Ground-truthing Land Subsidence as part of Optimal Water Management

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Optimal water management in the San Bernardino area of Southern California requires changing ground-water pumpage to achieve water-quantity and water-quality objectives. Achieving an optimal quantity and distribution of pumpage, as determined by a simulation/optimization model, requires preventing a reoccurrence of land subsidence that was caused historically by pumpage. The model included the maximum simulated drawdown, which occurred about 1965, as a constraint to prevent additional land subsidence. Because measured land-surface altitudes were evaluated only through 1970, the validity of using simulated maximum drawdown as a surrogate for the present preconsolidation head remained questionable. To answer this question and to ensure greater confidence in results of the model, land-surface altitudes were evaluated throughout the San Bernardino area for the period 1904-1998. This paper explains (1) the multiple-step process of analyzing a large amount of sometimes conflicting land-surface data to determine the extent of land subsidence and (2) how this ground-truthing can be incorporated in an optimal water-management plan. Published data on land subsidence in the study area were used with data for 72 survey lines from the National Oceanic and Atmospheric Administration. The process of adjusting all survey lines to each other included comparing the change in altitude to change in other physical features such as nearby ground-water levels. A geographic information system also was used to show the spatial relations between changes in land-surface altitude and the proximity to mountains, type and age of unconsolidated sediment, faults, and areas of greater ground-water pumping. Results of the ground-truthing demonstrate the inelastic and elastic behavior of the unconsolidated deposits and confirm that the maximum change in land-surface altitude in most parts of the San Bernardino area coincided with the maximum measured and simulated drawdown. Where this is not true, additional monitoring is needed, such as analysis of satellite INSAR (interferometric synthetic aperture radar) data and installation of extensometers.

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