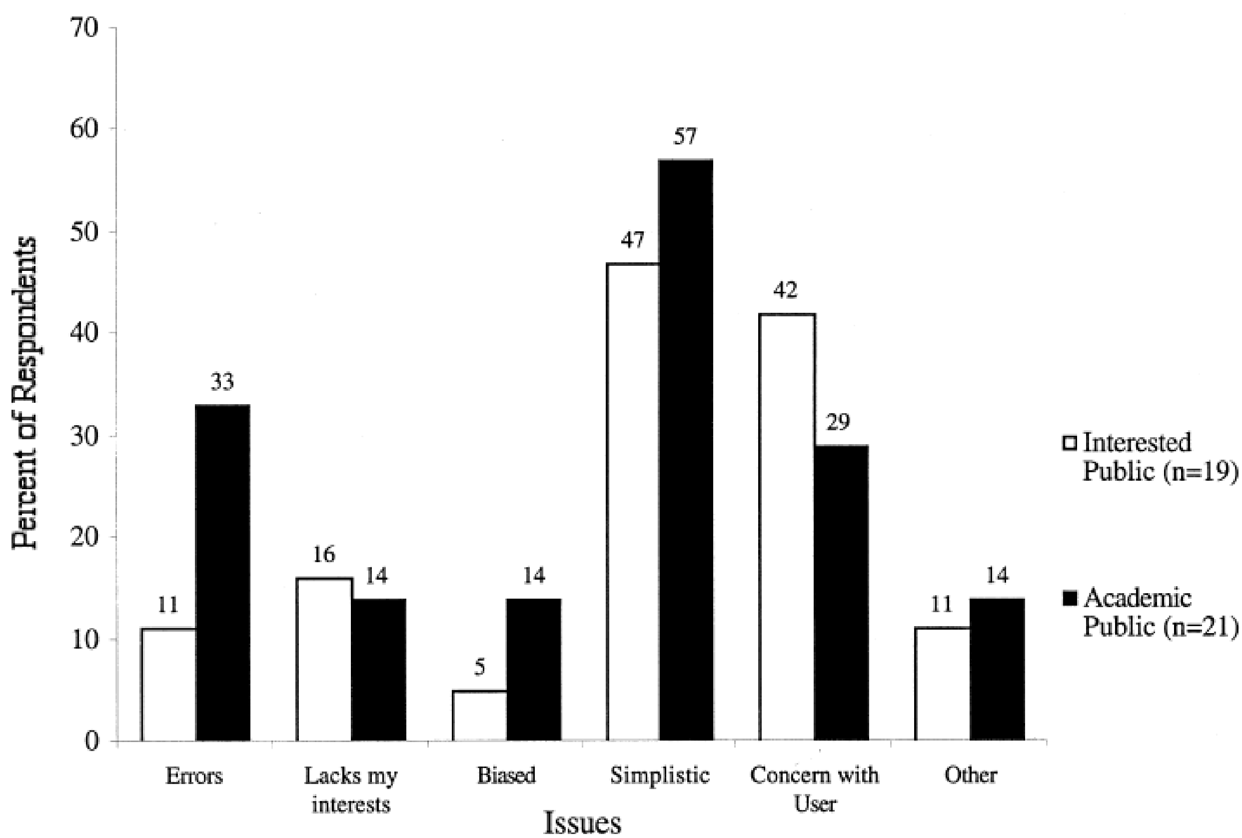

Figure 3. Comparing interested public and academic public concerns about the Middle Rio Grande region model. Respondents selected one or more concerns.

Of the 40 respondents who expressed a concern, 35% said that they would have a problem with 1 or more particular users. Table 5 shows who respondents said they would not want to use the MRG model. Although the number of individuals expressing this specific concern was small, it does provide more information related to ideas about trust and models.

Table 5. Number of respondents expressing concerns with specific model users

Potential user	No. of respondents citing
City Council	7
State Legislature	7
Water management agencies	3
Developers	1

Note: Respondent could select more than one user ($n = 14$)

The overall response was positive toward the MRG model, but there were some differences between the interested and academic public responses to the specific survey. Figures 4 and 5 show that the academic public was less inclined to say that they strongly agreed that the MRG model was a good way to encourage participation or was an appropriate tool for developing scenarios for decision-making. This might simply re- flect reluctance on the part of more academic-oriented respondents to select an extreme positive response or it might reflect some level of concern with having nonexperts make decisions that might not accurately reflect current scientific thinking.

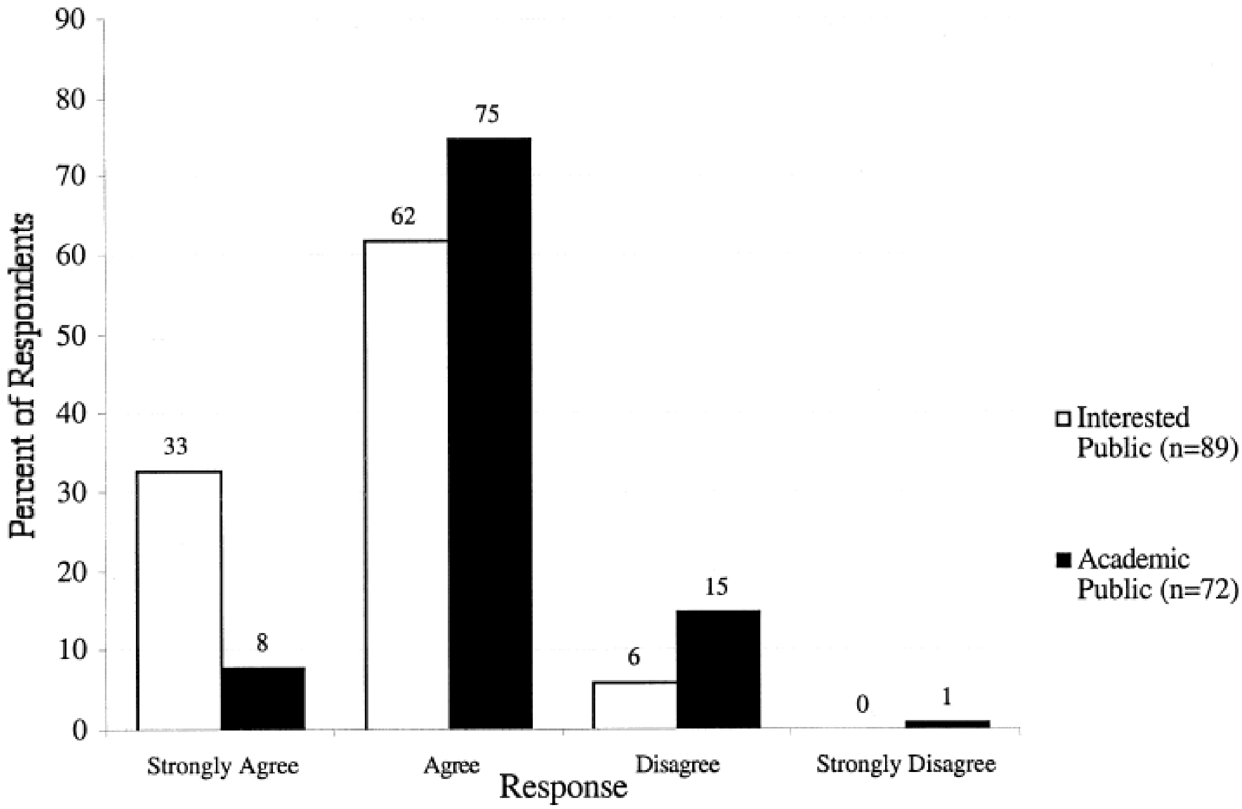

Figure 4. Responses from the interested public and the academic public to the statement: ''Using the model to create and submit ideal scenarios for water management is an effective way to get people like me to participate in the decision-making process'' (P = 0.0001).

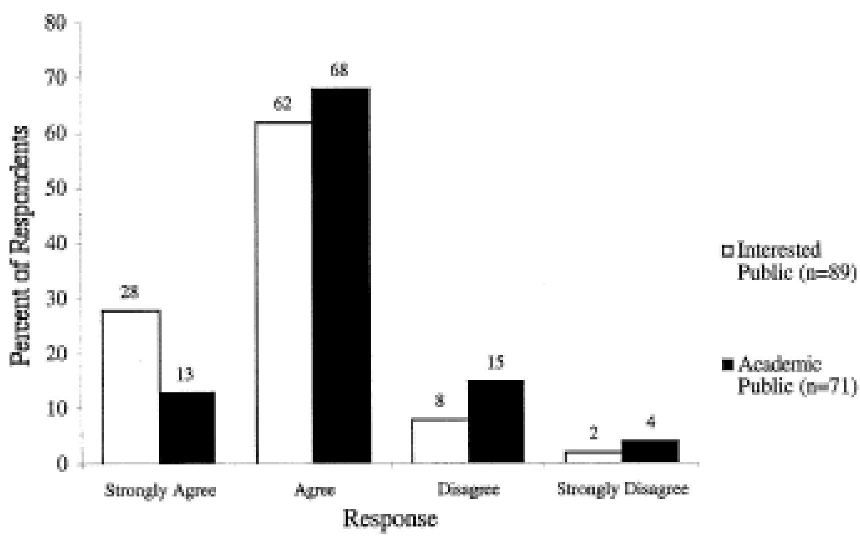

Figure 5. Responses from the interested public and the academic public to the statement: ''I believe the model is an appropriate tool for decision-makers to use to identify 'preferred scenarios' for making water policy decisions'' (P = 0.0111).

There were also differences among the reasons for having concern with the MRG model as shown in Figure 3. As might be expected, the academic public focused their concerns on errors and issues with model sophistication. One contributing factor to this result is that the attendees at the Aquatic Resources in Arid Lands conference were largely biologists and ecologists who commented that biology and ecology were underrepresented in the MRG model. This provides strong support for the importance of knowing who the public is and what their concerns and interests are when developing and using models in decision-making. This is one reason that collaborative model development is powerful, because participants from all backgrounds and perspectives can be involved. At the same time, any particular group is going to be biased toward their interests and might well perceive a lack of attention to their focus, even if other groups disagree.

The interested public concerns focused on sophistication and potential users. This is understandable, because the interested public, in this case, are people who live and work in the region and who will face direct impacts from any decisions made. Therefore, concerns with who might use the MRG model to what end become more important. Again, this might also suggest some level of concern with the MRG model replacing public input in the decision-making process and having the model be the scapegoat for poor decisions, as Saunders-Newton and Scott (2001) discussed. If this is the case, then there is reason to both celebrate and to be concerned. We should celebrate that those individuals who do express concern might see valid reasons for remaining vigilant about how and when we use numerical models in decision-making. On the other hand, a relatively small percentage of total respondents expressed these concerns, which might indicate that models have become so integral that people are becoming less critical in assessing their value and/or validity.

CONCLUSION

An interactive system dynamics model was developed and used to engage the public in developing a 50- year water use plan for the Middle Rio Grande in north-central New Mexico. Interesting aspects of this work include the level of public participation in model development and its application to water planning; the broad scope of the project; and the effort to document public attitudes about models in general and the MRG model in particular.

This article focuses on the expressed attitudes and perceptions toward models in general and toward using a specific model in regional water planning. Attitudes were assessed through two different surveys: one general to modeling and a second specific to the model developed for the Middle Rio Grande region. The surveys were used to canvas three different ‘‘publics.’’ The results show overwhelming support for using models in developing solutions to complex public policy issues and using models to educate and engage the public in such processes. These results are relevant to any environmental planning process. As models become the norm in most efforts, successful policy decisions and effective implementation might well depend not only on creating accurate, reliable models, but on fully understanding public attitudes toward those models, as well as toward model creators, users, and results.

The research reported here reflects the importance of attempts to quantify public attitudes toward models. Had the primary modelers relied just on the interviews with modeling team members and public response at early meetings, there would have been (and, in fact, there was) a prevailing attitude that the MRG model was unpopular and that they should seriously question its utility in the planning process. Responses to the specific survey showed a radically different attitude, providing good evidence that because members of the public pose hard questions about a model does not necessarily reflect a general dislike for that model. Given these results, it is plausible that the opposite scenario could or might have occurred in other projects. There have perhaps been situations where there appeared to be general support for a model, but if attitudes had been quantified, perhaps the situation was not as positive as it seemed. This could explain some negative experiences decision-makers have had with using models to develop policy. These types of relationship should be more thoroughly explored in future research.

Because trust is clearly an issue, more detailed analyses of attitudes about model creators and users are warranted. In the results reported here, there was likely a high trust rating for both Sandia Lab personnel and for the Water Assembly, which is a voluntary organization and not a governmental organization. In situations with low trust, it might be even more important to understand who the public is and what their attitudes are about models and modelers.

This project revealed that understanding who the public is and what their perceptions are might have an effect on a decision-making process using a model. It also showed that at a general level, the public supports using models in decision-making. This does raise a question about whether there is a causal relationship between accepting models and their ubiquity. Do people support model use because it is perceived as unavoidable? Or, because they are ubiquitous, are models assumed to be appropriate? What are the policy ramifications in either situation? This is a line of inquiry deserving greater attention.

ACKNOWLEDGMENTS

The Sandia National Laboratories Small Business Assistance Program in collaboration with the State of New Mexico provided funding for this project. The authors thank the Middle Rio Grande Water Assembly for allowing us to present our surveys at their public meetings. Finally, the final version of this article is greatly improved due to reviewer and editor comments.

REFERENCES

Cockerill K. 1996. Preliminary Sandia analysis. Unpublished report prepared for the Institute for Public Policy, University of New Mexico.

CRDSS (Colorado River Decision Support System). Undated. http://cdss.state.co.us/overview/bigoverview/crdsscov.asp. Accessed August 2003.

Costanza, R., and M. Ruth. 1998. Using dynamic modeling to scope environmental problems and build consensus. Environmental Management 22:183–195.

Costanza, R., and L. Cornwell. 1992. The 4P approach to dealing with scientific uncertainty. Environment 34:12–20, 42.

Ford, A. 1999. Modeling the environment: An introduction to system dynamics modeling of environmental systems. Island Press, Washington, DC.

Hellstro¨m, T., and M. Jacob. 1996. Uncertainty and values: The case of environmental impact assessment. Knowledge and Policy: The International Journal of Knowledge Transfer and Utilization 9:70–84.

Johnson, L. E. 1990. Computer-aided planning for multiple purpose reservoir operating policies. AWRA Water Resources Bulletin 26:299–311.

Jordao, L., P. Antones, R. Santos, N. Videira, and S. Martinho. 1997. In Barlas, Yaman, Dker, Vedat, Polat, Seckin (eds.), 15th International System Dynamics Conference: Systems approach to learning and education into the 21st century. Bogazici University Printing Office, Istanbul, Turkey.

McDonald, J. S., M. Hession, A. Rickard, M. J. Nieuwenhuijsen, and M. Kendall. 2002. Air quality management in UK local authorities: public understanding and participation. Journal of Environmental Planning and Management 45:571–590.

Palmer, R. N., A. M. Keyes, and S. Fisher. 1993. Water management in the 90's; A time for innovation. Pages 451–454 in K. Hon (ed.), Proceedings of the 20th Anniversary Conference. American Society for Civil Engineering, Washington, DC.

Passell, H. D., V. C. Tidwell, S. H. Conrad, R. P. Thomas, and J. Roach. 2003. Cooperative water resource modeling in the Middle Rio Grande basin. SAND Report 2003-0636. Sandia National Laboratories, Albuquerque, New Mexico.

Punnett, R. E., and J. M. Stiles. 1993. Water management in the 90's: A time for innovation. Pages 495–497 in K. Hon (ed.), Proceedings of the 20th Anniversary Conference. American Society for Civil Engineering, Washington, DC.

Randall, D., D. P. Sheer, and H. Meyer. 1988. Computerized decision support systems for water managers. Pages 88–95 in J. W. Labadie, L. E. Brazil, I. Corbu, L. E. Johnson (eds.), Proceedings of the 3rd Water Resources Operations Management Workshop. American Society for Civil Engineering, Washington, DC.

Rouwette, E. A. J. A, J. A. M. Vennix, and T. Mullekom. 2001. Group model building effectiveness: A review of assessment studies. System Dynamics Review 18:5–45.

Saunders-Newton, D., and H. Scott. 2001. ‘‘But the computer said!’’: Credible uses of computational modeling in public sector decision making. Social Science Computer Review 19:47– 65.

Stave, K. 2003. A system dynamics model to facilitate public understanding of water management options in Las Vegas, Nevada. Journal of Environmental Management 67:303–313.

Sterman, J. D. 2000. Business dynamics, systems thinking and modeling for a complex world. McGraw-Hill, Boston.

Sublet, V. H., V. T. Covello, and T. L. Tinker (eds). 1996. Scientific uncertainty and its influence on the public communication process. Proceedings of a NATO Advanced Research Workshop, Paris, France, September 8–10, 1994.

Kluwer Academic Publishers, Dordrecht. Tidwell, V. C., H. D. Passell, S. H. Conrad, and R. P. Thomas. 2004. System dynamics modeling for community-based water planning: An application to the Middle Rio Grande. Journal of Aquatic Sciences (in press).

van den Belt, M. 1998. Mediated modeling project: An integrated scoping model of the Upper Fox River Basin. Department of Natural and Applied Sciences, University of Wisconsin, Green Bay.

van den Belt, M. 2004. Mediated modeling: A system dynamics approach to environmental consensus building. Island Press, Washington, DC.

Vennix, J. 1996. Group model building: Facilitating team learning using system dynamics. John Wiley & Sons, New York.

Wallace, S. D., and F. Sancar. 1988. Pages 448–459 in J. B. Homer and A. Ford (eds). Proceedings of the 1988 International Conference of the Systems Dynamics Society. International System Dynamics Society, La Jolla, California.

Wills, G. 1999. A necessary evil: A history of American distrust of government. Simon & Schuster, New York.

Yearley, S. 1999. Computer models and the public’s understanding of science: A case-study analysis. Social Studies of Science 29:(6)845–866.