**Water Wars in the West?**

The poet W. H. Auden once said, "*Thousands have lived without love, not one without water.*" Like the air that we breathe, fresh water is essential to our survival. Unlike the air, however, fresh water is only available in certain places, and it is a much more limited resource than a causal look at the Earth would suggest. In spite of being the "water planet," without desalination, over 97% of the Earth's water is saltwater, unfit for human consumption. Moreover, 70% of the planet's fresh water is locked up in polar ice. (University of Michigan, 2000) Improving our management of the freshwater resource is among our most important challenges, and nowhere is this more evident than in the American Southwest. Here, rampant development has occurred in arid areas that are dependent on far-away freshwater sources. Las Vegas is one such example, a major city in the desert that depends on the Colorado River, 30 miles away, for 90% of its fresh water. Continued growth in cities like Las Vegas is unsustainable given the current demands on the river and the potential impact of global warming on the entire watershed. Local wars over water rights are a distinct possibility in the future, given the critical nature of the resource and number of interest groups involved.

In early history, human settlements were invariably situated near ready sources of fresh surface water. Rivers, lakes or natural springs could provide the volume of water needed to sustain the local human populations. As settlements grew ever larger, it became necessary to distribute water further and further from the source. Finally, the development of agriculture demanded that freshwater be diverted to fields far and wide to provide for irrigation. As a result, great engineering works in the form of man-made canals were initiated to move surface water from one area to another. These canals could provide for both transportation and water distribution, but they were limited by local geology and topography. To overcome this, elevated aqueducts were developed to move water regardless of the surface structure and elevation; rolling hills and rocky soils could be traversed.

Potable water could also be found underground, making it possible to establish new settlements far away from surface water sources. The volume of water made available by shallow wells was limited by the great effort required to raise it, which in turn limited the size of communities dependent on local wells. With the development of mechanized pumps, however, large volumes of water could be raised from deep underground and distributed over varied topography. Pipelines and pumping stations could move water long distances and eliminate evaporation or contamination problems common to open canals and aqueducts. As a result cities began to spring up in places that are nowhere near renewable water sources, and farmers began cultivating land in areas where natural precipitation could not sustain their crops.

Just as people had done for thousands of years, both Native Americans and European pioneers in North America established their settlements where they found easy access to fresh water. The growth in these settlements was limited to the extent that natural water sources could support them. In the arid American Southwest, gaining access to water from the Colorado River has historically been the limiting factor to growth for ranchers, farmers and cities. The Colorado River Basin is the primary source of fresh water for the entire region, which includes much of seven States. Rocky Mountain snow runoff provides as much as 88% (Dwyer, 2005) of the water in the natural watershed, resulting in significant seasonal variations in water levels. From roaring rapids in the spring to slow, shallow pools in the fall, the rivers feeding the watershed follow a natural cycle of flood and drought. People dependent on them have built dams and reservoirs to modulate the flow, most notably on the Colorado River itself. Today, the Colorado River Basin supplies water to 27 million people and irrigates over 3 million acres of cropland. (Barnett, Pierce 2009). The reservoirs created by the Glen Canyon Dam (Lake Powell) and Hoover Dam (Lake Meade) have helped tame the seasonal flood/drought cycle of the river, but they have also fostered growth and development in the area beyond what the natural watershed could support. In addition, new development dependent on the Colorado River water has spread far from the watershed itself, resulting in increasingly competing demands for the resource.

Global warming will exacerbate the problem of water shortages in the Southwest. According to one researcher, "The southwestern United States will become warmer and more arid, especially in the Colorado drainage basin" and the anticipated global water shortages/climate models suggest that "long-term sustainable deliveries from the Colorado River are likely in the range of 14-17 billion cubic meters/year." (Barnett, Pierce 2009). This level of flow is already being drawn off, and the combined effect of continued population growth and global warming will result in severe water shortages in the region. A prolonged drought over the past several years has brought renewed urgency to resolving the issue. "Last year (2003) was the worst year of drought in 300 years," said John Keys, commissioner of the Bureau of Reclamation, the U.S. Interior Department Agency that manages water projects in the west. "The Interior Department recently issued a report identifying the several dozen areas, including regions along the Mexican and Canadian borders, where water disputes could spark local, interstate and international crises over the next 25 years." (Cooper, 2003) In the meantime, major Southwestern cities continue to grow. Through the last decade, Las Vegas, although located in one of the country's most arid regions, was one of the fastest growing metropolitan areas in the US. In fact, the four Colorado River Basin states were the fastest growing (in percentage terms) of all U.S. states during the 1990s, with Nevada leading the way due to unprecedented development in Las Vegas. US Census figures show that between 1990 and 2000 the state grew by 66%; the 2010 Census will show another 35% growth to over 2.7 million people, 70% of whom live in Las Vegas. (US Census population estimate, http://www.census.gov/popest/states)

Both state and federal legislators have realized for many years that population growth in the Southwest is threatening to overwhelm local water supplies, with vast implications for the entire ecosystem in the area. Past efforts to store fresh water in reservoirs by building dams has proved to be detrimental to the environment. An Environmental Impact Study on the Glen Canyon Dam, for example, has the demonstrated negative effects of dam operation on endangered species and sediment flow. The 1992 Grand Canyon Protection Act was passed to address the environmental problems caused by operating the dam but it has proven hard to build consensus between interest groups, including traditional water and power interests, native tribes, government agencies and environmental groups. Today, law makers have a limited list of options for addressing the issue in the face of urban sprawl into the desert. Clearly, new ideas and policies are needed to avoid conflicts between the interest groups.

One idea is to find and tap underground reservoirs. In the early 1990's a government hydrology study was conducted in remote canyons of the southern Nevada desert, as part of an MX missile siting project. The study revealed underground water stores in more than 40 valleys. The water there is thought to originate in snowmelt, so it could be at least partially recharged annually. Seeing an opportunity to gain a new source of fresh water right in Nevada, the city of Las Vegas began conducting its own investigation, and in 2008 the Las Vegas Valley Water District applied for permits to tap up to 200,000 acre-feet of this pristine groundwater per year. (Johnson) The aquifers are located under the east-central portion of the state, so water would need to be raised and then pumped hundreds of miles to Las Vegas. An estimated 327 miles of pipeline, as well as dozens of pumping stations and power substations would be needed, at an estimated cost of $3.5 billion. This may sound like an extreme project, but it is not; both Arizona and California have undertaken water projects of similar scope to supply their major cities. These projects illustrate the dire circumstances in which southwestern states find themselves.

The idea of moving water from rural sources to population centers has been around since the ancient canals and aqueducts. The modern practice of moving water from one watershed basin to another is called "interbasin transfer." The practice is controversial but not unprecedented; Las Vegas, which depends on the Colorado River for 90% of its water supply, already draws water from outside its valley. Today, however, the rural source areas are not so remote; there are people living there who demand control of the water found under their feet. Large-scale groundwater withdrawals can impact more than just the water table. Vegetation growth, local wildlife, spring flow and surface water flow can also be affected. Local residents are often less than enthusiastic about a major city hundreds of miles away pumping water from beneath their land. There are significant costs, legal hurdles and potential for environmental impact to be considered when tapping remote groundwater reserves.

Even more controversial is tapping into "fossil water" deposits. The American West was once covered with a great inland sea, and remnants of the ancient ocean can be found deep underground, filtered free of salt and minerals, even in areas that are low-lying deserts today. The problem with fossil water is that it is not sustainable; even large reservoirs are eventually tapped out. Cities that grow to depend on them end up in a worse predicament than if their growth had been limited by sustainable water sources. Clearly, fossil water resources should not be considered a long term strategy.

With the advent of the global warming phenomenon, even those underground aquifers and surface flows that originate from snowmelt may be at risk. Snow pack has declined in the Western mountains as average temperatures have increased. Global climate models predict that the Southwest will become more arid in the Colorado River Basin, with temperature increases of 2-4 degrees C projected by 2050. These changes are expected to reduce the flow of the Colorado River by 10-30%, and will have a similar impact on groundwater resources. (Barnett, 2009). Natural climate cycles also play a significant role in the fluctuations of Colorado River flow. El Nino and La Nina effects, based on water temperatures in the Pacific Ocean, can cause temperature and rain pattern changes in the Southwest. The current drought could be part of that natural cycle. These variables mean that we need to look for multiple water sources to mitigate the effects that both natural cycles and global warming might have.

Another, more obvious idea is to build large desalination plants along the Pacific coast. After all, there is plenty of water available on the planet – it just needs to be treated and transported. However, there are several issues with desalination. Current process technology is costly because it requires tremendous amounts of energy. Disposal of the resulting salt is also a problem – dumping it back in to the ocean increases salinity and is detrimental to marine life, while leaving salt on the surface causes it to run off into surface water or leach into local groundwater.  Finally, water is heavy; transporting it hundreds of miles requires a great deal of energy and infrastructure.  To make desalination anything more than a last resort, more efficient desalination methods must be found.

Making better use of the available water resources is an important part of any solution. Many people who live in the Southwest are accustomed to a high standard of living – swimming pools, golf courses and flowering gardens, all of which demand great quantities of fresh water in the arid climate.  Las Vegas is an extreme example with its elaborate fountains and pools. Simply scaling back on the use of water in daily life would make it possible to forestall the looming shortages.  Mandating “brown” lawns, filling in swimming pools and outlawing fountains is probably too radical a step, but increasing the cost of water would be an effective way to get these things to happen as a result of market forces.  Water in the Southwest is greatly undervalued.  The true cost of the resource, especially if interbasin transfer projects come to fruition, could be charged to the consumer.  This would certainly be unpopular and politically difficult, but it would quickly change people’s expectations and behavior regarding water usage, resulting in real and sustained reductions in demand.

The most draconian but effective solution for the long term is to simply reverse the population growth that has taken place in the Southwest over the past hundred years. According to one theory, when faced with a severe drought between 800-1000AD, the Mayan people abandoned their great cities and dispersed to areas where they could find subsistence in lower density settlements. Calling on people to abandon Las Vegas and other major cities in the

Southwest is not practical, but certainly the growth of these cities can be curtailed by imposing moratoriums on building and increasing the cost of living there. For the long term we need to respect the "carrying capacity" of the area – and the Southwest is largely a desert. Prior to having the technology to pump water around it would be considered folly to build a large city in the Los Vegas valley. The artesian wells found there by the Southern Paiutes and later Spanish explorers provided sufficient water for a green valley and a few hundred people, but Bugsy Siegel got it wrong when he figured to make Las Vegas a metropolis. Now with almost 2 million inhabitants, the city is not capable of providing drinking water without pursuing Herculean engineering projects to draw it from hundreds of miles away. Out in the desert even the most diligent conservation measures can't compensate for a fast-growing population.

A combination of solutions outlined here probably offers the best way to resolve today's water shortages in the American Southwest, but it is only when the true cost of water is apparent to consumers that the problem will be resolved for the long term. Dams and reservoirs, pipelines and desalination plants can be built, but their associated costs must be borne in full by the local populace, without subsidies, to ensure that local growth is limited by the cost of living there. Increasing the cost of water would drive farmers in the Colorado River Basin to limit their crops to those that can thrive with little irrigation. Some people would simply determine that they can live better elsewhere. These economic refugees would move out of the area to a place where water is more plentiful and so less costly. Eventually the cities in the Southwest would better reflect the populations and lifestyles that their local resources can support. This economic reality may be harsh, but the alternative could well be open conflict among the millions demanding water in the West.

- Barnett, T. (2009).Sustainable water deliveries from the Colorado River in a changing climate, Proceedings of the National Academy of Sciences of the United States of America, vol:106 iss:18 pg: 7334-8

- Barnett, Pierce, T, D. (2009). Sustainable water deliveries from the Colorado River in a changing climate. 106(18), Retrieved from www.pnas.org/cgl/dol/10.1073/pnas.0812762106

- Colorado River Water Users Association. (2007). Retrieved from http://www.crwua.org/coloradoriver/riveruses/index.cfm?action=agriculture

- Cooper, Mary H. (2003). Water shortages. CQ Researcher, 13-27. Retrieved from http://www.cqpress.com/product/Researcher-Water-Shortages-v13-27.html

- Dwyer, Colleen. (2005, March). Lower Colorado River water delivery contracts. Retrieved from http://www.usbr.gov/lc/region/g4000/contracts/watersource.html

- Johnson, J. (2008). Water authority looks beneath for drought protection. Southwest Hydrology, Vol. 7(no. 5), Retrieved from http://www.swhydro.arizona.edu/

- Kuhn, E. (2005). Colorado River water supplies: back to the future. Southwest Hydrology, Vol. 4(no. 2), Retrieved from http://www.swhydro.arizona.edu/

- Stave, K. (2003). A System dynamics model to facilitate public understanding of water management options in Las Vegas, Nevada.  Department of Environmental Studies, University of Nevada.

- Water Science and Technology Board, (2009). Colorado River Basin Water Management (Adobe Digital Editions version)