Effects of Computerized Water Resource Management Simulation on Concern for Water Issues by Agribusiness and Water Management Professionals

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Statement of the Problem

Decisions concerning water resource management are ultimately made not by the scientist, engineer or technical manager, but by the layman and his elected representatives (1).

Growth in Oklahoma's population and standard of living is placing an increasing demand on water; often a limited and variable resource. At the same time effective management of our water resources is hampered by a lack of public understanding of the major variables and limits of the water resource system. Research provides us with new management alternatives, often faster than society can assimilate their implications. Responsible management of Oklahoma's water resources is dependent upon knowledgeable action by the citizens of Oklahoma and their elected representatives. The study reported here is a continuation of an extended research project designed to determine the public's existing level of water concern and knowledge base. In addition, data has been sought that would clarify the application of computer simulation for the purpose of influencing water management concerns and knowledge.

Treatment: The Water Resource Management Simulator

The use of computer simulation for complex environmental problems has great potential. It is uniquely suited to water resource education because it can (a) speed up or slow down time, (b) employ expensive or unavailable materials and procedures, (c) act to objectively select random phenomena, (d) provide active participation and input by the learner, (e) reduce complex problems to manageable size, (f) create problem situations where many

disciplines are interrelated, (g) provide users with immediate feedback, and (h) allow exploration of alternatives without having to live with harmful consequences.

A problem with computer simulation is that use is often limited to a few persons at any one time. Group interaction in clarifying problems, considering alternatives and trade-offs, decision making and cooperative action so necessary in resource problem-solving is slighted. The WRMS addresses this problem by providing input from a number of participants at one time, summarizing interactions, and sharing results simultaneously.

In addition to simultaneous group interaction, water issues can be considered without the emotional bias often common to local site specific water debates. Emotional involvement may be present but not to the degree it interferes with consideration of rational alternatives!

The WRMS offers up to 30 participants a visual model of hyrologic information on a large panel placed in view of an audience and provides opportunity to cooperatively develop and evaluate water management strategies. The WRMS models four problem areas common to river basins: (a) source and quantity, (b) use of water, (c) quality, and (d) political management of the water resource (1).

The large simulator panel placed in the view of the audience is programmed to display snow pack and instream flow based on actual USGS data for any one of nine possible basins being modeled. Instream flow, and water quality (silt and dissolving solids) are monitored by visual LED displays. Flashing lights

indicate serious low water or flood conditions. The Sub Basin Storage and Demand displays show current ground and surface water reserves, and the relative demand by users. Horizontal LEDs indicate the proportion of ground or surface water used, and the proportion of water consumed or returned to the stream. A clock in the upper right hand corner displays accelerated time in months and years.

The simulator is operated by participants using five small control consoles. Water management decisions regarding impoundment, demand, surface or ground source, technology applied to water use, and treatment of used water are made with controls on the consoles. Consoles allow participant input to the large display panel in four water use categories: (a) irrigation, (b) livestock, (c) municipal and industrial, and (d) energy.

A fifth console provides for the creation and management of a reservoir. The hydrologic situation and user input is summarized and displayed on the main panel providing the audience with the consequences of various user management practices. As the simulation operates, important data such as monthly instream flow, ground and surface water reserves and total demand are presented as a video color graphics display. In addition this data is stored in memory and can be retrieved as video graphs or for manual graph plotting.

The participants in a simulation may interact with the river basin model at any time, changing variables to optimize their situation. Supply/demand, pollution, applied technology, or other issues may be discussed, new management strategies planned

and another simulation initiated to test these newly developed strategies.

Specifically, the purpose of this study was to determine if interaction with a Multi-user Computerized Water Resource Management Simulator (WRMS) influences the level of water resource concern for professionals in Agribusiness (water users) and water management (water managers). To understand these concerns and how these concerns are influenced is critical to the development and implementation of water management policy.

Using Watkins (2) Water Concern Scale to measure effects of WRMS treatment, the study answered the following questions.

1. What similarities and differences exist between the water concerns of agricultural users and managers of water resources?
2. Does WRMS treatment significantly alter the level of water resource concerns?
3. What effects result from WRMS experience within and between "user" and "management" populations?
4. What is the agricultural and manager pre-WRMS treatment attitude toward water resource issues?
5. What dimensions of water resource concern are significantly influenced by WRMS treatment?

Procedure

Twenty-six agricultural leaders and twenty-five water managers were randomly assigned to experimental and control groups. Agricultural leaders were participants in the OSU Agricultural Leadership Program. Participants were young adults

selected on the basis of evidence of broad, well balanced concerns, interests and abilities affecting contributions to agriculture and society as a whole. The water manager population consisted of municipal, state and federal employees specifically involved in water management in Arkansas. Treatment consisted of a two-hour session with the computer. Table I summarizes the assignment to groups and overall design.

Table I
Design Summary

	Experimental(s)	Control(s)	Total
Agricultural Leaders	12	14	26
Water Managers	10	15	25
Total	22	29	51

Experimental group were given WRMS exposure then tested while the control were tested then received WRMS exposure. The highest possible water concern score on the 5 item test is 25.*

Results

I. Comparison of pre-test (control) concerns

Table II shows the comparison of mean responses of subjects prior to treatment. Both groups show a relatively high score of over 18. There was no significant difference in the level of concern for these two groups.

*See appendix

Table II
t-Test Pre-Test Comparison of Agribusiness and Water Manager Attitudes

	Group	N	X	SD	t	p
PRE	Agribusiness	14	18.86	1.7	0.5	0.62
	Water Managers	15	18.47	2.4		

Slightly higher scores were observed for water managers, however, item analysis (Table III) showed a significantly higher concern score for Agribusiness on item number 2. Agribusiness subjects had a higher mean entry concern level than water managers since they more often agreed that "water reclaimed from waste is as good as any water (item number 2).

Table III
Summary t-Test Comparison of Agribusiness and Water Manager Pre-Test Water Concern Scores by Item

Question	Source	N	X	SD	DF	t	p
1.	Agribusiness	14	2.71	1.2	27	-0.9	0.37
	Water Managers	15	3.13	1.3			
2.	Agribusiness	14	3.92	0.8	27	3.1	0.005*
	Water Managers	15	2.73	1.2			
3.	Agribusiness	14	3.64	1.0	27	-0.4	0.67
	Water Managers	15	3.80	0.9			
4.	Agribusiness	14	4.00	1.0	27	-0.2	0.86
	Water Managers	15	4.06	1.0			
5.	Agribusiness	14	4.57	0.5	27	-0.9	0.38
	Water Managers	15	4.73	0.5			

*Significant at the .05 level of confidence.

II. Effects of WRMS treatment on Water Concerns

A. Table IV shows the comparison of mean responses between pre-test control and post-test experimental groups. There was a significantly lower mean score registered by agribusiness subjects receiving treatment.

Table IV
t-Test Comparison of Pre/Post Test Mean
Scores of Agribusiness and Water Management Professionals

Source	Group	N	X	SD	t	p
Agribusiness	Pre-	14	18.86	2.13	99.2	.004*
	Post-	12	16.92	1.23		
Water Management	Pre-	15	18.47	2.40	0.94	.34
	Post-	10	19.40	1.99		

B. Comparison of agribusiness and water manager scores within control (pre-test) and experimental (post-test) groups is shown in Table V. The difference in concern level in the treatment groups is significant. The two difference populations responded significantly different to treatment.

Table V
t-Test Comparison of Agribusiness and Water Management Professionals Pre- and Post-Test Scores

Group	Source	N	X	SD	t	p
Pre-	Agribusiness	14	18.86	1.7	0.5	.62
	Water Managers	15	18.47	2.4		
Post-	Agribusiness	12	16.92	1.23	9.98	.005*
	Water Managers	10	19.40	1.99		

*Significant at the .05 level of confidence.

C. Control and experimental group responses for agribusiness and water management professionals is summarized in Table VI. Agriculture subjects in the WRMS treatment group scored significantly lower on items 1 and 2. (See appendix for items.) Water managers scored significantly lower on test item 1, but higher on items 2 and 4.

Table VI
t-Test Comparison of Pre/Post Test Scores
of Agribusiness and Water Management Professionals
by Item

Question	Source	Agribusiness X	t	p	Water Mgmt. Prof. X	t	p
1.	Pre-	2.71	-3.2	.004*	3.13	3.75	.001*
	Post-	1.50			1.50		
2.	Pre-	3.92	-2.8	.009*	2.73	2.43	0.022*
	Post-	2.92			4.00		
3.	Pre-	3.64	0.51	0.61	3.80	1.23	0.23
	Post-	3.83			4.30		
4.	Pre-	4.40	1.26	0.22	4.00	2.12	0.05*
	Post-	4.42			4.80		
5.	Pre-	4.57	-0.79	0.44	4.73	0.37	0.72
	Post-	4.25			4.80		

*Significant at 0.05 level.

III. Discussion

The purpose of this study was to determine if interaction with a multi-user computerized water resource management simulator influenced the level of water concern for professionals in agribusiness and water resource management occupations.

The following discussion is organized around the questions directing this study.

A. What similarities and differences exist between the water concerns of agricultural and water management professionals?

Data from the agriculture and water manager control groups indicate no significant difference in overall level of concern exists between these two populations. Both groups scored relatively high, however, item analysis revealed water managers scoring as high or higher on all items except item number two. Agribusiness professionals showed significantly higher concern by agreeing that "Water reclaimed from waste is as good as any other water."

A possible explanation for this finding is that water management professionals may be aware of unsolved waste removal problems, while agricultural professionals are tuned into using waste water for agricultural purposes.

B. Does WRMS treatment significantly alter the level of water resource concerns for agricultural and water management professionals?

Surprisingly, the level of concern for those agricultural professionals receiving WRMS treatment was significantly lower than the control! At the same time, the concern level of water managers was slightly higher with treatment. No significant difference between control groups existed but the reduced agricultural score was such that agricultural and water managers receiving treatment had significantly different levels of water concern. Experimental agribusiness professionals dropped considerably in level of concern while managers' scores increased specifically on item number 2.

The use of computer simulation as an information dissemination tool needs to be scrutinized to determine the desirability

of lowering concern levels. This lower concern level is of particular concern where it occurs with populations using great quantities of water.

C. What aspects of water resource concern are significantly influenced by WRMS treatment?

Agribusiness professionals with exposure to the WRMS scored significantly lower on items one and two. Water managers scored significantly lower on item one, but higher on items two and four. With WRMS treatment managers tended to believe that "waste water is as good as any other water," and not believe that "nature has a way of solving water supply problems before they get serious." These two ideas are responsible for the increase in water managers' mean score.

IV. Summary

The WRMS treatment apparently lowered the level of concern over water issues for agribusiness professionals while slightly increasing the concern of water managers. A factor that influenced this difference in mean response is question number 2, "water reclaimed from waste is as good as any other water." WRMS treatment groups in agribusiness disagreed and WRMS treatment groups in water management agreed with this statement. Agreement indicated a high level of concern over water issues.

If the base assumptions of randomization have been met, these two populations are very close in their water concern levels. They generally respond the same on 4 of 5 water concern items. The main point of disagreement is over the quality of

V. Group benefits

The findings of this study would benefit those attempting to solve water resource management issues where water managers and agricultural users must come together to resolve a water management issue. Where the issue of reuse of waste water is concerned, there is need for further clarification!

VI. Contribution to Existing Knowledge Base

Computer Assisted Instruction has been adopted as a major information dissemination strategy with comparatively little scrutiny. This study dealing with interactive computer simulations for water information dissemination indicates the need for evaluation of this form of instruction. It is apparent that all populations do not affectively react the same to this format for presenting water concepts.

In addition, data from this study supports previous studies where the response pattern to item number one is consistently lower. This pattern of response is not logical for known high concern level populations. The recommended scoring for item one on Watson's Water Concern Scale may not be valid.

References

1. Amend, John R. and Anita A. Arnold. "A Public Education Program in Water Resource Management," Journal of Geological Education, Vol. 31, p. 362, 1983.

2. Watkins, George A. "Developing a 'Water Concern' Scale," The Journal of Environmental Education, Vol. 5, No. 4, 1974.

Appendix

Water Concern Scale

Item	Score	Question
1		We really haven't thought about cutting down our use of water.
	1	strongly agree
	2	agree
	3	undecided
	4	disagree
	5	strongly disagree
2		Water reclaimed from waste is as good as any other water.
	5	strongly agree
	4	agree
	3	undecided
	2	disagree
	1	strongly disagree
3		Mankind has a right to free and unlimited use of water.
	1	strongly agree
	2	agree
	3	undecided
	4	disagree
	5	strongly disagree
4		Nature has a way to solve water supply problems before they get serious.
	1	strongly agree
	2	agree
	3	undecided
	4	disagree
	5	strongly disagree
5		It's the people who should do something about the water problem.
	5	strongly agree
	4	agree
	3	undecided
	2	disagree
	1	strongly disagree