Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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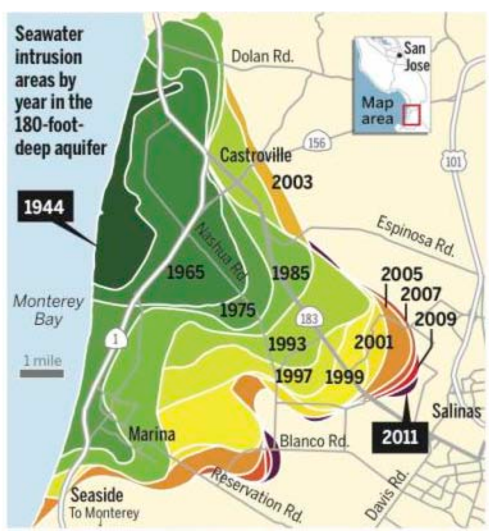
Groundwater–Out of sight but not out of mind

Ground subsidence in the San Joaquin Valley by 1977 had reached 30 feet from excess groundwater withdrawals.



Progressive seawater intrusion into the Lower Salinas Valley. Monterey County Water Resources Agency.

Our underground aquifers serve as reservoirs, pipelines and filters for the water beneath the surface. As subsurface reservoirs, they have lots of advantages over those at the surface: there are no construction costs; they don't silt up or trap sand destined for our beaches; they don't present seismic hazards as they age; and they don't take up valuable land area.

On the down side, however, water generally moves through aquifers very slowly, in fact, usually incredibly slowly. River velocities may be a foot per second (equivalent to 16 miles in a day), so a spill or pollutant can move downstream and mostly be gone in hours or days. Because groundwater moves so slowly (often a foot per day, or even a foot per year), flushing or removing a pollutant or contaminant from an aquifer can take a very long time.

As a result, regulations in California are very strict regarding what water we can put back into an aquifer. We can't just pipe storm-water run-off or recycled wastewater into the ground; it has to be cleaned to a very high level before it can be injected into the subsurface.

This slow motion flow also means that underground reservoirs can take a long time to be refilled when the groundwater table has been lowered. Three years of drought in California, and the continued overdraft of many groundwater basins, led to a historic legislative package of three bills signed by Governor Brown on September 16, 2014, which will for the first time, initiate groundwater sustainability planning and management for California's most distressed and overdrafted aquifers.

We haven't been balancing our groundwater checkbook. About 800 billion gallons of water are being drained annually from the Central Valley aquifers. The landmark legislation will require local governments to bring groundwater basins up to sustainable levels and limit future withdrawals to the rate of natural replenishment.

An additional problem with heavy groundwater usage, well known in the Santa Clara and Central valleys, is the subsidence of the ground surface accompanying the drawdown of the water table. In the 1950s and 1960s, tract homes in the Santa Clara Valley replaced fruit orchards and water demand increased dramatically.

As ground water pumping increased, the water table dropped as much as 250 feet. This led to compaction of the sediments in the aquifers and the settlement of the ground surface by as much as 13 feet in downtown San Jose by 1967. San Jose had the dubious distinction of being the first area in the United States where land subsidence was recognized as having been caused solely by excessive ground water removal.

While this may not seem like such a big deal, ground settlement produced major and expensive problems: sewage lines, which flow by gravity, no longer sloped in the right direction; a lowered land surface around the nearly flat-lying shoreline of southern San Francisco Bay led to flooding at high tides and the need to construct levees; streams overflowed more frequently; and water wells had to be repaired or redrilled.

The world's largest area of intense land subsidence from ground water withdrawal occurred in the San Joaquin Valley where over 5,000 square miles of agriculture land was affected. Maximum ground surface subsidence, near Mendota, reached over 28 feet. This produced severe problems in the construction and maintenance of water transport structures, such as canals, irrigation and drainage systems. In both the Santa Clara and San Joaquin valleys, subsidence has been terminated for the most part by importing surface water, and allowing the water table to begin to recover.

Excess pumping or overdraft of aquifers along coastlines creates another set of problems. In coastal areas, fresh water aquifers are commonly in contact with the ocean and are exposed to seawater. As long as the water table within the aquifer is above sea level, the inflow of salt water is repelled and little or no contamination occurs.

However, the increased demand for groundwater in many fertile coastal plain areas (the lower Pajaro and Salinas Valley areas, for example, but there are many, many others) has led to the lowering of the water table below sea level and the intrusion of a wedge of seawater into aquifers. Salt or brackish water soon appears in wells, making the water undrinkable and unusable for crops.

Since the 1940s, continuous heavy pumping of groundwater from the lower Salinas Valley between Moss Landing and Marina lowered the ground water table and allowed seawater to intrude the upper 180-foot aquifer. Wells were abandoned as they began to pump brackish water and new wells were drilled farther inland. The saltwater plume continued to move inland, and by 2011 it had reached nearly to Salinas, over 8 miles from the shoreline.