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Manuscript title: Metrics for Assessing the Quality of Groundwater Used for Public Supply, CA, USA: Equivalent-Population and Area

Supporting Information

14 pages

8 figures

5 tables

EXPLANATION FOR TABLES

The Tables are presented in 5 spreadsheets. Four of the spreadsheets (Tables S1, S2, S4, and S5) include multiple tabs. This document describes the organization of the tables, and presents the Table headers and footers.

Table S1 provides references, published by the United States Geological Survey (USGS), for the 87 study areas of the Priority Basin Project of the Groundwater Ambient Monitoring and Assessment Program (GAMA-PBP). There are three types of USGS publications: Data Series Reports (DSR), Scientific Investigations Reports (SIR), and Fact Sheets (FS). The first tab of the spreadsheet (Table S1a_StudyAreaInformation) lists the study areas and identification codes for the associated USGS reports. Tabs 2, 3, and 4 (S1b_DataSeries, S1c_ScientificInvestigation), and S1d_FactSheets) provide references for the USGS DSR, SIR, and FS documents. The table headers are included in the first row of the four tabs.

Table S1. USGS publications for the 87 study areas: (A) List of the 87 study-areas grouped by province, and references for the corresponding USGS (B) Data Series report, (C) Scientific Investigations Report, and (D) Fact Sheet.

Table S2 presents information and water-quality data for individual wells. There are twelve tabs. The first tab (S2_TableHeaders) presents headers and footers for tabs two to twelve. The second tab (S2a_Well_Information) presents information for each well (Table S2a): identification code (USGS-GAMA or CDPH PS_CODE), latitude and longitude (generalized to protect privacy of well owners), and location in study-area and study-area grid cell. GAMA

codes are alphanumeric and CDPH codes are numeric. Primary and secondary identification codes are provided for wells that were sampled by GAMA, but not analyzed for the entire suite of constituents; for those wells, additional data were obtained, where available, from the CDPH database. The next ten tabs (variously labeled) provide water quality data in terms of relative concentrations. Relative concentration is defined as the measured concentration of the constituent divided by the concentration of the health-based benchmark for that constituent (Table S3). The third tab (S2b_MRC_Classes) presents the maximum relative-concentration (MRC) for the following classes or sub-classes: any-constituent, trace elements, nitrate, organic compounds, solvents, fumigants, and gasoline-related constituents. The MRC for a constituent class or sub-class is the maximum relative-concentration for any constituent in that class or sub-class. The fourth through twelfth tabs provide relative concentrations for individual constituents, organized by class or sub-class: trace elements (22 constituents) (S2c_TraceElements), nitrate (S2d_Nitrate), solvents (25 constituents) (S2e1_Solvents), fumigants (7 constituents) (S2e2_ Fumigants), gasoline-related constituents (9 constituents) (S2e3_Gas), fungicides (5 constituents) (S2e4_Fungicides), herbicides (60 constituents) (S2e5_Herbicides), insecticides (36 constituents) (S2e6_Insecticides), and miscellaneous volatile organic compounds (15 constituents) (S2e7_MiscVOCs). Values of “-6666” are non-detects, and values of “-9999” indicate no data for that constituent. The USGS parameter code (P_code) is prepended to the constituent names. Table S3 provides a link between PCODE and chemical name, as well as STORET number.

Table S2. Information and results for individual wells: (A) Well information including identification code and location (generalized to protect privacy of well owners). (B) Results for

each well listing the maximum relative-concentrations (MRC) for constituent classes and sub-classes, Results for each well listing relative-concentrations for (C) trace elements, (D) nitrate, (E1) solvents, (E2) fumigants, (E3) gasoline-related constituents, (E4) fungicides, (E5) herbicides, (E6) insecticides, and (E7) miscellaneous volatile organic compounds (VOCs).

Table S3 presents information about the various water-quality constituents: the class or sub-class to which it was assigned, identification code (USGS PCODE and California Department of Public Health [CDPH] STORET number), and the associated human health benchmark (HHB). The table header is provided in the first row. For constituents having maximum contaminant levels (MCL), the MCL was used as the HHB for this study. MCLs are legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of contaminants in drinking water. MCLs established by the U.S. Environmental Protection Agency (USEPA) are the minimum standards with which states are required to comply, and individual states may choose to set more stringent standards. The state of California has established MCLs for additional constituents not regulated by the USEPA, as well as lowered the benchmark concentrations for a number of constituents with MCLs established by the USEPA. In this report, a benchmark set by the USEPA and adopted by the state is labeled "MCL-US," and one set by the state that is more stringent than the MCL-US is labeled "MCL-CA" [(24) (25)]. For constituents without an MCL-US or MCL-CA, non-regulatory health-based screening levels (HBSLs) are used as the HHB. HBSLs are established by the USGS using USEPA methodology for risk assessment [(26) (27)].

Table S3. Human-health benchmarks for individual constituents. Constituents are grouped by class and sub-class.

Table S4 presents summary information at the scale of study-areas. There are sixteen tabs. The first tab (S4_TableHeaders) presents headers for tabs two to sixteen. The second tab (S4a_StudyArea Information) describes each study-area: the hydrogeologic province within which it is located, the size (square kilometers), number of cells, and equivalent-population. Fifteen additional tabs provide summary information for groundwater quality. The tabs are organized by constituent and constituent class. For each constituent or constituent class, the summary lists for each study-area the number of cells (populated cells) and the number of wells (n_wells) with data for the constituent, the number of wells with high concentrations of the constituent (high_wells), the detection frequency of wells with high concentrations (rawfreq), and the areal-proportion of high concentrations. The second tab (S4b_Any) is a summary for the occurrence of any constituent at high concentrations (proportion_high). The third tab (S4c_Trace elements) is for trace elements, and the next five tabs are for selected trace elements: S4c1_Arsenic, S4c2_Manganese, S4c_Uranium, S4c4_Molybdenum, and S4c5_Fluoride. The tenth tab is for nitrate (S4d_nitrate). The eleventh through sixteenth tabs are for organic compounds: organic compounds as a class (S4e_Organics), solvents as a subclass (S4e1_Solvents), trichloroethene (S4e1a_TCE), tetrachloroethene (Table S4e1b_PCE), fumigants as a subclass (S4e2_Fumigant), and gasoline-related constituents as a sub-class (oxygenates and hydrocarbons) (S4e4_Gas).

Table S4. Information and results for study-areas. (A) Study-area information including assessed area, number of grid cells, and population relying upon groundwater [12]. Study-area results for: (B) Any constituent, (C) trace elements, (C1) arsenic, (C2) manganese, (C3) uranium, (C4) molybdenum, (C4) fluoride, (D) nitrate, (E) organic compounds, (E1) solvents, (E1a) trichloroethene (TCE), (E1b) tetrachloroethene (PCE), (E2) fumigants, and (E3) gasoline-related constituents .

Table S5 presents summary information for groundwater quality at the statewide scale and the scale of hydrogeologic provinces. There are three tabs: the first is for the proportion of the assessed area with high concentrations (S5a_Area), the second is for the proportion of the equivalent-population relying on groundwater with high concentrations (S5b_Population), and the third is for the proportion of the wells with high concentrations (S5c_Wells). Proportion is expressed as a percentage.

Table S5. Groundwater quality at the statewide scale and the scale of hydrogeologic provinces: (A) Proportion of assessed area with high concentrations; (B) Proportion of equivalent-population relying on groundwater with high concentrations; (C) Proportion of wells with high concentrations.

HYDROGEOLOGIC PROVINCES AND STUDY AREA GRIDS

Study-areas were the fundamental organizational unit for the GAMA-PBP. Each study-area was represented by a grid of equal-area cells. Figures S1 to S8 present study-area grids organized by

hydrogeologic province (from north to south and west to east): Klamath – Cascade Range & Modoc Plateau (Figure S1), Northern Coast Ranges (Figure S2), Southern Coast Ranges (Figure S3), Sacramento Valley (Figure S4), San Joaquin Valley (Figure S4), Sierra Nevada (Figure S5), Transverse and Selected Peninsular Ranges (Figure S6), San Diego Drainages (Figure S7), and Desert – Basin & Range (Figure S8)

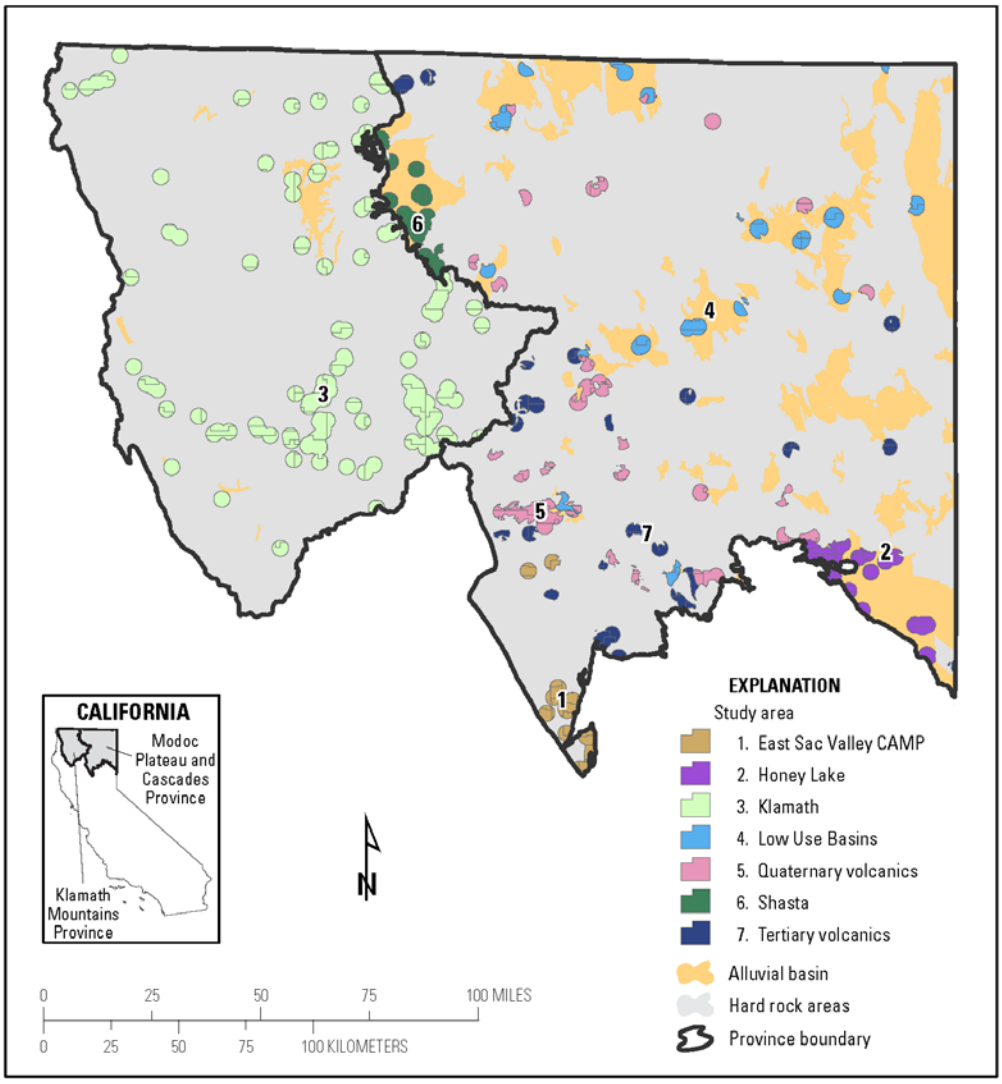

Figure S1. Map showing study-area grids for the Klamath Mountains, Cascades Range, and Modoc Plateau (KCM).

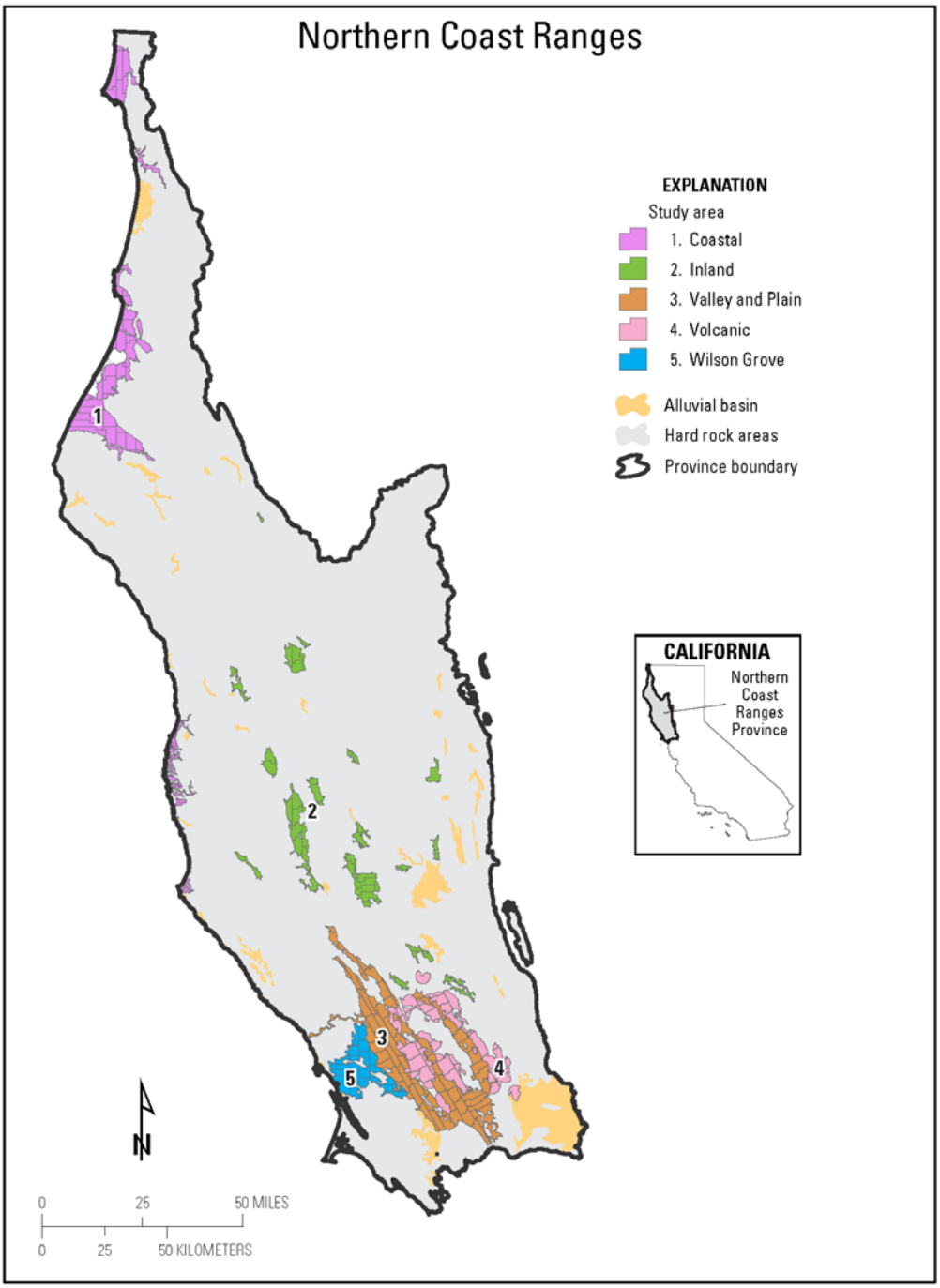

Figure S2. Map showing study-area grids for Northern Coast Ranges (NCR).

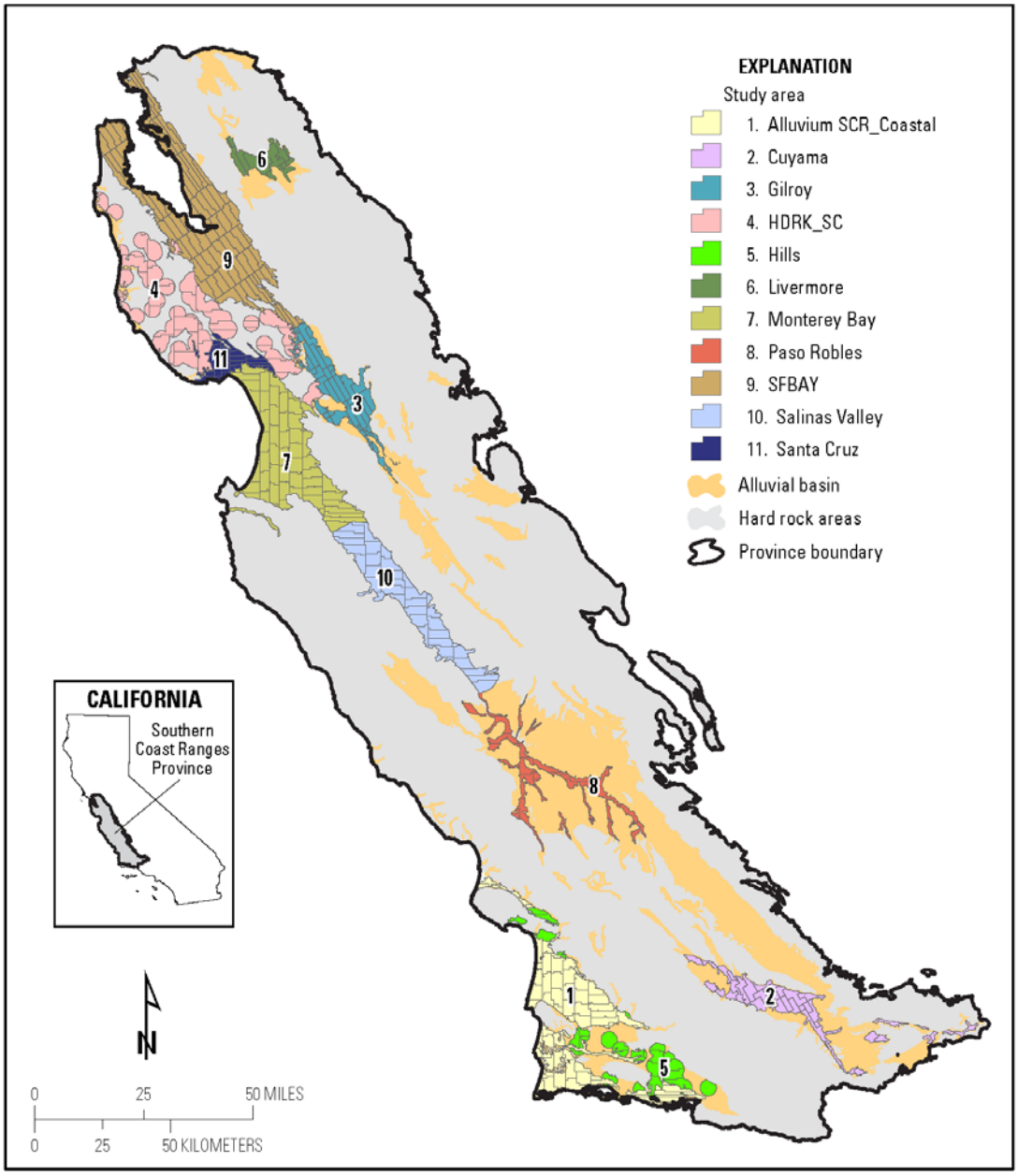

Figure S3. Map showing study-area grids for Southern Coast Ranges (SCR).

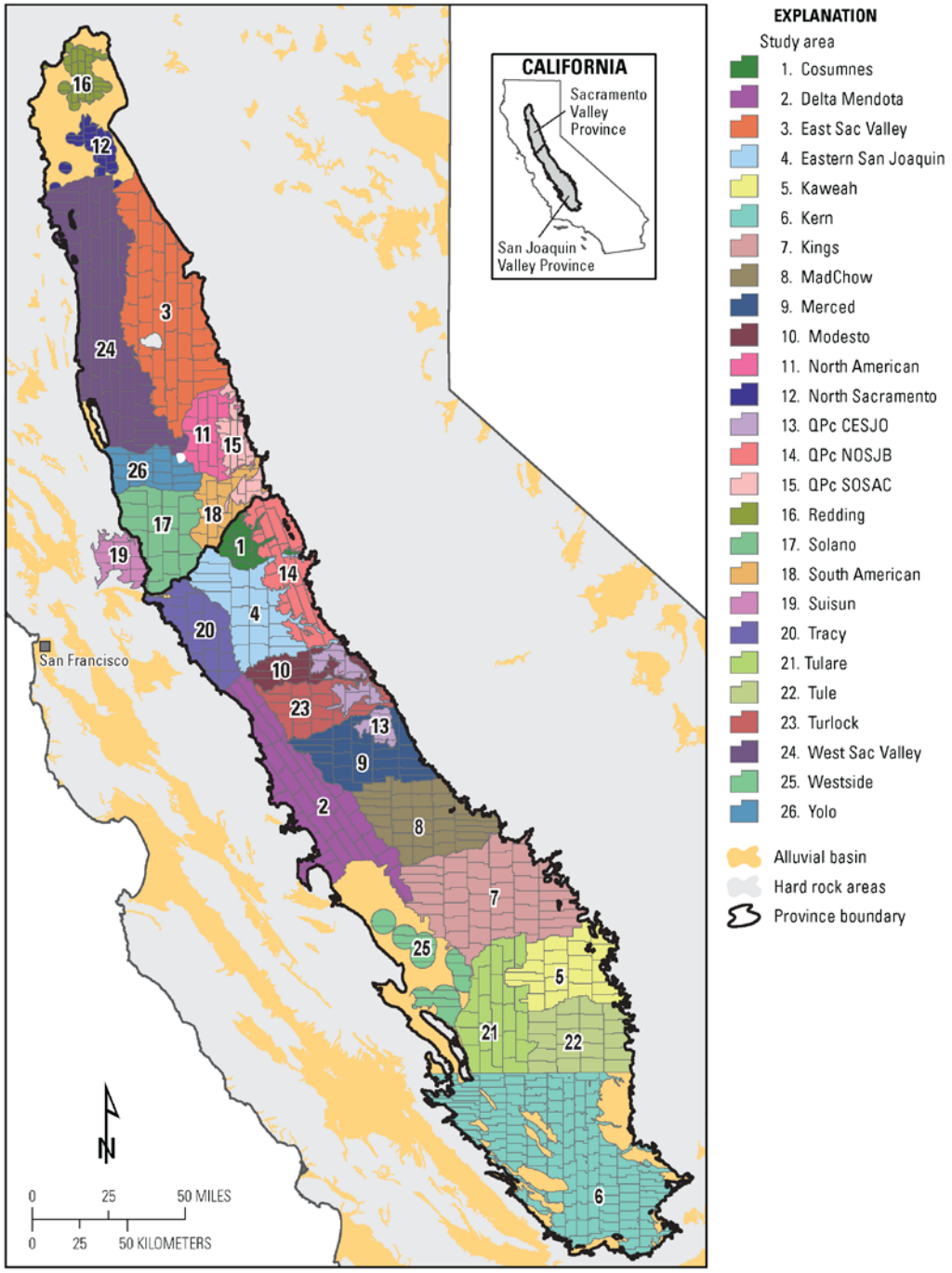

Figure S4. Map showing study-area grids for the Sacramento (SAC) and San Joaquin (SJV) Valleys.

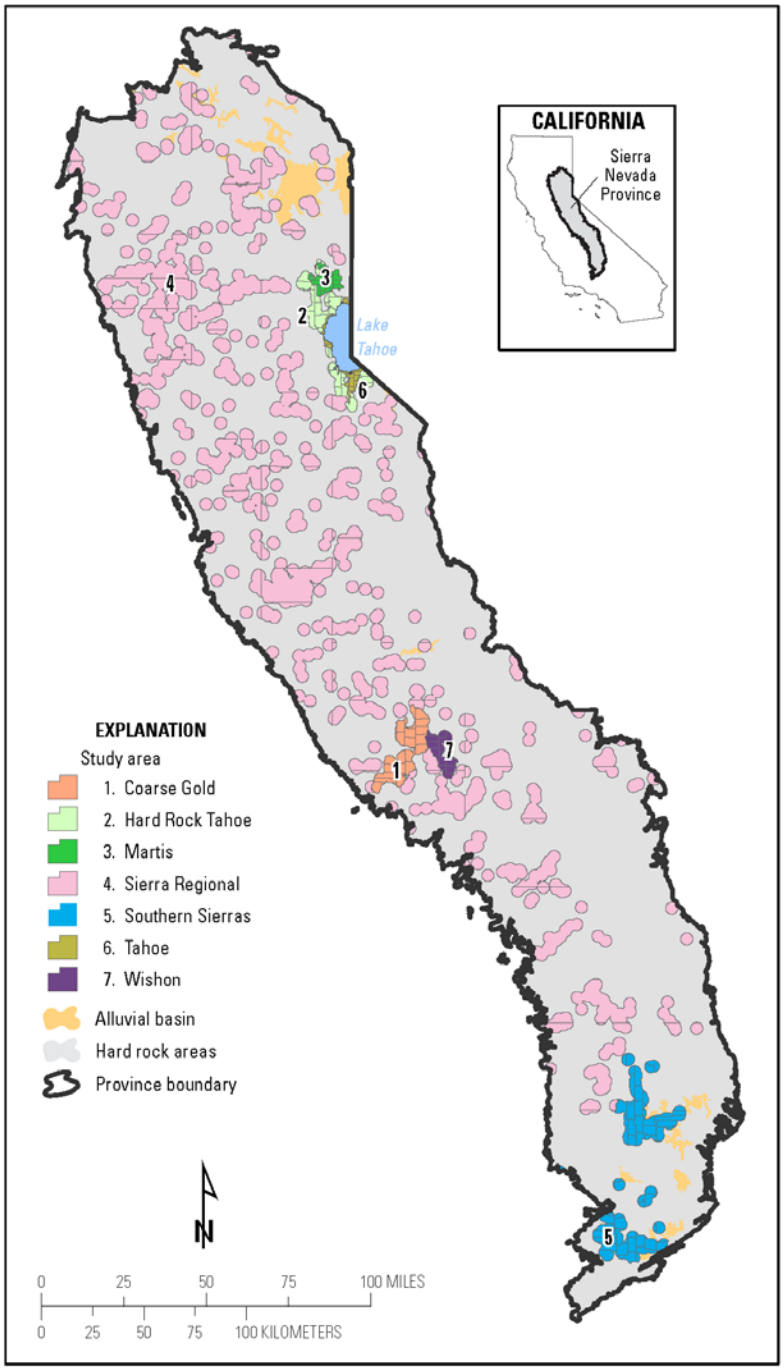

Figure S5. Map showing study-area grids for the Sierra Nevada (SNR).

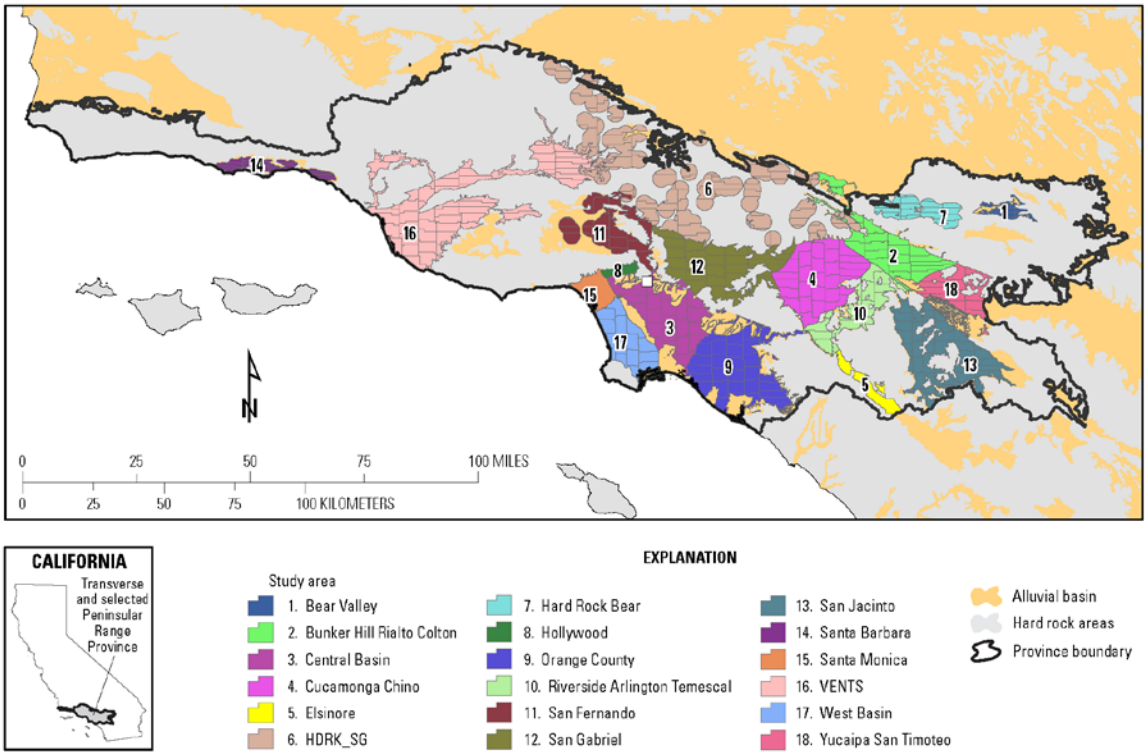

Figure S6. Map showing study-area grids for Transverse and Selected Peninsular Ranges (TSPR). Six study areas (2, 3, 4, 10, 11, 12) account for a large number of equivalent-people relying on groundwater with high concentrations of organic compounds.

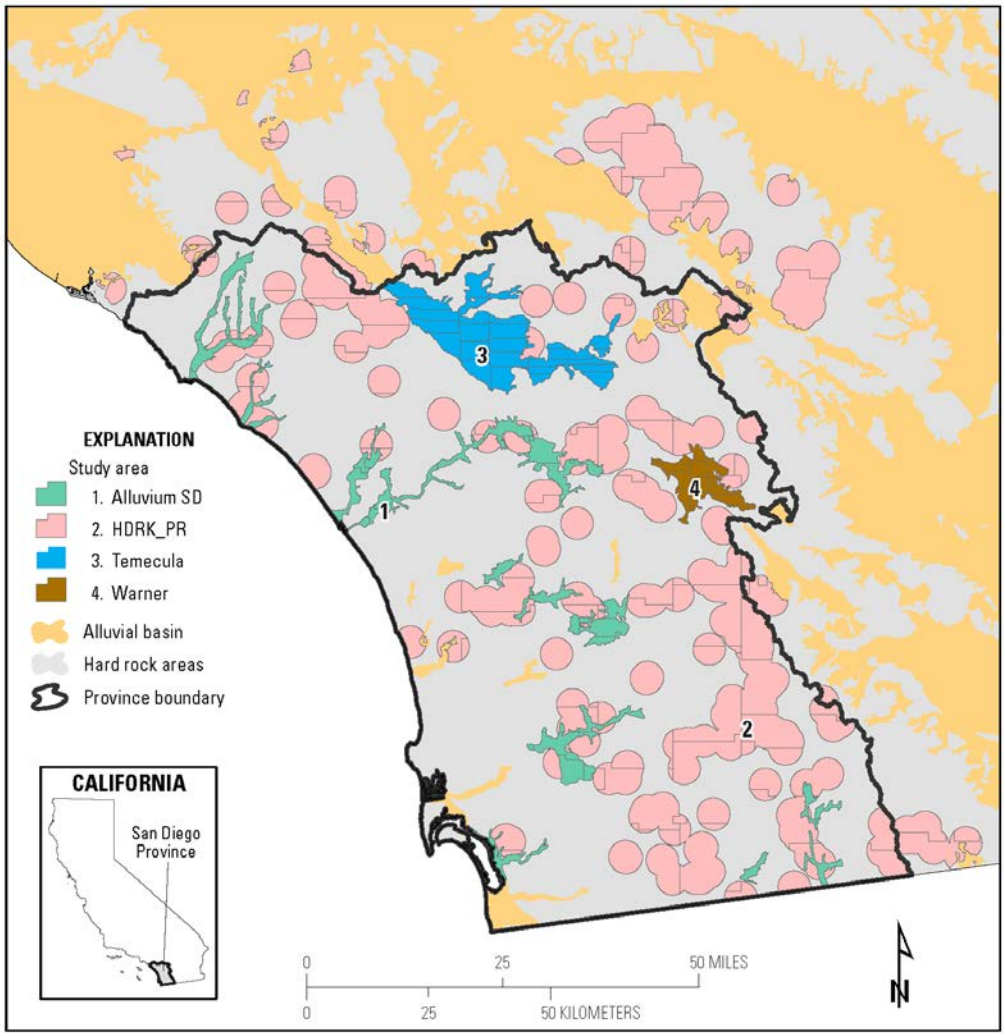

Figure S7. Map showing study-area grids for San Diego Drainages (SAN).

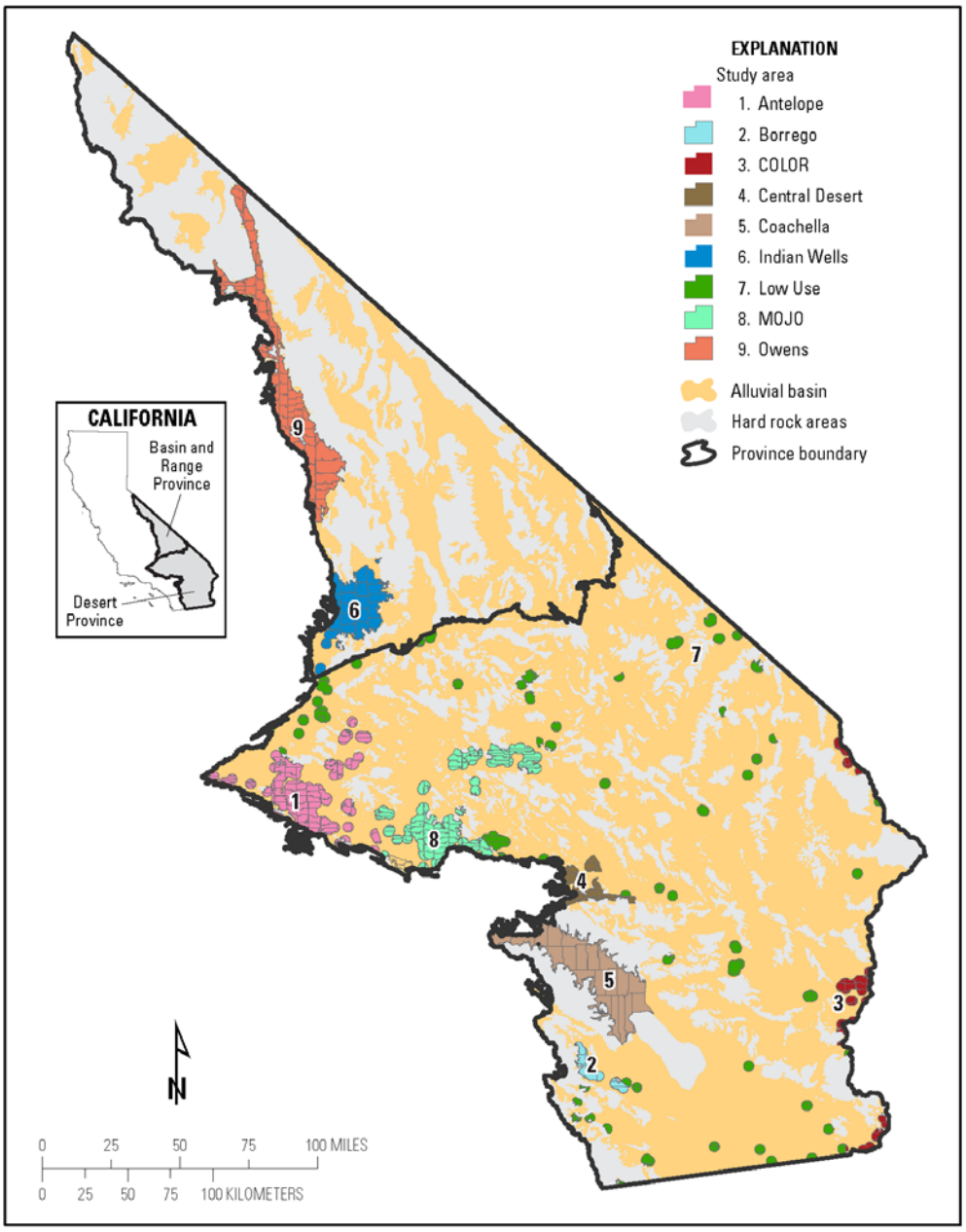

Figure S8. Map showing study-area grids for the Desert – Basin & Range (DBR).