New New Deal: Infrastructures on Life Support

MASON WHITE
University of Toronto

LOLA SHEPPARD
University of Waterloo

The United States has 6.5 percent of the world's fresh water within its borders, yet despite this abundance the country is entering a period of crippling water shortages. Even without factoring in the expected drought effects of climate change, thirty-six states predict shortfalls in the next ten years that will put their environmental and economic health at serious risk. Making the problem more acute, the driest states are also the fastest growing: six of the ten fastest-growing cities in the US—Dallas/Forth Worth, Phoenix, Houston, San Bernardino, Houston, and Las Vegas—are located in water-strapped regions of the southwest. The constant drive for urban growth in the face of water scarcity necessitates ever more elaborate infrastructure to transport water from wet regions to dry ones. Heroic efforts in the American southwest demonstrate what can be achieved, and at what cost, when this essential resource must be supplied to communities that have no ready access to water.

INFRASTRUCTURAL LANDSCAPES

Man-made water networks have successfully enabled cities to grow and prosper in the desert conditions of the southwest, but impending water shortages mean that increasingly complex regional water infrastructure is urgently needed, especially in the 243,000 km2 catchment area of the Colorado River basin.

The Colorado River is the site of ambitious feats of American engineering, many initiated during the 1930s under Franklin D. Roosevelt as part of the New Deal. Most notable is the Hoover Dam on the border between Nevada and Arizona, which created Lake Mead, the largest man-made lake in North America. The dams along the Colorado River collect water in enormous reservoirs, thus ensuring consistent supplies throughout the year, managing river levels, and providing hydroelectric power to the region. The reservoirs—which store more than 86 billion cubic meters of water, or four times the Colorado River's average annual volume—feed an artificial network of canals and pipelines. Three major aqueducts, essentially man-made rivers, divert water in the lower Colorado River basin. Combined, they form approximately 1065 km of water highways.

In the years between 1935 and 1993 almost every mile of the Colorado River was modified in some way by this system of dams, reservoirs, aqueducts, and pumping stations. Most of the river's flow in normal hydrologic years is now diverted for agricultural and municipal water supply, leaving very little to reach its mouth in the Pacific. In its present form, the basin's water management system has evolved into a symbiotic network between cities, landscape ecologies, and infrastructure technologies.

PARTITIONING WATERS

Even in the early days of development in the Southwest, water was a critical issue. As population centers grew and the attendant demand for water became ever more pressing, states dependent on Colorado River water feared California would establish priority rights. The 1922 Colorado River Compact was designed to permanently resolve this conflict. The agreement divided the waters of the Colorado River equally between "Upper and Lower Basin States." Wyoming, Colorado, Utah, and New Mexico were in the upper basin; and California, Arizona, and Nevada in the lower, with the demarcation line set at Lee's Ferry in northern Arizona. Each basin was to receive 7.5 million acre-feet per year (293 m^3/s). It later became apparent that these allocations based on hydrological data from a period when the Colorado River's flow was unusually high, would not be sustainable over the long term.

In 1963, a US Supreme Court decision redefined the agreement, reducing the quantity of water that was to be distributed among the lower-basin states, and revising upward the amounts that had been historically reserved for Indian tribes and federal public lands. Because the Colorado River Delta is in Mexico, that country also has a legitimate claim to its waters. The delta was once lush with vegetation and wildlife, but the construction of 29 dams and numerous up-river diversion projects over the past 60 years deprived the area of natural water flow, with its vital supply of silt and nutrients. In 1944, an international treaty allocated Mexico water rights in the amount of 58.6 m^3/s. In the 1960s, Mexican farmers complained that when the untreated runoff from the US made its way into the Colorado River as it headed south of the border, it raised the salinity levels, harming their crops. In 1992 one of the world's largest desalination plants was built in Yuma, Arizona, to treat agricultural runoff before it was delivered to Mexico. The competition for water in the Colorado River Basin continues to be an engineering and political problem. Given projected growth in the region, these interstate and international debates are only likely to intensify.

WATER TRADING / WATER BANKING

Every US state is divided into irrigation districts, legal bodies that trade in water capital. These districts are quasi-political municipal or regional entities created under special laws, for the purpose of supplying water and power to agricultural regions and cities. Farming districts are now selling their long-established water rights to thirsty urban centers. Water has become a highly valuable, tradable commodity. For example, a deal struck in summer 2008 between the Metropolitan Water District of California (MWD) and the Paolo Verde Valley called for farmers to divert 4.5 m^3/s of their water to Los Angeles, San Diego, and surrounding settlements in exchange for US$16.8 million a year. This desperate and expensive negotiation was necessary because the management of the Sacramento River Delta had reduced its contribution to the MWD by 30 percent, to protect a threatened fish species.

The legal frameworks regulating land and water rights in the western US are known as "first in time, first in right" or "prior appropriation" laws. Under these rules, water rights can be severed from the land, and sold or mortgaged as an independent piece of property by those who had the original, historical claim to the land. This is a "first come, first served" system that applies to both the surface water and the groundwater tributaries to a surface stream. The significance of this law is twofold. First, water can be traded as a commodity, independent of the land ownership. Second, these water rights have a fluctuating value.

The critical importance of water in this arid region, and its increasing value, has led to the practice of "water banking," a method of conserving unused river water as a buffer against the shortages caused by the regular droughts. Each year, the Arizona Water Banking Authority (AWBA) pays the delivery and storage costs of bringing Colorado River water into central and southern Arizona through the Central Arizona Project canal. The water is stored underground in existing aquifers (direct recharge) or is used by irrigation districts in lieu of pumping groundwater (indirect or in-lieu recharge). For each acre-foot of water stored, the AWBA accrues credit that can be redeemed in the future when an irrigation district or water corporation in Arizona or a neighboring state needs this backup water supply.

DESERT AGRICULTURE

Fifteen percent of America's crops and 13 percent of its livestock are produced on the 1.5 million hectares of farmland fed by the Colorado River; 80 to 90 percent of the water taken from the river is consumed by agriculture. Yuma, Arizona, and California's Imperial Valley are two of the nation's most important agricultural regions, though their capacity to supply food across the continent, especially during winter months, must be artificially sustained. Farming here is a billion-dollar industry. Imported water and a long growing season allow two crop cycles each year in the Imperial Valley, a major source of winter fruits and vegetables, cotton, grain, and alfalfa (a hugely water-intensive crop) for US and international markets. Considered one of the most productive agricultural regions in the world, the Valley consumes the vast majority of California's Colorado water allocation, as agreed upon in the 1922 compact. Yuma, the "Lettuce Capital of the World," has 40,000 hectares of agriculture supplying almost 90 percent of America's winter vegetables.

In late 1997, the federal government reduced California's Colorado River allocation, and as a result the Imperial Valley Irrigation District's allocation, by 9 percent, to take effect in 2003. The Bureau of Reclamation had ruled that local farmers were not making sufficient use of the water-saving practices commonly employed in other water-starved regions. Beginning in late 2003, Imperial Valley farmers agreed to idle their winter crops, to fulfill a water trade agreement mandating the transfer of thousands of acre-feet of water to San Diego and the Salton Sea.

The local water distribution network—the Imperial Irrigation District (IID)—comprises more than a hundred canal and pipeline branches. The system also includes check dams, spillways, pumping stations, and water reservoirs, all computer-monitored. The water infrastructure that has extended, and in some cases supplanted, the Colorado River is not only constructed, it is highly automated. The Imperial Valley is sustained by the All American canal, which was completed by the United States Bureau of Reclamation in 1942. Providing drinking water for nine cities and irrigation for over 200,000 hectares of farmland, it is the largest irrigation canal in the world, carrying up to 740.6 m^3 (26,155 cubic feet) per second of water.

MANUFACTURED ECOLOGIES

Perhaps the most striking aspect of the water infrastructure sustaining the southwest is the accelerated rate at which landscapes and ecologies are created, erased, and redefined. An extreme example of this environmental impact is the Salton Sea. During a season of heavy rain in 1905, the Colorado River breached its canal, flooding the Imperial Valley and re-filling an ancient inland sea bed. The resulting body of water was 72 km long and 32 km wide, a 932 km^2 sea with 177 km of shoreline. The Salton is endorheic, or terminal (without a natural outlet), and has high evaporation rates. It is officially designated as an agricultural sump for the Imperial Valley, and its water levels are sustained by agricultural run-off. Processes of evaporation and concentration result in a high, and increasing, saline content.

Organized recreation launched the urban development of the Salton Sea area in the 1920s. Boat racing became a major sport there during this period. Because high salinity increases buoyancy, the Salton was known as one of the fastest racing courses in the nation. In the 1950s the California Department of Fish and Game stocked the Salton with a variety of fish species, making it a significant destination for fishing, camping, hiking, bird watching, and boating. Tilapia, for example, a resilient fish that thrives in a high-saline environment, continues to flourish in the Salton. Development peaked in the 1950s and '60s, and the Salton became a California Riviera, with Hollywood film stars enjoying its luxury resorts, country clubs, marinas, and golf courses.

The Salton's fish and bird populations were in dramatic decline from the 1960s to the 1990s, as warm water and agri-chemical pollutants entered the lower food chain species. Many of these species have now bounced back, and by current estimates there are about 80 million tilapia in the Salton Sea. With large numbers of fish come large numbers of migrating birds (nearly 400 species), for whom the sea represents a key stop-over along a Pacific flyway that has been considerably degraded by the massive loss of wetlands throughout California.

One of the major problems with all of the Colorado River's water, exacerbated in the Salton Sea, is salinity. Salts run naturally off soils and rocks, and when river water is used for irrigation, some water evaporates, concentrating salts in the water that returns to the river. Salinity levels are also affected by evaporation from reservoir and aqueduct surfaces, and water use by plants along the river. Currently, the concentration of salt in the Salton Sea is 25 percent more saline than the ocean and increasing by a rate of approximately 1 percent annually, due largely to evaporation. The concentration of salt in the water of the Alamo and New rivers, Colorado tributaries that feed the Salton, is at 44,000 mg/L, or approximately 4.4 percent. By way of comparison, the Pacific Ocean is approximately 3.5 percent salt content, and the Colorado River water, prior to its diversion into the Imperial Valley, is about 0.7 percent salt content.

In 2003, a federally mandated requirement to transfer over 10 percent of the Imperial Valley's water allocation to San Diego threatened the Salton's future. Massive infrastructure projects are proposed to preserve the sea's ecological stability. California has until 2018 to come up with a long-term restoration plan for the Salton; without such a plan the sea will decline rapidly, losing roughly 60 percent of its volume, tripling its salinity, and exposing nearly 300 km^2 of lakebed within a dozen years. All of this will lead to massive die-offs of birds and fish as they are displaced from their habitats.

LANDSCAPES ON LIFE SUPPORT

Much as the New Deal infrastructure projects and the federal highway system fundamentally reconfigured the North American landscape in the 1950s and '60s, so national water infrastructure is poised to redefine our notion of natural landscapes in the early twenty-first century. However, the urgent need for these infrastructural landscapes also indicates that there is little room for visions of a nostalgic pre-modern natural condition in the Southwest. There is no turning back: if these ecosystems and habitats are to be maintained, and agricultural productivity to continue, the landscape must exist on some kind of life support. The question is not if it will require this work or when, but what it will address and how it will be occupied. The Salton Sea and its region of influence are in need of an urgent intervention that manages water in a new way. The iconic dams and canals of the past century are no longer the appropriate design response.

A new approach is needed, but most of the proposals for mitigating the collapse of the Salton Sea rely on old technological fixes: suggestions have ranged from piping water from the Pacific Gulf, with attendant large-scale desalination, to building huge barrier dams, pumping stations, and canals to partition the sea into northern and southern ecosystems. Most projects suggest that maintaining the sea in its current form is impossible, and take the current environmental problems as a liability to be accepted and accommodated. The Salton essentially is viewed as the hydrological refuse point for the farm systems of the Imperial Valley. How can the partitioning, banking and trading of water in the American Southwest manage such divergent interests? And, instead of being static and engineered, how can water infrastructure be interactive, public, and adaptable?

WATER FARMING: THE SALTON SEA

The Salton Sea's extreme salinity and threatened ecosystems offer an opportunity for economic, social, and ecological innovation. The issue of water demand across the region is central to the sea's future. With urban areas competing for Imperial Valley's allocated use of Colorado River water, the best strategy would be to remediate the water before it enters the Salton.

Our proposal establishes the Salton Sea as a site for water harvesting. In addition, no longer serving as an irrigation sump or supporting a mono-agricultural landscape, the Salton would offer harvests of kelp, algae, fish, and (in a return to its namesake) salt.

In this plan, solar ponds are staged along the Alamo and New rivers, and irrigation water entering the Salton is regulated at ocean-level salinity, or 3.5 percent salt content. Then, rather than a single partitioning of the sea as many have proposed, our plan populates it with floating pools or water-pads of various sizes and salinities. These pools serve as salinity regulation devices as well as farm plots, habitats, and recreational destinations. While other current proposals suggest a more aggressive division of the sea, this scheme envisions maintaining it in its current form, but stabilizing its salinity. The floating pool systems generate micro-ecologies that capitalize on the benefits of higher-salinity, or brine, water, including a rich growth of kelp and algae, a fertile environment for tilapia farming, and salt crystallization. The next step is freshwater farming. Freshwater harvesting converts ocean saline water into salt crystals and potable water, addressing the water quality issue within the Salton while also generating an economy of water trade for San Diego and Los Angeles.

There are four pool types, varying in scale and complexity, dedicated to production, harvesting, recreation, and habitat. These micro-ecologies are partially moored in place but can also migrate within a territorial range of the Salton. When maintenance or substantive harvesting is necessary, they can be brought close to the shore for collection or upgrade. Along the east and west shoreline of the Salton, the gridded landscape of the Imperial Valley is extended northward to generate a new water-efficient landscape sustained by the Salton and the Coachella Canal. Shifting from traditional water-intensive agriculture, the shoreline farms will integrate sea greenhouses, basins for water treatment and storage, and new wetlands fostering wildlife habitats. A series of bays, jetties and docks articulate this renewed Salton lakeshore, to support the land-based agriculture and to receive the water-borne islands.

Rather than a New Deal approach of massive engineering or iconic infrastructure, this scheme employs adaptable, responsive, small-scale interventions. Easily replaced or upgraded, these infrastructures double as landscape life support, creating new sites for production or recreation. The ambition is to supplement landscapes at risk rather than overhaul them. The scheme combines existing landscapes with emergent systems to catalyze a network of ecologies and economies in a new public realm.