PERSONAL WATER PERSPECTIVES: LEARNING FROM THE PAST

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INTRODUCTION

The beginning of a new millennium is a time to reflect on the past and apply what we learn to chart policies that meet the challenges of the future. Our experiences over the past century contain many useful lessons for shaping water management practices that can effectively address the threats of water shortage and pollution that are growing worldwide concerns. Some interpretations follow as food for thought in the process.

My awareness of water problems began while being raised on an irrigated California farm where water availability was crucial. My perspective for dealing with them was nurtured by studying under Ray Linsley at Stanford where engineering-economic planning was an emerging academic program. My engineering experience was in project planning in California. My teaching and research focused on integrating principles from hydrology and economics in water resources planning and floodplain management at Kentucky, Georgia Tech, and Utah State. For the last seven years, I have been working at the National Science Foundation to advance the science of hydrology and facilitate interdisciplinary collaborations to provide tools to people on the firing line of water management. The following thoughts are the products of this career.

CURRENT SETTING

Fifty years ago, water resources planning focused on building facilities to capture and deliver water for beneficial uses and to contain floods to reduce damages. People were quite sure that full resource development would foster economic growth and serve broad social needs. Governments built projects that proved financially costly, environmentally destructive, and politically divisive. Costs mounted because people ask for far more than they can afford when others pay the costs. Environmental harms increased as projects drained rivers and wetlands and converted forests, meadows, and deserts into fields and cities. Political differences deepened as jurisdictions sought to develop their own water resources with little regard for the needs of neighbors. Disputes mounted among towns, states, and nations.

As the water resource was more fully developed, projects became larger and more costly, and their adverse environmental impacts became more severe. Fiscal and environmental concerns caused the political process to halt construction as society looked around for alternative approaches to basic human needs. Now water withdrawals are approaching the upper limit to what nature can supply and fresh water resources are being reduced by pollution and threatened by climate change. People talk of "capping growth," but both the ideal and the implementation strategy are left fuzzy.

The difficulty in reducing water use is compounded because democracy is biased toward win-win "solutions." The political process has a hard time when gains require sacrifices. It resists use of models to find fair trade-offs, the quest that has shaped the careers of many of my colleagues. Policymakers forsook optimization and required impact statements to document the full environmental and social consequences of proposed actions in the hope that informing stakeholders and facilitating public participation would open the way to people who cared, working through endless minutia to ideal conclusions.

However, society is not having the thoughtful discussion among winners and losers that generates solutions and sustains actions. We have not arrived at plans for facing the serious consequences of depleted water supplies, spreading pollution, and havoc from severe storms. As water issues grow more severe, concern grows that the cumbersome process we have concocted is headed toward a stalemate rather than constructive policies finding fair solutions.

People see no light at the end of the tunnel, and fears mount in individuals, regions, and nations. We see increasing clashes between economic goals and environmental protection both within industrial societies (witness the growing green political movement) and between prosperous and less-privileged nations. Disparities in access to water and land resources and policies on waste creation and disposal are being institutionalized within an increasingly hostile political

milieu. Somehow, we must find a way out that can fulfill the diversity in human goals by applying a multiplicity of means to utilize the variability in available water supplies.

DIVERSITY IN GOALS

Over the last 50 years, the goal driving water resources management has evolved from meeting basic needs (water and food for people) to fostering economic development (maximizing benefits minus costs) and now to sustaining a viable living environment as indexed by reduced pollution and greater biological diversity and social harmony. However, the new ideal faces a fundamental problem. People pretty much agree on income as the measure of economic welfare but have many preferences for the environment and are likely to be downright contrary in disputes on cultural values. Economies prosper and falter. Governments are autocratic and democratic. Cultures, religions, food preferences, and concepts on the quality of life vary widely. We have no common integrated environmentally- and socially-based concept of welfare and no process for achieving one as water conflicts are exacerbated by diversities in goals among cultures, regions, and countries. We need an alternative to the impossible goal of pleasing everybody.

VARIABILITY IN NATURE

Management is compounded greatly by the fact that water availability and flood threats vary greatly among locations and over time. Climates are wet and dry, hot and cold. Fifty years ago, project planners worked on the supply side and designed works that varied appropriately with differences in water availability. As river systems approached full water use, waste loads reached carrying capacities, and floodplains filled with development, governments turned to working on the demand side and conceptualized a nonstructural approach to water resources management.

However, this policy also falls short. In the name of fairness through consistency, it fosters a level of uniformity that often clashes with the variety in natural conditions. Some 100-year floodplains are much safer than others. Conservation in some areas saves water for use by others. At other locations, it only speeds return flows to the sea. High concentrations of metals are highly toxic, but low concentrations cause nutrient deficiencies in natural ecosystems. Regulations and educational programs are biased toward a simple world view where all conservation is good and all waste is bad. In short, the deployment of uniform nonstructural measures is generating increasing frustrations among people who visualize major benefits from being different.

For example, both economic analysis and optimization theory tell us that increasing flood losses are inherent to a growing economy. Flood damages are the tax that nature levies on people gaining values from floodplain use. As more people invest to garner those benefits, the tax rises, just like every other tax that people pay for infrastructure and public services. The proper planning goal is not to eliminate or even reduce this tax but to use modern technology to reduce the loss of life and other human hardships and to shift payments to such less onerous methods as buying flood proofing and insurance.

Recent research in hydrology is increasingly turning to scale issues. Scale issues are also important on the water management side. At the small scale, land and water use practices are highly individualistic. Each person does his or her own thing within a regulatory framework that protects the public interest. Instead of using nonstructural programs to work toward uniformity, we should be facilitating ways for people to achieve their goals with minimal disruption to others. Since priorities change with circumstances, it is important for people to have the flexibility to adjust their actions, sometimes rapidly, as water supplies and demands vary over time. Bureaucratic management has difficulties with handling both variety and flexibility. The challenge is to find technology and supporting institutions that facilitate fair adjustments in the short term during floods and droughts as well as over time in response to changing climates, economies, and environments.

MULTIPLICITY OF MEANS

We need to cross one more bridge along the road to better water management. We must find a way to turn from developing supplies of raw water for "once through" use to reuse systems so that total water use can exceed withdrawals. We must recognize that waste transport and disposal are natural processes that continue over geologic time and seek better ways to integrate our "return flows" into natural systems while protecting nature from insults by new "artificial" contaminants. We must think of means other than full human control of high and low flows as we use floodplains and cope with droughts. We must heed costs as we form policy and avoid situations where too many costs are paid by "government" and too few by beneficiaries.

We can make progress toward this goal as we learn to manage in a context that recognizes the differences among water sources and the quality of water needed by various users. Many water users draw from streams or wells secured by personal rights while others are served by large utilities. Most take water from one source and discharge

return flows to another; but others, largely industries, install reuse systems. Some users capture and treat wastes, others discharge them for treatment in large plants, and still others disperse wastes in ways that add to non-point source loads. Some secure water supplies larger than they ordinarily need for safety during droughts. Many take excessive risks in uses of floodplain lands. A nonstructural approach based on regulations is just not able to sort through all this complexity and achieve equity.

The hope for influencing water use lies in applying market processes to guide exchanges of water among users requiring different times, places, or qualities; waste generation and disposal; floodplain land use; etc. Society is now gaining the information and technology needed to advance from treating water as a common public good to recognizing distinct "water products" that can be delivered to particular users at a specific location. Waters from different sources have different qualities and can be delivered to different uses or discharged into different streams. Waters can be treated to mesh with downstream conditions or recirculated for reuse in complex systems that cascade through uses progressively less sensitive to quality deterioration. Many kinds of wastes can also be removed and recirculated. Floodproofing practices can be varied with risks. Economic penalties can be structured to preserve local environmental values.

Advancing technology adds alternatives faster than regulators can respond. I see no other way out than innovative structuring of market forces to cause best practices to emerge. The possible roadblock of difficulty in gaining institutional acceptance of the science and technology needed to support such a market system must be faced head on. However, I would note that the vast change in handling information technology currently underway in the private sector demonstrates that new technology is accepted much more rapidly when working through markets than through regulations. Market processes give people maximum freedom to pursue personal preferences within constraints defined to protect public interests.

APPLICATION

We have come through an era when academics favored economic optimization as a planning objective but governments shaped water resources management programs (as opposed to projects) on the basis of political, social welfare, or environmental considerations. As a result, academics often moaned about "welfare costs" of public choices and being used by being asked to support preconceived notions rather than find answers. Over the last 20 years, disillusioned social scientists have turned away from water issues, and water management practice has been the loser.

Now, society is entering a more market-oriented era, and academics have formed tools for economic optimization that apply best to decisionmaking in a market context. Past use of these tools was often frustrated by a paucity of information, and we now have vast new capabilities for tracking water availabilities and demands. We can deliver current, reliable, local information so that individuals can follow ground water levels, stream flows, flood risks, etc., that affect them personally. Industries, businesses, and local governments can be connected to the "net" to access databases. All can deploy user-friendly computer programs to evaluate options. Governments at appropriate levels can monitor events and act as needed to protect the public interest.

CHALLENGES

I see four major additional challenges ahead:

1. We must craft and gain institutional acceptance of the needed market structure, giving special attention to resistance to change from vested interests receiving "water" subsidies.

2. We must deliver information that people want in a form they understand. The development of new technology needs to be coordinated with developing new means for educating managers on applications in their local situations, a continuing challenge through periods of technological innovation. We need to be sensitive to what people need to be comfortable with using new technology to assess their options.

3. We must keep current with new methods for water control, waste treatment, flood proofing, etc. Concepts can be distributed electronically, but technical and financial help will always be necessary in working out application details.

4. We must help people to be comfortable with uncertainty. As technology advances, people live in economies that become less tolerant of disruptions, and these can never be eliminated. We will have to work hard to develop information that water users and system regulators need to make better decisions in a context of uncertainty. Innovative concepts for new kinds of insurance can meet a major need.

CONCLUSION

The grand challenge is to integrate the above efforts. I dream of viable "water markets" where price signals and information from the "net" guide choices within a framework monitored to protect the public interest and having flexibility for needed adjustments. Participants would have ready access to a wide range of information on factors they believe important, and "watchdogs" would have access to information needed to protect the public interest and tools to take necessary actions.

In five pages, I cannot give details, but I hope this stimulates thinking.

And this brings me back to reflecting on my personal contribution. I have tried to work toward an ideal that transcends what society can accomplish in a generation. My lifetime has been spent in advancing the science, in developing and applying practical tools to use in water resources planning and management, and in training students and professionals to use them. I have worked toward better management at a university laboratory tied to serving water management at the state level and toward better science in the Hydrologic Science program at the National Science Foundation. I see progress as we travel a road through clouds of confusion.