TOWARDS A GROUND-WATER LEVEL CLIMATOLOGY OF THE SOUTHWESTERN UNITED STATES

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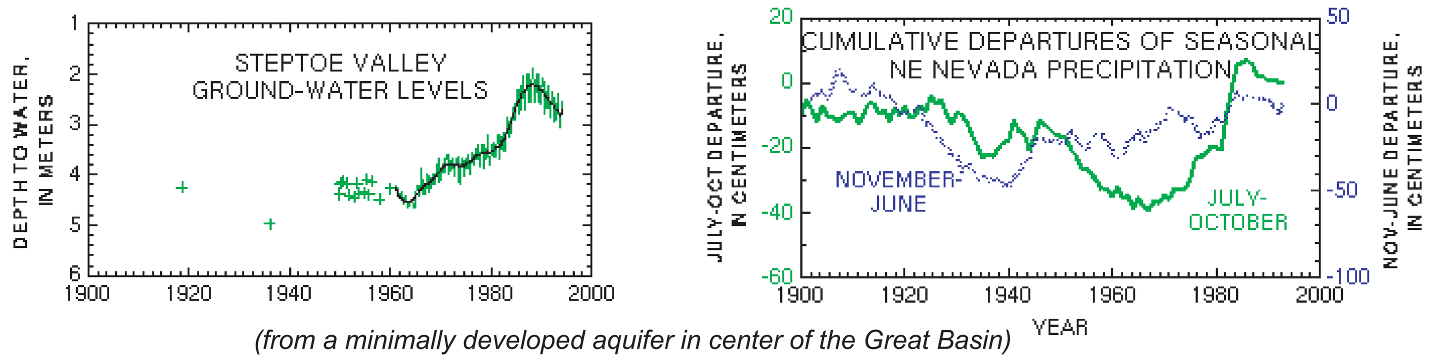
MOTIVATION FOR A LOOK AT HISTORICAL GROUND-WATER LEVELS AND CLIMATE

At present, 45 million people live in the southwestern United States, a region with some of the most productive agricultural land in the Nation. Because most surface water has been apropriated, the search for new water supplies emphasizes ground-water and conjunctive uses. Availability and sustainability of ground-water resources are commonly measured in terms of water levels and water budgets, streamflow discharge from ground-water systems, and riparian ecosystems. The USGS's Southwest Ground-Water Resources Program *(http://az.water.usgs.gov/swgwrp/Pages/Overview.html)* is analyzing connections between surface water and ground water in this critical region and is characterizing variations in recharge, discharge, and riparian conditions, in order to help improve understanding and management of the region's ground-water resources.

Traditionally, measures of ground-water sustainability have been interpreted mostly in terms of steady-state inflows, outflows, and levels. As part of the Southwest Ground-Water Resources Program, historical ground-water level variations at selected wells in 23 basins have been compared to regional- to global-scale clmate variations. This analysis of observed ground-water levels provides opportunities—for the ground-water hydrologist—to infer relations of arid-zone ground water to interannual and interdecadal climate variations, and—from the climatologist's viewpoint—to follow important ciimate signals into the subsurface.



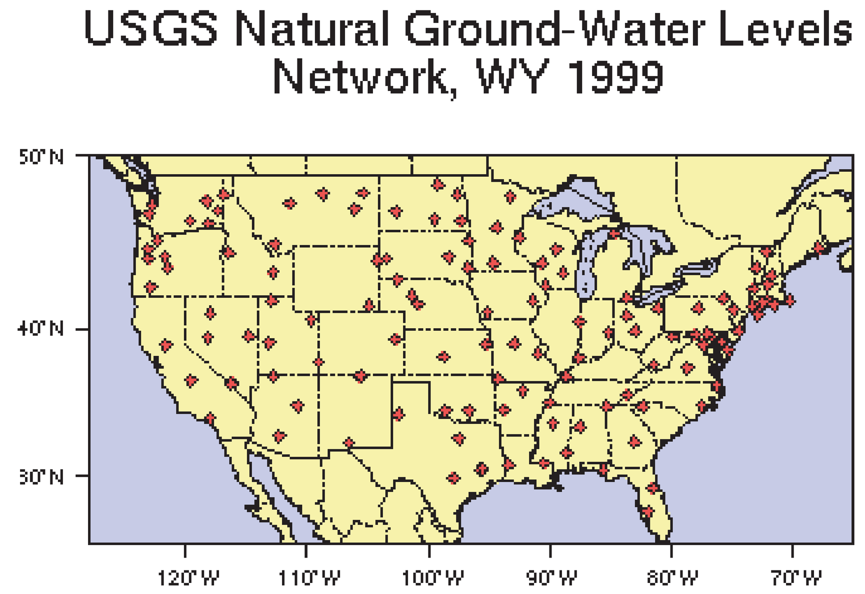
(from a minimally developed aquifer in center of the Great Basin)

APPROACHES

Because long-term historical records of ground-water level variations in undisturbed aquifers are rare, the USGS is approaching the problem of linking Southwestern ground-water levels to climatic variations from three directions:

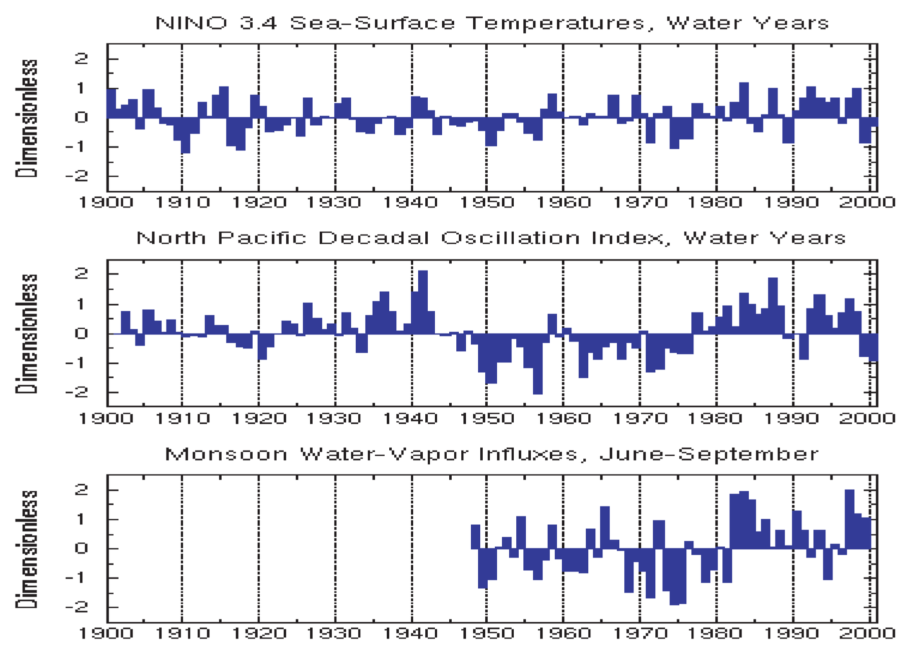
(1) A NEW NATIONAL HYDROCLIMATIC GROUND-WATER LEVELS NETWORK

Nationwide, a water-level monitoring network of over 100 wells tapping (almost) undisturbed, climatically responsive aquifers was established by the USGS in 1998 and is intended to develop, in the future, a basis for evaluations of drought-, climate-change, and development impacts *(http://water.usgs.gov/ogw/CBR.html)*.

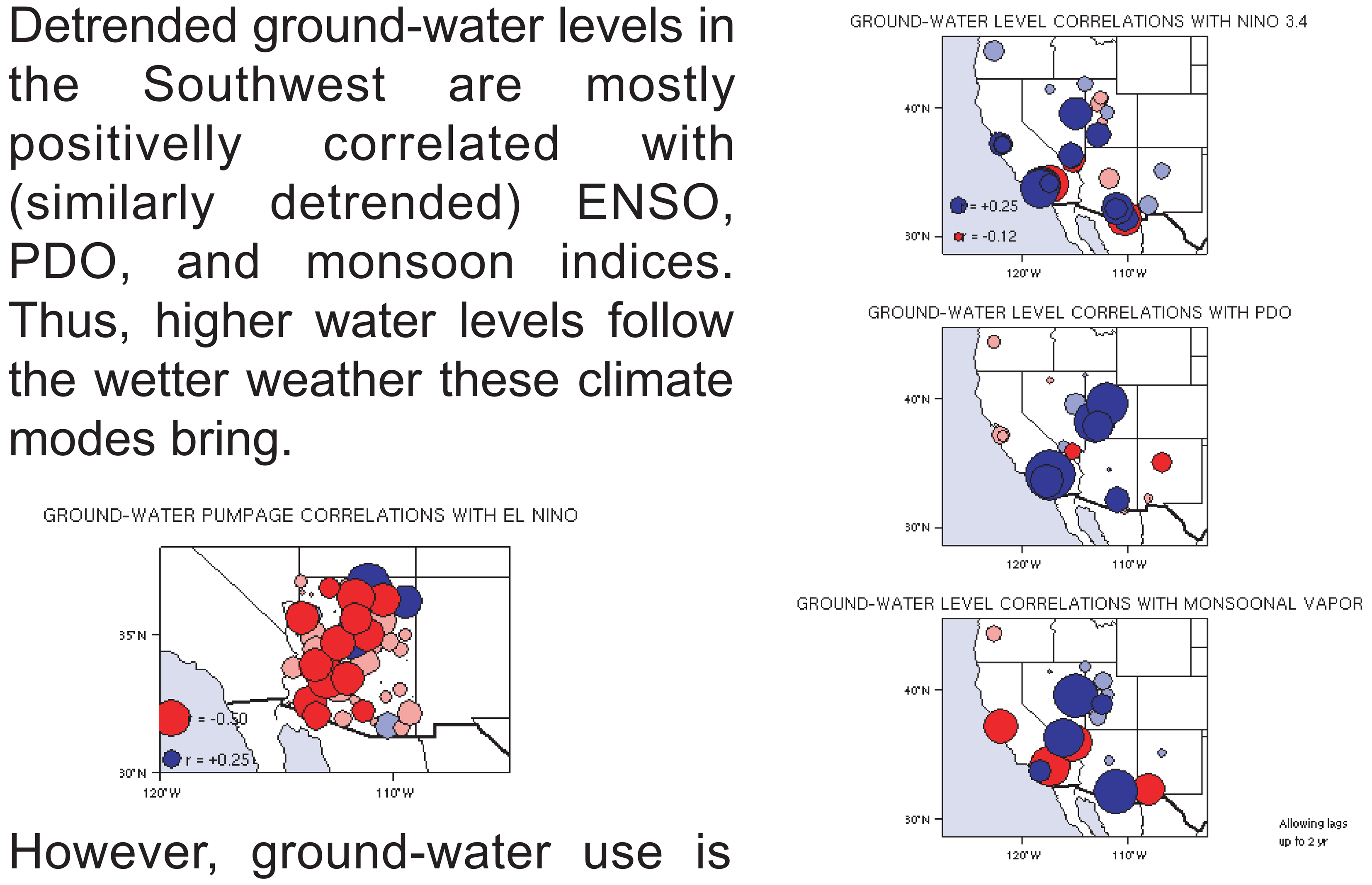


(2) COMPARISONS OF HISTORICAL GROUND-WATER LEVELS WITH CLIMATIC INDICES

Long-term historical records of monthly- to seasonal ground-water levels (mostly NOT in undeveloped aquifers) have been gathered, detrended, and then compared to important climatic indices that affect precipitation and temperatures in the Southwest: the El Nino/Southern Oscillation process (ENSO), the North Pacific Decadal Oscillation, and a Southwestern monsoon water-vapor influx index.



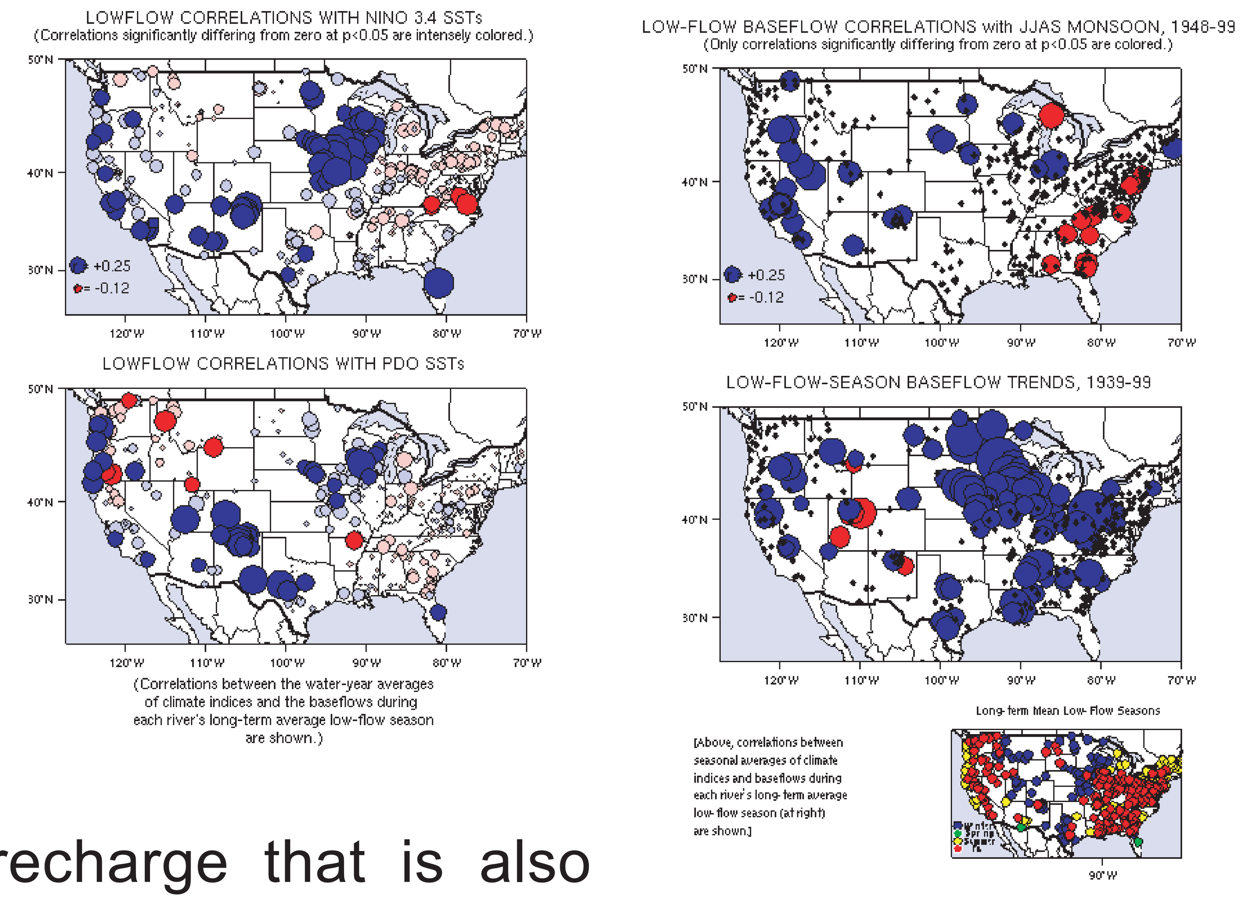
Detrended ground-water levels in the Southwest are mostly positivelly correlated with (similarly detrended) ENSO, PDO, and monsoon indices. Thus, higher water levels follow the wetter weather these climate modes bring.



However, ground-water use is negatively correlated with ENSO). Thus less pumpage occurs during these same wet episodes. This makes it difficult to know whether ground-water levels are correlating with the climate indices due to more recharge or less pumpage.

(3) ANALYSIS OF LOW-FLOW-SEASON BASEFLOW RATES

To sort this out, we are looking at baseflows in rivers with minimal human influences (from the USGS HCDN), upstream and removed from ground-water pumpage, as indicators of "subsurface storage"—even though they *do* tend to be distant from the primary aquifers. As expected, baseflow in the Southwest tends to be greater during wetter climate modes there.



We therefore expect that at least some ground-water response to ENSO, PDO, and monsoon in the Southwest is due to the increased recharge that is also reflected in these enhanced baseflows.