Is Our Future Dammed?

"We do not inherit the Earth from our fathers, we are borrowing it from our children."
—David Brower, Environmentalist, 1912-2000

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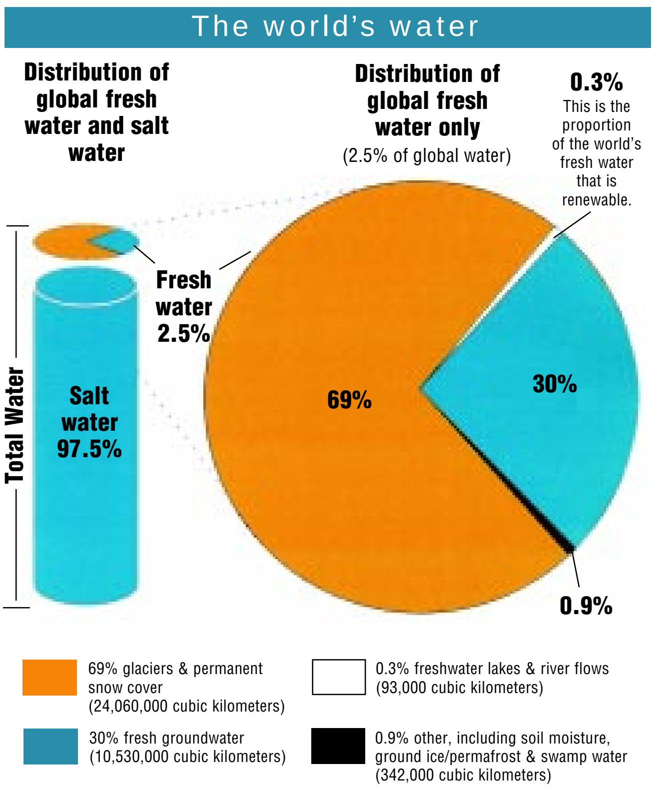
Is it animal, vegetable or mineral? This was usually the first question asked on the early TV show "20 Questions" as guest celebrities tried to identify a mysterious item in the contestant's mind. This simple question includes the family of everything that could exist in the universe and classifies it by common denominator into the simplest of divisions. The symbiotic interdependence among these diversely unrelated groups, however, is just now being appreciated and has become an increasing cause of concern as it relates to our future food and water supply.

A sustainable planet

A few years ago I had the opportunity to visit Biosphere II near the small town of Oracle, Ariz. Biosphere II (patterned after Biosphere I—Earth), was conceived as a noble experiment to design and test a miniature, self-contained and self-sustaining life support system. The idea was to see if man could survive in complete harmony and interdependence with this totally sealed environment as if he had just colonized some hostile planet. The only material that could be brought in from the outside was sunshine.

Man, of course, is representative of all animals in this model. The trees and plants represent all vegetables. And water, oxygen, nitrogen, etc., represent all minerals. In the cycle of life, the "wastes" of one species becomes the "food" for another—constantly recycling. On a molecular level, nothing can ever be destroyed. Oxygen will always be oxygen. Carbon will always be carbon. Water will always be water. Over time—and with outside influences such as climate, precipitation, tides and wind—atoms combine, change form, re-combine, split up and eventually return to a basic elemental form to be recycled. Over and over, generation after generation, eon after eon, it will continue.

One of the most important components in the delicate balance of nature is the role played by the simple compound—water. Water plays a strategic role not only in the creation of life but in sustaining it as well. Without water, Biosphere I would be just another lifeless planet, another rock orbiting the sun.



Natural distribution

Although there's adequate renewable fresh water today, Mother Nature doesn't always deliver it when and where it's needed. Floodwaters can't be stored and generally are lost as part of the total available water supply. Much of the world's groundwater occurs at great depths or in sparsely populated areas where it cannot be utilized. The Amazon River, for example, discharges one sixth of the world's total river flow through a thinly populated watershed. The question then becomes—How do we even all this out?

Dams—fat spots in rivers

Blocking the flow of a river to hold back and store water has been practiced for almost 5,000 years. The Nile River at Kosheish had a 50-foot-high masonry structure built to contain water for the city of Memphis around 2900 B.C. The oldest dam still in use is a rock filled structure about 20 feet high on the Orontes River in Syria, built about 1300 B.C. Dams not only store water for irrigation and man, they reduce peak flood water runoffs, can be used to generate hydroelectric power, can increase the depth of water in rivers to improve navigation and, as an incidental purpose, they can provide lakes for recreation. The multi-purpose dam is particularly important to developing countries. A small nation can reap tremendous benefits in agriculture, industry and the general quality of life, from a single dam.

Under this premise, dams must be a good thing. In the past few centuries, man has constructed over 800,000 of them including more than 40,000 large dams—those over 40 feet high. These dams have shifted so much weight that geophysicists believe they have actually shifted the axis and speed of rotation of the Earth. Collectively, they have created lakes with a surface area larger than the state of California.

The benefits of dams are many. Only about 20 percent of the world's cropland is irrigated. Yet that 20 percent produces nearly 40 percent of the world's farm product. One fifth of all electric power used on the planet comes from hydroelectric generation. The desert outpost of Las Vegas turned into the fastest growing U.S. metropolis by drawing 85 percent of its water and much of its electric power from nearby Hoover Dam. In the construction of a dam, millions of dollars are pumped into the local economy. Politicians who favor them become very popular and powerful.

Water distribution is doable

Water is abundant on Earth. But it's finite. Our best calculation tells us there are 326,000,000 cubic miles of water on Earth, approximately 0.12 percent of Earth's volume. Each year, about 0.03 percent of that total water purifies itself by evaporation from the oceans and falls to Earth as rain or snow. Roughly 78 percent of that falls back into the oceans while 22 percent—or 24,000 cubic miles—falls on the land masses. That's almost 4.5 million gallons of fresh water per person, throughout the world, per year. Contrary to popular belief, there isn't now, nor will there ever be, a water shortage. What we do have is an enormous distribution problem.

Less than 1 percent of Earth's water is fresh, liquid water. There is more fresh water locked up in the polar ice caps than exists in all of the lakes, rivers, soil and aquifers combined. Of the liquid water, making up only 0.6 percent of the total water, almost 98 percent is groundwater, some of which is several miles down. Lakes and rivers make up only 1.5 percent (of the 0.6 percent) and the rest is soil moisture. If we could only use the annual water supply that enters our smallest resource—rivers—we would still have over 850,000 gallons of water per person per year. Where's the shortage? As I said before, there is no shortage. We have a distribution problem.

Getting it where it's needed

There's plenty of archaeological evidence to tell us moving large quantities of water over large distances isn't a new problem. Ancient civilizations along the Tigris and Euphrates, the Nile and the Indus constructed shallow wells and canals to redirect and store water. As early as 2,500 B.C., inhabitants of the Indus river basin constructed brick lined wells and began building sanitary drainage systems. The ancient Greeks constructed tunnels, masonry conduits and clay pipe to bring water into their cities. By 200 B.C., pressurized pipe systems were developed to transport water from higher elevations to cisterns within cities. The Romans developed water delivery systems capable of carrying over 50 million gallons of water a day to various public fountains where its one million citizens could obtain it. That's over 50 gallons per day (gpd) per capita.

The fall of Rome and the general environmental neglect of the Middle Ages saw a steady decline in the engineering and construction of water supply systems. Construction was pretty much limited to repairing the aqueducts built by the Romans hundreds of years earlier.

The advent of the steam pump, developed in London in 1761, began the modern era of water distribution. The first water filtration—a slow, sand filter—was developed by James Simpson, an engineer in England. In 1829 and by the mid-1800s, water filtration of surface waters was prevalent in most of Europe. Disinfection, in the form of calcium hypochlorite, was introduced in 1897 and the use of liquid chlorine came along in 1914. Sterilization and filtration is the recognized treatment for all modern water supply systems today.

How much is enough?

Typical industrialized countries will use 50 gpd of water per person for domestic needs, 65 gpd for industrial use, 10 gpd for public use (fire protection, irrigation of public lands), and 25 gpd for waste. The actual variation is 35-to-500 gpd per capita for non-agricultural consumption. Seventy percent of this water eventually returns to streams and rivers and the remainder is lost through evaporation and transpiration from plants.

Those of us fortunate enough to live in a modern city with a modern water distribution system probably take water for granted. For us, water is cheap and plentiful. However, as many as 1.2 billion people—one fifth of the world's population—lack access to clean drinking water. Nearly 3 billion—half of the entire world—live without proper sanitation and more the 5 million people die each year from easily preventable waterborne diseases. For them, the water shortage is real. Complicating this is the fact water doesn't ship well. That is, it's too cheap and unwieldy to justify long-distance transport. I'll say it again—there's plenty of water; we just have a distribution problem.

While agrarian societies require little water for manufacturing, they will, instead, use the vast majority of their water resources for food production. It's estimated water usage for irrigation takes over 72 percent of the total fresh water supply worldwide. It takes 1,000 pounds of water to grow 1 pound of wheat, 15,000 pounds of water to produce a single pound of beef and an equal amount to grow a pound of cotton. For industrial production, it requires 5 pounds of water to make a pound of dry cement, 40 pounds for a pound of paper and 25 pounds for a pound of steel. Synthetic fibers, such as polyester, require as much as 4,500 pounds of water to produce a single pound of fiber. It's estimated that in 2000, about 25 percent of the Earth's total renewable water will be expended by man and at the dawn of the next century, the 20 billion inhabitants of the world will be required to capture all runoff from the entire planet to meet their water needs. Then, we'll have a water shortage.

The issue's dark side

Dams are great for the economy, the local residents, contractors and politicians—especially politicians. However, a dam is only a temporary quick fix with a finite life—after which, then what? The Colorado River carved out hundreds of cubic miles of rock and sand to create the Grand Canyon in the U.S. Southwest. This took millions of years and the job isn't finished. The erosion process is barely perceptible, but where is all the eroded rock and sand going today? It's being deposited behind the Glen Canyon and Hoover Dams. Eventually, these dams—and every other dam in the world—will fill with sediment. They will become the world's most expensive waterfalls, losing all ability to store water and most power generation capabilities.

On average, sediment deposits reduce the storage capacity of a reservoir by 1 percent a year. In high erosion areas, such as China, reservoirs fill at an average rate of 2.3 percent in a year. One dam on the silty Yellow River—the Yangouxia—lost almost a third of its storage capacity before it was ever commissioned. And how much maintenance money is being spent by world governments to protect the functions and utility of dams? The answer is none, nada, zilch, zero, zip. Dams are very temporary. Dams are a mortgage on future generations of the world. It's a mortgage that they'll never be able to retire. Then what?

Just as erosion of the Grand Canyon was imperceptible on a day-by-day basis, so is the damage caused by dams. Dams not only become the distribution center for water, they distribute the salt contained in that water as well. Radiating outward from any dam, irrigation water slowly poisons the land with salt. The exposed surface of the lakes created by dams loses as much as one third of their water each year to evaporation. The salinity of the water increases accordingly. Water distributed to surrounding croplands evaporates and the salt collects. As the irrigation water permeates the soil, it collects more salt and then returns to the river to increase its already higher total dissolved solids (TDS) load. On a single trip down the Colorado, the same water may be used for irrigation 18 times and more than double in salinity. Sometimes, the Colorado doesn't even flow to the sea. What about the native fish? Gone. What about the fertile flood plains downstream? Also gone. What about the silt that re-deposits on the beautiful Southern California and Mexican beaches? Almost gone—one estimate has it down by 80 percent. What about the nutrient that's trapped behind the dam? How can marine life survive downstream? It doesn't.

Perhaps the best example of a worse case disaster is Central Asia's Aral Sea. Soviet planners diverted two major rivers that feed the Aral in order to provide irrigation water for cotton farming in the surrounding desert. As the cotton bloomed, the Aral shrank. Today, it contains only a third of its original volume and may vanish completely. Fishing villages that once bordered the sea are now stranded desert habitats. All 24 native fish species have disappeared and the fish catch has dropped from 48,000 tons a year to zero in just a few decades. The area surrounding the sea is drier and hotter. Each year, wind storms whip up 44 million tons of salt and dust from the former seabed and scatter it over the river basin, contaminating drinking water with salt and agricultural chemicals and giving rise to diseases such as cancer, hepatitis and typhoid fever. Ironically, cotton production is down also. Similar events have occurred in California's Owens Valley and elsewhere.

Algae thrive on the nutrients trapped behind dams. They consume the lake's oxygen and turn the water slightly acidic. The water comes out of the dam free of sediment and hungry to capture new sediment from the riverbed downstream. Nine years after Hoover Dam was opened, hungry water robbed 89,000 acre feet of material from the first 87 miles of the riverbed below. In places, the riverbed dropped by as much as 13 feet and often took flood plain water tables with it.

All dams cause environmental damage by disturbing the ecosystem's order. But the biggest losers are the people displaced by dams. One estimate puts the worldwide total of people displaced by dams at 30-to-60 million.

Globally, irrigated land per capita peaked in 1978 and has dropped by 5 percent since then. Estimates are that it will drop by as much as 28 percent by 2020. Population growth is outstripping our collective ability to supply. New farming techniques and genetic engineering of crops requiring less water and, at the same time, more salt tolerant are on the horizon. Nonetheless, the scarcity and imbalance of water of suitable quality will become the most important factors in limiting future agricultural production and the availability of food. The mortgage will soon come due.

With the vast majority of the world's water earmarked for agriculture, one would surmise we're not going to run out of water but availability of food will be the limiting factor for survival. The average person sacrifices nearly his entire year's allocation of water for survival (about 200 gallons) in exchange for a single loaf of bread. Food, then, becomes "virtual" water. Stockpiling foodstuffs, such as grain, will lessen a society's need for water. However, unless there's something by way of natural resources with which to barter, it will also take water to raise the capital with which to trade.

Historically, civilizations based

on the need for irrigated farmland have failed because the land becomes poisoned by the increasing salinity. The Central Valley of California uses high technology planning and water re-use to get the most out of its crops. Eventually, the water becomes unusable because there have been no crops developed that can handle the high TDS of the recycled water. In addition, the water builds up boron with each use and has leached so much selenium from the soil that the only way to dispose of the "waste" water into nearby rivers is to use part of their normal allocation from nearby canals to dilute it. Each year, additional cropland has to lie fallow in order to come up with enough water to irrigate the remaining land still in production.

Some of us remember when even parts of the United States might have been compared to much of the Third World. As a kid growing up in northern Maine, our two-room house was too small to support a bathroom. Bathing was done at the kitchen sink with a sponge and water that was carried from an artesian well a few miles away and heated over a wood-burning stove. Whatever childhood diseases were around we shared: measles, mumps, chicken pox, colds and the flu. My older brother almost died from the dehydrating effects of cholera. It's hard to believe this still happens every day in over 50 percent of the world.

Sir Isaac Newton said that "for every action, there is an equal and opposite reaction." In layman's terms, "what goes up must come down." In my terms—"there's no such thing as a free lunch." Dams have upset the balance of nature and nature is going to get even.

FYI—Dams

For more information on dams and their environmental impact, see the following websites:

- World Commission on Dams: http://www.dams.org/
- World Health Organization: http://www.who.int/water_sanitation_health/vector/dams.htm
- Dam-Reservoir Info & Impact Archive: http://www.sandelman.ottawa.on.ca/dams/
- International Rivers Network: http://www.irn.org/
- Friends of Lake Powell: http://lakepowell.org/

The World Commission on Dams was to release its final Global Report on Nov. 16 in London by Nelson Mandela. An Interim Report, released in July 1999, is available on its website in PDF format.

Conclusion

The hungry masses of the world have come to depend upon dams for irrigation of cropland and a continued water supply. This is a short term, temporary solution. Instead, conservative water use practices such as drip irrigation and water re-use should be put into place for the long haul. Water is water, whether it comes from tropical rain or the local sewage treatment plant. We have the technology to process any water source for any use. It's a matter of the governments of the world sitting down with the common goal of long term survival and setting their priorities straight. It's a matter of money and a problem of distribution. Along with the problems comes an unlimited opportunity for the creative thinker to just wade right in.

References

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