WATER PLANNING FOR EQUILIBRIUM

Max Linn[1]/

As far as historians can tell there has been no golden age in which man and the land got along well together. This is certainly true in arid lands. The late British geographer Dudley Stamp believed that "so long as equilibrium is maintained, efforts to use arid lands may well prove highly successful. But equilibrium is very easily upset by any one of a large number of factors, and success is at once turned to failure on a large scale. The introduction of irrigation does not alter this concept of equilibrium; it merely changes the emphasis..."

I would make only one addition. The introduction of science and technology to man's use of arid regions does not alter the concept of equilibrium either. Again it merely changes the emphasis. As one observer put it, "Our ecology has been in a state of disequilibrium for several decades". Furthermore, ecological instability is increasing at such an accelerated rate that disasters are inevitable if the trend continues.

I cannot think of a better example of disequilibrium in ecology than the arid regions of the American Southwest. But why do we have this disequilibrium? And what shall we do to avoid disaster and to bring the system back to equilibrium?

Because I am not an expert on water resources, I must be cautious about offering answers. But the layman is certainly not precluded from asking questions, and he should. Let's start by looking at the relationship between water and development in the Southwest.

It is ironic that the very lack of rainfall in the Southwest which is responsible for the water shortage is also one of the main reasons why we have had such a tremendous development here. People come because of the dry climate and the great abundance of sunshine and open space. Industry comes for the same reason. And the long growing season and the predictable weather make the area extremely attractive to agriculture.

Obviously this three-way development has increased tremendously both the need for water and the competition for it. At the same time it has degraded the quality and decreased the quantity of the water that is available. People need water to drink and wash in and to carry away their waste products. They also want it for gardening and for recreation, perhaps to improve the natural environments with green belts, ponds, and lagoons.

On the other hand, commercial growers also need water, lots of it, often more than would be available even without other users. Thus agricultural

1/ Information Officer, Sandia Corporation, Albuquerque, New Mexico

interests come to look upon the use of water to maintain a green belt or a bosque as uneconomic or nonbeneficial. Shade trees, shrubs, and grasses which provide areas for picnicking, hiking, and camping and provide bird and game habitats come to be called phreatophytes--and phreatophytes, almost by definition, should be eradicated so that there can be more water for beneficial uses for irrigating crops.

So here we have the makings of a Greek tragedy. The irresistible forces of population growth, industrial development, and above all agriculture, all of which require water, are coming up against the immovable object which is the limitation of water resources--that very limitation which produced the appealing environment in the first place. And of course, whatever man does in arid regions affects his water supply and his water quality and shapes the land and changes the very climate that makes the area desirable.

This inter-relationship of man and water in the arid regions goes back through all of man's history and extends all over the globe.

Historical Perspective on Man and Water

Let's look at a bit of history. And in this instance I'm not citing history for the sake of custom--like telling stories that, though written into the text, begin "That reminds me..." The history of water usage more often misusage--has a profound warning for us; perhaps we can see it in time.

Both eastern and western civilizations began in arid lands, and in most cases decline was associated with misuse. The classical Greek civilization, for example, was built on misuse of the land. Here, slightly abbreviated, is what Plato had to say in Critias:

> At this period, Attica was still intact. Her mountains were lofty, soil clad hills. Her so-called shingle plains of the present day were full of rich soil and her mountains were heavy of forest. There are mountains in Attica which can now support nothing but bees. The country once produced boundless pasture for cattle. The annual supply of rainfall was not lost as it is at present, through being allowed to flow over the denuded surface into the sea, but was received by the country in all its abundance into a bosom where she stored it in her impervious potters urn, and so was able to discharge the drainage of the heights in the form of springs and rivers in abundant volume and over a wide territorial distribution.

That report of land destruction is 2500 years old. Today less than 5% of Greece remains in forest, and almost all topsoil is gone.

In Anatolia, now part of Turkey, 70% of the region was in forest in historical times. It has now been reduced to 13%. According to one geographer, "The bald mountains and foothills of the Mediterranean litoral, the Anatolian Plateau and Iran stand as stark witnesses of

millennia of uncontrolled utilization, and there is still little sign that the lessons of history have been read and understood or that the opposite trend in land use has yet arisen."

In India, the same story. Uncontrolled utilization; little or no concern for environmental factors; and then ultimate destruction of the land.

In Mesoptamia the downfall of Babylon has been attributed to the loss of soil fertility because of salinization caused by improper irrigation and drainage.

In Western Egypt many of the oases once covered much larger areas than they do today. There is direct evidence that they shrunk because the Romans dug wells that depleted the artesian aquifers faster than they could be replenished.

In other areas, such as the Nile Valley where man has lived successfully with dry conditions and water for thousands of years, just recently he has begun to create new kinds of problems by using new technologies. On the Nile, dams have been built to increase the efficiency of irrigation and extend it over larger areas. But this very process has taken away the age old means of fertilizing the land, letting the silt carried down river from Ethiopia extend over the land. Today only clear water is let onto the fields, and artificial fertilizers must take the place of the annual layer of silt. At the same time the new method which keeps water in the irrigation ditches all year round also allows a parasitic snail to live all year around in the ditches. Today in some Nile Villages up to 95% of the people are infected by schistosomiasis, a devastating liver and intestinal disease carried by this snail. There is no remedy in sight so long as this method of irrigation continues.

But we do not need to go as far afield as Asia and Africa to see the effects of land misuse and water misuse. Right here in the Rio Grande watershed we have a fine example of how men have turned a green valley into a wasteland.

The valley of the Rio Puerco from Cabezon South is today a wasteland with a usually dry river channel cut as much as 50 to 75 feet below the surface of the surrounding land. But it was not always so. According to historic records and field investigations, the valley was once filled with lush grasses and the river ran close to the surface so that there was plenty of water for cultivation.

In this valley a half dozen settlements were established whose economy was based on cattle, sheep, and agriculture. But in all cases the settlers took more than the land could give. In one place 10,000 head of cattle were put in a narrow valley to eat shoulder-high grass. Farmers built small dams and dug diversion channels for irrigation and then the problems started. A season or two of unusually heavy rains produced flooding and then disastrous erosion. The river began cutting a

deeper channel. Sometimes it went down as much as 10 feet in 1 year. Eventually the water was running so far below the surface of the surrounding land that irrigation was impractical. With cover gone and the irrigation water gone, the whole area was gradually abandoned.

The San Simon River, a tributary of the Gila in Eastern Arizona is a further example. In 1870 the San Simon Valley apparently was a picture of pristine beauty. The floor was flat and unbroken. Large areas were covered with grass thick enough and tall enough to be harvested for hay. In the 1880's 50,000 head of cattle were brought into the valley. By 1905 grazing combined with a critical 10 year drought extending from 1895 to 1904 had eliminated the protective grass covering the valley floor, leaving it ripe for gullying.

According to a U. S. Geological Survey report, today's picture of the valley is one of devastation; except in the short uncut reaches, the former grassy tracts are now barren flats, some completely devoid of vegetation, others supporting only an occasional stunted bush or clump of grass. In places along each side of the channel, belts up to 700 feet in width and several miles in length have been stripped of top soil to depths of 3 feet or more. Some of these remain flat and others have deteriorated into miniature badlands with relief of 2 to 6 feet. Under these conditions the potential silt contribution to the Gila River from the San Simon Valley is enormous, being limited only by the amount of water available for transportation.

There are many more examples. Civilizations that have gone down the drain, so to speak, cultures that have disappeared because man did not know how to get along with the land and the water. And all signs indicate that patterns are continuing, as if the thousands of years of experience in using arid lands and water had never occurred.

Modern Interactions of Man, Land and Water

The history of modern urban water projects in the West probably begins in San Francisco in 1900. By that time the city had grown sufficiently to outrun its water supply and engineers started looking for new sources. The result was the Hetch Hetchy Dam on the Tuolumne River in Yosemite National Park. (It flooded a canyon comparable in beauty and grandeur to Yosemite Valley itself).

The action began in San Francisco but it ended in Los Angeles. The population boom and the agricultural boom in Southern California have consistently required more and more water. And because Southern Californians have the votes, the state has undertaken massive water transport schemes to bring water from the North to the South. In fact, water utilization in the state today is almost total, and there is no major stream running unhindered to the Pacific Ocean.

Central Arizona presents a similar problem. If my figures are correct, in 1965 Arizona was pumping almost 5 billion gallons each day. Much

of this water was and still is being used for agriculture which has boomed in the state since World War II. The amount of ground water taken out is far beyond the amount being replenished by the scant rainfall in the state. The result of course is that water is the number one concern of people responsible for Arizona resources. One writer put it this way. "If Arizona goes forward it must travel on water. That is why nearly every time a drop of water falls in Arizona, state and federal agencies examine it, name it, claim it, dam it, or fight over it."

The Arizona water shortage brings up several problems. First of all, the question of water waste. Large quantities of water are used to irrigate low cash value forage crops or crops that can be produced in areas having abundant water. A second problem in overdrawing ground water is the permanent compaction of water bearing layers which reduces their carrying capacity forever. Attempts at recharging a compacted water layer will not restore this capacity. The next step is land settling. Outside Phoenix there are reported to be great cracks in the desert where aquifers have collapsed. The San Joaquin Valley in California settled 25 feet because of underground compaction. The Santa Clara Valley settled 11 feet and was then flooded by the San Francisco Bay salt water. Las Vegas, Nevada also has compaction problems.

A third problem is climate. Irrigation has changed the Phoenix area from a dry desert area into a moist almost subtropical area. Today evaporative coolers no longer work in Phoenix. And again as with the Southern California boom there is no end in sight to the development of central Arizona--except the availability of water.

For some, one solution to the over use of water in Arizona is more people. It takes more water by a factor of 4 or 5 to irrigate an acre of crop land than it does to service one populated acre in Phoenix or Tucson.

Projects to Benefit the Arid West

Spurred by the ever-increasing ground water deficit in Western Texas, New Mexico, Arizona, and Southern California, regional water developers have come up with some grandiose plans for interbasin water transportation. These plans could radically affect the ecology of the whole continent. Their scope boggles the mind.

First let's look at the Texas water plan. On December 17, 1968, the Texas Water Development Board unveiled what is described as the biggest water development proposal ever seriously considered in the United States: a 10 billion dollar plan to provide Texas and Eastern New Mexico with all the water needed over the next 50 years. It involved the construction of 68 reservoirs to store all water available from Texas streams; diversion to Texas of 13 million acre feet annually of water from the lower Mississippi River; and construction of two canals to carry in Mississippi water and the stored reservoir water from east Texas to the south and the arid west and to the New Mexico border.

By the time the plan came to a vote last August 5th, the claims and counterclaims of experts on both sides of the question had created considerable doubt in the minds of the voters that anybody really knew the total cost of such a plan either in dollars or in its effect upon the environment. Opponents said that by inundating an area larger than the state of Connecticut, invaluable agriculture land, wild life habitats, and recreational and scenic areas would be destroyed. They contended further that the restriction on river flow into the Gulf of Mexico would ruin the coastal base. A University of Texas professor also contended that the plan could change the weather and prevent moisture from the Gulf from reaching through West Texas. He maintained that existing irrigation had already upset the ecology of the high plains and providing more water would upset it more. The proponents either denied the claims or said the advantages to the economy of the state of having these vast new quantities of water could overcome any of foreseen disadvantages.

On August 5th the voters of Texas rejected the plan. The present status of the project or modifications of it are not clear.

When Hurley Campbell, an outdoor writer in the Baton Rouge Advocate, learned of the Texas water plan, he tried to deal with its effect on Louisiana in specific ways. But finally the potential impact overwhelmed him. The plan, he wrote, "would destroy life in Louisiana as we have known it." If that could be the effect of the Texas water plan on Louisiana, what could be the effect of NAWAPA, the 100 billion dollar North American Power and Water Alliance Plan proposed 5 years ago to bring Arctic and Canadian water to the western and midwestern portions of the United States and even as far south as Mexico? The plan calls for collecting water from major rivers in Alaska, the Yukon territory and British Columbia, and redistributing it via canals, mountain tunnels and existing streams.

The proposed benefits are considerable from an economic standpoint. The United States, for example, would receive 78 million acre feet of water annually and 38 million kilowatts of power for sale. It would increase irrigable land in the United States by some 40 million acres. It would stabilize and control the level of the Great Lakes and increase power production on the Niagara hydro-electric complex. Everything else about the plan is also stupendous, including the keystone, a 500-mile long reservoir in the magnificent gorge called the Rocky Mountain Trench, extending from British Columbia through Alberta to Flat Head Lake, Montana.

Even the critics agree that this 100 billion dollar plan is large and imaginative but it is so, according to University of California geographer, D. B. Luten, only within engineering limits.

The plan would destroy a great deal of the low-altitude wild lands of Alaska and Canada and a large fraction of the vestiges of such wild lands in the western states. Says Dr. Luten, "No one thus far has undertaken to compare our need for these wild lands centuries

hence with our need for water and no one on earth is either competent or in a position to do so objectively."

By comparison with the Northern American Water and Power Alliance, the Central Arizona project is a relatively small operation, costing perhaps a billion dollars. But Arizona politicians and economists consider the project absolutely essential to the continued growth of the State.

A good many questions should be asked about the CAP. What is the true cost of the water going to be? Fifty-five dollars an acre foot has been mentioned. Clearly no farmer could afford anything like that amount and there is no intention that he should have to pay it. That means yet another form of farm subsidy, and who is going to pay? And who gets the benefit of the subsidy? Most of the demand, roughly half, is for the irrigation of low-value forage crops which could be grown more economically elsewhere. The remaining agricultural need is for high value crops like lettuce and citrus fruits better suited to the area. The first irony is that most farmers raising forage came into the area during and after World War II and have not even the justification of long established claim to the water. The second irony is that without them, the Phoenix-Tucson area has enough water from already developed sources so that ground water, it has been estimated, would not be depleted for at least 160 years.

But there is really a much more basic question to be asked. What would happen if there were no Central Arizona project? What would happen if there were no plan to bring 2 million acre feet of water from the Colorado to irrigation projects in Central Arizona?

To digress for a moment, similar questions might be raised about the relatively minor New Mexico part of the Central Arizona project--the proposed dam on the Gila River at the Hooker site. Proponents of the dam allege that opposition is based on the fact that water would be backed into the Gila wilderness area. And it is implied that such opposition is unreasonable because the proposed dam would create a lake that would cover only 480 acres of the wilderness or about one-tenth of 1% of the total Gila wilderness area. This is an over simplification of the position against the Hooker Dam.

Conservationists also raise other questions about the dam--about the uses of the water, about the possibilities of getting underground water and about the projected life of the dam and the tremendous loss of water through evaporation. In fact, once all the objections have been raised, it seems apparent that the only justification for Hooker Dam is that it would be possible to construct it with Federal funds as a part of a political deal with Arizona to approve the Central Arizona project. And the fact that it <u>could</u> be constructed in no way indicates that it <u>should</u> be constructed.

Back to the main issue. As we have seen, the major use of water in Arizona, up to 90% of the total, is agriculture. Some economists

have said that if realistic prices were charged for the irrigation water used by agriculture, much of the Southwest water shortage, particularly that in Arizona, would vanish. Not only would uneconomic uses of the water in agriculture stop, but a tremendous amount of waste would also stop. At the same time there might be a shift in the use of water from agriculture to urban uses.

But before we go any further into the subject of what should be done versus what could be done let's look briefly at some other proposed water projects, in this case hydroelectric projects.

Major Hydroelectric Projects

The largest single hydroelectric project now being considered is on the Yukon River at Rampart Canyon. The purpose of the project is to give the economy of Alaska an economic boost by providing a large amount of low cost electric power which would supposedly attract electro-processing industries -- mainly aluminum producers. But an intensive feasibility study by the University of Michigan School of Natural Resources indicates Rampart would have negligible affect upon the economy and would give Alaska 700% oversupply of electricity 1,000 miles from the nearest customer. Said one writer: "The 50% increase predicted by proponents as resulting from the Rampart Canyon Dam is nothing but sheer exuberance."

On the other hand the reactions of fishermen, wild life conservationists, and lumbermen to the project have been anything but exuberant. The average annual catch of salmon on the Yukon River by both commercial and subsistence fisheries approximates 800,000 fish. Construction of the dam would reduce this catch by one-quarter to one-half and the loss would be more than economic. To the Eskimos and Indians living along the river the annual fish camp and the drying of the salmon in racks is perhaps the only time now when he is free from unemployment worries and other benefits of white man's civilization. The advantages of this condition to these people cannot be measured in economic terms.

Another problem would be the loss of water fowl. The fish and wildlife service estimates over a half-million migratory ducks normally breed on the Yukon Flats above Rampart Canyon, and the average fowl population of adults and young is estimated at about a million and a half birds. Rampart Dam would destroy 2.4 million acres of high density breeding habitats and 4.5 million acres of lower density habitat in one stroke.

The Rampart project would also mean a great loss of mammals and forests. But above and beyond the loss is of course the question of whether there is a need for the power and whether it will be competitive, with nuclear power in the future. And similar questions are being raised regarding other proposed hydroelectric projects. A project in Manitoba, Canada, to raise the level of Southern Indian Lake 32 feet would produce 6,000 megawatts of electricity and cost a

billion dollars. It would also submerge timber stands producing 10 million dollars a year and destroy a million dollar annual fishing industry, two Indian villages of 650 people, a major nesting ground of the Canada goose, whitefish spawning grounds, and hundreds of miles of streams, small lakes, and rivers which are the major vacation and recreation areas in the province. The project has been called "Manitoba Madness" by the British magazine New Scientist.

And construction of the Glen Canyon Dam, which won a 1964 award for civil engineering achievement, has also had its share of controversies. This hydroelectric project, which provides power for the California grid, has destroyed an area of great scenic value. Conservation groups are especially bitter about the dam because even those who designed it admit that it will be silted up and unusable in only a few short decades, while the canyon, which took the Colorado River millions of years to create, will never be recovered. Others have complained that Lake Powell is especially wasteful because of the great loss of precious Colorado River water through seepage and evaporation. And despite their sad history, the dam builders would have built two more dams in the Grand Canyon.

And of course what is happening in North America in terms of hydroelectric and irrigation projects, is also happening in other parts of the world - perhaps even on a larger scale. The Georgraphical Review of January this year suggests that more than a million Africans are affected by recent man-made lakes. In this poor area of the world the suffering caused by dam construction is perhaps difficult for us to conceive, but one point is everywhere the same. When man builds a dam he modifies nature and human society in many more ways than he usually understands.

We Need a New Philosophy of Water Use

I have gone beyond the problems directly related to water use in arid regions and have taken up the problems of water projects in all kinds of regions among all kinds of people. My purpose has been to indicate in some small way that the approach we take to water here is not an isolated one but it is part of an overall approach that man has taken to water and indeed all resources on this planet ever since he had a recorded history and long before. Man has always acted upon the assumption that he has in infinite resource base: if it's there, use it; when it's gone, move on.

For the most part I have been raising questions, at least implied questions, not proposing solutions. Now let me put forward a few suggestions of things we might do, or perhaps must do if we are to find a better relationship with water and with all natural resources on this planet. For one thing, perhaps we ought to re-examine the functions of irrigation. There appears to be growing evidence that it is fundamentally wrong. Even more important, I would like to raise questions about the concept of water and growth. For example, what makes

population growth in arid lands so sacred? Is it not true that projections of population growth are likely to be self-fulfilling prophesies? What would happen if water is just not provided?

Two years ago a panel of resource experts for the American Association for the Advancement of Science examined the future of the arid west and concluded that it would continue to grow, water shortage or no, but that the growth in this part of the United States would be concentrated in comparatively few cities. In other words it would be mainly urban growth. Now our population is already 80% urban compared to 65% for the rest of the United States. And what has happened, in many cases, is that the urban areas such as Phoenix and Albuquerque and Denver and the vast urban complexes of southern California have to some extent grown at the expense of land and water used by irrigation farmers.

To some, urbanization seems to be a solution to the water problem. It takes more water to irrigate an acre of land for agriculture than it does to provide service both for drinking and waste disposal per urbanized acre.

On the other hand, some resource experts have questioned whether unlimited urban growth is desirable in land as dry as the southwest. According to Homer Ashland of the University of California at Riverside, the debris made by megalopolis is much harder to dispose of in arid regions. Air pollution tends to be worse because there is little rainfall to clear the atmosphere. Water pollution is harder to handle because there is little flow in rivers to dilute it. Thus urban growth in the southwest can very well destroy those values that attract people to come to the area in the first place. A typical example of course is Los Angeles, which once boasted the best climate in the United States.

And so we come to a new approach--water planning for equilibrium. Geographer Stamp has said that in arid regions the balance between man and his activities on the one hand and the environment on the other is extremely delicate. If this is true--and I believe it is--it will certainly not be easy for us to achieve an optimum use of resources indefinitely from an ecological and economic standpoint. And yet even though it is difficult this must be our aim. We can accept only those plans that provide for indefinite use of resources for the continuing benefit of man and nature.

If indefinite use seems hard for us, let us consider the alternative that history has presented. The arid lands more than any other parts of the earth seem to have favored the highest developments of mankind in practical achievement and standards of living and wealth, material and cultural, and yet in so many cases destruction of these civilizations has been complete, far more so than in the mid-latitudes where slower developments have led to more lasting results. Imbalance in the arid lands is nothing short of disastrous because there is much less latitude of action than under other conditions--in areas that are more forgiving of man's errors. Perhaps we can go further in developing water resources for the arid lands of the southwest, but not much further without endangering the quality of the environment, without destroying diversity,

upsetting ecology in major areas, and actually wasting water. Therefore, perhaps we should begin to question more seriously than ever both the need for and the desirability of our major water projects - and even all the small water projects which affect the environment. We can no longer rely solely on economic or technical or engineering feasibility in deciding whether we ought to undertake a project. Perhaps instead of trying to do all we can to develop and increase resources in the Southwest we, ought to see how much we can avoid doing. In the words of Nobel Prize physicist Murray Gell-Mann, our major goal might well be to record "land marks of technological renunciation" as we move toward a meaningful harmony with the environment.

And above all, in planning for equilibrium we have to get rid of the numbers game in money and people. We have to aim for quality rather than quantity.

Consider one more point. Water is a part of the natural system upon which all life on this planet depends. No other planet in our solar system has water. Let us plan and think and act accordingly. And let us learn from history.