THE FUTURE OF WATER: IDENTIFYING AND DEVELOPING EFFECTIVE METHODS FOR MANAGING WATER IN ARID AND SEMI-ARID REGIONS

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ABSTRACT

Availability and access to potable water supplies is quickly becoming a large problem throughout the arid and semi-arid regions of the world. These semi-arid and arid regions account for only 2 percent of the total global runoff and have the least amount of annual precipitation. Compare this value to the Amazon River Basin that carries 16 percent of the global runoff, and there emerges the problem (UNEP, 2000). This lack of runoff in arid regions has, and continues, to compound drought and water supply problems that numerous communities are already facing. Many of these areas are playing witness to unprecedented population growth coupled with water shortages due to low runoff, overuse and long-term drought situations. Arid areas all over the world are in need of more responsible sustainable socio-economic development. This responsible development would allow people to realize the needs and consequences of large scale growth in a water deprived locale before major problems arise.

The presentation will review what is being done to better manage and re-allocate existing water resources, since new sources are rarely available:

- Conservation/ water efficiency
- Reuse
- Desalinization
- Groundwater development and treatment
- Stormwater capture and treatment
- Water Transfer/ Marketing
- Conjunctive Use
- Surface Water Imports

KEYWORDS

Sustainability, arid regions, drought, population growth, water, water resources, water supply, reuse, desalinization, precipitation, development.

WATER AS A RESOURCE

Comprising over 80 percent of the Earth's surface, over 66 percent of the human body, water is, and will continue to be, the most important resource in the world. With a continually growing human population and a global warming trend, availability and access to potable water is becoming an ever increasing problem. In no region of the world is water a more precious commodity then in the dry and arid climates. It is at these locales that there is the greatest need to collaborate and develop techniques for properly managing existing supplies of fresh water.

WATER AS A REALITY

Some time ago, around eighteen thousand years, the earth was at the peak of its latest ice age. Almost 32 percent of the land area was covered by glacial ice. Fast forward several thousand years to present day and we see only a mere 10 percent of the land area covered by glacial ice (NOAA, 2002). This recession of the ice is evidence of a global warming trend, believed, to a large extent, a natural cycle of the Earth. This slight change in global climate has given birth to the formation of vast arid and semi-arid regions, which comprise upwards of 40 percent of the earth's land area, see Figure 1.

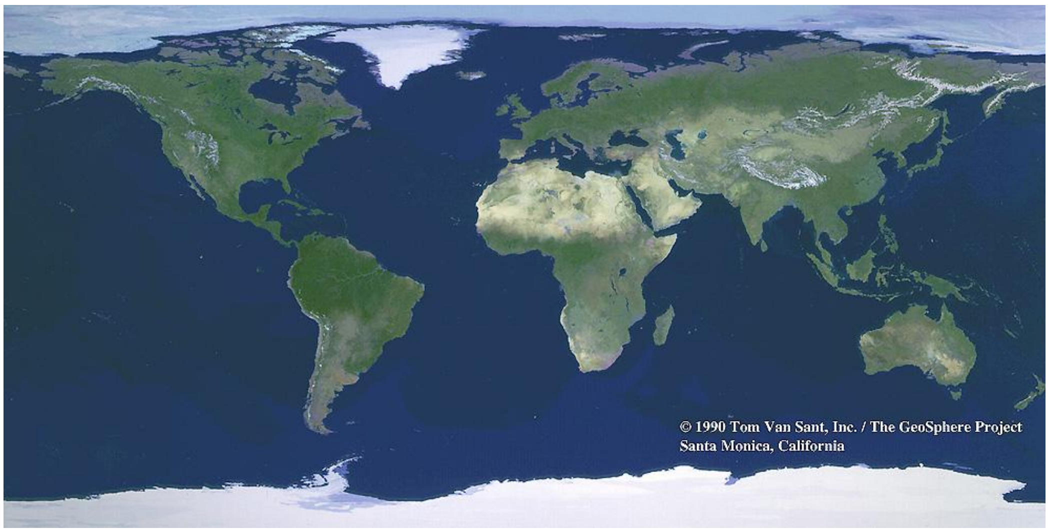

Figure 1:
A Mercator global projection map that depicts the deserts of the world. The deserts and semi-arid areas are marked in varying shades of brown, with the lighter browns representing drier climates. Non-desert and humid climates are marked in varying shades of green, depending upon amount of moisture, with darker greens representing moister climates. The Polar Regions are marked in white.
Source: Tom Van Sant, Inc./The GeoSphere Project. Available at: http://ag.arizona.edu/~lmilich/desert.html

These semi-arid and arid regions account for only 2 percent of the total global runoff and have the least amount of annual precipitation, see Figure 2. Compare this value to the Amazon River Basin that carries 16 percent of the global runoff, and there emerges the problem (UNEP, 2000). This lack of runoff in arid regions has, and continues, to compound drought and water supply problems that numerous communities are already facing. Even throughout the United States, there is a significant variance in the amount of annual precipitation.

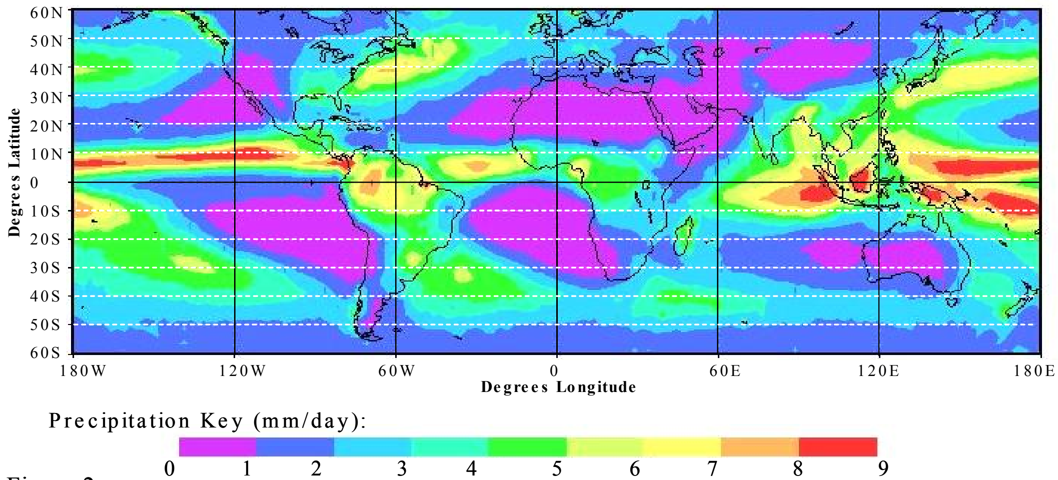

Figure 2:

Global daily average precipitation, averaged 1987-1999, (mm/day).

Source: Global Precipitation Climatology Project (GPCP). Available at: http://orbit-net.nesdis.noaa.gov/arad/gpcp

A large share of the western US, particularly the Southwest, receive well under 5 inches per year. Various areas in the eastern US receive 100 inches per year or above, see Figure 3. While it is estimated that there is enough fresh water in the world to meet all current and future demands of humans, it is not allocated evenly throughout the world (UNEP, 2000).

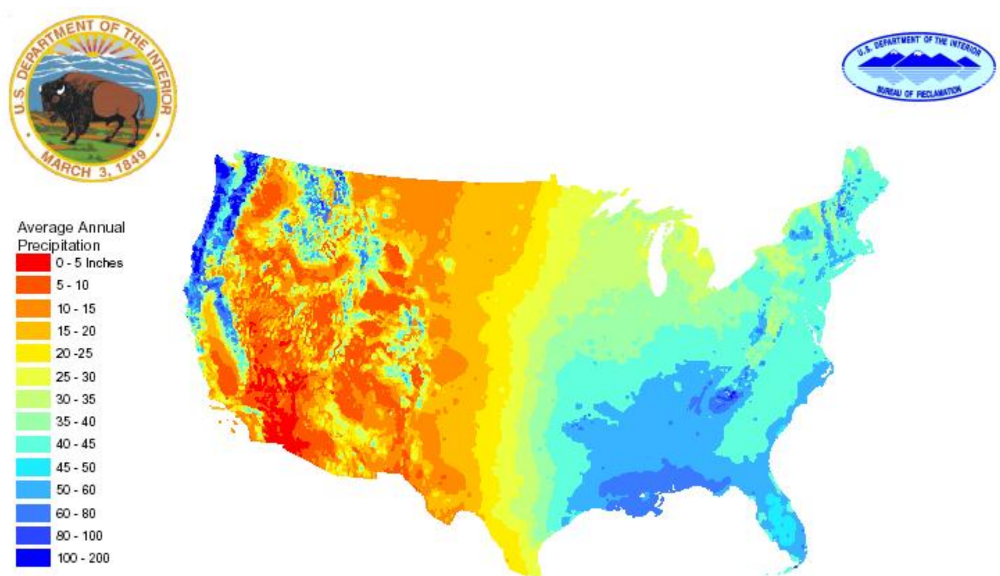

Figure 3:
Average inches of annual precipitation in the United States, averaged 1961-1990.
Source: United Stated Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS). Available at: http://www.ncgc.nrcs.usda.gov/branch/gdb/products/climate/index.html

WATER AND GROWTH

Arid areas all over the world are in need of more responsible socio-economic development. This responsible development would allow people to realize the needs and consequences of large scale growth in a water deprived locale before major problems arise. The major population centres of the western United States as well as those in the Middle East, northern

Africa, and South America are growing larger by the day. Already, the existing supplies of water in the western US are allocated, and in many places over allocated (DOI, 2003). The Ogallala Aquifer located in the high plains of the United States, one of the largest aquifers in the world, is declining at almost 2 feet per year. At current use levels, not accounting for projected increases, this Aquifer will be empty in less than 100 years (NPGD). In heat of the southwest US, temperatures sore upwards of 125 degrees Fahrenheit with very little rainfall. The Colorado River runs through this region and with the advent of dam building, has spawned the City of Las Vegas and fuelled the population explosions of Arizona and Southern California, see Figure 4.

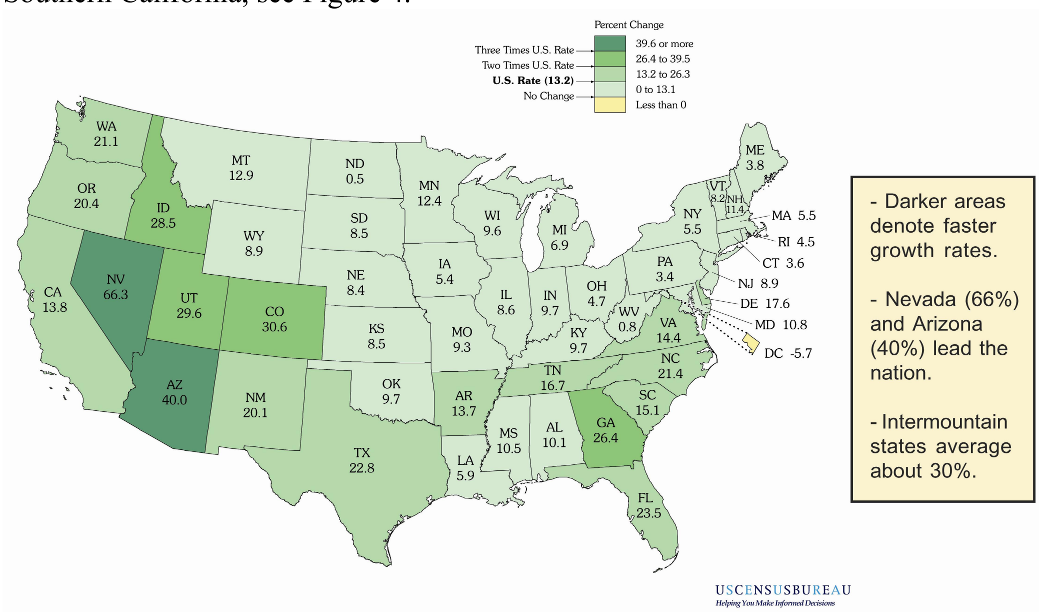

Figure 4:
United States population percent change from 1990 to 2000. Note the particularly high growth rates in the west compared to the remaining portion of the country.
Source: United States Census Bureau. Available at: http://quickfacts.census.gov/qfd/maps/thematic/PL0120000.html

The Hoover dam, holding back an impressive 28.5 million acre-feet of water at capacity, supplies much of Las Vegas and surroundings with water and hydro-electric power (USBR, 2003). But all is not well in this small oasis, as several consecutive years of abnormally high temperatures and below average precipitation in the west have left the Colorado River trickling at an all time record low. Combine this with increased water demands from the Colorado River by Arizona, California, Nevada, and Mexico and the situation gets even worse. Water surface levels in Lake Mead and Lake Powell dropped to near record and record lows respectively. In a United States Geological Survey (USGS) fact sheet released in June 2004, historical Colorado River flow data "suggest that the current drought may be comparable to or more severe than the largest known drought in 500 years" (Webb *et al*, 2004).

CASE STUDY: Lower Colorado River Basin

On January 1, 2004, the Southern Nevada Water Authority (SNWA) declared a Drought Alert for Southern Nevada due to the low water elevations of Lake Mead. Historically, the last time Lake Mead saw such a low water level was in December of 1967 (USBR, 2004). Figure 5 shows the monthly average water surface elevations of Lake Mead since it began to fill in 1935. Over the last 4 years (2000-2004), Lake Mead has witnessed a water surface elevation drop of nearly 83 feet.

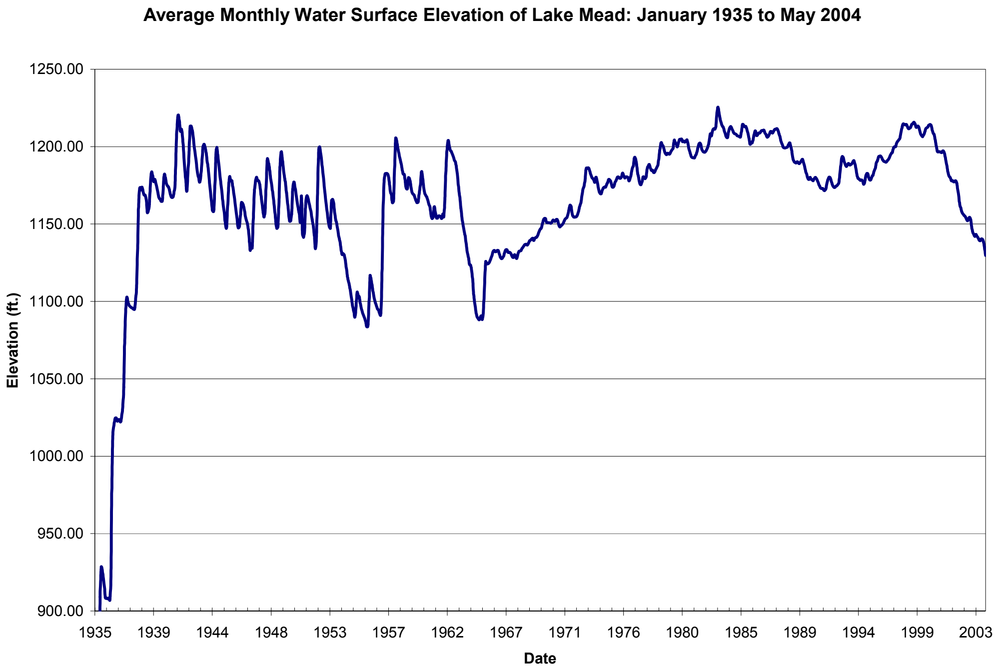

Figure 5:
The average monthly surface elevations of Lake Mead. The measurements were taken beginning when the lake began to fill in 1935 (hence the low elevations for the first several years).
Source: United State Bureau of Reclamation (USBR), Lower Colorado Region.
*Available at: http://www.usbr.gov/lc/region/g4000/hourly/mead-elv.*html

While 83 feet is significant, consider that when Lake Mead is at capacity, a single foot drop in the water surface elevation equals nearly 158,000 acre feet of water loss. The lake dropped below the 1,145 ft level in January 2004, prompting SNWA to issue the Drought Alert. A Drought Alert is the second phase of a three phase alert system developed in SNWA's Drought Plan.

The aptly named Drought Plan consists, in part, of a three phase alert system that identifies a Drought Watch, Drought Alert and a Drought Emergency. The three phases are implemented when water surface levels of Lake Mead approach 1,145 ft, lie between 1,145 ft to 1,125 ft, and drop below 1,125 ft, respectively. Each drought phase corresponds directly to the amount of water allocated to SNWA. Under normal conditions, SNWA is allotted 300,000 acre-ft from the Colorado River for domestic use. During a Drought Emergency, SNWA may not exceed this amount. During the other drought phases, SNWA may take additional acre-ft from the Colorado River depending upon the conditions set forth in the Interim Surplus Guidelines and designations made by the Secretary of the Interior (SNWA, 2004).

The SNWA Drought Plan establishes specific criteria to warrant the declaration of a drought phase in addition to setting forth procedural steps SNWA, local residents and businesses should follow to minimize adverse effects of a drought crisis. One of the major points in the Drought Plan is public awareness and involvement during drought situations. By utilizing media sources, setting up local displays, advertising, and creating partnership programs with local businesses and industries, SNWA has created a network of information to alert the public of any drought crisis. This network also provides the public with steps to follow during such times. Several of the specific steps SNWA implements under a drought watch or alert are outlined below:

Watering Restrictions

Residential watering is restricted during the fall, winter and spring months to specific days and times. Watering of municipal areas and schools is restricted similar to residential areas with golf courses being required to implement water budgets.

Outdoor Water Use

Outdoor washing of surfaces, buildings, equipment and vehicles is allowed only when water is discharged to a sanitary sewer system so that it may be reused. Installation of new landscapes that consist of grasses and turf are restricted to specific instances. Installation of landscapes requiring little irrigation is encouraged.

Water Rates and Incentives

Water rates and surcharges may be increased and/or applied to reduce the water demand. Any property owner found wasting water is given a warning with a second violation resulting in fines and/or other penalties. A unique program employed by SNWA to reduce water consumption pays a resident or business $1 per square foot of turf they convert into a water efficient landscape. Since the program's implementation in 1999, SNWA estimates an annual average of 1.1 billion gallons of water saved.

Currently, SNWA is still developing additional steps that will be needed to deal with a Drought Emergency (SWNA Drought Plan, 2004). Depending upon weather conditions and precipitation amounts in the West over the next several months, SNWA may enter a Drought Emergency phase as early as January 2005 (SNWA, 2004).

Long range flow forecasts for the Colorado River and surface elevations of Lake Mead do not suggest a great improvement any time soon (USBR, 2004). It is likely that the majority of any improvements will be countered by the large population flux into the Southwest. However, water purveyors in the area are prepared to deal with this circumstance.

Southern Nevada

In Southern Nevada, SNWA has prepared a plan that outlines additional water sources to meet projected demands through 2050. Direct reuse of treated wastewater is highly utilized for non-potable purposes in Southern Nevada. This practice frees up additional water supplies to be used for potable purposes. SNWA plans to fully use their groundwater rights in the Las Vegas Valley. Thus far, no contamination has been observed in SNWA's groundwater sources. Perchlorate contamination remains of concern as the former Kerr McGee Chemical superfund site lies in nearby Henderson, Nevada. To meet the more distant demand, SNWA is looking into using surface water from both in the Las Vegas Valley and throughout the State. Additional sources of groundwater are found in the Valley, but lie shallow in the ground. These sources will require treatment, which is not yet economically feasible (SNWA Water Resource Plan, 2004).

Southern California

With Southern California lying at the tail end of the Colorado River and combined with the population boom, the local water utilities are also searching for alternative methods to meet their water demands. The Los Angles Department of Water and Power (LADWP) are planning to build a desalinization plant to help meet the current demands. Further desalinization plants around LA and Southern California may very well be needed to meet demands. LADWP is also investigating the storage of storm water in the ground to be used eventually for potable purposes. Currently, a large share of runoff is conveyed and stored, but LADWP's investigations are looking into a more direct storage of the full runoff (LADWP Urban Water Management Plan, FY 2003). San Gabriel Basin Water Quality Authority has implemented a demonstration project in the Basin where contaminated groundwater will be extracted from the EPA Superfund site of the Baldwin Park Operating Unit. The treated effluent will be discharged to local water utilities. Similar projects are planned for surrounding areas where groundwater contamination exists (USBR Title XVI, 2003).

URBAN AND AGRICULTURE NEEDS

Urban, agricultural and industrial sectors all compete for limited supplies of water. In most areas, agriculture is the largest user of water. Urban areas, however, can often afford to pay more for water. This creates an inherent tension between these sectors. As population growth increases the need for both water and food, this tension can be expected to increase. It could be further exacerbated by climate change and pollution or salination of existing water sources. Water marketing, transfers and other cooperative approaches hold promise but must be implemented before the tensions erupt into conflict.

BEFORE THE DAM BREAKS

The time has come to embark upon discussions relating to the deficiency of drinkable water in the arid and semi-arid regions of the world. Techniques are needed to effectively manage potable water sources such as the Ogallala Aquifer, the Colorado River Basin and others so as to stretch these supplies indefinitely. Some approaches to be considered but not limited to are:

- A sharing of worldwide technologies relating to water conservation and management.
- The development of public outreach and educational water conservation programs worldwide.
- Review of effective and non-effective water management practices.
- Review of effective and non-effective water reuse practices
- Ongoing identification and realization of severe drought areas.
- Review and assessment of major existing potable water supplies worldwide.
- In depth identification, analysis, and feasibility of creating new potable water supplies.
- In depth identification, analysis, and feasibility of using cooperative transfers and management of existing supplies among urban, agricultural and industrial sectors.
- Encouragement of responsible socio-economic development.
- Implementation of incentives to reduce water demand.
- Practicing responsible conservation methods during non-drought times.

The above points serve as a good forefront to begin discussions on water use and supply issues, especially in areas lacking adequate supply. While satisfying the needs of the human populations will be headlining such discussions, one must not forget that the water needs of local eco-systems must also be met. The timing of these discussions is critical as the worst time to deal with any issue pertaining to water shortage will be during one.

WATER TOMORROW

Water is a finite resource. We will not wake up tomorrow and suddenly have enough to meet the demand. Only through responsible development and effective water resource management will the human population be able to contend with a shortage of it. A shortage of water will be a monumental one unlike anything the world has ever seen before and rivaled only by a shortage of air to breathe. In the words of Benjamin Franklin, "When the well is dry, we learn the worth of water."

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