

WATER RESOURCES IN THE TWENTIETH AND ONE HALF CENTURY: 1950-2050

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At the millennium's end one tires of predictions for the next millennium, or even the next 25 years. I suspect that a much more useful activity might be to go back and take a look at the studies and developments that occurred during the previous 50 years as the basis for the next 50 years. In 1950 the demographers were still looking back on the low fertility period of the 1930s and 40s, and even though the "baby boom" was beginning to sprout all around them, the population forecasts were modest. For example, demographers in the 1940s forecast the year 2000 global population to be just 3 billion; the United Nations (U.N.) estimated that the actual 6 billion mark was passed on October 12, 1999! Global water withdrawal was predicted to increase almost three-fold from 2,500 km³ to 6,800 km³ in 2000. Based upon World Bank and World Resources Institute data, I estimate the 1998 withdrawals to be as low as 3,800 km³.

In this note, I concentrate mainly on the United States (U.S.) situation with only a few remarks on what was happening in the rest of the world. For the United States, 1950 is a good point to start examining our current views of the nation's water resources future. For example, starting with a base of 151 million the year 2000 forecast was for 235 million, whereas the actual 1998 population was more like 270 million. Although the economy was heating up, the official views of economic activity were quite modest. Combined population and economic growth were used to predict the future demands for resources, notably water and energy. The energy forecasts were remarkably close but for all the wrong reasons: under-estimate of population and over-estimate of per capita use. The water projections made in the 1950s for the year 2000 were completely off the mark by a factor of three (1,200 km³ as opposed to an actual 400 km³ per year). The quality of these projections should be borne in mind when we look forward another 50 years.

The 50 years from 1950 to 2000 brought many radical changes to how we manage the water sector of the U.S. economy. At the outset the country was recovering from the effects of a long depression masked by the hyper-activity induced by World War II. In the water sector the

feeling was that there was a great need to resume the large-scale development-oriented projects of the New Deal era. This was to be implemented by the federal agencies charged with development, the Corps of Engineers and the Bureau of Reclamation. There was great enthusiasm in the federal establishment for moving ahead with this task. Quickly, however, conflicts of jurisdiction and philosophy of design surfaced, and a set of national commissions were set up to deal with resolving the planning issues. At first, there were several major commissions that drove policy in the direction of resource development (irrigation, power, and flood control) and which led to vast outlays on construction programs. Later the emphasis moved toward quality and ecosystem protection issues that led to even larger federal expenditure programs (wastewater treatment and sewer grants). The era has come to an end with much attention to quality and ecosystems often based upon removal of large infrastructure projects that were constructed at the beginning of the era (Kissimmee River in Florida), and the role of the federal government greatly reduced vis-à-vis local government and private actors.

THE FIRST FIFTY YEARS: 1950-2000

Federal Activities: The Policy Commissions

The past half-century has indeed been one of major actions by the federal government with respect to water policy and water development. More important than the projections of resource use, the 1950s ushered in thirty years of water policy commissions and widespread federal involvement in the development of methodologies for planning and developing large water projects and programs.

The half-century started with the Hoover Commission on the Reorganization of the Executive Branch (1949) which recommended sweeping reorganizations of the water agencies, and in its second report (1955), the strengthening of the Bureau of the Budget project evaluation capabilities and the setting-up of inter-agency river basin commissions. Concurrently the President's

Commission on Water Resources (the Cooke Commission, 1950) focused on regional development and recommended the setting up of major river basin commissions and a Board of Review to ensure that the projects undertaken would not be considered in isolation but as parts of overall multipurpose basin programs. To understand the mindset of the Cooke Commission, one only needs to consider that despite its emphasis on multipurpose programs, it almost completely ignored recreation, fish and wildlife, and suggested waiting 10 years before further federal intervention in water pollution control. In an interesting comment on technical innovation, it predicted that the amount of rainfall could be doubled by cloud seeding! In 1955 the Eisenhower administration established an inter-agency cabinet-level Presidential Committee on Water Resources Policy to consider the recommendations of both the Cooke and the Hoover Commissions. The unprecedented increases in industrial water use and pollution in the late 1950s led in 1959 to the establishment of the Senate Select Committee on National Water Resources, chaired by Senator Kerr. The Kerr Commission focused on the need to avert water shortages due to economic growth and on the technical measures to accomplish to avert them. The Kerr Commission's research recommendations were later incorporated into the 1965 Water Resources Research Act that also established the Water Resources Council in the Executive Office of the President.

In 1968 spurred in a large part by dissension over the allocation of the waters of the Colorado Basin, a series of environmental accidents involving fish kills and oil platform blowouts, Congress created a National Water Commission (NWC). In a major departure from the other commissions the NWC declared that future demands for water are responsive to water policy and, therefore, plans should be made to design the future rather than accept it as given. It forecast a shift of priorities away from water development to water conservation and enhancement of water quality. It favored greater use of economic approaches to reduce water losses, increase efficiency, advance water conservation, and embraced the beneficiary-pay principle. The commission called for a reexamination of laws and legal institutions governing water resources as long overdue, and tried to define and clarify the federal government's role in water. Finally, the commission concluded that the front-line actor should not be the highest level of government, but "the level of government nearest to the problem with the capacities required to represent all the interests and resolve the matter in timely and equitable fashion." In 1969 President Nixon appointed a Task Force on Resources and the Environment which led in rapid succession to the National Environment Policy Act of 1969, which included establishing the Council on Environmental Quality, and in

December 1970 to establishment of the Environmental Protection Agency (EPA). In the meantime Congress had itself been very busy with the Clean Water Restoration Act of 1966 which established an entirely new scale of federal entitlements for water quality clean-up, and the \$18 billion 1972 Clean Water Act. The 1972 act meant that the EPA was essentially on its own amongst the federal water agencies, with the largest federal programs and the smallest technical manpower to administer them.

Shortly after the NWC reported to Congress, in 1973 the National Water Quality Commission (NWQC) mandated by the 1972 Clean Water Act was established. While noting the emergence of non-point sources as potentially the most serious problem, the Commission urged the continuation of the massive construction grants program. Also, because of the lack of administrative capacity at EPA the commission recommended that many of the administrative and regulatory functions be handed over to the states. Soon after the NWQC report was presented in 1976, the new president, Jimmy Carter, set-up the President's Water Resources Policy Study Task Force. This task force was notable for its emphasis on three aspects of policy: its advocacy of a role for the states in federal project decisions; its support for cost sharing and pricing reforms; and its recommendation that the Water Resources Council be responsible for the application of evaluation standards to all federal water projects.

Despite the plethora of commissions, the 20th century ended with two more: the National Drought Commission (1990-1994) and the Galloway Commission Report on the 1993 Floods on the Mississippi River.

DIGESTING THE COMMISSIONS

The advent of the Reagan years brought with it a healthy reassessment of federal roles in water development and management. In a sense, we have come back to the recommendations of the NWC with respect to the beneficiary-pay principle now firmly entrenched in the minds of the federal bureaucrats. This has, as expected, brought much of the extravagant spending of the early decades to a halt. Now all federal water expenditures are subject to careful screening of who the beneficiaries are and how are they going to pay. Most federal activity is now restricted to areas where water behaves most like a public good: public health, fisheries, flood control, and sustainable development. This does not imply that the federal government is doing these activities optimally, or even correctly, but that it is avoiding areas where market-based instruments are likely to work better than government regulation. This is seen in the openness to

privatization of public water utilities, the deregulation of hydropower within the context of the newly emancipated electric power systems, and the encouragement of water markets, water banks, and other market-based instruments.

The Bush and Clinton administrations both declared themselves to be “environmental presidencies.” Much of the time during the Bush administration water policy was held hostage to wrangling about the “no net loss of wetlands” sound bite. Significant water policy progress was made, however, in two bills: the Reclamation Projects Authorization and Adjustment Act and the Western Water Policy Act Review Act of 1992. Both were notable for their emphases on tempering irrigation and power withdrawals in favor of fish, wildlife, and riparian vegetation. Another piece of legislation passed in 1992, the Energy Policy Act, has, through its Section 235 on national water efficiency standards, the potential for reducing water demands by households and industry. Apart from the emergency response to floods and droughts, the Clinton administration has maintained a fairly low profile on water issues, with Vice President Gore pushing environmental concerns towards global warming issues.

NON-FEDERAL ACTIVITIES

While all the comings and goings of the federal agencies and federal activities are well documented, what was happening at the state and local level is not so well documented. Locally most of the attention this century has always focused on water quality, particularly drinking water, and depending on the location within the U.S., irrigation, flood control, or hydro-power were also major concerns. Since the 1950s, however, the local water issues have become increasingly drawn into the federal concerns. Clearly, increasingly complex water regulations and attendant grant programs have made paying attention to the federal activities a profitable game for local players. But increasingly, the federal mandates are accompanied by exhortations to do good, but no federal money. States and localities are being thrown back onto their own sources of funding. This is a potentially interesting area for creative financing and regulation. Worldwide, the water sectors are undergoing widespread privatization in a wide variety of modalities. This has only recently become an issue in U.S. domestic markets with Atlanta being the largest utility to privatize.

Two major local issues, however, have had a lasting impact on water policy nationwide. The first was the six-year long drought (1987-1992) in California, and the creative public-private partnership that helped resolve

what otherwise could have been a major disaster. The governor, Pete Wilson, created a Drought Water Bank that put together the best aspects of private marketing and public regulation, and effectively solved the drought shortages in southern California. The other issue was the 1993 floods on the Mississippi-Missouri river system. The flood caused unprecedented damage along the rivers and led to a major rethinking on the part of federal and local agencies about the role of embankments along the major rivers. These two events have had great impact on how water policy is carried out. One policy problem, however, that underlines many of the remaining policy conflicts is that of land-use control. In the wetlands the taking issue is embedded in the debate about allowable uses for privately held land. This issue pits environmentalists against landholders, developers, and farmers. With the Federal Energy Regulatory Commission (FERC) and the Endangered Species Act effectively dealing with the issues of free-flowing streams, wetland regulation remains the one big remaining issue. Of course, this ignores the non-point source problem which, in itself, raises many of the taking issues. It is difficult to predict how these two issues will play out in the next 50 years.

THE REST OF THE WORLD

During the first 50 years of the 1950-2050 century increasing concern has been registered internationally and within nations and regions. The first U.N. Conference on Water was held in Mar del Plata in 1977, five years after the U.N. Conference on Environment in Stockholm (1972) identified the critical role played by water in environmental management. At the conference a lot of attention was paid to water supply and sanitation in third world countries. Realizing that 20 percent of the world's population did not have access to safe drinking water and 50 percent lacked access to adequate sanitation, the U.N. declared the 1980s as the UN's Water and Sanitation Decade. Despite massive efforts on the part of the U.N. and its specialized agencies (WHO, UNICEF, the WMO, and UNEP), the rapid population growth of the decade meant that despite increasing numbers of people served, the percentages without access remained fairly constant.

This concern about global water has manifested itself through the development of new international institutions and a series of international conferences; starting with the First United Nations Water Conference at Mar del Plata, in 1977, through the Dublin Water Conference in 1992, and culminating in a planned massive meeting on Water for the 21st Century in the Hague starting on World Water Day in March 2000. The new institutions and think tanks include the World Water Council, the Global Water

Program, and the World Commission on Water for the 21st Century. These have spun-off many local and regional programs and institutions all focused upon the potential crisis in water availability over the next 50 years.

In many countries, particularly in Europe, the early part of the era was spent in rehabilitating wartime damage to water systems as well as the economies. Interesting and diverse developments took place in France and England. France decided early on to decentralize the control of water and water quality away from the central government in Paris. They developed river basin agencies (Agence de Bassin) with remarkably strong regulatory and financial powers that are now being copied in many other countries. France also encouraged privatization of the municipal water systems and developed the largest companies in the world with excellent development and management skills which are now the major players worldwide in the privatization of water (including in the U.S.). The British, on the other hand, maintained tight central control over the regional water utilities, until Mrs. Thatcher's remarkable sell-off of the water industry to private bidders in the late 1980s.

THE NEXT FIFTY YEARS: 2000-2050

Over the coming 50 years we can expect the global population to continue growing until it starts to level-off in the region of 9.3 billions. Depending upon the rate of income growth in the world, the water use could be as low as 4,900 km³ and as high as 9,250 km³ by 2050. Whatever the actual number, these figures are getting uncomfortably close to the estimated 13,700 km³ of potentially easily available water. When one adds the necessary instream flow requirements for ecosystem sustainability, the water situation looks very serious indeed. At the regional level there will be many countries that will be much closer to their available water supplies. Hence, the worldwide concern over the availability of the quantity of fresh water.

Unfortunately, it looks as though most of the developing countries will spend the next 50 years struggling to provide safe drinking water and sanitation to their burgeoning urban populations and enough irrigation water to maintain the high levels of food production needed to provide improved diets, at the expense of their ability to restore and maintain their already damaged aquatic ecosystems. Some of the methods to satisfy their food and water demands are already available. These include the trading of "virtual water" via the world grain trade, the use of genetically modified crops that will be water efficient, and the provision of non-water based sanitation.

We can look forward to seeing greater use of these methods over the coming decades.

What about the U.S.? Fortunately, the U.S. is in a relatively privileged situation with respect to availability of fresh water. This does not imply, however, that the U.S. is going to be trouble free over the next 50 years. Recall that hydrologically the U.S. is essentially two countries; the moist east and the arid west. How the issues involving native Americans' water rights and instream flows for ecosystem management are resolved are likely to be much more constraining in the west than the east. Other issues that loom on the horizon are the potential for revival of old, and the introduction of new water-borne diseases and the emergence of micro-pollutants from pharmaceuticals and other trace chemicals which pass easily through our current treatment facilities. One major unresolved issue that will need better approaches during the coming 50 years is that of cleaning-up the "superfund sites." On the plus side we are now just entering the phase of ultra-filtration using new and different membranes which promise to revolutionize water and wastewater treatment.

International issues between the U.S. and its neighbors are becoming increasingly tense with respect to water pollution and water withdrawals, and international conflicts over water are likely to consume more and more of our time. The CIA has recently announced that "environment is a national security issue." The WTO is likely to infringe more and more upon our sovereign powers of water quality regulation, stoking trade wars and other conflicts.

To maintain sustainable flows of high quality we have the advice from all of the Presidential Commissions and the experience gained over the first 50 years. It seems that there is little need to spend more time and effort on new commissions. The water issues are well understood, all the regulations, and more, that we need are already on the books. What remains is the "political will" to pursue the blueprints already in hand. Will we be able to mobilize the political will, will there be a backlash against environmental regulation akin to that in the early Reagan period, or will there be a revision and simplification of the regulations to reflect our new found confidence in market based instruments?

The unresolved global warming issue could turn out to be the major challenge for water development during the next 50 years, or it may not be. There is so much uncertainty in the good science and so much certainty in the bad science, that it makes effective analysis very hard.

Recent weather events, such as floods, droughts, and cyclonic storms have variously been attributed to global warming or unusual El Nino events. Casual reviews of the statistical databases, however, lead one to conclude that most of the comments focus upon the level of damages which are, of course, tied directly to the increased population and increased value of property at risk. Clearly, there is a need to watch the evolving data and look for signals of change that are above the noise level of the data. We desperately need to develop better analytic tools that will incorporate the high levels of uncertainty along with extremely large economic and social risks.

SOME CONCLUDING REMARKS

I had the good fortune to start in graduate school at Harvard at the height of the Water Program. These were heady days. Otto Eckstein, Arthur Maass, Robert Dorfman, Gordon Fair, Harold Thomas, Jr., Mike Fiering, Steve Marglin, Bob Burden, Maynard Hufschmidt, Henry Jacoby, Harry Schwartz, Blair Bower, Cliff Russell, and Walter Spofford were just a few of my daily acquaintances. Of course, I thought it would last forever. Like Camelot it did not. But the training was good and aided by my senior colleagues I did spend many of the succeeding years like a good apostle carrying the gospel to the unconverted. But maybe the training was too good, because it made one realize that no matter how good the data, no matter how good the models, no matter how good the economic analysis, there were always institutional monsters lurking in the shadows. It is now commonplace to refer to getting the "enabling environment right" the way we used to talk about getting the "prices right" in the old days. However, we have good and well-established methods for "getting the prices right," but not for the institutional issues. There are so many institutional designs that could work, but we have no easy way to predict *a priori* which will work best. This calls for a very broad framework in which to set planning and development of water resources, often referred to as Integrated Water Resources Management (IWRM). This is exactly what was called for in the President's Water Commissions during the 1950s. Unfortunately, there are no simple examples of successful application of IWRM. There have been some near misses. For example, the 1965 U.S. Water Resources Council's mandate was a good example, but it failed precisely because it set out to confront the institutional forces opposed to IWRM. Despite the demise of the WRC, the conceptual

framework is still being followed by major U.S. agencies such as the Corps of Engineers and the Bureau of Reclamation. Also, even though they are region-based, the French Agence de Bassin are very much in the spirit of IWRM.

From a policy point of view, a remarkable development is taking place. Following the Dublin Principles, the world water community has committed itself to using the concepts of Integrated Water Resources Management (IWRM) developed during the 50s and 60s in the U.S. and Western Europe. Hence, there is an even greater need to ensure that the studies are integrated, comprehensive, analytic, and policy oriented. This is what I believe systems analysis does best. I am, therefore, greatly in favor of studies that are now described as Decision Support Systems (DSS). DSS can be the interactive tool for decision-makers, the stakeholders, and the professionals around which they can focus their arguments and negotiations.

In this paper, I have spent a considerable amount of time reminding us of the immense amount of institutional effort that has been expended on water policy in the U.S. From 1950 onward all aspects of water policy, management, and development issues have been microscopically examined. The issues have changed, but the concerns and approaches have been the same. How best to provide adequate water supply and water quality to the growing population at reasonable costs and with little damage to the environment. "Plus ça change, plus le même chose," best describes the nation over the past 50 years. We have moved from the poverty motivated Roosevelt New Deal to a situation of hyper-affluence of the late 1990s. The dams that were built at mid-century are now being torn down to recreate free-flowing rivers; the ground water that we carelessly polluted in the 1950s surge of industrial growth is now being cleaned up at immense cost; the traditional federal water agencies are now in serious decline to be replaced by other agencies, such as the EPA, with concern for the new issues. After all the changes we are still faced with the need for strong institutions and regulations to deal with new challenges and old unresolved issues. In the end, despite all of the commissions and committees, we find ourselves better off than most countries, but worse off with respect to our expectations, and still faced with muddling through another 50 years.