LIQUID ASSETS IN A DRY LAND:
WATER USE IN THE SAN JOAQUIN VALLEY, CALIFORNIA

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BACKGROUND:

California's rapid rate of population growth and urban expansion has been a looming environmental issue for decades. The object of this project is to investigate patterns of water use for the years between 1985 and 2000, using data from the USGS National Atlas and the US Census. The region selected for this study is the San Joaquin Valley, which has undergone rapid change in land use patterns as the population has increased.

In an historically agricultural region which lacks sufficient year-round rainfall to support crop growth, irrigation has been an essential part of the agricultural system (Figure 1b). Californians have constructed dams on most major rivers, drilled wells to tap into the underground water supply, and built a system of aqueducts to move water from places where it *is* to places where it is not. In this century, climate change associated with global warming is a cause for increasing concern. The annual snowpack in the Sierra Nevada Mountains, upon which all human activity in the region depends, is expected to diminish with increasing temperatures, and California's Mediterranean climate produces little rainfall in the summer months. Thus all water must be obtained from either surface runoff during the spring, or withdrawn from groundwater aquifers.

Environmental consequences related to the pressures of human activity and California's water resources are outlined in Figure 2. All of these are already in play, raising questions as to the limits of population growth as well as to the long-term health of the agricultural economy in the state. Clearly, the scope of the problem is complex—all facets are inextricably linked; however, water is the key and the essential ingredient if California is to enjoy a sustainable future.

Figure 1a (left). Index map of California, showing location of counties in the San Joaquin Valley.

Figure 1b (below). Irrigation is the dominant category of water use in the San Joaquin Valley.

FIGURE 2. FRAMING THE PROBLEM:

CALIFORNIA'S WATER RESOURCES—
SURFACE WATER, GROUNDWATER,
"IMPORTED WATER"

CLIMATE FACTORS—
RISING GLOBAL TEMPERATURES WILL AFFECT
AMOUNT OF PRECIPITATION,
WINTER SNOWPACK AND SPRING RUNOFF

HUMAN ACTIVITIES RELATED TO WATER USE IN A SEMI-ARID CLIMATE—
DAMMING OF RIVERS,
WITHDRAWAL OF GROUNDWATER,

ENVIRONMENTAL CONSEQUENCES—
URBANIZATION => LOSS OF FARMLAND
INCREASING POPULATION => WATER RESTRICTIONS
WITHDRAWAL OF GROUNDWATER => VALLEY FLOOR SUBSIDENCE
IRRIGATION => SOIL DEGRADATION DUE TO SALINIZATION
GLOBAL WARMING => DECREASE IN WINTER SNOWPACK

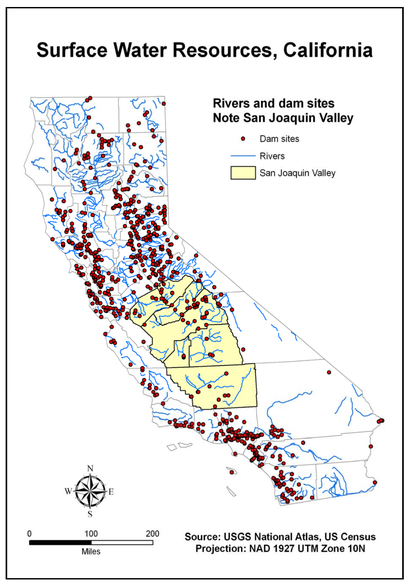

Figure 3. Annual spring runoff from the snow pack in the Sierra Nevada Mountains (east of the Valley) provides a large part of the fresh water supply for the region. In drought years, runoff is low, and the extensive system of dams helps retain what water is available.

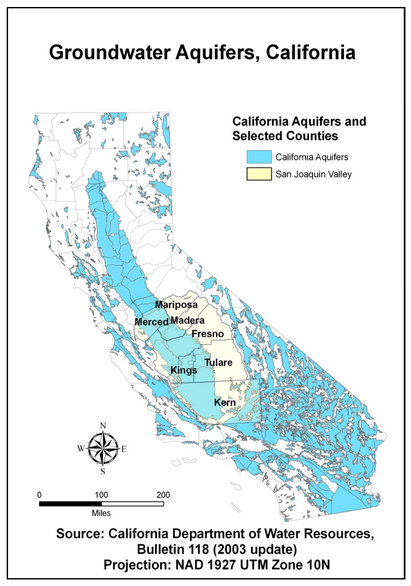

Figure 4. The Central Valley Aquifer is about 400 miles long and 20 to 70 miles wide. The aquifer is contained in marine and alluvial sediments derived from the Sierra Nevada. It is this aquifer that enables California to be one of the most important agricultural areas in the world.

METHODS:

Census data were downloaded from the US Census 2000 website. Water use and water resources data were downloaded from the USGS National Atlas for the years 1985, 1990, 1995 and 2000. Water use values are reported in millions of gallons per day (MGal/Day). All attribute tables were selected by location for the counties of interest in the San Joaquin Valley—Fresno, Kern, Kings, Madera, Mariposa, Merced and Tulare. Water use data were linked to the census data by a series of spatial joins, producing an attribute table containing all census information as well as water use data for each of the four years under investigation. Queries and calculations on the combined water resource/census data were performed in order to generate results shown in Figures 5 and 6.

RESULTS:

Water use data joined to census data provide an opportunity for analysis of water use trends in the San Joaquin Valley. Although water use data are available for all four years included in this study, the data sets contain some "mutually exclusive" categories. Data for public supply, surface water and groundwater are available for all four years (Figure 6).

Figure 5a shows the population growth for each county in the San Joaquin Valley. Figure 5b shows *per capita* water use for the years for which population data are available. In Figure 5c, the use of fresh water for public supply can be tracked for all four years. These data were derived from a query in which the water used for public supply was calculated as a percentage of total water used. This approach was used to generate the results shown in Figures 6a-c as well.

DISCUSSION:

The challenges facing California with regard to its water supply are enormously complex. Water used for irrigation accounts for the greatest percentage of California's consumption. Still, most counties in the San Joaquin Valley used less water for irrigation in 1990 than in 1985, which may be a reason for guarded optimism (Figure 6a). Without an increase in the amount of imported surface water, by 2010 the San Joaquin Valley will require groundwater withdrawals in excess of recharge (U.S. Geological Survey, Groundwater Atlas). Although improved irrigation techniques can help to lessen the problem, any period of sustained drought will only exacerbate the situation.

Californians will be required to conserve water at previously unimagined levels in the coming years. Although one might hope that the trend for *per capita* water use continues (*i.e.*, decreasing water use despite increasing population; Figures 5a, b), a larger population will, at some point, require an increase in the public water supply. The complex patterns seen in Figure 5c may be related to each county's land use: farmland vs. urban, with grasslands (= ranchlands, for the most part) or undisturbed natural vegetation are also part of the picture.

Detailed investigations of water use categories in addition to those considered here would enhance the understanding of the many demands on the water resources of the San Joaquin Valley and elsewhere. Continued careful monitoring of water use in all categories will be essential for appropriate allocation of water to competing interests. California's future rests in the wise use and management of its "liquid assets".

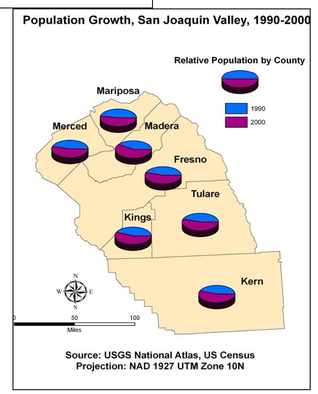

Figure 5a. Census data for the counties in the San Joaquin Valley. One consequence of this growth is the urbanization of what was once farmland.

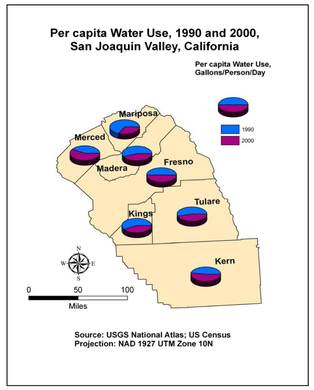

Figure 5b. Trends in per capita water use vary between counties in the San Joaquin Valley. Despite overall population growth, it would appear that people in some counties are conserving water better than in others.

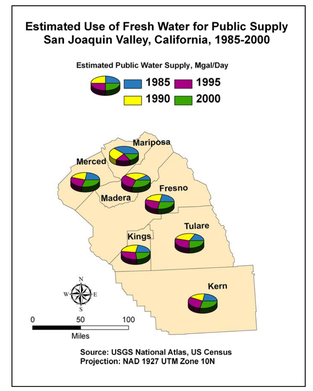

Figure 5c. Values would be affected not only by human population, but also by trends in other types of water use (e.g. irrigation, industrial, etc.).

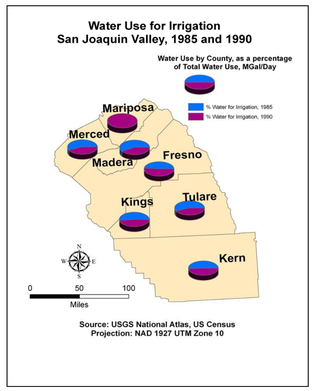

Figure 6a. California uses the vast majority of its water for irrigation. In all counties, the amount of water used for irrigation decreased between 1985 and 1990.

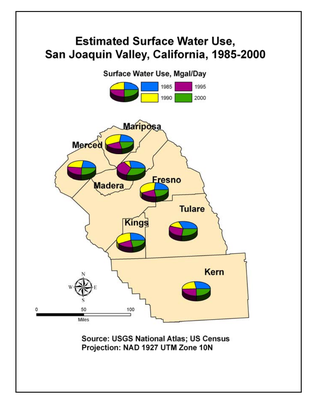

Figure 6b. Surface water use will depend on the amount of precipitation received in any given year. California receives most of its rain in the winter months.

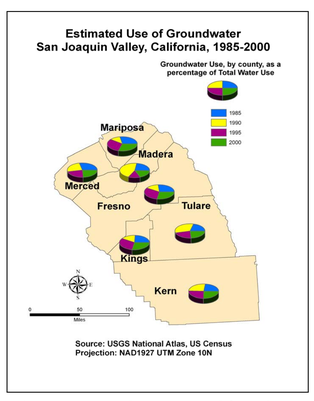

Figure 6c. Groundwater pumped from the Central Valley aquifer over the last century has caused subsidence of the valley floor.