WATER FOR THE SUNBELT: A GLOBAL PERSPECTIVE

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Introduction

I have had a long and continued interest in water. When I was a young boy living on a farm on Medicine Lodge Creek in Idaho, I remember the fights over the limited water supply in the stream. The Water Master had to carry a gun to enforce the headgate flows to the farms along the creek. Even then people at the head of the creek used some water illegally at night. The water rights on our farm were filed in 1890 -- too late to get first call on water during the dry years. In a good year with heavy winter snows in the mountains, we had enough water to irrigate three to four times. In a dry year we were lucky to get one "watering" during the early spring, and on those gravelly soils in Idaho, the crops dried up to the point where we could not mow and stack hay, but could salvage some production by turning the cows into the fields.

Water supplies became even more critical during the 1929 Depression and the drought of the 30's, forcing my father to seek other employment. We contracted to stack hay in the Big Hole Valley and Horse Prairie in Montana and leased a hot springs resort in Idaho to try to make ends meet. Our access to open range for our horses and cattle was substantially curtailed when the Taylor Grazing Act was passed in 1934. Several farm/ranch operators went out of business as a result of cuts in grazing allotments, including some of my relatives.

The lack of water on our old farm in Idaho served as one good reason for me to join the Navy during World War II. For nearly four years I saw plenty of water as I served on three aircraft carriers in the North Atlantic and South Pacific -- frequently seasick. And, while salt water was abundant in every direction from the carrier, I well remember the orders to conserve fresh water on board and the limitations in the showers and mess hall. "Water, water everywhere, but not a drop to drink." Even now, good economical techniques for salt water conversion are not within our grasp. Despite this, we have word that the new administration will close out the desalinization research at Roswell and at other locations in the west. The challenge to convert salt water to fresh water and to develop methods to utilize brackish water is still a major goal of the scientific and business community, as well as a problem for the Navy. Indeed, it might be logical to seek National defense funds to maintain the valuable desalinization research at Roswell.

After World War II, I left the farm, but two of my brothers tried to salvage the old home place by digging a well for supplemental irrigation. My older brother cut an apple limb from a tree in our yard and "waterwitched" the first hole. It turned out dry so he moved closer to the creek. A second well did hit water, but the cost and erratic supply never made an economic operation. The old home place is now dried up and abandoned. There is something both nostalgic and sad about an abandoned, formerly-irrigated farm turned back to weeds. And my story has been repeated in many areas of the west. A Newsweek special calls this "The Browning of America," stating that "...the water wars have erupted once again...." (1)

My early work with the Soil Conservation Service in Idaho from 1946-50 was aimed at developing one of the first systems for contour irrigation of potatoes in the United States. Our work unit received a special merit award from USDA for this early water conservation work. At Texas A&M, my interest in water was enhanced from my research on the dry range lands of the Edwards Plateau of Texas. I have conducted studies on range pitting, soil compaction, soil aggregate-size distribution, the effect of roots on water infiltration and other matters that relate to effective water use on rangelands.

As I moved into the Dean's position at Texas Tech, my interests shifted from specific concerns about water conservation and range management to the larger issue of world food production. It became increasingly clear from my latter studies that water was a limiting factor in food production and water use was critical to world food supplies. Also, since the economy of the High Plains of Texas is sustained from water stored in the Ogallala formation, the wise use of this depletable underground resource was of utmost importance to our future. Consequently, I helped organize the West Texas Water Institute at Texas Tech and argued for a share of the Water Research funds through the Department of Interior. Later, we formed "Water, Incorporated" as a means of organizing support for possible water importation into the High Plains of Texas and Eastern New Mexico.

When I moved to New Mexico, I had the pleasant opportunity to work closely with Dr. Ralph Stucky, Professor John Clark, Dr. Garrey Carruthers, and now, Dr. Tom Bahr, as we have strengthened our research and education programs relating to this important resource.

My assignment at this conference is to help bring to your attention a global and regional perspective on the water situation and to set the stage for more specific discussions of water for the growing Sunbelt. I have divided this presentation into three sections:

(1) Water - our most critical resource;

(2) The evasive nature of the water resource - A global perspective; and

(3) The research imperative.

Water: Our Most Critical Resource

First, how important is water, as a resource, in comparison with other resource needs, such as land and energy? It is my belief that _for the next two, perhaps three decades, energy (both cost and availability) will be the most critical factor in food production and economic development both at home and abroad_. But energy is different from the other resources in that there is an adequate supply of energy in our system _if we can capture it_ and make it available to people in a usable and economical form. Some of the new research on energy alternatives looks promising -- particularly the developments in solar energy, geothermal, and in bioconversion. If we can gear up our research effort, which should be multiplied by a factor of ten, we _can_ find solutions to the energy problem and design systems for food and fiber production and industrial development based upon renewable rather than depletable energy supplies.

The second important resource, then, is land. While I am concerned about land, and particularly about the rapid transfer of good crop land to other purposes such as buildings, asphalt, and concrete, I believe that land will not become limiting in the United States for many years into the future. At the present time, we are losing well over three million acres of agricultural land in the United States each year to other purposes. The recently released "National Agricultural Lands Study" points to this loss in America's agricultural land base (2). Dr. David McClintock, in a technical paper supporting the National Agricultural Lands Study, stated it this way:

> "International relations in the 1980's and 1990's are likely to be influenced by resource scarcities to a considerably greater extent than in the past. These, rather than conventional rivalries, will pose increasing dangers to global security.... American cropland must be perceived as a global as well as a national resource." (3)

The loss of cropland is not only a problem in the United States, but is a world-wide phenomenon with industrial development and population increases. Indeed, we must become more concerned about this loss of land to irreversible transfers and to erosion. Nevertheless, as new technology develops and crop yields increase, the amount of land required to sustain each person decreases. We still have some flexibility in this resource.

That means, then, that water is more critical in the long term than either land or energy. We can, and must, find solutions to the energy problem; we can, and will, determine ways to operate with a smaller relative land base, but the amount of water in our system is fixed.

There is no substitute for water. Water is a renewable resource. Man uses it as it moves through the hydrologic cycle, usually pollutes it to a certain extent, and feeds it back into the system. While we can reduce the dependence upon water by increasing the efficiency of water use, there is a very limited supply which must be husbanded with great care as the world population increases.

Let us first look at the value of water to world food and fiber production. A few years ago scientists were talking about the great potential in the higher rainfall zones of the tropics. Much of this optimism has disappeared as we have learned more and more about the sensitivity of the tropics and the difficulty in producing food under these kinds of situations. This means, of course, that the arid and semi-arid lands, the vast moderate to low rainfall areas will still be the major areas for world food production. At the present time there are only about eight countries in the world with surplus food production potential, and the United States and Canada contribute about 70 percent of this export production. We also hold about 40 percent of the world's grain reserves. In 1980, for the second year in a row, the world ate more grain than it produced (4). This emphasizes our vulnerability and our dependence on annual production.

Irrigated agriculture is becoming much more important with time as the world's population increases the demand for food and fiber. The recent growth in irrigated land has not only been in the traditional irrigated areas, but in the moderate to high rainfall zones as a risk reducing factor. For example, in the United States, Nebraska has become the fifth most irrigated state in the nation. Also, irrigation is becoming more important in the less-developed areas of the world -- perhaps the major hope for many of these poor countries. McNamara, retiring president of the World Bank, recently stated that on a global basis, the major increase in total food output in recent years has been associated with expanding the area under cultivation -- particularly the irrigated sector. He states that in the last ten years, roughly 40 percent of all increases in developing country food production has come from expanded irrigation (5). In the past 50 years the areas of land under irrigation has increased threefold and the costs have escalated far more rapidly than the general inflation rate. He also states that despite this development, water has been traditionally treated as a free good and this encourages waste. As you know, the irrigated acreage in the United States comprises about 15 percent of the total harvested crop land, but provides in excess of 25 percent of all crop production. The statistics coming out of the High Plains Study emphasize even more the importance of irrigated agriculture in the United States food situation.

The Evasive Nature of the Water Resource - A Global Perspective

The evasive nature of water as a resource is emphasized by the highly variable patterns of precipitation (in time and space) and the complicated pathways of water as it passes through the hydrologic cycle -- from ocean to land and back to the ocean. While water is, in a very real sense, a renewable resource, the use of this water as it moves through the cycle is the basis for life itself. Thus, the "rate of movement" of water through the ecosystem is more important to mankind than the location of water in the system at any point in time.

Water can be transferred in space from so-called surplus areas to water-short regions by water diversions or inter-basin construction facilities or, to some extent, by weather modification techniques. The latter approach, that is, the effectiveness of "rainmaking," is very difficult to measure.

Water can be transferred in time by constructing storage facilities along streams or by variable withdrawals and variable recharge of underground aquifers. Desalinization can also be considered as a technique for transferring water in time. Desalinization is an established but expensive technology presently applied to only minute water quantities on a global perspective.

I have stated that water movement through the hydrologic cycle is probably more important to man than the location of water at any given point in time. Nevertheless, some statistics on the location of water at any given time can be used for comparisons among countries and regions. Some generalizations from these statistics follow:

(1) About four-fifths of the precipitation falls over oceans and only one-fifth over land.

(2) The proportion of the water resource in the freshwater form is a small fraction of the total supply -- most of the world's water is salty.

(3) Two-thirds of the fresh water supply is to be found in the glaciers and ice cover of the polar regions.

The "Global 2000 Report to the President," released in 1980, defined six general properties of water (6):

(1) Water is ubiquitous, that is, no place on earth is wholly without water -- although I have personally visited some places on earth with no "measurable" precipitation.

(2) Water is a heterogeneous resource. Water is found in liquid, solid or gaseous states.

(3) Water is a renewable resource. However, it is important to recognize the difference between "consumptive" and "non-consumptive" use.

(4) Water may be a common property. Here the report emphasizes the difficulty in defining water rights and the overall attitude that water is a free good.

(5) Water is used in vast quantities. The global 2000 committee estimated that total water withdrawals is three orders of magnitude larger than the world's combined production of minerals, petroleum, coal, and all metal and non-metal ores.

(6) Water is very inexpensive. While this generalization is also true, my pocketbook hurt when I had to pay $3.60 per liter for bottled (but non-contaminated) water in African Sahel.

To this Global 2000 report we should add several other generalizations about water:

(1) As our standard of living rises so does our per capita use of water for domestic, industrial, and agricultural purposes. An individual needs only about 2 liters daily for drinking, but water use rises rapidly with the level of income. My study in sub-Saharan Africa indicated that

the average water consumption from wells was 10-15 liters per person per day for home use, about 20 liters for cattle and about 3 liters for sheep and goats. In the United States our home use is about 681 liters (180 gallons) for personal use. However, to sustain our present life style for industrial purposes, the average American uses over 2500 gallons per day (5).

(2) Our largest per capita water requirement is for food. For example, we spend about a ton of water to produce a pound of bread and on some of our Southwestern rangelands over 100 tons of water are associated with the production of a pound of beef (7). Much of the water "associated with" the production of meat is dissipated by undesirable weeds and brush or evaporates from the unprotected soil surface. Such statistics provide a convincing argument for better water management in the food sector. "It is time to assemble better data on such water use and to design systems for food production which value water with the concern of the desert Nomad" (8).

(3) Agriculture cannot compete for water against municipalities, business and industry. These other uses can afford to pay more for water and will continue to purchase water rights away from the food sector. We see this transfer every year in New Mexico and in other agricultural states -- and this moves land out of food production just as surely and as effectively as housing or highway encroachment directly on the land. Substantial transfers have been made in recent years in our state to energy, mining and utilities. There is no doubt in my mind that, if all of the land that you can identify from the air that is marked out for

potential housing development along the Rio Grande watershed, was to develop as the promoters state, there would be little, if any, water left for food and fiber production in this State.

An FAO water study indicated that irrigation used 70 percent of the world water in 1967 but, because of the increase in demands from mining and industry, agricultural use would drop to 51 percent by the year 2000 (6). At the same time that we see this shift of water out of the agricultural sector, we still see more expansion of irrigation into dry farm lands -- particularly in the Third World countries. The amount of irrigated land in the world is projected to reach 273 million hectares (acres) by 1990 (6).

If we look again at world-wide water supplies, considering run-off as the primary measure of availability, we note that South America is wealthy, North America and Africa intermediate, and Australia and Asia "water poor." A Rockefeller Foundation report recently stated that "Asia, overall, has the most restricted water situation in the developing world and...." "...the most critical water resource problems exist in the very high population areas of Hong Kong and Singapore." (9)

A few comments about water and the Soviet Union might be appropriate at this time. Agricultural production has been a high priority for the Soviets for many years -- but they seldom reach their goals. One of their major agricultural zones is around the Aral Sea, which is the fourth largest inland fresh water body in the world. The Aral Sea is now dying -- its level is falling and the salinity is rising as river waters that normally keep it fresh are increasingly diverted to irrigate cotton. The Soviet Union is the world's leading producer of cotton, mostly from irrigated land. The USSR cotton exports in 1980 were worth about $500 million. In this area, as well as in other parts of the USSR, salt is a serious problem on the irrigated lands. One report estimates that 40 percent of the irrigation water in the USSR is now used to leach out or wash away the salts on irrigated lands (10). This brings to mind another point about water: we cannot discuss water without examining both the quantity and the quality aspects.

The Soviets have done more experimentation with weather modification and have planned more water transfer schemes than any other Nation. A gigantic water diversion project is now being planned to bring water from Siberia to the southern deserts north of Iran and Afghanistan at an estimated cost of $20-30 billion. This would dwarf our modest proposals for inter-basin transfers being studied by the eight-state High Plains Study team in size, but our cost estimates are higher than the Soviets. Many members of the scientific community, including some from the USSR, are concerned about the ecological consequences of the USSR massive water diversion project. We are also concerned about some of their other schemes to influence the environment.

From a world perspective, it is not possible to separate the water resource from climate, since evaporation, transpiration, and precipitation are a part of the climate complex. Decisions made in this decade about our energy options will have a profound effect on future climate and water supplies. There is increasing and irrefutable evidence that the increasing CO_2 content of the upper atmosphere is resulting from the burning of fossil fuels as we attempt to satisfy our insatiable energy appetites. About one-third of the man-made CO_2 comes from America. And, as the CO_2 content of the upper atmosphere increases, a corresponding gradual warming of the globe takes place. Dr. James Henson of the National Aeronautics and Space Administration states that the existence of the warming effect has been confirmed to his satisfaction (11). Several recent issues of "Science" have carried articles of concern about this CO_2 phenomenon.

There is increasing evidence that coal, if used in large quantities, may be our most hazardous future fuel option from the environmental standpoint. A gradual warming of the climate will work to the distinct advantage of the Soviet Union and will increase drought and water shortages in the United States and certain other parts of the globe. As an ecologist, this problem reinforces my conviction that we must increase our research on non-fossil fuel energy options -- particularly solar, geothermal, wind and bioconversion. Even the nuclear option may be preferable to massive use of coal. There is no doubt that <u>our water future and our energy future are inseparably intertwined</u>.

To an increasing extent <u>water is becoming the subject of litigation</u>. There are now over 160 Supreme Court decisions relating to water issues, and Steve Reynolds, who many of you know, the State Engineer for New Mexico, stated that a Supreme Court judge told him recently that because of his association with water he was the most litigious S.O.B. in the history of the state. There have been about 60 Supreme Court opinions involving the New Mexico State Engineer alone in the last 25 years. The

El Paso challenge to New Mexico underground water will now be added to the list. Personally, I am very leery about the decisions involving water that have been relegated to the courts, but this trend seems to be increasing. It is interesting that in Steve Reynolds' opinion, and I quote, "These cases seem to demonstrate the wisdom and sound common sense that the court has applied to our water law. I submit that we have reason to be profoundly grateful for the contribution that our judicial system has made to water management in New Mexico." Steve may be optimistic because he has often been on the right side. Generally, I do not favor developing water regulations or any other regulations in the courts.

The Research Imperative

It should be obvious from my overview on the importance of water as a resource that more research must be one of our highest priorities. The rush to the sunbelt may come to a screeching halt after a decade if we do not plan now to meet our water needs. Data from the 1980 census shows that, while the United States grew 11.4 percent during the 70's, New Mexico grew 27.8 percent; Texas 27.1 percent; Arizona 53.1 percent; Nevada 63.5 percent; Utah 37.9 percent; California 18.5 percent and Colorado 30.7 percent (12). All of these states are water short and solar energy rich, which says something about research priorities. But, both water and solar energy are being considered by the new administration for substantial cuts.

We must learn to measure everything that we do in units of water and become more conscious of water in all aspects of our daily life. Unfortunately, too much of our research is not designed with water as a constraint. How can we increase the efficiency of water use in food production, processing and distribution systems?

We must step up our research on photosynthesis, not only to capture more energy from the sun by this process, but also to determine more effective ways to increase the efficiency of water. More emphasis must be placed on plant breeding using water as the prime measurement unit. Some of our research already indicates that by selecting plants for various water regimes we can increase the production potential in excess of 200 percent over the nonselected plant varieties. We must also learn to reuse water and shortcut the hydrologic cycle.

The High Plains Study is one example of a major research effort which was long overdue. This multistate study is just beginning to yield valuable information for those of us concerned about the resource and involved in the decision-making process. It was the subject of a MacNeil/Lehrer Report on November 27, 1980 called "Running Dry." In the interview with Mr. Lehrer, Governor John Carlin of Kansas, Chairman of the eight-state Board of Governors said, "The solution (to our depletion problem) must start right now ... not in 20 years!" The High Plains Study, as you know, has concluded that by the year 2000 the Ogallala will supply only enough water to irrigate 56 percent of the needed acreage in the six-state area. The aquifer, of course, is the primary source of irrigation, municipal and industrial water in the states of Texas, New

Mexico, Oklahoma, Colorado, Kansas and Nebraska. I serve on the advisory committee for Governor King on this council along with Steve Reynolds, Bob Lansford and others. Today's research on the Ogallala aquifer will be essential to our decision-making process as we plan for the future. It is now obvious that we will reach the "economic limits" of the Ogallala long before we reach the engineering and technological limits. No doubt the high cost of energy is leading to more careful conservation practices. At this point, the possibilities for water importation do not look very encouraging.

In our recent attempt to defend the work of our Water Resources Research Institute against proposed cuts by the Reagan administration, we submitted three examples of substantial payoffs from investments in water research (13):

(1) Funding from the Department of Interior of $60,000 over a three-year period was used to support a study to reduce the amount of leaching water without adversely affecting soils or crop yields. The computer model developed showed that the Pecos River Valley in New Mexico could reduce water costs by $500,000 per year and reduce salt input into the Pecos River by 235,000 tons per year.

(2) Seven related water projects in Texas and New Mexico were instrumental in the development of a low pressure drip irrigation system which is now saving both energy and water in the High Plains. Over a 20-year period the value of water saved is in excess of $800 million and energy savings could be about $100 million per year.

(3) A new drought-resistant alfalfa has been developed at NMSU which should save 100,000 acre-feet of water for New Mexico without significant losses in yields. Other drought-resistant and salt-tolerant crops can be developed through research.

There are many more examples of the potential pay off through investments in research and education. The future of our Sunbelt lies in our ability to analyze more carefully our water options and in our ability to better conserve this essential and evasive resource.

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