REFLECTIONS ON WATER MANAGEMENT, ACADEMIA AND DISCIPLINARY PERSPECTIVES IN THE UNITED STATES

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INTRODUCTION

The water resources of the United States reflect a mature state of development both physically and institutionally. Emphasis in new development to provide economically valuable services such as flood control and navigation has diminished. Emphasis is increasing on operating and maintaining existing systems to maintain and improve services, and the "reengineering" of existing systems for environmental purposes and environmental quality. Therefore, much of the last half of the 20th Century in the U.S. is characterized by tension between traditional water users, new water development interests and the environmental community. Water withdrawal for all purposes declined in 1980, has leveled off since then, and has been reliably projected to increase only 7 percent by 2040. Water management planning has evolved from an engineering approach to project siting and design to include economic analysis, environmental effects and, more recently, dam removal. Traditional decisionmaking tools for new water development are now often insufficient to inform this new setting and lead to a consensus on needed actions. Planning methods and the involvement of academia and the various professional disciplines in the process is evolving to a new balance.

According to the United States Geological Survey (USGS), water withdrawals in 1995 were about 2 percent less than 1990 and about 10 percent less than 1980 (Solley et al., 1998). As a planner who had a role in the 1975 National Water Assessment (served as Mid-Atlantic Regional Study Director for the 1975 National Assessment and later as special consultant for water conservation and forecast assumptions to the Director of the Water Resources Council), I'm particularly pleased to report that these findings were as predicted by that assessment. It was the first major national water resources study to predict a reversal in the then common belief that water demands were ever increasing and that planning for the future was primarily for the development of new supplies. Much of the reduction in water use over the past 30 years has come about as a result of strong local and state efforts with a supportive public and environmental community focused on beneficial reduction. Some federal actions such as regulatory approaches for water quality affected industrial water use because of mandated process changes and contributed to use reductions, although increasing consumptive losses. The conservation trend continues.

Detailed benefit-cost and multi-objective planning procedures favored by engineers and economists were developed largely after most projects had been built as a result of pressure for better decision tests. The federally-funded Water Resources Council and the many river basin commissions set up to assist in the development-oriented planning processes are now also gone (Schilling, 1998). The last quarter of the 20th Century was dominated by a transition from traditional water quantity development approaches to water quality and environmental issues, largely because basic quantity needs had been met. More recently, dam removal is frequently being considered for river restoration or through the Federal Energy Regulatory Commission re-licensing process (Bednarek, 2001). The decision-making models of the engineer and economist were similar in the respect that they relied on site-specific predicted outcomes for water control or economic effects generally predicated on overall growing demands. The water quality regulatory models have been largely based on standards generally applied across the board, a more political/legal approach, which at this point arguably has met the nation's most basic water quality improvement needs. Both of these models were successful, making major contributions to solving historic problems. Future water planning and management problems are, therefore, likely to be characterized differently and involve a different mix of solution mechanisms.

The USGS also indicates that U.S. water withdrawals during the 20th Century, until 1980, outpaced population growth. The drop after that was due to declines in the 3 largest use sectors, irrigation, thermo-electric and industrial and commercial. When this phenomenon was first observed in 1985, it was thought that above-average rainfall and economic slowdown could be

responsible. The fact that no significant changes were observed between 1985 to 1995 despite lower rainfall in 1990 and improved economic conditions suggests that the trend is the result of more fundamental societal change. Yet, total US withdrawals for the domestic and public water use portion, the 4th largest use sector, has, contrary to the overall trend, increased. The increase was primarily caused by population growth, although per capita use in this sector increased from 89 gpcd in 1960 to 122 gpcd in 1990 -- primarily as a result of decreasing average household size. Significantly, this trend appears to have reversed with a drop to 120 gpcd in 1995 and could also indicate a new long-term trend due to a stabilization in household size, older housing, plumbing retrofit and conservation. Livestock use, a smaller use category, has also continued to increase.

DISCUSSION

Overall, since the nation's most basic quality and quantity needs have been met, decision making for water management in the U.S. is becoming increasingly complex. It is now characterized by increased pressure for environmental restoration and declining water use except for domestic and public supplies. In addition, projections of water use by the United State Department of Agriculture to 2040, based on an analysis of all use categories and factors affecting use, forecasts increased use only in the domestic and public use sectors, as well as livestock (Brown, 1999). The adaptive management practices employed by professional water managers in coping with normal climate variability are also likely to be sufficient to deal with potential climate change in this timeframe (Schilling and Stakhiv, 1998). Therefore, water use in the U.S. in the early 21st Century will increasingly face conflicts predominantly related to management of existing developed systems for the environment and personal and urban lifestyle needs. There are some high profile examples; the defining characteristics of the regional wetlands of the south Florida ecosystem have been lost or substantially altered as a result of conflict for water use between the environment, agricultural and urban needs over the last century. Shared vision consent-seeking processes, not just economic analysis, have been used to plan for future restoration. The Columbia-Snake River system, extensively developed for navigation, irrigation and flood control, is under study for removal of four large mainstream reservoirs for restoration of salmon and steelhead spawning runs. Here again, traditional benefit-cost analysis, with complete restoration, would not favor this action over traditional management practices. The Mississippi River, draining much of the U.S. westward development, has also become the focus of renewed attention for revised water management for environmental purposes. The Missouri is under active study for habitat restoration opportunities and revision of the Missouri River master control manual is likely to impinge severely on traditional navigation and flood control as well as environmental purposes. Planning for navigation improvement involving possible lock capacity expansions on the Upper Mississippi has created huge controversy. The Alabama-Coosa-Tallapoosa/Appalachicola-Chattahooche-Flint, (ACT /ACF) is also an example of a recent interstate conflict over water use centering on the demands of the urbanizing state of Florida, the urban demands of the city of Atlanta in Georgia, and the rural state of Alabama.

Curiously, amidst the clear shift to larger scale reengineering and a several decade long downturn in large-scale river basin water resources planning, the U.S. is also experiencing a watershed rival. Depending on who counts, there are 3000-4000 citizen watershed-related organizations in the U.S., numerous watershed conferences and much watershed rhetoric. At the same time the Natural Resources Conservation Service's PL 566 program, a traditional watershed program, also continues to be minimally funded. A common feature of efforts to deal with the larger regional examples, as well as many watershed issues, is the use of outcome-based consent-seeking processes. Unlike the predictive approaches of the engineers and economists who dominated water planning and management in the mid-20th Century, the 21st Century is beginning with more willingness to undertake actions, particularly for environmental restoration, where the ability to predict outcomes is uncertain.

PERSONAL CAREER OBSERVATIONS

My own water management experience in the last half of the 20th Century began in the early 1960's with the Corps of Engineers. It may provide some useful insight into the involvement and perspective of various professions in water management, as well as research. The first "economist" I worked with was actually an engineer with some economics education assigned to do economic analysis. Shortly, thereafter I was fortunate enough to be assigned to the Corps Baltimore District Basin Planning Branch under Harry Schwarz, an innovative and adaptive planner. We did have a real economist, but no other non-engineering disciplines. I was also fortunate in that position to work on the latter phases of the Potomac River Study and the beginning of the Susquehanna River Study. In this time frame, there was an emerging awareness that the Potomac was the nation's river and momentum was building toward the landmark Water Resources Planning Act of 1965, establishing the Water Resources Council, River Basin Commissions, and a multi-objective planning approach.

In that atmosphere, I remember early meetings where the Secretary of Interior expressed concern over the limited approaches taken on the Potomac, particularly to recognize the cultural values of a free-flowing river. The engineer and economist team had proposed nearly 20 dams (the only tool we had) for purposes including dilution of pollution in the Potomac estuary. Other approaches, including waste treatment, regulation and reduced water use, were ultimately found and only one dam was ever built. The Susquehanna study was initiated with Harry's urging as a more open, fish-bowl-planning-like process as a result of the Potomac "dams can't solve every problem" experience.

I changed positions in the late 1960's and worked for the State of Nebraska as Head of Watershed Planning and as a representative to the Missouri Basin Interagency Study. I was again fortunate to work under an insightful individual like Warren Fairchild who later became Director of the Water Resources Council and Assistant Commissioner of the Bureau of Reclamation. A great deal of change was occurring in Nebraska at that time. I was fortunate to participate in consultations with individuals like Henry Caulfield, the principal author of the Water Resources Planning Act of 1965 and Warren Viessman, an academician with a problem solving focus, at the University of Nebraska. In this timeframe, I was not only impressed with the increasing role and importance of conservation and environmental interests in water management, but also with the intergovernmental roles of government and agencies as Nebraska's water laws underwent a comprehensive review and revision under Warren Fairchild's leadership. I returned to the Corps to head up the plan formulation effort on the North Atlantic Regional Study with a responsibility to address state needs and respond to a Blue Ribbon Advisory Group with academic members like Gilbert White, Nathaniel Wolman, Abel Wolman and Arthur Maass. Strong state programs were represented by forthright officials such as Francis Montanari from New York on the Coordinating Committee, who also asked hard questions. Harry Schwarz was determined to make this interagency-intergovernmental effort work and to use modern economic analysis methods to inform the process as well. The econometric input-output model he championed was well ahead of it's time, as were the attempts to form explicit plans for each planning objective. Although Harry has been well acknowledged for his effort to use the best of academia, he devoted equal attention to the policy, political and intergovernmental aspects of planning. He aggressively sought advice and contractual help from academics and outside experts to fill in the gaps. Since my job, as a practitioner with a state background, necessarily involved defense of the plan formulation process to the states, other Federal agencies and the Advisory Group, I learned a lot, sometimes painfully. Primarily, I learned that it wasn't possible to put all considerations into the quantitative and predictive methods of the engineers and economists. Never-the-less we tried hard to put things like fish and wildlife, recreation and social and cultural values into quasi-comparable formats. The overarching lesson I learned was that the multiple disciplines involved actually approach problem description and solution differently. Many of the disciplines did not use or feel comfortable with the quantitative or predictive models of the engineer or economist. Overall, the consent-seeking process itself was most important and the models used needed to be designed to inform that process.

Upon completion of the North Atlantic Regional Study in the early 1970's, I again worked for Warren Fairchild -- this time at the Bureau of Reclamation on the Western U.S. Water Plan as the plan formulation specialist. Although this study was designed as an interagency effort, it was aborted prior to completion primarily because the agencies and states involved were not convinced that their interests were reflected. It also relied primarily on the in-house expertise of the agency staffs involved. The perception that the plan was to focus on new irrigation project development, at the expense of other interests, was never overcome. Again, the importance of designing a consent-seeking process to incorporate good information and values of all disciplines was reinforced. I returned to the Corps and once again worked for Harry Schwarz, this time as the Senior Study Manager on the Northeastern U.S. Water Supply Study. This study was authorized as a result of the Northeastern U.S. drought of the early 1960's. Although water supply storage was included in some Corps reservoirs, it was a jealously guarded traditional local responsibility. In addition by this time environmental interests had developed much more salience at national and regional levels. The lessons learned about not confining solutions to those within a single agency's scope and the importance of an inclusive process in conducting water management studies were applied in this study. I initiated water conservation studies as a direct result of a study process where knowledgable environmental and public interest groups also questioned the notion of ever-increasing demand. Use of academicians and water supply experts as consultants to work with the team was critical. As a result of these studies, water demand measures were considered, for the first time in a major study, on an equal basis with supply increase measures. The concept, however, was simple from an engineer or economist viewpoint; costs were assigned along with expected yield (reductions in demand), and implementation responsibilities for each demand

management measure. In effect, conservation methods were treated like water supply project alternatives. No new Federal projects resulted from this study but it did foster better planning for use of supplies and conservation. The lessons learned were: (1) it's easier to deal with other disciplines and values if the data can be made comparable; (2) responsibilities for implementation should not constrain consideration of alternatives; and (3) most environmental and social water management issues aren't easy.

From the late 1970's until my retirement I was fortunate to work at the Institute for Water Resources, where I remained in place and water resource leaders and jobs changed around me. The early understanding that water problems were more than engineering, which I had received from Harry Schwarz and Warren Fairchild, continued to impact the rest of my career. Certainly, I used the Inter-governmental Personnel Act (IPA) to actually detail academics to IWR. This included early interaction with Universities Council on Water Resources figures like Duane Baumann and establishment of a UCOWR Fellow position at IWR in the early 1980's. I also sought out and used expert private sector consultants to address special problems and to fill disciplinary voids. Overall, using up to 3-to-1 leveraging of in-house resources in this manner allowed IWR to obtain both expertise and perspective to address special or new problems using extended matrix teams composed of in-house academic and consultant resources. Using these techniques, I provided leadership for some noteworthy major national studies. They included the 1977 White House Drought Study, National Wetland Mitigation Banking Study and National Water Infrastructure studies as well as numerous Corps of Engineers-oriented policy studies all of which also continued to improve my perspective on multi-disciplinary decision-making. Various disciplines approached integration into these multi-disciplinary processes, at least initially, with some fundamentally different perspectives and values at the personal level. Based on my experience, I believe engineers are generally reductionist, reducing problems to ones they can solve with the range of tools available with predictable results. Economists also generally reduce problems; but to price, economic value, and projected monetary results rather than structures. Environmentalists, often consistent with a biological science perspective, tend to be more descriptive of current or desired end states, with sometimes limited ability to predict the changes or changing relationships necessary to achieve those states. Social and political scientists are more likely to observe views and describe relationships, often valuing process design more than outcome. In general the geographers I've worked with have been more varied and harder to typify, but are generally applied geographers seeking practical solutions using social science rigor and tools. In summary, whether any individual or profession precisely fits over-generalized categories such as the preceding, or not, doesn't matter. What does matter is developing water planning and management processes to better reflect the range of perspectives in decision-making.

My last few years of experience at the Institute, where I continued professional association activities, participated in the Aspen Institute's Dialogue on Dams and Rivers, and my association with Planning and Management Consultants, Ltd., (PMCL) have provided an opportunity to reflect on future directions. Multi-disciplinary planning as a process, in whole or in part, appears absent from the present quality protection oriented watershed approach and from many *ad-hoc* smaller scale restoration efforts. The commendable focus on community involvement for consensus in both areas will result, I believe, in a natural progression to solving tougher problems, as the easy ones are solved, and will create renewed demand for some level of alternative comparison. As was the case in the evolution of water project planning processes in the mid-20th Century, an involved public and differing disciplinary perspectives, along with the need to consider decommisioning and restoration needs, will create a renewed environment for good multi-disciplinary planning. Certainly, the recognition by many in the environmental community, epitomized perhaps by Bjorn Lomborg (2001) in his book "*The Skeptical Environmentalist*" that the "litany" of big environmental fears is not backed by evidence, also supports better planning.

We are witnessing major data gathering, software and hardware breakthroughs, which can also help to improve the dialogue among water professionals and the publics they serve. They are helping to increase the "water literacy" of all. Real time and interactive simulation and model building is on the verge of revolutionizing the process of water negotiation. In the past, experts listened, then built brilliant models that only they could manipulate. Not surprisingly, those models also reflected, in many cases unconsciously, the values and often reductionist context of their creators. Those stakeholders who were so disposed could simply reject them as black boxes producing answers the experts, but not they, wanted. But today, it is possible to work together jointly, transparently and cheaply to create sophisticated models with high validity to work in real time with both professional and non-professional stakeholders. It is a little like playing computer games with a river basin or watershed. The point is that the stakeholders as part of the creation of a "single text"

negotiating document jointly own the relationships and algorithm used. This helps parties to create shared visions. It creates a cognitive map of alternatives in situations where parties are primarily disposed to cooperate. Some of the planning tools developed at IWR are representative of the new evolving market for planning and management assistance.

Planning Manual and Primer – used simple guidance and instructional material for new planners. Despite the self-evident nature of these documents to experienced planners, they became best sellers in today's environment where many have not had experience in a planning process. They have been used as course materials in several universities.

Shared Vision – a way to use computers to help stakeholders discuss, negotiate and participate in water resources analyses. It bridged the gap in planning between specialized computer analysis tools and the way people conceptualize problems and make decisions.

Simplified Decision Support Software: IWR Plan – conducts three processing functions: (1) as an aid to discussion, negotiation and formulation of combinations; (2) cost-effectiveness analysis of combinations and incremental cost analysis of cost-effective combinations; and (3) identifying the plans which are the best financial investments for any given performance level. Effects on a range of decision variables are displayed in user-friendly graphics.

Operations and Maintenance Business Information Link: OMBIL - developed to improve the management of the Corps' existing projects through real time integration of management information systems from the specific project operations level up to the executive policy/financial level of the agency.

I was fortunate to have been mentored in the formative stage of my career by leaders who where engaged in the major water resources programs of the day and who valued diversity of perspective. My experience with the IWR program, and more recently PMCL, indicates that, despite the trends since then in water use reduction, national needs still exist in a number of areas and will require renewed attention to establish demand, improve management of existing assets and assess environmental tradeoffs. The agenda for Water Resources Research in the 21st Century recently published by the Water Science and Technology Board (2001) continues to emphasize the importance of research in many of the traditional water availability, use and institutional areas. However, the results of the national listening sessions on water resources challenges conducted by the Corps also verify growing and changing national needs in flood and disaster response as well as restoration, development and management for transportation and water supply (U.S. Army Corps of Engineers, 2001). In addition, the tragic events of September 11, 2001 have heightened awareness of the need to add water infrastructure security expertise to the interdisciplinary skill mix required in water resources, planning and management (Environment and Water Resources Institute, 2002).

CONCLUSION

As the new millenium begins, water resources planning and management begins a new paradigm as well. Clearly the last couple of decades of the 20th Century provided less opportunity to develop new multi-disciplinary planning and management skills, since there were fewer interagency-intergovernmental efforts. In addition most of the nation's experienced water resources planners are now out of the work force, creating an intergenerational experience transfer gap. Since many water resources planning and management problems will now involve decisions to unbuild and restore, as well as to build, more involvement by disciplines other than engineering and economics will continue to be required. Just as clearly, many of the *ad-hoc* environmental restoration and other remaining water resources needs, such as water supply and flood management, increasingly require such skills. Problems have moved up the scale from simple, recognizable and *ad-hoc* to hard, comprehensive and inter-disciplinary. Yet what and how you think about water management is still largely related to your education and your experience. Cross-disciplinary planning experience has declined in agencies and academia as well, and it is not emphasized in higher education. Many new and younger faces will be involved in the future presenting a good opportunity for mentoring and development. Academicians and agencies to be involved in the education of future water resource professionals would be well-advised to create ways to work with experienced planners and expert consultants to create service learning, mentoring and teaming opportunities to compliment disciplinary learning and traditional research to shorten the learning curve for all. New cross-disciplinary research to integrate ecological, engineering, economic and social decision-making is also needed.

AUTHOR

Kyle E. Schilling retired from Federal service December 31, 1999. He is currently a member of the Board of Directors of Planning and Management Consultants, Limited. Previously, he was the Director of the U.S. Army Corps of Engineers, Institute for

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